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MASTER'S THESIS

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Lifting/Installation analysis of spool.
Comparison between brace and spreader solution from a structural, operational and economical point of view

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Preface

This report is the result of the work on my Master's thesis at the University in Stavanger, faculty of science and technology. It is written in collaboration with the subsea service provider Subsea 7.

The report includes a theoretical study, a structural analysis, and discussions around operational and economical issues.

Dr. Daniel Karunakaran, *UiS and Subsea 7*, has been the person with academic responsibility for the thesis, and Kristian Lindtveit, *Subsea 7*, has been my supervisor during this time. Their guidance and support have been a great help for me, and I would like to express my genuine gratitude towards them both.

Additionally I would like to thank Arild Østhus, Per Moi, Pål Ravndal and Joel Ireland for their input on questions regarding various topics.

Stavanger, 15. June 2011

Hallvard Hope

> "Nothing is particularly hard if you divide it into small jobs."
> Henry Ford

Abstract

As large sections of production pipe are lifted and installed, forces act on the structure. If initial analyses of the structural integrity show that the pipe will fail, support elements have to be introduced. The two most used solutions are the spreader beam and the brace bar, which deals with the problem in somewhat different ways.

A pipe section, called a spool, is analyzed using both of the solutions to reveal differences in the structural impact. The result of this is that the spreader beam shows considerably lower utilization of the pipe capacity, mostly due to a significant reduction of bending moments found in the brace bar analysis.

The structure is also exposed to buckling issues in the areas where compression loads occur. The standard method for buckling analysis is to use the Euler theory. This basic method uses only fixed and moment free restraints for the beam members, and might not be sufficient to represent the true conditions for the spool. Therefore, a method based on elastic restraints is used for the buckling analysis in this thesis. It turns out that the method in general gives higher buckling lengths for the spool than if Euler theory is used.

A parametric study of varying buckling lengths shows an interesting behavior of the utilization results provided by the software program Staad.Pro. The study suggests that the program overestimates the capacity of the pipe, if the results are compared to Euler theory.

Operational and economical issues are compared and discussed, highlighting advantages and disadvantages with the two solutions.

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Definitions

Terms

Brace:	Rigid pipe section connected between two points on the spool pipe, used to stiffen it and limit deflections.
Design factor:	Factors to be applied for design of structural elements which includes relevant load factors, consequence factors and local dynamics.
Dynamic amplification factor:	A factor accounting for the global dynamic effects normally experienced during lifting.
Fibre sling:	Slings made of high performance manmade fibres.
Lifting equipment:	Temporary installed equipment such as slings, shackles, and spreader beams, necessary to perform the lift.
Lift points:	The attachment points for slings on the lifted object, normally designed as padeyes or padear/trunnions.
Padeye:	Lift point on a structure consisting of a steel main plate with a matched hole for the shackle pin. The hole may be reinforced by a plate ("cheek plate") on each side.
Rigging arrangement:	The complete system of slings, shackles and spreader beams.
Shackle:	A structural component composed by a bow and a pin linking for example a sling or a wire to a padeye.
Skew load factor:	A factor accounting for the extra loading on slings caused by the effect of inaccurate sling lengths and other uncertainties with respect to force distribution in the rigging arrangement.
Sling:	A strap used between lift point and crane hook during lifting. The term sling is also used for a steel rope with an eye at each end ("wire sling").
Splash zone:	Upper part of the water level, where waves occur and where we find the highest dynamic loads.

Spreader beam:	Lifting equipment which is placed between two or more wire slings to relieve the lifted structure of local horizontal compression forces.
Spool:	A section of fixed pipe that makes up the final connection between the laid pipeline and for example a subsea production tree.
Termination head:	*A part at the end of the spool that enables a safe and easy connection to other equipment.*

Abbreviations and symbols

CoG:	Centre of gravity
DAF:	Dynamic amplification factor
E:	Young's modulus ("Modulus of elasticity")
I	Second moment of inertia
ID:	Inner diameter
k_x	Linear spring stiffness
k_φ	Rotational spring stiffness
MBL:	Minimum breaking load
OD:	Outer diameter
ROV:	Remotely operated vehicle.
SKL:	Skew load factor
SWL:	Safe working load
S7:	Subsea 7
β:	Buckling length factor

1 Introduction

Background

Installation of spools is a major part of the operations done by Subsea 7. A spool is a section of rigid production piping complete with fittings and connection flanges. It is fabricated onshore, and transported to the field on offshore vessels. The spool is then lifted off the vessel with a crane, lowered to the sea floor and connected to other subsea equipment.

If the spool is thin relative to its length, it is not very resistant to external loads. In these cases the spool is fitted with support devices to distribute the loads and prevent buckling. There are essentially two different types of support devices used in the industry today. One is the spreader beam, where the direction of the loads is changed by introducing a beam between two of the lifting wires. The other support device is the brace bar, which is connected directly between two points on the spool. The structural effect on the spool when using one solution versus the other is a matter of interest for Subsea 7.

Another area subject to continuous discussion is the buckling length analyses as the spool hangs in the wires. Normal practice in buckling analyses is to use the Euler theory, which uses fixed and pinned end conditions for the members. This theory is quite basic and perhaps not sufficient enough to represent the true conditions that occur in a spool lift. Using elastically restrained end conditions is presumed to give a better representation, and the effect of using this method needs to be checked.

Purpose

The purpose of this thesis is to:

- Highlight how a spool is affected structurally when using a brace and a spreader solution.
- Investigate how the buckling lengths are affected when pipe members are modeled with elastic restraints instead of fixed or pinned end conditions.
- Discuss which operational issues are important to consider when a brace solution and a spreader solution are compared.
- Discuss factors that affect the cost of installing a spool.

Content

The report starts with an introduction to Euler’s buckling theory and a presentation of the special theory involving buckling with elastic restraints.

Following this is a chapter on structural analysis of the spool with the two solutions. The chapter introduces how the different solutions are modeled and tested in the software program Staad.Pro, along with a part where different buckling analyses are carried out. This makes up the main part of the thesis.

Basic procedures for the structural analysis of spreaders and braces are presented to highlight some differences in the engineering work load. All results from the structural analysis are presented in a chapter of its own where they are commented and discussed.

A chapter on operational considerations are presented and discussed, as well as a chapter on general economical differences between the two solutions.

At the end, a final conclusion is presented, summing up the discussions from the different parts.

Computer programs

Software programs used in the writing of this thesis are:

- Staad.Pro – Used to model spools and perform structural analyses.
- Microsoft Excel – Used for calculations and to fabricate tables and diagrams.
- Microsoft Paint – Used to create sketches and edit figures

2 Special theory

The industry standard when it comes to buckling analysis is to use the Euler theory. This theory is a simple method of achieving fairly well models for the failure modes due to buckling. The downside with this theory is that it only includes fixed and moment free restraints.

It is assumed that beams connected to other beams in some degree have restraints that work as elastic springs. This would instinctively mean that the beams are more exposed to buckling than if they had fixed end restraints. Therefore, buckling theory based on elastic restraints is investigated to see what effect this has on buckling.

Both of the theories are presented in the following chapter.

The main challenge in achieving a correct buckling analysis result is not necessarily the calculations, since these are quite basic mathematics. The difficult part is to "read" the problem correctly, and to *understand* and *assume* the right end conditions of the members. Small differences in these assumptions may lead to very large variations in results and acceptance criteria.

2.1 General buckling theory

Buckling is a stability problem due to compression loads that can cause failure of structural members. Buckling happens when relatively slender members deflect laterally due to a certain compression force. For situations where axial compression forces occur, buckling issues shall always be considered.

The term "Buckling" is often somewhat imprecisely used for two phenomena: Elastic stability and inelastic collapse.

"Euler force", P_E (for a perfect column), is the force that makes the columns equilibrium state *unstable*. "Buckling force", P_b, is the force that leads to *collapse* of a real column with imperfections and eccentricities when considering the materials elastic-plastic properties. The "Critical force", P_{cr}, only makes the column unstable. It does not represent the columns real capacity, and is just a helping value in the capacity calculation.

2.2 Euler's theory of buckling

The chapter on Euler's theory is based on material from (Irgens, 2006):

The most used theory for buckling issues was first presented by Leonhard Euler, and therefore carries his name; "Euler's theory of buckling". The theory is very simple to understand and use, but builds on a couple of assumptions that rarely comply with real conditions:

- The compression load acts through the absolute center of the columns cross sectional area.
- The column is completely straight before the load is applied.
- There are no imperfections in the column.

Additional assumptions are:

- The columns material is elastic and follows Hooke's law.
- The columns displacement is small.

The Euler force, P_E, is defined as:

$$P_E = \frac{\pi^2 EI}{L^2}$$

Where L is the length of a column with *pinned ends*. A pinned connection has no moment restrictions in the buckling plane.

To compensate for different end conditions (either fixed or pinned) the term "buckling length" is introduced. This length is based on the length of the column, with a series of factors introduced for the different end conditions:

The Euler theory presents five different types of centrically loaded columns (here, L_k is the buckling length, and P_k is the critical force):

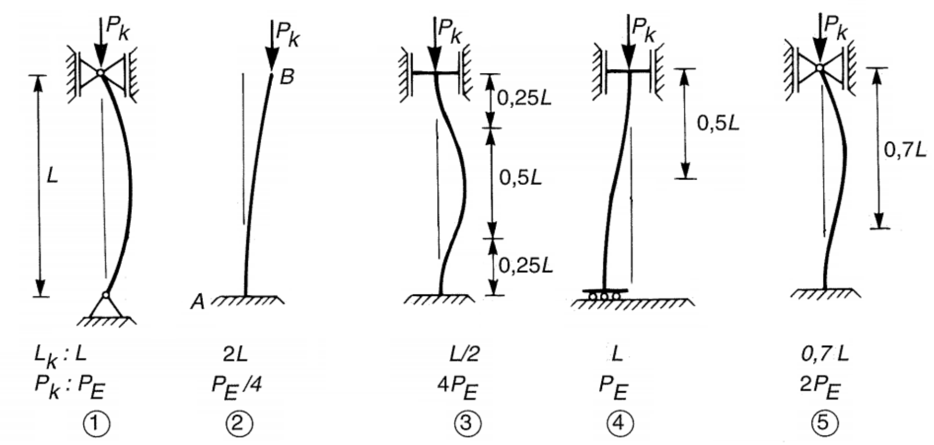


Figure 2.2-1Euler cases from (Irgens, 2006)

Then, we have to assume instability for P = P_{cr}, where P_{cr} is the critical compression force and L_b is the buckling length:

$$P_{cr} = \frac{\pi^2 EI}{{L_b}^2}$$

The capacity can also be expressed as a "Critical compression stress":

$$\sigma_c = \frac{\pi^2 E}{\lambda_c^2}$$

where λ_c is the columns slenderness ratio:

$$\lambda_c = \frac{L_b}{i} = L_b \sqrt{\frac{A}{I}}$$

When the critical compression stress is plotted, we get what is referred to as the "Euler curve":

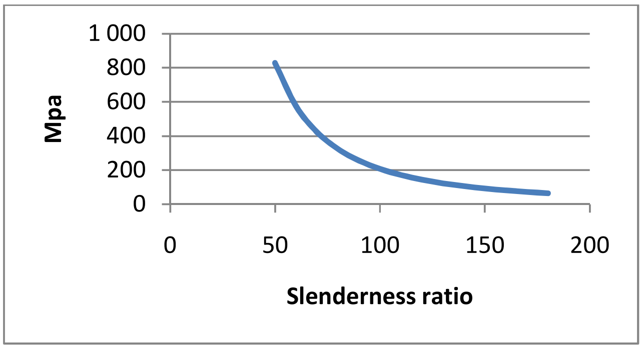


Figure 2.2-2 Euler curve

This curve represents the assumed capacity for the column at different values of slenderness ratio.

For short (non-slender) columns, the critical compression stress is equal to the yield stress of the material, $\sigma_c = \sigma_{yield}$. For steel members, non-slender columns are normally defined as having a slenderness ratio below 100.

2.3 Buckling analysis, using elastic restriction

2.3.1 Correlation with Euler theory

This chapter is mostly based on material from (Larsen, 2010), and highlights the connection between Euler theory and elastic restraint theory:

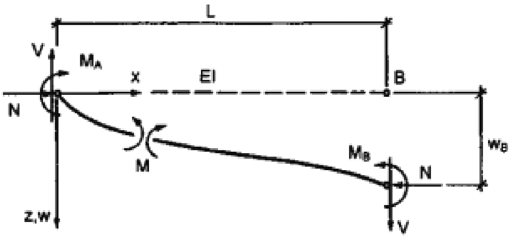


Figure 2.3-1 Beam with arbitrary end loads, from (Larsen, 2010)

The buckling shape of a beam like the one in Figure 2.3-1 is given by the equation

$$w(x) = C_1 \sin kx + C_2 \cos kx - \frac{1}{N}(M_A + V * x), \qquad Eq.1$$

If we look at a beam with one fixed end and one pinned and guided end, it has the following end conditions:

$$w(0) = w(L) = 0, \qquad w''(0) = 0$$

Equilibrium yields:

$$\sum M = 0 \rightarrow M_{\boldsymbol{A}} + V * L = 0 \rightarrow V = \frac{-M_{\boldsymbol{A}}}{L}$$

$$\sum F_{\boldsymbol{Z}} = 0 \rightarrow V_{\boldsymbol{A}} - V_{\boldsymbol{B}} = 0$$

Eq.1 takes the form:

$$w(x) = C_1 \sin kx + C_2 \cos kx - \frac{1}{N}\left(M_A + \frac{-M_A}{L} * x\right)$$

$$w(x) = C_1 \sin kx + C_2 \cos kx - \frac{1}{N}\left(M_A - \frac{M_A * x}{L}\right)$$

$$w(x) = C_1 \sin kx + C_2 \cos kx - \frac{M_A}{N}\left(1 - \frac{x}{L}\right), \qquad Eq.2$$

The inclination is given by the derivative:

$$w(x)' = C_1 k \cos kx - C_2 k \sin kx + \frac{M_A}{N * L}$$

End conditions w(0) = w(0)'= 0 give:

$$C_2 = \frac{M_A}{N}, \qquad C_1 = -\frac{1}{kL}\frac{M_A}{N}$$

Entered into the Eq.2, we get:

$$w(x) = -\frac{1}{kL}\frac{M_A}{N}\sin kx + \frac{M_A}{N}\cos kx - \frac{M_A}{N}\left(1 - \frac{x}{L}\right)$$
$$w(x) = \frac{M_A}{N}\left(-\frac{1}{kL}\sin kx + \cos kx\right) - \frac{M_A}{N}\left(1 - \frac{x}{L}\right)$$

No deflection at x=L; w(L) = 0:

$$w(L) = \frac{M_A}{N}\left(-\frac{1}{kL}\sin kL + \cos kL\right) - \frac{M_A}{N}\left(1 - \frac{L}{L}\right)$$
$$w(L) = \frac{M_A}{N}\left(-\frac{\sin kL}{kL} + \cos kL\right) = 0$$

$\frac{M_A}{N} \neq 0 \rightarrow$

$$\left(-\frac{\sin kL}{kL} + \cos kL\right) = 0$$
$$-\sin kL + kL * \cos kL = 0$$
$$kL * \cos kL = \sin kL$$
$$kL = \frac{\sin kL}{\cos kL}$$

$$kL = \tan kL, \qquad Eq.3$$

This expression can be solved graphically:

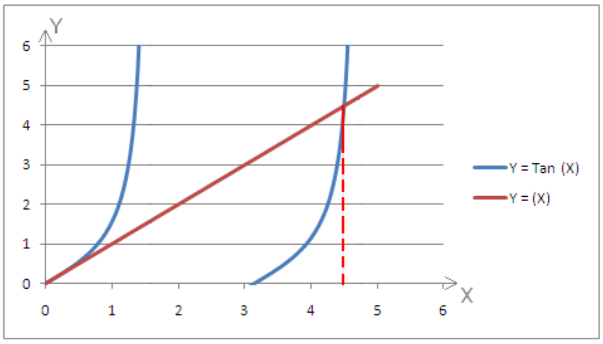


Figure 2.3-2 Tan(x) plotting

From the intersection in the graph we find

$$x = kL = 4{,}493$$

Using this value, we can derive the critical load from the following equation:

$$P_{cr} = \frac{(kL)^2 EI}{L^2} = \frac{(4{,}493)^2 EI}{L^2}$$

The buckling length is defined so that the critical force for a column with arbitrary end conditions is equal to the critical force for a double-sided pinned column with length L.

This means that for the beam in the example, we have

$$P_{cr} = \frac{(4{,}493)^2 EI}{L^2} = \frac{\pi^2 EI}{{L_b}^2}$$

which gives us the buckling length:

$${L_b}^2 = \frac{\pi^2}{(4{,}493)^2} L^2$$

$$\boldsymbol{L_b \approx 0{,}7 * L}$$

This corresponds to case 5 of the Euler columns (Figure 2.2-1).

2.3.2 Elastic restraints

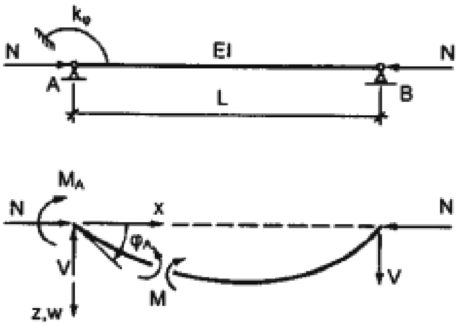


Figure 2.3-3 Elastically restrained column, from (Larsen, 2010)

The figure shows a column with an elastic restraint at end A in the form of a rotational spring with stiffness $\boldsymbol{k_\varphi}$. End B is pinned. In the deformed state, end A has a positive rotation $\boldsymbol{\varphi_A}$ and the spring exerts a moment to the column in the order

$$M_A = -k_\varphi * \varphi_A$$

Moment equilibrium of the column gives

$$V = \frac{k_\varphi}{L} * \varphi_A$$

Eq. 1 then becomes:

$$w(x) = C_1 \sin kx + C_2 \cos kx - \frac{1}{N}\left(\left(-k_\varphi * \varphi_A\right) + \left(\frac{k_\varphi}{L} * \varphi_A * x\right)\right)$$

$$w(x) = C_1 \sin kx + C_2 \cos kx + \frac{1}{N}\left(\left(k_\varphi * \varphi_A\right)\left(1 - \frac{x}{L}\right)\right)$$

$$w(x) = C_1 \sin kx + C_2 \cos kx + \frac{k_\varphi * \varphi_A}{N}\left(1 - \frac{x}{L}\right)$$

And with the columns end conditions as

$w(0) = 0$
→

$$C_2 + \frac{k_\varphi * \varphi_A}{N} = 0$$

$w(L) = 0$
→

$$C_1 \sin kL + C_2 \cos kL = 0$$

Compatibility gives the inclination:

$w_{,x}(0)' = \varphi_A$
→

$$w(x)' = k * C_1 \cos kx - k * C_2 \sin kx - \frac{k_\varphi * \varphi_A}{NL}$$

$$w(0)' = k * C_1 \cancel{\cos kx} \cancel{- k * C_2 \sin kx} - \frac{k_\varphi * \varphi_A}{NL} = \varphi_A$$

$$k * C_1 - \frac{k_\varphi * \varphi_A}{NL} = \varphi_A$$

This gives the constants:

$$C_2 = \frac{1}{k}\left(1 + \frac{k_\varphi}{NL}\right)\varphi_A, \qquad C_2 = -\frac{k_\varphi * \varphi_A}{N}$$

The conditional equation for stability becomes:

$$w(L) = \frac{1}{k}\left(1 + \frac{k_\varphi}{NL}\right)\varphi_A \sin kL \; - \frac{k_\varphi * \varphi_A}{N} \cos kL = 0$$

This can be written in a different form:

$$
\begin{aligned}
&\frac{1}{k}\left(1+\frac{k_\varphi}{NL}\right)\cancel{\varphi_A} = \frac{k_\varphi * \cancel{\varphi_A}}{N * \tan kL} \\
&\frac{1}{k}\left(1+\frac{k_\varphi}{NL}\right) * \frac{kL * N}{k_\varphi} = \frac{k_\varphi}{N * \tan kL} * \frac{kL * N}{k_\varphi} \\
&\frac{1}{\cancel{k}}\left(1+\frac{k_\varphi}{NL}\right) * \frac{\cancel{k}L * N}{k_\varphi} = \frac{\cancel{k_\varphi}}{\cancel{N} * \tan kL} * \frac{kL * \cancel{N}}{\cancel{k_\varphi}} \\
&\left(1+\frac{k_\varphi}{NL}\right) * \frac{NL}{k_\varphi} = \frac{kL}{\tan kL}
\end{aligned}
$$

$$
\begin{aligned}
&\frac{kL}{\tan kL} = 1 + \frac{NL}{k_\varphi} = 1 + \frac{(kL)^2}{\frac{k_\varphi L}{EI}} \\
&\frac{kL}{\tan kL} = 1 + \frac{(kL)^2}{k^*{}_\varphi}\ , \qquad\qquad Eq.4
\end{aligned}
$$

Where the dimensionless rotational stiffness is

$$k^*{}_\varphi = k_\varphi \frac{L}{EI}$$

E, L and I are values for the member experiencing axial compression force.

Notice: In the special case $\boldsymbol{k^*{}_\varphi} = \infty$ (equivalent to a fixed end), Eq.4 gives:

$$
\begin{aligned}
\frac{kL}{\tan kL} &= 1 + \frac{(kL)^2}{k^*{}_\varphi} \\
\frac{kL}{\tan kL} &= 1 + \frac{(kL)^2}{\infty} \\
\frac{kL}{\tan kL} &= 1
\end{aligned}
$$

$$kL = \tan kL$$

This is the same as the result for the example in chapter 2.3.1 (Eq.3)

From Eq.4 we can find and plot the solution for $\boldsymbol{kL}$ as a function of $\boldsymbol{k^*}_{\boldsymbol{\varphi}}$:

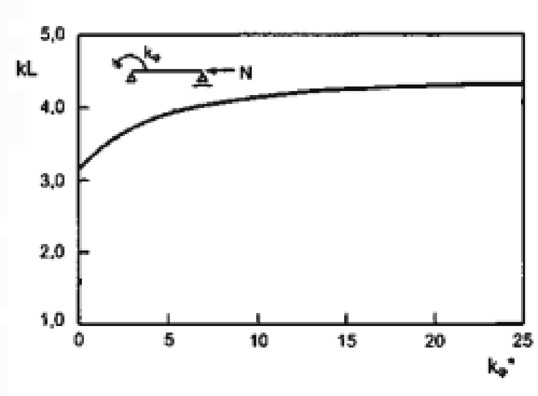


Figure 2.3-4 Buckling parameter *kL*, from (Larsen, 2010)

When introducing the buckling length factor $\beta = \frac{\pi}{kL}$, we can plot the following graph for the column with one elastic and one pinned, guided end:

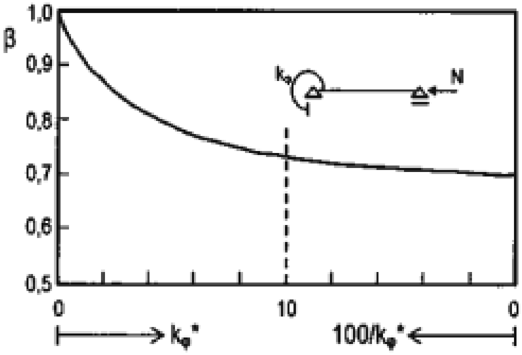


Figure 2.3-5 Buckling factor β, from (Larsen, 2010)

Figure 2.3-5 is used to find the buckling length factor, which is used in the calculation of the buckling length:

$$L_k = \frac{\pi}{kL} L = \beta * L$$

$\boldsymbol{L}$ is here the total length of the column under compression force.

Similarly as for the Euler theory, basic systems for stability of elastically restrained columns are presented for various end conditions:

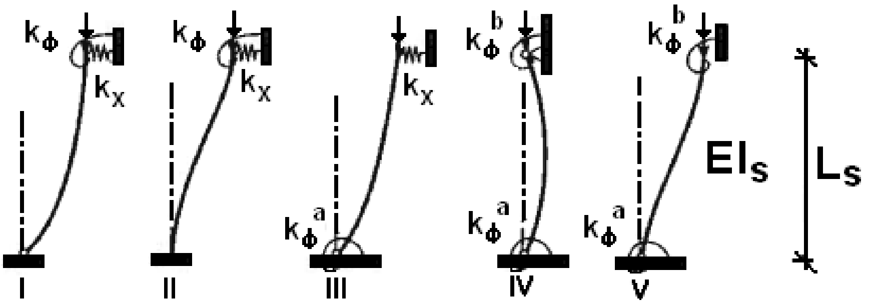
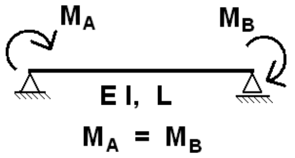
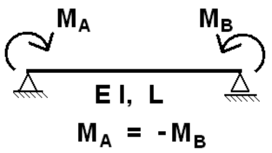
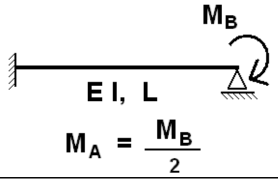


Figure 2.3-6 Systems with elastic restraints, from (Larsen, 2010)

As the columns often are connected to (and supported by) beams, the stiffnesses k_x and k_φ can be determined from the values in Table 2.3-1. The stiffness is given as the relation between the moment and the corresponding rotation, or the force and corresponding deflection in the connection point between column and beam.

Table 2.3-1 Beam stiffness

Element type	Stiffness	Element type	Stiffness
	$\frac{3\,EI}{L}$		$\frac{6\,EI}{L}$
	$\frac{2\,EI}{L}$		$\frac{4\,EI}{L}$

For these different systems with their end conditions, we can find and plot the buckling factor in the same way as in Figure 2.3-5. The figures Figure 2.3-7, Figure 2.3-8, Figure 2.3-9 and Figure 2.3-10 are retrieved from (Larsen, 2010):

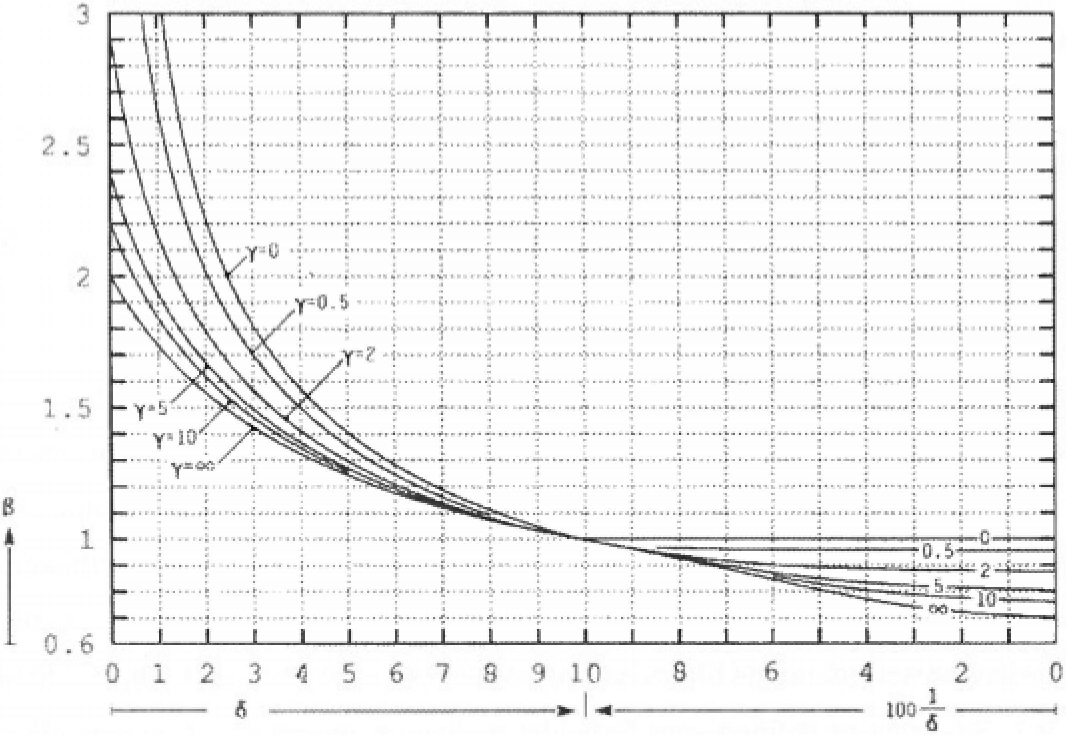


Figure 2.3-7 Buckling factors for system 1 and 3

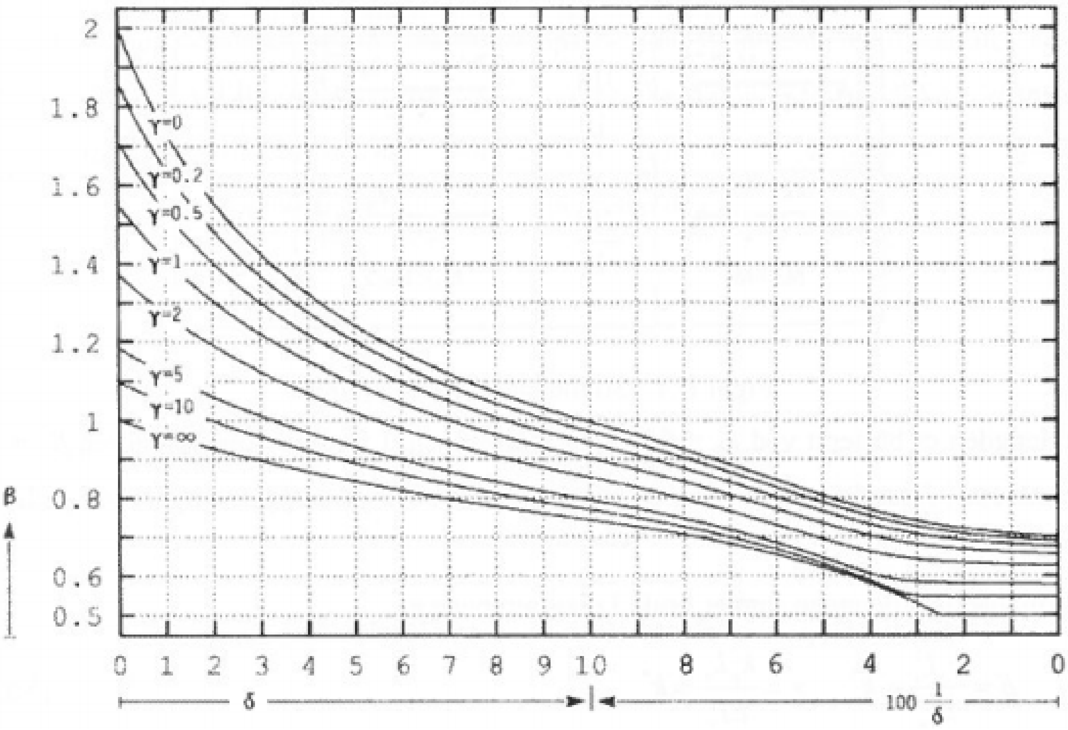


Figure 2.3-8 Buckling factors for system 2

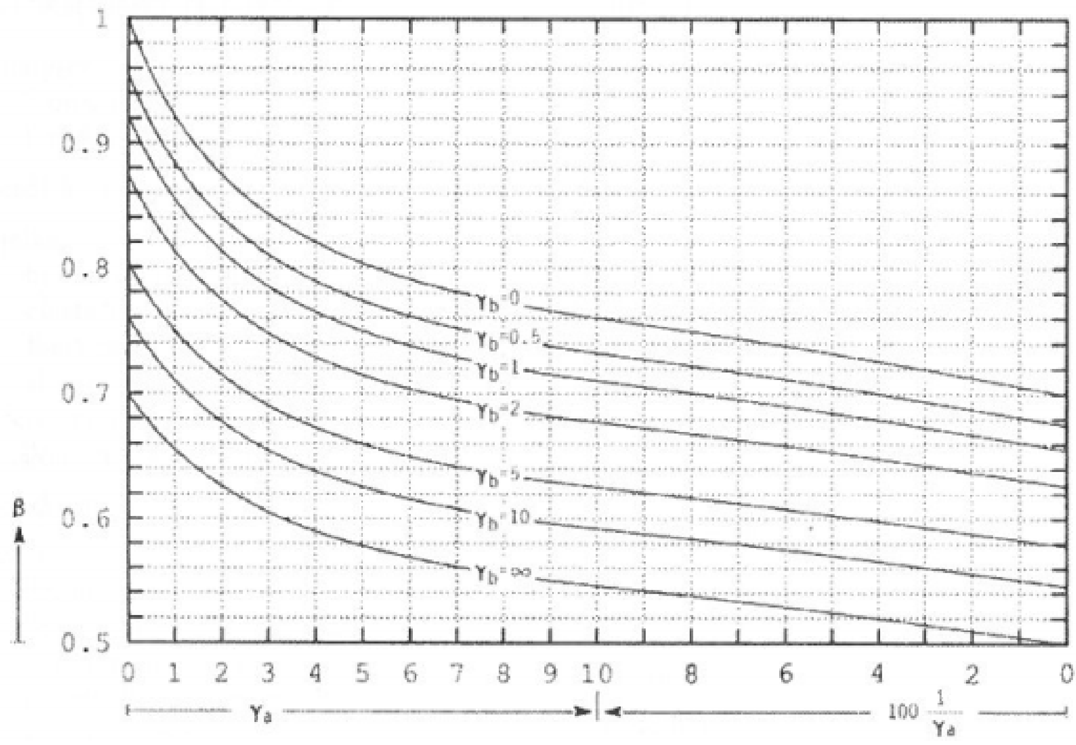


Figure 2.3-9 Buckling factors for system 4

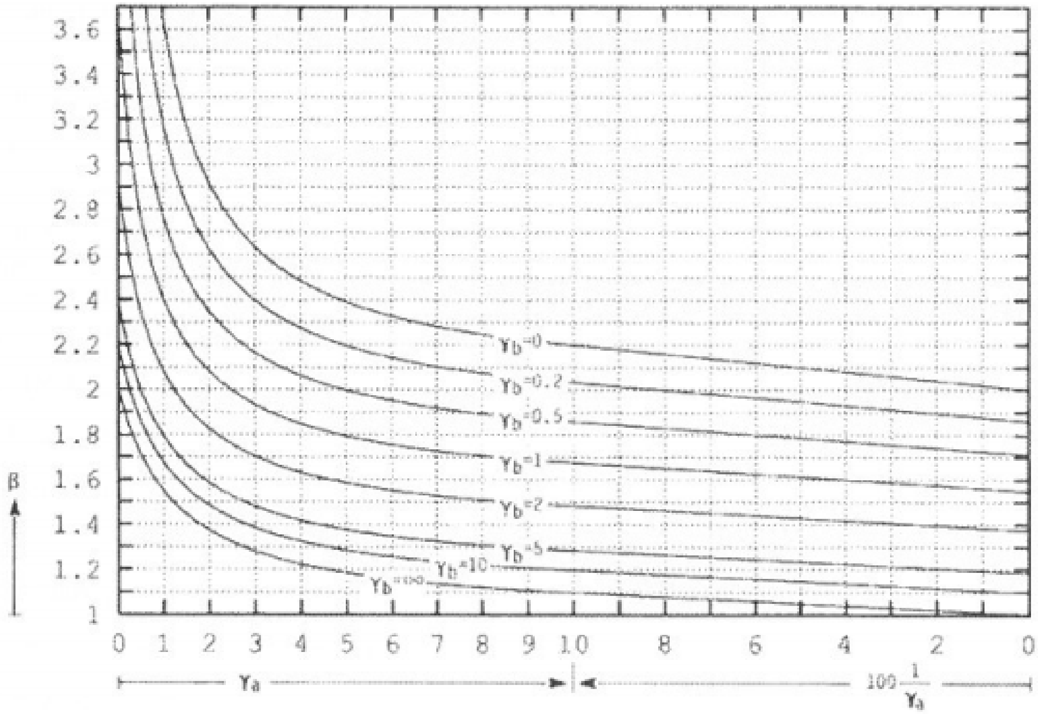


Figure 2.3-10 Buckling factors for system 5

Two examples are presented to show the use of the graphs, and to check the theory of elastic restraints against the Euler theory:

Example 1:

System 2 with elastic restraints as follows

$$k_x = \delta = 0, \qquad k_\varphi = \gamma = 0$$

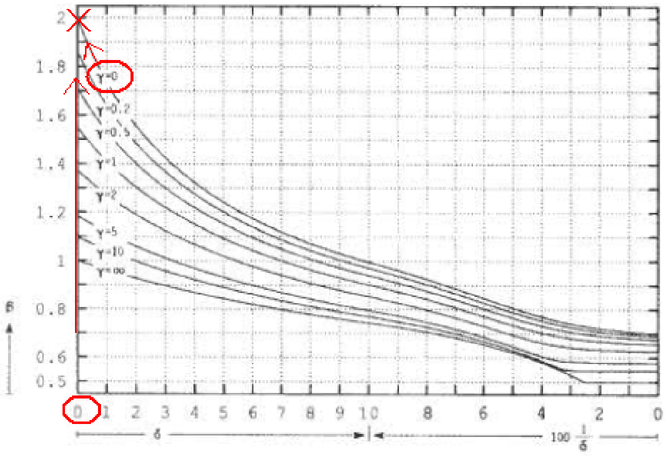
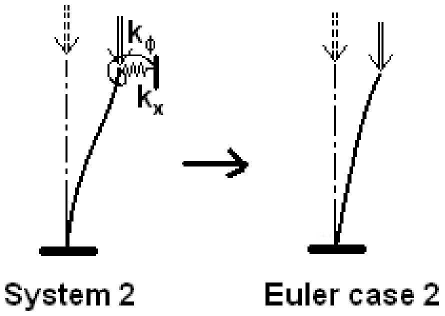


Figure 2.3-11 Buckling factor example, system 2



From the graph we find $\boldsymbol{\beta = 2.0}$, which is the same as case 2 in the Euler theory.

Example 2:

System 4 with elastic restraints as follows

$$k_{\varphi}{}^{a} = \gamma_a = \infty, \qquad k_{\varphi}{}^{b} = \gamma_b = 0$$

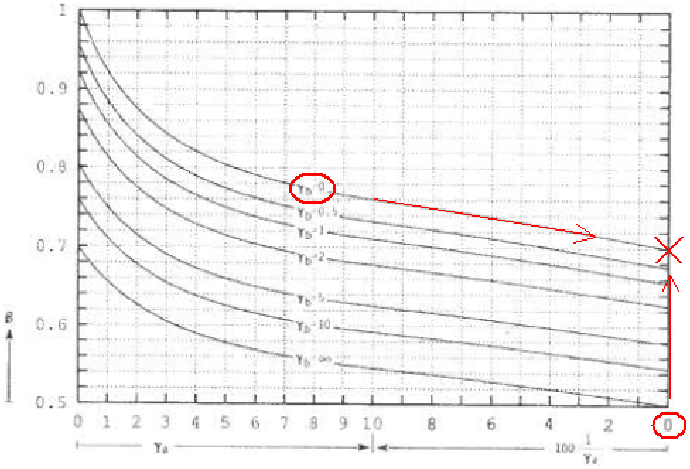
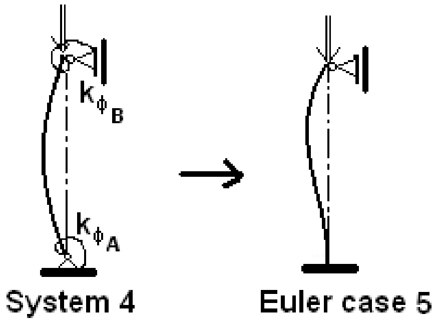


Figure 2.3-12 Buckling factor example, system 4



From the graph we find $\boldsymbol{\beta = 0.7}$, which is the same as case 5 in the Euler theory.

System 3 (from Figure 2.3-6) with linear spring $\boldsymbol{k_x = 0}$ is considered to be the most useful model for the analysis of spools.

In order to make it easier to find the right buckling factor, the values from (Larsen, 2010) are plotted for $\boldsymbol{k_x = 0}$ and varying values of the dimensionless rotational stiffness $\boldsymbol{k^*_\varphi = \gamma}$:

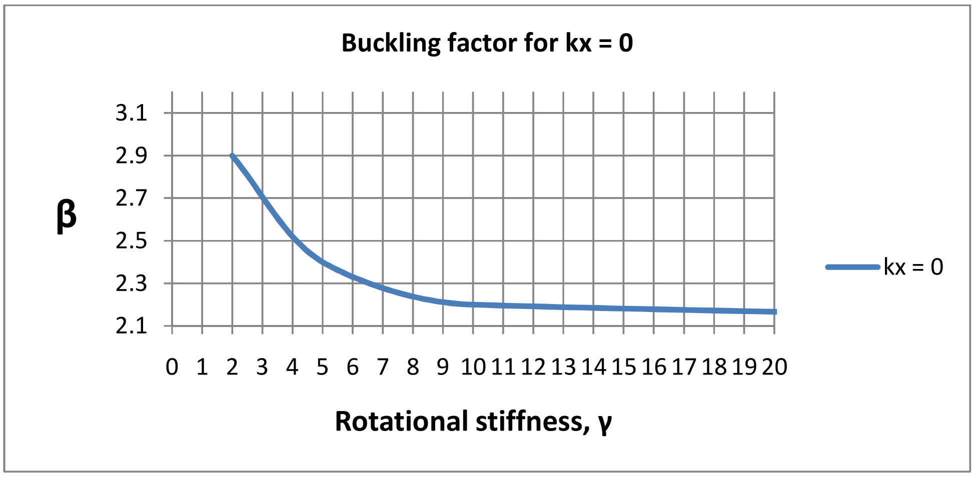


Figure 2.3-13 Buckling factor, system 1 and 3, kx=0

Note to figure: $\beta \rightarrow 2 \; as \; \gamma \rightarrow \infty$

From Figure 2.3-13 we can see that the buckling length factors for $\boldsymbol{k_\varphi = \gamma} < 2$ are not included in the diagram. These factors are therefore estimated (see procedure in appendix 9.4), and we get the following diagram for the buckling length factors:

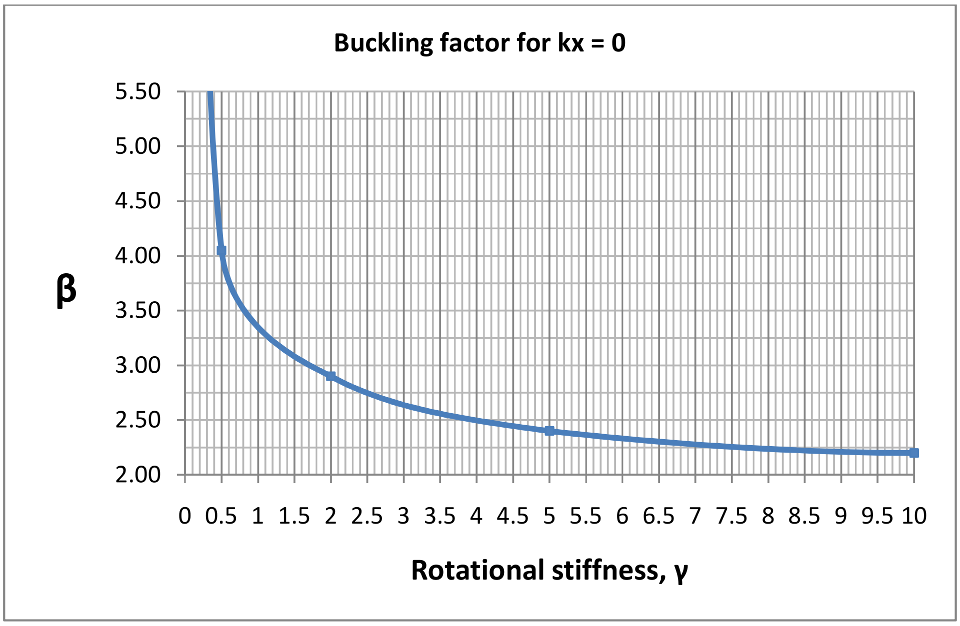


Figure 2.3-14 Estimated buckling length factors, system 1and3, kx=0

3 Structural analysis

3.1 General

In the following section, the structural impacts on spools are evaluated. Two design setups are presented. One where the spool is fitted with two brace bars, and one where a spreader beam is used:

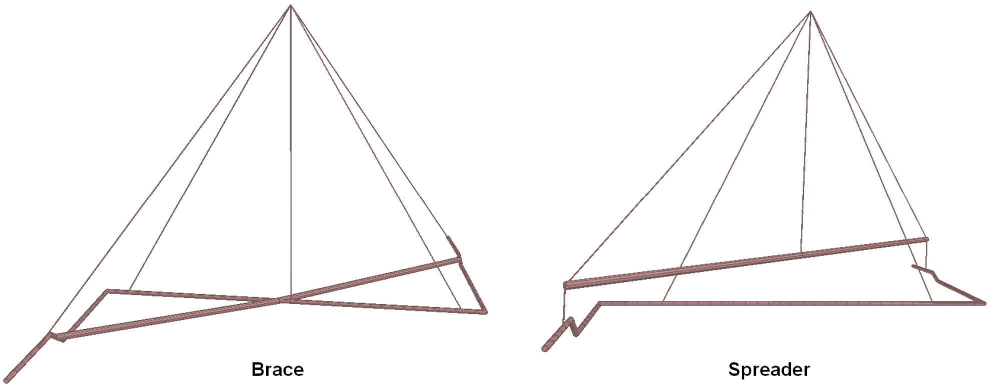


Figure 3.1-1 Spool fitted with brace and spreader

The spool used in the structural analysis is a 12” tie-in spool installed on the Vega field (See appendix 9.1). Total length of the spool is approximately 66 meters, and it is fitted with two termination heads. The total weight of the spool and brace/spreader is around 40 tons.

The spools are modeled in Staad.Pro as a pure steel pipe construction, without any weight coating (concrete), but the *weight* of the coating is accounted for (see appendix 9.2).

In addition to the spool analysis, two separate tests are performed in Staad.Pro on straight pipe section. The purpose of these tests is to investigate the effect of the slenderness ratio on buckling, and to provide a sensitivity analysis on the results Staad.Pro gives.

The chapter “Special theory” is used thoroughly in the buckling analysis of the Z-spool (chapters 3.5.3 and 3.5.4), and the buckling factors that are found here are applied in Staad.Pro for the structural analysis.

The results from the different parts of the structural analysis are presented in chapter 4.

3.2 Design premises

3.2.1 Load cases

The different scenarios that the spool encounters as it is installed are represented by the different load cases. Each load case includes a calculated force applied to certain members of the spool. The details can be found in appendices 9.5 and 9.6.

Table 3.2-1 Load cases in STAAD.Pro, Brace

Object	Load case
Spool in air	11
Trapped water in spool (50%)	15
Spool in water (submerged)	21

Table 3.2-2 Load cases in STAAD.Pro, Spreader

Object	Load case
Spool in air	11
Spreader in air	12
Trapped water in spool (50%)	15
Trapped water in spreader (50%)	16
Spool in water (submerged)	21
Spreader in water	22

3.2.2 Load factors

The load factors used in the structural analysis are according to DNV Rules for planning and execution of marine operations (DNV-OS-C101):

Table 3.2-3 Load factors, Brace

Description	Factor
Design factor	1.5
SKL	1.05
Weight inaccuracy factor	1.05
DAF	1.8

Table 3.2-4 Load factors, Spreader

Description	Factor
Design factor, spool	1.5
Design factor, spreader	1.7
SKL	1.05
Weight inaccuracy factor	1.05
DAF	1.3

3.2.3 Load combinations

The load cases and load factors are combined to make up the following load combinations

Table 3.2-5 Load combinations in STAAD.Pro, Brace

Load combination	Load cases	Total Load factor	Description
100	11	1.00	Static weight in air
101	21	1.00	Static weight in water
111	11	2.14	Lift in air, structural design
115	11	2.98	Spool in splash zone, structural design
	15	2.98	
121	11	1.43	Lift in air, rigging design
125	11	1.98	Spool in splash zone, rigging design
	15	1.98	
126	21	1.98	Spool in water, rigging design
211	21	2.98	Lift in water, structural design
221	21	1.98	Lift in water, rigging design

Table 3.2-6 Load combinations in STAAD.Pro, Spreader

Load combination	Load cases	Total Load factor	Description
100	11	1.00	Static weight in air
	12	1.00	
101	21	1.00	Static weight in water
	22	1.00	
111	11	2.15	Lift in air, structural design
	12	2.43	
115	11	2.15	Spool in splash zone, structural design
	12	2.43	
	15	2.15	
116	12	2.43	Spool in water, structural design
	16	2.43	
	21	2.15	
121	11	1.43	Lift in air, rigging design
	12	1.43	
125	11	1.43	Spool in splash zone, rigging design
	12	1.43	
	15	1.43	
126	12	1.43	Spool in water, rigging design
	16	1.43	
	21	1.43	
211	21	2.15	Lift in water, structural design
	22	2.43	
221	21	1.43	Lift in water, rigging design
	22	1.43	

3.2.4 Material factor

The material factor applied to the structures in Staad.Pro is according to NS 3472 (Norsk Standard).

Table 3.2-7 Material factor, Brace and spreader

Description	Factor
Material factor	1.15

3.2.5 Material properties

The material properties used in Staad.Pro are presented in the following table:

Table 3.2-8 Material properties, Brace and spreader

Property	Value	Unit	Description
Young's modulus	2.05e+008	kN/m2	Design value for structural steel
Young's modulus	6.00e+007	kN/m2	Design value for wire cable steel
Minimum yield stress	450	MPa	SAWL 450 I S structural steel (spool)
Minimum yield stress	355	MPa	Construction steel (spreader, brace)
Minimum yield stress	1770	MPa	Steel wire sling
Steel density	7833	kg/m3	Design value
Poisson's ratio	0.3		

3.3 Staad.Pro modeling of spool with brace

The following chapter explains how the brace case model is built up in Staad.Pro, and what kinds of properties are assigned to it.

An overview of the spool with braces can be seen in Figure 3.3-1.

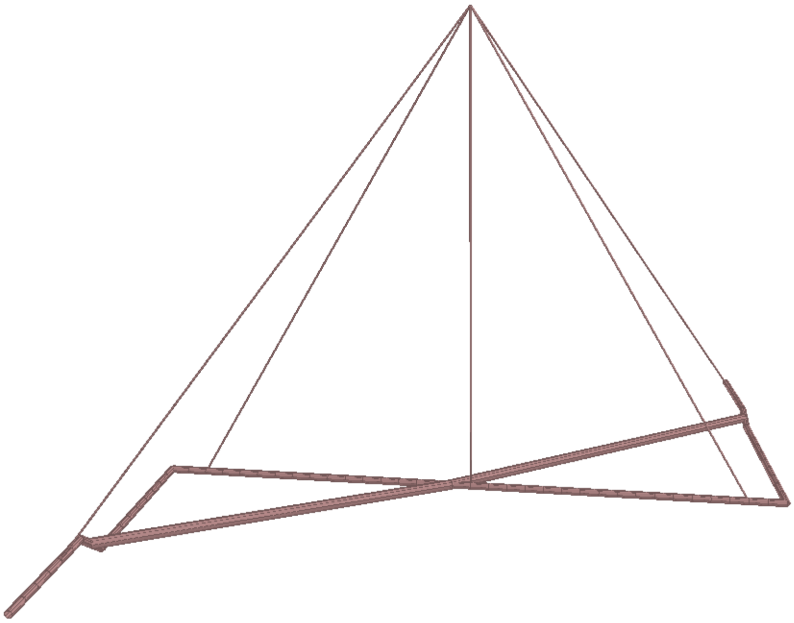


Figure 3.3-1 3D-rendering of spool with brace supports

The spool is made up by a total of 69 connected members, numbered from 1 to 69 as shown in Figure 3.3-2. Each member of the spool is roughly 1 meter long.

The first brace bar is connected to the “gooseneck” of the spool at member 7 and 33. The second brace bar runs from member 33 to 63. The two brace bars are numbered 200 and 201 respectively.

The steel wires run from the crane hook and down to the spool, connected to members 5, 19, 34, 49 and 65.

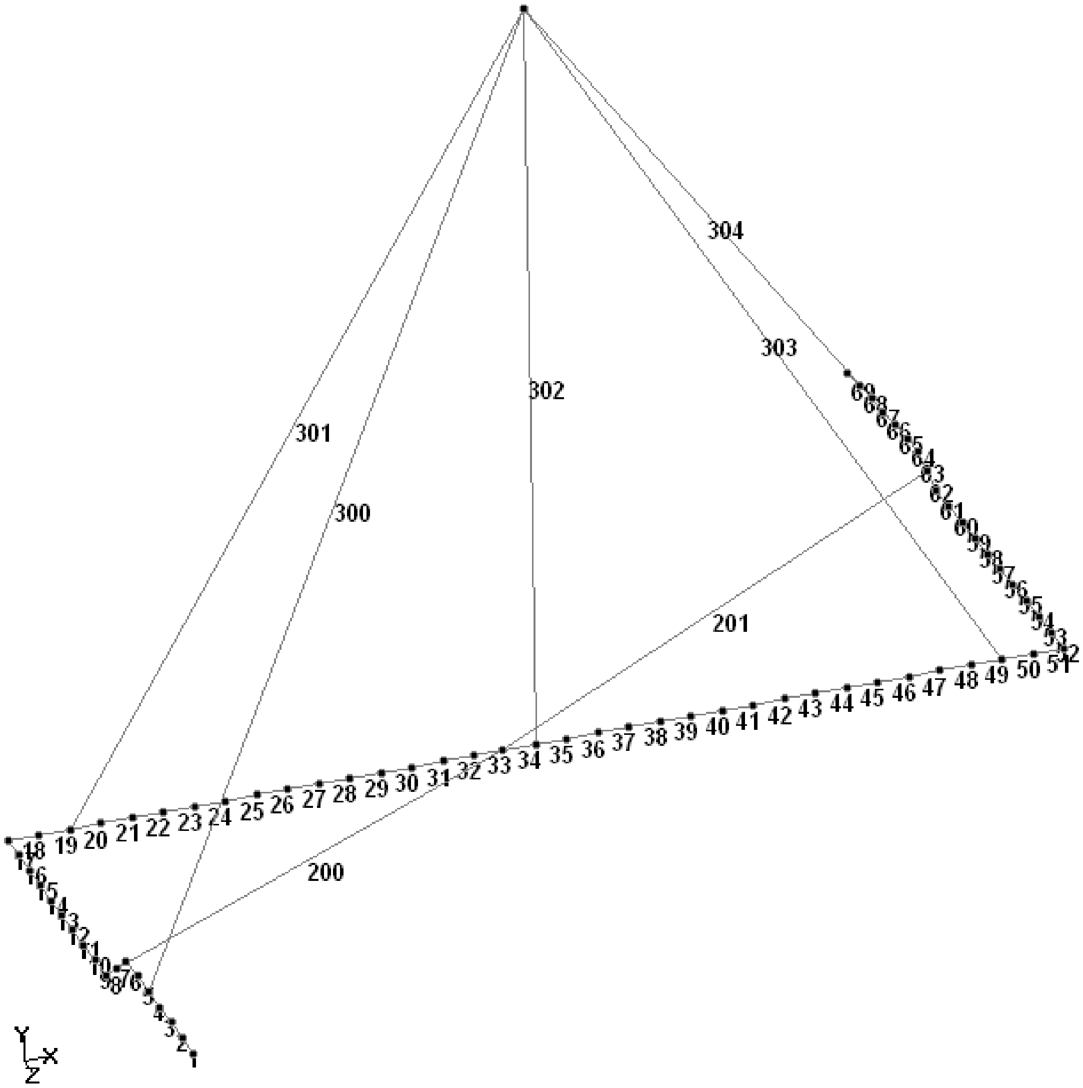


Figure 3.3-2 Member numbering, brace

Physical properties are assigned to the different members. This includes inner and outer diameter of the braces, wires and spool pipe:

Table 3.3-1 Dimensions, brace case

	Spool pipe	Brace bar	Wire sling
Outer diameter	363.2 mm	508.0 mm	70.0 mm
Inner Diameter	304.8 mm	470.0 mm	20.0 mm

Material properties such as elastic modulus and yield strength are also assigned. Detailed values are as presented in Table 3.2-8.

Since wires cannot transfer bending moments, connections between wires, brace and spool are set to be moment free. These types of connections are marked with small circles in Figure 3.3-3.

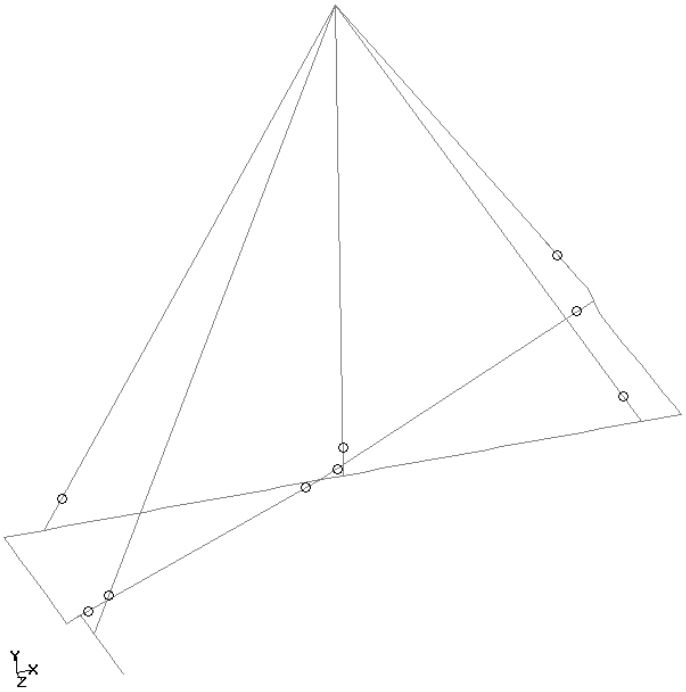


Figure 3.3-3 Moment free connections, brace

In order to stabilize the modeled spool, light spring supports are added to two nodes of the structure (see Figure 3.3-4). The supports prevent the spool from rotating about the hook node, and only restrict the model from moving excessively in the horizontal plane. There is no restriction in vertical direction. The stiffness of the springs is set to 5kN/m. This is low enough to avoid affecting the results of the structural analysis.

The crane hook is represented with a pinned (moment free) support.

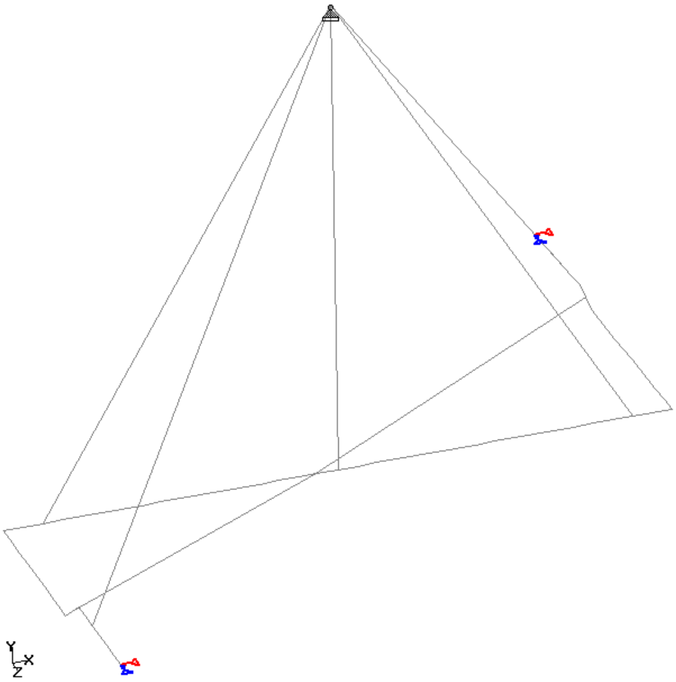


Figure 3.3-4 Supports, brace

An essential part of achieving a stable model is to place the hook point over the structures center of gravity. The CoG is found by first running a preliminary analysis in Staad.Pro with the hook point in an estimated CoG, and from this retrieve the following values:

- Total summation force in vertical direction (Y)
- Summation of moments around the global origin, about X and Z-axis.

To find the coordinate for the CoG in the X-direction, the moment about the Z-axis is divided by the force in Y-direction: $\boldsymbol{X_{coord.}} = \frac{\boldsymbol{MZ}}{\boldsymbol{FY}}$

For the Z-direction the calculation is: $\boldsymbol{Z_{coord.}} = \frac{\boldsymbol{MX}}{\boldsymbol{FY}}$

The different load cases are calculated on the basis of engineering drawings of the spool (see appendices 9.1 *Spool drawings* and 9.2 *Weight calculation*).

An example is presented in Figure 3.3-5, where load combination 100 is shown (Load case 11 with load factor 1.00). Rest of the load combinations for the brace case and how they are applied can be found in appendix 9.7.

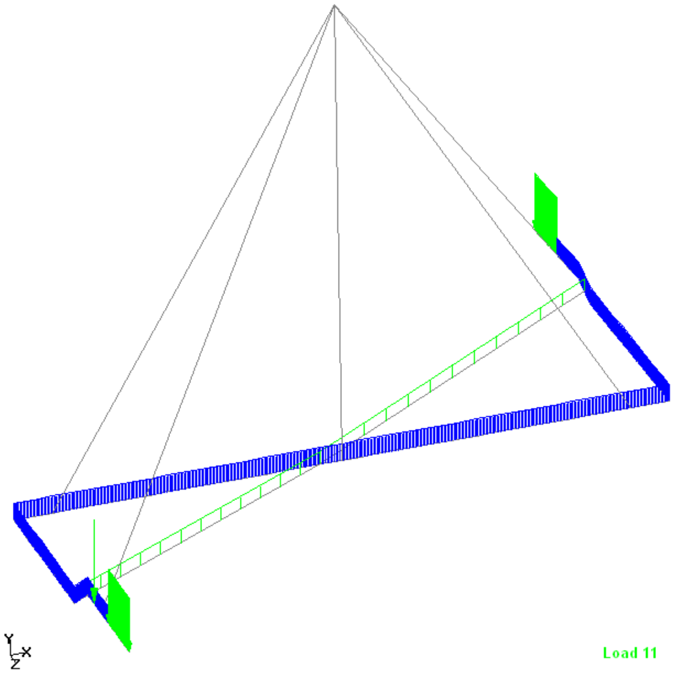


Figure 3.3-5 Load combination 100, brace

Results from this analysis are presented and commented in chapter 4.2.

3.4 Staad.Pro modeling of spool with spreader

The following chapter presents the modeling of the spreader case in Staad.Pro, and the physical properties that are assigned.

An overview of the spool with the spreader beam can be seen in Figure 3.4-1:

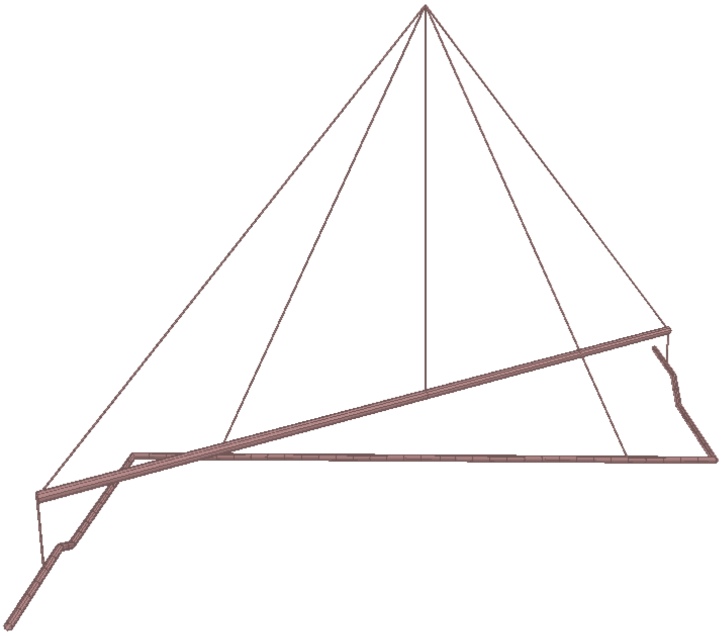


Figure 3.4-1 3D-rendering of spool with spreader beam

Since the purpose of the thesis is to compare the two lifting arrangements on the same spool, the exact same nodes are used for the spool model in the spreader and brace case.

The member numbering is therefore also the same, with 69 sections numbered from 1 to 69.

The wires are arranged in the same way, with the exception of two additional wires running between the spreader beam and the spool. In addition, the connection points of two of the main wires (300 and 304) are moved from the spool and over to the spreader beam. The wire members are numbered from 300 to 306.

The spreader beam is built up by two sections in order to have a node to connect the center wire to (member 302). The sections are numbered 200 and 201. See Figure 3.4-2 for reference.

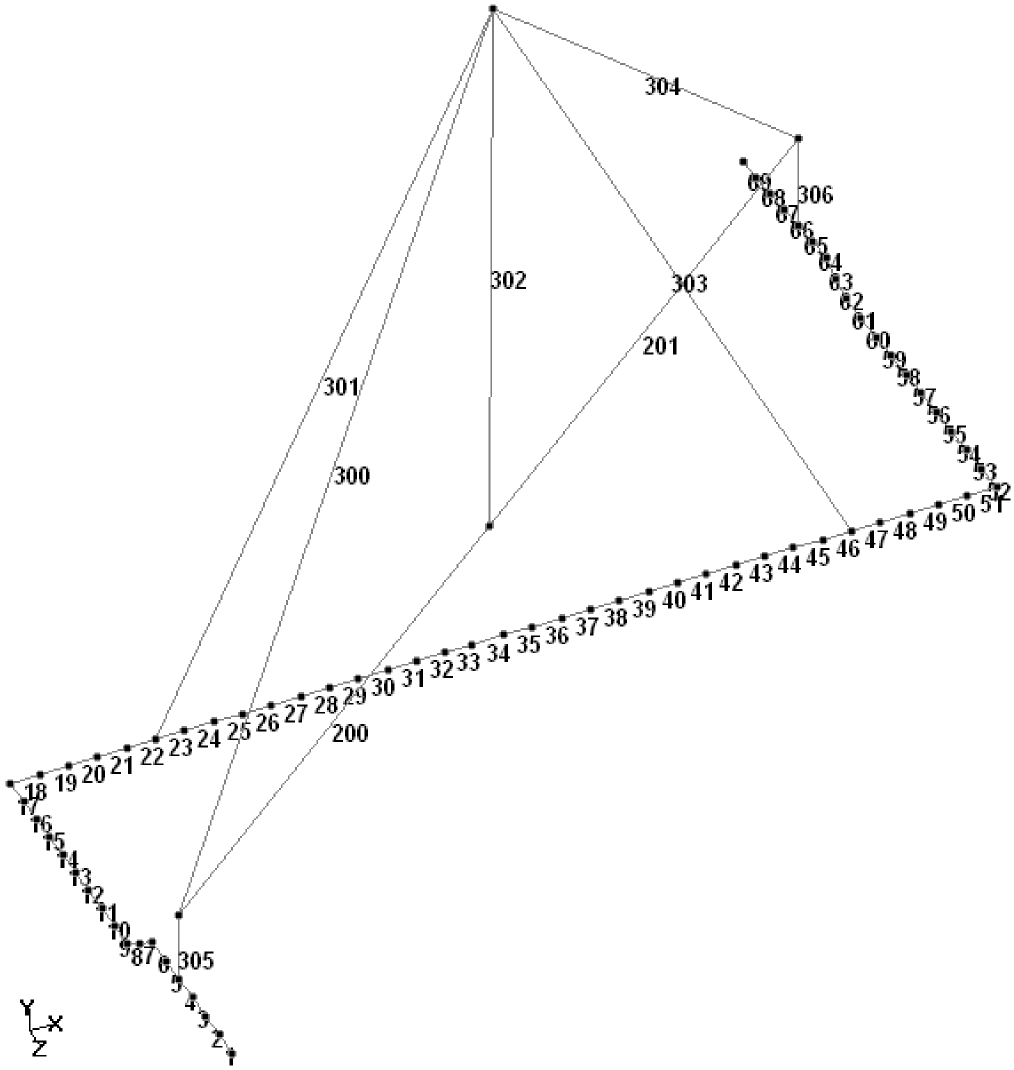


Figure 3.4-2 Member numbering, spreader

Physical properties are assigned to the different parts.

Table 3.4-1 Dimensions, spreader case

	Spool pipe	Spreader beam	Wire sling
Outer diameter	363.2 mm	508.0 mm	70.0 mm
Inner Diameter	304.8 mm	470.0 mm	20.0 mm

More detailed values for physical properties can be found in appendix 9.8.

Connections between wires, spreader and spool are set to be moment free, shown as small circles in Figure 3.4-3.

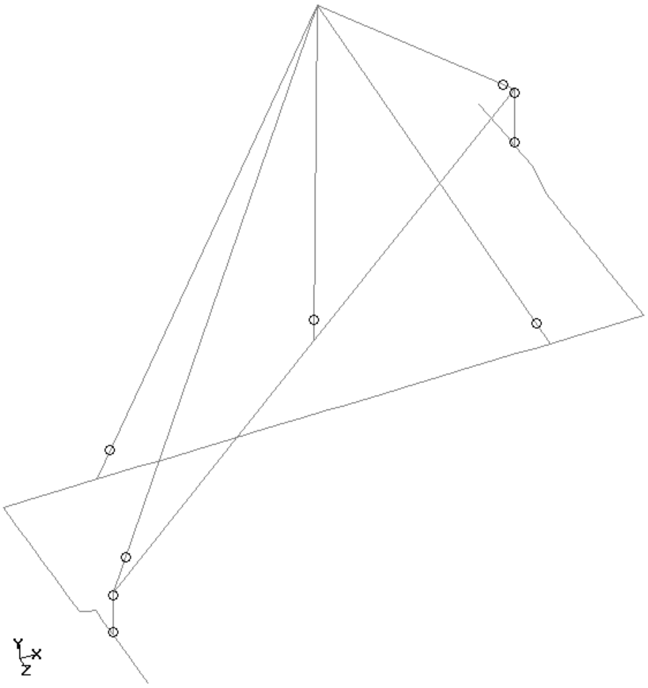


Figure 3.4-3 Moment free connections, spreader

Light spring supports are added to the spreader and the spool in order to stabilize them (Figure 3.4-4). The stiffness of the springs is set to 5kN/m. The crane hook is represented with a pinned (moment free) support. The CoG of the hook point is found in the same way as explained for the brace case.

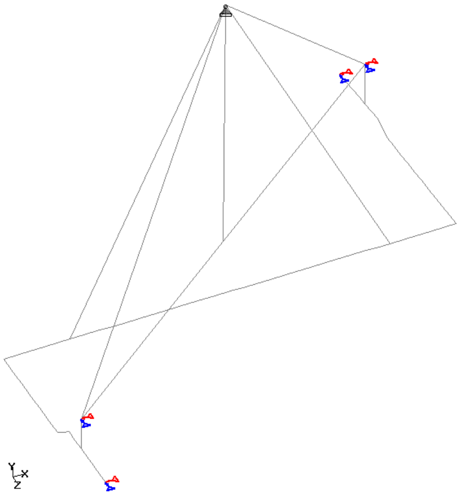


Figure 3.4-4 Supports, spreader

Different load cases are combined and added to the model. As an example, load combination 100 is shown in Figure 3.4-5 (Load case 11 and 12 with load factor 1.00). Rest of the load combinations for the spreader case can be found in appendix 9.8.

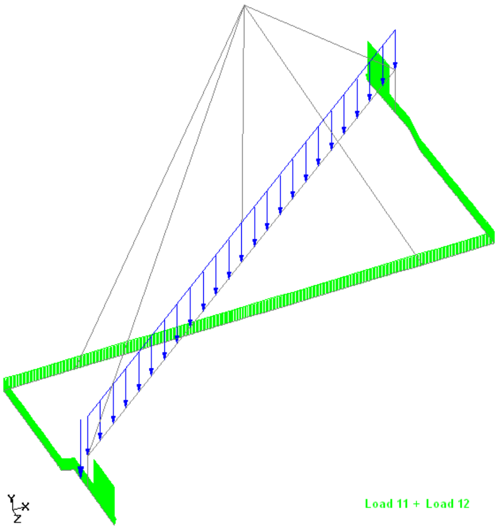


Figure 3.4-5 Load combination 100, spreader

Results from this analysis are presented and commented in chapter 0

3.5 Buckling analysis

This chapter includes two tests performed in Staad.Pro, and a section where the theory of elastic restrain is used to calculate buckling length factors for the Z-spool.

3.5.1 Straight pipe test 1

This test is meant to reveal the impact that buckling factors have on the capacity of the spool. A 10 meter long section of straight pipe is modeled as shown in Figure 3.5-1. The pipe is lifted with two moment free wires, one at each end, giving a model with pinned supports. According to Euler's theory, this implies a buckling factor of 1, or in other words that the correct buckling length of the whole pipe should be 10 meters ($L_k = L$).

The model is built up by 10 members of 1 meter each (Figure 3.5-2), and two main cases are tested on the pipe. For the first main case the buckling lengths are set to 1 meter (giving a buckling factor of $\frac{1}{10} = 0.1$), and for the second one the buckling lengths are set to 10 meters (giving a buckling factor of $\frac{10}{10} = 1.0$, which corresponds to Euler case 1).

Three different values are used for the outer diameter; 0.25m, 0.35m and 0.5m. For each outer diameter, three different inner diameters are checked.

The applied load (denoted "GY" in the result tables) is tuned for each case, so that maximum utilization ratio for the case with buckling length of 10 meters is approximately between 95% and 100% of the pipe's capacity. This is done to lessen the relative difference in utilization due to various capacities for the different pipe cross sections. It also helps achieving a more comparable result. The applied load ranges from 4.5kN to 90kN (Displayed in the result tables in chapter 4.5.1).

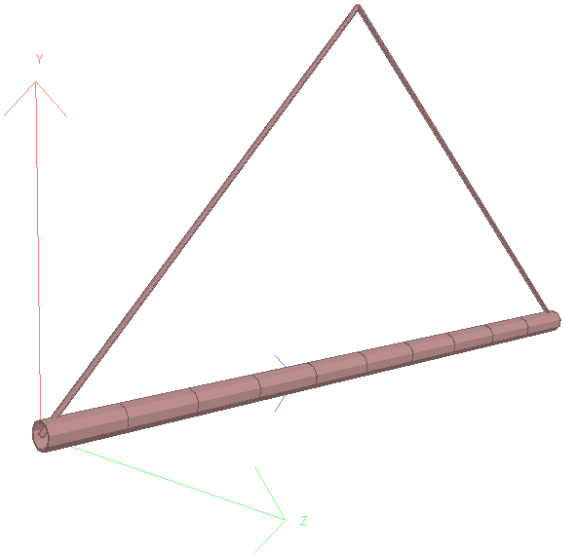


Figure 3.5-1 3D-rendering, 10 meter straight pipe

For future reference, the pipe members are numbered in the following order (Figure 3.5-2):

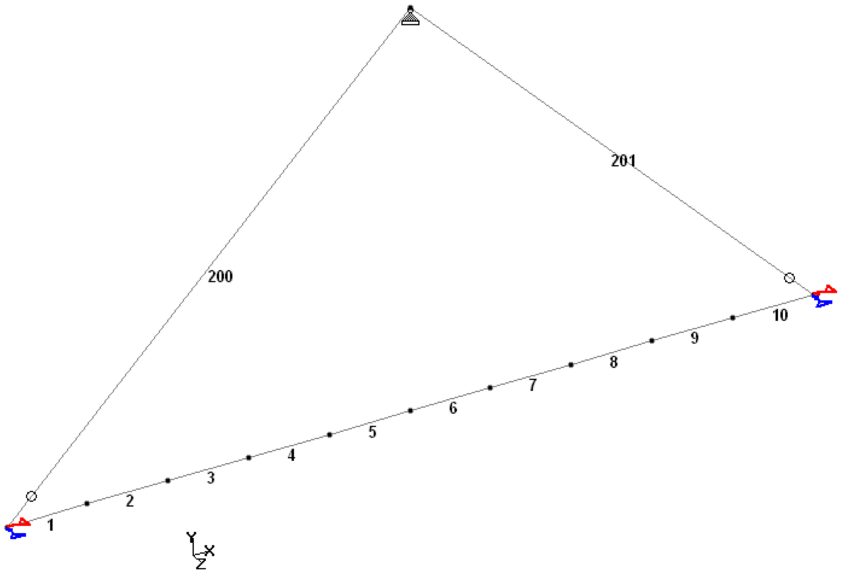


Figure 3.5-2 Member numbering, 10 meter pipe

The load is applied as a uniform member load (Figure 3.5-3):

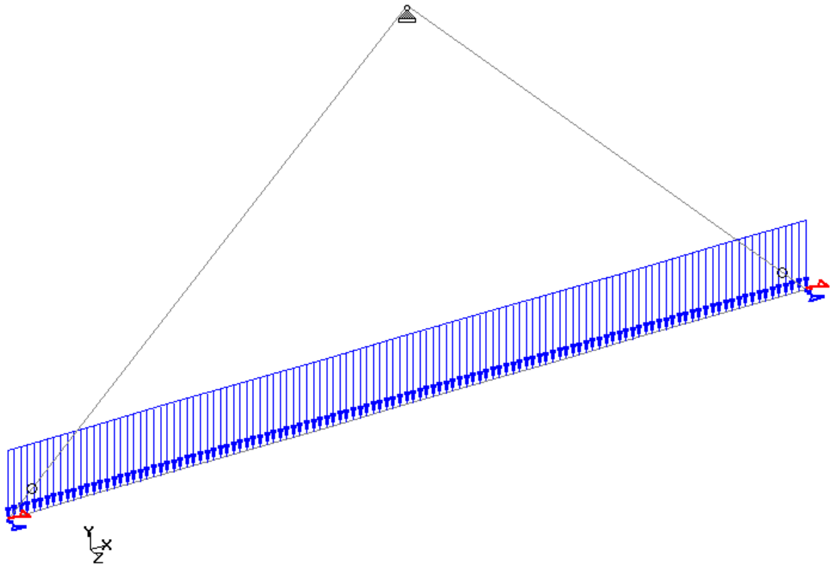


Figure 3.5-3 Applied load, 10 meter pipe

Results from this test are shown and commented in chapter 4.5.1

3.5.2 Straight pipe test 2

The effect of how varying buckling length factor affects the utilization ratio of a pipe is further investigated through a sensitivity analysis. In this test the pipe length is increased to 50 meters (50 members of 1meter length), and the outer diameter and wall thickness is kept constant (see Table 3.5-1). The utilization ratios are found and extracted from Staad.Pro, and evaluated by plotting the values in diagrams (chapter 4.5.2).

Table 3.5-1 Dimensions, 50 meter pipe

Dimensions	
Outer diameter	500.0 mm
Inner Diameter	50.0 mm

The varying factors in this test are the applied load and buckling length.

Table 3.5-2 Test parameters

Parameters	**Min. Value**	**Max. Value**
Applied load	1.50 kN/m	4.00 kN/m
Buckling length	5 m *	130 m**

*Corresponds to a buckling length factor of 0.1

** Corresponds to a buckling length factor of 2.6

An overview of the structure can be seen in Figure 3.5-4.

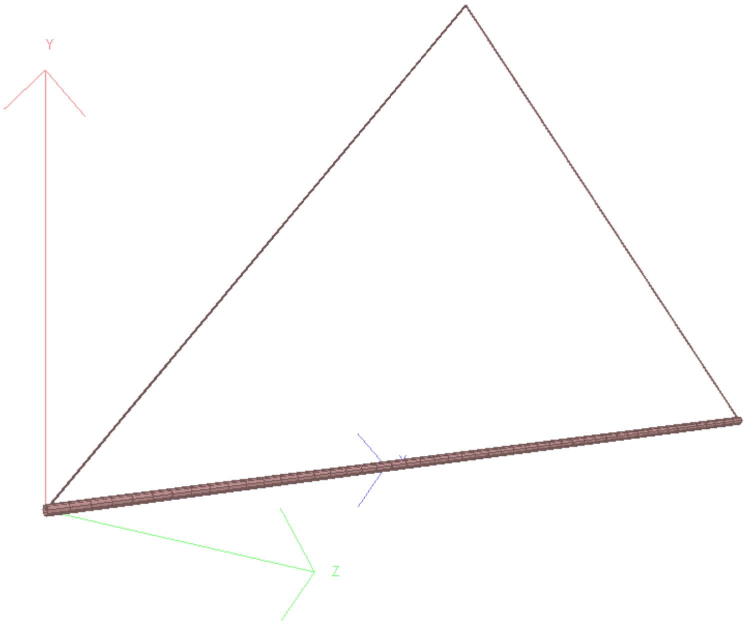


Figure 3.5-4 3D rendering of 50 meter straight pipe

The pipe members are numbered from 1 to 50 as shown in Figure 3.5-5, and the load is applied as an evenly distributed load (see Figure 3.5-6).

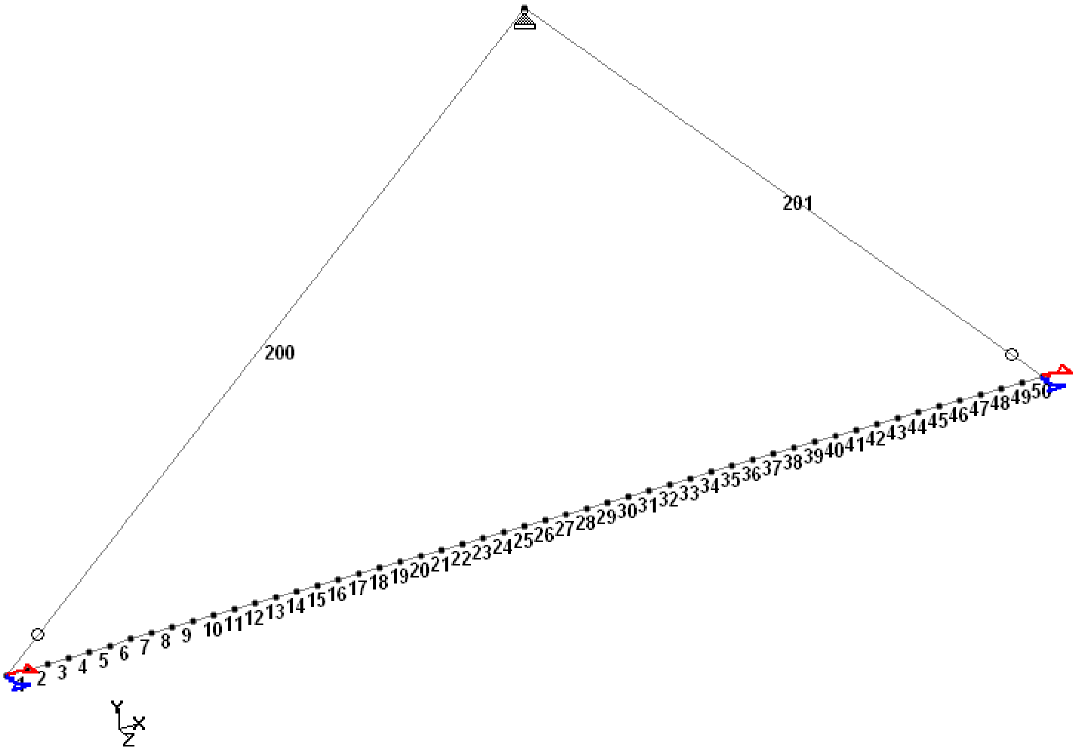


Figure 3.5-5 Member numbering, 50m pipe

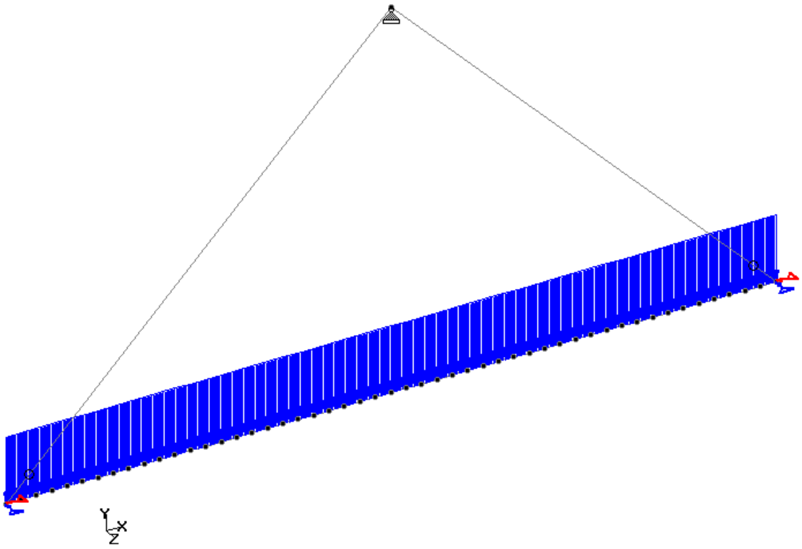


Figure 3.5-6 Applied load, 50m pipe

Results from this test are shown and discussed in chapter 4.5.2

3.5.3 Buckling of Z-spool, brace case

This section presents how buckling factors for the Z-spool are found according to the method with elastic restraints. It also shows how the spool with braces is modeled with respect to end conditions.

The brace solution has a total of seven different connection points. Some are between the spool and rigging, and others between the spool and braces. This leads to relatively complex models of the structure, where the stiffness (and therefore also the resistance to buckling) of one beam is dependent on the attributes of the connected beam(s).

An overview of the spool model with braces is shown in Figure 3.5-7.

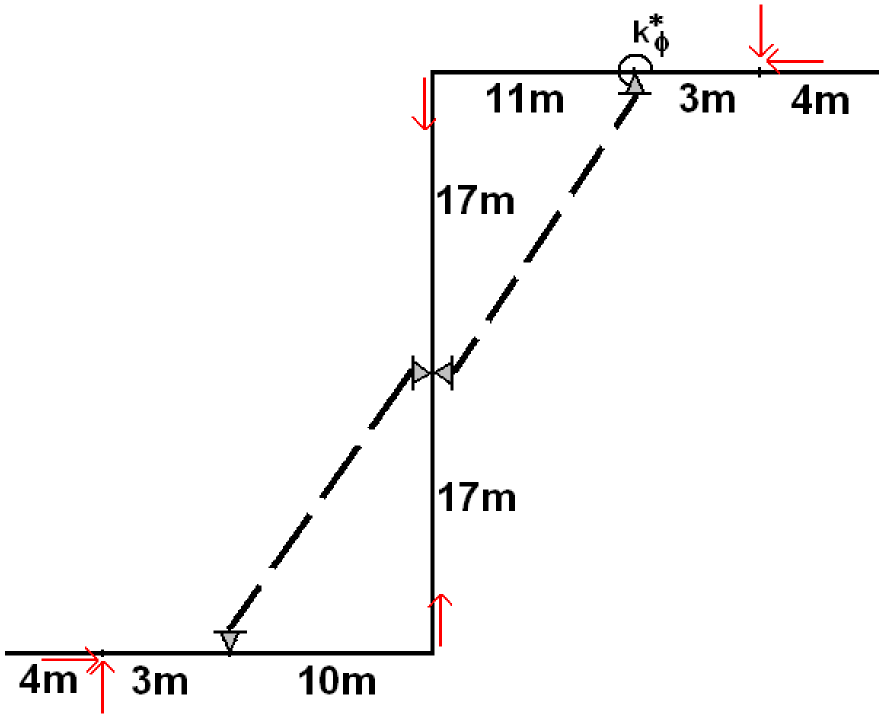


Figure 3.5-7 Overview of connection points and forces, brace case

The results from this chapter are gathered and commented in chapter 4.5.3.

3.5.3.1 Buckling in global XZ-plane ("horizontal" plane)

To find the buckling length for the 3 meter long section (noted "**c**" in Figure 3.5-8), it is isolated and modeled apart from the rest of the spool. The stiffness of the rotational spring depends on the characteristics of the connected beam (noted "**b**"). The buckling length is calculated using the side of the spool with the longest member (11 meter section), since this gives the lowest stiffness. The same value found from these calculations is used for the side with the 10 meter long section. This is considered a conservative approach.

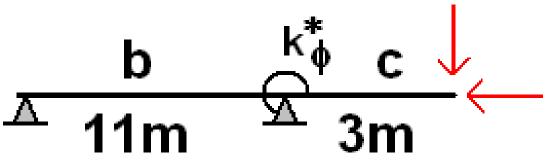


Figure 3.5-8 Pinned-pinned model, 3 meter section, XZ-plane, brace

The moment needed to create a unit angle rotation is given by beam theory, and varies with the end conditions of the beam. Refer Table 2.3-1.

From beam theory:

$$k_\varphi = \frac{3EI_b}{L_b}$$

Dimensionless rotational stiffness:

$$k^*{}_\varphi = \frac{3EI_b}{L_b} * \frac{L_c}{EI_c} = 3 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_b} = 3 * \frac{3}{11}$$

$$k^*{}_\varphi = \mathbf{0.82}$$

As mentioned in chapter 2.3.2, the graph for system 1 and 3 from (Larsen, 2010) does not provide buckling length values for $[k_x = 0, k_\varphi < 2]$, and is therefore estimated (see appendix 9.4). From the graph with estimated values (Figure 2.3-14) we find:

$$For\ \gamma = k^*{}_\varphi = 0.82 \rightarrow \ \boldsymbol{\beta} \approx \mathbf{3.50}$$

This is a conservative model, since the only contribution to the spring is the stiffness of the 11 meter long beam, and this again is modeled with a *moment free support* at the left end.

