Universitetet i Stavanger

FACULTY OF SCIENCE AND TECHNOLOGY

MASTER'S THESIS

Study program/specialization: Master in Offshore Technology – Subsea Control Systems	Spring semester, 2008 Open / ~~Confidential~~
Author: Sten Magne Eng Jakobsen	……………………………………… (signature author)
Instructor: Arnfinn Nergaard (UIS) Supervisor: Erlend Hovland (Acergy Norway AS)	
Title of Master's Thesis: Passive Heave Compensation of Heavy Modules Norwegian title: Passiv hivkompensering av tunge moduler	
ECTS: 30	
Subject headings: Passive Heave Compensation	Pages: 108 + attachments/other: 43 Stavanger, 16-6/2008 Date/year

Preface

This report contains my work done by with my master thesis during spring 2008. The thesis is mandatory at University of Stavanger in fulfilling master degree in offshore technology.
Aim is to acknowledge the expertise the student have after its education.
The thesis contains issues related to the subsea engineering industry, where the focus is on vessel response and performance of a passive heave compensation system.

Thesis is performed in cooperation with subsea engineering company Acergy, where naval discipline leader Erlend Hovland has been teaching supervisor.
The thesis takes a broad look at heavy module installation and tries to look at this aspect in a new way, with implementing already known compensation technology from drilling industry to the subsea industry.
The student has to use advanced marine engineering software in aim of finding the results that are needed. In evaluating the concept software's like MOSES and MathCAD are used.

Many people have been involved in the thesis where the two supervisors have to be mentioned specially:

- Arnfinn Nergaard, Professor University of Stavanger
- Erlend Hovland, Naval Discipline Manager Acergy Norway AS

In addition several colleagues at Acergy have come with important contributions and the whole naval discipline should have a special thanks.

Stavanger, 16th June 2008 Sten Magne Eng Jakobsen

Abstract

New subsea technology has increased size and weight of installed modules significantly. This thesis looks at heavy module installation from barge, through moonpool with use of passive heave compensation.

An installation barge is designed with moonpool used as working platform for installation. Motion responses for barge are analyzed with use of marine engineering software MOSES. Responses found shows a significantly impact from moonpool, and it doubtingly if software is capable of calculate actual barge. Motion response found is used in operational analysis of compensator.

Mathematical models of first and second order are established to evaluate chosen passive compensator. Models calculate residual motion of module under a given harmonic force with respect to frequency ω.
Two first order models are established with use of different theories, transfer function and motion of equation. System is simplified and evaluated model results correspond well. Transfer function model is evaluated for varying variables. Results show that resonance frequency has a large impact on compensator performance. Resonance frequency is determined by compensator stiffness and module mass, following compensator stiffness are important for compensator performance.
One second order model is evaluated and includes some of the simplifications made for first order system. The second model gives a more accurate view of the physical situation.
Calculations show that all three models correlate well, where largest difference between models is in resonance area. The passive compensator works best for high ω, in contrast to compared semi-active compensator.
Calculations shows that model for motion of equation are most conservative, while the second order models gives largest changes for changing water depth.
Results are based on theoretical evaluations and model test should be performed to conclude if models represents physical situation.

Designed system should fulfil installation criteria's for modules given by a max velocity for landing. Evaluated barge has largest velocities for lowest values of ω. Without compensation the barge Hs for installation is below 1m Hs, and defined as low. Compensator with evaluated inputs is not able to reduce the highest velocities, and does not increase the weather window significantly.
Compensator does not increase weather window for operation, and inputs should be analysed. System should be designed to meet barges motion response.

1. Introduction 1
1.1 Marine Operations 1
1.2 Heavy Lift Operations 3
1.2.1 Monohull Vessels 4
1.2.2 Semi Submersible Crane Vessels 5
1.2.3 Barges 6
1.2.4 Wet Tow 7
2. Objective of work 8
3. Selection of barge concept 9
3.1 Design basis 9
3.2 Design considerations 10
3.2.1 Stability 10
3.2.2 Moonpool 13
3.2.3 Module handling 16
3.3 Barge Design 20
4. Calculate motion response of The barge 22
4.1.1 MOSES-analysis results 26
5. Discuss and select a passive compensator concept 35
5.1 Heave compensation 35
5.1.1 Passive heave compensation 38
5.1.2 Active Heave Compensation 40
5.1.3 Semi-active compensation system 41
5.2 Chosen concept 44
6. Mathematical models 49
6.1 1. Order mathematical models 49
6.1.1 Transfer function model 51
6.1.2 Harmonic motion model 52
6.2 2. Order mathematical model 55
6.3 Defining Variables 59
7. Comparison and evaluation of mathematical models 67
7.1 1. Order System – Transfer Function 67
7.2 1. Order System – Harmonic Motion Model 75
7.3 2. Order Model 77
7.4 Comparison of models 89
7.5 Tension relation during compensation 93
8. Operational Study 95
8.1 Wave energy spectrum 95
8.2 Kristin Field 97
8.3 Girassol field 100
9. Conlusions 103
9.1 Barge design 103
9.2 Passive heave compensator system 104
9.3 Operational 106
10. References 107
10.1 Additional references in appendixes 108

Appendix:
Appendix A: 1. Order Mathematical Models
Appendix B: 2. Order Mathematical Model
Appendix C: Moonpool Calculations
Appendix D: Moonpool Barge RAO's and Motion Characteristics

Figure list:

Chapter 1:
[1] Figure 1.1: Marine operations represented with Acergy Piper [1]
[2] Figure 1.2: Skandi Acergy [1]
[3] Figure 1.3: Sapura 3000 [1]
[4] Figure 1.4: Heerema Marine Contractor Thialf [4]
[5] Figure 1.5: Wet tow system – Subsea 7 [5]

Chapter 3:
[6] Figure 3.1: Transversal stability
[7] Figure 3.2: Moonpool RAO for different designs [10]
[8] Figure 3.3: Damping in circular moonpool [18]
[9] Figure 3.4: Skidding ways in yard [1]
[10] Figure 3.5: MHS on Normand Flower – operated by Deep Ocean [9]
[11] Figure 3.6: Installation of Tordis SSBI with use of Saipem 7000 [1]
[12] Figure 3.7: 3D model of barge

Chapter 4:
[13] Figure 4.1: Simple block model of barge
[14] Figure 4.2: Frame function explanation, MOSES model of far Saga [1]
[15] Figure 4.3: MOSES model – barge with mesh 1134 panels
[16] Figure 4.4: Wave heading relative to vessel
[17] Figure 4.5: Calculated points
[18] Figure 4.6: Heave RAO for COG, 3 different headings
[19] Figure 4.7: Heave RAO for barge with and without moonpool
[20] Figure 4.8: Heave RAO for both lifting points
[21] Figure 4.9: RAO comparison at 0 degree
[22] Figure 4.10: RAO comparison at 90 degree

Chapter 5:
[23] Figure 5.1: Wash out during installation [15]
[24] Figure 5.2: Passive heave compensator
[25] Figure 5.3: Passive heave compensator - GPV
[26] Figure 5.4: Active heave compensator - cylinder
[27] Figure 5.5: Semi-active compensation system
[28] Figure 5.6: Semi-active winch compensation system [7]
[29] Figure 5.7: Acergy Eagle compensation system – semi active [1]
[30] Figure 5.8: Semi-active cylinder compensation – Hydralift model [17]
[31] Figure 5.9: Landing phase
[32] Figure 5.10: Chosen concept mounted on barge
[33] Figure 5.11: Chosen compensator concept
[34] Figure 5.12: Force in cylinder
[35] Figure 5.13: Velocities in system

Chapter 6:
[36] Figure 6.1: First order system
[37] Figure 6.2: New compensator variables
[38] Figure 6.3: Free body diagram
[39] Figure 6.4: Second order system
[40] Figure 6.5: Free body diagram – second order model
[41] Figure 6.6: Cranemaster© load curve

Chapter 7:
[42] Figure 7.1: Response transfer function
[43] Figure 7.2: Response with varying depth
[44] Figure 7.3: Varying compensator stiffness
[45] Figure 7.4: Varying compensator damping
[46] Figure 7.5: Varying drag damping
[47] Figure 7.6: Increased drag
[48] Figure 7.7: Varying module mass
[49] Figure 7.8: Response harmonic motion model
[50] Figure 7.9: Varying compensator stiffness
[51] Figure 7.10: Response 2. order system
[52] Figure 7.11: System under harmonic motion
[53] Figure 7.12: System under harmonic motion – increased damping
[54] Figure 7.13: Numerical evaluation
[55] Figure 7.14: Numerical analysis to Fourier analysis
[56] Figure 7.15: Fourier analysis output
[57] Figure 7.16: Varying compensator stiffness
[58] Figure 7.17: Varying compensator damping
[59] Figure 7.18: Varying drag damping
[60] Figure 7.19: Varying module mass
[61] Figure 7.20: Varying compensator mass
[62] Figure 7.21: Varying water depth
[63] Figure 7.22: Comparison of models
[64] Figure 7.23: Compensator stiffness times 3
[65] Figure 7.24: 70 % lower compensator stiffness
[66] Figure 7.25: Performance of active heave compensator [18]
[67] Figure 7.26: Tension relation of compensator and lift wire [22]
[68] Figure 7.27: Displacement – tension relation of compensator [22]
[69] Figure 7.28: Tension during compensation

Chapter 8:
[70] Figure 8.1: JONSWAP spectra for North Sea and West Africa, 2m Hs
[71] Figure 8.2: Motion velocities Kristin field
[72] Figure 8.3: Kristin field – with compensator
[73] Figure 8.4: West Africa – Girassol field
[74] Figure 8.5: Girassol field – with compensator
[75] Figure 8.6: Girassol field – Operational compensator
[76] Figure 8.7: Hs probability, Girassol and Kristin field

Table list:

Chapter 3:
[1] Table 3.1: Design parameters
[2] Table 3.2: Comparison of barge size

Chapter 4:
[3] Table 4.1: MOSES data
[4] Table 4.2: Wave lengths for different periods
[5] Table 4.3: Main specifications for compared vessels
[6] Table 4.4: JONSWAP analysis for North Sea waters
[7] Table 4.5: JONSWAP analysis for West African waters

Chapter 6:
[8] Table 6.1: Flexpack 21 specification [23]

Chapter 8:
[9] Table 8.1: JONSWAP spectra input

Abreviations

CFD	Computational Fluid Analysis
COG	Centre of Gravity
DAF	Dynamical Amplification Factor
DP	Dynamic Positioning
GPV	Gas Pressure Vessels
GRP	Glass Reinforced Plastic
Hs	Average height of the one-third largest waves
IMR	Inspection, Maintenance and Repair
JONSWAP	Wave Spectrum
MHS	Module Handling System
MOSES	Marine Analysis Software
MRU	Motion Response Unit
NCS	Norwegian Continental Shelf
OCV	Offshore Construction Vessel
RAO	Response Amplitude Operator
ROV	Remotely Operated Vehicle
SEMI	Semi Submersible
SSCV	Semi Submersible Crane Vessel
SWL	Safety Weight Load
Tordis SSBI	Tordis Subsea Boost and Injection

1. INTRODUCTION

1.1 MARINE OPERATIONS

Marine operations play a vital in offshore oil and gas field developments where the need for advanced solutions in deep water constantly increases.

Demand for energy has grown rapidly the last 40 years, and a big part of the energy today is today produced from non-renewable sources like oil and gas. This has forced through an enormous development in the industry with increased resources on research and development.
The early fields like Ekofisk where developed in shallow waters with topside structures. We now see large new gas fields like Ormen Lange that are developed with a subsea to shore tieback solution.
In a technical aspect we are now able to develop smaller and more advanced fields, with respect to both drilling and subsea technology.
Due to the high transformation of the requirements and expectations, the business demand for marine operations has increased.

Due to high development in the business demands for marine operations has increased.

- Heavy structures to be installed
- Advanced pipe design with heating and “pipe in pipe”
- Larger depths
- Remote locations
- New equipment e.g. subsea processing and pressure boosting

The growth in the market has driven the day rates to all time high, and new ships are constantly entering the market. The market is dominated by a few operators as Technip, Acergy, Allseas, Subsea 7 and Saipem, but smaller contractors are also entering the market. Deep Ocean is a Norwegian example of a company that recently has expanded, partly due to contracts with StatoilHydro.

Typical marine operations on an offshore field development can be:

- Seismic survey
- Pipe lay
- Module installation
- Inspection, maintenance and repair
- Survey

All operations are performed with highly specialized vessels outfitted with advanced equipment and personnel for these tasks.

Figure 1.1: Picture shows Acergy Piper during pipe lay close to Sleipner field centre. Several marine operations are in action; pipe lay, anchor handling, extra pushing tugs, pipe supply vessel (outside picture) and a survey vessel to monitor touchdown (outside picture). [1]

From an economical point of view, marine operations have been topic to changes both in negative and positive way. The price on materials and personnel has increased rapidly and has made the projects more costly and more difficult to plan. In the same way the oil price has increased to record levels make the projects more profitable.

The main consideration for an offshore field development is always the net present value (NPV) of the project, and in order to attain a NPG as high as possible the cost has to be kept to a minimum.

The offshore business is based on tendering, where the responsibility are transferred from the developer and on to the contractor. This will in a monopoly market create high prices for the developer, while higher competition in the market will push the price down and the interest will increase.

Offshore operations are highly exposed to competition, which gives an attitude of constantly development of the business.

1.2 HEAVY LIFT OPERATIONS

The first offshore fields where developed in shallow waters with topside structures due to lack of large offshore cranes. The installed modules were small, the offshore completion work was time demanding and costly, but the enormous reservoirs justified the developments.

The search for more cost effective solutions increased the lifting capacities, and semi submersible crane vessels (SSCV's) were developed. With lifting capacities up to 14,200 tons (Heerema Thailf) these vessels changed the way of how to develop offshore fields.
It was now possible to complete whole deck structures at shore, with only a small amount of offshore completion work. This new way of construction reduced considerably the development cost a made development of new technology possible.

As all the discovered large oil and gas fields in shallow waters have already been developed, new technology has been introduced to be able to produce from smaller and more complex fields.
The subsea technology has been developed to be reliable and cost efficient, and offshore field developments are now in a large extent dependent of it.
Developed from simple x-mas trees with small amount of functions and short control distance, we nowadays are able to install subsea to shore fields with distances up to 140 km. The control and monitoring systems allow us to produce a subsea field in the same way as we operate a platform field, although there might be some drawbacks to the reservoir performance. In the same way as the platforms became larger the subsea structures also became larger. As an example Ormen Lange has 8 well slots and a weight of 1150 tons [2].

This thesis will take into account the latest technology developments, and look at a barge for heavy module installation. Up to now such installations have been performed with SSCV's or monohull vessels with large offshore cranes. Such vessels are very expensive to hire and have also very limited availability.
Both types of vessels are thoroughly described in the following subchapters.

1.2.1 Monohull Vessels

Vessels designed to perform offshore construction work can be defined in two ways.

The first group of vessels is typically up to 170m long and can perform installation work up to 400 tons. They have high transit speeds up to 18 knots and are designed to operate in harsh weather environments. Work typically performed is:

- Smaller installation work
- IMR
- Reeling and flexible pipe lay
- Umbilical installation

Due to the flexible design and high transit speed, the vessels are capable of working in remote areas.

The Skandi Acergy, as viewed in figure 1.2 is a new built vessels that is a perfect example of this first group of vessels. With a maximum speed of 18 knots and 350 ton subsea lift crane capacity in addition to the possibility of reeling and flexible pipe lay, the vessels performs a universal working platform for marine operations.

Figure 1.2: Skandi Acergy [1]

The second group of vessels consists of flat bottomed vessels equipped with DP capabilities, and are made for operating in calm environments.

Typical areas for use of these vessels are; West Africa, Asian waters and the Gulf of Mexico.

Due to the size combined with the shape of the hull a vessel like Sapura 3000 (figure 1.3) will perform badly in harsh environments. The strengths of these vessels are high crane capacity, large deck space and pipe lay possibilities. The size of the vessel, the transit speed are important factors to take into consideration when evaluating the different vessels and making the cost decisions.

Figure 1.3: Sapura 3000 [1]

1.2.2 Semi Submersible Crane Vessels

The need for cost reduction in offshore field developments forced through the development of semi submersible crane vessels (SSCV). These vessels are self propelled DP capable semi submersible rigs equipped with heavy lift cranes that can perform lifts up to 14,200 tons. Today there are two main contractors in this business; Heerema and Saipem, and they operate the two largest SSCV's in the world.

SSCV's are essential in the modern structure of offshore field developments. With capabilities of operating all over the world they perform both topside and subsea lifts, and have in the last few years also been involved in decommission work. Based on the design they perform very well during lifting operations, and the large displacement is also an advantage during pipe lay in deep waters with large top tension requirements.

SSCV's where originally designed for lift of modules like jackets and topsides, but following the development in the subsea part of the industry these vessels also perform installation of large subsea modules. In autumn 2007 Saipem 7000 installed the TORDIS IOR template in NCS with a max weight of 1250 tons [3].

In contrast to the specification for this thesis, the SSCV's usually do not have possibilities for heave compensation.

Figure 1.4: Heerema Marine Contractor vessel Thialf [4]

1.2.3 Barges

Barges offer a cheap way for transportation of offshore structures, and have been used since the early years of the industry. They are cheap to build, and with only a small amount of equipment located on board the off-hire rate is low.
Barges are designed in many ways but the common characteristics is the flat bottomed hull, as a box, where the hull is divided into compartments for both structural and ballasting purposes.
As a cargo mover the barge represents large load capabilities to a low cost, but the limitations are high. Barges are designed to lift large loads, and will perform badly in other situations for example while towing.
Looking at the behaviour in waves a barge will perform badly, based on simple calculations of the heave period.

Heave period is a simple mass/water plane ratio that defines the heave resonant period. The lower this period becomes, the worse the barge will perform in waves. Barges consist of small mass, and the water plane area is very large, which gives a low heave period. For instance a SEMI will have a much larger mass, while the water plane area is reduced with use of pontoons and columns. This simple argument is why drilling rigs used in the North Sea are based on SEMI's
The thesis looks at heavy module handling in both the North Sea and in West African waters, two areas with different weather conditions.
In the North Sea a barge will only be usable through the summer months, while it can be used throughout the year in West Africa.

1.2.4 Wet Tow

Module installations offshore are challenging operations both while in air and in the splash zone. Often the module faces the largest forces in its lifetime during installation.
To increase the operational window and reduce risk for cost overrun, new concepts have been developed, where Subsea 7 have patented a method for wet tow of heavy templates. The templates will be transported on a barge to a nearby fjord, deployed in calm environments, and wet stored for later pickup by a construction vessel. By use of relatively small monohull vessels the module can be wet towed to its location, avoiding offshore lifts.
In stead of an offshore crane the concept uses a standard offshore winch for the lift. A lift wire is routed through moonpool and is used for pickup of the template, which are locked into a rigging also mounted in the moonpool. Located on site the winch takes over the lift again, now mounted with an in-line passive heave compensator, and the template are submerged to the seabed.
The system was first used the summer of 2007 on Tyrihans field in northern North-Sea, during installation of 4 x 260 Te templates [5].

The illustration below presents how the lifting arrangement is located above the moonpool of the offshore construction vessel Botnica. The lift wire from the winch is routed over a fairlead and down through the moonpool. To increase the lifting capacity of the winch the wire are routed through a subsea sheave and is finally connected to a passive heave compensator attached to a frame above the moonpool.

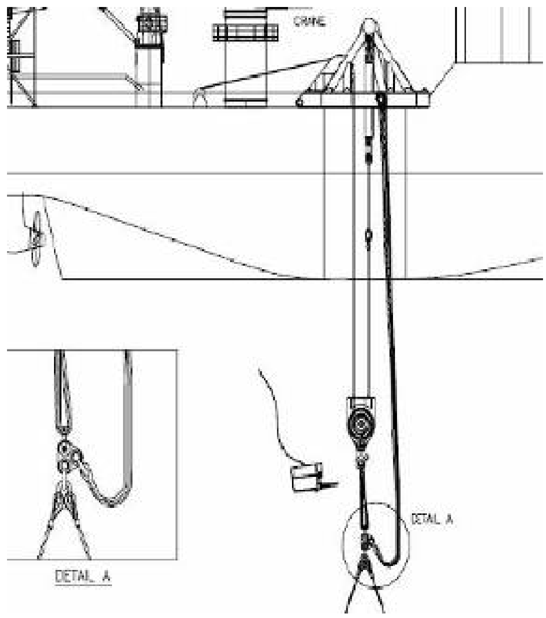


Figure 1.5: Wet tow system – Subsea 7 [5]

The concept lets relatively small offshore construction vessels install large templates to an affordable cost, but it requires relatively large weather windows to perform such operation. The operation is performed in a safe manner, with all critical operations done by use of ROV.

2. OBJECTIVE OF WORK

The development of the subsea technology have forced through new ways of thinking in the oil and gas business. New technology makes it possible to move processing and compression equipment subsea.
Fields developed are at increasing water depths, and the new technology represents heavy equipment located on seabed.
This thesis looks at heavy module installation in Norwegian and West African waters, from barge through moonpool with compensation system.

Task:

"Passive heave compensation of heavy modules"

This thesis is divided into 6 main sections:

1) Select a barge concept suitable for the operation
2) Calculate motion response of the barge
3) Discuss and select a passive compensator concept
4) Establish mathematical models for calculation of residual motion
5) Comparison and evaluation of mathematical models
6) Operational study

The barge and its technical systems should be able to meet requirements for the next decade. Specifications for the systems will be based on SSBI Tordis installed by StatoilHydro autumn 2007. The module is representative for the latest technology used.

Module specifications [1]:

Tordis SSBI:

Length:	47m
Breadth:	21m
Height:	18m
Mass:	1000 tons

Operational criteria:

Max landing velocity: 0.5 m/s

3. SELECTION OF BARGE CONCEPT

Barge design should b made according to objective of work.

3.1 DESIGN BASIS

Specifications for barge:

- Approved stability
- Capable of mobilizing two modules at one time
- Constructed with moonpool
- Minimizing moonpool water elevation
- Removable module handling system

Moonpool specifications:

Length:	50m
Breadth:	30m

Specifications of module handling system:

Height:	Module + rigging
Lifting capacity:	1000 tons
Lifting points:	2

Operational requirements:

Barge should be capable of working in the North Sea and West African waters. Areas are represented with two locations:

North Sea field:	Kristin – operated by StatoilHydro
Water depth:	350m
West Africa field:	Girassol – operated by Total
Water depth:	1300m

Weather data for given locations should be evaluated with use of JONSWAP wave spectrum. Spectrum input variables should be adjusted to meet the wave statistics for area.

3.2 DESIGN CONSIDERATIONS

3.2.1 Stability

Several subjects are to be considered when planning offshore operations. This section looks at barge stability and barge response function in waves.

Stability checks are used to calculate if barge is capable of performing planned operations. Main considerations are buoyancy and keeping stable equilibrium during all phases of operation.

Vessels motions, velocities and acceleration are used in operational studies of vessels. These data are inputs in calculating forces that cargo, seafastening and barge has to withstand. Data are also called vessels Response Amplitude Operators, RAO's.

Buoyancy can be expressed by Archimedes law which tells us that a body submerged in a fluid experiences an upward buoyant force equal to [6]:

$$F_{\nabla} = \rho g \nabla$$

In which:

- F_{∇} = buoyant force
- ∇ = volume of the submerged part of the object
- g is gravity acceleration
- ρ is sea water density

From this law we can define object placed in water in three ways. Some will float, some will sink and some will neither float nor sink.
The objects floating are called positive buoyant, those sinking are called negative buoyant and the last one not floating or sinking are called neutrally buoyant.
An object is floating when the buoyant force is larger then the exposed load on the object. An object is sinking when the exposed load is larger than the buoyant force. Neutral buoyant is the condition when the exposed force is equal to buoyant force, and the object is in a stable condition.

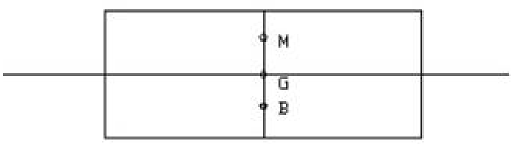
Static floating stability is of interest for ship designers and owners, and represents:

> "Up-righting properties of the structure when it is brought out of equilibrium or balance by a disturbance in the form of a force and/or moment" [7].

A rectangular barge will have two kinds of stability, longitudinal and transverse stability.
The longitudinal stability rotates around the transverse axis and is measured in meters or degree. When a vessel is in horizontal stability we say it floats without trim. Transversal stability rotates around the longitudinal axis and measured in meters or degree. The inclination of vessels is defined as heel.
Stability checks use the transversal stability to check the vessels sea keeping capabilities. The same calculations also can be used for the longitudinal stability.
This section will take a closer look at so called undamaged stability for a simple rectangular shaped barge. The output from the stability check is the calculated GM.

Calculations to follow represent small angels of inclinations and do not implement dynamically effects from forces and response.

When a stable floating body is disturbed to an external force (M_H) it will start to heel. This heel will affect the submerged shape of the body and the centre of buoyancy will move (B), where B_0 becomes the new centre of buoyancy.
Drawing a vertical line from the new centre of buoyancy, a point will be created where the line crosses the centre line of the barge. This point is called the fake metacentre M.
Distance between point G and M (GM) is a common expression in defining vessel stability.



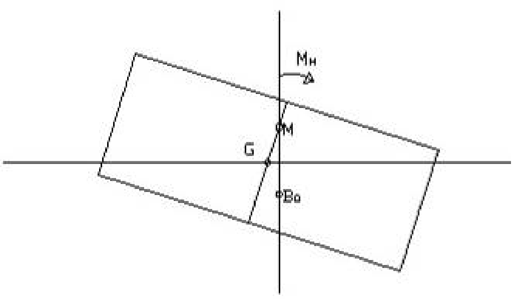


Figure 3.1: Transversal stability

When GM is above zero a new force that tends up righting the vessel are created when with vessel heel. This force, M_r, is created by the couple between the force of gravity and the force of buoyancy.

M_r can be written as:

$$M_r = \Delta GM \sin(\varphi)$$

For small angels of inclination, $\sin(\varphi) \approx \varphi$, then we have:

$$M_r = \Delta GM\varphi$$

M_r is the force that tries to keep vessel in an equilibrium condition.

Based on the calculated GM the vessel stability can be analyzed in the following way [8]. Statements also explain the M_r influence to the stability.

- GM > 0 → M_r > 0: The vessel will go back to its original position when the external influence is removed. It is in the stable equilibrium.
- GM = 0 → M_r = 0: The vessel is in a condition of neutral equilibrium
- GM < 0 → M_r < 0: The vessel is in a condition of unstable equilibrium. It will continue to incline even if the external influence is removed.

GM specifications are given in standards used for vessel design.

The vessels RAO's gives a response spectrum for all 6 degrees of freedom. Numbers have to be calculated by use of marine software, and are given as a ratio of heave motion.
Theory behind motion response is quite involved and will not be described.
RAO's are created for different headings and for different wave periods.

3.2.2 Moonpool

Size and location

The moonpool design should meet the given requirements, 50m x 30m. Compared to other moonpool designs the requirements are large, standard sized moonpools have a size of 7.2m x 7.2m [1].

Preferred location of moonpool is in centre of roll and pitch motions, in centre of barge. This is to minimize the heave motions of the crane hook. The requirement for mobilization of two modules at one time demands a hull length that is at least 3 times moonpool length. Barge breadth should be as slender as possible, but be able to keep structural strength.

Design is in this report simplified. Chosen design has to be prepared more thoroughly for work beyond motions response.

Moonpool design will affect barge operational capabilities in several ways.
When designing a moonpool several issues have to be discussed in order to find the most preferable design.

Two issues are discussed:

- Water column elevation
- Damping

Water column elevation

The new DNV standard for offshore operations includes a section for moonpool calculations. This includes a graph for investigation of the water column excitation in moonpool.

Input data are based on model test for offshore vessels with standard sized moonpools. Tests are performed at MARINTEK [10].

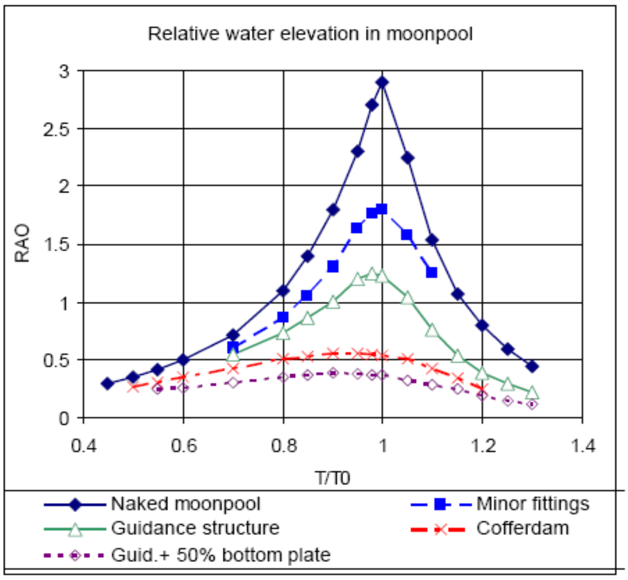


Figure 3.2: Moonpool RAO for different designs [10]

Figure 3.2:

- T is wave period
- T0 is moonpool resonance period
- RAO is amplitude ratio of relative water plug elevation to incoming wave elevation
- Curves for different restrictions in moonpool

The graph illustrates water elevation with different types of restrictions in moonpool.

It is discussable if the standard can be used for the moonpool design in this report. Designed moonpool is large compared to the evaluated moonpools in reference.

To find the exact moonpool water elevation test should be performed in proper CFD analysis or with use of model tests.

Water motions inside moonpool are important to establish when calculating marine forces on modules during lowering.

Elevation should be as low as possible to keep drag and added mass forces on module to a minimum.

Hydrodynamic coeffecients are not evaluated in this thses and it is assumed that forces on module in moonpool will not be the limitating for operations.

Damping

Moonpools are a challenge when designing offshore construction vessels. It complicates the structural design and will often increase the drag factor for the hull.

A moonpool can also make a positive effect to vessle response.
In Sphaier [11] the moonpool influence to vessel RAO's are evaluated.

Figure 3.3 compares the vertical motion for different water entrance openings. Tests are performed with use of a monocolumn SPAR platform. Curves presents amplification of vertical motion with changed water entrance area in bottom.

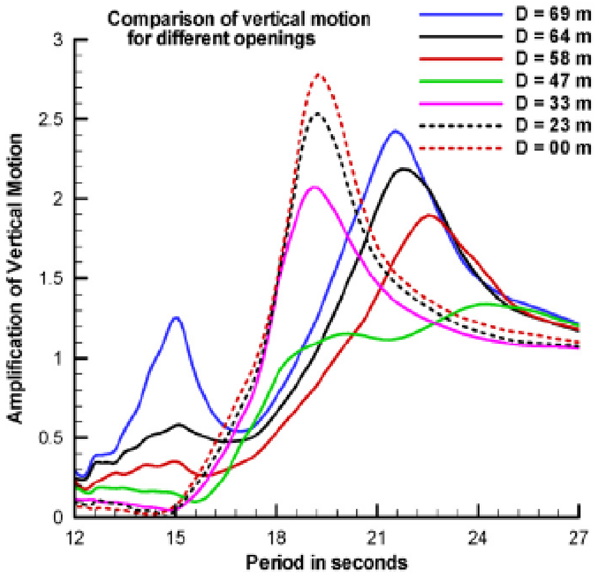


Figure 3.3: Damping in circular moonpool [18]

Where:

- Wave periods in seconds, x-axis
- Amplification of vertical motion, y-axis
- Spar external diameter, 95m
- Internal diameter, 69m

As observed the amplification change with varying water entrance area. Reduction is low when restriction in opening, and most interesting observation is when D=47, half of monocolumn diameter. With this restiction the damping is considerable, and the response is reduced to just above one.
The observations will be useful during evaluations in chapter 4.

3.2.3 Module handling

An important part of the installation system presented in this thesis is the module handling system. The system will not be detail analyzed but one solution is briefly discussed. This will make it easier for the reader to get a full overview over heavy module installation.
The process for transporting the module from yard to installation location can be described in three steps: mobilization, onboard handling and installation.

Mobilization

Mobilization is the process where the vessel arrives to quay in preparing for the next project to be performed. Equipment is lifted on board the vessel with use of its own crane, or by use of harbour cranes.
The design weight for the system presented in this report is 1000 tons which gives lifting related problems. Some large yards are capable of doing such large lifts, but it is reasonable to believe that the mobilization have to be performed by skidding.

Skidding is a technique where the module is placed on greased steel beams. Module is skidded on beams with use of hydraulic jacks or winches. System is well known in industry where heavy topside modules are skidded onto barges and installed with large crane vessels offshore.
Figure 3.4 shows skid way in yard and it is also possible to see a barge with mounted skid ways.
Skidding is proposed as a good alternative for mobilization of the installation barge.

Figure 3.4: Skidding ways in yard [1]

After module is skidded onboard the vessel it has to be sea fastened due to prevailing rules and regulations. This can be e.g. DNV or Noble Denton.
The necessary sea fastening is calculated from accelerations analyzed for the barge. Barge will not leave quay before weather forecasts are according to calculated criterias.

On board handling

Installation barge is equipped with a moonpool that complicates the module handling. It is assumed that with use of moonpool hatches and skidding beams it will be possible to use skidding to place module inside the module handling system above the moonpool.

Offshore module handling could be performed in this sequence:

- Safety meeting with all involved personnel
- Preparation of all included equipment
- Removing of sea fastening
- Skidding into moonpool
- Mounting of lifting system
- Lock cursor frame
- Lift module
- Lower moonpool hatches
- Deploy module subsea

Installation

The barge is to be equipped with a module handling system located above the moonpool, a system designed to lift and control the module during installation.

The idea of a module handing system comes from the subsea IMR industry. Handling systems have been used for safe and efficient operation for many years. Existing systems are mounted above moonpools with a dimension of 7.2m x 7.2m and are usually rated up to 50 tons (PSV Far Saga [1]). The moonpool can be closed with hatches including skidding beams.

This allows the module to be transported into the moonpool area without lifting. While lifting the module a cursor frame will guide the module until it is complete submerged.

Figure 3.5 shows the MHS installed on Normand Flower operated by subsea contractor Deep Ocean. System is rated to 30 tons and contains 5 storage locations for modules.

Figure 3.5: MHS on Normand Flower – operated by Deep Ocean [9]

The MHS designed for the installation barge will be based on the same principles as the IMR handling systems. Dimensions of module and lifting system will require a different larger design.

Some parameters are important to implement in the system.

Design parameters:

Parameter	Reason
Cursor frame	Lock position of module during lift - adjustable
Adjustable lifting point locations	Adjustable to module size
Safe wire routing	Wire to be routed in safe distance from personnel
Moonpool hatches with skidding ways	Allows skidding of module into moonpool area
Allows for both 1, 2 and 4 point lift	Adjustable to module size

Table 3.1: Design parameters

Rigging height

Cranes and lifting equipment are usually designed for one or two lifting points. Rigging are used to transfer forces into the actual lifting points on module and can be considerably high.

This is due to decomposed forces that occur due to an angle between sling and module.

Avoiding large loads in the rigging it's an issue to keep the angle relative the module as high as possible, where this will increase the rigging height significantly.

The competitors for this concept are all based on cranes which allows for high rigging height. Figure 3.6 shows lift of Tordis SSBI from Saipem 7000, a 4 point lift with rigging that allows Saipem to use both cranes.

Figure 3.6: Lift of Tordis SSBI with use of Saipem 7000 [1]

The barge designed is to be fitted with a module handling system kept as low as possible. Large height of this system increases the weight considerably. It will also react negative on vessel stability, GM. Keeping rigging height low will be necessary in project planning.

Lifting operations at offshore location is dangerous due to swing in module. Standard way to avoid this to use tugger winches connected to the module, where such operations need very good planning. The risk for all included personnel and equipment are also considerably high.

With low rigging height the probability for swing in lifting system becomes smaller.

Module handling system should be designed with cursor frame for module locking. It should also be designed for use of low rigging height.

3.3 BARGE DESIGN

Initial requirements have to be met when designing barge. At this stage several assumptions are made and the design can only be used for calculating the response.

Because of the moonpool explained in chapter 2, the size of the barge is large. Due to the required ability to mobilize the two modules at the same time, the length of the barge will be at least three times the moonpool length.

Chosen barge concept:

Length:	180m
Breadth:	60m
Moonpool length:	50m
Moonpool breadth:	30m

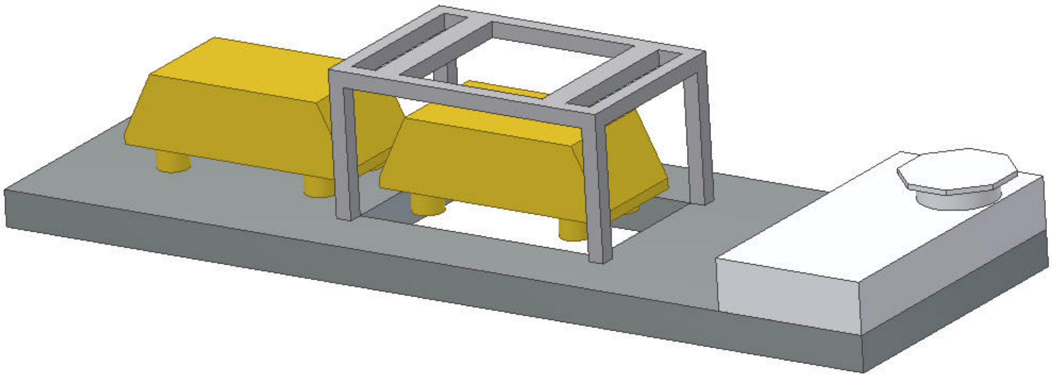


Figure 3.7: 3D model of barge

All auxiliary equipments will be located between the module handling system and the quarters. Compensators will also be mounted in this area (see chapter 5.2 for specifications).

The chosen barge design is particularly large. This large barge design compared with standard North Sea barges might look strange for the reader.

	Installation barge	300 feet North Sea Barge
Length	180m	91m
Breadth	60m	27m
Depth	11m	6m

Table 3.2: Comparison of barge size

The large size can be explained by:

- The moonpool located in centre of pitch and roll motions
- Large modules
- Mobilizing of two modules at same time
- A large deck area required for lifting equipment [12]

In addition to this the module handling system will be removable. This allows the barge to be used for transport of large equipment, e.g. platform bridges.

4. CALCULATE MOTION RESPONSE OF THE BARGE

The RAO's and motions response for the designed barge are calculated. Marine analysis software MOSES is used for the calculations.

The wanted results from calculations are:

- Stability
- Barge RAO's
- Motion characteristics
- Comparison of analysis with and without moonpool

The software has capability to take use of two different methods for calculations; strip-theory and 3D-diffraction theory [13].

Strip theory is in MOSES the most convenient way to find the RAO's. By dividing the underwater part of the vessel into a number of strips with an infinite width, two-dimensional added mass and damping coefficients could be found for every strip. The 3D added mass and damping coefficients are found by taking the 2D coefficients and integrate them over the length of the ship. Using strip theory implies that the variation of flow in the cross-sectional plane is much larger than the variation in the longitudinal direction. This will not be true at the ends of the hull. Strip theory is basically a high frequency theory. This means that if headway speed is included, the theory will fail when the vessel is going in waves from behind. Strip theory is also most applicable for low Froude numbers, $Fn<0.4$. The basic assumptions for strip theory are

- Linear response between ship and waves
- Slender body, $L>>B$
- All viscous effects are neglected
- No lift generated by the hull itself

3D-diffraction theory can not be solved analytically, so we need to use numerical methods to find the ship motions. First the geometry has to be divided into several panels. A source is then placed in each panel, and the strength of the source is found by the boundary condition. This represents the normal component of the panels forced motion. In other words; zero relatively fluid motion at the panel. The fluid velocity in this relation is the sum of all the other sources placed on the geometry. When the source strength is known, the velocity potentional can be found, and further on the dynamic pressure, forces, damping and added mass for

each panel. Basic assumptions for Diffraction theory are the same as for potential theory.
The fluid needs to be:

- Incompressible
- In viscid (ideal fluid)
- Irrotational

Based on the shape of the hull and by following the software supplier's recommendation, 3D diffraction theory is used for calculations. Strip theory is not able to handle two hulls close to each other, and this is the actual case for the moonpool.

MOSES modelling

It takes some time to be familiar with MOSES modelling. There are several ways to model a vessel in MOSES, and the modelling is based on two different techniques; block function and frame function.

The block function is a quite simple technique where the vessel is modelled with different blocks that are combined with each others. The figure below illustrates how the barge is made of two blocks, one barge block and one block that is used for the cut-out of the moonpool.

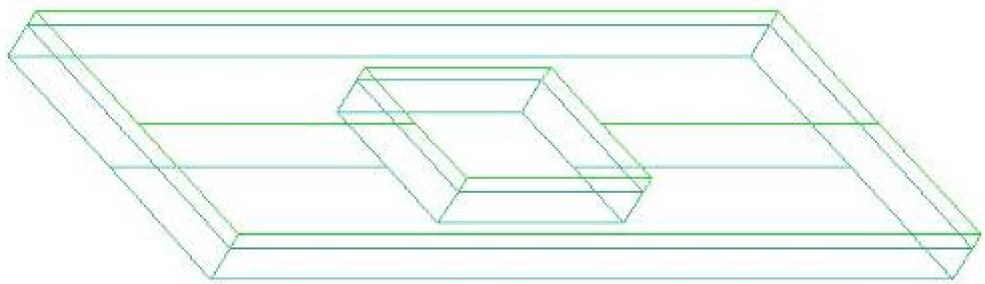


Figure 4.1: Simple block model of the barge

In the second method the vessel is modelled in the same way that vessels have been defined in several hundred years; with the use of frames.
By defining the different frames of the vessels, the program draws lines from frame to frame and the hull shape is defined. To show how this function can be used for a relatively advanced vessel, the figure below shows the hull of IMR vessel PSV Far Saga [1].

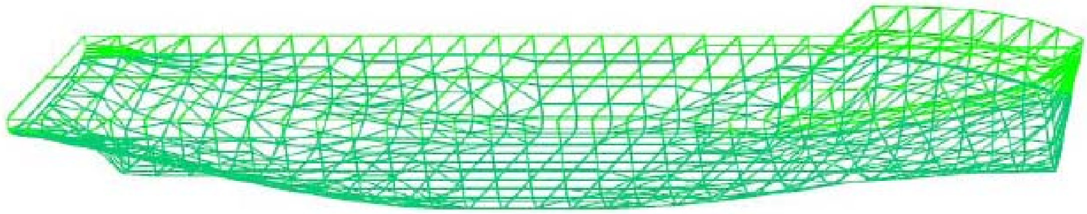


Figure 4.2: Frame function explanation, MOSES model of FAR SAGA [1]

Because of the programs capabilities, special design elements like roll dampers and cofferdams will not be calculated.
This is because MOSES is not able to calculate viscous effects.
The first, damping in roll movements, will not create any challenges in this project due to the large width of the barge, the cross-section stability will be very high for a wide flat bottom barge.
The last, damping created in cofferdams, is a positive effect that creates damping in both the barge and for moonpool water elevation. The damping effect is not taken into consideration during any calculation, but is described in section 3.2.2.

MESH control is important to get realistic results with the use of the 3D diffraction theory. The programmer defines maximum distance between the nodes, and the program creates the mesh over the whole structure.
The most accurate results are calculated using square panels, and it may be necessary to implement more planes in the model to straighten the mesh.
In addition the program has capability to reduce the amount of nodes that will occur when different blocks are combined.
The program inputs for the barge are:

- Max nodes distance: 4m
- Min nodes distance: 0.09m

The barge was first modelled after using the block method with a single cut-out for the moonpool. Some extra planes where added to straighten the mesh. The figure below shows the barge with mesh used.

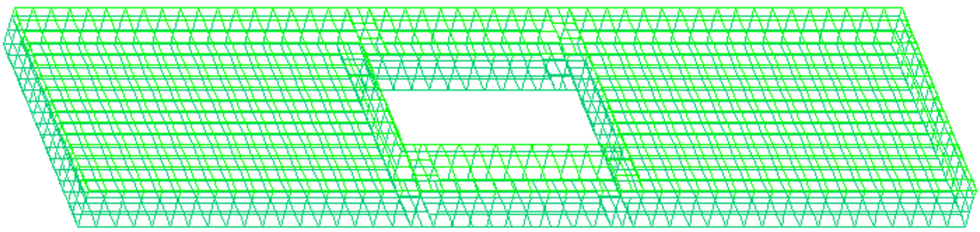


Figure 4.3: MOSES model – barge with mesh 1134 panels

Using this method there where experienced some problems with negative damping and negative added mass. The problem was located at periods up to 6 seconds when the barge was modelled by the use of blocks only. Several of the techniques described in the previous section were tried with no luck; redefined mesh, increased number of panels, applying more planes in the model and decreasing the draft. Still the results were not approved and the model was rejected.
The barge was now modelled with the use of frame theory. The moonpool were still created as a block and extracted from the frame-defined hull.
After some tryouts it now was possible to create the results without any negative damping. The results for the barge were approved, and a complete RAO report is presented in appendix D.

4.1.1 MOSES-analysis results

The following section contains analyses performed to show the barge capability. The section includes:

- RAO's for different headings
- Barge with and without moonpool
- RAO's for lifting points

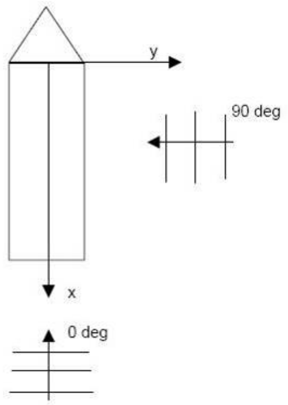


Figure 4.4 Wave heading relative to vessel

Figure 4.4 shows how the wave directions are defined in MOSES. The system of the coordinates has it origin in the bow, with x-axis positive backwards, z-axis upwards and y-axis towards starboard side.

To establish radii of gyration for roll r_{44}, pitch r_{55} and yaw r_{66} the formulas given in Faltinsen [24] have been used.

$$r_{44} = 0.34 \text{ X Bm}$$

$$r_{55} = r_{66} = 0.27 \text{ X Lpp}$$

Where Bm is width and Lpp is the overall length of the barge.

As described in chapter 3.2.1 the barge stability is explained by use of calculated GM.

The GM for the installation barge needs a little explanation.

In general barges have large GM's since width of vessels is large compared to the height. A low height gives the vessel a low centre of gravity, while a wide vessel will give a high metacentre height.

The installation barge is equipped with a moonpool that will affect the GM in a positive way. The moonpool will change the radii of gyration in a positive way since masses are moved out on the edges. The moonpool also reduces the displacement of the vessel.

At the other end the buoyancy centre B will be moved to a higher level which will decrease the GM.
If we look at the sum of these elements the GM for the installation barge without cargo and equipment should be satisfying.
The GM is not calculated with cargo, but since the weight of the cargo is assumed to be small related to the barge displacement the GM will not be affected that much.

Input to MOSES	
r_{44}	20.4m
r_{55}	48.6m
r_{66}	48.6m
Calculated by MOSES	
GM	46.5m

Table 4.1: MOSES data

RAO's are created for three different places on the barge, COG and both lifting points used. The COG is used to compare the barge with and without the moonpool.
RAO's for lifting points are used to find motion response used for operational studies of compensation system.
Lifting points are located mid ship five meters from moonpool edges, at 70m and 110m while the COG is assumed to be in the central point of the barge at 90m.

Assumptions used for calculations:

- Draft 7m
- COG in mid ship, centre of barge, z=5
- Ballasting used to keep COG at origin during operation

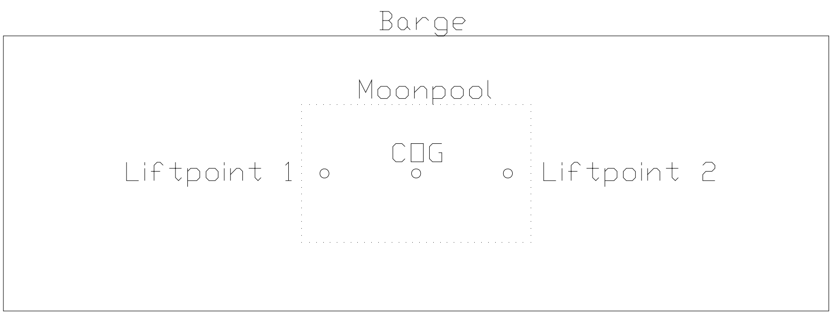


Figure 4.5: Calculated points

The graph in figure 4.6 shows COG heave RAO's for the three headings.

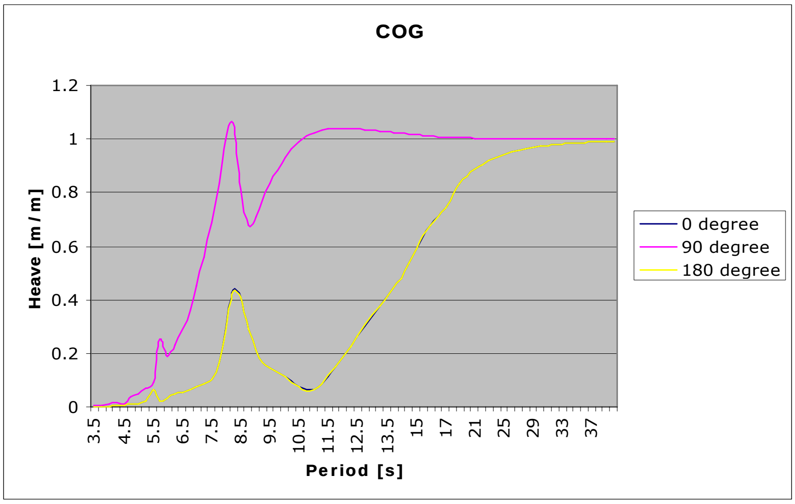


Figure 4.6: Heave RAO for COG, 3 different headings

As observed response for 0 and 180 degree are identical. From figure 4.5 this is explained by the symmetrical design of barge.
Responses are different when comparing 0 and 90 degree headings, which have to be considered during planning.
It is normal to take account for this by require a specific vessel heading for operation.
This can not be done for the moonpool barge as it has two lifting points. Modules are installed with a specific heading where is required..
Operations from moonpool barge have to be planned for worst case heading.

The sharp peaks occurring make the RAO results quite unusual. The analysed barge is 180 meter long and the dynamical situation for such a large vessel should not create peaks as observed.

Table 4.2 tries to explain the unusual results.

Period [s]	**Omega [rad/s]**	**Wave length [m]**
5.5	1.14	47
5.75	1.09	52
8.25	0.76	106
8.75	0.72	120
9.75	0.64	148
11	0.57	189

Table 4.2: Wave lengths for different periods

Barge responds differently for different calculated wave periods. The vessel response closes towards 1 as wave period increase.
Looking at the graph for 90 degree heading there is a peak at 5.75s with corresponding wave period of 52m.
The width of the barge is 60m, and the peak can be explained by the barge response to a wave length equal to the width.
Next peak in 90 degree heading is located at 8.25s which corresponds to 106m length. This point does not match any physical dimensions.
Only 0,5s after the peak at 8.25s there is a low value at 8.75s, corresponding to 120m wave length. The wave length at this point is exactly twice the width of the barge, where this should not have any impact.
After this point the response for the barge is getting closer to zero, which it should do for large periods.

The 0 and 180 degree curves are also affected by sharp peaks. The first peak is located at 5.5s which corresponds to 47m wave length. For the 90 degree heading this can be related to the width of the barge, but has no physical correspondence with the 0 and 180 degree heading.

The next peak is located at 8.25s which corresponds to the high peak in 90 degree heading. The reason why peaks are located at this specific point is not discovered.
A low value for the 0 and 180 degree curves is found at a period of 11s. This value corresponds to 189m wave length which is close to the length of the barge.
As seen for the 90 degree heading there was a low value where the wave length met the width of barge.
It seems like the barge response will get low values when wave length meet physical dimension in the corresponding direction.

Figure 4.7 shows how the moonpool affects the RAO for the barge.

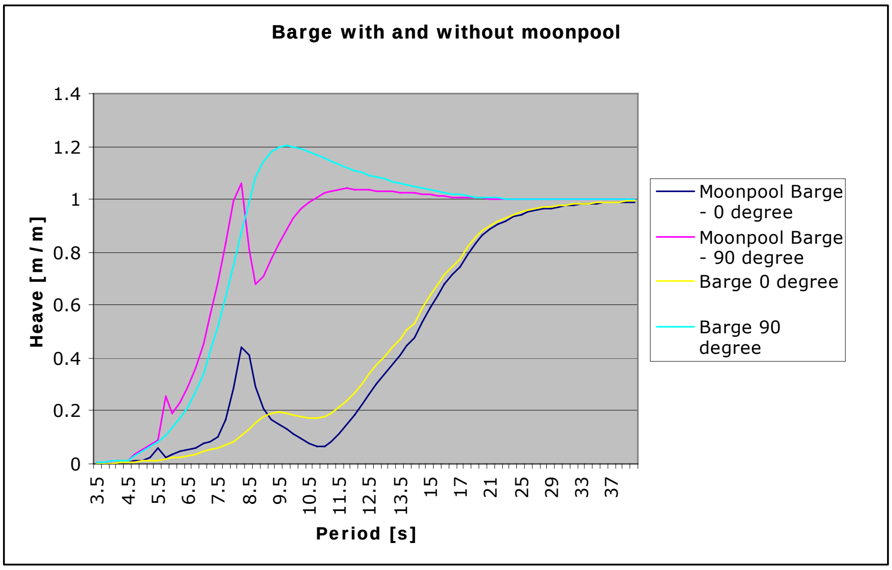


Figure 4.7: Heave RAO for barge with and without moonpool

As explained in the moonpool section chapter 3.2.2 a vessel with a moonpool will be affected by mainly damping and excitation forces from the moonpool.
The moonpool water column resonance period is calculated in appendix C using MARINTEK calculations [10], where the calculations give a resonance period of 10 seconds.
It is assumed that when wave periods meet the moonpool resonance period the response will increase. For a 90 degree heading this is not the case, as the moonpool lowers the results from 8 sec until 15 sec.
The moonpool affect to 90 degree heading changes results in a positive way since the response does not exceed much above 1 at any given period.
The curve for the barge without the moonpool has a smoother line, but it increases up to maximum 10 sec. The moonpool resonance period does not help explaining any of the different periods that are discussed above.

Curves for 0 degree heading vary quite much. The curve for the barge without the moonpool looks like a regression line for the moonpool barge.
The calculated resonance period for the moonpool is 10s, a period that is explaining any of the peaks that we observe.

The moonpool barge is to be equipped with two lifting points located inside the moonpool, figure 4.5.
The two lifting points are located at 70m and 110m from the bow, where the heave response will differ from the COG results. Figure 4.8 shows heave RAO for both lifting points for 0 degree and 90 degree wave heading.
As observed response curves for 90 degree heading corresponds 100%, which is expected due to the design.
The two other graphs show that RAO's will be different for the two lifting points with the same heading.
This requires that the lifting winches and the compensators are individual devices and operations should be planned according to the highest values.

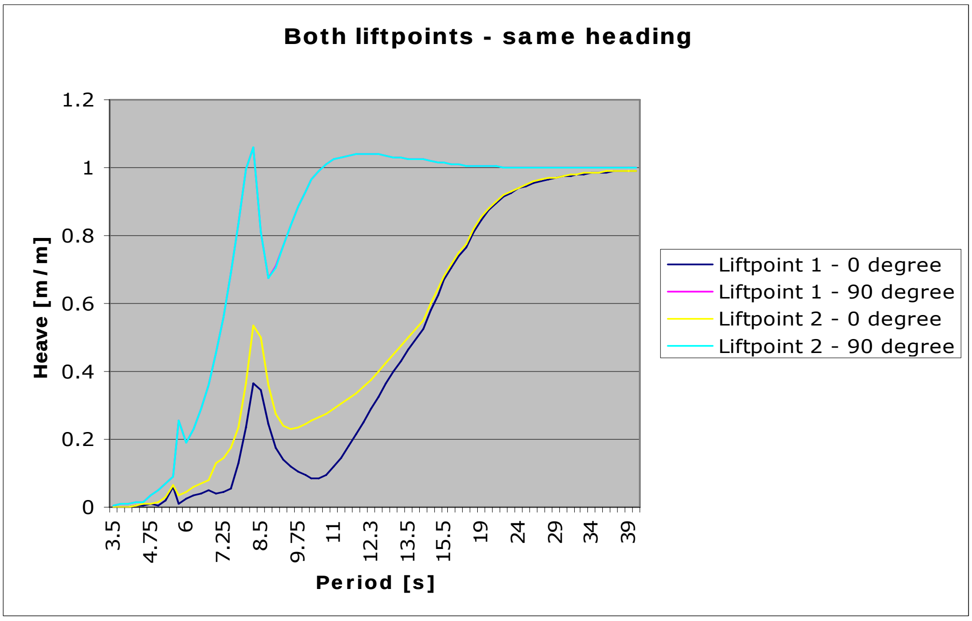


Figure 4.8: Heave RAO for both lifting points

The barge response compared to other large vessels is evaluated below.

	Installation Barge	Skandi Acergy	Alvheim FPSO	Acergy Piper
Type	Barge	Monohull construction vessel	Monohull FPSO operating in North Sea	World wide S-lay pipe lay SEMI
Length	180m	157m	233m	167m
Breadth	60m	27m	42m	58m
Displacement	66700 ton	17000 ton	104000 ton	53500 ton

Table 4.3: Main specifications for compared vessels

The vessels compared are large of size. These should be representative vessels when comparing vessels in heavy module installation. All input data is based on analysis done by 3D diffraction theory.

The curves in figure 4.9 show how the different vessels perform with heading 0 degree.

The two monohull vessels have some small peaks with low periods, but still the results are quite similar. The barge results coincide quite well with the results from the two monohull vessels, where the barge has a large peak due to its moonpool. The SEMI pipe lay vessel Acergy Piper shows clearly its capabilities compared to the monohull vessels. The Piper has a larger natural period due to a smaller cross-sectional area in the water line. This can clearly be observed in the graph as the SEMI's response is lower for all periods up to 17 seconds

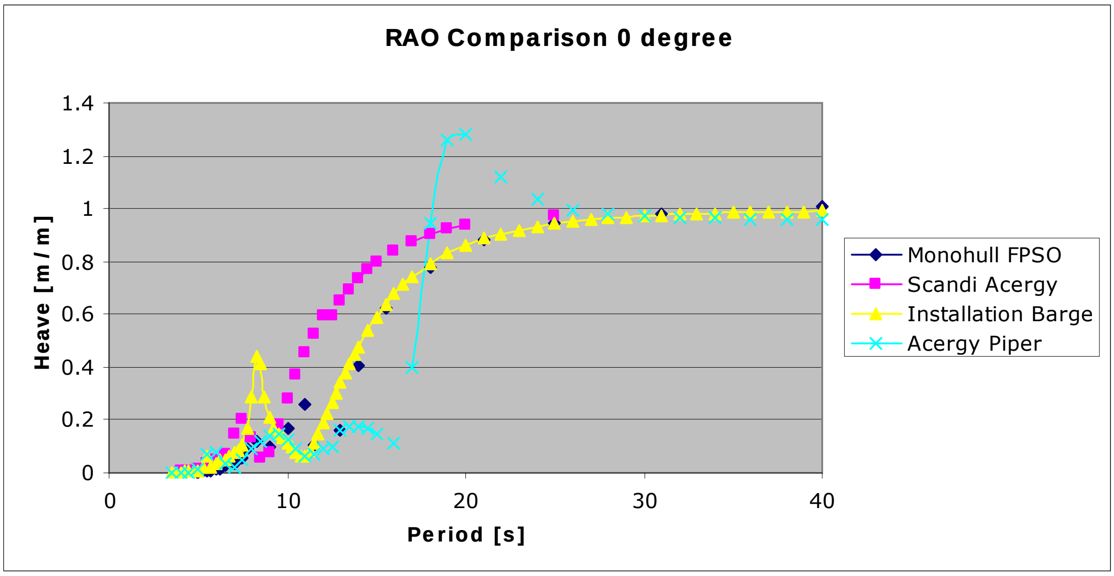


Figure 4.9: RAO comparison at 0 degree

Figure 4.10 shows the response for the mentioned vessels in 90 degree wave heading.
The vessels performance correlates in the same way as for figure 4.9.

It is observed that the two monohull vessels get a response peak over 1, while the installation barge stays below 1 for almost all periods. It is presented in figure 4.7 that it's the moonpool that affects the barge in this way. The curve for the barge without the moonpool, figure 4.7, correlates closely to the two monohull vessels. Acergy Piper shows also in this graph why a SEMI design is well suited for offshore operations. Response stays below 1 up to 18 seconds wave period which is larger than for the other vessels.

