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PREFACE

This thesis marks the end of my master program in offshore construction and materials at the University of Stavanger.

I would like to thank WorleyParsons Rosenberg for having offices and software at my disposal. I also want to thank my instructor at UiS, Sudath C. Siriwardane for his support on this work, Morten Nilssen for coming up with an idea for my thesis, Neil J. Foster for all guidance related to piping analysis in Caesar II and Ali Shariatpanahi for all guidance related to structural analysis in STAAD.Pro during my work.

Hundvåg, 15. June 2015

Siv-Anni Tveit

SUMMARY

Structural and piping stress analyses are generally conducted separately in most of the situations. A pipe stress analysis is performed based on loads caused by pressure, temperature variations, weight of the pipe (with contents) and blast. The pipes are analysed for several load cases separated into different design types like sustained, expansion and occasional. Established practice in piping design and calculation does not specifically account for structural flexibility. It is assumed that flexibility in the structure is minimal and that the structure is stiff relative to the piping load and in comparison with the piping itself. The objective of this thesis is to evaluate the conservatism of the established practice. Run different types of sensitivity analysis regarding stiffness of pipe versus stiffness of the supporting structure, i.e pipe-structure interaction.

Limitations for this thesis I have chosen to look at a 20 inch pipe in a simplified system and is supported in ten equally spaced locations of 5m. Three pipe thicknesses are chosen, 4.73mm, 12.70mm and 20.62mm. For calculations of piping stress and restraint support loads Caesar II has been used. Four pipe supports has been modeled using the structural analysis program STAAD.Pro. Pipe support in node 70 and 90 (Caesar ref.) is set as fixed to a concrete deck and pipe support in node 110 and 130 (Caesar ref.) is set as sliding restraints fixed to a steel beam deck.

For design loads the vertical load is the weight of the operating pipe span carried by the supports, the horizontal load will be assumed equal to the friction force. The pipe line and the pipe support are also to be calculated to withstand explosion loads directed from 6 locations. This model for pipeline and supports will be tested in four cases.

The first case: The established practice where structural and piping stress analyses are run separately.

The second case: Structural and piping stress analyses will be runned combined by implementing the deck deflection calculated in the first case for pipe support in node 110 and 130. The supports for node 70 and 90 are fixed to concrete deck and are assumed to have zero deflection.

The third case: Structural and piping stress analyses will be runned combined by implementing the max acceptable deck deflection ($L/200$) for pipe support in node 110 and

node 130.

The fourth case: In this case the pipe support for node 110 and 130 are set to fail, which means that these two pipe supports will not take any loads from the pipe, only direct blast loads.

These four cases will be compared with respect to changes in pipeline restraint forces, utilization of pipe line stress, pipe line deflection, structural deck deflection, utilization of support beam, displacements in the pipe support.