If the 11 meter section instead is modeled with a *fixed* end-support (see Figure 3.5-9), the stiffness of the beam increases and we get the following result:

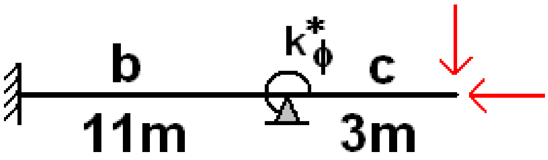


Figure 3.5-9 Fixed-pinned model, 3 meter section, XZ-plane, brace

From beam theory:

$$k_{\varphi} = \frac{4\,EI_b}{L_b}$$

Dimensionless rotational stiffness:

$$k^{*}{}_{\varphi} = \frac{4\,EI_b}{L_b} * \frac{L_c}{EI_c} = 4 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_b} = 4 * \frac{3}{11}$$

$$k^{*}{}_{\varphi} = \mathbf{1.09}$$

The graph for <u>system 3</u> with kx=0 (Figure 9.4-4) gives:

$$For\ \gamma = k^{*}{}_{\varphi} = 1.09 \rightarrow \boldsymbol{\beta} = \mathbf{3.30}$$

This model is not very realistic for the spool case, since there will be *some* rotation at the left end of the beam, but not as much as if the beam was pinned (Figure 3.5-8). It is presumed that a fair estimate is to set the stiffness of the beam to the mean value between the Pinned-pinned and Fixed-pinned case. I.e. $k_{\varphi} = \frac{3.5\ EI_b}{L_b}$, which leads to the following result:

Dimensionless rotational stiffness:

$$k^{*}{}_{\varphi} = \frac{3.5 * EI_b}{L_b} * \frac{L_c}{EI_c} = 3.5 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_b} = 3.5 * \frac{3}{11}$$

$$k^{*}{}_{\varphi} = \mathbf{0.95}$$

The graph for <u>system 3</u> with kx=0 (Figure 9.4-4) gives:

$$For\ \gamma = k^{*}{}_{\varphi} = 0.95 \rightarrow \boldsymbol{\beta} \approx \mathbf{3.40}$$

This is the buckling factor used in the Staad.Pro analysis for the 3 meter sections.

For the 11 meter section, the buckling factor is found by applying the following model (Figure 3.5-10):

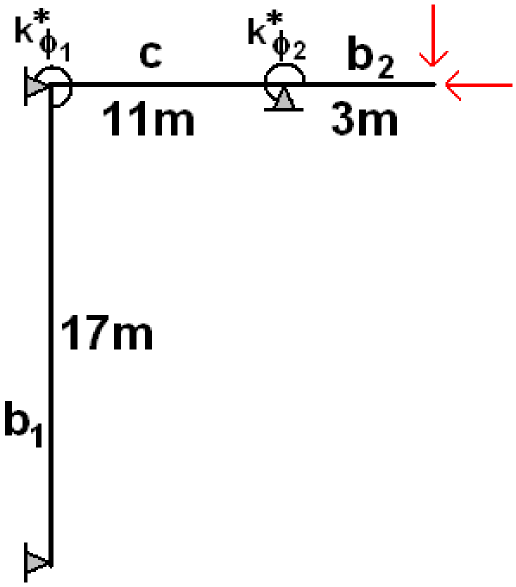


Figure 3.5-10 Model of 11 meter section, XZ-plane, brace

From beam theory:

$$k_{\varphi 1} = k_{\varphi 2} = \frac{3\,EI_b}{L_b}$$

Dimensionless rotational stiffness:

$$k^*{}_{\varphi 1} = \frac{3\,EI_{b1}}{L_{b1}} * \frac{L_c}{EI_c} = 3 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_{b1}} = 3 * \frac{11}{3}$$

$$k^*{}_{\varphi 1} = \mathbf{11.0}$$

$$k^*{}_{\varphi 2} = \frac{3\,EI_{b2}}{L_{b2}} * \frac{L_c}{EI_c} = 3 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_{b2}} = 3 * \frac{11}{17}$$

$$k^*{}_{\varphi 2} = \mathbf{1.94}$$

The graph for system 4 (Figure 2.3-9) gives:

$$For\ \gamma_b = k^*{}_{\varphi 1} = 11.0\ and\ \gamma_a = k^*{}_{\varphi 2} = 1.94 \rightarrow \boldsymbol{\beta} \approx \mathbf{0.68}$$

This factor is also applied for the 10 meter section (slightly conservative).

17 meter section:

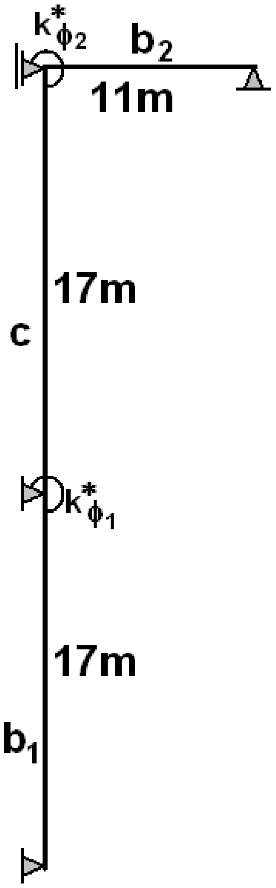


Figure 3.5-11 Model of 17 meter section, XZ-plane, brace

From beam theory:

$$k_{\varphi 1} = k_{\varphi 2} = \frac{3\, EI_b}{L_b}$$

Dimensionless rotational stiffness:

$$k^*{}_{\varphi 1} = \frac{3\, EI_{b1}}{L_{b1}} * \frac{L_c}{EI_c} = 3 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_{b1}} = 3 * \frac{17}{17} = \mathbf{3.00}$$

$$k^*{}_{\varphi 2} = \frac{3\, EI_{b2}}{L_{b2}} * \frac{L_c}{EI_c} = 3 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_{b2}} = 3 * \frac{17}{11} = \mathbf{4.64}$$

The graph for system 4 (Figure 2.3-9) gives:

$$For\ \gamma_b = k^*{}_{\varphi 1} = 3.00\ and\ \gamma_a = k^*{}_{\varphi 2} = 4.64 \rightarrow \boldsymbol{\beta} \approx \mathbf{0.7}$$

The brace bars themselves (members 200 and 201 in Figure 3.3-2) are intended to be mounted with moment free connections to the spool, but are restricted from moving sideways (i.e. they act as if they are guided). This leads to system 4 from (Larsen, 2010) with $\gamma_b = 0,\ \ \gamma_a = 0$ (or Euler case 1), see Figure 2.2-1 and Figure 2.3-6.

The graph for system 4 (Figure 2.3-9) gives:

$$For\ \gamma_b = {k^*}_{\varphi 1} = 0.00\ and\ \gamma_a = {k^*}_{\varphi 2} = 0.00 \rightarrow \boldsymbol{\beta} \approx \mathbf{1.00}$$

This factor applies for *all buckling planes* (XY, ZY and XZ), and is therefore not mentioned in the subsequent chapter.

Preliminary analyses in Staad.Pro show that the part of the spool that is on the outside of the wire slings (members 1-5 and 66-69 in Figure 3.3-2) experience no compression forces (ref. Figure 4.2-5). Buckling factors are therefore *not needed* for these members.

This applies for *all buckling planes* (XY, ZY and XZ).

3.5.3.2 Buckling in global XY- and ZY-plane ("vertical" planes)

For displacement in the vertical direction, the two pipe sections of 11 and 3 meters displayed in Figure 3.5-7 are considered as one common member. The buckling length factor for this *14 meter section* is found in the following way:

Shear modulus, steel: $G = \frac{E}{2(1+v)} = \frac{E}{2(1+0.3)} = \frac{E}{2.6}$

Torsion constant, spool: $J = I_p = \frac{\pi(OD^4 - ID^4)}{2}$

Second moment of inertia, spool: $I_z = I_y = \frac{\pi(OD^4 - ID^4)}{4} = \frac{I_p}{2}$

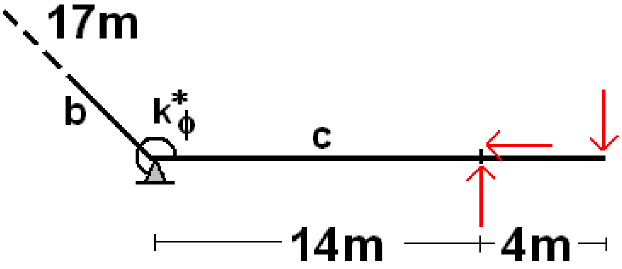


Figure 3.5-12 Model for 14 meter section, ZY-plane, brace

The rotational stiffness k^*_φ depends on the torsional stiffness of the 17 meter long member:

$$k^*_\varphi = \frac{GI_p}{L_b} * \frac{L_c}{EI_c} = \frac{GI_p}{EI_c} * \frac{L_c}{L_b}$$

$$k^*_\varphi = \frac{\frac{E}{2.6} I_p}{E \frac{I_p}{2}} * \frac{L_c}{L_b} \frac{2\,\cancel{E}}{2.6\,\cancel{E}} * \frac{L_c}{L_b}$$

$$k^*_\varphi = \frac{2}{2.6} * \frac{14}{17}$$

$$\boldsymbol{k^*_\varphi = 0.63}$$

The graph for <u>system 3</u> with kx=0 (Figure 9.4-4) gives:

$$For\ \gamma = k^*_\varphi = 0.63 \rightarrow \boldsymbol{\beta \approx 3.75}$$

This factor is also applied for the 13 meter section (slightly conservative).

Note: The length of the beam (L_b) is set to 17 meters, and not 34 meters because the rotational moment caused by the 14 meter section is assumed to be counter acted by the 13 meter section. This gives zero rotation at the center of the 34 meter long spool section (equivalent to fixed end condition for the 17 meter long beam).

17 meter section:

The beam is assumed to only be supported at the center joint (by wire 302), leaving the outer ends free to move in the vertical XY-plane.

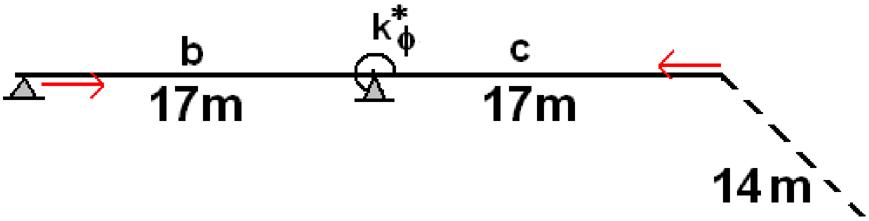


Figure 3.5-13 Model for 17 meter section, XY-plane, brace

From beam theory:

$$k_{\varphi} = \frac{3\,EI_b}{L_b}$$

Dimensionless rotational stiffness:

$$k^*{}_{\varphi} = \frac{3\,EI_b}{L_b} * \frac{L_c}{EI_c} = 3 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_b} = 3 * \frac{17}{17}$$

$$k^*{}_{\varphi} = \mathbf{3.00}$$

The graph for system 3 with kx=0 (Figure 9.4-4) gives:

$$For\ \gamma = k^*{}_{\varphi} = 3.00 \ \rightarrow \ \boldsymbol{\beta} \approx \mathbf{2.70}$$

This factor is applied for *both* of the 17 meter sections.

3.5.4 Buckling of Z-spool, spreader case

The following chapter presents the modeling of the spool with spreader with respect to end conditions and how the buckling length factors are calculated.

The spreader case has less connection points than the brace case, giving a bit less complicated models for buckling length calculation (Figure 3.5-14). On the other hand, having a spreader beam hanging above the spool gives us an extra dynamic system, with its own inertia. This means that the loads can work in different directions, depending on the relative movement between the spool and the spreader beam.

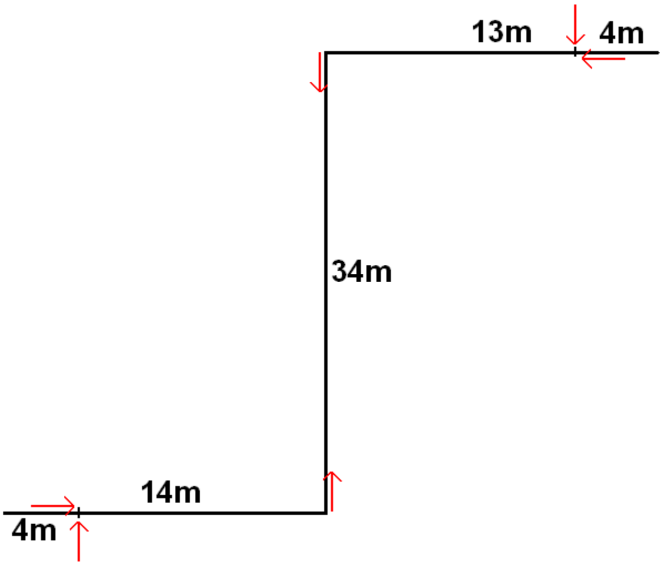


Figure 3.5-14 Overview of wire connection points and forces, spreader case

For the spreader modeling in the XZ-plane ("horizontal" plane), two failure modes are evaluated. One where the end forces from the slings act in opposite directions (failure mode 1), and one where they act in the same direction (failure mode 2). The latter of these cases can occur if the spreader bar is accelerated in the opposite direction of the spool.

For the XY- and ZY-plane ("vertical" planes) the deflections and failure modes are quite similar to the ones in the brace case.

3.5.4.1 Buckling in global XZ-plane ("horizontal" plane)

Failure mode 1:

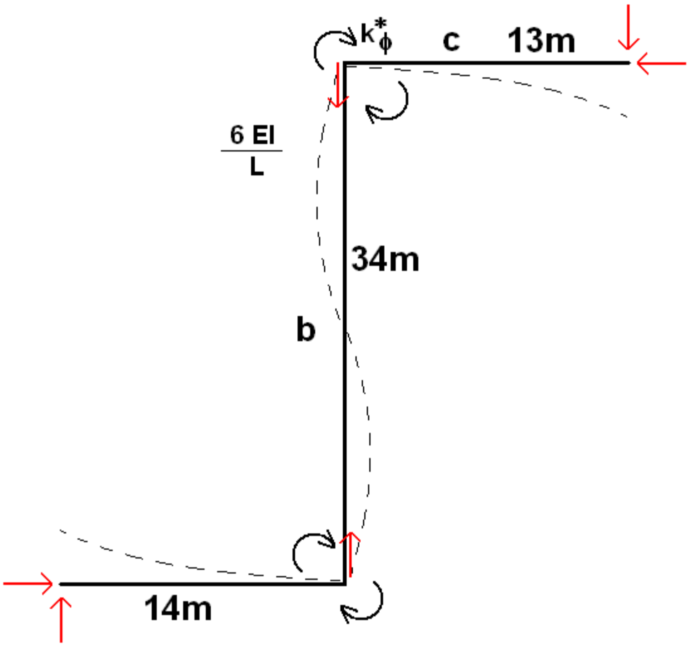


Figure 3.5-15 Failure mode 1, 13 meter section, XZ-plane, spreader

From beam theory:

$$k_{\varphi} = \frac{6EI}{L}$$

Dimensionless rotational stiffness:

$$k^{*}{}_{\varphi} = \frac{6 * EI_b}{L_b} * \frac{L_c}{EI_c} = 6 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_b} = 6 * \frac{13}{34}$$

$$k^{*}{}_{\varphi} = \mathbf{2.29}$$

The graph for system 3 with kx=0 (Figure 9.4-4) gives:

$$For\ \gamma = k^{*}{}_{\varphi} = 2.29 \rightarrow \boldsymbol{\beta} \approx \mathbf{2.80}$$

Failure mode 2:

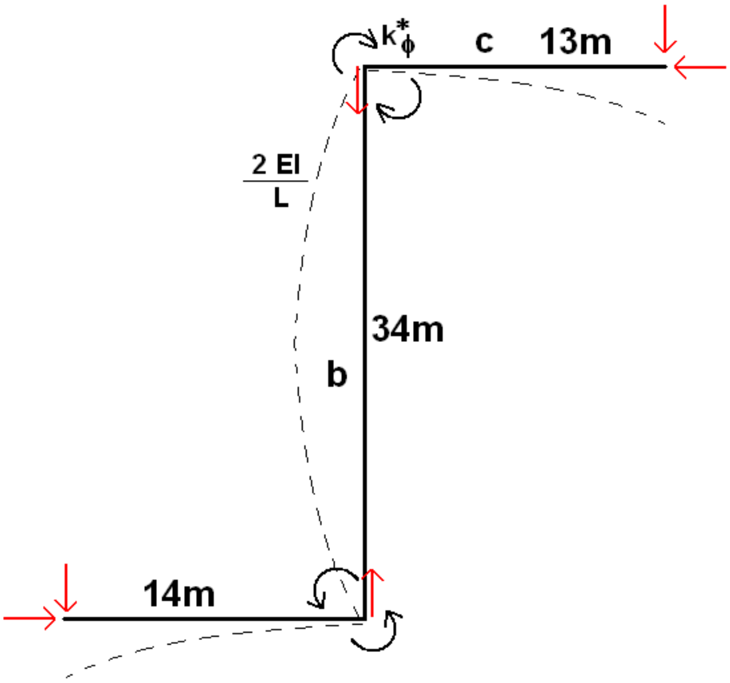


Figure 3.5-16 Failure mode 2, 13 meter section, XZ-plane, spreader

From beam theory:

$$k_\varphi = \frac{2EI}{L}$$

Dimensionless rotational stiffness:

$$k^*{}_\varphi = \frac{2 * EI_b}{L_b} * \frac{L_c}{EI_c} = 2 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_b} = 2 * \frac{13}{34}$$

$$k^*{}_\varphi = \mathbf{0.76}$$

The graph for system 3 with kx=0 (Figure 9.4-4) gives:

$$For\ \gamma = k^*{}_\varphi = 0.76 \rightarrow \boldsymbol{\beta} \approx \mathbf{3.60}$$

The highest buckling factor (failure mode 2) is applied in Staad.Pro, and is also used for the 14 meter section (slightly conservative).

34 meter section:

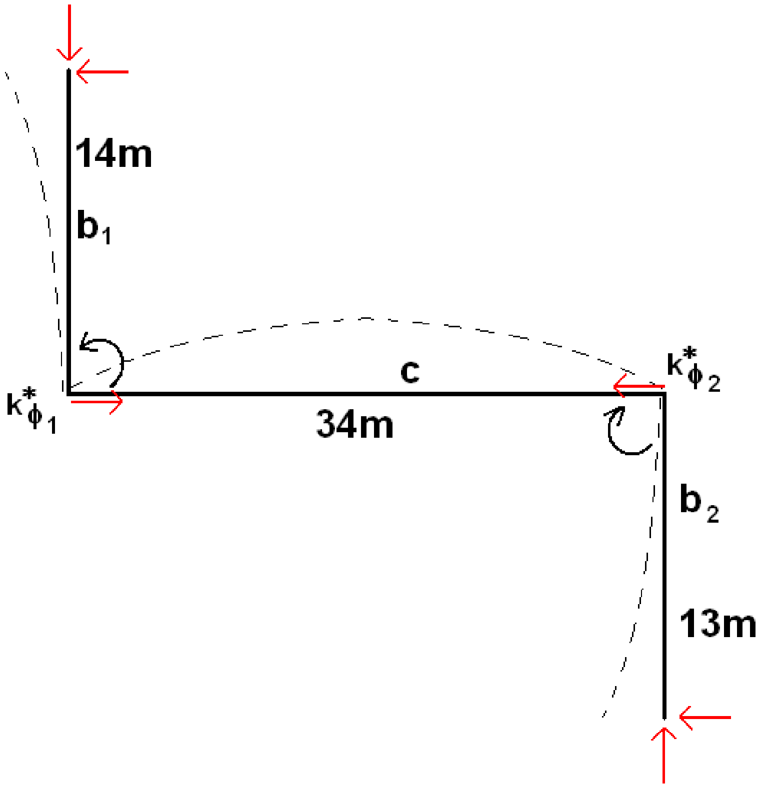


Figure 3.5-17 Model for 34 meter beam, XZ-plane, spreader

Since the ends of the 13- and 14 meter long sections are connected to vertical slings, they can move freely in the XZ-plane. The springs $\boldsymbol{k^*}_{\boldsymbol{\varphi 1}}$ and $\boldsymbol{k^*}_{\boldsymbol{\varphi 2}}$ are set to zero, and the resulting buckling factor is therefore:

The graph for system 4 (Figure 2.3-9) gives:

$$For\ \gamma_b = k^*{}_{\varphi 1} = 0.00\ and\ \gamma_a = k^*{}_{\varphi 2} = 0.00 \rightarrow \boldsymbol{\beta} \approx \mathbf{1.00}$$

Spreader beam:

The spreader beam is only connected to wires, and the short (members 305, 306) and long (members 300, 304) wires are connected in the same nodes on the beam. The center wire (member 302) is connected to the spreader beam, but has no restricting effect on the horizontal displacement of the beam.

This means there are no moment restrictions for the end conditions, and we get the following model:

Figure 3.5-18 Model of spreader beam, XZ-plane

The graph for system 4 (Figure 2.3-9) gives:

$$For\ \gamma_b = k^*{}_{\varphi 1} = 0.00\ and\ \gamma_a = k^*{}_{\varphi 2} = 0.00 \rightarrow\ \boldsymbol{\beta} \approx \mathbf{1.00}$$

3.5.4.2 Buckling in global XY- and ZY-plane ("vertical" planes)

34 meter section:

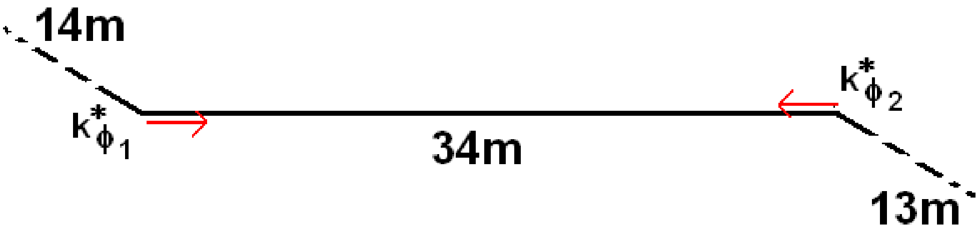


Figure 3.5-19 Model for 34 meter beam, XY-plane, spreader

The 34 meter section is connected to moment free slings. The springs $\boldsymbol{k^*}_{\boldsymbol{\varphi 1}}$ and $\boldsymbol{k^*}_{\boldsymbol{\varphi 2}}$ are therefore set to zero, and we can find the buckling factor:

The graph for system 4 (Figure 2.3-9) gives:

$$For\ \gamma_b = k^*{}_{\varphi 1} = 0.00\ and\ \gamma_a = k^*{}_{\varphi 2} = 0.00 \rightarrow \boldsymbol{\beta} \approx \mathbf{1.00}$$

14 meter section:

Here, the argumentation for the end conditions are the same as in the brace case (Figure 3.5-12), as well as the model. We therefore get the same buckling factor:

The graph for system 3 with kx=0 (Figure 9.4-4) gives:

$$For\ \gamma = k^*{}_{\varphi} = 0.63\ \rightarrow \boldsymbol{\beta} \approx \mathbf{3.75}$$

This factor is also applied for the 13 meter section (slightly conservative).

Spreader beam:

In the vertical direction, the spreader beam is restricted in both ends, and at the center of the beam. Although in the center the beam is really just restricted against downwards deflection (and not upwards). But as long as the wire running from the crane hook to the center of the spreader bar (member 302 in Figure 3.4-2) is not slack we get the following buckling length factor for the section:

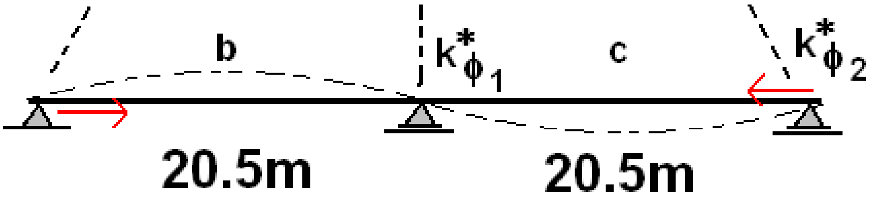


Figure 3.5-20 Model for spreader beam, XY-plane

From beam theory:

$$k_{\varphi 1} = \frac{3\,EI_b}{L_b}$$

Dimensionless rotational stiffness:

$$k^*{}_{\varphi 1} = \frac{3\,EI_b}{L_b} * \frac{L_c}{EI_c} = 3 * \frac{\cancel{EI_b}}{\cancel{EI_c}} * \frac{L_c}{L_b} = 3 * \frac{20.5}{20.5}$$

$$k^*{}_{\varphi 1} = \mathbf{3.00}$$

$$k^*{}_{\varphi 2} = \mathbf{0.00}$$

The graph for <u>system 4</u> (Figure 2.3-9) gives:

$$For\ \gamma_b = k^*{}_{\varphi 1} = 3.00\ and\ \gamma_a = k^*{}_{\varphi 2} = 0.00 \rightarrow \boldsymbol{\beta} \approx \mathbf{0.84}$$

3.6 Check list for brace cases

When brace bars are used, they have to be secured tightly to the spool to ensure that the spool cannot move relative to the brace. This is achieved by using so-called brace clamps, which are connected to the spool by using two Kevlar strops on each clamp (see Figure 3.6-1 and Figure 3.6-2). The strops are tightened with bolts, which increase the normal force between the spool and the clamp, and a higher friction is achieved.

The following chapter goes through the procedure for verifying the brace clamp and spool pipe when a brace solution is used. The additional hoop stress from the clamp has to be taken into consideration when the spools structural integrity is checked. The structural integrity of the clamp itself must also be checked.

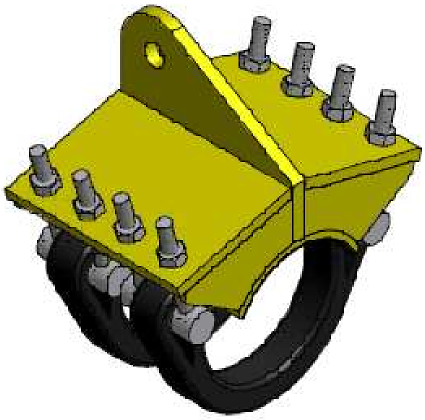


Figure 3.6-1 3D-rendering of brace clamp

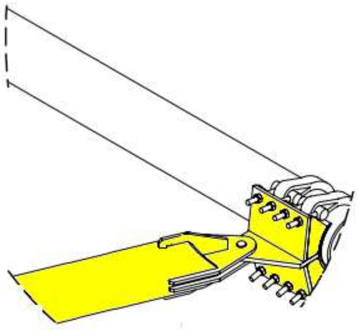


Figure 3.6-2 Connection between brace (yellow) and spool

The following abbreviations and symbols are used in the equations in this chapter:

Table 3.6-1 Abbreviations, brace calculations

Symbol	Description	Symbol	Description
F_y	Shear force, vertical	τ_t	Torsional shear stress
F_x	Shear force, longitudinal	τ_y	Shear stress, strong axis
α	Clamp area factor	τ_z	Shear stress, weak axis
δ	Unit deflection	f_{ys}	Yield stress for spool steel
R	Radius of spool	$\gamma_{m.steel}$	Material factor, steel
L	Length of clamp	$\gamma_{m.kev}$	Material factor, kevlar strop
M_1	In-plane moment	MBL	Minimum break load
M_0	Out-of-plane moment	$f_{8.8}$	Ultimate strength, grade 8.8 bolts
$F_{pre.bolt}$	Pretension force in one bolt	d_{bolt}	Cross sectional diameter, bolts
$A_{s.bolt}$	Cross sectional area of bolts	t_p	Thickness, clamp padeye plate
$f_{u.bolt}$	Ultimate stress of bolts	t_{fp}	Thickness, flange plate
F_{res}	Residual force in bolts	$\gamma_{m.bolt}$	Bolt factor
n_{bolt}	Number of bolts	f_y	Yield stress, construction steel
γ_f	Load factor	$A_{shear.c}$	Shear area, clamp padeye
t_{pipe}	Wall thickness of pipe	$A_{s.bolt}$	Cross sectional area, bolt
σ_h	Hoop stress	$A_{shear.b}$	Shear area, brace padeye
σ_N	Normal stress	$t_{p.b}$	Thickness of brace padeye plate
σ_{bz}	Bending stress, strong axis	M	Bending moment
σ_{by}	Bending stress, weak axis	w	Section modulus
		C	Compression force in brace
		h	Height of plate cross section

The bolts must be able to transfer enough compression force on the pipe to ensure that the friction capacity between the clamp and the spool is greater than the external shear forces:

- A bolt diameter is selected for check
- According to (Williams, 1988), the necessary pressure to prevent clamp uplift is determined by the equation:

$$\sigma = \sqrt{\left(\frac{2 * F_y}{\alpha * \pi * R * L}\right)^2 + \left(\frac{M_1 * 6}{\alpha * \pi * R * L^2}\right)^2}$$

- (Williams, 1988): Capacity against slip is determined by:

$$\tau = \sqrt{\left(\frac{F_x}{\alpha * \pi * R * L}\right)^2 + \left(\frac{M_0}{R * \alpha * \pi * R * L}\right)^2}$$

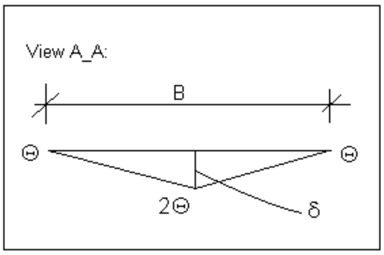
- Maximum pretension load of the bolts is given by (ref. NS3472 (Norsk Standard), Section 12.5.2.7):

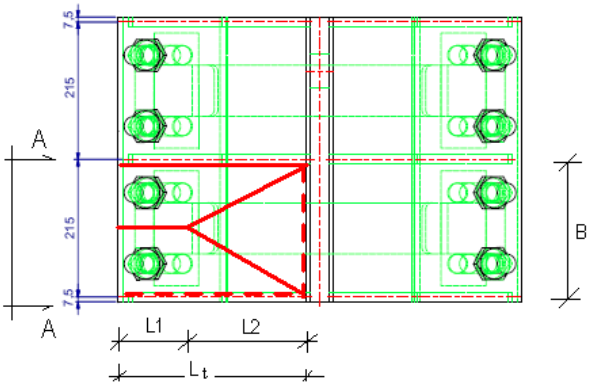
$$F_{pre.bolt} = 0.63 * A_{s.bolt} * f_{u.bolt}$$

- A pretension load is chosen, and checked against the capacities for uplift and slip.

The bolts rest on the plates of the clamp, and therefore exert loads to it.

- The clamp flange plates capacities are checked by using unit deflection method. The external work from the bolts is checked against the internal work needed to achieve the same unit deflection, and plasticity is reached.





External work: $$W_e = 2 * F_{pre.bolt} * \gamma_f * \delta$$

Plastic moment capacity, plate: $$m_p = \frac{(t_{fp})^2 * f_y}{4 * \gamma_{m.steel}}$$

Internal work: $$W_i = m_p * \left[L1 * 2 * \frac{\delta}{\frac{B}{2}} + L2 * 2 * \frac{\delta}{\frac{B}{2}} + (L1 + L2) * \frac{\delta}{\frac{B}{2}} + B * \frac{\delta}{(L1+L2)} \right]$$

Utilization: $$UR = \frac{W_e}{W_i}$$

The capacity of the Kevlar strops must be larger than the force applied by the bolts. Also, the minimum bending diameter and width of bolt required from the manufacturer must not be exceeded.

- Kevlar strops are chosen and checked.

Allowable load: $$F_{a.kev} = \frac{MBL}{\gamma_{kev}}$$

Tension in Kevlar strop: $$F_{t.kev} = 2 * F_{pre.bolt} * \gamma_f$$

Utilization: $$UR = \frac{F_{t.kev}}{F_{a.kev}}$$

Stresses on the spool pipe are checked.

- Axial and shear forces, as well as moments at the connection point between clamp and spool are retrieved from Staad.Pro.
- These forces are used to calculate normal, bending, torsional and shear stresses in the spool.
- Clamp pressure on pipe is found by:

$$P_{pipe} = \frac{-F_{res} * n_{bolt} * \gamma_f}{L * \alpha * R}$$

From this, the hoop stress in the pipe can be found:

$$\sigma_h = \frac{P_{pipe} * R}{t_{pipe}}$$

- Then, the combined stresses are found for strong and weak axis respectively:

$$\sigma_{pipe.S} = \sqrt{(\sigma_h)^2 + (\sigma_{bz} + \sigma_N)^2 - \sigma_h * (\sigma_{bz} + \sigma_N) + 3(\tau_t^2 + \tau_y^2)}$$

$$\sigma_{pipe.W} = \sqrt{(\sigma_h)^2 + \left(\sigma_{by} + \sigma_N\right)^2 - \sigma_h * \left(\sigma_{by} + \sigma_N\right) + 3(\tau_t^2 + \tau_z^2)}$$

- The allowable stress in the pipe is found:

$$\sigma_A = \frac{f_{ys}}{\gamma_{m.steel}}$$

The utilization of the spool is checked:

$$U.R = \frac{\max(\sigma_{pipe.S} \, , \; \sigma_{pipe.W})}{\sigma_A}$$

The padeye plate on the clamp is checked:

- Bearing stress capacity of clamp padeye

$$F_B = \frac{1.5 * f_{8.8} * d_{bolt} * t_p}{\gamma_{m.bolt}}$$

Tear out capacity of clamp padeye

$$F_{T.c} = \frac{f_y * A_{shear.c}}{\gamma_{m.steel} * \sqrt{3}}$$

Shear capacity of bolt

$$F_s = \frac{0.6 * f_{8.8} * n_{bolts} * A_{s.bolt}}{\gamma_{m.bolt}}$$

End section of brace bar:

- Tear out of brace padeye

$$F_{T.b} = \frac{f_y * A_{shear.b}}{\gamma_{m.steel} * \sqrt{3}}$$

Bearing stress

$$F_B = \frac{1.5 * f_{8.8} * d_{bolt} * t_{p.b}}{\gamma_{m.bolt}}$$

Cross section of plate:

- Perpendicular stress

$$\sigma_p = \frac{M}{w} + \frac{C}{2 * h * t_{p.b}}$$

- Shear stress

$$\tau = \frac{F_y}{h * t_{p.b}}$$

- Combined stress

$$\sigma_c = \sqrt{\left(\sigma_p\right)^2 + 3 * (\tau)^2}$$

- Utilization is checked:

$$UR = \sigma_c * \frac{\gamma_{m.steel}}{f_y}$$

3.7 Check list for spreader cases

The following chapter presents basic checks that are performed when a spreader beam solution is used.

The spreader beam is built up by sections of pipe (Figure 3.7-1). The sections are connected by flanges bolted together. This enables the spreader length to be changed and used for lifting different spools. The capacity of the bolted connections is checked to see if they are larger than the capacity of the pipe. If the connections have larger moment and shear capacity, we can assume that the Staad.Pro analysis of the spreader beam covers all necessary checks except padeye design.

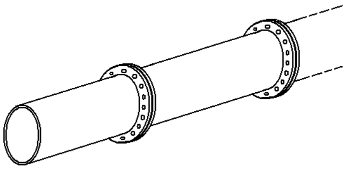


Figure 3.7-1 Bolted connections, spreader beam

The following abbreviations and symbols are used in the equations in this chapter:

Table 3.7-1 Abbreviations and symbols for spreader bar check list

Symbol	Description	Symbol	Description
f_y	Yield stress, pipe material	$A_{s.bolt}$	Cross sectional area of bolt
γ_m	Material factor, steel	$\gamma_{m.bolt}$	Bolt factor
A	Section area	n_{bolts}	Number of bolts
W	Section modulus	d	Distance between bolts
$f_{8.8}$	Ultimate strength, grade 8.8 bolts		

Allowable stress is defined:

$$f_A = \frac{f_y}{\gamma_m}$$

Axial capacity of the spreader beam pipe is found:

$$F_{A.pipe} = A * f_A$$

Moment capacity:

$$M_{pipe} = W * f_A$$

Shear capacity:

$$V_{pipe} = \frac{2 * A * f_A}{\pi * \sqrt{3}}$$

Bolted connections are checked.

- According to NS 3472 (Norsk Standard) – 12.5.2.3, the axial capacity of a bolt is:

$$F_{bolt} = \frac{0.9 * f_{8.8} * A_{s.bolt}}{\gamma_{m.bolt}}$$

Total axial capacity for the bolts is given by:

$$F_{A.Bolts} = n_{bolts} * F_{bolt}$$

If the bolts capacity is larger than the pipes, the check is OK.

$$F_{A.Bolts} > F_{A.pipe} \rightarrow OK$$

Moment capacity for the bolts is found by looking at a selection of bolts on the upper and lower edge of the pipe flange (see Figure 3.7-2):

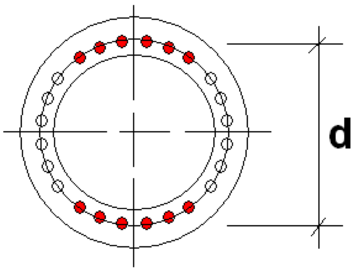


Figure 3.7-2 Spreader beam flange bolts

$$M_{Bolts} = 6 * F_{Bolt} * d$$

If the bolts capacity is larger than the pipes, the check is OK.

$$M_{Bolts} > M_{pipe} \rightarrow OK$$

Shear capacity of the bolts is found. According to NS 3472 (Norsk Standard) – 12.5.2.1, this is:

$$F_s = \frac{0.6 * f_{8.8} * n_{bolts} * A_{s.bolt}}{\gamma_{m.bolt}}$$

If the bolts capacity is larger than the pipes, the check is OK.

$$F_s > V_{pipe} \rightarrow OK$$

Padeye capacity calculations are the same as the ones presented for the brace case.

4 Results, structural part

4.1 General

This chapter presents the results from the analyses and tests performed on spools and pipe sections. The results are commented and discussed consecutively as the analyses are presented.

4.2 Staad.Pro results, brace case

4.2.1 Figures

An overview of the spool with brace bars subjected to load is shown in Figure 4.2-1. The bending moments occurring abut local Z- and Y-axis are displayed.

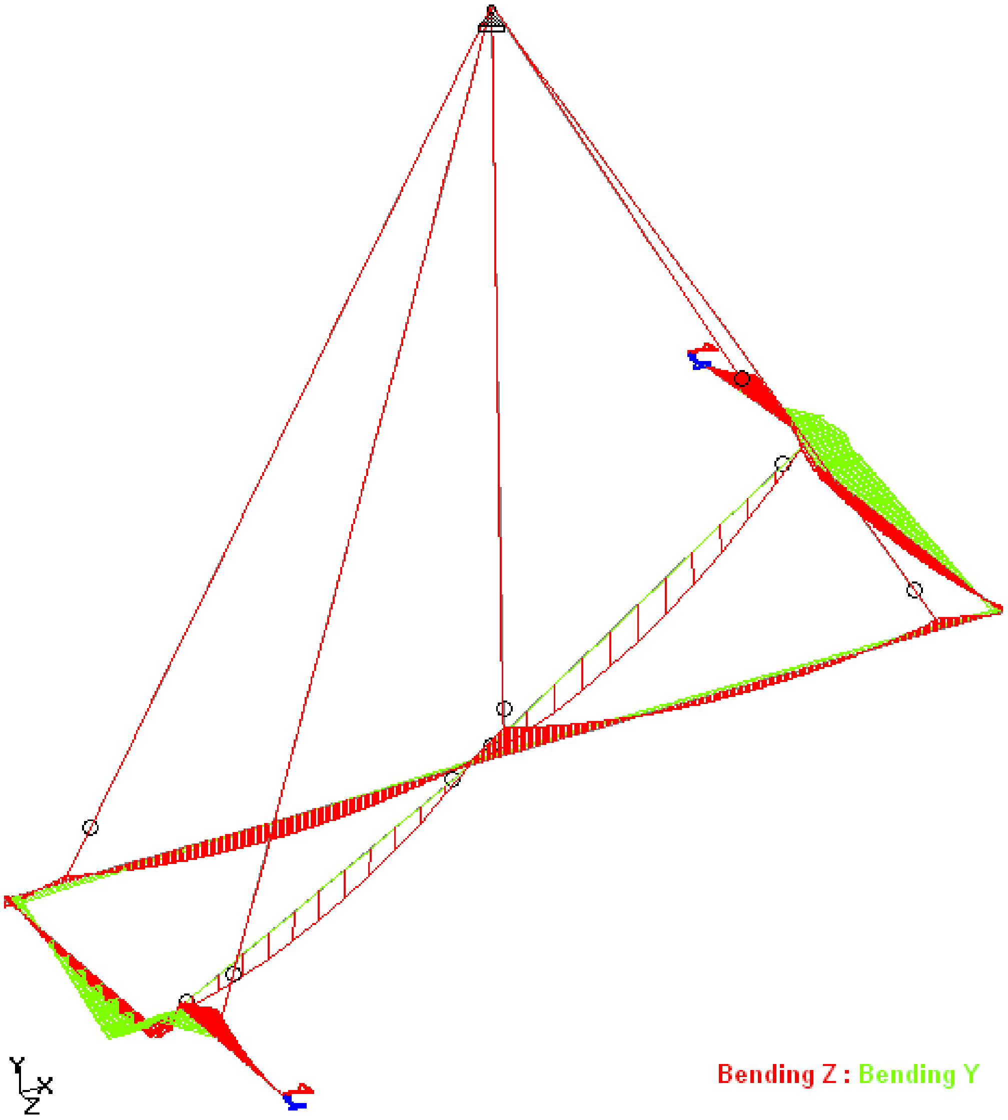


Figure 4.2-1 ISO view of bending moments, brace

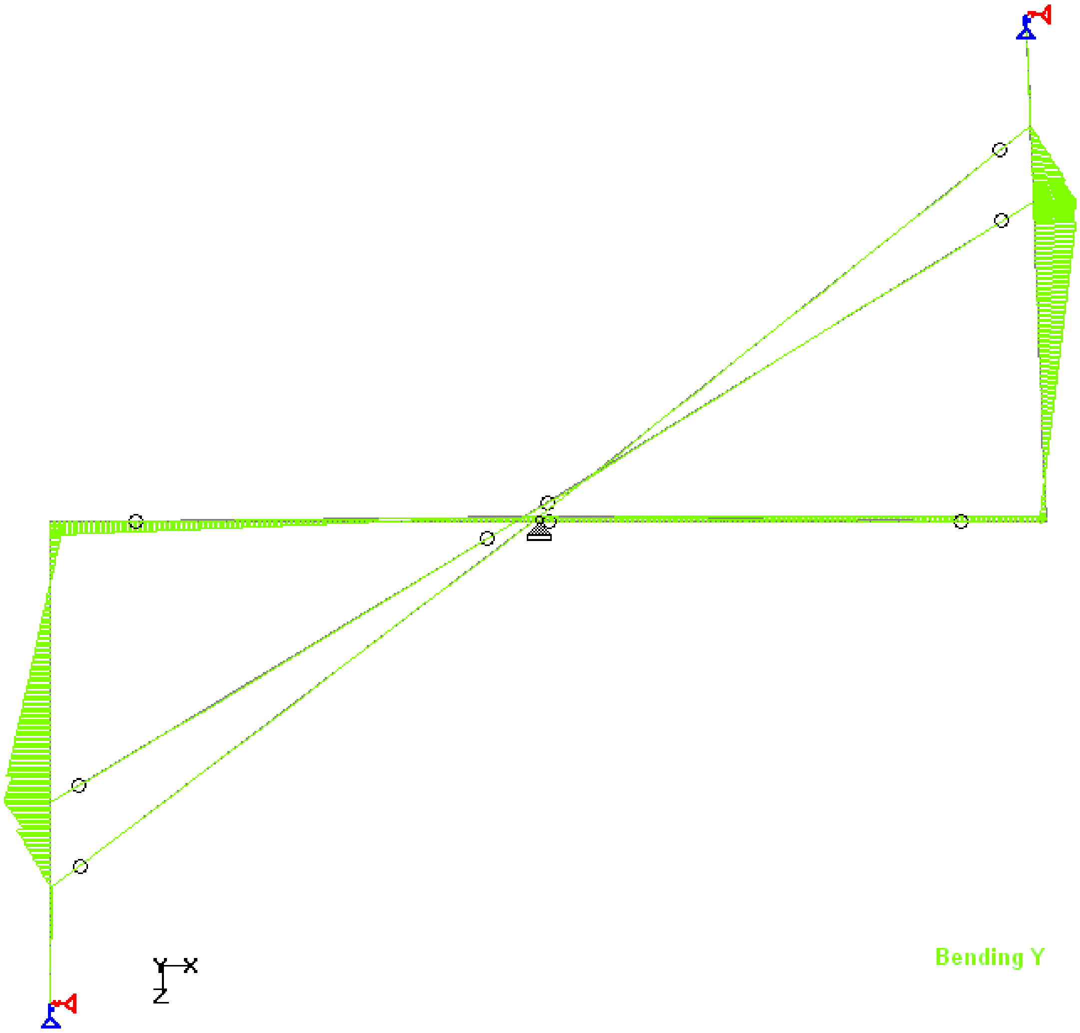


Figure 4.2-2 Bending moments viewed from above, brace

Figure 4.2-1 and Figure 4.2-2 show relatively large bending moments in the XZ-plane at the connection points between the braces and the spool. This is caused by the horizontal force combined with the distance between the end of the brace bar and the wire sling (members 201 and 304, 200 and 300).

The peak value is found in members 7 and 8, with a bending moment of **515 kNm**.

Notice:
Since the braces take up most of the horizontal forces from the slings (Figure 4.2-5), virtually no bending moment occurs in the two 90 degree bends of the spool (area around members 17 and 52).

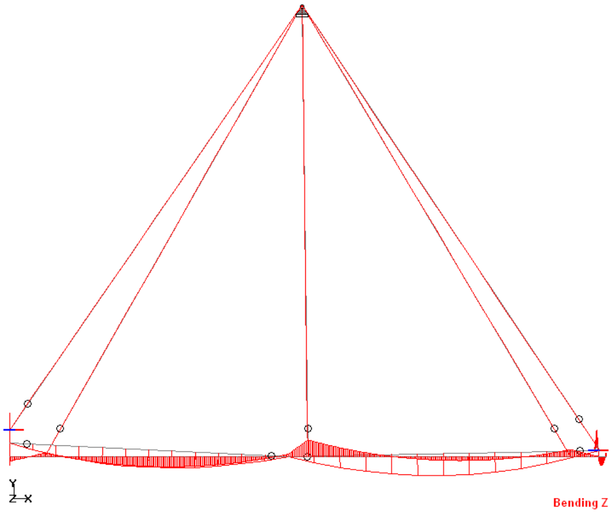


Figure 4.2-3 XY-plane view of bending moments, brace

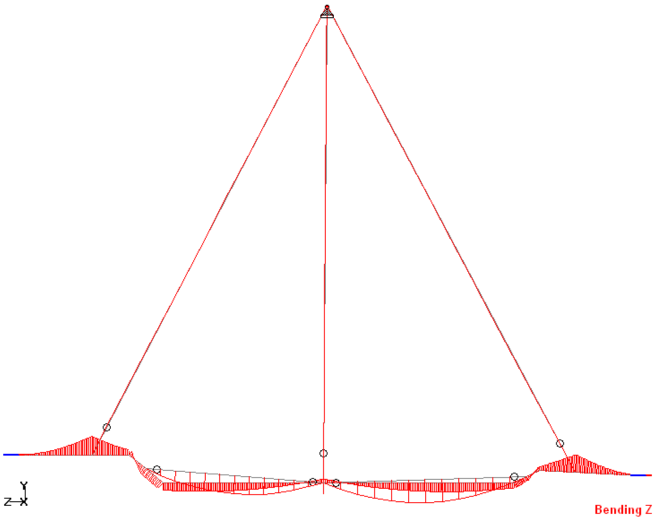


Figure 4.2-4 ZY-plane view of bending moments, brace

Bending moments in the XY-plane peak where the center wire (member 302) is connected. This is due to the weight of the long spool section and the brace bars. The peak value occurs in members 34 and 35 with **310 kNm**

The heavy termination heads and the ends of the spool induce bending moments in the ZY-plane at the connection points of the wires. The peak value in these points is **281 kNm**, and is found in member 65.

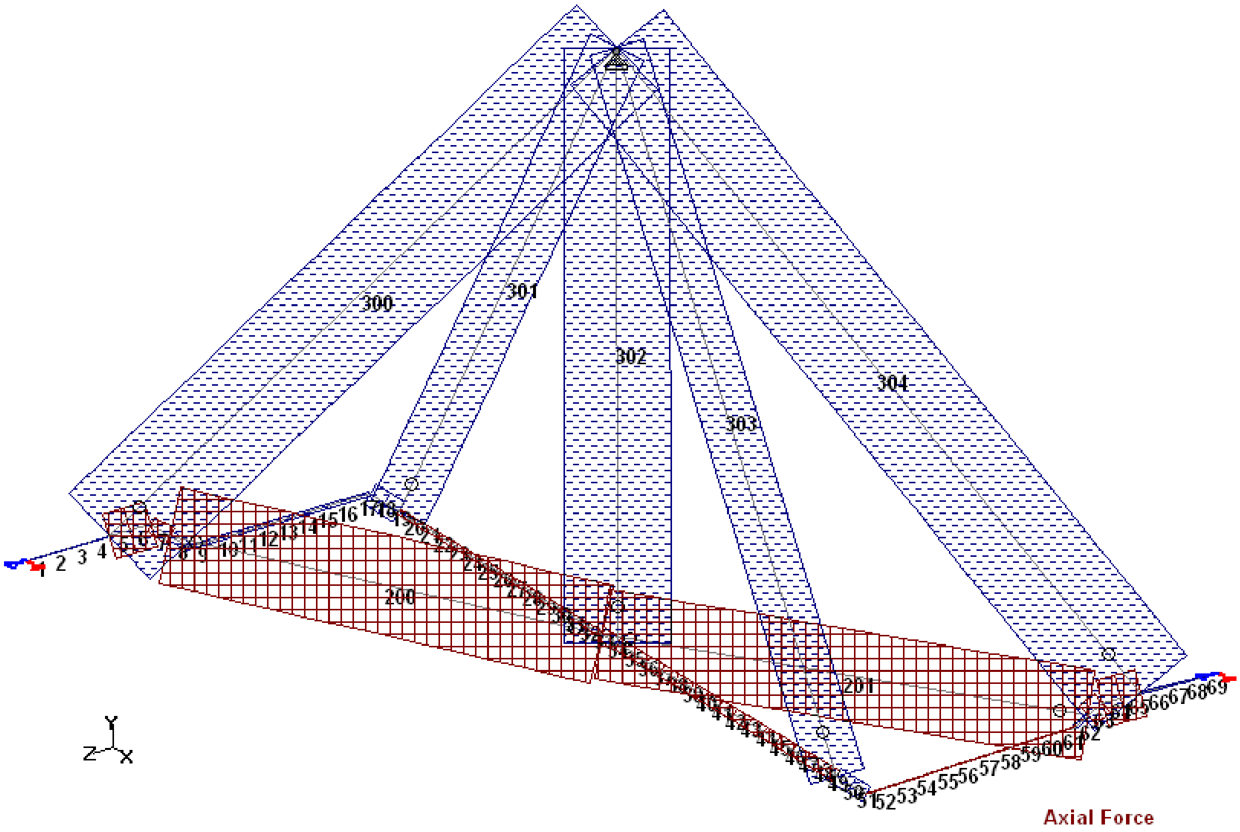


Figure 4.2-5 Graphical display of axial forces, brace. Blue=Tension, Brown=Compression

Table 4.2-1 Axial forces in wires and braces

Member	Force [kN]
200	-320
201	-294
300	382
301	197
302	370
303	187
304	381
34	-45

Figure 4.2-5 shows large axial forces in the brace bars. The spool is nearly unaffected by axial forces, except in two places. In the pipe sections between the end wires and the brace bars we find axial forces in the order of ~**150 kN**. Also, between the connection points for wires 301 and 303, a compression force of **45 kN** occurs.

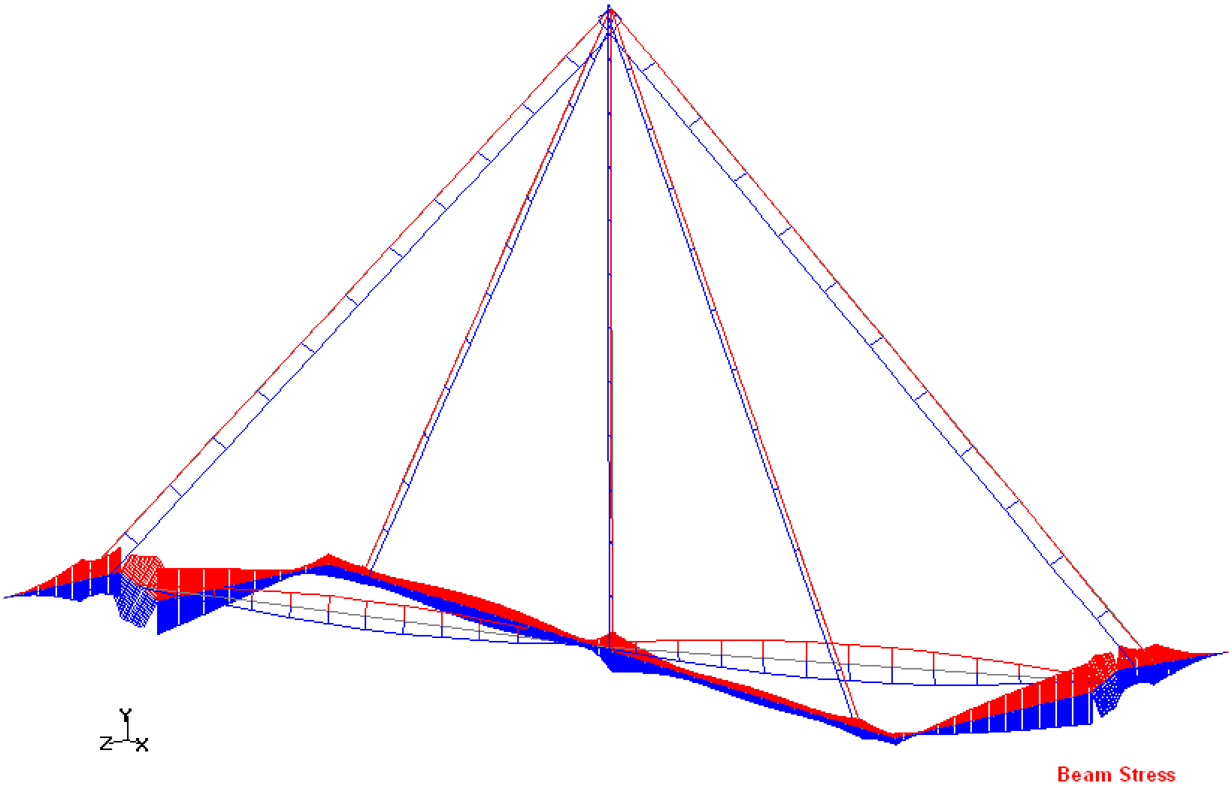


Figure 4.2-6 Beam stress, brace

The areas and members with the highest beam stresses are located through Figure 4.2-6. The members with the highest stresses in the brace case are members 4, 5, 7, 8, 26, 27, 34, 35, 49, 50, 62, 63, 65, 66, 200 and 201.

The values for the beam stresses are presented in Table 4.2-3.

4.2.2 Numerical results

The 20 members with highest utilization are presented in Table 4.2-2. Specially commented values are marked with yellow.

The biggest utilizations are found in the spool members subjected to the largest compression forces (members 5, 6, 7, 63, 64 and 65).

The highest utilization for the brace case is **96 %.**

Table 4.2-2 Results from structural analysis of brace case

Member	Utilization	Type of load	Failure mode	Due to loadcase
5	96 %	Compression	Stability	115
65	94 %	Compression	Stability	115
6	92 %	Compression	Stability	115
64	91 %	Compression	Stability	115
7	84 %	Compression	Stability	115
63	68 %	Compression	Stability	115
201	66 %	Compression	Stability	115
8	64 %	Tension	Von Mises	115
34	61 %	Compression	Stability	115
35	61 %	Compression	Stability	115
9	57 %	Tension	Von Mises	115
62	57 %	Tension	Von Mises	115
61	55 %	Compression	Stability	115
200	52 %	Compression	Stability	115
10	50 %	Tension	Von Mises	115
60	50 %	Compression	Stability	115
36	48 %	Compression	Stability	115
59	45 %	Compression	Stability	115
11	44 %	Tension	Von Mises	115
58	40 %	Compression	Stability	115

Notice:

From Table 4.2-2 we see that member 65 has a much higher utilization than member 8, but at the same time we can see in Table 4.2-3 that member 8 is subjected to over twice as much combined stress as member 65. This high utilization is therefore explained by the high axial compression stress and the much higher buckling length factor (3.40 vs. 0.68), again showing the importance and effect of this parameter.

Stresses are presented for the members with the highest stresses found from Figure 4.2-6. Commented values are marked yellow:

Table 4.2-3 Highest stresses, brace case

Unit: kN/m^2									
Member	**Load**	**End**	**Axial**	**Type**	**Bend-Y**	**Bend-Z**	**Combined**	**Shear-Y**	**Shear-Z**
4	115	0	43.1	T	2960.5	72756.5	72859.9	7752.2	157.7
		1	43.1	T	3947.3	123331.3	123437.6	8414.1	157.7
5	115	0	4885.5	C	3947.3	123331.3	128280	10334.3	12789.7
		1	4885.5	C	76076	60741.7	102236	9672.4	12789.7
7	115	0	1457.8	C	121263.9	12453.7	123359.4	11860	12789.7
		1	1709	C	217234.7	74227.8	231275.2	11243.4	12789.7
8	115	0	889.4	T	217234.7	74227.8	230455.7	835.2	4771.1
		1	638.2	T	181433.5	78181.1	198199.3	218.5	4771.1
26	115	0	795.2	C	18126.3	79767.8	82596.5	924.6	773.5
		1	795.2	C	13232.2	83500.2	85337.3	255.2	773.5
27	115	0	795.2	C	13232.2	83500.2	85337.3	255.2	773.5
		1	795.2	C	8338	82997.5	84210.5	414.1	773.5
34	115	0	1446	C	20524.5	6102.9	22858.6	17468.3	277.6
		1	1446	C	22461.3	130552.6	133916.6	18206.4	277.6
35	115	0	1300.5	C	22461.3	130552.6	133771.2	5791.3	114.4
		1	1300.5	C	23185.5	96026.5	100086.5	5121.9	114.4
49	115	0	1300.5	C	32599.5	32587.9	47395	3579.5	114.4
		1	1300.5	C	33323.6	57354.2	67632.8	4248.8	114.4
50	115	0	1814.6	T	33323.6	57354.2	68146.9	6141.8	43.8
		1	1814.6	T	33600.6	20610.2	41232.7	5472.4	43.8
62	115	0	394.8	T	186390.1	61238.1	196586.9	1915.6	3609.9
		1	503	T	203775	50900.9	210539	2377.3	3609.9
63	115	0	2511	C	203767.5	50903.5	212540.5	11833.6	13036.3
		1	2402.8	C	140993.9	7190.2	143579.9	12295.2	13036.3
65	115	0	5039.1	C	81082.6	61024.9	106520.3	9247.6	13036.9
		1	5055.9	C	2481.1	118700.1	123781.9	9884.5	13036.9
66	115	0	206.1	T	2481.7	118700.1	118932.1	8383.6	102.9
		1	189.3	T	1861.4	70073.5	70287.5	7746.7	102.9
200	115	0	10701.3	C	0	0	10701.3	5955.1	0
		1	10941.2	C	0	0	10941.2	5955.1	0
201	115	0	10145.9	C	0	0	10145.9	6672.3	0
		1	10042.6	C	0	0	10042.6	6672.3	0

Peak values for stress in spool:

Axial:	**5 056**	**kN/m^2**
Combined:	**231 275**	**kN/m^2**

The governing load case is 115. The forces and moments acting on a selection of members are listed for this load case. Forces and moments due to other load cases can be found in appendix 9.7. Values commented are marked with yellow.

Table 4.2-4 Forces and moments, load case 115, brace case

Units: kN, m							
Member	**Joint**	**Axial**	**Shear-Y**	**Shear-Z**	**Torsion**	**Mom-Y**	**Mom-Z**
200.00	14.00	312.35	87.00	0.00	0.00	0.00	0.00
	38.00	-319.36	87.00	0.00	0.00	0.00	0.00
201.00	38.00	296.15	97.47	0.00	0.00	0.00	0.00
	65.00	-293.13	97.47	0.00	0.00	0.00	0.00
6.00	13.00	149.69	123.93	196.93	0.00	180.35	144.00
	5.00	-149.69	-113.74	-196.93	0.00	-370.06	-29.52
7.00	5.00	44.66	182.62	196.93	-233.03	287.48	29.52
	14.00	-52.36	-173.12	-196.93	233.03	-514.99	175.97
8.00	14.00	-27.25	12.86	-73.46	-233.03	514.99	-175.97
	6.00	19.55	-3.36	73.46	233.03	-430.12	185.34
22.00	26.00	24.36	55.46	11.91	64.35	-89.38	-53.31
	27.00	-24.36	-45.15	-11.91	-64.35	77.78	102.32
23.00	27.00	24.36	45.15	11.91	64.35	-77.78	-102.32
	28.00	-24.36	-34.85	-11.91	-64.35	66.18	141.29
33.00	37.00	24.36	-57.91	11.91	64.35	38.25	-40.20
	38.00	-24.36	67.16	-11.91	-64.35	-48.66	-14.47
34.00	38.00	44.30	-268.97	4.27	64.35	48.66	14.47
	39.00	-44.30	280.33	-4.27	-64.35	-53.25	-309.50
35.00	39.00	39.85	89.17	1.76	64.35	53.25	309.50
	40.00	-39.85	-78.86	-1.76	-64.35	-54.97	-227.65
46.00	50.00	39.85	-24.20	1.76	64.35	72.13	-38.64
	51.00	-39.85	34.50	-1.76	-64.35	-73.85	10.05
47.00	51.00	39.85	-34.50	1.76	64.35	73.85	-10.05
	52.00	-39.85	44.81	-1.76	-64.35	-75.57	-28.58
63.00	65.00	76.94	-182.21	200.73	-177.75	-483.07	-120.68
	8.00	-73.62	189.32	-200.73	177.75	334.25	-17.05
64.00	8.00	153.86	-132.58	200.75	0.00	-378.58	17.04
	66.00	-154.37	142.39	-200.75	0.00	192.22	-144.67
65.00	66.00	154.39	-142.39	200.74	0.02	-192.22	144.67
	67.00	-154.91	152.20	-200.74	-0.02	5.88	-281.40

4.3 Staad.Pro results, spreader case

4.3.1 Figures

An overview of the spool with spreader beam subjected to load is shown in Figure 4.3-1. The bending moments occurring abut local Z- and Y-axis are displayed.

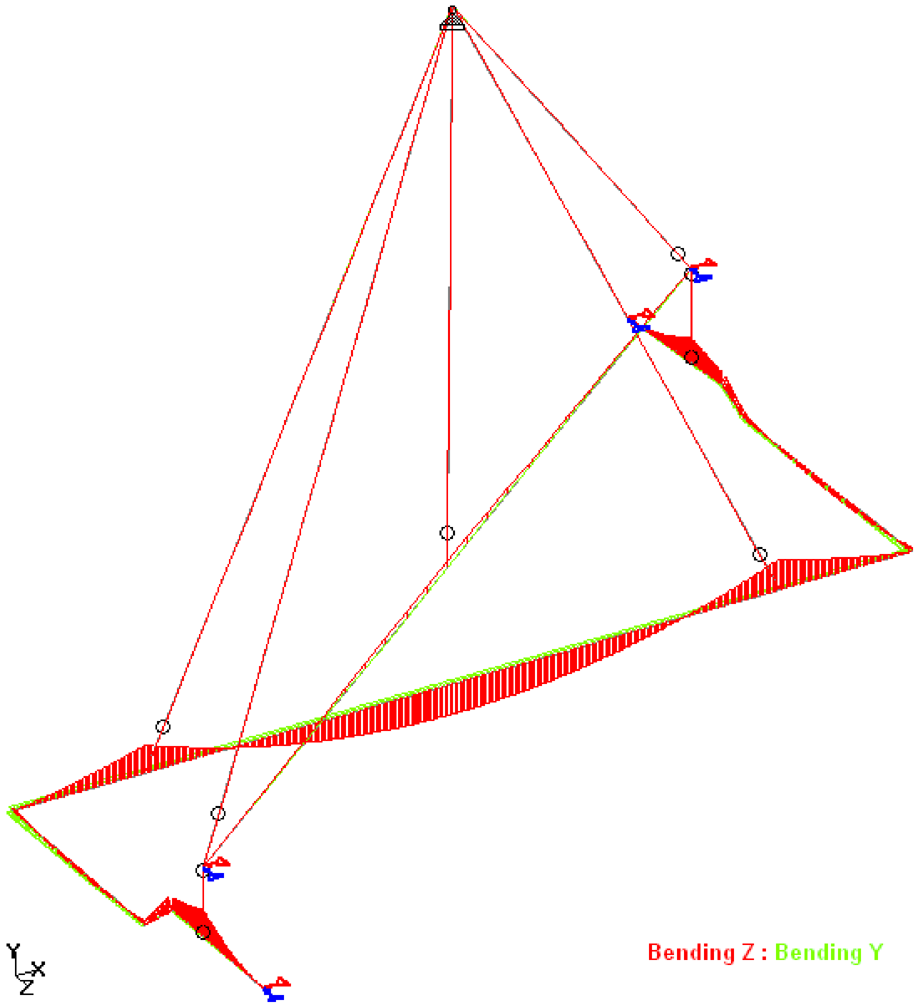


Figure 4.3-1 ISO view of bending moments, spreader

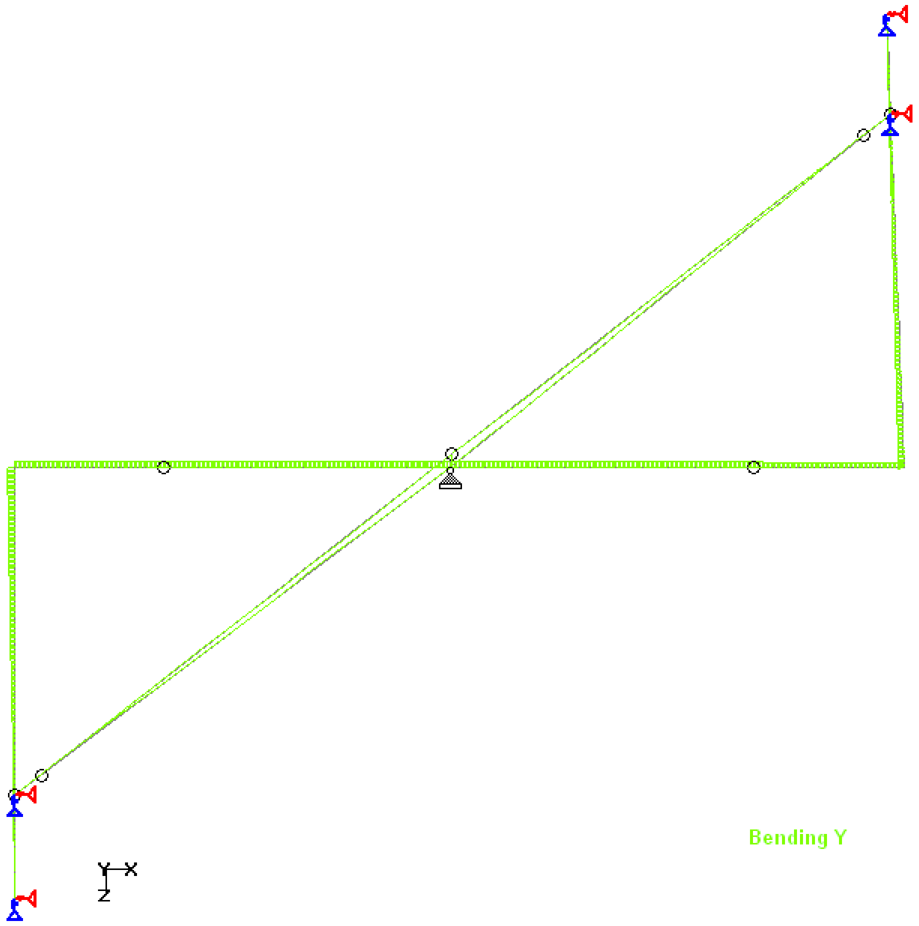


Figure 4.3-2 Bending moments viewed from above, spreader

As opposed to the brace case, we can see from Figure 4.3-1 and Figure 4.3-2 that virtually no horizontal bending moment is exerted on the spool if a spreader beam is used.

This is because the connection points on the ends of the spreader beam are placed directly above the connection points on the spool. We then end up with wires running vertically between the spool and the spreader.

The peak value is found in members 17 and 18, with a bending moment of **62 kNm**.

Special consideration:

If the spreader beam is set into motion (by for instance vessel movement), and moves out of frequency with the spool, horizontal forces *will* be applied to the spool. These forces will most likely be larger than that which the DAF covers in the spreader case analysis performed for this thesis. Horizontal forces should therefore be considered added in an extended analysis.

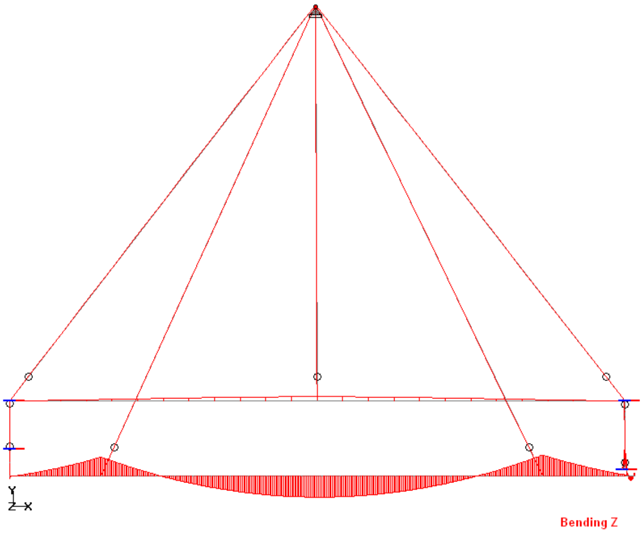


Figure 4.3-3 XY-plane view of bending moments, spreader

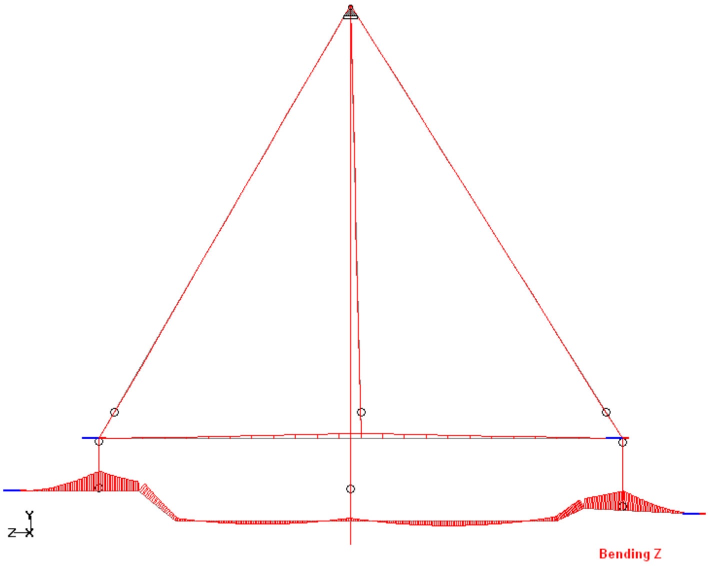


Figure 4.3-4 ZY-plane view of bending moments, spreader

Bending moment curves in the vertical direction are quite similar in the spreader and brace cases seen perpendicular to the ZY-plane (Figure 4.2-4 and Figure 4.3-4). This is because the weights of the spool and termination heads are unchanged, and the connection points between the wires and the spool are the same. Peak value is **203 kNm**, in member 65.

The largest difference is found in the long section in the XY-plane view, where the brace bar solution has three connection points on the spool, while the spreader bar has two (see Figure 4.2-3 and Figure 4.3-3). This leads to a different shape in the bending moment curve, and a bit lower values. The peak value is **276 kNm**, and occurs in members 46 and 47.

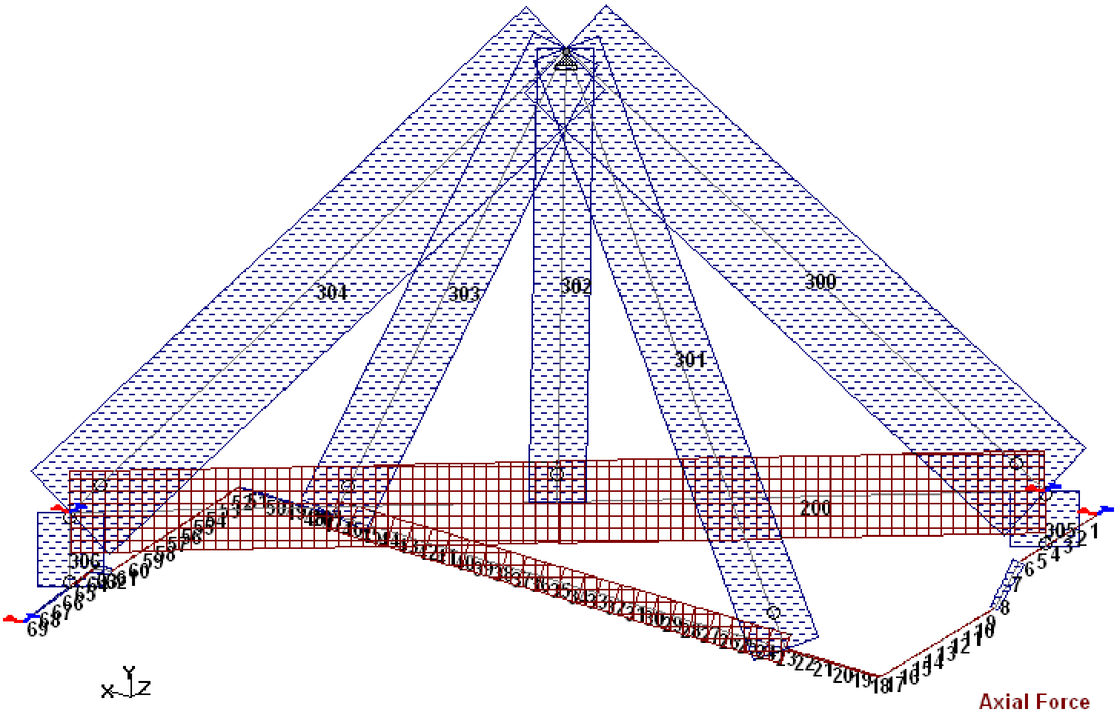


Figure 4.3-5 Graphical display of axial forces, spreader. Blue=Tension, Brown=Compression

Table 4.3-1 Axial forces in wires and spreader

Member	Force [kN]
200	-201
201	-199
300	297
301	176
302	146
303	184
304	277
34	-76

In the spreader case, the only part of the spool experiencing significant compression loads are the members between the two slings connected directly to the spool (members 23 through 46).

Compared to the figure showing axial forces in the brace case (Figure 4.2-5), we here see that the compression force in the spool for members between wires 301 and 303 is increased from 45kN to **76kN**. This is because the horizontal bending moment we find in the brace case *counteracts* the compression force caused by wires 301 and 303.

Since this bending moment is not present in the spreader case, the horizontal force from the wires (roughly the same in both cases) is taken up by the spool, and causes this slightly higher compression force.

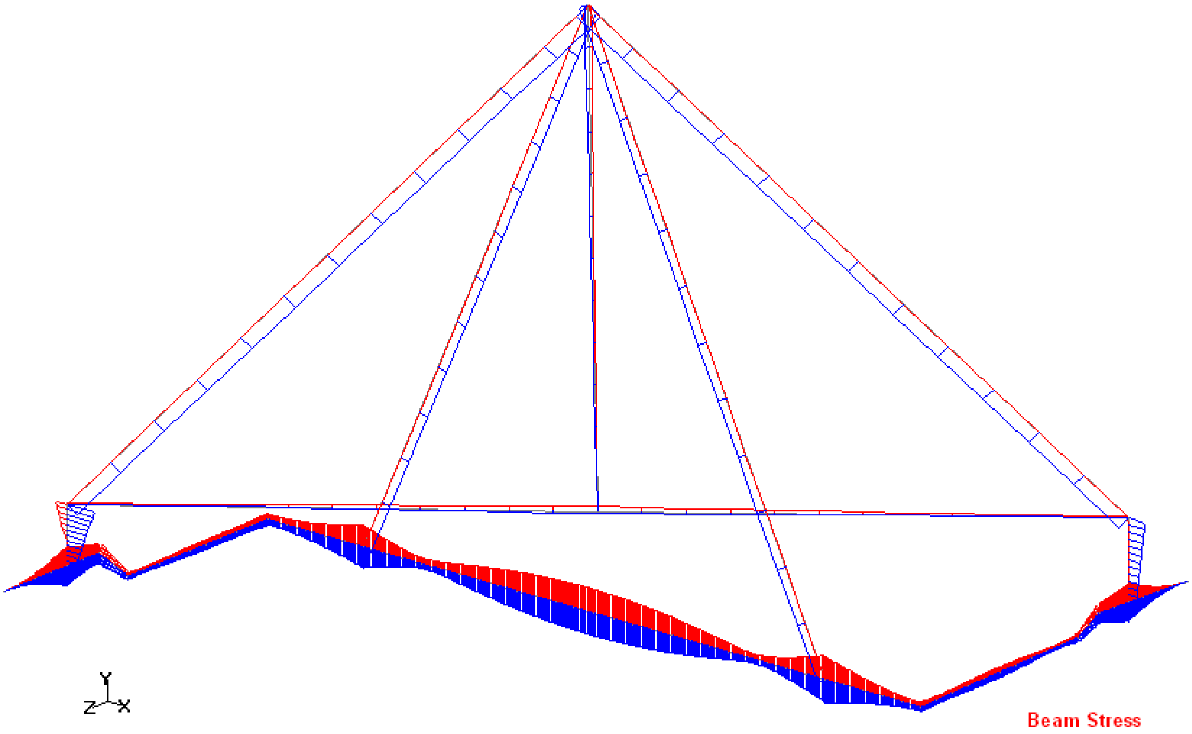


Figure 4.3-6 Beam stress, spreader

The areas and members with the highest beam stresses are located through Figure 4.3-6. The members with the highest stresses in the brace case are members 4, 5, 22, 23, 34, 35, 46, 47, 65, 66, 200 and 201.

The values for the beam stresses are presented in Table 4.3-3.

4.3.2 Numerical results

The 20 members with highest utilization are presented in Table 4.3-2

Table 4.3-2 Results from structural analysis of spreader case

Member	Utilization	Type of load	Failure mode	Due to load case
200	75 %	Compression	Stability	116
201	75 %	Compression	Stability	116
34	46 %	Compression	Stability	115
46	43 %	Compression	Stability	115
35	42 %	Compression	Stability	115
36	41 %	Compression	Stability	115
23	40 %	Compression	Stability	115
32	40 %	Compression	Stability	115
37	39 %	Compression	Stability	115
31	38 %	Compression	Stability	115
33	38 %	Compression	Stability	115
38	37 %	Compression	Stability	115
30	34 %	Compression	Stability	115
39	33 %	Compression	Stability	115
45	32 %	Compression	Stability	115
47	31 %	Tension	Von Mises	115
29	30 %	Compression	Stability	115
22	29 %	Compression	Von Mises	115
24	29 %	Compression	Stability	115
40	28 %	Compression	Stability	115

Compared to Table 4.2-2, showing utilizations for the brace case, we see that the utilization for lifting support (brace/spreader) has increased from 57% and 66% to 75% even though the compression force is decreased significantly. This is due to the difference in the applied buckling length, and the bending moment.

The highest utilization in the spool is found in the members located towards the middle of the long section (members 34, 35, 36) and at the connection point of the wire (member 46).

The peak utilization for the spreader case is **46%**.

Stresses are presented for the members with the highest stresses found from Figure 4.3-6. Values that are commented are marked with yellow:

Table 4.3-3 Highest stresses, spreader

Unit: kN/m2									
Member	**Load**	**End**	**Axial**	**Type**	**Bend-Y**	**Bend-Z**	**Combined**	**Shear-Y**	**Shear-Z**
4	115	0	8.5	C	3128.5	52492.1	52593.8	5593	166.7
		1	8.5	C	4171.4	88980.6	89086.9	6070.6	166.7
5	115	0	7.8	C	4171.4	88980.6	89086.1	5200.6	277.2
		1	7.8	C	5905.8	57934.8	58242.8	4723.1	277.2
22	115	0	139.3	C	25650.5	78709.8	82923.3	4179.2	15.4
		1	139.3	C	25552.9	106681.3	109838.2	4662.1	15.4
23	115	0	2512	C	25552.9	106681.3	112210.9	5731.1	29.3
		1	2512	C	25367.4	71945.4	78798.6	5248.2	29.3
34	115	0	2512	C	23531.4	107066.3	112133.7	468.7	29.3
		1	2512	C	23326.9	108478.9	113470.6	63.8	29.3
35	115	0	2512	C	23326.9	108478.9	113470.6	63.8	29.3
		1	2512	C	23141.4	106547.6	111543.7	546.7	29.3
46	115	0	2512	C	21286.4	80824.5	86092.5	5375.8	29.3
		1	2512	C	21100.9	116367.1	120776.7	5858.7	29.3
47	115	0	87.4	T	21100.9	116367.1	118352.2	4895.6	43.5
		1	87.4	T	20825.6	86918.3	89465.8	4412.7	43.5
65	115	0	121.9	C	6013.9	62202.8	62614.7	3663.9	172.1
		1	134	C	4976.1	85678.2	85956.6	4123.4	172.1
66	115	0	133.2	T	4975.7	85678.3	85955.8	6050.2	206.3
		1	121.1	T	3731.7	50585.6	50844.2	5590.7	206.3
200	116	0	5828.3	C	119.9	492.1	6334.8	3887.4	109
		1	5828.3	C	9676.8	127202.1	133397.9	6800.1	109
201	116	0	5711.4	C	9671.6	127202.2	133280.7	6796.7	109
		1	5711.4	C	117.6	191.4	5936	3890.8	109

Peak values for stress in spool:

Axial:	**2 512**	**kN/m^2**
Combined:	**120 777**	**kN/m^2**

The forces and moments occurring in selected members are shown in the following table. Values that are commented are marked with yellow.

Table 4.3-4 Forces and moments, load case 115, spreader case

Units: kN, m							
Member	**Joint**	**Axial**	**Shear-Y**	**Shear-Z**	**Torsion**	**Mom-Y**	**Mom-Z**
200.00	200.00	201.44	39.39	-1.16	1.90	-0.79	-3.43
	201.00	-201.44	73.00	1.16	-1.90	24.73	-343.54
201.00	201.00	198.92	72.90	1.16	1.90	-24.70	343.54
	202.00	-198.92	39.48	-1.16	-1.90	0.77	1.46
6.00	13.00	0.24	54.69	4.27	0.00	14.00	137.34
	5.00	-0.24	-47.33	-4.27	0.00	-18.11	-88.21
7.00	5.00	-29.62	36.92	4.27	-11.41	14.07	88.21
	14.00	24.07	-30.07	-4.27	11.41	-19.00	-49.51
8.00	14.00	-24.07	30.07	4.27	-11.41	19.00	49.51
	6.00	18.52	-23.22	-4.27	11.41	-23.93	-18.73
22.00	26.00	4.27	-64.35	-0.24	39.41	60.81	186.60
	27.00	-4.27	71.78	0.24	-39.41	-60.58	-252.91
23.00	27.00	76.97	88.25	-0.45	39.41	60.58	252.91
	28.00	-76.97	-80.81	0.45	-39.41	-60.14	-170.56
33.00	37.00	76.97	13.89	-0.45	39.41	56.18	-244.59
	38.00	-76.97	-7.22	0.45	-39.41	-55.79	253.82
34.00	38.00	76.97	7.22	-0.45	39.41	55.79	-253.82
	39.00	-76.97	0.98	0.45	-39.41	-55.30	257.17
35.00	39.00	76.97	-0.98	-0.45	39.41	55.30	-257.17
	40.00	-76.97	8.42	0.45	-39.41	-54.86	252.59
46.00	50.00	76.97	-82.77	-0.45	39.41	50.46	191.61
	51.00	-76.97	90.21	0.45	-39.41	-50.02	-275.87
47.00	51.00	-2.68	75.38	-0.67	39.41	50.02	275.87
	52.00	2.68	-67.94	0.67	-39.41	-49.37	-206.06
63.00	65.00	-17.81	-40.01	-2.65	7.86	16.72	66.81
	8.00	20.20	45.14	2.65	-7.86	-14.75	-98.38
64.00	8.00	3.36	-49.34	-2.65	0.00	16.72	98.38
	66.00	-3.73	56.41	2.65	0.00	-14.26	-147.46
65.00	66.00	3.73	-56.41	-2.65	0.01	14.26	147.46
	67.00	-4.10	63.49	2.65	-0.01	-11.80	-203.12

4.4 Summary, Staad.Pro results

The main results from the structural analysis are presented in Table 4.4-1.

Table 4.4-1 Summary of results

		Brace	Spreader	
Bending moments	BY	515	62	kNm
	BZ	310	276	kNm
	BZ	281	203	kNm
Axial force	Peak	150	76	kN
	Between wires	45	76	kN
Stress	Axial	5 056	2 512	kN/m^2
	Combined	231 275	120 777	kN/m^2
Utilization	Peak	96	46	%

The difference between the two solutions is biggest at the bending moments in the local about-Y axis, where the spreader bar virtually eliminates the bending moment. There is also a reduction in the local about-Z axis for the spreader case, but not that significant.

For the axial force in the spool, the spreader again has the lowest peak value, but between the wires (301 and 303), the case is the opposite.

The brace case shows higher stresses both axially and combined, as well as a much higher peak value for the spool pipe utilization.

4.5 Buckling analysis results

4.5.1 Results from Straight pipe test 1

The tables presented in the following chapter show the utilization ratios for each of the ten members of the straight pipe. The relative differences between the values are also presented.

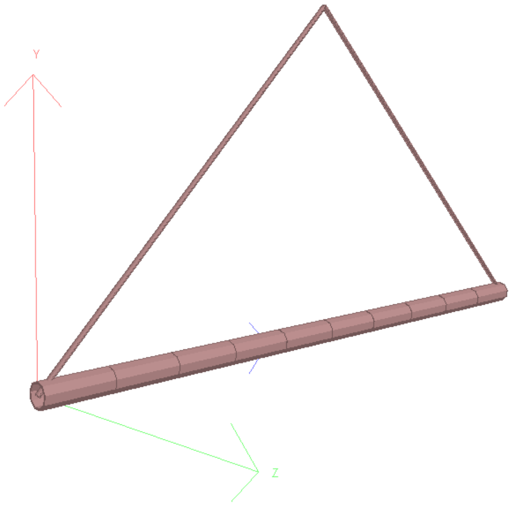


Figure 4.5-1 10 meter pipe used in the test

The results are commented at the end of the chapter section.