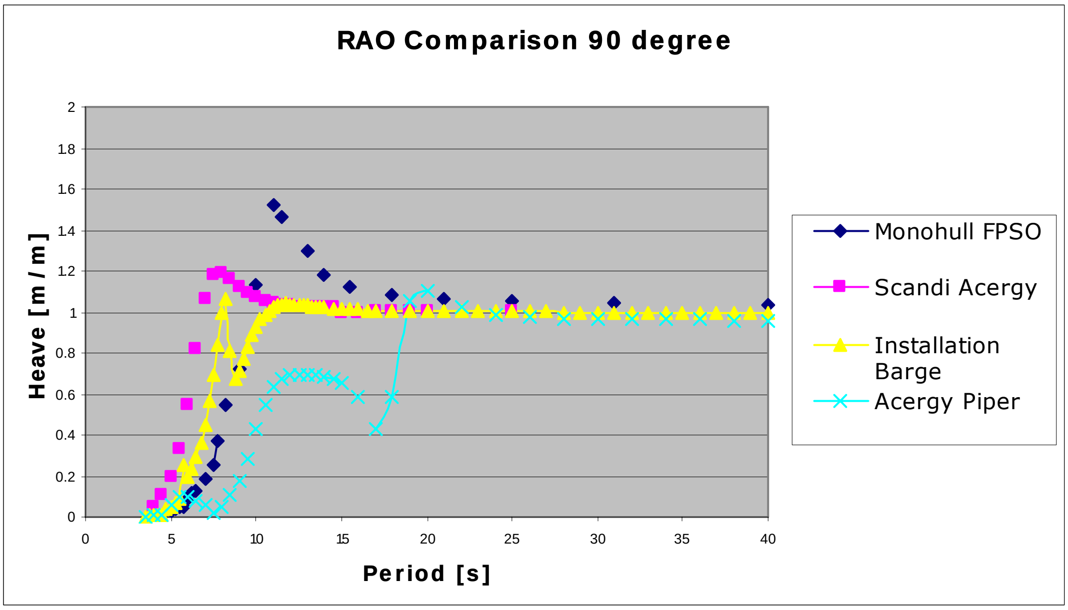


Figure 4.10: RAO comparison at 90 degree

The motion response is calculated as it is needed for the compensator evaluation. The motion response is motions, velocities and accelerations for a vessel in a given wave spectrum.
The barge motion response is calculated by the use of JONSWAP wave spectrum, both for the North Sea and West Africa.
The JONSWAP spectrum can be found as an input in the MOSES software, and will create maximum responses for the different areas, based on a change in the gamma factor.

The RAO's used for all analysis later in this report are from the barge without the moonpool. This is done because results from the moonpool analysis can not be qualified due to limitations in the software.
The motion response is calculated for lifting point 110m from the stern.

The installation barge in North Sea waters:

Velocity and Acceleration analysis - Kristin			
JONSWAP height:	1	m	
Gamma factor	1	(peaked ness factor)	
Max values	**Heave**	**Heading [deg]**	**Period [s]**
Motions:	0.917 [m/m]	90	14
Velocities:	0.490 [m/s]	90	9
Accelerations:	0.350 [m/s^2]	90	7

Table 4.4: JONSWAP analysis North Sea waters

The installation barge in West Africa waters:

Velocity and Acceleration analysis - Girassol			
JONSWAP height:	1	m	
Gamma factor	2		
Max values	**Heave**	**Heading [deg]**	**Period [s]**
Motions	0.920 [m/m]	90	14
Velocities	0.499 [m/s]	90	8
Accelerations	0.369 [m/s^2]	90	6

Table 4.5: JONSWAP analysis West African waters

The tables give the maximum motions, velocities and accelerations for the installation barge in the different areas. As observed the only difference between a gamma 1 and a gamma 2 spectrum is a slight change in the results and earlier peaks. The results from the spectra are linear and can be multiplied with any given sea state to get the motions results for that actual given case.

5. DISCUSS AND SELECT A PASSIVE COMPENSATOR CONCEPT

5.1 HEAVE COMPENSATION

All marine operations are affected by their environment like weather and waves. Weather condition has to be monitored in order to perform safe operations. Since work has to be stopped when weather exceeds a pre-set value, all marine contractors are aiming for setting this value at a highest possible level.
In addition to monitoring of the weather a well detailed planning of the operations is a crucial success factor.

Different vessels have different response to waves. Hull designs like barges, SEMI's, catamarans and trimarans react differently. Responses are possible to calculate with the use of marine software (e.g. MOSES) and response for the chosen barge is calculated in chapter 4.
Designing a vessel for offshore installation work requires calculations for vessel motion response. The motion response is used to calculate the highest feasible sea state.

Drilling engineers where designing at an early stage heave compensation systems. The aim was to increase the weather windows for operations. The design purpose for these systems is simple, keeping equipment stable related to seabed.

Floating drilling units are working all year round and are very expensive to operate. Downtime related to weather limitations is very expensive due to high day rates. Working all year round means that the wave height can be very large during winter storms, e.g. in the North Sea. The SEMI's are build to have minimum heave response to the waves, but heave motion of drilling rig will still be considerably high.
As the oil fields are developed on deeper waters, the weight of equipment has increased. The state of the art compensation systems are capable to compensate up to 1000 tons of weight.

Wave height and weight are the main challenges for drill-string compensation systems.

Heave compensation in subsea construction is a well known technology, and compared to the drilling industry there is less weight.. Vessels used can be divided in two sections as explained in chapter 1, where the largest vessels generally do not have heave compensation systems. Smaller vessel working with smaller structures and weights up to 400 tons are in contrast mainly designed with compensation systems.

A subsea lift can be divided in several phases:

1. Landing of load on seabed
    a. Splash zone
    b. Landing phase
    c. Hook release
2. Picking-up load from seabed
    a. Engaging hook to load
    b. Lifting load of seabed
    c. Splash zone

While installing modules larger than the standard moonpool size (7.2m x 7.2m) there is no alternative to over side deployment. Large forces will occur on structure in the splash zone. A heave compensation system can reduce these forces, e.g. forces from drag and added mass.
The compensation system will then monitor the maximum potential power in the wire and spool out wire when the load increases above a preset value.

When landing on seabed a heave compensator will try to keep the module in a constant distance from sea bed.
This phase is critical due to large forces on the impact with sea bed. Operators use a maximum velocity restriction for landing the modules.
A much used maximum landing speed is 0.5 m/s, as will be used on the Gjøa template summer 2008 [14].

During the hook release it is important to prevent snap loads in wire, hook or installed equipment.
A compensation system can in this case be used to monitor vessel movement, and start feeding out wire while the vessel is on the top of the wave.

The last phase described is a constant tension used while lowering and retrieving equipment in soft soil.

Templates have in many cases large suction anchors to keep the module stable on the seabed. Using a constant tension system the penetration of these suction anchors will be controllable. This is important to avoid wash-out around the anchors.

Wash-out is a problem and has occurred several times in the North Sea [15].

The system will also help stabilizing high suction anchors during landing penetration.

Figure 5.1: Wash out during installation [15]

Heave compensation can in general be divided into three kinds of system; passive, semi-active and active systems.
Generally compensation is based on two kinds of equipment; cylinder or winch. Since knowledge of these systems is quite important to evaluate work done the following section contains a brief overview.

5.1.1 Passive heave compensation

Passive heave compensation is based on a cylinder working towards an accumulator. This gives the system a spring-damper effect.
The system is designed to hold the static load which can be adjusted with pressure in the accumulator.
The volume of gas determines how much the pressure increases in compensation mode, e.g. the spring stiffness in system.
Passive compensation system can be designed in two different ways, cylinder based and winch based.

1

The system can be made as a cylinder filled with gas. In this case the cylinder is mounted in-line, between the crane hook and the module.
The system is defined as a subsea compensator, and the technology is known as a Cranemaster© [16]

There are several configurations of a compensator and it is possible to connect additional bottles of gas to increase the gas volume.
From the supplier Cranemaster© there can be supplied compensators from 12 to 400 tons.

The main challenge for the subsea compensator is the restricted gas volume and not the possibility of adjustment of gas pressure during operation.

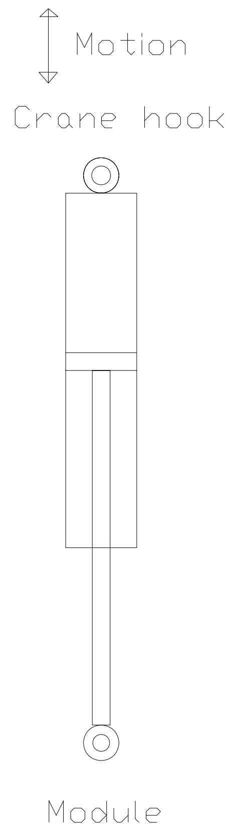


Figure 5.2: Passive heave compensator

2

For compensators mounted on vessels large gas volumes can be installed. These compensators generally use hydraulic fluid between the compensating cylinder and accumulator.

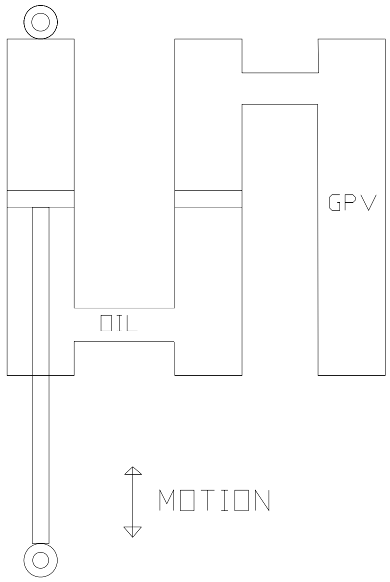


Figure 5.3: Passive heave compensator - GPV

Figure 5.3 shows a simple sketch of the system, the gas volume of the accumulator will be increased with the use of gas cylinders (GPV).

Compensators mounted on vessel generally have larger gas volumes, and thus softer spring stiffness. This gives a better compensation.
Earlier several modes for compensation were mentioned for use in special cases of installation. These modes require changes in gas pressure and gas volume which are difficult do to. In general the gas volume is fixed and therefore the gas pressure has to be changed with compressors.
Due to the large gas volumes the change of the gas pressure takes time, and it is not recommended to be performed during operation.

Passive compensators work with the use of stored energy, and have no energy consumption during operation. This requires pre-charged accumulators prior to operation.

5.1.2 Active Heave Compensation

An active compensator system holds both static weight of load and compensate for motion in one single hydraulic system.
Compensation can be performed both by cylinder and by winch. In both cases the hydraulic system will require high flow levels. Flow levels can be up to several thousands of litre pr. minute for heavy lift systems.
Active compensation systems can also be based on electrical winches.

The systems are controlled by signals from the MRU (motion reference unit), measuring heave of vessel.
High flow in the system is very difficult to control and the system will easily come in an unstable position.
As shown in figure 5.4 the cylinder holds the whole load, and is compensating for motion.

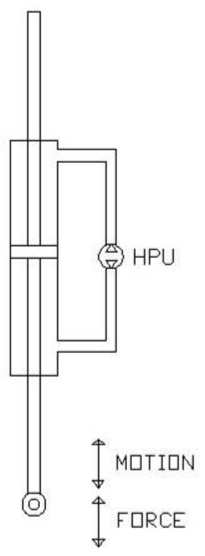


Figure 5.4: Active heave compensation - cylinder

5.1.3 Semi-active compensation system

Semi-active systems use advantages from both passive and active systems.
A passive cylinder carries the load and an active controlled cylinder helps the none-ideal spring to overcome the friction losses. This adds additional movement to ensure proper compensation.

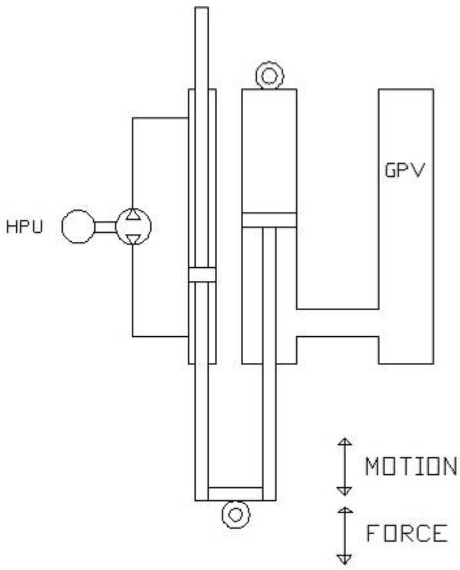


Figure 5.5: Semi-active compensation system

If the static load will vary in mass, as it most usually does, the pressure in the accumulator has to be adjusted from one load case to another. Such an operation could be relative time demanding, and will not be performed during operation.

The semi active compensator can be designed with different set ups, both cylinder and winch based concepts.

The winch based system uses several hydraulic motors with variable displacement who are connected to the winch drum. During lowering and hoisting all engines are connected to the hydraulic circuit. In compensation mode several of the motors are connected to an accumulator system with GPV's. The variable displacement in the engines adjusts the weight to be compensated. The other engines who are still connected to the hydraulic circuit perform the compensation motion.
According to crane constructor Hydralift [17], a semi-active system will be able to reduce the power requirement with up to 75 % related to an equal rated active system.

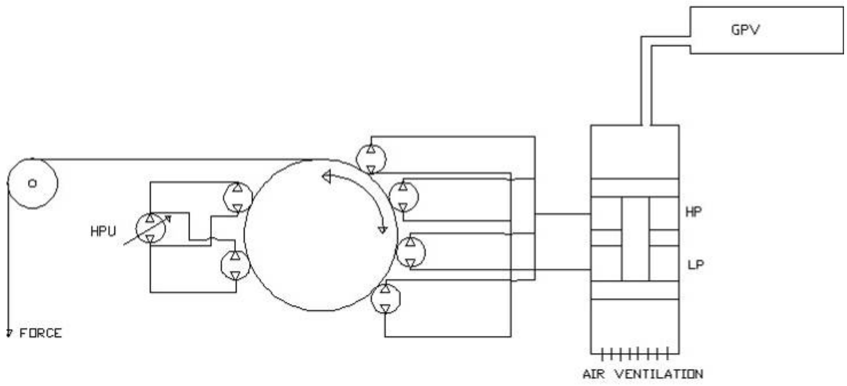


Figure 5.6: Semi-active winch compensation system [17]

A semi-active cylinder can be created in several ways, divided between several cylinders or a combined cylinder.
Figure 5.7 shows the cylinder designed for use on 125 tons heave compensation system mounted on Acergy Eagle [1]. The cylinder is designed with two pistons. The largest one is used as an accumulator piston while the smallest one, still connected with the same rod, is used for the active part. Such cylinders are well known, and are widely used in drilling packages.

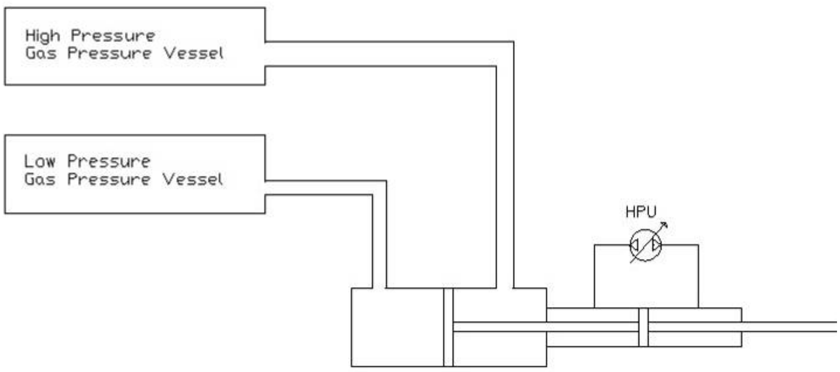


Figure 5.7: Acergy Eagle compensation system – semi-active [1]

Another way to construct a system is with use of two or more cylinders connected to a common steel bar. As shown in figure 5.8 there are two cylinders in passive mode, used to hold the static weight of the load. The third cylinder performs the compensation motion. This system is used by crane constructor Hydralift [17].

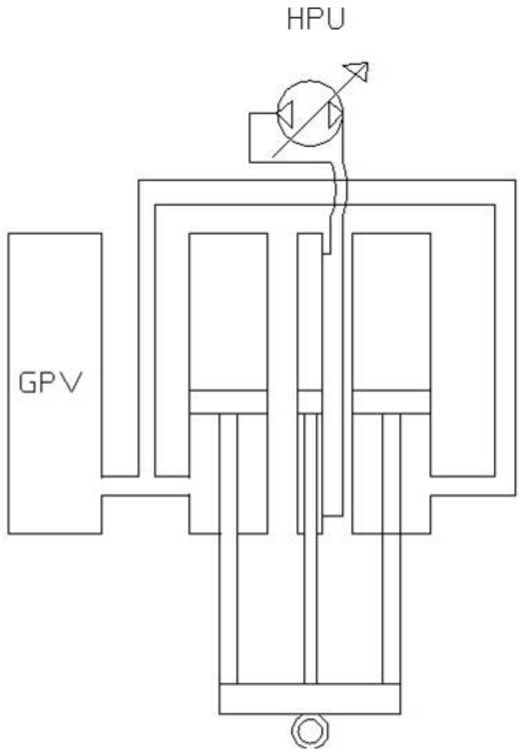


Figure 5.8: Semi-active cylindre compensation – Hydralift model [17]

5.2 CHOSEN CONCEPT

Design case for the passive heave compensator is landing phase.

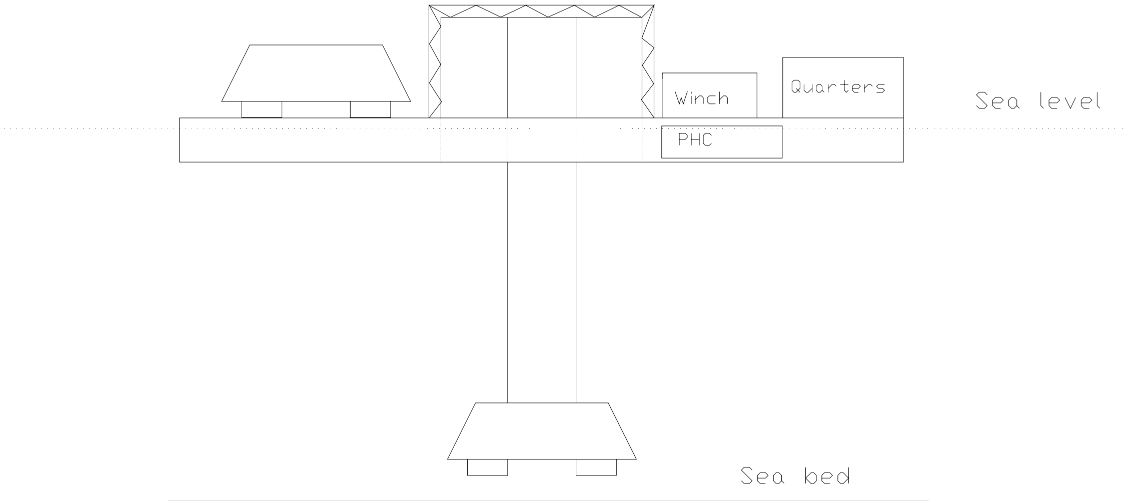


Figure 5.9: Landing phase

Heave compensator shall be designed to minimize motion from module.
Chosen concept for passive heave compensation:

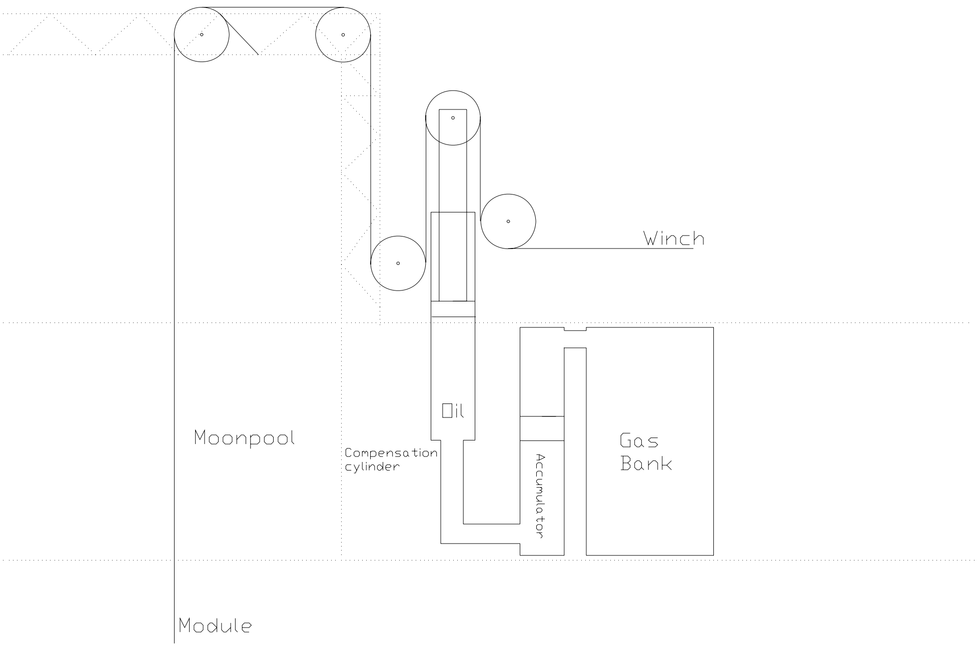


Figure 5.10: Chosen concept mounted on barge

ALL calculations for compensation system are based on TWO systems. This means e.g. that each system is designed for half module weight.

Compensation concept is given in the objectives for thesis, pure passive compensation.
Figure 5.11 shows the selected passive heave compensation system.

System is designed to keep large units like cylinder and accumulator on and below deck. To minimize piston area system is designed for force on piston side in cylinder where several sheaves are used to achieve this. The two systems will be located beside each other, and lifting wires are routed through module handling system to specific lifting point.

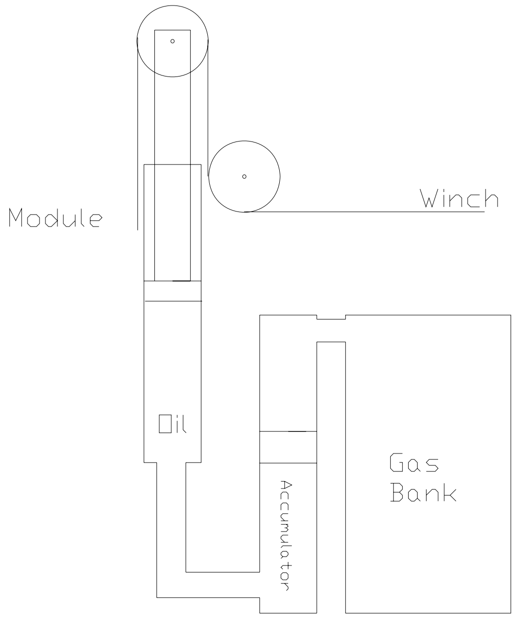


Figure 5.11: Chosen compensator concept

Compared to active and semi-active systems the compensator has positive qualities. Especially for heavy loads:

- No energy consumption during operation
- Simpler system

Force in cylinder is calculated according to figure 5.12.

F1 represents wire force
F2 represents winch holdback force
F3 is force in cylinder

$$F3=F1+F2$$

F1 and F2 will be the same, and the force to be carried by cylinder is 2 times wire force.

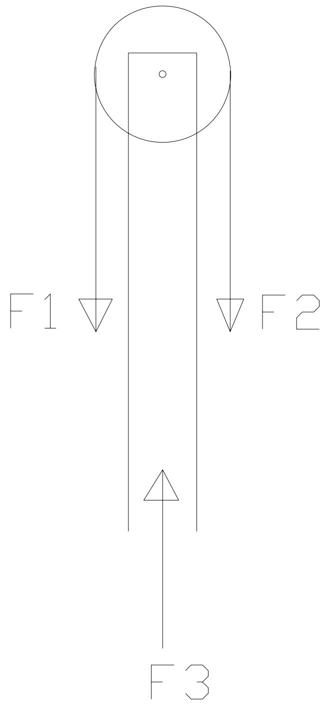


Figure 5.12: Force in cylinder

Velocities are needed for calculations, and defined below

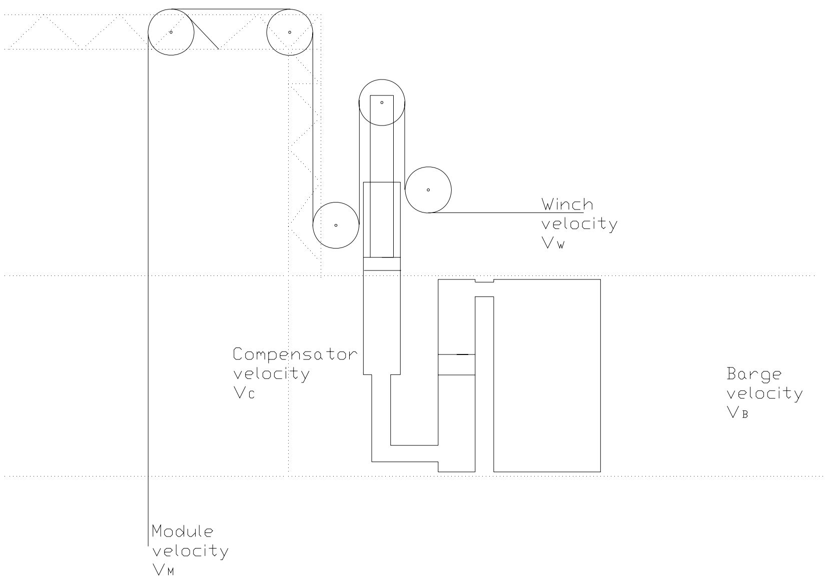


Figure 5.13: Velocities in system

Velocities:

- Barge velocity, V_B, calculated in chapter 4.
- Winch velocity, V_W,
- Module, V_M,
- Compensator velocity, V_C,

Barge velocities are calculated for the installation barge in chapter 4.

Module speed while lowering:

$$V_M = V_B + V_W$$

Module speed in compensation mode, standstill:

$$V_M = V_B + V_C$$

Module speed at landing:

$$V_M = V_B + V_C + V_W$$

The compensator velocity is of interest for calculations performed. At 100 % compensation velocity in compensator will be:

$$V_C = 2 \bullet V_B$$

The passive compensator is designed with hydraulic oil as medium between cylinder and accumulator. It is the piston area and hydraulic pressure that carries the load.
At static load the cylinder should be at mid-stroke. Accumulator gas pressure should be pre charged to this requirement.
All calculations performed are also shown in appendix A.

Static load are sum of module and wire force:

Wire weight is found in data sheet for chosen wire. The argument and calculations for wire are shown in chapter 6.3, defining variables.

Wire weight: $W_{weight} := 100.5 \frac{kg}{m}$

Module weight: $W_{module} := 500\,ton$

North Sea – Kristin:

Water depth: $WD_{Kristin} := 350\ m$

Wire weight: $W_{wireK} := W_{weight} \cdot WD_{Kristin}$

$W_{wireK} = 35\,ton$

Static load: $F_{Kristin} := 2\left(W_{module} + W_{wireK}\right) \cdot a$

$F_{Kristin} = 10500\ kN$

West Africa – Girassol:

Water depth: $WD_{Girassol} := 1300\ m$

Wire weight: $W_{wireG} := W_{weight} \cdot WD_{Girassol}$

$W_{wireG} = 131\,ton$

Static load: $F_{Girassol} := 2\left(W_{module} + W_{wireG}\right) \cdot a$

$F_{Girassol} = 12373\ kN$

Static load in cylinder is multiplied with 2 according to figure 5.12.

6. MATHEMATICAL MODELS

Mathematical models for the compensator are established to find the residual motion of the module. There are defined two first order models and one second order where results are compared. Input motion is represented with amplitude and frequency ω from the barge

6.1 1. ORDER MATHEMATICAL MODELS

To find residual motion of the module, two first order mathematical models are established.

The two models are created with use of different theories, one with use of transfer function theory and one as a simple spring-damper system from motion of equation.
Both first order models use the system described in figure 6.1.
Output from models is module response:

$$\text{Response} := \frac{x1}{X}$$

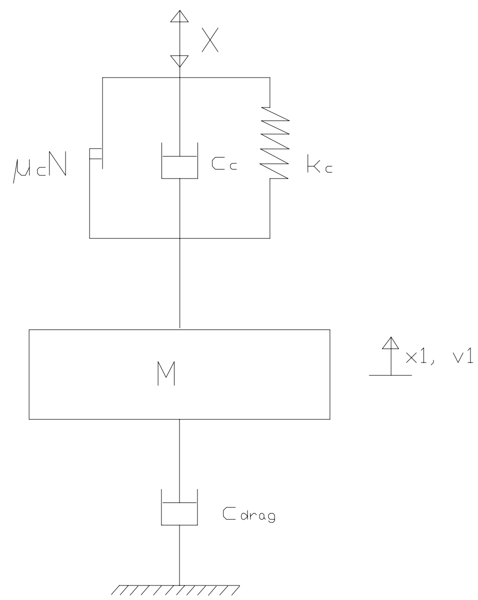


Figure 6.1: First order system

Variables in model:

- Xsin(ωt) is barge motion
- x1 is module motion
- v1 is module motion
- c_{drag} is drag motion on module
- k_c is compensator stiffness
- c_c is compensator damping
- $\mu_c N$ is mechanical friction in system
- M is module mass

System equations do not contain elements for friction. To include friction it needs to be calculated as an equivalent damping and added to the compensator damping. Figure 6.2 show the change that this affects to system:

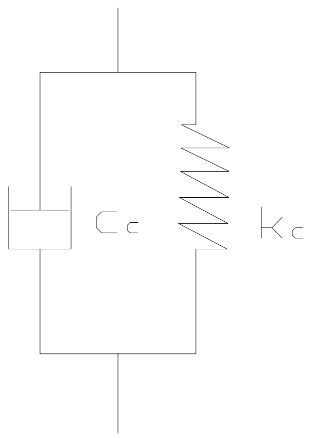


Figure 6.2: New compensator variables.

Where:

- C_c is compensator damping + equivalent friction damping
- K_c is compensator stiffness

Simplifications for model are:

- The wire is infinite stiff, all masses moves together
- Mass of compensator is very small compared to the module weight, it is therefore included in this weight.
- Mass of wire is included into module weight
- Wire stiffness is much higher than compensator stiffness, wire as a spring is therefore not included.
- Friction is calculated as equivalent damping

6.1.1 Transfer function model

The transfer function model is according to the model given in reference [18], page 175.

$$\text{Response} := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{c_c^{\,2}}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_c \cdot M}}}$$

Where:

- Response is $\frac{x1}{X}$, ref figure 6.1
- M is mass of module, compensator and wire
- ω is barge period
- ω_0 is un-dampened natural frequency
- k_c is compensator spring constant
- c_c is compensator damping
- c_d is drag damping on module

Un-damped natural frequency is found from equation:

$$\omega_0 := \sqrt{\frac{k_c}{M}}$$

From the above expressions it can be concluded that to obtain efficient heave compensation:

- The natural frequency, ω_0 should be as low as possible
- The heave compensator damping should be as low as possible, unless resonant motions are expected
- As the natural frequency is calculated by mass of load, a passive compensator system will perform better with a heavy load than a light load.

Model will not be further explained in this report.

6.1.2 Harmonic motion model

Compensator model can also be calculated using motion of equation. The theory and background for this method can be found in reference [19].
System use same first order model as described in figure 6.1.

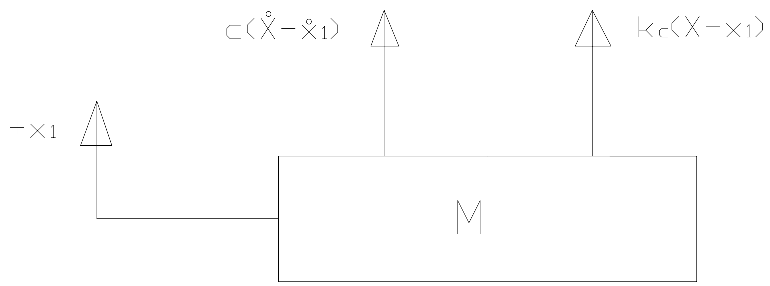


Figure 6.3: Free body diagram

System can be described as a free body diagram:
Where:

- X is barge motion
- x1 is module motion
- M is module mass
- k_c is compensator damping
- C is defined as = Compensator damping (C_c) – drag damping (C_d)

Motion of equation becomes:

$$m\ddot{x}1 + c(\dot{X} - \dot{x}1) + k(X - x1) = 0$$

If X is $x(t) = X\sin(\omega t)$, new equation becomes

$$m\ddot{x}1 + c\dot{x}1 + k_c x1 = k_c X + c\dot{X} = k_c X\sin(\omega t) + c\omega X\cos(\omega t)$$

The theory behind solving this equation is quite involved and will not be thoroughly explained. The solved solution is found in reference [19], page 240.

$$\frac{x1}{X} = \sqrt{\frac{1 + (2\zeta r)^2}{(1 - r^2)^2 + (2\zeta r)^2}}$$

Definition of variables:

Natural frequency of system: $\omega_n := \sqrt{\frac{k_c}{M}}$

Frequency ratio: $r := \frac{\omega}{\omega_n}$

Critical damping: $c_{crit} := 2 \cdot M \cdot \omega_n$

Damping ratio: $\zeta := \frac{c_c - c_d}{c_{crit}}$

Critical damping factor can be explained from the motion of equation [19]:

$$M\ddot{x} + c\dot{x} + k_c x = 0$$

We assume a solution on form:

$$x(t) = Ce^{st}$$

Where C and s is undetermined constants. Inserting this into motion of equation it leads to the characteristic equation

$$Ms^2 + cs + k_c = 0$$

The root of which are:

$$s_{1,2} = \frac{-c \pm \sqrt{c^2 - 4Mk_c}}{2M} = -\frac{c}{2M} \pm \sqrt{\left(\frac{c}{2M}\right)^2 - \frac{k_c}{M}}$$

The critical damping c_c is defined as the value of the damping constant c for which the square root in equation above becomes zero.

$$\left(\frac{c}{2M}\right)^2 - \frac{k_c}{M} = 0$$

Or

$$c_{crit} = 2M\sqrt{\frac{k_c}{M}} = 2\sqrt{k_c M} = 2M\omega_n$$

Response function for system under harmonic motion:

$$\text{Response}_{\text{hmotion}} := \sqrt{\frac{1 + (2\zeta \cdot r)^2}{\left(1 - r^2\right)^2 + (2\zeta \cdot r)^2}}$$

Where:

- Response is $\frac{x_1}{X}$
- M is module mass
- ω is barge period
- ω_n is un-dampened natural frequency
- k_c is compensator spring constant
- c_c is compensator damping
- c_d is drag damping on module
- c_{crit} is critical damping

This function expresses the first order system described in figure 6.1 by use of motion of equation.
The results from the functions should correspond to the results from the other first order function, as both express the same system.

6.2 2. ORDER MATHEMATICAL MODEL

The second order mathematical model is an expansion of the first order model. This model includes some of the simplifications that are set for the first order model.

Model is defined as a second order model since two masses are included, mass of the moving parts in compensator and the module itself. Crane wire mass is included into the module mass.

This model is more correct to the physical problem. More variables are used to define the physical situation in a compensator system.

Compared to the first order system, the second order system includes both compensator mass and crane wire stiffness.

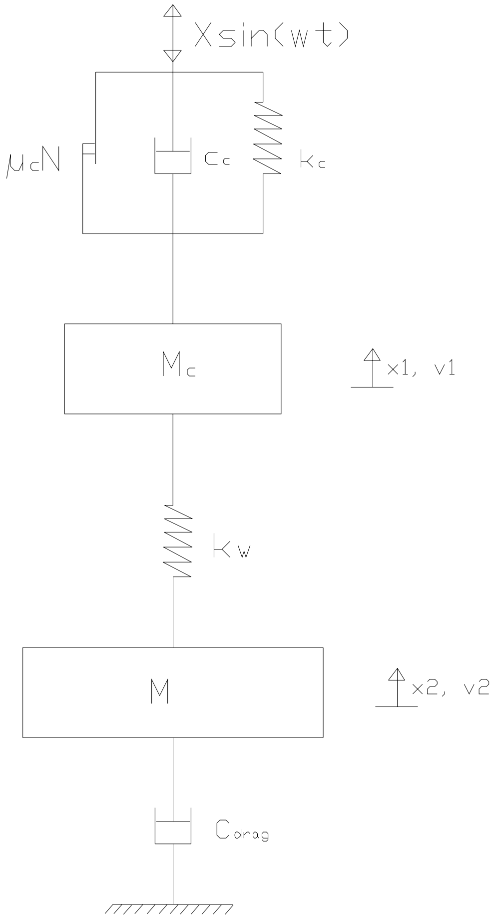


Figure 6.4: Second order system

Variables in model:

- Xsin(ωt) is barge motion
- x1 is compensator motion
- x1 is compensator motion
- x2 is module motion
- v2 is module motion
- c_{drag} is drag motion on module
- k_c is compensator stiffness
- c_c is compensator damping
- $\mu_c N$ is mechanical friction in system
- k_w is crane wire stiffness
- M_c is compensator mass
- M is module and wire mass

Simplifications for model are:

- Mass of wire is included into module weight
- Friction is calculated as equivalent damping

As for the first order system it is not possible to implement friction into the model. To include friction it needs to be calculated as an equivalent damping and added to the compensator damping. New system is viewed in figure 6.2.

System can be expressed with free body diagrams:

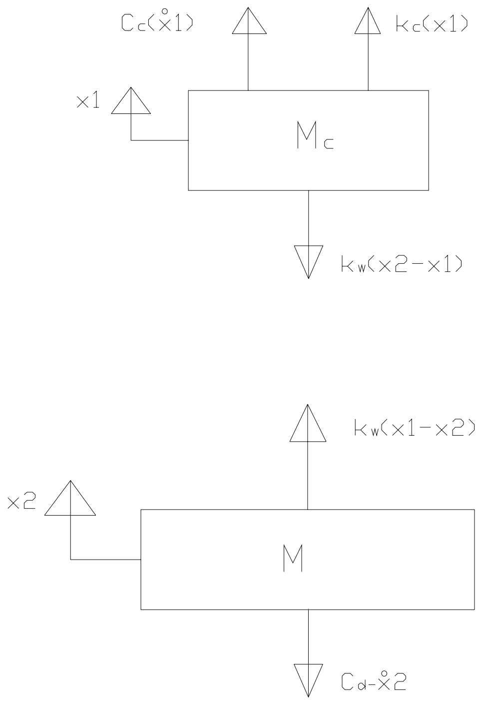


Figure 6.5: Free body diagram – second order model

Dynamic equilibrium of the masses M_c and M may be expressed as:

$$M_c\ddot{x}_x + c_c\dot{x}_1 + k_c x + k_w(x_1 - x_2) = F_c(t)$$
$$M\ddot{x}_2 + c_d\dot{x} + k_w(x_2 - x_1) = 0$$

$F_c(t)$ is a time dependent vertical force on top of compensator.
The following statement shows that giving excitation, $X\sin(\omega \cdot t)$, as input to system (figure 6.4) is equivalent to applying a harmonic force of magnitude X to the mass.

Then $F_c(t)$ is given by:

$$F_c(t) = X\sin(\omega \cdot t) \cdot k_c + X\omega\cos(\omega \cdot t) \cdot c_c$$

Where:

- X is vertical motion of barge
- ω is motion frequency
- k_c is compensator stiffness
- c_c is compensator damping

System written on matrix form:

$$M\ddot{x} + C\dot{x} + kx = F_c(t)$$

$$M_{matrix} = \begin{pmatrix} M_c & 0 \\ 0 & M \end{pmatrix}$$

$$C_{matrix} = \begin{pmatrix} c_c & 0 \\ 0 & c_d \end{pmatrix}$$

$$K_{matrix} = \begin{pmatrix} k_c + k_w & -k_w \\ -k_w & k_w \end{pmatrix}$$

$$F_{matrix} = \begin{pmatrix} X\sin(\omega t) \cdot k_c + X\cos(\omega t) \cdot c_c \\ 0 \end{pmatrix}$$

The forced motion to system is caused by barge, and is expressed in matrix F. Motion is defined with use of vertical barge motion, X, and the response for barge is defined by:

$$\text{Response} = \frac{x2}{X}$$

In order to solve the system, mathematical software MathCAD is used. The second order differential equations are replaced by four first order differential equations.

$$\begin{pmatrix} M_c & 0 \\ 0 & M \end{pmatrix} \cdot \begin{pmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{pmatrix} + \begin{pmatrix} c_c & 0 \\ 0 & c_d \end{pmatrix} \cdot \begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} + \begin{pmatrix} k_c + k_w & -k_w \\ -k_w & k_w \end{pmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} X \sin(\omega \cdot t) \cdot k_c + X\omega \cos(\omega \cdot t) \\ 0 \end{pmatrix}$$

For the new system with four coupled first order equations we introduce new variables:

$$y_0 = x_1 \qquad y_1 = \dot{x}_1 \qquad y_2 = x_2 \qquad y_3 = \dot{x}_2$$

$$M_c \ddot{x}_2 + c_c \dot{x}_1 + (k_c + k_w)x = (X \cdot k_c \cdot \sin(\omega \cdot t) + X \cdot c_c \cdot \omega \cos(\omega \cdot t))$$

Or

$$\dot{y}_1 = \frac{(Xk_c \omega \sin(\omega \cdot t) + Xc_c \cdot \omega \cos(\omega \cdot t)}{M_c} - \frac{c_c}{M_c} y_2 - \frac{(k_c + k_w)}{M_c} y_0 + \frac{k_w}{M_c} y_2$$

and

$$M\ddot{x}_2 + c_d \dot{x}_2 - k_w x_1 + k_w x_2 = 0$$

Or

$$\dot{y}_3 = -\frac{c_d}{M} y_3 - \frac{k_w}{M} y_0 - \frac{k_w}{M} y_2$$

System has initial conditions:

$$y_0(0) = 0 \qquad y_1(0) = 0 \qquad y_2(0) = 0 \qquad y_3(0) = 0$$

System is solved in analysis chapter 7.1.3.

6.3 DEFINING VARIABLES

In order to solve the system numerically variables has to be defined. Variables for module mass and added mass are calculated inputs from Tordis module while the rest of the variables will not represent an actual case. These values are assumed. Analysis with varying variables will determine the module response due to changing input parameters.

Compensator mass

Compensator mass combines:

- Assumed mass for hydraulic oil
- Assumed mass for pistons, rod and wire sheave (ref figure 5.11)

The mass of the compensator system is difficult to predict since the hydraulic system is not established. Assumed weights for model are:

- Mass of oil: $M_{oil} := 3ton$
- Mass of steel components: $M_{steel} := 3ton$

The assumed mass of compensator mass will be.

$$M_{comp} := M_{steel} + M_{oil}$$

$$M_{comp} = 6\,ton$$

Compensator mass is very small compared to module mass.

Drag damping

Drag force are viscous forces around the submerged module. Force is acting in opposite way of module motion.

Drag force can be calculated after formula given in DNV Marine Operations [20]:

$$F_d = 0.5 \cdot \rho \cdot C_d \cdot A_p \cdot v_r^{\,2} \qquad [N]$$

Where:

- ρ is sea water density
- C_d drag coefficient
- A_p is area of object projected on a horizontal plane
- v_r is characteristic vertical relative velocity between object and water particles. v_r is velocity in module after compensation.

As seen in mathematical models the drag force is modelled as a damper to the module. Barge motion will try to pull the module upwards and drag force will hold back. Opposite the drag force will restrict gravity force to lower the module.
The force is proportional to velocity squared.

Calculating the drag damping force from the module is very much work and are not performed in this thesis.

It is assumed a value of $C_d = 500 \frac{kNs}{m}$ for calculations to follow.

Analysis performed will show how the system works with the assumed value. In addition the value is changed looking for drag impact on module response.

Compensator damping

Compensator damping is time demanding to calculate. As seen in the mathematical models the damping is a sum of friction in the compensator system and the compensator damping.

Friction

Friction is a value that is not dependant on motion, velocity or acceleration. Friction force is defined by:

$$F_f = \mu \cdot fN$$

Where:

- μ is friction factor between mass and base
- fN is friction force acting in plane of contact.

Friction forces will occur in:

- Cylinder
- Accumulator
- Wire
- Wire sheaves

All mentioned places of friction are lubricated surfaces and the friction force is assumed to be small.

Viscous

Viscous damping in compensator is related to the hydraulic oil and accumulator gas.
At this preliminary stage viscous damping is not possible to calculate.

Compensator damping is assumed to be small compared to drag damping.

Input value for compensator damping is:

$$C_c = 20 \frac{kNs}{m}$$

Chosen value will be evaluated in analysis.

Compensator spring stiffness

In a passive compensator the spring stiffness is important as it defines the force needed for compensation. The chosen passive system use a gas accumulator design the spring in the compensator.

A compensator system is defined as a quick accumulator system [25]. This means that the compression and expansion takes place during t< 15 sec.
A quick accumulator system is an adiabatic process assuming no heat exchange with surroundings.

For an adiabatic process we have equation:

$$p_1 \cdot V_1^{\kappa} = p_2 V_2^{\kappa}$$

Where:

- p_1 is maximum gas pressure at full charged accumulator
- V_1 is volume of gas at maximum pressure
- p_2 is minimum operating pressure
- V_2 is volume of gas at pressure p_2
- κ is factor for linearity

Figure 6.6 shows the pressure/stroke curves for a 400 ton Cranemaster© [16] at four different loads.
The curves indicate the non-linearity in the compensator caused by energy build-up in gas. An increase in κ-factor will increase the steepness more, and a decrease will flatten the curve.
When $\kappa = 1$ the system is linear.

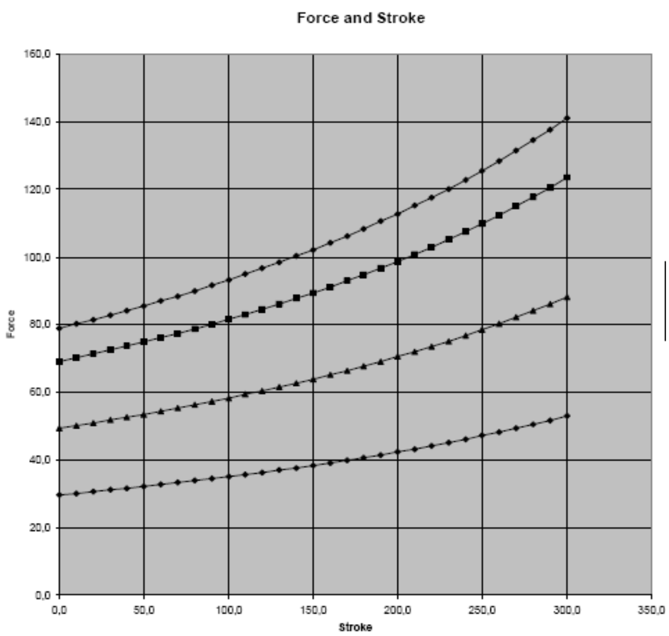


Figure 6.6: Cranemaster© load curve [16]

Spring stiffness used in calculations is assumed to be linear.

Assumed value used is $k_c = 1000 \dfrac{kN}{m}$

Crane wire stiffness

After consulting with Viking Mooring in Stavanger a non rotating crane wire are chosen, Flecxpack 21. Recommended safety factor from supplier is $SF_{wire} = 3$ of SWL; this factor is used in calculations and is not further discussed.
The chosen wire is frequently used by companies like Acergy, Subsea7, Hydramarine and Saipem for subsea lifting operations.

Specs for wire Flexpack 21:

Producer	Redaelli			E-modulus: 210GPA	
Product	Flexpack 21				
Diameter	**MBF (Minimum Break Force)**			**Weight**	
mm	kN	M tons	S tons	Air (kg/m)	Water (kg/m)
146	17100	1740	1920	106,6	92,7
148	17500	1780	1960	109,5	95,3
150	18000	1830	2020	112,5	97,9
152	18500	1880	2080	115,5	100,5
154	18900	1920	2120	118,6	103,2
156	19400	1970	2180	121,7	105,9
158	19900	2020	2260	124,8	108,6

Table 6.1: Flexpack 21 specifications [23]

As given in specifications, design water depth is 350 and 1300m.

Wire weight: $W_{weight} := 103.2\frac{kg}{m}$

Module weight: $W_{module} := 500\,ton$

North Sea – Kristin:

Water depth: $WD_{Kristin} := 350\,m$

Wire weight: $W_{wireK} := W_{weight} \cdot WD_{Kristin}$

$M_{wireK} = 36\,ton$

West Africa – Girassol:

Water depth: $WD_{Girassol} := 1300\,m$

Wire weight: $W_{wireG} := W_{weight} \cdot WD_{Girassol}$

$W_{wireG} = 134\,ton$

Design load for wire are sum of module and wire mass. Design water depth for system is 1300m and the wire has to be calculated for this depth. Weights for Girassol are therefore used.

$$F_{wire} = (M_{module} + M_{wire}) \cdot 9.81 \frac{m}{s^2}$$
$$F_{wire} = 6219 kN$$

$$Desgin\ load = F_{wire} \cdot SF_{wire}$$
$$Design\ load = 18658 kN$$

Wire chosen for installation system is with diameter of 154mm, ref table 6.1.

Crane wire stiffness:

$$k_{wire} = \frac{E \cdot A}{L}$$

Where:

- E is modulus of elasticy for wire. Table 6.1 gives 210 GPa
- A is cross sectional area of wire
- L is wire length

Wire cross sectional area:

$$A_{cw} := \left(\frac{154mm}{2}\right)^2 \cdot \pi$$

$$A_{cw} = 0.019\ m^2$$

Crane wire stiffness for Kristin and Girassol field:

$$WD_{Kristin} := 350m \qquad WD_{Girassol} := 1300\ m$$

$$kw_{kristin} := \frac{E \cdot A_{cw}}{WD_{Kristin}} \qquad kw_{girassol} := \frac{E \cdot A_{cw}}{WD_{Girassol}}$$

$$kw_{kristin} = 11176 \frac{kN}{m} \qquad kw_{girassol} = 3009 \frac{kN}{m}$$

Module mass in calculations

Due to the simplifications in the mathematical models, module mass is a value of several variables.

For the first order systems the module mass includes:

- M_m is module mass
- M_{comp} is mass of compensator
- M_a is added mass
- M_{wireK} or M_{wireG} is mass of crane wire

For second order systems the module mass includes:

- M_m is module mass
- M_{wireK} or M_{wireG} is mass of crane wire
- M_a is added mass

Added mass is further discussed below.

Masses:

$$M_m = 500\,\text{ton}$$

$$M_{comp} = 6\,\text{ton}$$

$$M_a = 1600\,\text{ton}$$

Kristin Field, first order:

$$M_m = 500\,\text{ton}$$

$$M_{comp} = 6\,\text{ton}$$

$$M_a = 1600\,\text{ton}$$

$$M_{K1} := M_m + M_{comp} + M_a + M_{wireK}$$

$$M_{K1} = 2142\,\text{ton}$$

Girassol field, first order:

$$M_m = 500\,\text{ton}$$

$$M_{comp} = 6\,\text{ton}$$

$$M_a = 1600\,\text{ton}$$

$$M_{G1} := M_m + M_{comp} + M_a + M_{wireG}$$

$$M_{G1} = 2240\,\text{ton}$$

Kristin Field, second order:

$$M_m = 500ton$$

$$M_a = 1600ton$$

$$M_{K2} := M_m + M_a + M_{wireK}$$

$$M_{K2} = 2136 \ ton$$

Girassol field, second order:

$$M_m = 500ton$$

$$M_a = 1600ton$$

$$M_{G2} := M_m + M_a + M_{wireG}$$

$$M_{G2} = 2234 \ ton$$

As for the drag force discussed earlier the added mass is a force that reacts on the module. Added mass can be calculated using DNV standard for Marine Operations [20]:

$$m_{add} = \rho V C_m$$

Where:

- ρ is sea water density
- V is volume of displaced water
- C_m is added mass coefficient as a function of depth

Finding the actual added mass for the module is time demanding, and are not performed in this thesis.

Added mass calculated for Tordis SSBI, as calculated by Rune Stigedal [21].

Added mass for Tordis SSBI: $M_a = 1600ton$

7. COMPARISON AND EVALUATION OF MATHEMATICAL MODELS

The two first order models described in chapter 5.1 are calculated in appendix A, and the results from the analyses are presented below.

Analysis shows residual motion in the module after compensation.
Input motion amplitude X = 1 for all models

7.1 1. ORDER SYSTEM – TRANSFER FUNCTION

Residual motion is given on form:

$$\text{Response} = \frac{x_1}{X}$$

The system is under a motion with variation frequency, and the response shows the residual motion for the given frequency.
Due to its simplification the system is evaluated without crane wire stiffness. The crane wire mass and compensator mass is included into the module mass.

Evaluations to follow uses mass of module for Kristin field. A comparison of Kristin and Girassol field is presented later in chapter.

Un-dampened natural frequency:

$$\omega_0 := \sqrt{\frac{k_c}{M}} \qquad \omega_0 = 0.68\frac{1}{s} \qquad T_0 := \frac{2\pi}{\omega_0} \qquad T_0 = 9.19 \ \ s$$

Following response are calculated with initial input data defined in chapter 6.3.

Eqeation is given:

$$\text{Response}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_c \cdot M}}}$$

Input data, Kristin field.

Mass: $M = 2141\text{ton}$

Compensator damping: $c_c = 20\frac{\text{kN}\cdot\text{s}}{\text{m}}$

Drag damping: $c_d = 500\frac{\text{kN}\cdot\text{s}}{\text{m}}$

Compensator stiffness: $k_c = 1000\frac{\text{kN}}{\text{m}}$

As seen the drag damping only occur in the denominator. It follows that the drag damping c_d should be as high as possible to reduce the response.

The response becomes:

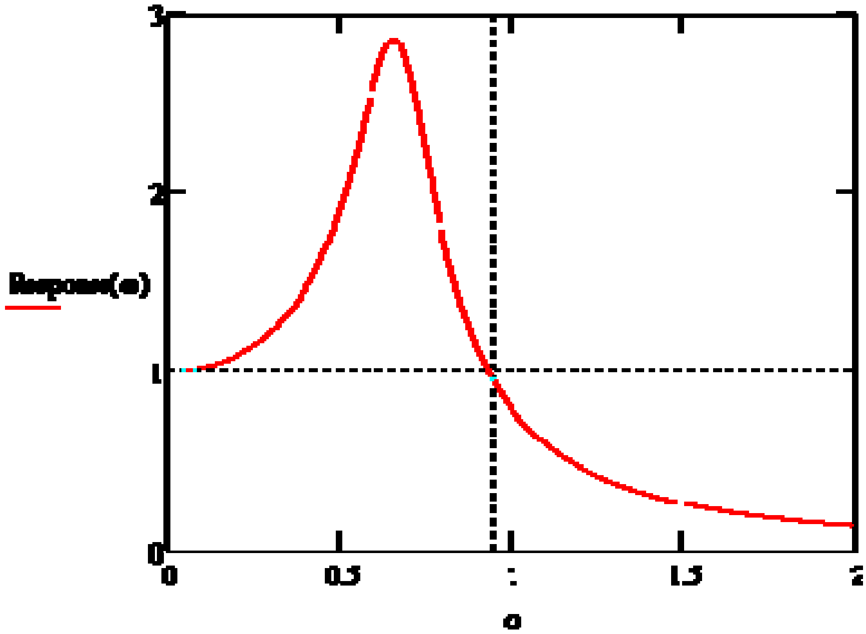


Figure 7.1: Response transfer function

The figure shows the response of the compensator. The peak corresponds to un-dampened natural frequency for the system.

Peak is high above 1 and system should never be used for these frequencies.

Dotted lines shows where the response becomes 1 for frequencies below this point the compensator will not work.

Compensator limit:

$$\omega = 0.934 \frac{rad}{s} \; at \; response = 1$$

$$T = \frac{2\pi}{\varpi}$$

$$T = 6.72s$$

As observed from the graph compensator will close towards 1 as the omega decreases. This is according to the physical system:

Long waves → slow motions → compensator will not react → Response =1

The compensator system should work for varying water depths. Two cases are used in this report, Kristin field in the North Sea and Girassol in West Africa. The crane wire stiffness is seen as infinite stiff, the only difference in first order model is larger module mass.

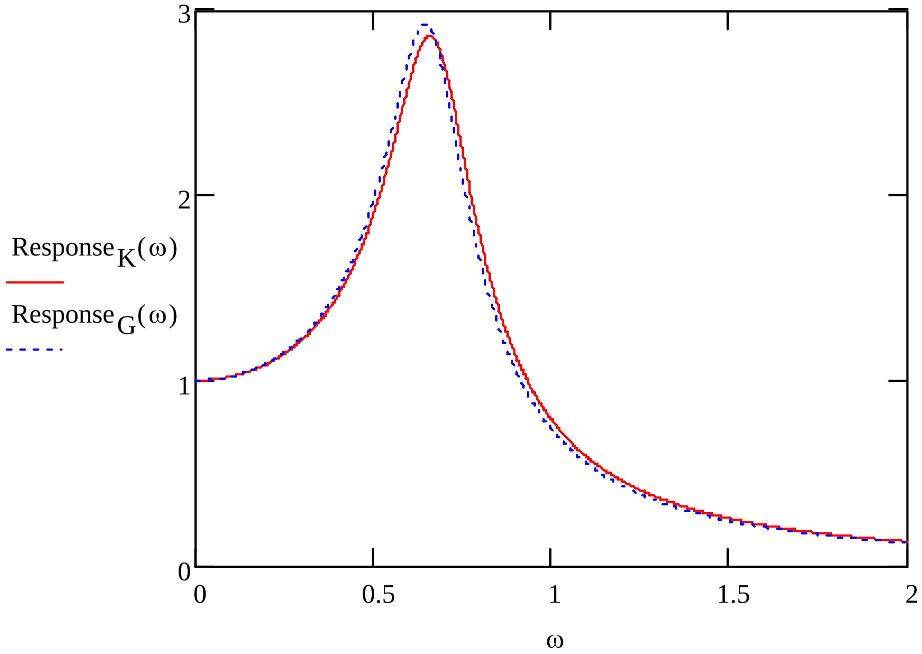


Figure 7.2: Response with varying water depth

Observed is a small change in peak position due to changed natural period of system. The height of the peak in resonance increases a little due to higher mass in motion.

As calculated earlier the systems crane wire stiffness is changing for these two water depths. The model is not able to calculate the variation from this change. Results for from this evaluation should be compared to result from second order model, where it is possible to implement crane wire stiffness.

Compensator efficiency varies with for different inputs. Below the response is evaluated for changing compensator stiffness, compensator damping, drag damping and mass of module:

The input data for evaluations are Kristin field.

Input values are changed with a scaling factor.

Varying compensator stiffness

$$\text{Variation}_{kc} := \begin{pmatrix} 2 \cdot k_c \\ 3 \cdot k_c \\ 0.5 \cdot k_c \\ 0.3 \cdot k_c \\ 0.1 \cdot k_c \end{pmatrix}$$

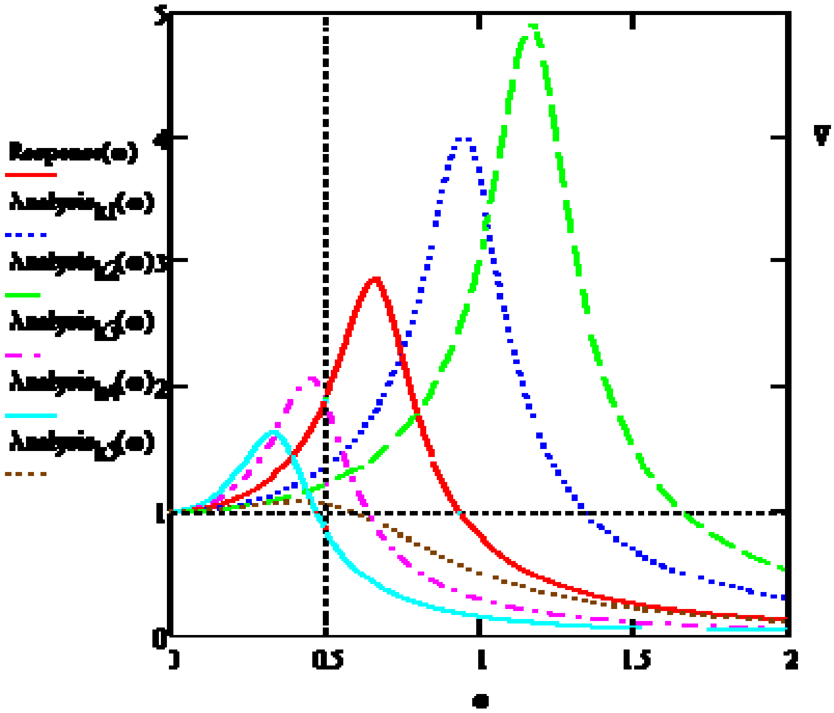


Figure 7.3: Varying compensator stiffness

The compensator stiffness has a large impact on the response. Both peak height and peak position change. Change in position can be explained by the natural frequency.

The natural frequency is calculated with use of stiffness, and for analysis k4 we get a new resonant frequency:

$$\omega_0 := \sqrt{\frac{k_c}{M}} \qquad \omega_{0k4} := \sqrt{\frac{k_{c4}}{M}} \qquad \omega_{0k4} = 0.37\frac{1}{s}$$

This corresponds to observed values. The compensator limit changes much due to the stiffness in system. New limit in analysis k4:

$$\omega = 0.471\frac{rad}{s} \qquad T = \frac{2\pi}{\omega} \qquad T = 13\,\text{second}$$

This new limit increases the operational window for the compensator and observed is that the compensator spring stiffness plays a vital role for compensator performance.

Varying compensator damping

$$Variation_c := \begin{pmatrix} 2 \cdot c_c \\ 3 \cdot c_c \\ 0.5 \cdot c_c \\ 0.3 \cdot c_c \\ 0.1 \cdot c_c \end{pmatrix}$$

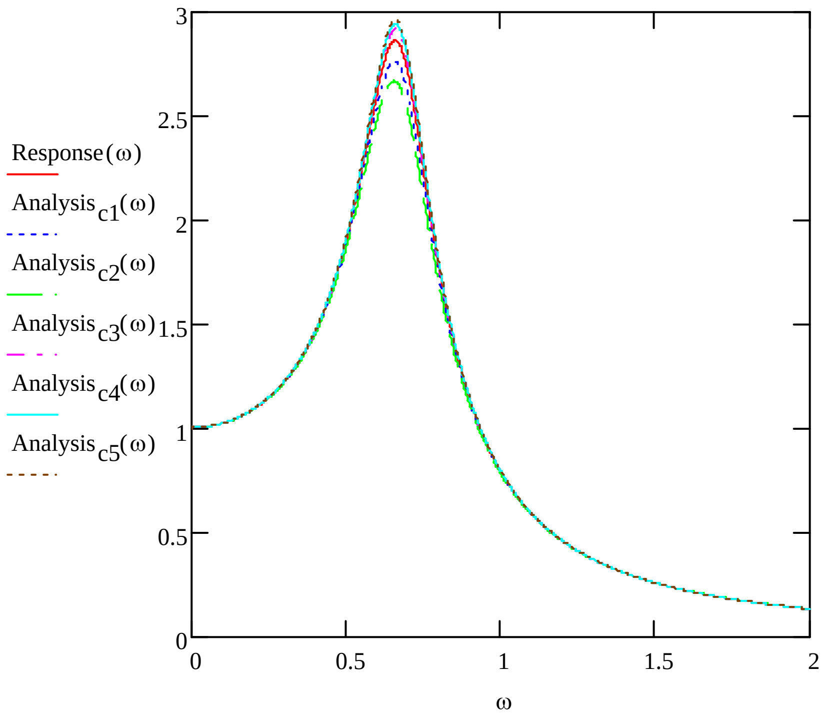


Figure 7.4: Varying compensator damping

As observed the forces acting in the system is not affected by the compensator damping unless in the resonance area.
Compensator damping is low compared to drag damping and the observed changes in compensator are low.