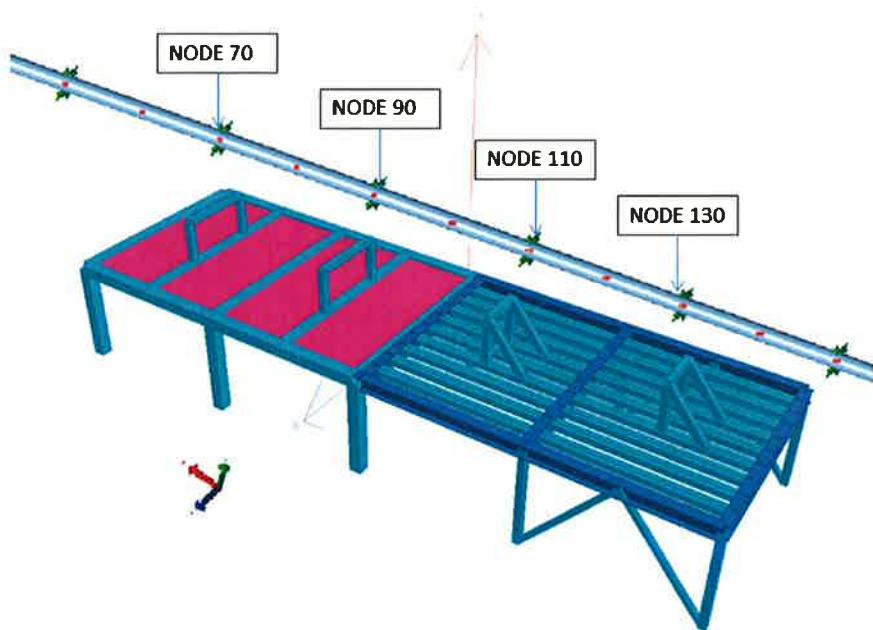


Figure 1 Model for piping and structural

As a conclusion on the results from this thesis it can be stated that pipe lines with large stiffness can have a very big impact on the pipe supports when included the variation in deck deflection. On the other hand deflection did not seem to have any large impact on the pipe stress other than expansion in this thesis. A flexible pipe line seems to be more beneficial for a pipe support considering the restraint loads, thus leading to a higher utilization and deflection in pipe stress analysis. As I experienced in performing this thesis, interacting piping and structural is very time consuming and as current engineering schedule often means that structural deflection are not available at the time of pipe stress analysis, it will result in additional analysis, where the results might not give a result that makes any significance in the end. As a guide it is important to take in to consideration possible large deck deflections that can occur and have an impact on piping as well as structural.

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1.0 INTRODUCTION

1.1 BACKGROUND

Structural and piping stress analyses are generally conducted separately in most of the situations. The piping engineers perform pipe stress analysis using the software CAESAR II in accordance with design codes like ASME B31.3 and EN 13480. A pipe stress analysis is performed based on loads caused by pressure, temperature variations, weight of the pipe (with contents) and possibly seismic, wind, ice or blast. The pipes are analysed for several load cases separated into different design load type like sustained, expansion and occasional. The limits for these stresses from each design load type are set by the piping codes in ASME B31.3 and BPV, section II, Part D. As long as there are no overstressed lines in the piping system, the pipe line system are therefore acceptable. The location and type of pipe support also has an impact in the pipe stress analysis. Established practice in piping design and calculation does not specifically account for structural flexibility. It is assumed that flexibility in the structure is minimal and that the structure is stiff relative to the piping load and in comparison with the piping itself. In normal practice all loads in piping stress calculation are run as static loads in CAESAR II. The pipe support loads generated at the pipe lines restraint positions is passed over to the structural engineers, in order for them to make design and calculation for the pipe support/module structure interface.

1.2 PROBLEM STATED

The effect from deck deflections and flexibility in structures and heavy equipment such as storage tanks can be considered relevant in design/calculation and therefore also necessary to be reported back to piping for additional calculation.

Some piping systems can be very critical and difficult to design, due to loads that can be caused by internal pressure, temperature variations, weight of the pipe (with contents), vibrations, fatigue and connection to sensitive equipment. A badly designed piping system as well as a bad positioning of supports can have an enormous and detrimental impact on sensitive connected equipment. Flanges may separate, gases or fluids escape and detonate, start a fire, and people may be exposed to toxic fluids and gases.

Limitations for this thesis I have chosen to look at a 20 inch pipe in a simplified system supported in ten equally spaced locations. For calculations of piping stress and restraint support loads Caesar II has been used. Four pipe supports has been modeled using the structural analysis program STAAD.Pro. Pipe support in node 70 and 90 (Caesar ref.) is set as fixed to a concrete deck and pipe support in node 110 and 130 (Caesar ref.) is set as sliding restraints fixed to a steel beam deck.

For design loads the vertical load is the weight of the operating pipe span carried by the supports, the horizontal load will be assumed equal to the friction force. The pipe line and the pipe support are also to be calculated to withstand explosion loads directed from 6 locations. This model for pipeline and supports will be tested in four cases.

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These four cases will be compared with respect to changes in pipeline restraint forces, utilization of pipe line stress, pipe line deflection, structural deck deflection, utilization of support beam, displacements in the pipe support.

The procedure of implementing structural deflection in Caesar II has been executed as demonstrated by the piping department and in the Caesar manual. [19]

1.3 OBJECTIVE

The objective of this thesis is to evaluate the conservatism of the established practice. Run different types of sensitivity analysis regarding stiffness of pipe versus stiffness of the supporting structure, i.e pipe-structure interaction. Establish final recommendations for

procedures or methods for performing this type of interaction analysis.