4.5.1.1 Outer diameter 0.25m

OD	**0.25**	**GY =**	**-18kN**
ID	**0.20**		
	BY,BZ=1	BY,BZ=10	
Memb*	Utilization	Utilization	**Difference**
5	82	96	**17 %**
6	82	96	**17 %**
4	79	92	**16 %**
7	79	92	**16 %**
3	69	80	**16 %**
8	69	80	**16 %**
2	53	61	**15 %**
9	53	61	**15 %**
1	31	35	**13 %**
10	31	35	**13 %**
		Avg.	**15 %**

OD	**0.25**	**GY =**	**-9kN**
ID	**0.23**		
	BY,BZ=1	BY,BZ=10	
Memb*	Utilization	Utilization	**Difference**
5	86	100	**16 %**
6	86	100	**16 %**
4	83	96	**16 %**
7	83	96	**16 %**
3	73	84	**15 %**
8	73	84	**15 %**
2	56	64	**14 %**
9	56	64	**14 %**
1	33	37	**12 %**
10	33	37	**12 %**
		Avg.	**15 %**

OD	**0.25**	**GY =**	**-4.5kN**
ID	**0.24**		
	BY,BZ=1	BY,BZ=10	
Memb*	Utilization	Utilization	**Difference**
5	81	94	**16 %**
6	81	94	**16 %**
4	78	90	**15 %**
7	78	90	**15 %**
3	68	78	**15 %**
8	68	78	**15 %**
2	53	60	**13 %**
9	53	60	**13 %**
1	31	34	**10 %**
10	31	34	**10 %**
		Avg.	**14 %**

*Refer to Figure 3.5-2

4.5.1.2 Outer diameter 0.35m

OD	0.35	GY =	-40kN
ID	0.30		
	BY, BZ = 1	BY, BZ = 10	
Memb*	Utilization	Utilization	Difference
5	87	95	9 %
6	87	95	9 %
4	83	91	10 %
7	83	91	10 %
3	73	79	8 %
8	73	79	8 %
2	56	61	9 %
9	56	61	9 %
1	33	35	6 %
10	33	35	6 %
		Avg.	8 %

OD	0.35	GY =	-19kN
ID	0.33		
	BY, BZ = 1	BY, BZ = 10	
Memb*	Utilization	Utilization	Difference
5	90	99	10 %
6	90	99	10 %
4	87	95	9 %
7	87	95	9 %
3	76	83	9 %
8	76	83	9 %
2	59	64	8 %
9	59	64	8 %
1	35	37	6 %
10	35	37	6 %
		Avg.	9 %

OD	0.35	GY =	-10kN
ID	0.34		
	BY, BZ = 1	BY, BZ = 10	
Memb*	Utilization	Utilization	Difference
5	91	100	10 %
6	91	100	10 %
4	88	96	9 %
7	88	96	9 %
3	77	84	9 %
8	77	84	9 %
2	60	64	7 %
9	60	64	7 %
1	36	37	3 %
10	36	37	3 %
		Avg.	8 %

*Refer to Figure 3.5-2

4.5.1.3 Outer diameter 0.50m

OD	**0.50**	**GY =**	**-90kN**
ID	**0.45**		
	BY, BZ = 1	BY, BZ = 10	
Memb*	Utilization	Utilization	**Difference**
5	91	96	**5 %**
6	91	96	**5 %**
4	87	92	**6 %**
7	87	92	**6 %**
3	77	81	**5 %**
8	77	81	**5 %**
2	60	62	**3 %**
9	60	62	**3 %**
1	37	37	**0 %**
10	37	37	**0 %**
		Avg.	**4 %**

OD	**0.50**	**GY =**	**-57kN**
ID	**0.47**		
	BY, BZ = 1	BY, BZ = 10	
Memb*	Utilization	Utilization	**Difference**
5	90	96	**7 %**
6	90	96	**7 %**
4	87	92	**6 %**
7	87	92	**6 %**
3	76	81	**7 %**
8	76	81	**7 %**
2	60	62	**3 %**
9	60	62	**3 %**
1	37	37	**0 %**
10	37	37	**0 %**
		Avg.	**4 %**

OD	**0.50**	**GY =**	**-20kN**
ID	**0.49**		
	BY, BZ = 1	BY, BZ = 10	
Memb*	Utilization	Utilization	**Difference**
5	90	95	**6 %**
6	90	95	**6 %**
4	86	91	**6 %**
7	86	91	**6 %**
3	76	80	**5 %**
8	76	80	**5 %**
2	59	62	**5 %**
9	59	62	**5 %**
1	37	37	**0 %**
10	37	37	**0 %**
		Avg.	**4 %**

*Refer to Figure 3.5-2

Maximum differences between the cases with buckling lengths of 10 meters versus buckling lengths of 1 meter are summed up in Table 4.5-1:

Table 4.5-1 Maximum error due to difference in buckling length

Outer diameter	Maximum difference
0.25	17 %
0.35	10 %
0.50	7 %

4.5.1.4 Diagrams

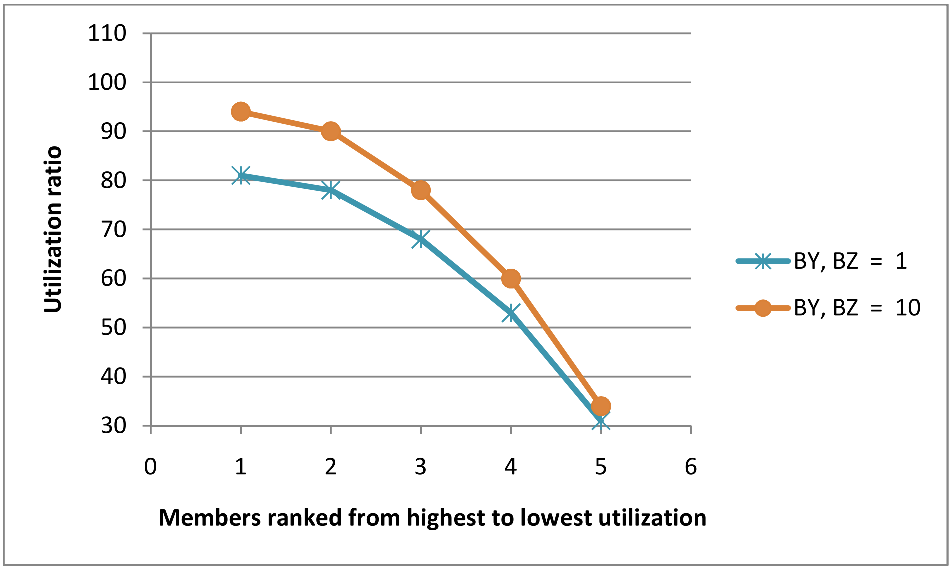


Figure 4.5-2 Plotted values for OD=0.25, ID=0.24

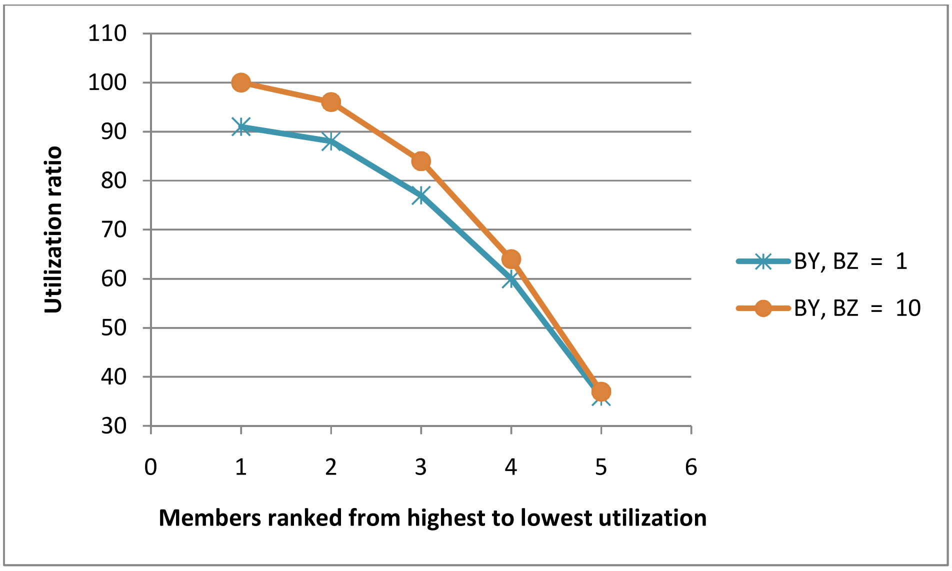


Figure 4.5-3 Plotted values for OD=0.35, ID=0.34

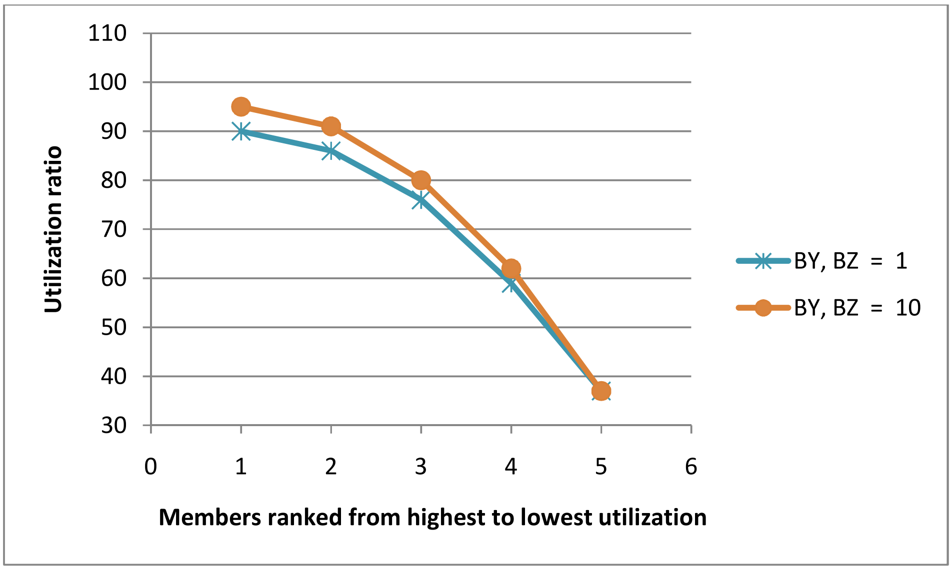


Figure 4.5-4 Plotted values for OD=0.50, ID=0.49

4.5.1.5 Discussion

From the tables we see that the *difference* in utilization ratios is kept close to constant for different cross sections as long as the outer diameter is the same. For the case with OD=0.25, the maximum difference is steady at around 16% for all three cross sections. For OD=0.35 and OD=0.50, the maximum difference is steady at around 10% and 6 % respectively.

Table 4.5-1 along with the figures clearly show a larger spread in the utilization ratios for slender columns.

This indicates that wrong estimations of buckling length affect slender members in a higher degree than thicker members.

4.5.2 Results from Straight pipe test 2

In this test, the maximum utilization ratio is found for each buckling length and presented in tables along with the member numbers. The utilization ratios are plotted in diagrams to highlight a special behavior that is observed in the Staad.Pro results.

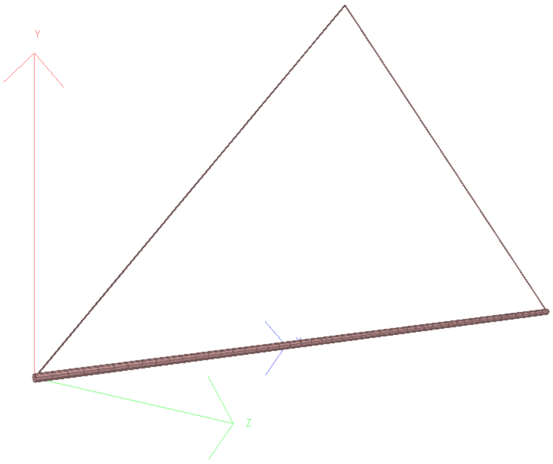


Figure 4.5-5 The 50m pipe used in the test

The results are commented at the end of the chapter section.

4.5.2.1 *Load -1.50 kN/m*

Table 4.5-2 Utilization of members, load 1.50kN/m

GY = -1.50 kN/m		
Buckling length [m]	**Max utilization [%]**	**Members***
5	36	22, 23, 24, 25, 26, 27, 28, 29
10	37	24, 25, 26, 27
15	37	23, 24, 25, 26, 27, 28
20	38	23, 24, 25, 26, 27, 28
25	39	23, 24, 25, 26, 27, 28
30	41	24, 25, 26, 27
35	43	23, 24, 25, 26, 27, 28
40	46	25, 26
45	49	23, 24, 25, 26, 27, 28
50	53	23, 24, 25, 26, 27, 28
55	58	23, 24, 25, 26, 27, 28
60	62	25, 26
65	63	23, 24, 25, 26, 27, 28
70	64	23, 24, 25, 26, 27, 28
75	66	24, 25, 26, 27
80	67	22, 23, 24, 25, 26, 27, 28, 29
85	69	23, 24, 25, 26, 27, 28
90	71	24, 25, 26, 27
95	73	24, 25, 26, 27
100	75	24, 25, 26, 27
105	77	24, 25, 26, 27
110	79	23, 24, 25, 26, 27, 28
115	81	22, 23, 24, 25, 26, 27, 28, 29
120	84	24, 25, 26, 27
125	86	23, 24, 25, 26, 27, 28
130	89	24, 25, 26, 27

*Ref. Figure 3.5-5

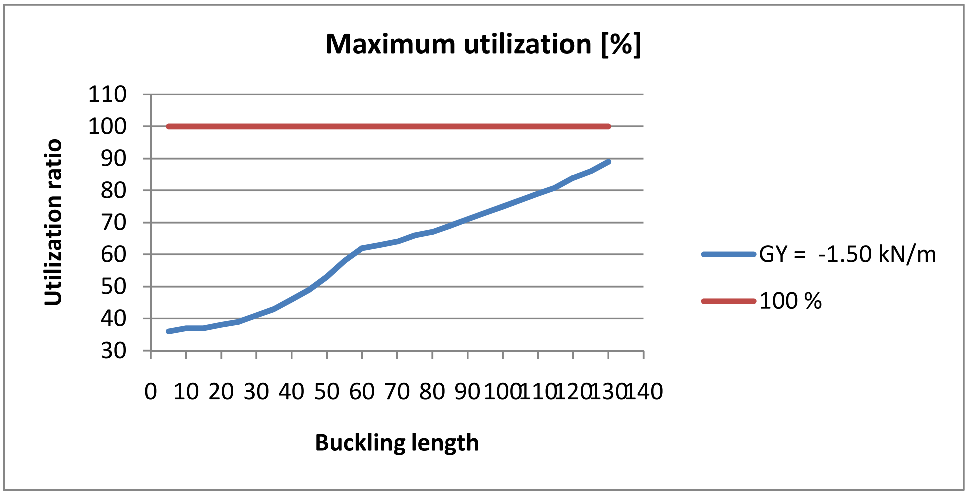


Figure 4.5-6 Max utilization, load 1.50kN/m

4.5.2.2 Load -2.00 kN/m

Table 4.5-3 Utilization of members, load 2.00kN/m

GY = -2.00 kN/m		
Buckling length [m]	**Max utilization [%]**	**Members***
5	49	25, 26
10	49	23, 24, 25, 26, 27, 28
15	49	22, 23, 24, 25, 26, 27, 28, 29
20	51	24, 25, 26, 27
25	53	24, 25, 26, 27
30	55	22, 23, 24, 25, 26, 27, 28, 29
35	59	23, 24, 25, 26, 27, 28
40	63	22, 23, 24, 25, 26, 27, 28, 29
45	69	23, 24, 25, 26, 27, 28
50	76	24, 25, 26, 27
55	81	25, 26
60	82	23, 24, 25, 26, 27, 28
65	84	24, 25, 26, 27
70	86	24, 25, 26, 27
75	88	24, 25, 26, 27
80	90	24, 25, 26, 27
85	92	23, 24, 25, 26, 27, 28
90	94	23, 24, 25, 26, 27, 28
95	97	24, 25, 26, 27
100	100	25, 26
105	102	23, 24, 25, 26, 27, 28
110	105	23, 24, 25, 26, 27, 28
115	108	23, 24, 25, 26, 27, 28
120	112	25, 26
125	115	24, 25, 26, 27
130	118	23, 24, 25, 26, 27, 28

*Ref. Figure 3.5-5

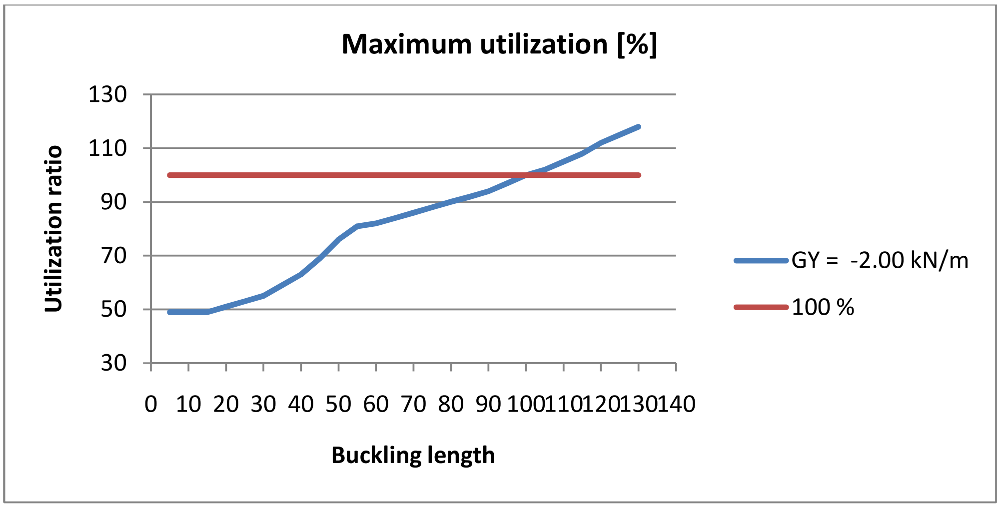


Figure 4.5-7 Max utilization, load 2.00kN/m

4.5.2.3 Load -2.45 kN/m

Table 4.5-4 Utilization of members, load 2.45kN/m

GY = -2.45 kN/m		
Buckling length [m]	**Max utilization [%]**	**Members***
5	60	25, 26
10	60	23, 24, 25, 26, 27, 28
15	61	24, 25, 26, 27
20	63	25, 26
25	65	23, 24, 25, 26, 27, 28
30	69	23, 24, 25, 26, 27, 28
35	74	23, 24, 25, 26, 27, 28
40	81	24, 25, 26, 27
45	89	24, 25, 26, 27
50	97	24, 25, 26, 27
55	99	25, 26
60	101	25, 26
65	103	24, 25, 26, 27
70	105	24, 25, 26, 27
75	107	23, 24, 25, 26, 27, 28
80	110	24, 25, 26, 27
85	113	24, 25, 26, 27
90	116	24, 25, 26, 27
95	119	24, 25, 26, 27
100	122	24, 25, 26, 27
105	125	23, 24, 25, 26, 27, 28
110	129	24, 25, 26, 27
115	133	24, 25, 26, 27
120	137	24, 25, 26, 27
125	141	24, 25, 26, 27
130	145	24, 25, 26, 27

*Ref. Figure 3.5-5

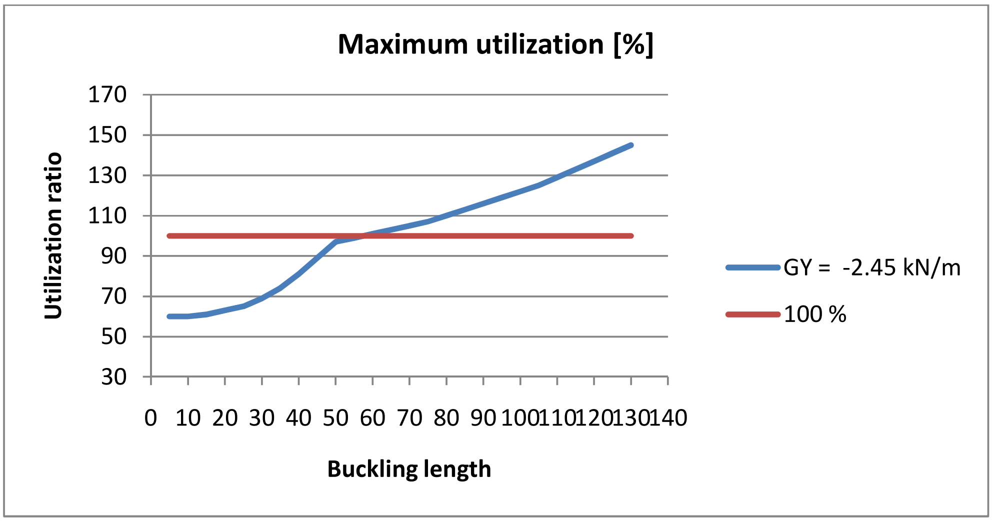


Figure 4.5-8 Max utilization, load 2.45kN/m

4.5.2.4 Load -3.00 kN/m

Table 4.5-5 Utilization of members, load 3.00kN/m

GY = -3.00 kN/m		
Buckling length [m]	**Max utilization [%]**	**Members***
5	73	24, 25, 26, 27
10	73	23, 24, 25, 26, 27, 28
15	75	24, 25, 26, 27
20	77	23, 24, 25, 26, 27, 28
25	81	23, 24, 25, 26, 27, 28
30	87	25, 26
35	94	24, 25, 26, 27
40	103	23, 24, 25, 26, 27, 28
45	115	24, 25, 26, 27
50	119	25, 26
55	121	24, 25, 26, 27
60	123	24, 25, 26, 27
65	126	24, 25, 26, 27
70	128	23, 24, 25, 26, 27, 28
75	131	23, 24, 25, 26, 27, 28
80	135	25, 26
85	138	24, 25, 26, 27
90	142	25, 26
95	145	23, 24, 25, 26, 27, 28
100	149	23, 24, 25, 26, 27, 28
105	154	25, 26
110	158	24, 25, 26, 27
115	163	25, 26
120	167	23, 24, 25, 26, 27, 28
125	172	23, 24, 25, 26, 27, 28
130	178	25, 26

*Ref. Figure 3.5-5

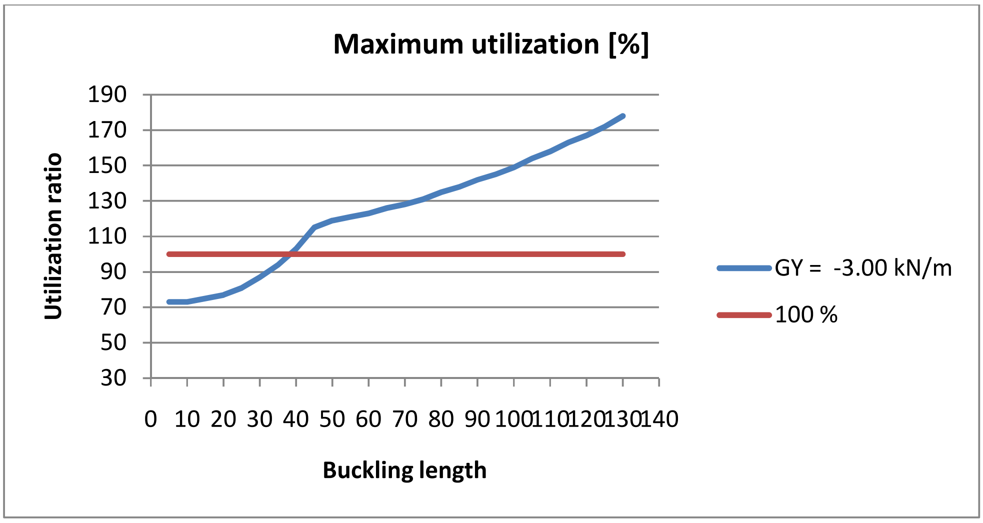


Figure 4.5-9 Max utilization, load 3.00kN/m

4.5.2.5 Load -4.00 kN/m

Table 4.5-6 Utilization of members, load 4.00kN/m

GY = -4.00 kN/m		
Buckling length [m]	Max utilization [%]	Members*
5	97	23, 24, 25, 26, 27, 28
10	98	23, 24, 25, 26, 27, 28
15	100	23, 24, 25, 26, 27, 28
20	104	23, 24, 25, 26, 27, 28
25	111	24, 25, 26, 27
30	120	24, 25, 26, 27
35	133	25, 26
40	149	25, 26
45	155	23, 24, 25, 26, 27, 28
50	158	24, 25, 26, 27
55	161	24, 25, 26, 27
60	164	24, 25, 26, 27
65	168	25, 26
70	171	24, 25, 26, 27
75	175	24, 25, 26, 27
80	180	25, 26
85	184	24, 25, 26, 27
90	189	24, 25, 26, 27
95	194	24, 25, 26, 27
100	199	24, 25, 26, 27
105	205	24, 25, 26, 27
110	211	25, 26
115	217	24, 25, 26, 27
120	223	24, 25, 26, 27
125	230	24, 25, 26, 27
130	237	24, 25, 26, 27

*Ref. Figure 3.5-5

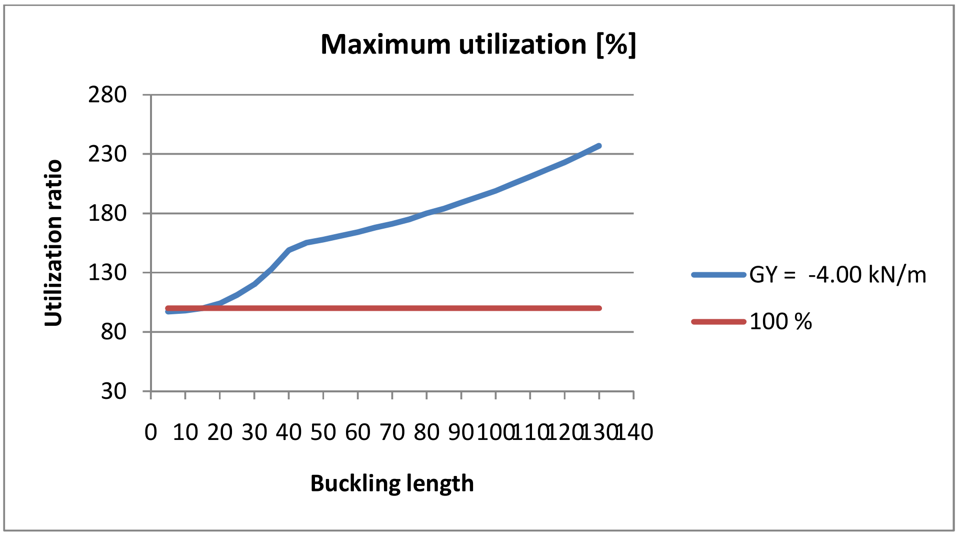


Figure 4.5-10 Max utilization, load 4.00kN/m

4.5.2.6 All loads

Table 4.5-7 Max utilization for all loads

	Max utilization [%]				
Buckling factor	**GY= -4.00 kN/m**	**GY= -3.00 kN/m**	**GY= -2.45 kN/m**	**GY= -2.00 kN/m**	**GY= -1.50 kN/m**
0.1	97	73	59	49	36
0.2	98	73	60	49	37
0.3	100	75	61	49	37
0.4	104	77	63	51	38
0.5	111	81	65	53	39
0.6	120	87	69	55	41
0.7	133	94	74	59	43
0.8	149	103	80	63	46
0.9	155	115	89	69	49
1.0	158	119	97	76	53
1.1	161	121	99	81	58
1.2	164	123	100	82	62
1.3	168	126	103	84	63
1.4	171	128	104	86	64
1.5	175	131	107	88	66
1.6	180	135	110	90	67
1.7	184	138	113	92	69
1.8	189	142	115	94	71
1.9	194	145	119	97	73
2.0	199	149	122	100	75
2.1	205	154	125	102	77
2.2	211	158	129	105	79
2.3	217	163	133	108	81
2.4	223	167	137	112	84
2.5	230	172	141	115	86
2.6	237	178	145	118	89

The values in Table 4.5-7 are plotted, and can be viewed in Figure 4.5-11.

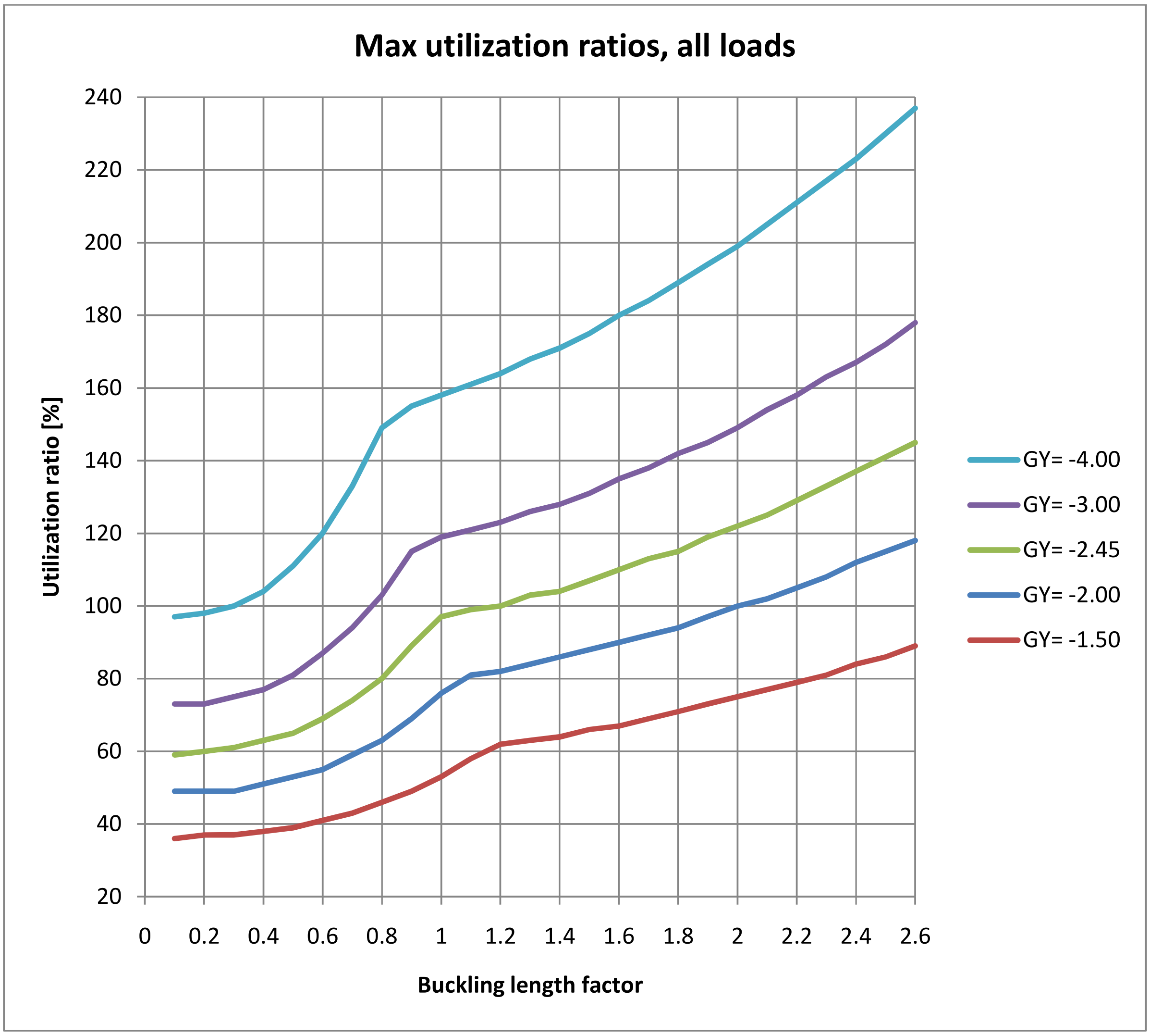


Figure 4.5-11 Max utilization, all loads

4.5.2.7 Discussion

The utilization ratio, UR, is given by the general equation $UR = \frac{Applied\ load}{Load\ capacity}$.

In this test ("Straight pipe test 2"), the applied load is kept constant, and the buckling length is varied. This means that the UR should, according to Euler's theory (chapter 2.2), follow the equation:

$$UR = \frac{Applied\ load}{Load\ capacity} = \frac{Constant}{\frac{\pi EI}{(L_k)^2}}$$

As the cross section and elastic modulus also is constant, the UR should be proportional to the squared value of the buckling length:

$$UR = \frac{Constant}{\frac{\pi EI}{(L_k)^2}} = \frac{Constant}{\frac{Constant}{(L_k)^2}} = C * (L_k)^2$$

As we see from the graphs in this chapter, this is not the case. The UR curves start off by showing a parabolic tendency, then reach a peak and change direction.

If we take a look at the case with the load of GY=-2.00 kN/m, and extend the parabolic part of the graph, this curve crosses the 100% mark at a significantly lower buckling length than the curve from the Staad.Pro test. See Figure 4.5-12 for explanation.

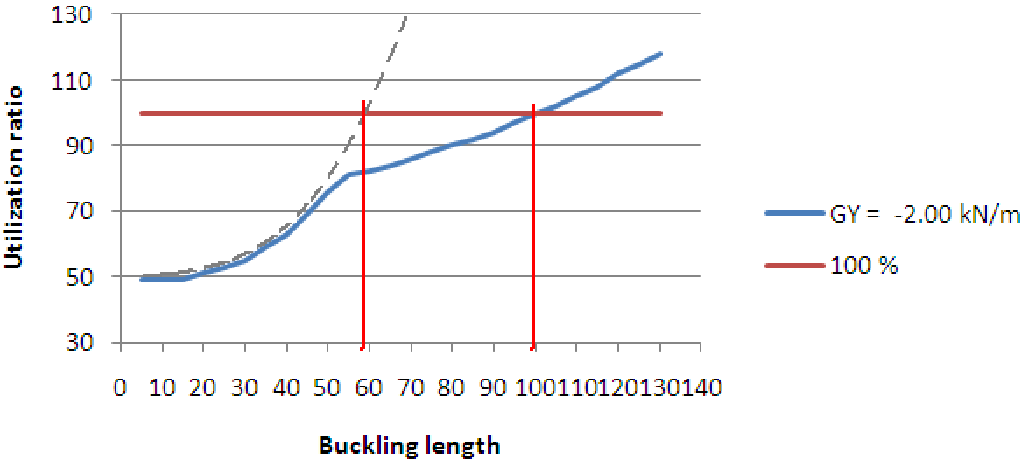


Figure 4.5-12 Graph extension

If then for example the buckling length for the member is calculated to be 70, the member would pass the Staad.Pro check, but should according to Euler theory fail. This indicates that Staad.Pro overestimates the capacity of the pipe members, compared to Euler theory. If this truly is the case, one might accept analyses that should have been discarded.

4.5.3 Results, buckling calculations for Z-spool

4.5.3.1 Numerical results

The buckling length factors found in the buckling analysis are summarized in Table 4.5-8.

Table 4.5-8 Buckling factors for brace and spreader case

	Buckling factors					Buckling factors			
	BY		BZ			BY		BZ	
Member	**Brace**	**Spreader**	**Brace**	**Spreader**	**Member**	**Brace**	**Spreader**	**Brace**	**Spreader**
1	-	-	-	-	36	0.70	1.00	2.70	1.00
2	-	-	-	-	37	0.70	1.00	2.70	1.00
3	-	-	-	-	38	0.70	1.00	2.70	1.00
4	-	-	-	-	39	0.70	1.00	2.70	1.00
5	3.40	3.60	3.75	3.75	40	0.70	1.00	2.70	1.00
6	3.40	3.60	3.75	3.75	41	0.70	1.00	2.70	1.00
7	3.40	3.60	3.75	3.75	42	0.70	1.00	2.70	1.00
8	0.68	3.60	3.75	3.75	43	0.70	1.00	2.70	1.00
9	0.68	3.60	3.75	3.75	44	0.70	1.00	2.70	1.00
10	0.68	3.60	3.75	3.75	45	0.70	1.00	2.70	1.00
11	0.68	3.60	3.75	3.75	46	0.70	1.00	2.70	1.00
12	0.68	3.60	3.75	3.75	47	0.70	1.00	2.70	1.00
13	0.68	3.60	3.75	3.75	48	0.70	1.00	2.70	1.00
14	0.68	3.60	3.75	3.75	49	0.70	1.00	2.70	1.00
15	0.68	3.60	3.75	3.75	50	0.68	1.00	2.70	1.00
16	0.68	3.60	3.75	3.75	51	0.68	1.00	2.70	1.00
17	0.68	3.60	3.75	3.75	52	0.68	3.60	3.75	3.75
18	0.68	1.00	2.70	1.00	53	0.68	3.60	3.75	3.75
19	0.68	1.00	2.70	1.00	54	0.68	3.60	3.75	3.75
20	0.70	1.00	2.70	1.00	55	0.68	3.60	3.75	3.75
21	0.70	1.00	2.70	1.00	56	0.68	3.60	3.75	3.75
22	0.70	1.00	2.70	1.00	57	0.68	3.60	3.75	3.75
23	0.70	1.00	2.70	1.00	58	0.68	3.60	3.75	3.75
24	0.70	1.00	2.70	1.00	59	0.68	3.60	3.75	3.75
25	0.70	1.00	2.70	1.00	60	0.68	3.60	3.75	3.75
26	0.70	1.00	2.70	1.00	61	0.68	3.60	3.75	3.75
27	0.70	1.00	2.70	1.00	62	0.68	3.60	3.75	3.75
28	0.70	1.00	2.70	1.00	63	3.40	3.60	3.75	3.75
29	0.70	1.00	2.70	1.00	64	3.40	3.60	3.75	3.75
30	0.70	1.00	2.70	1.00	65	3.40	3.60	3.75	3.75
31	0.70	1.00	2.70	1.00	66	-	-	-	-
32	0.70	1.00	2.70	1.00	67	-	-	-	-
33	0.70	1.00	2.70	1.00	68	-	-	-	-
34	0.70	1.00	2.70	1.00	69	-	-	-	-
35	0.70	1.00	2.70	1.00					

Since the connection points on the spool are different for each case, the section lengths exposed to buckling issues are not the same. This means that it would not be very meaningful to look only at the buckling length *factors*, but also the buckling *lengths* that are found and applied to the Staad.Pro models (see Table 4.5-9).

Table 4.5-9 Buckling lengths for brace and spreader case

	Buckling length [m]			
	BY		BZ	
Member	Brace	Spreader	Brace	Spreader
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	10.20	50.40	48.75	52.50
6	10.20	50.40	48.75	52.50
7	10.20	50.40	48.75	52.50
8	7.48	50.40	48.75	52.50
9	7.48	50.40	48.75	52.50
10	7.48	50.40	48.75	52.50
11	7.48	50.40	48.75	52.50
12	7.48	50.40	48.75	52.50
13	7.48	50.40	48.75	52.50
14	7.48	50.40	48.75	52.50
15	7.48	50.40	48.75	52.50
16	7.48	50.40	48.75	52.50
17	7.48	50.40	48.75	52.50
18	7.48	24.00	45.90	24.00
19	7.48	24.00	45.90	24.00
20	11.90	24.00	45.90	24.00
21	11.90	24.00	45.90	24.00
22	11.90	24.00	45.90	24.00
23	11.90	24.00	45.90	24.00
24	11.90	24.00	45.90	24.00
25	11.90	24.00	45.90	24.00
26	11.90	24.00	45.90	24.00
27	11.90	24.00	45.90	24.00
28	11.90	24.00	45.90	24.00
29	11.90	24.00	45.90	24.00
30	11.90	24.00	45.90	24.00
31	11.90	24.00	45.90	24.00
32	11.90	24.00	45.90	24.00
33	11.90	24.00	45.90	24.00
34	11.90	24.00	45.90	24.00
35	11.90	24.00	45.90	24.00
36	11.90	24.00	45.90	24.00
37	11.90	24.00	45.90	24.00
38	11.90	24.00	45.90	24.00
39	11.90	24.00	45.90	24.00
40	11.90	24.00	45.90	24.00
41	11.90	24.00	45.90	24.00
42	11.90	24.00	45.90	24.00
43	11.90	24.00	45.90	24.00
44	11.90	24.00	45.90	24.00
45	11.90	24.00	45.90	24.00
46	11.90	24.00	45.90	24.00
47	11.90	24.00	45.90	24.00
48	11.90	24.00	45.90	24.00
49	11.90	24.00	45.90	24.00
50	7.48	24.00	45.90	24.00
51	7.48	24.00	45.90	24.00
52	7.48	50.40	48.75	52.50
53	7.48	50.40	48.75	52.50
54	7.48	50.40	48.75	52.50
55	7.48	50.40	48.75	52.50
56	7.48	50.40	48.75	52.50
57	7.48	50.40	48.75	52.50
58	7.48	50.40	48.75	52.50
59	7.48	50.40	48.75	52.50
60	7.48	50.40	48.75	52.50
61	7.48	50.40	48.75	52.50
62	7.48	50.40	48.75	52.50
63	10.20	50.40	48.75	52.50
64	10.20	50.40	48.75	52.50
65	10.20	50.40	48.75	52.50
66	-	-	-	-
67	-	-	-	-
68	-	-	-	-
69	-	-	-	-

In order to get a better overview of the differences in buckling factors and buckling lengths, the values are also presented in diagrams.

4.5.3.2 Diagrams

Graphic display of the buckling length factors

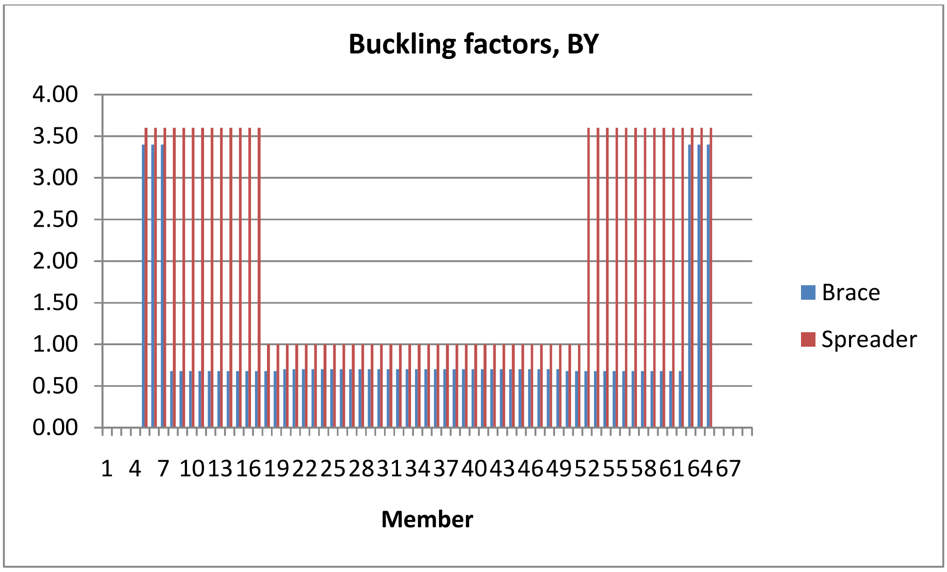


Figure 4.5-13 Buckling length factors, about local Y-axis

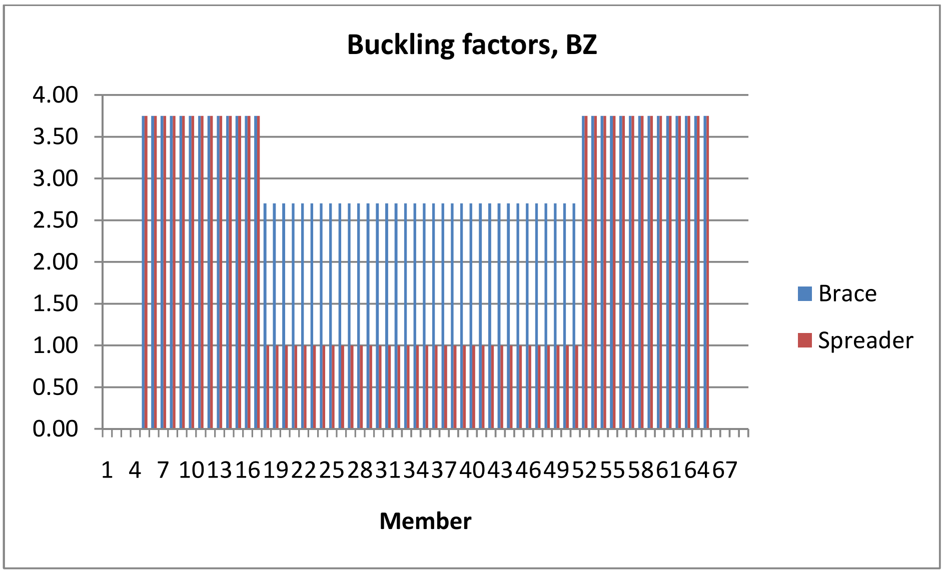


Figure 4.5-14 Buckling length factors, about local Z-axis

Graphic display of the buckling lengths

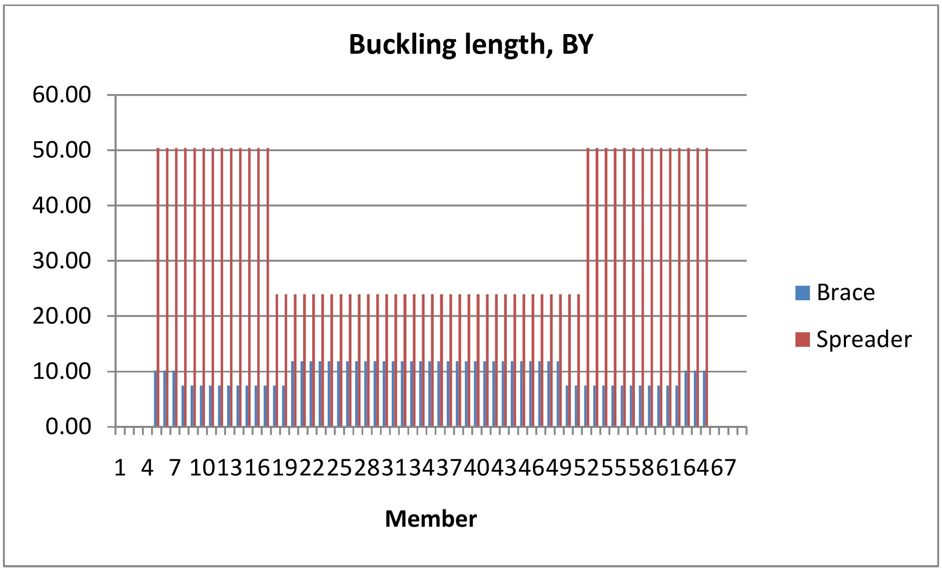


Figure 4.5-15 Buckling lengths, about local Y-axis

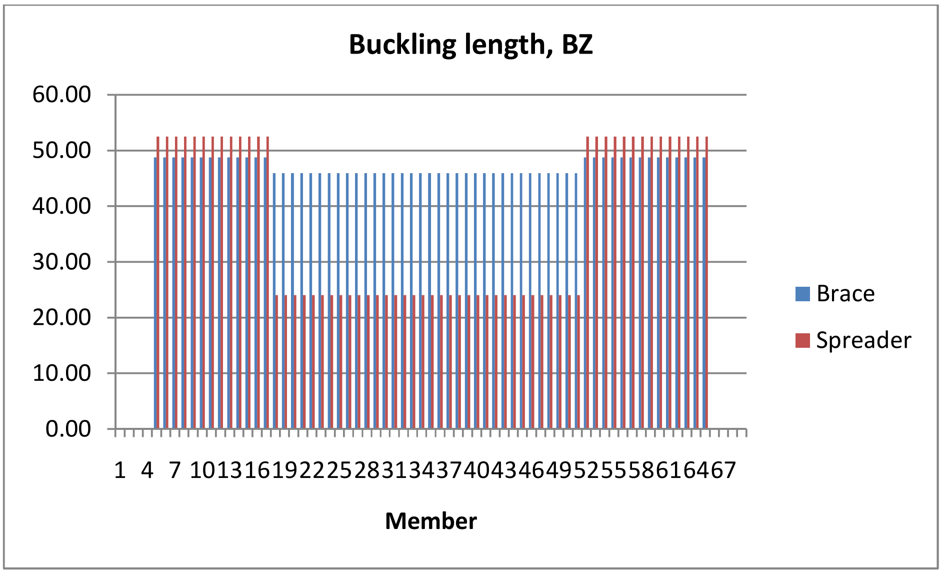


Figure 4.5-16 Buckling lengths, about local Z-axis

4.5.3.3 Discussion

If we look at the buckling length *factors*, the values for the members toward the end of the spool stand out as high compared to the rest of the members in the spool. This is the case for both the spreader and the brace solution (well illustrated in the diagrams in chapter 4.5.3.2). About local Y-axis, the largest differences in buckling factors are found for members 8 to 17 and 52 to 65, where the brace case has 0.68 and the spreader case has 3.60. About local Z-axis, the largest differences appear in members 18 to 51. The brace case has for these members buckling factors of 2.70, while the spreader case has 1.00.

When looking at the buckling *lengths* we find a somewhat different picture, where the brace case has small variations in buckling lengths for the members, while the spreader case show larger differences. About local Y-axis, the largest differences in buckling lengths between the two solutions are found for members 8 to 17 and 52 to 65, where the brace case has 7.48 meters and the spreader case has 50.40 meters. About local Z-axis, the largest differences appear in members 18 to 51. The brace case has for these members buckling lengths of 45.90 meters, while the spreader case has 24.00 meters.

We see that the comparison of buckling issues between the two solutions quickly becomes complex and complicated.

4.6 Structural conclusion

4.6.1 Staad.Pro analysis

For the structural analysis of the impact on the spool, the clearest difference between the brace case and the spreader case is the reduced horizontal bending moment we get when using the spreader solution.

On the other hand, the bending moments we see in the brace case could theoretically be reduced by moving the braces closer to the connection points of the wire slings (see an example in appendix 9.3 where this is done). The reason why the braces are not placed here in this analysis is that the clamps due to geometrical issues cannot be connected at that location, and would therefore not work in practice.

The overall utilization of the spool pipe is higher for the brace solution compared with the spreader solution. For the spool in this analysis, the spreader beam is therefore said to be preferred if we look at it from a purely structural point of view.

4.6.2 Buckling

The results from “Straight pipe test 1” clearly indicate that it is increasingly important to find the correct/accurate buckling lengths for *slender* pipe sections. As the members get more slender the attention towards buckling issues should be intensified. The test also tells us that even though a pipe has relatively thick walls, and one might instinctively think that it is very resilient to erroneous buckling length factors, the important parameter is the slenderness ratio. This must on the other hand not be confused with the pipe member’s resilience to the buckling itself, which obviously increases with the cross sectional area of the pipe.

The sensitivity analysis performed in “Straight pipe test 2” yields a very interesting result. This indicates that the utilization results we get from Staad.Pro do not follow the basic Euler theory for buckling. If this in fact is the case, the consequence might be that structures that fail according to Euler theory are approved and accepted after a Staad.Pro analysis. These indications are only observed and not investigated further in this thesis.

Using a spreader beam instead of a brace bar, or vice versa, changes the connection points on the spool. This again changes the end conditions of the pipe members, and therefore also the buckling length factors. Since the connection points are not the same for the two solutions, the sections exposed to compression loads (and buckling issues) are not identical. This means that a high buckling factor in one of the solutions might not be critical, if the section it is applied to is very short.

This can be illustrated when comparing member 7 and 8 in the brace case. Member 8 has a buckling length *factor* of 0.68, and is part of a section with a buckling *length* of 7.48 meters. Member 7 has a buckling length *factor* of 3.40 (400% higher than the one in member 8), but is part of a section with a buckling *length* of 10.20 meters (just 36% higher than the one in member 8). In other words, the much higher *factor* in member 7 does not affect the buckling *length* in the same proportion, since it is applied to a shorter pipe section.

The highest value for buckling length factors from the Euler theory is $\beta = 2.00$. The results from the buckling calculations based on the method with elastic restraints suggest factors of up to as high as $\beta = 3.75$. This indicates that the Euler theory provides buckling length factors that are too low, giving too high capacities for members in the structural analysis.

The buckling length factor of 3.75, derived from the buckling analysis seems however very high, when considering the highest value in the Euler theory is 2.00. This leads to the question of whether the results can be trusted or not, and should therefore be investigated further before deciding whether or not to use the method of elastic restraints in buckling analyses.

5 Operational

5.1 General

This chapter is mainly based on a discussion with Joel Ireland (senior installation engineer at S7).

From an operational point of view there are several differences between the brace and the spreader solution. The operational issues mentioned here play a big part in the decision process when choosing which solution to go for.

5.2 Sea state limitations

During offshore operations, the wave conditions have a big effect on when it is possible to install a spool. From a structural point, the installation procedure is often given a maximum value for the allowed wave height and wave period.

Brace bar solutions in general have better (higher) sea state limitations than spreader beam solutions. This has much to do with the fact that the spool with the brace bar acts as *one* dynamic system instead of two, which is the case for the spreader solution. Because of this, slack wire lines are more easily avoided, and a higher sea state can be accepted. A higher sea state limit means that the risk for having to wait for the right weather is lower.

An important rule for all offshore work is that the crew members feel safe in what they do. Therefore, in many cases, the *crew's* sea state limit for operations on deck might be the limiting factor even if the spool can handle bigger waves.

5.3 Structural flexibility

Before installation or even the design of the spools can start, the seabed must be mapped and surveyed. The relative distance between the spools intended connection points are here measured. This can be done in a variety of ways, but two common methods are “Photogrammetry” and “LBL acoustic metrology”. Without going further into the details of these methods, the accuracy is +/- 3mm for the photogrammetry, and +/- 350 mm for the LBL acoustic metrology.

If LBL acoustic metrology is used, and the connection points are rigid, the uncertainties in the measurements demand that the spool has some flexibility during installation. This flexibility is most easily achieved with a spreader solution, since it does not restrict the spools deflections in the horizontal plane. A brace solution might prove too rigid in some cases.

5.4 Maneuvering on deck

The deck areas of installation vessels are usually fully utilized, and are therefore relatively crowded with a tight space between objects. To prevent spools from damaging other equipment on deck as they are lifted off during offshore installation, “bumper bars” are often welded to the deck. The bumper bars are temporary and custom made horizontal supports made of construction steel (see Figure 5.4-1). The bars are fitted with wooden beams where they come into contact with the spool. The bumper bars make up a vertical slot where the spool is lifted out from.

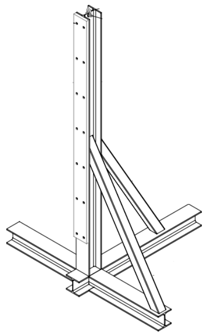


Figure 5.4-1 Bumper bar

Spools with spreader beams are more complicated to maneuver and lift off the deck than spools with braces. The spreader beam first has to be lifted out from its supports, and then *moved over* to the combined CoG of the spreader and the spool. If there is some movement in the vessel, snap loads might occur in the wires running from the relatively heavy spreader beam to the spool. This is highly unwanted.

When using a brace, the crane hook is centered over the CoG, and the spool is lifted straight off the deck. This is a much simpler operation for the crane operator and the deck crew.

5.5 Wet-storing of spools

In cases where the spool has to be abandoned during installation (for example if the installation vessel encounter sudden bad weather, or if there are damage to connection points on subsea equipment), the common routine is simply to set the spool piece down on the sea bed and come back later to finish the installation.

In these situations, brace solutions have a definite advantage versus the spreader. Since the braces are fixed to the spool, the spool can simply be landed on the sea floor. The crane hook is disconnected by a ROV, and the wire slings are laid down beside the spool.

If spreader beams are used, these have to be taken especially into consideration when the spool is meant to be wet-stored, because the spreader cannot be laid on top of the spool. This problem occurs mostly for Z-shaped spool, where the spreader is situated close to the “center” of the structure, and the slings are not long enough to reach out beside the spool (Figure 5.5-1). In these cases, the spreader beam slings have to be disconnected (Figure 5.5-2). This means *at least* two extra ROV-operations compared to the brace solution (one for disconnection, and one for reconnection).

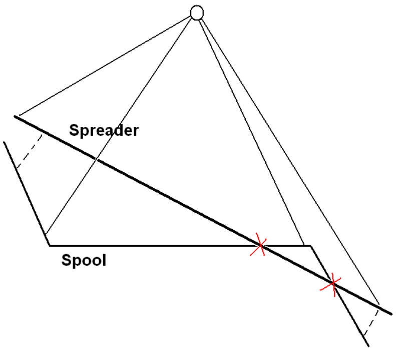


Figure 5.5-1 Spreader colliding with spool

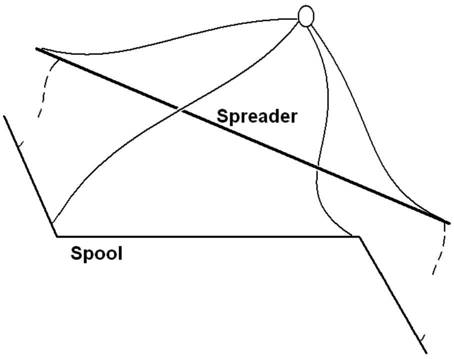


Figure 5.5-2 Spreader slings disconnected

It is also worth noticing that normal wire shackles are difficult for an ROV to reconnect, so in order to be able to reconnect the spreader within a reasonable time, the spreader rigging is often fitted with an extra set of ROV hooks (Figure 5.5-3). These hooks are not optimal for these kinds of lifting operations, since they don’t have a completely closed loop (like a shackle does). The spring loaded lock may fail and open, leaving the wire free to fall out if we encounter slack slings. The extra hooks also mean additional engineering check work.

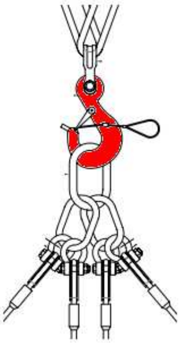


Figure 5.5-3 ROV hook

5.6 Recovery

The recovery of braces and spreaders is an operation that needs to be performed after every installation of a spool.

The brace clamps have to be removed from the spool after it is installed. This involves cutting off the Kevlar strops with a ROV-tool, and then retrieving the brace bars themselves. The brace bars are usually attached to the wire slings with a (slack) Y-link during the spool installation. As the brace clamps are cut, the slings connected to the spool pipe are disconnected. The brace bar is then recovered as it hangs off the Y-link (see Figure 5.6-1). For spool pipes with small dimensions, issues with enough room for the ROV cutting tool have been encountered. As the outer diameter of the pipe decreases, so does the gap between the pipe and the clamp. This is a factor that may delay the recovery process.

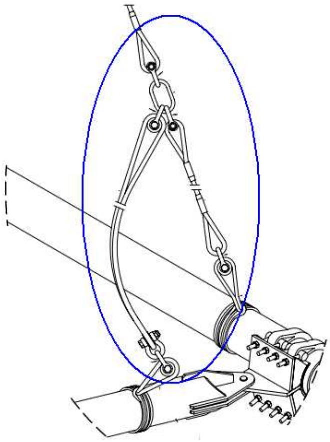


Figure 5.6-1 Y-link for brace recovery

Spreader beams do not need any such specialized tool operations before they can be retrieved. The wires and fiber slings are disconnected from the spool by unscrewing the shackles. This is a procedure performed by the ROV with its standard, onboard tools.

5.7 Size/weight

Spreader beams are usually much longer and heavier than brace bars. The sheer size and weight of them often makes them more difficult to retrieve onto deck than braces.

Since the spreader beams are longer than the brace bars, they are also designed with a larger outer diameter and thicker walls, to avoid buckling issues. This increases the weight of the spreader, which affects the combined center of gravity for the spool and the spreader a great deal. In the case of an L-shaped spool with heavy termination heads, the CoG is pushed far out to one side (Figure 5.7-1). This leads to poor sea state characteristics for the spool, because the corner furthest away from the CoG (marked red in the figure) is very light compared to the rest of the spool. When the spool then is lowered through the splash zone, there is a higher probability of getting slack wires and subsequent snap loads.

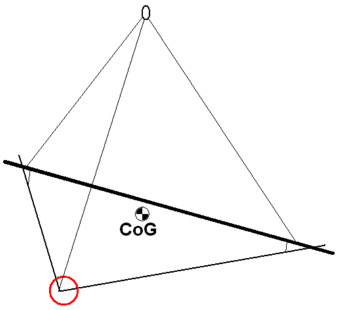


Figure 5.7-1 Center of gravity pushed to the side

One way to work around this problem is to attach steel weights to the spool, and move the CoG closer to the physical center of the structure. The weights are then removed after the spool is installed.

5.8 Mobilization

Lifting of heavy equipment (including spools) onto the deck is part of the mobilization of an offshore vessel. Mobilization with spools using brace solutions demand fewer operations than a spool with spreader, since a spreader solution is more likely to need bumper bars on deck, and also demands a support stand. For a brace solution, blocks of Styrofoam are used to support the brace and spool. These supports are so light that they can be moved by hand, and are therefore not dependent on an available crane.

This also comes into play when the spool is test lifted on land. A spool with braces is much easier to handle.

Spools are often fabricated in sections inside production halls. The sections are moved out to the quay side and assembled and stored before mobilization. If braces are used, it is easier to stack the spools upon each other, thus not taking up so much room at the quay.

When the spreader beam rests on support stands, it is located several meters above deck level. This makes it harder for the deck crew to make last-minute changes and adjustments to the rigging of the spool, for example if a shackle needs to be either changed or added.

5.9 Re-use

A single spreader beam can potentially be used for installing more than one spool on the same offshore trip, while brace bar solutions demand a unique set of braces for each spool. This may free up deck area on the vessel, but involves re-rigging the spreader beam to fit the other spools.

Braces still have the possibility to be used again if they are modified. The modifications that most likely have to be done are to replace the Kevlar strops, and also replace the brace clamp if the dimensions of the new spool are different from the previous.

5.10 Summary

Discussions with senior in-house personnel conclude that braces are the preferred method for support during spool lift operations.

This does however not mean that braces *always* are the best solution to go for. Each spool installation project has to be evaluated by itself, and the decision for whether to go for a brace solution or a spreader solution must be made on the basis of a total evaluation of all (or at least most of) the criteria mentioned above.

One solution might have some advantages that lead to other disadvantages and vice versa. This is why operational and structural engineers have to work together closely to find the *optimum* solution for a given installation.

6 Economical

The economical side of spool lifting can roughly be divided into three parts:

- Preproduction phase
- Fabrication
- Operation

6.1 Preproduction

The costs related to the preproduction phase involve time spent on engineering work for:

- *Designing* the lifting arrangements
- *Checking* the structural integrity of the equipment
- *Planning* the lift operation.

The preproduction phase is a relatively small contributor to the overall cost, and there are no significant differences between brace solutions and spreader solutions when it comes to the time spent on this phase.

6.2 Fabrication

The costs for fabrication of the lifting equipment involve:

- Cost of materials

  This includes materials directly to the fabrication of the spreader/brace, but also materials for deck accessories required by the lifting equipment. This involves accessories like bumper bars and support stands.

- Cost of welding/assembly

  The cost of the work needed to assemble the equipment.

- Testing of equipment and verification from third party surveyor

  All lifting equipment has to go through third party testing and verification which among other criteria set demands on material quality. A spreader beam is classified as lifting equipment, while a brace bar is seen as an integrated part of the lifted structure. This means that a spreader beam has higher demands for testing and verification than a brace bar. The costs for testing and verification are therefore also higher for a spreader beam.

Production cost examples from two in-house projects are presented: Due to confidentiality, the projects are called Project 1 and Project 2, where one is a spreader beam, and the other a brace bar with clamps.

Table 6.2-1 Production cost examples from projects

Desciption	Cost
Project 1, spreader beam, 50 meters long	1 300 000 NOK
Project 2, brace bar and clamps	930 000 NOK

In this example the spreader beam is more costly to produce. This is however dependent on the type of spool that is lifted. If the spool for example requires *two* brace bars, the production cost might favor the spreader beam.

An additional factor is the number of spools that are meant to be installed on a trip. If for example 3 Z-spools shall be installed, a single spreader beam can be chosen to lift all of the spools, or a solution with braces can be used. The brace solution would then most likely include a total of 6 brace bars (2 on each spool). In this case the cost of production would be considerably lower for the spreader solution.

6.3 Operation

Costs for execution and operation are closely related to the previous chapter on operational issues. The expenses are driven by the time spent on:

- Rigging the spool and preparing it for lift (onshore)

Rigging of the spool onshore is a fairly small cost factor, and the differences between the solutions are not that big. A small favor might be given to the spreader, since this only involves rigging of light wires, while the brace bars have to be moved over to the spool and connected to it mechanically.

- Mobilization

This includes preparation of the deck and lifting the spools from the quay side onto the vessel. Preparation of the deck involves making and welding sea fastening brackets, and welding and securing other equipment like bumper bars and support stands.

- Deployment/installation

The time spent on installing the spools with the different solutions might vary quite a bit. As mentioned in the operational chapter, a spreader solution normally has a lower sea state acceptance level than a brace solution. This leads to a higher risk for having to wait on acceptable weather conditions to perform the installation, and can drive up the costs of hiring the vessel. The time spent on the actual lifting operation from the deck of the vessel and into the sea depends on how long it takes to remove sea fastening on deck, disconnecting the spool once it is on the sea floor, and potential re-rigging of the lifting gear (spreader).

- Recovery

Recovery of spreaders generally takes longer time than braces. This may also include waiting on weather with the spreader still submerged to retrieve the spreader onto the deck in a safe manner.

The cost of hiring the offshore vessel is one of the biggest cost-drivers for a spool installation. Prices per day may lie in the range of $ 200 000 to $ 300 000. The operational part is therefore where the biggest differences in cost between brace and spreader solutions can be seen.

An example where the different parameters are estimated is presented in Table 6.3-1. The fabrication costs from Table 6.2-1 are used, and the calculation example includes *two* brace bars.

Table 6.3-1 Cost estimation example

Description		pr hr		
Vessel cost			75000	NOK
Engineer			875	NOK
Rigging personnel			625	NOK
Activity	Hrs	Spreader	Brace	
Fabrication		1 300 000	1 860 000	NOK
Rigging of spool onshore, 3 rigging personnel	3	5 625		NOK
Rigging of spool onshore, 3 rigging personnel	5		9 375	NOK
Recovery and re-rigging of spreader offshore	4	300 000		NOK
Engineering for spreader bar test lift	15	13 125		NOK
Engineering for structural verification	20		17 500	NOK
Engineering for structural verification	15	13 125		NOK
Engineering for certification documentation	30	26 250		NOK
Cost for spreader beam test lift and certification		30 000		NOK
Extra risk for waiting on weather (spreader)	5	375 000		NOK
SUM		2 063 125	1 886 875	NOK
Difference		176 250		NOK

The example shows a difference of 176 250 NOK in favor of the brace solution. This is much due to the costs of re-rigging and the estimated extra cost of having to wait on weather. This shows that so-called "Critical time" (i.e. the time spent on offshore operations) on the vessel is very important.

Other factors that affect the cost level is:

- Re-use of the equipment on other projects

  If the lifting equipment is re-used for several projects, the fabrication costs can basically be ruled out, although there is usually a small cost for hiring the equipment. The spreader beam has in these cases an advantage over the brace bar solution. The spreader is easier to re-use because the length of the spreader can be adjusted to fit spools of different sizes. It is also not dependent on the diameter of the spool, like the clamps in the brace case are.

- Payment models

  The payment models for installation of spools can be different from project to project. One option is that the whole procedure has a fixed price, where the contractor takes most of the economical risk of delays like having to wait on weather, installation problems etc. For these kinds of payment models the spreader beam has a disadvantage, but usually the additional risk that the contractor takes is rewarded with a higher price.

  Another model is where the payment is done according to the time spent. Here, the commissioner takes the risk, and the payment is usually lower.

Discussion

When it comes to the economical *differences* between braces and spreader solutions, there are many factors playing a part in the overall cost. One factor however, stands out as the most important. The effective time spent on the vessel is the main contributor to the cost in a project. Therefore, solutions with a low "Critical time" are preferred from an economical point of view.

In general the cost picture for a spool installation can be sketched as shown in Figure 6.3-1. The first part in the figure (1) is the cost for preproduction phase, with engineering work. Part (2) is the fabrication cost, and part (3) is the operational time on the offshore vessel.

We might say that if an engineer spends ~50 hours on a solution that reduces the operational time of the vessel with ~2 hours, it may be well worth it.

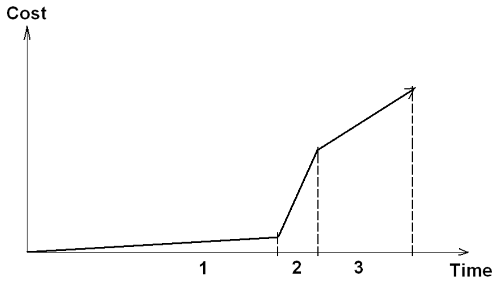


Figure 6.3-1 Cost development

7 Final conclusion

Using a spreader beam instead of a brace bar on this spool has a large reduction effect on the horizontal bending moment, and the maximum utilization of the spool pipe is reduced by over 50 percent. So, from a structural point of view, the spreader beam is the most favorable for this spool.

The parameter study of the buckling factor in Staad.Pro revealed a strange behavior for the utilization ratio that the program returns. The test indicates that the results do not follow a parabolic curve, as should be expected according to Euler theory.

The calculation of buckling length factors with the method of elastic restraints show that this method gives significantly higher buckling factors than Euler theory. A possible source of error in this case is however that the buckling factors for values below a certain limit are estimated. These estimations may be inaccurate.

From an operational point of view, braced solutions are normally preferred, mainly because they are easier to handle and have better sea state limits than spreader solutions. If a special requirement like flexibility comes up, this can be a determining factor in the choice of solution.

The cost of a spool installation is mainly driven by the fabrication cost of the lifting equipment and the effective time spent on the vessel.

The decision of going for either a spreader beam or a brace bar as support during a spool lift is not a straight forward procedure, but is dependent on a total evaluation of the structural part, the operational part and the estimated cost of the lift.

Suggestions for further work is to:

- Investigate or verify the reliability of the results from the buckling analysis
- Investigate the behavior of the result diagrams from the parameter study

8 References

DNV-OS-C101. *Rules for the Planning and Execution of Marine Operations.*

Irgens, F. (2006). *Fasthetslære.* Trondheim: Tapir Akademisk Forlag.

Larsen, P. K. (2010). *Dimensjonering av stålkonstruksjoner.* Trondheim: Tapir Akademisk Forlag.

Norsk Standard. *NS 3472.*

Williams, D. (1988, January). Recent clamps on the Forties platforms. *The Naval Architect* .

9 Appendices

Spool drawings

Weight calculation

Reduced bending moments by moving braces

Buckling factor estimation

Staad.Pro input file, brace case

Staad.Pro input file, spreader case

Staad.Pro outprint, brace case

Staad.Pro outprint, spreader case

9.1 Spool drawings

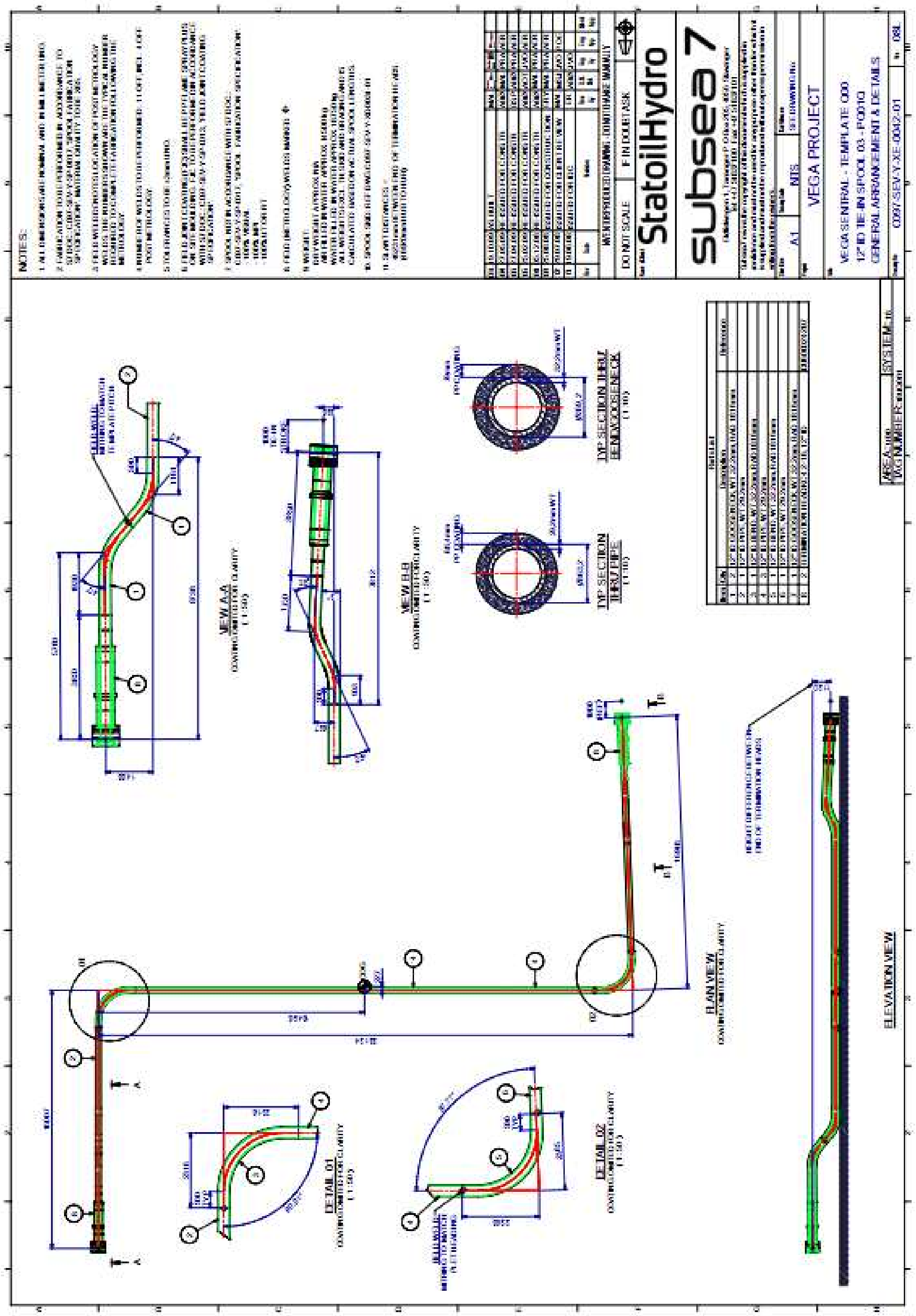


Figure 9.1-1 Overview drawing of Z-spool, 12"

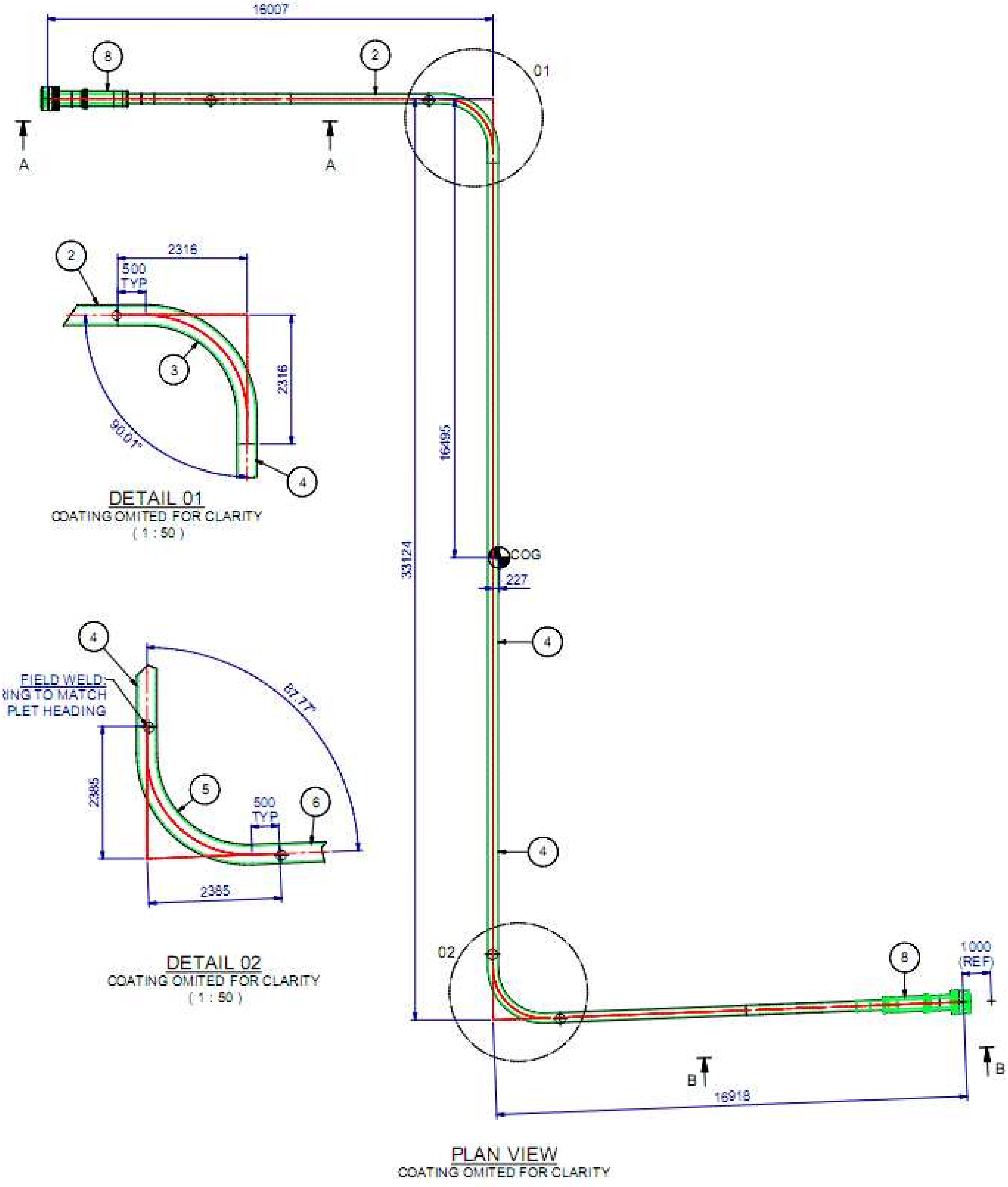


Figure 9.1-2 Plan view of Z-spool

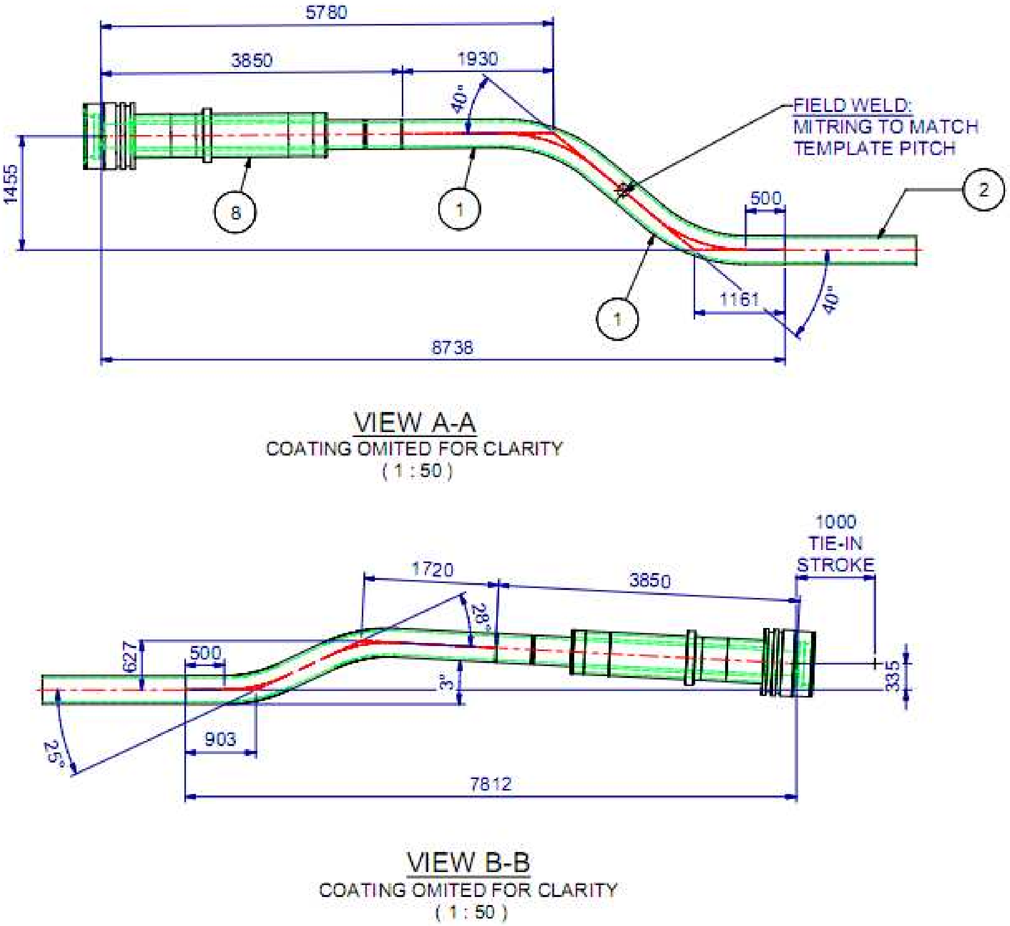


Figure 9.1-3 Detail view A-A and B-B

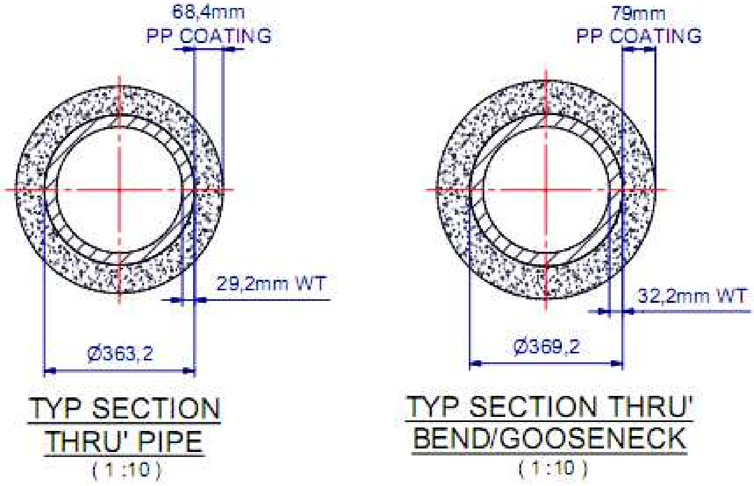


Figure 9.1-4 Detail section view

9.2 Weight calculation

Table 9.2-1 Weight calculation, spool

12" spool	ID (mm)	Thickness (mm)	OD (mm)	Netto area (mm2)	In air Density (kg/m3)	Weight (kg/m)	In water Density (kg/m3)	Weight (kg/m)	
Pipe	304.8	29.2	363.2	30639.3	7850	240.52	6825	209.11	
Coating	363.2	68.4	500	92744.3	900	83.47	-125	-11.59	
SUM						323.99		197.52	
						3.18	**kN/m**	**1.94**	**kN/m**
Trapped water				72965.9	1025	74.79			
						0.73	**kN/m**		
Length of spool				66.59	m				
Weight in air						**21574.40**	kg		
Trapped water						4980.27	kg		
Weight of spool in water						13152.88	kg		
Weight of spool included trapped water						**18133.15**	kg		

Table 9.2-2 Weight calculation, spreader beam and brace bar

Spreader beam and Brace bar	ID (mm)	Thickness (mm)	OD (mm)	Netto area (mm2)	In air Density (kg/m3)	Weight (kg/m)	In water Density (kg/m3)	Weight (kg/m)	
Spreader/ Brace	470	19	508	29188.5	7850	229.13	6825	199.21	
						2.25	**kN/m**	**1.95**	**kN/m**
Weight of spreader/brace in water, air filled						21.38 0.21			
Trapped water 50%				173494.5	1025	88.92			
						0.87	**kN/m**		

9.3 Reduced bending moments by moving braces

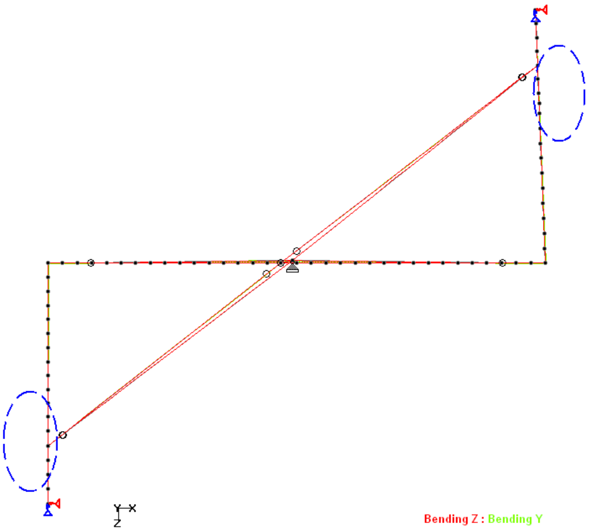


Figure 9.3-1 Bending moments from above, braces moved

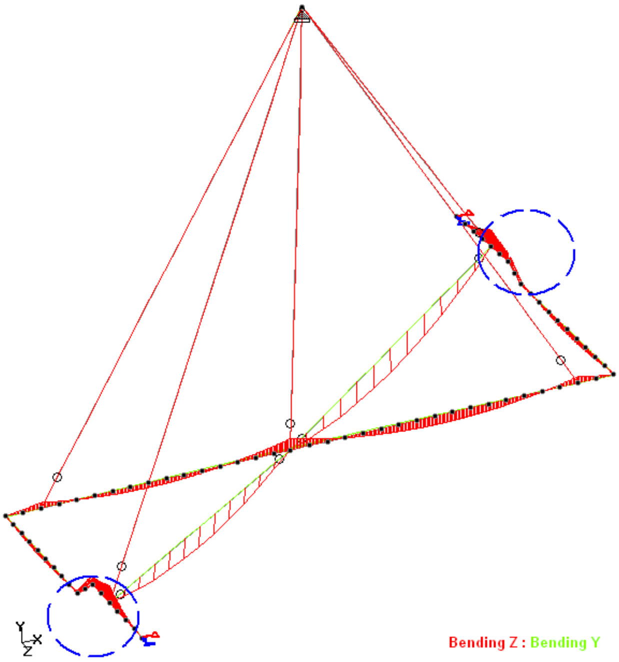


Figure 9.3-2 ISO view of case with moved braces

9.4 Buckling factor estimation

Values extracted from the graph for system 1 and 3 in (Larsen, 2010):

Table 9.4-1 Values from graph

γ	kx = 0	kx = 1	kx = 2
0.00	-	-	2.22
0.50	-	2.62	2.02
2.00	2.90	2.16	1.79
5.00	2.40	1.93	1.67
10.00	2.20	1.83	1.62
∞	2.00	1.74	1.56

This gives the following graph:

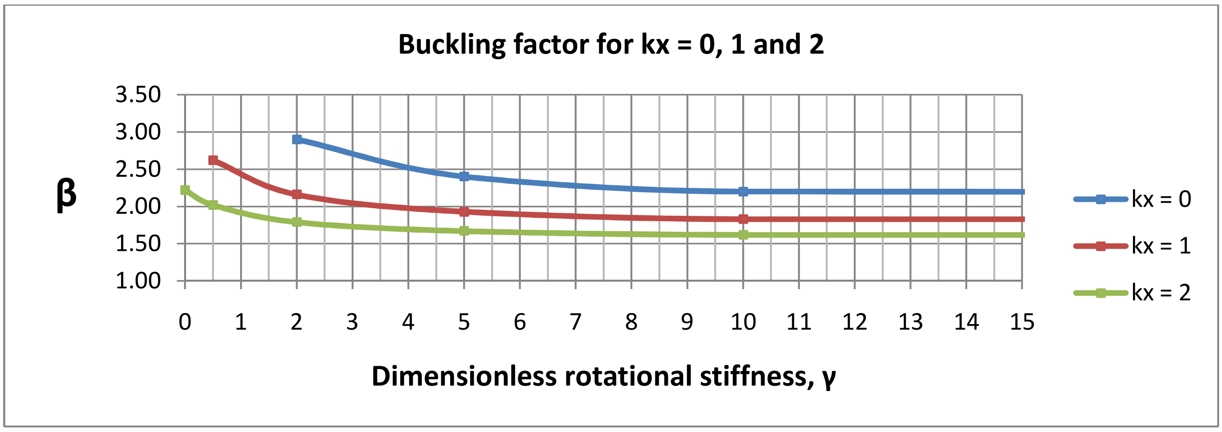


Figure 9.4-1 Graph for buckling factors, system 1 and 3

The numerical difference between values for γ equal to **2, 5** and **10** are found, as well as the relative difference in percent:

Table 9.4-2 Numerical change, and change in percent

	a	b	
γ	kx0 - kx1	kx1 - kx2	a / b
10.00	0.37	0.21	176 %
5.00	0.47	0.26	181 %
2.00	0.74	0.37	200 %

From here, the change in percent is again found, and plotted in a graph along with a linear extrapolation to find the next point: $\frac{181}{176} = 3\%$, $\frac{200}{181} = 11\%$

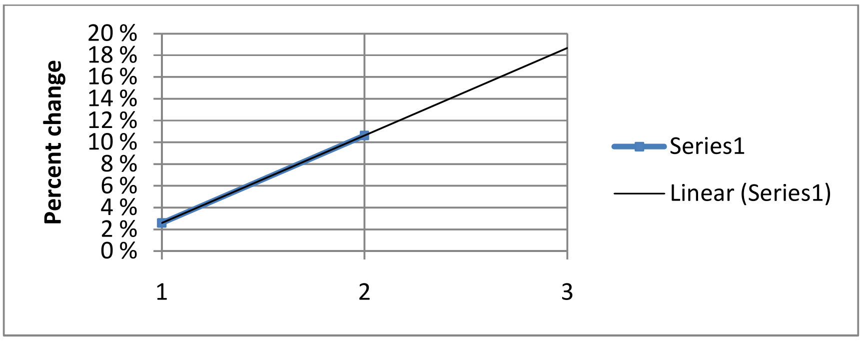


Figure 9.4-2 Linear extrapolation estimate

From the graph we find the next estimate for the change to be 19%. In other words, the difference in values for $\gamma = 0.5$ is $200\ \% * 1{,}19 = 238\ \%$

Table 9.4-3 Estimate for γ=0.5

	a	b	
γ	**kx0 - kx1**	**kx1 - kx2**	**a / b**
10.00	0.37	0.21	176 %
5.00	0.47	0.26	181 %
2.00	0.74	0.37	200 %
0.50	**X**	**0.60**	**238 %**

From this we find the numerical difference X:

$$X = 0.60 * 238\% = 1.43$$

We can then fill in the value for $\boldsymbol{k_\varphi = \gamma = 0.5}$, $\boldsymbol{kx = 0}$ in the table:

$$2.62 + 1.43 = \mathbf{4.05}$$

Table 9.4-4 Estimated value for γ=0.5 , kx=0

γ	kx = 0	kx = 1	kx = 2
0.00	-	-	2.22
0.50	**4.05**	2.62	2.02
2.00	2.90	2.16	1.79
5.00	2.40	1.93	1.67
10.00	2.20	1.83	1.62
∞	2.00	1.74	1.56

The value for $\boldsymbol{k_\varphi = \gamma = 0}$, $\boldsymbol{kx = 1}$ is not represented in the graph from (Larsen, 2010), but can be estimated fairly well, since the value is *right outside* the graph area. The value is estimated to $\boldsymbol{\beta = 3.20}$:

Table 9.4-5 Estimated value for γ=0.00 , kx=1

γ	kx = 0	kx = 1	kx = 2
0.00	-	**3.20**	2.22
0.50	4.05	2.62	2.02
2.00	2.90	2.16	1.79
5.00	2.40	1.93	1.67
10.00	2.20	1.83	1.62
∞	2.00	1.74	1.56

The last value in the table ($\boldsymbol{k_\varphi = \gamma = 0\ ,\ kx = 0}$) is in reality infinite, since this means that the beam is completely instable. In order to get a smooth graph, this value is set to $\boldsymbol{\beta = 15.00}$:

Table 9.4-6 Estimated value for γ=0.00 , kx=0

γ	kx = 0	kx = 1	kx = 2
0.00	**15.00**	3.20	2.22
0.50	4.05	2.62	2.02
2.00	2.90	2.16	1.79
5.00	2.40	1.93	1.67
10.00	2.20	1.83	1.62
∞	2.00	1.74	1.56

This table is plotted, and we get the following graph:

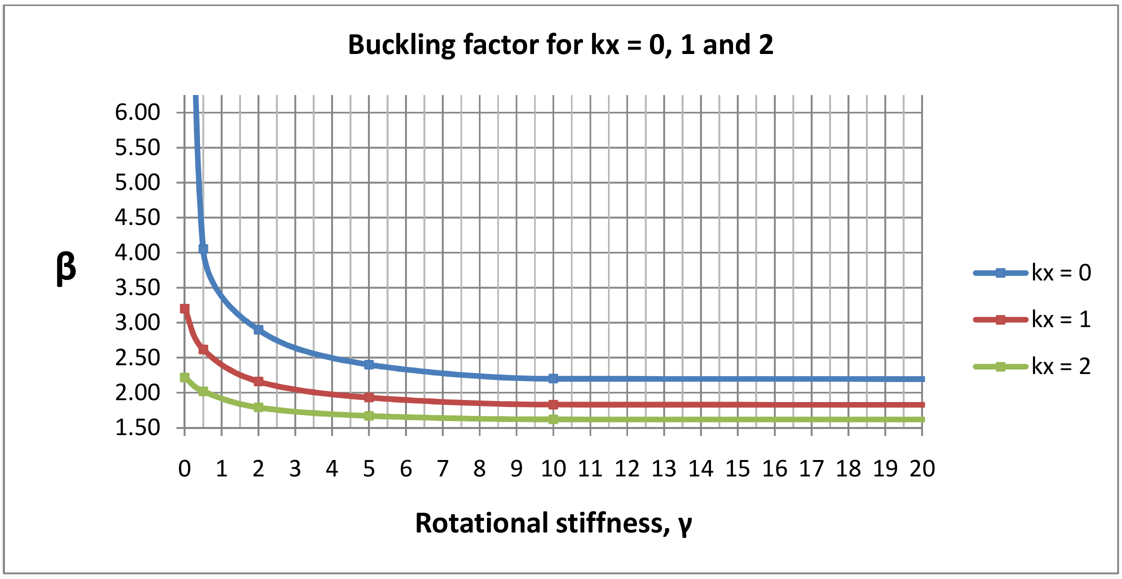


Figure 9.4-3 Complete buckling factor estimation for system 1 and 3, with kx=0 kx=1 kx=2

A close-up view of the graph for kx=0 in the range $\gamma \in [0,10]$:

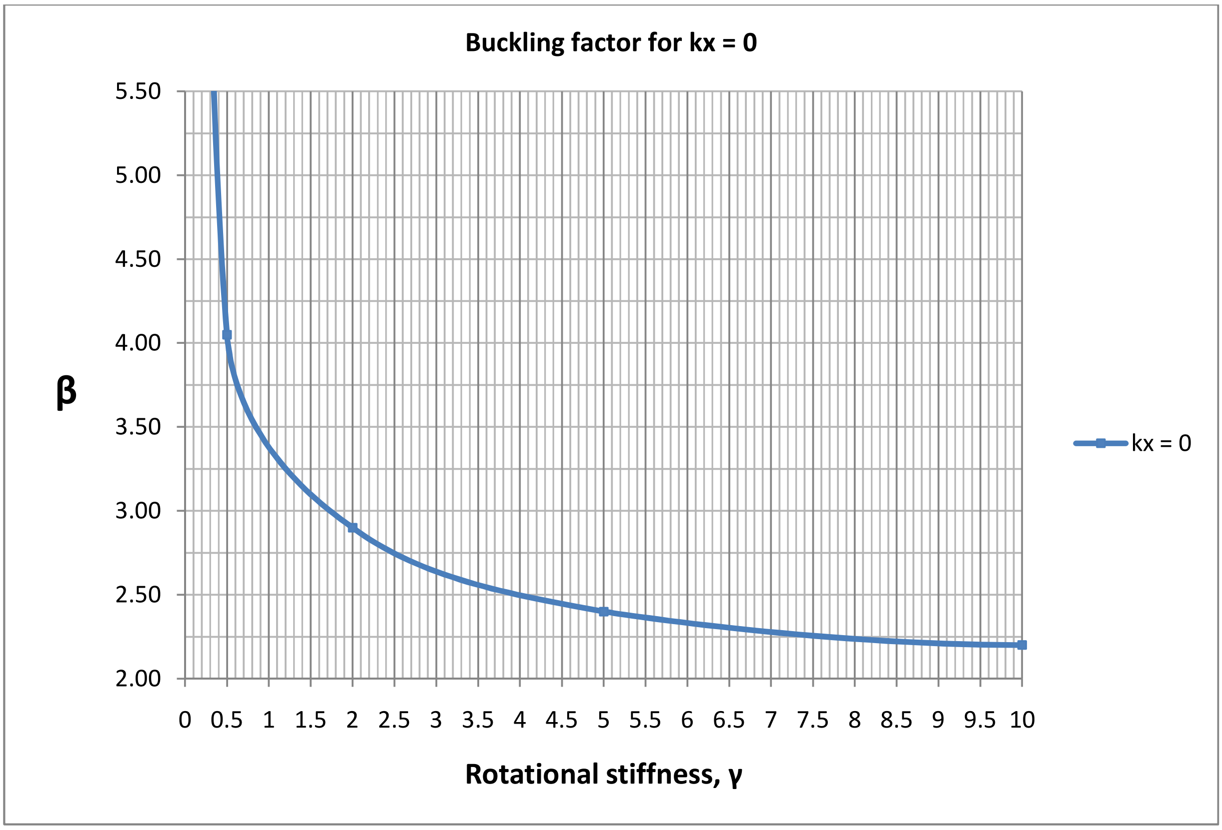
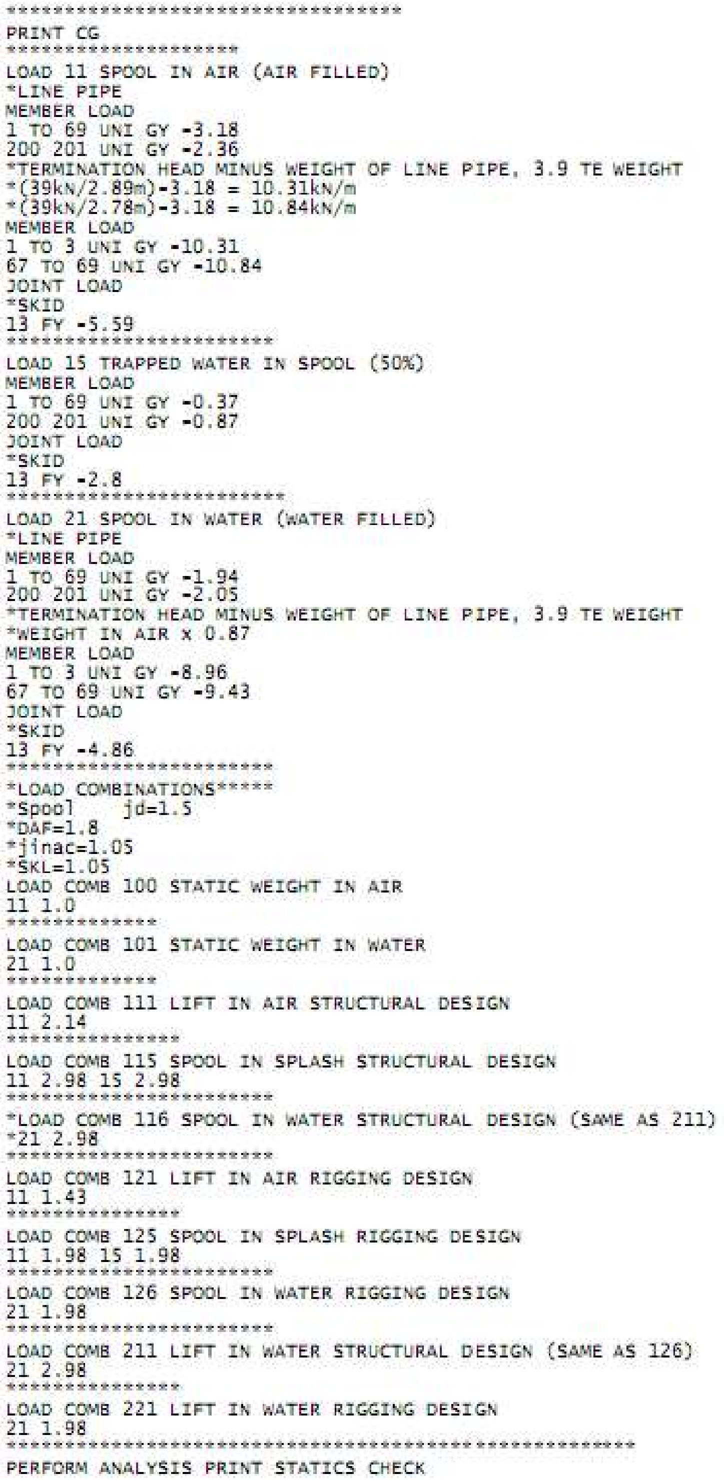


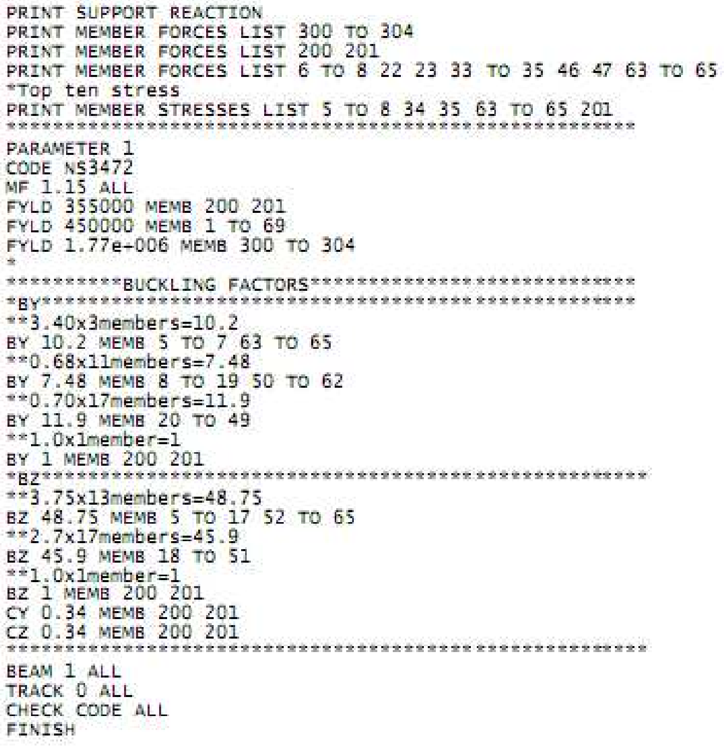
Figure 9.4-4 Estimated buckling factors for system 1 and 3, with kx=0

9.5 Staad.Pro input file, brace case

```
STAAD SPACE
START JOB INFORMATION
ENGINEER DATE 15-Apr-11
JOB PART Z-SPOOL
JOB NAME Thesis
ENGINEER NAME HHO
END JOB INFORMATION
INPUT WIDTH 60
UNIT METER KN
JOINT COORDINATES
1 0 1.455 0; 2 0 0 -16; 3 33.123 0 -16; 4 32.462 0.335 -32.894;
5 0 1.455 -5.78; 6 0 0 -7.575; 7 32.732 0 -25.9933; 8 32.6795 0.6267 -27.3362;
9 0 1.455 -0.963333; 10 0 1.455 -1.92667; 11 0 1.455 -2.89;
12 0 1.455 -3.85333; 13 0 1.455 -4.81667; 14 0 0.7275 -6.6775; 15 0 0 -8.51111;
16 0 0 -9.44722; 17 0 0 -10.3833; 18 0 0 -11.3194; 19 0 0 -12.2556;
20 0 0 -13.1917; 21 0 0 -14.1278; 22 0 0 -15.0639; 23 0.974206 0 -16;
24 1.94841 0 -16; 25 2.92262 0 -16; 26 3.89682 0 -16; 27 4.87103 0 -16;
28 5.84524 0 -16; 29 6.81944 0 -16; 30 7.79365 0 -16; 31 8.76785 0 -16;
32 9.74206 0 -16; 33 10.7163 0 -16; 34 11.6905 0 -16; 35 12.6647 0 -16;
36 13.6389 0 -16; 37 14.6131 0 -16; 38 15.4873 0 -16; 39 16.5615 0 -16;
40 17.5357 0 -16; 41 18.5099 0 -16; 42 19.4841 0 -16; 43 20.4583 0 -16;
44 21.4325 0 -16; 45 22.4067 0 -16; 46 23.3809 0 -16; 47 24.3551 0 -16;
48 25.3294 0 -16; 49 26.3036 0 -16; 50 27.2778 0 -16; 51 28.252 0 -16;
52 29.2262 0 -16; 53 30.2004 0 -16; 54 31.1746 0 -16; 55 32.1488 0 -16;
56 33.0839 0 -16.9993; 57 33.0448 0 -17.9987; 58 33.0057 0 -18.998;
59 32.9666 0 -19.9973; 60 32.9275 0 -20.9966; 61 32.8884 0 -21.996;
62 32.8493 0 -22.9953; 63 32.8102 0 -23.9946; 64 32.7711 0 -24.9939;
65 32.7057 0.31335 -26.6648; 66 32.6432 0.578083 -28.2625;
67 32.607 0.529467 -29.1888; 68 32.5707 0.48085 -30.1151;
69 32.5345 0.432233 -31.0414; 70 32.4982 0.383617 -31.9677;
500 16.26 25 -16.17;
MEMBER INCIDENCES
1 1 9; 2 9 10; 3 10 11; 4 11 12; 5 12 13; 6 13 5; 7 5 14; 8 14 6; 9 6 15;
10 15 16; 11 16 17; 12 17 18; 13 18 19; 14 19 20; 15 20 21; 16 21 22; 17 22 2;
18 2 23; 19 23 24; 20 24 25; 21 25 26; 22 26 27; 23 27 28; 24 28 29; 25 29 30;
26 30 31; 27 31 32; 28 32 33; 29 33 34; 30 34 35; 31 35 36; 32 36 37; 33 37 38;
34 38 39; 35 39 40; 36 40 41; 37 41 42; 38 42 43; 39 43 44; 40 44 45; 41 45 46;
42 46 47; 43 47 48; 44 48 49; 45 49 50; 46 50 51; 47 51 52; 48 52 53; 49 53 54;
50 54 55; 51 55 3; 52 3 56; 53 56 57; 54 57 58; 55 58 59; 56 59 60; 57 60 61;
58 61 62; 59 62 63; 60 63 64; 61 64 7; 62 7 65; 63 65 8; 64 8 66; 65 66 67;
66 67 68; 67 68 69; 68 69 70; 69 70 4; 200 14 38; 201 38 65; 300 12 500;
301 24 500; 302 39 500; 303 54 500; 304 67 500;
*****************************************************
DEFINE MATERIAL START
ISOTROPIC STEEL
E 2.05e+008
POISSON 0.3
DENSITY 77
DAMP 0.03
*
ISOTROPIC MATERIAL1
E 6e+007
POISSON 0.3
DENSITY 77
DAMP 2.8026e-044
END DEFINE MATERIAL
******************************************************
MEMBER RELEASE
300 TO 304 START MX MY MZ
200 201 START MX MY MZ
200 201 END MY MZ
******************************************************
SUPPORTS
1 4 FIXED BUT FY MX MY MZ KFX 5 KFZ 5
500 PINNED
******************************************************
DRAW ISOM SUPP
******************************************************
MEMBER PROPERTY EUROPEAN
1 TO 69 TABLE ST PIPE OD 0.3632 ID 0.3048
300 TO 304 TABLE ST PIPE OD 0.07 ID 0.02
200 201 TABLE ST PIPE OD 0.508 ID 0.47
****************************************
CONSTANTS
MATERIAL STEEL MEMB 1 TO 69 200 201
MATERIAL MATERIAL1 MEMB 300 TO 304
```



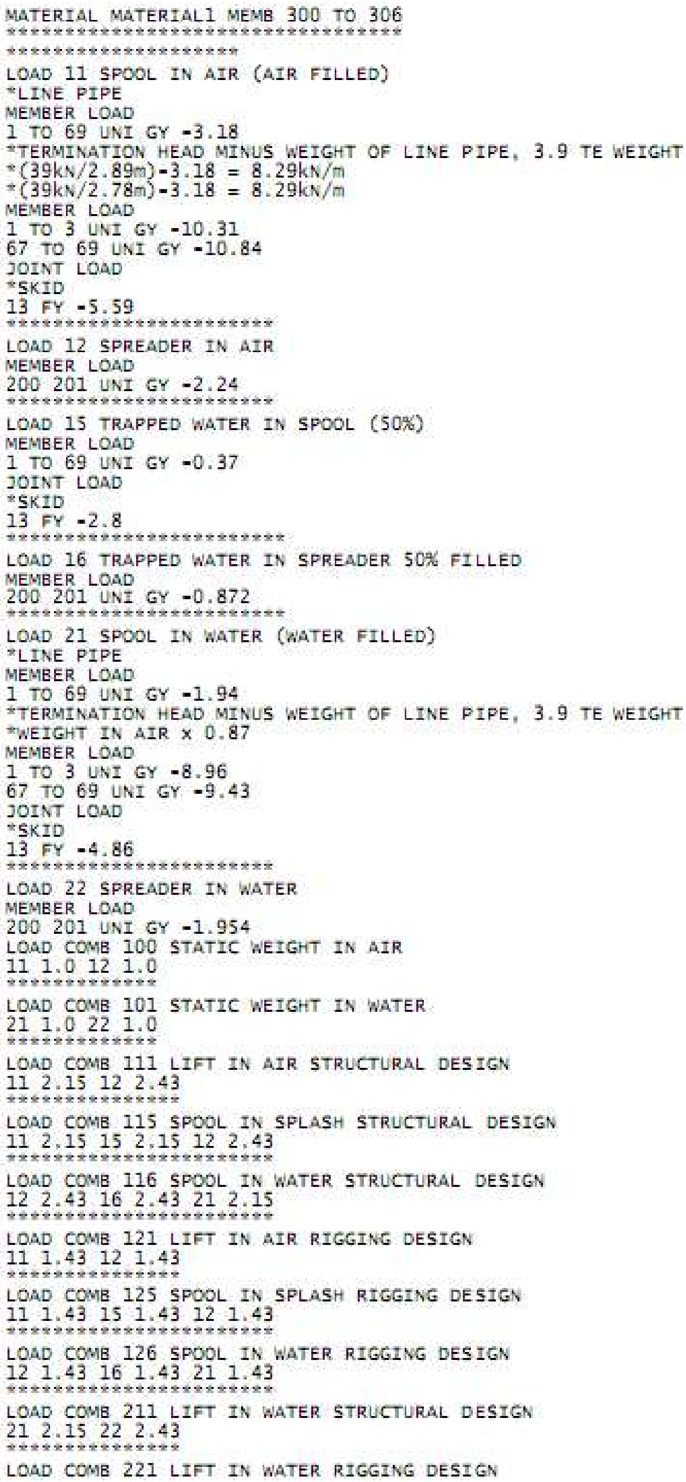
```
**********************************
PRINT CG
********************
LOAD 11 SPOOL IN AIR (AIR FILLED)
*LINE PIPE
MEMBER LOAD
1 TO 69 UNI GY -3.18
200 201 UNI GY -2.36
*TERMINATION HEAD MINUS WEIGHT OF LINE PIPE, 3.9 TE WEIGHT
*(39kN/2.89m)-3.18 = 10.31kN/m
*(39kN/2.78m)-3.18 = 10.84kN/m
MEMBER LOAD
1 TO 3 UNI GY -10.31
67 TO 69 UNI GY -10.84
JOINT LOAD
*SKID
13 FY -5.59
***********************
LOAD 15 TRAPPED WATER IN SPOOL (50%)
MEMBER LOAD
1 TO 69 UNI GY -0.37
200 201 UNI GY -0.87
JOINT LOAD
*SKID
13 FY -2.8
************************
LOAD 21 SPOOL IN WATER (WATER FILLED)
*LINE PIPE
MEMBER LOAD
1 TO 69 UNI GY -1.94
200 201 UNI GY -2.05
*TERMINATION HEAD MINUS WEIGHT OF LINE PIPE, 3.9 TE WEIGHT
*WEIGHT IN AIR x 0.87
MEMBER LOAD
1 TO 3 UNI GY -8.96
67 TO 69 UNI GY -9.43
JOINT LOAD
*SKID
13 FY -4.86
***********************
*LOAD COMBINATIONS*****
*Spool    jd=1.5
*DAF=1.8
*jinac=1.05
*SKL=1.05
LOAD COMB 100 STATIC WEIGHT IN AIR
11 1.0
*************
LOAD COMB 101 STATIC WEIGHT IN WATER
21 1.0
*************
LOAD COMB 111 LIFT IN AIR STRUCTURAL DESIGN
11 2.14
***************
LOAD COMB 115 SPOOL IN SPLASH STRUCTURAL DESIGN
11 2.98 15 2.98
***********************
*LOAD COMB 116 SPOOL IN WATER STRUCTURAL DESIGN (SAME AS 211)
*21 2.98
***********************
LOAD COMB 121 LIFT IN AIR RIGGING DESIGN
11 1.43
***************
LOAD COMB 125 SPOOL IN SPLASH RIGGING DESIGN
11 1.98 15 1.98
***********************
LOAD COMB 126 SPOOL IN WATER RIGGING DESIGN
21 1.98
***********************
LOAD COMB 211 LIFT IN WATER STRUCTURAL DESIGN (SAME AS 126)
21 2.98
***************
LOAD COMB 221 LIFT IN WATER RIGGING DESIGN
21 1.98
******************************************************
PERFORM ANALYSIS PRINT STATICS CHECK
```



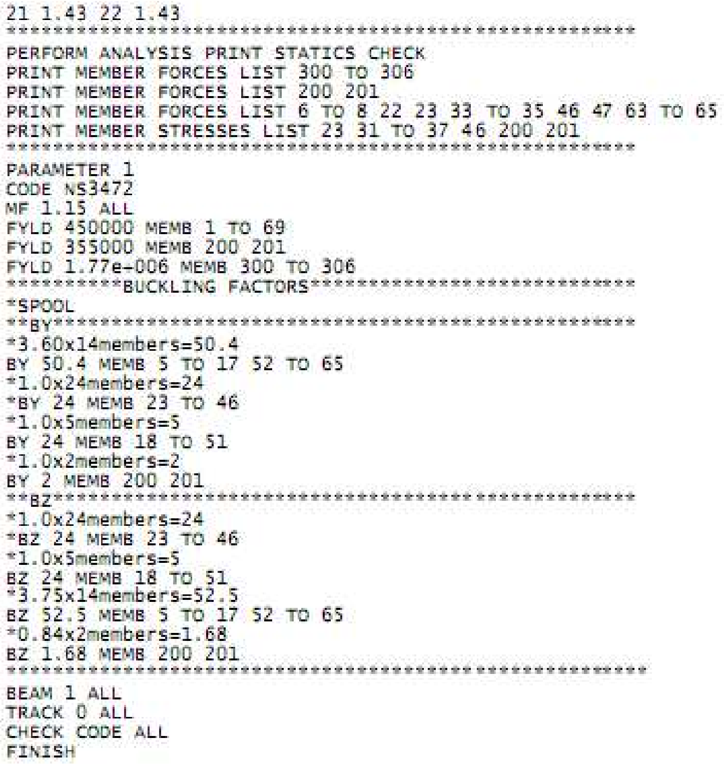
```
PRINT SUPPORT REACTION
PRINT MEMBER FORCES LIST 300 TO 304
PRINT MEMBER FORCES LIST 200 201
PRINT MEMBER FORCES LIST 6 TO 8 22 23 33 TO 35 46 47 63 TO 65
*Top ten stress
PRINT MEMBER STRESSES LIST 5 TO 8 34 35 63 TO 65 201
******************************************************
PARAMETER 1
CODE NS3472
MF 1.15 ALL
FYLD 355000 MEMB 200 201
FYLD 450000 MEMB 1 TO 69
FYLD 1.77e-006 MEMB 300 TO 304
*
**********BUCKLING FACTORS****************************
*BY***************************************************
**3.40x3members=10.2
BY 10.2 MEMB 5 TO 7 63 TO 65
**0.68x11members=7.48
BY 7.48 MEMB 8 TO 19 50 TO 62
**0.70x17members=11.9
BY 11.9 MEMB 20 TO 49
**1.0x1member=1
BY 1 MEMB 200 201
*BZ****************************************************
**3.75x13members=48.75
BZ 48.75 MEMB 5 TO 17 52 TO 65
**2.7x17members=45.9
BZ 45.9 MEMB 18 TO 51
**1.0x1member=1
BZ 1 MEMB 200 201
CY 0.34 MEMB 200 201
CZ 0.34 MEMB 200 201
*******************************************************
BEAM 1 ALL
TRACK 0 ALL
CHECK CODE ALL
FINISH
```

9.6 Staad.Pro input file, spreader case

```
STAAD SPACE
START JOB INFORMATION
ENGINEER DATE 15-Apr-11
JOB PART Z-SPOOL
JOB NAME Thesis
ENGINEER NAME HHO
END JOB INFORMATION
INPUT WIDTH 60
UNIT METER KN
JOINT COORDINATES
1 0 1.455 0; 2 0 0 -16; 3 33.123 0 -16; 4 32.462 0.335 -32.894;
5 0 1.455 -5.78; 6 0 0 -7.575; 7 32.732 0 -25.9933; 8 32.6795 0.6267 -27.3362;
9 0 1.455 -0.963333; 10 0 1.455 -1.92667; 11 0 1.455 -2.89;
12 0 1.455 -3.85333; 13 0 1.455 -4.81667; 14 0 0.7275 -6.6775; 15 0 0 -8.51111;
16 0 0 -9.44722; 17 0 0 -10.3833; 18 0 0 -11.3194; 19 0 0 -12.2556;
20 0 0 -13.1917; 21 0 0 -14.1278; 22 0 0 -15.0639; 23 0.974206 0 -16;
24 1.94841 0 -16; 25 2.92262 0 -16; 26 3.89682 0 -16; 27 4.87103 0 -16;
28 5.84524 0 -16; 29 6.81944 0 -16; 30 7.79365 0 -16; 31 8.76785 0 -16;
32 9.74206 0 -16; 33 10.7163 0 -16; 34 11.6905 0 -16; 35 12.6647 0 -16;
36 13.6389 0 -16; 37 14.6131 0 -16; 38 15.4873 0 -16; 39 16.5615 0 -16;
40 17.5357 0 -16; 41 18.5099 0 -16; 42 19.4841 0 -16; 43 20.4583 0 -16;
44 21.4325 0 -16; 45 22.4067 0 -16; 46 23.3809 0 -16; 47 24.3551 0 -16;
48 25.3294 0 -16; 49 26.3036 0 -16; 50 27.2778 0 -16; 51 28.252 0 -16;
52 29.2262 0 -16; 53 30.2004 0 -16; 54 31.1746 0 -16; 55 32.1488 0 -16;
56 33.0839 0 -16.9993; 57 33.0448 0 -17.9987; 58 33.0057 0 -18.998;
59 32.9666 0 -19.9973; 60 32.9275 0 -20.9966; 61 32.8884 0 -21.996;
62 32.8493 0 -22.9953; 63 32.8102 0 -23.9946; 64 32.7711 0 -24.9939;
65 32.7057 0.31335 -26.6648; 66 32.6432 0.578083 -28.2625;
67 32.607 0.529467 -29.1888; 68 32.5707 0.48085 -30.1151;
69 32.5345 0.432233 -31.0414; 70 32.4982 0.383617 -31.9677; 200 0 4 -3.853;
201 16.3035 4 -16.521; 202 32.607 4 -29.189; 500 16.227 25 -16.032;
MEMBER INCIDENCES
1 1 9; 2 9 10; 3 10 11; 4 11 12; 5 12 13; 6 13 5; 7 5 14; 8 14 6; 9 6 15;
10 15 16; 11 16 17; 12 17 18; 13 18 19; 14 19 20; 15 20 21; 16 21 22; 17 22 2;
18 2 23; 19 23 24; 20 24 25; 21 25 26; 22 26 27; 23 27 28; 24 28 29; 25 29 30;
26 30 31; 27 31 32; 28 32 33; 29 33 34; 30 34 35; 31 35 36; 32 36 37; 33 37 38;
34 38 39; 35 39 40; 36 40 41; 37 41 42; 38 42 43; 39 43 44; 40 44 45; 41 45 46;
42 46 47; 43 47 48; 44 48 49; 45 49 50; 46 50 51; 47 51 52; 48 52 53; 49 53 54;
50 54 55; 51 55 3; 52 3 56; 53 56 57; 54 57 58; 55 58 59; 56 59 60; 57 60 61;
58 61 62; 59 62 63; 60 63 64; 61 64 7; 62 7 65; 63 65 8; 64 8 66; 65 66 67;
66 67 68; 67 68 69; 68 69 70; 69 70 4; 200 200 201; 201 201 202; 300 200 500;
301 27 500; 302 201 500; 303 51 500; 304 202 500; 305 12 200; 306 67 202;
*****************************************************
DEFINE MATERIAL START
ISOTROPIC STEEL
E 2.05e+008
POISSON 0.3
DENSITY 77
DAMP 0.03
*
ISOTROPIC MATERIAL1
E 6e+007
POISSON 0.3
DENSITY 77
DAMP 2.8026e-044
END DEFINE MATERIAL
******************************************************
MEMBER RELEASE
301 303 305 306 START MX MY MZ
305 306 END MY
300 302 304 START MY MZ
******************************************************
SUPPORTS
1 4 200 202 FIXED BUT FY MX MY MZ KFX 5 KFZ 5
500 PINNED
******************************************************
DRAW ISOM SUPP
******************************************************
MEMBER PROPERTY EUROPEAN
1 TO 69 TABLE ST PIPE OD 0.3632 ID 0.3048
200 201 TABLE ST PIPE OD 0.508 ID 0.47
300 TO 306 TABLE ST PIPE OD 0.07 ID 0.02
****************************************
CONSTANTS
BETA 0 MEMB 305
MATERIAL STEEL MEMB 1 TO 69 200 201
```

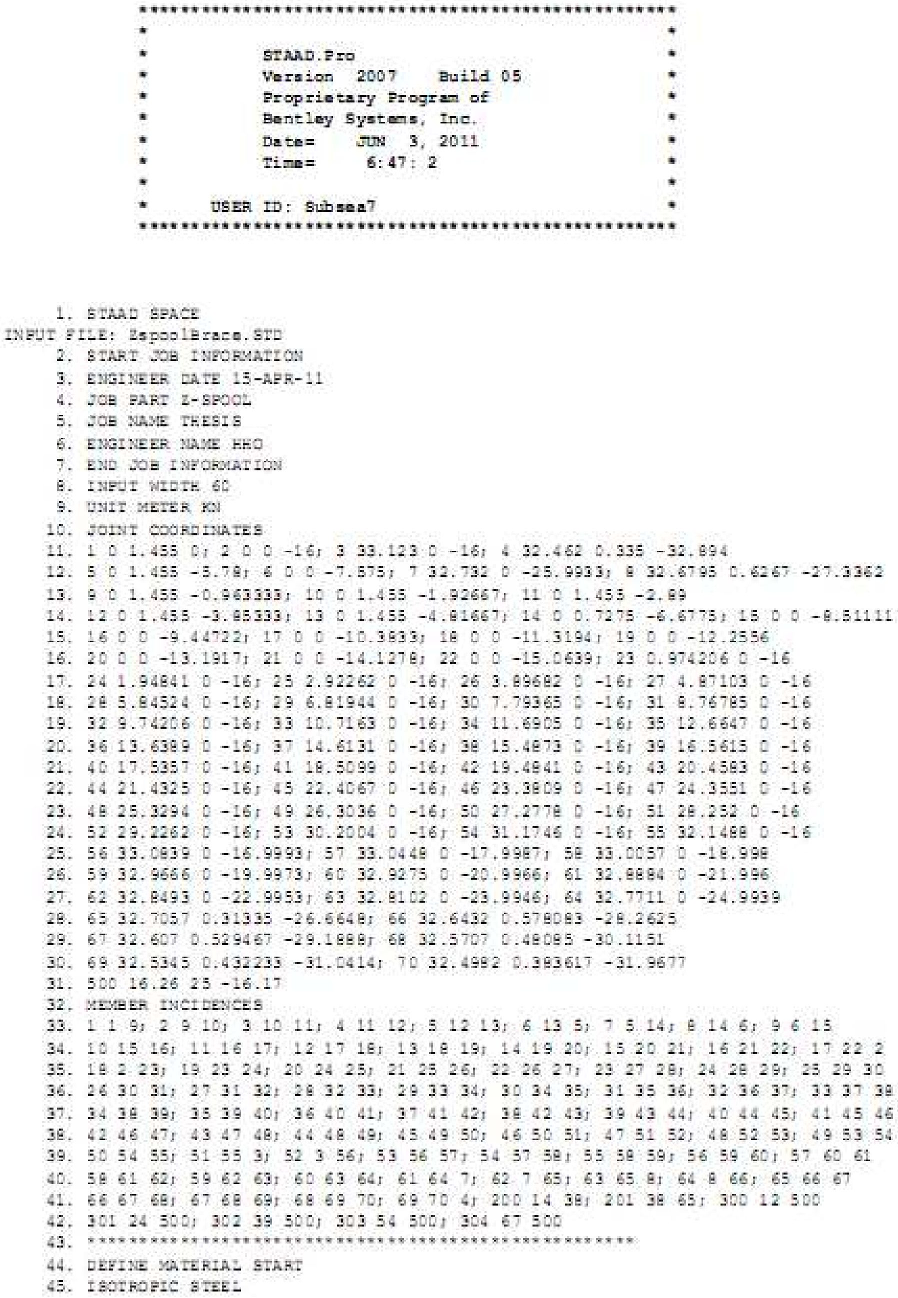


```
MATERIAL MATERIAL1 MEMB 300 TO 306
**********************************
********************
LOAD 11 SPOOL IN AIR (AIR FILLED)
*LINE PIPE
MEMBER LOAD
1 TO 69 UNI GY -3.18
*TERMINATION HEAD MINUS WEIGHT OF LINE PIPE, 3.9 TE WEIGHT
*(39kN/2.89m)-3.18 = 8.29kN/m
*(39kN/2.78m)-3.18 = 8.29kN/m
MEMBER LOAD
1 TO 3 UNI GY -10.31
67 TO 69 UNI GY -10.84
JOINT LOAD
*SKID
13 FY -5.59
***********************
LOAD 12 SPREADER IN AIR
MEMBER LOAD
200 201 UNI GY -2.24
***********************
LOAD 15 TRAPPED WATER IN SPOOL (50%)
MEMBER LOAD
1 TO 69 UNI GY -0.37
JOINT LOAD
*SKID
13 FY -2.8
************************
LOAD 16 TRAPPED WATER IN SPREADER 50% FILLED
MEMBER LOAD
200 201 UNI GY -0.872
************************
LOAD 21 SPOOL IN WATER (WATER FILLED)
*LINE PIPE
MEMBER LOAD
1 TO 69 UNI GY -1.94
*TERMINATION HEAD MINUS WEIGHT OF LINE PIPE, 3.9 TE WEIGHT
*WEIGHT IN AIR x 0.87
MEMBER LOAD
1 TO 3 UNI GY -8.96
67 TO 69 UNI GY -9.43
JOINT LOAD
*SKID
13 FY -4.86
***********************
LOAD 22 SPREADER IN WATER
MEMBER LOAD
200 201 UNI GY -1.954
LOAD COMB 100 STATIC WEIGHT IN AIR
11 1.0 12 1.0
*************
LOAD COMB 101 STATIC WEIGHT IN WATER
21 1.0 22 1.0
*************
LOAD COMB 111 LIFT IN AIR STRUCTURAL DESIGN
11 2.15 12 2.43
***************
LOAD COMB 115 SPOOL IN SPLASH STRUCTURAL DESIGN
11 2.15 15 2.15 12 2.43
***********************
LOAD COMB 116 SPOOL IN WATER STRUCTURAL DESIGN
12 2.43 16 2.43 21 2.15
***********************
LOAD COMB 121 LIFT IN AIR RIGGING DESIGN
11 1.43 12 1.43
***************
LOAD COMB 125 SPOOL IN SPLASH RIGGING DESIGN
11 1.43 15 1.43 12 1.43
***********************
LOAD COMB 126 SPOOL IN WATER RIGGING DESIGN
12 1.43 16 1.43 21 1.43
***********************
LOAD COMB 211 LIFT IN WATER STRUCTURAL DESIGN
21 2.15 22 2.43
***************
LOAD COMB 221 LIFT IN WATER RIGGING DESIGN
```

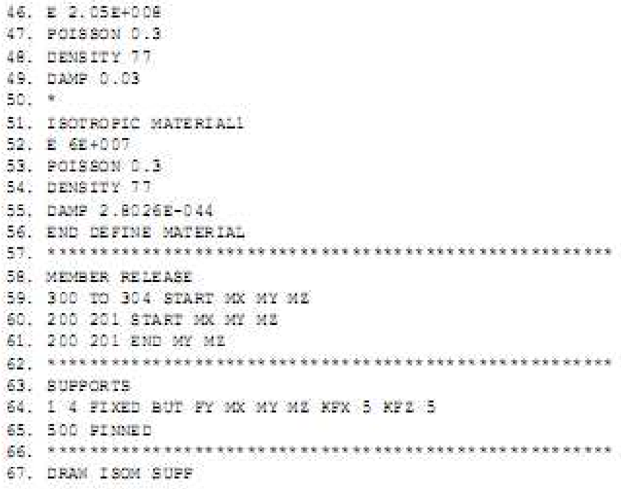


```
21 1.43 22 1.43
******************************************************
PERFORM ANALYSIS PRINT STATICS CHECK
PRINT MEMBER FORCES LIST 300 TO 306
PRINT MEMBER FORCES LIST 200 201
PRINT MEMBER FORCES LIST 6 TO 8 22 23 33 TO 35 46 47 63 TO 65
PRINT MEMBER STRESSES LIST 23 31 TO 37 46 200 201
******************************************************
PARAMETER 1
CODE NS3472
MF 1.15 ALL
FYLD 450000 MEMB 1 TO 69
FYLD 355000 MEMB 200 201
FYLD 1.77e-006 MEMB 300 TO 306
**********BUCKLING FACTORS****************************
*SPOOL
**BY**************************************************
*3.60x14members=50.4
BY 50.4 MEMB 5 TO 17 52 TO 65
*1.0x24members=24
*BY 24 MEMB 23 TO 46
*1.0x5members=5
BY 24 MEMB 18 TO 51
*1.0x2members=2
BY 2 MEMB 200 201
**BZ**************************************************
*1.0x24members=24
*BZ 24 MEMB 23 TO 46
*1.0x5members=5
BZ 24 MEMB 18 TO 51
*3.75x14members=52.5
BZ 52.5 MEMB 5 TO 17 52 TO 65
*0.84x2members=1.68
BZ 1.68 MEMB 200 201
*******************************************************
BEAM 1 ALL
TRACK 0 ALL
CHECK CODE ALL
FINISH
```

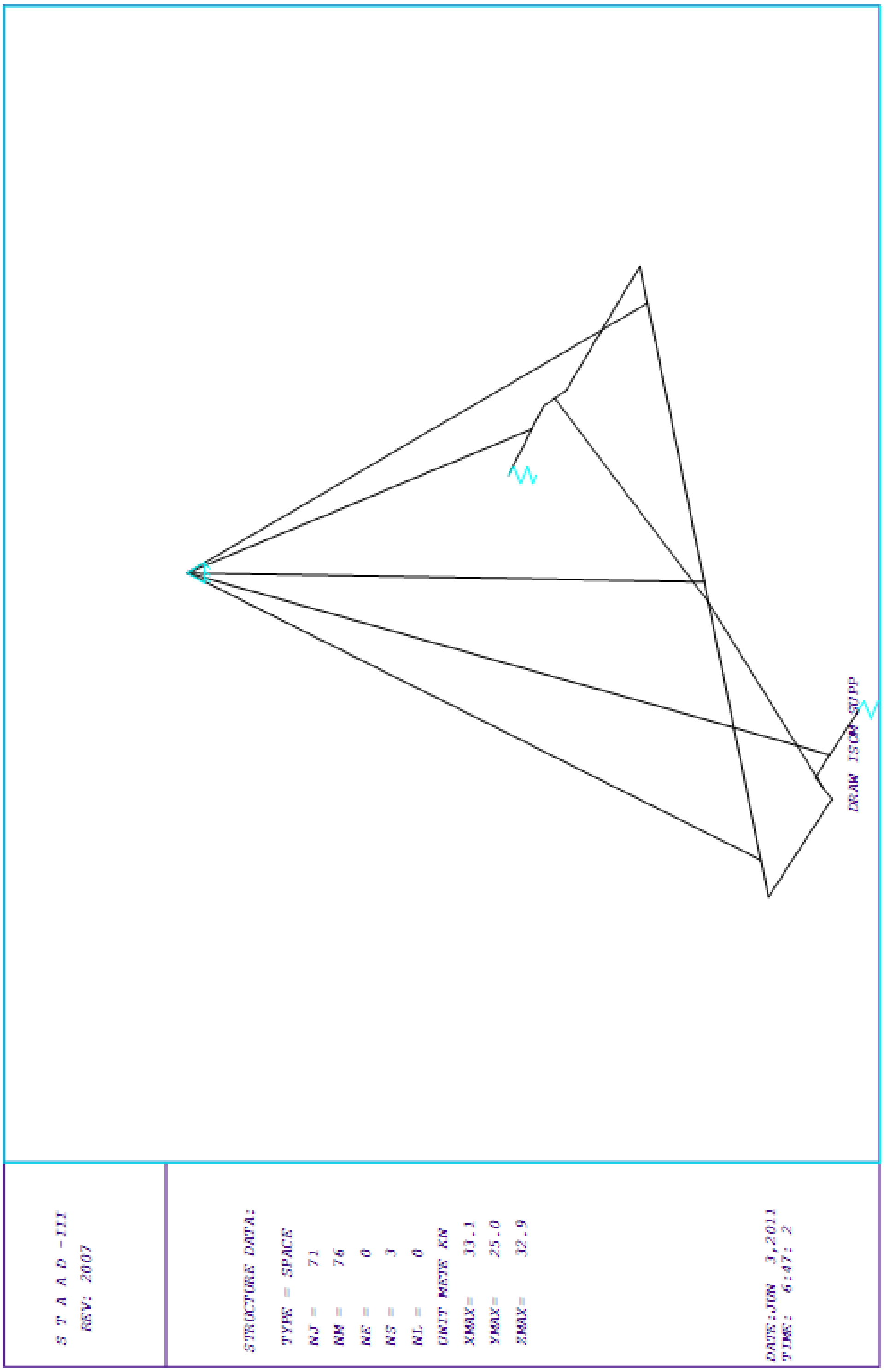
9.7 Staad.Pro outprint, brace case

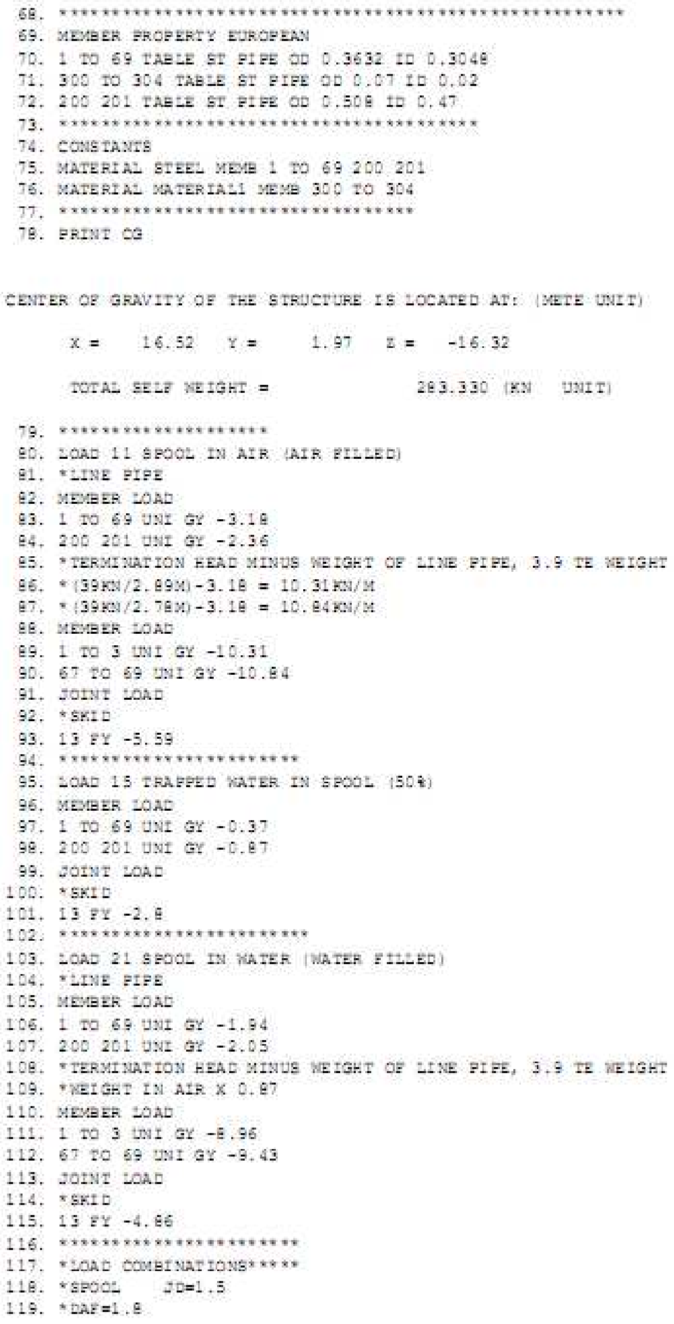


```
 ****************************************************
 *                                                  *
 *           STAAD.Pro                              *
 *           Version  2007     Build 05             *
 *           Proprietary Program of                 *
 *           Bentley Systems, Inc.                  *
 *           Date=    JUN  3, 2011                  *
 *           Time=     6:47: 2                      *
 *                                                  *
 *      USER ID: Subsea7                            *
 ****************************************************


      1. STAAD SPACE
INPUT FILE: ZspoolBrace.STD
      2. START JOB INFORMATION
      3. ENGINEER DATE 15-APR-11
      4. JOB PART Z-SPOOL
      5. JOB NAME THESIS
      6. ENGINEER NAME HHO
      7. END JOB INFORMATION
      8. INPUT WIDTH 60
      9. UNIT METER KN
     10. JOINT COORDINATES
     11. 1 0 1.455 0; 2 0 0 -16; 3 33.123 0 -16; 4 32.462 0.335 -32.894
     12. 5 0 1.455 -5.78; 6 0 0 -7.575; 7 32.732 0 -25.9933; 8 32.6795 0.6267 -27.3362
     13. 9 0 1.455 -0.963333; 10 0 1.455 -1.92667; 11 0 1.455 -2.89
     14. 12 0 1.455 -3.85333; 13 0 1.455 -4.81667; 14 0 0.7275 -6.6775; 15 0 0 -8.51111
     15. 16 0 0 -9.44722; 17 0 0 -10.3833; 18 0 0 -11.3194; 19 0 0 -12.2556
     16. 20 0 0 -13.1917; 21 0 0 -14.1278; 22 0 0 -15.0639; 23 0.974206 0 -16
     17. 24 1.94841 0 -16; 25 2.92262 0 -16; 26 3.89682 0 -16; 27 4.87103 0 -16
     18. 28 5.84524 0 -16; 29 6.81944 0 -16; 30 7.79365 0 -16; 31 8.76785 0 -16
     19. 32 9.74206 0 -16; 33 10.7163 0 -16; 34 11.6905 0 -16; 35 12.6647 0 -16
     20. 36 13.6389 0 -16; 37 14.6131 0 -16; 38 15.4873 0 -16; 39 16.5615 0 -16
     21. 40 17.5357 0 -16; 41 18.5099 0 -16; 42 19.4841 0 -16; 43 20.4583 0 -16
     22. 44 21.4325 0 -16; 45 22.4067 0 -16; 46 23.3809 0 -16; 47 24.3551 0 -16
     23. 48 25.3294 0 -16; 49 26.3036 0 -16; 50 27.2778 0 -16; 51 28.252 0 -16
     24. 52 29.2262 0 -16; 53 30.2004 0 -16; 54 31.1746 0 -16; 55 32.1488 0 -16
     25. 56 33.0839 0 -16.9993; 57 33.0448 0 -17.9987; 58 33.0057 0 -18.998
     26. 59 32.9666 0 -19.9973; 60 32.9275 0 -20.9966; 61 32.8884 0 -21.996
     27. 62 32.8493 0 -22.9953; 63 32.8102 0 -23.9946; 64 32.7711 0 -24.9939
     28. 65 32.7057 0.31335 -26.6648; 66 32.6432 0.578083 -28.2625
     29. 67 32.607 0.529467 -29.1888; 68 32.5707 0.48085 -30.1151
     30. 69 32.5345 0.432233 -31.0414; 70 32.4982 0.383617 -31.9677
     31. 500 16.26 25 -16.17
     32. MEMBER INCIDENCES
     33. 1 1 9; 2 9 10; 3 10 11; 4 11 12; 5 12 13; 6 13 5; 7 5 14; 8 14 6; 9 6 15
     34. 10 15 16; 11 16 17; 12 17 18; 13 18 19; 14 19 20; 15 20 21; 16 21 22; 17 22 2
     35. 18 2 23; 19 23 24; 20 24 25; 21 25 26; 22 26 27; 23 27 28; 24 28 29; 25 29 30
     36. 26 30 31; 27 31 32; 28 32 33; 29 33 34; 30 34 35; 31 35 36; 32 36 37; 33 37 38
     37. 34 38 39; 35 39 40; 36 40 41; 37 41 42; 38 42 43; 39 43 44; 40 44 45; 41 45 46
     38. 42 46 47; 43 47 48; 44 48 49; 45 49 50; 46 50 51; 47 51 52; 48 52 53; 49 53 54
     39. 50 54 55; 51 55 3; 52 3 56; 53 56 57; 54 57 58; 55 58 59; 56 59 60; 57 60 61
     40. 58 61 62; 59 62 63; 60 63 64; 61 64 7; 62 7 65; 63 65 8; 64 8 66; 65 66 67
     41. 66 67 68; 67 68 69; 68 69 70; 69 70 4; 200 14 38; 201 38 65; 300 12 500
     42. 301 24 500; 302 39 500; 303 54 500; 304 67 500
     43. ******************************************************
     44. DEFINE MATERIAL START
     45. ISOTROPIC STEEL
```

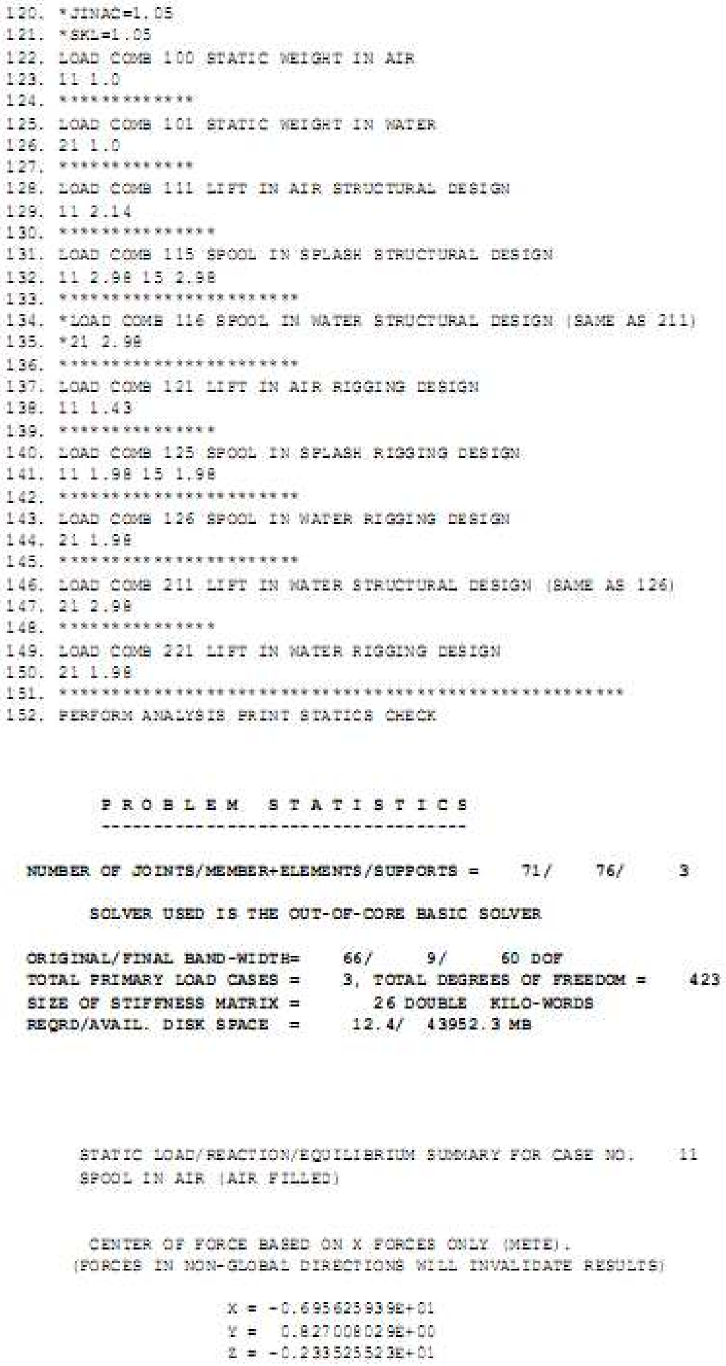


```
E 2.05E+008
POISSON 0.3
DENSITY 77
DAMP 0.03
*
ISOTROPIC MATERIAL1
E 6E+007
POISSON 0.3
DENSITY 77
DAMP 2.8026E-044
END DEFINE MATERIAL
*******************************************************
MEMBER RELEASE
300 TO 304 START MX MY MZ
200 201 START MX MY MZ
200 201 END MY MZ
*******************************************************
SUPPORTS
1 4 FIXED BUT FY MX MY MZ KFX 5 KFZ 5
500 PINNED
*******************************************************
DRAW ISOM SUPP
```

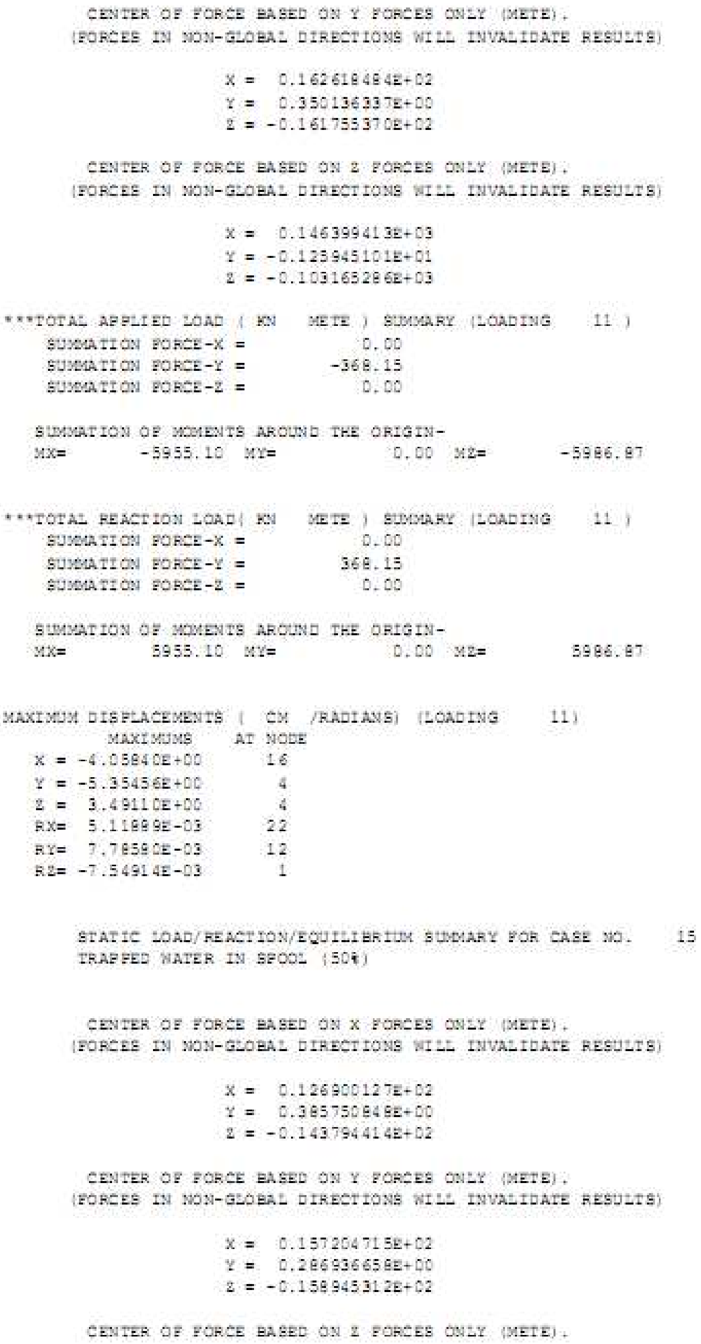

DRAW ISOM SUPP
S T A A D -III
REV: 2007
STRUCTURE DATA:
TYPE = SPACE
NJ = 71
NM = 76
NE = 0
NS = 3
NL = 0
UNIT METE KN
XMAX= 33.1
YMAX= 25.0
ZMAX= 32.9
DATE:JUN 3,2011
TIME: 6:47: 2



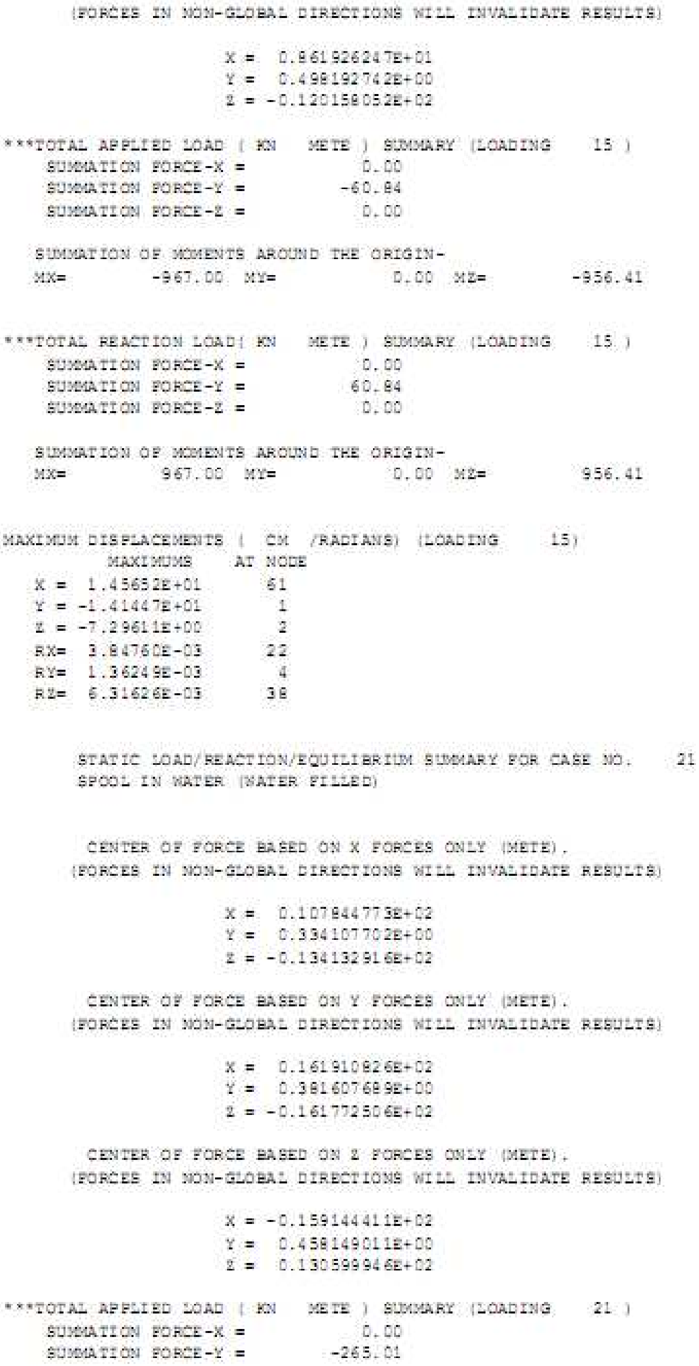
```
  68. *********************************************************
  69. MEMBER PROPERTY EUROPEAN
  70. 1 TO 69 TABLE ST PIPE OD 0.3632 ID 0.3048
  71. 300 TO 304 TABLE ST PIPE OD 0.07 ID 0.02
  72. 200 201 TABLE ST PIPE OD 0.508 ID 0.47
  73. ****************************************
  74. CONSTANTS
  75. MATERIAL STEEL MEMB 1 TO 69 200 201
  76. MATERIAL MATERIAL1 MEMB 300 TO 304
  77. **********************************
  78. PRINT CG


CENTER OF GRAVITY OF THE STRUCTURE IS LOCATED AT: (METE UNIT)

      X =    16.52   Y =     1.97   Z =   -16.32

      TOTAL SELF WEIGHT =              283.330 (KN   UNIT)

  79. ********************
  80. LOAD 11 SPOOL IN AIR (AIR FILLED)
  81. *LINE PIPE
  82. MEMBER LOAD
  83. 1 TO 69 UNI GY -3.18
  84. 200 201 UNI GY -2.36
  85. *TERMINATION HEAD MINUS WEIGHT OF LINE PIPE, 3.9 TE WEIGHT
  86. *(39KN/2.89M)-3.18 = 10.31KN/M
  87. *(39KN/2.78M)-3.18 = 10.84KN/M
  88. MEMBER LOAD
  89. 1 TO 3 UNI GY -10.31
  90. 67 TO 69 UNI GY -10.84
  91. JOINT LOAD
  92. *SKID
  93. 13 FY -5.59
  94. ***********************
  95. LOAD 15 TRAPPED WATER IN SPOOL (50%)
  96. MEMBER LOAD
  97. 1 TO 69 UNI GY -0.37
  98. 200 201 UNI GY -0.87
  99. JOINT LOAD
 100. *SKID
 101. 13 FY -2.8
 102. ************************
 103. LOAD 21 SPOOL IN WATER (WATER FILLED)
 104. *LINE PIPE
 105. MEMBER LOAD
 106. 1 TO 69 UNI GY -1.94
 107. 200 201 UNI GY -2.05
 108. *TERMINATION HEAD MINUS WEIGHT OF LINE PIPE, 3.9 TE WEIGHT
 109. *WEIGHT IN AIR X 0.87
 110. MEMBER LOAD
 111. 1 TO 3 UNI GY -8.96
 112. 67 TO 69 UNI GY -9.43
 113. JOINT LOAD
 114. *SKID
 115. 13 FY -4.86
 116. ***********************
 117. *LOAD COMBINATIONS*****
 118. *SPOOL    JD=1.5
 119. *DAF=1.8
```



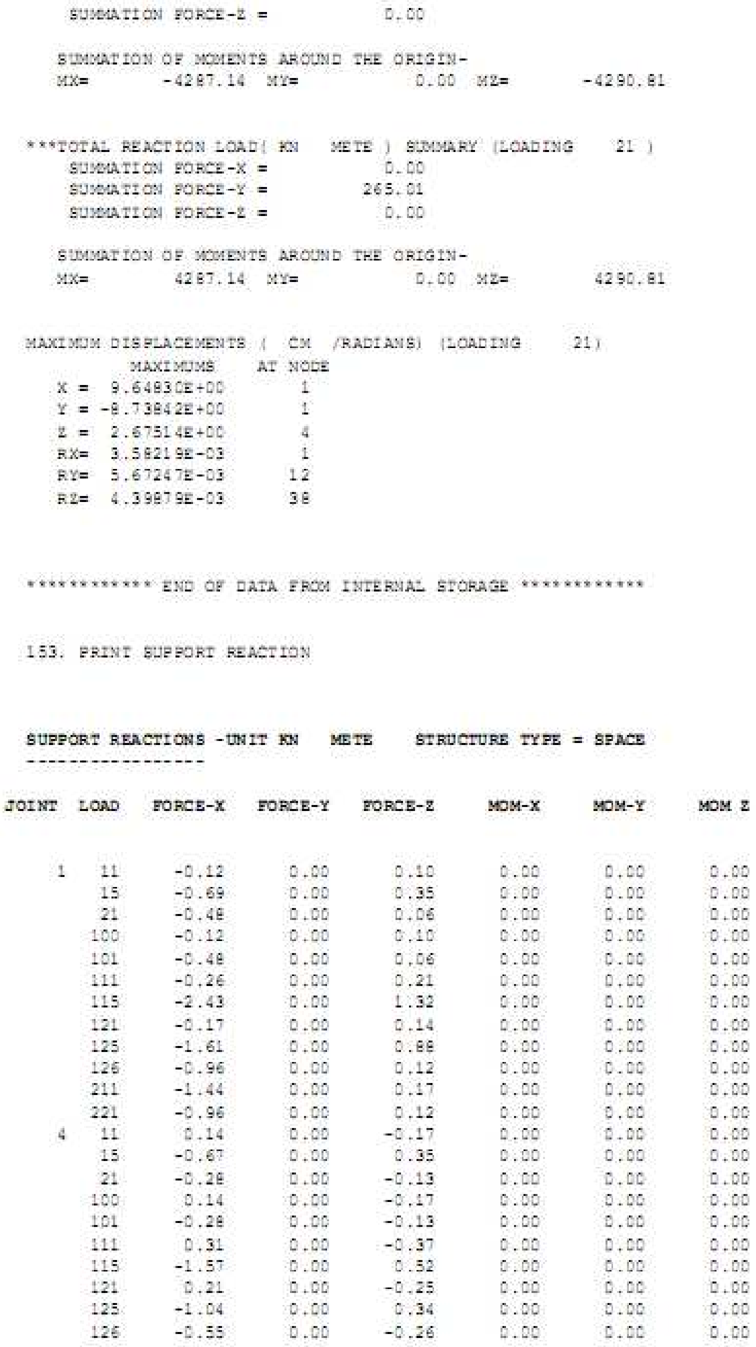
```
120. *JINAC=1.05
121. *SKL=1.05
122. LOAD COMB 100 STATIC WEIGHT IN AIR
123. 11 1.0
124. *************
125. LOAD COMB 101 STATIC WEIGHT IN WATER
126. 21 1.0
127. *************
128. LOAD COMB 111 LIFT IN AIR STRUCTURAL DESIGN
129. 11 2.14
130. ***************
131. LOAD COMB 115 SPOOL IN SPLASH STRUCTURAL DESIGN
132. 11 2.98 15 2.98
133. ***********************
134. *LOAD COMB 116 SPOOL IN WATER STRUCTURAL DESIGN (SAME AS 211)
135. *21 2.98
136. ***********************
137. LOAD COMB 121 LIFT IN AIR RIGGING DESIGN
138. 11 1.43
139. ***************
140. LOAD COMB 125 SPOOL IN SPLASH RIGGING DESIGN
141. 11 1.98 15 1.98
142. ***********************
143. LOAD COMB 126 SPOOL IN WATER RIGGING DESIGN
144. 21 1.98
145. ***********************
146. LOAD COMB 211 LIFT IN WATER STRUCTURAL DESIGN (SAME AS 126)
147. 21 2.98
148. ***************
149. LOAD COMB 221 LIFT IN WATER RIGGING DESIGN
150. 21 1.98
151. *******************************************************
152. PERFORM ANALYSIS PRINT STATICS CHECK


         P R O B L E M   S T A T I S T I C S
         -----------------------------------

  NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =    71/    76/     3

        SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

  ORIGINAL/FINAL BAND-WIDTH=    66/     9/     60 DOF
  TOTAL PRIMARY LOAD CASES =    3, TOTAL DEGREES OF FREEDOM =    423
  SIZE OF STIFFNESS MATRIX =        26 DOUBLE  KILO-WORDS
  REQRD/AVAIL. DISK SPACE  =     12.4/  43952.3 MB




       STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    11
       SPOOL IN AIR (AIR FILLED)


        CENTER OF FORCE BASED ON X FORCES ONLY (METE).
      (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                   X = -0.695625939E+01
                   Y =  0.827008029E+00
                   Z = -0.233525523E+01
```



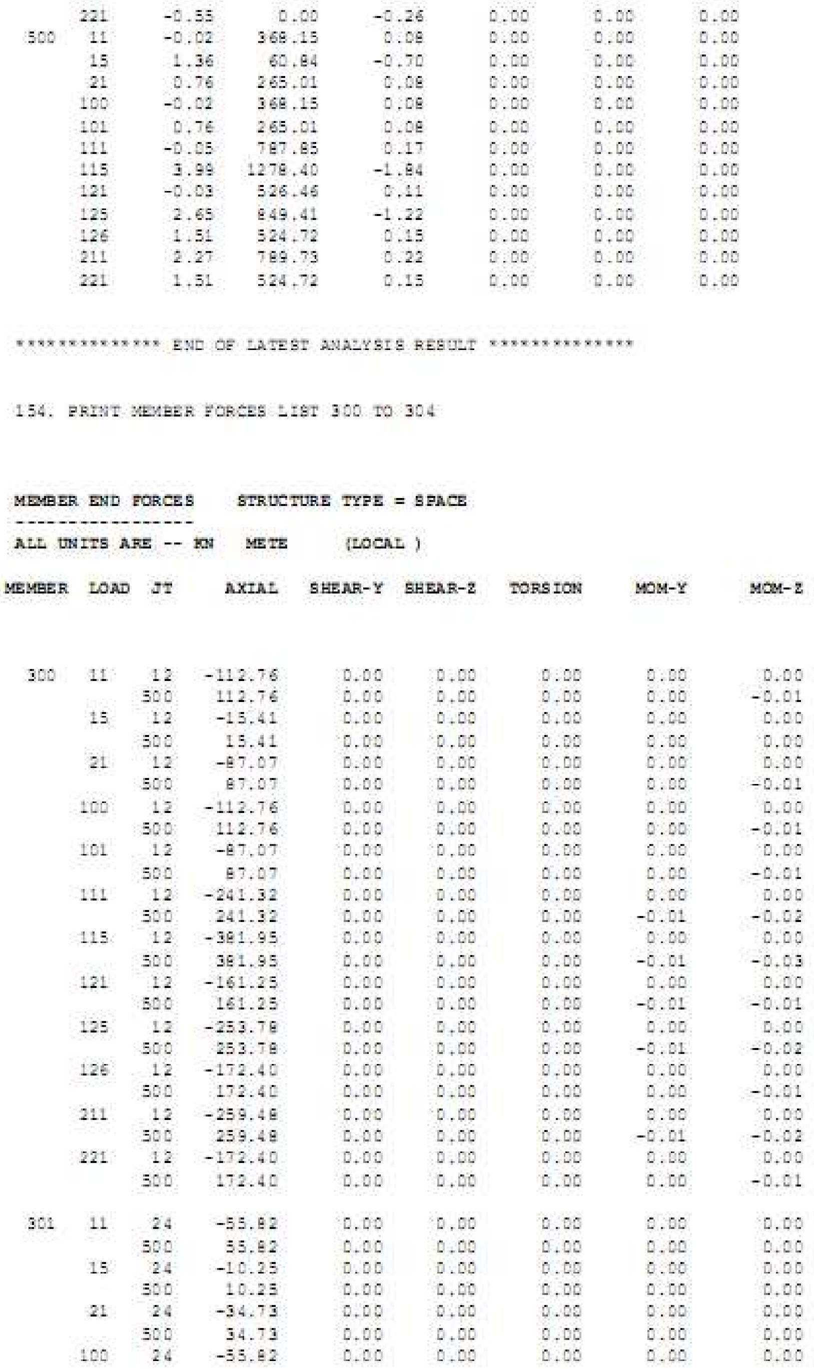
```
        CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
       (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.162618484E+02
                     Y =  0.350136337E+00
                     Z = -0.161755370E+02

        CENTER OF FORCE BASED ON Z FORCES ONLY (METE).
       (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.146399413E+03
                     Y = -0.123945101E+01
                     Z = -0.103165286E+03

***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    11 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =        -368.15
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=      -5955.10  MY=           0.00  MZ=      -5986.87


***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    11 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =         368.15
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=       5955.10  MY=           0.00  MZ=       5986.87


MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     11)
          MAXIMUMS    AT NODE
   X = -4.05840E+00      16
   Y = -5.35456E+00       4
   Z =  3.49110E+00       4
   RX=  5.11889E-03      22
   RY=  7.78580E-03      12
   RZ= -7.54914E-03       1


       STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    15
       TRAPPED WATER IN SPOOL (50%)


        CENTER OF FORCE BASED ON X FORCES ONLY (METE).
       (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.126900127E+02
                     Y =  0.385750848E+00
                     Z = -0.143794414E+02

        CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
       (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.157204715E+02
                     Y =  0.286936658E+00
                     Z = -0.158945312E+02

        CENTER OF FORCE BASED ON Z FORCES ONLY (METE).
```



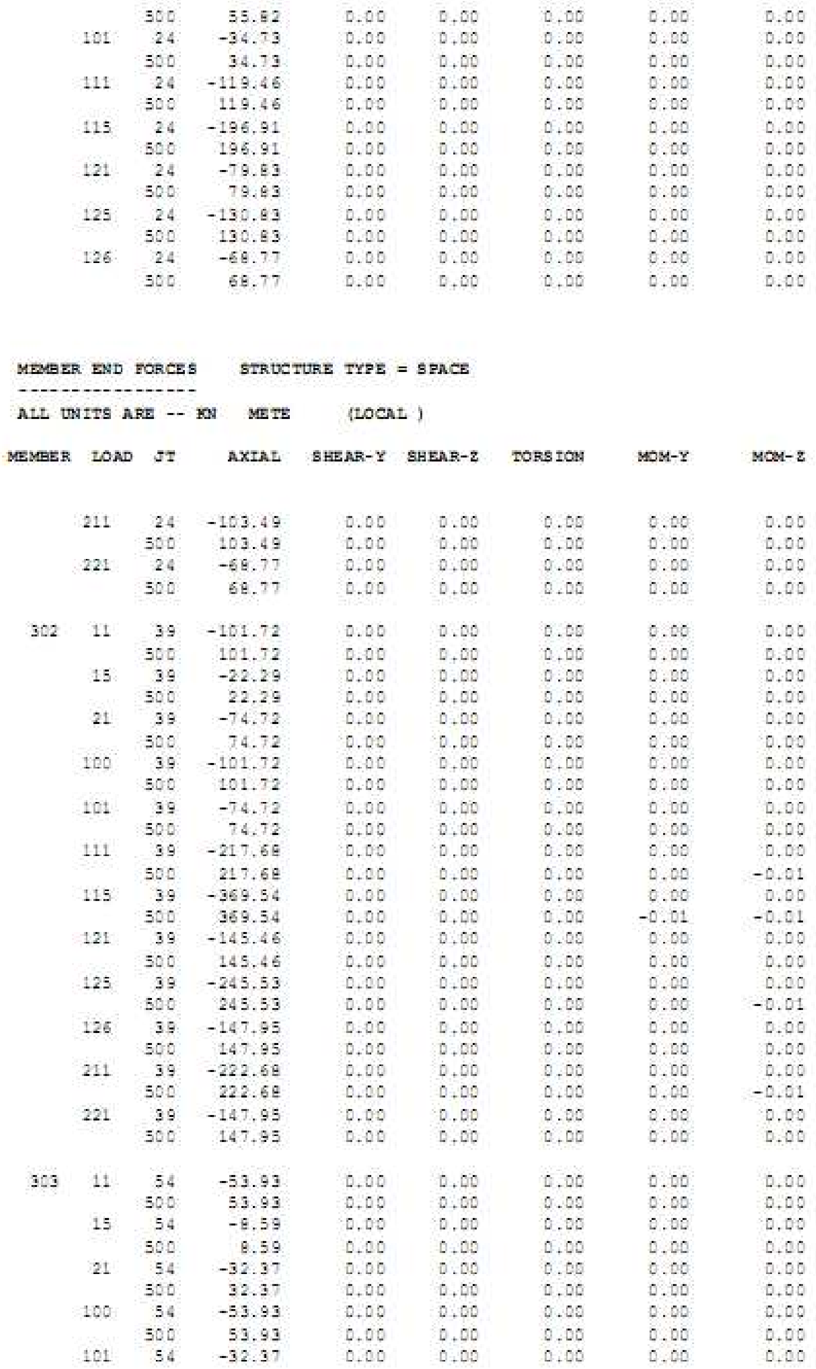
```
      (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.861926247E+01
                     Y =  0.498192742E+00
                     Z = -0.120158052E+02

***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    15 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =         -60.84
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=        -967.00  MY=           0.00  MZ=        -956.41

***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    15 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =          60.84
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=         967.00  MY=           0.00  MZ=         956.41

MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     15)
          MAXIMUMS    AT NODE
   X =  1.45652E+01      61
   Y = -1.41447E+01       1
   Z = -7.29611E+00       2
   RX=  3.84760E-03      22
   RY=  1.36249E-03       4
   RZ=  6.31626E-03      38

      STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    21
      SPOOL IN WATER (WATER FILLED)

       CENTER OF FORCE BASED ON X FORCES ONLY (METE).
      (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.107844773E+02
                     Y =  0.334107702E+00
                     Z = -0.134132916E+02

       CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
      (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.161910826E+02
                     Y =  0.381607689E+00
                     Z = -0.161772506E+02

       CENTER OF FORCE BASED ON Z FORCES ONLY (METE).
      (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X = -0.159144411E+02
                     Y =  0.458149011E+00
                     Z =  0.130599946E+02

***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    21 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =        -265.01
```



```
     SUMMATION FORCE-Z =           0.00

    SUMMATION OF MOMENTS AROUND THE ORIGIN-
    MX=       -4287.14  MY=          0.00  MZ=       -4290.81


 ***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    21 )
     SUMMATION FORCE-X =           0.00
     SUMMATION FORCE-Y =         265.01
     SUMMATION FORCE-Z =           0.00

    SUMMATION OF MOMENTS AROUND THE ORIGIN-
    MX=        4287.14  MY=          0.00  MZ=        4290.81


 MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     21)
           MAXIMUMS    AT NODE
    X =  9.64830E+00       1
    Y = -8.73842E+00       1
    Z =  2.67514E+00       4
    RX=  3.58219E-03       1
    RY=  5.67247E-03      12
    RZ=  4.39879E-03      38


 ************ END OF DATA FROM INTERNAL STORAGE ************


 153. PRINT SUPPORT REACTION


 SUPPORT REACTIONS -UNIT KN   METE    STRUCTURE TYPE = SPACE
 -----------------

JOINT  LOAD   FORCE-X   FORCE-Y   FORCE-Z     MOM-X     MOM-Y     MOM Z


    1   11     -0.12      0.00      0.10      0.00      0.00      0.00
        15     -0.69      0.00      0.35      0.00      0.00      0.00
        21     -0.48      0.00      0.06      0.00      0.00      0.00
       100     -0.12      0.00      0.10      0.00      0.00      0.00
       101     -0.48      0.00      0.06      0.00      0.00      0.00
       111     -0.26      0.00      0.21      0.00      0.00      0.00
       115     -2.43      0.00      1.32      0.00      0.00      0.00
       121     -0.17      0.00      0.14      0.00      0.00      0.00
       125     -1.61      0.00      0.88      0.00      0.00      0.00
       126     -0.96      0.00      0.12      0.00      0.00      0.00
       211     -1.44      0.00      0.17      0.00      0.00      0.00
       221     -0.96      0.00      0.12      0.00      0.00      0.00
    4   11      0.14      0.00     -0.17      0.00      0.00      0.00
        15     -0.67      0.00      0.35      0.00      0.00      0.00
        21     -0.28      0.00     -0.13      0.00      0.00      0.00
       100      0.14      0.00     -0.17      0.00      0.00      0.00
       101     -0.28      0.00     -0.13      0.00      0.00      0.00
       111      0.31      0.00     -0.37      0.00      0.00      0.00
       115     -1.57      0.00      0.52      0.00      0.00      0.00
       121      0.21      0.00     -0.25      0.00      0.00      0.00
       125     -1.04      0.00      0.34      0.00      0.00      0.00
       126     -0.55      0.00     -0.26      0.00      0.00      0.00
```



```
         221     -0.55      0.00     -0.26      0.00      0.00      0.00
 500      11     -0.02    368.15      0.08      0.00      0.00      0.00
          15      1.36     60.84     -0.70      0.00      0.00      0.00
          21      0.76    265.01      0.08      0.00      0.00      0.00
         100     -0.02    368.15      0.08      0.00      0.00      0.00
         101      0.76    265.01      0.08      0.00      0.00      0.00
         111     -0.05    787.85      0.17      0.00      0.00      0.00
         115      3.99   1278.40     -1.84      0.00      0.00      0.00
         121     -0.03    526.46      0.11      0.00      0.00      0.00
         125      2.65    849.41     -1.22      0.00      0.00      0.00
         126      1.51    524.72      0.15      0.00      0.00      0.00
         211      2.27    789.73      0.22      0.00      0.00      0.00
         221      1.51    524.72      0.15      0.00      0.00      0.00

************** END OF LATEST ANALYSIS RESULT **************

154. PRINT MEMBER FORCES LIST 300 TO 304


MEMBER END FORCES    STRUCTURE TYPE = SPACE
-----------------
ALL UNITS ARE -- KN  METE     (LOCAL )

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


  300    11    12   -112.76     0.00     0.00      0.00      0.00       0.00
              500    112.76     0.00     0.00      0.00      0.00      -0.01
         15    12    -15.41     0.00     0.00      0.00      0.00       0.00
              500     15.41     0.00     0.00      0.00      0.00       0.00
         21    12    -87.07     0.00     0.00      0.00      0.00       0.00
              500     87.07     0.00     0.00      0.00      0.00      -0.01
        100    12   -112.76     0.00     0.00      0.00      0.00       0.00
              500    112.76     0.00     0.00      0.00      0.00      -0.01
        101    12    -87.07     0.00     0.00      0.00      0.00       0.00
              500     87.07     0.00     0.00      0.00      0.00      -0.01
        111    12   -241.32     0.00     0.00      0.00      0.00       0.00
              500    241.32     0.00     0.00      0.00     -0.01      -0.02
        115    12   -381.95     0.00     0.00      0.00      0.00       0.00
              500    381.95     0.00     0.00      0.00     -0.01      -0.03
        121    12   -161.25     0.00     0.00      0.00      0.00       0.00
              500    161.25     0.00     0.00      0.00     -0.01      -0.01
        125    12   -253.78     0.00     0.00      0.00      0.00       0.00
              500    253.78     0.00     0.00      0.00     -0.01      -0.02
        126    12   -172.40     0.00     0.00      0.00      0.00       0.00
              500    172.40     0.00     0.00      0.00      0.00      -0.01
        211    12   -259.48     0.00     0.00      0.00      0.00       0.00
              500    259.48     0.00     0.00      0.00     -0.01      -0.02
        221    12   -172.40     0.00     0.00      0.00      0.00       0.00
              500    172.40     0.00     0.00      0.00      0.00      -0.01

  301    11    24    -55.82     0.00     0.00      0.00      0.00       0.00
              500     55.82     0.00     0.00      0.00      0.00       0.00
         15    24    -10.25     0.00     0.00      0.00      0.00       0.00
              500     10.25     0.00     0.00      0.00      0.00       0.00
         21    24    -34.73     0.00     0.00      0.00      0.00       0.00
              500     34.73     0.00     0.00      0.00      0.00       0.00
        100    24    -55.82     0.00     0.00      0.00      0.00       0.00
```



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              500     55.82      0.00      0.00       0.00       0.00        0.00
         101   24    -34.73      0.00      0.00       0.00       0.00        0.00
              500     34.73      0.00      0.00       0.00       0.00        0.00
         111   24   -119.46      0.00      0.00       0.00       0.00        0.00
              500    119.46      0.00      0.00       0.00       0.00        0.00
         115   24   -196.91      0.00      0.00       0.00       0.00        0.00
              500    196.91      0.00      0.00       0.00       0.00        0.00
         121   24    -79.83      0.00      0.00       0.00       0.00        0.00
              500     79.83      0.00      0.00       0.00       0.00        0.00
         125   24   -130.83      0.00      0.00       0.00       0.00        0.00
              500    130.83      0.00      0.00       0.00       0.00        0.00
         126   24    -68.77      0.00      0.00       0.00       0.00        0.00
              500     68.77      0.00      0.00       0.00       0.00        0.00


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE     (LOCAL )

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


         211   24   -103.49      0.00      0.00       0.00       0.00        0.00
              500    103.49      0.00      0.00       0.00       0.00        0.00
         221   24    -68.77      0.00      0.00       0.00       0.00        0.00
              500     68.77      0.00      0.00       0.00       0.00        0.00

    302   11   39   -101.72      0.00      0.00       0.00       0.00        0.00
              500    101.72      0.00      0.00       0.00       0.00        0.00
          15   39    -22.29      0.00      0.00       0.00       0.00        0.00
              500     22.29      0.00      0.00       0.00       0.00        0.00
          21   39    -74.72      0.00      0.00       0.00       0.00        0.00
              500     74.72      0.00      0.00       0.00       0.00        0.00
         100   39   -101.72      0.00      0.00       0.00       0.00        0.00
              500    101.72      0.00      0.00       0.00       0.00        0.00
         101   39    -74.72      0.00      0.00       0.00       0.00        0.00
              500     74.72      0.00      0.00       0.00       0.00        0.00
         111   39   -217.68      0.00      0.00       0.00       0.00        0.00
              500    217.68      0.00      0.00       0.00       0.00       -0.01
         115   39   -369.54      0.00      0.00       0.00       0.00        0.00
              500    369.54      0.00      0.00       0.00      -0.01       -0.01
         121   39   -145.46      0.00      0.00       0.00       0.00        0.00
              500    145.46      0.00      0.00       0.00       0.00        0.00
         125   39   -245.53      0.00      0.00       0.00       0.00        0.00
              500    245.53      0.00      0.00       0.00       0.00       -0.01
         126   39   -147.95      0.00      0.00       0.00       0.00        0.00
              500    147.95      0.00      0.00       0.00       0.00        0.00
         211   39   -222.68      0.00      0.00       0.00       0.00        0.00
              500    222.68      0.00      0.00       0.00       0.00       -0.01
         221   39   -147.95      0.00      0.00       0.00       0.00        0.00
              500    147.95      0.00      0.00       0.00       0.00        0.00

    303   11   54    -53.93      0.00      0.00       0.00       0.00        0.00
              500     53.93      0.00      0.00       0.00       0.00        0.00
          15   54     -8.59      0.00      0.00       0.00       0.00        0.00
              500      8.59      0.00      0.00       0.00       0.00        0.00
          21   54    -32.37      0.00      0.00       0.00       0.00        0.00
              500     32.37      0.00      0.00       0.00       0.00        0.00
         100   54    -53.93      0.00      0.00       0.00       0.00        0.00
              500     53.93      0.00      0.00       0.00       0.00        0.00
         101   54    -32.37      0.00      0.00       0.00       0.00        0.00
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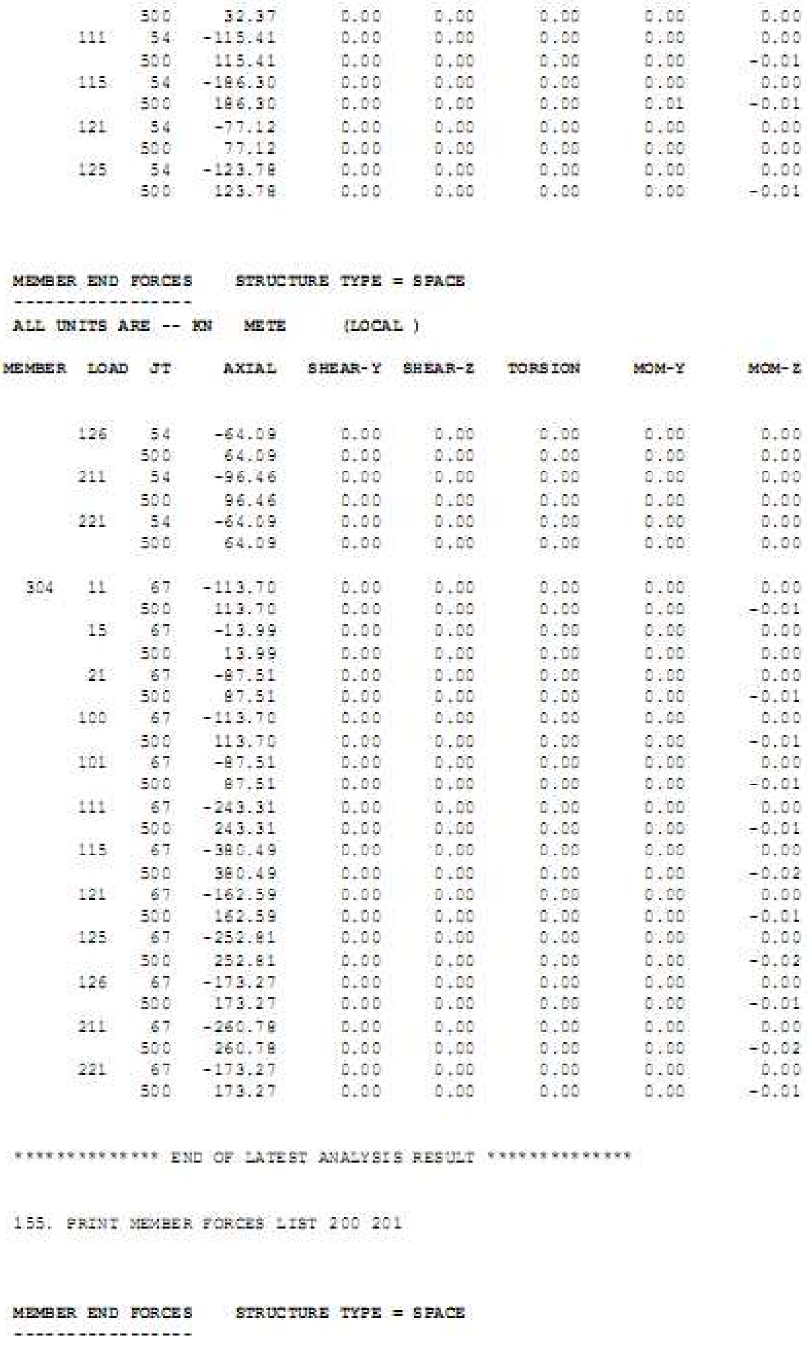