Compensator damping only affects frequencies close to resonance. This correspond to the given statement that compensator damping should be as low as possible to prevent resonant motions.

Varying drag damping

$$Variation_d := \begin{pmatrix} 2 \cdot c_d \\ 3 \cdot c_d \\ 0.5 \cdot c_d \\ 0.3 \cdot c_d \\ 0.1 \cdot c_d \end{pmatrix}$$

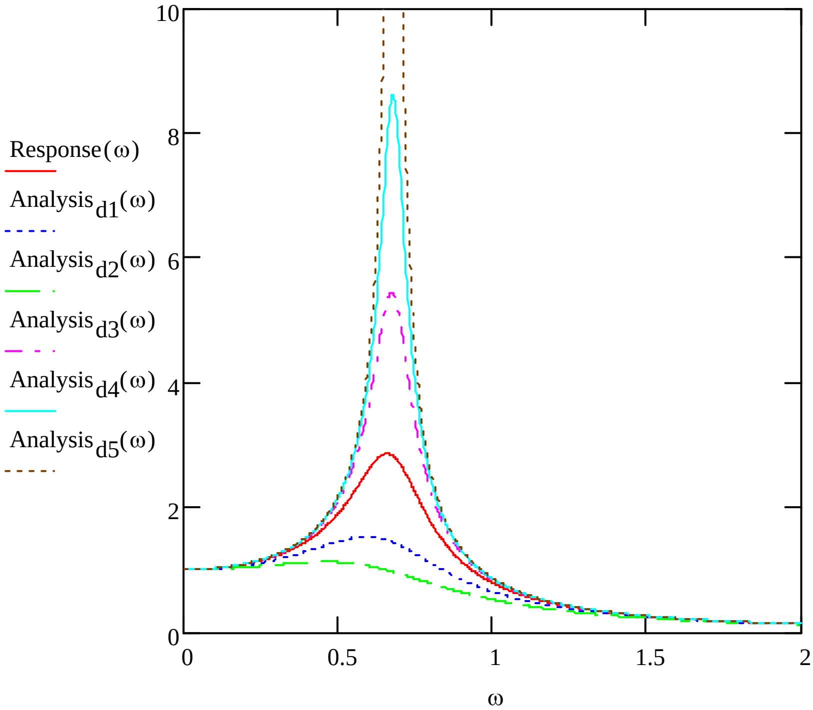


Figure 7.5: Varying drag damping

The experienced drag on module is able to affect the compensator response much. Results in resonance area varies from above 10 and as low as just above 1.

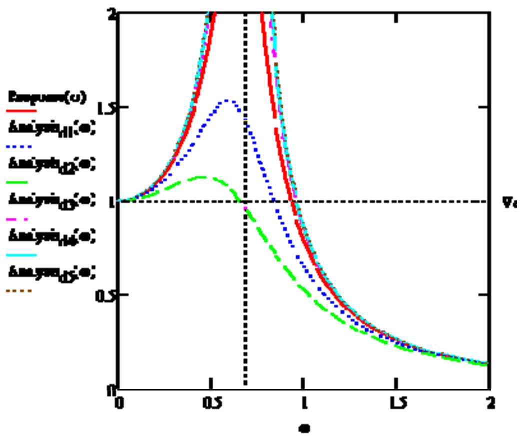


Figure 7.6: Increased drag

As seen in figure 7.6 an increase in drag of factor 3 will move the limit of compensator to:

$$\omega = 0.654 \frac{rad}{s} \; at\ response = 1$$

$$T = \frac{2\pi}{\varpi}$$

This value is increasing the operational window of compensator.

$$T = 10.0s$$

Changes in module mass

$$\text{Variation}_M := \begin{pmatrix} 2 \cdot M \\ 3 \cdot M \\ 0.5 \cdot M \\ 0.3 \cdot M \\ 0.1 \cdot M \end{pmatrix}$$

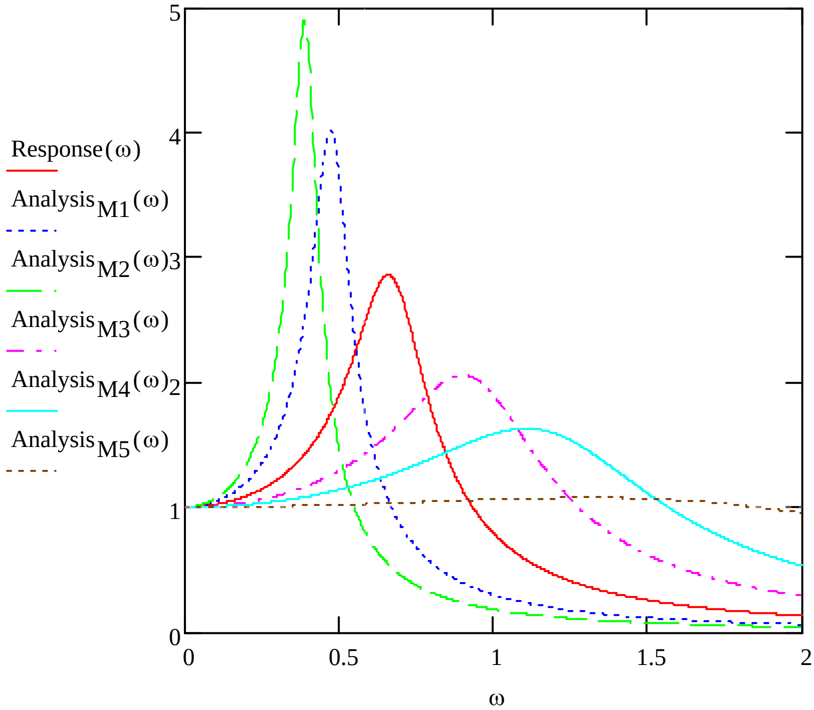


Figure 7.7: Varying module mass

Compensator response varies much due to varying module mass. X-axis value changes with resonance period, while y-axis value changes with swinging mass. A high mass is preferable to reduce resonant frequency, while a low mass is preferable to limit motion in resonance.

In analysis M2 the mass is multiplied 3 times.

The response is 1 at $\omega = 0.552 \frac{rad}{s}$

This gives:

Increased mass changes operational frequency considerably.

$$\omega = 0.552 \frac{rad}{s} \; at \; response = 1$$

$$T = \frac{2\pi}{\varpi}$$

$$T = 11.4 s.$$

7.2 1. ORDER SYSTEM – HARMONIC MOTION MODEL

The theory for the model is presented in chapter 6.2 and will not be discussed. Input values are same as for the transfer function model:

$\omega_n := \sqrt{\frac{k_c}{M}}$ $\omega_n = 0.68\frac{1}{s}$ $T_n := \frac{2\pi}{\omega_n}$ $T_n = 9.19s$

Where ω_n is natural frequency

Frequency ratio: $r(\omega) := \frac{\omega}{\omega_n}$

Critical damping: $c_{crit} := 2 \cdot M \cdot \omega_n$ $c_{crit} = 2927\frac{kN \cdot s}{m}$

Damping ratio: $\zeta := \frac{c_c - c_d}{c_{crit}}$ $\zeta = -0.16$

The system is under harmonic motion, and the response is defined as:

Response h motion = $\frac{x_1}{X}$

$$\text{Response}_{hmotion}(\omega) := \sqrt{\frac{1 + \left[2\zeta \cdot \left(\frac{\omega}{\omega_n}\right)\right]^2}{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(2\zeta \cdot \frac{\omega}{\omega_n}\right)^2}}$$

The results for the system should correspond to the values calculated for the other first order system. The models evaluate the same physical system with the same inputs.

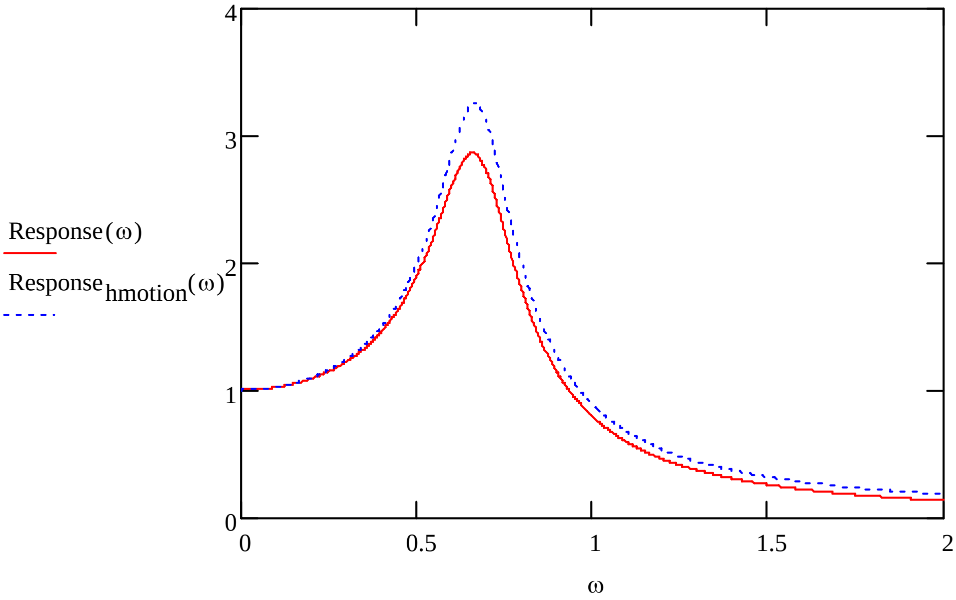


Figure 7.8: Response harmonic motion model

Figure shows the calculated results for both transfer function model, and harmonically motion model. The models are closely correlated where harmonic motion model are slightly more conservative.

The model is calculated with varying compensator stiffness.

The results are closely correlated for the transfer function, but peak in resonance are lower.
This peak difference is due to differences in damping. Motion of equation model uses a function for critical damping to express the damping ratio. Drag damping is therefore included in both numerator and denominator. Transfer function model only include drag in denominator.

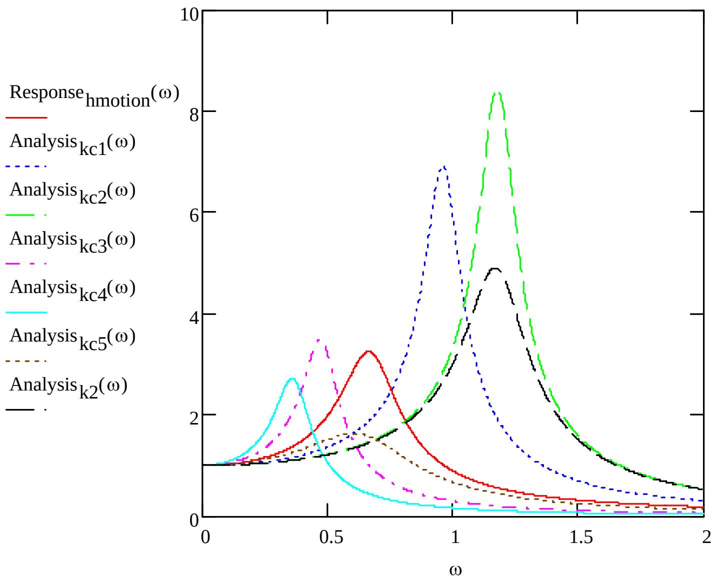


Figure 7.9: Varying compensator stiffness

7.3 2. ORDER MODEL

Equations representing the mathematical model of second order are presented in chapter 6.2.
The numerical problem is solved by using Mathematical software MathCAD.
Results for first order models are run with continuous ω while the results for the second order model are plotted for a given number of ω.
All calculations are presented in appendix B.

Initial conditions for the model are set to zero; the system is under harmonically motion, see figure 5.1, with motion amplitude X=1.

Input data are for Kristin field. See chapter 5.2 for more details:

$$M_c = 6ton$$
$$M = 2135ton$$
$$C_c = 20\frac{kNs}{m}$$
$$C_d = 500\frac{kNs}{m}$$
$$k_c = 1000\frac{kN}{m}$$
$$k_w = 11167\frac{kN}{m}$$

$$\omega_{range} = \begin{pmatrix} 1.571 \\ 1.047 \\ 0.785 \\ 0.628 \\ 0.524 \\ 0.449 \\ 0.393 \\ 0.349 \\ 0.314 \\ 0.286 \end{pmatrix} \frac{1}{s}$$

An important indicator for how the system will perform in different wave conditions is the eigenfrequencies for each part of the system.
Eigenfrequencies represents natural frequency for undamped free vibration of system, and can be found by evaluating the eigenvalues for a second order mathematical system, [19]:

Eigenvalues are found by creating a dynamical matrix D:

$$D := M_{matrix}^{-1} \cdot K_{matrix}$$

Eigenvalues are calculated using software MathCAD:

$$e_{val} := \text{eigenvals}(D)$$

With result:

$$e_{val} = \begin{pmatrix} 2032.635 \\ 0.429 \end{pmatrix}$$

Resonance values are square root of eigenvalues:

$$\text{resonans}_{val} := \sqrt{e_{val}}$$

With result:

$$\text{resonans}_{val} = \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix}$$

As seen the eigenvalue for the two different systems are quite different.
The lowest value, ω=0.66 is likely to occur as this represents barge motion of 9.5 seconds.
When motion from barge meets the resonance frequency peak amplitude is expected.

Response is defined as:

$$\text{Res} = \frac{x_1}{X}$$

Response function for the second order mathematical model, Kristin field:

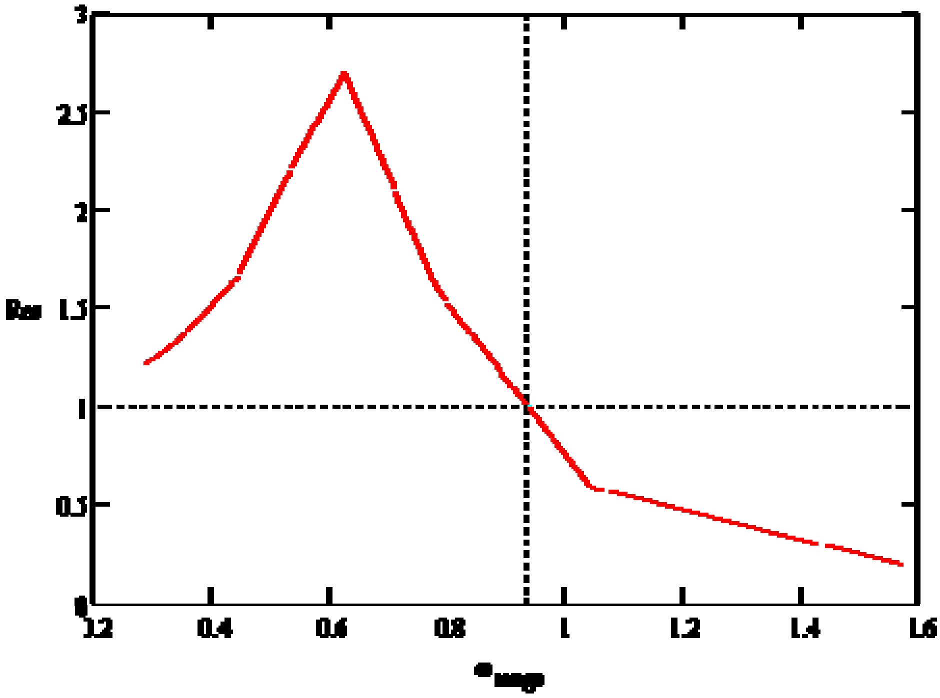


Figure 7.10: Response 2. Order system

Figure shows that the compensator will work well for high motion frequencies. Peak for evaluated values are found at $\omega = 0.628$, this is the closest value to the natural frequency that are evaluated.

To qualify if the highest peak is found in resonance, 5 iterations are performed

$$\omega_{iteration} := \begin{pmatrix} 0.635 \\ 0.645 \\ 0.655 \\ 0.665 \\ 0.675 \end{pmatrix} \qquad Value_{peak} := \begin{pmatrix} 6.19 \\ 6.44 \\ 6.44 \\ 6.22 \\ 5.83 \end{pmatrix}$$

Matrices show that the second order system will have peak response at resonance frequency.

As observed the compensator closes towards 1 for low frequencies. For low frequencies the motion will be so slow that the system will not be able to react. The slowness in the system due to the damping and the compensator stiffness is too high.

The intersection point of dotted lines indicates value for response equal to 1. This value of omega represents the lowest value of omega where the compensator will work. If system excitation has lower frequencies the compensator will not be able to compensate the motion.

$$\omega = 0.97\frac{rad}{s} \; at \; response = 1$$

$$T = \frac{2\pi}{\varpi}$$

$$T = 6.5$$

As observed the given input data gives a compensator limit at period of 6.5s. Value corresponds close to the value found for the fist order mathematical model.

The second order system is under harmonic motion which gives the possibility to evaluate time to system come stable. Figure 5.13 shows that the system use several periods converging to a stable position.

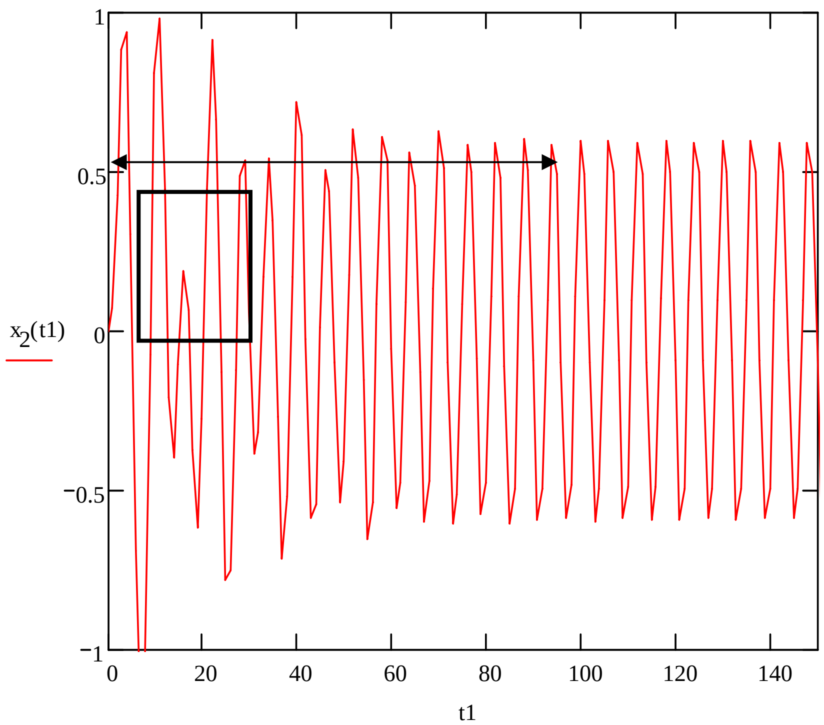


Figure 7.11: System under harmonic motion

Where:

- X_2(t1) is motion of module with respect to t1
- t1 is steps: 1 step is $t_1 = \frac{T1}{1000}$ where T1 is 1000

Such a lag in the system is not preferable, and can mainly be described by two phenomena's:

- Drag damping
- System response to motion

The drag damping is positive in the system as it both decrease resonant motion and reduce the time for the system to become stable.

Figure below shows Response of module (x_2)for drag damping multiplied with 3.

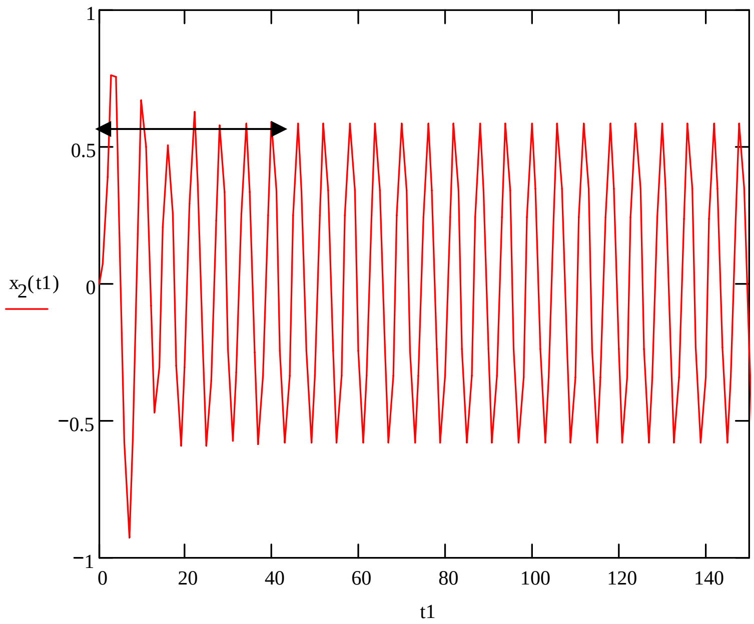


Figure 7.12: System under harmonic motion – increased damping

As observed the time for system to come stable is reduced from approximately 100 steps to 50 steps.
The system becomes more stable with high drag damping.
Damping effect in resonance is evaluated later during the section of varying variables.

The black box in figure 7.12 shows that the peak of the curve is not following a harmonic motion.
In order to try to explain the occurring phenomena, the output signal from the compensator system is analyzed with Fourier theory.

Analysing the output signal into waves with specific frequencies allows us to find which frequencies that occurs in the signal.

Any periodic function x(t) of period τ , can be expressed in the form of a complex Fourier series:

$$x(t) = \sum_{n=-\infty}^{\infty} c_n \cdot e^{in\omega_0 t}$$

where ω0 is the fundamental frequency given by

$$\omega_0 = \frac{2\pi}{\tau}$$

and the complex Fourier coefficients can be expressed by:

$$c_n = \frac{1}{\tau} \int_{\frac{-\tau}{2}}^{\frac{\tau}{2}} x(t) \cdot e^{in\omega_0 t} dt$$

The analysed data (see figure 7.12) are based on an example frequency $\omega = 1.047$.

Resonant frequency for system is:

$$\text{resonans}_{\text{val}} = \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix}$$

The software used for calculations are MathCAD and program need to solve the problem numerically.

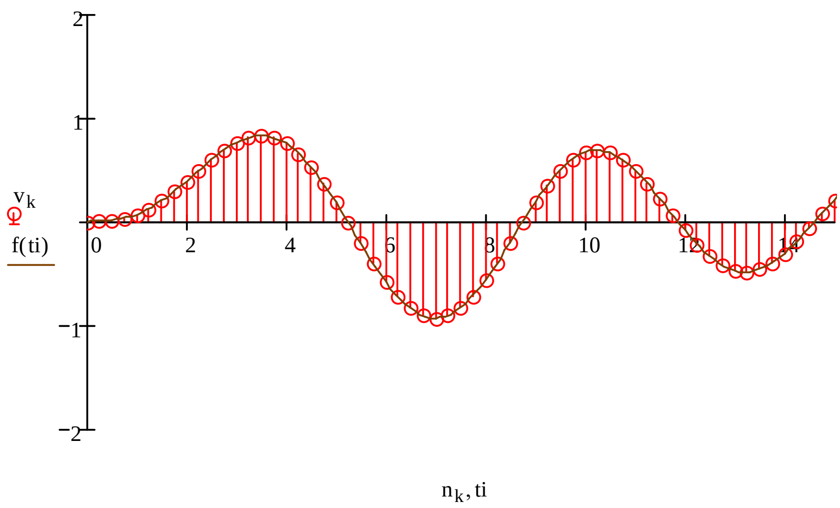


Figure 7.13: Numerical evaluation

Where:

- f is x_2
- V_k is read-off values for Fourier analysis

Input data for Fourier analysis, V_k is from the last figure:

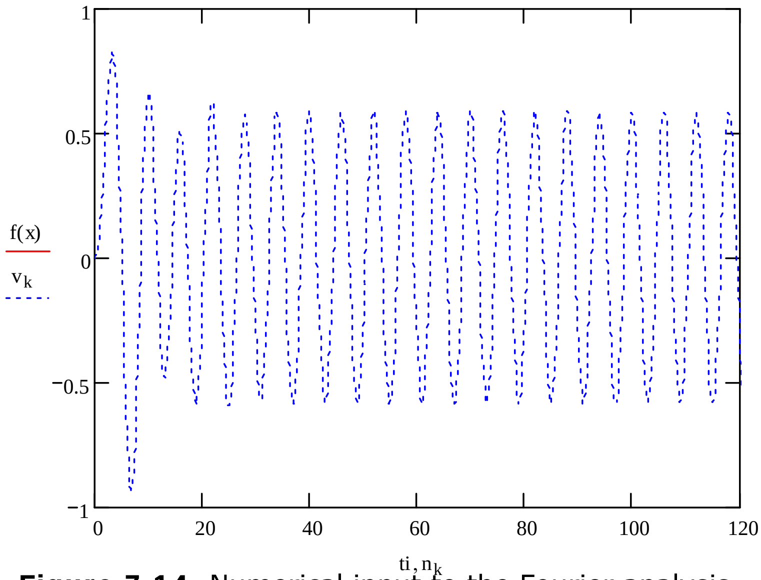


Figure 7.14: Numerical input to the Fourier analysis

By use of Fourier theory and pre-defined functions in the program Fourier frequencies are found.

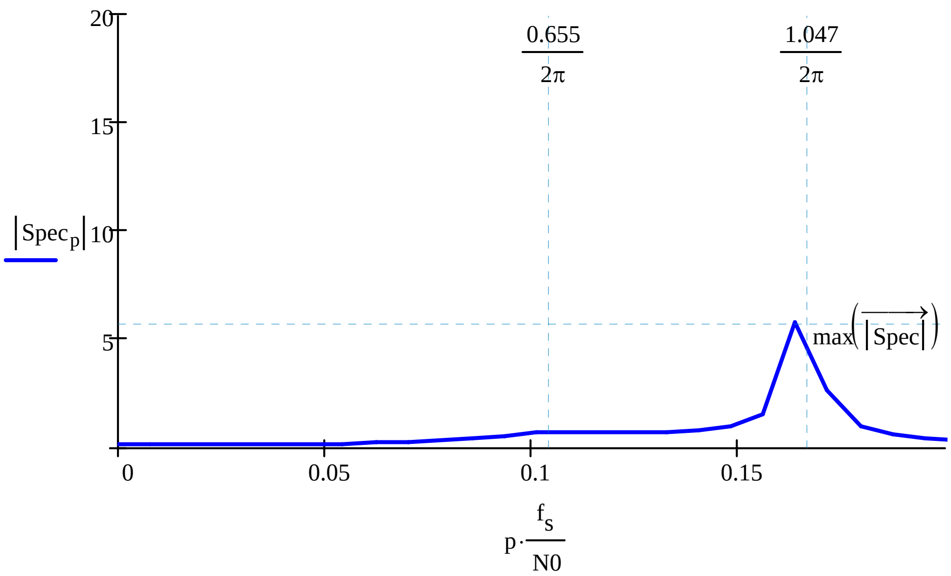


Figure 7.15: Fourier analysis output

The peaks are located at:

$$f_1 = 0.10156$$
$$f_2 = 0.16406$$

$$\omega_1 = 2\pi \cdot f_1 = 0.638$$
$$\omega_2 = 2\pi \cdot f_2 = 1.031$$

The two found frequencies correlate closely to the motion frequency and the system resonance frequency.
Analysis shows that the output signal is dominated by two frequencies. One frequency is of course the motion frequency to system, while the other are calculated to be the resonance frequency.
Conclusion becomes that system is affected by resonance frequency for other frequencies than resonance. A low resonance frequency is both positive to system response and reduces influence to harmonic motion.

Second order system is analyzed with varying input.
Below there are shown figures for changes in the compensator stiffness, compensator damping, drag damping and the module mass.
In those cases where the resonance frequencies change these are also shown.

Varying compensator stiffness

$$Res_{val2kc} := \begin{pmatrix} 46.893 \\ 0.89 \end{pmatrix} \quad Res_{val3kc} := \begin{pmatrix} 48.643 \\ 1.052 \end{pmatrix} \quad Res_{val0.5kc} := \begin{pmatrix} 44.153 \\ 0.473 \end{pmatrix} \quad Res_{val0.3kc} := \begin{pmatrix} 43.775 \\ 0.369 \end{pmatrix}$$

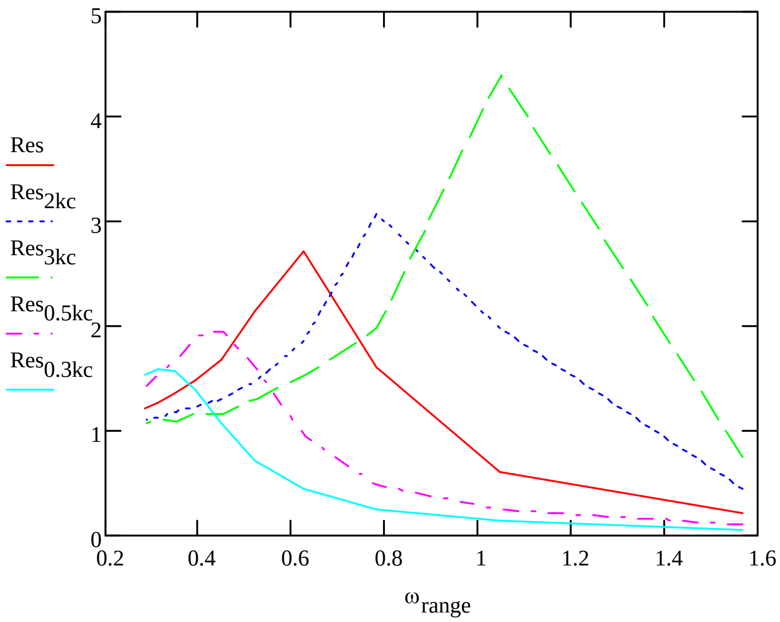


Figure 7.16: Varying compensator stiffness

Varying compensator damping

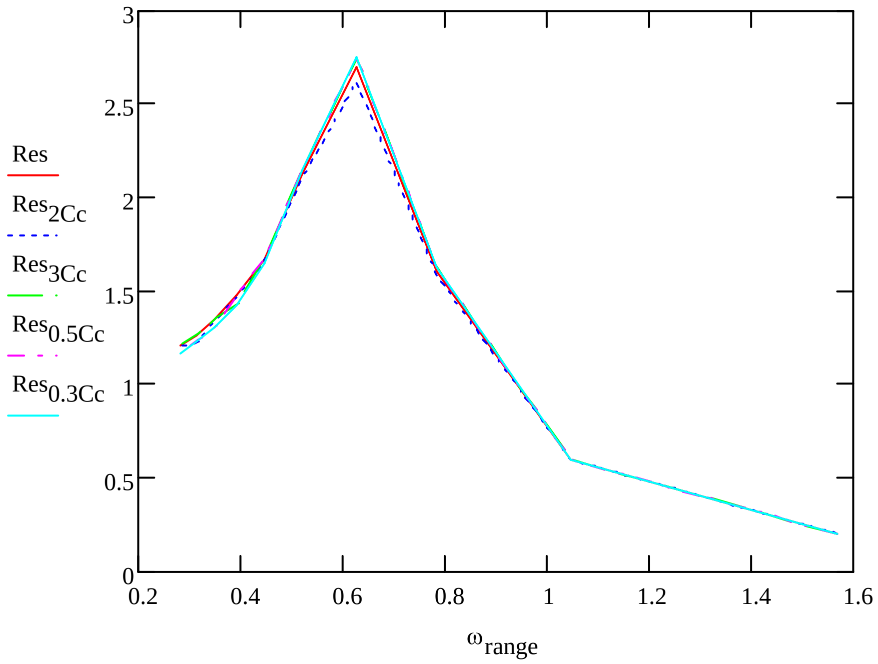


Figure 7.17: Varying compensator damping

Varying drag damping

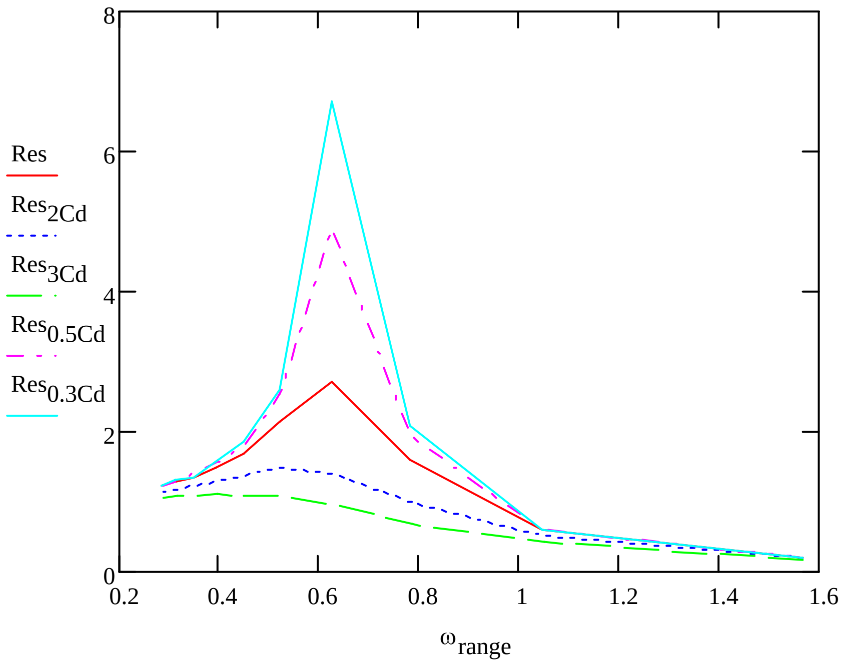


Figure 7.18: Varying drag damping

Varying module mass

$$Res_{val2M} := \begin{pmatrix} 45.058 \\ 0.463 \end{pmatrix} \quad Res_{val3M} := \begin{pmatrix} 45.049 \\ 0.378 \end{pmatrix} \quad Res_{val0.5M} := \begin{pmatrix} 45.058 \\ 0.856 \end{pmatrix} \quad Res_{val0.3M} := \begin{pmatrix} 45.058 \\ 1.193 \end{pmatrix}$$

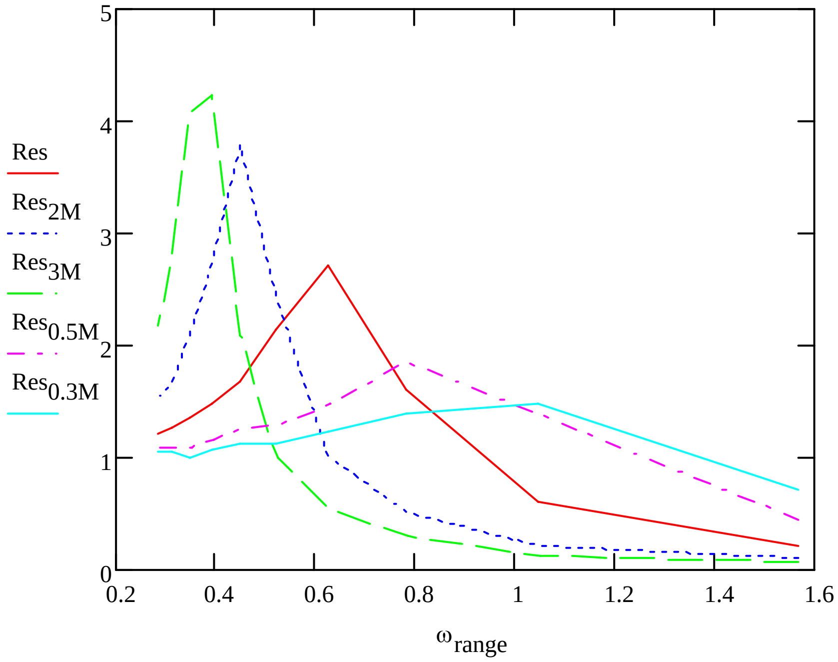


Figure 7.19: Varying module mass

Varying compensator mass

$$Res_{val2Mc} := \begin{pmatrix} 31.917 \\ 0.654 \end{pmatrix} \quad Res_{val3Mc} := \begin{pmatrix} 26.091 \\ 0.653 \end{pmatrix} \quad Res_{val0.5Mc} := \begin{pmatrix} 63.722 \\ 0.655 \end{pmatrix} \quad Res_{val0.3Mc} := \begin{pmatrix} 78.028 \\ 0.655 \end{pmatrix}$$

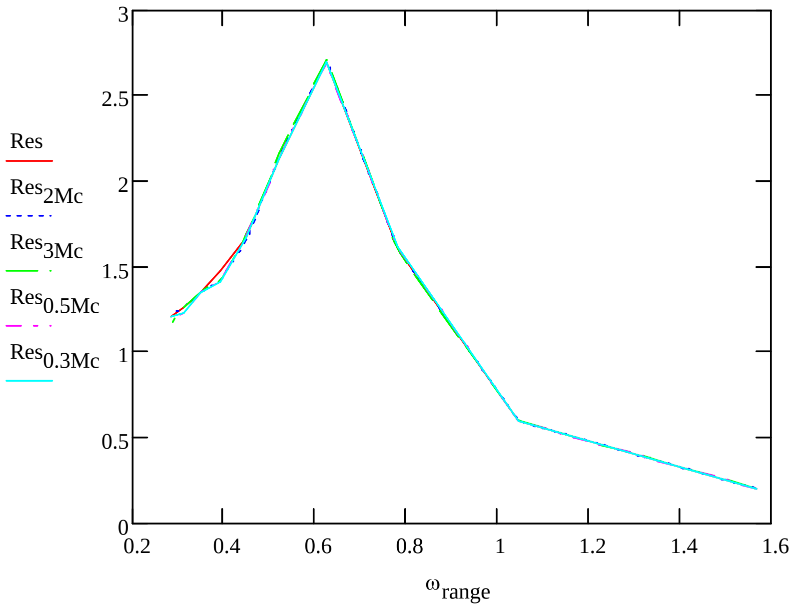


Figure 7.20: Varying compensator mass

Analysis performed shows how the changing variables affects the system. The responses are quite the same as for the first order models.

It can be concluded that the performance of system highly depends on the resonance frequency.
It is the compensator stiffness and the mass of module that has the largest effect on the compensator performance.
The resonance frequencies for system are found by calculating the eigenvalues, which gives possibility to evaluate the coupled system. The resonance frequency decides for which frequency the peak will occur and with that for which frequencies the response will be below zero.

Both drag and compensator damping affects the system for frequencies close to the resonance frequency only and decreases the time for system to come stable.

For varying compensator mass the system compensator does not change response at all. Compensator mass are small compared to the module mass and are not able to change the response.

One of the benefits with the second order model is the possibility to implement crane wire stiffness.
Requirements for the barge are operations at Kristin field and Girassol field, 350m WD and 1300m WD.

$$M = 2231 ton$$

$$k_w = 3009 \frac{kN}{m}$$

All calculations presented above are performed with crane wire stiffness and crane wire weight for Kristin field.

Results from the calculations at Girassol field are:

$$\text{resonans}_{val} = \begin{pmatrix} 25.869 \\ 0.58 \end{pmatrix}$$

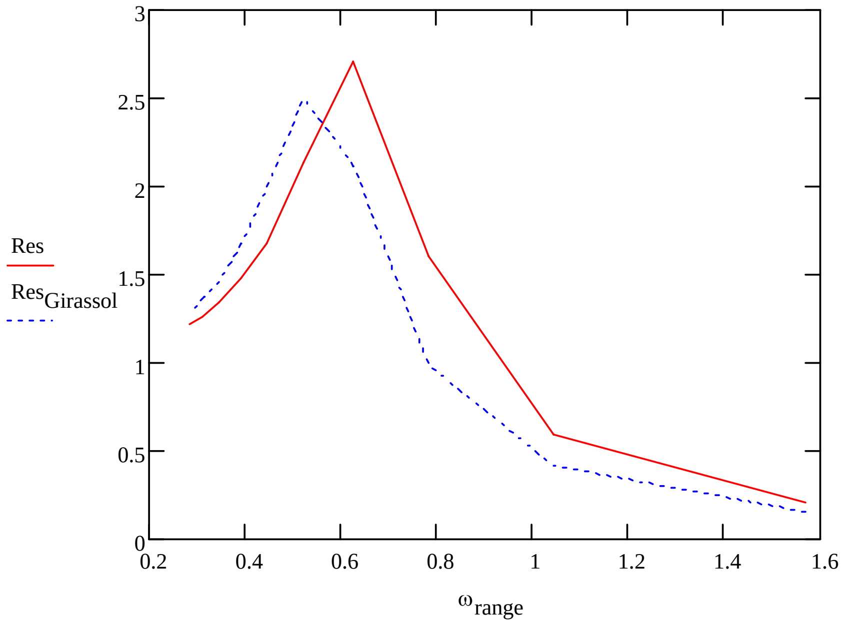


Figure 7.21: Varying water depth

As observed the crane wire stiffness does affect both position on x-axis and the peak value. Red curve is Kristin and Blue is Girassol.
Resonance period is calculated to be ω=0.592 where this value is not evaluated in the interval. To qualify that resonance frequency gives highest peak 5 iterations shows:

$$\omega_{iterate} \begin{pmatrix} 0.55 \\ 0.56 \\ 0.57 \\ 0.58 \\ 0.59 \end{pmatrix} \qquad Res_{Girassol} := \begin{pmatrix} 2.50 \\ 2.55 \\ 2.50 \\ 2.46 \\ 2.45 \end{pmatrix}$$

Compensator response changes due to the varying water depth and the crane wire mass. Analysis shows that assuming crane wire stiffness to be infinite stiff will give a more conservative compensator response.

7.4 COMPARISON OF MODELS

This report contains 3 analyses of the different mathematical models. All calculations are presented in the previous chapters.

Figure 7.22 show response for the three models with input data specified in chapter 6.3

- Red line is the second order model
- Blue line is the transfer function model
- Green line is the harmonic motion model

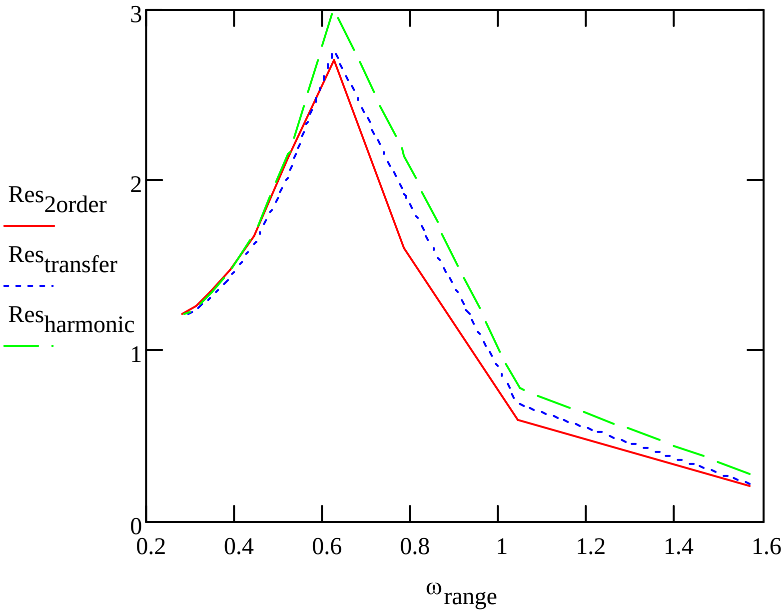


Figure 7.22: Comparison of models

As seen the values corresponds closely to each other. The harmonic model is the most conservative.
It can be concluded from this graph that all three models are usable in finding the residual motion for the module. As seen in analysis of the different models, the results when changing variables also corresponds well. Harmonic motion model gives a lower peak in resonance than for the other models.

Results are based on theoretical evaluations of a physical system. Due to lack of experienced data for passive compensator, results are not compared to physical performance of a constructed system.
Model test should be performed to qualify the models before design and construction of system.

For a given installation case it is not possible to change all kinds of input data that done in this report.

Fixed inputs are:

- Module mass
- Drag damping, calculated from module
- Compensator damping, value for given designed system
- Wire stiffness, wire is designed for the given system
- Compensator mass, value for designed system

The only variable that can be changed is the compensator stiffness.

According to 6.1.3 compensator stiffness is defined by pressure and volume of gas in accumulator

Gas pressure is changed due to module weight, and volume is changed to get the required compensator stiffness.

Figure 7.23 show how changes in stiffness varying response for the three evaluated systems:

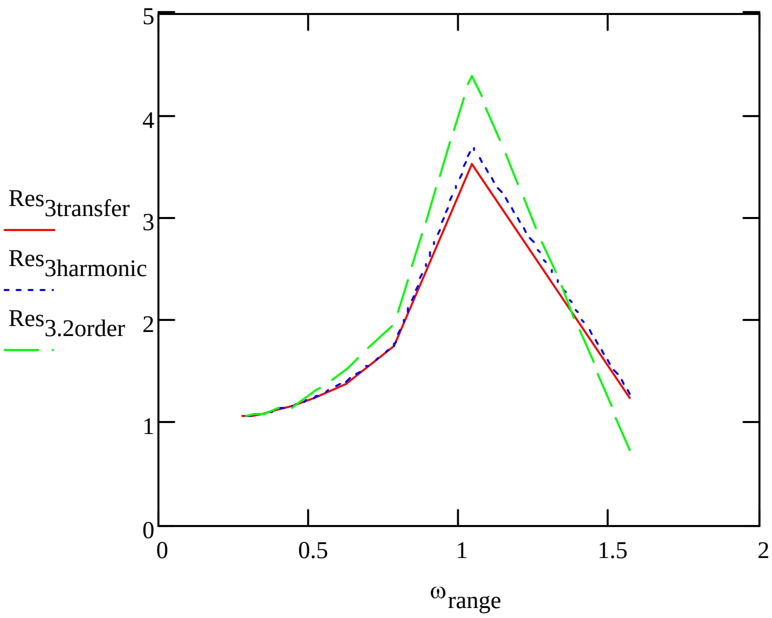


Figure 7.23: Compensator stiffness times 3

Figure show the response for compensator 3 times higher than defined in chapter 6.3.

Evaluated compensator stiffness: $k_c = 3000 \frac{kN}{m}$

With this stiffness the compensator becomes useless, as response is above 1 for all evaluated values.

Figure 7.24 shows the response with compensator stiffness 70% lower than in defined value in chapter 6.3.

Evaluated compensator stiffness: $k_c = 300 \frac{kN}{m}$

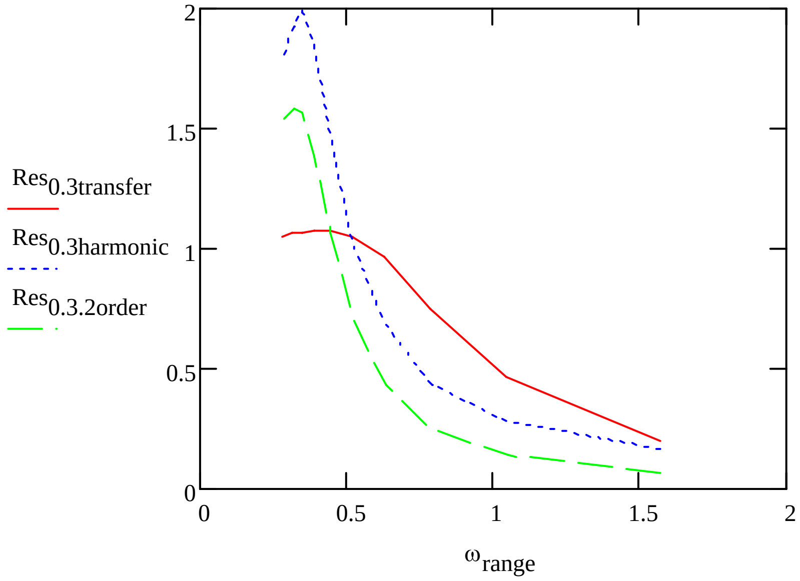


Figure 7.24: 70 % lower compensator stiffness

As observed the three models correlates for the evaluated frequencies. The second order model is more conservative with low compensator stiffness.

The method of passive compensation has been thorough investigated in this report, and limitations have been discovered. The system works best with heavy module weight and when exposed to high frequencies.

Most systems in the industry today are semi-active, and generally these systems should perform better.
As explained in chapter 5.1.3 these systems are based on passive systems to hold the static load, but uses an active part to improve the compensation performance.

Figure 7.23 shows measured data for a semi-active heave compensation system found in reference [18].

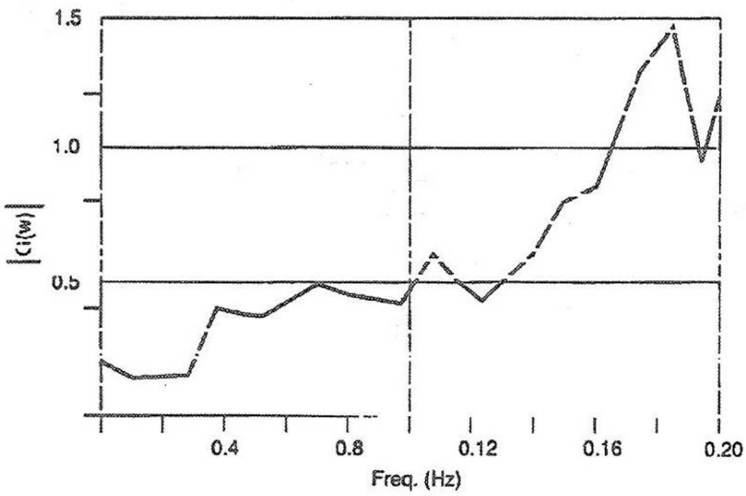


Figure 7.25: Performance of Active Heave Compensator [18]

Where:

- Y-axis is computed response between vertical load motion and top motion
- X-axis is frequencies given in hertz

The figure can not be used to compare the actual residual motion; as we do not know enough about the system. System performance gives a clear indicator that system has a different characteristic.
The semi-active system works best for low frequencies, and will in some cases amplify the motions in regions where the passive compensation will work very well.

This is in contrast to the passive compensator that works best for high frequencies.

7.5 TENSION RELATION DURING COMPENSATION

The previous subchapters presented the efficiency of the compensator with changing variables. This section will give an overview of how the tension variates in crane wire.

Figure 7.26 shows how stroke is executed due to tension in system. Position S_1 shows system with static load. Up to this point position changes is due to the wire stiffness.
Position change from S_1 up to S_2 requires a small change in tension, which corresponds to the purpose of a compensator. Position change is determined by the stiffness of the compensator spring.
S_2 represents the maximum stroke of compensator, and a position change beyond this point will be in the lifting wire.
Point S_2 should never be reached during operation.

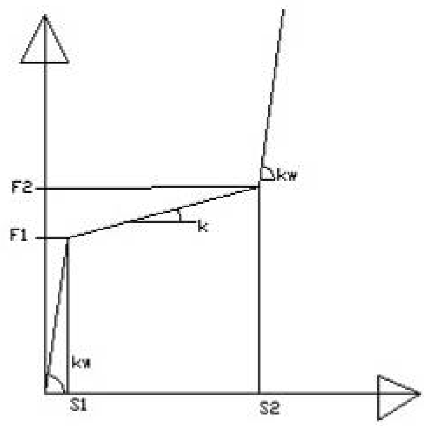


Figure 7.26: Tension relation of compensator and lift wire [22]

A compensation cycle between S_1 and S_2 can be presented simplified with figure 7.27.
The figure includes both damping and friction and shows how the tension in crane wire is due to stroke of compensator.

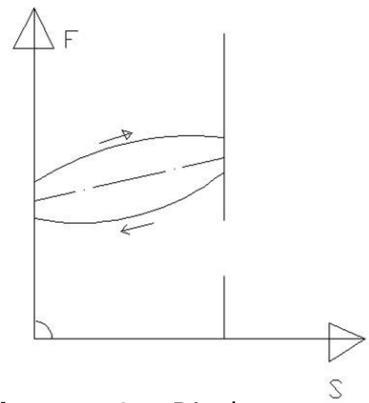


Figure 7.27: Displacement – tension relation of compensator [22]

A simplified case for the modelled compensator is presented in figure 7.28. The compensator damping is not calculated, and the compensator stiffness is linear. This is according to assumption presented in chapter 6.3.

Model input:

- Kristin field 350m WD
- Crane wire stiffness $k_w = 11167 \dfrac{kN}{m}$
- Compensator stiffness $k_c = 1000 \dfrac{kN}{m}$
- Static hook load: Module mass + crane wire weight

$$M_M = 500ton$$
$$M_{CW} = 35ton$$
$$F = (500ton + 35ton) \cdot 9.81 \frac{m}{s^2}$$
$$F = 5248kN$$

Calculations are performed in appendix A.

Tension in lift wire is calculated including both wire and compensator stiffness. The damping influence will affect the shown graph in the same way as for figure 5.21.

Where:

- F_0 is zero
- F_1 is static load
- F_2 is compensation mid
- F_3 is compensation end
- F_4 is override of compensator

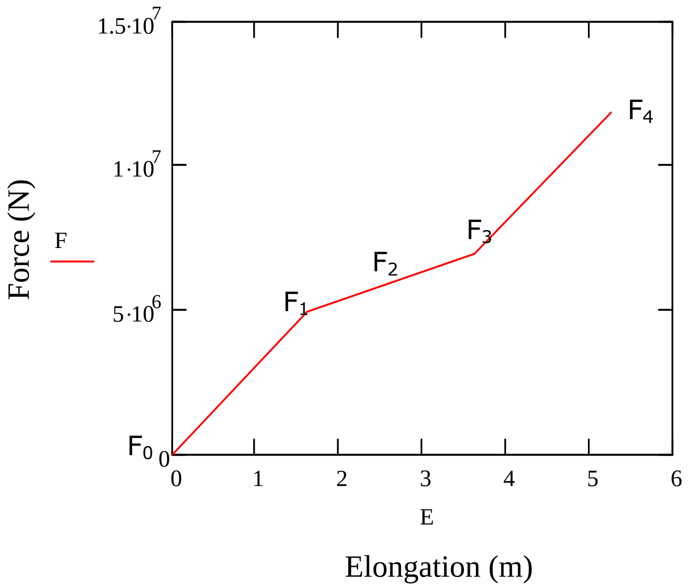


Figure 7.28: Tension during compensation

$$F = \begin{pmatrix} 0 \\ 5250 \\ 6250 \\ 7250 \\ 12500 \end{pmatrix} kN \qquad E = \begin{pmatrix} 0 \\ 1.75 \\ 2.75 \\ 3.75 \\ 5.5 \end{pmatrix} m$$

8. OPERATIONAL STUDY

All analysis's in this chapter is performed according to the results from the second order model presented in chapter 7.1.3.

8.1 WAVE ENERGY SPECTRUM

The operational requirement is to perform installation operations in the North Sea and outside West Africa.
The weather conditions for these areas are different, the North Sea is dominated by more short waves than West Africa. Operational performance is calculated for the Kristin field in North Sea and the Girassol field outside West Africa.
When evaluating each field the see state is the only variable since it is seen as the limiting factor.. Wind and current loads are not evaluated in this analysis.

All the weather information is based on information from Acergy internally and un-published documents and weather-reports supplied by clients, so no references to published papers are therefore given.

In order to evaluate the system performance at the two fields, the wave energy calculations and the wave height probability analysis are used.

The energy in a wave spectrum can be defined with the JONSWAP spectrum, where the energy is a variable of the wave frequency.

The JONSWAP function can be defined with the following formula.

$$S(f) = 0.3125 H_{mo}^2 T_p (\frac{f}{f_p})^{-5} \exp(-1.25(\frac{f}{f_p})^{-4})(1-0.287\ln\gamma)\gamma^{\exp(-0.5(\frac{\frac{f}{f_p}-1}{\sigma})^2)}$$

Where:

- f is frequency $f_p = \frac{1}{T_p}$
- $\sigma = 0.07 \ for \ f \leq f_p \ and \ \sigma = 0.09 \ for \ f > f_p$
- γ (gamma) is the peaked ness parameter (see below)
- H_{mo} is significant wave height
- T_p is spectral peak period

The JONSWAP analysis method is useable for both the North Sea and for West Africa.

The following inputs are used for the two areas.

	North Sea	West Africa
Gamma factor	1	2
H_m	2m	2m
T_p	11s	15s

Table 8.1: JONSWAP spectra input

The JONSWAP spectra for the two areas becomes – simplified by σ=0.07 for all values. The curves show the energy in the waves, S(f) is for North Sea while S2(f) is for West Africa.

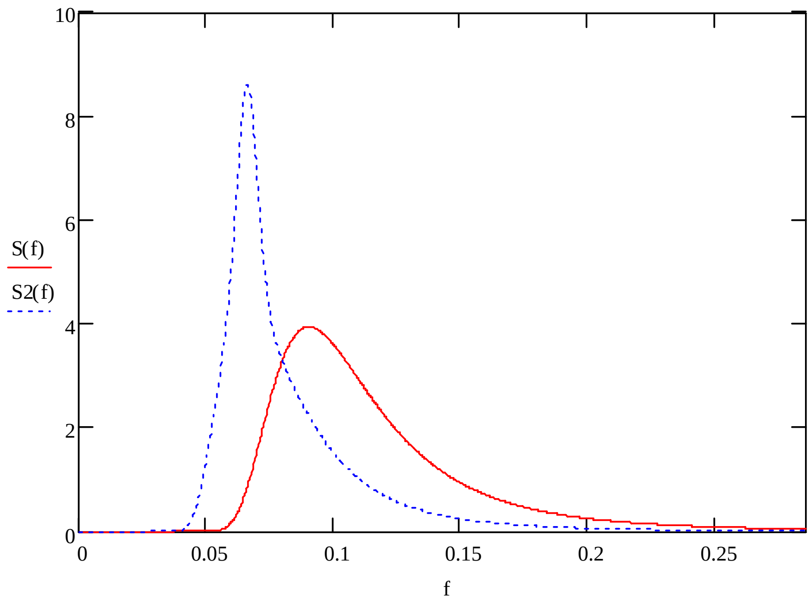


Figure 8.1: JONSWAP spectra for North Sea and West Africa, 2m Hs

8.2 KRISTIN FIELD

MOSES software calculates the velocity for the barge in the JONSWAP spectrum with respect to frequencies.
The motion response for the barge at the Kristin field:

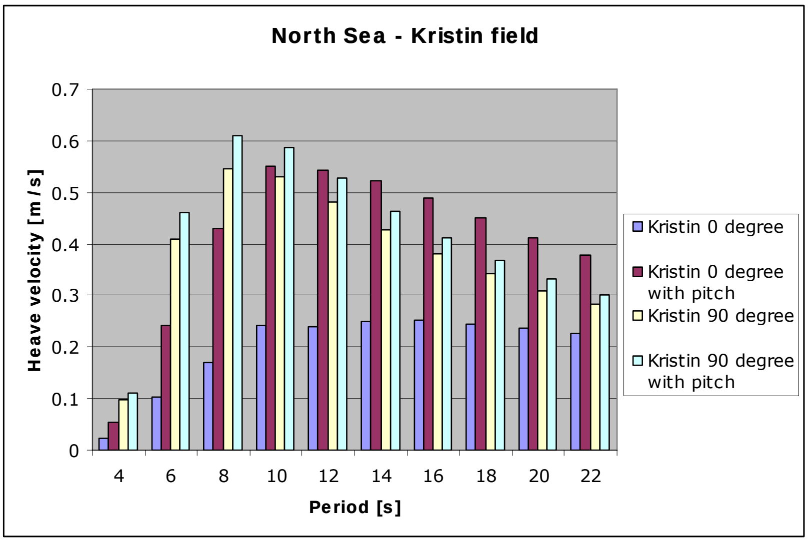


Figure 8.2: Motion velocities Kristin field

Figure 8.2 shows the heave velocity for the barge at the Kristin field at 1m wave height. The graph shows velocity for:

- The heave velocity
- The summed velocity of heave and pitch

The pitch velocity should be included into design sea state as lifting point is different to barge centre in longitudinal direction. This will take into account for the situations were barge responds to both maximum heave and maximum pitch.

As observed the pitch velocity contributes much in 0 degree heading.

Maximum seabed landing speed is 0.5 m/s.

The idea for the compensator is to reduce heave and velocity of module to increase operational Hs.
Compensator response is dimensionless and can be used to find module velocity after compensation.

Compensator response, second order, for Kristin field with initial inputs:

$$T_p := \begin{pmatrix} 4 \\ 6 \\ 8 \\ 10 \\ 12 \\ 14 \\ 16 \\ 18 \\ 20 \\ 22 \end{pmatrix} \qquad Res := \begin{pmatrix} 0.2 \\ 0.59 \\ 1.6 \\ 2.7 \\ 2.13 \\ 1.67 \\ 1.47 \\ 1.34 \\ 1.26 \\ 1.21 \end{pmatrix}$$

As discussed earlier the compensator does not work for periods above 6.7 seconds. Observed from figure 8.2 this does not increase the operational window since compensator does not reduce the largest velocities.

For a 70% reduction in compensator stiffness the response becomes:

$$T_p := \begin{pmatrix} 4 \\ 6 \\ 8 \\ 10 \\ 12 \\ 14 \\ 16 \\ 18 \\ 20 \\ 22 \end{pmatrix} \qquad Res_{0.3.2order} := \begin{pmatrix} 0.06 \\ 0.134 \\ 0.25 \\ 0.44 \\ 0.71 \\ 1.07 \\ 1.39 \\ 1.57 \\ 1.58 \\ 1.53 \end{pmatrix}$$

As observed the response for compensator changes and compensator limit are now just below 14s.