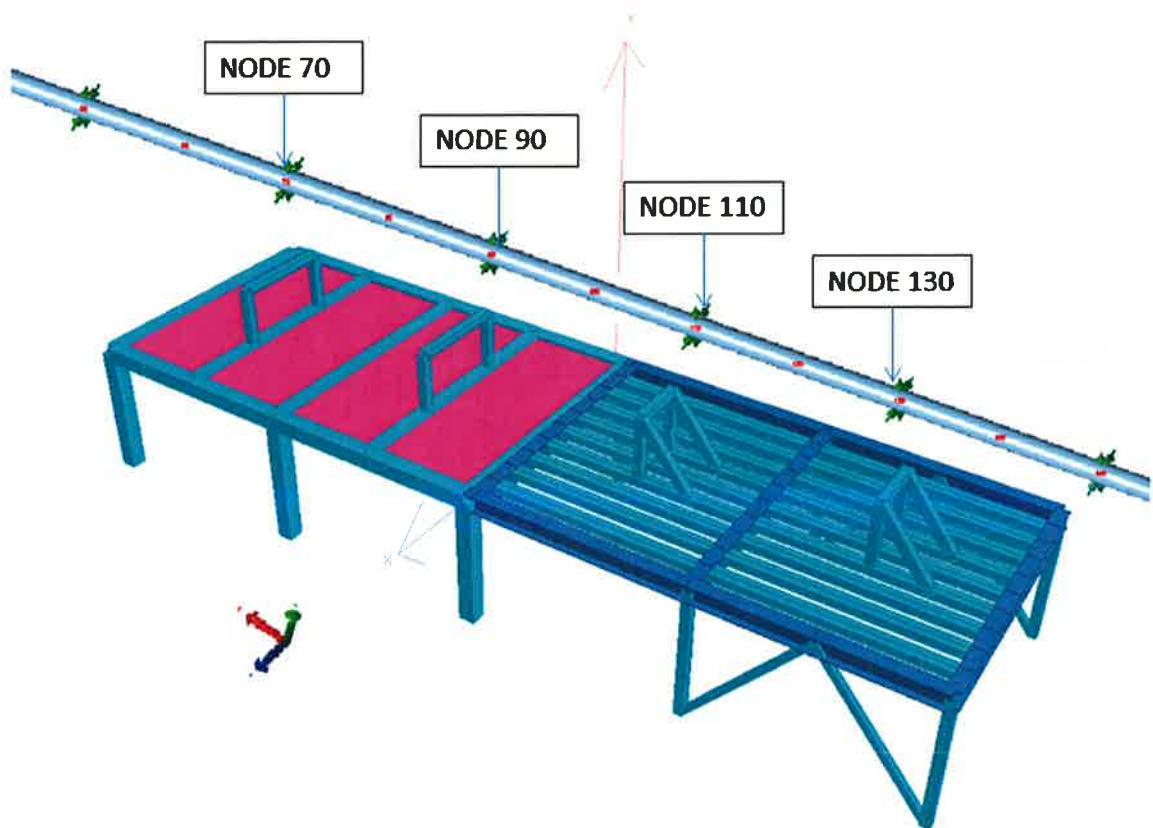


Figure 1 Model for piping and structural

2.0 THEORY AND METHODOLOGY

2.1 ELASTIC LIMIT

The stress at the yield point is the elastic limit at which a material begins to deform plastically. Prior to the yield point the material will deform elastically. Beyond the elastic limit, deformation will occur permanent and non-reversible. Elastic deformation will return to its original shape when the applied stress is removed. Up to the yield point, the stress is proportional to strain (Hooke's law). [1]

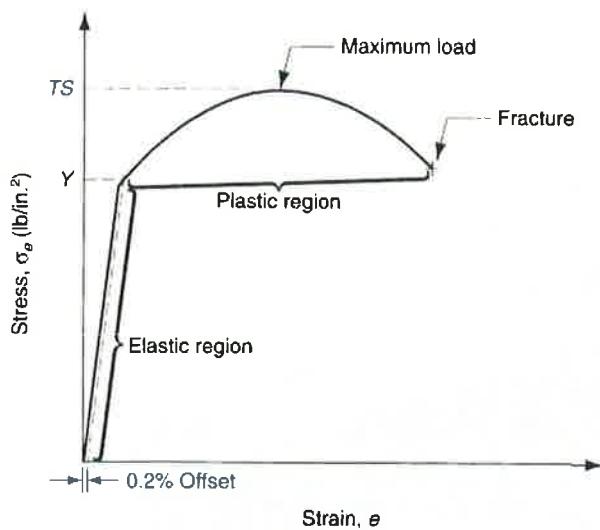


Figure 2: Stress strain behavior of ductile material [2]

Von Mises yield criterion suggests that yielding of material starts when its von Mises stress σ_v reaches a critical value known as the yield strength, σ_y .