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              500     32.37      0.00      0.00       0.00       0.00       0.00
        111    54   -115.41      0.00      0.00       0.00       0.00       0.00
              500    115.41      0.00      0.00       0.00       0.00      -0.01
        115    54   -186.30      0.00      0.00       0.00       0.00       0.00
              500    186.30      0.00      0.00       0.00       0.01      -0.01
        121    54    -77.12      0.00      0.00       0.00       0.00       0.00
              500     77.12      0.00      0.00       0.00       0.00       0.00
        125    54   -123.78      0.00      0.00       0.00       0.00       0.00
              500    123.78      0.00      0.00       0.00       0.00      -0.01


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE     (LOCAL )

 MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


        126    54    -64.09      0.00      0.00       0.00       0.00       0.00
              500     64.09      0.00      0.00       0.00       0.00       0.00
        211    54    -96.46      0.00      0.00       0.00       0.00       0.00
              500     96.46      0.00      0.00       0.00       0.00       0.00
        221    54    -64.09      0.00      0.00       0.00       0.00       0.00
              500     64.09      0.00      0.00       0.00       0.00       0.00

    304   11   67   -113.70      0.00      0.00       0.00       0.00       0.00
              500    113.70      0.00      0.00       0.00       0.00      -0.01
         15    67    -13.99      0.00      0.00       0.00       0.00       0.00
              500     13.99      0.00      0.00       0.00       0.00       0.00
         21    67    -87.51      0.00      0.00       0.00       0.00       0.00
              500     87.51      0.00      0.00       0.00       0.00      -0.01
        100    67   -113.70      0.00      0.00       0.00       0.00       0.00
              500    113.70      0.00      0.00       0.00       0.00      -0.01
        101    67    -87.51      0.00      0.00       0.00       0.00       0.00
              500     87.51      0.00      0.00       0.00       0.00      -0.01
        111    67   -243.31      0.00      0.00       0.00       0.00       0.00
              500    243.31      0.00      0.00       0.00       0.00      -0.01
        115    67   -380.49      0.00      0.00       0.00       0.00       0.00
              500    380.49      0.00      0.00       0.00       0.00      -0.02
        121    67   -162.59      0.00      0.00       0.00       0.00       0.00
              500    162.59      0.00      0.00       0.00       0.00      -0.01
        125    67   -252.81      0.00      0.00       0.00       0.00       0.00
              500    252.81      0.00      0.00       0.00       0.00      -0.02
        126    67   -173.27      0.00      0.00       0.00       0.00       0.00
              500    173.27      0.00      0.00       0.00       0.00      -0.01
        211    67   -260.78      0.00      0.00       0.00       0.00       0.00
              500    260.78      0.00      0.00       0.00       0.00      -0.02
        221    67   -173.27      0.00      0.00       0.00       0.00       0.00
              500    173.27      0.00      0.00       0.00       0.00      -0.01


  ************** END OF LATEST ANALYSIS RESULT **************


  155. PRINT MEMBER FORCES LIST 200 201


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
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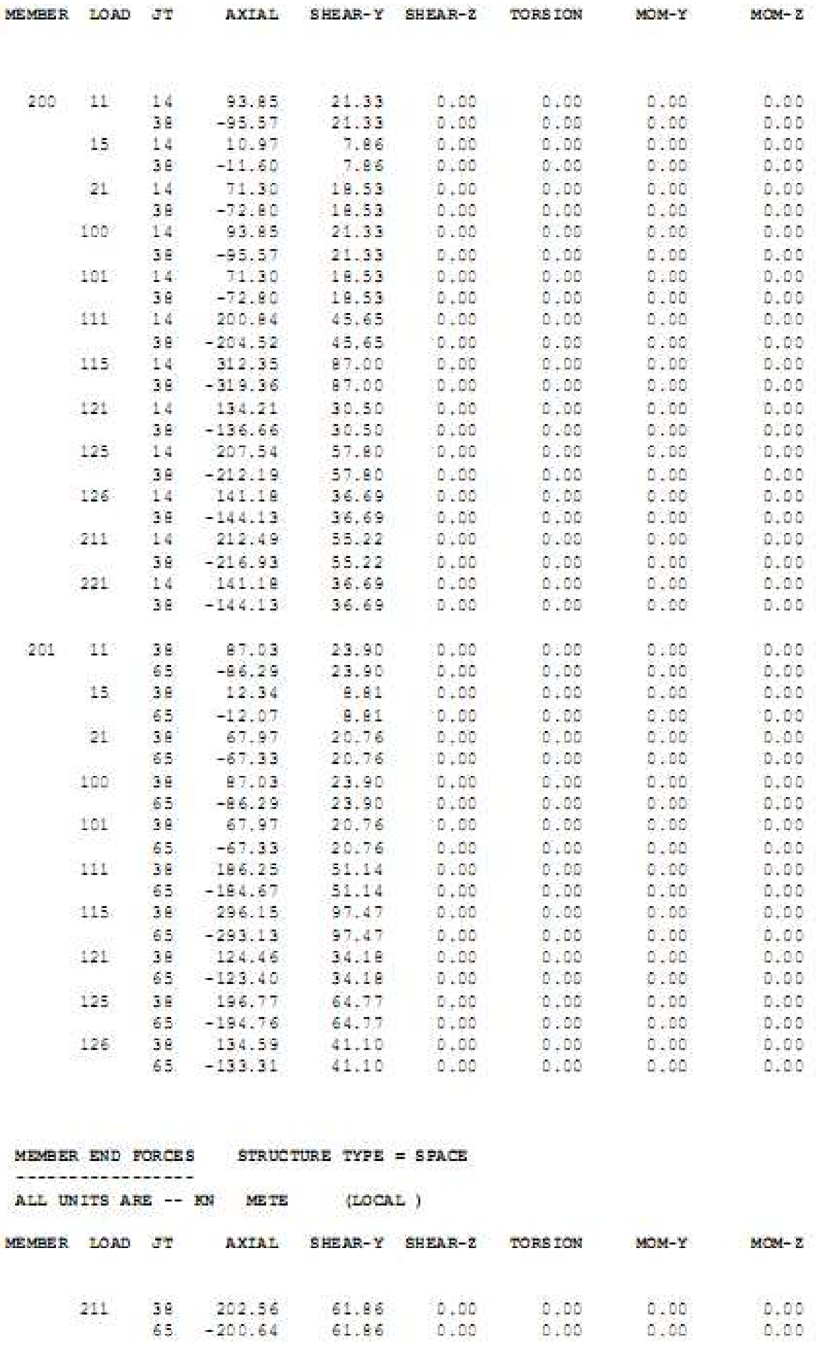

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MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


   200    11   14     93.85     21.33     0.00      0.00      0.00       0.00
               38    -95.57     21.33     0.00      0.00      0.00       0.00
          15   14     10.97      7.86     0.00      0.00      0.00       0.00
               38    -11.60      7.86     0.00      0.00      0.00       0.00
          21   14     71.30     18.53     0.00      0.00      0.00       0.00
               38    -72.80     18.53     0.00      0.00      0.00       0.00
         100   14     93.85     21.33     0.00      0.00      0.00       0.00
               38    -95.57     21.33     0.00      0.00      0.00       0.00
         101   14     71.30     18.53     0.00      0.00      0.00       0.00
               38    -72.80     18.53     0.00      0.00      0.00       0.00
         111   14    200.84     45.65     0.00      0.00      0.00       0.00
               38   -204.52     45.65     0.00      0.00      0.00       0.00
         115   14    312.35     87.00     0.00      0.00      0.00       0.00
               38   -319.36     87.00     0.00      0.00      0.00       0.00
         121   14    134.21     30.50     0.00      0.00      0.00       0.00
               38   -136.66     30.50     0.00      0.00      0.00       0.00
         125   14    207.54     57.80     0.00      0.00      0.00       0.00
               38   -212.19     57.80     0.00      0.00      0.00       0.00
         126   14    141.18     36.69     0.00      0.00      0.00       0.00
               38   -144.13     36.69     0.00      0.00      0.00       0.00
         211   14    212.49     55.22     0.00      0.00      0.00       0.00
               38   -216.93     55.22     0.00      0.00      0.00       0.00
         221   14    141.18     36.69     0.00      0.00      0.00       0.00
               38   -144.13     36.69     0.00      0.00      0.00       0.00

   201    11   38     87.03     23.90     0.00      0.00      0.00       0.00
               65    -86.29     23.90     0.00      0.00      0.00       0.00
          15   38     12.34      8.81     0.00      0.00      0.00       0.00
               65    -12.07      8.81     0.00      0.00      0.00       0.00
          21   38     67.97     20.76     0.00      0.00      0.00       0.00
               65    -67.33     20.76     0.00      0.00      0.00       0.00
         100   38     87.03     23.90     0.00      0.00      0.00       0.00
               65    -86.29     23.90     0.00      0.00      0.00       0.00
         101   38     67.97     20.76     0.00      0.00      0.00       0.00
               65    -67.33     20.76     0.00      0.00      0.00       0.00
         111   38    186.25     51.14     0.00      0.00      0.00       0.00
               65   -184.67     51.14     0.00      0.00      0.00       0.00
         115   38    296.15     97.47     0.00      0.00      0.00       0.00
               65   -293.13     97.47     0.00      0.00      0.00       0.00
         121   38    124.46     34.18     0.00      0.00      0.00       0.00
               65   -123.40     34.18     0.00      0.00      0.00       0.00
         125   38    196.77     64.77     0.00      0.00      0.00       0.00
               65   -194.76     64.77     0.00      0.00      0.00       0.00
         126   38    134.59     41.10     0.00      0.00      0.00       0.00
               65   -133.31     41.10     0.00      0.00      0.00       0.00


 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- KN   METE     (LOCAL )

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


         211   38    202.56     61.86     0.00      0.00      0.00       0.00
               65   -200.64     61.86     0.00      0.00      0.00       0.00
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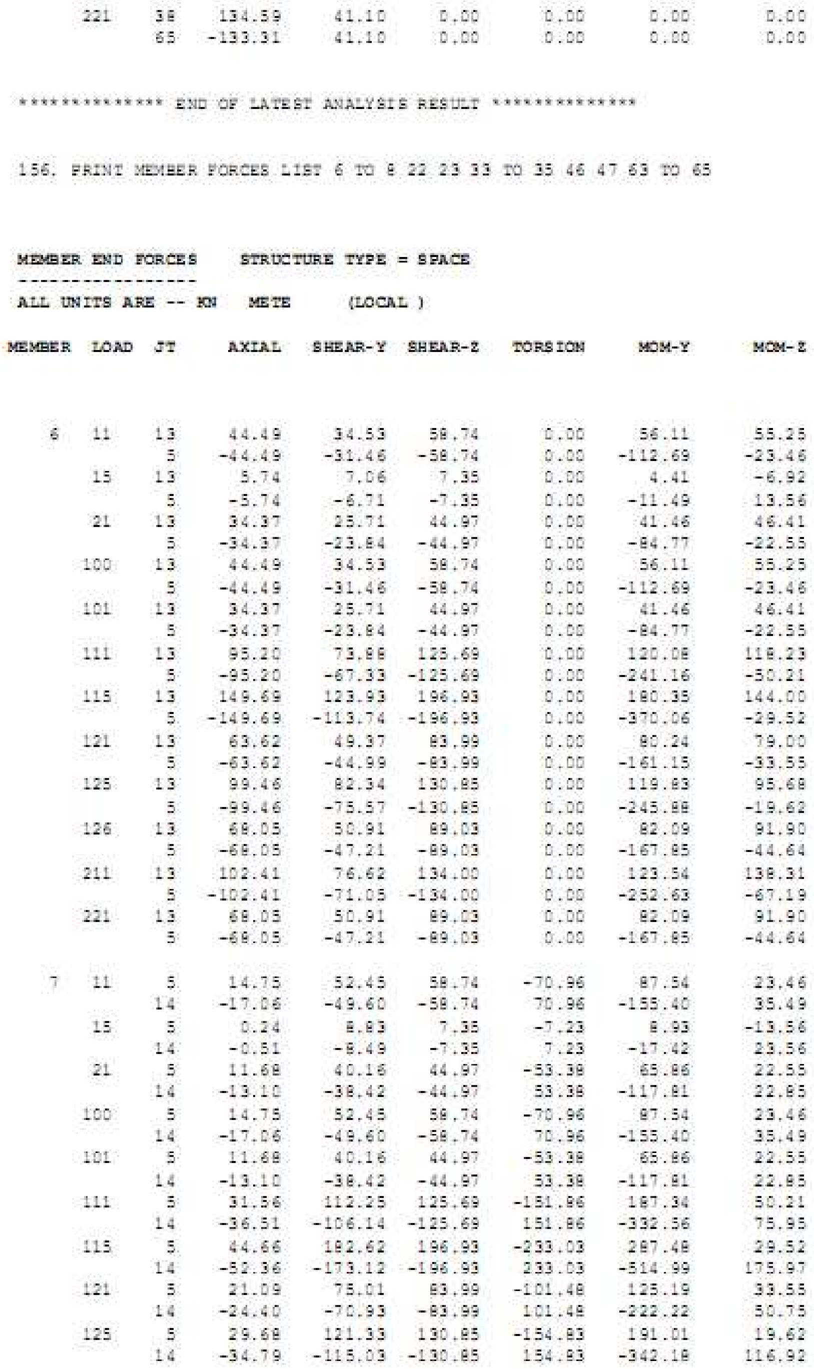

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     221    38    134.59     41.10      0.00       0.00       0.00       0.00
            65   -133.31     41.10      0.00       0.00       0.00       0.00

 ************** END OF LATEST ANALYSIS RESULT **************

 156. PRINT MEMBER FORCES LIST 6 TO 8 22 23 33 TO 35 46 47 63 TO 65


 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- KN   METE     (LOCAL )

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


      6    11    13     44.49     34.53     58.74      0.00      56.11      55.25
                  5    -44.49    -31.46    -58.74      0.00    -112.69     -23.46
          15    13      5.74      7.06      7.35      0.00       4.41      -6.92
                  5     -5.74     -6.71     -7.35      0.00     -11.49      13.56
          21    13     34.37     25.71     44.97      0.00      41.46      46.41
                  5    -34.37    -23.84    -44.97      0.00     -84.77     -22.55
         100    13     44.49     34.53     58.74      0.00      56.11      55.25
                  5    -44.49    -31.46    -58.74      0.00    -112.69     -23.46
         101    13     34.37     25.71     44.97      0.00      41.46      46.41
                  5    -34.37    -23.84    -44.97      0.00     -84.77     -22.55
         111    13     95.20     73.88    125.69      0.00     120.08     118.23
                  5    -95.20    -67.33   -125.69      0.00    -241.16     -50.21
         115    13    149.69    123.93    196.93      0.00     180.35     144.00
                  5   -149.69   -113.74   -196.93      0.00    -370.06     -29.52
         121    13     63.62     49.37     83.99      0.00      80.24      79.00
                  5    -63.62    -44.99    -83.99      0.00    -161.15     -33.55
         125    13     99.46     82.34    130.85      0.00     119.83      95.68
                  5    -99.46    -75.57   -130.85      0.00    -245.88     -19.62
         126    13     68.05     50.91     89.03      0.00      82.09      91.90
                  5    -68.05    -47.21    -89.03      0.00    -167.85     -44.64
         211    13    102.41     76.62    134.00      0.00     123.54     138.31
                  5   -102.41    -71.05   -134.00      0.00    -252.63     -67.19
         221    13     68.05     50.91     89.03      0.00      82.09      91.90
                  5    -68.05    -47.21    -89.03      0.00    -167.85     -44.64

      7    11     5     14.75     52.45     58.74    -70.96      87.54      23.46
                 14    -17.06    -49.60    -58.74     70.96    -155.40      35.49
          15     5      0.24      8.83      7.35     -7.23       8.93     -13.56
                 14     -0.51     -8.49     -7.35      7.23     -17.42      23.56
          21     5     11.68     40.16     44.97    -53.38      65.86      22.55
                 14    -13.10    -38.42    -44.97     53.38    -117.81      22.85
         100     5     14.75     52.45     58.74    -70.96      87.54      23.46
                 14    -17.06    -49.60    -58.74     70.96    -155.40      35.49
         101     5     11.68     40.16     44.97    -53.38      65.86      22.55
                 14    -13.10    -38.42    -44.97     53.38    -117.81      22.85
         111     5     31.56    112.25    125.69   -151.86     187.34      50.21
                 14    -36.51   -106.14   -125.69    151.86    -332.56      75.95
         115     5     44.66    182.62    196.93   -233.03     287.48      29.52
                 14    -52.36   -173.12   -196.93    233.03    -514.99     175.97
         121     5     21.09     75.01     83.99   -101.48     125.19      33.55
                 14    -24.40    -70.93    -83.99    101.48    -222.22      50.75
         125     5     29.68    121.33    130.85   -154.83     191.01      19.62
                 14    -34.79   -115.03   -130.85    154.83    -342.18     116.92
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         126    5     23.14     79.52    89.03   -105.70    130.40     44.64
               14    -25.93    -76.07   -89.03    105.70   -233.25     45.24


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE      (LOCAL )

MEMBER  LOAD   JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y     MOM-Z


         211    5     34.82    119.68   134.00   -159.08    196.25     67.19
               14    -39.03   -114.50  -134.00    159.08   -351.06     68.09
         221    5     23.14     79.52    89.03   -105.70    130.40     44.64
               14    -25.93    -76.07   -89.03    105.70   -233.25     45.24

     8    11   14     -9.81      5.24   -22.34    -70.96    155.40    -35.49
                6      7.49     -2.39    22.34     70.96   -129.59     39.90
          15   14      0.66     -0.93    -2.31     -7.23     17.42    -23.56
                6     -0.93      1.26     2.31      7.23    -14.75     22.30
          21   14     -5.89      2.89   -16.71    -53.38    117.81    -22.85
                6      4.48     -1.15    16.71     53.38    -98.50     25.18
         100   14     -9.81      5.24   -22.34    -70.96    155.40    -35.49
                6      7.49     -2.39    22.34     70.96   -129.59     39.90
         101   14     -5.89      2.89   -16.71    -53.38    117.81    -22.85
                6      4.48     -1.15    16.71     53.38    -98.50     25.18
         111   14    -20.99     11.22   -47.81   -151.86    332.56    -75.95
                6     16.04     -5.11    47.81    151.86   -277.32     85.38
         115   14    -27.25     12.86   -73.46   -233.03    514.99   -175.97
                6     19.55     -3.36    73.46    233.03   -430.12    185.34
         121   14    -14.02      7.50   -31.95   -101.48    222.22    -50.75
                6     10.72     -3.42    31.95    101.48   -185.31     57.06
         125   14    -18.11      8.54   -48.81   -154.83    342.18   -116.92
                6     12.99     -2.24    48.81    154.83   -285.79    123.15
         126   14    -11.67      5.72   -33.09   -105.70    233.25    -45.24
                6      8.88     -2.27    33.09    105.70   -195.02     49.86
         211   14    -17.56      8.61   -49.81   -159.08    351.06    -68.09
                6     13.36     -3.42    49.81    159.08   -293.52     75.04
         221   14    -11.67      5.72   -33.09   -105.70    233.25    -45.24
                6      8.88     -2.27    33.09    105.70   -195.02     49.86

    22    11   26      5.39     15.84     3.99     17.57    -26.70    -17.94
               27     -5.39    -12.74    -3.99    -17.57     22.82     31.86
          15   26      2.78      2.77     0.01      4.03     -3.29      0.05
               27     -2.78     -2.41    -0.01     -4.03      3.28      2.47
          21   26      0.54      9.95     2.56     12.39    -20.33    -15.33
               27     -0.54     -8.06    -2.56    -12.39     17.84     24.10
         100   26      5.39     15.84     3.99     17.57    -26.70    -17.94
               27     -5.39    -12.74    -3.99    -17.57     22.82     31.86
         101   26      0.54      9.95     2.56     12.39    -20.33    -15.33
               27     -0.54     -8.06    -2.56    -12.39     17.84     24.10
         111   26     11.54     33.89     8.53     37.59    -57.15    -38.40
               27    -11.54    -27.26    -8.53    -37.59     48.83     68.18
         115   26     24.36     55.46    11.91     64.35    -89.38    -53.31
               27    -24.36    -45.15   -11.91    -64.35     77.78    102.32
         121   26      7.71     22.65     5.70     25.12    -38.19    -25.66
               27     -7.71    -18.22    -5.70    -25.12     32.63     45.56
         125   26     16.19     36.85     7.91     42.76    -59.39    -35.42
               27    -16.19    -30.00    -7.91    -42.76     51.68     67.98
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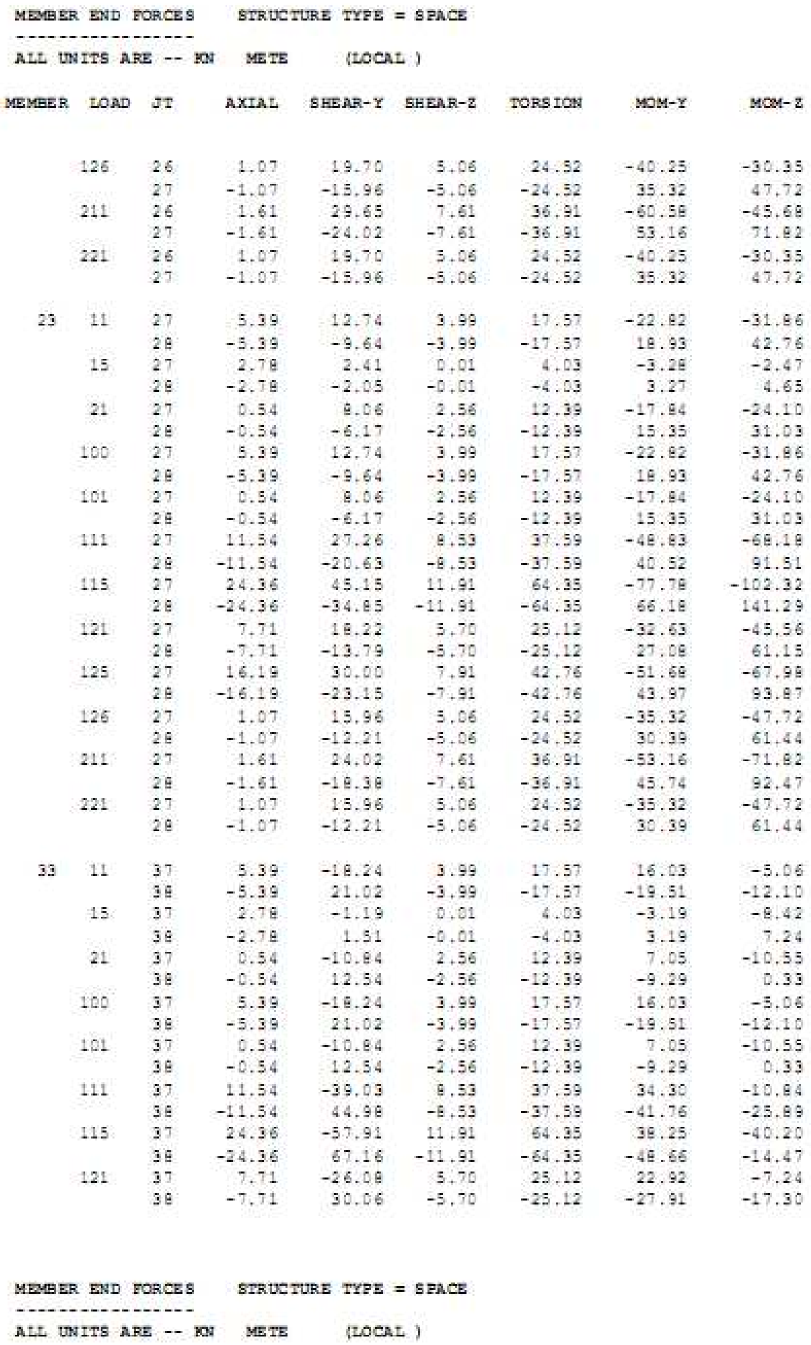

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 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- KN   METE     (LOCAL )

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


         126   26     1.07     19.70     5.06     24.52    -40.25     -30.35
               27    -1.07    -15.96    -5.06    -24.52     35.32      47.72
         211   26     1.61     29.65     7.61     36.91    -60.58     -45.68
               27    -1.61    -24.02    -7.61    -36.91     53.16      71.82
         221   26     1.07     19.70     5.06     24.52    -40.25     -30.35
               27    -1.07    -15.96    -5.06    -24.52     35.32      47.72

    23    11   27     5.39     12.74     3.99     17.57    -22.82     -31.86
               28    -5.39     -9.64    -3.99    -17.57     18.93      42.76
          15   27     2.78      2.41     0.01      4.03     -3.28      -2.47
               28    -2.78     -2.05    -0.01     -4.03      3.27       4.65
          21   27     0.54      8.06     2.56     12.39    -17.84     -24.10
               28    -0.54     -6.17    -2.56    -12.39     15.35      31.03
         100   27     5.39     12.74     3.99     17.57    -22.82     -31.86
               28    -5.39     -9.64    -3.99    -17.57     18.93      42.76
         101   27     0.54      8.06     2.56     12.39    -17.84     -24.10
               28    -0.54     -6.17    -2.56    -12.39     15.35      31.03
         111   27    11.54     27.26     8.53     37.59    -48.83     -68.18
               28   -11.54    -20.63    -8.53    -37.59     40.52      91.51
         115   27    24.36     45.15    11.91     64.35    -77.78    -102.32
               28   -24.36    -34.85   -11.91    -64.35     66.18     141.29
         121   27     7.71     18.22     5.70     25.12    -32.63     -45.56
               28    -7.71    -13.79    -5.70    -25.12     27.08      61.15
         125   27    16.19     30.00     7.91     42.76    -51.68     -67.98
               28   -16.19    -23.15    -7.91    -42.76     43.97      93.87
         126   27     1.07     15.96     5.06     24.52    -35.32     -47.72
               28    -1.07    -12.21    -5.06    -24.52     30.39      61.44
         211   27     1.61     24.02     7.61     36.91    -53.16     -71.82
               28    -1.61    -18.38    -7.61    -36.91     45.74      92.47
         221   27     1.07     15.96     5.06     24.52    -35.32     -47.72
               28    -1.07    -12.21    -5.06    -24.52     30.39      61.44

    33    11   37     5.39    -18.24     3.99     17.57     16.03      -5.06
               38    -5.39     21.02    -3.99    -17.57    -19.51     -12.10
          15   37     2.78     -1.19     0.01      4.03     -3.19      -8.42
               38    -2.78      1.51    -0.01     -4.03      3.19       7.24
          21   37     0.54    -10.84     2.56     12.39      7.05     -10.55
               38    -0.54     12.54    -2.56    -12.39     -9.29       0.33
         100   37     5.39    -18.24     3.99     17.57     16.03      -5.06
               38    -5.39     21.02    -3.99    -17.57    -19.51     -12.10
         101   37     0.54    -10.84     2.56     12.39      7.05     -10.55
               38    -0.54     12.54    -2.56    -12.39     -9.29       0.33
         111   37    11.54    -39.03     8.53     37.59     34.30     -10.84
               38   -11.54     44.98    -8.53    -37.59    -41.76     -25.89
         115   37    24.36    -57.91    11.91     64.35     38.25     -40.20
               38   -24.36     67.16   -11.91    -64.35    -48.66     -14.47
         121   37     7.71    -26.08     5.70     25.12     22.92      -7.24
               38    -7.71     30.06    -5.70    -25.12    -27.91     -17.30


 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- KN   METE     (LOCAL )
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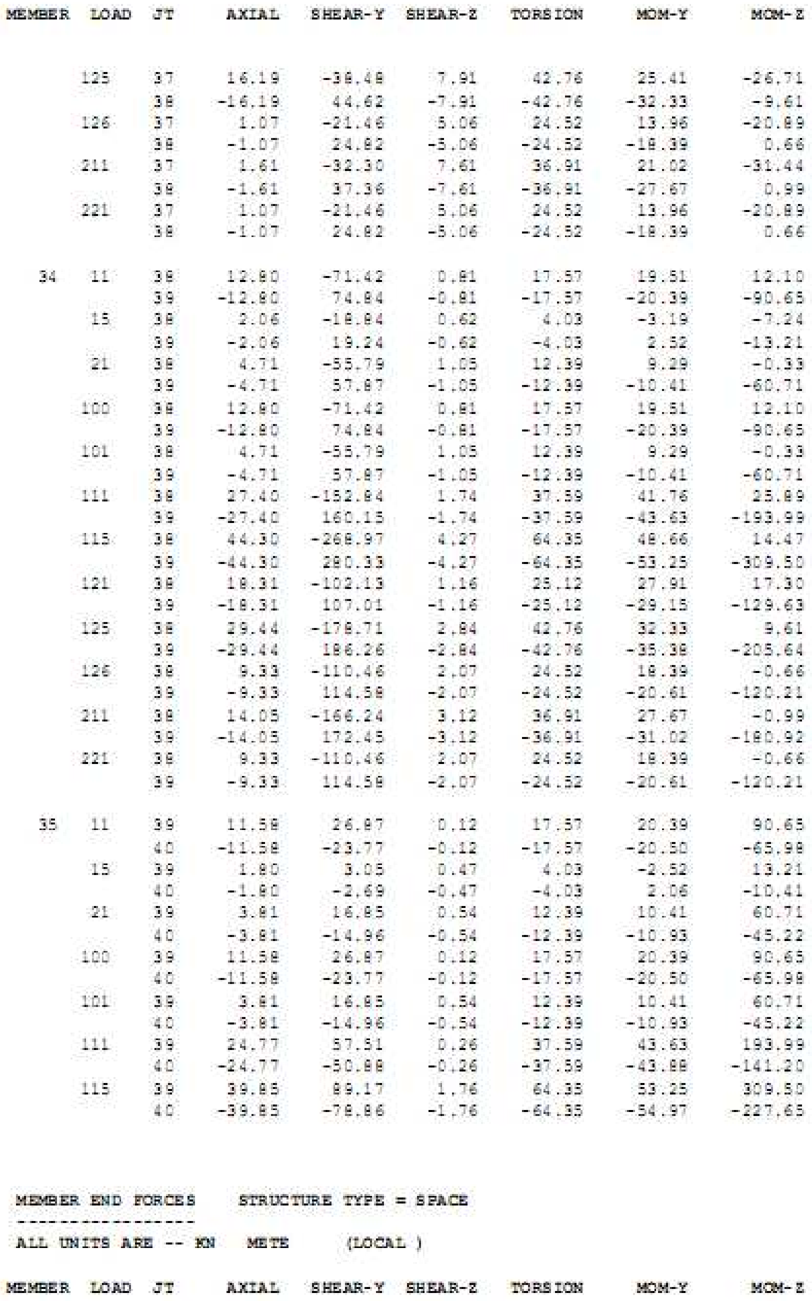

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MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y       MOM-Z


        125   37     16.19    -38.48     7.91     42.76     25.41      -26.71
              38    -16.19     44.62    -7.91    -42.76    -32.33       -9.61
        126   37      1.07    -21.46     5.06     24.52     13.96      -20.89
              38     -1.07     24.82    -5.06    -24.52    -18.39        0.66
        211   37      1.61    -32.30     7.61     36.91     21.02      -31.44
              38     -1.61     37.36    -7.61    -36.91    -27.67        0.99
        221   37      1.07    -21.46     5.06     24.52     13.96      -20.89
              38     -1.07     24.82    -5.06    -24.52    -18.39        0.66

    34   11   38     12.80    -71.42     0.81     17.57     19.51       12.10
              39    -12.80     74.84    -0.81    -17.57    -20.39      -90.65
         15   38      2.06    -18.84     0.62      4.03     -3.19       -7.24
              39     -2.06     19.24    -0.62     -4.03      2.52      -13.21
         21   38      4.71    -55.79     1.05     12.39      9.29       -0.33
              39     -4.71     57.87    -1.05    -12.39    -10.41      -60.71
        100   38     12.80    -71.42     0.81     17.57     19.51       12.10
              39    -12.80     74.84    -0.81    -17.57    -20.39      -90.65
        101   38      4.71    -55.79     1.05     12.39      9.29       -0.33
              39     -4.71     57.87    -1.05    -12.39    -10.41      -60.71
        111   38     27.40   -152.84     1.74     37.59     41.76       25.89
              39    -27.40    160.15    -1.74    -37.59    -43.63     -193.99
        115   38     44.30   -268.97     4.27     64.35     48.66       14.47
              39    -44.30    280.33    -4.27    -64.35    -53.25     -309.50
        121   38     18.31   -102.13     1.16     25.12     27.91       17.30
              39    -18.31    107.01    -1.16    -25.12    -29.15     -129.63
        125   38     29.44   -178.71     2.84     42.76     32.33        9.61
              39    -29.44    186.26    -2.84    -42.76    -35.38     -205.64
        126   38      9.33   -110.46     2.07     24.52     18.39       -0.66
              39     -9.33    114.58    -2.07    -24.52    -20.61     -120.21
        211   38     14.05   -166.24     3.12     36.91     27.67       -0.99
              39    -14.05    172.45    -3.12    -36.91    -31.02     -180.92
        221   38      9.33   -110.46     2.07     24.52     18.39       -0.66
              39     -9.33    114.58    -2.07    -24.52    -20.61     -120.21

    35   11   39     11.58     26.87     0.12     17.57     20.39       90.65
              40    -11.58    -23.77    -0.12    -17.57    -20.50      -65.98
         15   39      1.80      3.05     0.47      4.03     -2.52       13.21
              40     -1.80     -2.69    -0.47     -4.03      2.06      -10.41
         21   39      3.81     16.85     0.54     12.39     10.41       60.71
              40     -3.81    -14.96    -0.54    -12.39    -10.93      -45.22
        100   39     11.58     26.87     0.12     17.57     20.39       90.65
              40    -11.58    -23.77    -0.12    -17.57    -20.50      -65.98
        101   39      3.81     16.85     0.54     12.39     10.41       60.71
              40     -3.81    -14.96    -0.54    -12.39    -10.93      -45.22
        111   39     24.77     57.51     0.26     37.59     43.63      193.99
              40    -24.77    -50.88    -0.26    -37.59    -43.88     -141.20
        115   39     39.85     89.17     1.76     64.35     53.25      309.50
              40    -39.85    -78.86    -1.76    -64.35    -54.97     -227.65


 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- KN   METE      (LOCAL )

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y       MOM-Z
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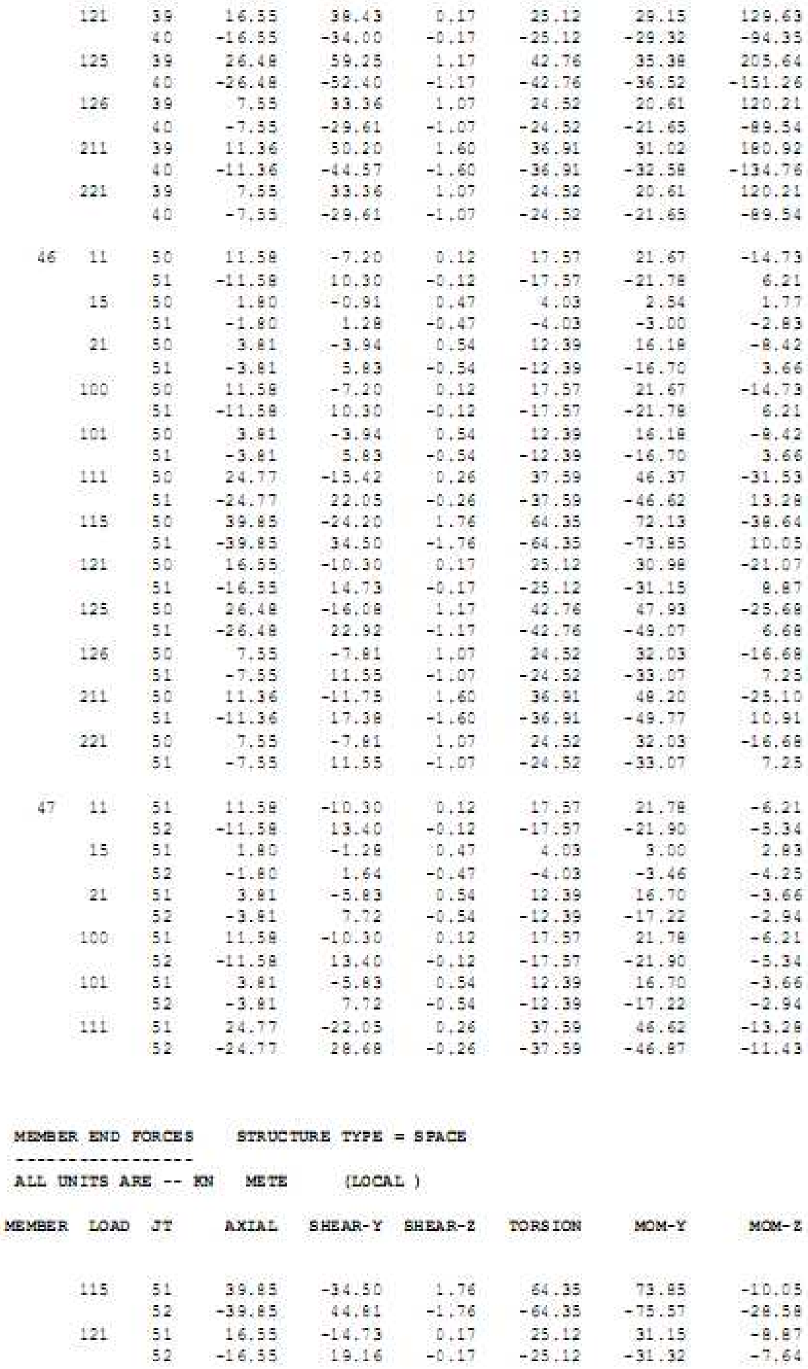

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         121   39     16.55     38.43      0.17     25.12     29.15    129.63
               40    -16.55    -34.00     -0.17    -25.12    -29.32    -94.35
         125   39     26.48     59.25      1.17     42.76     35.38    205.64
               40    -26.48    -52.40     -1.17    -42.76    -36.52   -151.26
         126   39      7.55     33.36      1.07     24.52     20.61    120.21
               40     -7.55    -29.61     -1.07    -24.52    -21.65    -89.54
         211   39     11.36     50.20      1.60     36.91     31.02    180.92
               40    -11.36    -44.57     -1.60    -36.91    -32.58   -134.76
         221   39      7.55     33.36      1.07     24.52     20.61    120.21
               40     -7.55    -29.61     -1.07    -24.52    -21.65    -89.54

    46    11   50     11.58     -7.20      0.12     17.57     21.67    -14.73
               51    -11.58     10.30     -0.12    -17.57    -21.78      6.21
          15   50      1.80     -0.91      0.47      4.03      2.54      1.77
               51     -1.80      1.28     -0.47     -4.03     -3.00     -2.83
          21   50      3.81     -3.94      0.54     12.39     16.18     -8.42
               51     -3.81      5.83     -0.54    -12.39    -16.70      3.66
         100   50     11.58     -7.20      0.12     17.57     21.67    -14.73
               51    -11.58     10.30     -0.12    -17.57    -21.78      6.21
         101   50      3.81     -3.94      0.54     12.39     16.18     -8.42
               51     -3.81      5.83     -0.54    -12.39    -16.70      3.66
         111   50     24.77    -15.42      0.26     37.59     46.37    -31.53
               51    -24.77     22.05     -0.26    -37.59    -46.62     13.28
         115   50     39.85    -24.20      1.76     64.35     72.13    -38.64
               51    -39.85     34.50     -1.76    -64.35    -73.85     10.05
         121   50     16.55    -10.30      0.17     25.12     30.98    -21.07
               51    -16.55     14.73     -0.17    -25.12    -31.15      8.87
         125   50     26.48    -16.08      1.17     42.76     47.93    -25.68
               51    -26.48     22.92     -1.17    -42.76    -49.07      6.68
         126   50      7.55     -7.81      1.07     24.52     32.03    -16.68
               51     -7.55     11.55     -1.07    -24.52    -33.07      7.25
         211   50     11.36    -11.75      1.60     36.91     48.20    -25.10
               51    -11.36     17.38     -1.60    -36.91    -49.77     10.91
         221   50      7.55     -7.81      1.07     24.52     32.03    -16.68
               51     -7.55     11.55     -1.07    -24.52    -33.07      7.25

    47    11   51     11.58    -10.30      0.12     17.57     21.78     -6.21
               52    -11.58     13.40     -0.12    -17.57    -21.90     -5.34
          15   51      1.80     -1.28      0.47      4.03      3.00      2.83
               52     -1.80      1.64     -0.47     -4.03     -3.46     -4.25
          21   51      3.81     -5.83      0.54     12.39     16.70     -3.66
               52     -3.81      7.72     -0.54    -12.39    -17.22     -2.94
         100   51     11.58    -10.30      0.12     17.57     21.78     -6.21
               52    -11.58     13.40     -0.12    -17.57    -21.90     -5.34
         101   51      3.81     -5.83      0.54     12.39     16.70     -3.66
               52     -3.81      7.72     -0.54    -12.39    -17.22     -2.94
         111   51     24.77    -22.05      0.26     37.59     46.62    -13.28
               52    -24.77     28.68     -0.26    -37.59    -46.87    -11.43


 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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 ALL UNITS ARE -- KN   METE     (LOCAL )

MEMBER  LOAD  JT     AXIAL   SHEAR-Y   SHEAR-Z   TORSION     MOM-Y     MOM-Z


         115   51     39.85    -34.50      1.76     64.35     73.85    -10.05
               52    -39.85     44.81     -1.76    -64.35    -75.57    -28.58
         121   51     16.55    -14.73      0.17     25.12     31.15     -8.87
               52    -16.55     19.16     -0.17    -25.12    -31.32     -7.64
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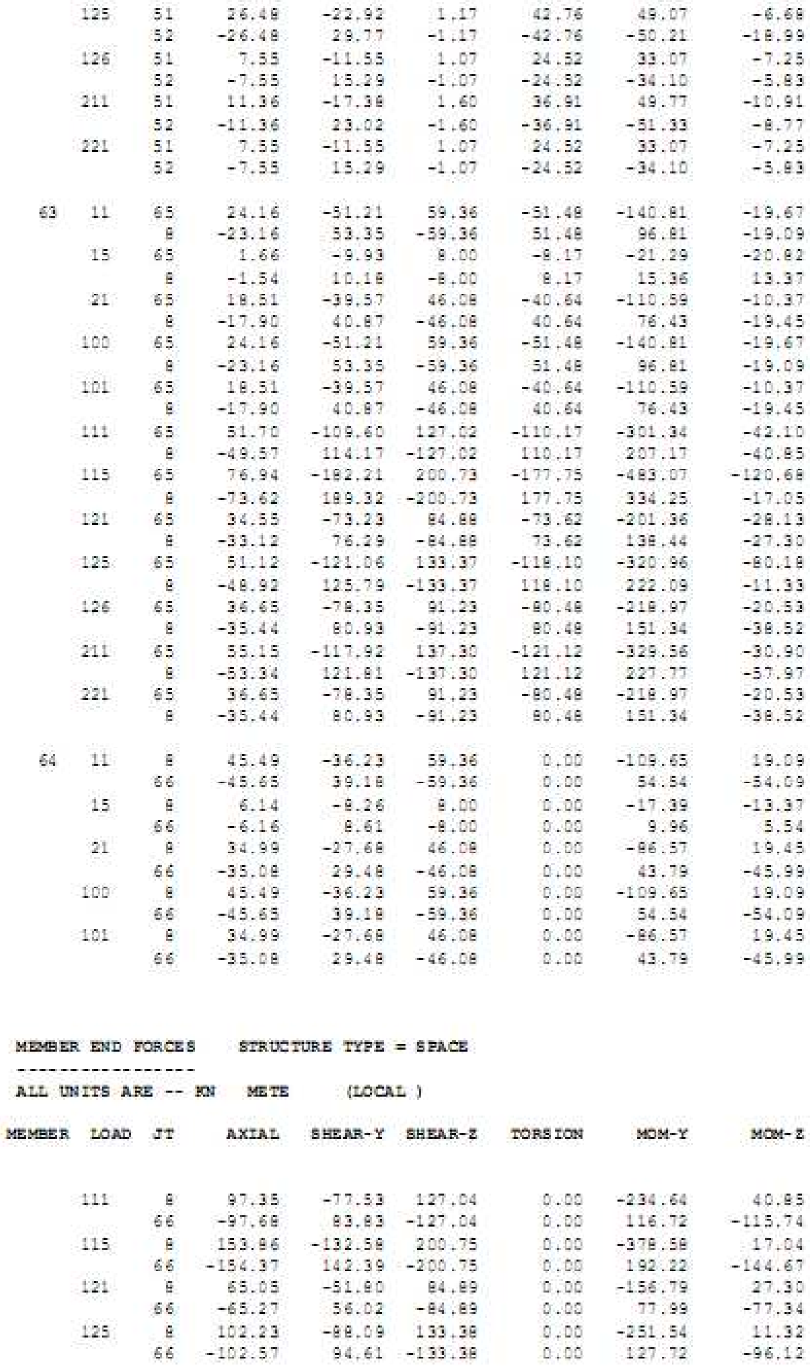

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         125    51     26.48    -22.92     1.17     42.76     49.07      -6.68
                52    -26.48     29.77    -1.17    -42.76    -50.21     -18.99
         126    51      7.55    -11.55     1.07     24.52     33.07      -7.25
                52     -7.55     15.29    -1.07    -24.52    -34.10      -5.83
         211    51     11.36    -17.38     1.60     36.91     49.77     -10.91
                52    -11.36     23.02    -1.60    -36.91    -51.33      -8.77
         221    51      7.55    -11.55     1.07     24.52     33.07      -7.25
                52     -7.55     15.29    -1.07    -24.52    -34.10      -5.83

    63    11    65     24.16    -51.21    59.36    -51.48   -140.81     -19.67
                 8    -23.16     53.35   -59.36     51.48     96.81     -19.09
          15    65      1.66     -9.93     8.00     -8.17    -21.29     -20.82
                 8     -1.54     10.18    -8.00      8.17     15.36      13.37
          21    65     18.51    -39.57    46.08    -40.64   -110.59     -10.37
                 8    -17.90     40.87   -46.08     40.64     76.43     -19.45
         100    65     24.16    -51.21    59.36    -51.48   -140.81     -19.67
                 8    -23.16     53.35   -59.36     51.48     96.81     -19.09
         101    65     18.51    -39.57    46.08    -40.64   -110.59     -10.37
                 8    -17.90     40.87   -46.08     40.64     76.43     -19.45
         111    65     51.70   -109.60   127.02   -110.17   -301.34     -42.10
                 8    -49.57    114.17  -127.02    110.17    207.17     -40.85
         115    65     76.94   -182.21   200.73   -177.75   -483.07    -120.68
                 8    -73.62    189.32  -200.73    177.75    334.25     -17.05
         121    65     34.55    -73.23    84.88    -73.62   -201.36     -28.13
                 8    -33.12     76.29   -84.88     73.62    138.44     -27.30
         125    65     51.12   -121.06   133.37   -118.10   -320.96     -80.18
                 8    -48.92    125.79  -133.37    118.10    222.09     -11.33
         126    65     36.65    -78.35    91.23    -80.48   -218.97     -20.53
                 8    -35.44     80.93   -91.23     80.48    151.34     -38.52
         211    65     55.15   -117.92   137.30   -121.12   -329.56     -30.90
                 8    -53.34    121.81  -137.30    121.12    227.77     -57.97
         221    65     36.65    -78.35    91.23    -80.48   -218.97     -20.53
                 8    -35.44     80.93   -91.23     80.48    151.34     -38.52

    64    11     8     45.49    -36.23    59.36      0.00   -109.65      19.09
                66    -45.65     39.18   -59.36      0.00     54.54     -54.09
          15     8      6.14     -8.26     8.00      0.00    -17.39     -13.37
                66     -6.16      8.61    -8.00      0.00      9.96       5.54
          21     8     34.99    -27.68    46.08      0.00    -86.57      19.45
                66    -35.08     29.48   -46.08      0.00     43.79     -45.99
         100     8     45.49    -36.23    59.36      0.00   -109.65      19.09
                66    -45.65     39.18   -59.36      0.00     54.54     -54.09
         101     8     34.99    -27.68    46.08      0.00    -86.57      19.45
                66    -35.08     29.48   -46.08      0.00     43.79     -45.99


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE      (LOCAL )

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


         111     8     97.35    -77.53   127.04      0.00   -234.64      40.85
                66    -97.68     83.83  -127.04      0.00    116.72    -115.74
         115     8    153.86   -132.58   200.75      0.00   -378.58      17.04
                66   -154.37    142.39  -200.75      0.00    192.22    -144.67
         121     8     65.05    -51.80    84.89      0.00   -156.79      27.30
                66    -65.27     56.02   -84.89      0.00     77.99     -77.34
         125     8    102.23    -88.09   133.38      0.00   -251.54      11.32
                66   -102.57     94.61  -133.38      0.00    127.72     -96.12
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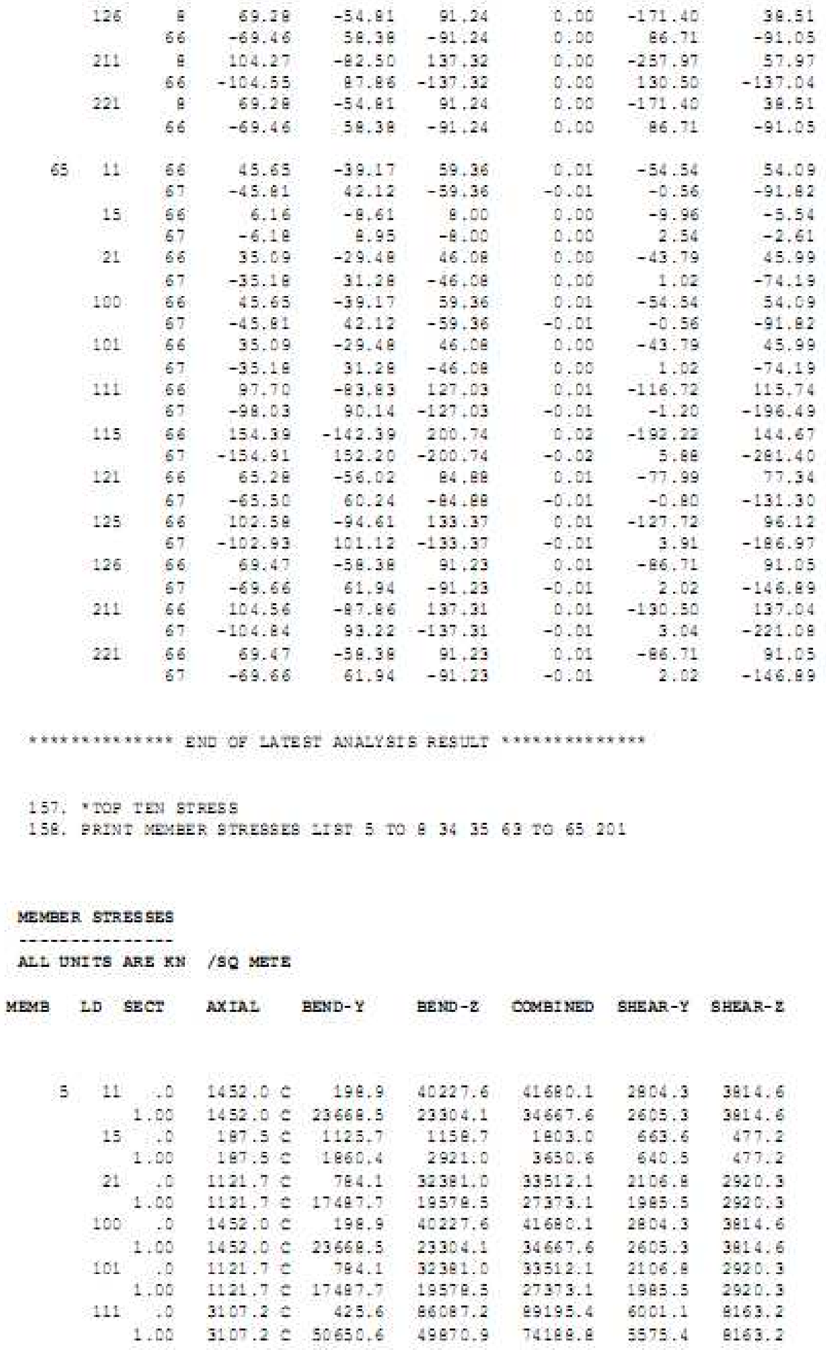

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        126     8     69.28    -54.81    91.24      0.00   -171.40     38.51
               66    -69.46     58.38   -91.24      0.00     86.71    -91.05
        211     8    104.27    -82.50   137.32      0.00   -257.97     57.97
               66   -104.55     87.86  -137.32      0.00    130.50   -137.04
        221     8     69.28    -54.81    91.24      0.00   -171.40     38.51
               66    -69.46     58.38   -91.24      0.00     86.71    -91.05

   65    11    66     45.65    -39.17    59.36      0.01    -54.54     54.09
               67    -45.81     42.12   -59.36     -0.01     -0.56    -91.82
         15    66      6.16     -8.61     8.00      0.00     -9.96     -5.54
               67     -6.18      8.95    -8.00      0.00      2.54     -2.61
         21    66     35.09    -29.48    46.08      0.00    -43.79     45.99
               67    -35.18     31.28   -46.08      0.00      1.02    -74.19
        100    66     45.65    -39.17    59.36      0.01    -54.54     54.09
               67    -45.81     42.12   -59.36     -0.01     -0.56    -91.82
        101    66     35.09    -29.48    46.08      0.00    -43.79     45.99
               67    -35.18     31.28   -46.08      0.00      1.02    -74.19
        111    66     97.70    -83.83   127.03      0.01   -116.72    115.74
               67    -98.03     90.14  -127.03     -0.01     -1.20   -196.49
        115    66    154.39   -142.39   200.74      0.02   -192.22    144.67
               67   -154.91    152.20  -200.74     -0.02      5.88   -281.40
        121    66     65.28    -56.02    84.88      0.01    -77.99     77.34
               67    -65.50     60.24   -84.88     -0.01     -0.80   -131.30
        125    66    102.58    -94.61   133.37      0.01   -127.72     96.12
               67   -102.93    101.12  -133.37     -0.01      3.91   -186.97
        126    66     69.47    -58.38    91.23      0.01    -86.71     91.05
               67    -69.66     61.94   -91.23     -0.01      2.02   -146.89
        211    66    104.56    -87.86   137.31      0.01   -130.50    137.04
               67   -104.84     93.22  -137.31     -0.01      3.04   -221.08
        221    66     69.47    -58.38    91.23      0.01    -86.71     91.05
               67    -69.66     61.94   -91.23     -0.01      2.02   -146.89


 ************** END OF LATEST ANALYSIS RESULT **************


 157. *TOP TEN STRESS
 158. PRINT MEMBER STRESSES LIST 5 TO 8 34 35 63 TO 65 201


 MEMBER STRESSES
 ---------------
 ALL UNITS ARE KN  /SQ METE

MEMB   LD  SECT     AXIAL      BEND-Y     BEND-Z   COMBINED  SHEAR-Y  SHEAR-Z


    5   11    .0    1452.0 C     198.9    40227.6    41680.1    2804.3   3814.6
            1.00    1452.0 C  23668.5    23304.1    34667.6    2605.3   3814.6
        15    .0     187.5 C   1125.7     1158.7     1803.0     663.6    477.2
            1.00     187.5 C   1860.4     2921.0     3650.6     640.5    477.2
        21    .0    1121.7 C     784.1    32381.0    33512.1    2106.8   2920.3
            1.00    1121.7 C  17487.7    19578.5    27373.1    1985.5   2920.3
       100    .0    1452.0 C     198.9    40227.6    41680.1    2804.3   3814.6
            1.00    1452.0 C  23668.5    23304.1    34667.6    2605.3   3814.6
       101    .0    1121.7 C     784.1    32381.0    33512.1    2106.8   2920.3
            1.00    1121.7 C  17487.7    19578.5    27373.1    1985.5   2920.3
       111    .0    3107.2 C     425.6    86087.2    89195.4    6001.1   8163.2
            1.00    3107.2 C  50650.6    49870.9    74188.8    5575.4   8163.2
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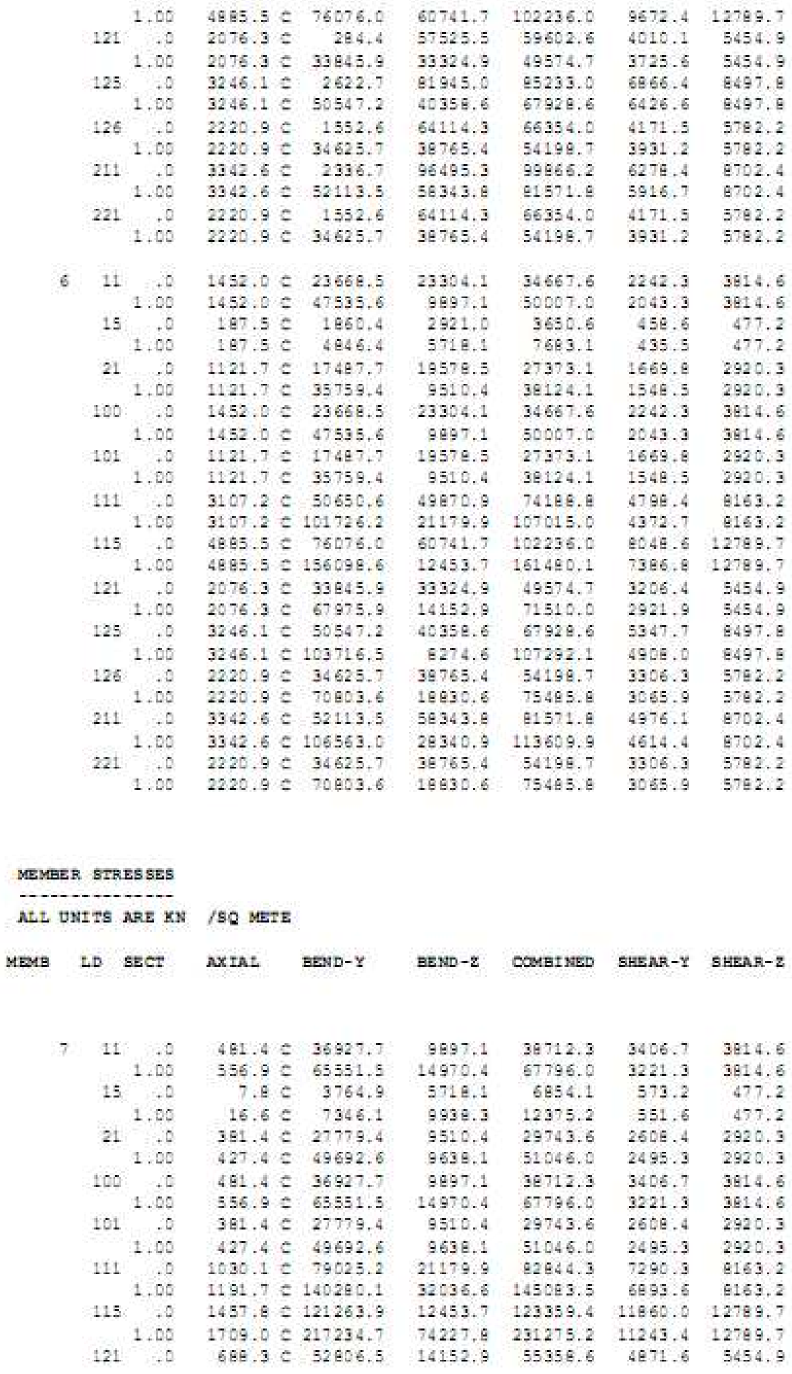

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                  1.00     4885.5 C   76076.0     60741.7   102236.0     9672.4   12789.7
           121      .0     2076.3 C     284.4     57525.5    59602.6     4010.1    5454.9
                  1.00     2076.3 C   33845.9     33324.9    49574.7     3725.6    5454.9
           125      .0     3246.1 C    2622.7     81945.0    85233.0     6866.4    8497.8
                  1.00     3246.1 C   50547.2     40358.6    67928.6     6426.6    8497.8
           126      .0     2220.9 C    1552.6     64114.3    66354.0     4171.5    5782.2
                  1.00     2220.9 C   34625.7     38765.4    54198.7     3931.2    5782.2
           211      .0     3342.6 C    2336.7     96495.3    99866.2     6278.4    8702.4
                  1.00     3342.6 C   52113.5     58343.8    81571.8     5916.7    8702.4
           221      .0     2220.9 C    1552.6     64114.3    66354.0     4171.5    5782.2
                  1.00     2220.9 C   34625.7     38765.4    54198.7     3931.2    5782.2

     6      11      .0     1452.0 C   23668.5     23304.1    34667.6     2242.3    3814.6
                  1.00     1452.0 C   47535.6      9897.1    50007.0     2043.3    3814.6
            15      .0      187.5 C    1860.4      2921.0     3650.6      458.6     477.2
                  1.00      187.5 C    4846.4      5718.1     7683.1      435.5     477.2
            21      .0     1121.7 C   17487.7     19578.5    27373.1     1669.8    2920.3
                  1.00     1121.7 C   35759.4      9510.4    38124.1     1548.5    2920.3
           100      .0     1452.0 C   23668.5     23304.1    34667.6     2242.3    3814.6
                  1.00     1452.0 C   47535.6      9897.1    50007.0     2043.3    3814.6
           101      .0     1121.7 C   17487.7     19578.5    27373.1     1669.8    2920.3
                  1.00     1121.7 C   35759.4      9510.4    38124.1     1548.5    2920.3
           111      .0     3107.2 C   50650.6     49870.9    74188.8     4798.4    8163.2
                  1.00     3107.2 C  101726.2     21179.9   107015.0     4372.7    8163.2
           115      .0     4885.5 C   76076.0     60741.7   102236.0     8048.6   12789.7
                  1.00     4885.5 C  156098.6     12453.7   161480.1     7386.8   12789.7
           121      .0     2076.3 C   33845.9     33324.9    49574.7     3206.4    5454.9
                  1.00     2076.3 C   67975.9     14152.9    71510.0     2921.9    5454.9
           125      .0     3246.1 C   50547.2     40358.6    67928.6     5347.7    8497.8
                  1.00     3246.1 C  103716.5      8274.6   107292.1     4908.0    8497.8
           126      .0     2220.9 C   34625.7     38765.4    54198.7     3306.3    5782.2
                  1.00     2220.9 C   70803.6     18830.6    75485.8     3065.9    5782.2
           211      .0     3342.6 C   52113.5     58343.8    81571.8     4976.1    8702.4
                  1.00     3342.6 C  106563.0     28340.9   113609.9     4614.4    8702.4
           221      .0     2220.9 C   34625.7     38765.4    54198.7     3306.3    5782.2
                  1.00     2220.9 C   70803.6     18830.6    75485.8     3065.9    5782.2


  MEMBER STRESSES
  ---------------
  ALL UNITS ARE KN  /SQ METE

 MEMB    LD   SECT       AXIAL     BEND-Y       BEND-Z   COMBINED    SHEAR-Y   SHEAR-Z


     7      11      .0      481.4 C   36927.7      9897.1    38712.3     3406.7    3814.6
                  1.00      556.9 C   65551.5     14970.4    67796.0     3221.3    3814.6
            15      .0        7.8 C    3764.9      5718.1     6854.1      573.2     477.2
                  1.00       16.6 C    7346.1      9938.3    12375.2      551.6     477.2
            21      .0      381.4 C   27779.4      9510.4    29743.6     2608.4    2920.3
                  1.00      427.4 C   49692.6      9638.1    51046.0     2495.3    2920.3
           100      .0      481.4 C   36927.7      9897.1    38712.3     3406.7    3814.6
                  1.00      556.9 C   65551.5     14970.4    67796.0     3221.3    3814.6
           101      .0      381.4 C   27779.4      9510.4    29743.6     2608.4    2920.3
                  1.00      427.4 C   49692.6      9638.1    51046.0     2495.3    2920.3
           111      .0     1030.1 C   79025.2     21179.9    82844.3     7290.3    8163.2
                  1.00     1191.7 C  140280.1     32036.6   145083.5     6893.6    8163.2
           115      .0     1457.8 C  121263.9     12453.7   123359.4    11860.0   12789.7
                  1.00     1709.0 C  217234.7     74227.8   231275.2    11243.4   12789.7
           121      .0      688.3 C   52806.5     14152.9    55358.6     4871.6    5454.9
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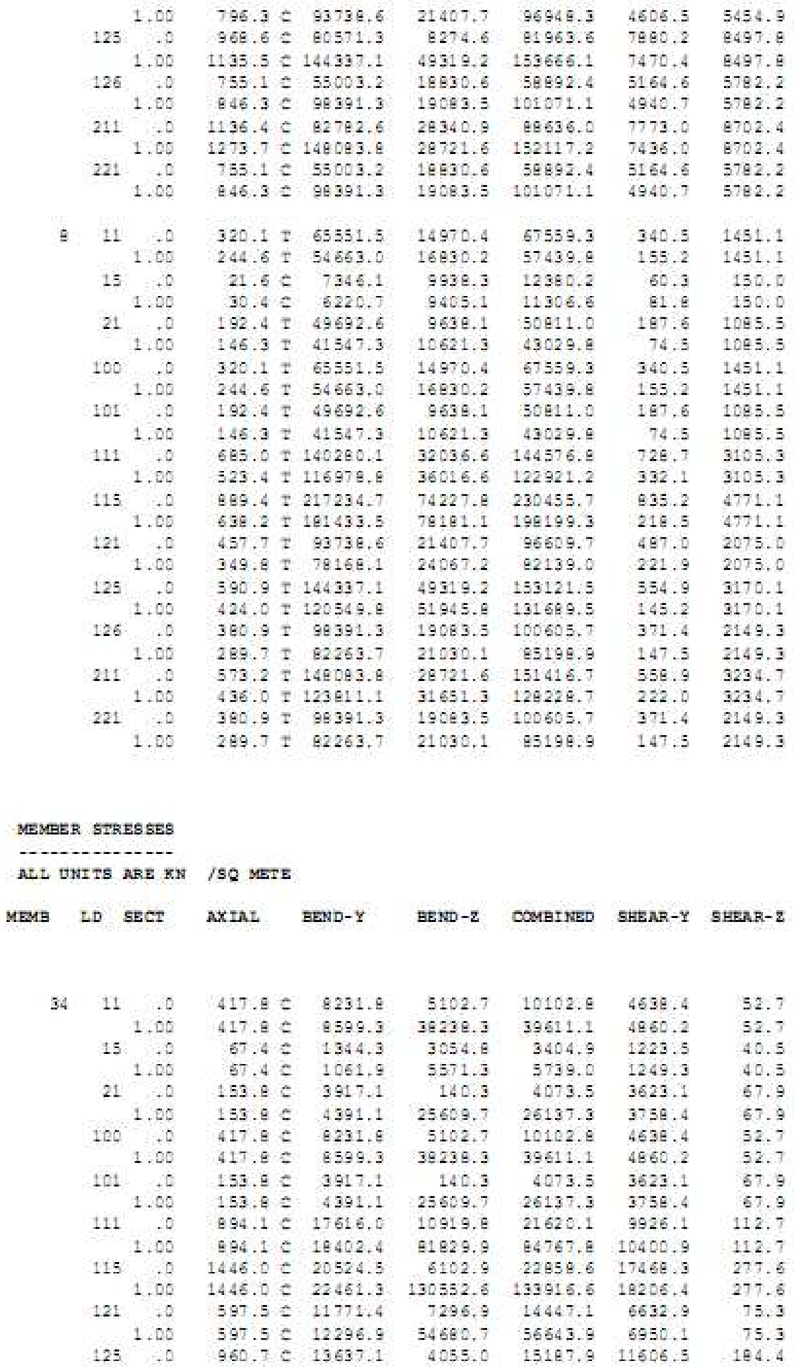

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            1.00      796.3 C  93738.6    21407.7    96948.3    4606.5    5454.9
      125    .0       968.6 C  80571.3     8274.6    81963.6    7880.2    8497.8
            1.00     1135.5 C 144337.1    49319.2   153666.1    7470.4    8497.8
      126    .0       755.1 C  55003.2    18830.6    58892.4    5164.6    5782.2
            1.00      846.3 C  98391.3    19083.5   101071.1    4940.7    5782.2
      211    .0      1136.4 C  82782.6    28340.9    88636.0    7773.0    8702.4
            1.00     1273.7 C 148083.8    28721.6   152117.2    7436.0    8702.4
      221    .0       755.1 C  55003.2    18830.6    58892.4    5164.6    5782.2
            1.00      846.3 C  98391.3    19083.5   101071.1    4940.7    5782.2

  8    11    .0       320.1 T  65551.5    14970.4    67559.3     340.5    1451.1
            1.00      244.6 T  54663.0    16830.2    57439.8     155.2    1451.1
       15    .0        21.6 C   7346.1     9938.3    12380.2      60.3     150.0
            1.00       30.4 C   6220.7     9405.1    11306.6      81.8     150.0
       21    .0       192.4 T  49692.6     9638.1    50811.0     187.6    1085.5
            1.00      146.3 T  41547.3    10621.3    43029.8      74.5    1085.5
      100    .0       320.1 T  65551.5    14970.4    67559.3     340.5    1451.1
            1.00      244.6 T  54663.0    16830.2    57439.8     155.2    1451.1
      101    .0       192.4 T  49692.6     9638.1    50811.0     187.6    1085.5
            1.00      146.3 T  41547.3    10621.3    43029.8      74.5    1085.5
      111    .0       685.0 T 140280.1    32036.6   144576.8     728.7    3105.3
            1.00      523.4 T 116978.8    36016.6   122921.2     332.1    3105.3
      115    .0       889.4 T 217234.7    74227.8   230455.7     835.2    4771.1
            1.00      638.2 T 181433.5    78181.1   198199.3     218.5    4771.1
      121    .0       457.7 T  93738.6    21407.7    96609.7     487.0    2075.0
            1.00      349.8 T  78168.1    24067.2    82139.0     221.9    2075.0
      125    .0       590.9 T 144337.1    49319.2   153121.5     554.9    3170.1
            1.00      424.0 T 120549.8    51945.8   131689.5     145.2    3170.1
      126    .0       380.9 T  98391.3    19083.5   100605.7     371.4    2149.3
            1.00      289.7 T  82263.7    21030.1    85198.9     147.5    2149.3
      211    .0       573.2 T 148083.8    28721.6   151416.7     558.9    3234.7
            1.00      436.0 T 123811.1    31651.3   128228.7     222.0    3234.7
      221    .0       380.9 T  98391.3    19083.5   100605.7     371.4    2149.3
            1.00      289.7 T  82263.7    21030.1    85198.9     147.5    2149.3


 MEMBER STRESSES
 ---------------
 ALL UNITS ARE KN  /SQ METE

MEMB   LD  SECT     AXIAL    BEND-Y     BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z


 34    11    .0       417.8 C   8231.8     5102.7    10102.8    4638.4      52.7
            1.00      417.8 C   8599.3    38238.3    39611.1    4860.2      52.7
       15    .0        67.4 C   1344.3     3054.8     3404.9    1223.5      40.5
            1.00       67.4 C   1061.9     5571.3     5739.0    1249.3      40.5
       21    .0       153.8 C   3917.1      140.3     4073.5    3623.1      67.9
            1.00      153.8 C   4391.1    25609.7    26137.3    3758.4      67.9
      100    .0       417.8 C   8231.8     5102.7    10102.8    4638.4      52.7
            1.00      417.8 C   8599.3    38238.3    39611.1    4860.2      52.7
      101    .0       153.8 C   3917.1      140.3     4073.5    3623.1      67.9
            1.00      153.8 C   4391.1    25609.7    26137.3    3758.4      67.9
      111    .0       894.1 C  17616.0    10919.8    21620.1    9926.1     112.7
            1.00      894.1 C  18402.4    81829.9    84767.8   10400.9     112.7
      115    .0      1446.0 C  20524.5     6102.9    22858.6   17468.3     277.6
            1.00     1446.0 C  22461.3   130552.6   133916.6   18206.4     277.6
      121    .0       597.5 C  11771.4     7296.9    14447.1    6632.9      75.3
            1.00      597.5 C  12296.9    54680.7    56643.9    6950.1      75.3
      125    .0       960.7 C  13637.1     4055.0    15187.9   11606.5     184.4
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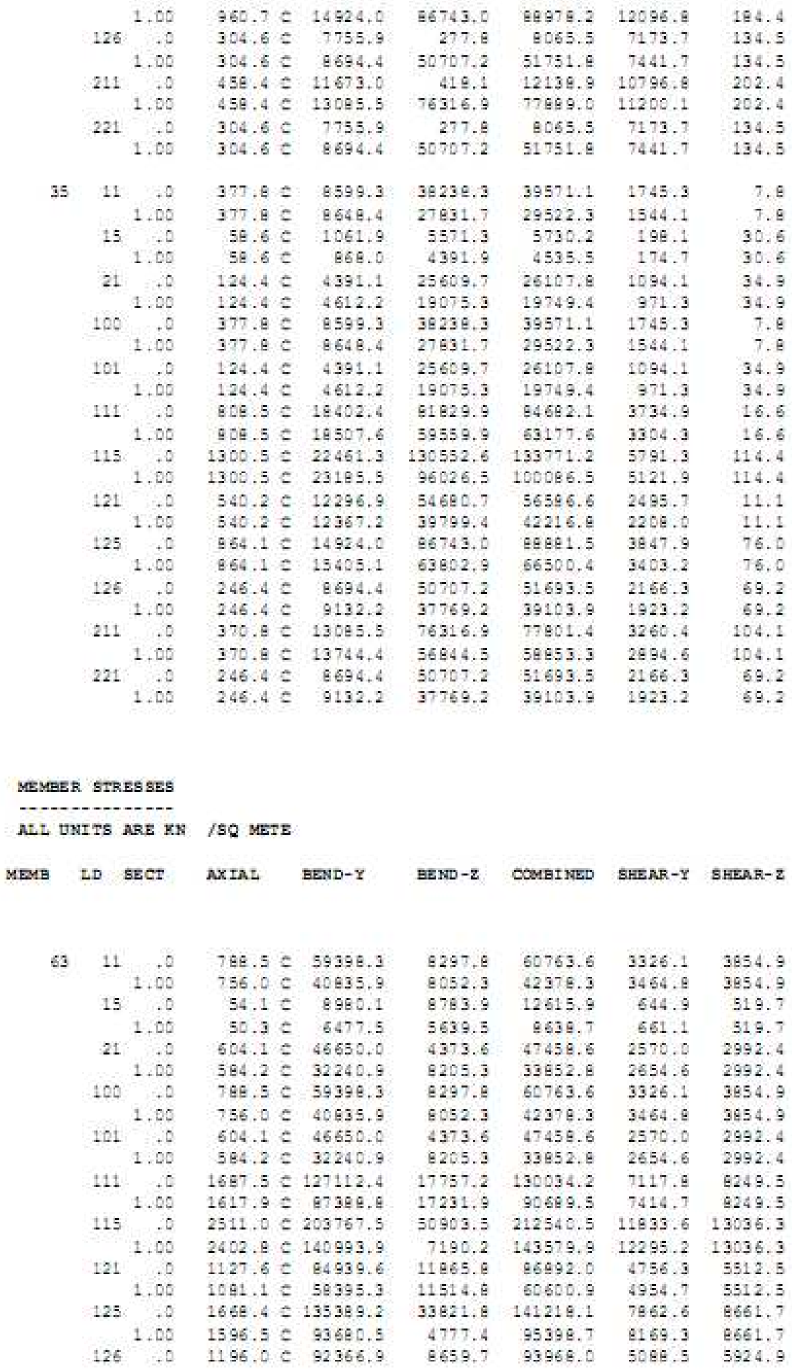

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             1.00    960.7 C   14924.0   86743.0   88978.2  12096.8    184.4
        126    .0    304.6 C    7755.9     277.8    8065.5   7173.7    134.5
             1.00    304.6 C    8694.4   50707.2   51751.8   7441.7    134.5
        211    .0    458.4 C   11673.0     418.1   12138.9  10796.8    202.4
             1.00    458.4 C   13085.5   76316.9   77889.0  11200.1    202.4
        221    .0    304.6 C    7755.9     277.8    8065.5   7173.7    134.5
             1.00    304.6 C    8694.4   50707.2   51751.8   7441.7    134.5

   35    11    .0    377.8 C    8599.3   38238.3   39571.1   1745.3      7.8
             1.00    377.8 C    8648.4   27831.7   29522.3   1544.1      7.8
         15    .0     58.6 C    1061.9    5571.3    5730.2    198.1     30.6
             1.00     58.6 C     868.0    4391.9    4535.5    174.7     30.6
         21    .0    124.4 C    4391.1   25609.7   26107.8   1094.1     34.9
             1.00    124.4 C    4612.2   19075.3   19749.4    971.3     34.9
        100    .0    377.8 C    8599.3   38238.3   39571.1   1745.3      7.8
             1.00    377.8 C    8648.4   27831.7   29522.3   1544.1      7.8
        101    .0    124.4 C    4391.1   25609.7   26107.8   1094.1     34.9
             1.00    124.4 C    4612.2   19075.3   19749.4    971.3     34.9
        111    .0    808.5 C   18402.4   81829.9   84682.1   3734.9     16.6
             1.00    808.5 C   18507.6   59559.9   63177.6   3304.3     16.6
        115    .0   1300.5 C   22461.3  130552.6  133771.2   5791.3    114.4
             1.00   1300.5 C   23185.5   96026.5  100086.5   5121.9    114.4
        121    .0    540.2 C   12296.9   54680.7   56586.6   2495.7     11.1
             1.00    540.2 C   12367.2   39799.4   42216.8   2208.0     11.1
        125    .0    864.1 C   14924.0   86743.0   88881.5   3847.9     76.0
             1.00    864.1 C   15405.1   63802.9   66500.4   3403.2     76.0
        126    .0    246.4 C    8694.4   50707.2   51693.5   2166.3     69.2
             1.00    246.4 C    9132.2   37769.2   39103.9   1923.2     69.2
        211    .0    370.8 C   13085.5   76316.9   77801.4   3260.4    104.1
             1.00    370.8 C   13744.4   56844.5   58853.3   2894.6    104.1
        221    .0    246.4 C    8694.4   50707.2   51693.5   2166.3     69.2
             1.00    246.4 C    9132.2   37769.2   39103.9   1923.2     69.2


  MEMBER  STRESSES
  ----------------
  ALL UNITS ARE KN  /SQ METE

MEMB     LD  SECT    AXIAL      BEND-Y    BEND-Z  COMBINED  SHEAR-Y  SHEAR-Z


   63    11    .0    788.5 C   59398.3    8297.8   60763.6   3326.1   3854.9
             1.00    756.0 C   40835.9    8052.3   42378.3   3464.8   3854.9
         15    .0     54.1 C    8980.1    8783.9   12615.9    644.9    519.7
             1.00     50.3 C    6477.5    5639.5    8638.7    661.1    519.7
         21    .0    604.1 C   46650.0    4373.6   47458.6   2570.0   2992.4
             1.00    584.2 C   32240.9    8205.3   33852.8   2654.6   2992.4
        100    .0    788.5 C   59398.3    8297.8   60763.6   3326.1   3854.9
             1.00    756.0 C   40835.9    8052.3   42378.3   3464.8   3854.9
        101    .0    604.1 C   46650.0    4373.6   47458.6   2570.0   2992.4
             1.00    584.2 C   32240.9    8205.3   33852.8   2654.6   2992.4
        111    .0   1687.5 C  127112.4   17757.2  130034.2   7117.8   8249.5
             1.00   1617.9 C   87388.8   17231.9   90689.5   7414.7   8249.5
        115    .0   2511.0 C  203767.5   50903.5  212540.5  11833.6  13036.3
             1.00   2402.8 C  140993.9    7190.2  143579.9  12295.2  13036.3
        121    .0   1127.6 C   84939.6   11865.8   86892.0   4756.3   5512.5
             1.00   1081.1 C   58395.3   11514.8   60600.9   4954.7   5512.5
        125    .0   1668.4 C  135389.2   33821.8  141218.1   7862.6   8661.7
             1.00   1596.5 C   93680.5    4777.4   95398.7   8169.3   8661.7
        126    .0   1196.0 C   92366.9    8659.7   93968.0   5088.5   5924.9
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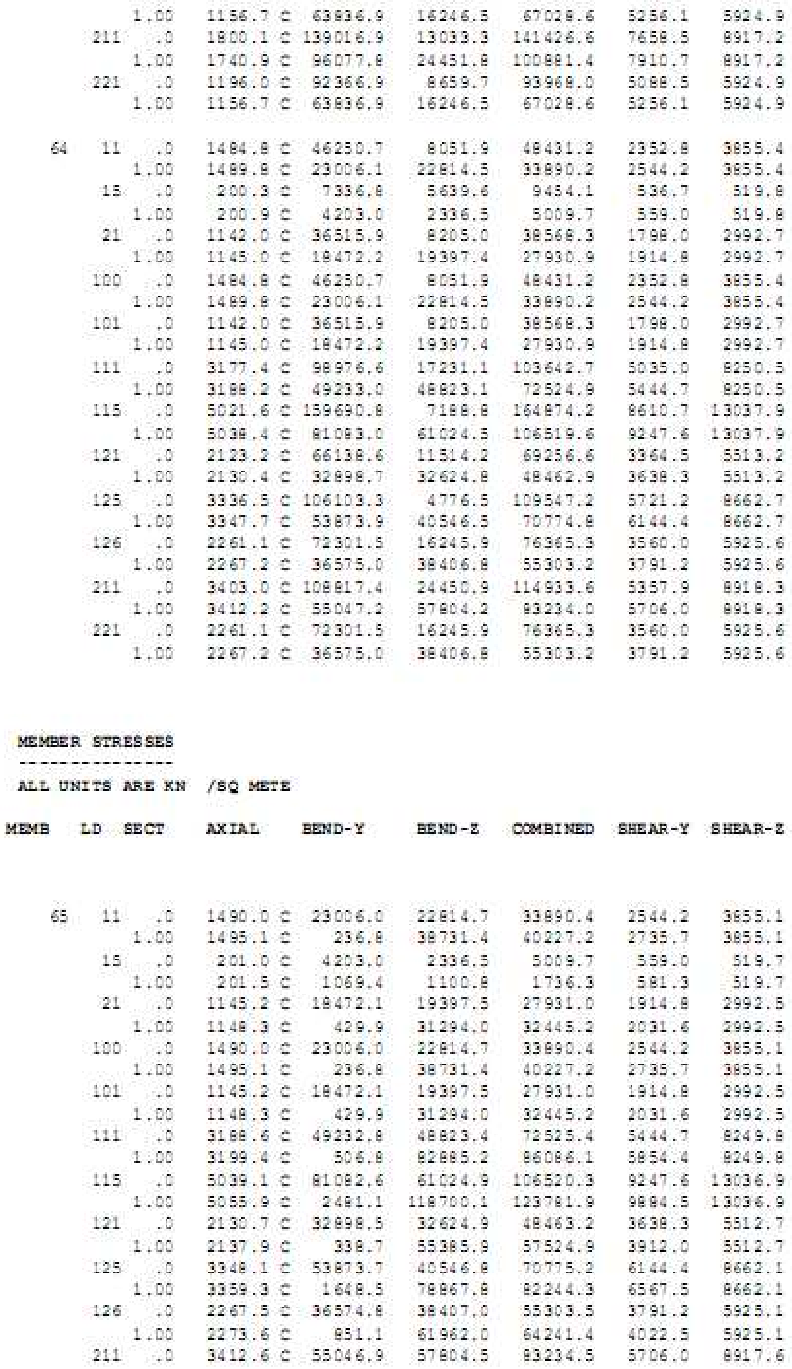

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                 1.00   1156.7 C  63836.9    16246.5    67028.6    5256.1    5924.9
           211    .0    1800.1 C 139016.9    13033.3   141426.6    7658.5    8917.2
                 1.00   1740.9 C  96077.8    24451.8   100881.4    7910.7    8917.2
           221    .0    1196.0 C  92366.9     8659.7    93968.0    5088.5    5924.9
                 1.00   1156.7 C  63836.9    16246.5    67028.6    5256.1    5924.9

     64     11    .0    1484.8 C  46250.7     8051.9    48431.2    2352.8    3855.4
                 1.00   1489.8 C  23006.1    22814.5    33890.2    2544.2    3855.4
            15    .0     200.3 C   7336.8     5639.6     9454.1     536.7     519.8
                 1.00    200.9 C   4203.0     2336.5     5009.7     559.0     519.8
            21    .0    1142.0 C  36515.9     8205.0    38568.3    1798.0    2992.7
                 1.00   1145.0 C  18472.2    19397.4    27930.9    1914.8    2992.7
           100    .0    1484.8 C  46250.7     8051.9    48431.2    2352.8    3855.4
                 1.00   1489.8 C  23006.1    22814.5    33890.2    2544.2    3855.4
           101    .0    1142.0 C  36515.9     8205.0    38568.3    1798.0    2992.7
                 1.00   1145.0 C  18472.2    19397.4    27930.9    1914.8    2992.7
           111    .0    3177.4 C  98976.6    17231.1   103642.7    5035.0    8250.5
                 1.00   3188.2 C  49233.0    48823.1    72524.9    5444.7    8250.5
           115    .0    5021.6 C 159690.8     7188.8   164874.2    8610.7   13037.9
                 1.00   5038.4 C  81083.0    61024.5   106519.6    9247.6   13037.9
           121    .0    2123.2 C  66138.6    11514.2    69256.6    3364.5    5513.2
                 1.00   2130.4 C  32898.7    32624.8    48462.9    3638.3    5513.2
           125    .0    3336.5 C 106103.3     4776.5   109547.2    5721.2    8662.7
                 1.00   3347.7 C  53873.9    40546.5    70774.8    6144.4    8662.7
           126    .0    2261.1 C  72301.5    16245.9    76365.3    3560.0    5925.6
                 1.00   2267.2 C  36575.0    38406.8    55303.2    3791.2    5925.6
           211    .0    3403.0 C 108817.4    24450.9   114933.6    5357.9    8918.3
                 1.00   3412.2 C  55047.2    57804.2    83234.0    5706.0    8918.3
           221    .0    2261.1 C  72301.5    16245.9    76365.3    3560.0    5925.6
                 1.00   2267.2 C  36575.0    38406.8    55303.2    3791.2    5925.6


  MEMBER  STRESSES
  ----------------
  ALL UNITS ARE KN  /SQ METE

 MEMB   LD  SECT     AXIAL     BEND-Y     BEND-Z   COMBINED   SHEAR-Y   SHEAR-Z


     65     11    .0    1490.0 C  23006.0    22814.7    33890.4    2544.2    3855.1
                 1.00   1495.1 C    236.8    38731.4    40227.2    2735.7    3855.1
            15    .0     201.0 C   4203.0     2336.5     5009.7     559.0     519.7
                 1.00    201.5 C   1069.4     1100.8     1736.3     581.3     519.7
            21    .0    1145.2 C  18472.1    19397.5    27931.0    1914.8    2992.5
                 1.00   1148.3 C    429.9    31294.0    32445.2    2031.6    2992.5
           100    .0    1490.0 C  23006.0    22814.7    33890.4    2544.2    3855.1
                 1.00   1495.1 C    236.8    38731.4    40227.2    2735.7    3855.1
           101    .0    1145.2 C  18472.1    19397.5    27931.0    1914.8    2992.5
                 1.00   1148.3 C    429.9    31294.0    32445.2    2031.6    2992.5
           111    .0    3188.6 C  49232.8    48823.4    72525.4    5444.7    8249.8
                 1.00   3199.4 C    506.8    82885.2    86086.1    5854.4    8249.8
           115    .0    5039.1 C  81082.6    61024.9   106520.3    9247.6   13036.9
                 1.00   5055.9 C   2481.1   118700.1   123781.9    9884.5   13036.9
           121    .0    2130.7 C  32898.5    32624.9    48463.2    3638.3    5512.7
                 1.00   2137.9 C    338.7    55385.9    57524.9    3912.0    5512.7
           125    .0    3348.1 C  53873.7    40546.8    70775.2    6144.4    8662.1
                 1.00   3359.3 C   1648.5    78867.8    82244.3    6567.5    8662.1
           126    .0    2267.5 C  36574.8    38407.0    55303.5    3791.2    5925.1
                 1.00   2273.6 C    851.1    61962.0    64241.4    4022.5    5925.1
           211    .0    3412.6 C  55046.9    57804.5    83234.5    5706.0    8917.6
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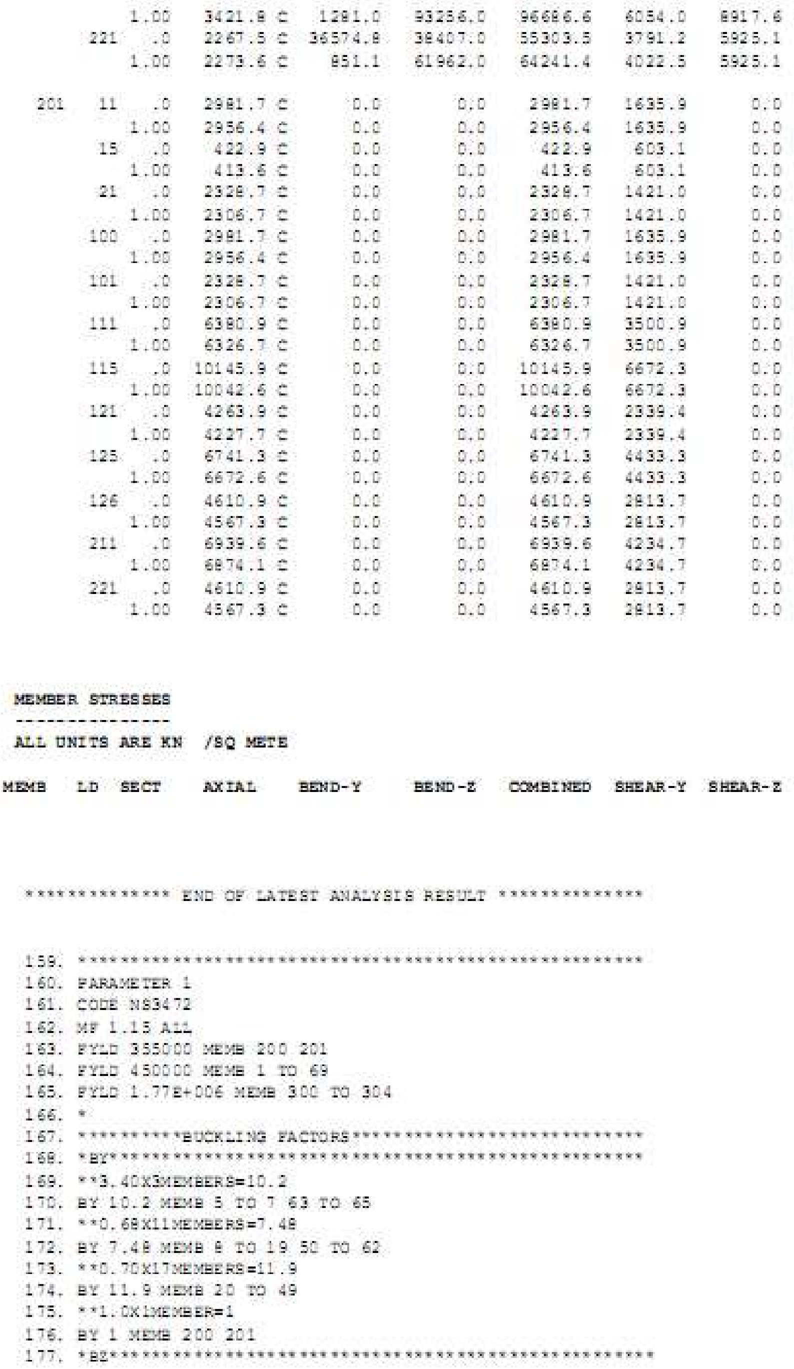