Figure 8.3 shows the heave velocities at Kristin with compensator.
Both 0 degree and 90 degree heading are implemented with compensator.

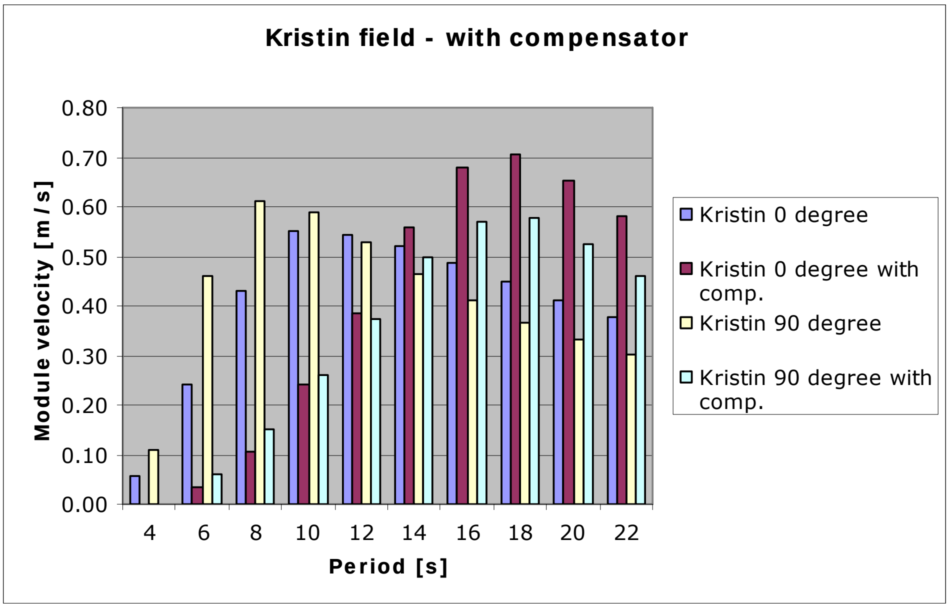


Figure 8.3: Kristin field – with compensator

As observed the compensator reduces velocity for values up to 12 seconds and reduction is quite large. As the compensator does not work for periods from 14 seconds and above, it will not be used for these periods.

Problem is that compensator is not able to reduce the velocity for high periods, where large velocities occur.

Given compensator does not increase the operational window significantly. This makes a compensator that does not work.

As seen from analysis in chapter 7 it is possible to increase compensator performance by adjusting variables. Compensator stiffness should be designed to match performance of working platform, in this case the barge.

8.3 GIRASSOL FIELD

Motion response for barge at Girassol field, from MOSES analysis:

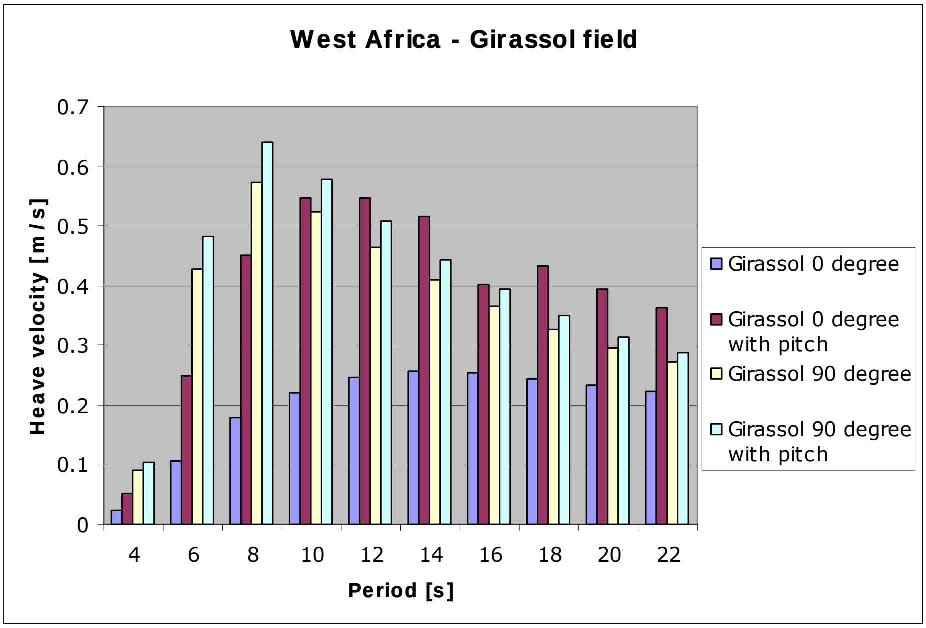


Figure 8.4: West Africa – Girassol field

Figure shows velocities for barge at Girassol location outside West Africa at 1m Hs. The numbers are closely related to the ones for the North Sea.

As observed the barge is not usable for module installations because of high velocities.

By including a compensator we should be able to increase the weather window for barge. Two variables for compensator stiffness are used; define value and 70% reduction.

$$T_p := \begin{pmatrix} 4 \\ 6 \\ 8 \\ 10 \\ 12 \\ 14 \\ 16 \\ 18 \\ 20 \\ 22 \end{pmatrix} \qquad Res_{Girassol} := \begin{pmatrix} 0.15 \\ 0.41 \\ 0.98 \\ 2.12 \\ 2.50 \\ 1.98 \\ 1.66 \\ 1.45 \\ 1.36 \\ 1.28 \end{pmatrix} \qquad Res_{0.3Girassol} := \begin{pmatrix} 0.05 \\ 0.12 \\ 0.22 \\ 0.39 \\ 0.61 \\ 0.92 \\ 1.51 \\ 1.6 \\ 1.6 \\ 1.58 \end{pmatrix}$$

As observed compensator with initial defined variables have poor performance. The compensator does not work for periods above 8 seconds.

With 70% decreased compensator stiffness the result looks quite different. Compensator now works for periods up to 14 seconds, which is 2 seconds higher than for the North Sea. Figure 8.5 shows compensator performance for 0 and 90 degree heading at Girassol field.

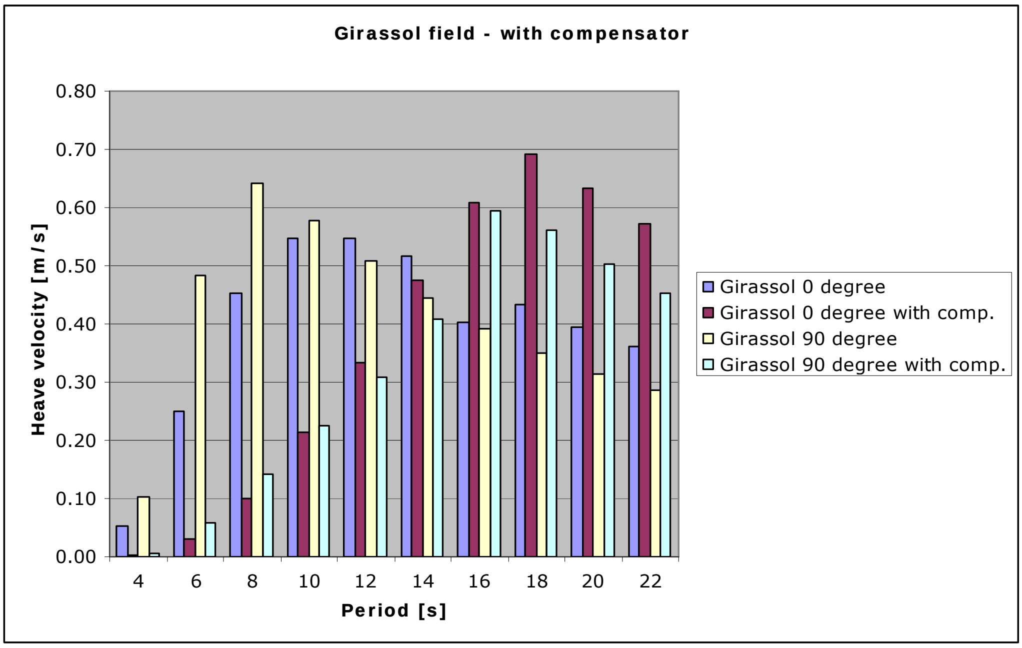


Figure 8.5: Girassol field – with compensator

As observed highest velocity is at the same period for the North Sea, but the value is higher.

Figure 8.6 shows operational compensator at Girassol field, performance of the compensator is set to be 1 above limit.

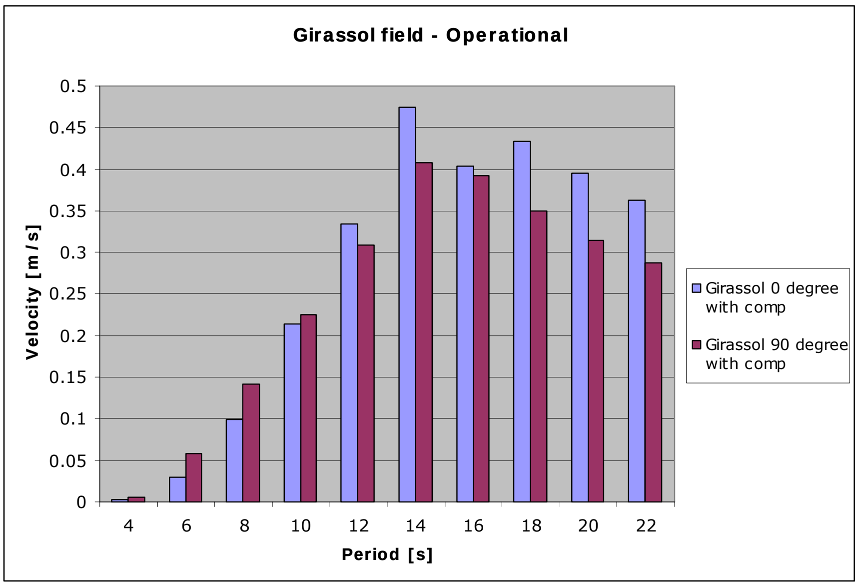


Figure 8.6: Girassol field – Operational compensator

As observed in figure the compensator is able to qualify 1m Hs as the operational window. Observations give that the velocity are low up to 12 second, while it close to 0.5 m/s for above periods.

The graph in figure 8.7 shows the probability for actual Hs in the summer months (June, July and August) and on an all year basis.

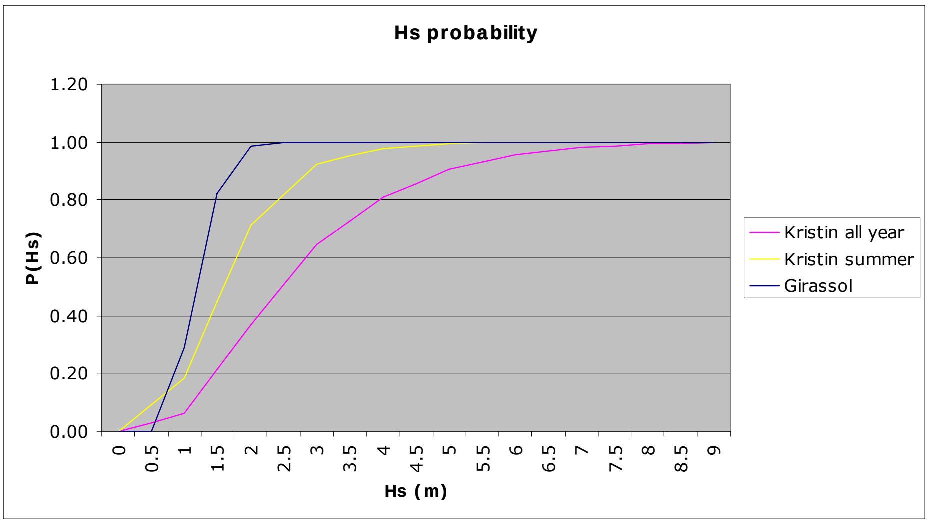


Figure 8.7: Hs probability, Girassol and Kristin field

As observed the sea state is much rougher in the North Sea than outside West Africa. An installation criterion of 1m Hs. is very low in the North Sea, while it gives almost 50% probability of installation outside West Africa.

It is possible to increase operational weather window by setting a criteria for maximum wave period.
Following the JONSWAP spectrums in figure 8.1 this will work best for the North Sea since peak period is lower there than for West Africa (see table 8.1).

Compensator performance should be designed to meet requirements for operation. The compensator defined with input data from chapter 6.3 does not for either in the North Sea or in West Africa.
By decreasing compensator stiffness performance can be improved.

9. CONLUSIONS

9.1 BARGE DESIGN

The barge designed in this report is well suited for heavy lift operations. With its large size it is possible to mobilize to off modules at one time, and the moonpool reduces hydrodynamic forces on module.
The barge is suited with a module handling system for safe and efficient handling

The RAO's for the barge is evaluated by use of marine calculation software MOSES, where the results are not the way that we could predict.
Much work is done in to quality assurance for the presented RAO's, but still the results are strange.
The results for both 0 and 90 degree heading have some peaks that the author is not capable of establish reasonable arguments fro. The results are compared to both wavelengths and calculations for the moonpool, but the results still are strange.
When the barge is evaluated without a moonpool, the results look very good and are easily comparable to other large vessels.
Software has its limitations and the analyses show that the program may not be capable of calculating RAO's for vessels with such large moonpools.
This statement follows indications given by colleagues when performing the work.

Barge with and without moonpool is calculated for motion response in North Sea and West African areas.
Since the responses for barge with moonpool can not be qualified, results from barge without moonpool are used in operational analysis.
Compared to other monohull vessels responses are closely correlated an data gives a realistic overview of the actual situation.

Much work is still left designing a barge for moonpool installation of large modules, but calculated values are usable to evaluate heave compensator system presented in this report.

9.2 PASSIVE HEAVE COMPENSATOR SYSTEM

The weight of the installed subsea modules have increased with the technology development. The report discusses the installation of a 1000 ton module from a barge, through the moonpool with passive compensation.

Mathematical models for passive heave compensation designed in chapter 5 have been proven to work well. Two different systems are evaluated; two first order system and one second order system.

The input data is a combination of calculated and assumed values. The scope of work requirements used for installation of the Tordis module has been used as reference for the input data.
Some values are assumed to be able to calculate the mathematical models.
The values are used for numerical calculation of compensator, where the residual motion is evaluated for varying variables.
The motion input is harmonic and represents the excitation of system from the barge.

The first order system is evaluated by two models and is simplified to only include one mass. This allows the use of relatively simple modelling techniques, but the flexibility has decreased. The models can only be evaluated for infinite stiff crane wire.
The models used are described by two different theories, transfer functions and motion of equation.
The two models correlate closely and the motion of equation proves to be most conservative. The models are evaluated with defined input data and results in a compensator that only works for high frequencies. The limit for the compensator is set to be where the residual motion is equal to the excited motion.
Damping motion from the drag and the compensator affect response only in resonance and have a small impact below response of 1.
Further the resonance frequency is decided by the crane wire stiffness and the module mass has a big impact on the system. The resonance frequency should be as low as possible. A low resonance frequency gives a good compensator performance.

The second order system implements some of the assumptions in the first order model, and a more physical correct result is expected.

The Model uses more variables in the system design and is represented by two masses. The model implements the crane wire stiffness, not covered by the first order models.

The calculated results show a close a correlation between the three models.
The compensator works best for high frequencies and some differences are found in the resonance area.
The performance of the model follows the same as for the first order model, but the drag impact on the system stability is also evaluated with this model.
A high drag damping makes the system more stable as it requires less time to come into a stable harmonic motion.

In the time domain analysis for single frequency, analysis has been used to explain the residual motion.
It follows that the natural frequencies occur in the output signal for frequencies different from the resonance. This affects the system stability.

All models evaluated give almost the same response for the analysed passive compensator. The evaluated compensator works best for high frequencies.
The second order model is expected to be the most accurate as it implements more variables, while the harmonic motion gives the most conservative result.

The results are not compared to measurements of a physical constructed compensator. The mathematical models should be evaluated with models test before it is used to design a compensator.

Compared to the measurements of a semi-active system the passive compensator works best for opposite frequencies. The evaluated semi-active compensator proves to work best for low frequencies.

9.3 OPERATIONAL

The operational analysis is performed by use of JONSWAP wave spectra's for the two areas North Sea and West Africa. The barges design works very well for installation operations in calm weather at the two specific locations.

In the North Sea the barges response to waves are reduced by the very large size of the barge. The waves that occur in the North Sea have a lower peak value compared to West Africa where this fits the response curves for both barge and compensation system well.

In planning operation

10. REFERENCES

[1] Acergy Norway AS and clients, Confidential Reports, 2008

[2] Offshore.no, Article 26.06.2007, (last checked 11.06.08) http://offshore.no/nyheter/sak.aspx?Id=18033

[3] FMCTechnologies, Tordis field info (last checked 11.06.08) http://www.fmctechnologies.com/Subsea/Projects/Norway/StatoilTordis.aspx

[4] Heerema Marine Contractors, picture of Thialf, (last checked 11.06.08) http://hmc.heerema.com/Corporate/Fleet/Thialf/tabid/378/Default.aspx

[5] Ulstein, T.K, Presentation Subsea Lifting Operations 2007 Wet tow of subsea templates, 2007

[6] Massie W. W. and Journée J.M.J, Course Syllabus Offshore Hydromechanics, Delft University of Technology, January 2001

[7] Thomas C. Gillmer and Bruce Johnson (1982), Introduction to naval architecture, E. & F. N. Spon Ltd

[8] Gudmestad O.T., Stabilitet, Lecture notes in Marine Technology, University of Stavanger 2007

[9] Møllstre, A, Presentation Subsea Lifting Operations 2007 Subsea Module Handling System (Deep Ocean), 2007

[10] Sandvik, P.C, COSMAR Moonpool dynamics, SINTEF Trondheim April 2007

[11] Sphaier, S.H., Torres, F.G.S, Masetti, I.Q., Costa, A.P., Levi, C., Monocolumn behaviour in waves: Experimental analysis, CENPES-Petrobas Brazil, 2006

[12] TTS Offshore Handling Equipment, Anchor Handling Winches, (last checked 11.06.08) http://www.tts-marine.com/upload/3515/Brochure%20TTS-OHE%20AHT%20Winches.pdf

[13] Ultramarine, MOSES manual (last checked 11.06.08) http://www.ultramarine.com/hdesk/document/ref_man.htm

[14] Personal communication with Acergy colleagues

[15] Van Raaij, E., Presentation Subsea Lifting Operations 2007 Lessons learnt during suction anchor and template installations from a geotechnical viewpoint, 2007

[16] Andreassen, A.L, Presentation Subsea Lifting Operations 2007 Use of Cranemaster for Seabed Retrievals, 2007

[17] Hydralift, Intelligent load handling, presentation at Acergy Norway AS, 2008

[18] Nielsen F.G, Lecture Notes – SIN 1546 Marine Operations, NTNU 2003

[19] Rao S.S, Mechanical Vibrations Fourth Edition, Prentice Hall ISBN 013-196751-7, 2004

[20] DNV, Rules For Planning and Execution of Marine Operations, 1996

[21] Personal communication with Rune Stigedal, June 2008

[22] MACSI software manual, Marintek Trondheim

[23] Redaelli, Flexpack data sheet, 2008 (last checked 11.06.08) www.redaelliwireropes.com/prodotti/prodotti.htm

[24] Faltinsen, O.M, Sea loads on ships and offshore structures, Cambridge ISBN 0-521-45870-6, 1998

[25] Oiltech, Hydropneumatiske Akkumulatorer, (last checked 11.06.08) http://www.oiltech.no/pdf/Akkumulatorbok_Oiltech.pdf

10.1 ADDITIONAL REFERENCES IN APPENDIXES

Appendix A – 1. Order Mathematical Models:

[1] Rao S.S, Mechanical Vibrations Fourth Edition, Prentice Hall ISBN 013-196751-7, 2004

[2] Nielsen F.G, Lecture Notes SIN 1546 Marine Operations, NTNU 2003

[3] Personal communication with Professor Jasna B. Jakobsen, May 2008

[4] Personal communication with colleague Rune Stigedal, May 2008

[5] Personal communication with colleague Gabriel Grødem, May 2008

Appendix B – 2. Order Mathematical Model:

[6] Rao S.S, Mechanical Vibrations Fourth Edition, Prentice Hall ISBN 013-196751-7, 2004

[7] Nielsen F.G, Lecture Notes SIN 1546 Marine Operations, NTNU 2003

Appendix C – Moonpool Calculations:

[8] Sandvik, P.C, COSMAR Moonpool dynamics, SINTEF Trondheim April 2007

Appendix D – Moonpool barge RAO's and Motion Characteristics:

[9] RAO and vessel motion report made with marine analysis program MOSES. Ultramarine Inc.

Appendix A

1. Order Mathematical Models

Appendix A
1. Order Mathemathical Models

References:

/1/ Rao S.S., Mechanical Vibrations Fourth Edition, Prentice Hall
ISBN 013-196751-7, 2004

/2/ Nielsen F.G., Lecture Notes SIN 1546 Marine Opeations, NTNU 2003

/3/ Personal communication with Professor Jasna B. Jakobsen, May 2008

/4/ Personal communication with colleague Rune Stigedal, May 2008

/5/ Personal communication with colleague Gabriel Grødem, May 2008

1. Input

$ton := 1000kg$

Motion amplitude $A_m := 1$

Mass of module $M_m := 500000kg$

Added mass $M_a := 1600000kg$

Compensator stiffness $k_c := 1000\frac{kN}{m}$

System design period

$$T_p := \begin{pmatrix} 4 \\ 6 \\ 8 \\ 10 \\ 12 \\ 14 \\ 16 \\ 18 \\ 20 \\ 22 \end{pmatrix} \cdot s$$

Heave velocity of barge

$$V_H := \begin{pmatrix} 0.06 \\ 0.24 \\ 0.43 \\ 0.55 \\ 0.54 \\ 0.52 \\ 0.49 \\ 0.45 \\ 0.41 \\ 0.38 \end{pmatrix} \cdot \frac{m}{s}$$

reference RAO in appendix D

1.1 Calculation of mass of compensator system

The mass of compensator system is total weight the elements that moves during compensation, including:

- sheave
- piston
- piston rod
- accumulator piston
- hydraulic oil

Assumed weigth of steel components:

$M_{steel} := 3ton$

Assumed weight of oil

$M_{oil} := 3ton$

Mass of compensation system

$M_{comp} := M_{steel} + M_{oil}$

$M_{comp} = 6\,ton$

1.2 Crane wire

In the dynamical model the crane wire is seen as a spring with a defined wire stiffness, where the spring constant varies with water depth.

$$k_{wire} = \frac{E \cdot A}{L}$$

Input crane wire:

Young modulus: $E := 2.1 \cdot 10^{8} \frac{kN}{m^2}$

Area $A_{cw} := \left(\frac{154mm}{2}\right)^2 \cdot \pi$ $A_{cw} = 0.019\,m^2$

Weight: $W_{wire} := 103.2 \frac{kg}{m}$

North Sea - Kristin field

$WD_{Kristin} := 350m$

$M_{wireK} := W_{wire} \cdot WD_{Kristin}$

$kw_{kristin} := \frac{E \cdot A_{cw}}{WD_{Kristin}}$

$M_{wireK} = 36\,ton$

$kw_{kristin} = 11176\,\frac{kN}{m}$

West Africa - Girassol Field:

$WD_{Girassol} := 1300m$

$M_{wireG} := W_{wire} \cdot WD_{Girassol}$

$kw_{girassol} := \frac{E \cdot A_{cw}}{WD_{Girassol}}$

$M_{wireG} = 134\,ton$

$kw_{girassol} = 3009\,\frac{kN}{m}$

1.3 Module Mass

First order systems:

- Module mass
- Compensator mass
- Added mass

Second oders system:

- Module mass
- Added mass

North Sea - Kristin field

$M_m = 500\,ton$

$M_{comp} = 6\,ton$

$M_a = 1600\,ton$

$M_{K1} := M_m + M_{comp} + M_a + M_{wireK}$

$M_{K1} = 2142\,ton$

North Sea - Kristin field

$M_m = 500\,ton$

$M_a = 1600\,ton$

$M_{K2} := M_m + M_a + M_{wireK}$

$M_{K2} = 2136\,ton$

West Africa - Girassol Field:

$M_m = 500\,\text{ton}$

$M_{comp} = 6\,\text{ton}$

$M_a = 1600\,\text{ton}$

$M_{G1} := M_m + M_{comp} + M_a + M_{wireG}$

$M_{G1} = 2240\,\text{ton}$

West Africa - Girassol Field:

$M_m = 500\,\text{ton}$

$M_a = 1600\,\text{ton}$

$M_{G2} := M_m + M_a + M_{wireG}$

$M_{G2} = 2234\,\text{ton}$

1.4 Compensator damping

Equivalent damping related to mechanical friction in system

$$c_c := 20\,\frac{\text{kN}\cdot\text{s}}{\text{m}}$$

1.5 Drag damping on module

$$c_d := 500\,\frac{\text{kN}\cdot\text{s}}{\text{m}}$$

2. 1.-Order System - Transfer Fuction

$M := M_{K1}$

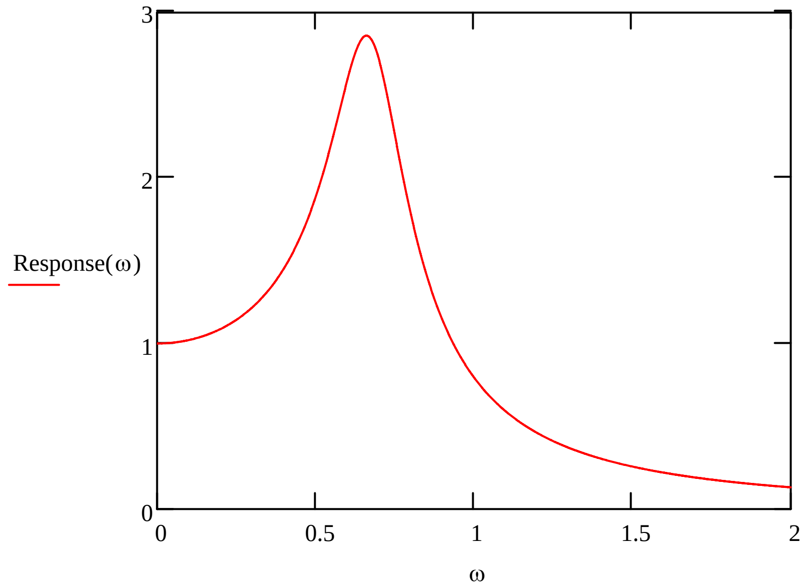
Approximately undamped natural frequency

$\omega_0 := \sqrt{\frac{k_c}{M}}$ $\omega_0 = 0.68\,\frac{1}{s}$ $T_0 := \frac{2\pi}{\omega_0}$ $T_0 = 9.2\,s$

Residual motion in module

The residual motion in module is expressed with the response function showed below.

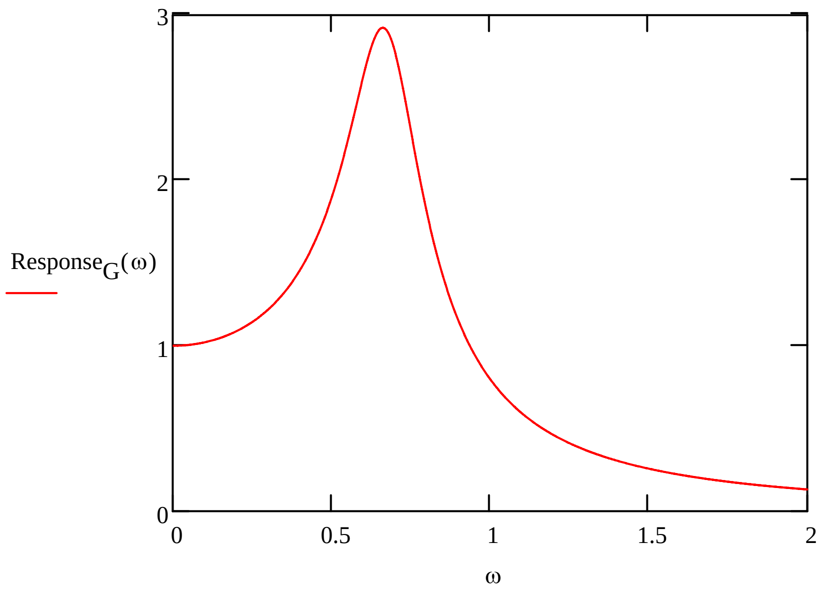
$$\text{Response}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_c \cdot M}}}$$



2.1 Girassol field

$$\omega_{0G} := \sqrt{\frac{k_c}{M_{G1}}}$$

$$\text{Response}_G(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M_{G1}}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_c \cdot M_{G1}}}}$$



3. 1.-order system - harmonic motion model

Since the stiffness of crane wire are much larger than compensator stiffness we use the stiffnes factor for the compensator.

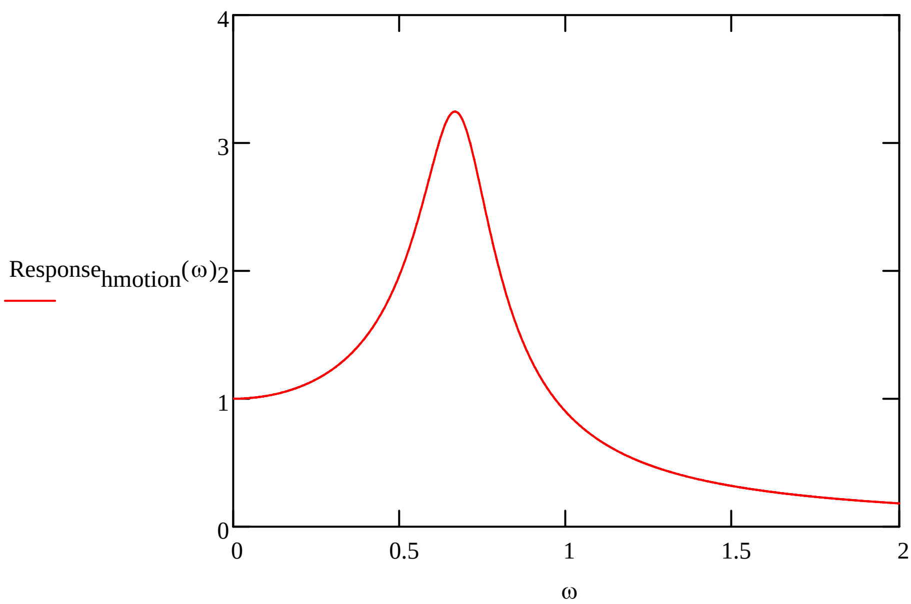
$\omega_n := \sqrt{\frac{k_c}{M}}$ $\qquad \omega_n = 0.68\,\frac{1}{s}$ $\qquad T_n := \frac{2\pi}{\omega_n}$ $\qquad T_n = 9.2\,s$

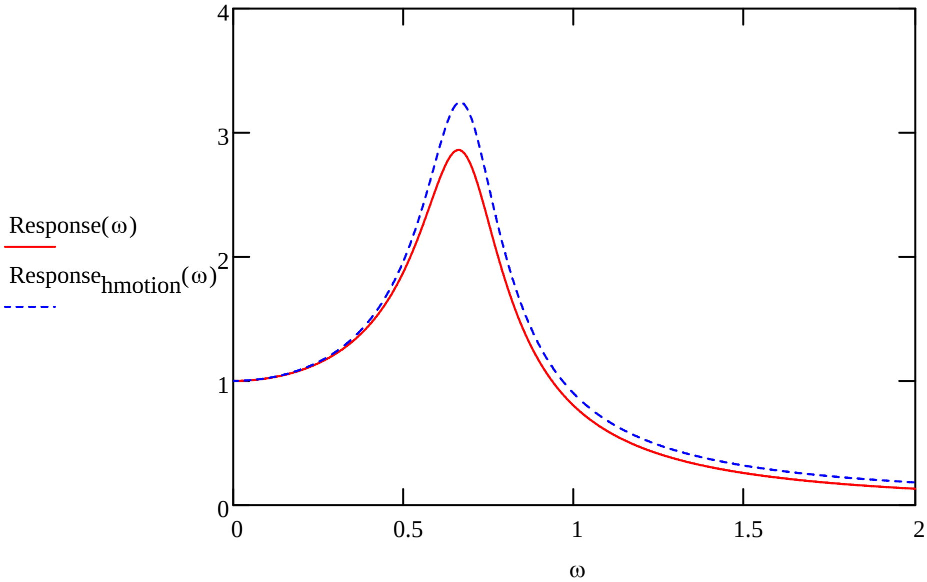
$r(\omega) := \frac{\omega}{\omega_n}$

$c_{crit} := 2 \cdot M \cdot \omega_n$ $\qquad c_{crit} = 2927\,\frac{kN \cdot s}{m}$

$\zeta := \frac{c_c - c_d}{c_{crit}}$ $\qquad \zeta = -0.16$

$$Response_{hmotion}(\omega) := \sqrt{\frac{1 + \left[2\zeta \cdot \left(\frac{\omega}{\omega_n}\right)\right]^2}{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(2\zeta \cdot \frac{\omega}{\omega_n}\right)^2}}$$





Response(ω)
Response_hmotion(ω)
4
3
2
1
0
0
0.5
1
1.5
2
ω

4. 2.-order system

In order to solve the 2. order dynamical system, the system is divided into 4 differential equations.

$$M_{matrix} = \begin{pmatrix} M_c & 0 \\ 0 & M \end{pmatrix}$$

$$C_{matrix} = \begin{pmatrix} c_c & 0 \\ 0 & c_d \end{pmatrix}$$

$$K_{matrix} = \begin{pmatrix} k_c + k_w & -k_w \\ -k_w & k_w \end{pmatrix}$$

$$F_{matrix} = \begin{pmatrix} X\sin(\omega t)\cdot k_c + X\cos(\omega t)\cdot c_c \\ 0 \end{pmatrix}$$

$$y0(0) = 0$$

$$y1(0) = 0$$

$$y2(0) = 0$$

$$y3(0) = 0$$

Given:

$$\frac{d}{du}y0(u) = y1(u)$$

$$\frac{d}{du}y1(u) = \frac{X\cdot k_c\cdot \sin(\omega\cdot u) + X\cdot c_c\cdot \cos(\omega\cdot u)}{M_c} - \frac{c_c}{M_c}y1(u) - \left(\frac{k_c + k_w}{M_c}\right)\cdot y0(u) + \left(\frac{k_w}{M_c}\right)\cdot y2(u)$$

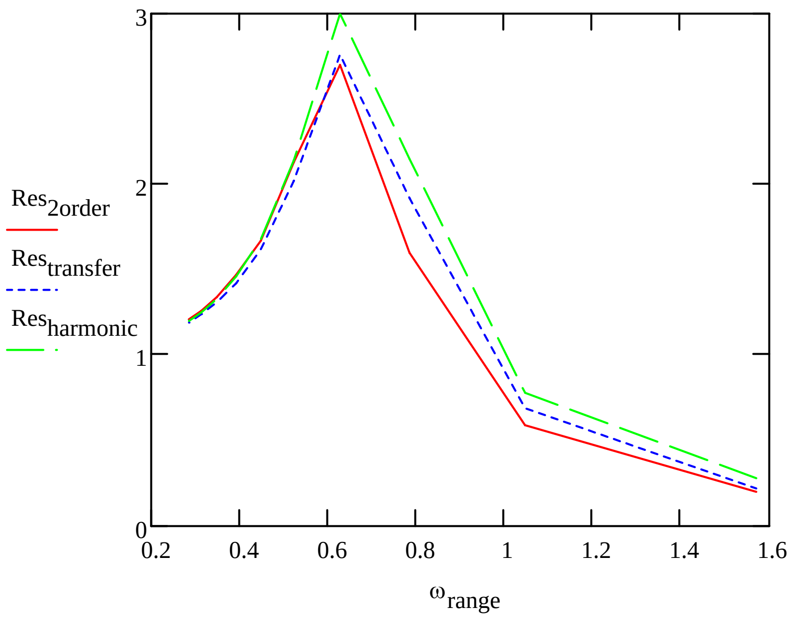
$$\frac{d}{du}y2(u) = y3(u)$$

$$\frac{d}{du}y3(u) = -\frac{c_d}{M}\cdot y3(u) + \left(\frac{k_w}{M}\right)\cdot y0(u) - \left(\frac{k_w}{M}\right)\cdot y2(u)$$

The response from the 2.order dynamical model is showed in table and graph below.

$$T_p = \begin{pmatrix} 4 \\ 6 \\ 8 \\ 10 \\ 12 \\ 14 \\ 16 \\ 18 \\ 20 \\ 22 \end{pmatrix} s \qquad \omega_{range} := \frac{2\pi}{T_p} \qquad \omega_{range} = \begin{pmatrix} 1.571 \\ 1.047 \\ 0.785 \\ 0.628 \\ 0.524 \\ 0.449 \\ 0.393 \\ 0.349 \\ 0.314 \\ 0.286 \end{pmatrix} \frac{1}{s}$$

$$Res_{2order} := \begin{pmatrix} 0.2 \\ 0.59 \\ 1.6 \\ 2.7 \\ 2.13 \\ 1.67 \\ 1.47 \\ 1.34 \\ 1.26 \\ 1.21 \end{pmatrix} \quad Res_{Girassol} := \begin{pmatrix} 0.16 \\ 0.4 \\ 1.13 \\ 3.9 \\ 4.26 \\ 2.4 \\ 1.80 \\ 1.55 \\ 1.39 \\ 1.29 \end{pmatrix} \quad Res_{transfer} := \begin{pmatrix} 0.22 \\ 0.69 \\ 1.92 \\ 2.76 \\ 2.02 \\ 1.62 \\ 1.42 \\ 1.31 \\ 1.24 \\ 1.19 \end{pmatrix} \quad Res_{harmonic} := \begin{pmatrix} 0.28 \\ 0.78 \\ 2.15 \\ 3 \\ 2.14 \\ 1.68 \\ 1.46 \\ 1.33 \\ 1.25 \\ 1.2 \end{pmatrix}$$



5. Analysis

5.1 Variations in compensator stiffness

5.11 Analysis 1

$$k_{c1} := 2 \cdot k_c$$

$$\omega_{0k1} := \sqrt{\frac{k_{c1}}{M}} \quad \text{Analysis}_{k1}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0k1}}\right)^2 \cdot \frac{{c_c}^2}{k_{c1} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_{0k1}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0k1}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_{c1} \cdot M}}}$$

5.12 Analysis 2

$$k_{c2} := 3 \cdot k_c$$

$$\omega_{0k2} := \sqrt{\frac{k_{c2}}{M}} \quad \text{Analysis}_{k2}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0k2}}\right)^2 \cdot \frac{{c_c}^2}{k_{c2} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_{0k2}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0k2}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_{c2} \cdot M}}}$$

5.13 Analysis 3

$$k_{c3} := 0.5 \cdot k_c$$

$$\omega_{0k3} := \sqrt{\frac{k_{c3}}{M}}$$

$$\text{Analysis}_{k3}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0k3}}\right)^2 \cdot \frac{{c_c}^2}{k_{c3} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_{0k3}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0k3}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_{c3} \cdot M}}}$$

5.14 Analysis 4

$$k_{c4} := 0.3 \cdot k_c$$

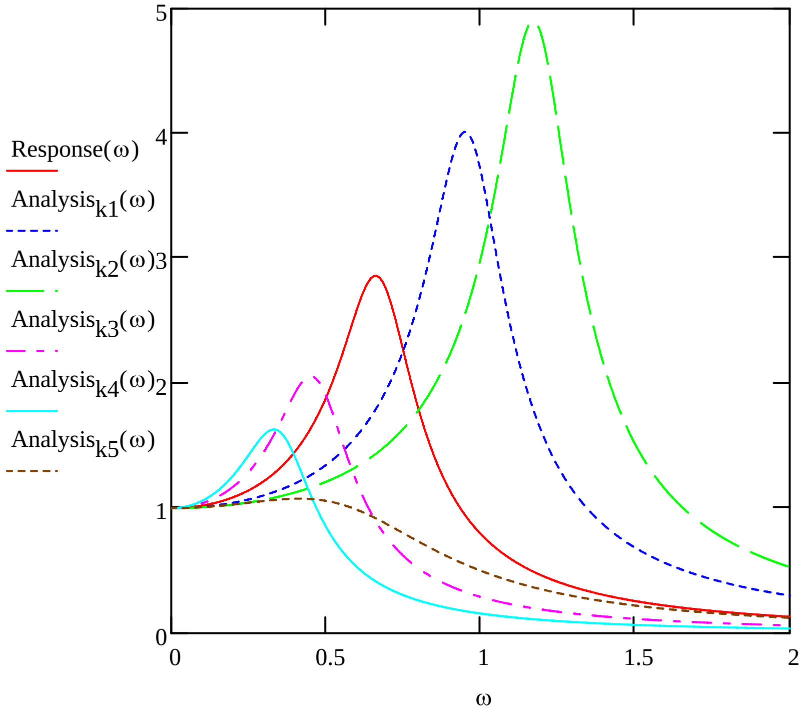
$$\omega_{0k4} := \sqrt{\frac{k_{c4}}{M}} \qquad Analysis_{k4}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0k4}}\right)^2 \cdot \frac{{c_c}^2}{k_{c4} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_{0k4}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0k4}}\right)^2 \cdot \frac{\left(c_c + c_d\right)^2}{k_{c4} \cdot M}}}$$

5.15 Analysis 5

$$k_{c5} := 0.1 \cdot k_c$$

$$\omega_{0k5} := \sqrt{\frac{k_{c5}}{M}} \qquad Analysis_{k5}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_c}^2}{k_{c5} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_c + c_d\right)^2}{k_{c5} \cdot M}}}$$

5.16 Variation in compensator stiffness results



$$Variation_{kc} := \begin{pmatrix} 2 \cdot k_c \\ 3 \cdot k_c \\ 0.5 \cdot k_c \\ 0.3 \cdot k_c \\ 0.1 \cdot k_c \end{pmatrix}$$

5.2 Variation in compensator damping

5.21 Analysis 1

$$c_{c1} := 2 \cdot c_c$$

$$\text{Analysis}_{c1}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_{c1}}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_{c1} + c_d\right)^2}{k_c \cdot M}}}$$

5.22 Analysis 2

$$c_{c2} := 3 \cdot c_c$$

$$\text{Analysis}_{c2}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_{c2}}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_{c2} + c_d\right)^2}{k_c \cdot M}}}$$

5.23 Analysis 3

$$c_{c3} := 0.5 \cdot c_c$$

$$\text{Analysis}_{c3}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_{c3}}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_{c3} + c_d\right)^2}{k_c \cdot M}}}$$

5.24 Analysis 4

$$c_{c4} := 0.3 \cdot c_c$$

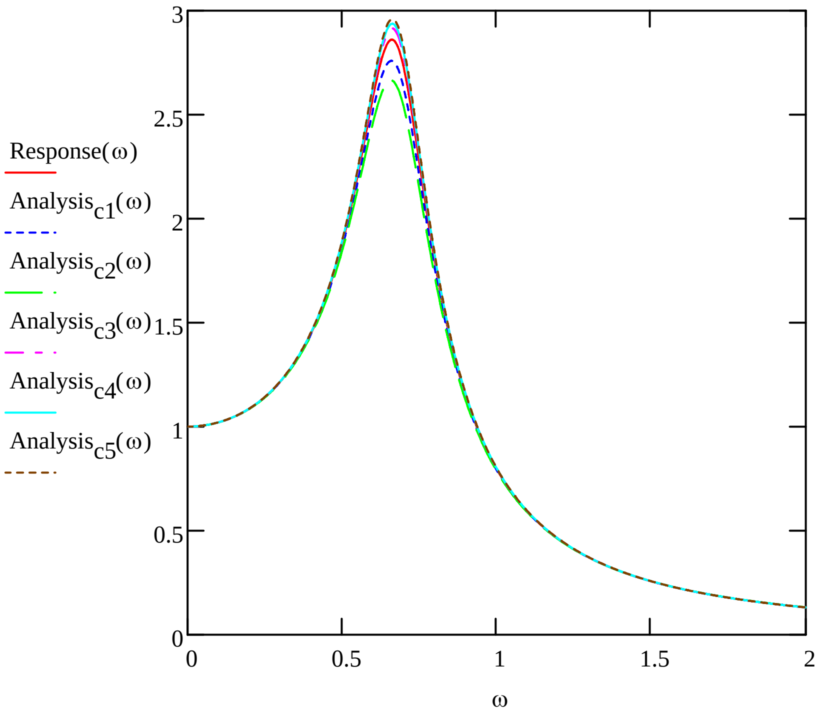
$$\mathrm{Analysis}_{c4}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{c_{c4}{}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_{c4} + c_d\right)^2}{k_c \cdot M}}}$$

5.25 Analysis 5

$$c_{c5} := 0.1 \cdot c_c$$

$$\mathrm{Analysis}_{c5}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{c_{c5}{}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_{c5} + c_d\right)^2}{k_c \cdot M}}}$$

5.26 Variation in compensator damping results



$$\mathrm{Variation}_c := \begin{pmatrix} 2 \cdot c_c \\ 3 \cdot c_c \\ 0.5 \cdot c_c \\ 0.3 \cdot c_c \\ 0.1 \cdot c_c \end{pmatrix}$$

5.3 Varition in drag damping

5.31 Analysis 1

$$c_{d1} := 2 \cdot c_d$$

$$\text{Analysis}_{d1}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_c + c_{d1}\right)^2}{k_c \cdot M}}}$$

5.32 Analysis 2

$$c_{d2} := 3 \cdot c_d$$

$$\text{Analysis}_{d2}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_c + c_{d2}\right)^2}{k_c \cdot M}}}$$

5.33 Analysis 3

$$c_{d3} := 0.5 \cdot c_d$$

$$\text{Analysis}_{d3}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_c + c_{d3}\right)^2}{k_c \cdot M}}}$$

5.34 Analysis 4

$$c_{d4} := 0.3 \cdot c_d$$

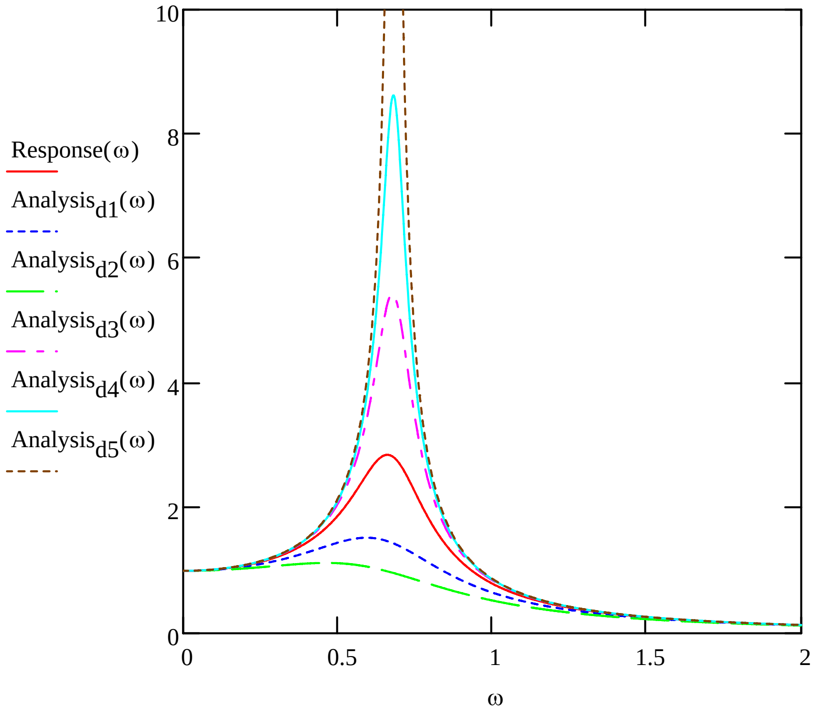
$$\text{Analysis}_{d4}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{c_c^{\,2}}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_c + c_{d4}\right)^2}{k_c \cdot M}}}$$

5.35 Analysis 5

$$c_{d5} := 0.1 \cdot c_d$$

$$\text{Analysis}_{d5}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{c_c^{\,2}}{k_c \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{\left(c_c + c_{d5}\right)^2}{k_c \cdot M}}}$$

5.36 Variation in drag damping results



$$\text{Variation}_d := \begin{pmatrix} 2 \cdot c_d \\ 3 \cdot c_d \\ 0.5 \cdot c_d \\ 0.3 \cdot c_d \\ 0.1 \cdot c_d \end{pmatrix}$$

5.4 Variation in mass

5.41 Analysis 1

$$M_1 := 2 \cdot M$$

$$\omega_{0M1} := \sqrt{\frac{k_c}{M_1}}$$

$$\text{Analysis}_{M1}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0M1}}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M_1}}{\left[1 - \left(\frac{\omega}{\omega_{0M1}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0M1}}\right)^2 \cdot \frac{\left(c_c + c_d\right)^2}{k_c \cdot M_1}}}$$

5.42 Analysis 2

$$M_2 := 3M$$

$$\omega_{0M2} := \sqrt{\frac{k_c}{M_2}}$$

$$\text{Analysis}_{M2}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0M2}}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M_2}}{\left[1 - \left(\frac{\omega}{\omega_{0M2}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0M2}}\right)^2 \cdot \frac{\left(c_c + c_d\right)^2}{k_c \cdot M_2}}}$$

5.43 Analysis 3

$$M_3 := 0.5M$$

$$\omega_{0M3} := \sqrt{\frac{k_c}{M_3}}$$

$$\text{Analysis}_{M3}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0M3}}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M_3}}{\left[1 - \left(\frac{\omega}{\omega_{0M3}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0M3}}\right)^2 \cdot \frac{\left(c_c + c_d\right)^2}{k_c \cdot M_3}}}$$

5.44 Analysis 4

$M_4 := 0.3M$

$\omega_{0M4} := \sqrt{\frac{k_c}{M_4}}$

$$\text{Analysis}_{M4}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0M4}}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M_4}}{\left[1 - \left(\frac{\omega}{\omega_{0M4}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0M4}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_c \cdot M_4}}}$$

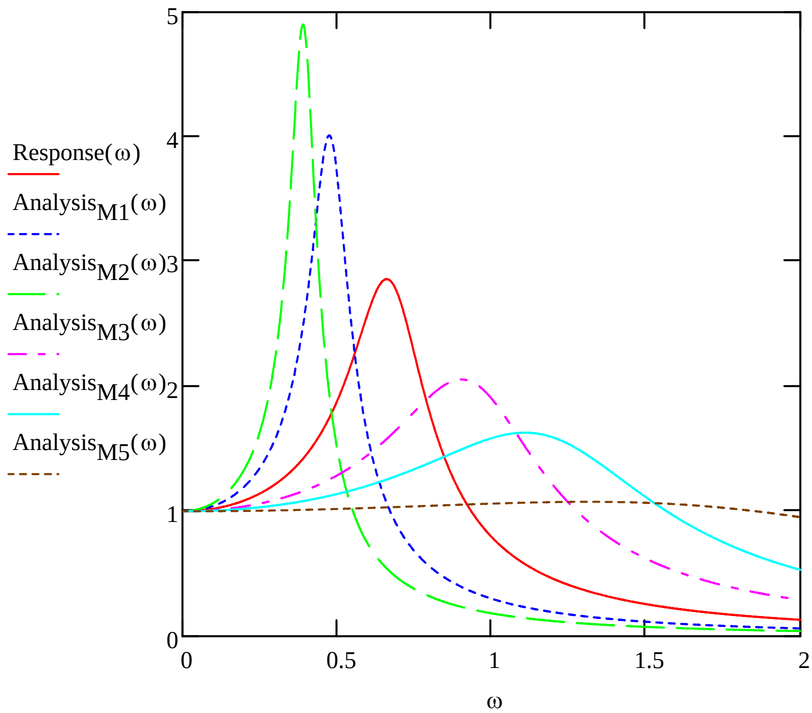
5.45 Analysis 5

$M_5 := 0.1M$

$\omega_{0M5} := \sqrt{\frac{k_c}{M_5}}$

$$\text{Analysis}_{M5}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0M5}}\right)^2 \cdot \frac{{c_c}^2}{k_c \cdot M_5}}{\left[1 - \left(\frac{\omega}{\omega_{0M5}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0M5}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_c \cdot M_5}}}$$

5.46 Variation in mass results



$$\text{Variation}_M := \begin{pmatrix} 2 \cdot M \\ 3 \cdot M \\ 0.5 \cdot M \\ 0.3 \cdot M \\ 0.1 \cdot M \end{pmatrix}$$

5.5 Variations in compensator stiffness - harmonic motion model

5.51 Analysis 1

$$M := M_2$$

$$k_1 := 2 \cdot k_c$$

$$\omega_{0kc1} := \sqrt{\frac{k_1}{M}} \quad Analysis_{kc1}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0k1}}\right)^2 \cdot \frac{{c_c}^2}{k_{c1} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_{0k1}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0k1}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_{c1} \cdot M}}}$$

5.52 Analysis 2

$$k_2 := 3 \cdot k_c$$

$$\omega_{0kc2} := \sqrt{\frac{k_{c2}}{M}} \quad Analysis_{kc2}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0k2}}\right)^2 \cdot \frac{{c_c}^2}{k_{c2} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_{0k2}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0k2}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_{c2} \cdot M}}}$$

5.53 Analysis 3

$$k_3 := 0.5 \cdot k_c$$

$$\omega_{0kc3} := \sqrt{\frac{k_{c3}}{M}}$$

$$Analysis_{kc3}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0k3}}\right)^2 \cdot \frac{{c_c}^2}{k_{c3} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_{0k3}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0k3}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_{c3} \cdot M}}}$$

5.54 Analysis 4

$$k_4 := 0.3 \cdot k_c$$

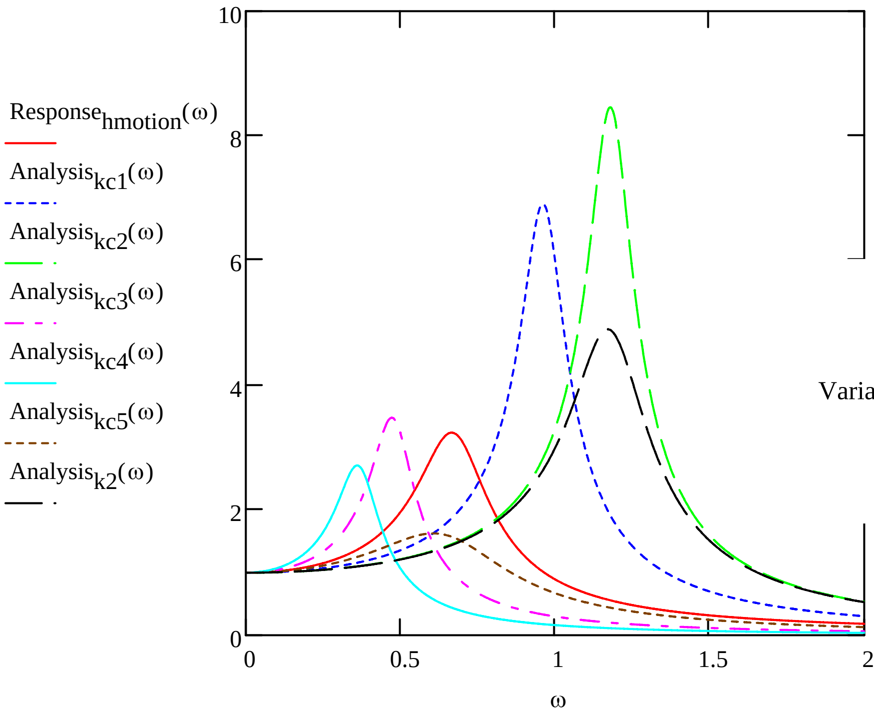
$$\omega_{0kc4} := \sqrt{\frac{k_{c4}}{M}} \quad Analysis_{kc4}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_{0k4}}\right)^2 \cdot \frac{{c_c}^2}{k_{c4} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_{0k4}}\right)^2\right]^2 + \left(\frac{\omega}{\omega_{0k4}}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_{c4} \cdot M}}}$$

5.55 Analysis 5

$$k_5 := 0.1 \cdot k_c$$

$$\omega_{0kc5} := \sqrt{\frac{k_{c5}}{M}} \quad Analysis_{kc5}(\omega) := \sqrt{\frac{1 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{{c_c}^2}{k_{c5} \cdot M}}{\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2 \cdot \frac{(c_c + c_d)^2}{k_{c5} \cdot M}}}$$

5.56 Variation in compensator stiffness results

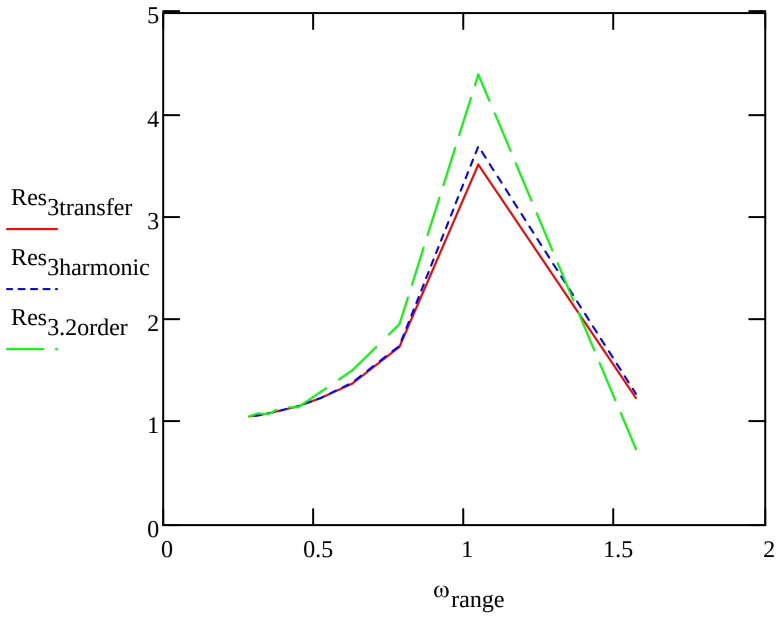


$$Variation_{kc} := \begin{pmatrix} 2 \cdot k_c \\ 3 \cdot k_c \\ 0.5 \cdot k_c \\ 0.3 \cdot k_c \\ 0.1 \cdot k_c \end{pmatrix}$$

6. Response variations for all three models

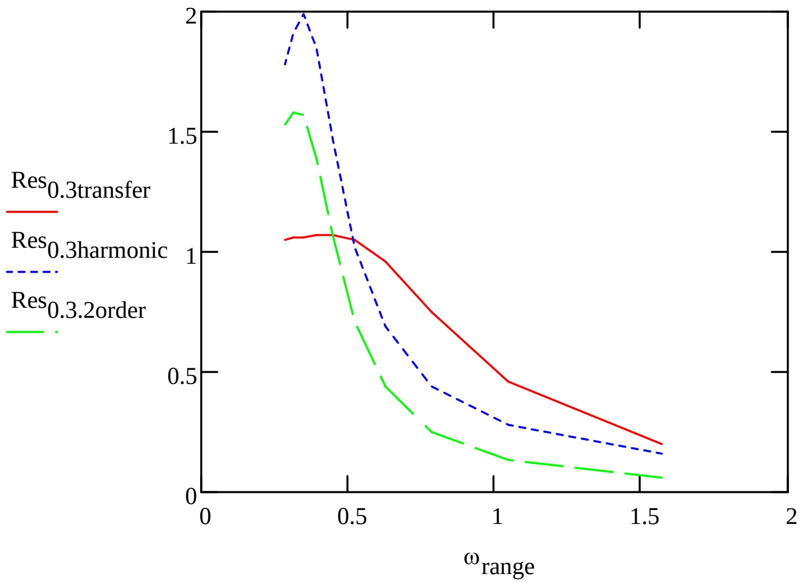
6.1 Compensator stiffness times 3

$$Res_{3transfer} := \begin{pmatrix} 1.24 \\ 3.52 \\ 1.74 \\ 1.38 \\ 1.24 \\ 1.16 \\ 1.12 \\ 1.09 \\ 1.07 \\ 1.06 \end{pmatrix} \qquad Res_{3harmonic} := \begin{pmatrix} 1.28 \\ 3.7 \\ 1.75 \\ 1.39 \\ 1.24 \\ 1.16 \\ 1.12 \\ 1.09 \\ 1.07 \\ 1.06 \end{pmatrix} \qquad Res_{3.2order} := \begin{pmatrix} 0.74 \\ 4.40 \\ 1.96 \\ 1.51 \\ 1.30 \\ 1.15 \\ 1.15 \\ 1.08 \\ 1.09 \\ 1.06 \end{pmatrix}$$



6.2 Compensator stiffness times 0.3

$$Res_{0.3transfer} := \begin{pmatrix} 0.2 \\ 0.46 \\ 0.75 \\ 0.96 \\ 1.05 \\ 1.07 \\ 1.07 \\ 1.06 \\ 1.06 \\ 1.05 \end{pmatrix} \quad Res_{0.3harmonic} := \begin{pmatrix} 0.16 \\ 0.28 \\ 0.44 \\ 0.69 \\ 1.02 \\ 1.47 \\ 1.85 \\ 1.99 \\ 1.91 \\ 1.78 \end{pmatrix} \quad Res_{0.3.2order} := \begin{pmatrix} 0.06 \\ 0.134 \\ 0.25 \\ 0.44 \\ 0.71 \\ 1.07 \\ 1.39 \\ 1.57 \\ 1.58 \\ 1.53 \end{pmatrix}$$



7. Tension in crane hook

Crane wire stiffnes $k_w := kw_{kristin}$ $k_w = 11176\,\frac{kN}{m}$

Static hook $Load_s := M_m + M_{wireK}$

$$F_s := Load_s \cdot 9.81\,\frac{m}{s^2}$$

Compensator stroke

$$Stroke := \begin{pmatrix} 0 \\ 0.2 \\ 0.4 \\ 0.6 \\ 0.8 \\ 1.0 \\ 1.2 \\ 1.4 \\ 1.6 \\ 1.8 \\ 2 \end{pmatrix} \cdot m$$

Calculation of poits in graph:

F_0 = zero

F_1 = Static load

F_2 = Compensation mid

F_3 = Compensator end

F_4 = Override of compensator

$F_1 := F_s$

$E_1 := \frac{F_s}{k_2}$

$F_2 := F_1 + k_c \cdot 1m$

$E_2 := E_1 + 1m$

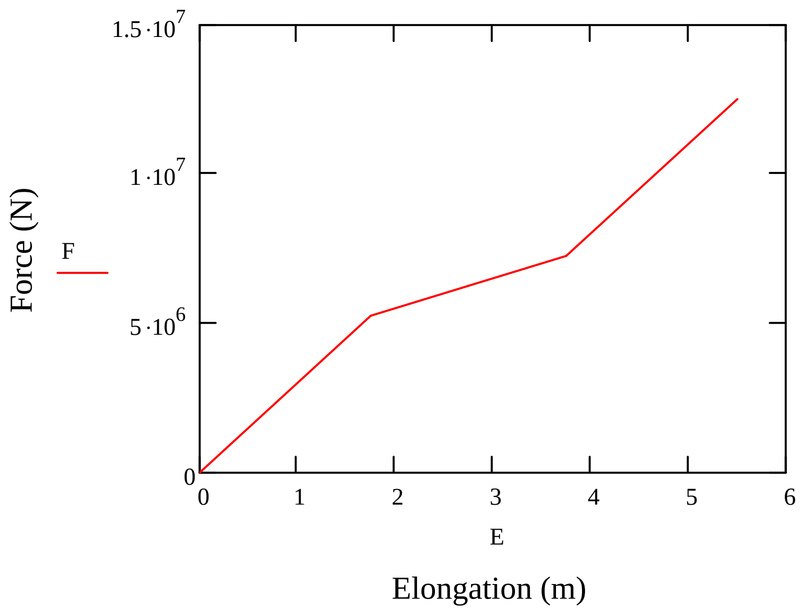
$F_3 := F_1 + k_c \cdot 2 \cdot m$

$E_3 := E_1 + 2m$

$F_4 := F_1 + k_c \cdot 2m + F_s$

$E_4 := 2 \cdot E_1 + 2m$

$$F = \begin{pmatrix} 0 \\ 5259 \\ 6259 \\ 7259 \\ 12519 \end{pmatrix} kN \qquad E = \begin{pmatrix} 0 \\ 1.75 \\ 2.75 \\ 3.75 \\ 5.51 \end{pmatrix} m$$



Appendix B

2. Order Mathematical Model

Appendix B
2. OrderMathematical Model

References:

/1/ Rao S.S., Mechanical Vibrations Fourth Edition, Prentice Hall ISBN 013-196751-7, 2004

/2/ Nielsen F.G., Lecture Notes SIN 1546 Marine Opeations, NTNU 2003

1. Input

$ton := 1000kg$

Mass compensator	$M_c := 6$	ton
Mass module (incl. added mass)	$M := 2135$	$\frac{kN}{m}$
Compensator stiffness	$k_c := 1000$	$\frac{kN}{m}$
Crane wire stiffness	$k_w := 11167$	$\frac{kN \cdot s}{m}$
Compensator damping:	$c_c := 20$	$\frac{kN \cdot s}{m}$
Drag damping:	$c_d := 500$	
Heave amplitude	$X := 1$	

$$T_p := \begin{pmatrix} 4 \\ 6 \\ 8 \\ 10 \\ 12 \\ 14 \\ 16 \\ 18 \\ 20 \\ 22 \end{pmatrix} \cdot s \qquad \omega_{range} := \frac{2\pi}{T_p} \qquad \omega_{range} = \begin{pmatrix} 1.571 \\ 1.047 \\ 0.785 \\ 0.628 \\ 0.524 \\ 0.449 \\ 0.393 \\ 0.349 \\ 0.314 \\ 0.286 \end{pmatrix} \frac{1}{s}$$

Example 1:

$\omega := 1.047$

2. Calculation

$$M_{matrix} := \begin{pmatrix} M_c & 0 \\ 0 & M \end{pmatrix}$$

$$C_{matrix} := \begin{pmatrix} c_c & 0 \\ 0 & c_d \end{pmatrix}$$

$$K_{matrix} := \begin{pmatrix} k_c + k_w & -k_w \\ -k_w & k_w \end{pmatrix}$$

$$D := M_{matrix}^{-1} \cdot K_{matrix} \qquad D = \begin{pmatrix} 2.028 \times 10^3 & -1.861 \times 10^3 \\ -5.23 & 5.23 \end{pmatrix}$$

$$e_{val} := \text{eigenvals}(D) \qquad e_{val} = \begin{pmatrix} 2032.635 \\ 0.429 \end{pmatrix}$$

$$resonans_{val} := \sqrt{e_{val}} \qquad resonans_{val} = \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix}$$

$$T1 := 1000 \qquad t1 := 0, \frac{T1}{1 \times 10^3} .. T1$$

Given

$$\frac{d}{du} y0(u) = y1(u)$$

$$y0(0) = 0$$

$$\frac{d}{du} y1(u) = \frac{X \cdot k_c \cdot \sin(\omega \cdot u) + X \cdot c_c \cdot \omega \cdot \cos(\omega \cdot u)}{M_c} - \frac{c_c}{M_c} y1(u) - \left(\frac{k_c + k_w}{M_c}\right) \cdot y0(u) + \left(\frac{k_w}{M_c}\right) \cdot y2(u)$$

$$y1(0) = 0$$

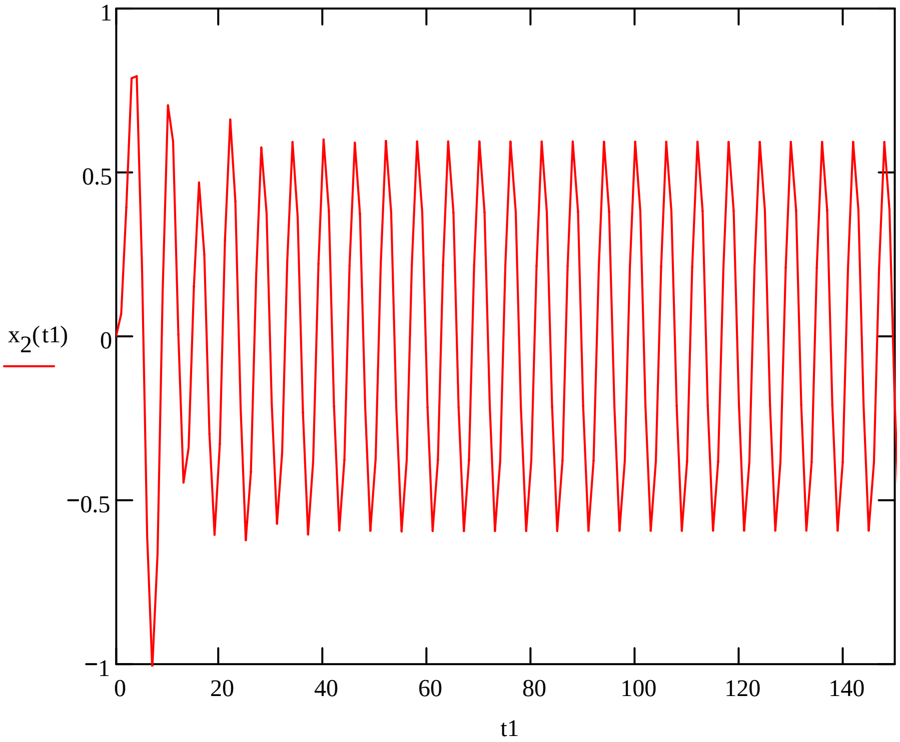
$$\frac{d}{du} y2(u) = y3(u)$$

$$y2(0) = 0$$

$$\frac{d}{du} y3(u) = -\frac{c_d}{M} \cdot y3(u) + \left(\frac{k_w}{M}\right) \cdot y0(u) - \left(\frac{k_w}{M}\right) \cdot y2(u)$$

$$y3(0) = 0$$

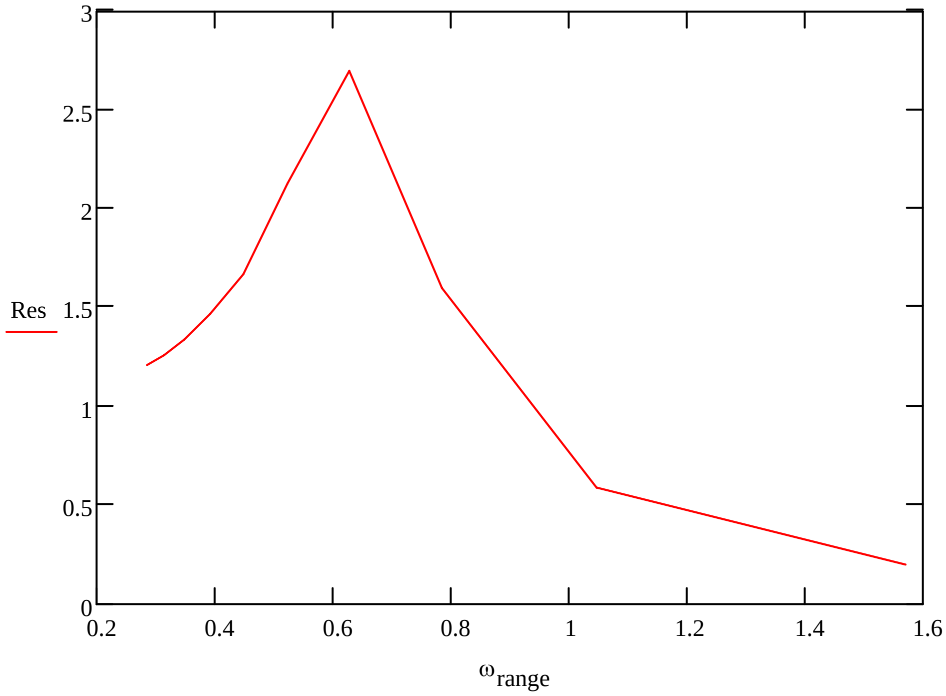
$$\begin{pmatrix} x_1 \\ v_1 \\ x_2 \\ v_2 \end{pmatrix} := \text{Odesolve}\left[\begin{pmatrix} y0 \\ y1 \\ y2 \\ y3 \end{pmatrix}, u, T1, 1000\right]$$



Response:

$$Response = Res = \frac{x_2}{X}$$

$$Res := \begin{pmatrix} 0.2 \\ 0.59 \\ 1.6 \\ 2.7 \\ 2.13 \\ 1.67 \\ 1.47 \\ 1.34 \\ 1.26 \\ 1.21 \end{pmatrix}$$

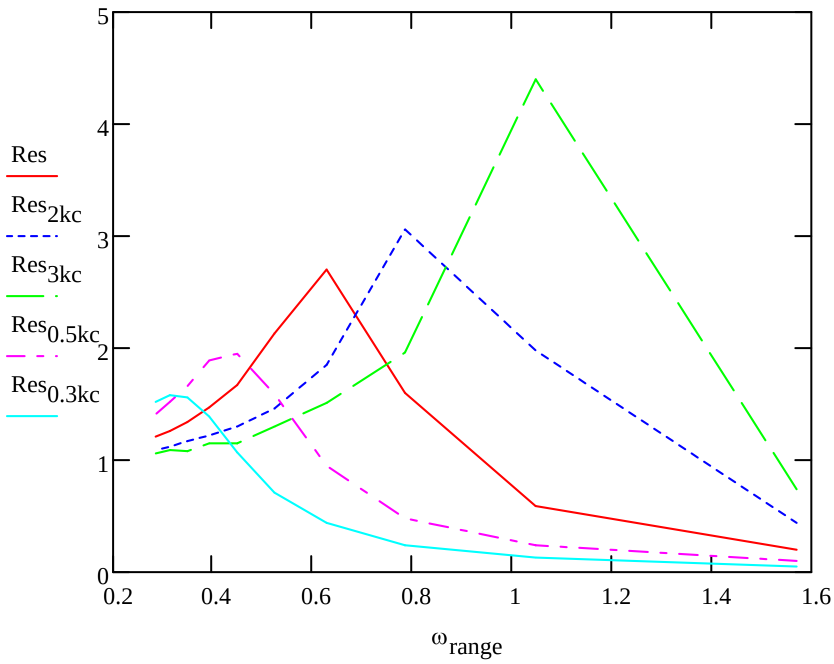


$$\omega_{iteration} := \begin{pmatrix} 0.635 \\ 0.645 \\ 0.655 \\ 0.665 \\ 0.675 \end{pmatrix} \qquad Value_{peak} := \begin{pmatrix} 2.66 \\ 2.66 \\ 2.7 \\ 2.6 \\ 2.58 \end{pmatrix}$$

2.1 Varying in compensator stiffness

$$Res_{2kc} := \begin{pmatrix} 0.44 \\ 1.98 \\ 3.06 \\ 1.85 \\ 1.46 \\ 1.3 \\ 1.22 \\ 1.17 \\ 1.12 \\ 1.09 \end{pmatrix} \quad Res_{3kc} := \begin{pmatrix} 0.74 \\ 4.40 \\ 1.96 \\ 1.51 \\ 1.30 \\ 1.15 \\ 1.15 \\ 1.08 \\ 1.09 \\ 1.06 \end{pmatrix} \quad Res_{0.5kc} := \begin{pmatrix} 0.1 \\ 0.24 \\ 0.48 \\ 0.95 \\ 1.59 \\ 1.95 \\ 1.89 \\ 1.66 \\ 1.52 \\ 1.41 \end{pmatrix} \quad Res_{0.3kc} := \begin{pmatrix} 0.05 \\ 0.13 \\ 0.24 \\ 0.44 \\ 0.71 \\ 1.07 \\ 1.39 \\ 1.56 \\ 1.58 \\ 1.52 \end{pmatrix}$$

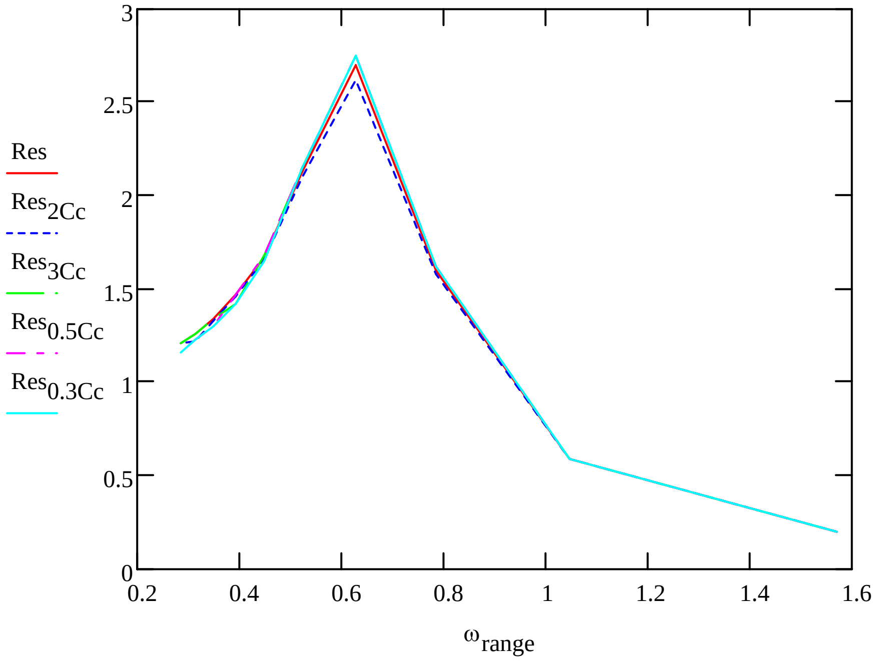
$$Res_{val2kc} := \begin{pmatrix} 46.893 \\ 0.89 \end{pmatrix} \quad Res_{val3kc} := \begin{pmatrix} 48.643 \\ 1.052 \end{pmatrix} \quad Res_{val0.5kc} := \begin{pmatrix} 44.153 \\ 0.473 \end{pmatrix} \quad Res_{val0.3kc} := \begin{pmatrix} 43.775 \\ 0.369 \end{pmatrix}$$



2.2 Varying compensator damping

$$Res_{2Cc} := \begin{pmatrix} 0.2 \\ 0.59 \\ 1.58 \\ 2.62 \\ 2.1 \\ 1.66 \\ 1.46 \\ 1.33 \\ 1.22 \\ 1.21 \end{pmatrix} \quad Res_{3Cc} := \begin{pmatrix} 0.2 \\ 0.59 \\ 1.62 \\ 2.75 \\ 2.15 \\ 1.68 \\ 1.42 \\ 1.34 \\ 1.26 \\ 1.21 \end{pmatrix} \quad Res_{0.5Cc} := \begin{pmatrix} 0.2 \\ 0.59 \\ 1.62 \\ 2.75 \\ 2.15 \\ 1.68 \\ 1.47 \\ 1.3 \\ 1.23 \\ 1.16 \end{pmatrix} \quad Res_{0.3Cc} := \begin{pmatrix} 0.2 \\ 0.59 \\ 1.62 \\ 2.75 \\ 2.15 \\ 1.65 \\ 1.42 \\ 1.30 \\ 1.23 \\ 1.16 \end{pmatrix}$$

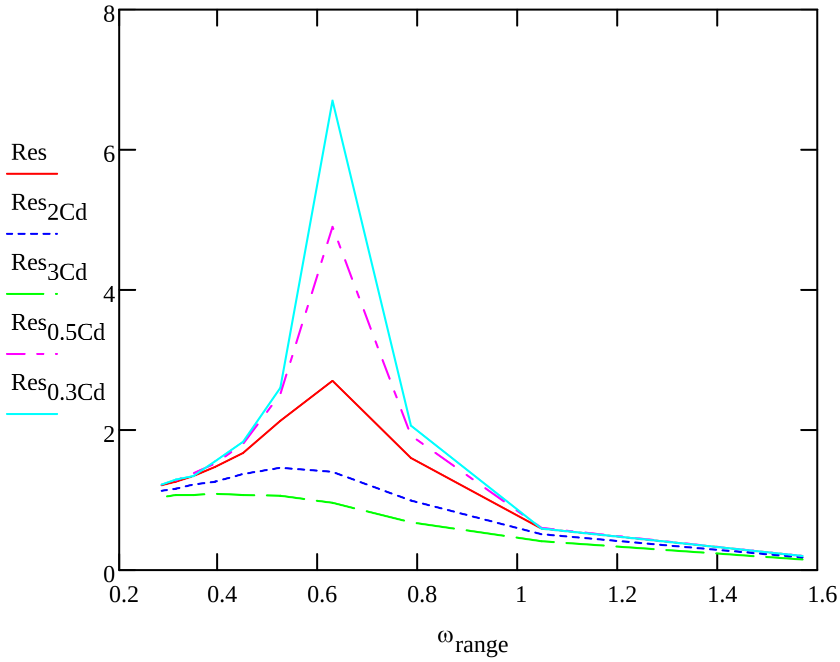
$$Res_{val2Cc} := \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix} \quad Res_{val2Cc} := \begin{pmatrix} 48.085 \\ 0.655 \end{pmatrix} \quad Res_{val0.5Cc} := \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix} \quad Res_{val0.3Cc} := \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix}$$



2.3 Varying drag damping

$$Res_{2Cd} := \begin{pmatrix} 0.18 \\ 0.51 \\ 0.99 \\ 1.4 \\ 1.46 \\ 1.37 \\ 1.26 \\ 1.22 \\ 1.16 \\ 1.13 \end{pmatrix} \quad Res_{3Cd} := \begin{pmatrix} 0.15 \\ 0.41 \\ 0.68 \\ 0.96 \\ 1.06 \\ 1.07 \\ 1.09 \\ 1.07 \\ 1.07 \\ 1.04 \end{pmatrix} \quad Res_{0.5Cd} := \begin{pmatrix} 0.20 \\ 0.6 \\ 1.92 \\ 4.9 \\ 2.51 \\ 1.8 \\ 1.52 \\ 1.38 \\ 1.28 \\ 1.22 \end{pmatrix} \quad Res_{0.3Cd} := \begin{pmatrix} 0.20 \\ 0.59 \\ 2.06 \\ 6.7 \\ 2.6 \\ 1.83 \\ 1.55 \\ 1.34 \\ 1.29 \\ 1.22 \end{pmatrix}$$

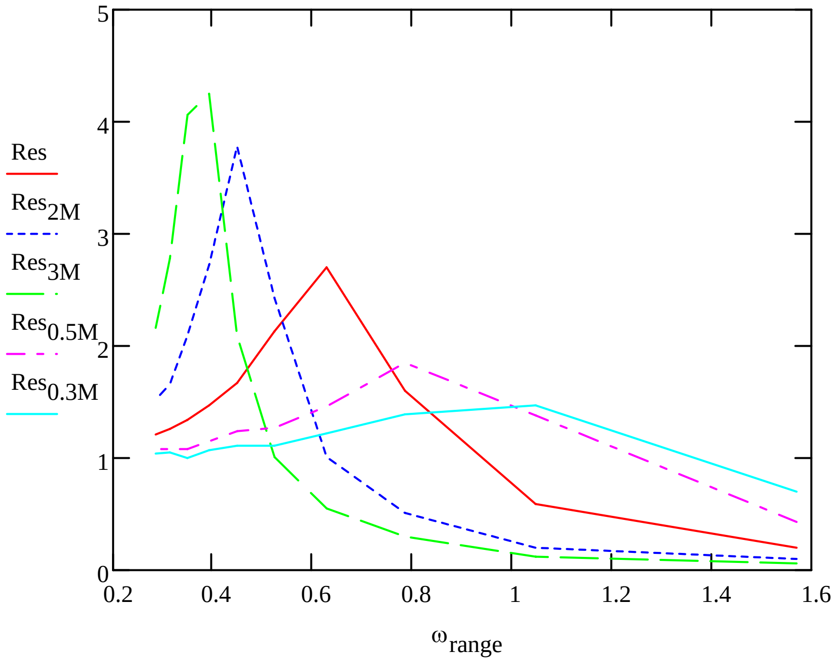
$$Res_{val2Cd} := \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix} \quad Res_{val2Cd} := \begin{pmatrix} 48.085 \\ 0.655 \end{pmatrix} \quad Res_{val0.5Cd} := \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix} \quad Res_{val0.3Cd} := \begin{pmatrix} 45.085 \\ 0.655 \end{pmatrix}$$



2.4 Variation in mass

$$Res_{2M} := \begin{pmatrix} 0.1 \\ 0.2 \\ 0.51 \\ 1.01 \\ 2.43 \\ 3.78 \\ 2.72 \\ 2.09 \\ 1.66 \\ 1.52 \end{pmatrix} \quad Res_{3M} := \begin{pmatrix} 0.06 \\ 0.12 \\ 0.3 \\ 0.55 \\ 1.01 \\ 2.09 \\ 4.25 \\ 4.06 \\ 2.78 \\ 2.16 \end{pmatrix} \quad Res_{0.5M} := \begin{pmatrix} 0.43 \\ 1.38 \\ 1.85 \\ 1.46 \\ 1.27 \\ 1.24 \\ 1.15 \\ 1.08 \\ 1.08 \\ 1.08 \end{pmatrix} \quad Res_{0.3M} := \begin{pmatrix} 0.7 \\ 1.47 \\ 1.39 \\ 1.22 \\ 1.11 \\ 1.11 \\ 1.07 \\ 1 \\ 1.05 \\ 1.04 \end{pmatrix}$$

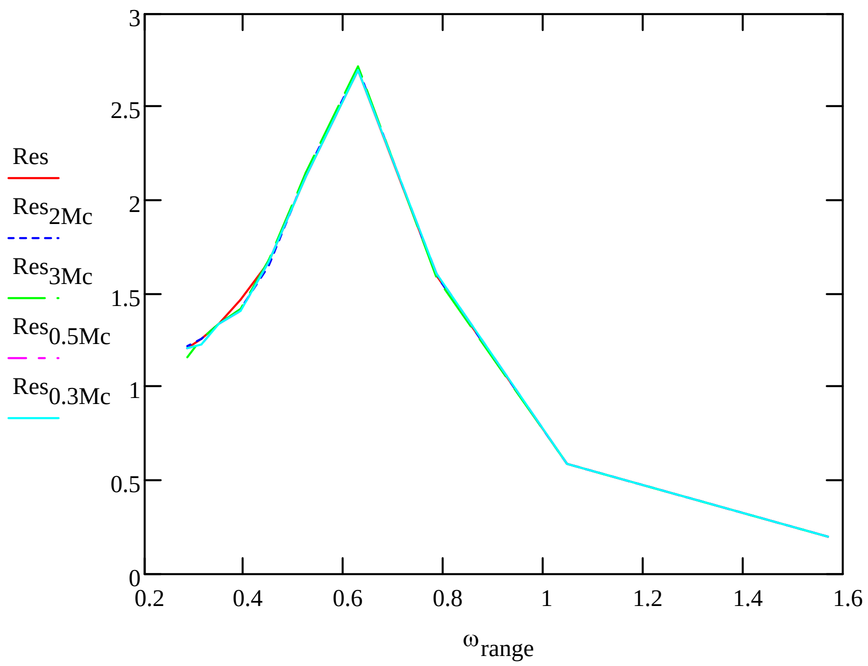
$$Res_{val2M} := \begin{pmatrix} 45.058 \\ 0.463 \end{pmatrix} \quad Res_{val3M} := \begin{pmatrix} 45.049 \\ 0.378 \end{pmatrix} \quad Res_{val0.5M} := \begin{pmatrix} 45.058 \\ 0.856 \end{pmatrix} \quad Res_{val0.3M} := \begin{pmatrix} 45.058 \\ 1.193 \end{pmatrix}$$



2.4 Variation in compensator mass

$$Res_{2Mc} := \begin{pmatrix} 0.2 \\ 0.59 \\ 1.60 \\ 2.71 \\ 2.14 \\ 1.65 \\ 1.42 \\ 1.34 \\ 1.26 \\ 1.22 \end{pmatrix} \quad Res_{3Mc} := \begin{pmatrix} 0.20 \\ 0.59 \\ 1.59 \\ 2.72 \\ 2.15 \\ 1.68 \\ 1.42 \\ 1.34 \\ 1.26 \\ 1.16 \end{pmatrix} \quad Res_{0.5Mc} := \begin{pmatrix} 0.20 \\ 0.59 \\ 1.61 \\ 2.70 \\ 2.13 \\ 1.67 \\ 1.41 \\ 1.34 \\ 1.23 \\ 1.21 \end{pmatrix} \quad Res_{0.3Mc} := \begin{pmatrix} 0.20 \\ 0.59 \\ 1.61 \\ 2.70 \\ 2.13 \\ 1.67 \\ 1.41 \\ 1.34 \\ 1.23 \\ 1.21 \end{pmatrix}$$

$$Res_{val2Mc} := \begin{pmatrix} 31.917 \\ 0.654 \end{pmatrix} \quad Res_{val3Mc} := \begin{pmatrix} 26.091 \\ 0.653 \end{pmatrix} \quad Res_{val0.5Mc} := \begin{pmatrix} 63.722 \\ 0.655 \end{pmatrix} \quad Res_{val0.3Mc} := \begin{pmatrix} 78.028 \\ 0.655 \end{pmatrix}$$



2.5 New crane wire stiffness - Girassol

In this anaylsis a crane wire for the stiffness for 1300 meter is used.

Input crane wire:

Young modulus: $E := 210\text{GPa}$

Area $A_{cw} := \left(\frac{154\text{mm}}{2}\right)^2 \cdot \pi$ $A_{cw} = 0.019\ \text{m}^2$

West Africa - Girassol Field:

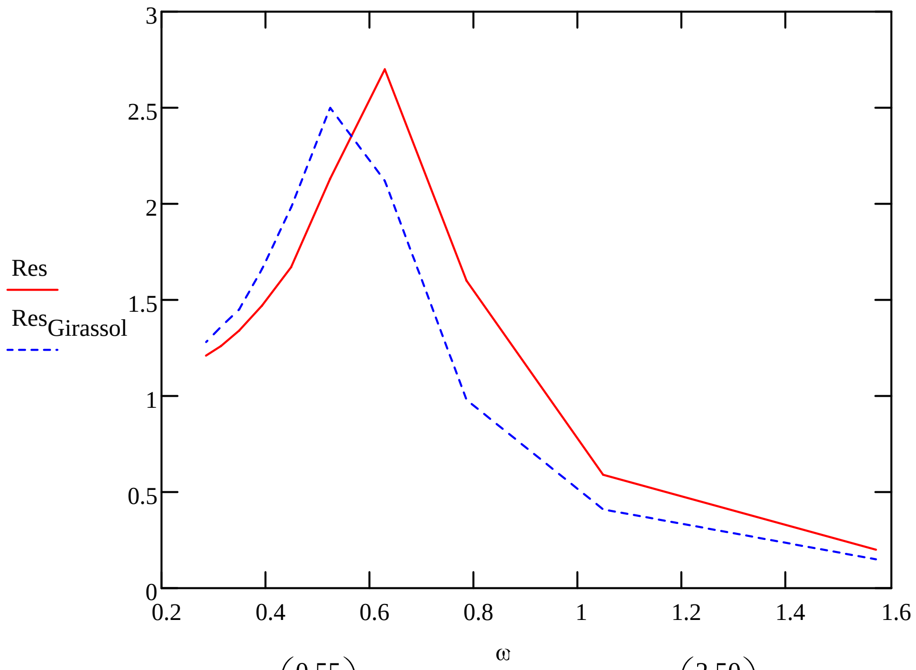
$wd_{girassol} := 1300\text{m}$

$kw_{girassol} := \frac{E \cdot A_{cw}}{wd_{girassol}}$

$kw_{girassol} = 3009\ \frac{\text{kN}}{\text{m}}$

$Res_{valGirrasol} := \begin{pmatrix} 25.869 \\ 0.592 \end{pmatrix}$

$Res_{Girassol} := \begin{pmatrix} 0.15 \\ 0.41 \\ 0.98 \\ 2.12 \\ 2.50 \\ 1.98 \\ 1.66 \\ 1.45 \\ 1.36 \\ 1.28 \end{pmatrix}$



$\omega_{iterate} \begin{pmatrix} 0.55 \\ 0.56 \\ 0.57 \\ 0.58 \\ 0.59 \end{pmatrix}$ $Res_{Girassol} := \begin{pmatrix} 2.50 \\ 2.55 \\ 2.50 \\ 2.46 \\ 2.45 \end{pmatrix}$

2. Fourier Analysis

Fourier analysis is used to analyse the output signal, and check if the compensator function works as expected. The anaylsis output should be the frequencies for the signals that the outout has.

To be able to calculate the output signal, the signal has to be converted into numerical data.

$$f(x) := x_2(x)$$

$$N0 := 512$$

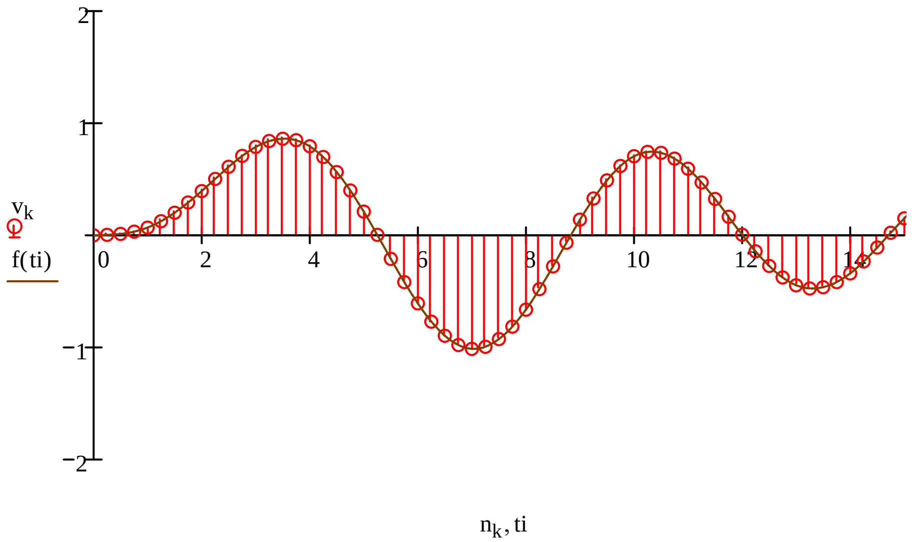
$$f_s := 4$$ Sampling per second

$$k := 0 .. N0 - 1$$

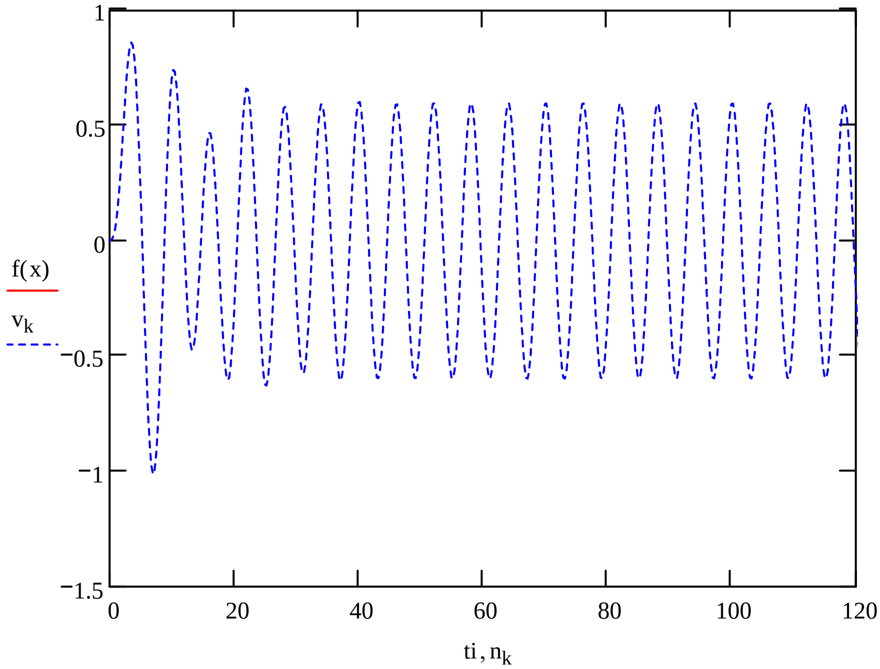
$$n_k := \frac{k}{f_s}$$

$$v_k := f(n_k)$$

$$ti := 0, 0.1 .. 20$$



The red lines in the graph showes sampled values



The graph shows the data that are used in the fourier analysis

$$Spec := fft(v)$$

fft is the MathCAD built in for calculation the Fast Fourier Transform

$$p := 0 .. \frac{N0}{2} \qquad c_p = \frac{1}{\sqrt{N0}} \cdot \sum_k \left[v_k \cdot e^{i \cdot \left(\frac{2 \cdot \pi \cdot p}{N0} \right) \cdot k} \right]$$

Variables used in calculations:

$N0 = 512$

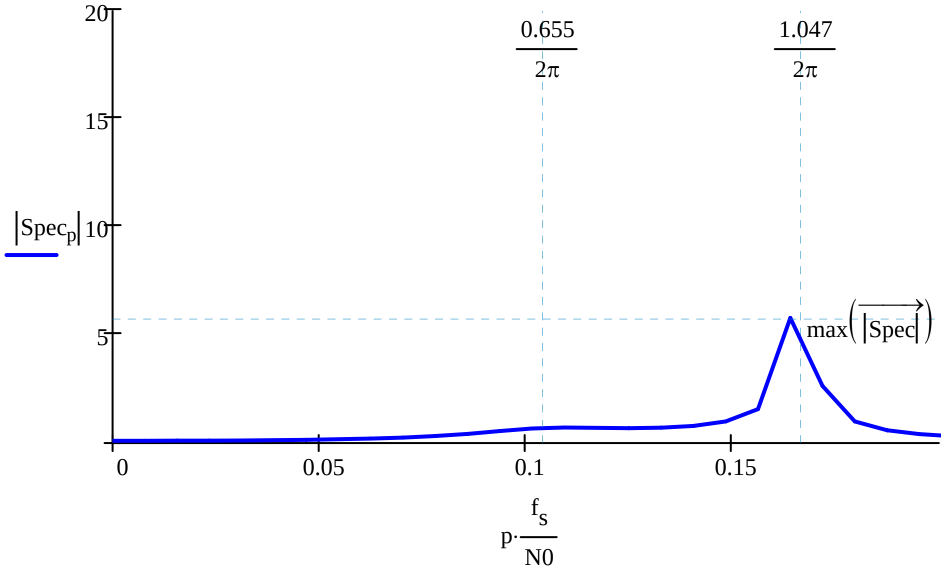
$length(Spec) = 257$

$\frac{1}{T0} = 0.083$ signal frequency

$N0 \equiv 2^9$

$T0 \equiv 12.1$ period

$f_s \equiv 4$ sampling frequency



The peak values are located at:

$$f_1 := 0.10156$$

$$f_2 := 0.16406$$

Which corresponds to:

$$\omega_1 := (2\pi)\cdot f_1 \qquad \omega_1 = 0.638$$

$$\omega_2 := (2\pi)\cdot f_2 \qquad \omega_2 = 1.031$$

Appendix C

Moonpool Calculations

Appendix C
Moonpool Calculations

1. Intodruction

1.1 General

This spreadsheet is used to determine characteristic forces when lifting the template through moonpool. The deployment vessel is the barge looked at in the corresponding master thesis.

References:

/1/ Sandvik, P.C, COSMAR Moonpool dynamic, SINTEF Trondheim, April 2007

1.2 Constants

Sea water density: $\rho_{sea} := 1025 \frac{kg}{m^3}$

1.3 Simplifications

- The vertical motion of the lifted object can be considered to be the same as the vertical motio of the moonpool structure.
- The winch speed is small compared to the wave particle motion.
- The blocking effect from the lifted object on the moonpool water is moderate.
- Cursors prevent impact into the moonpool walls. Only vertiucal forces parallel to the moonpool axis are considered.
- The moonpool dimensions are small compared to the ship breadth.
- Only motion of the water and object in axial direction is considered(i.e. no transverse wave models)

2. Input Data

2.1 Moonpool Main Dimensions

Length: $L := 50m$

Breadth: $B := 30m$

Area: $A := L \cdot B$ $\qquad A = 1.5 \times 10^3 \cdot m^2$

Height (draft): $h := 7m$

Rectangualar geometry parameter (3.6.1.5): $\kappa := 0.46$

3. Calculations

3.1 Moonpool Resonance Period - section 3, 3.6.1.5

Energy-equivalent mass:

$$M_{eq} = \rho_{sea} \cdot A(h) \left(\int_0^h \frac{A(h)}{A(z)} \, dz + \frac{A(h)}{A(0)} \cdot \kappa \cdot \sqrt{A(0)} \right)$$

Simplified equetion for moonpool with constant section area:

$$M_{eq} := \rho_{sea} \cdot A \cdot \left(h + \kappa \cdot \sqrt{A}\right) \qquad M_{eq} = 3.815 \times 10^7 \, kg$$

Moonpool resonance period:

$$T_0 = 2\pi \sqrt{\frac{M_{eq}}{\rho_{sea} \cdot g \cdot A}}$$

Simplified equation for moonpool with constant section area:

$$T_0 := 2\pi \sqrt{\frac{h + \kappa \cdot \sqrt{A}}{g}} \qquad T_0 = 9.995 \, s$$

Appendix D

Moonpool Barge RAO's and Motion Characteristics

(Only as .PDF document)

```
***********************************************************************************************************
*                                            ***  MOSES   ***                                              *
*                                            ----------------                     10 June, 2008            *
*                                                                                                          *
***********************************************************************************************************

                              +++ I M A G E S   O F   I N P U T   D A T A +++
                              ===============================================

                &insert barge.ppo
                $
                $@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
                $@                                                                      @
                $@                              Defaults                                @
                $@                                                                      @
                $@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
                $
                $
                $*****************************************          Set Dimensions
                $
                &dimen -save -dimen Meters   M-Tons
                &LOCAL xfac = 1 yfac = 1 zfac = 1
                &default -save
                &default -fyield 248.04 -alpha 3.6111E-6 -spgravit 7.8492 -emodulus 1.9981E5 \
                       -poi_ratio 0.3 -kfac 1 1 -cmfac 0.85 0.85 -flood no -use @
                $
                $@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
                $@                                                                      @
                $@                            Define Points                             @
                $@                                                                      @
                $@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
                $
                $
                $*****************************************          Set factors
                $
                &set xfac = 1
                &set yfac = 1
                &set zfac = 1
                $
                $*****************************************          Set body to BARGE
                $
                &describe body BARGE
                $
                $*****************************************          Define Coordinates
                $
                *PNT0001     0.000*%xfac   -30.000*%yfac
                *PNT0002     0.000*%xfac   -30.000*%yfac    10.000*%zfac
                *PNT0003     0.000*%xfac   -20.000*%yfac
                *PNT0004     0.000*%xfac   -10.000*%yfac
                *PNT0005
                *PNT0006     0.000*%xfac     0.000*%yfac    10.000*%zfac
                *PNT0007     0.000*%xfac    10.000*%yfac
                *PNT0008     0.000*%xfac    20.000*%yfac
                *PNT0009     0.000*%xfac    30.000*%yfac
                *PNT0010     0.000*%xfac    30.000*%yfac    10.000*%zfac
                *PNT1001   180.000*%xfac   -30.000*%yfac
                *PNT1002   180.000*%xfac   -30.000*%yfac    10.000*%zfac
                *PNT1003   180.000*%xfac   -20.000*%yfac
                *PNT1004   180.000*%xfac   -10.000*%yfac
                *PNT1005   180.000*%xfac
                *PNT1006   180.000*%xfac     0.000*%yfac    10.000*%zfac
```

```
*****************************************************************************************************************
*                                                  ***  MOSES   ***                                              *
*                                                  ----------------                        10 June, 2008        *
*                                                                                                               *
*****************************************************************************************************************
```

```
                 +++ I M A G E S   O F   I N P U T   D A T A +++
                 ===============================================

*PNT1007   180.000*%xfac    10.000*%yfac
*PNT1008   180.000*%xfac    20.000*%yfac
*PNT1009   180.000*%xfac    30.000*%yfac
*PNT1010   180.000*%xfac    30.000*%yfac    10.000*%zfac
$
$@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
$@                                                                      @
$@                           Define BARGE                               @
$@                                                                      @
$@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
$
$
$*****************************************          Set Piece to BARGE
$
&describe piece BARGE    -diftype 3ddif -perm 1.00
$
$*****************************************          Define Panels
$
PANEL *PNT0002 *PNT0001 *PNT0003 *PNT0004 *PNT0005 *PNT0007 *PNT0008 *PNT0009  \
       *PNT0010 *PNT0006
PANEL *PNT0003 *PNT0001 *PNT1001 *PNT1003
PANEL *PNT0001 *PNT0002 *PNT1002 *PNT1001
PANEL *PNT0002 *PNT0006 *PNT1006 *PNT1002
PANEL *PNT0004 *PNT0003 *PNT1003 *PNT1004
PANEL *PNT0005 *PNT0004 *PNT1004 *PNT1005
PANEL *PNT0007 *PNT0005 *PNT1005 *PNT1007
PANEL *PNT0006 *PNT0010 *PNT1010 *PNT1006
PANEL *PNT0008 *PNT0007 *PNT1007 *PNT1008
PANEL *PNT0009 *PNT0008 *PNT1008 *PNT1009
PANEL *PNT0010 *PNT0009 *PNT1009 *PNT1010
PANEL *PNT1006 *PNT1010 *PNT1009 *PNT1008 *PNT1007 *PNT1005 *PNT1004 *PNT1003  \
       *PNT1001 *PNT1002
$
$*****************************************          Finish Up
$
&dimen -remember
&default -remember
```

```
*****************************************************************************************************
*                                            ***  MOSES  ***                                        *
*                                            ----------------                   10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.     GMT            =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   Heading          =   0.00 Deg.      Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20  *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.919	103	0.000	0	0.994	16	0.000	0	0.143	-76	0.000	0
0.1611	39.00	0.914	104	0.000	0	0.993	17	0.000	0	0.150	-75	0.000	0
0.1653	38.00	0.909	104	0.000	0	0.992	18	0.000	0	0.158	-75	0.000	0
0.1698	37.00	0.903	105	0.000	0	0.991	19	0.000	0	0.167	-74	0.000	0
0.1745	36.00	0.897	106	0.000	0	0.990	20	0.000	0	0.176	-73	0.000	0
0.1795	35.00	0.891	107	0.000	0	0.989	21	0.000	0	0.186	-72	0.000	0
0.1848	34.00	0.883	108	0.000	0	0.988	22	0.000	0	0.197	-71	0.000	0
0.1904	33.00	0.875	109	0.000	0	0.986	23	0.000	0	0.209	-70	0.000	0
0.1963	32.00	0.866	110	0.000	0	0.984	25	0.000	0	0.222	-69	0.000	0
0.2027	31.00	0.856	112	0.000	0	0.982	26	0.000	0	0.236	-67	0.000	0
0.2094	30.00	0.844	113	0.000	0	0.980	28	0.000	0	0.251	-66	0.000	0
0.2167	29.00	0.831	115	0.000	0	0.977	30	0.000	0	0.268	-64	0.000	0
0.2244	28.00	0.817	117	0.000	0	0.974	32	0.000	0	0.287	-62	0.000	0
0.2327	27.00	0.801	119	0.000	0	0.970	35	0.000	0	0.308	-60	0.000	0
0.2417	26.00	0.782	121	0.000	0	0.965	38	0.000	0	0.330	-58	0.000	0
0.2513	25.00	0.760	123	0.000	0	0.959	41	0.000	0	0.356	-56	0.000	0
0.2618	24.00	0.736	126	0.000	0	0.952	44	0.000	0	0.384	-53	0.000	0
0.2732	23.00	0.707	129	0.000	0	0.943	48	0.000	0	0.415	-50	0.000	0
0.2856	22.00	0.674	133	0.000	0	0.932	53	0.000	0	0.449	-46	0.000	0
0.2992	21.00	0.635	137	0.000	0	0.918	58	0.000	0	0.488	-42	0.000	0
0.3142	20.00	0.589	142	0.000	0	0.900	64	0.000	0	0.531	-37	0.000	0
0.3307	19.00	0.535	148	0.000	0	0.877	71	0.000	0	0.578	-31	0.000	0
0.3491	18.00	0.471	155	0.000	0	0.848	79	0.000	0	0.629	-25	0.000	0
0.3696	17.00	0.394	162	0.000	0	0.810	89	0.000	0	0.684	-17	0.000	0
0.3808	16.50	0.350	167	0.000	0	0.786	95	0.000	0	0.713	-12	0.000	0
0.3927	16.00	0.302	172	0.000	0	0.760	101	0.000	0	0.742	-8	0.000	0
0.4054	15.50	0.250	177	0.000	0	0.729	108	0.000	0	0.771	-2	0.000	0
0.4189	15.00	0.193	-175	0.000	0	0.695	116	0.000	0	0.800	3	0.000	0
0.4333	14.50	0.132	-168	0.000	0	0.658	126	0.000	0	0.826	9	0.000	0
0.4488	14.00	0.067	-160	0.000	0	0.618	137	0.000	0	0.849	16	0.000	0
0.4570	13.75	0.033	-152	0.000	0	0.597	143	0.000	0	0.859	20	0.000	0
0.4654	13.50	0.005	-28	0.000	0	0.577	149	0.000	0	0.867	24	0.000	0
0.4742	13.25	0.039	23	0.000	0	0.556	156	0.000	0	0.873	28	0.000	0
0.4833	13.00	0.075	30	0.000	0	0.536	164	0.000	0	0.876	33	0.000	0
0.4928	12.75	0.112	36	0.000	0	0.516	172	0.000	0	0.876	38	0.000	0
0.5027	12.50	0.148	41	0.000	0	0.497	-178	0.000	0	0.873	43	0.000	0

```
*****************************************************************************************************
*                                              ***  MOSES  ***                                      *
*                                              ----------------                  10 June, 2008      *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   Heading          =   0.00 Deg.       Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20    *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.184	47	0.000	0	0.480	-168	0.000	0	0.865	48	0.000	0
0.5236	12.00	0.218	53	0.000	0	0.464	-158	0.000	0	0.851	54	0.000	0
0.5347	11.75	0.250	59	0.000	0	0.449	-147	0.000	0	0.831	60	0.000	0
0.5464	11.50	0.279	66	0.000	0	0.435	-136	0.000	0	0.803	67	0.000	0
0.5585	11.25	0.303	74	0.000	0	0.422	-124	0.000	0	0.768	75	0.000	0
0.5712	11.00	0.322	82	0.000	0	0.409	-111	0.000	0	0.724	83	0.000	0
0.5845	10.75	0.334	91	0.000	0	0.396	-97	0.000	0	0.672	92	0.000	0
0.5984	10.50	0.339	101	0.000	0	0.383	-83	0.000	0	0.613	102	0.000	0
0.6130	10.25	0.336	112	0.000	0	0.369	-68	0.000	0	0.548	115	0.000	0
0.6283	10.00	0.325	126	0.000	0	0.354	-52	0.000	0	0.480	129	0.000	0
0.6444	9.75	0.308	141	0.000	0	0.337	-34	0.000	0	0.415	147	0.000	0
0.6614	9.50	0.287	160	0.000	0	0.319	-15	0.000	0	0.360	169	0.000	0
0.6793	9.25	0.266	-178	0.000	0	0.298	4	0.000	0	0.321	-165	0.000	0
0.6981	9.00	0.247	-153	0.000	0	0.275	26	0.000	0	0.302	-137	0.000	0
0.7181	8.75	0.233	-125	0.000	0	0.250	50	0.000	0	0.296	-109	0.000	0
0.7392	8.50	0.225	-94	0.000	0	0.224	76	0.000	0	0.292	-82	0.000	0
0.7616	8.25	0.220	-61	0.000	0	0.197	106	0.000	0	0.280	-55	0.000	0
0.7854	8.00	0.214	-27	0.000	0	0.170	140	0.000	0	0.256	-26	0.000	0
0.8107	7.75	0.208	12	0.000	0	0.141	177	0.000	0	0.213	7	0.000	0
0.8378	7.50	0.176	49	0.000	0	0.120	-138	0.000	0	0.170	40	0.000	0
0.8666	7.25	0.163	90	0.000	0	0.099	-88	0.000	0	0.130	80	0.000	0
0.8976	7.00	0.157	145	0.000	0	0.082	-33	0.000	0	0.104	140	0.000	0
0.9308	6.75	0.142	-140	0.000	0	0.066	28	0.000	0	0.091	-139	0.000	0
0.9666	6.50	0.106	-64	0.000	0	0.049	93	0.000	0	0.071	-64	0.000	0
1.0053	6.25	0.080	6	0.000	0	0.043	167	0.000	0	0.049	-2	0.000	0
1.0472	6.00	0.075	82	0.000	0	0.035	-96	0.000	0	0.035	70	0.000	0
1.0927	5.75	0.087	-172	0.000	0	0.027	3	0.000	0	0.036	-173	0.000	0
1.1424	5.50	0.055	-41	0.000	0	0.019	113	0.000	0	0.025	-45	0.000	0
1.1968	5.25	0.040	66	0.000	0	0.017	-112	0.000	0	0.018	49	0.000	0
1.2566	5.00	0.047	-102	0.000	0	0.012	51	0.000	0	0.010	-102	0.000	0
1.3228	4.75	0.043	37	0.000	0	0.010	-130	0.000	0	0.015	24	0.000	0
1.3963	4.50	0.030	-67	0.000	0	0.005	84	0.000	0	0.007	-72	0.000	0
1.4784	4.25	0.018	113	0.000	0	0.006	-74	0.000	0	0.003	103	0.000	0
1.5708	4.00	0.013	63	0.000	0	0.001	-118	0.000	0	0.002	56	0.000	0
1.6755	3.75	0.008	60	0.000	0	0.001	-87	0.000	0	0.001	96	0.000	0
1.7952	3.50	0.012	160	0.000	0	0.001	-4	0.000	0	0.001	162	0.000	0

```
*************************************************************************************************
*                                          ***  MOSES  ***                                      *
*                                          ---------------                 10 June, 2008        *
*                                                                                               *
*                                                                                               *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.    GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  =  48.6 Meters *
*   Heading          =   0.00 Deg.       Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20   *
*                                                                                               *
*************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.005	-28	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
2.0944	3.00	0.004	-65	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0

```
*** MOSES ***
10 June, 2008

Draft           =  7.0 Meters    Trim Angle        =  0.00 Deg.    GMT            = 41.4 Meters
Roll Gy. Radius = 20.4 Meters    Pitch Gy. Radius = 48.6 Meters    Yaw Gy. Radius = 48.6 Meters
Heading         = 15.00 Deg.     Forward Speed     =  0.00 Knots   Linearization Based on 1/ 20
```

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.888	102	0.238	106	0.994	16	0.037	102	0.138	-76	0.036	-166
0.1611	39.00	0.884	103	0.237	106	0.994	16	0.039	103	0.145	-76	0.037	-166
0.1653	38.00	0.879	103	0.236	107	0.993	17	0.041	104	0.153	-75	0.039	-165
0.1698	37.00	0.873	104	0.235	108	0.992	18	0.043	105	0.161	-74	0.041	-164
0.1745	36.00	0.868	105	0.233	109	0.991	19	0.046	105	0.170	-73	0.044	-163
0.1795	35.00	0.861	106	0.232	110	0.990	20	0.048	106	0.180	-73	0.046	-163
0.1848	34.00	0.854	107	0.230	112	0.989	22	0.051	107	0.190	-72	0.049	-162
0.1904	33.00	0.846	108	0.228	113	0.988	23	0.054	108	0.202	-71	0.052	-161
0.1963	32.00	0.838	109	0.226	114	0.986	25	0.058	110	0.214	-69	0.055	-159
0.2027	31.00	0.828	110	0.223	116	0.984	26	0.061	111	0.228	-68	0.058	-158
0.2094	30.00	0.817	112	0.221	118	0.982	28	0.066	112	0.243	-67	0.062	-157
0.2167	29.00	0.805	113	0.218	120	0.980	30	0.070	114	0.259	-65	0.066	-155
0.2244	28.00	0.791	115	0.214	122	0.977	32	0.075	116	0.278	-63	0.070	-153
0.2327	27.00	0.776	117	0.211	125	0.973	34	0.080	117	0.298	-61	0.075	-151
0.2417	26.00	0.758	119	0.207	127	0.969	37	0.086	120	0.320	-59	0.081	-149
0.2513	25.00	0.738	121	0.202	131	0.964	40	0.093	122	0.344	-57	0.087	-147
0.2618	24.00	0.715	124	0.196	134	0.957	44	0.100	125	0.371	-54	0.093	-144
0.2732	23.00	0.688	127	0.190	138	0.949	48	0.108	128	0.402	-51	0.100	-141
0.2856	22.00	0.656	130	0.183	143	0.940	52	0.117	131	0.435	-47	0.108	-138
0.2992	21.00	0.620	134	0.175	149	0.927	57	0.126	135	0.473	-43	0.117	-134
0.3142	20.00	0.577	138	0.166	156	0.912	63	0.137	140	0.515	-39	0.126	-129
0.3307	19.00	0.526	143	0.155	163	0.891	70	0.148	145	0.561	-33	0.136	-123
0.3491	18.00	0.465	149	0.143	173	0.865	78	0.160	152	0.612	-27	0.147	-117
0.3696	17.00	0.393	156	0.129	-174	0.831	88	0.172	159	0.667	-19	0.158	-110
0.3808	16.50	0.351	160	0.122	-167	0.810	93	0.178	163	0.696	-15	0.164	-105
0.3927	16.00	0.306	164	0.114	-160	0.786	100	0.183	168	0.725	-10	0.169	-101
0.4054	15.50	0.257	168	0.106	-151	0.758	107	0.188	173	0.755	-5	0.174	-95
0.4189	15.00	0.204	172	0.097	-140	0.728	114	0.192	179	0.784	0	0.178	-90
0.4333	14.50	0.147	175	0.089	-128	0.694	123	0.194	-174	0.812	6	0.182	-83
0.4488	14.00	0.087	173	0.081	-115	0.657	134	0.194	-168	0.838	13	0.184	-76
0.4570	13.75	0.057	166	0.078	-107	0.638	140	0.193	-164	0.849	16	0.185	-72
0.4654	13.50	0.032	138	0.074	-99	0.618	146	0.191	-160	0.859	20	0.185	-68
0.4742	13.25	0.034	80	0.071	-90	0.599	152	0.188	-156	0.867	24	0.185	-63
0.4833	13.00	0.062	56	0.068	-81	0.579	159	0.183	-152	0.873	29	0.184	-59
0.4928	12.75	0.094	51	0.066	-71	0.560	167	0.177	-148	0.876	33	0.183	-54
0.5027	12.50	0.129	51	0.064	-61	0.541	175	0.169	-143	0.876	38	0.181	-48

```
*************************************************************************************************************
*                                                *** MOSES ***                                              *
*                                                ----------------                  10 June, 2008            *
*                                                                                                           *
*                                                                                                           *
*   Draft            =  7.0 Meters      Trim Angle       =  0.00 Deg.     GMT              = 41.4 Meters *
*   Roll Gy. Radius  = 20.4 Meters      Pitch Gy. Radius = 48.6 Meters    Yaw Gy. Radius   = 48.6 Meters *
*   Heading          = 15.00 Deg.       Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20    *
*                                                                                                           *
*************************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.163	53	0.062	-50	0.522	-175	0.159	-139	0.872	44	0.178	-43
0.5236	12.00	0.197	57	0.061	-40	0.504	-166	0.146	-134	0.863	49	0.175	-36
0.5347	11.75	0.229	62	0.060	-30	0.486	-156	0.130	-129	0.848	55	0.170	-30
0.5464	11.50	0.258	67	0.059	-21	0.469	-145	0.110	-124	0.827	62	0.164	-23
0.5585	11.25	0.284	73	0.057	-12	0.450	-134	0.085	-119	0.798	69	0.158	-15
0.5712	11.00	0.306	80	0.054	-6	0.430	-122	0.054	-116	0.761	76	0.150	-7
0.5845	10.75	0.322	88	0.050	-2	0.409	-110	0.017	-123	0.716	85	0.141	1
0.5984	10.50	0.331	98	0.045	-3	0.386	-96	0.031	90	0.663	94	0.130	10
0.6130	10.25	0.334	108	0.040	-14	0.361	-81	0.088	89	0.603	105	0.118	20
0.6283	10.00	0.329	120	0.041	-37	0.335	-64	0.157	91	0.539	118	0.105	30
0.6444	9.75	0.318	134	0.057	-62	0.310	-44	0.238	93	0.473	133	0.089	42
0.6614	9.50	0.302	150	0.088	-78	0.295	-21	0.325	93	0.409	151	0.071	54
0.6793	9.25	0.282	168	0.124	-89	0.295	1	0.393	90	0.354	173	0.051	66
0.6981	9.00	0.261	-169	0.149	-97	0.302	22	0.406	85	0.312	-161	0.029	79
0.7181	8.75	0.241	-144	0.150	-100	0.294	42	0.353	84	0.285	-133	0.007	83
0.7392	8.50	0.222	-116	0.130	-96	0.265	63	0.264	89	0.269	-104	0.017	-61
0.7616	8.25	0.206	-85	0.101	-84	0.226	88	0.171	101	0.255	-75	0.038	-47
0.7854	8.00	0.192	-51	0.069	-63	0.186	119	0.091	122	0.236	-44	0.057	-28
0.8107	7.75	0.181	-10	0.040	-26	0.147	155	0.032	171	0.206	-10	0.071	-8
0.8378	7.50	0.153	27	0.025	39	0.120	-161	0.030	-72	0.174	22	0.074	13
0.8666	7.25	0.146	68	0.029	114	0.097	-110	0.053	-19	0.141	58	0.066	37
0.8976	7.00	0.148	120	0.039	167	0.081	-55	0.063	21	0.113	109	0.046	62
0.9308	6.75	0.135	-172	0.042	-145	0.068	5	0.058	64	0.085	-177	0.016	93
0.9666	6.50	0.093	-101	0.036	-96	0.051	67	0.041	115	0.059	-97	0.019	-59
1.0053	6.25	0.062	-33	0.024	-30	0.041	135	0.020	-164	0.043	-30	0.046	-21
1.0472	6.00	0.056	43	0.016	76	0.030	-129	0.024	-36	0.036	35	0.048	18
1.0927	5.75	0.070	146	0.022	178	0.025	-26	0.033	43	0.032	135	0.025	67
1.1424	5.50	0.044	-95	0.019	-99	0.018	74	0.019	125	0.018	-91	0.013	-79
1.1968	5.25	0.022	2	0.011	38	0.014	-163	0.013	-72	0.016	1	0.030	0
1.2566	5.00	0.036	-163	0.014	-171	0.011	7	0.015	60	0.008	-172	0.013	90
1.3228	4.75	0.023	-40	0.010	-3	0.007	166	0.008	-120	0.010	-38	0.020	-20
1.3963	4.50	0.018	-150	0.008	-159	0.003	17	0.007	84	0.004	-162	0.009	114
1.4784	4.25	0.010	-16	0.003	29	0.002	130	0.004	-29	0.002	2	0.015	12
1.5708	4.00	0.007	-75	0.004	-59	0.000	0	0.003	-111	0.001	-59	0.008	-54
1.6755	3.75	0.006	-102	0.002	-59	0.000	0	0.002	-105	0.000	0	0.002	-42
1.7952	3.50	0.001	-167	0.001	-57	0.000	0	0.001	-59	0.001	83	0.002	-21

```
*************************************************************************************************************
*                                              ***  MOSES  ***                                              *
*                                              ----------------                    10 June, 2008            *
*                                                                                                           *
*                                                                                                           *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   Heading          =  15.00 Deg.       Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20    *
*                                                                                                           *
*************************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	-112	0.001	74	0.000	0	0.001	-145	0.000	0	0.003	112
2.0944	3.00	0.001	-48	0.001	5	0.000	0	0.001	-168	0.000	0	0.002	80