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              1.00   3421.8 C   1281.0   93256.0   96686.6   6054.0   8917.6
         221   .0    2267.5 C  36574.8   38407.0   55303.5   3791.2   5925.1
              1.00   2273.6 C    851.1   61962.0   64241.4   4022.5   5925.1

  201     11   .0    2981.7 C      0.0       0.0    2981.7   1635.9      0.0
              1.00   2956.4 C      0.0       0.0    2956.4   1635.9      0.0
          15   .0     422.9 C      0.0       0.0     422.9    603.1      0.0
              1.00    413.6 C      0.0       0.0     413.6    603.1      0.0
          21   .0    2328.7 C      0.0       0.0    2328.7   1421.0      0.0
              1.00   2306.7 C      0.0       0.0    2306.7   1421.0      0.0
         100   .0    2981.7 C      0.0       0.0    2981.7   1635.9      0.0
              1.00   2956.4 C      0.0       0.0    2956.4   1635.9      0.0
         101   .0    2328.7 C      0.0       0.0    2328.7   1421.0      0.0
              1.00   2306.7 C      0.0       0.0    2306.7   1421.0      0.0
         111   .0    6380.9 C      0.0       0.0    6380.9   3500.9      0.0
              1.00   6326.7 C      0.0       0.0    6326.7   3500.9      0.0
         115   .0   10145.9 C      0.0       0.0   10145.9   6672.3      0.0
              1.00  10042.6 C      0.0       0.0   10042.6   6672.3      0.0
         121   .0    4263.9 C      0.0       0.0    4263.9   2339.4      0.0
              1.00   4227.7 C      0.0       0.0    4227.7   2339.4      0.0
         125   .0    6741.3 C      0.0       0.0    6741.3   4433.3      0.0
              1.00   6672.6 C      0.0       0.0    6672.6   4433.3      0.0
         126   .0    4610.9 C      0.0       0.0    4610.9   2813.7      0.0
              1.00   4567.3 C      0.0       0.0    4567.3   2813.7      0.0
         211   .0    6939.6 C      0.0       0.0    6939.6   4234.7      0.0
              1.00   6874.1 C      0.0       0.0    6874.1   4234.7      0.0
         221   .0    4610.9 C      0.0       0.0    4610.9   2813.7      0.0
              1.00   4567.3 C      0.0       0.0    4567.3   2813.7      0.0


 MEMBER STRESSES
 ---------------
 ALL UNITS ARE KN  /SQ METE

MEMB   LD  SECT    AXIAL     BEND-Y     BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z



  ************** END OF LATEST ANALYSIS RESULT **************


  159. ********************************************************
  160. PARAMETER 1
  161. CODE NS3472
  162. MF 1.15 ALL
  163. FYLD 355000 MEMB 200 201
  164. FYLD 450000 MEMB 1 TO 69
  165. FYLD 1.77E+006 MEMB 300 TO 304
  166. *
  167. **********BUCKLING FACTORS*****************************
  168. *BY****************************************************
  169. **3.40X3MEMBERS=10.2
  170. BY 10.2 MEMB 5 TO 7 63 TO 65
  171. **0.68X11MEMBERS=7.48
  172. BY 7.48 MEMB 8 TO 19 50 TO 62
  173. **0.70X17MEMBERS=11.9
  174. BY 11.9 MEMB 20 TO 49
  175. **1.0X1MEMBER=1
  176. BY 1 MEMB 200 201
  177. *BZ*****************************************************
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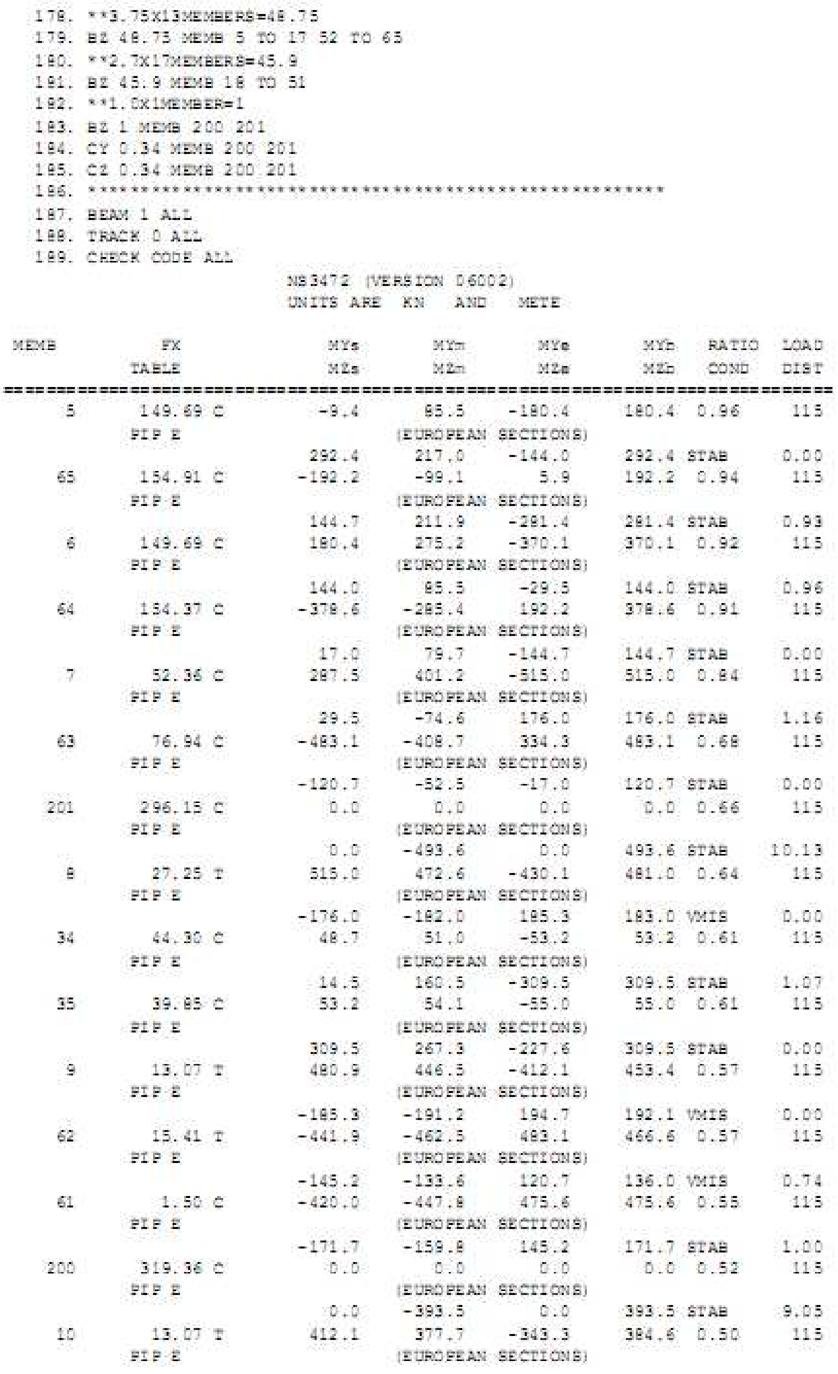

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  178. **3.75X13MEMBERS=48.75
  179. BZ 48.75 MEMB 5 TO 17 52 TO 65
  180. **2.7X17MEMBERS=45.9
  181. BZ 45.9 MEMB 18 TO 51
  182. **1.0X1MEMBER=1
  183. BZ 1 MEMB 200 201
  184. CY 0.34 MEMB 200 201
  185. CZ 0.34 MEMB 200 201
  186. *******************************************************
  187. BEAM 1 ALL
  188. TRACK 0 ALL
  189. CHECK CODE ALL
                          NS3472 (VERSION 06002)
                          UNITS ARE  KN   AND   METE

MEMB          FX                MYs       MYm       MYe        MYb   RATIO   LOAD
           TABLE                MZs       MZn       MZe        MZb   COND    DIST
==================================================================================
    5      149.69 C            -9.4      85.5    -180.4      180.4  0.96      115
           PIPE                         (EUROPEAN SECTIONS)
                              292.4     217.0    -144.0      292.4 STAB      0.00
   65      154.91 C          -192.2     -99.1       5.9      192.2  0.94      115
           PIPE                         (EUROPEAN SECTIONS)
                              144.7     211.9    -281.4      281.4 STAB      0.93
    6      149.69 C           180.4     275.2    -370.1      370.1  0.92      115
           PIPE                         (EUROPEAN SECTIONS)
                              144.0      85.5     -29.5      144.0 STAB      0.96
   64      134.37 C          -378.6    -285.4     192.2      378.6  0.91      115
           PIPE                         (EUROPEAN SECTIONS)
                               17.0      79.7    -144.7      144.7 STAB      0.00
    7       52.36 C           287.5     401.2    -515.0      515.0  0.84      115
           PIPE                         (EUROPEAN SECTIONS)
                               29.5     -74.6     176.0      176.0 STAB      1.16
   63       76.94 C          -483.1    -408.7     334.3      483.1  0.68      115
           PIPE                         (EUROPEAN SECTIONS)
                             -120.7     -52.5     -17.0      120.7 STAB      0.00
  201      296.15 C             0.0       0.0       0.0        0.0  0.66      115
           PIPE                         (EUROPEAN SECTIONS)
                                0.0    -493.6       0.0      493.6 STAB     10.13
    8       27.25 T           515.0     472.6    -430.1      481.0  0.64      115
           PIPE                         (EUROPEAN SECTIONS)
                             -176.0    -182.0     185.3      183.0 VMIS      0.00
   34       44.30 C            48.7      51.0     -53.2       53.2  0.61      115
           PIPE                         (EUROPEAN SECTIONS)
                               14.5     160.5    -309.5      309.5 STAB      1.07
   35       39.85 C            53.2      54.1     -55.0       55.0  0.61      115
           PIPE                         (EUROPEAN SECTIONS)
                              309.5     267.3    -227.6      309.5 STAB      0.00
    9       13.07 T           480.9     446.5    -412.1      453.4  0.57      115
           PIPE                         (EUROPEAN SECTIONS)
                             -185.3    -191.2     194.7      192.1 VMIS      0.00
   62       15.41 T          -441.9    -462.5     483.1      466.6  0.57      115
           PIPE                         (EUROPEAN SECTIONS)
                             -145.2    -133.6     120.7      136.0 VMIS      0.74
   61        1.50 C          -420.0    -447.8     475.6      475.6  0.55      115
           PIPE                         (EUROPEAN SECTIONS)
                             -171.7    -159.8     145.2      171.7 STAB      1.00
  200      319.36 C             0.0       0.0       0.0        0.0  0.52      115
           PIPE                         (EUROPEAN SECTIONS)
                                0.0    -393.5       0.0      393.5 STAB      9.05
   10       13.07 T           412.1     377.7    -343.3      384.6  0.50      115
           PIPE                         (EUROPEAN SECTIONS)
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                            -194.7    -195.9     194.7     195.9 VMIS      0.00
     60        1.50 C       -364.4    -392.2     420.0     420.0  0.50      115
            PIP E                 (EUROPEAN SECTIONS)
                            -187.7    -181.0     171.7     187.7 STAB      1.00
     36       39.85 C         55.0      55.8     -56.7      56.7  0.48      115
            PIP E                 (EUROPEAN SECTIONS)
                             227.6     190.5    -155.8     227.6 STAB      0.00
                           NS3472 (VERSION 06002)
                           UNITS ARE  KN   AND   METE

 MEMB         FX               MYs       MYm       MYe       MYb   RATIO    LOAD
            TABLE              MZs       MZm       MZe       MZb   COND     DIST
================================================================================
     59        1.50 C       -308.8    -336.6     364.4     364.4  0.45      115
            PIP E                 (EUROPEAN SECTIONS)
                            -193.1    -191.7     187.7     193.1 STAB      1.00
     11       13.07 T        343.3     308.9    -274.6     315.8  0.44      115
            PIP E                 (EUROPEAN SECTIONS)
                            -194.7    -191.3     185.5     192.2 VMIS      0.00
     58        1.50 C       -253.2    -281.0     308.8     308.8  0.40      115
            PIP E                 (EUROPEAN SECTIONS)
                            -187.9    -191.8     193.1     193.1 STAB      1.00
     26       24.36 C        -43.0     -37.2      31.4      43.0  0.39      115
            PIP E                 (EUROPEAN SECTIONS)
                            -189.1    -194.8     198.0     198.0 STAB      0.97
     27       24.36 C        -31.4     -25.6      19.8      31.4  0.39      115
            PIP E                 (EUROPEAN SECTIONS)
                            -198.0    -198.6     196.8     198.7 STAB      0.16
     28       24.36 C        -19.8     -14.0       8.2      19.8  0.39      115
            PIP E                 (EUROPEAN SECTIONS)
                            -196.8    -192.4     185.5     196.8 STAB      0.00
     25       24.36 C        -54.6     -48.8      43.0      54.6  0.38      115
            PIP E                 (EUROPEAN SECTIONS)
                            -170.2    -180.9     189.1     189.1 STAB      0.97
     12       13.07 T        274.6     240.2    -205.8     247.1  0.37      115
            PIP E                 (EUROPEAN SECTIONS)
                            -165.5    -177.5     167.1     179.3 VMIS      0.00
     29       24.36 C         -8.2      -2.4      -3.4       8.2  0.37      115
            PIP E                 (EUROPEAN SECTIONS)
                            -185.5    -176.1     164.3     185.5 STAB      0.00
     37       39.85 C         56.7      57.5     -58.4      58.4  0.37      115
            PIP E                 (EUROPEAN SECTIONS)
                             155.8     123.7     -94.1     155.8 STAB      0.00
     24       24.36 C        -66.2     -60.4      54.6      66.2  0.35      115
            PIP E                 (EUROPEAN SECTIONS)
                            -141.3    -157.0     170.2     170.2 STAB      0.97
     49       39.85 C         77.3      78.1     -79.0      79.0  0.35      115
            PIP E                 (EUROPEAN SECTIONS)
                              77.3     105.4    -136.0     136.0 STAB      0.97
     57        1.50 C       -197.6    -225.4     253.2     253.2  0.35      115
            PIP E                 (EUROPEAN SECTIONS)
                            -172.1    -181.4     187.9     187.9 STAB      1.00
     30       24.36 C          3.4       9.2     -15.0      15.0  0.33      115
            PIP E                 (EUROPEAN SECTIONS)
                            -164.3    -149.9     132.9     164.3 STAB      0.00
      4        1.32 T         -7.0      -8.2       9.4       8.4  0.32      115
            PIP E                 (EUROPEAN SECTIONS)
                             172.5     231.2    -292.4     245.6 VMIS      0.96
     13       13.07 T        205.8     171.4    -137.0     178.3  0.31      115
            PIP E                 (EUROPEAN SECTIONS)
                            -167.1    -154.4     139.3     157.1 VMIS      0.00
     66        6.31 T         -5.9      -5.1       4.4       5.3  0.31      115
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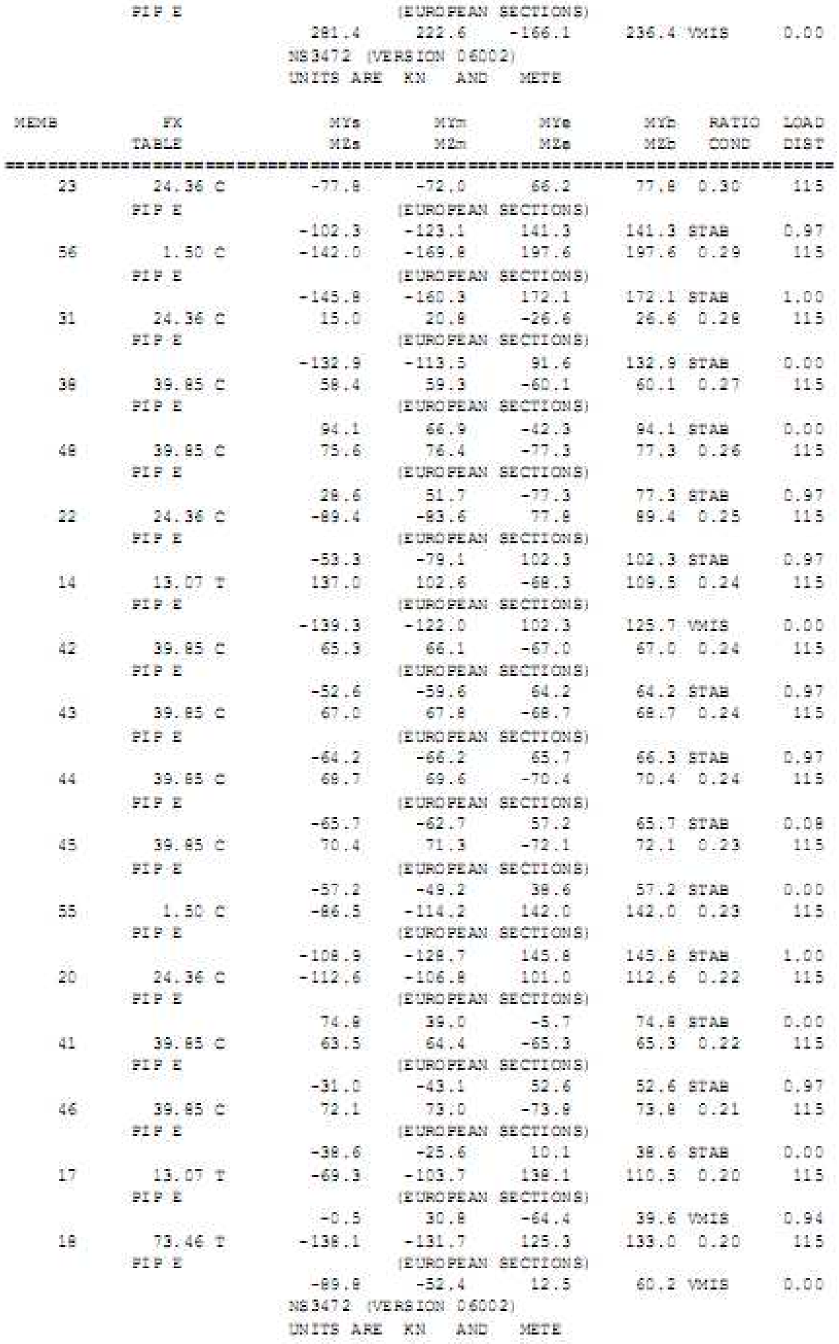

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           PIP E                   (EUROPEAN SECTIONS)
                         281.4     222.6    -166.1     236.4 VMIS      0.00
                       NS3472 (VERSION 06002)
                       UNITS ARE  KN   AND   METE

MEMB          FX              MYs       MYm       MYe       MYb   RATIO  LOAD
           TABLE              MZs       MZm       MZe       MZb   COND   DIST
=============================================================================
    23       24.36 C        -77.8     -72.0      66.2      77.8  0.30     115
           PIP E                   (EUROPEAN SECTIONS)
                           -102.3    -123.1     141.3     141.3 STAB      0.97
    56        1.50 C       -142.0    -169.8     197.6     197.6  0.29     115
           PIP E                   (EUROPEAN SECTIONS)
                           -145.8    -160.3     172.1     172.1 STAB      1.00
    31       24.36 C         15.0      20.8     -26.6      26.6  0.28     115
           PIP E                   (EUROPEAN SECTIONS)
                           -132.9    -113.5      91.6     132.9 STAB      0.00
    38       39.85 C         58.4      59.3     -60.1      60.1  0.27     115
           PIP E                   (EUROPEAN SECTIONS)
                             94.1      66.9     -42.3      94.1 STAB      0.00
    48       39.85 C         75.6      76.4     -77.3      77.3  0.26     115
           PIP E                   (EUROPEAN SECTIONS)
                             28.6      51.7     -77.3      77.3 STAB      0.97
    22       24.36 C        -89.4     -83.6      77.8      89.4  0.25     115
           PIP E                   (EUROPEAN SECTIONS)
                            -53.3     -79.1     102.3     102.3 STAB      0.97
    14       13.07 T        137.0     102.6     -68.3     109.5  0.24     115
           PIP E                   (EUROPEAN SECTIONS)
                           -139.3    -122.0     102.3     125.7 VMIS      0.00
    42       39.85 C         65.3      66.1     -67.0      67.0  0.24     115
           PIP E                   (EUROPEAN SECTIONS)
                            -52.6     -59.6      64.2      64.2 STAB      0.97
    43       39.85 C         67.0      67.8     -68.7      68.7  0.24     115
           PIP E                   (EUROPEAN SECTIONS)
                            -64.2     -66.2      65.7      66.3 STAB      0.97
    44       39.85 C         68.7      69.6     -70.4      70.4  0.24     115
           PIP E                   (EUROPEAN SECTIONS)
                            -65.7     -62.7      57.2      65.7 STAB      0.08
    45       39.85 C         70.4      71.3     -72.1      72.1  0.23     115
           PIP E                   (EUROPEAN SECTIONS)
                            -57.2     -49.2      38.6      57.2 STAB      0.00
    55        1.50 C        -86.5    -114.2     142.0     142.0  0.23     115
           PIP E                   (EUROPEAN SECTIONS)
                           -108.9    -128.7     145.8     145.8 STAB      1.00
    20       24.36 C       -112.6    -106.8     101.0     112.6  0.22     115
           PIP E                   (EUROPEAN SECTIONS)
                             74.8      39.0      -5.7      74.8 STAB      0.00
    41       39.85 C         63.5      64.4     -65.3      65.3  0.22     115
           PIP E                   (EUROPEAN SECTIONS)
                            -31.0     -43.1      52.6      52.6 STAB      0.97
    46       39.85 C         72.1      73.0     -73.8      73.8  0.21     115
           PIP E                   (EUROPEAN SECTIONS)
                            -38.6     -25.6      10.1      38.6 STAB      0.00
    17       13.07 T        -69.3    -103.7     138.1     110.5  0.20     115
           PIP E                   (EUROPEAN SECTIONS)
                             -0.5      30.8     -64.4      39.6 VMIS      0.94
    18       73.46 T       -138.1    -131.7     125.3     133.0  0.20     115
           PIP E                   (EUROPEAN SECTIONS)
                            -89.8     -52.4      12.5      60.2 VMIS      0.00
                       NS3472 (VERSION 06002)
                       UNITS ARE  KN   AND   METE
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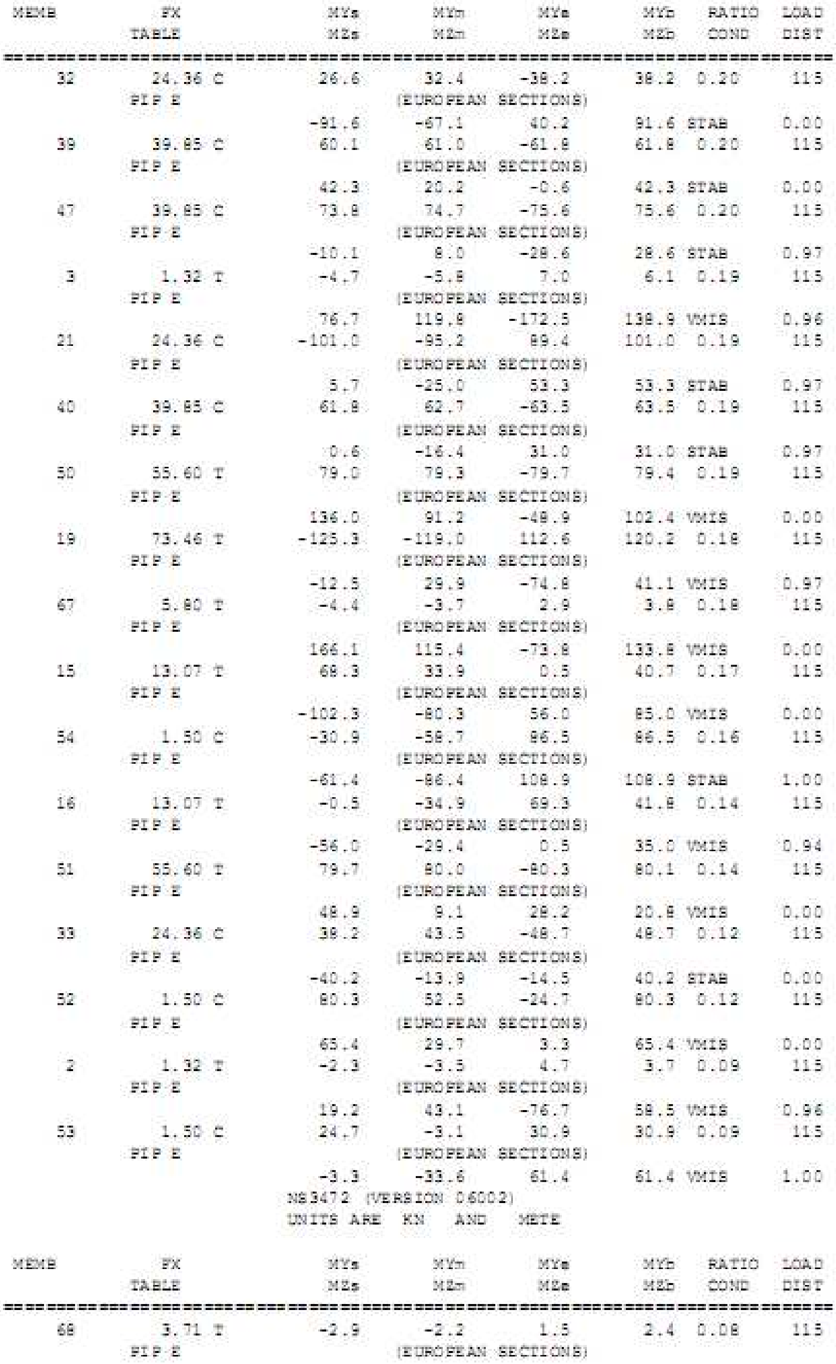

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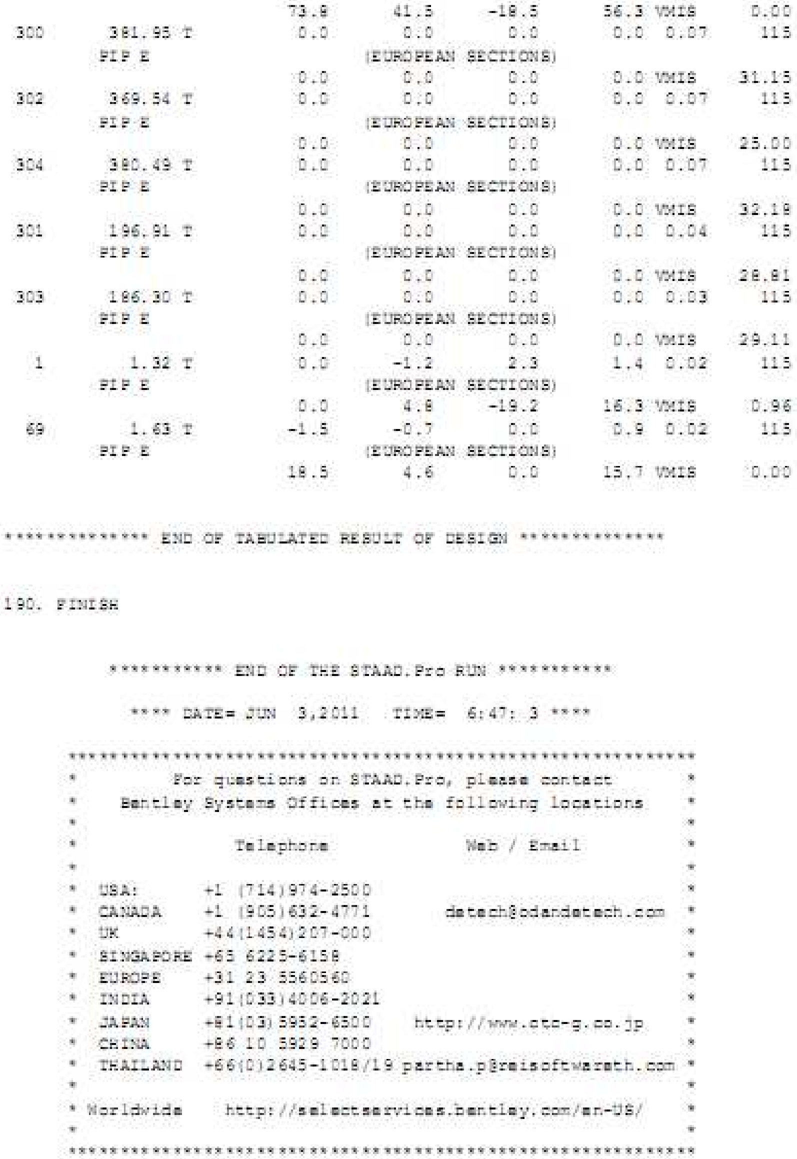
 MEMB          FX                MYs        MYn        MYe        MYb   RATIO  LOAD
             TABLE               MZs        MZn        MZe        MZb   COND   DIST
=====================================================================================
     32     24.36 C             26.6       32.4      -38.2       38.2  0.20     115
           PIP E                      (EUROPEAN SECTIONS)
                               -91.6      -67.1       40.2       91.6 STAB     0.00
     39     39.85 C             60.1       61.0      -61.8       61.8  0.20     115
           PIP E                      (EUROPEAN SECTIONS)
                                42.3       20.2       -0.6       42.3 STAB     0.00
     47     39.85 C             73.8       74.7      -75.6       75.6  0.20     115
           PIP E                      (EUROPEAN SECTIONS)
                               -10.1        8.0      -28.6       28.6 STAB     0.97
      3      1.32 T             -4.7       -5.8        7.0        6.1  0.19     115
           PIP E                      (EUROPEAN SECTIONS)
                                76.7      119.8     -172.5      138.9 VMIS     0.96
     21     24.36 C           -101.0      -95.2       89.4      101.0  0.19     115
           PIP E                      (EUROPEAN SECTIONS)
                                 5.7      -25.0       53.3       53.3 STAB     0.97
     40     39.85 C             61.8       62.7      -63.5       63.5  0.19     115
           PIP E                      (EUROPEAN SECTIONS)
                                 0.6      -16.4       31.0       31.0 STAB     0.97
     50     55.60 T             79.0       79.3      -79.7       79.4  0.19     115
           PIP E                      (EUROPEAN SECTIONS)
                               136.0       91.2      -48.9      102.4 VMIS     0.00
     19     73.46 T           -125.3     -119.0      112.6      120.2  0.18     115
           PIP E                      (EUROPEAN SECTIONS)
                               -12.5       29.9      -74.8       41.1 VMIS     0.97
     67      5.80 T             -4.4       -3.7        2.9        3.8  0.18     115
           PIP E                      (EUROPEAN SECTIONS)
                               166.1      115.4      -73.8      133.8 VMIS     0.00
     15     13.07 T             68.3       33.9        0.5       40.7  0.17     115
           PIP E                      (EUROPEAN SECTIONS)
                              -102.3      -80.3       56.0       85.0 VMIS     0.00
     54      1.50 C            -30.9      -58.7       86.5       86.5  0.16     115
           PIP E                      (EUROPEAN SECTIONS)
                               -61.4      -86.4      108.9      108.9 STAB     1.00
     16     13.07 T             -0.5      -34.9       69.3       41.8  0.14     115
           PIP E                      (EUROPEAN SECTIONS)
                               -56.0      -29.4        0.5       35.0 VMIS     0.94
     51     55.60 T             79.7       80.0      -80.3       80.1  0.14     115
           PIP E                      (EUROPEAN SECTIONS)
                                48.9        9.1       28.2       20.8 VMIS     0.00
     33     24.36 C             38.2       43.5      -48.7       48.7  0.12     115
           PIP E                      (EUROPEAN SECTIONS)
                               -40.2      -13.9      -14.5       40.2 STAB     0.00
     52      1.50 C             80.3       52.5      -24.7       80.3  0.12     115
           PIP E                      (EUROPEAN SECTIONS)
                                65.4       29.7        3.3       65.4 VMIS     0.00
      2      1.32 T             -2.3       -3.5        4.7        3.7  0.09     115
           PIP E                      (EUROPEAN SECTIONS)
                                19.2       43.1      -76.7       58.5 VMIS     0.96
     53      1.50 C             24.7       -3.1       30.9       30.9  0.09     115
           PIP E                      (EUROPEAN SECTIONS)
                                -3.3      -33.6       61.4       61.4 VMIS     1.00
                             NS3472 (VERSION 06002)
                             UNITS ARE  KN   AND   METE

 MEMB          FX                MYs        MYn        MYe        MYb   RATIO  LOAD
             TABLE               MZs        MZn        MZe        MZb   COND   DIST
=====================================================================================
     68      3.71 T             -2.9       -2.2        1.5        2.4  0.08     115
           PIP E                      (EUROPEAN SECTIONS)
```



```
                              73.8       41.5      -18.5       56.3 VMIS     0.00
  300      381.95 T            0.0        0.0        0.0        0.0  0.07     115
          PIPE                         (EUROPEAN SECTIONS)
                               0.0        0.0        0.0        0.0 VMIS    31.15
  302      369.54 T            0.0        0.0        0.0        0.0  0.07     115
          PIPE                         (EUROPEAN SECTIONS)
                               0.0        0.0        0.0        0.0 VMIS    25.00
  304      380.49 T            0.0        0.0        0.0        0.0  0.07     115
          PIPE                         (EUROPEAN SECTIONS)
                               0.0        0.0        0.0        0.0 VMIS    32.19
  301      196.91 T            0.0        0.0        0.0        0.0  0.04     115
          PIPE                         (EUROPEAN SECTIONS)
                               0.0        0.0        0.0        0.0 VMIS    28.81
  303      186.30 T            0.0        0.0        0.0        0.0  0.03     115
          PIPE                         (EUROPEAN SECTIONS)
                               0.0        0.0        0.0        0.0 VMIS    29.11
    1        1.32 T            0.0       -1.2        2.3        1.4  0.02     115
          PIPE                         (EUROPEAN SECTIONS)
                               0.0        4.8      -19.2       16.3 VMIS     0.96
   69        1.63 T           -1.5       -0.7        0.0        0.9  0.02     115
          PIPE                         (EUROPEAN SECTIONS)
                              18.5        4.6        0.0       15.7 VMIS     0.00


************** END OF TABULATED RESULT OF DESIGN **************

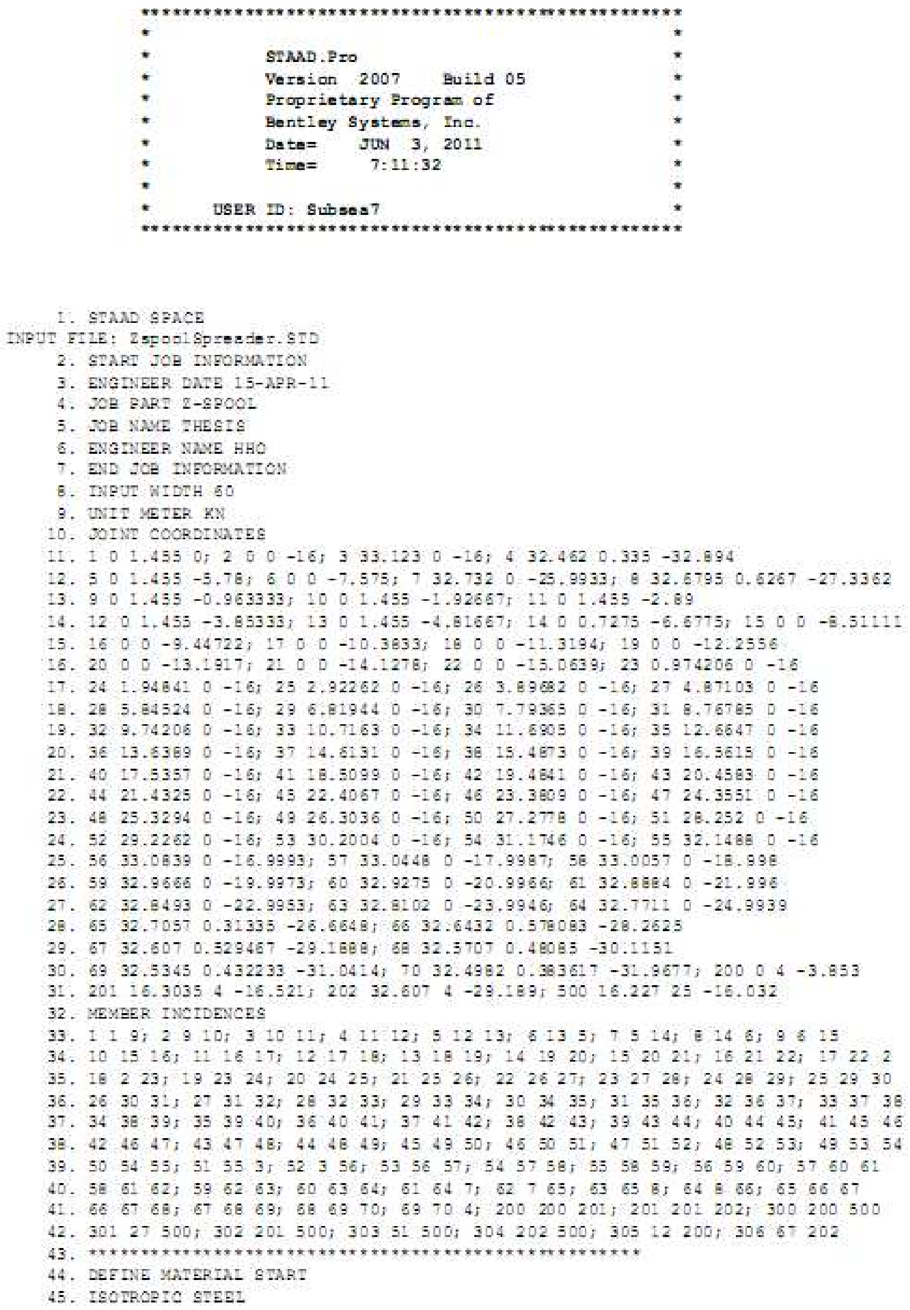

190. FINISH


          *********** END OF THE STAAD.Pro RUN ***********

            **** DATE= JUN  3,2011   TIME=  6:47: 3 ****

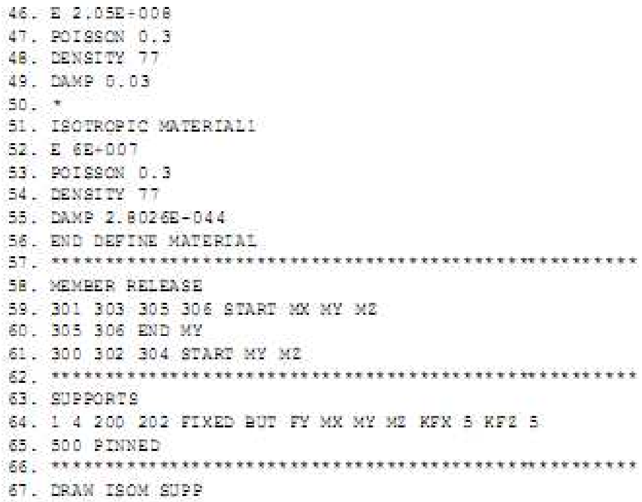
      ************************************************************
      *          For questions on STAAD.Pro, please contact      *
      *     Bentley Systems Offices at the following locations   *
      *                                                          *
      *                Telephone              Web / Email        *
      *                                                          *
      *  USA:        +1  (714)974-2500                           *
      *  CANADA      +1  (905)632-4771      detech@odandetech.com *
      *  UK          +44(1454)207-000                            *
      *  SINGAPORE +65 6225-6158                                 *
      *  EUROPE      +31 23 5560560                              *
      *  INDIA       +91(033)4006-2021                           *
      *  JAPAN       +81(03)5952-6500    http://www.ctc-g.co.jp  *
      *  CHINA       +86 10 5929 7000                            *
      *  THAILAND   +66(0)2645-1018/19 partha.p@reisoftwareth.com *
      *                                                          *
      * Worldwide    http://selectservices.bentley.com/en-US/    *
      *                                                          *
      ************************************************************
```

9.8 Staad.Pro outprint, spreader case

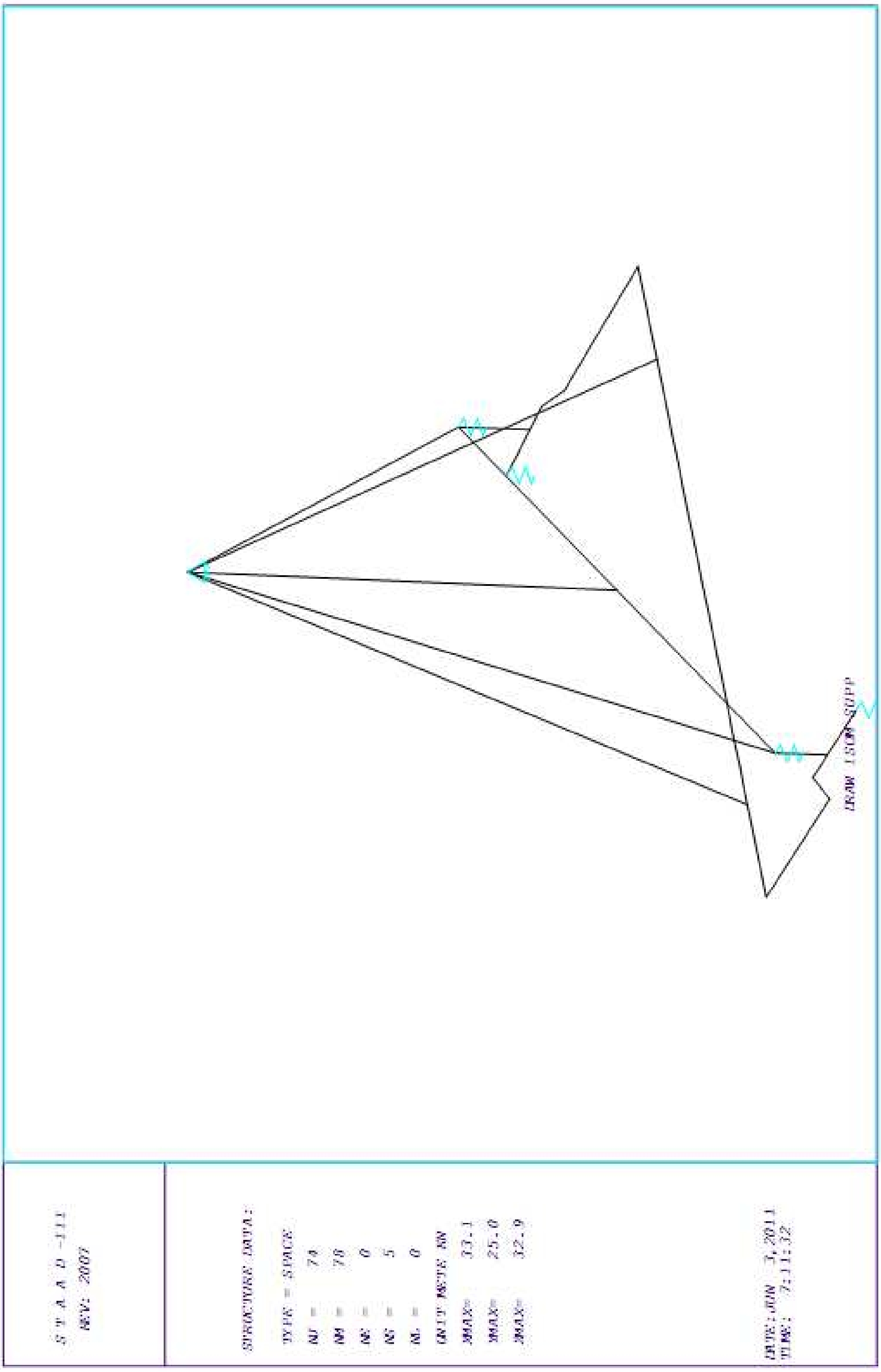


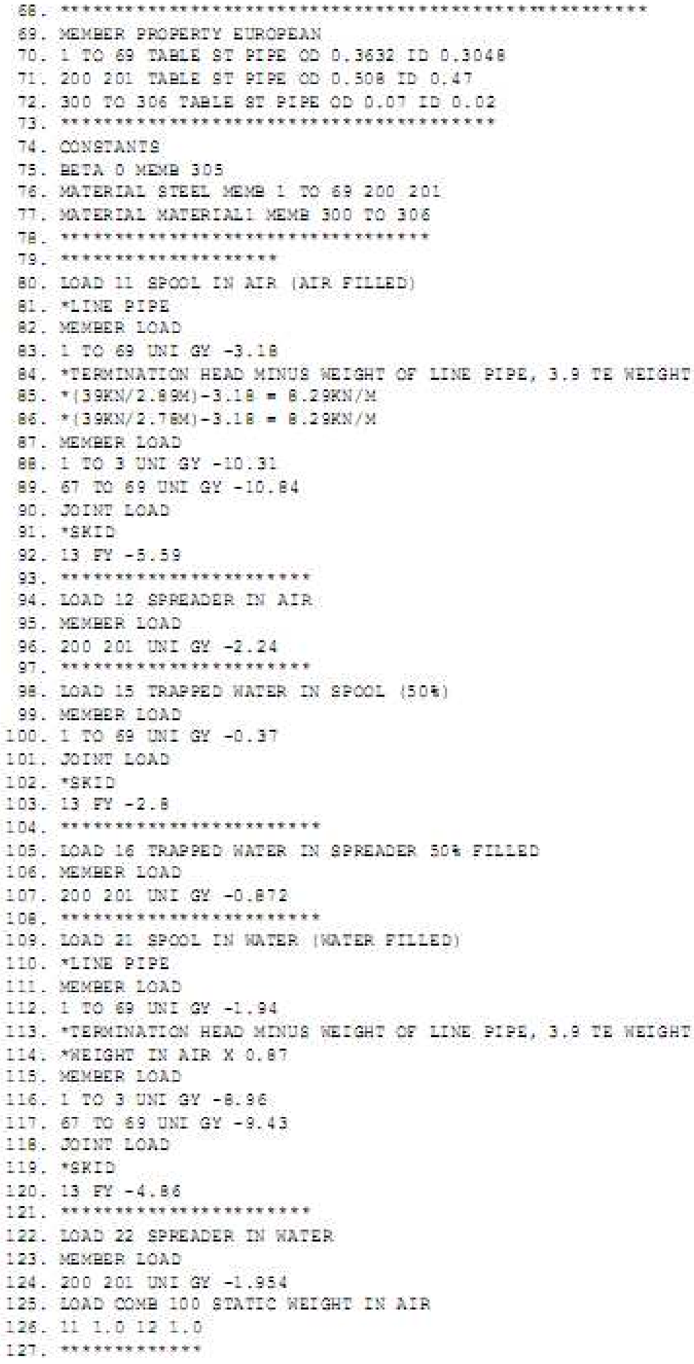
```
****************************************************
*                                                  *
*           STAAD.Pro                              *
*           Version  2007     Build 05             *
*           Proprietary Program of                 *
*           Bentley Systems, Inc.                  *
*           Date=    JUN  3, 2011                  *
*           Time=     7:11:32                      *
*                                                  *
*      USER ID: Subsea7                            *
****************************************************


      1. STAAD SPACE
INPUT FILE: ZspoolSpreader.STD
      2. START JOB INFORMATION
      3. ENGINEER DATE 15-APR-11
      4. JOB PART Z-SPOOL
      5. JOB NAME THESIS
      6. ENGINEER NAME HHO
      7. END JOB INFORMATION
      8. INPUT WIDTH 60
      9. UNIT METER KN
     10. JOINT COORDINATES
     11. 1 0 1.455 0; 2 0 0 -16; 3 33.123 0 -16; 4 32.462 0.335 -32.894
     12. 5 0 1.455 -5.78; 6 0 0 -7.575; 7 32.732 0 -25.9933; 8 32.6795 0.6267 -27.3362
     13. 9 0 1.455 -0.963333; 10 0 1.455 -1.92667; 11 0 1.455 -2.89
     14. 12 0 1.455 -3.85333; 13 0 1.455 -4.81667; 14 0 0.7275 -6.6775; 15 0 0 -8.51111
     15. 16 0 0 -9.44722; 17 0 0 -10.3833; 18 0 0 -11.3194; 19 0 0 -12.2556
     16. 20 0 0 -13.1917; 21 0 0 -14.1278; 22 0 0 -15.0639; 23 0.974206 0 -16
     17. 24 1.94841 0 -16; 25 2.92262 0 -16; 26 3.89682 0 -16; 27 4.87103 0 -16
     18. 28 5.84524 0 -16; 29 6.81944 0 -16; 30 7.79365 0 -16; 31 8.76785 0 -16
     19. 32 9.74206 0 -16; 33 10.7163 0 -16; 34 11.6905 0 -16; 35 12.6647 0 -16
     20. 36 13.6389 0 -16; 37 14.6131 0 -16; 38 15.4873 0 -16; 39 16.5615 0 -16
     21. 40 17.5357 0 -16; 41 18.5099 0 -16; 42 19.4841 0 -16; 43 20.4583 0 -16
     22. 44 21.4325 0 -16; 45 22.4067 0 -16; 46 23.3809 0 -16; 47 24.3551 0 -16
     23. 48 25.3294 0 -16; 49 26.3036 0 -16; 50 27.2778 0 -16; 51 28.252 0 -16
     24. 52 29.2262 0 -16; 53 30.2004 0 -16; 54 31.1746 0 -16; 55 32.1488 0 -16
     25. 56 33.0839 0 -16.9993; 57 33.0448 0 -17.9987; 58 33.0057 0 -18.998
     26. 59 32.9666 0 -19.9973; 60 32.9275 0 -20.9966; 61 32.8884 0 -21.996
     27. 62 32.8493 0 -22.9953; 63 32.8102 0 -23.9946; 64 32.7711 0 -24.9939
     28. 65 32.7057 0.31335 -26.6648; 66 32.6432 0.578083 -28.2625
     29. 67 32.607 0.529467 -29.1888; 68 32.5707 0.48085 -30.1151
     30. 69 32.5345 0.432233 -31.0414; 70 32.4982 0.383617 -31.9677; 200 0 4 -3.853
     31. 201 16.3035 4 -16.521; 202 32.607 4 -29.189; 500 16.227 25 -16.032
     32. MEMBER INCIDENCES
     33. 1 1 9; 2 9 10; 3 10 11; 4 11 12; 5 12 13; 6 13 5; 7 5 14; 8 14 6; 9 6 15
     34. 10 15 16; 11 16 17; 12 17 18; 13 18 19; 14 19 20; 15 20 21; 16 21 22; 17 22 2
     35. 18 2 23; 19 23 24; 20 24 25; 21 25 26; 22 26 27; 23 27 28; 24 28 29; 25 29 30
     36. 26 30 31; 27 31 32; 28 32 33; 29 33 34; 30 34 35; 31 35 36; 32 36 37; 33 37 38
     37. 34 38 39; 35 39 40; 36 40 41; 37 41 42; 38 42 43; 39 43 44; 40 44 45; 41 45 46
     38. 42 46 47; 43 47 48; 44 48 49; 45 49 50; 46 50 51; 47 51 52; 48 52 53; 49 53 54
     39. 50 54 55; 51 55 3; 52 3 56; 53 56 57; 54 57 58; 55 58 59; 56 59 60; 57 60 61
     40. 58 61 62; 59 62 63; 60 63 64; 61 64 7; 62 7 65; 63 65 8; 64 8 66; 65 66 67
     41. 66 67 68; 67 68 69; 68 69 70; 69 70 4; 200 200 201; 201 201 202; 300 200 500
     42. 301 27 500; 302 201 500; 303 51 500; 304 202 500; 305 12 200; 306 67 202
     43. ******************************************************
     44. DEFINE MATERIAL START
     45. ISOTROPIC STEEL
```

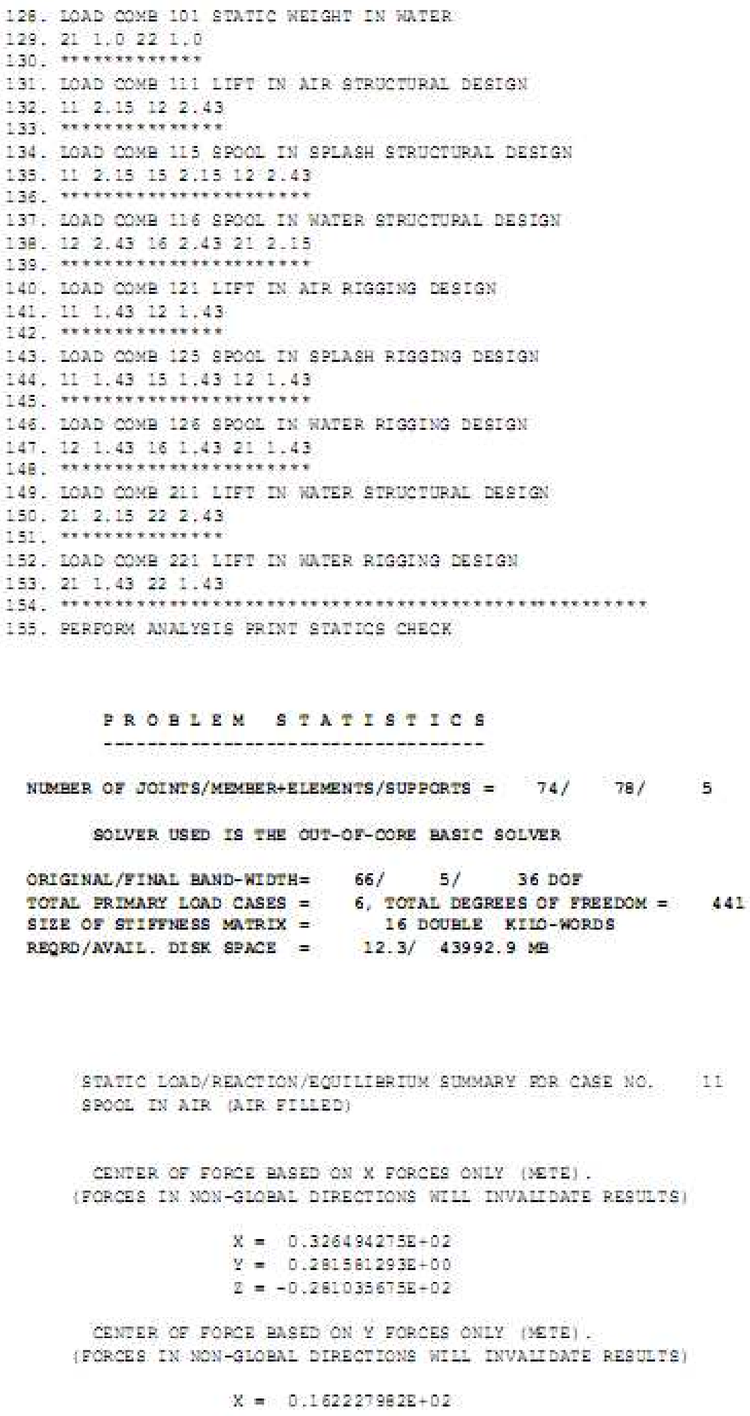


```
46. E 2.05E+008
47. POISSON 0.3
48. DENSITY 77
49. DAMP 0.03
50. *
51. ISOTROPIC MATERIAL1
52. E 6E+007
53. POISSON 0.3
54. DENSITY 77
55. DAMP 2.8026E-044
56. END DEFINE MATERIAL
57. *******************************************************
58. MEMBER RELEASE
59. 301 303 305 306 START MX MY MZ
60. 305 306 END MY
61. 300 302 304 START MY MZ
62. *******************************************************
63. SUPPORTS
64. 1 4 200 202 FIXED BUT FY MX MY MZ KFX 5 KFZ 5
65. 500 PINNED
66. *******************************************************
67. DRAW ISOM SUPP
```


DRAW ISOM SUPP
S T A A D -III
REV: 2007
STRUCTURE DATA:
TYPE = SPACE
NJ = 74
NM = 78
NP = 0
NS = 5
NL = 0
UNIT METE KN
XMAX= 33.1
YMAX= 25.0
ZMAX= 32.9
DATE: JUN 3,2011
TIME: 7:11:32



```
 68. ********************************************************
 69. MEMBER PROPERTY EUROPEAN
 70. 1 TO 69 TABLE ST PIPE OD 0.3632 ID 0.3048
 71. 200 201 TABLE ST PIPE OD 0.508 ID 0.47
 72. 300 TO 306 TABLE ST PIPE OD 0.07 ID 0.02
 73. ****************************************
 74. CONSTANTS
 75. BETA 0 MEMB 305
 76. MATERIAL STEEL MEMB 1 TO 69 200 201
 77. MATERIAL MATERIAL1 MEMB 300 TO 306
 78. ***********************************
 79. ********************
 80. LOAD 11 SPOOL IN AIR (AIR FILLED)
 81. *LINE PIPE
 82. MEMBER LOAD
 83. 1 TO 69 UNI GY -3.18
 84. *TERMINATION HEAD MINUS WEIGHT OF LINE PIPE, 3.9 TE WEIGHT
 85. *(39KN/2.89M)-3.18 = 8.29KN/M
 86. *(39KN/2.78M)-3.18 = 8.29KN/M
 87. MEMBER LOAD
 88. 1 TO 3 UNI GY -10.31
 89. 67 TO 69 UNI GY -10.84
 90. JOINT LOAD
 91. *SKID
 92. 13 FY -5.59
 93. ***********************
 94. LOAD 12 SPREADER IN AIR
 95. MEMBER LOAD
 96. 200 201 UNI GY -2.24
 97. ***********************
 98. LOAD 15 TRAPPED WATER IN SPOOL (50%)
 99. MEMBER LOAD
100. 1 TO 69 UNI GY -0.37
101. JOINT LOAD
102. *SKID
103. 13 FY -2.8
104. ************************
105. LOAD 16 TRAPPED WATER IN SPREADER 50% FILLED
106. MEMBER LOAD
107. 200 201 UNI GY -0.872
108. ************************
109. LOAD 21 SPOOL IN WATER (WATER FILLED)
110. *LINE PIPE
111. MEMBER LOAD
112. 1 TO 69 UNI GY -1.94
113. *TERMINATION HEAD MINUS WEIGHT OF LINE PIPE, 3.9 TE WEIGHT
114. *WEIGHT IN AIR X 0.87
115. MEMBER LOAD
116. 1 TO 3 UNI GY -8.96
117. 67 TO 69 UNI GY -9.43
118. JOINT LOAD
119. *SKID
120. 13 FY -4.86
121. ***********************
122. LOAD 22 SPREADER IN WATER
123. MEMBER LOAD
124. 200 201 UNI GY -1.954
125. LOAD COMB 100 STATIC WEIGHT IN AIR
126. 11 1.0 12 1.0
127. *************
```



```
128. LOAD COMB 101 STATIC WEIGHT IN WATER
129. 21 1.0 22 1.0
130. *************
131. LOAD COMB 111 LIFT IN AIR STRUCTURAL DESIGN
132. 11 2.15 12 2.43
133. ***************
134. LOAD COMB 115 SPOOL IN SPLASH STRUCTURAL DESIGN
135. 11 2.15 15 2.15 12 2.43
136. ***********************
137. LOAD COMB 116 SPOOL IN WATER STRUCTURAL DESIGN
138. 12 2.43 16 2.43 21 2.15
139. ***********************
140. LOAD COMB 121 LIFT IN AIR RIGGING DESIGN
141. 11 1.43 12 1.43
142. ***************
143. LOAD COMB 125 SPOOL IN SPLASH RIGGING DESIGN
144. 11 1.43 15 1.43 12 1.43
145. ***********************
146. LOAD COMB 126 SPOOL IN WATER RIGGING DESIGN
147. 12 1.43 16 1.43 21 1.43
148. ***********************
149. LOAD COMB 211 LIFT IN WATER STRUCTURAL DESIGN
150. 21 2.15 22 2.43
151. ***************
152. LOAD COMB 221 LIFT IN WATER RIGGING DESIGN
153. 21 1.43 22 1.43
154. ******************************************************
155. PERFORM ANALYSIS PRINT STATICS CHECK


        P R O B L E M   S T A T I S T I C S
        -----------------------------------

  NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =    74/    78/     5

       SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

  ORIGINAL/FINAL BAND-WIDTH=    66/     5/     36 DOF
  TOTAL PRIMARY LOAD CASES =    6, TOTAL DEGREES OF FREEDOM =    441
  SIZE OF STIFFNESS MATRIX =       16 DOUBLE  KILO-WORDS
  REQRD/AVAIL. DISK SPACE  =     12.3/  43992.9 MB



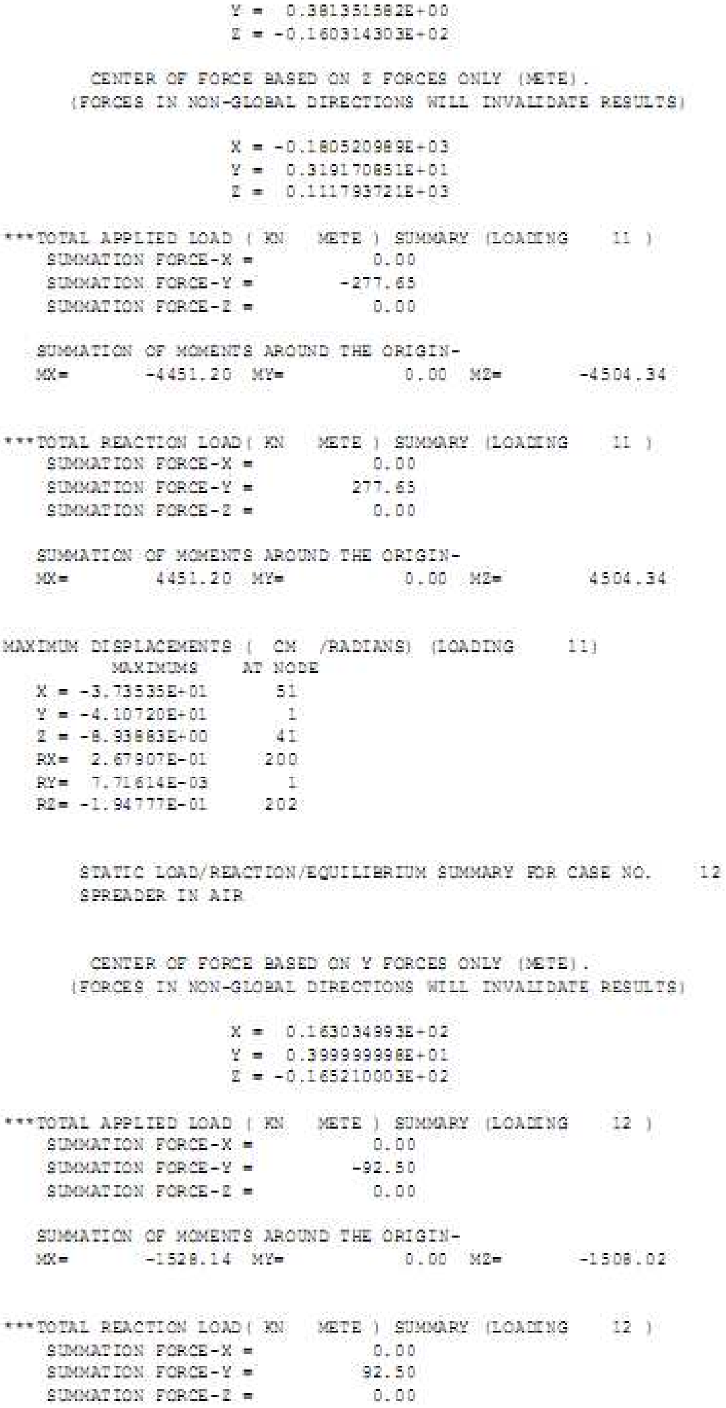

      STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    11
      SPOOL IN AIR (AIR FILLED)


       CENTER OF FORCE BASED ON X FORCES ONLY (METE).
     (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                    X =  0.326494275E+02
                    Y =  0.281581293E+00
                    Z = -0.281035675E+02

       CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
     (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                    X =  0.162227982E+02
```



```
                    Y =  0.381351582E+00
                    Z = -0.160314303E+02

       CENTER OF FORCE BASED ON Z FORCES ONLY (METE).
     (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                    X = -0.180520989E+03
                    Y =  0.319170851E+01
                    Z =  0.111793721E+03

***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    11 )
    SUMMATION FORCE-X =          0.00
    SUMMATION FORCE-Y =       -277.65
    SUMMATION FORCE-Z =          0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=      -4451.20  MY=          0.00  MZ=      -4504.34


***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    11 )
    SUMMATION FORCE-X =          0.00
    SUMMATION FORCE-Y =        277.65
    SUMMATION FORCE-Z =          0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=       4451.20  MY=          0.00  MZ=       4504.34


MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     11)
         MAXIMUMS    AT NODE
   X = -3.73535E+01      51
   Y = -4.10720E+01       1
   Z = -8.93863E+00      41
   RX=  2.67907E-01     200
   RY=  7.71614E-03       1
   RZ= -1.94777E-01     202


      STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    12
      SPREADER IN AIR

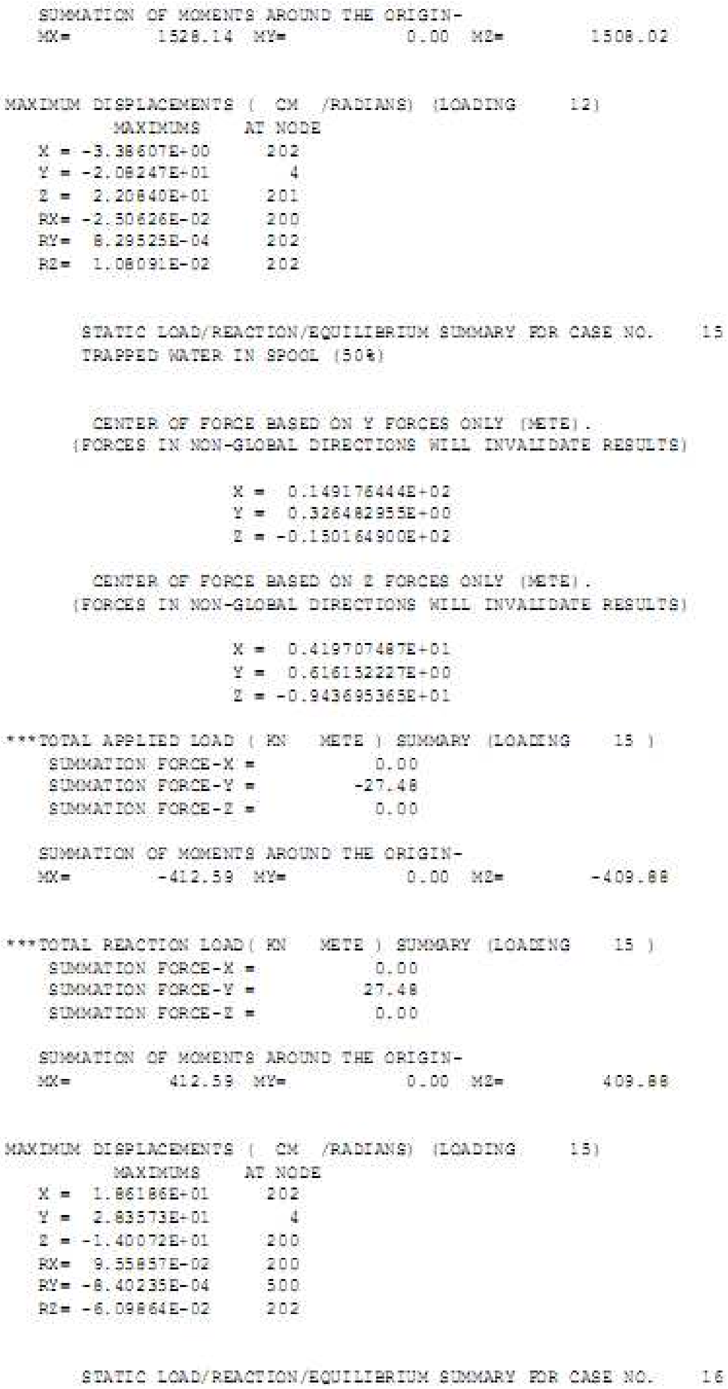

       CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
     (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                    X =  0.163034993E+02
                    Y =  0.399999998E+01
                    Z = -0.165210003E+02

***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    12 )
    SUMMATION FORCE-X =          0.00
    SUMMATION FORCE-Y =        -92.50
    SUMMATION FORCE-Z =          0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=      -1528.14  MY=          0.00  MZ=      -1508.02


***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    12 )
    SUMMATION FORCE-X =          0.00
    SUMMATION FORCE-Y =         92.50
    SUMMATION FORCE-Z =          0.00
```



```
   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=       1528.14  MY=          0.00  MZ=       1508.02


MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     12)
         MAXIMUMS    AT NODE
   X = -3.38607E-00     202
   Y = -2.08247E+01       4
   Z =  2.20840E+01     201
   RX= -2.50626E-02     200
   RY=  8.29525E-04     202
   RZ=  1.08091E-02     202


       STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    15
       TRAPPED WATER IN SPOOL (50%)


        CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
      (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.149176444E+02
                     Y =  0.326482955E+00
                     Z = -0.150164900E+02

        CENTER OF FORCE BASED ON Z FORCES ONLY (METE).
      (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.419707487E+01
                     Y =  0.616132227E+00
                     Z = -0.943695365E+01

***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    15 )
    SUMMATION FORCE-X =          0.00
    SUMMATION FORCE-Y =        -27.48
    SUMMATION FORCE-Z =          0.00

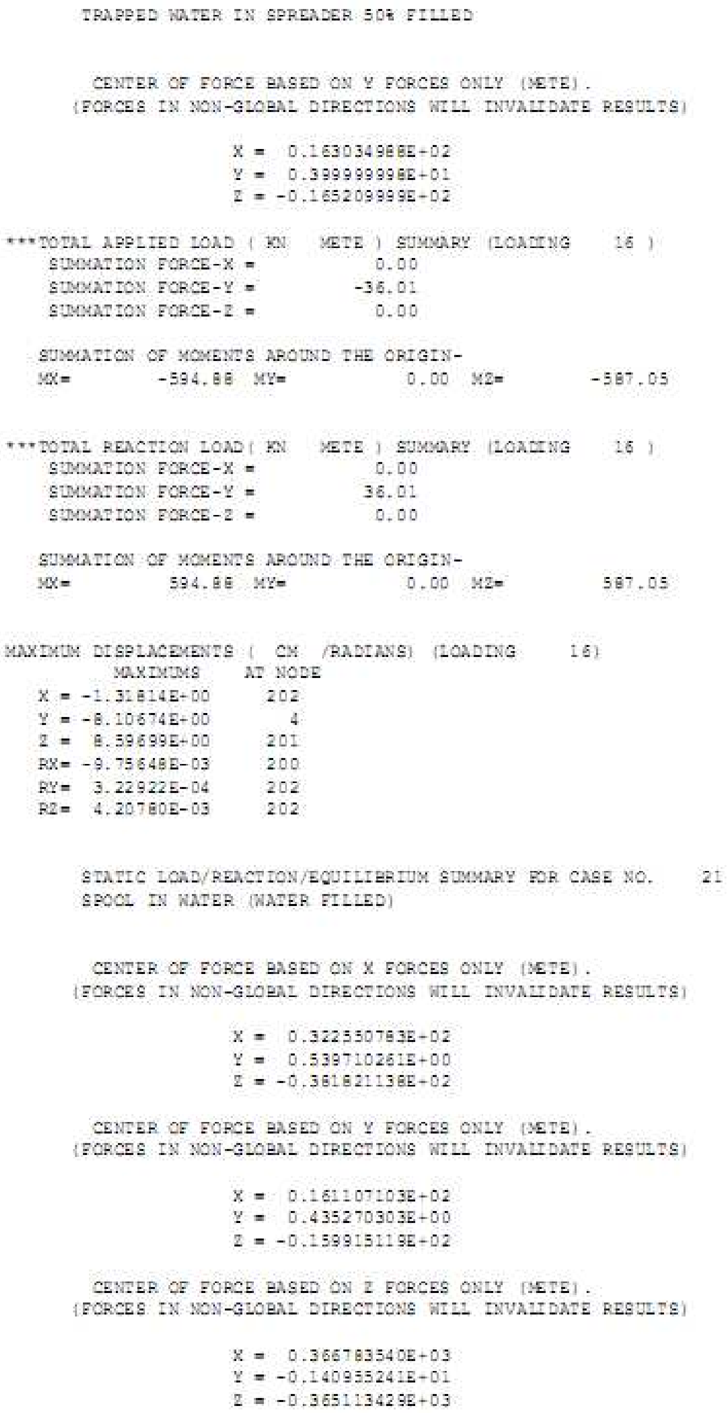
   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=       -412.59  MY=          0.00  MZ=       -409.88


***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    15 )
    SUMMATION FORCE-X =          0.00
    SUMMATION FORCE-Y =         27.48
    SUMMATION FORCE-Z =          0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=        412.59  MY=          0.00  MZ=        409.88


MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     15)
         MAXIMUMS    AT NODE
   X =  1.86186E+01     202
   Y =  2.83573E+01       4
   Z = -1.40072E+01     200
   RX=  9.55857E-02     200
   RY= -8.40235E-04     500
   RZ= -6.09864E-02     202


       STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    16
```



```
        TRAPPED WATER IN SPREADER 50% FILLED


         CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
        (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                       X =  0.163034988E+02
                       Y =  0.399999998E+01
                       Z = -0.165209999E+02

***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    16 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =         -36.01
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=        -594.88  MY=           0.00  MZ=        -587.05


***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    16 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =          36.01
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=         594.88  MY=           0.00  MZ=         587.05


MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     16)
          MAXIMUMS    AT NODE
   X = -1.31814E+00     202
   Y = -8.10674E+00       4
   Z =  8.59699E+00     201
   RX= -9.75648E-03     200
   RY=  3.22922E-04     202
   RZ=  4.20780E-03     202


        STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    21
        SPOOL IN WATER (WATER FILLED)


         CENTER OF FORCE BASED ON X FORCES ONLY (METE).
        (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

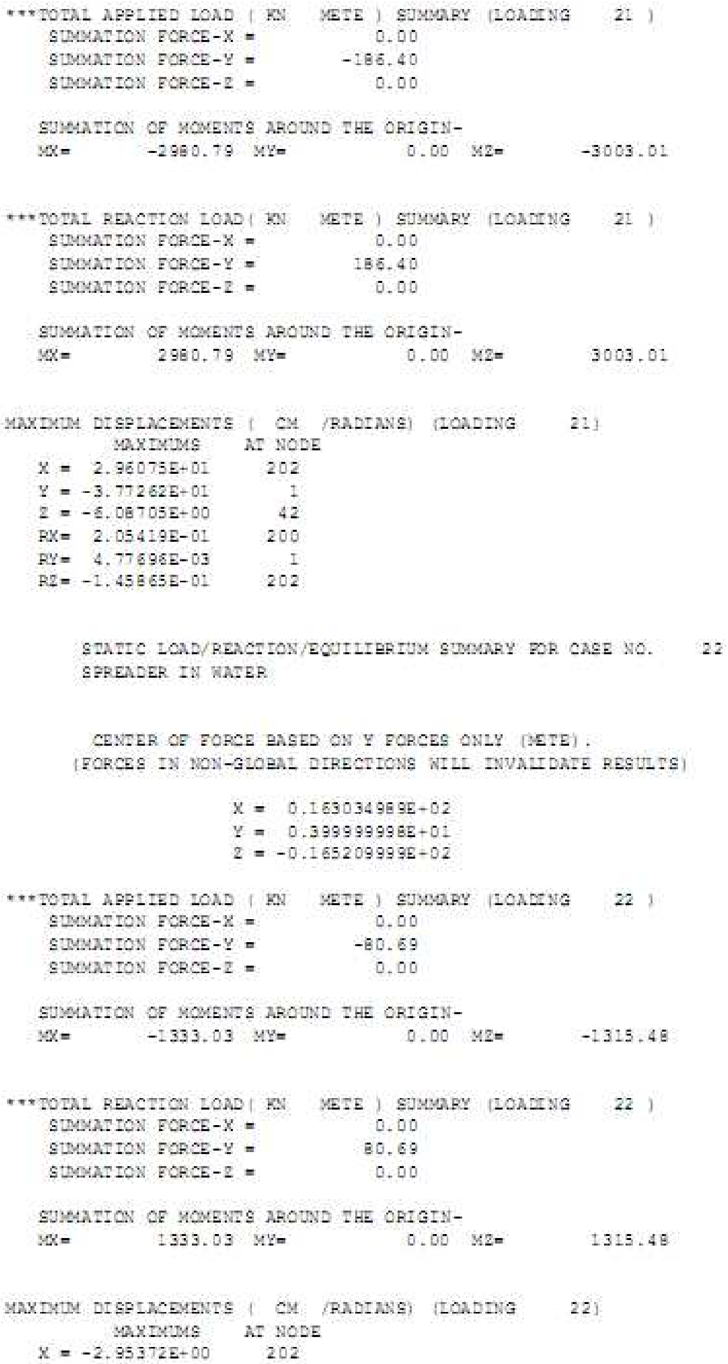
                       X =  0.322530783E+02
                       Y =  0.539710261E+00
                       Z = -0.361821138E+02

         CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
        (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                       X =  0.161107103E+02
                       Y =  0.435270303E+00
                       Z = -0.159915119E+02

         CENTER OF FORCE BASED ON Z FORCES ONLY (METE).
        (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                       X =  0.366783540E+03
                       Y = -0.140935241E+01
                       Z = -0.365113429E+03
```



```
***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    21 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =        -186.40
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=       -2980.79  MY=           0.00  MZ=       -3003.01


***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    21 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =         186.40
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=        2980.79  MY=           0.00  MZ=        3003.01


MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     21)
          MAXIMUMS    AT NODE
   X =  2.96075E+01     202
   Y = -3.77262E+01       1
   Z = -6.08705E+00      42
   RX=  2.05419E-01     200
   RY=  4.77696E-03       1
   RZ= -1.45865E-01     202


       STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO.    22
       SPREADER IN WATER


        CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
      (FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)

                     X =  0.163034989E-02
                     Y =  0.399999998E+01
                     Z = -0.165209999E+02

***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    22 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =         -80.69
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=       -1333.03  MY=           0.00  MZ=       -1315.48


***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    22 )
    SUMMATION FORCE-X =           0.00
    SUMMATION FORCE-Y =          80.69
    SUMMATION FORCE-Z =           0.00

   SUMMATION OF MOMENTS AROUND THE ORIGIN-
   MX=        1333.03  MY=           0.00  MZ=        1315.48


MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING     22)
          MAXIMUMS    AT NODE
   X = -2.95372E+00     202
```

```
    Z =  1.92644E+01     201
    RX= -2.18626E-02     200
    RY=  7.23612E-04     202
    RZ=  9.42895E-03     202


 ************ END OF DATA FROM INTERNAL STORAGE ************


 156. PRINT MEMBER FORCES LIST 300 TO 306

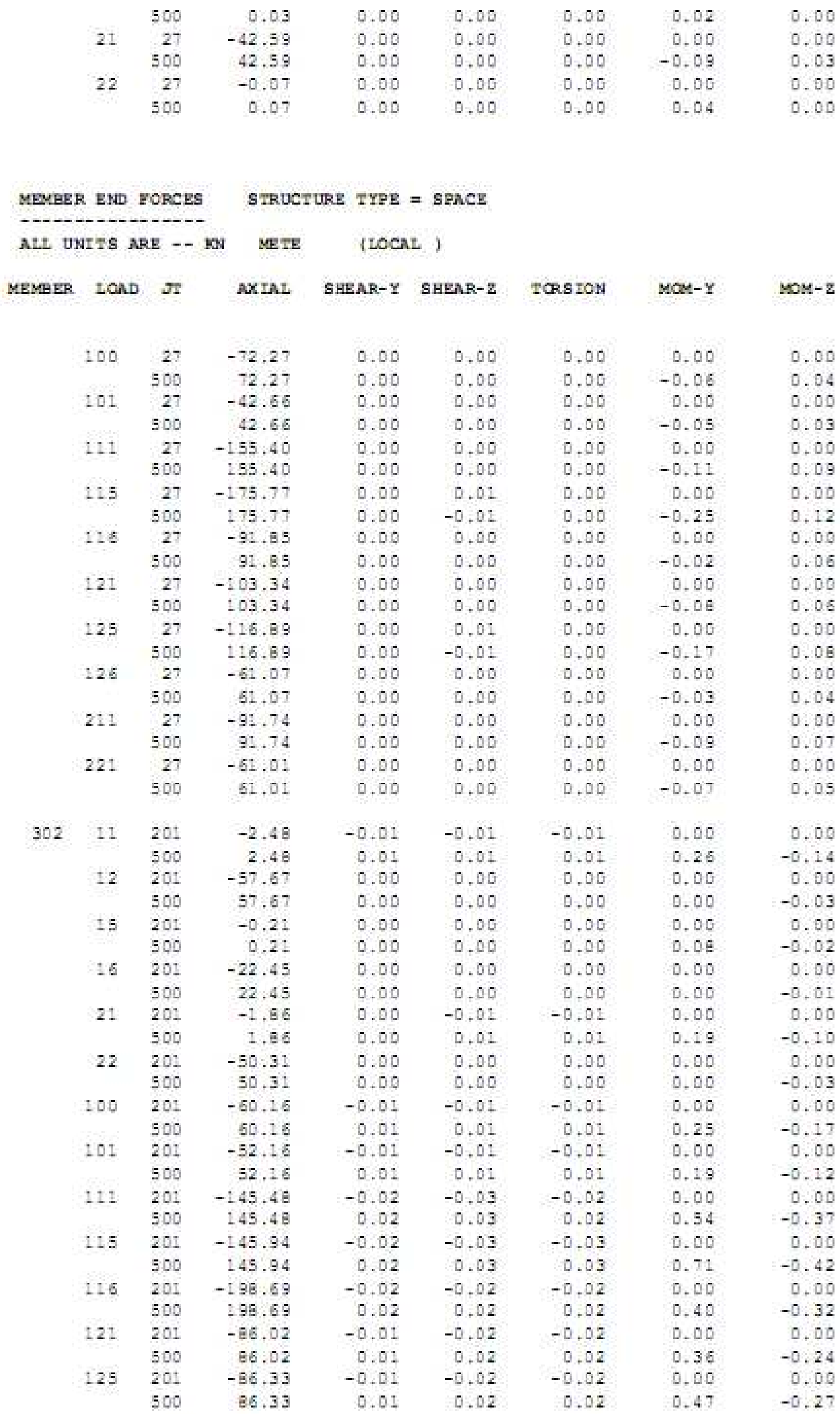

 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- KN   METE     (LOCAL )

MEMBER  LOAD  JT      AXIAL  SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z



   300   11   200   -101.68     0.00     0.01      0.40      0.00       0.00
              500    101.68     0.00    -0.01     -0.40     -0.15      -0.06
         12   200    -24.12     0.00     0.00     -0.02      0.00       0.00
              500     24.12     0.00     0.00      0.02     -0.01       0.02
         15   200     -8.77     0.00     0.00      0.14      0.00       0.00
              500      8.77     0.00     0.00     -0.14     -0.04      -0.03
         16   200     -9.39     0.00     0.00     -0.01      0.00       0.00
              500      9.39     0.00     0.00      0.01      0.00       0.01
         21   200    -76.36     0.00     0.00      0.31      0.00       0.00
              500     76.36     0.00     0.00     -0.31     -0.11      -0.05
         22   200    -21.04     0.00     0.00     -0.02      0.00       0.00
              500     21.04     0.00     0.00      0.02     -0.01       0.01
        100   200   -125.80     0.00     0.01      0.38      0.00       0.00
              500    125.80     0.00    -0.01     -0.38     -0.16      -0.04
        101   200    -97.41     0.00     0.00      0.28      0.00       0.00
              500     97.41     0.00     0.00     -0.28     -0.12      -0.03
        111   200   -277.23     0.00     0.01      0.80      0.00       0.00
              500    277.23     0.00    -0.01     -0.80     -0.34      -0.09
        115   200   -296.08    -0.01     0.01      1.10      0.00       0.00
              500    296.08     0.01    -0.01     -1.10     -0.42      -0.15
        116   200   -245.62     0.00     0.01      0.57      0.00       0.00
              500    245.62     0.00    -0.01     -0.57     -0.26      -0.05
        121   200   -179.90     0.00     0.01      0.54      0.00       0.00
              500    179.90     0.00    -0.01     -0.54     -0.22      -0.06
        125   200   -192.43     0.00     0.01      0.73      0.00       0.00
              500    192.43     0.00    -0.01     -0.73     -0.28      -0.10
        126   200   -157.13     0.00     0.01      0.39      0.00       0.00
              500    157.13     0.00    -0.01     -0.39     -0.17      -0.04
        211   200   -215.32     0.00     0.01      0.61      0.00       0.00
              500    215.32     0.00    -0.01     -0.61     -0.25      -0.07
        221   200   -139.29     0.00     0.01      0.41      0.00       0.00
              500    139.29     0.00    -0.01     -0.41     -0.16      -0.05

   301   11    27    -72.18     0.00     0.00      0.00      0.00       0.00
              500     72.18     0.00     0.00      0.00     -0.11       0.05
         12    27     -0.08     0.00     0.00      0.00      0.00       0.00
              500      0.08     0.00     0.00      0.00      0.05       0.00
         15    27     -9.47     0.00     0.00      0.00      0.00       0.00
              500      9.47     0.00     0.00      0.00     -0.06       0.01
         16    27     -0.03     0.00     0.00      0.00      0.00       0.00
```



```
               500       0.03      0.00      0.00      0.00       0.02       0.00
          21    27     -42.59      0.00      0.00      0.00       0.00       0.00
               500      42.59      0.00      0.00      0.00      -0.09       0.03
          22    27      -0.07      0.00      0.00      0.00       0.00       0.00
               500       0.07      0.00      0.00      0.00       0.04       0.00


 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- KN   METE      (LOCAL )

MEMBER  LOAD    JT      AXIAL   SHEAR-Y   SHEAR-Z   TORSION      MOM-Y      MOM-Z


         100    27     -72.27      0.00      0.00      0.00       0.00       0.00
               500      72.27      0.00      0.00      0.00      -0.06       0.04
         101    27     -42.66      0.00      0.00      0.00       0.00       0.00
               500      42.66      0.00      0.00      0.00      -0.05       0.03
         111    27    -155.40      0.00      0.00      0.00       0.00       0.00
               500     155.40      0.00      0.00      0.00      -0.11       0.09
         115    27    -175.77      0.00      0.01      0.00       0.00       0.00
               500     175.77      0.00     -0.01      0.00      -0.25       0.12
         116    27     -91.85      0.00      0.00      0.00       0.00       0.00
               500      91.85      0.00      0.00      0.00      -0.02       0.06
         121    27    -103.34      0.00      0.00      0.00       0.00       0.00
               500     103.34      0.00      0.00      0.00      -0.08       0.06
         125    27    -116.89      0.00      0.01      0.00       0.00       0.00
               500     116.89      0.00     -0.01      0.00      -0.17       0.08
         126    27     -61.07      0.00      0.00      0.00       0.00       0.00
               500      61.07      0.00      0.00      0.00      -0.03       0.04
         211    27     -91.74      0.00      0.00      0.00       0.00       0.00
               500      91.74      0.00      0.00      0.00      -0.09       0.07
         221    27     -61.01      0.00      0.00      0.00       0.00       0.00
               500      61.01      0.00      0.00      0.00      -0.07       0.05