```
***************************************************************************************************
*                                          ***  MOSES  ***                                        *
*                                          ----------------                 10 June, 2008         *
*                                                                                                 *
*                                                                                                 *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.    GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   Heading          =  30.00 Deg.       Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20    *
*                                                                                                 *
***************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.798	100	0.461	104	0.996	14	0.072	101	0.124	-78	0.062	-168
0.1611	39.00	0.794	101	0.459	105	0.995	15	0.076	102	0.130	-77	0.065	-167
0.1653	38.00	0.790	102	0.457	105	0.995	16	0.080	102	0.137	-76	0.068	-166
0.1698	37.00	0.785	102	0.454	106	0.994	17	0.084	103	0.145	-76	0.072	-166
0.1745	36.00	0.780	103	0.451	107	0.994	18	0.089	104	0.153	-75	0.076	-165
0.1795	35.00	0.774	104	0.448	108	0.993	19	0.094	105	0.161	-74	0.080	-164
0.1848	34.00	0.768	104	0.445	109	0.992	20	0.099	105	0.171	-73	0.085	-163
0.1904	33.00	0.762	105	0.441	111	0.991	21	0.105	106	0.181	-72	0.090	-162
0.1963	32.00	0.754	106	0.437	112	0.990	23	0.112	107	0.192	-71	0.095	-161
0.2027	31.00	0.746	107	0.433	113	0.988	24	0.119	109	0.205	-70	0.101	-160
0.2094	30.00	0.737	109	0.428	115	0.987	26	0.127	110	0.218	-69	0.107	-159
0.2167	29.00	0.727	110	0.422	117	0.985	27	0.136	111	0.233	-68	0.115	-158
0.2244	28.00	0.715	111	0.416	119	0.983	29	0.145	113	0.250	-66	0.122	-156
0.2327	27.00	0.702	113	0.409	121	0.980	32	0.156	115	0.268	-64	0.131	-154
0.2417	26.00	0.687	115	0.401	124	0.977	34	0.168	116	0.288	-62	0.140	-152
0.2513	25.00	0.670	117	0.392	126	0.973	37	0.181	119	0.310	-60	0.151	-150
0.2618	24.00	0.651	119	0.382	130	0.968	40	0.195	121	0.335	-58	0.162	-148
0.2732	23.00	0.628	121	0.371	133	0.962	44	0.211	124	0.363	-55	0.175	-145
0.2856	22.00	0.602	124	0.357	138	0.955	48	0.229	127	0.394	-52	0.189	-142
0.2992	21.00	0.571	127	0.342	143	0.946	52	0.249	131	0.428	-48	0.204	-138
0.3142	20.00	0.536	131	0.325	149	0.934	58	0.271	135	0.467	-44	0.221	-134
0.3307	19.00	0.493	135	0.304	156	0.919	64	0.295	140	0.511	-39	0.239	-129
0.3491	18.00	0.443	140	0.281	164	0.899	72	0.321	145	0.559	-33	0.259	-124
0.3696	17.00	0.383	145	0.255	175	0.873	80	0.349	152	0.612	-27	0.279	-117
0.3808	16.50	0.349	148	0.240	-178	0.857	85	0.363	156	0.641	-23	0.290	-113
0.3927	16.00	0.312	151	0.224	-171	0.838	91	0.377	160	0.671	-18	0.300	-109
0.4054	15.50	0.271	154	0.208	-163	0.817	97	0.391	164	0.701	-14	0.310	-104
0.4189	15.00	0.227	157	0.191	-153	0.793	104	0.404	169	0.733	-9	0.319	-99
0.4333	14.50	0.180	158	0.174	-142	0.766	112	0.415	175	0.764	-3	0.327	-93
0.4488	14.00	0.130	157	0.158	-130	0.736	121	0.424	-178	0.795	2	0.333	-87
0.4570	13.75	0.105	153	0.150	-122	0.720	126	0.427	-175	0.810	5	0.336	-83
0.4654	13.50	0.082	146	0.142	-114	0.703	131	0.428	-172	0.824	9	0.338	-79
0.4742	13.25	0.063	130	0.135	-105	0.686	137	0.429	-168	0.837	13	0.339	-75
0.4833	13.00	0.056	104	0.129	-96	0.669	143	0.427	-165	0.849	17	0.339	-71
0.4928	12.75	0.065	79	0.124	-86	0.652	149	0.423	-161	0.860	21	0.339	-66
0.5027	12.50	0.087	65	0.121	-75	0.634	156	0.416	-157	0.869	25	0.337	-62

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                     10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*   Draft           =   7.0 Meters      Trim Angle       =   0.00 Deg.    GMT              = 41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   Heading         =  30.00 Deg.       Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20   *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.114	59	0.118	-64	0.615	163	0.406	-152	0.875	30	0.334	-56
0.5236	12.00	0.143	57	0.117	-53	0.597	171	0.391	-148	0.878	35	0.330	-51
0.5347	11.75	0.173	58	0.117	-42	0.578	179	0.372	-143	0.877	40	0.325	-45
0.5464	11.50	0.203	60	0.117	-31	0.557	-172	0.346	-138	0.871	46	0.318	-38
0.5585	11.25	0.232	64	0.117	-21	0.535	-163	0.312	-133	0.860	51	0.309	-31
0.5712	11.00	0.258	69	0.116	-12	0.511	-153	0.269	-128	0.843	58	0.299	-24
0.5845	10.75	0.281	75	0.112	-4	0.484	-143	0.213	-123	0.819	65	0.286	-16
0.5984	10.50	0.300	82	0.104	0	0.453	-131	0.143	-118	0.787	73	0.272	-7
0.6130	10.25	0.315	90	0.091	1	0.417	-119	0.052	-109	0.747	81	0.255	1
0.6283	10.00	0.324	99	0.073	-7	0.375	-105	0.065	62	0.699	90	0.235	11
0.6444	9.75	0.326	109	0.059	-40	0.330	-89	0.211	67	0.643	100	0.212	22
0.6614	9.50	0.323	120	0.085	-87	0.291	-67	0.381	66	0.578	112	0.186	33
0.6793	9.25	0.312	134	0.141	-112	0.279	-42	0.527	62	0.507	125	0.156	45
0.6981	9.00	0.294	149	0.200	-124	0.291	-18	0.613	58	0.430	140	0.123	58
0.7181	8.75	0.271	166	0.240	-129	0.303	0	0.621	56	0.353	159	0.086	73
0.7392	8.50	0.244	-172	0.237	-127	0.289	18	0.531	59	0.280	-177	0.047	91
0.7616	8.25	0.214	-148	0.210	-118	0.256	39	0.409	69	0.220	-148	0.008	133
0.7854	8.00	0.183	-120	0.173	-102	0.216	63	0.291	84	0.178	-113	0.031	-66
0.8107	7.75	0.158	-85	0.129	-79	0.174	93	0.181	109	0.157	-71	0.066	-43
0.8378	7.50	0.123	-50	0.090	-46	0.139	128	0.099	145	0.145	-35	0.092	-20
0.8666	7.25	0.111	-10	0.060	1	0.105	171	0.053	-144	0.136	0	0.106	3
0.8976	7.00	0.113	40	0.046	68	0.078	-138	0.060	-59	0.128	39	0.105	29
0.9308	6.75	0.110	102	0.050	136	0.060	-78	0.078	-1	0.103	90	0.086	58
0.9666	6.50	0.082	164	0.056	-166	0.047	-16	0.082	48	0.059	145	0.052	94
1.0053	6.25	0.058	-142	0.054	-110	0.042	43	0.071	101	0.029	-147	0.010	177
1.0472	6.00	0.050	-87	0.041	-44	0.034	117	0.048	169	0.025	-64	0.032	-31
1.0927	5.75	0.047	1	0.023	45	0.022	-157	0.029	-80	0.032	16	0.048	17
1.1424	5.50	0.029	131	0.020	166	0.014	-49	0.032	30	0.019	114	0.039	75
1.1968	5.25	0.022	-152	0.020	-91	0.013	59	0.029	121	0.010	-158	0.009	126
1.2566	5.00	0.017	16	0.006	25	0.009	-170	0.011	-93	0.007	18	0.014	18
1.3228	4.75	0.025	144	0.006	-158	0.007	-10	0.011	62	0.014	131	0.020	93
1.3963	4.50	0.012	68	0.002	0	0.004	-159	0.005	-133	0.005	51	0.002	120
1.4784	4.25	0.012	15	0.004	58	0.003	0	0.003	63	0.001	61	0.015	89
1.5708	4.00	0.004	-86	0.005	-79	0.001	-18	0.003	-42	0.000	0	0.008	-83
1.6755	3.75	0.002	-161	0.002	-138	0.000	0	0.002	-89	0.000	0	0.006	-148
1.7952	3.50	0.000	0	0.001	-149	0.000	0	0.000	0	0.000	0	0.004	-173

```
*********************************************************************************************************
*                                              ***  MOSES  ***                                          *
*                                              ----------------                     10 June, 2008       *
*                                                                                                       *
*                                                                                                       *
*   Draft             =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   Heading           =  30.00 Deg.        Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20    *
*                                                                                                       *
*********************************************************************************************************
```

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	-11	0.001	-59	0.000	0	0.000	0	0.000	0	0.002	-105
2.0944	3.00	0.001	70	0.000	0	0.000	0	0.000	0	0.000	0	0.001	-4

```
*****************************************************************************************************
*                                         ***  MOSES  ***                                          *
*                                         ----------------                    10 June, 2008        *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   Heading          =  45.00 Deg.       Forward Speed    =   0.00 Knots    Linearization Based on 1/ 20   *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.653	98	0.653	101	0.997	12	0.102	99	0.101	-80	0.071	-170
0.1611	39.00	0.650	99	0.650	102	0.997	13	0.107	100	0.107	-79	0.075	-169
0.1653	38.00	0.647	99	0.647	103	0.997	14	0.113	100	0.112	-79	0.079	-169
0.1698	37.00	0.643	99	0.643	103	0.997	14	0.119	101	0.118	-78	0.083	-168
0.1745	36.00	0.639	100	0.640	104	0.996	15	0.126	101	0.125	-78	0.088	-168
0.1795	35.00	0.635	101	0.635	105	0.996	16	0.133	102	0.132	-77	0.093	-167
0.1848	34.00	0.630	101	0.631	106	0.995	17	0.141	103	0.140	-76	0.098	-166
0.1904	33.00	0.625	102	0.626	107	0.995	18	0.150	103	0.148	-75	0.104	-165
0.1963	32.00	0.620	103	0.620	108	0.994	19	0.159	104	0.158	-75	0.110	-165
0.2027	31.00	0.613	103	0.614	109	0.993	20	0.170	105	0.168	-74	0.117	-164
0.2094	30.00	0.606	104	0.607	110	0.992	22	0.181	106	0.179	-73	0.124	-163
0.2167	29.00	0.599	105	0.600	112	0.991	23	0.193	107	0.191	-71	0.133	-162
0.2244	28.00	0.590	106	0.591	114	0.990	25	0.207	109	0.205	-70	0.142	-160
0.2327	27.00	0.580	108	0.582	115	0.988	27	0.223	110	0.220	-69	0.152	-159
0.2417	26.00	0.569	109	0.571	117	0.986	29	0.240	112	0.236	-67	0.163	-157
0.2513	25.00	0.556	110	0.559	120	0.984	31	0.259	113	0.255	-65	0.175	-155
0.2618	24.00	0.542	112	0.546	122	0.981	34	0.280	115	0.276	-63	0.188	-154
0.2732	23.00	0.526	114	0.530	125	0.978	37	0.304	117	0.299	-61	0.203	-151
0.2856	22.00	0.506	116	0.512	129	0.974	40	0.331	120	0.325	-59	0.220	-149
0.2992	21.00	0.484	119	0.491	133	0.969	44	0.361	123	0.354	-56	0.238	-146
0.3142	20.00	0.458	121	0.468	138	0.962	49	0.395	126	0.388	-52	0.258	-142
0.3307	19.00	0.428	124	0.440	144	0.953	54	0.434	130	0.425	-48	0.280	-138
0.3491	18.00	0.391	128	0.407	151	0.942	60	0.478	135	0.468	-43	0.305	-134
0.3696	17.00	0.348	132	0.369	159	0.927	68	0.526	140	0.516	-38	0.331	-128
0.3808	16.50	0.324	134	0.348	164	0.917	72	0.553	143	0.543	-35	0.344	-125
0.3927	16.00	0.297	136	0.326	170	0.906	76	0.580	147	0.571	-31	0.358	-122
0.4054	15.50	0.268	138	0.301	177	0.893	82	0.609	150	0.601	-28	0.371	-118
0.4189	15.00	0.236	140	0.276	-174	0.879	87	0.639	154	0.632	-23	0.384	-113
0.4333	14.50	0.202	141	0.249	-165	0.862	93	0.670	159	0.665	-19	0.396	-109
0.4488	14.00	0.165	140	0.221	-153	0.843	100	0.700	164	0.700	-14	0.407	-103
0.4570	13.75	0.146	139	0.208	-147	0.833	104	0.715	166	0.717	-11	0.412	-100
0.4654	13.50	0.127	137	0.195	-139	0.822	108	0.730	169	0.735	-8	0.417	-97
0.4742	13.25	0.109	133	0.183	-131	0.811	113	0.744	172	0.753	-5	0.420	-94
0.4833	13.00	0.092	126	0.172	-121	0.799	117	0.757	175	0.771	-2	0.423	-90
0.4928	12.75	0.079	115	0.163	-110	0.786	122	0.770	178	0.789	1	0.425	-87
0.5027	12.50	0.073	99	0.157	-98	0.774	127	0.780	-178	0.807	4	0.426	-83

*** MOSES ***

10 June, 2008

Draft = 7.0 Meters	Trim Angle = 0.00 Deg.	GMT = 41.4 Meters
Roll Gy. Radius = 20.4 Meters	Pitch Gy. Radius = 48.6 Meters	Yaw Gy. Radius = 48.6 Meters
Heading = 45.00 Deg.	Forward Speed = 0.00 Knots	Linearization Based on 1/ 20

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.075	81	0.155	-85	0.760	133	0.789	-174	0.825	8	0.427	-78
0.5236	12.00	0.088	67	0.156	-72	0.746	138	0.795	-171	0.841	12	0.425	-74
0.5347	11.75	0.106	58	0.161	-58	0.731	144	0.798	-167	0.856	16	0.423	-68
0.5464	11.50	0.129	53	0.170	-46	0.715	151	0.796	-163	0.869	20	0.419	-63
0.5585	11.25	0.154	52	0.182	-34	0.697	157	0.788	-159	0.880	25	0.414	-57
0.5712	11.00	0.180	52	0.196	-23	0.677	164	0.774	-155	0.888	30	0.407	-51
0.5845	10.75	0.206	54	0.210	-13	0.654	172	0.749	-151	0.892	35	0.399	-44
0.5984	10.50	0.231	57	0.223	-4	0.627	179	0.713	-147	0.891	40	0.388	-36
0.6130	10.25	0.254	61	0.232	3	0.595	-171	0.659	-143	0.883	46	0.376	-28
0.6283	10.00	0.275	65	0.233	10	0.557	-163	0.581	-139	0.868	51	0.361	-20
0.6444	9.75	0.291	71	0.220	15	0.511	-154	0.469	-135	0.842	58	0.343	-10
0.6614	9.50	0.302	77	0.185	19	0.453	-143	0.311	-129	0.804	64	0.323	0
0.6793	9.25	0.306	85	0.116	25	0.384	-130	0.133	-94	0.750	71	0.299	10
0.6981	9.00	0.301	93	0.042	79	0.321	-112	0.211	-14	0.678	79	0.271	22
0.7181	8.75	0.287	103	0.096	153	0.283	-90	0.364	-1	0.589	87	0.239	34
0.7392	8.50	0.264	115	0.154	167	0.258	-69	0.431	4	0.487	98	0.203	48
0.7616	8.25	0.235	130	0.188	179	0.234	-47	0.438	13	0.381	111	0.164	64
0.7854	8.00	0.203	148	0.200	-166	0.208	-23	0.407	26	0.279	128	0.122	81
0.8107	7.75	0.178	172	0.192	-148	0.179	3	0.348	43	0.184	153	0.081	100
0.8378	7.50	0.132	-164	0.175	-126	0.154	31	0.284	64	0.120	-176	0.035	123
0.8666	7.25	0.108	-137	0.149	-99	0.125	64	0.216	91	0.079	-134	0.009	-57
0.8976	7.00	0.092	-98	0.119	-67	0.098	101	0.153	124	0.070	-76	0.046	-22
0.9308	6.75	0.069	-42	0.085	-28	0.072	143	0.097	167	0.073	-17	0.073	2
0.9666	6.50	0.041	19	0.055	21	0.047	-167	0.056	-131	0.062	33	0.087	28
1.0053	6.25	0.024	78	0.037	91	0.032	-107	0.046	-48	0.045	75	0.082	56
1.0472	6.00	0.021	139	0.034	175	0.025	-26	0.055	25	0.029	121	0.057	84
1.0927	5.75	0.023	-142	0.034	-110	0.020	55	0.056	89	0.015	-168	0.032	108
1.1424	5.50	0.012	-70	0.025	-42	0.014	135	0.040	153	0.006	-35	0.014	117
1.1968	5.25	0.008	-108	0.012	41	0.007	-141	0.021	-123	0.006	73	0.015	103
1.2566	5.00	0.019	-49	0.007	-130	0.002	45	0.013	30	0.001	18	0.015	108
1.3228	4.75	0.003	101	0.010	-18	0.002	-139	0.011	146	0.004	175	0.015	131
1.3963	4.50	0.010	-74	0.013	148	0.000	0	0.005	-46	0.001	-110	0.021	158
1.4784	4.25	0.009	3	0.018	46	0.001	-154	0.006	-44	0.001	-17	0.008	-5
1.5708	4.00	0.002	72	0.006	-151	0.000	0	0.000	0	0.000	0	0.017	-148
1.6755	3.75	0.002	61	0.001	163	0.000	0	0.002	51	0.000	0	0.004	-64
1.7952	3.50	0.001	-171	0.002	-147	0.000	0	0.001	-16	0.000	0	0.005	-74

*** MOSES ***

10 June, 2008

Draft = 7.0 Meters	Trim Angle = 0.00 Deg.	GMT = 41.4 Meters
Roll Gy. Radius = 20.4 Meters	Pitch Gy. Radius = 48.6 Meters	Yaw Gy. Radius = 48.6 Meters
Heading = 45.00 Deg.	Forward Speed = 0.00 Knots	Linearization Based on 1/ 20

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	-145	0.002	-88	0.000	0	0.000	0	0.000	0	0.002	-29
2.0944	3.00	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0

```
****************************************************************************************************
*                                      ***  MOSES  ***                                             *
*                                      ----------------                      10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*   Draft           =   7.0 Meters     Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   Heading         =  60.00 Deg.      Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20   *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.463	95	0.801	98	0.999	9	0.125	96	0.072	-82	0.062	-172
0.1611	39.00	0.461	95	0.797	98	0.999	10	0.132	97	0.075	-82	0.065	-172
0.1653	38.00	0.459	96	0.793	99	0.999	10	0.139	97	0.079	-82	0.068	-172
0.1698	37.00	0.456	96	0.789	99	0.999	11	0.146	97	0.084	-81	0.072	-171
0.1745	36.00	0.454	96	0.785	100	0.999	11	0.155	98	0.088	-81	0.076	-171
0.1795	35.00	0.451	97	0.780	101	0.998	12	0.164	98	0.094	-80	0.080	-170
0.1848	34.00	0.448	97	0.775	101	0.998	13	0.173	99	0.099	-80	0.085	-170
0.1904	33.00	0.444	98	0.769	102	0.998	13	0.184	99	0.105	-79	0.090	-169
0.1963	32.00	0.441	98	0.762	103	0.998	14	0.196	100	0.112	-79	0.095	-169
0.2027	31.00	0.437	99	0.755	104	0.997	15	0.209	101	0.119	-78	0.101	-168
0.2094	30.00	0.432	99	0.747	104	0.997	16	0.223	101	0.127	-77	0.108	-167
0.2167	29.00	0.427	100	0.738	105	0.997	17	0.239	102	0.136	-77	0.115	-167
0.2244	28.00	0.422	100	0.728	107	0.996	19	0.256	103	0.145	-76	0.123	-166
0.2327	27.00	0.415	101	0.717	108	0.996	20	0.275	104	0.156	-75	0.132	-165
0.2417	26.00	0.408	102	0.705	109	0.995	22	0.297	105	0.168	-74	0.142	-164
0.2513	25.00	0.400	103	0.691	111	0.994	23	0.321	106	0.181	-72	0.152	-162
0.2618	24.00	0.391	104	0.675	113	0.994	25	0.348	108	0.196	-71	0.164	-161
0.2732	23.00	0.381	105	0.657	115	0.992	28	0.379	109	0.213	-69	0.177	-159
0.2856	22.00	0.369	106	0.635	118	0.991	30	0.414	111	0.232	-67	0.192	-158
0.2992	21.00	0.355	108	0.611	120	0.990	33	0.454	113	0.254	-65	0.208	-155
0.3142	20.00	0.339	109	0.583	124	0.988	37	0.500	115	0.279	-63	0.227	-153
0.3307	19.00	0.320	111	0.550	128	0.985	41	0.553	118	0.307	-60	0.247	-150
0.3491	18.00	0.298	113	0.511	133	0.982	45	0.614	121	0.339	-57	0.269	-147
0.3696	17.00	0.272	115	0.464	139	0.978	51	0.686	125	0.377	-53	0.294	-143
0.3808	16.50	0.257	117	0.438	143	0.975	54	0.727	127	0.398	-51	0.306	-141
0.3927	16.00	0.241	118	0.409	147	0.972	57	0.771	130	0.421	-48	0.320	-138
0.4054	15.50	0.224	119	0.377	152	0.968	61	0.819	132	0.445	-45	0.333	-136
0.4189	15.00	0.204	120	0.343	158	0.964	65	0.871	135	0.471	-42	0.347	-132
0.4333	14.50	0.184	120	0.305	165	0.959	69	0.928	138	0.500	-39	0.360	-129
0.4488	14.00	0.161	120	0.265	174	0.953	74	0.991	141	0.532	-35	0.372	-125
0.4570	13.75	0.149	119	0.245	179	0.950	77	1.025	143	0.548	-34	0.378	-123
0.4654	13.50	0.137	118	0.224	-173	0.947	80	1.060	145	0.566	-31	0.384	-121
0.4742	13.25	0.125	117	0.204	-165	0.943	83	1.097	147	0.584	-29	0.389	-118
0.4833	13.00	0.112	114	0.185	-155	0.939	86	1.136	149	0.603	-27	0.394	-116
0.4928	12.75	0.100	110	0.170	-143	0.936	89	1.177	151	0.623	-25	0.399	-113
0.5027	12.50	0.089	105	0.160	-128	0.931	92	1.220	153	0.644	-22	0.402	-110

```
*****************************************************************************************************
*                                            ***  MOSES  ***                                        *
*                                            ----------------                    10 June, 2008      *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.    GMT            =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters  Yaw Gy. Radius  =  48.6 Meters *
*   Heading          =  60.00 Deg.       Forward Speed   =  0.00 Knots    Linearization Based on 1/ 20   *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.079	96	0.158	-111	0.927	96	1.266	155	0.666	-20	0.405	-107
0.5236	12.00	0.072	85	0.166	-94	0.922	100	1.314	158	0.689	-17	0.407	-103
0.5347	11.75	0.070	71	0.186	-78	0.917	104	1.365	160	0.713	-14	0.409	-99
0.5464	11.50	0.074	57	0.217	-64	0.912	108	1.420	162	0.737	-11	0.409	-95
0.5585	11.25	0.084	45	0.257	-53	0.905	112	1.477	165	0.762	-9	0.409	-91
0.5712	11.00	0.099	36	0.305	-44	0.898	117	1.538	167	0.787	-6	0.407	-86
0.5845	10.75	0.116	31	0.367	-40	0.894	121	1.569	167	0.811	-3	0.405	-80
0.5984	10.50	0.136	27	0.428	-34	0.884	125	1.625	168	0.834	0	0.401	-74
0.6130	10.25	0.157	25	0.493	-30	0.872	130	1.670	169	0.854	2	0.397	-68
0.6283	10.00	0.179	24	0.561	-26	0.856	135	1.711	169	0.870	5	0.391	-61
0.6444	9.75	0.199	24	0.627	-24	0.837	139	1.730	168	0.878	8	0.385	-53
0.6614	9.50	0.216	24	0.680	-24	0.808	143	1.704	166	0.875	11	0.377	-45
0.6793	9.25	0.229	25	0.704	-25	0.762	147	1.604	162	0.856	14	0.367	-36
0.6981	9.00	0.234	26	0.674	-27	0.687	150	1.394	156	0.816	16	0.355	-27
0.7181	8.75	0.231	28	0.581	-29	0.583	155	1.085	152	0.752	20	0.340	-16
0.7392	8.50	0.218	32	0.453	-26	0.468	162	0.750	151	0.668	24	0.322	-5
0.7616	8.25	0.197	38	0.313	-16	0.358	173	0.438	159	0.570	30	0.300	6
0.7854	8.00	0.171	47	0.205	2	0.269	-170	0.224	-178	0.469	38	0.275	19
0.8107	7.75	0.151	62	0.135	33	0.196	-149	0.117	-129	0.369	51	0.247	34
0.8378	7.50	0.114	76	0.104	74	0.145	-124	0.113	-68	0.285	64	0.215	50
0.8666	7.25	0.093	91	0.098	117	0.106	-94	0.137	-30	0.213	79	0.179	67
0.8976	7.00	0.077	112	0.099	156	0.078	-59	0.150	0	0.153	99	0.140	84
0.9308	6.75	0.058	140	0.099	-166	0.059	-19	0.148	30	0.101	122	0.102	101
0.9666	6.50	0.037	165	0.094	-130	0.046	21	0.135	62	0.058	145	0.066	115
1.0053	6.25	0.026	-170	0.084	-91	0.038	59	0.116	96	0.028	170	0.034	107
1.0472	6.00	0.022	-139	0.069	-48	0.033	103	0.093	134	0.008	-156	0.035	72
1.0927	5.75	0.020	-92	0.047	0	0.024	153	0.062	175	0.004	25	0.045	84
1.1424	5.50	0.013	-41	0.023	69	0.013	-151	0.030	-134	0.011	86	0.044	117
1.1968	5.25	0.020	-2	0.014	-173	0.017	-147	0.009	-57	0.016	121	0.034	167
1.2566	5.00	0.017	-17	0.020	-57	0.008	105	0.008	109	0.005	-154	0.011	-129
1.3228	4.75	0.019	38	0.018	37	0.006	-136	0.006	-167	0.008	61	0.015	129
1.3963	4.50	0.007	116	0.012	125	0.003	-50	0.005	-85	0.003	162	0.022	179
1.4784	4.25	0.007	66	0.005	-86	0.002	124	0.001	108	0.001	6	0.020	-102
1.5708	4.00	0.003	102	0.003	33	0.000	0	0.001	-50	0.000	0	0.016	-84
1.6755	3.75	0.002	101	0.002	17	0.000	0	0.000	0	0.000	0	0.008	-5
1.7952	3.50	0.001	176	0.002	-131	0.000	0	0.000	0	0.000	0	0.003	-23

```
*************************************************************************************************************
*                                               ***  MOSES  ***                                             *
*                                               ----------------                     10 June, 2008          *
*                                                                                                           *
*                                                                                                           *
*   Draft            =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   Heading          =  60.00 Deg.        Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20    *
*                                                                                                           *
*************************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	-27	0.001	-38	0.000	0	0.000	0	0.000	0	0.002	100
2.0944	3.00	0.001	-5	0.001	-41	0.000	0	0.000	0	0.000	0	0.001	-130

```
*************************************************************************************************
*                                         ***  MOSES  ***                                       *
*                                         ---------------                  10 June, 2008        *
*                                                                                               *
*                                                                                               *
*  Draft            =   7.0 Meters    Trim Angle       =   0.00 Deg.    GMT              =  41.4 Meters *
*  Roll Gy. Radius  =  20.4 Meters    Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*  Heading          =  75.00 Deg.     Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20    *
*                                                                                               *
*************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.240	92	0.894	94	1.000	5	0.140	93	0.037	-85	0.036	-175
0.1611	39.00	0.239	92	0.890	94	1.000	6	0.147	93	0.039	-85	0.038	-175
0.1653	38.00	0.238	92	0.886	95	1.000	6	0.155	94	0.041	-85	0.040	-175
0.1698	37.00	0.237	92	0.882	95	1.000	6	0.164	94	0.043	-85	0.042	-175
0.1745	36.00	0.235	92	0.877	95	1.000	7	0.173	94	0.046	-85	0.044	-175
0.1795	35.00	0.234	92	0.871	95	1.000	7	0.183	94	0.048	-84	0.046	-174
0.1848	34.00	0.233	93	0.866	96	1.000	8	0.194	94	0.051	-84	0.049	-174
0.1904	33.00	0.231	93	0.859	96	1.000	8	0.206	95	0.054	-84	0.052	-174
0.1963	32.00	0.229	93	0.852	97	1.000	9	0.219	95	0.058	-84	0.055	-174
0.2027	31.00	0.227	93	0.844	97	1.000	9	0.234	95	0.062	-83	0.059	-173
0.2094	30.00	0.225	93	0.836	97	1.000	10	0.250	96	0.066	-83	0.062	-173
0.2167	29.00	0.223	93	0.826	98	1.000	10	0.268	96	0.070	-82	0.067	-172
0.2244	28.00	0.220	94	0.816	99	1.000	11	0.287	97	0.075	-82	0.071	-172
0.2327	27.00	0.217	94	0.804	99	1.001	12	0.309	97	0.081	-81	0.076	-172
0.2417	26.00	0.214	94	0.790	100	1.001	13	0.334	98	0.087	-81	0.082	-171
0.2513	25.00	0.210	94	0.775	101	1.001	14	0.362	98	0.094	-80	0.088	-170
0.2618	24.00	0.205	95	0.758	102	1.001	15	0.393	99	0.102	-80	0.095	-170
0.2732	23.00	0.201	95	0.738	103	1.002	17	0.429	100	0.111	-79	0.103	-169
0.2856	22.00	0.195	95	0.716	104	1.002	18	0.469	101	0.121	-78	0.112	-168
0.2992	21.00	0.189	96	0.689	106	1.003	20	0.516	102	0.133	-77	0.121	-167
0.3142	20.00	0.181	96	0.658	108	1.004	22	0.571	103	0.146	-75	0.132	-166
0.3307	19.00	0.173	97	0.622	110	1.006	24	0.635	104	0.161	-74	0.144	-164
0.3491	18.00	0.163	97	0.579	112	1.008	27	0.710	106	0.179	-72	0.158	-162
0.3696	17.00	0.151	97	0.527	116	1.011	30	0.801	108	0.200	-70	0.173	-160
0.3808	16.50	0.144	97	0.497	118	1.013	32	0.853	109	0.211	-69	0.181	-159
0.3927	16.00	0.137	97	0.463	120	1.016	34	0.911	110	0.224	-68	0.189	-158
0.4054	15.50	0.129	97	0.426	122	1.018	36	0.975	111	0.238	-66	0.197	-156
0.4189	15.00	0.121	97	0.385	126	1.022	39	1.047	112	0.254	-65	0.206	-155
0.4333	14.50	0.112	96	0.338	130	1.026	41	1.128	114	0.271	-63	0.215	-153
0.4488	14.00	0.101	95	0.286	135	1.031	44	1.221	115	0.290	-61	0.223	-151
0.4570	13.75	0.096	94	0.258	139	1.034	45	1.272	116	0.300	-60	0.228	-150
0.4654	13.50	0.090	93	0.229	144	1.037	47	1.328	117	0.311	-59	0.232	-148
0.4742	13.25	0.085	92	0.198	150	1.040	48	1.387	118	0.323	-58	0.236	-147
0.4833	13.00	0.079	90	0.168	159	1.044	50	1.452	119	0.335	-57	0.239	-145
0.4928	12.75	0.073	87	0.140	172	1.048	52	1.522	120	0.348	-55	0.243	-144
0.5027	12.50	0.066	84	0.120	-167	1.052	54	1.599	121	0.363	-54	0.246	-142

```
*****************************************************************************************************
*                                           ***  MOSES  ***                                         *
*                                           ----------------                  10 June, 2008         *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   Heading          =  75.00 Deg.       Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20    *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.060	79	0.118	-141	1.057	55	1.684	121	0.378	-53	0.249	-140
0.5236	12.00	0.054	73	0.154	-120	1.068	57	1.765	121	0.395	-52	0.252	-138
0.5347	11.75	0.049	65	0.202	-106	1.078	59	1.856	120	0.412	-51	0.254	-136
0.5464	11.50	0.045	53	0.258	-95	1.084	61	1.963	121	0.431	-49	0.256	-133
0.5585	11.25	0.043	39	0.329	-88	1.093	62	2.074	120	0.452	-48	0.257	-130
0.5712	11.00	0.044	24	0.410	-83	1.101	64	2.200	120	0.473	-47	0.258	-127
0.5845	10.75	0.049	9	0.503	-80	1.109	66	2.332	119	0.496	-46	0.259	-123
0.5984	10.50	0.056	-3	0.608	-79	1.116	68	2.476	118	0.519	-46	0.259	-119
0.6130	10.25	0.066	-13	0.724	-78	1.122	69	2.624	116	0.541	-45	0.259	-115
0.6283	10.00	0.077	-22	0.848	-79	1.126	71	2.765	113	0.563	-45	0.259	-110
0.6444	9.75	0.089	-29	0.975	-81	1.127	71	2.884	109	0.581	-46	0.258	-104
0.6614	9.50	0.101	-36	1.096	-84	1.120	72	2.962	105	0.593	-46	0.258	-98
0.6793	9.25	0.112	-42	1.191	-88	1.098	72	2.963	99	0.594	-47	0.257	-92
0.6981	9.00	0.119	-48	1.240	-92	1.053	71	2.856	92	0.582	-48	0.255	-85
0.7181	8.75	0.122	-54	1.229	-97	0.976	70	2.629	86	0.553	-49	0.252	-78
0.7392	8.50	0.119	-59	1.223	-102	0.900	69	2.454	77	0.507	-50	0.248	-70
0.7616	8.25	0.111	-63	1.016	-102	0.740	71	1.891	77	0.449	-48	0.240	-60
0.7854	8.00	0.098	-65	0.856	-100	0.606	75	1.487	77	0.386	-45	0.231	-50
0.8107	7.75	0.087	-63	0.702	-94	0.484	81	1.141	81	0.328	-38	0.220	-37
0.8378	7.50	0.065	-61	0.568	-85	0.381	90	0.862	89	0.271	-30	0.216	-23
0.8666	7.25	0.051	-59	0.453	-74	0.294	101	0.644	98	0.222	-20	0.211	-7
0.8976	7.00	0.043	-54	0.354	-59	0.223	115	0.472	112	0.182	-7	0.205	9
0.9308	6.75	0.037	-37	0.271	-42	0.166	132	0.339	128	0.151	8	0.195	27
0.9666	6.50	0.027	-13	0.202	-21	0.120	153	0.238	147	0.122	28	0.182	46
1.0053	6.25	0.018	4	0.146	4	0.084	178	0.163	169	0.095	50	0.169	68
1.0472	6.00	0.012	17	0.100	35	0.054	-150	0.107	-166	0.072	74	0.153	92
1.0927	5.75	0.006	35	0.061	75	0.032	-115	0.059	-139	0.052	102	0.130	119
1.1424	5.50	0.002	-46	0.035	131	0.019	-65	0.024	-110	0.034	135	0.100	149
1.1968	5.25	0.013	-122	0.024	-149	0.027	17	0.002	-86	0.018	-167	0.073	-173
1.2566	5.00	0.004	-153	0.023	-62	0.006	90	0.014	153	0.018	-146	0.047	-139
1.3228	4.75	0.007	23	0.035	-7	0.006	176	0.011	-164	0.004	-20	0.028	-56
1.3963	4.50	0.017	161	0.021	59	0.007	-52	0.011	-116	0.012	179	0.007	-115
1.4784	4.25	0.005	40	0.017	112	0.003	-91	0.008	-68	0.001	12	0.016	-117
1.5708	4.00	0.001	59	0.003	-118	0.001	45	0.005	17	0.001	-59	0.009	-76
1.6755	3.75	0.001	-125	0.005	82	0.001	-118	0.000	0	0.001	99	0.013	50
1.7952	3.50	0.001	-158	0.000	0	0.000	0	0.000	0	0.000	0	0.007	20

```
*****************************************************************************************************************
*                                              ***  MOSES  ***                                                  *
*                                              ----------------                          10 June, 2008          *
*                                                                                                               *
*                                                                                                               *
*   Draft              =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT               =  41.4 Meters *
*   Roll Gy. Radius    =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius    =  48.6 Meters *
*   Heading            =  75.00 Deg.        Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20     *
*                                                                                                               *
*****************************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	-1	0.003	121	0.000	0	0.000	0	0.000	0	0.006	160
2.0944	3.00	0.000	0	0.001	121	0.000	0	0.000	0	0.000	0	0.000	0

```
****************************************************************************************************
*                                              ***  MOSES  ***                                     *
*                                              ----------------                    10 June, 2008   *
*                                                                                                  *
*                                                                                                  *
*   Draft           =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   Heading         =  90.00 Deg.       Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20   *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.000	0	0.926	90	1.000	1	0.145	90	0.000	0	0.000	0
0.1611	39.00	0.000	0	0.922	90	1.000	2	0.152	90	0.000	0	0.000	0
0.1653	38.00	0.000	0	0.918	90	1.000	2	0.161	90	0.000	0	0.000	0
0.1698	37.00	0.000	0	0.913	90	1.000	2	0.169	90	0.000	0	0.000	0
0.1745	36.00	0.000	0	0.908	90	1.000	2	0.179	90	0.000	0	0.000	0
0.1795	35.00	0.000	0	0.903	90	1.000	2	0.190	90	0.000	0	0.000	0
0.1848	34.00	0.000	0	0.897	90	1.000	2	0.201	90	0.000	0	0.000	0
0.1904	33.00	0.000	0	0.890	90	1.000	2	0.214	90	0.000	0	0.000	0
0.1963	32.00	0.000	0	0.883	90	1.000	2	0.227	90	0.000	0	0.000	0
0.2027	31.00	0.000	0	0.875	90	1.001	2	0.242	90	0.000	0	0.000	0
0.2094	30.00	0.000	0	0.866	90	1.001	3	0.259	90	0.000	0	0.000	0
0.2167	29.00	0.000	0	0.857	90	1.001	3	0.278	90	0.000	0	0.000	0
0.2244	28.00	0.000	0	0.846	90	1.001	3	0.298	90	0.000	0	0.000	0
0.2327	27.00	0.000	0	0.834	90	1.001	3	0.321	90	0.000	0	0.000	0
0.2417	26.00	0.000	0	0.820	90	1.001	3	0.347	90	0.000	0	0.000	0
0.2513	25.00	0.000	0	0.804	90	1.002	4	0.376	90	0.000	0	0.000	0
0.2618	24.00	0.000	0	0.787	90	1.002	4	0.409	90	0.000	0	0.000	0
0.2732	23.00	0.000	0	0.767	90	1.003	4	0.446	90	0.000	0	0.000	0
0.2856	22.00	0.000	0	0.743	90	1.004	5	0.489	90	0.000	0	0.000	0
0.2992	21.00	0.000	0	0.716	90	1.005	5	0.538	90	0.000	0	0.000	0
0.3142	20.00	0.000	0	0.685	90	1.006	6	0.596	89	0.000	0	0.000	0
0.3307	19.00	0.000	0	0.647	90	1.009	7	0.664	89	0.000	0	0.000	0
0.3491	18.00	0.000	0	0.603	90	1.012	7	0.745	89	0.000	0	0.000	0
0.3696	17.00	0.000	0	0.549	90	1.017	8	0.842	89	0.000	0	0.000	0
0.3808	16.50	0.000	0	0.517	91	1.020	9	0.899	89	0.000	0	0.000	0
0.3927	16.00	0.000	0	0.482	91	1.024	9	0.962	89	0.000	0	0.000	0
0.4054	15.50	0.000	0	0.443	91	1.028	10	1.033	89	0.000	0	0.000	0
0.4189	15.00	0.000	0	0.398	91	1.033	10	1.113	89	0.000	0	0.000	0
0.4333	14.50	0.000	0	0.348	92	1.040	11	1.204	88	0.001	-31	0.000	0
0.4488	14.00	0.000	0	0.291	94	1.051	11	1.307	87	0.001	-38	0.000	0
0.4570	13.75	0.000	0	0.259	95	1.056	11	1.365	87	0.001	-42	0.000	0
0.4654	13.50	0.000	0	0.224	96	1.061	12	1.428	87	0.001	-46	0.000	0
0.4742	13.25	0.000	0	0.189	100	1.069	12	1.494	86	0.001	-52	0.000	0
0.4833	13.00	0.000	0	0.150	105	1.076	12	1.568	85	0.001	-58	0.000	0
0.4928	12.75	0.000	0	0.111	114	1.083	12	1.648	85	0.001	-63	0.000	0
0.5027	12.50	0.000	0	0.079	137	1.093	12	1.734	83	0.001	-70	0.000	0

*** MOSES ***

10 June, 2008

Draft	= 7.0 Meters	Trim Angle	= 0.00 Deg.	GMT	= 41.4 Meters
Roll Gy. Radius	= 20.4 Meters	Pitch Gy. Radius	= 48.6 Meters	Yaw Gy. Radius	= 48.6 Meters
Heading	= 90.00 Deg.	Forward Speed	= 0.00 Knots	Linearization Based on 1/ 20	

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.000	0	0.069	179	1.101	12	1.830	83	0.001	-77	0.000	0
0.5236	12.00	0.000	0	0.102	-145	1.111	12	1.936	82	0.001	-86	0.000	0
0.5347	11.75	0.000	0	0.160	-131	1.122	12	2.050	80	0.001	-95	0.000	0
0.5464	11.50	0.000	0	0.231	-124	1.133	12	2.179	79	0.001	-105	0.000	0
0.5585	11.25	0.000	0	0.313	-121	1.145	11	2.320	77	0.001	-116	0.000	0
0.5712	11.00	0.001	160	0.407	-121	1.157	11	2.475	74	0.001	-127	0.000	0
0.5845	10.75	0.001	154	0.513	-122	1.170	10	2.643	71	0.001	-139	0.000	0
0.5984	10.50	0.001	147	0.632	-124	1.182	9	2.819	67	0.001	-152	0.000	0
0.6130	10.25	0.001	138	0.763	-128	1.193	8	3.001	63	0.001	-168	0.000	0
0.6283	10.00	0.001	128	0.904	-132	1.201	6	3.180	57	0.001	177	0.000	0
0.6444	9.75	0.001	117	1.049	-138	1.204	3	3.334	51	0.002	159	0.000	0
0.6614	9.50	0.001	105	1.188	-144	1.199	0	3.444	43	0.002	141	0.000	0
0.6793	9.25	0.001	91	1.309	-152	1.180	-2	3.485	35	0.002	121	0.000	0
0.6981	9.00	0.002	77	1.394	-160	1.143	-6	3.429	26	0.002	100	0.001	46
0.7181	8.75	0.002	61	1.428	-168	1.082	-11	3.260	16	0.002	78	0.001	34
0.7392	8.50	0.002	46	1.396	-176	0.991	-15	2.966	7	0.001	56	0.001	22
0.7616	8.25	0.001	31	1.303	177	0.876	-19	2.583	0	0.001	34	0.001	11
0.7854	8.00	0.001	17	1.176	172	0.752	-21	2.176	-5	0.001	15	0.001	0
0.8107	7.75	0.001	9	1.038	170	0.630	-22	1.795	-9	0.001	0	0.001	-12
0.8378	7.50	0.001	-6	0.893	171	0.517	-20	1.445	-9	0.001	-17	0.001	-20
0.8666	7.25	0.001	-34	0.766	173	0.422	-17	1.156	-7	0.000	0	0.001	-32
0.8976	7.00	0.001	-57	0.654	177	0.341	-12	0.921	-4	0.000	0	0.001	-49
0.9308	6.75	0.001	-53	0.558	-175	0.273	-5	0.726	1	0.000	0	0.001	-63
0.9666	6.50	0.000	0	0.475	-166	0.217	3	0.567	9	0.000	0	0.001	-75
1.0053	6.25	0.000	0	0.404	-156	0.172	14	0.438	19	0.000	0	0.001	-86
1.0472	6.00	0.000	0	0.342	-144	0.135	27	0.336	31	0.000	0	0.000	0
1.0927	5.75	0.000	0	0.291	-130	0.105	43	0.258	46	0.000	0	0.000	0
1.1424	5.50	0.000	0	0.247	-113	0.081	60	0.196	64	0.000	0	0.000	0
1.1968	5.25	0.000	0	0.206	-95	0.065	80	0.149	84	0.000	0	0.000	0
1.2566	5.00	0.000	0	0.172	-79	0.045	101	0.110	100	0.000	0	0.000	0
1.3228	4.75	0.000	0	0.134	-35	0.032	141	0.079	143	0.000	0	0.000	0
1.3963	4.50	0.000	0	0.107	-11	0.010	176	0.052	165	0.000	0	0.000	0
1.4784	4.25	0.000	0	0.097	2	0.014	-169	0.030	178	0.000	0	0.000	0
1.5708	4.00	0.000	0	0.055	66	0.010	-117	0.028	-113	0.000	0	0.000	0
1.6755	3.75	0.000	0	0.039	140	0.003	-35	0.005	-38	0.000	0	0.000	0
1.7952	3.50	0.000	0	0.018	-115	0.003	58	0.013	70	0.000	0	0.000	0

```
*************************************************************************************************************
*                                           ***  MOSES  ***                                                 *
*                                           ----------------                      10 June, 2008             *
*                                                                                                           *
*                                                                                                           *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   Heading          =  90.00 Deg.       Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20    *
*                                                                                                           *
*************************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.000	0	0.024	-54	0.002	149	0.000	0	0.000	0	0.000	0
2.0944	3.00	0.000	0	0.017	54	0.000	0	0.004	-124	0.000	0	0.000	0

*** MOSES ***

10 June, 2008

Draft = 7.0 Meters	Trim Angle = 0.00 Deg.	GMT = 41.4 Meters
Roll Gy. Radius = 20.4 Meters	Pitch Gy. Radius = 48.6 Meters	Yaw Gy. Radius = 48.6 Meters
Heading = 105.00 Deg.	Forward Speed = 0.00 Knots	Linearization Based on 1/ 20

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.240	-94	0.894	86	0.999	-2	0.140	86	0.037	86	0.036	-3
0.1611	39.00	0.239	-94	0.890	86	0.999	-2	0.147	86	0.039	86	0.038	-3
0.1653	38.00	0.238	-94	0.886	85	0.999	-2	0.155	86	0.041	86	0.040	-3
0.1698	37.00	0.237	-95	0.882	85	0.999	-2	0.164	86	0.043	86	0.042	-3
0.1745	36.00	0.235	-95	0.877	85	0.999	-2	0.173	86	0.046	86	0.044	-3
0.1795	35.00	0.234	-95	0.871	85	0.999	-3	0.183	85	0.048	85	0.046	-4
0.1848	34.00	0.233	-96	0.866	84	0.999	-3	0.194	85	0.051	85	0.049	-4
0.1904	33.00	0.231	-96	0.859	84	0.999	-3	0.206	85	0.054	85	0.052	-4
0.1963	32.00	0.229	-97	0.852	83	0.999	-3	0.219	85	0.058	85	0.055	-4
0.2027	31.00	0.227	-97	0.844	83	0.998	-3	0.234	84	0.062	84	0.059	-5
0.2094	30.00	0.225	-98	0.836	83	0.998	-4	0.250	84	0.066	84	0.062	-5
0.2167	29.00	0.223	-98	0.826	82	0.998	-4	0.268	83	0.070	83	0.067	-6
0.2244	28.00	0.220	-99	0.816	81	0.998	-4	0.287	83	0.075	83	0.071	-6
0.2327	27.00	0.217	-100	0.804	81	0.997	-5	0.309	82	0.081	82	0.076	-6
0.2417	26.00	0.213	-101	0.790	80	0.997	-5	0.334	82	0.087	82	0.082	-7
0.2513	25.00	0.210	-102	0.775	79	0.997	-6	0.362	81	0.094	81	0.088	-8
0.2618	24.00	0.205	-103	0.758	78	0.996	-6	0.393	80	0.102	81	0.095	-8
0.2732	23.00	0.201	-104	0.738	77	0.996	-7	0.429	79	0.111	80	0.103	-9
0.2856	22.00	0.195	-106	0.715	76	0.995	-8	0.469	79	0.121	79	0.112	-10
0.2992	21.00	0.189	-108	0.689	74	0.995	-9	0.516	77	0.133	78	0.121	-11
0.3142	20.00	0.181	-110	0.658	73	0.994	-10	0.571	76	0.146	76	0.132	-12
0.3307	19.00	0.173	-112	0.622	71	0.993	-11	0.635	75	0.161	75	0.144	-14
0.3491	18.00	0.163	-115	0.578	68	0.993	-12	0.710	73	0.179	73	0.158	-16
0.3696	17.00	0.151	-119	0.526	65	0.993	-14	0.801	71	0.199	71	0.173	-18
0.3808	16.50	0.144	-121	0.496	63	0.993	-15	0.853	69	0.211	70	0.181	-19
0.3927	16.00	0.137	-124	0.462	61	0.993	-16	0.910	68	0.224	69	0.189	-20
0.4054	15.50	0.129	-127	0.425	59	0.993	-17	0.975	66	0.237	68	0.197	-21
0.4189	15.00	0.121	-130	0.383	57	0.995	-18	1.046	64	0.253	66	0.206	-23
0.4333	14.50	0.111	-134	0.335	54	0.997	-20	1.127	62	0.269	65	0.215	-24
0.4488	14.00	0.101	-139	0.282	50	0.998	-21	1.219	60	0.288	63	0.223	-26
0.4570	13.75	0.096	-142	0.252	48	1.001	-22	1.269	58	0.298	62	0.228	-26
0.4654	13.50	0.091	-145	0.220	46	1.002	-23	1.323	57	0.309	61	0.232	-27
0.4742	13.25	0.085	-149	0.186	42	1.004	-24	1.382	55	0.320	60	0.236	-28
0.4833	13.00	0.079	-153	0.149	38	1.005	-25	1.445	54	0.333	59	0.239	-29
0.4928	12.75	0.073	-158	0.110	33	1.008	-27	1.512	52	0.346	57	0.243	-30
0.5027	12.50	0.067	-165	0.069	22	1.010	-28	1.586	50	0.360	56	0.246	-31

*** MOSES ***

10 June, 2008

Draft = 7.0 Meters	Trim Angle = 0.00 Deg.	GMT = 41.4 Meters
Roll Gy. Radius = 20.4 Meters	Pitch Gy. Radius = 48.6 Meters	Yaw Gy. Radius = 48.6 Meters
Heading = 105.00 Deg.	Forward Speed = 0.00 Knots	Linearization Based on 1/ 20

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.061	-172	0.032	-17	1.013	-30	1.666	47	0.375	54	0.249	-32
0.5236	12.00	0.056	178	0.046	-101	1.015	-32	1.754	45	0.391	53	0.252	-32
0.5347	11.75	0.051	166	0.097	-126	1.018	-34	1.849	42	0.409	51	0.254	-33
0.5464	11.50	0.047	152	0.158	-136	1.020	-36	1.954	39	0.428	49	0.255	-34
0.5585	11.25	0.045	135	0.227	-143	1.022	-38	2.069	35	0.448	46	0.257	-35
0.5712	11.00	0.047	116	0.304	-149	1.024	-41	2.195	31	0.469	43	0.258	-35
0.5845	10.75	0.051	98	0.389	-155	1.024	-44	2.331	26	0.492	40	0.258	-36
0.5984	10.50	0.058	81	0.484	-162	1.023	-48	2.474	21	0.515	36	0.259	-36
0.6130	10.25	0.068	66	0.588	-170	1.020	-52	2.621	14	0.538	32	0.259	-37
0.6283	10.00	0.079	52	0.699	-179	1.014	-56	2.762	6	0.560	27	0.258	-37
0.6444	9.75	0.091	39	0.813	170	1.005	-62	2.881	-3	0.578	21	0.258	-37
0.6614	9.50	0.103	26	0.922	159	0.989	-68	2.959	-13	0.591	14	0.258	-37
0.6793	9.25	0.113	13	1.014	147	0.963	-75	2.968	-26	0.593	7	0.257	-37
0.6981	9.00	0.120	0	1.062	133	0.917	-83	2.851	-39	0.582	0	0.256	-38
0.7181	8.75	0.123	-12	1.062	119	0.849	-92	2.624	-54	0.553	-9	0.253	-38
0.7392	8.50	0.120	-26	1.003	105	0.755	-102	2.286	-68	0.507	-18	0.248	-38
0.7616	8.25	0.111	-39	0.895	92	0.642	-111	1.886	-80	0.450	-26	0.241	-38
0.7854	8.00	0.098	-50	0.760	82	0.524	-119	1.481	-89	0.388	-32	0.232	-37
0.8107	7.75	0.086	-60	0.630	74	0.419	-125	1.135	-96	0.329	-36	0.221	-36
0.8378	7.50	0.065	-69	0.515	68	0.327	-130	0.858	-101	0.273	-41	0.216	-33
0.8666	7.25	0.051	-81	0.416	62	0.250	-134	0.639	-104	0.223	-44	0.211	-31
0.8976	7.00	0.043	-90	0.331	57	0.187	-138	0.470	-106	0.184	-46	0.206	-29
0.9308	6.75	0.037	-89	0.255	52	0.138	-142	0.338	-106	0.152	-46	0.196	-28
0.9666	6.50	0.027	-84	0.191	47	0.099	-145	0.237	-106	0.123	-45	0.183	-28
1.0053	6.25	0.018	-88	0.140	41	0.068	-147	0.163	-105	0.096	-44	0.169	-27
1.0472	6.00	0.013	-99	0.099	32	0.040	-151	0.107	-104	0.073	-43	0.153	-26
1.0927	5.75	0.006	-108	0.063	16	0.022	-161	0.059	-103	0.053	-42	0.129	-25
1.1424	5.50	0.003	136	0.038	-9	0.009	-168	0.024	-104	0.034	-38	0.100	-25
1.1968	5.25	0.013	31	0.031	-42	0.015	-7	0.002	-112	0.018	-15	0.073	-23
1.2566	5.00	0.006	-25	0.036	-67	0.011	118	0.014	84	0.018	-35	0.047	-29
1.3228	4.75	0.007	86	0.027	-89	0.004	77	0.012	80	0.004	44	0.028	6
1.3963	4.50	0.017	169	0.026	-109	0.007	64	0.011	74	0.012	-170	0.007	-106
1.4784	4.25	0.005	-12	0.025	-141	0.002	47	0.008	56	0.001	-38	0.016	-173
1.5708	4.00	0.001	-68	0.004	-175	0.001	60	0.005	66	0.001	171	0.009	151
1.6755	3.75	0.001	14	0.005	160	0.000	0	0.000	0	0.001	-122	0.013	-172
1.7952	3.50	0.001	-135	0.005	39	0.000	0	0.000	0	0.000	0	0.007	42

```
*****************************************************************************************************
*                                                *** MOSES ***                                      *
*                                                ----------------              10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   Heading          = 105.00 Deg.        Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20    *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	-120	0.003	82	0.000	0	0.000	0	0.000	0	0.006	44
2.0944	3.00	0.000	0	0.001	4	0.000	0	0.000	0	0.000	0	0.000	0

*** MOSES ***

10 June, 2008

Draft = 7.0 Meters	Trim Angle = 0.00 Deg.	GMT = 41.4 Meters
Roll Gy. Radius = 20.4 Meters	Pitch Gy. Radius = 48.6 Meters	Yaw Gy. Radius = 48.6 Meters
Heading = 120.00 Deg.	Forward Speed = 0.00 Knots	Linearization Based on 1/ 20

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.463	-97	0.801	82	0.998	-6	0.125	83	0.072	83	0.062	-6
0.1611	39.00	0.461	-97	0.797	82	0.998	-6	0.132	83	0.075	83	0.065	-6
0.1653	38.00	0.459	-98	0.793	81	0.997	-6	0.139	83	0.079	83	0.068	-6
0.1698	37.00	0.456	-98	0.789	81	0.997	-7	0.146	82	0.084	82	0.072	-7
0.1745	36.00	0.454	-99	0.785	80	0.997	-7	0.155	82	0.088	82	0.076	-7
0.1795	35.00	0.451	-99	0.780	79	0.997	-8	0.164	81	0.094	81	0.080	-8
0.1848	34.00	0.448	-100	0.775	79	0.996	-8	0.173	81	0.099	81	0.085	-8
0.1904	33.00	0.444	-101	0.769	78	0.996	-9	0.184	80	0.105	80	0.090	-9
0.1963	32.00	0.441	-101	0.762	77	0.995	-9	0.196	80	0.112	80	0.095	-9
0.2027	31.00	0.437	-102	0.755	77	0.994	-10	0.209	79	0.119	79	0.101	-10
0.2094	30.00	0.432	-103	0.747	76	0.994	-11	0.223	78	0.127	78	0.108	-11
0.2167	29.00	0.427	-104	0.738	75	0.993	-12	0.239	77	0.136	78	0.115	-11
0.2244	28.00	0.422	-105	0.728	73	0.992	-13	0.256	77	0.145	77	0.123	-12
0.2327	27.00	0.415	-106	0.717	72	0.991	-14	0.275	76	0.156	76	0.132	-13
0.2417	26.00	0.408	-108	0.705	71	0.989	-15	0.297	74	0.168	75	0.142	-14
0.2513	25.00	0.400	-109	0.691	69	0.987	-16	0.321	73	0.181	73	0.152	-16
0.2618	24.00	0.391	-111	0.675	67	0.985	-17	0.348	72	0.196	72	0.164	-17
0.2732	23.00	0.381	-113	0.656	65	0.983	-19	0.379	70	0.213	70	0.177	-19
0.2856	22.00	0.369	-116	0.635	63	0.979	-21	0.414	68	0.232	68	0.192	-20
0.2992	21.00	0.355	-118	0.611	60	0.976	-23	0.454	66	0.254	66	0.208	-23
0.3142	20.00	0.339	-122	0.582	56	0.971	-26	0.500	64	0.279	64	0.227	-25
0.3307	19.00	0.320	-126	0.549	52	0.965	-28	0.553	61	0.307	61	0.247	-28
0.3491	18.00	0.298	-130	0.510	48	0.957	-32	0.614	57	0.339	58	0.269	-31
0.3696	17.00	0.272	-136	0.463	42	0.947	-36	0.686	53	0.376	54	0.294	-35
0.3808	16.50	0.257	-139	0.437	38	0.941	-38	0.727	51	0.397	52	0.306	-37
0.3927	16.00	0.241	-143	0.407	34	0.933	-41	0.771	49	0.419	50	0.320	-39
0.4054	15.50	0.224	-147	0.376	29	0.925	-43	0.819	46	0.443	47	0.333	-42
0.4189	15.00	0.205	-152	0.341	24	0.916	-46	0.871	43	0.469	44	0.347	-45
0.4333	14.50	0.184	-158	0.302	18	0.907	-50	0.927	39	0.498	41	0.360	-48
0.4488	14.00	0.162	-166	0.261	10	0.895	-54	0.989	35	0.528	37	0.372	-51
0.4570	13.75	0.150	-170	0.239	5	0.888	-56	1.023	33	0.545	36	0.378	-53
0.4654	13.50	0.138	-175	0.217	0	0.881	-58	1.058	30	0.562	34	0.384	-55
0.4742	13.25	0.126	178	0.194	-7	0.873	-60	1.094	28	0.580	31	0.389	-57
0.4833	13.00	0.114	170	0.170	-15	0.866	-63	1.132	25	0.598	29	0.394	-59
0.4928	12.75	0.102	162	0.148	-25	0.857	-65	1.172	22	0.618	27	0.398	-61
0.5027	12.50	0.091	151	0.129	-39	0.848	-68	1.214	19	0.638	24	0.402	-63

```
*****************************************************************************************************
*                                             ***  MOSES  ***                                       *
*                                             ----------------                   10 June, 2008      *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   Heading          = 120.00 Deg.       Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20   *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.082	137	0.114	-57	0.837	-71	1.258	16	0.660	21	0.405	-65
0.5236	12.00	0.076	121	0.109	-79	0.826	-75	1.304	12	0.682	18	0.407	-67
0.5347	11.75	0.074	102	0.113	-103	0.815	-78	1.350	8	0.705	15	0.408	-70
0.5464	11.50	0.078	82	0.131	-125	0.801	-82	1.401	3	0.729	11	0.409	-72
0.5585	11.25	0.087	64	0.159	-142	0.785	-87	1.453	-1	0.754	7	0.408	-75
0.5712	11.00	0.101	48	0.193	-157	0.768	-92	1.507	-6	0.779	2	0.407	-77
0.5845	10.75	0.118	34	0.233	-170	0.747	-97	1.562	-12	0.803	-2	0.404	-80
0.5984	10.50	0.138	22	0.277	176	0.724	-103	1.616	-19	0.826	-7	0.401	-82
0.6130	10.25	0.158	10	0.323	163	0.698	-109	1.668	-28	0.846	-14	0.396	-85
0.6283	10.00	0.179	0	0.369	150	0.669	-117	1.709	-37	0.862	-21	0.391	-88
0.6444	9.75	0.199	-11	0.416	135	0.636	-125	1.737	-49	0.871	-28	0.384	-91
0.6614	9.50	0.216	-23	0.448	118	0.602	-134	1.711	-63	0.868	-37	0.376	-95
0.6793	9.25	0.229	-34	0.454	98	0.562	-146	1.600	-80	0.850	-47	0.367	-98
0.6981	9.00	0.234	-47	0.425	75	0.507	-160	1.391	-99	0.811	-58	0.355	-103
0.7181	8.75	0.231	-59	0.358	51	0.433	-176	1.096	-118	0.749	-70	0.340	-107
0.7392	8.50	0.218	-72	0.256	27	0.339	166	0.748	-135	0.666	-81	0.322	-112
0.7616	8.25	0.198	-83	0.146	3	0.242	147	0.437	-144	0.569	-93	0.300	-118
0.7854	8.00	0.173	-94	0.063	-31	0.161	129	0.224	-143	0.469	-104	0.275	-124
0.8107	7.75	0.152	-100	0.038	-126	0.105	108	0.116	-115	0.370	-113	0.247	-130
0.8378	7.50	0.115	-110	0.070	-175	0.063	77	0.111	-77	0.287	-123	0.215	-138
0.8666	7.25	0.095	-121	0.098	163	0.046	32	0.134	-64	0.215	-134	0.179	-147
0.8976	7.00	0.080	-129	0.116	147	0.046	-1	0.148	-62	0.155	-143	0.141	-158
0.9308	6.75	0.060	-133	0.124	133	0.044	-27	0.146	-63	0.103	-151	0.102	-173
0.9666	6.50	0.038	-143	0.120	119	0.041	-54	0.134	-67	0.059	-164	0.065	164
1.0053	6.25	0.026	-159	0.106	101	0.037	-81	0.116	-73	0.028	180	0.033	115
1.0472	6.00	0.022	-174	0.084	81	0.032	-101	0.093	-81	0.008	168	0.035	35
1.0927	5.75	0.020	-178	0.053	57	0.023	-120	0.062	-91	0.005	-62	0.045	-3
1.1424	5.50	0.012	173	0.023	21	0.011	-154	0.030	-100	0.011	-59	0.044	-28
1.1968	5.25	0.020	146	0.012	-66	0.020	145	0.009	-90	0.016	-92	0.034	-44
1.2566	5.00	0.016	48	0.019	-144	0.009	17	0.008	0	0.005	-84	0.011	-59
1.3228	4.75	0.019	19	0.021	165	0.001	-51	0.006	-13	0.008	41	0.016	111
1.3963	4.50	0.007	-7	0.012	105	0.002	-48	0.006	-26	0.003	38	0.022	55
1.4784	4.25	0.007	173	0.009	0	0.002	48	0.001	42	0.001	113	0.020	7
1.5708	4.00	0.003	63	0.013	-135	0.001	113	0.001	92	0.000	0	0.016	-122
1.6755	3.75	0.002	-112	0.004	127	0.000	0	0.000	0	0.000	0	0.008	139
1.7952	3.50	0.001	104	0.004	-58	0.000	0	0.000	0	0.000	0	0.003	-95