   302    11   201      -2.48     -0.01     -0.01     -0.01       0.00       0.00
               500       2.48      0.01      0.01      0.01       0.26      -0.14
          12   201     -57.67      0.00      0.00      0.00       0.00       0.00
               500      57.67      0.00      0.00      0.00       0.00      -0.03
          15   201      -0.21      0.00      0.00      0.00       0.00       0.00
               500       0.21      0.00      0.00      0.00       0.08      -0.02
          16   201     -22.45      0.00      0.00      0.00       0.00       0.00
               500      22.45      0.00      0.00      0.00       0.00      -0.01
          21   201      -1.86      0.00     -0.01     -0.01       0.00       0.00
               500       1.86      0.00      0.01      0.01       0.19      -0.10
          22   201     -50.31      0.00      0.00      0.00       0.00       0.00
               500      50.31      0.00      0.00      0.00       0.00      -0.03
         100   201     -60.16     -0.01     -0.01     -0.01       0.00       0.00
               500      60.16      0.01      0.01      0.01       0.25      -0.17
         101   201     -52.16     -0.01     -0.01     -0.01       0.00       0.00
               500      52.16      0.01      0.01      0.01       0.19      -0.12
         111   201    -145.48     -0.02     -0.03     -0.02       0.00       0.00
               500     145.48      0.02      0.03      0.02       0.54      -0.37
         115   201    -145.94     -0.02     -0.03     -0.03       0.00       0.00
               500     145.94      0.02      0.03      0.03       0.71      -0.42
         116   201    -198.69     -0.02     -0.02     -0.02       0.00       0.00
               500     198.69      0.02      0.02      0.02       0.40      -0.32
         121   201     -86.02     -0.01     -0.02     -0.02       0.00       0.00
               500      86.02      0.01      0.02      0.02       0.36      -0.24
         125   201     -86.33     -0.01     -0.02     -0.02       0.00       0.00
               500      86.33      0.01      0.02      0.02       0.47      -0.27
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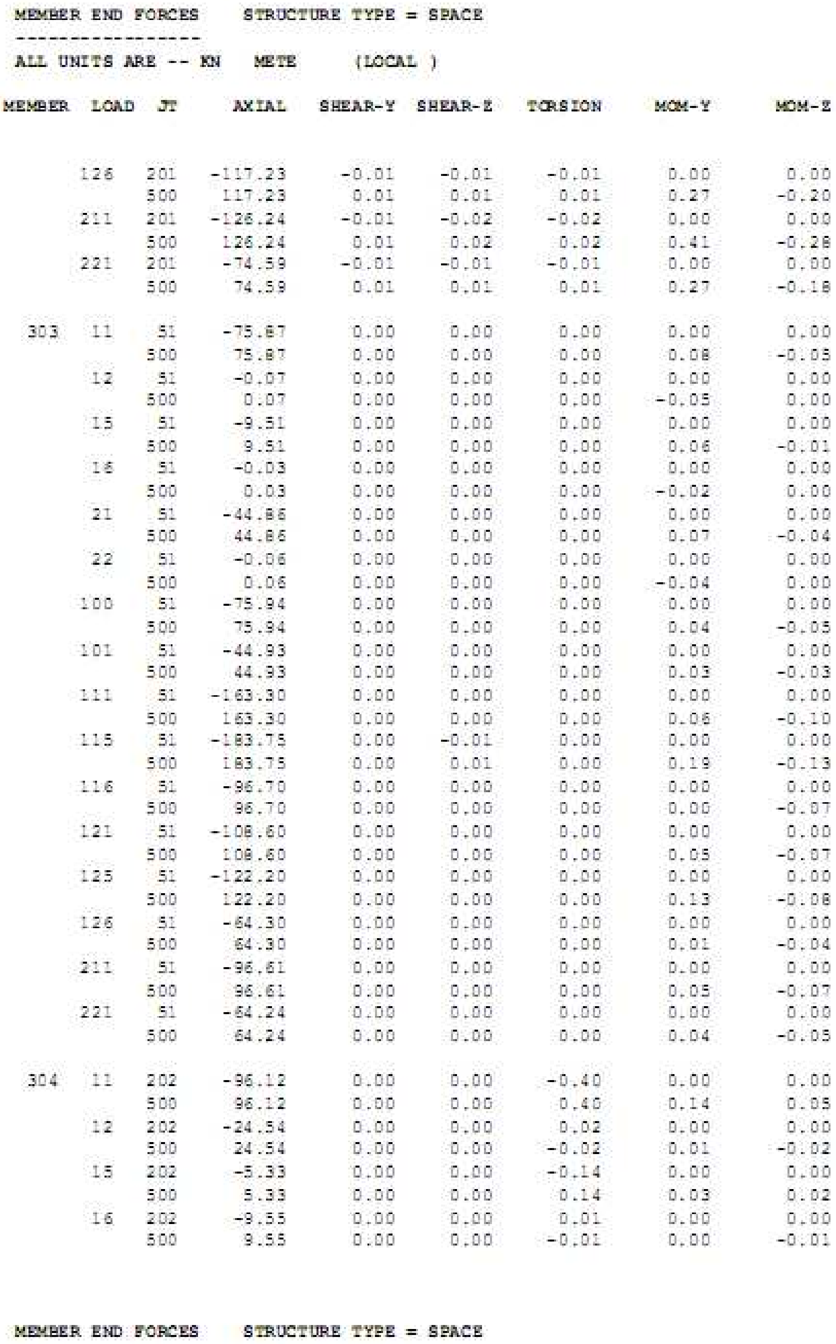

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 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- KN   METE      (LOCAL )

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


         126  201   -117.23    -0.01    -0.01     -0.01      0.00       0.00
              500    117.23     0.01     0.01      0.01      0.27      -0.20
         211  201   -126.24    -0.01    -0.02     -0.02      0.00       0.00
              500    126.24     0.01     0.02      0.02      0.41      -0.28
         221  201    -74.59    -0.01    -0.01     -0.01      0.00       0.00
              500     74.59     0.01     0.01      0.01      0.27      -0.18

   303    11   51    -75.87     0.00     0.00      0.00      0.00       0.00
              500     75.87     0.00     0.00      0.00      0.08      -0.05
          12   51     -0.07     0.00     0.00      0.00      0.00       0.00
              500      0.07     0.00     0.00      0.00     -0.05       0.00
          15   51     -9.51     0.00     0.00      0.00      0.00       0.00
              500      9.51     0.00     0.00      0.00      0.06      -0.01
          16   51     -0.03     0.00     0.00      0.00      0.00       0.00
              500      0.03     0.00     0.00      0.00     -0.02       0.00
          21   51    -44.86     0.00     0.00      0.00      0.00       0.00
              500     44.86     0.00     0.00      0.00      0.07      -0.04
          22   51     -0.06     0.00     0.00      0.00      0.00       0.00
              500      0.06     0.00     0.00      0.00     -0.04       0.00
         100   51    -75.94     0.00     0.00      0.00      0.00       0.00
              500     75.94     0.00     0.00      0.00      0.04      -0.05
         101   51    -44.93     0.00     0.00      0.00      0.00       0.00
              500     44.93     0.00     0.00      0.00      0.03      -0.03
         111   51   -163.30     0.00     0.00      0.00      0.00       0.00
              500    163.30     0.00     0.00      0.00      0.06      -0.10
         115   51   -183.75     0.00    -0.01      0.00      0.00       0.00
              500    183.75     0.00     0.01      0.00      0.19      -0.13
         116   51    -96.70     0.00     0.00      0.00      0.00       0.00
              500     96.70     0.00     0.00      0.00      0.00      -0.07
         121   51   -108.60     0.00     0.00      0.00      0.00       0.00
              500    108.60     0.00     0.00      0.00      0.05      -0.07
         125   51   -122.20     0.00     0.00      0.00      0.00       0.00
              500    122.20     0.00     0.00      0.00      0.13      -0.08
         126   51    -64.30     0.00     0.00      0.00      0.00       0.00
              500     64.30     0.00     0.00      0.00      0.01      -0.04
         211   51    -96.61     0.00     0.00      0.00      0.00       0.00
              500     96.61     0.00     0.00      0.00      0.05      -0.07
         221   51    -64.24     0.00     0.00      0.00      0.00       0.00
              500     64.24     0.00     0.00      0.00      0.04      -0.05

   304    11  202    -96.12     0.00     0.00     -0.40      0.00       0.00
              500     96.12     0.00     0.00      0.40      0.14       0.05
          12  202    -24.54     0.00     0.00      0.02      0.00       0.00
              500     24.54     0.00     0.00     -0.02      0.01      -0.02
          15  202     -5.33     0.00     0.00     -0.14      0.00       0.00
              500      5.33     0.00     0.00      0.14      0.03       0.02
          16  202     -9.55     0.00     0.00      0.01      0.00       0.00
              500      9.55     0.00     0.00     -0.01      0.00      -0.01


 MEMBER END FORCES    STRUCTURE TYPE = SPACE
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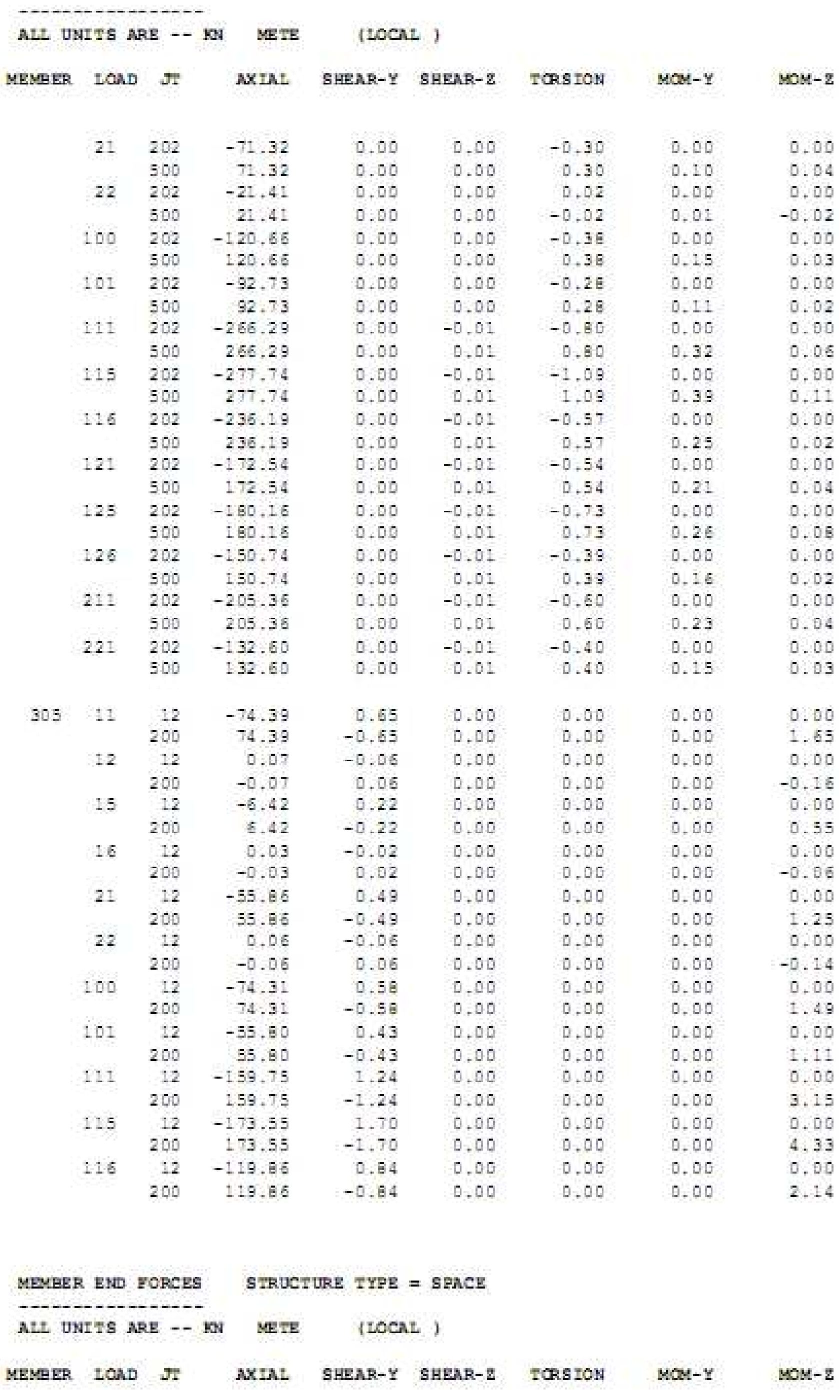

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  -----------------
  ALL UNITS ARE -- KN   METE     (LOCAL )

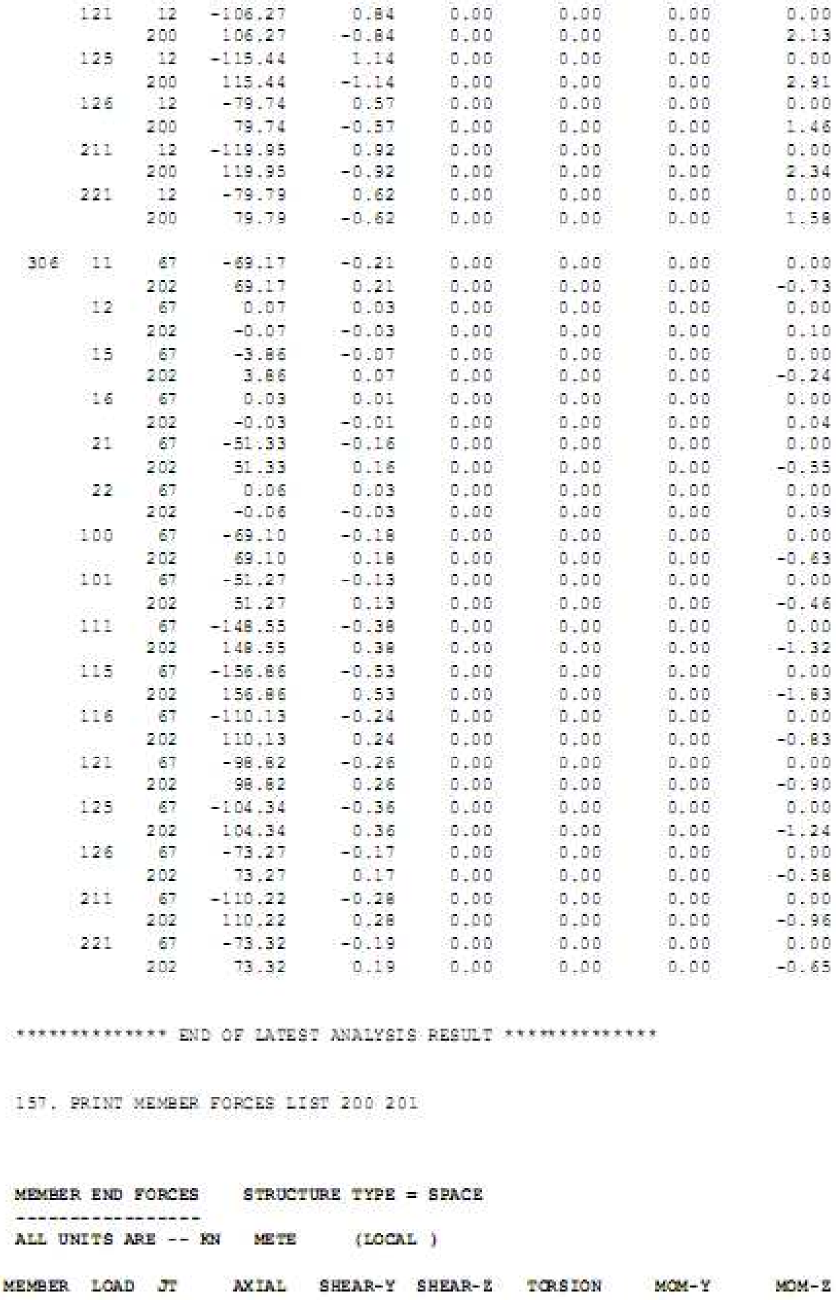
 MEMBER  LOAD    JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z

            21   202    -71.32      0.00     0.00     -0.30      0.00       0.00
                 500     71.32      0.00     0.00      0.30      0.10       0.04
            22   202    -21.41      0.00     0.00      0.02      0.00       0.00
                 500     21.41      0.00     0.00     -0.02      0.01      -0.02
           100   202   -120.66      0.00     0.00     -0.38      0.00       0.00
                 500    120.66      0.00     0.00      0.38      0.15       0.03
           101   202    -92.73      0.00     0.00     -0.28      0.00       0.00
                 500     92.73      0.00     0.00      0.28      0.11       0.02
           111   202   -266.29      0.00    -0.01     -0.80      0.00       0.00
                 500    266.29      0.00     0.01      0.80      0.32       0.06
           115   202   -277.74      0.00    -0.01     -1.09      0.00       0.00
                 500    277.74      0.00     0.01      1.09      0.39       0.11
           116   202   -236.19      0.00    -0.01     -0.57      0.00       0.00
                 500    236.19      0.00     0.01      0.57      0.25       0.02
           121   202   -172.54      0.00    -0.01     -0.54      0.00       0.00
                 500    172.54      0.00     0.01      0.54      0.21       0.04
           125   202   -180.16      0.00    -0.01     -0.73      0.00       0.00
                 500    180.16      0.00     0.01      0.73      0.26       0.08
           126   202   -150.74      0.00    -0.01     -0.39      0.00       0.00
                 500    150.74      0.00     0.01      0.39      0.16       0.02
           211   202   -205.36      0.00    -0.01     -0.60      0.00       0.00
                 500    205.36      0.00     0.01      0.60      0.23       0.04
           221   202   -132.60      0.00    -0.01     -0.40      0.00       0.00
                 500    132.60      0.00     0.01      0.40      0.15       0.03

    305     11    12    -74.39      0.65     0.00      0.00      0.00       0.00
                 200     74.39     -0.65     0.00      0.00      0.00       1.65
            12    12      0.07     -0.06     0.00      0.00      0.00       0.00
                 200     -0.07      0.06     0.00      0.00      0.00      -0.16
            15    12     -6.42      0.22     0.00      0.00      0.00       0.00
                 200      6.42     -0.22     0.00      0.00      0.00       0.55
            16    12      0.03     -0.02     0.00      0.00      0.00       0.00
                 200     -0.03      0.02     0.00      0.00      0.00      -0.06
            21    12    -55.86      0.49     0.00      0.00      0.00       0.00
                 200     55.86     -0.49     0.00      0.00      0.00       1.25
            22    12      0.06     -0.06     0.00      0.00      0.00       0.00
                 200     -0.06      0.06     0.00      0.00      0.00      -0.14
           100    12    -74.31      0.58     0.00      0.00      0.00       0.00
                 200     74.31     -0.58     0.00      0.00      0.00       1.49
           101    12    -55.80      0.43     0.00      0.00      0.00       0.00
                 200     55.80     -0.43     0.00      0.00      0.00       1.11
           111    12   -159.75      1.24     0.00      0.00      0.00       0.00
                 200    159.75     -1.24     0.00      0.00      0.00       3.15
           115    12   -173.55      1.70     0.00      0.00      0.00       0.00
                 200    173.55     -1.70     0.00      0.00      0.00       4.33
           116    12   -119.86      0.84     0.00      0.00      0.00       0.00
                 200    119.86     -0.84     0.00      0.00      0.00       2.14


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE     (LOCAL )

 MEMBER  LOAD    JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z
```



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         121    12   -106.27      0.84      0.00      0.00      0.00      0.00
               200    106.27     -0.84      0.00      0.00      0.00      2.13
         125    12   -115.44      1.14      0.00      0.00      0.00      0.00
               200    115.44     -1.14      0.00      0.00      0.00      2.91
         126    12    -79.74      0.57      0.00      0.00      0.00      0.00
               200     79.74     -0.57      0.00      0.00      0.00      1.46
         211    12   -119.95      0.92      0.00      0.00      0.00      0.00
               200    119.95     -0.92      0.00      0.00      0.00      2.34
         221    12    -79.79      0.62      0.00      0.00      0.00      0.00
               200     79.79     -0.62      0.00      0.00      0.00      1.58

   306    11    67    -69.17     -0.21      0.00      0.00      0.00      0.00
               202     69.17      0.21      0.00      0.00      0.00     -0.73
          12    67      0.07      0.03      0.00      0.00      0.00      0.00
               202     -0.07     -0.03      0.00      0.00      0.00      0.10
          15    67     -3.86     -0.07      0.00      0.00      0.00      0.00
               202      3.86      0.07      0.00      0.00      0.00     -0.24
          16    67      0.03      0.01      0.00      0.00      0.00      0.00
               202     -0.03     -0.01      0.00      0.00      0.00      0.04
          21    67    -51.33     -0.16      0.00      0.00      0.00      0.00
               202     51.33      0.16      0.00      0.00      0.00     -0.55
          22    67      0.06      0.03      0.00      0.00      0.00      0.00
               202     -0.06     -0.03      0.00      0.00      0.00      0.09
         100    67    -69.10     -0.18      0.00      0.00      0.00      0.00
               202     69.10      0.18      0.00      0.00      0.00     -0.63
         101    67    -51.27     -0.13      0.00      0.00      0.00      0.00
               202     51.27      0.13      0.00      0.00      0.00     -0.46
         111    67   -148.55     -0.38      0.00      0.00      0.00      0.00
               202    148.55      0.38      0.00      0.00      0.00     -1.32
         115    67   -156.86     -0.53      0.00      0.00      0.00      0.00
               202    156.86      0.53      0.00      0.00      0.00     -1.83
         116    67   -110.13     -0.24      0.00      0.00      0.00      0.00
               202    110.13      0.24      0.00      0.00      0.00     -0.83
         121    67    -98.82     -0.26      0.00      0.00      0.00      0.00
               202     98.82      0.26      0.00      0.00      0.00     -0.90
         125    67   -104.34     -0.36      0.00      0.00      0.00      0.00
               202    104.34      0.36      0.00      0.00      0.00     -1.24
         126    67    -73.27     -0.17      0.00      0.00      0.00      0.00
               202     73.27      0.17      0.00      0.00      0.00     -0.58
         211    67   -110.22     -0.28      0.00      0.00      0.00      0.00
               202    110.22      0.28      0.00      0.00      0.00     -0.96
         221    67    -73.32     -0.19      0.00      0.00      0.00      0.00
               202     73.32      0.19      0.00      0.00      0.00     -0.65


  ************** END OF LATEST ANALYSIS RESULT **************


  157. PRINT MEMBER FORCES LIST 200 201


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE     (LOCAL )

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z
```

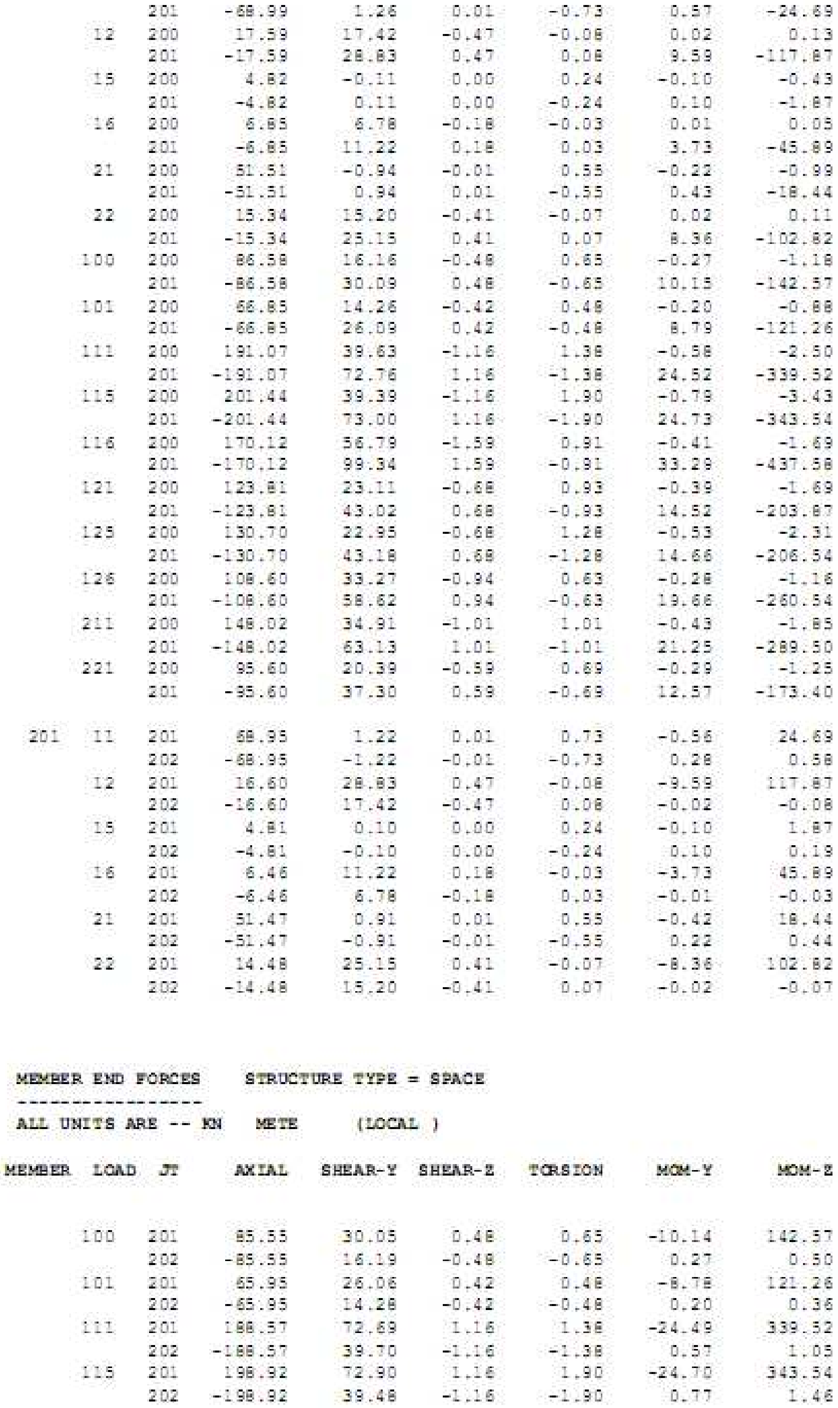

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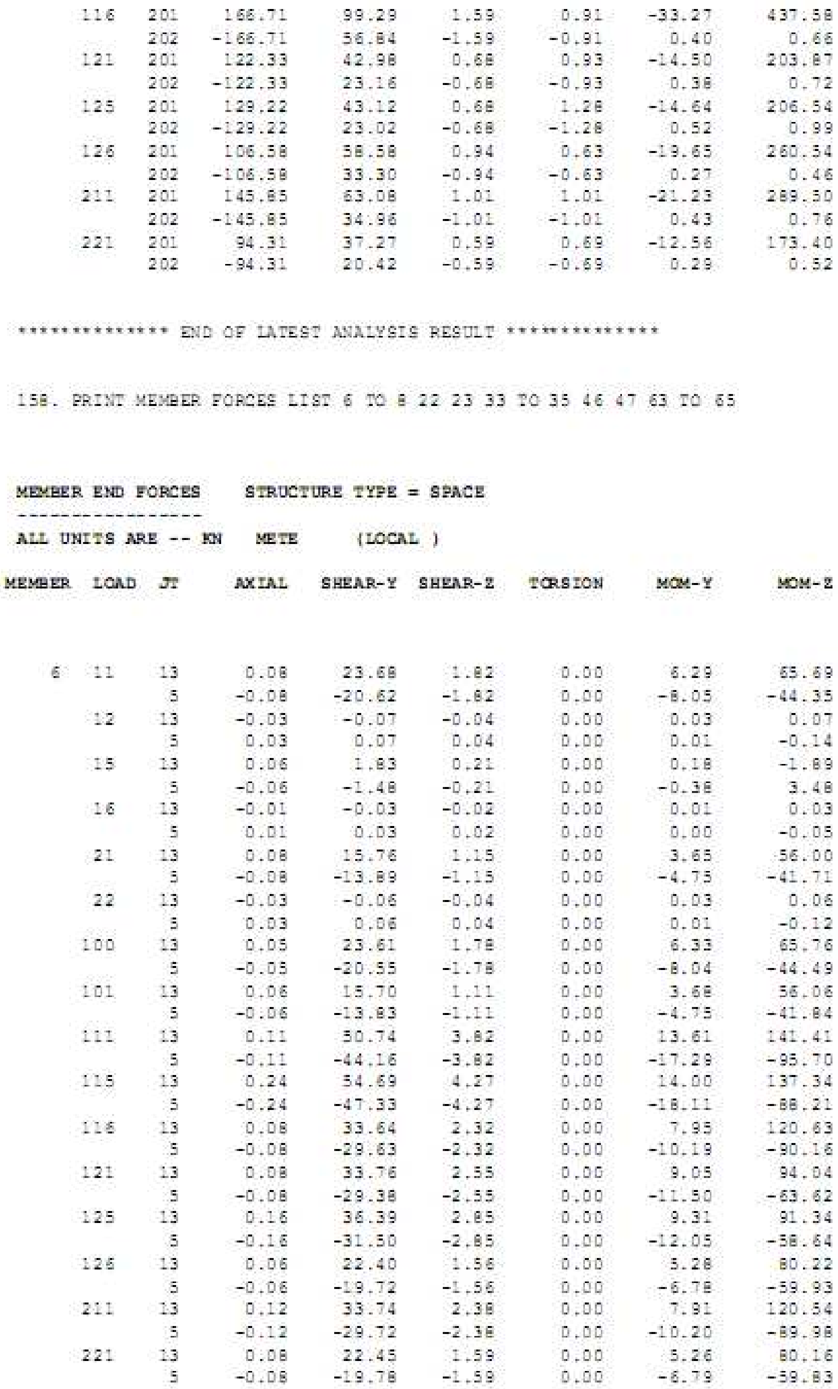
                  201    -68.99      1.26      0.01     -0.73      0.57    -24.69
             12   200     17.59     17.42     -0.47     -0.08      0.02      0.13
                  201    -17.59     28.83      0.47      0.08      9.59   -117.87
             15   200      4.82     -0.11      0.00      0.24     -0.10     -0.43
                  201     -4.82      0.11      0.00     -0.24      0.10     -1.87
             16   200      6.85      6.78     -0.18     -0.03      0.01      0.05
                  201     -6.85     11.22      0.18      0.03      3.73    -45.89
             21   200     51.51     -0.94     -0.01      0.55     -0.22     -0.99
                  201    -51.51      0.94      0.01     -0.55      0.43    -18.44
             22   200     15.34     15.20     -0.41     -0.07      0.02      0.11
                  201    -15.34     25.15      0.41      0.07      8.36   -102.82
            100   200     86.58     16.16     -0.48      0.65     -0.27     -1.18
                  201    -86.58     30.09      0.48     -0.65     10.15   -142.57
            101   200     66.85     14.26     -0.42      0.48     -0.20     -0.88
                  201    -66.85     26.09      0.42     -0.48      8.79   -121.26
            111   200    191.07     39.63     -1.16      1.38     -0.58     -2.50
                  201   -191.07     72.76      1.16     -1.38     24.52   -339.52
            115   200    201.44     39.39     -1.16      1.90     -0.79     -3.43
                  201   -201.44     73.00      1.16     -1.90     24.73   -343.54
            116   200    170.12     56.79     -1.59      0.91     -0.41     -1.69
                  201   -170.12     99.34      1.59     -0.91     33.29   -437.58
            121   200    123.81     23.11     -0.68      0.93     -0.39     -1.69
                  201   -123.81     43.02      0.68     -0.93     14.52   -203.87
            125   200    130.70     22.95     -0.68      1.28     -0.53     -2.31
                  201   -130.70     43.18      0.68     -1.28     14.66   -206.54
            126   200    108.60     33.27     -0.94      0.63     -0.28     -1.16
                  201   -108.60     58.62      0.94     -0.63     19.66   -260.54
            211   200    148.02     34.91     -1.01      1.01     -0.43     -1.85
                  201   -148.02     63.13      1.01     -1.01     21.25   -289.50
            221   200     95.60     20.39     -0.59      0.69     -0.29     -1.25
                  201    -95.60     37.30      0.59     -0.69     12.57   -173.40

      201    11   201     68.95      1.22      0.01      0.73     -0.56     24.69
                  202    -68.95     -1.22     -0.01     -0.73      0.28      0.58
             12   201     16.60     28.83      0.47     -0.08     -9.59    117.87
                  202    -16.60     17.42     -0.47      0.08     -0.02     -0.08
             15   201      4.81      0.10      0.00      0.24     -0.10      1.87
                  202     -4.81     -0.10      0.00     -0.24      0.10      0.19
             16   201      6.46     11.22      0.18     -0.03     -3.73     45.89
                  202     -6.46      6.78     -0.18      0.03     -0.01     -0.03
             21   201     51.47      0.91      0.01      0.55     -0.42     18.44
                  202    -51.47     -0.91     -0.01     -0.55      0.22      0.44
             22   201     14.48     25.15      0.41     -0.07     -8.36    102.82
                  202    -14.48     15.20     -0.41      0.07     -0.02     -0.07


   MEMBER END FORCES    STRUCTURE TYPE = SPACE
   -----------------
   ALL UNITS ARE -- KN   METE      (LOCAL )

  MEMBER  LOAD  JT     AXIAL   SHEAR-Y   SHEAR-Z   TORSION     MOM-Y     MOM-Z


            100   201     85.55     30.05      0.48      0.65    -10.14    142.57
                  202    -85.55     16.19     -0.48     -0.65      0.27      0.50
            101   201     65.95     26.06      0.42      0.48     -8.78    121.26
                  202    -65.95     14.28     -0.42     -0.48      0.20      0.36
            111   201    188.57     72.69      1.16      1.38    -24.49    339.52
                  202   -188.57     39.70     -1.16     -1.38      0.57      1.05
            115   201    198.92     72.90      1.16      1.90    -24.70    343.54
                  202   -198.92     39.48     -1.16     -1.90      0.77      1.46
```



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         116   201    166.71     99.29      1.59      0.91    -33.27    437.58
               202   -166.71     56.84     -1.59     -0.91      0.40      0.66
         121   201    122.33     42.98      0.68      0.93    -14.50    203.87
               202   -122.33     23.16     -0.68     -0.93      0.38      0.72
         125   201    129.22     43.12      0.68      1.28    -14.64    206.54
               202   -129.22     23.02     -0.68     -1.28      0.52      0.99
         126   201    106.58     58.58      0.94      0.63    -19.65    260.54
               202   -106.58     33.30     -0.94     -0.63      0.27      0.46
         211   201    145.85     63.08      1.01      1.01    -21.23    289.50
               202   -145.85     34.96     -1.01     -1.01      0.43      0.76
         221   201     94.31     37.27      0.59      0.69    -12.56    173.40
               202    -94.31     20.42     -0.59     -0.69      0.29      0.52


  ************** END OF LATEST ANALYSIS RESULT **************


  158. PRINT MEMBER FORCES LIST 6 TO 8 22 23 33 TO 35 46 47 63 TO 65


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE     (LOCAL )

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y     MOM-Z



      6   11    13      0.08     23.68      1.82      0.00      6.29     65.69
                 5     -0.08    -20.62     -1.82      0.00     -8.05    -44.35
          12    13     -0.03     -0.07     -0.04      0.00      0.03      0.07
                 5      0.03      0.07      0.04      0.00      0.01     -0.14
          15    13      0.06      1.83      0.21      0.00      0.18     -1.89
                 5     -0.06     -1.48     -0.21      0.00     -0.38      3.48
          16    13     -0.01     -0.03     -0.02      0.00      0.01      0.03
                 5      0.01      0.03      0.02      0.00      0.00     -0.05
          21    13      0.08     15.76      1.15      0.00      3.65     56.00
                 5     -0.08    -13.89     -1.15      0.00     -4.75    -41.71
          22    13     -0.03     -0.06     -0.04      0.00      0.03      0.06
                 5      0.03      0.06      0.04      0.00      0.01     -0.12
         100    13      0.05     23.61      1.78      0.00      6.33     65.76
                 5     -0.05    -20.55     -1.78      0.00     -8.04    -44.49
         101    13      0.06     15.70      1.11      0.00      3.68     56.06
                 5     -0.06    -13.83     -1.11      0.00     -4.75    -41.84
         111    13      0.11     50.74      3.82      0.00     13.61    141.41
                 5     -0.11    -44.16     -3.82      0.00    -17.29    -95.70
         115    13      0.24     54.69      4.27      0.00     14.00    137.34
                 5     -0.24    -47.33     -4.27      0.00    -18.11    -88.21
         116    13      0.08     33.64      2.32      0.00      7.95    120.63
                 5     -0.08    -29.63     -2.32      0.00    -10.19    -90.16
         121    13      0.08     33.76      2.55      0.00      9.05     94.04
                 5     -0.08    -29.38     -2.55      0.00    -11.50    -63.62
         125    13      0.16     36.39      2.85      0.00      9.31     91.34
                 5     -0.16    -31.50     -2.85      0.00    -12.05    -58.64
         126    13      0.06     22.40      1.56      0.00      5.28     80.22
                 5     -0.06    -19.72     -1.56      0.00     -6.78    -59.93
         211    13      0.12     33.74      2.38      0.00      7.91    120.54
                 5     -0.12    -29.72     -2.38      0.00    -10.20    -89.98
         221    13      0.08     22.45      1.59      0.00      5.26     80.16
                 5     -0.08    -19.78     -1.59      0.00     -6.79    -59.83
```

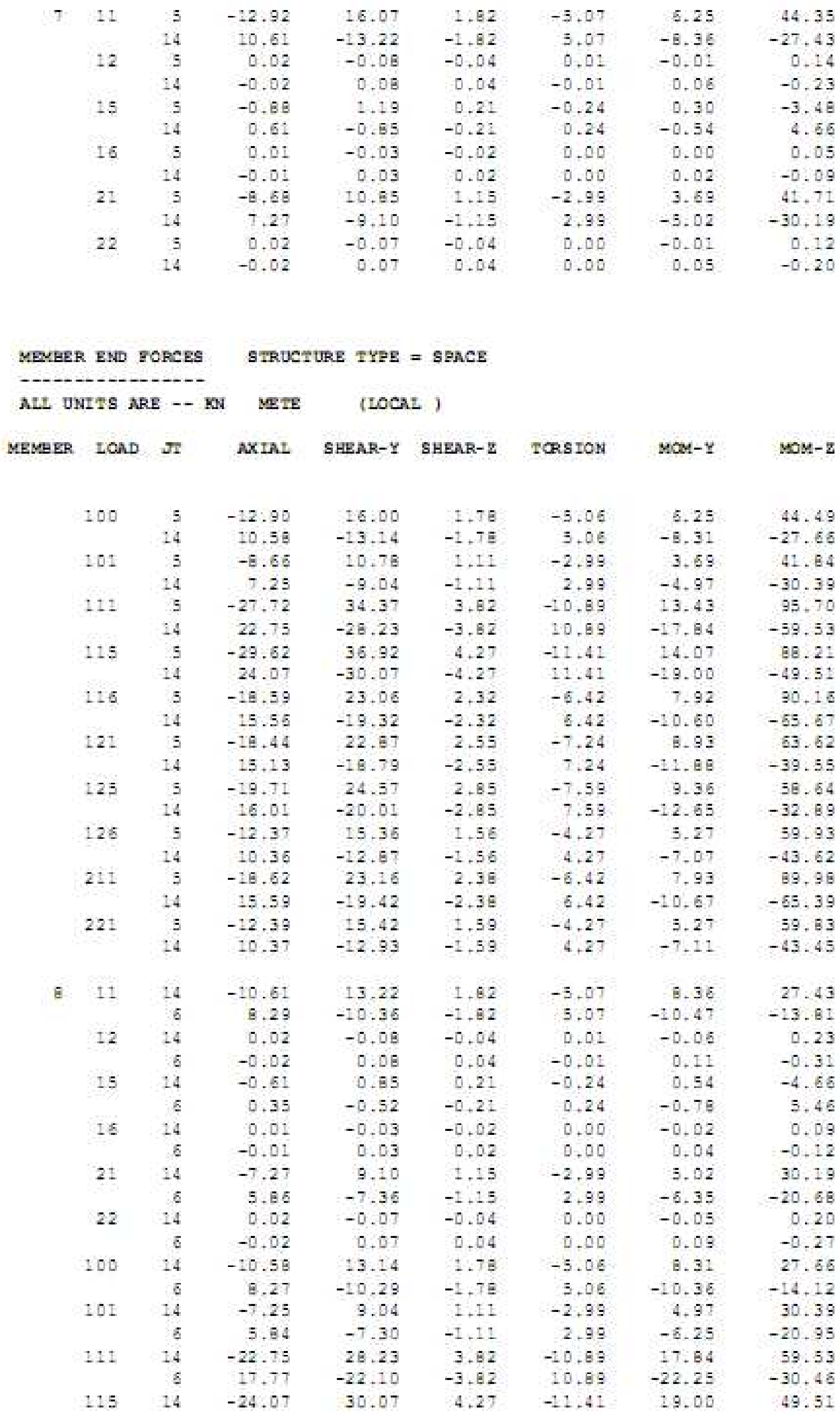

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   7   11     5    -12.92    16.07     1.82    -5.07     6.25    44.35
             14     10.61   -13.22    -1.82     5.07    -8.36   -27.43
       12     5      0.02    -0.08    -0.04     0.01    -0.01     0.14
             14     -0.02     0.08     0.04    -0.01     0.06    -0.23
       15     5     -0.88     1.19     0.21    -0.24     0.30    -3.48
             14      0.61    -0.85    -0.21     0.24    -0.54     4.66
       16     5      0.01    -0.03    -0.02     0.00     0.00     0.05
             14     -0.01     0.03     0.02     0.00     0.02    -0.09
       21     5     -8.68    10.85     1.15    -2.99     3.69    41.71
             14      7.27    -9.10    -1.15     2.99    -5.02   -30.19
       22     5      0.02    -0.07    -0.04     0.00    -0.01     0.12
             14     -0.02     0.07     0.04     0.00     0.05    -0.20


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE      (LOCAL )

 MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


       100    5    -12.90    16.00     1.78    -5.06     6.25    44.49
             14     10.58   -13.14    -1.78     5.06    -8.31   -27.66
       101    5     -8.66    10.78     1.11    -2.99     3.69    41.84
             14      7.25    -9.04    -1.11     2.99    -4.97   -30.39
       111    5    -27.72    34.37     3.82   -10.89    13.43    95.70
             14     22.75   -28.23    -3.82    10.89   -17.84   -59.53
       115    5    -29.62    36.92     4.27   -11.41    14.07    88.21
             14     24.07   -30.07    -4.27    11.41   -19.00   -49.51
       116    5    -18.59    23.06     2.32    -6.42     7.92    90.16
             14     15.56   -19.32    -2.32     6.42   -10.60   -65.67
       121    5    -18.44    22.87     2.55    -7.24     8.93    63.62
             14     15.13   -18.79    -2.55     7.24   -11.88   -39.55
       125    5    -19.71    24.57     2.85    -7.59     9.36    58.64
             14     16.01   -20.01    -2.85     7.59   -12.65   -32.89
       126    5    -12.37    15.36     1.56    -4.27     5.27    59.93
             14     10.36   -12.87    -1.56     4.27    -7.07   -43.62
       211    5    -18.62    23.16     2.38    -6.42     7.93    89.98
             14     15.59   -19.42    -2.38     6.42   -10.67   -65.39
       221    5    -12.39    15.42     1.59    -4.27     5.27    59.83
             14     10.37   -12.93    -1.59     4.27    -7.11   -43.45

   8   11    14    -10.61    13.22     1.82    -5.07     8.36    27.43
              6      8.29   -10.36    -1.82     5.07   -10.47   -13.81
       12    14      0.02    -0.08    -0.04     0.01    -0.06     0.23
              6     -0.02     0.08     0.04    -0.01     0.11    -0.31
       15    14     -0.61     0.85     0.21    -0.24     0.54    -4.66
              6      0.35    -0.52    -0.21     0.24    -0.78     5.46
       16    14      0.01    -0.03    -0.02     0.00    -0.02     0.09
              6     -0.01     0.03     0.02     0.00     0.04    -0.12
       21    14     -7.27     9.10     1.15    -2.99     5.02    30.19
              6      5.86    -7.36    -1.15     2.99    -6.35   -20.68
       22    14      0.02    -0.07    -0.04     0.00    -0.05     0.20
              6     -0.02     0.07     0.04     0.00     0.09    -0.27
      100    14    -10.58    13.14     1.78    -5.06     8.31    27.66
              6      8.27   -10.29    -1.78     5.06   -10.36   -14.12
      101    14     -7.25     9.04     1.11    -2.99     4.97    30.39
              6      5.84    -7.30    -1.11     2.99    -6.25   -20.95
      111    14    -22.75    28.23     3.82   -10.89    17.84    59.53
              6     17.77   -22.10    -3.82    10.89   -22.25   -30.46
      115    14    -24.07    30.07     4.27   -11.41    19.00    49.51
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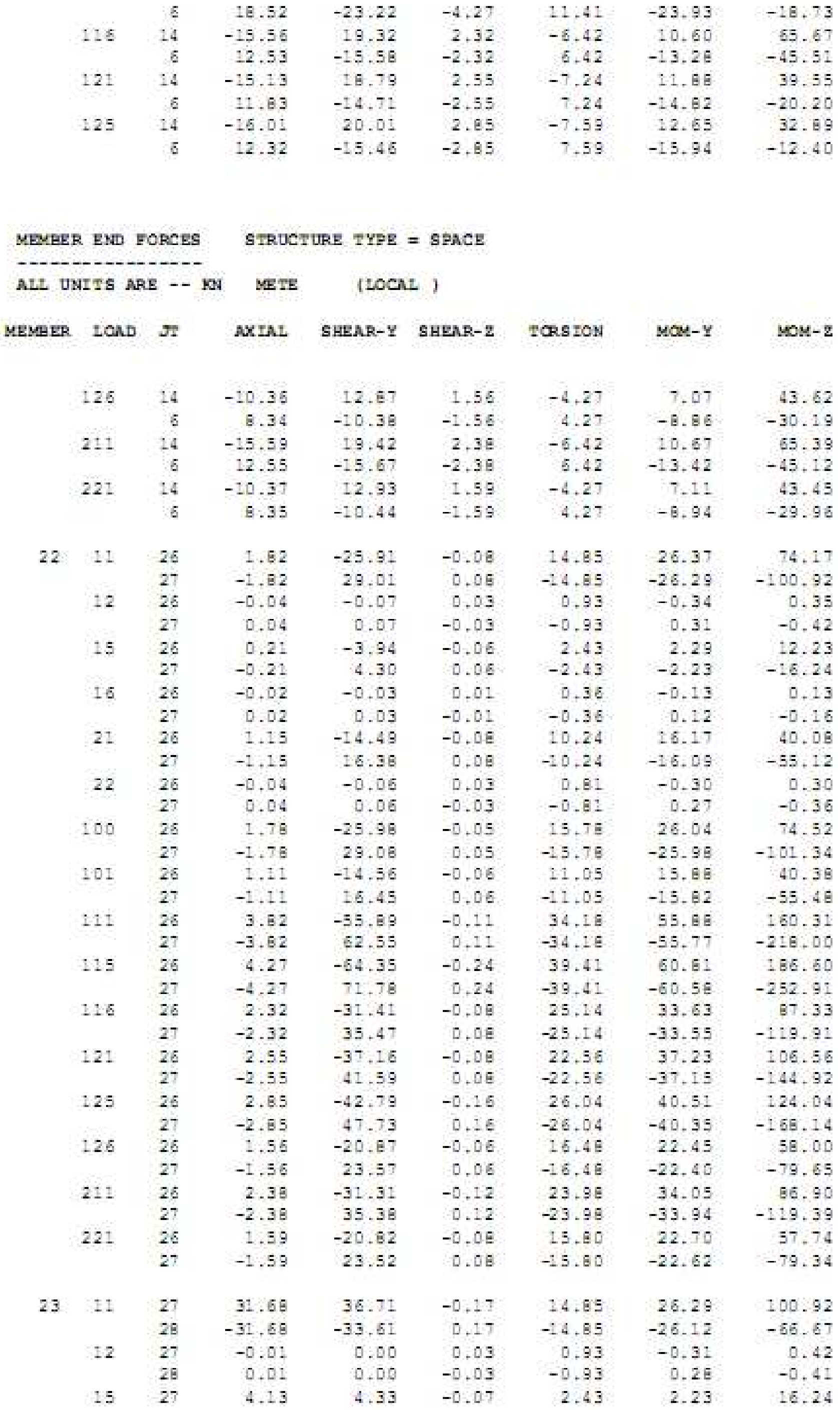

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                6     18.52    -23.22    -4.27     11.41    -23.93    -18.73
        116    14    -15.56     19.32     2.32     -6.42     10.60     65.67
                6     12.53    -15.58    -2.32      6.42    -13.28    -45.51
        121    14    -15.13     18.79     2.55     -7.24     11.88     39.55
                6     11.83    -14.71    -2.55      7.24    -14.82    -20.20
        125    14    -16.01     20.01     2.85     -7.59     12.65     32.89
                6     12.32    -15.46    -2.85      7.59    -15.94    -12.40

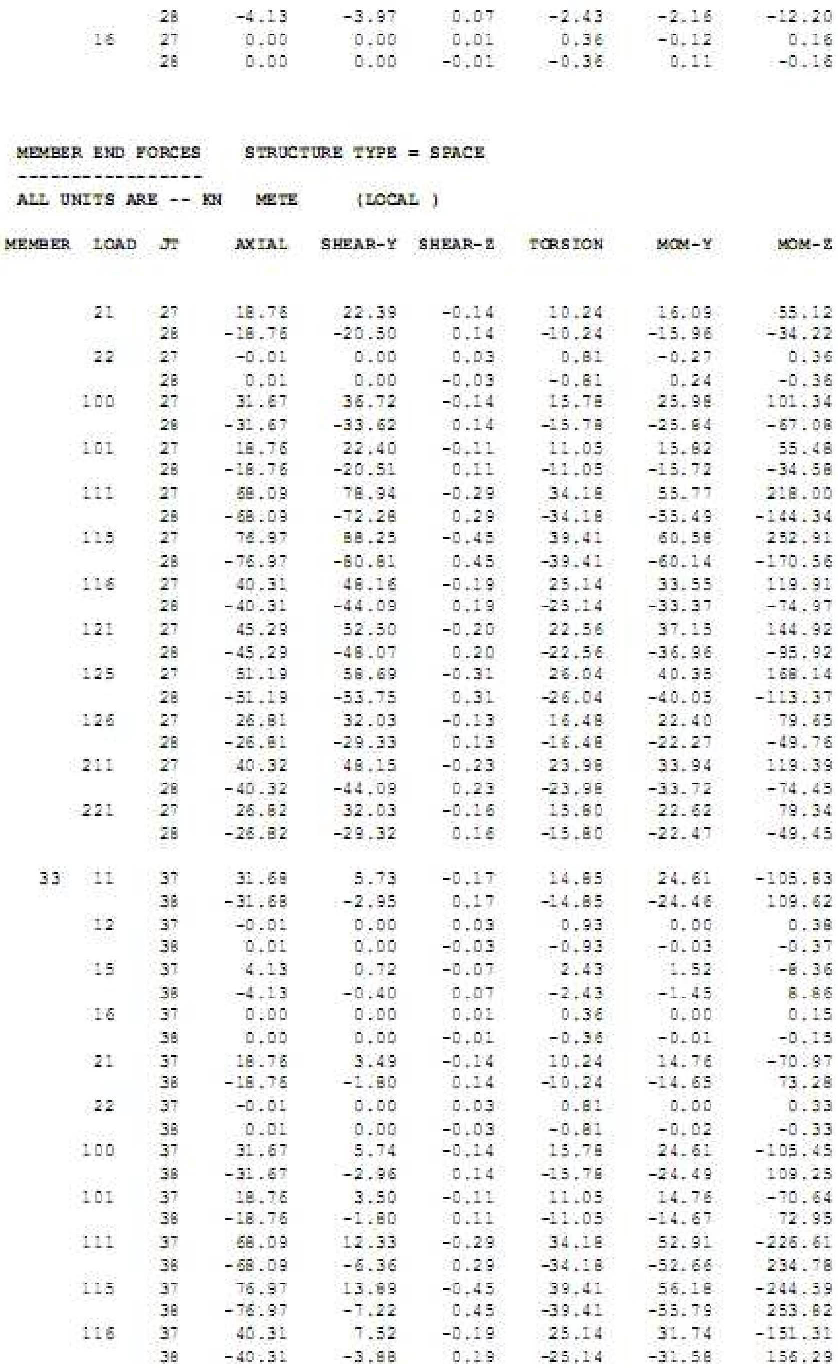

 MEMBER END FORCES    STRUCTURE TYPE = SPACE
 -----------------
 ALL UNITS ARE -- KN   METE     (LOCAL )

MEMBER LOAD    JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y     MOM-Z


        126    14    -10.36     12.87     1.56     -4.27      7.07     43.62
                6      8.34    -10.38    -1.56      4.27     -8.86    -30.19
        211    14    -15.59     19.42     2.38     -6.42     10.67     65.39
                6     12.55    -15.67    -2.38      6.42    -13.42    -45.12
        221    14    -10.37     12.93     1.59     -4.27      7.11     43.45
                6      8.35    -10.44    -1.59      4.27     -8.94    -29.96

  22     11    26      1.82    -25.91    -0.08     14.85     26.37     74.17
               27     -1.82     29.01     0.08    -14.85    -26.29   -100.92
         12    26     -0.04     -0.07     0.03      0.93     -0.34      0.35
               27      0.04      0.07    -0.03     -0.93      0.31     -0.42
         15    26      0.21     -3.94    -0.06      2.43      2.29     12.23
               27     -0.21      4.30     0.06     -2.43     -2.23    -16.24
         16    26     -0.02     -0.03     0.01      0.36     -0.13      0.13
               27      0.02      0.03    -0.01     -0.36      0.12     -0.16
         21    26      1.15    -14.49    -0.08     10.24     16.17     40.08
               27     -1.15     16.38     0.08    -10.24    -16.09    -55.12
         22    26     -0.04     -0.06     0.03      0.81     -0.30      0.30
               27      0.04      0.06    -0.03     -0.81      0.27     -0.36
        100    26      1.78    -25.98    -0.05     15.78     26.04     74.52
               27     -1.78     29.08     0.05    -15.78    -25.98   -101.34
        101    26      1.11    -14.56    -0.06     11.05     15.88     40.38
               27     -1.11     16.45     0.06    -11.05    -15.82    -55.48
        111    26      3.82    -55.89    -0.11     34.18     55.88    160.31
               27     -3.82     62.55     0.11    -34.18    -55.77   -218.00
        115    26      4.27    -64.35    -0.24     39.41     60.81    186.60
               27     -4.27     71.78     0.24    -39.41    -60.58   -252.91
        116    26      2.32    -31.41    -0.08     25.14     33.63     87.33
               27     -2.32     35.47     0.08    -25.14    -33.55   -119.91
        121    26      2.55    -37.16    -0.08     22.56     37.23    106.56
               27     -2.55     41.59     0.08    -22.56    -37.15   -144.92
        125    26      2.85    -42.79    -0.16     26.04     40.51    124.04
               27     -2.85     47.73     0.16    -26.04    -40.35   -168.14
        126    26      1.56    -20.87    -0.06     16.48     22.45     58.00
               27     -1.56     23.57     0.06    -16.48    -22.40    -79.65
        211    26      2.38    -31.31    -0.12     23.98     34.05     86.90
               27     -2.38     35.38     0.12    -23.98    -33.94   -119.39
        221    26      1.59    -20.82    -0.08     15.80     22.70     57.74
               27     -1.59     23.52     0.08    -15.80    -22.62    -79.34

  23     11    27     31.68     36.71    -0.17     14.85     26.29    100.92
               28    -31.68    -33.61     0.17    -14.85    -26.12    -66.67
         12    27     -0.01      0.00     0.03      0.93     -0.31      0.42
               28      0.01      0.00    -0.03     -0.93      0.28     -0.41
         15    27      4.13      4.33    -0.07      2.43      2.23     16.24
```



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               28     -4.13     -3.97     0.07     -2.43     -2.16     -12.20
        16     27      0.00      0.00     0.01      0.36     -0.12       0.16
               28      0.00      0.00    -0.01     -0.36      0.11      -0.16


   MEMBER END FORCES    STRUCTURE TYPE = SPACE
   -----------------
   ALL UNITS ARE -- KN    METE      (LOCAL )

 MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


        21     27     18.76     22.39    -0.14     10.24     16.09      55.12
               28    -18.76    -20.50     0.14    -10.24    -15.96     -34.22
        22     27     -0.01      0.00     0.03      0.81     -0.27       0.36
               28      0.01      0.00    -0.03     -0.81      0.24      -0.36
       100     27     31.67     36.72    -0.14     15.78     25.98     101.34
               28    -31.67    -33.62     0.14    -15.78    -25.84     -67.08
       101     27     18.76     22.40    -0.11     11.05     15.82      55.48
               28    -18.76    -20.51     0.11    -11.05    -15.72     -34.58
       111     27     68.09     78.94    -0.29     34.18     55.77     218.00
               28    -68.09    -72.28     0.29    -34.18    -55.49    -144.34
       115     27     76.97     88.25    -0.45     39.41     60.58     252.91
               28    -76.97    -80.81     0.45    -39.41    -60.14    -170.56
       116     27     40.31     48.16    -0.19     25.14     33.55     119.91
               28    -40.31    -44.09     0.19    -25.14    -33.37     -74.97
       121     27     45.29     52.50    -0.20     22.56     37.15     144.92
               28    -45.29    -48.07     0.20    -22.56    -36.96     -95.92
       125     27     51.19     58.69    -0.31     26.04     40.35     168.14
               28    -51.19    -53.75     0.31    -26.04    -40.05    -113.37
       126     27     26.81     32.03    -0.13     16.48     22.40      79.65
               28    -26.81    -29.33     0.13    -16.48    -22.27     -49.76
       211     27     40.32     48.15    -0.23     23.98     33.94     119.39
               28    -40.32    -44.09     0.23    -23.98    -33.72     -74.45
       221     27     26.82     32.03    -0.16     15.80     22.62      79.34
               28    -26.82    -29.32     0.16    -15.80    -22.47     -49.45

    33  11     37     31.68      5.73    -0.17     14.85     24.61    -105.83
               38    -31.68     -2.95     0.17    -14.85    -24.46     109.62
        12     37     -0.01      0.00     0.03      0.93      0.00       0.38
               38      0.01      0.00    -0.03     -0.93     -0.03      -0.37
        15     37      4.13      0.72    -0.07      2.43      1.52      -8.36
               38     -4.13     -0.40     0.07     -2.43     -1.45       8.86
        16     37      0.00      0.00     0.01      0.36      0.00       0.15
               38      0.00      0.00    -0.01     -0.36     -0.01      -0.15
        21     37     18.76      3.49    -0.14     10.24     14.76     -70.97
               38    -18.76     -1.80     0.14    -10.24    -14.65      73.28
        22     37     -0.01      0.00     0.03      0.81      0.00       0.33
               38      0.01      0.00    -0.03     -0.81     -0.02      -0.33
       100     37     31.67      5.74    -0.14     15.78     24.61    -105.45
               38    -31.67     -2.96     0.14    -15.78    -24.49     109.25
       101     37     18.76      3.50    -0.11     11.05     14.76     -70.64
               38    -18.76     -1.80     0.11    -11.05    -14.67      72.95
       111     37     68.09     12.33    -0.29     34.18     52.91    -226.61
               38    -68.09     -6.36     0.29    -34.18    -52.66     234.78
       115     37     76.97     13.89    -0.45     39.41     56.18    -244.59
               38    -76.97     -7.22     0.45    -39.41    -55.79     253.82
       116     37     40.31      7.52    -0.19     25.14     31.74    -151.31
               38    -40.31     -3.88     0.19    -25.14    -31.58     156.29
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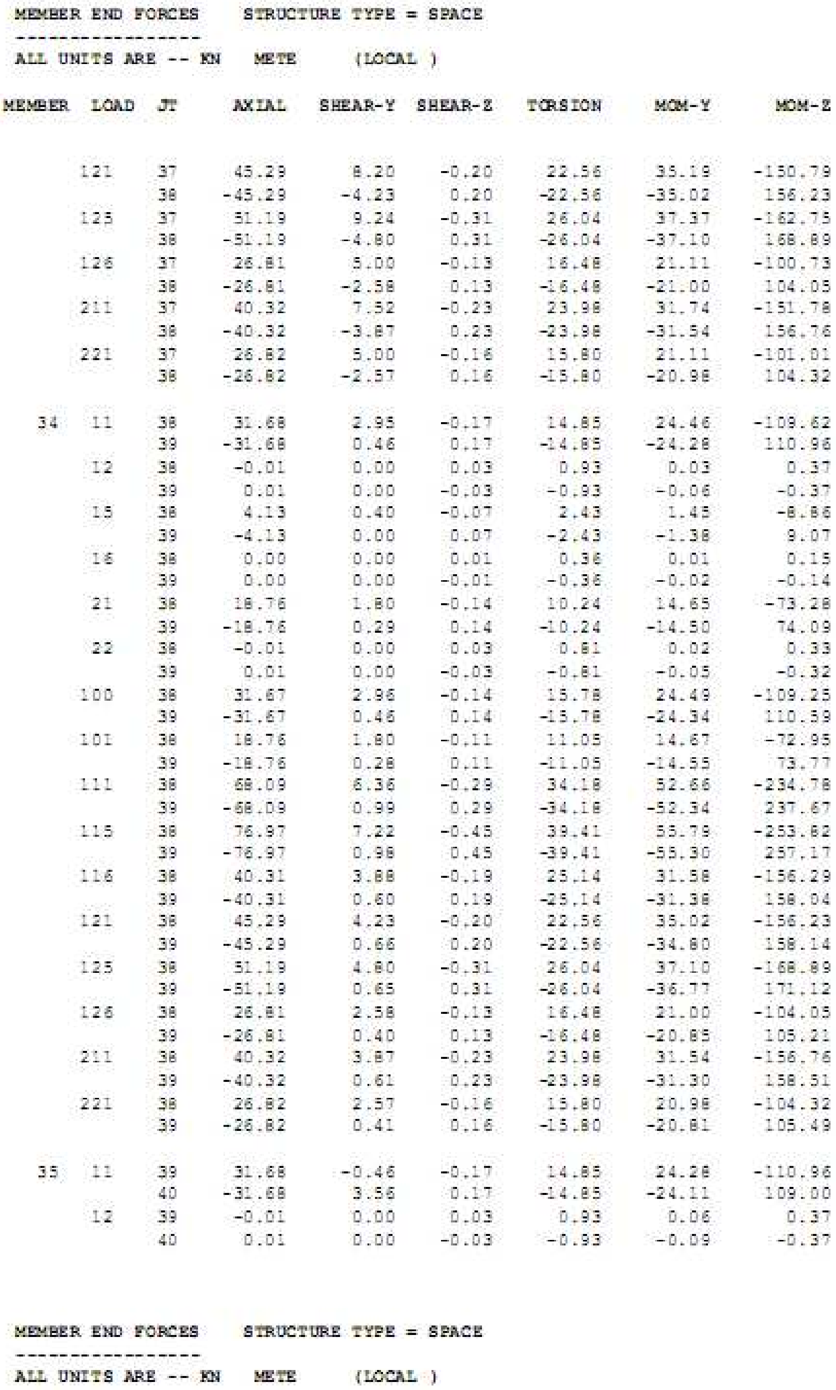

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  MEMBER END FORCES    STRUCTURE TYPE = SPACE
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  ALL UNITS ARE -- KN   METE     (LOCAL )

 MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


          121   37     45.29     8.20    -0.20     22.56     35.19    -150.79
                38    -45.29    -4.23     0.20    -22.56    -35.02     156.23
          125   37     51.19     9.24    -0.31     26.04     37.37    -162.75
                38    -51.19    -4.80     0.31    -26.04    -37.10     168.89
          126   37     26.81     5.00    -0.13     16.48     21.11    -100.73
                38    -26.81    -2.58     0.13    -16.48    -21.00     104.05
          211   37     40.32     7.52    -0.23     23.98     31.74    -151.78
                38    -40.32    -3.87     0.23    -23.98    -31.54     156.76
          221   37     26.82     5.00    -0.16     15.80     21.11    -101.01
                38    -26.82    -2.57     0.16    -15.80    -20.98     104.32

     34    11   38     31.68     2.95    -0.17     14.85     24.46    -109.62
                39    -31.68     0.46     0.17    -14.85    -24.28     110.96
           12   38     -0.01     0.00     0.03      0.93      0.03       0.37
                39      0.01     0.00    -0.03     -0.93     -0.06      -0.37
           15   38      4.13     0.40    -0.07      2.43      1.45      -8.86
                39     -4.13     0.00     0.07     -2.43     -1.38       9.07
           16   38      0.00     0.00     0.01      0.36      0.01       0.15
                39      0.00     0.00    -0.01     -0.36     -0.02      -0.14
           21   38     18.76     1.80    -0.14     10.24     14.65     -73.28
                39    -18.76     0.29     0.14    -10.24    -14.50      74.09
           22   38     -0.01     0.00     0.03      0.81      0.02       0.33
                39      0.01     0.00    -0.03     -0.81     -0.05      -0.32
          100   38     31.67     2.96    -0.14     15.78     24.49    -109.25
                39    -31.67     0.46     0.14    -15.78    -24.34     110.59
          101   38     18.76     1.80    -0.11     11.05     14.67     -72.95
                39    -18.76     0.28     0.11    -11.05    -14.55      73.77
          111   38     68.09     6.36    -0.29     34.18     52.66    -234.78
                39    -68.09     0.99     0.29    -34.18    -52.34     237.67
          115   38     76.97     7.22    -0.45     39.41     55.79    -253.82
                39    -76.97     0.98     0.45    -39.41    -55.30     257.17
          116   38     40.31     3.88    -0.19     25.14     31.58    -156.29
                39    -40.31     0.60     0.19    -25.14    -31.38     158.04
          121   38     45.29     4.23    -0.20     22.56     35.02    -156.23
                39    -45.29     0.66     0.20    -22.56    -34.80     158.14
          125   38     51.19     4.80    -0.31     26.04     37.10    -168.89
                39    -51.19     0.65     0.31    -26.04    -36.77     171.12
          126   38     26.81     2.58    -0.13     16.48     21.00    -104.05
                39    -26.81     0.40     0.13    -16.48    -20.85     105.21
          211   38     40.32     3.87    -0.23     23.98     31.54    -156.76
                39    -40.32     0.61     0.23    -23.98    -31.30     158.51
          221   38     26.82     2.57    -0.16     15.80     20.98    -104.32
                39    -26.82     0.41     0.16    -15.80    -20.81     105.49

     35    11   39     31.68    -0.46    -0.17     14.85     24.28    -110.96
                40    -31.68     3.56     0.17    -14.85    -24.11     109.00
           12   39     -0.01     0.00     0.03      0.93      0.06       0.37
                40      0.01     0.00    -0.03     -0.93     -0.09      -0.37


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE     (LOCAL )
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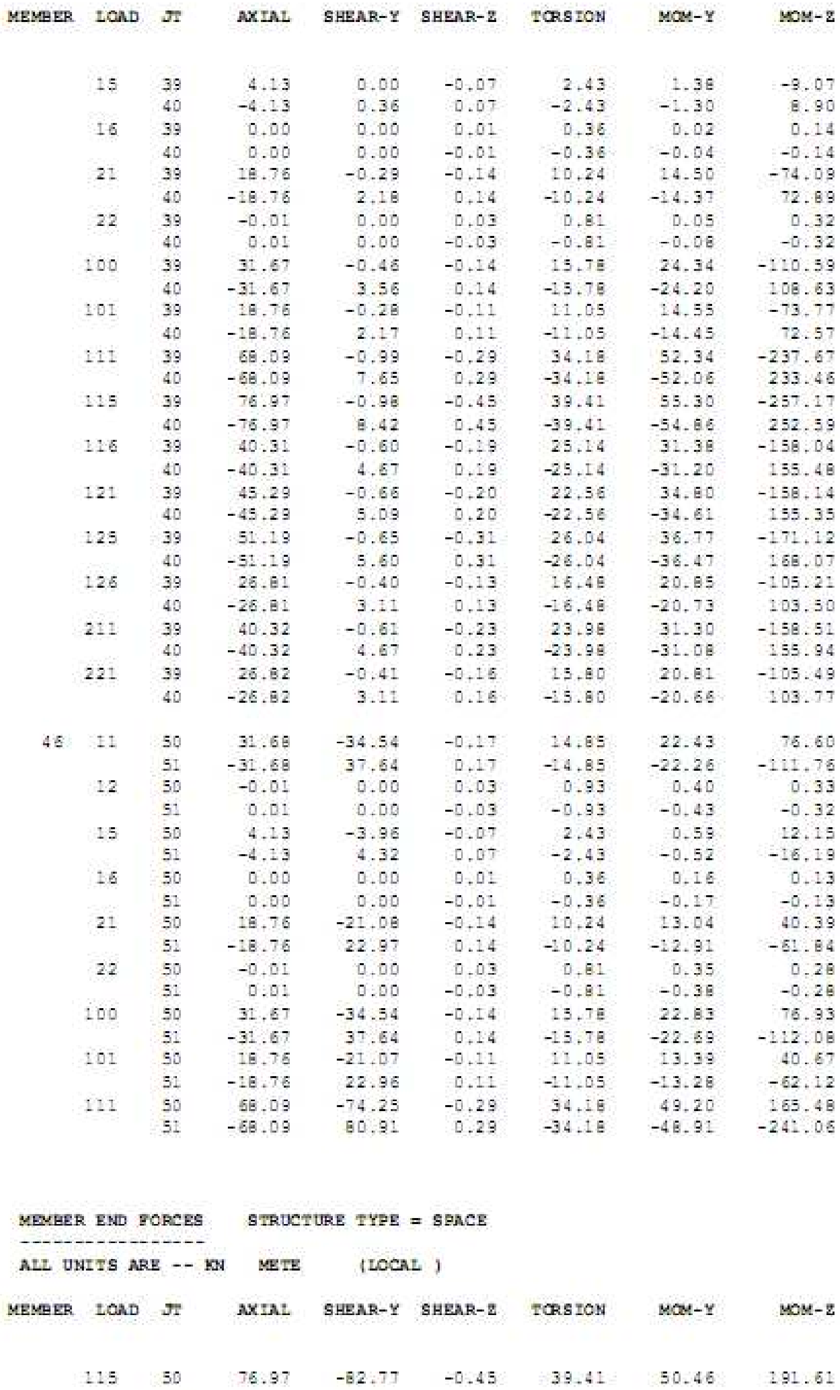

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 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


           15   39     4.13      0.00    -0.07      2.43      1.38      -9.07
                40    -4.13      0.36     0.07     -2.43     -1.30       8.90
           16   39     0.00      0.00     0.01      0.36      0.02       0.14
                40     0.00      0.00    -0.01     -0.36     -0.04      -0.14
           21   39    18.76     -0.29    -0.14     10.24     14.50     -74.09
                40   -18.76      2.18     0.14    -10.24    -14.37      72.89
           22   39    -0.01      0.00     0.03      0.81      0.05       0.32
                40     0.01      0.00    -0.03     -0.81     -0.08      -0.32
          100   39    31.67     -0.46    -0.14     15.78     24.34    -110.59
                40   -31.67      3.56     0.14    -15.78    -24.20     108.63
          101   39    18.76     -0.28    -0.11     11.05     14.55     -73.77
                40   -18.76      2.17     0.11    -11.05    -14.45      72.57
          111   39    68.09     -0.99    -0.29     34.18     52.34    -237.67
                40   -68.09      7.65     0.29    -34.18    -52.06     233.46
          115   39    76.97     -0.98    -0.45     39.41     55.30    -257.17
                40   -76.97      8.42     0.45    -39.41    -54.86     252.59
          116   39    40.31     -0.60    -0.19     25.14     31.38    -158.04
                40   -40.31      4.67     0.19    -25.14    -31.20     155.48
          121   39    45.29     -0.66    -0.20     22.56     34.80    -158.14
                40   -45.29      5.09     0.20    -22.56    -34.61     155.35
          125   39    51.19     -0.65    -0.31     26.04     36.77    -171.12
                40   -51.19      5.60     0.31    -26.04    -36.47     168.07
          126   39    26.81     -0.40    -0.13     16.48     20.85    -105.21
                40   -26.81      3.11     0.13    -16.48    -20.73     103.50
          211   39    40.32     -0.61    -0.23     23.98     31.30    -158.51
                40   -40.32      4.67     0.23    -23.98    -31.08     155.94
          221   39    26.82     -0.41    -0.16     15.80     20.81    -105.49
                40   -26.82      3.11     0.16    -15.80    -20.66     103.77

     46    11   50    31.68    -34.54    -0.17     14.85     22.43      76.60
                51   -31.68     37.64     0.17    -14.85    -22.26    -111.76
           12   50    -0.01      0.00     0.03      0.93      0.40       0.33
                51     0.01      0.00    -0.03     -0.93     -0.43      -0.32
           15   50     4.13     -3.96    -0.07      2.43      0.59      12.15
                51    -4.13      4.32     0.07     -2.43     -0.52     -16.19
           16   50     0.00      0.00     0.01      0.36      0.16       0.13
                51     0.00      0.00    -0.01     -0.36     -0.17      -0.13
           21   50    18.76    -21.08    -0.14     10.24     13.04      40.39
                51   -18.76     22.97     0.14    -10.24    -12.91     -61.84
           22   50    -0.01      0.00     0.03      0.81      0.35       0.28
                51     0.01      0.00    -0.03     -0.81     -0.38      -0.28
          100   50    31.67    -34.54    -0.14     15.78     22.83      76.93
                51   -31.67     37.64     0.14    -15.78    -22.69    -112.08
          101   50    18.76    -21.07    -0.11     11.05     13.39      40.67
                51   -18.76     22.96     0.11    -11.05    -13.28     -62.12
          111   50    68.09    -74.25    -0.29     34.18     49.20     165.48
                51   -68.09     80.91     0.29    -34.18    -48.91    -241.06


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN  METE     (LOCAL )

 MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


          115   50    76.97    -82.77    -0.45     39.41     50.46     191.61
```

```
                 51     -76.97     90.21      0.45    -39.41    -50.02   -275.87
          116    50      40.31    -45.30     -0.19     25.14     29.39     87.93
                 51     -40.31     49.37      0.19    -25.14    -29.21   -134.04
          121    50      45.29    -49.39     -0.20     22.56     32.65    110.00
                 51     -45.29     53.82      0.20    -22.56    -32.45   -160.28
          125    50      51.19    -55.06     -0.31     26.04     33.49    127.38
                 51     -51.19     60.00      0.31    -26.04    -33.19   -183.43
          126    50      26.81    -30.13     -0.13     16.48     19.44     58.40
                 51     -26.81     32.83      0.13    -16.48    -19.31    -89.07
          211    50      40.32    -45.31     -0.23     23.98     28.88     87.52
                 51     -40.32     49.37      0.23    -23.98    -28.66   -133.64
          221    50      26.82    -30.14     -0.16     15.80     19.15     58.16
                 51     -26.82     32.84      0.16    -15.80    -19.00    -88.83

     47    11    51      -1.21     30.73     -0.26     14.85     22.26    111.76
                 52       1.21    -27.64      0.26    -14.85    -22.00    -83.33
           12    51      -0.04      0.07      0.03      0.93      0.43      0.32
                 52       0.04     -0.07     -0.03     -0.93     -0.46     -0.25
           15    51       0.01      4.25     -0.09      2.43      0.52     16.19
                 52      -0.01     -3.89      0.09     -2.43     -0.43    -12.23
           16    51      -0.02      0.03      0.01      0.36      0.17      0.13
                 52       0.02     -0.03     -0.01     -0.36     -0.18     -0.10
           21    51      -0.68     17.46     -0.19     10.24     12.91     61.84
                 52       0.68    -15.57      0.19    -10.24    -12.72    -45.75
           22    51      -0.04      0.06      0.03      0.81      0.38      0.28
                 52       0.04     -0.06     -0.03     -0.81     -0.40     -0.22
          100    51      -1.25     30.80     -0.23     15.78     22.69    112.08
                 52       1.25    -27.71      0.23    -15.78    -22.47    -83.58
          101    51      -0.72     17.52     -0.16     11.05     13.28     62.12
                 52       0.72    -15.63      0.16    -11.05    -13.13    -45.97
          111    51      -2.69     66.25     -0.48     34.18     48.91    241.06
                 52       2.69    -59.59      0.48    -34.18    -48.44   -179.77
          115    51      -2.68     75.38     -0.67     39.41     50.02    275.87
                 52       2.68    -67.94      0.67    -39.41    -49.37   -206.06
          116    51      -1.60     37.78     -0.30     25.14     29.21    134.04
                 52       1.60    -33.72      0.30    -25.14    -28.92    -99.22
          121    51      -1.78     44.05     -0.33     22.56     32.45    160.28
                 52       1.78    -39.62      0.33    -22.56    -32.13   -119.52
          125    51      -1.77     50.12     -0.45     26.04     33.19    183.43
                 52       1.77    -45.18      0.45    -26.04    -32.75   -137.00
          126    51      -1.06     25.11     -0.21     16.48     19.31     89.07
                 52       1.06    -22.41      0.21    -16.48    -19.11    -65.92
          211    51      -1.55     37.69     -0.34     23.98     28.66    133.64
                 52       1.55    -33.63      0.34    -23.98    -28.33    -98.90
          221    51      -1.03     25.06     -0.23     15.80     19.00     88.83
                 52       1.03    -22.36      0.23    -15.80    -18.77    -65.74


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE      (LOCAL )

 MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


     63    11    65      -7.71    -17.27     -1.19      3.50      7.45     33.43
                  8       8.71     19.41      1.19     -3.50     -6.56    -47.03
           12    65       0.00      0.08     -0.04      0.06      0.14      0.18
                  8       0.00     -0.08      0.04     -0.06     -0.11     -0.12
           15    65      -0.57     -1.42      0.01      0.09      0.17     -2.56
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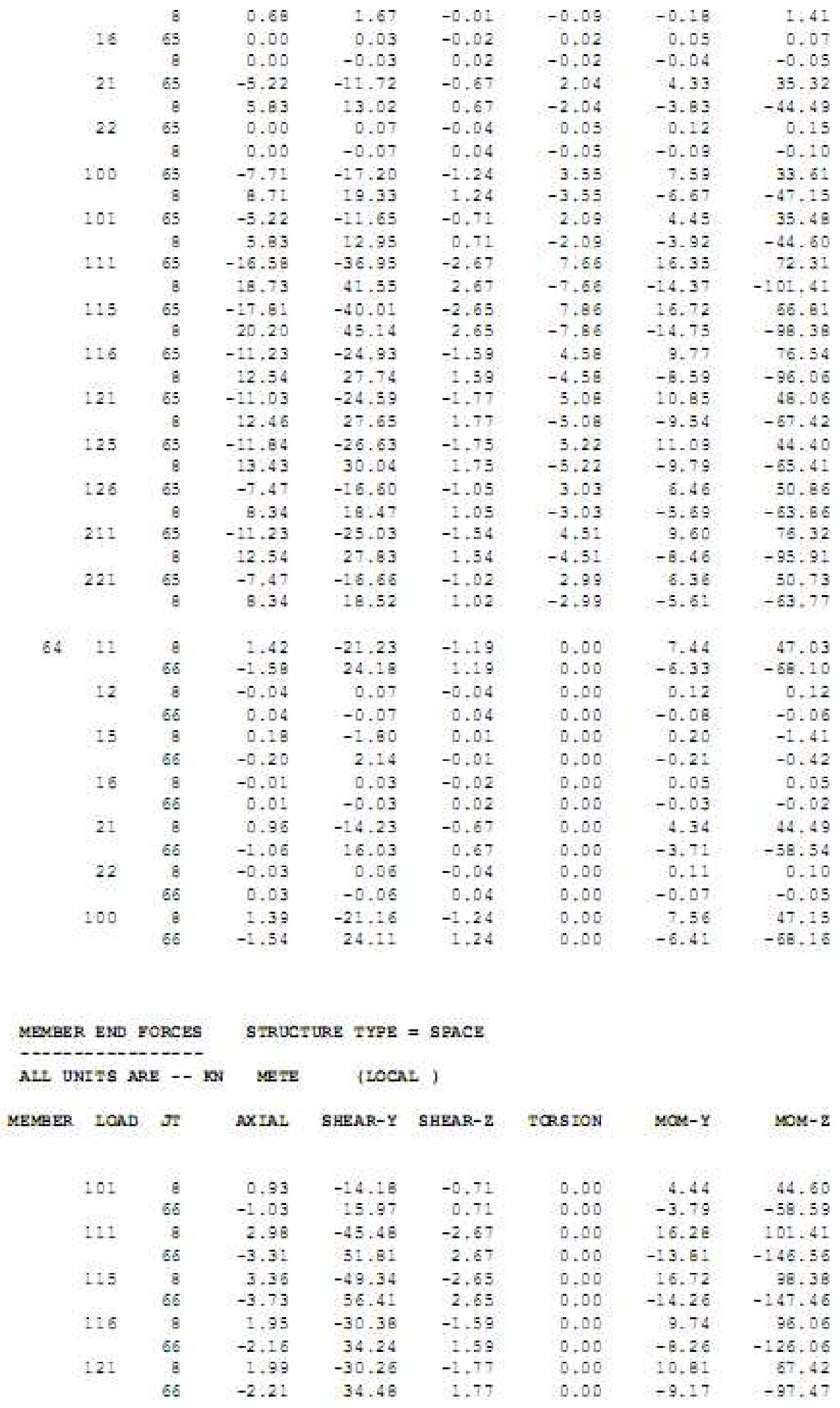

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                 8      0.68      1.67     -0.01     -0.09     -0.18      1.41
          16    65      0.00      0.03     -0.02      0.02      0.05      0.07
                 8      0.00     -0.03      0.02     -0.02     -0.04     -0.05
          21    65     -5.22    -11.72     -0.67      2.04      4.33     35.32
                 8      5.83     13.02      0.67     -2.04     -3.83    -44.49
          22    65      0.00      0.07     -0.04      0.05      0.12      0.15
                 8      0.00     -0.07      0.04     -0.05     -0.09     -0.10
         100    65     -7.71    -17.20     -1.24      3.55      7.59     33.61
                 8      8.71     19.33      1.24     -3.55     -6.67    -47.15
         101    65     -5.22    -11.65     -0.71      2.09      4.45     35.48
                 8      5.83     12.95      0.71     -2.09     -3.92    -44.60
         111    65    -16.58    -36.95     -2.67      7.66     16.35     72.31
                 8     18.73     41.55      2.67     -7.66    -14.37   -101.41
         115    65    -17.81    -40.01     -2.65      7.86     16.72     66.81
                 8     20.20     45.14      2.65     -7.86    -14.75    -98.38
         116    65    -11.23    -24.93     -1.59      4.58      9.77     76.54
                 8     12.54     27.74      1.59     -4.58     -8.59    -96.06
         121    65    -11.03    -24.59     -1.77      5.08     10.85     48.06
                 8     12.46     27.65      1.77     -5.08     -9.54    -67.42
         125    65    -11.84    -26.63     -1.75      5.22     11.09     44.40
                 8     13.43     30.04      1.75     -5.22     -9.79    -65.41
         126    65     -7.47    -16.60     -1.05      3.03      6.46     50.86
                 8      8.34     18.47      1.05     -3.03     -5.69    -63.86
         211    65    -11.23    -25.03     -1.54      4.51      9.60     76.32
                 8     12.54     27.83      1.54     -4.51     -8.46    -95.91
         221    65     -7.47    -16.66     -1.02      2.99      6.36     50.73
                 8      8.34     18.52      1.02     -2.99     -5.61    -63.77

    64    11     8      1.42    -21.23     -1.19      0.00      7.44     47.03
                66     -1.58     24.18      1.19      0.00     -6.33    -68.10
          12     8     -0.04      0.07     -0.04      0.00      0.12      0.12
                66      0.04     -0.07      0.04      0.00     -0.08     -0.06
          15     8      0.18     -1.80      0.01      0.00      0.20     -1.41
                66     -0.20      2.14     -0.01      0.00     -0.21     -0.42
          16     8     -0.01      0.03     -0.02      0.00      0.05      0.05
                66      0.01     -0.03      0.02      0.00     -0.03     -0.02
          21     8      0.96    -14.23     -0.67      0.00      4.34     44.49
                66     -1.06     16.03      0.67      0.00     -3.71    -58.54
          22     8     -0.03      0.06     -0.04      0.00      0.11      0.10
                66      0.03     -0.06      0.04      0.00     -0.07     -0.05
         100     8      1.39    -21.16     -1.24      0.00      7.56     47.15
                66     -1.54     24.11      1.24      0.00     -6.41    -68.16


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
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  ALL UNITS ARE -- KN   METE      (LOCAL )

 MEMBER  LOAD  JT      AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


         101     8      0.93    -14.18     -0.71      0.00      4.44     44.60
                66     -1.03     15.97      0.71      0.00     -3.79    -58.59
         111     8      2.98    -45.48     -2.67      0.00     16.28    101.41
                66     -3.31     51.81      2.67      0.00    -13.81   -146.56
         115     8      3.36    -49.34     -2.65      0.00     16.72     98.38
                66     -3.73     56.41      2.65      0.00    -14.26   -147.46
         116     8      1.95    -30.38     -1.59      0.00      9.74     96.06
                66     -2.16     34.24      1.59      0.00     -8.26   -126.06
         121     8      1.99    -30.26     -1.77      0.00     10.81     67.42
                66     -2.21     34.48      1.77      0.00     -9.17    -97.47
```

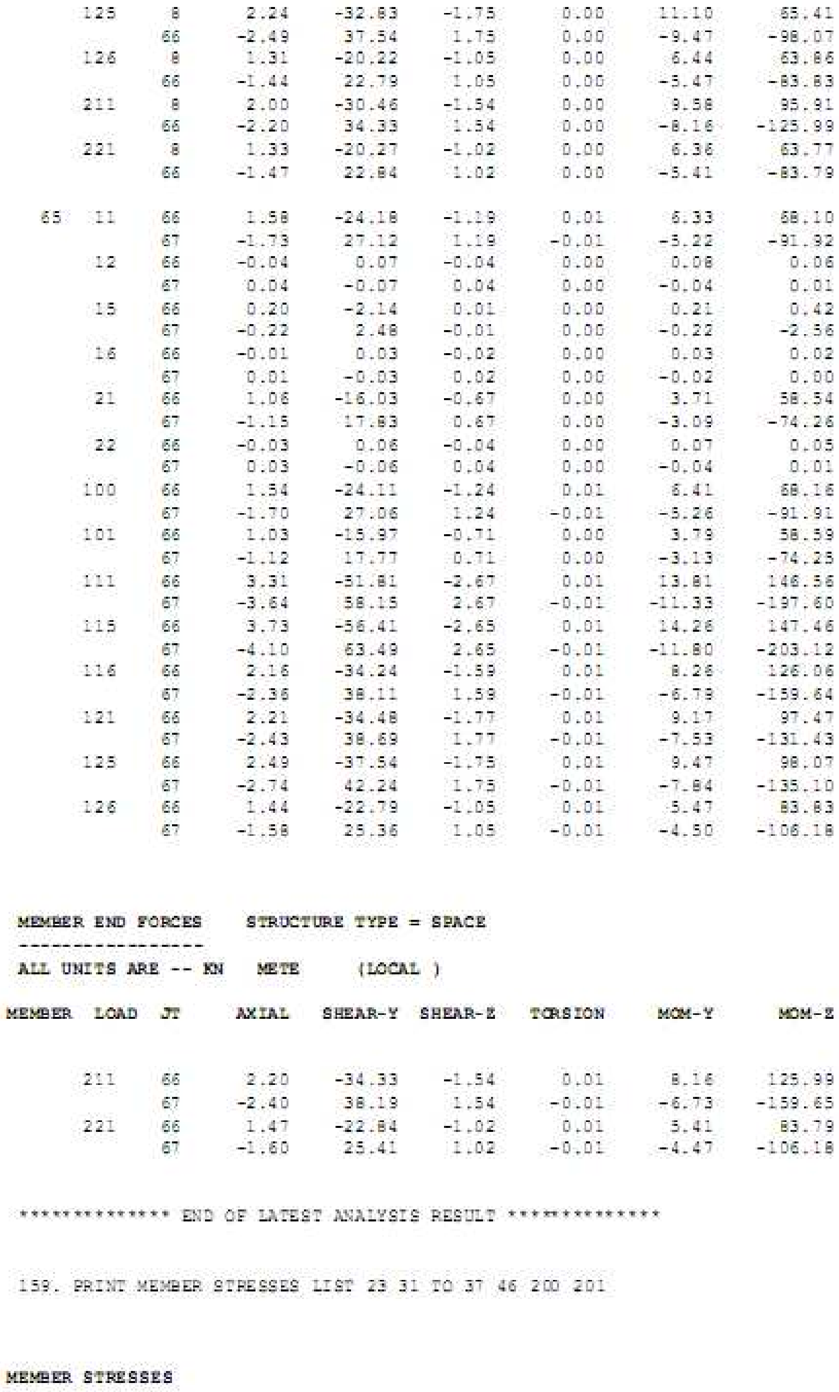

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         125   8      2.24    -32.83     -1.75      0.00     11.10     65.41
              66     -2.49     37.54      1.75      0.00     -9.47    -98.07
         126   8      1.31    -20.22     -1.05      0.00      6.44     63.86
              66     -1.44     22.79      1.05      0.00     -5.47    -83.83
         211   8      2.00    -30.46     -1.54      0.00      9.58     95.91
              66     -2.20     34.33      1.54      0.00     -8.16   -125.99
         221   8      1.33    -20.27     -1.02      0.00      6.36     63.77
              66     -1.47     22.84      1.02      0.00     -5.41    -83.79