```
*****************************************************************************************************************
*                                               ***  MOSES  ***                                                 *
*                                               ---------------                        10 June, 2008            *
*                                                                                                               *
*                                                                                                               *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters     *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters     *
*   Heading          = 120.00 Deg.       Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20        *
*                                                                                                               *
*****************************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	-12	0.002	130	0.000	0	0.000	0	0.000	0	0.002	116
2.0944	3.00	0.001	29	0.001	-139	0.000	0	0.000	0	0.000	0	0.001	-97

```
*************************************************************************************************
*                                         ***  MOSES  ***                                       *
*                                         ----------------                10 June, 2008         *
*                                                                                               *
*                                                                                               *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.    GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  =  48.6 Meters *
*   Heading          = 135.00 Deg.      Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20   *
*                                                                                               *
*************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.653	-99	0.653	79	0.996	-9	0.102	81	0.101	81	0.071	-8
0.1611	39.00	0.650	-100	0.650	78	0.996	-10	0.107	80	0.107	80	0.075	-9
0.1653	38.00	0.647	-100	0.647	77	0.995	-10	0.113	80	0.112	80	0.079	-9
0.1698	37.00	0.643	-101	0.643	77	0.995	-11	0.119	79	0.118	79	0.083	-10
0.1745	36.00	0.639	-102	0.639	76	0.994	-12	0.126	79	0.125	79	0.088	-10
0.1795	35.00	0.635	-102	0.635	75	0.994	-12	0.133	78	0.132	78	0.093	-11
0.1848	34.00	0.630	-103	0.631	74	0.993	-13	0.141	77	0.140	77	0.098	-12
0.1904	33.00	0.625	-104	0.626	73	0.992	-14	0.150	76	0.148	76	0.104	-13
0.1963	32.00	0.620	-105	0.620	72	0.991	-15	0.159	76	0.158	76	0.110	-13
0.2027	31.00	0.613	-106	0.614	71	0.990	-16	0.170	75	0.168	75	0.117	-14
0.2094	30.00	0.606	-107	0.607	70	0.988	-17	0.181	74	0.179	74	0.124	-15
0.2167	29.00	0.599	-109	0.600	68	0.987	-18	0.193	72	0.191	72	0.133	-16
0.2244	28.00	0.590	-110	0.591	67	0.985	-20	0.207	71	0.205	71	0.142	-18
0.2327	27.00	0.580	-112	0.582	65	0.982	-21	0.223	70	0.220	70	0.152	-19
0.2417	26.00	0.569	-114	0.571	63	0.979	-23	0.240	68	0.236	68	0.163	-21
0.2513	25.00	0.556	-116	0.559	60	0.976	-25	0.259	66	0.255	66	0.175	-23
0.2618	24.00	0.542	-118	0.546	58	0.972	-27	0.280	64	0.276	64	0.188	-24
0.2732	23.00	0.526	-121	0.530	55	0.967	-30	0.304	62	0.299	62	0.203	-27
0.2856	22.00	0.506	-124	0.512	51	0.961	-33	0.331	59	0.325	60	0.220	-29
0.2992	21.00	0.484	-127	0.491	47	0.953	-36	0.361	56	0.354	57	0.238	-32
0.3142	20.00	0.458	-131	0.467	42	0.943	-40	0.395	53	0.387	53	0.258	-36
0.3307	19.00	0.427	-136	0.439	37	0.930	-44	0.434	49	0.425	49	0.280	-40
0.3491	18.00	0.391	-142	0.407	30	0.914	-49	0.477	44	0.467	45	0.305	-44
0.3696	17.00	0.348	-149	0.369	21	0.893	-56	0.526	39	0.515	39	0.331	-50
0.3808	16.50	0.324	-154	0.348	16	0.880	-59	0.553	36	0.541	36	0.344	-53
0.3927	16.00	0.297	-159	0.325	10	0.864	-63	0.580	32	0.569	33	0.358	-56
0.4054	15.50	0.268	-164	0.301	4	0.847	-67	0.609	28	0.598	29	0.371	-60
0.4189	15.00	0.236	-171	0.275	-3	0.826	-72	0.639	24	0.629	25	0.384	-64
0.4333	14.50	0.202	180	0.249	-12	0.803	-77	0.669	19	0.661	21	0.396	-68
0.4488	14.00	0.166	169	0.222	-23	0.775	-83	0.700	14	0.694	15	0.407	-73
0.4570	13.75	0.148	163	0.208	-29	0.760	-86	0.715	11	0.711	13	0.412	-76
0.4654	13.50	0.129	154	0.195	-37	0.743	-89	0.730	8	0.729	10	0.416	-78
0.4742	13.25	0.112	144	0.182	-44	0.726	-93	0.744	5	0.746	7	0.420	-81
0.4833	13.00	0.096	131	0.171	-53	0.707	-97	0.757	1	0.764	4	0.423	-84
0.4928	12.75	0.083	113	0.158	-63	0.688	-101	0.768	-2	0.781	0	0.425	-87
0.5027	12.50	0.077	91	0.149	-74	0.667	-105	0.778	-6	0.799	-3	0.426	-90

```
*****************************************************************************************************
*                                        ***  MOSES  ***                                            *
*                                        ----------------                      10 June, 2008        *
*                                                                                                   *
*                                                                                                   *
*   Draft           =   7.0 Meters     Trim Angle      =   0.00 Deg.    GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters    Pitch Gy. Radius =  48.6 Meters  Yaw Gy. Radius   =  48.6 Meters *
*   Heading         = 135.00 Deg.      Forward Speed   =  0.00 Knots    Linearization Based on 1/ 20    *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.080	67	0.142	-86	0.645	-109	0.787	-10	0.815	-7	0.426	-94
0.5236	12.00	0.091	46	0.138	-99	0.621	-114	0.792	-15	0.831	-11	0.425	-97
0.5347	11.75	0.109	28	0.136	-113	0.595	-119	0.795	-20	0.846	-16	0.423	-101
0.5464	11.50	0.130	14	0.136	-126	0.568	-125	0.792	-26	0.859	-20	0.419	-105
0.5585	11.25	0.155	2	0.138	-140	0.539	-132	0.784	-32	0.870	-26	0.414	-109
0.5712	11.00	0.180	-7	0.140	-153	0.508	-138	0.769	-38	0.878	-32	0.407	-113
0.5845	10.75	0.205	-17	0.142	-166	0.475	-146	0.744	-46	0.881	-38	0.398	-118
0.5984	10.50	0.230	-26	0.141	-178	0.440	-155	0.707	-54	0.880	-45	0.388	-122
0.6130	10.25	0.253	-36	0.139	170	0.400	-165	0.658	-62	0.873	-52	0.375	-127
0.6283	10.00	0.273	-45	0.127	159	0.361	-176	0.581	-72	0.858	-60	0.360	-133
0.6444	9.75	0.290	-55	0.105	154	0.319	169	0.470	-84	0.833	-69	0.343	-139
0.6614	9.50	0.301	-65	0.081	163	0.275	152	0.313	-94	0.796	-79	0.323	-145
0.6793	9.25	0.305	-75	0.100	-170	0.228	129	0.135	-78	0.743	-90	0.299	-152
0.6981	9.00	0.300	-86	0.169	-172	0.176	99	0.207	-17	0.672	-102	0.271	-159
0.7181	8.75	0.287	-97	0.226	169	0.132	62	0.359	-25	0.585	-114	0.239	-168
0.7392	8.50	0.264	-108	0.254	150	0.107	20	0.430	-41	0.485	-127	0.203	-176
0.7616	8.25	0.235	-119	0.257	131	0.100	-19	0.436	-57	0.379	-139	0.164	173
0.7854	8.00	0.203	-129	0.243	113	0.100	-52	0.402	-72	0.278	-149	0.122	163
0.8107	7.75	0.177	-135	0.217	96	0.093	-80	0.344	-85	0.183	-154	0.080	151
0.8378	7.50	0.131	-145	0.184	79	0.091	-101	0.281	-96	0.119	-158	0.035	140
0.8666	7.25	0.106	-155	0.144	60	0.076	-118	0.214	-106	0.078	-152	0.009	-68
0.8976	7.00	0.090	-156	0.099	40	0.050	-140	0.152	-113	0.069	-133	0.047	-79
0.9308	6.75	0.068	-143	0.049	14	0.029	-176	0.096	-116	0.074	-119	0.074	-100
0.9666	6.50	0.040	-131	0.010	-80	0.017	150	0.055	-106	0.062	-120	0.088	-125
1.0053	6.25	0.025	-130	0.035	168	0.002	154	0.044	-77	0.045	-134	0.082	-153
1.0472	6.00	0.022	-134	0.054	130	0.013	-63	0.055	-67	0.030	-153	0.057	169
1.0927	5.75	0.024	-130	0.054	97	0.015	-80	0.056	-76	0.015	-155	0.032	121
1.1424	5.50	0.012	-140	0.034	62	0.010	-117	0.040	-95	0.006	-105	0.013	47
1.1968	5.25	0.008	88	0.012	6	0.004	-163	0.021	-107	0.006	-91	0.015	-61
1.2566	5.00	0.019	36	0.015	171	0.003	-52	0.013	-62	0.001	108	0.015	-164
1.3228	4.75	0.003	64	0.020	105	0.004	-31	0.011	-75	0.004	135	0.015	91
1.3963	4.50	0.010	95	0.004	15	0.000	0	0.005	-60	0.001	55	0.021	-29
1.4784	4.25	0.009	-2	0.016	-120	0.000	0	0.006	133	0.001	-18	0.006	-12
1.5708	4.00	0.002	-140	0.006	0	0.000	0	0.000	0	0.000	0	0.017	-1
1.6755	3.75	0.002	-41	0.003	-158	0.000	0	0.002	125	0.000	0	0.004	-171
1.7952	3.50	0.001	130	0.004	-100	0.000	0	0.001	108	0.000	0	0.005	-127

```
 ****************************************************************************************************
 *                                            ***  MOSES  ***                                        *
 *                                            ----------------                   10 June, 2008       *
 *                                                                                                   *
 *                                                                                                   *
 *   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT              =  41.4 Meters *
 *   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
 *   Heading          = 135.00 Deg.       Forward Speed   =  0.00 Knots     Linearization Based on 1/ 20    *
 *                                                                                                   *
 ****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	139	0.002	-41	0.000	0	0.000	0	0.000	0	0.002	-104
2.0944	3.00	0.000	0	0.001	-108	0.000	0	0.000	0	0.000	0	0.000	0

```
*****************************************************************************************************
*                                           ***  MOSES  ***                                         *
*                                           ----------------                  10 June, 2008         *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.    GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   Heading          = 150.00 Deg.      Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20   *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.798	-101	0.461	76	0.995	-12	0.072	79	0.124	79	0.062	-10
0.1611	39.00	0.794	-102	0.459	75	0.994	-13	0.076	78	0.130	78	0.065	-11
0.1653	38.00	0.790	-102	0.457	75	0.993	-13	0.080	77	0.137	77	0.068	-12
0.1698	37.00	0.785	-103	0.454	74	0.993	-14	0.084	77	0.145	77	0.072	-12
0.1745	36.00	0.780	-104	0.451	73	0.992	-15	0.089	76	0.153	76	0.076	-13
0.1795	35.00	0.774	-105	0.448	72	0.991	-16	0.094	75	0.161	75	0.080	-14
0.1848	34.00	0.768	-106	0.445	71	0.990	-17	0.099	74	0.171	74	0.085	-15
0.1904	33.00	0.762	-107	0.441	69	0.989	-18	0.105	73	0.181	73	0.090	-16
0.1963	32.00	0.754	-108	0.437	68	0.987	-19	0.112	72	0.192	72	0.095	-17
0.2027	31.00	0.746	-109	0.433	67	0.985	-21	0.119	71	0.205	71	0.101	-18
0.2094	30.00	0.737	-110	0.428	65	0.983	-22	0.127	70	0.218	70	0.107	-19
0.2167	29.00	0.727	-112	0.422	63	0.981	-24	0.136	69	0.233	69	0.115	-20
0.2244	28.00	0.715	-114	0.416	61	0.978	-26	0.145	67	0.250	67	0.122	-22
0.2327	27.00	0.702	-116	0.409	59	0.975	-28	0.156	65	0.268	65	0.131	-24
0.2417	26.00	0.687	-118	0.401	56	0.971	-30	0.168	63	0.288	63	0.140	-26
0.2513	25.00	0.670	-120	0.392	54	0.966	-32	0.181	61	0.310	61	0.151	-28
0.2618	24.00	0.650	-123	0.382	50	0.960	-35	0.195	59	0.335	59	0.162	-30
0.2732	23.00	0.628	-126	0.371	47	0.953	-38	0.211	56	0.363	56	0.175	-33
0.2856	22.00	0.602	-129	0.357	42	0.944	-42	0.229	53	0.393	53	0.189	-36
0.2992	21.00	0.571	-133	0.342	37	0.933	-46	0.249	49	0.428	49	0.204	-40
0.3142	20.00	0.535	-138	0.325	31	0.918	-51	0.271	45	0.467	45	0.221	-44
0.3307	19.00	0.493	-144	0.304	24	0.900	-57	0.295	40	0.510	40	0.239	-49
0.3491	18.00	0.442	-151	0.281	16	0.877	-64	0.321	34	0.558	35	0.259	-54
0.3696	17.00	0.383	-159	0.254	5	0.846	-72	0.349	27	0.611	28	0.279	-61
0.3808	16.50	0.348	-164	0.240	0	0.827	-76	0.363	24	0.639	24	0.290	-65
0.3927	16.00	0.311	-169	0.224	-7	0.805	-81	0.377	19	0.668	20	0.300	-69
0.4054	15.50	0.271	-176	0.208	-15	0.779	-87	0.391	15	0.698	15	0.310	-74
0.4189	15.00	0.227	176	0.192	-24	0.749	-93	0.404	9	0.728	10	0.319	-78
0.4333	14.50	0.180	166	0.175	-35	0.715	-100	0.415	4	0.759	5	0.327	-84
0.4488	14.00	0.132	151	0.159	-47	0.675	-107	0.424	-2	0.788	0	0.333	-90
0.4570	13.75	0.108	141	0.152	-54	0.653	-111	0.426	-5	0.803	-4	0.336	-93
0.4654	13.50	0.085	126	0.144	-62	0.630	-116	0.428	-9	0.816	-7	0.338	-96
0.4742	13.25	0.068	103	0.138	-70	0.605	-120	0.428	-13	0.829	-11	0.339	-100
0.4833	13.00	0.062	72	0.131	-79	0.578	-125	0.427	-17	0.841	-15	0.339	-104
0.4928	12.75	0.070	41	0.126	-88	0.550	-130	0.423	-22	0.851	-19	0.338	-107
0.5027	12.50	0.090	18	0.121	-98	0.520	-135	0.416	-27	0.859	-24	0.337	-111

```
*******************************************************************************************************
*                                             ***  MOSES  ***                                         *
*                                             ----------------                       10 June, 2008    *
*                                                                                                     *
*                                                                                                     *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   Heading          = 150.00 Deg.       Forward Speed   =  0.00 Knots     Linearization Based on 1/ 20   *
*                                                                                                     *
*******************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.116	2	0.117	-108	0.489	-141	0.406	-32	0.865	-29	0.334	-116
0.5236	12.00	0.144	-9	0.113	-118	0.456	-147	0.391	-37	0.867	-34	0.330	-120
0.5347	11.75	0.173	-19	0.110	-128	0.422	-154	0.372	-44	0.866	-39	0.324	-125
0.5464	11.50	0.202	-28	0.107	-138	0.387	-161	0.346	-50	0.861	-45	0.317	-130
0.5585	11.25	0.230	-37	0.103	-147	0.351	-169	0.312	-57	0.850	-51	0.309	-135
0.5712	11.00	0.256	-45	0.098	-155	0.314	-178	0.269	-65	0.833	-58	0.298	-141
0.5845	10.75	0.279	-54	0.093	-161	0.277	172	0.214	-74	0.809	-65	0.286	-147
0.5984	10.50	0.298	-62	0.088	-163	0.241	161	0.143	-83	0.778	-72	0.271	-153
0.6130	10.25	0.312	-70	0.087	-160	0.205	147	0.053	-91	0.738	-80	0.255	-160
0.6283	10.00	0.320	-79	0.098	-154	0.171	131	0.064	62	0.691	-88	0.235	-167
0.6444	9.75	0.323	-87	0.131	-152	0.141	108	0.209	49	0.635	-96	0.212	-175
0.6614	9.50	0.319	-96	0.186	-162	0.116	75	0.373	28	0.572	-105	0.186	175
0.6793	9.25	0.308	-104	0.245	177	0.103	31	0.523	2	0.501	-114	0.156	165
0.6981	9.00	0.291	-113	0.284	152	0.106	-15	0.608	-25	0.425	-122	0.123	155
0.7181	8.75	0.268	-121	0.290	125	0.114	-56	0.605	-52	0.348	-129	0.086	144
0.7392	8.50	0.240	-129	0.263	99	0.116	-88	0.528	-78	0.275	-134	0.047	133
0.7616	8.25	0.209	-136	0.212	75	0.107	-115	0.410	-99	0.215	-136	0.008	140
0.7854	8.00	0.178	-141	0.155	51	0.092	-139	0.290	-116	0.174	-134	0.031	-86
0.8107	7.75	0.152	-142	0.096	26	0.075	-167	0.181	-129	0.153	-128	0.066	-100
0.8378	7.50	0.119	-147	0.044	-7	0.050	175	0.100	-133	0.143	-132	0.092	-118
0.8666	7.25	0.109	-151	0.015	-125	0.018	153	0.052	-110	0.136	-142	0.106	-139
0.8976	7.00	0.113	-150	0.047	159	0.012	18	0.057	-72	0.129	-152	0.105	-163
0.9308	6.75	0.110	-144	0.070	126	0.018	-17	0.076	-69	0.103	-157	0.086	169
0.9666	6.50	0.082	-144	0.071	93	0.015	-90	0.081	-81	0.058	-163	0.051	143
1.0053	6.25	0.058	-161	0.052	57	0.023	-145	0.071	-97	0.029	-166	0.009	160
1.0472	6.00	0.049	175	0.020	20	0.016	-157	0.047	-108	0.025	-161	0.033	-128
1.0927	5.75	0.047	176	0.017	155	0.002	-46	0.027	-85	0.032	-169	0.048	-168
1.1424	5.50	0.029	-155	0.034	113	0.004	-72	0.032	-76	0.019	-172	0.039	148
1.1968	5.25	0.022	163	0.025	54	0.009	-131	0.029	-101	0.010	157	0.009	83
1.2566	5.00	0.016	-163	0.004	-167	0.004	-179	0.011	-90	0.007	-159	0.014	-158
1.3228	4.75	0.025	171	0.017	102	0.006	-71	0.011	-90	0.014	157	0.020	121
1.3963	4.50	0.012	-84	0.003	0	0.002	170	0.005	-109	0.005	-101	0.002	-36
1.4784	4.25	0.013	5	0.007	96	0.004	-171	0.003	-124	0.002	43	0.015	81
1.5708	4.00	0.004	9	0.001	-2	0.001	-126	0.002	-117	0.000	0	0.008	12
1.6755	3.75	0.002	-13	0.003	-7	0.000	0	0.002	-119	0.000	0	0.006	-2
1.7952	3.50	0.000	0	0.002	-61	0.000	0	0.000	0	0.000	0	0.004	-45

```
*****************************************************************************************************
*                                              ***  MOSES  ***                                      *
*                                              ----------------                 10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.    GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters  Yaw Gy. Radius   =  48.6 Meters *
*   Heading          = 150.00 Deg.       Forward Speed   =  0.00 Knots    Linearization Based on 1/ 20    *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	9	0.001	-109	0.000	0	0.000	0	0.000	0	0.002	-87
2.0944	3.00	0.001	-141	0.001	119	0.000	0	0.000	0	0.000	0	0.001	145

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                       10 June, 2008     *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.    GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   Heading          = 165.00 Deg.       Forward Speed    =  0.00 Knots    Linearization Based on 1/ 20    *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.888	-102	0.238	74	0.994	-14	0.037	77	0.138	77	0.036	-12
0.1611	39.00	0.884	-103	0.237	74	0.993	-15	0.039	77	0.145	77	0.037	-12
0.1653	38.00	0.879	-103	0.236	73	0.992	-16	0.041	76	0.153	76	0.039	-13
0.1698	37.00	0.873	-104	0.235	72	0.991	-16	0.043	75	0.161	75	0.041	-14
0.1745	36.00	0.868	-105	0.233	71	0.990	-17	0.046	74	0.170	74	0.044	-15
0.1795	35.00	0.861	-106	0.232	70	0.989	-18	0.048	74	0.180	74	0.046	-15
0.1848	34.00	0.854	-107	0.230	68	0.988	-20	0.051	73	0.190	73	0.049	-16
0.1904	33.00	0.846	-108	0.228	67	0.987	-21	0.054	72	0.202	72	0.052	-17
0.1963	32.00	0.838	-109	0.226	66	0.985	-22	0.058	70	0.214	70	0.055	-19
0.2027	31.00	0.828	-111	0.223	64	0.983	-24	0.061	69	0.228	69	0.058	-20
0.2094	30.00	0.817	-112	0.221	62	0.980	-26	0.066	68	0.243	68	0.062	-21
0.2167	29.00	0.805	-114	0.218	60	0.978	-27	0.070	66	0.259	66	0.066	-23
0.2244	28.00	0.791	-116	0.214	58	0.974	-29	0.075	64	0.277	64	0.070	-25
0.2327	27.00	0.776	-118	0.211	55	0.970	-32	0.080	62	0.297	62	0.075	-27
0.2417	26.00	0.758	-120	0.207	53	0.965	-34	0.086	60	0.320	60	0.081	-29
0.2513	25.00	0.738	-122	0.202	49	0.960	-37	0.093	58	0.344	58	0.087	-31
0.2618	24.00	0.715	-125	0.196	46	0.953	-41	0.100	55	0.371	55	0.093	-34
0.2732	23.00	0.688	-128	0.190	42	0.944	-44	0.108	52	0.402	52	0.100	-37
0.2856	22.00	0.656	-132	0.183	37	0.933	-48	0.117	49	0.435	49	0.108	-40
0.2992	21.00	0.620	-137	0.175	31	0.920	-53	0.126	44	0.473	44	0.117	-44
0.3142	20.00	0.576	-142	0.166	25	0.903	-59	0.137	40	0.514	40	0.126	-49
0.3307	19.00	0.525	-147	0.155	17	0.882	-66	0.148	34	0.560	34	0.136	-54
0.3491	18.00	0.464	-154	0.143	7	0.854	-73	0.160	28	0.610	28	0.147	-61
0.3696	17.00	0.392	-163	0.129	-4	0.817	-83	0.172	20	0.665	21	0.158	-68
0.3808	16.50	0.350	-168	0.122	-11	0.794	-88	0.178	16	0.693	16	0.164	-72
0.3927	16.00	0.305	-173	0.114	-18	0.768	-94	0.183	11	0.722	12	0.169	-77
0.4054	15.50	0.257	179	0.106	-27	0.738	-100	0.188	6	0.751	7	0.174	-82
0.4189	15.00	0.204	172	0.098	-37	0.702	-107	0.192	0	0.779	1	0.178	-88
0.4333	14.50	0.147	161	0.090	-49	0.662	-115	0.194	-5	0.806	-4	0.182	-94
0.4488	14.00	0.088	145	0.083	-62	0.615	-124	0.194	-12	0.831	-11	0.184	-100
0.4570	13.75	0.059	128	0.079	-70	0.589	-129	0.193	-16	0.841	-15	0.185	-104
0.4654	13.50	0.038	93	0.076	-78	0.561	-134	0.191	-20	0.851	-19	0.185	-108
0.4742	13.25	0.040	36	0.073	-86	0.531	-139	0.188	-25	0.858	-23	0.185	-112
0.4833	13.00	0.064	4	0.070	-95	0.500	-145	0.183	-29	0.864	-27	0.184	-116
0.4928	12.75	0.096	-11	0.068	-103	0.467	-151	0.177	-34	0.867	-32	0.183	-120
0.5027	12.50	0.129	-22	0.065	-113	0.432	-157	0.169	-40	0.866	-37	0.181	-125

*** MOSES ***

10 June, 2008

Draft = 7.0 Meters	Trim Angle = 0.00 Deg.	GMT = 41.4 Meters
Roll Gy. Radius = 20.4 Meters	Pitch Gy. Radius = 48.6 Meters	Yaw Gy. Radius = 48.6 Meters
Heading = 165.00 Deg.	Forward Speed = 0.00 Knots	Linearization Based on 1/ 20

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.163	-31	0.063	-122	0.395	-164	0.159	-46	0.862	-42	0.178	-130
0.5236	12.00	0.196	-39	0.061	-131	0.357	-171	0.146	-52	0.853	-48	0.174	-135
0.5347	11.75	0.227	-46	0.059	-140	0.318	-179	0.130	-59	0.838	-54	0.170	-140
0.5464	11.50	0.256	-54	0.056	-148	0.278	172	0.110	-67	0.817	-60	0.164	-146
0.5585	11.25	0.282	-61	0.053	-155	0.237	164	0.085	-76	0.789	-67	0.158	-152
0.5712	11.00	0.303	-69	0.051	-160	0.196	154	0.054	-87	0.753	-74	0.150	-158
0.5845	10.75	0.318	-77	0.048	-162	0.156	144	0.017	-109	0.708	-81	0.141	-165
0.5984	10.50	0.328	-84	0.049	-160	0.118	133	0.031	86	0.656	-88	0.130	-172
0.6130	10.25	0.330	-92	0.054	-156	0.082	119	0.087	67	0.597	-95	0.118	179
0.6283	10.00	0.325	-99	0.069	-156	0.049	98	0.156	51	0.533	-101	0.105	170
0.6444	9.75	0.314	-107	0.094	-163	0.026	51	0.236	32	0.467	-107	0.089	160
0.6614	9.50	0.297	-113	0.125	180	0.032	-29	0.319	8	0.403	-112	0.071	149
0.6793	9.25	0.276	-119	0.154	156	0.059	-71	0.382	-18	0.347	-114	0.051	137
0.6981	9.00	0.254	-124	0.167	127	0.084	-101	0.398	-48	0.305	-115	0.030	123
0.7181	8.75	0.233	-127	0.154	96	0.096	-129	0.351	-78	0.277	-116	0.007	97
0.7392	8.50	0.215	-130	0.121	65	0.090	-155	0.263	-105	0.261	-118	0.016	-74
0.7616	8.25	0.199	-133	0.081	35	0.074	178	0.172	-127	0.248	-122	0.038	-95
0.7854	8.00	0.186	-135	0.043	0	0.053	154	0.093	-144	0.232	-129	0.056	-114
0.8107	7.75	0.177	-135	0.017	-83	0.037	130	0.033	-139	0.203	-136	0.070	-135
0.8378	7.50	0.151	-143	0.031	-177	0.007	101	0.028	-65	0.172	-149	0.074	-158
0.8666	7.25	0.145	-153	0.048	140	0.019	-62	0.050	-61	0.139	-163	0.066	174
0.8976	7.00	0.146	-156	0.056	104	0.022	-75	0.062	-75	0.111	-167	0.046	144
0.9308	6.75	0.133	-150	0.048	65	0.009	-133	0.058	-94	0.084	-155	0.015	111
0.9666	6.50	0.092	-148	0.027	16	0.016	157	0.040	-113	0.058	-144	0.020	-105
1.0053	6.25	0.061	-158	0.010	-118	0.014	157	0.019	-111	0.043	-155	0.046	-146
1.0472	6.00	0.055	-168	0.028	137	0.009	-114	0.024	-66	0.036	-176	0.047	165
1.0927	5.75	0.070	-164	0.032	76	0.008	-95	0.033	-86	0.032	-175	0.024	115
1.1424	5.50	0.043	-159	0.011	-2	0.006	159	0.018	-119	0.018	-155	0.013	-142
1.1968	5.25	0.022	168	0.014	138	0.004	-135	0.013	-84	0.016	168	0.030	166
1.2566	5.00	0.036	-148	0.017	57	0.005	-154	0.015	-102	0.008	-157	0.013	107
1.3228	4.75	0.023	163	0.006	155	0.003	-103	0.008	-97	0.010	164	0.020	-176
1.3963	4.50	0.018	-149	0.009	61	0.001	-162	0.007	-94	0.004	-161	0.008	114
1.4784	4.25	0.009	108	0.008	128	0.002	35	0.004	-85	0.002	131	0.016	134
1.5708	4.00	0.007	124	0.002	155	0.001	-50	0.002	-91	0.001	147	0.008	143
1.6755	3.75	0.006	110	0.001	-89	0.000	0	0.002	-72	0.000	0	0.002	171
1.7952	3.50	0.001	-24	0.001	141	0.000	0	0.001	-90	0.001	-128	0.003	127

*** MOSES ***

10 June, 2008

Draft = 7.0 Meters	Trim Angle = 0.00 Deg.	GMT = 41.4 Meters
Roll Gy. Radius = 20.4 Meters	Pitch Gy. Radius = 48.6 Meters	Yaw Gy. Radius = 48.6 Meters
Heading = 165.00 Deg.	Forward Speed = 0.00 Knots	Linearization Based on 1/ 20

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.001	-125	0.002	120	0.000	0	0.001	20	0.000	0	0.003	98
2.0944	3.00	0.001	-1	0.001	159	0.000	0	0.001	60	0.000	0	0.001	126

```
*******************************************************************************************************
*                                            ***  MOSES  ***                                          *
*                                            ----------------                    10 June, 2008        *
*                                                                                                     *
*                                                                                                     *
*   Draft             =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT             = 41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  = 48.6 Meters *
*   Heading           = 180.00 Deg.       Forward Speed   =  0.00 Knots     Linearization Based on 1/ 20  *
*                                                                                                     *
*******************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.1571	40.00	0.919	-102	0.000	0	0.994	-15	0.000	0	0.143	77	0.000	0
0.1611	39.00	0.914	-103	0.000	0	0.993	-16	0.000	0	0.150	76	0.000	0
0.1653	38.00	0.909	-103	0.000	0	0.992	-17	0.000	0	0.158	76	0.000	0
0.1698	37.00	0.903	-104	0.000	0	0.991	-18	0.000	0	0.167	75	0.000	0
0.1745	36.00	0.897	-105	0.000	0	0.990	-19	0.000	0	0.176	74	0.000	0
0.1795	35.00	0.891	-106	0.000	0	0.989	-20	0.000	0	0.186	73	0.000	0
0.1848	34.00	0.883	-107	0.000	0	0.988	-21	0.000	0	0.197	72	0.000	0
0.1904	33.00	0.875	-108	0.000	0	0.986	-22	0.000	0	0.209	71	0.000	0
0.1963	32.00	0.866	-109	0.000	0	0.984	-24	0.000	0	0.222	70	0.000	0
0.2027	31.00	0.856	-111	0.000	0	0.982	-25	0.000	0	0.236	68	0.000	0
0.2094	30.00	0.844	-112	0.000	0	0.980	-27	0.000	0	0.251	67	0.000	0
0.2167	29.00	0.831	-114	0.000	0	0.977	-29	0.000	0	0.268	65	0.000	0
0.2244	28.00	0.817	-116	0.000	0	0.974	-31	0.000	0	0.287	63	0.000	0
0.2327	27.00	0.800	-118	0.000	0	0.970	-34	0.000	0	0.308	61	0.000	0
0.2417	26.00	0.782	-120	0.000	0	0.965	-37	0.000	0	0.330	59	0.000	0
0.2513	25.00	0.760	-122	0.000	0	0.959	-40	0.000	0	0.356	57	0.000	0
0.2618	24.00	0.736	-125	0.000	0	0.952	-43	0.000	0	0.384	54	0.000	0
0.2732	23.00	0.707	-128	0.000	0	0.943	-47	0.000	0	0.415	51	0.000	0
0.2856	22.00	0.674	-132	0.000	0	0.932	-52	0.000	0	0.449	47	0.000	0
0.2992	21.00	0.635	-136	0.000	0	0.918	-57	0.000	0	0.487	43	0.000	0
0.3142	20.00	0.589	-141	0.000	0	0.901	-63	0.000	0	0.530	38	0.000	0
0.3307	19.00	0.534	-147	0.000	0	0.879	-70	0.000	0	0.577	32	0.000	0
0.3491	18.00	0.469	-153	0.000	0	0.850	-78	0.000	0	0.628	26	0.000	0
0.3696	17.00	0.392	-161	0.000	0	0.813	-88	0.000	0	0.682	18	0.000	0
0.3808	16.50	0.348	-166	0.000	0	0.789	-94	0.000	0	0.710	14	0.000	0
0.3927	16.00	0.300	-170	0.000	0	0.762	-100	0.000	0	0.739	9	0.000	0
0.4054	15.50	0.248	-176	0.000	0	0.731	-107	0.000	0	0.767	4	0.000	0
0.4189	15.00	0.192	177	0.000	0	0.695	-114	0.000	0	0.794	-1	0.000	0
0.4333	14.50	0.131	170	0.000	0	0.652	-123	0.000	0	0.820	-8	0.000	0
0.4488	14.00	0.066	162	0.000	0	0.603	-132	0.000	0	0.842	-15	0.000	0
0.4570	13.75	0.032	156	0.000	0	0.576	-137	0.000	0	0.851	-19	0.000	0
0.4654	13.50	0.004	9	0.000	0	0.547	-142	0.000	0	0.859	-23	0.000	0
0.4742	13.25	0.039	-24	0.000	0	0.516	-148	0.000	0	0.864	-27	0.000	0
0.4833	13.00	0.075	-30	0.000	0	0.483	-154	0.000	0	0.867	-32	0.000	0
0.4928	12.75	0.111	-36	0.000	0	0.448	-160	0.000	0	0.867	-36	0.000	0
0.5027	12.50	0.147	-41	0.000	0	0.411	-167	0.000	0	0.863	-42	0.000	0

*** MOSES ***

10 June, 2008

Draft	= 7.0 Meters	Trim Angle	= 0.00 Deg.	GMT	= 41.4 Meters
Roll Gy. Radius	= 20.4 Meters	Pitch Gy. Radius	= 48.6 Meters	Yaw Gy. Radius	= 48.6 Meters
Heading	= 180.00 Deg.	Forward Speed	= 0.00 Knots	Linearization Based on 1/ 20	

+++ M O T I O N R E S P O N S E O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
0.5129	12.25	0.183	-47	0.000	0	0.372	-174	0.000	0	0.855	-47	0.000	0
0.5236	12.00	0.216	-53	0.000	0	0.331	177	0.000	0	0.841	-53	0.000	0
0.5347	11.75	0.248	-59	0.000	0	0.289	169	0.000	0	0.822	-59	0.000	0
0.5464	11.50	0.276	-66	0.000	0	0.246	161	0.000	0	0.795	-66	0.000	0
0.5585	11.25	0.300	-72	0.000	0	0.201	152	0.000	0	0.760	-72	0.000	0
0.5712	11.00	0.319	-79	0.000	0	0.156	143	0.000	0	0.717	-79	0.000	0
0.5845	10.75	0.330	-87	0.000	0	0.112	135	0.000	0	0.665	-86	0.000	0
0.5984	10.50	0.335	-94	0.000	0	0.069	128	0.000	0	0.606	-93	0.000	0
0.6130	10.25	0.332	-101	0.000	0	0.031	132	0.000	0	0.542	-99	0.000	0
0.6283	10.00	0.321	-108	0.000	0	0.019	-145	0.000	0	0.474	-105	0.000	0
0.6444	9.75	0.303	-114	0.000	0	0.045	-124	0.000	0	0.409	-109	0.000	0
0.6614	9.50	0.282	-119	0.000	0	0.069	-133	0.000	0	0.353	-110	0.000	0
0.6793	9.25	0.259	-123	0.000	0	0.085	-147	0.000	0	0.313	-110	0.000	0
0.6981	9.00	0.239	-125	0.000	0	0.092	-164	0.000	0	0.293	-109	0.000	0
0.7181	8.75	0.225	-126	0.000	0	0.089	177	0.000	0	0.286	-110	0.000	0
0.7392	8.50	0.217	-127	0.000	0	0.079	157	0.000	0	0.284	-115	0.000	0
0.7616	8.25	0.213	-129	0.000	0	0.062	137	0.000	0	0.274	-123	0.000	0
0.7854	8.00	0.209	-133	0.000	0	0.042	114	0.000	0	0.252	-133	0.000	0
0.8107	7.75	0.204	-136	0.000	0	0.026	102	0.000	0	0.210	-142	0.000	0
0.8378	7.50	0.174	-147	0.000	0	0.002	-77	0.000	0	0.168	-155	0.000	0
0.8666	7.25	0.160	-157	0.000	0	0.020	-95	0.000	0	0.128	-167	0.000	0
0.8976	7.00	0.154	-159	0.000	0	0.013	-122	0.000	0	0.102	-164	0.000	0
0.9308	6.75	0.140	-149	0.000	0	0.014	125	0.000	0	0.090	-147	0.000	0
0.9666	6.50	0.105	-144	0.000	0	0.019	111	0.000	0	0.071	-144	0.000	0
1.0053	6.25	0.079	-154	0.000	0	0.011	154	0.000	0	0.049	-163	0.000	0
1.0472	6.00	0.075	-169	0.000	0	0.013	-140	0.000	0	0.035	178	0.000	0
1.0927	5.75	0.086	-166	0.000	0	0.003	156	0.000	0	0.036	-167	0.000	0
1.1424	5.50	0.055	-151	0.000	0	0.007	114	0.000	0	0.025	-156	0.000	0
1.1968	5.25	0.040	-179	0.000	0	0.006	-138	0.000	0	0.018	164	0.000	0
1.2566	5.00	0.046	-142	0.000	0	0.006	162	0.000	0	0.010	-143	0.000	0
1.3228	4.75	0.043	178	0.000	0	0.005	-90	0.000	0	0.015	164	0.000	0
1.3963	4.50	0.030	-134	0.000	0	0.002	116	0.000	0	0.007	-140	0.000	0
1.4784	4.25	0.016	156	0.000	0	0.004	152	0.000	0	0.003	146	0.000	0
1.5708	4.00	0.012	172	0.000	0	0.000	0	0.000	0	0.001	168	0.000	0
1.6755	3.75	0.008	171	0.000	0	0.000	0	0.000	0	0.001	-150	0.000	0
1.7952	3.50	0.012	-166	0.000	0	0.000	0	0.000	0	0.001	-164	0.000	0

```
*****************************************************************************************************************
*                                              ***  MOSES  ***                                                  *
*                                              ----------------                        10 June, 2008            *
*                                                                                                               *
*                                                                                                               *
*   Draft            =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   Heading          = 180.00 Deg.        Forward Speed    =  0.00 Knots     Linearization Based on 1/ 20    *
*                                                                                                               *
*****************************************************************************************************************
```

+++ M O T I O N   R E S P O N S E   O P E R A T O R S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

E N C O U N T E R		Surge / Wave Ampl.		Sway / Wave Ampl.		Heave / Wave Ampl.		Roll / Wave Ampl.		Pitch / Wave Ampl.		Yaw / Wave Ampl.	
Frequency -(Rad/Sec)-	Period -(Sec)-	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase	Ampl.	Phase
1.9333	3.25	0.005	-174	0.000	0	0.001	169	0.000	0	0.000	0	0.000	0
2.0944	3.00	0.004	-172	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                    10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*   Draft             =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height   =  1.00 Meters      Period           =   4.0  Sec.     M. Heading       =   0.0  Deg.  *
*   S. Coef.          = 200.                                                 Gamma            =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.001	0.006	0.001	0.008	0.001	0.015
Ave of 1/3 Highest	0.028	0.002	0.013	0.002	0.016	0.003	0.030
Ave of 1/10 Highest	0.035	0.002	0.016	0.003	0.021	0.004	0.039
Maximum	0.051	0.004	0.023	0.005	0.030	0.005	0.057

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.015	0.001	0.006	0.001	0.008	0.002	0.016
Ave of 1/3 Highest	0.030	0.002	0.012	0.003	0.016	0.003	0.033
Ave of 1/10 Highest	0.038	0.003	0.016	0.003	0.020	0.004	0.042
Maximum	0.056	0.004	0.023	0.005	0.029	0.006	0.061

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.001	0.006	0.001	0.008	0.002	0.018
Ave of 1/3 Highest	0.034	0.002	0.013	0.003	0.016	0.004	0.037
Ave of 1/10 Highest	0.044	0.003	0.016	0.004	0.020	0.005	0.047
Maximum	0.064	0.004	0.024	0.005	0.030	0.007	0.068

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ----------------                   10 June, 2008          *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   5.0  Sec.     M. Heading      =   0.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.028	0.002	0.019	0.004	0.025	0.002	0.034
Ave of 1/3 Highest	0.056	0.005	0.038	0.009	0.050	0.005	0.068
Ave of 1/10 Highest	0.071	0.006	0.049	0.011	0.064	0.006	0.086
Maximum	0.104	0.009	0.071	0.016	0.094	0.008	0.126

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.025	0.002	0.016	0.003	0.021	0.002	0.030
Ave of 1/3 Highest	0.050	0.004	0.031	0.007	0.041	0.004	0.059
Ave of 1/10 Highest	0.064	0.005	0.040	0.009	0.053	0.006	0.075
Maximum	0.093	0.007	0.058	0.013	0.077	0.008	0.110

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.024	0.002	0.013	0.003	0.018	0.002	0.027
Ave of 1/3 Highest	0.047	0.004	0.027	0.006	0.035	0.004	0.054
Ave of 1/10 Highest	0.060	0.004	0.034	0.007	0.045	0.006	0.069
Maximum	0.088	0.007	0.050	0.010	0.066	0.008	0.101

```
****************************************************************************************************
*                                          ***  MOSES  ***                                         *
*                                          ---------------                    10 June, 2008        *
*                                                                                                  *
*                                                                                                  *
*   Draft           =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period           =   6.0  Sec.     M. Heading      =   0.0  Deg.  *
*   S. Coef.        = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.043	0.004	0.039	0.009	0.053	0.003	0.059
Ave of 1/3 Highest	0.087	0.008	0.079	0.018	0.107	0.006	0.117
Ave of 1/10 Highest	0.111	0.010	0.100	0.023	0.136	0.008	0.150
Maximum	0.161	0.015	0.146	0.034	0.199	0.012	0.218

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.034	0.003	0.028	0.007	0.038	0.003	0.044
Ave of 1/3 Highest	0.068	0.006	0.057	0.013	0.077	0.005	0.089
Ave of 1/10 Highest	0.087	0.008	0.073	0.017	0.098	0.007	0.113
Maximum	0.126	0.011	0.106	0.024	0.143	0.010	0.165

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.028	0.002	0.021	0.005	0.029	0.002	0.035
Ave of 1/3 Highest	0.056	0.005	0.043	0.010	0.058	0.005	0.070
Ave of 1/10 Highest	0.071	0.006	0.055	0.012	0.073	0.006	0.090
Maximum	0.104	0.009	0.080	0.018	0.107	0.008	0.131

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ----------------                    10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   7.0  Sec.     M. Heading      =   0.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y =   10.0 Z =   30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.055	0.005	0.061	0.013	0.088	0.005	0.083
Ave of 1/3 Highest	0.111	0.010	0.123	0.027	0.176	0.009	0.166
Ave of 1/10 Highest	0.141	0.013	0.157	0.034	0.224	0.012	0.211
Maximum	0.206	0.019	0.229	0.050	0.326	0.017	0.308

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.039	0.004	0.040	0.009	0.056	0.003	0.056
Ave of 1/3 Highest	0.078	0.007	0.080	0.019	0.111	0.006	0.112
Ave of 1/10 Highest	0.099	0.010	0.103	0.024	0.142	0.008	0.143
Maximum	0.144	0.014	0.150	0.035	0.207	0.011	0.208

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.029	0.003	0.027	0.007	0.037	0.002	0.040
Ave of 1/3 Highest	0.057	0.006	0.055	0.013	0.073	0.004	0.079
Ave of 1/10 Highest	0.073	0.007	0.069	0.017	0.094	0.006	0.101
Maximum	0.107	0.010	0.101	0.025	0.137	0.008	0.147

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                 10 June, 2008           *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT             = 41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  = 48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period          =   8.0  Sec.     M. Heading      =  0.0  Deg.  *
*   S. Coef.         = 200.                                                Gamma           =  2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.062	0.005	0.082	0.012	0.127	0.007	0.103
Ave of 1/3 Highest	0.124	0.009	0.164	0.023	0.254	0.013	0.205
Ave of 1/10 Highest	0.158	0.012	0.209	0.030	0.324	0.017	0.262
Maximum	0.230	0.017	0.304	0.043	0.473	0.025	0.382

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.040	0.003	0.048	0.008	0.073	0.004	0.063
Ave of 1/3 Highest	0.080	0.006	0.096	0.016	0.147	0.008	0.126
Ave of 1/10 Highest	0.103	0.008	0.123	0.020	0.187	0.010	0.160
Maximum	0.150	0.012	0.179	0.029	0.273	0.015	0.234

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.028	0.002	0.030	0.005	0.044	0.002	0.041
Ave of 1/3 Highest	0.055	0.004	0.059	0.011	0.088	0.005	0.081
Ave of 1/10 Highest	0.070	0.006	0.076	0.014	0.112	0.006	0.103
Maximum	0.102	0.008	0.111	0.020	0.164	0.009	0.151

```
****************************************************************************************************
*                                         ***  MOSES  ***                                          *
*                                         ----------------                 10 June, 2008           *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.    GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters  Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period          =   9.0  Sec.    M. Heading      =   0.0  Deg.  *
*   S. Coef.         = 200.                                               Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.059	0.005	0.101	0.011	0.158	0.008	0.117
Ave of 1/3 Highest	0.118	0.009	0.203	0.022	0.317	0.017	0.235
Ave of 1/10 Highest	0.151	0.012	0.259	0.028	0.404	0.021	0.300
Maximum	0.220	0.017	0.377	0.041	0.589	0.031	0.437

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.037	0.003	0.054	0.007	0.085	0.005	0.065
Ave of 1/3 Highest	0.073	0.006	0.108	0.014	0.170	0.009	0.131
Ave of 1/10 Highest	0.093	0.007	0.138	0.018	0.217	0.012	0.167
Maximum	0.136	0.011	0.201	0.026	0.317	0.017	0.243

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.024	0.002	0.031	0.005	0.048	0.003	0.039
Ave of 1/3 Highest	0.048	0.004	0.061	0.009	0.095	0.005	0.078
Ave of 1/10 Highest	0.061	0.005	0.078	0.012	0.121	0.007	0.099
Maximum	0.090	0.007	0.113	0.017	0.177	0.010	0.145

```
****************************************************************************************************************
*                                              ***  MOSES  ***                                                 *
*                                              ----------------                            10 June, 2008       *
*                                                                                                              *
*                                                                                                              *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.      GMT              =  41.4 Meters   *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters     Yaw Gy. Radius   =  48.6 Meters   *
*   JONSWAP  Height  =  1.00 Meters      Period           =  10.0  Sec.      M. Heading       =   0.0  Deg.    *
*   S. Coef.         = 200.                                                  Gamma            =   2.0          *
*                                                                                                              *
****************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.056	0.005	0.121	0.011	0.174	0.009	0.134
Ave of 1/3 Highest	0.112	0.010	0.243	0.023	0.348	0.019	0.268
Ave of 1/10 Highest	0.143	0.013	0.310	0.029	0.444	0.024	0.341
Maximum	0.208	0.018	0.452	0.042	0.648	0.035	0.498

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.032	0.003	0.059	0.007	0.088	0.005	0.067
Ave of 1/3 Highest	0.064	0.006	0.118	0.013	0.176	0.009	0.135
Ave of 1/10 Highest	0.082	0.007	0.151	0.017	0.224	0.012	0.172
Maximum	0.120	0.010	0.220	0.025	0.327	0.018	0.251

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.021	0.002	0.031	0.004	0.046	0.003	0.037
Ave of 1/3 Highest	0.041	0.004	0.061	0.008	0.093	0.005	0.074
Ave of 1/10 Highest	0.053	0.005	0.078	0.011	0.118	0.006	0.094
Maximum	0.077	0.007	0.114	0.016	0.172	0.009	0.138

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ---------------                    10 June, 2008          *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period           =  11.0  Sec.     M. Heading       =   0.0  Deg.  *
*   S. Coef.         = 200.                                                Gamma            =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.062	0.006	0.141	0.012	0.179	0.010	0.154
Ave of 1/3 Highest	0.123	0.011	0.282	0.023	0.357	0.019	0.308
Ave of 1/10 Highest	0.157	0.014	0.360	0.029	0.455	0.025	0.393
Maximum	0.229	0.021	0.525	0.043	0.664	0.036	0.573

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.031	0.003	0.063	0.006	0.086	0.005	0.071
Ave of 1/3 Highest	0.062	0.006	0.127	0.013	0.171	0.009	0.141
Ave of 1/10 Highest	0.079	0.007	0.162	0.016	0.218	0.012	0.180
Maximum	0.116	0.010	0.236	0.023	0.318	0.017	0.263

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.018	0.002	0.031	0.004	0.043	0.002	0.036
Ave of 1/3 Highest	0.037	0.003	0.061	0.008	0.086	0.005	0.071
Ave of 1/10 Highest	0.047	0.004	0.078	0.010	0.110	0.006	0.091
Maximum	0.069	0.006	0.114	0.014	0.161	0.009	0.133

```
*****************************************************************************************************************
*                                            ***  MOSES  ***                                                    *
*                                            ----------------                        10 June, 2008              *
*                                                                                                               *
*                                                                                                               *
*   Draft             =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height   =  1.00 Meters       Period           =  12.0  Sec.     M. Heading       =   0.0  Deg.  *
*   S. Coef.          = 200.                                                  Gamma            =   2.0        *
*                                                                                                               *
*****************************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.075	0.006	0.159	0.011	0.176	0.010	0.176
Ave of 1/3 Highest	0.150	0.013	0.318	0.023	0.353	0.020	0.351
Ave of 1/10 Highest	0.191	0.016	0.405	0.029	0.450	0.025	0.448
Maximum	0.278	0.024	0.591	0.042	0.656	0.036	0.654

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.033	0.003	0.066	0.006	0.081	0.004	0.074
Ave of 1/3 Highest	0.065	0.006	0.133	0.012	0.162	0.009	0.148
Ave of 1/10 Highest	0.083	0.007	0.169	0.015	0.206	0.011	0.189
Maximum	0.122	0.011	0.247	0.021	0.301	0.016	0.275

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.002	0.030	0.003	0.039	0.002	0.035
Ave of 1/3 Highest	0.035	0.003	0.060	0.007	0.079	0.004	0.069
Ave of 1/10 Highest	0.044	0.004	0.076	0.009	0.101	0.006	0.088
Maximum	0.065	0.006	0.111	0.012	0.147	0.008	0.129

```
****************************************************************************************************
*                                      ***  MOSES  ***                                             *
*                                      ----------------                     10 June, 2008          *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  13.0  Sec.     M. Heading      =   0.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.090	0.007	0.174	0.011	0.171	0.010	0.196
Ave of 1/3 Highest	0.181	0.015	0.348	0.022	0.342	0.019	0.392
Ave of 1/10 Highest	0.231	0.019	0.443	0.028	0.436	0.024	0.500
Maximum	0.337	0.027	0.647	0.041	0.636	0.036	0.730

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.035	0.003	0.068	0.005	0.075	0.004	0.077
Ave of 1/3 Highest	0.071	0.006	0.136	0.011	0.151	0.008	0.154
Ave of 1/10 Highest	0.090	0.007	0.174	0.013	0.192	0.011	0.196
Maximum	0.131	0.011	0.253	0.020	0.281	0.016	0.286

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.001	0.029	0.003	0.036	0.002	0.033
Ave of 1/3 Highest	0.033	0.003	0.058	0.006	0.072	0.004	0.067
Ave of 1/10 Highest	0.043	0.004	0.074	0.008	0.091	0.005	0.085
Maximum	0.062	0.005	0.108	0.011	0.133	0.007	0.124

```
*********************************************************************************************************
*                                          ***  MOSES  ***                                              *
*                                          ----------------                    10 June, 2008            *
*                                                                                                       *
*                                                                                                       *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  14.0  Sec.     M. Heading       =   0.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma            =   2.0        *
*                                                                                                       *
*********************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.106	0.008	0.186	0.010	0.164	0.009	0.214
Ave of 1/3 Highest	0.212	0.016	0.372	0.021	0.328	0.019	0.429
Ave of 1/10 Highest	0.270	0.021	0.475	0.027	0.418	0.024	0.547
Maximum	0.394	0.030	0.693	0.039	0.609	0.035	0.797

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.038	0.003	0.069	0.005	0.070	0.004	0.079
Ave of 1/3 Highest	0.076	0.006	0.137	0.010	0.140	0.008	0.157
Ave of 1/10 Highest	0.097	0.008	0.175	0.012	0.178	0.010	0.200
Maximum	0.141	0.011	0.256	0.018	0.260	0.014	0.292

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.016	0.001	0.028	0.003	0.033	0.002	0.032
Ave of 1/3 Highest	0.032	0.003	0.055	0.005	0.065	0.004	0.064
Ave of 1/10 Highest	0.041	0.003	0.071	0.007	0.083	0.005	0.082
Maximum	0.060	0.005	0.103	0.010	0.121	0.007	0.120

```
****************************************************************************************************
*                                         ***  MOSES  ***                                          *
*                                         ---------------                        10 June, 2008     *
*                                                                                                  *
*                                                                                                  *
*  Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*  Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*  JONSWAP  Height  =  1.00 Meters      Period           =  16.0  Sec.     M. Heading      =   0.0  Deg.  *
*  S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.133	0.010	0.204	0.009	0.148	0.009	0.244
Ave of 1/3 Highest	0.265	0.019	0.409	0.019	0.296	0.017	0.488
Ave of 1/10 Highest	0.339	0.024	0.521	0.024	0.377	0.022	0.622
Maximum	0.494	0.036	0.760	0.035	0.550	0.032	0.907

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.042	0.003	0.068	0.004	0.060	0.003	0.080
Ave of 1/3 Highest	0.083	0.006	0.136	0.008	0.119	0.007	0.159
Ave of 1/10 Highest	0.106	0.008	0.173	0.010	0.152	0.009	0.203
Maximum	0.155	0.012	0.253	0.015	0.222	0.012	0.296

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.015	0.001	0.025	0.002	0.027	0.001	0.029
Ave of 1/3 Highest	0.030	0.002	0.050	0.004	0.054	0.003	0.059
Ave of 1/10 Highest	0.039	0.003	0.064	0.005	0.068	0.004	0.075
Maximum	0.056	0.004	0.093	0.008	0.100	0.006	0.109

```
*********************************************************************************************************
*                                        ***  MOSES  ***                                                *
*                                        ----------------                   10 June, 2008               *
*                                                                                                       *
*                                                                                                       *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  18.0  Sec.     M. Heading       =   0.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma            =   2.0        *
*                                                                                                       *
*********************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.154	0.011	0.217	0.008	0.132	0.008	0.266
Ave of 1/3 Highest	0.308	0.021	0.433	0.017	0.264	0.015	0.532
Ave of 1/10 Highest	0.392	0.027	0.552	0.022	0.337	0.020	0.678
Maximum	0.572	0.040	0.806	0.031	0.491	0.029	0.989

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.043	0.003	0.066	0.003	0.051	0.003	0.079
Ave of 1/3 Highest	0.087	0.006	0.131	0.007	0.102	0.006	0.158
Ave of 1/10 Highest	0.111	0.008	0.167	0.009	0.130	0.007	0.201
Maximum	0.162	0.012	0.244	0.013	0.189	0.011	0.293

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.001	0.022	0.002	0.022	0.001	0.026
Ave of 1/3 Highest	0.028	0.002	0.045	0.003	0.045	0.002	0.053
Ave of 1/10 Highest	0.036	0.003	0.057	0.004	0.057	0.003	0.068
Maximum	0.053	0.004	0.083	0.006	0.083	0.005	0.099

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ---------------                   10 June, 2008          *
*                                                                                                   *
*                                                                                                   *
*  Draft            =   7.0 Meters    Trim Angle       =   0.00 Deg.    GMT             =  41.4 Meters *
*  Roll Gy. Radius  =  20.4 Meters    Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  =  48.6 Meters *
*  JONSWAP  Height  =  1.00 Meters    Period           =  20.0  Sec.    M. Heading      =   0.0  Deg.  *
*  S. Coef.         = 200.                                              Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.170	0.012	0.225	0.008	0.118	0.007	0.282
Ave of 1/3 Highest	0.341	0.023	0.450	0.015	0.235	0.014	0.565
Ave of 1/10 Highest	0.434	0.030	0.574	0.019	0.300	0.018	0.720
Maximum	0.634	0.043	0.837	0.028	0.438	0.026	1.051

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.044	0.003	0.063	0.003	0.044	0.002	0.077
Ave of 1/3 Highest	0.088	0.006	0.125	0.006	0.087	0.005	0.153
Ave of 1/10 Highest	0.113	0.008	0.160	0.007	0.111	0.006	0.196
Maximum	0.164	0.012	0.233	0.011	0.162	0.009	0.285

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.013	0.001	0.020	0.001	0.019	0.001	0.024
Ave of 1/3 Highest	0.026	0.002	0.040	0.003	0.037	0.002	0.048
Ave of 1/10 Highest	0.033	0.002	0.051	0.004	0.048	0.003	0.061
Maximum	0.049	0.004	0.074	0.005	0.069	0.004	0.089

```
*****************************************************************************************************
*                                            ***  MOSES  ***                                        *
*                                            ---------------                     10 June, 2008      *
*                                                                                                   *
*                                                                                                   *
*  Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*  Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*  JONSWAP  Height  =  1.00 Meters      Period           =  22.0  Sec.     M. Heading      =   0.0  Deg.  *
*  S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.183	0.012	0.231	0.007	0.105	0.006	0.295
Ave of 1/3 Highest	0.366	0.025	0.462	0.014	0.210	0.012	0.590
Ave of 1/10 Highest	0.467	0.032	0.589	0.017	0.268	0.016	0.752
Maximum	0.681	0.046	0.859	0.025	0.391	0.023	1.097

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.044	0.003	0.060	0.003	0.038	0.002	0.074
Ave of 1/3 Highest	0.088	0.006	0.119	0.005	0.075	0.004	0.148
Ave of 1/10 Highest	0.112	0.008	0.152	0.006	0.096	0.005	0.189
Maximum	0.163	0.011	0.222	0.009	0.140	0.008	0.276

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.012	0.001	0.018	0.001	0.016	0.001	0.022
Ave of 1/3 Highest	0.024	0.002	0.036	0.002	0.032	0.002	0.043
Ave of 1/10 Highest	0.031	0.002	0.046	0.003	0.040	0.002	0.055
Maximum	0.045	0.003	0.066	0.005	0.059	0.003	0.080

```
***************************************************************************************************
*                                        ***  MOSES  ***                                          *
*                                        ---------------                      10 June, 2008       *
*                                                                                                 *
*                                                                                                 *
*   Draft            =   7.0 Meters     Trim Angle      =   0.00 Deg.    GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters  Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period          =   4.0  Sec.    M. Heading      =  45.0  Deg.  *
*   S. Coef.         = 200.                                              Gamma           =   2.0        *
*                                                                                                 *
***************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.006	0.008	0.006	0.011	0.007	0.008	0.012
Ave of 1/3 Highest	0.012	0.015	0.012	0.023	0.013	0.015	0.023
Ave of 1/10 Highest	0.016	0.020	0.016	0.029	0.017	0.019	0.030
Maximum	0.023	0.029	0.023	0.042	0.025	0.028	0.043

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.006	0.008	0.006	0.011	0.006	0.008	0.011
Ave of 1/3 Highest	0.012	0.015	0.012	0.022	0.012	0.016	0.023
Ave of 1/10 Highest	0.015	0.019	0.015	0.028	0.015	0.020	0.029
Maximum	0.022	0.028	0.021	0.040	0.022	0.030	0.042

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.006	0.008	0.005	0.011	0.006	0.009	0.011
Ave of 1/3 Highest	0.012	0.016	0.011	0.022	0.011	0.018	0.023
Ave of 1/10 Highest	0.016	0.020	0.014	0.027	0.014	0.023	0.029
Maximum	0.023	0.030	0.020	0.040	0.021	0.034	0.043

```
*****************************************************************************************************
*                                        ***  MOSES  ***                                            *
*                                       ----------------                        10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period          =   5.0  Sec.     M. Heading      =  45.0  Deg.  *
*   S. Coef.         = 200.                                                Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.021	0.021	0.023	0.036	0.034	0.018	0.037
Ave of 1/3 Highest	0.041	0.041	0.046	0.073	0.067	0.036	0.075
Ave of 1/10 Highest	0.053	0.053	0.059	0.093	0.086	0.046	0.095
Maximum	0.077	0.077	0.086	0.135	0.125	0.067	0.139

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.018	0.018	0.030	0.025	0.016	0.031
Ave of 1/3 Highest	0.033	0.036	0.037	0.060	0.051	0.031	0.061
Ave of 1/10 Highest	0.043	0.045	0.047	0.076	0.065	0.040	0.078
Maximum	0.062	0.066	0.069	0.111	0.094	0.058	0.114

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.016	0.015	0.025	0.020	0.014	0.026
Ave of 1/3 Highest	0.028	0.031	0.030	0.050	0.039	0.029	0.052
Ave of 1/10 Highest	0.036	0.040	0.039	0.064	0.050	0.036	0.066
Maximum	0.052	0.058	0.056	0.093	0.073	0.053	0.096

```
*****************************************************************************************************
*                                             ***  MOSES  ***                                       *
*                                             ---------------                   10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period          =   6.0  Sec.     M. Heading      =  45.0  Deg.  *
*   S. Coef.         = 200.                                                Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.040	0.034	0.053	0.073	0.083	0.036	0.075
Ave of 1/3 Highest	0.080	0.069	0.106	0.147	0.166	0.072	0.150
Ave of 1/10 Highest	0.102	0.088	0.136	0.187	0.211	0.091	0.191
Maximum	0.148	0.128	0.198	0.273	0.308	0.133	0.278

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.030	0.027	0.037	0.054	0.058	0.026	0.055
Ave of 1/3 Highest	0.060	0.054	0.075	0.109	0.115	0.051	0.110
Ave of 1/10 Highest	0.076	0.069	0.095	0.139	0.147	0.065	0.140
Maximum	0.111	0.100	0.139	0.202	0.214	0.095	0.205

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.023	0.022	0.027	0.042	0.041	0.019	0.042
Ave of 1/3 Highest	0.046	0.043	0.055	0.083	0.082	0.038	0.083
Ave of 1/10 Highest	0.059	0.055	0.070	0.106	0.105	0.049	0.106
Maximum	0.085	0.081	0.102	0.155	0.152	0.071	0.155

```
*********************************************************************************************************
*                                              ***  MOSES  ***                                         *
*                                              ----------------                      10 June, 2008     *
*                                                                                                       *
*                                                                                                       *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   7.0  Sec.     M. Heading      =  45.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                       *
*********************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.052	0.041	0.090	0.106	0.137	0.059	0.112
Ave of 1/3 Highest	0.104	0.081	0.180	0.211	0.274	0.118	0.223
Ave of 1/10 Highest	0.133	0.103	0.229	0.269	0.349	0.150	0.285
Maximum	0.194	0.151	0.335	0.393	0.510	0.219	0.415

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.037	0.029	0.057	0.070	0.090	0.038	0.074
Ave of 1/3 Highest	0.073	0.057	0.115	0.139	0.179	0.077	0.148
Ave of 1/10 Highest	0.093	0.073	0.146	0.177	0.229	0.098	0.188
Maximum	0.136	0.107	0.213	0.259	0.333	0.143	0.275

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.026	0.021	0.038	0.048	0.060	0.026	0.051
Ave of 1/3 Highest	0.053	0.042	0.075	0.095	0.120	0.052	0.101
Ave of 1/10 Highest	0.067	0.054	0.096	0.122	0.153	0.066	0.129
Maximum	0.098	0.079	0.140	0.177	0.223	0.097	0.188

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ---------------                  10 June, 2008            *
*                                                                                                  *
*                                                                                                  *
*   Draft             =   7.0 Meters     Trim Angle       =   0.00 Deg.    GMT              =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height   =  1.00 Meters     Period           =   8.0  Sec.    M. Heading       =  45.0  Deg.  *
*   S. Coef.          = 200.                                               Gamma            =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.051	0.045	0.125	0.140	0.168	0.076	0.143
Ave of 1/3 Highest	0.103	0.091	0.251	0.280	0.337	0.151	0.286
Ave of 1/10 Highest	0.131	0.116	0.320	0.357	0.429	0.193	0.365
Maximum	0.191	0.169	0.467	0.521	0.626	0.282	0.532

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.034	0.030	0.073	0.084	0.103	0.045	0.086
Ave of 1/3 Highest	0.068	0.059	0.147	0.168	0.205	0.091	0.172
Ave of 1/10 Highest	0.087	0.075	0.187	0.214	0.262	0.116	0.220
Maximum	0.127	0.110	0.273	0.313	0.382	0.169	0.321

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.023	0.020	0.044	0.053	0.064	0.028	0.054
Ave of 1/3 Highest	0.047	0.040	0.089	0.105	0.129	0.057	0.108
Ave of 1/10 Highest	0.060	0.052	0.113	0.134	0.164	0.072	0.138
Maximum	0.087	0.075	0.165	0.196	0.239	0.105	0.201

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                           *
*                                          ----------------                    10 June, 2008         *
*                                                                                                    *
*                                                                                                    *
*   Draft            =   7.0 Meters      Trim Angle       =  0.00 Deg.      GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   9.0  Sec.     M. Heading       =  45.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma            =   2.0        *
*                                                                                                    *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.047	0.047	0.152	0.159	0.178	0.085	0.165
Ave of 1/3 Highest	0.094	0.093	0.304	0.318	0.356	0.171	0.331
Ave of 1/10 Highest	0.119	0.119	0.387	0.406	0.454	0.218	0.422
Maximum	0.174	0.173	0.565	0.592	0.663	0.318	0.616

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.030	0.028	0.082	0.089	0.102	0.048	0.091
Ave of 1/3 Highest	0.059	0.055	0.163	0.178	0.204	0.095	0.182
Ave of 1/10 Highest	0.076	0.071	0.208	0.227	0.260	0.122	0.233
Maximum	0.110	0.103	0.304	0.332	0.379	0.177	0.339

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.020	0.018	0.046	0.052	0.061	0.028	0.053
Ave of 1/3 Highest	0.040	0.036	0.092	0.104	0.121	0.056	0.106
Ave of 1/10 Highest	0.051	0.046	0.117	0.133	0.154	0.071	0.135
Maximum	0.074	0.067	0.171	0.194	0.225	0.103	0.198

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ---------------                    10 June, 2008         *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  10.0  Sec.     M. Heading      =  45.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.048	0.051	0.172	0.163	0.177	0.090	0.185
Ave of 1/3 Highest	0.096	0.103	0.343	0.327	0.354	0.179	0.371
Ave of 1/10 Highest	0.122	0.131	0.437	0.417	0.451	0.229	0.473
Maximum	0.178	0.191	0.638	0.608	0.658	0.333	0.689

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.027	0.027	0.086	0.086	0.096	0.047	0.094
Ave of 1/3 Highest	0.055	0.054	0.171	0.173	0.192	0.094	0.188
Ave of 1/10 Highest	0.070	0.069	0.218	0.220	0.245	0.120	0.239
Maximum	0.102	0.101	0.318	0.321	0.357	0.175	0.349

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.016	0.045	0.048	0.055	0.026	0.051
Ave of 1/3 Highest	0.035	0.033	0.090	0.096	0.110	0.052	0.102
Ave of 1/10 Highest	0.045	0.041	0.115	0.123	0.140	0.066	0.130
Maximum	0.065	0.060	0.167	0.179	0.204	0.097	0.189

```
****************************************************************************************************
*                                          ***  MOSES  ***                                         *
*                                          ---------------                   10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*  Draft           =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*  Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*  JONSWAP  Height  =  1.00 Meters     Period           =  11.0  Sec.     M. Heading      =  45.0  Deg.  *
*  S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.055	0.060	0.187	0.160	0.170	0.090	0.204
Ave of 1/3 Highest	0.111	0.120	0.374	0.321	0.340	0.180	0.408
Ave of 1/10 Highest	0.141	0.153	0.477	0.409	0.434	0.230	0.520
Maximum	0.206	0.224	0.696	0.597	0.633	0.335	0.759

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.028	0.028	0.087	0.081	0.089	0.045	0.096
Ave of 1/3 Highest	0.055	0.057	0.174	0.162	0.177	0.089	0.191
Ave of 1/10 Highest	0.070	0.072	0.222	0.206	0.226	0.114	0.244
Maximum	0.103	0.105	0.324	0.301	0.329	0.166	0.355

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.016	0.015	0.043	0.043	0.049	0.024	0.048
Ave of 1/3 Highest	0.032	0.031	0.086	0.087	0.098	0.047	0.097
Ave of 1/10 Highest	0.041	0.039	0.110	0.111	0.125	0.060	0.124
Maximum	0.060	0.057	0.160	0.162	0.182	0.088	0.180

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ---------------                         10 June, 2008     *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters     Trim Angle      =   0.00 Deg.    GMT            =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters  Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period          =  12.0  Sec.    M. Heading      =  45.0  Deg.  *
*   S. Coef.         = 200.                                              Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.066	0.070	0.199	0.154	0.161	0.088	0.221
Ave of 1/3 Highest	0.131	0.141	0.398	0.308	0.323	0.176	0.442
Ave of 1/10 Highest	0.167	0.179	0.508	0.393	0.412	0.225	0.564
Maximum	0.244	0.262	0.741	0.573	0.600	0.328	0.823

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.029	0.030	0.087	0.075	0.081	0.042	0.096
Ave of 1/3 Highest	0.058	0.060	0.174	0.149	0.162	0.084	0.192
Ave of 1/10 Highest	0.073	0.076	0.221	0.190	0.206	0.107	0.245
Maximum	0.107	0.111	0.323	0.278	0.301	0.156	0.358

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.015	0.015	0.041	0.039	0.044	0.021	0.046
Ave of 1/3 Highest	0.030	0.029	0.081	0.078	0.088	0.043	0.092
Ave of 1/10 Highest	0.039	0.038	0.104	0.100	0.112	0.055	0.117
Maximum	0.056	0.055	0.152	0.145	0.163	0.080	0.171

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ----------------                    10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT            =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  13.0  Sec.     M. Heading     =  45.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma          =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.076	0.081	0.209	0.146	0.152	0.085	0.236
Ave of 1/3 Highest	0.152	0.161	0.417	0.292	0.304	0.170	0.473
Ave of 1/10 Highest	0.194	0.205	0.532	0.373	0.387	0.216	0.603
Maximum	0.283	0.300	0.777	0.544	0.565	0.316	0.879

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.030	0.031	0.086	0.068	0.074	0.039	0.096
Ave of 1/3 Highest	0.060	0.063	0.171	0.137	0.147	0.077	0.192
Ave of 1/10 Highest	0.077	0.080	0.218	0.174	0.188	0.099	0.245
Maximum	0.113	0.117	0.318	0.254	0.274	0.144	0.357

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.014	0.038	0.035	0.039	0.019	0.043
Ave of 1/3 Highest	0.029	0.028	0.077	0.070	0.078	0.039	0.087
Ave of 1/10 Highest	0.037	0.036	0.098	0.089	0.100	0.049	0.110
Maximum	0.053	0.053	0.142	0.130	0.145	0.072	0.161

```
*******************************************************************************************************
*                                          ***  MOSES  ***                                            *
*                                          ---------------                      10 June, 2008         *
*                                                                                                     *
*                                                                                                     *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.   GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters  Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period           =  14.0  Sec.   M. Heading      =  45.0  Deg.  *
*   S. Coef.         = 200.                                              Gamma           =   2.0        *
*                                                                                                     *
*******************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.086	0.090	0.216	0.138	0.142	0.081	0.249
Ave of 1/3 Highest	0.172	0.180	0.432	0.276	0.284	0.162	0.499
Ave of 1/10 Highest	0.220	0.229	0.551	0.351	0.362	0.206	0.636
Maximum	0.320	0.335	0.804	0.513	0.529	0.301	0.928

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.031	0.033	0.084	0.063	0.067	0.036	0.095
Ave of 1/3 Highest	0.063	0.065	0.167	0.125	0.134	0.071	0.190
Ave of 1/10 Highest	0.080	0.083	0.213	0.160	0.171	0.091	0.243
Maximum	0.117	0.121	0.311	0.233	0.249	0.133	0.354

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.014	0.036	0.031	0.035	0.017	0.041
Ave of 1/3 Highest	0.027	0.027	0.072	0.063	0.070	0.035	0.081
Ave of 1/10 Highest	0.035	0.035	0.091	0.080	0.089	0.044	0.104
Maximum	0.051	0.051	0.133	0.117	0.130	0.065	0.151

```
***************************************************************************************************************
*                                              ***  MOSES  ***                                                *
*                                              ----------------                      10 June, 2008            *
*                                                                                                             *
*                                                                                                             *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   4.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                             *
***************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.001	0.058	0.025	0.067	0.003	0.005	0.063
Ave of 1/3 Highest	0.002	0.116	0.051	0.134	0.007	0.011	0.127
Ave of 1/10 Highest	0.002	0.148	0.064	0.170	0.009	0.014	0.162
Maximum	0.003	0.216	0.094	0.249	0.013	0.020	0.236

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.001	0.062	0.025	0.064	0.003	0.006	0.067
Ave of 1/3 Highest	0.002	0.124	0.049	0.129	0.006	0.011	0.133
Ave of 1/10 Highest	0.002	0.158	0.063	0.164	0.008	0.015	0.170
Maximum	0.003	0.230	0.092	0.239	0.012	0.021	0.248

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.001	0.069	0.025	0.064	0.003	0.006	0.074
Ave of 1/3 Highest	0.002	0.139	0.050	0.129	0.006	0.013	0.148
Ave of 1/10 Highest	0.003	0.177	0.064	0.164	0.008	0.016	0.188
Maximum	0.004	0.258	0.094	0.240	0.012	0.023	0.275

```
*****************************************************************************************************
*                                               ***  MOSES  ***                                     *
*                                               ----------------                    10 June, 2008   *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   5.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.131	0.079	0.224	0.011	0.010	0.153
Ave of 1/3 Highest	0.005	0.262	0.158	0.448	0.021	0.019	0.306
Ave of 1/10 Highest	0.006	0.334	0.202	0.572	0.027	0.025	0.391
Maximum	0.009	0.488	0.294	0.834	0.039	0.036	0.570

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.115	0.065	0.182	0.009	0.009	0.132
Ave of 1/3 Highest	0.004	0.229	0.130	0.364	0.017	0.018	0.264
Ave of 1/10 Highest	0.005	0.293	0.165	0.464	0.022	0.023	0.336
Maximum	0.008	0.427	0.241	0.676	0.033	0.034	0.490

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.105	0.055	0.152	0.007	0.009	0.118
Ave of 1/3 Highest	0.004	0.210	0.110	0.304	0.015	0.018	0.237
Ave of 1/10 Highest	0.005	0.267	0.140	0.388	0.019	0.022	0.302
Maximum	0.007	0.390	0.205	0.566	0.028	0.033	0.440

```
*****************************************************************************************************************
*                                              ***  MOSES  ***                                                  *
*                                              ----------------                          10 June, 2008         *
*                                                                                                               *
*                                                                                                               *
*   Draft             =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height   =  1.00 Meters       Period           =   6.0  Sec.     M. Heading       =  90.0  Deg.  *
*   S. Coef.          = 200.                                                  Gamma            =   2.0         *
*                                                                                                               *
*****************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.004	0.210	0.155	0.440	0.020	0.012	0.261
Ave of 1/3 Highest	0.009	0.420	0.309	0.880	0.040	0.025	0.522
Ave of 1/10 Highest	0.011	0.536	0.395	1.123	0.051	0.031	0.665
Maximum	0.016	0.781	0.576	1.638	0.074	0.046	0.971

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.166	0.115	0.328	0.015	0.010	0.202
Ave of 1/3 Highest	0.007	0.331	0.230	0.656	0.030	0.020	0.403
Ave of 1/10 Highest	0.009	0.422	0.293	0.836	0.038	0.026	0.514
Maximum	0.013	0.616	0.427	1.220	0.056	0.038	0.750

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.135	0.088	0.250	0.012	0.009	0.161
Ave of 1/3 Highest	0.005	0.269	0.175	0.500	0.023	0.018	0.321
Ave of 1/10 Highest	0.007	0.343	0.223	0.637	0.029	0.022	0.410
Maximum	0.010	0.501	0.326	0.930	0.043	0.033	0.597

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ----------------                      10 June, 2008       *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   7.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.005	0.239	0.217	0.596	0.027	0.014	0.323
Ave of 1/3 Highest	0.010	0.477	0.434	1.192	0.054	0.028	0.645
Ave of 1/10 Highest	0.013	0.609	0.553	1.520	0.068	0.036	0.823
Maximum	0.019	0.888	0.807	2.218	0.100	0.052	1.200

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.004	0.176	0.148	0.415	0.019	0.010	0.230
Ave of 1/3 Highest	0.008	0.352	0.296	0.829	0.037	0.021	0.460
Ave of 1/10 Highest	0.010	0.449	0.378	1.057	0.047	0.026	0.587
Maximum	0.014	0.655	0.551	1.542	0.069	0.039	0.856

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.134	0.104	0.295	0.013	0.008	0.170
Ave of 1/3 Highest	0.006	0.268	0.208	0.589	0.027	0.016	0.339
Ave of 1/10 Highest	0.007	0.341	0.265	0.751	0.034	0.021	0.432
Maximum	0.010	0.498	0.387	1.096	0.049	0.030	0.631

```
*************************************************************************************************
*                                     ***  MOSES  ***                                           *
*                                     ---------------                   10 June, 2008           *
*                                                                                               *
*                                                                                               *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period           =   8.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                                Gamma           =   2.0        *
*                                                                                               *
*************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.005	0.207	0.244	0.606	0.028	0.015	0.320
Ave of 1/3 Highest	0.010	0.414	0.488	1.212	0.056	0.030	0.640
Ave of 1/10 Highest	0.012	0.528	0.622	1.545	0.071	0.038	0.816
Maximum	0.018	0.770	0.908	2.254	0.104	0.055	1.190

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.149	0.154	0.398	0.018	0.010	0.214
Ave of 1/3 Highest	0.007	0.297	0.308	0.796	0.036	0.020	0.428
Ave of 1/10 Highest	0.008	0.379	0.393	1.015	0.046	0.025	0.546
Maximum	0.012	0.553	0.573	1.481	0.068	0.037	0.796

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.111	0.101	0.269	0.012	0.007	0.150
Ave of 1/3 Highest	0.005	0.221	0.202	0.539	0.025	0.015	0.300
Ave of 1/10 Highest	0.006	0.282	0.257	0.687	0.031	0.019	0.382
Maximum	0.009	0.412	0.375	1.002	0.046	0.027	0.557

```
*****************************************************************************************************
*                                         ***  MOSES  ***                                           *
*                                         ----------------                     10 June, 2008        *
*                                                                                                   *
*                                                                                                   *
*   Draft             =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height   =  1.00 Meters      Period           =   9.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.          = 200.                                                 Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.005	0.174	0.253	0.557	0.026	0.015	0.307
Ave of 1/3 Highest	0.010	0.347	0.507	1.114	0.053	0.030	0.614
Ave of 1/10 Highest	0.012	0.443	0.646	1.420	0.067	0.038	0.783
Maximum	0.018	0.646	0.943	2.072	0.098	0.056	1.143

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.124	0.149	0.352	0.016	0.009	0.194
Ave of 1/3 Highest	0.006	0.248	0.298	0.704	0.033	0.019	0.387
Ave of 1/10 Highest	0.008	0.316	0.379	0.897	0.042	0.024	0.494
Maximum	0.011	0.461	0.554	1.309	0.061	0.035	0.720

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.092	0.092	0.232	0.011	0.006	0.130
Ave of 1/3 Highest	0.004	0.184	0.185	0.464	0.021	0.013	0.261
Ave of 1/10 Highest	0.005	0.235	0.235	0.591	0.027	0.016	0.332
Maximum	0.008	0.343	0.343	0.863	0.040	0.024	0.485

```
*****************************************************************************************************
*                                             ***  MOSES  ***                                       *
*                                             ----------------                   10 June, 2008      *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  10.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                                  Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.006	0.155	0.257	0.504	0.024	0.015	0.300
Ave of 1/3 Highest	0.011	0.309	0.513	1.008	0.049	0.029	0.599
Ave of 1/10 Highest	0.014	0.394	0.654	1.285	0.062	0.037	0.764
Maximum	0.021	0.575	0.955	1.875	0.091	0.055	1.115

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.107	0.141	0.310	0.015	0.009	0.177
Ave of 1/3 Highest	0.006	0.214	0.282	0.619	0.029	0.017	0.354
Ave of 1/10 Highest	0.008	0.273	0.360	0.790	0.037	0.022	0.452
Maximum	0.011	0.399	0.525	1.152	0.054	0.032	0.659

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.079	0.083	0.201	0.009	0.006	0.115
Ave of 1/3 Highest	0.004	0.157	0.167	0.402	0.019	0.011	0.229
Ave of 1/10 Highest	0.005	0.201	0.213	0.512	0.024	0.014	0.293
Maximum	0.007	0.293	0.310	0.747	0.035	0.021	0.427

```
****************************************************************************************************
*                                         ***  MOSES  ***                                          *
*                                         ---------------                   10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT            =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  11.0  Sec.     M. Heading     =  90.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma          =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.006	0.146	0.257	0.455	0.022	0.014	0.296
Ave of 1/3 Highest	0.013	0.292	0.515	0.909	0.045	0.028	0.592
Ave of 1/10 Highest	0.016	0.372	0.656	1.159	0.057	0.036	0.754
Maximum	0.024	0.543	0.957	1.691	0.083	0.053	1.101

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.095	0.133	0.273	0.013	0.008	0.163
Ave of 1/3 Highest	0.006	0.190	0.266	0.546	0.026	0.016	0.327
Ave of 1/10 Highest	0.008	0.242	0.339	0.696	0.033	0.020	0.416
Maximum	0.012	0.353	0.494	1.015	0.048	0.029	0.607

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.068	0.075	0.175	0.008	0.005	0.101
Ave of 1/3 Highest	0.003	0.136	0.150	0.349	0.016	0.010	0.203
Ave of 1/10 Highest	0.004	0.174	0.192	0.445	0.021	0.013	0.259
Maximum	0.007	0.253	0.279	0.650	0.030	0.018	0.377

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                   10 June, 2008         *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters       Period           =  12.0  Sec.     M. Heading       =  90.0  Deg.  *
*   S. Coef.         = 200.                                                  Gamma            =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.007	0.144	0.257	0.410	0.021	0.013	0.295
Ave of 1/3 Highest	0.015	0.288	0.514	0.820	0.041	0.027	0.590
Ave of 1/10 Highest	0.019	0.368	0.655	1.045	0.052	0.034	0.752
Maximum	0.027	0.536	0.956	1.525	0.076	0.050	1.097

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.086	0.125	0.241	0.012	0.007	0.151
Ave of 1/3 Highest	0.006	0.172	0.249	0.482	0.023	0.014	0.303
Ave of 1/10 Highest	0.008	0.219	0.318	0.614	0.030	0.018	0.386
Maximum	0.012	0.319	0.464	0.896	0.043	0.026	0.563

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.059	0.068	0.153	0.007	0.004	0.090
Ave of 1/3 Highest	0.003	0.119	0.135	0.305	0.014	0.009	0.180
Ave of 1/10 Highest	0.004	0.151	0.173	0.389	0.018	0.011	0.230
Maximum	0.006	0.221	0.252	0.567	0.027	0.016	0.335

```
****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                   10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  13.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.008	0.147	0.256	0.370	0.019	0.013	0.296
Ave of 1/3 Highest	0.017	0.294	0.513	0.740	0.037	0.025	0.591
Ave of 1/10 Highest	0.021	0.375	0.654	0.943	0.048	0.032	0.754
Maximum	0.031	0.547	0.954	1.376	0.070	0.047	1.100

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.079	0.117	0.213	0.010	0.006	0.141
Ave of 1/3 Highest	0.007	0.158	0.234	0.426	0.021	0.013	0.282
Ave of 1/10 Highest	0.008	0.201	0.299	0.544	0.026	0.016	0.360
Maximum	0.012	0.293	0.436	0.793	0.038	0.024	0.525

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.002	0.052	0.061	0.134	0.006	0.004	0.080
Ave of 1/3 Highest	0.003	0.104	0.122	0.267	0.013	0.008	0.161
Ave of 1/10 Highest	0.004	0.133	0.156	0.341	0.016	0.010	0.205
Maximum	0.006	0.194	0.227	0.497	0.023	0.014	0.299

```
****************************************************************************************************
*                                           ***  MOSES  ***                                        *
*                                           ----------------                 10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  14.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.009	0.152	0.256	0.334	0.017	0.012	0.298
Ave of 1/3 Highest	0.018	0.304	0.511	0.669	0.034	0.024	0.595
Ave of 1/10 Highest	0.023	0.388	0.652	0.853	0.044	0.030	0.759
Maximum	0.034	0.566	0.951	1.244	0.064	0.044	1.107

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.073	0.110	0.189	0.009	0.006	0.132
Ave of 1/3 Highest	0.007	0.147	0.220	0.379	0.018	0.012	0.265
Ave of 1/10 Highest	0.009	0.187	0.281	0.483	0.023	0.015	0.338
Maximum	0.013	0.273	0.410	0.704	0.034	0.022	0.493

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.001	0.046	0.055	0.118	0.006	0.003	0.072
Ave of 1/3 Highest	0.003	0.092	0.110	0.235	0.011	0.007	0.144
Ave of 1/10 Highest	0.004	0.118	0.141	0.300	0.014	0.009	0.184
Maximum	0.005	0.172	0.205	0.438	0.021	0.013	0.268

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                       10 June, 2008     *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  16.0  Sec.     M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.010	0.165	0.254	0.276	0.014	0.010	0.303
Ave of 1/3 Highest	0.021	0.329	0.508	0.552	0.029	0.021	0.606
Ave of 1/10 Highest	0.027	0.420	0.648	0.704	0.037	0.027	0.773
Maximum	0.039	0.613	0.945	1.027	0.054	0.039	1.127

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.066	0.098	0.151	0.007	0.005	0.118
Ave of 1/3 Highest	0.007	0.132	0.196	0.303	0.015	0.010	0.236
Ave of 1/10 Highest	0.009	0.168	0.250	0.386	0.019	0.012	0.301
Maximum	0.013	0.245	0.365	0.563	0.028	0.018	0.439

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.001	0.037	0.046	0.093	0.004	0.003	0.059
Ave of 1/3 Highest	0.003	0.074	0.091	0.186	0.009	0.005	0.118
Ave of 1/10 Highest	0.003	0.095	0.116	0.237	0.011	0.007	0.150
Maximum	0.005	0.138	0.170	0.345	0.016	0.010	0.219

```
*****************************************************************************************************
*                                         ***  MOSES  ***                                           *
*                                         ---------------                      10 June, 2008        *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.    GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period           =  18.0  Sec.    M. Heading       =  90.0  Deg.  *
*   S. Coef.         = 200.                                               Gamma            =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.011	0.177	0.253	0.231	0.012	0.009	0.309
Ave of 1/3 Highest	0.023	0.354	0.506	0.462	0.025	0.018	0.618
Ave of 1/10 Highest	0.029	0.451	0.645	0.589	0.031	0.023	0.788
Maximum	0.043	0.658	0.941	0.859	0.046	0.034	1.149

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.061	0.088	0.123	0.006	0.004	0.107
Ave of 1/3 Highest	0.007	0.121	0.176	0.246	0.012	0.008	0.214
Ave of 1/10 Highest	0.009	0.154	0.224	0.313	0.016	0.010	0.272
Maximum	0.013	0.225	0.327	0.457	0.023	0.015	0.397

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.001	0.031	0.038	0.075	0.004	0.002	0.049
Ave of 1/3 Highest	0.002	0.061	0.076	0.149	0.007	0.004	0.098
Ave of 1/10 Highest	0.003	0.078	0.097	0.190	0.009	0.006	0.125
Maximum	0.004	0.114	0.142	0.277	0.013	0.008	0.182

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                  10 June, 2008          *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.    GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters  Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period          =  20.0  Sec.    M. Heading      =  90.0  Deg.  *
*   S. Coef.         = 200.                                               Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.012	0.188	0.252	0.196	0.011	0.008	0.315
Ave of 1/3 Highest	0.024	0.375	0.504	0.391	0.021	0.016	0.629
Ave of 1/10 Highest	0.031	0.478	0.643	0.499	0.027	0.020	0.802
Maximum	0.046	0.698	0.938	0.728	0.039	0.030	1.170

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.057	0.080	0.101	0.005	0.003	0.098
Ave of 1/3 Highest	0.007	0.113	0.159	0.203	0.010	0.007	0.195
Ave of 1/10 Highest	0.008	0.144	0.203	0.259	0.013	0.009	0.249
Maximum	0.012	0.210	0.296	0.377	0.019	0.013	0.364

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.001	0.026	0.032	0.061	0.003	0.002	0.041
Ave of 1/3 Highest	0.002	0.052	0.065	0.122	0.006	0.004	0.083
Ave of 1/10 Highest	0.003	0.066	0.083	0.156	0.007	0.005	0.106
Maximum	0.004	0.096	0.121	0.227	0.011	0.007	0.154

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ----------------                    10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.    GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period           =  22.0  Sec.    M. Heading       =  90.0  Deg.  *
*   S. Coef.         = 200.                                               Gamma            =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.013	0.196	0.252	0.168	0.009	0.007	0.319
Ave of 1/3 Highest	0.026	0.393	0.503	0.336	0.018	0.014	0.639
Ave of 1/10 Highest	0.033	0.501	0.642	0.428	0.023	0.018	0.815
Maximum	0.048	0.731	0.936	0.624	0.034	0.026	1.188

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.003	0.053	0.073	0.085	0.004	0.003	0.090
Ave of 1/3 Highest	0.006	0.106	0.145	0.170	0.009	0.006	0.180
Ave of 1/10 Highest	0.008	0.136	0.185	0.217	0.011	0.007	0.230
Maximum	0.012	0.198	0.271	0.316	0.016	0.011	0.336

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.001	0.022	0.028	0.051	0.002	0.002	0.036
Ave of 1/3 Highest	0.002	0.044	0.056	0.102	0.005	0.003	0.071
Ave of 1/10 Highest	0.002	0.056	0.071	0.129	0.006	0.004	0.091
Maximum	0.004	0.082	0.104	0.189	0.009	0.006	0.132

```
****************************************************************************************************
*                                             ***  MOSES  ***                                      *
*                                             ---------------                    10 June, 2008     *
*                                                                                                  *
*                                                                                                  *
*   Draft             =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height   =  1.00 Meters      Period           =   4.0  Sec.     M. Heading      = 135.0  Deg.  *
*   S. Coef.          = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.006	0.008	0.003	0.011	0.007	0.008	0.011
Ave of 1/3 Highest	0.012	0.017	0.007	0.022	0.013	0.015	0.022
Ave of 1/10 Highest	0.016	0.021	0.008	0.029	0.017	0.019	0.028
Maximum	0.023	0.031	0.012	0.042	0.025	0.028	0.040

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.006	0.008	0.003	0.011	0.006	0.008	0.011
Ave of 1/3 Highest	0.012	0.017	0.006	0.021	0.012	0.016	0.022
Ave of 1/10 Highest	0.015	0.022	0.008	0.027	0.015	0.020	0.028
Maximum	0.022	0.031	0.012	0.040	0.022	0.030	0.040

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.006	0.009	0.003	0.011	0.006	0.009	0.011
Ave of 1/3 Highest	0.012	0.018	0.006	0.021	0.011	0.018	0.023
Ave of 1/10 Highest	0.016	0.023	0.008	0.027	0.014	0.023	0.029
Maximum	0.023	0.034	0.011	0.040	0.021	0.034	0.043

```
*****************************************************************************************************************
*                                          ***  MOSES  ***                                                      *
*                                          ----------------                            10 June, 2008            *
*                                                                                                               *
*                                                                                                               *
*   Draft             =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters  *
*   Roll Gy. Radius   =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters  *
*   JONSWAP  Height   =  1.00 Meters       Period           =   5.0  Sec.     M. Heading       = 135.0  Deg.   *
*   S. Coef.          = 200.                                                  Gamma            =   2.0         *
*                                                                                                               *
*****************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.020	0.022	0.012	0.036	0.033	0.018	0.032
Ave of 1/3 Highest	0.041	0.044	0.025	0.072	0.067	0.036	0.065
Ave of 1/10 Highest	0.052	0.056	0.032	0.092	0.085	0.046	0.083
Maximum	0.076	0.082	0.046	0.134	0.124	0.067	0.121

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.019	0.010	0.030	0.025	0.016	0.027
Ave of 1/3 Highest	0.033	0.037	0.019	0.059	0.050	0.031	0.053
Ave of 1/10 Highest	0.042	0.047	0.025	0.075	0.064	0.040	0.068
Maximum	0.062	0.069	0.036	0.110	0.094	0.058	0.099

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.016	0.008	0.025	0.020	0.014	0.023
Ave of 1/3 Highest	0.028	0.032	0.016	0.050	0.039	0.029	0.046
Ave of 1/10 Highest	0.036	0.041	0.020	0.063	0.050	0.036	0.058
Maximum	0.052	0.060	0.029	0.092	0.073	0.053	0.085

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ----------------                     10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   6.0  Sec.     M. Heading       = 135.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma            =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.040	0.038	0.032	0.073	0.082	0.036	0.063
Ave of 1/3 Highest	0.079	0.075	0.064	0.146	0.164	0.071	0.127
Ave of 1/10 Highest	0.101	0.096	0.082	0.186	0.209	0.091	0.162
Maximum	0.148	0.140	0.119	0.271	0.305	0.133	0.236

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.030	0.030	0.022	0.054	0.057	0.026	0.047
Ave of 1/3 Highest	0.060	0.059	0.044	0.108	0.114	0.051	0.095
Ave of 1/10 Highest	0.076	0.076	0.056	0.138	0.146	0.065	0.121
Maximum	0.111	0.110	0.081	0.201	0.213	0.095	0.176

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.023	0.024	0.015	0.041	0.041	0.019	0.036
Ave of 1/3 Highest	0.046	0.048	0.031	0.083	0.081	0.038	0.073
Ave of 1/10 Highest	0.058	0.061	0.039	0.105	0.104	0.049	0.093
Maximum	0.085	0.089	0.057	0.154	0.151	0.071	0.136

```
*****************************************************************************************************************
*                                               ***  MOSES  ***                                                 *
*                                               ---------------                          10 June, 2008          *
*                                                                                                               *
*                                                                                                               *
*   Draft            =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters       Period           =   7.0  Sec.     M. Heading       = 135.0  Deg.  *
*   S. Coef.         = 200.                                                  Gamma            =   2.0        *
*                                                                                                               *
*****************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.052	0.040	0.061	0.105	0.136	0.059	0.090
Ave of 1/3 Highest	0.104	0.080	0.123	0.210	0.271	0.117	0.179
Ave of 1/10 Highest	0.133	0.102	0.156	0.268	0.346	0.150	0.229
Maximum	0.193	0.148	0.228	0.391	0.505	0.218	0.334

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.037	0.029	0.037	0.069	0.089	0.038	0.060
Ave of 1/3 Highest	0.073	0.059	0.075	0.138	0.178	0.077	0.120
Ave of 1/10 Highest	0.093	0.075	0.096	0.176	0.226	0.098	0.153
Maximum	0.136	0.110	0.139	0.257	0.330	0.143	0.223

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.026	0.022	0.024	0.047	0.059	0.026	0.042
Ave of 1/3 Highest	0.052	0.045	0.047	0.095	0.119	0.052	0.084
Ave of 1/10 Highest	0.067	0.057	0.060	0.121	0.151	0.066	0.107
Maximum	0.097	0.083	0.088	0.177	0.221	0.096	0.156

```
****************************************************************************************************
*                                       ***  MOSES  ***                                            *
*                                       ---------------                    10 June, 2008           *
*                                                                                                  *
*                                                                                                  *
*  Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*  Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*  JONSWAP  Height  =  1.00 Meters     Period           =   8.0  Sec.     M. Heading      = 135.0  Deg.  *
*  S. Coef.         = 200.                                                Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.051	0.039	0.095	0.139	0.167	0.076	0.114
Ave of 1/3 Highest	0.102	0.077	0.189	0.279	0.333	0.151	0.228
Ave of 1/10 Highest	0.131	0.099	0.241	0.355	0.425	0.193	0.291
Maximum	0.190	0.144	0.352	0.519	0.620	0.281	0.425

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.034	0.026	0.053	0.084	0.102	0.045	0.069
Ave of 1/3 Highest	0.068	0.053	0.107	0.168	0.203	0.091	0.137
Ave of 1/10 Highest	0.087	0.067	0.136	0.214	0.259	0.116	0.175
Maximum	0.127	0.098	0.198	0.312	0.378	0.169	0.255

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.023	0.019	0.031	0.052	0.064	0.028	0.043
Ave of 1/3 Highest	0.047	0.038	0.062	0.105	0.127	0.057	0.087
Ave of 1/10 Highest	0.060	0.049	0.079	0.134	0.162	0.072	0.110
Maximum	0.087	0.071	0.115	0.195	0.237	0.105	0.161

```
****************************************************************************************************************
*                                               ***  MOSES  ***                                                *
*                                               ----------------                     10 June, 2008             *
*                                                                                                              *
*                                                                                                              *
*   Draft            =   7.0 Meters       Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters       Period           =   9.0  Sec.     M. Heading       = 135.0  Deg.  *
*   S. Coef.         = 200.                                                  Gamma            =   2.0        *
*                                                                                                              *
****************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.047	0.041	0.124	0.159	0.176	0.085	0.139
Ave of 1/3 Highest	0.094	0.083	0.248	0.317	0.353	0.171	0.278
Ave of 1/10 Highest	0.119	0.106	0.316	0.404	0.450	0.218	0.354
Maximum	0.174	0.154	0.461	0.590	0.656	0.318	0.517

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.030	0.025	0.065	0.089	0.101	0.048	0.075
Ave of 1/3 Highest	0.059	0.050	0.129	0.178	0.202	0.095	0.151
Ave of 1/10 Highest	0.075	0.064	0.164	0.226	0.257	0.121	0.192
Maximum	0.110	0.094	0.240	0.330	0.375	0.177	0.280

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.020	0.017	0.035	0.052	0.060	0.028	0.044
Ave of 1/3 Highest	0.040	0.034	0.070	0.104	0.120	0.055	0.087
Ave of 1/10 Highest	0.051	0.044	0.089	0.133	0.153	0.071	0.111
Maximum	0.074	0.063	0.129	0.193	0.223	0.103	0.162

```
****************************************************************************************************
*                                        ***  MOSES  ***                                           *
*                                        ---------------                     10 June, 2008         *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.      GMT            =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters     Yaw Gy. Radius =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  10.0  Sec.      M. Heading     = 135.0  Deg.  *
*   S. Coef.         = 200.                                                  Gamma          =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.048	0.048	0.148	0.163	0.175	0.090	0.163
Ave of 1/3 Highest	0.096	0.096	0.297	0.326	0.350	0.179	0.326
Ave of 1/10 Highest	0.122	0.123	0.378	0.416	0.446	0.228	0.416
Maximum	0.178	0.179	0.552	0.606	0.651	0.333	0.607

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.027	0.025	0.072	0.086	0.095	0.047	0.081
Ave of 1/3 Highest	0.055	0.051	0.143	0.172	0.190	0.094	0.162
Ave of 1/10 Highest	0.070	0.065	0.182	0.220	0.242	0.120	0.206
Maximum	0.102	0.095	0.266	0.320	0.354	0.175	0.300

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.016	0.036	0.048	0.054	0.026	0.043
Ave of 1/3 Highest	0.035	0.031	0.072	0.096	0.108	0.052	0.086
Ave of 1/10 Highest	0.045	0.040	0.092	0.122	0.138	0.066	0.110
Maximum	0.065	0.058	0.134	0.178	0.202	0.096	0.160

```
****************************************************************************************************
*                                          ***  MOSES  ***                                         *
*                                          ---------------                     10 June, 2008       *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  11.0  Sec.     M. Heading      = 135.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.055	0.058	0.168	0.160	0.169	0.090	0.186
Ave of 1/3 Highest	0.111	0.116	0.336	0.320	0.337	0.180	0.372
Ave of 1/10 Highest	0.141	0.148	0.428	0.408	0.430	0.229	0.475
Maximum	0.206	0.216	0.625	0.596	0.628	0.335	0.692

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.028	0.027	0.076	0.081	0.088	0.045	0.085
Ave of 1/3 Highest	0.055	0.054	0.151	0.161	0.175	0.089	0.170
Ave of 1/10 Highest	0.070	0.069	0.193	0.206	0.224	0.114	0.216
Maximum	0.103	0.101	0.281	0.300	0.326	0.166	0.316

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.016	0.015	0.036	0.043	0.049	0.024	0.042
Ave of 1/3 Highest	0.032	0.030	0.072	0.087	0.097	0.047	0.084
Ave of 1/10 Highest	0.041	0.038	0.091	0.110	0.124	0.060	0.107
Maximum	0.060	0.055	0.133	0.161	0.181	0.088	0.156

*** MOSES ***

10 June, 2008

Draft	= 7.0 Meters	Trim Angle	= 0.00 Deg.	GMT	= 41.4 Meters
Roll Gy. Radius	= 20.4 Meters	Pitch Gy. Radius	= 48.6 Meters	Yaw Gy. Radius	= 48.6 Meters
JONSWAP Height	= 1.00 Meters	Period	= 12.0 Sec.	M. Heading	= 135.0 Deg.
S. Coef.	= 200.			Gamma	= 2.0

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.066	0.069	0.183	0.154	0.160	0.088	0.207
Ave of 1/3 Highest	0.131	0.138	0.367	0.308	0.320	0.176	0.413
Ave of 1/10 Highest	0.167	0.176	0.468	0.392	0.408	0.225	0.527
Maximum	0.244	0.257	0.682	0.572	0.596	0.328	0.768

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.029	0.029	0.077	0.074	0.080	0.042	0.088
Ave of 1/3 Highest	0.058	0.058	0.155	0.149	0.160	0.084	0.175
Ave of 1/10 Highest	0.073	0.074	0.197	0.190	0.205	0.107	0.223
Maximum	0.107	0.108	0.288	0.277	0.298	0.155	0.326

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.015	0.014	0.035	0.039	0.043	0.021	0.040
Ave of 1/3 Highest	0.030	0.028	0.069	0.078	0.087	0.043	0.081
Ave of 1/10 Highest	0.039	0.036	0.088	0.099	0.111	0.055	0.103
Maximum	0.056	0.053	0.129	0.145	0.161	0.080	0.150

```
***************************************************************************************************************
*                                              ***  MOSES  ***                                                *
*                                              ----------------                      10 June, 2008            *
*                                                                                                             *
*                                                                                                             *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  13.0  Sec.     M. Heading       = 135.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma            =   2.0        *
*                                                                                                             *
***************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.076	0.080	0.195	0.146	0.151	0.085	0.224
Ave of 1/3 Highest	0.152	0.159	0.391	0.292	0.301	0.170	0.449
Ave of 1/10 Highest	0.194	0.203	0.498	0.372	0.384	0.216	0.572
Maximum	0.283	0.296	0.727	0.543	0.561	0.315	0.835

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.030	0.031	0.078	0.068	0.073	0.039	0.089
Ave of 1/3 Highest	0.060	0.061	0.156	0.136	0.146	0.077	0.178
Ave of 1/10 Highest	0.077	0.078	0.198	0.174	0.186	0.099	0.227
Maximum	0.112	0.114	0.289	0.254	0.272	0.144	0.331

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.014	0.033	0.035	0.039	0.019	0.039
Ave of 1/3 Highest	0.029	0.027	0.066	0.070	0.077	0.039	0.077
Ave of 1/10 Highest	0.037	0.035	0.085	0.089	0.099	0.049	0.099
Maximum	0.053	0.051	0.123	0.130	0.144	0.072	0.144

```
*****************************************************************************************************
*                                       ***  MOSES  ***                                             *
*                                       ----------------                        10 June, 2008       *
*                                                                                                   *
*                                                                                                   *
*  Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT             =  41.4 Meters *
*  Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  =  48.6 Meters *
*  JONSWAP  Height  =  1.00 Meters      Period          =  14.0  Sec.     M. Heading      = 135.0  Deg.  *
*  S. Coef.         = 200.                                                Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.086	0.089	0.205	0.138	0.141	0.081	0.240
Ave of 1/3 Highest	0.172	0.178	0.410	0.275	0.282	0.162	0.479
Ave of 1/10 Highest	0.220	0.227	0.523	0.351	0.360	0.206	0.611
Maximum	0.320	0.332	0.762	0.512	0.525	0.301	0.891

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.031	0.032	0.077	0.062	0.066	0.036	0.089
Ave of 1/3 Highest	0.063	0.064	0.154	0.125	0.133	0.071	0.179
Ave of 1/10 Highest	0.080	0.082	0.197	0.159	0.169	0.091	0.228
Maximum	0.117	0.119	0.287	0.232	0.247	0.133	0.332

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.013	0.031	0.031	0.035	0.017	0.037
Ave of 1/3 Highest	0.027	0.027	0.063	0.063	0.069	0.035	0.074
Ave of 1/10 Highest	0.035	0.034	0.080	0.080	0.088	0.044	0.094
Maximum	0.051	0.049	0.117	0.117	0.129	0.065	0.137

```
**************************************************************************************************
*                                        ***  MOSES  ***                                         *
*                                        ---------------                     10 June, 2008       *
*                                                                                                *
*                                                                                                *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period           =   4.0  Sec.     M. Heading      = 180.0  Deg.  *
*   S. Coef.         = 200.                                                Gamma           =   2.0        *
*                                                                                                *
**************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.014	0.001	0.002	0.001	0.008	0.001	0.014
Ave of 1/3 Highest	0.027	0.002	0.003	0.002	0.016	0.003	0.028
Ave of 1/10 Highest	0.035	0.003	0.004	0.003	0.020	0.004	0.035
Maximum	0.051	0.004	0.006	0.005	0.030	0.005	0.051

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.015	0.001	0.002	0.001	0.008	0.002	0.015
Ave of 1/3 Highest	0.030	0.002	0.004	0.003	0.016	0.003	0.030
Ave of 1/10 Highest	0.038	0.003	0.005	0.003	0.020	0.004	0.038
Maximum	0.055	0.004	0.007	0.005	0.029	0.006	0.056

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.001	0.002	0.001	0.008	0.002	0.017
Ave of 1/3 Highest	0.034	0.003	0.004	0.003	0.016	0.004	0.034
Ave of 1/10 Highest	0.043	0.003	0.005	0.004	0.020	0.005	0.044
Maximum	0.063	0.005	0.008	0.005	0.029	0.007	0.064

```
****************************************************************************************************
*                                          ***  MOSES  ***                                         *
*                                          ----------------                    10 June, 2008       *
*                                                                                                  *
*                                                                                                  *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   5.0  Sec.     M. Heading      = 180.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                  *
****************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.027	0.002	0.005	0.004	0.025	0.002	0.028
Ave of 1/3 Highest	0.055	0.005	0.010	0.009	0.050	0.005	0.056
Ave of 1/10 Highest	0.070	0.006	0.013	0.011	0.063	0.006	0.071
Maximum	0.102	0.009	0.019	0.016	0.092	0.008	0.104

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.025	0.002	0.004	0.003	0.020	0.002	0.025
Ave of 1/3 Highest	0.049	0.004	0.008	0.007	0.041	0.004	0.050
Ave of 1/10 Highest	0.063	0.005	0.010	0.008	0.052	0.006	0.064
Maximum	0.092	0.008	0.015	0.012	0.076	0.008	0.093

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.023	0.002	0.004	0.003	0.017	0.002	0.024
Ave of 1/3 Highest	0.047	0.004	0.007	0.005	0.035	0.004	0.047
Ave of 1/10 Highest	0.059	0.005	0.009	0.007	0.044	0.006	0.060
Maximum	0.086	0.007	0.013	0.010	0.065	0.008	0.088

```
*****************************************************************************************************
*                                            ***  MOSES  ***                                        *
*                                            ---------------                  10 June, 2008         *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters     Trim Angle       =   0.00 Deg.    GMT            =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters     Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters     Period           =   6.0  Sec.    M. Heading     = 180.0  Deg.  *
*   S. Coef.         = 200.                                               Gamma          =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.042	0.004	0.011	0.009	0.052	0.003	0.044
Ave of 1/3 Highest	0.085	0.008	0.022	0.018	0.105	0.006	0.088
Ave of 1/10 Highest	0.108	0.011	0.029	0.023	0.134	0.008	0.112
Maximum	0.158	0.015	0.042	0.033	0.195	0.012	0.164

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.033	0.003	0.008	0.006	0.038	0.003	0.034
Ave of 1/3 Highest	0.066	0.006	0.016	0.013	0.075	0.005	0.069
Ave of 1/10 Highest	0.085	0.008	0.020	0.017	0.096	0.007	0.087
Maximum	0.124	0.012	0.029	0.024	0.140	0.010	0.128

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.027	0.002	0.006	0.005	0.028	0.002	0.028
Ave of 1/3 Highest	0.055	0.005	0.012	0.010	0.056	0.005	0.056
Ave of 1/10 Highest	0.070	0.006	0.015	0.012	0.072	0.006	0.071
Maximum	0.102	0.009	0.021	0.018	0.105	0.008	0.104

```
*******************************************************************************************************************
*                                          ***  MOSES  ***                                                        *
*                                          ----------------                              10 June, 2008            *
*                                                                                                                 *
*                                                                                                                 *
*   Draft             =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height   =  1.00 Meters      Period           =   7.0  Sec.     M. Heading       = 180.0  Deg.  *
*   S. Coef.          = 200.                                                 Gamma            =   2.0        *
*                                                                                                                 *
*******************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.054	0.006	0.024	0.013	0.086	0.005	0.059
Ave of 1/3 Highest	0.108	0.011	0.048	0.026	0.173	0.009	0.119
Ave of 1/10 Highest	0.138	0.015	0.061	0.034	0.220	0.012	0.152
Maximum	0.202	0.021	0.089	0.049	0.321	0.017	0.221

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.038	0.004	0.014	0.009	0.055	0.003	0.041
Ave of 1/3 Highest	0.076	0.008	0.028	0.018	0.109	0.006	0.081
Ave of 1/10 Highest	0.097	0.010	0.035	0.023	0.139	0.008	0.104
Maximum	0.141	0.015	0.052	0.034	0.203	0.011	0.151

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.028	0.003	0.009	0.007	0.036	0.002	0.029
Ave of 1/3 Highest	0.056	0.006	0.017	0.013	0.072	0.004	0.059
Ave of 1/10 Highest	0.071	0.008	0.022	0.017	0.092	0.006	0.075
Maximum	0.104	0.011	0.032	0.024	0.134	0.008	0.110

```
*****************************************************************************************************
*                                         ***  MOSES  ***                                           *
*                                         ----------------                   10 June, 2008          *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle      =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters   Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period          =   8.0  Sec.     M. Heading      = 180.0  Deg.  *
*   S. Coef.         = 200.                                                Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.061	0.005	0.045	0.011	0.126	0.007	0.076
Ave of 1/3 Highest	0.122	0.010	0.090	0.023	0.251	0.013	0.151
Ave of 1/10 Highest	0.155	0.013	0.114	0.029	0.320	0.017	0.193
Maximum	0.226	0.019	0.167	0.043	0.467	0.025	0.282

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.040	0.003	0.023	0.008	0.072	0.004	0.046
Ave of 1/3 Highest	0.079	0.007	0.046	0.015	0.145	0.008	0.092
Ave of 1/10 Highest	0.101	0.009	0.058	0.020	0.185	0.010	0.117
Maximum	0.147	0.013	0.085	0.029	0.270	0.015	0.170

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.027	0.002	0.012	0.005	0.043	0.002	0.030
Ave of 1/3 Highest	0.054	0.005	0.024	0.011	0.087	0.005	0.059
Ave of 1/10 Highest	0.069	0.006	0.031	0.014	0.111	0.006	0.076
Maximum	0.101	0.009	0.045	0.020	0.161	0.009	0.111

```
*****************************************************************************************************
*                                          ***  MOSES  ***                                          *
*                                          ---------------                    10 June, 2008         *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =   9.0  Sec.     M. Heading      = 180.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.058	0.005	0.074	0.011	0.157	0.008	0.094
Ave of 1/3 Highest	0.117	0.010	0.148	0.022	0.313	0.017	0.189
Ave of 1/10 Highest	0.149	0.013	0.189	0.028	0.400	0.021	0.241
Maximum	0.217	0.018	0.276	0.041	0.583	0.031	0.351

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.036	0.003	0.035	0.007	0.084	0.005	0.051
Ave of 1/3 Highest	0.072	0.006	0.071	0.014	0.168	0.009	0.101
Ave of 1/10 Highest	0.092	0.008	0.090	0.018	0.215	0.012	0.129
Maximum	0.134	0.012	0.132	0.026	0.313	0.017	0.188

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.024	0.002	0.017	0.005	0.047	0.003	0.030
Ave of 1/3 Highest	0.047	0.004	0.035	0.009	0.094	0.005	0.059
Ave of 1/10 Highest	0.060	0.005	0.045	0.012	0.120	0.007	0.075
Maximum	0.088	0.008	0.065	0.017	0.175	0.010	0.110

```
*********************************************************************************************************
*                                        ***  MOSES  ***                                                *
*                                        ----------------                    10 June, 2008              *
*                                                                                                       *
*                                                                                                       *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  10.0  Sec.     M. Heading      = 180.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                       *
*********************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.055	0.005	0.104	0.011	0.172	0.009	0.118
Ave of 1/3 Highest	0.111	0.010	0.208	0.023	0.345	0.019	0.236
Ave of 1/10 Highest	0.141	0.013	0.266	0.029	0.440	0.024	0.301
Maximum	0.206	0.019	0.388	0.042	0.642	0.035	0.439

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.032	0.003	0.047	0.007	0.087	0.005	0.057
Ave of 1/3 Highest	0.064	0.006	0.094	0.013	0.174	0.009	0.113
Ave of 1/10 Highest	0.081	0.008	0.120	0.017	0.222	0.012	0.145
Maximum	0.118	0.011	0.174	0.025	0.324	0.018	0.211

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.020	0.002	0.022	0.004	0.046	0.003	0.030
Ave of 1/3 Highest	0.040	0.004	0.044	0.008	0.092	0.005	0.060
Ave of 1/10 Highest	0.052	0.005	0.055	0.011	0.117	0.006	0.076
Maximum	0.075	0.007	0.081	0.016	0.170	0.009	0.111

```
*****************************************************************************************************************
*                                              ***  MOSES  ***                                                  *
*                                              ----------------                          10 June, 2008          *
*                                                                                                               *
*                                                                                                               *
*   Draft            =   7.0 Meters       Trim Angle       =   0.00 Deg.      GMT              =  41.4 Meters  *
*   Roll Gy. Radius  =  20.4 Meters       Pitch Gy. Radius =  48.6 Meters     Yaw Gy. Radius   =  48.6 Meters  *
*   JONSWAP  Height  =  1.00 Meters       Period           =  11.0  Sec.      M. Heading       = 180.0  Deg.   *
*   S. Coef.         = 200.                                                   Gamma            =   2.0         *
*                                                                                                               *
*****************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.061	0.006	0.130	0.011	0.177	0.010	0.144
Ave of 1/3 Highest	0.122	0.012	0.261	0.023	0.354	0.020	0.288
Ave of 1/10 Highest	0.156	0.015	0.333	0.029	0.451	0.025	0.368
Maximum	0.227	0.022	0.485	0.043	0.658	0.036	0.536

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.031	0.003	0.055	0.006	0.085	0.005	0.063
Ave of 1/3 Highest	0.061	0.006	0.110	0.012	0.169	0.009	0.127
Ave of 1/10 Highest	0.078	0.007	0.141	0.016	0.216	0.012	0.161
Maximum	0.114	0.011	0.205	0.023	0.315	0.017	0.235

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.018	0.002	0.024	0.004	0.043	0.002	0.030
Ave of 1/3 Highest	0.036	0.003	0.048	0.007	0.085	0.005	0.061
Ave of 1/10 Highest	0.046	0.004	0.062	0.010	0.109	0.006	0.077
Maximum	0.068	0.006	0.090	0.014	0.159	0.009	0.113

```
****************************************************************************************************************
*                                              ***  MOSES  ***                                                 *
*                                              ----------------                          10 June, 2008         *
*                                                                                                              *
*                                                                                                              *
*   Draft             =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius   =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height   =  1.00 Meters      Period           =  12.0  Sec.     M. Heading       = 180.0  Deg.  *
*   S. Coef.          = 200.                                                 Gamma            =   2.0        *
*                                                                                                              *
****************************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.074	0.007	0.152	0.011	0.175	0.010	0.169
Ave of 1/3 Highest	0.149	0.013	0.304	0.023	0.350	0.020	0.338
Ave of 1/10 Highest	0.190	0.017	0.387	0.029	0.446	0.025	0.431
Maximum	0.276	0.024	0.565	0.042	0.651	0.036	0.629

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.032	0.003	0.061	0.006	0.080	0.004	0.069
Ave of 1/3 Highest	0.065	0.006	0.121	0.011	0.160	0.009	0.138
Ave of 1/10 Highest	0.083	0.008	0.155	0.015	0.204	0.011	0.175
Maximum	0.121	0.011	0.225	0.021	0.298	0.017	0.256

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.017	0.002	0.025	0.003	0.039	0.002	0.030
Ave of 1/3 Highest	0.034	0.003	0.050	0.007	0.078	0.004	0.061
Ave of 1/10 Highest	0.044	0.004	0.064	0.008	0.100	0.006	0.078
Maximum	0.064	0.006	0.093	0.012	0.145	0.008	0.113

```
*********************************************************************************************************
*                                            ***  MOSES  ***                                            *
*                                            ----------------                       10 June, 2008       *
*                                                                                                       *
*                                                                                                       *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT              =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius   =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  13.0  Sec.     M. Heading       = 180.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma            =   2.0        *
*                                                                                                       *
*********************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.090	0.007	0.169	0.011	0.170	0.010	0.192
Ave of 1/3 Highest	0.180	0.015	0.338	0.022	0.340	0.019	0.383
Ave of 1/10 Highest	0.230	0.019	0.431	0.028	0.433	0.025	0.489
Maximum	0.335	0.027	0.629	0.041	0.632	0.036	0.713

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.035	0.003	0.064	0.005	0.075	0.004	0.073
Ave of 1/3 Highest	0.070	0.006	0.128	0.011	0.150	0.008	0.146
Ave of 1/10 Highest	0.089	0.008	0.163	0.013	0.191	0.011	0.186
Maximum	0.131	0.011	0.237	0.020	0.278	0.016	0.271

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.016	0.001	0.025	0.003	0.035	0.002	0.030
Ave of 1/3 Highest	0.033	0.003	0.050	0.006	0.071	0.004	0.060
Ave of 1/10 Highest	0.042	0.004	0.064	0.008	0.091	0.005	0.077
Maximum	0.061	0.006	0.094	0.011	0.132	0.007	0.112

```
*****************************************************************************************************
*                                         ***  MOSES  ***                                           *
*                                         ---------------                     10 June, 2008         *
*                                                                                                   *
*                                                                                                   *
*   Draft            =   7.0 Meters      Trim Angle       =   0.00 Deg.     GMT             =  41.4 Meters *
*   Roll Gy. Radius  =  20.4 Meters      Pitch Gy. Radius =  48.6 Meters    Yaw Gy. Radius  =  48.6 Meters *
*   JONSWAP  Height  =  1.00 Meters      Period           =  14.0  Sec.     M. Heading      = 180.0  Deg.  *
*   S. Coef.         = 200.                                                 Gamma           =   2.0        *
*                                                                                                   *
*****************************************************************************************************
```

+++ M O T I O N   S T A T I S T I C S +++

Results are in Body System

Of Point On Body BARGE At X = 110.0 Y = 10.0 Z = 30.0

Maximum Responses Based on a Multiplier of 3.720

Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

Single Amplitude Motions

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.106	0.008	0.183	0.010	0.163	0.009	0.211
Ave of 1/3 Highest	0.211	0.016	0.365	0.021	0.326	0.019	0.422
Ave of 1/10 Highest	0.269	0.021	0.466	0.027	0.415	0.024	0.538
Maximum	0.393	0.030	0.679	0.039	0.606	0.035	0.785

Single Amplitude Velocities

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.038	0.003	0.065	0.005	0.069	0.004	0.076
Ave of 1/3 Highest	0.075	0.006	0.131	0.010	0.139	0.008	0.151
Ave of 1/10 Highest	0.096	0.008	0.167	0.012	0.177	0.010	0.193
Maximum	0.140	0.011	0.243	0.018	0.258	0.015	0.281

Single Amplitude Accelerations

	Surge	Sway	Heave	Roll	Pitch	Yaw	Mag
Root Mean Square	0.016	0.001	0.025	0.003	0.032	0.002	0.029
Ave of 1/3 Highest	0.032	0.003	0.049	0.005	0.064	0.004	0.059
Ave of 1/10 Highest	0.041	0.004	0.063	0.007	0.082	0.005	0.075
Maximum	0.060	0.005	0.092	0.010	0.120	0.007	0.110