    65    11  66      1.58    -24.18     -1.19      0.01      6.33     68.10
              67     -1.73     27.12      1.19     -0.01     -5.22    -91.92
          12  66     -0.04      0.07     -0.04      0.00      0.08      0.06
              67      0.04     -0.07      0.04      0.00     -0.04      0.01
          15  66      0.20     -2.14      0.01      0.00      0.21      0.42
              67     -0.22      2.48     -0.01      0.00     -0.22     -2.56
          16  66     -0.01      0.03     -0.02      0.00      0.03      0.02
              67      0.01     -0.03      0.02      0.00     -0.02      0.00
          21  66      1.06    -16.03     -0.67      0.00      3.71     58.54
              67     -1.15     17.83      0.67      0.00     -3.09    -74.26
          22  66     -0.03      0.06     -0.04      0.00      0.07      0.05
              67      0.03     -0.06      0.04      0.00     -0.04      0.01
         100  66      1.54    -24.11     -1.24      0.01      6.41     68.16
              67     -1.70     27.06      1.24     -0.01     -5.26    -91.91
         101  66      1.03    -15.97     -0.71      0.00      3.79     58.59
              67     -1.12     17.77      0.71      0.00     -3.13    -74.25
         111  66      3.31    -51.81     -2.67      0.01     13.81    146.56
              67     -3.64     58.15      2.67     -0.01    -11.33   -197.60
         115  66      3.73    -56.41     -2.65      0.01     14.26    147.46
              67     -4.10     63.49      2.65     -0.01    -11.80   -203.12
         116  66      2.16    -34.24     -1.59      0.01      8.26    126.06
              67     -2.36     38.11      1.59     -0.01     -6.79   -159.64
         121  66      2.21    -34.48     -1.77      0.01      9.17     97.47
              67     -2.43     38.69      1.77     -0.01     -7.53   -131.43
         125  66      2.49    -37.54     -1.75      0.01      9.47     98.07
              67     -2.74     42.24      1.75     -0.01     -7.84   -135.10
         126  66      1.44    -22.79     -1.05      0.01      5.47     83.83
              67     -1.58     25.36      1.05     -0.01     -4.50   -106.18


  MEMBER END FORCES    STRUCTURE TYPE = SPACE
  -----------------
  ALL UNITS ARE -- KN   METE     (LOCAL )

MEMBER  LOAD  JT     AXIAL   SHEAR-Y  SHEAR-Z   TORSION     MOM-Y      MOM-Z


         211  66      2.20    -34.33     -1.54      0.01      8.16    125.99
              67     -2.40     38.19      1.54     -0.01     -6.73   -159.65
         221  66      1.47    -22.84     -1.02      0.01      5.41     83.79
              67     -1.60     25.41      1.02     -0.01     -4.47   -106.18


  ************** END OF LATEST ANALYSIS RESULT **************


  159. PRINT MEMBER STRESSES LIST 23 31 TO 37 46 200 201


MEMBER STRESSES
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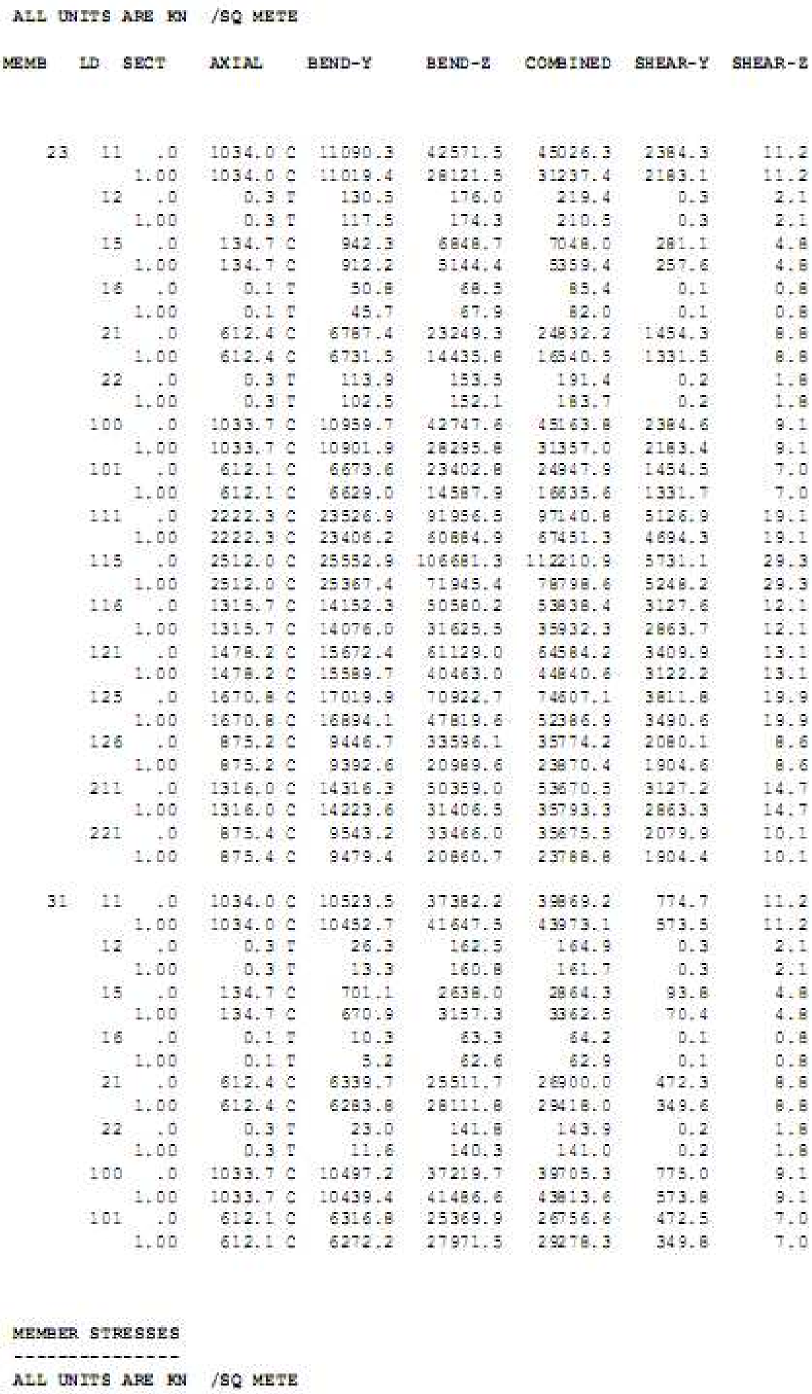

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 ALL UNITS ARE KN  /SQ METE

MEMB   LD  SECT     AXIAL    BEND-Y     BEND-Z   COMBINED  SHEAR-Y  SHEAR-Z


    23   11   .0    1034.0 C  11090.3   42571.5   45026.3   2384.3     11.2
              1.00  1034.0 C  11019.4   28121.5   31237.4   2183.1     11.2
         12   .0       0.3 T    130.5     176.0     219.4      0.3      2.1
              1.00     0.3 T    117.5     174.3     210.5      0.3      2.1
         15   .0     134.7 C    942.3    6848.7    7048.0    281.1      4.8
              1.00   134.7 C    912.2    5144.4    5359.4    257.6      4.8
         16   .0       0.1 T     50.8      68.5      85.4      0.1      0.8
              1.00     0.1 T     45.7      67.9      82.0      0.1      0.8
         21   .0     612.4 C   6787.4   23249.3   24832.2   1454.3      8.8
              1.00   612.4 C   6731.5   14435.8   16540.5   1331.5      8.8
         22   .0       0.3 T    113.9     153.5     191.4      0.2      1.8
              1.00     0.3 T    102.5     152.1     183.7      0.2      1.8
        100   .0    1033.7 C  10959.7   42747.6   45163.8   2384.6      9.1
              1.00  1033.7 C  10901.9   28295.8   31357.0   2183.4      9.1
        101   .0     612.1 C   6673.6   23402.8   24947.9   1454.5      7.0
              1.00   612.1 C   6629.0   14587.9   16635.6   1331.7      7.0
        111   .0    2222.3 C  23526.9   91956.5   97140.8   5126.9     19.1
              1.00  2222.3 C  23406.2   60884.9   67451.3   4694.3     19.1
        115   .0    2512.0 C  25552.9  106681.3  112210.9   5731.1     29.3
              1.00  2512.0 C  25367.4   71945.4   78798.6   5248.2     29.3
        116   .0    1315.7 C  14152.3   50580.2   53838.4   3127.6     12.1
              1.00  1315.7 C  14076.0   31625.5   35932.3   2863.7     12.1
        121   .0    1478.2 C  15672.4   61129.0   64584.2   3409.9     13.1
              1.00  1478.2 C  15589.7   40463.0   44840.6   3122.2     13.1
        125   .0    1670.8 C  17019.9   70922.7   74607.1   3811.8     19.9
              1.00  1670.8 C  16894.1   47819.6   52386.9   3490.6     19.9
        126   .0     875.2 C   9446.7   33596.1   35774.2   2080.1      8.6
              1.00   875.2 C   9392.6   20989.6   23870.4   1904.6      8.6
        211   .0    1316.0 C  14316.3   50359.0   53670.5   3127.2     14.7
              1.00  1316.0 C  14223.6   31406.5   35793.3   2863.3     14.7
        221   .0     875.4 C   9543.2   33466.0   35675.5   2079.9     10.1
              1.00   875.4 C   9479.4   20860.7   23788.8   1904.4     10.1

    31   11   .0    1034.0 C  10523.5   37382.2   39869.2    774.7     11.2
              1.00  1034.0 C  10452.7   41647.5   43973.1    573.5     11.2
         12   .0       0.3 T     26.3     162.5     164.9      0.3      2.1
              1.00     0.3 T     13.3     160.8     161.7      0.3      2.1
         15   .0     134.7 C    701.1    2638.0    2864.3     93.8      4.8
              1.00   134.7 C    670.9    3157.3    3362.5     70.4      4.8
         16   .0       0.1 T     10.3      63.3      64.2      0.1      0.8
              1.00     0.1 T      5.2      62.6      62.9      0.1      0.8
         21   .0     612.4 C   6339.7   25511.7   26900.0    472.3      8.8
              1.00   612.4 C   6283.8   28111.8   29418.0    349.6      8.8
         22   .0       0.3 T     23.0     141.8     143.9      0.2      1.8
              1.00     0.3 T     11.6     140.3     141.0      0.2      1.8
        100   .0    1033.7 C  10497.2   37219.7   39705.3    775.0      9.1
              1.00  1033.7 C  10439.4   41486.6   43813.6    573.8      9.1
        101   .0     612.1 C   6316.8   25369.9   26756.6    472.5      7.0
              1.00   612.1 C   6272.2   27971.5   29278.3    349.8      7.0


 MEMBER STRESSES
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 ALL UNITS ARE KN  /SQ METE
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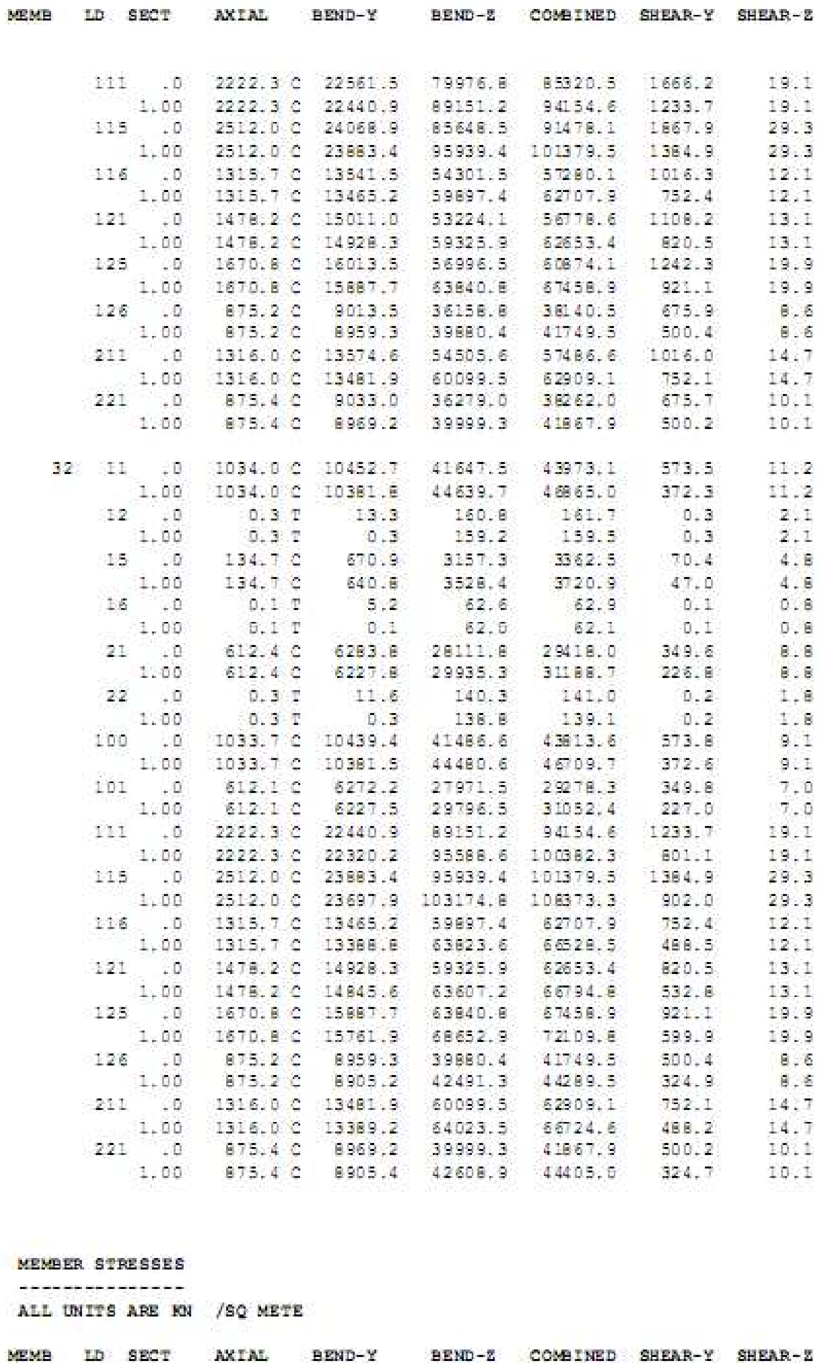

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MEMB   LD  SECT    AXIAL     BEND-Y      BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z


       111    .0   2222.3 C  22561.5    79976.8    85320.5   1666.2     19.1
            1.00   2222.3 C  22440.9    89151.2    94154.6   1233.7     19.1
       115    .0   2512.0 C  24068.9    85648.5    91478.1   1867.9     29.3
            1.00   2512.0 C  23883.4    95939.4   101379.5   1384.9     29.3
       116    .0   1315.7 C  13541.5    54301.5    57280.1   1016.3     12.1
            1.00   1315.7 C  13465.2    59897.4    62707.9    752.4     12.1
       121    .0   1478.2 C  15011.0    53224.1    56778.6   1108.2     13.1
            1.00   1478.2 C  14928.3    59325.9    62653.4    820.5     13.1
       125    .0   1670.8 C  16013.5    56996.5    60874.1   1242.3     19.9
            1.00   1670.8 C  15887.7    63840.8    67458.9    921.1     19.9
       126    .0    875.2 C   9013.5    36158.8    38140.5    675.9      8.6
            1.00    875.2 C   8959.3    39880.4    41749.5    500.4      8.6
       211    .0   1316.0 C  13574.6    54505.6    57486.6   1016.0     14.7
            1.00   1316.0 C  13481.9    60099.5    62909.1    752.1     14.7
       221    .0    875.4 C   9033.0    36279.0    38262.0    675.7     10.1
            1.00    875.4 C   8969.2    39999.3    41867.9    500.2     10.1

  32    11    .0   1034.0 C  10452.7    41647.5    43973.1    573.5     11.2
            1.00   1034.0 C  10381.8    44639.7    46865.0    372.3     11.2
        12    .0      0.3 T     13.3      160.8      161.7      0.3      2.1
            1.00      0.3 T      0.3      159.2      159.5      0.3      2.1
        15    .0    134.7 C    670.9     3157.3     3362.5     70.4      4.8
            1.00    134.7 C    640.8     3528.4     3720.9     47.0      4.8
        16    .0      0.1 T      5.2       62.6       62.9      0.1      0.8
            1.00      0.1 T      0.1       62.0       62.1      0.1      0.8
        21    .0    612.4 C   6283.8    28111.8    29418.0    349.6      8.8
            1.00    612.4 C   6227.8    29935.3    31188.7    226.8      8.8
        22    .0      0.3 T     11.6      140.3      141.0      0.2      1.8
            1.00      0.3 T      0.3      138.8      139.1      0.2      1.8
       100    .0   1033.7 C  10439.4    41486.6    43813.6    573.8      9.1
            1.00   1033.7 C  10381.5    44480.6    46709.7    372.6      9.1
       101    .0    612.1 C   6272.2    27971.5    29278.3    349.8      7.0
            1.00    612.1 C   6227.5    29796.5    31052.4    227.0      7.0
       111    .0   2222.3 C  22440.9    89151.2    94154.6   1233.7     19.1
            1.00   2222.3 C  22320.2    95588.6   100382.3    801.1     19.1
       115    .0   2512.0 C  23883.4    95939.4   101379.5   1384.9     29.3
            1.00   2512.0 C  23697.9   103174.8   108373.3    902.0     29.3
       116    .0   1315.7 C  13465.2    59897.4    62707.9    752.4     12.1
            1.00   1315.7 C  13388.8    63823.6    66528.5    488.5     12.1
       121    .0   1478.2 C  14928.3    59325.9    62653.4    820.5     13.1
            1.00   1478.2 C  14845.6    63607.2    66794.8    532.8     13.1
       125    .0   1670.8 C  15887.7    63840.8    67458.9    921.1     19.9
            1.00   1670.8 C  15761.9    68652.9    72109.8    599.9     19.9
       126    .0    875.2 C   8959.3    39880.4    41749.5    500.4      8.6
            1.00    875.2 C   8905.2    42491.3    44289.5    324.9      8.6
       211    .0   1316.0 C  13481.9    60099.5    62909.1    752.1     14.7
            1.00   1316.0 C  13389.2    64023.5    66724.6    488.2     14.7
       221    .0    875.4 C   8969.2    39999.3    41867.9    500.2     10.1
            1.00    875.4 C   8905.4    42608.9    44405.0    324.7     10.1


 MEMBER STRESSES
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 ALL UNITS ARE KN  /SQ METE

MEMB   LD  SECT    AXIAL     BEND-Y      BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z
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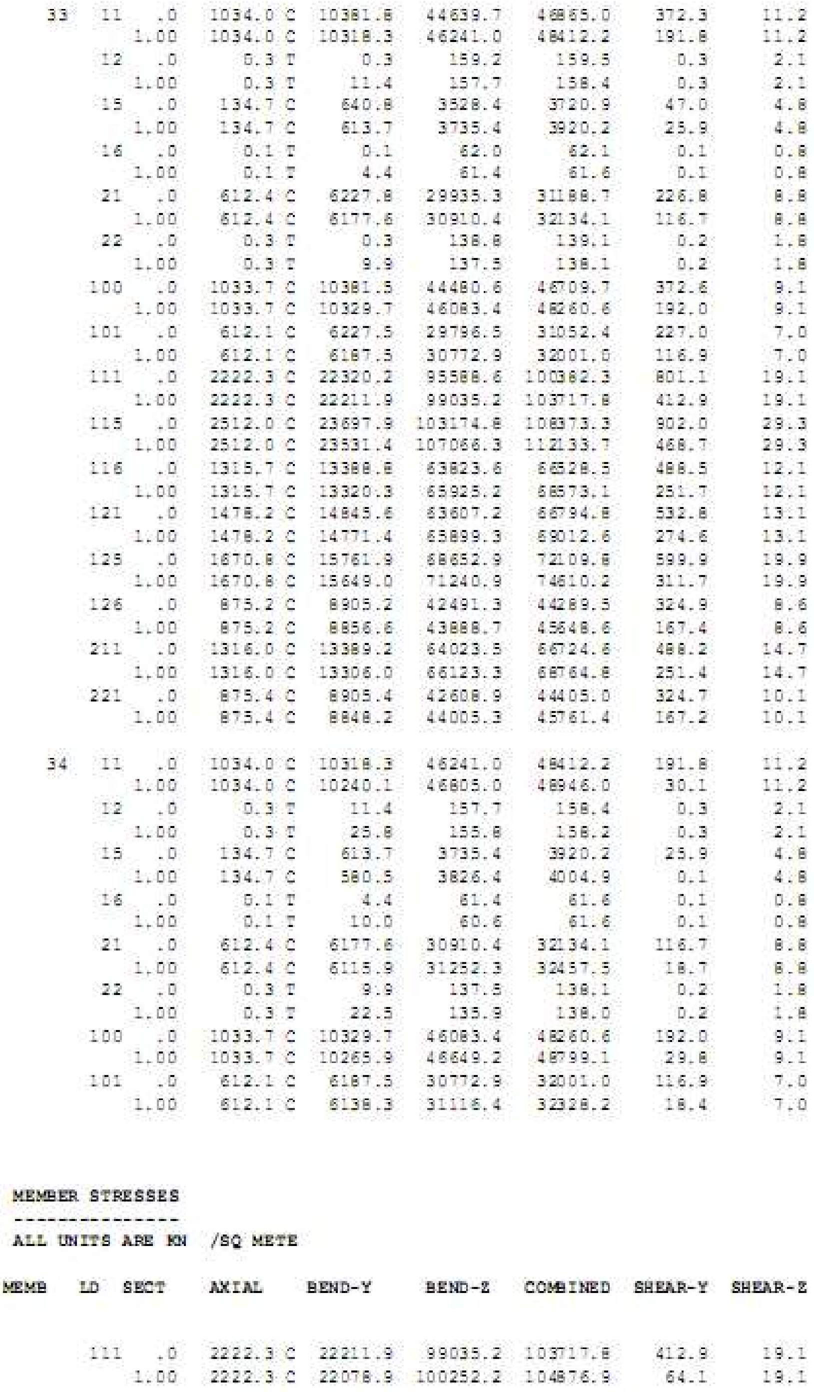

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  33   11    .0    1034.0 C  10381.8   44639.7   46865.0     372.3      11.2
            1.00   1034.0 C  10318.3   46241.0   48412.2     191.8      11.2
       12    .0       0.3 T      0.3     159.2     159.5       0.3       2.1
            1.00      0.3 T     11.4     157.7     158.4       0.3       2.1
       15    .0     134.7 C    640.8    3528.4    3720.9      47.0       4.8
            1.00    134.7 C    613.7    3735.4    3920.2      25.9       4.8
       16    .0       0.1 T      0.1      62.0      62.1       0.1       0.8
            1.00      0.1 T      4.4      61.4      61.6       0.1       0.8
       21    .0     612.4 C   6227.8   29935.3   31188.7     226.8       8.8
            1.00    612.4 C   6177.6   30910.4   32134.1     116.7       8.8
       22    .0       0.3 T      0.3     138.8     139.1       0.2       1.8
            1.00      0.3 T      9.9     137.5     138.1       0.2       1.8
      100    .0    1033.7 C  10381.5   44480.6   46709.7     372.6       9.1
            1.00   1033.7 C  10329.7   46083.4   48260.6     192.0       9.1
      101    .0     612.1 C   6227.5   29796.5   31052.4     227.0       7.0
            1.00    612.1 C   6187.5   30772.9   32001.0     116.9       7.0
      111    .0    2222.3 C  22320.2   95588.6  100382.3     801.1      19.1
            1.00   2222.3 C  22211.9   99035.2  103717.8     412.9      19.1
      115    .0    2512.0 C  23697.9  103174.8  108373.3     902.0      29.3
            1.00   2512.0 C  23531.4  107066.3  112133.7     468.7      29.3
      116    .0    1315.7 C  13388.8   63823.6   66528.5     488.5      12.1
            1.00   1315.7 C  13320.3   65925.2   68573.1     251.7      12.1
      121    .0    1478.2 C  14845.6   63607.2   66794.8     532.8      13.1
            1.00   1478.2 C  14771.4   65899.3   69012.6     274.6      13.1
      125    .0    1670.8 C  15761.9   68652.9   72109.8     599.9      19.9
            1.00   1670.8 C  15649.0   71240.9   74610.2     311.7      19.9
      126    .0     875.2 C   8905.2   42491.3   44289.5     324.9       8.6
            1.00    875.2 C   8856.6   43888.7   45648.6     167.4       8.6
      211    .0    1316.0 C  13389.2   64023.5   66724.6     488.2      14.7
            1.00   1316.0 C  13306.0   66123.3   68764.8     251.4      14.7
      221    .0     875.4 C   8905.4   42608.9   44405.0     324.7      10.1
            1.00    875.4 C   8848.2   44005.3   45761.4     167.2      10.1

  34   11    .0    1034.0 C  10318.3   46241.0   48412.2     191.8      11.2
            1.00   1034.0 C  10240.1   46805.0   48946.0      30.1      11.2
       12    .0       0.3 T     11.4     157.7     158.4       0.3       2.1
            1.00      0.3 T     25.8     155.8     158.2       0.3       2.1
       15    .0     134.7 C    613.7    3735.4    3920.2      25.9       4.8
            1.00    134.7 C    580.5    3826.4    4004.9       0.1       4.8
       16    .0       0.1 T      4.4      61.4      61.6       0.1       0.8
            1.00      0.1 T     10.0      60.6      61.6       0.1       0.8
       21    .0     612.4 C   6177.6   30910.4   32134.1     116.7       8.8
            1.00    612.4 C   6115.9   31252.3   32457.5      18.7       8.8
       22    .0       0.3 T      9.9     137.5     138.1       0.2       1.8
            1.00      0.3 T     22.5     135.9     138.0       0.2       1.8
      100    .0    1033.7 C  10329.7   46083.4   48260.6     192.0       9.1
            1.00   1033.7 C  10265.9   46649.2   48799.1      29.8       9.1
      101    .0     612.1 C   6187.5   30772.9   32001.0     116.9       7.0
            1.00    612.1 C   6138.3   31116.4   32328.2      18.4       7.0


 MEMBER STRESSES
 ---------------
 ALL UNITS ARE KN  /SQ METE

MEMB   LD  SECT     AXIAL    BEND-Y     BEND-Z   COMBINED  SHEAR-Y  SHEAR-Z


      111    .0    2222.3 C  22211.9   99035.2  103717.8     412.9      19.1
            1.00   2222.3 C  22078.9  100252.2  104876.9      64.1      19.1
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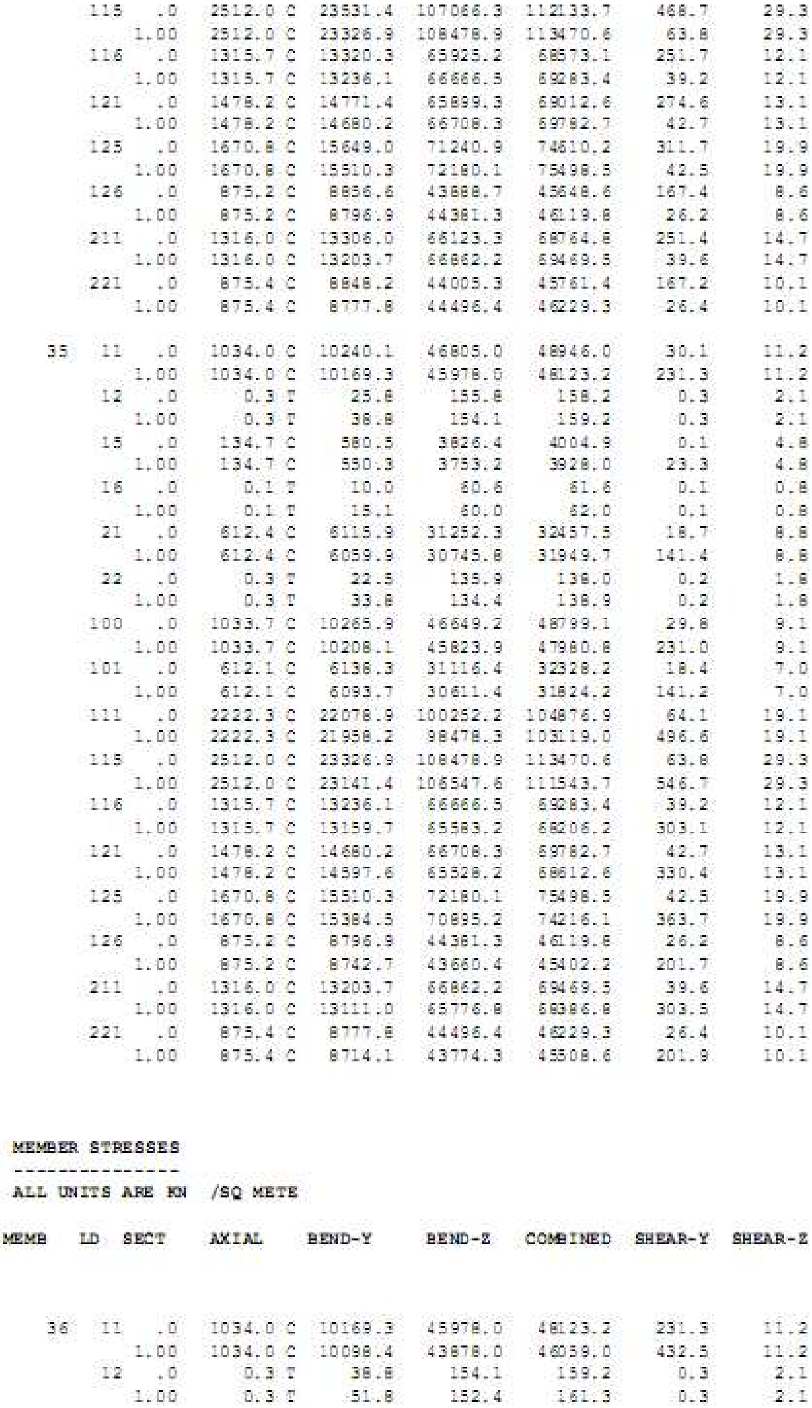

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         115    .0    2512.0 C   23531.4  107066.3  112133.7     468.7      29.3
              1.00    2512.0 C   23326.9  108478.9  113470.6      63.8      29.3
         116    .0    1315.7 C   13320.3   65925.2   68573.1     251.7      12.1
              1.00    1315.7 C   13236.1   66666.5   69283.4      39.2      12.1
         121    .0    1478.2 C   14771.4   65899.3   69012.6     274.6      13.1
              1.00    1478.2 C   14680.2   66708.3   69782.7      42.7      13.1
         125    .0    1670.8 C   15649.0   71240.9   74610.2     311.7      19.9
              1.00    1670.8 C   15510.3   72180.1   75498.5      42.5      19.9
         126    .0     875.2 C    8856.6   43888.7   45648.6     167.4       8.6
              1.00     875.2 C    8796.9   44381.3   46119.8      26.2       8.6
         211    .0    1316.0 C   13306.0   66123.3   68764.8     251.4      14.7
              1.00    1316.0 C   13203.7   66862.2   69469.5      39.6      14.7
         221    .0     875.4 C    8848.2   44005.3   45761.4     167.2      10.1
              1.00     875.4 C    8777.8   44496.4   46229.3      26.4      10.1

    35    11    .0    1034.0 C   10240.1   46805.0   48946.0      30.1      11.2
              1.00    1034.0 C   10169.3   45978.0   48123.2     231.3      11.2
          12    .0       0.3 T      25.8     155.8     158.2       0.3       2.1
              1.00       0.3 T      38.8     154.1     159.2       0.3       2.1
          15    .0     134.7 C     580.5    3826.4    4004.9       0.1       4.8
              1.00     134.7 C     550.3    3753.2    3928.0      23.3       4.8
          16    .0       0.1 T      10.0      60.6      61.6       0.1       0.8
              1.00       0.1 T      15.1      60.0      62.0       0.1       0.8
          21    .0     612.4 C    6115.9   31252.3   32457.5      18.7       8.8
              1.00     612.4 C    6059.9   30745.8   31949.7     141.4       8.8
          22    .0       0.3 T      22.5     135.9     136.0       0.2       1.8
              1.00       0.3 T      33.8     134.4     138.9       0.2       1.8
         100    .0    1033.7 C   10265.9   46649.2   48799.1      29.8       9.1
              1.00    1033.7 C   10208.1   45823.9   47980.8     231.0       9.1
         101    .0     612.1 C    6138.3   31116.4   32328.2      18.4       7.0
              1.00     612.1 C    6093.7   30611.4   31824.2     141.2       7.0
         111    .0    2222.3 C   22078.9  100252.2  104876.9      64.1      19.1
              1.00    2222.3 C   21958.2   98478.3  103119.0     496.6      19.1
         115    .0    2512.0 C   23326.9  108478.9  113470.6      63.8      29.3
              1.00    2512.0 C   23141.4  106547.6  111543.7     546.7      29.3
         116    .0    1315.7 C   13236.1   66666.5   69283.4      39.2      12.1
              1.00    1315.7 C   13159.7   65583.2   68206.2     303.1      12.1
         121    .0    1478.2 C   14680.2   66708.3   69782.7      42.7      13.1
              1.00    1478.2 C   14597.6   65528.2   68612.6     330.4      13.1
         125    .0    1670.8 C   15510.3   72180.1   75498.5      42.5      19.9
              1.00    1670.8 C   15384.5   70895.2   74216.1     363.7      19.9
         126    .0     875.2 C    8796.9   44381.3   46119.8      26.2       8.6
              1.00     875.2 C    8742.7   43660.4   45402.2     201.7       8.6
         211    .0    1316.0 C   13203.7   66862.2   69469.5      39.6      14.7
              1.00    1316.0 C   13111.0   65776.8   68386.8     303.5      14.7
         221    .0     875.4 C    8777.8   44496.4   46229.3      26.4      10.1
              1.00     875.4 C    8714.1   43774.3   45508.6     201.9      10.1


 MEMBER STRESSES
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 ALL UNITS ARE KN  /SQ METE

MEMB   LD   SECT    AXIAL     BEND-Y     BEND-Z    COMBINED  SHEAR-Y   SHEAR-Z


    36    11    .0    1034.0 C   10169.3   45978.0   48123.2     231.3      11.2
              1.00    1034.0 C   10098.4   43878.0   46059.0     432.5      11.2
          12    .0       0.3 T      38.8     154.1     159.2       0.3       2.1
              1.00       0.3 T      51.8     152.4     161.3       0.3       2.1
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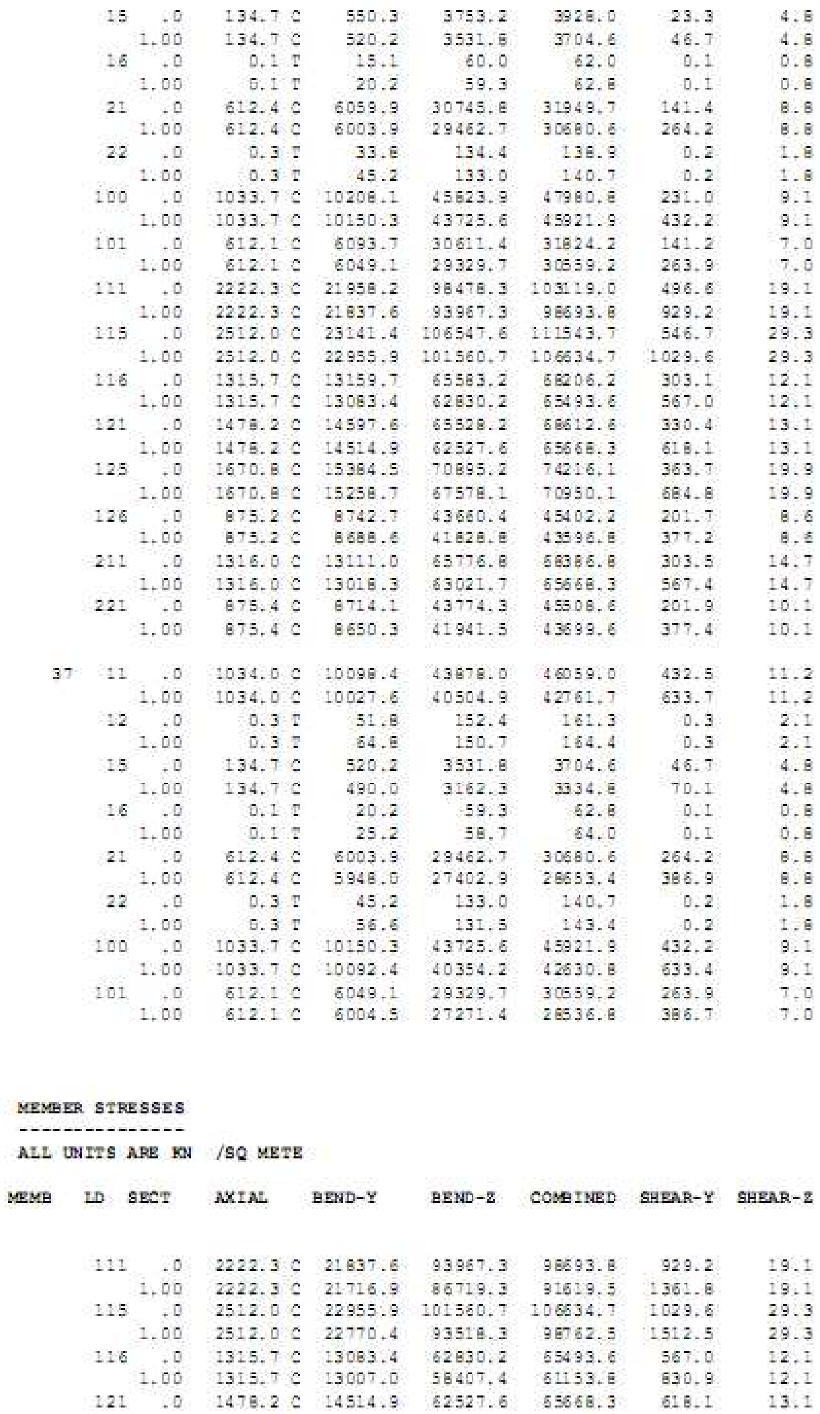

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         15    .0    134.7 C    550.3    3753.2    3928.0     23.3      4.8
             1.00    134.7 C    520.2    3531.8    3704.6     46.7      4.8
         16    .0      0.1 T     15.1      60.0      62.0      0.1      0.8
             1.00      0.1 T     20.2      59.3      62.8      0.1      0.8
         21    .0    612.4 C   6059.9   30745.8   31949.7    141.4      8.8
             1.00    612.4 C   6003.9   29462.7   30680.6    264.2      8.8
         22    .0      0.3 T     33.8     134.4     138.9      0.2      1.8
             1.00      0.3 T     45.2     133.0     140.7      0.2      1.8
        100    .0   1033.7 C  10208.1   45823.9   47980.8    231.0      9.1
             1.00   1033.7 C  10150.3   43725.6   45921.9    432.2      9.1
        101    .0    612.1 C   6093.7   30611.4   31824.2    141.2      7.0
             1.00    612.1 C   6049.1   29329.7   30559.2    263.9      7.0
        111    .0   2222.3 C  21958.2   98478.3  103119.0    496.6     19.1
             1.00   2222.3 C  21837.6   93967.3   98693.8    929.2     19.1
        115    .0   2512.0 C  23141.4  106547.6  111543.7    546.7     29.3
             1.00   2512.0 C  22955.9  101560.7  106634.7   1029.6     29.3
        116    .0   1315.7 C  13159.7   65583.2   68206.2    303.1     12.1
             1.00   1315.7 C  13083.4   62830.2   65493.6    567.0     12.1
        121    .0   1478.2 C  14597.6   65528.2   68612.6    330.4     13.1
             1.00   1478.2 C  14514.9   62527.6   65668.3    618.1     13.1
        125    .0   1670.8 C  15384.5   70895.2   74216.1    363.7     19.9
             1.00   1670.8 C  15258.7   67578.1   70950.1    684.8     19.9
        126    .0    875.2 C   8742.7   43660.4   45402.2    201.7      8.6
             1.00    875.2 C   8688.6   41828.8   43596.8    377.2      8.6
        211    .0   1316.0 C  13111.0   65776.8   68386.8    303.5     14.7
             1.00   1316.0 C  13018.3   63021.7   65668.3    567.4     14.7
        221    .0    875.4 C   8714.1   43774.3   45508.6    201.9     10.1
             1.00    875.4 C   8650.3   41941.5   43699.6    377.4     10.1

   37    11    .0   1034.0 C  10098.4   43878.0   46059.0    432.5     11.2
             1.00   1034.0 C  10027.6   40504.9   42761.7    633.7     11.2
         12    .0      0.3 T     51.8     152.4     161.3      0.3      2.1
             1.00      0.3 T     64.8     150.7     164.4      0.3      2.1
         15    .0    134.7 C    520.2    3531.8    3704.6     46.7      4.8
             1.00    134.7 C    490.0    3162.3    3334.8     70.1      4.8
         16    .0      0.1 T     20.2      59.3      62.8      0.1      0.8
             1.00      0.1 T     25.2      58.7      64.0      0.1      0.8
         21    .0    612.4 C   6003.9   29462.7   30680.6    264.2      8.8
             1.00    612.4 C   5948.0   27402.9   28653.4    386.9      8.8
         22    .0      0.3 T     45.2     133.0     140.7      0.2      1.8
             1.00      0.3 T     56.6     131.5     143.4      0.2      1.8
        100    .0   1033.7 C  10150.3   43725.6   45921.9    432.2      9.1
             1.00   1033.7 C  10092.4   40354.2   42630.8    633.4      9.1
        101    .0    612.1 C   6049.1   29329.7   30559.2    263.9      7.0
             1.00    612.1 C   6004.5   27271.4   28536.8    386.7      7.0


 MEMBER STRESSES
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 ALL UNITS ARE KN  /SQ METE

MEMB   LD  SECT    AXIAL     BEND-Y     BEND-Z   COMBINED  SHEAR-Y  SHEAR-Z


        111    .0   2222.3 C  21837.6   93967.3   98693.8    929.2     19.1
             1.00   2222.3 C  21716.9   86719.3   91619.5   1361.8     19.1
        115    .0   2512.0 C  22955.9  101560.7  106634.7   1029.6     29.3
             1.00   2512.0 C  22770.4   93518.3   98762.5   1512.5     29.3
        116    .0   1315.7 C  13083.4   62830.2   65493.6    567.0     12.1
             1.00   1315.7 C  13007.0   58407.4   61153.8    830.9     12.1
        121    .0   1478.2 C  14514.9   62527.6   65668.3    618.1     13.1
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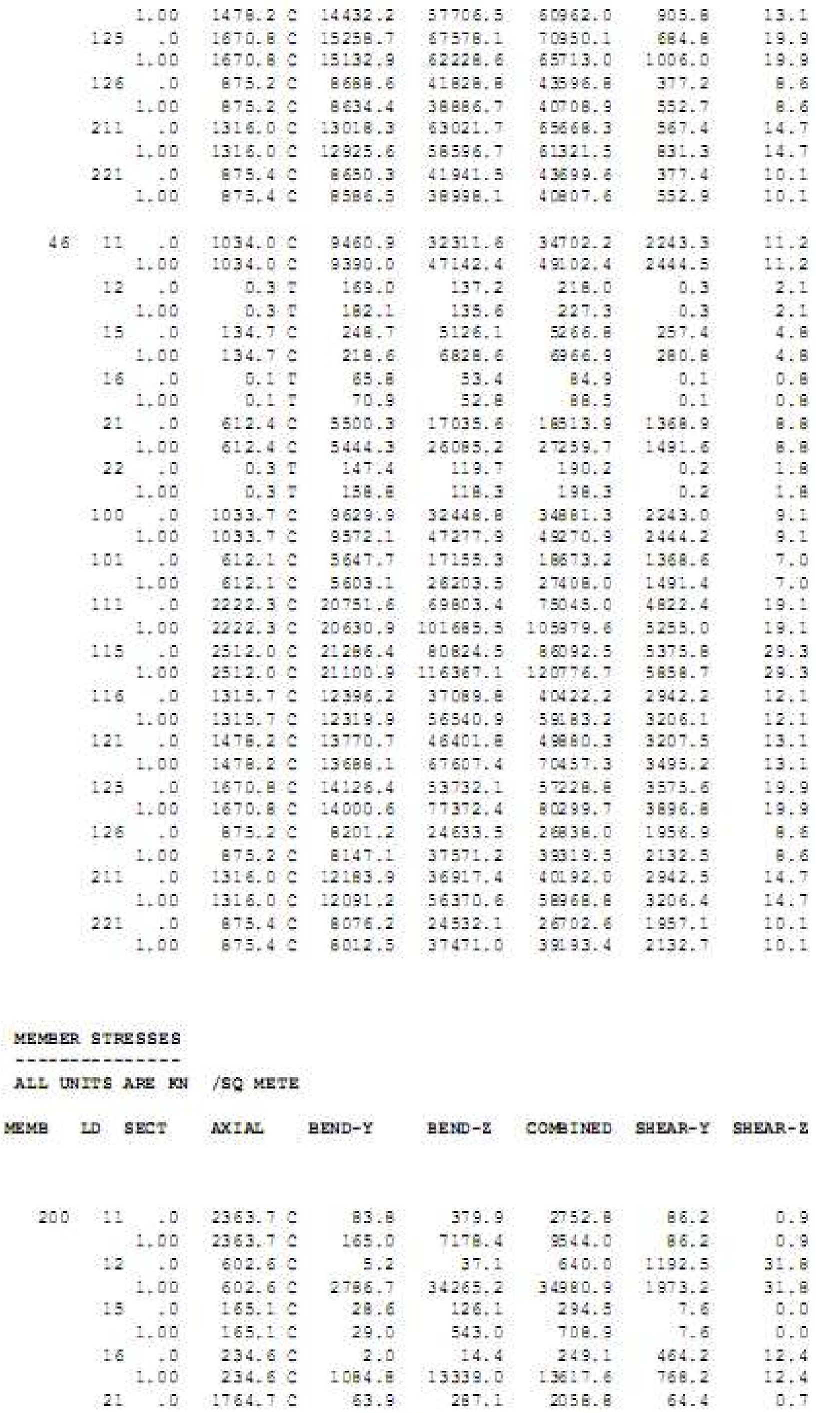

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              1.00   1478.2 C  14432.2   57706.5   60962.0    905.8      13.1
        125    .0    1670.8 C  15258.7   67578.1   70950.1    684.8      19.9
              1.00   1670.8 C  15132.9   62228.6   65713.0   1006.0      19.9
        126    .0     875.2 C   8688.6   41828.8   43596.8    377.2       8.6
              1.00    875.2 C   8634.4   38886.7   40708.9    552.7       8.6
        211    .0    1316.0 C  13018.3   63021.7   65668.3    567.4      14.7
              1.00   1316.0 C  12925.6   58596.7   61321.5    831.3      14.7
        221    .0     875.4 C   8650.3   41941.5   43699.6    377.4      10.1
              1.00    875.4 C   8586.5   38998.1   40807.6    552.9      10.1

    46   11    .0    1034.0 C   9460.9   32311.6   34702.2   2243.3      11.2
              1.00   1034.0 C   9390.0   47142.4   49102.4   2444.5      11.2
         12    .0       0.3 T    169.0     137.2     218.0      0.3       2.1
              1.00      0.3 T    182.1     135.6     227.3      0.3       2.1
         15    .0     134.7 C    248.7    5126.1    5266.8    257.4       4.8
              1.00    134.7 C    218.6    6828.6    6966.9    280.8       4.8
         16    .0       0.1 T     65.8      53.4      84.9      0.1       0.8
              1.00      0.1 T     70.9      52.8      88.5      0.1       0.8
         21    .0     612.4 C   5500.3   17035.6   18513.9   1368.9       8.8
              1.00    612.4 C   5444.3   26085.2   27259.7   1491.6       8.8
         22    .0       0.3 T    147.4     119.7     190.2      0.2       1.8
              1.00      0.3 T    158.8     118.3     198.3      0.2       1.8
        100    .0    1033.7 C   9629.9   32448.8   34881.3   2243.0       9.1
              1.00   1033.7 C   9572.1   47277.9   49270.9   2444.2       9.1
        101    .0     612.1 C   5647.7   17155.3   18673.2   1368.6       7.0
              1.00    612.1 C   5603.1   26203.5   27408.0   1491.4       7.0
        111    .0    2222.3 C  20751.6   69803.4   75045.0   4822.4      19.1
              1.00   2222.3 C  20630.9  101685.5  105979.6   5255.0      19.1
        115    .0    2512.0 C  21286.4   80824.5   86092.5   5375.8      29.3
              1.00   2512.0 C  21100.9  116367.1  120776.7   5858.7      29.3
        116    .0    1315.7 C  12396.2   37089.8   40422.2   2942.2      12.1
              1.00   1315.7 C  12319.9   56540.9   59183.2   3206.1      12.1
        121    .0    1478.2 C  13770.7   46401.8   49880.3   3207.5      13.1
              1.00   1478.2 C  13688.1   67607.4   70457.3   3495.2      13.1
        125    .0    1670.8 C  14126.4   53732.1   57228.8   3575.6      19.9
              1.00   1670.8 C  14000.6   77372.4   80299.7   3896.8      19.9
        126    .0     875.2 C   8201.2   24633.5   26836.0   1956.9       8.6
              1.00    875.2 C   8147.1   37571.2   39319.5   2132.5       8.6
        211    .0    1316.0 C  12183.9   36917.4   40192.0   2942.5      14.7
              1.00   1316.0 C  12091.2   56370.6   58968.8   3206.4      14.7
        221    .0     875.4 C   8076.2   24532.1   26702.6   1957.1      10.1
              1.00    875.4 C   8012.5   37471.0   39193.4   2132.7      10.1


  MEMBER STRESSES
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  ALL UNITS ARE KN  /SQ METE

 MEMB   LD  SECT    AXIAL    BEND-Y     BEND-Z    COMBINED  SHEAR-Y  SHEAR-Z


   200   11    .0    2363.7 C     83.8     379.9    2752.8     86.2       0.9
              1.00   2363.7 C    165.0    7178.4    9544.0     86.2       0.9
         12    .0     602.6 C      5.2      37.1     640.0   1192.5      31.8
              1.00    602.6 C   2786.7   34265.2   34980.9   1973.2      31.8
         15    .0     165.1 C     28.6     126.1     294.5      7.6       0.0
              1.00    165.1 C     29.0     543.0     708.9      7.6       0.0
         16    .0     234.6 C      2.0      14.4     249.1    464.2      12.4
              1.00    234.6 C   1084.8   13339.0   13617.6    768.2      12.4
         21    .0    1764.7 C     63.9     287.1    2058.8     64.4       0.7
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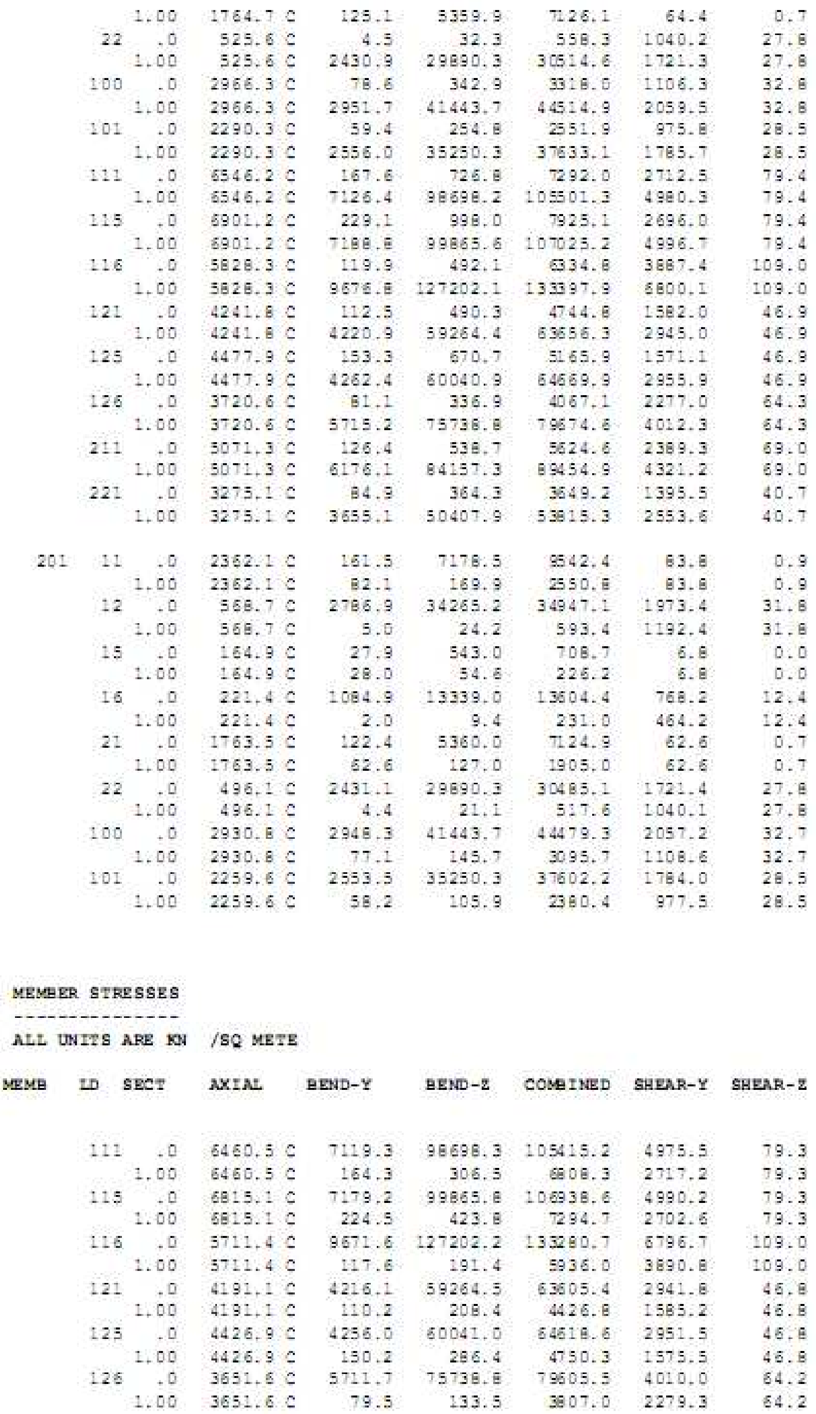

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                 1.00    1764.7 C     125.1     5359.9     7126.1      64.4       0.7
            22    .0      525.6 C       4.5       32.3      558.3    1040.2      27.8
                 1.00     525.6 C    2430.9    29890.3    30514.6    1721.3      27.8
           100    .0     2966.3 C      78.6      342.9     3318.0    1106.3      32.8
                 1.00    2966.3 C    2951.7    41443.7    44514.9    2059.5      32.8
           101    .0     2290.3 C      59.4      254.8     2551.9     975.8      28.5
                 1.00    2290.3 C    2556.0    35250.3    37633.1    1785.7      28.5
           111    .0     6546.2 C     167.6      726.8     7292.0    2712.5      79.4
                 1.00    6546.2 C    7126.4    98698.2   105501.3    4980.3      79.4
           115    .0     6901.2 C     229.1      998.0     7925.1    2696.0      79.4
                 1.00    6901.2 C    7188.8    99865.6   107025.2    4996.7      79.4
           116    .0     5828.3 C     119.9      492.1     6334.8    3887.4     109.0
                 1.00    5828.3 C    9676.8   127202.1   133397.9    6800.1     109.0
           121    .0     4241.8 C     112.5      490.3     4744.8    1582.0      46.9
                 1.00    4241.8 C    4220.9    59264.4    63656.3    2945.0      46.9
           125    .0     4477.9 C     153.3      670.7     5165.9    1571.1      46.9
                 1.00    4477.9 C    4262.4    60040.9    64669.9    2955.9      46.9
           126    .0     3720.6 C      81.1      336.9     4067.1    2277.0      64.3
                 1.00    3720.6 C    5715.2    75738.8    79674.6    4012.3      64.3
           211    .0     5071.3 C     126.4      538.7     5624.6    2389.3      69.0
                 1.00    5071.3 C    6176.1    84157.3    89454.9    4321.2      69.0
           221    .0     3275.1 C      84.9      364.3     3649.2    1395.5      40.7
                 1.00    3275.1 C    3655.1    50407.9    53815.3    2553.6      40.7

     201    11    .0     2362.1 C     161.5     7178.5     9542.4      83.8       0.9
                 1.00    2362.1 C      82.1      169.9     2550.8      83.8       0.9
            12    .0      568.7 C    2786.9    34265.2    34947.1    1973.4      31.8
                 1.00     568.7 C       5.0       24.2      593.4    1192.4      31.8
            15    .0      164.9 C      27.9      543.0      708.7       6.8       0.0
                 1.00     164.9 C      28.0       54.6      226.2       6.8       0.0
            16    .0      221.4 C    1084.9    13339.0    13604.4     768.2      12.4
                 1.00     221.4 C       2.0        9.4      231.0     464.2      12.4
            21    .0     1763.5 C     122.4     5360.0     7124.9      62.6       0.7
                 1.00    1763.5 C      62.6      127.0     1905.0      62.6       0.7
            22    .0      496.1 C    2431.1    29890.3    30485.1    1721.4      27.8
                 1.00     496.1 C       4.4       21.1      517.6    1040.1      27.8
           100    .0     2930.8 C    2948.3    41443.7    44479.3    2057.2      32.7
                 1.00    2930.8 C      77.1      145.7     3095.7    1108.6      32.7
           101    .0     2259.6 C    2553.5    35250.3    37602.2    1784.0      28.5
                 1.00    2259.6 C      58.2      105.9     2380.4     977.5      28.5


  MEMBER STRESSES
  ---------------
  ALL UNITS ARE KN   /SQ METE

 MEMB    LD   SECT     AXIAL     BEND-Y      BEND-Z   COMBINED   SHEAR-Y   SHEAR-Z


           111    .0     6460.5 C    7119.3    98698.3   105415.2    4975.5      79.3
                 1.00    6460.5 C     164.3      306.5     6808.3    2717.2      79.3
           115    .0     6815.1 C    7179.2    99865.8   106938.6    4990.2      79.3
                 1.00    6815.1 C     224.5      423.8     7294.7    2702.6      79.3
           116    .0     5711.4 C    9671.6   127202.2   133280.7    6796.7     109.0
                 1.00    5711.4 C     117.6      191.4     5936.0    3890.8     109.0
           121    .0     4191.1 C    4216.1    59264.5    63605.4    2941.8      46.8
                 1.00    4191.1 C     110.2      208.4     4426.8    1585.2      46.8
           125    .0     4426.9 C    4256.0    60041.0    64618.6    2951.5      46.8
                 1.00    4426.9 C     150.2      286.4     4750.3    1575.5      46.8
           126    .0     3651.6 C    5711.7    75738.8    79605.5    4010.0      64.2
                 1.00    3651.6 C      79.5      133.5     3807.0    2279.3      64.2
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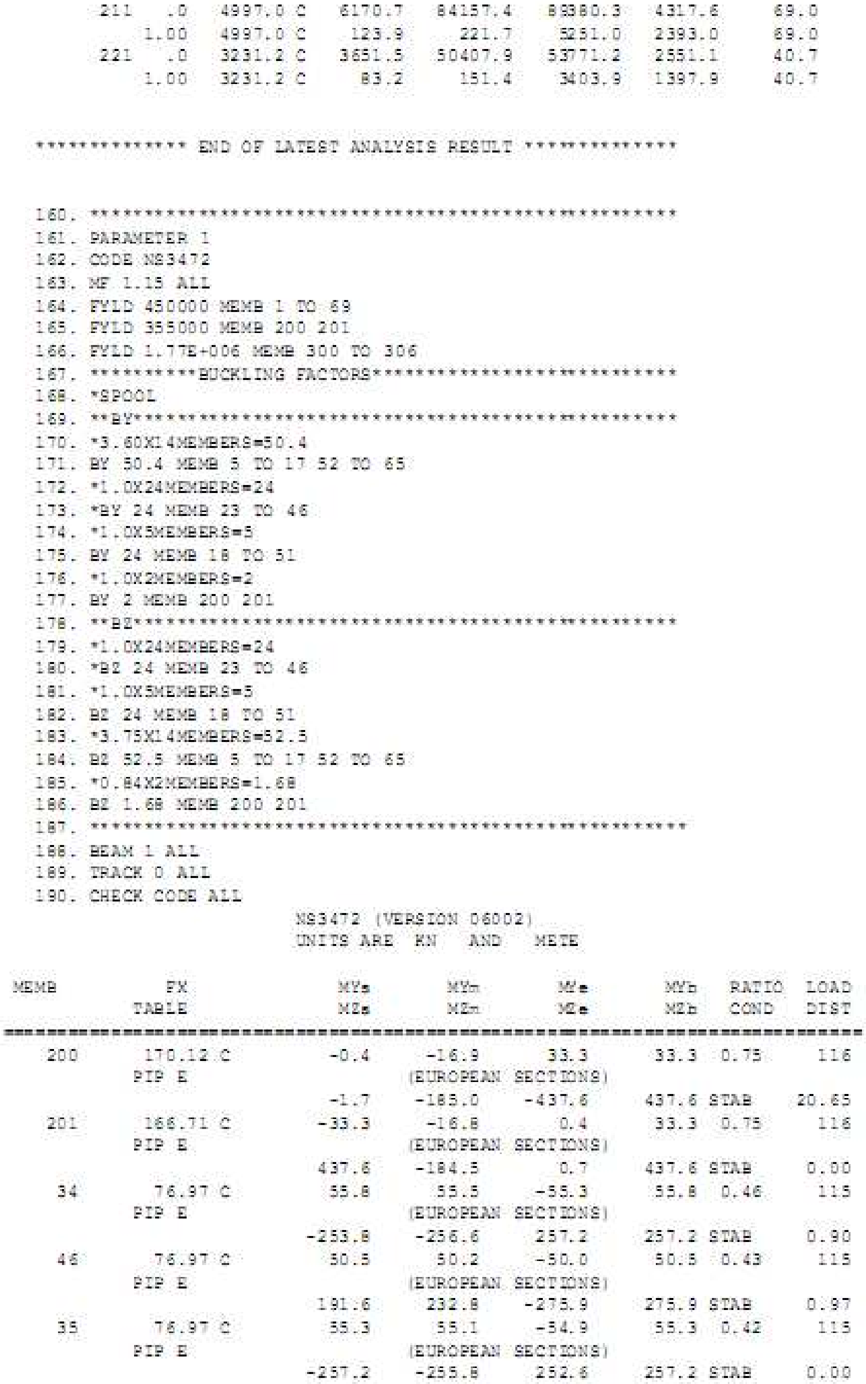

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      211    .0   4997.0 C   6170.7   84157.4   89380.3   4317.6      69.0
           1.00   4997.0 C    123.9     221.7    5251.0   2393.0      69.0
      221    .0   3231.2 C   3651.5   50407.9   53771.2   2551.1      40.7
           1.00   3231.2 C     83.2     151.4    3403.9   1397.9      40.7


 ************** END OF LATEST ANALYSIS RESULT **************


 160. ******************************************************
 161. PARAMETER 1
 162. CODE NS3472
 163. MF 1.15 ALL
 164. FYLD 450000 MEMB 1 TO 69
 165. FYLD 355000 MEMB 200 201
 166. FYLD 1.77E+006 MEMB 300 TO 306
 167. **********BUCKLING FACTORS****************************
 168. *SPOOL
 169. **BY***************************************************
 170. *3.60X14MEMBERS=50.4
 171. BY 50.4 MEMB 5 TO 17 52 TO 65
 172. *1.0X24MEMBERS=24
 173. *BY 24 MEMB 23 TO 46
 174. *1.0X5MEMBERS=5
 175. BY 24 MEMB 18 TO 51
 176. *1.0X2MEMBERS=2
 177. BY 2 MEMB 200 201
 178. **BZ***************************************************
 179. *1.0X24MEMBERS=24
 180. *BZ 24 MEMB 23 TO 46
 181. *1.0X5MEMBERS=5
 182. BZ 24 MEMB 18 TO 51
 183. *3.75X14MEMBERS=52.5
 184. BZ 52.5 MEMB 5 TO 17 52 TO 65
 185. *0.84X2MEMBERS=1.68
 186. BZ 1.68 MEMB 200 201
 187. *******************************************************
 188. BEAM 1 ALL
 189. TRACK 0 ALL
 190. CHECK CODE ALL
                        NS3472 (VERSION 06002)
                        UNITS ARE  KN   AND   METE

MEMB          FX               MYs       MYn       MYe       MYb  RATIO  LOAD
           TABLE               MZs       MZn       MZe       MZb  COND   DIST
=============================================================================
  200      170.12 C           -0.4     -16.9      33.3      33.3  0.75    116
           PIP E                    (EUROPEAN SECTIONS)
                              -1.7    -183.0    -437.6     437.6 STAB   20.65
  201      166.71 C          -33.3     -16.8       0.4      33.3  0.75    116
           PIP E                    (EUROPEAN SECTIONS)
                             437.6    -184.5       0.7     437.6 STAB    0.00
   34       76.97 C           55.8      55.5     -55.3      55.8  0.46    115
           PIP E                    (EUROPEAN SECTIONS)
                            -253.8    -256.6     257.2     257.2 STAB    0.90
   46       76.97 C           50.5      50.2     -50.0      50.5  0.43    115
           PIP E                    (EUROPEAN SECTIONS)
                             191.6     232.8    -275.9     275.9 STAB    0.97
   35       76.97 C           55.3      55.1     -54.9      55.3  0.42    115
           PIP E                    (EUROPEAN SECTIONS)
                            -257.2    -255.8     252.6     257.2 STAB    0.00
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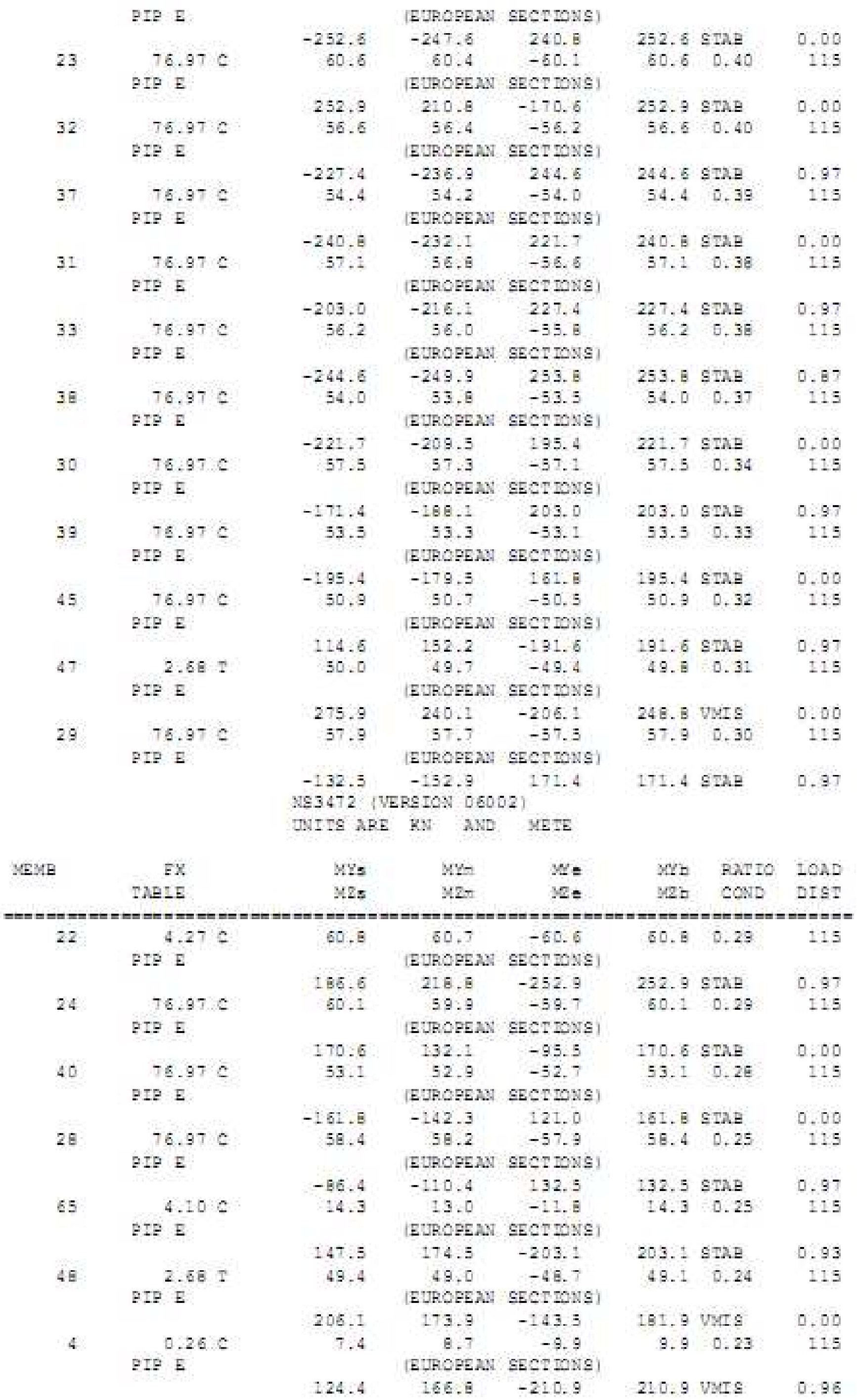

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           PIP E                    (EUROPEAN SECTIONS)
                          -252.6    -247.6     240.8     252.6 STAB     0.00
     23      76.97 C        60.6      60.4     -60.1      60.6  0.40     115
           PIP E                    (EUROPEAN SECTIONS)
                           252.9     210.8    -170.6     252.9 STAB     0.00
     32      76.97 C        56.6      56.4     -56.2      56.6  0.40     115
           PIP E                    (EUROPEAN SECTIONS)
                          -227.4    -236.9     244.6     244.6 STAB     0.97
     37      76.97 C        54.4      54.2     -54.0      54.4  0.39     115
           PIP E                    (EUROPEAN SECTIONS)
                          -240.8    -232.1     221.7     240.8 STAB     0.00
     31      76.97 C        57.1      56.8     -56.6      57.1  0.38     115
           PIP E                    (EUROPEAN SECTIONS)
                          -203.0    -216.1     227.4     227.4 STAB     0.97
     33      76.97 C        56.2      56.0     -55.8      56.2  0.38     115
           PIP E                    (EUROPEAN SECTIONS)
                          -244.6    -249.9     253.8     253.8 STAB     0.87
     38      76.97 C        54.0      53.8     -53.5      54.0  0.37     115
           PIP E                    (EUROPEAN SECTIONS)
                          -221.7    -209.5     195.4     221.7 STAB     0.00
     30      76.97 C        57.5      57.3     -57.1      57.5  0.34     115
           PIP E                    (EUROPEAN SECTIONS)
                          -171.4    -188.1     203.0     203.0 STAB     0.97
     39      76.97 C        53.5      53.3     -53.1      53.5  0.33     115
           PIP E                    (EUROPEAN SECTIONS)
                          -195.4    -179.5     161.8     195.4 STAB     0.00
     45      76.97 C        50.9      50.7     -50.5      50.9  0.32     115
           PIP E                    (EUROPEAN SECTIONS)
                           114.6     152.2    -191.6     191.6 STAB     0.97
     47       2.68 T        50.0      49.7     -49.4      49.8  0.31     115
           PIP E                    (EUROPEAN SECTIONS)
                           275.9     240.1    -206.1     248.8 VMIS     0.00
     29      76.97 C        57.9      57.7     -57.5      57.9  0.30     115
           PIP E                    (EUROPEAN SECTIONS)
                          -132.5    -152.9     171.4     171.4 STAB     0.97
                         NS3472 (VERSION 06002)
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 MEMB          FX             MYs       MYn       MYe       MYb  RATIO  LOAD
           TABLE              MZs       MZn       MZe       MZb  COND   DIST
================================================================================
     22       4.27 C        60.8      60.7     -60.6      60.8  0.29     115
           PIP E                    (EUROPEAN SECTIONS)
                           186.6     218.8    -252.9     252.9 STAB     0.97
     24      76.97 C        60.1      59.9     -59.7      60.1  0.29     115
           PIP E                    (EUROPEAN SECTIONS)
                           170.6     132.1     -95.5     170.6 STAB     0.00
     40      76.97 C        53.1      52.9     -52.7      53.1  0.28     115
           PIP E                    (EUROPEAN SECTIONS)
                          -161.8    -142.3     121.0     161.8 STAB     0.00
     28      76.97 C        58.4      58.2     -57.9      58.4  0.25     115
           PIP E                    (EUROPEAN SECTIONS)
                           -86.4    -110.4     132.5     132.5 STAB     0.97
     65       4.10 C        14.3      13.0     -11.8      14.3  0.25     115
           PIP E                    (EUROPEAN SECTIONS)
                           147.5     174.5    -203.1     203.1 STAB     0.93
     48       2.68 T        49.4      49.0     -48.7      49.1  0.24     115
           PIP E                    (EUROPEAN SECTIONS)
                           206.1     173.9    -143.5     181.9 VMIS     0.00
      4       0.26 C         7.4       8.7      -9.9       9.9  0.23     115
           PIP E                    (EUROPEAN SECTIONS)
                           124.4     166.8    -210.9     210.9 VMIS     0.96
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      5          0.24 C         9.9      11.9     -14.0      14.0  0.23     115
             PIP E                      (EUROPEAN SECTIONS)
                              210.9     173.3    -137.3     210.9 STAB     0.00
     41         76.97 C        52.7      52.4     -52.2      52.7  0.23     115
             PIP E                      (EUROPEAN SECTIONS)
                             -121.0     -97.9      73.0     121.0 STAB     0.00
     21          4.27 C        61.0      60.9     -60.8      61.0  0.22     115
             PIP E                      (EUROPEAN SECTIONS)
                              127.5     156.2    -186.6     186.6 VMIS     0.97
     44         76.97 C        51.3      51.1     -50.9      51.3  0.22     115
             PIP E                      (EUROPEAN SECTIONS)
                               44.8      78.8    -114.6     114.6 STAB     0.97
     66          4.08 T        11.8      10.3      -8.8      10.6  0.22     115
             PIP E                      (EUROPEAN SECTIONS)
                              203.1     160.7    -119.9     170.7 VMIS     0.00
     25         76.97 C        59.7      59.5     -59.3      59.7  0.20     115
             PIP E                      (EUROPEAN SECTIONS)
                               95.5      60.6     -27.6      95.5 STAB     0.00
     27         76.97 C        58.8      58.6     -58.4      58.8  0.19     115
             PIP E                      (EUROPEAN SECTIONS)
                              -33.0     -60.6      86.4      86.4 STAB     0.97
     64          3.73 C        16.7      15.5     -14.3      16.7  0.19     115
             PIP E                      (EUROPEAN SECTIONS)
                               98.4     122.1    -147.5     147.5 STAB     0.93
     42         76.97 C        52.2      52.0     -51.8      52.2  0.17     115
             PIP E                      (EUROPEAN SECTIONS)
                              -73.0     -46.3      17.7      73.0 STAB     0.00
     49          2.68 T        48.7      48.4     -48.1      48.5  0.17     115
             PIP E                      (EUROPEAN SECTIONS)
                              143.5     114.9     -88.2     122.3 VMIS     0.00
                            NS3472 (VERSION 06002)
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  MEMB          FX              MYs       MYm       MYe       MYb  RATIO  LOAD
             TABLE              MZs       MZm       MZe       MZb  COND   DIST
===============================================================================
     20          4.27 C        61.3      61.2     -61.0      61.3  0.16     115
             PIP E                      (EUROPEAN SECTIONS)
                               75.7     100.7    -127.5     127.5 VMIS     0.97
      6          0.11 C        13.6      15.5     -17.3      17.3  0.15     111
             PIP E                      (EUROPEAN SECTIONS)
                              141.4     117.8     -95.7     141.4 STAB     0.00
     26         76.97 C        59.3      59.0     -58.8      59.3  0.15     115
             PIP E                      (EUROPEAN SECTIONS)
                               27.6      -3.6      33.0      33.0 STAB     0.97
     43         76.97 C        51.8      51.6     -51.3      51.8  0.15     115
             PIP E                      (EUROPEAN SECTIONS)
                              -17.7      12.6     -44.8      44.8 STAB     0.97
      3          0.26 C         4.9       6.2      -7.4       7.4  0.14     115
             PIP E                      (EUROPEAN SECTIONS)
                               55.3      86.4    -124.4     124.4 VMIS     0.96
     67          3.71 T         8.8       7.4      -5.9       7.7  0.13     115
             PIP E                      (EUROPEAN SECTIONS)
                              119.9      83.3     -53.3      96.6 VMIS     0.00
     19          4.27 C        61.5      61.4     -61.3      61.5  0.12     115
             PIP E                      (EUROPEAN SECTIONS)
                               31.1      52.5     -75.7      75.7 VMIS     0.97
     50          2.68 T        48.1      47.7     -47.4      47.8  0.12     115
             PIP E                      (EUROPEAN SECTIONS)
                               88.2      63.2     -40.1      69.8 VMIS     0.00
    305        173.55 T         0.0       0.0       0.0       0.0  0.12     115
             PIP E                      (EUROPEAN SECTIONS)
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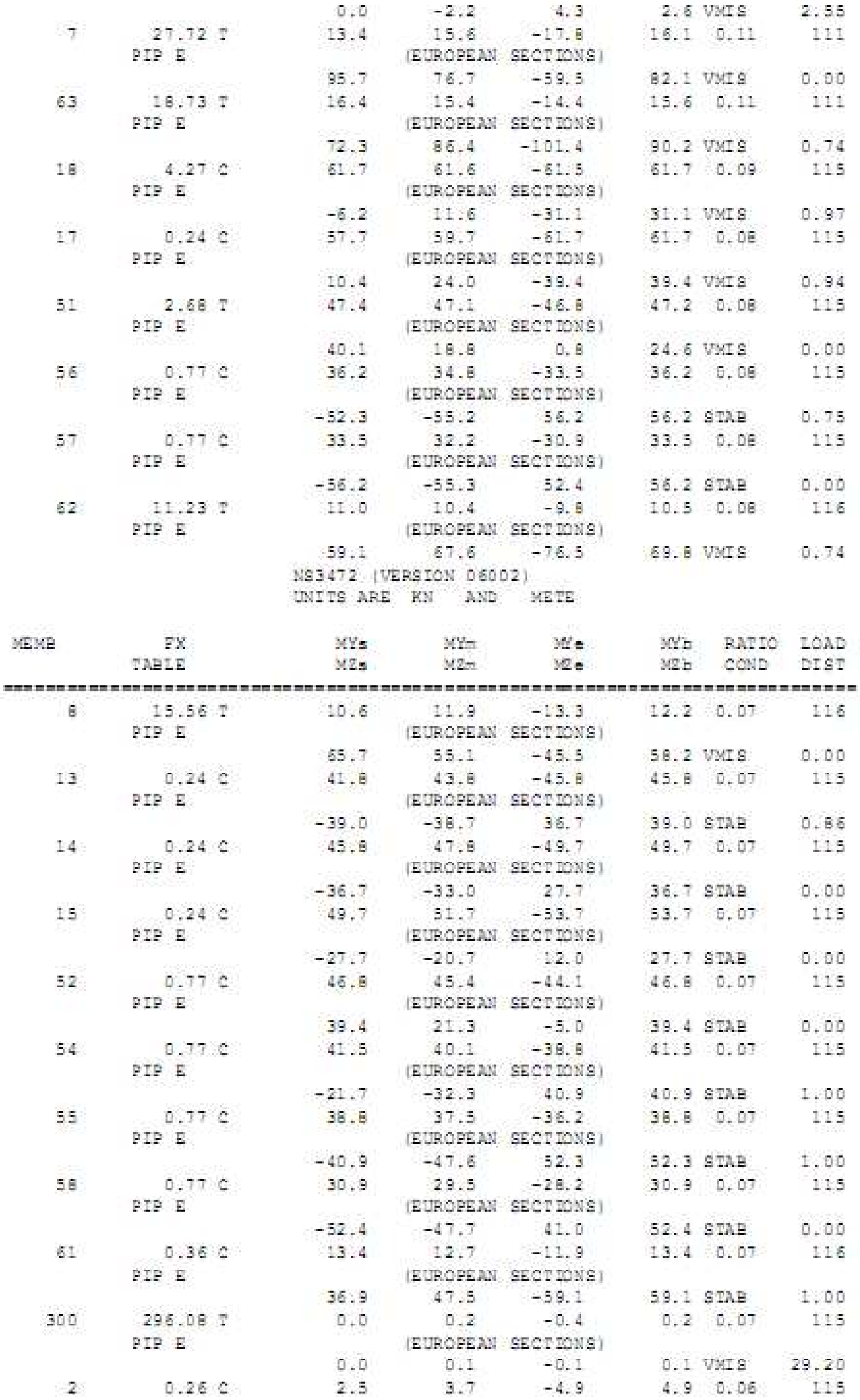

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                               0.0      -2.2       4.3      2.6 VMIS      2.55
      7       27.72 T         13.4      15.6     -17.8     16.1   0.11     111
           PIP E                     (EUROPEAN SECTIONS)
                              95.7      76.7     -59.5     82.1 VMIS      0.00
     63       18.73 T         16.4      15.4     -14.4     15.6   0.11     111
           PIP E                     (EUROPEAN SECTIONS)
                              72.3      86.4    -101.4     90.2 VMIS      0.74
     18        4.27 C         61.7      61.6     -61.5     61.7   0.09     115
           PIP E                     (EUROPEAN SECTIONS)
                              -6.2      11.6     -31.1     31.1 VMIS      0.97
     17        0.24 C         57.7      59.7     -61.7     61.7   0.08     115
           PIP E                     (EUROPEAN SECTIONS)
                              10.4      24.0     -39.4     39.4 VMIS      0.94
     51        2.68 T         47.4      47.1     -46.8     47.2   0.08     115
           PIP E                     (EUROPEAN SECTIONS)
                              40.1      18.8       0.8     24.6 VMIS      0.00
     56        0.77 C         36.2      34.8     -33.5     36.2   0.08     115
           PIP E                     (EUROPEAN SECTIONS)
                             -52.3     -55.2      56.2     56.2 STAB      0.75
     57        0.77 C         33.5      32.2     -30.9     33.5   0.08     115
           PIP E                     (EUROPEAN SECTIONS)
                             -56.2     -55.3      52.4     56.2 STAB      0.00
     62       11.23 T         11.0      10.4      -9.8     10.5   0.08     116
           PIP E                     (EUROPEAN SECTIONS)
                              59.1      67.6     -76.5     69.8 VMIS      0.74
                          NS3472 (VERSION 06002)
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MEMB           FX              MYs       MYm       MYe      MYb    RATIO  LOAD
           TABLE               MZs       MZm       MZe      MZb     COND   DIST
================================================================================
      8       15.56 T         10.6      11.9     -13.3     12.2   0.07     116
           PIP E                     (EUROPEAN SECTIONS)
                              65.7      55.1     -45.5     58.2 VMIS      0.00
     13        0.24 C         41.8      43.8     -45.8     45.8   0.07     115
           PIP E                     (EUROPEAN SECTIONS)
                             -39.0     -38.7      36.7     39.0 STAB      0.86
     14        0.24 C         45.8      47.8     -49.7     49.7   0.07     115
           PIP E                     (EUROPEAN SECTIONS)
                             -36.7     -33.0      27.7     36.7 STAB      0.00
     15        0.24 C         49.7      51.7     -53.7     53.7   0.07     115
           PIP E                     (EUROPEAN SECTIONS)
                             -27.7     -20.7      12.0     27.7 STAB      0.00
     52        0.77 C         46.8      45.4     -44.1     46.8   0.07     115
           PIP E                     (EUROPEAN SECTIONS)
                              39.4      21.3      -5.0     39.4 STAB      0.00
     54        0.77 C         41.5      40.1     -38.8     41.5   0.07     115
           PIP E                     (EUROPEAN SECTIONS)
                             -21.7     -32.3      40.9     40.9 STAB      1.00
     55        0.77 C         38.8      37.5     -36.2     38.8   0.07     115
           PIP E                     (EUROPEAN SECTIONS)
                             -40.9     -47.6      52.3     52.3 STAB      1.00
     58        0.77 C         30.9      29.5     -28.2     30.9   0.07     115
           PIP E                     (EUROPEAN SECTIONS)
                             -52.4     -47.7      41.0     52.4 STAB      0.00
     61        0.36 C         13.4      12.7     -11.9     13.4   0.07     116
           PIP E                     (EUROPEAN SECTIONS)
                              36.9      47.5     -59.1     59.1 STAB      1.00
    300      296.08 T          0.0       0.2      -0.4      0.2   0.07     115
           PIP E                     (EUROPEAN SECTIONS)
                               0.0       0.1      -0.1      0.1 VMIS     29.20
      2        0.26 C          2.5       3.7      -4.9      4.9   0.06     115
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           PIP E                    (EUROPEAN SECTIONS)
                              13.8       31.1      -55.3     55.3 VMIS     0.96
      11         0.24 C       33.8       35.8      -37.8     37.8  0.06     115
           PIP E                    (EUROPEAN SECTIONS)
                             -23.5      -29.9       34.6     34.6 STAB     0.94
      12         0.24 C       37.8       39.8      -41.8     41.8  0.06     115
           PIP E                    (EUROPEAN SECTIONS)
                             -34.6      -37.6       39.0     39.0 STAB     0.94
      16         0.24 C       53.7       55.7      -57.7     57.7  0.06     115
           PIP E                    (EUROPEAN SECTIONS)
                             -12.0       -1.7      -10.4     12.0 VMIS     0.94
      53         0.77 C       44.1       42.8      -41.5     44.1  0.06     115
           PIP E                    (EUROPEAN SECTIONS)
                               5.0       -9.3       21.7     21.7 STAB     1.00
      59         0.77 C       28.2       26.9      -25.6     28.2  0.06     115
           PIP E                    (EUROPEAN SECTIONS)
                             -41.0      -32.4       22.0     41.0 STAB     0.00
      68         2.21 T        5.9        4.4       -2.9      4.7  0.06     115
           PIP E                    (EUROPEAN SECTIONS)
                              53.3       30.0      -13.4     40.7 VMIS     0.00
                          NS3472 (VERSION 06002)
                          UNITS ARE  KN   AND   METE

MEMB                 FX        MYs        MYm        MYe      MYb RATIO    LOAD
           TABLE               MZs        MZn        MZe      MZb  COND    DIST
===============================================================================
     304       277.74 T        0.0       -0.2        0.4      0.2  0.06     115
           PIP E                    (EUROPEAN SECTIONS)
                               0.0       -0.1        0.1      0.1 VMIS    29.71
     306       156.86 T        0.0        0.0        0.0      0.0  0.06     115
           PIP E                    (EUROPEAN SECTIONS)
                               0.0        0.9       -1.8      1.1 VMIS     3.47
       9         0.08 C       14.4       15.4      -16.5     16.5  0.05     116
           PIP E                    (EUROPEAN SECTIONS)
                              45.5       36.6      -28.6     45.5 STAB     0.00
      10         0.24 C       29.8       31.8      -33.8     33.8  0.05     115
           PIP E                    (EUROPEAN SECTIONS)
                              -5.7      -15.4       23.5     23.5 VMIS     0.94
     302       198.69 T        0.0       -0.2        0.4      0.2  0.05     116
           PIP E                    (EUROPEAN SECTIONS)
                               0.0        0.2       -0.3      0.2 VMIS    21.01
      60         0.36 C       15.0       14.2      -13.4     15.0  0.04     116
           PIP E                    (EUROPEAN SECTIONS)
                              18.9       27.4      -36.9     36.9 STAB     1.00
     301       175.77 T        0.0        0.1       -0.2      0.1  0.04     115
           PIP E                    (EUROPEAN SECTIONS)
                               0.0       -0.1        0.1      0.1 VMIS    27.46
     303       183.75 T        0.0       -0.1        0.2      0.1  0.04     115
           PIP E                    (EUROPEAN SECTIONS)
                               0.0        0.1       -0.1      0.1 VMIS    27.74
       1         0.26 C        0.0        1.2       -2.5      2.5  0.02     115
           PIP E                    (EUROPEAN SECTIONS)
                               0.0        3.5      -13.8     13.8 VMIS     0.96
      69         0.80 T        2.9        1.5        0.0      1.8  0.02     115
           PIP E                    (EUROPEAN SECTIONS)
                              13.4        3.3        0.0     11.3 VMIS     0.00


  ************** END OF TABULATED RESULT OF DESIGN **************


  191. FINISH
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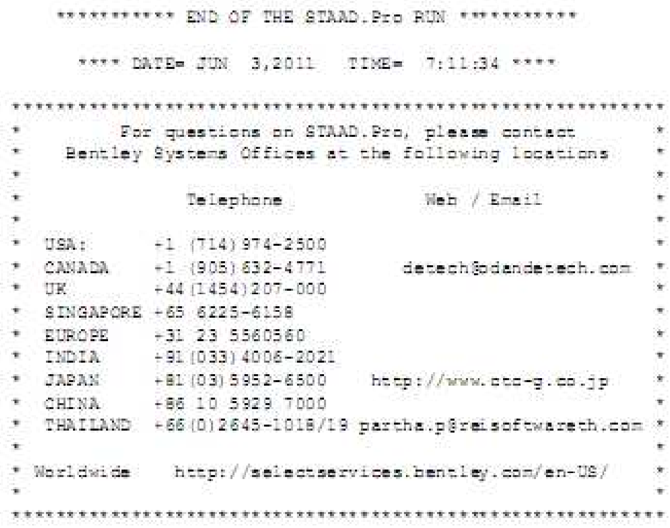

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    *********** END OF THE STAAD.Pro RUN ***********

      **** DATE= JUN  3,2011   TIME=  7:11:34 ****

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*         For questions on STAAD.Pro, please contact       *
*    Bentley Systems Offices at the following locations    *
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*                                                          *
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*  CANADA    +1 (905)632-4771       detech@odandetech.com  *
*  UK        +44(1454)207-000                              *
*  SINGAPORE +65 6225-6158                                 *
*  EUROPE    +31 23 5560560                                *
*  INDIA     +91(033)4006-2021                             *
*  JAPAN     +81(03)5952-6500    http://www.ctc-g.co.jp    *
*  CHINA     +86 10 5929 7000                              *
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*                                                          *
* Worldwide    http://selectservices.bentley.com/en-US/    *
*                                                          *
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Final page

“All’s well that ends well”
W. Shakespeare