The criterion is expressed as:

$$J_2 = K^2$$

Where J_2 is the second deviatoric stress invariant and K is the yield stress of the material in pure shear. In the case of pure shear stress $\sigma_{12} = \sigma_{21} \neq 0$, while all other $\sigma_{ij} = 0$, von Mises criterion becomes:

$$\sigma_{12} = k = \frac{\sigma_y}{\sqrt{3}}$$

Where σ_y is the yield strength of the material. The von Mises stress is set equal to the yield strength and combined with the equations above, the von Mises yield criterion can be expressed as:

$$\sigma_v = \sigma_y = \sqrt{3 \cdot J_2}$$

Substituting J_2 with terms of the Cauchy stress tensor components.

$$J_2 = \frac{1}{6} \cdot \left| (\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2 \right|$$

Inserting this into the von Mises yield criterion equation and the following von Mises stress equation is obtained:

$$\sigma_v = \sqrt{\frac{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}{2}}$$

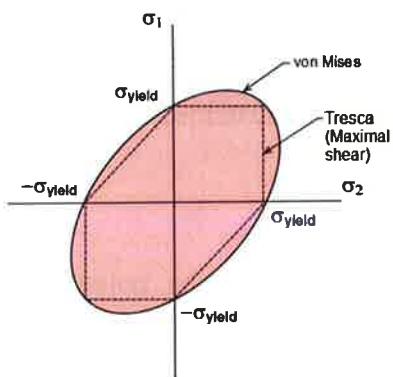


Figure 3 Intersection of the von Mises yield criterion

The tresca maximum shear stress criterion predicts plastic yielding for stress states that are still elastic according to the von Mises criterion. Tresca criterion is therefore more conservative. [3]

2.2 FLEXIBILITY

The stiffness of a material is the extent to which it resists deformation in response to an applied force. For an elastic body with a single degree of freedom (DOF) (for example, stretching or compression of a rod), the stiffness is defined as

$$K = \frac{F}{X}$$

Where, K is stiffness of the beam representing the beam between two nodes

F is the force applied on the body

X is the resulting position of these nodes

Temperature expansion/contraction or other imposed displacements like deck deflections or settlement can cause alternating bending moments that might be detrimental for the pipe itself, flanges, branch connections, pipe supports and connected equipment such as pumps and compressors. The design of pipe systems should be executed in such a way that parts of the piping itself act as a spring and release or reduce the internal bending stresses or longitudinal stresses that otherwise can be detrimental. Local loads on the pipe are calculated based on this final position (X) of each point in the system. Code – defined stresses (sustained, expansion range and occasional) are calculated using these loads. [14]

The flexibility in pipe systems can be improved by:

- Use a material with lower Young's Modulus. It should however be noted that materials with lower Young's Modulus will in general have lower allowable basic stress.
- Use a material with a higher yield-or tensile strength
- Use a material quality that does not need additional corrosion and erosion allowance, and thereby obtains a reduction in the wall thickness which again gives more flexibility since the moment of inertia is reduced with a reduction of the pipe wall thickness. Use of thinner wall could result in greater vibration.
- Changes in the run direction (offsets, bends and loops) or by use of expansion joints or flexible couplings of the slip joint, ball joint or bellow type.
- Changing the spacing of pipe-supports and their function (e.g. removal of a guide close to a bend to add flexibility). [14]

2.3 CASTIGLIANOS METHOD

Most pipe analysis programs use the theorems of Castigliano as the basis for their calculations. Castiglianatos second theorem applies to find deformation of linearly elastic systems. If the strain energy of a linearly elastic structure can be expressed as a function of generalised force Q_i , then the partial derivative of the strain energy with respect to generalised force gives the generalised displacement q_i in the direction of Q_i . [5]

$$q_i = \frac{dU}{dQ_i}$$

2.4 BEAM DEFLECTION THEORY

To determine beam deflection a standard fundamental formula is used.

$$\frac{1}{R} = \frac{M}{EI} = -\left(\frac{d^2y}{dx^2} \right)$$

R = the radius of curvature at a distance x from the origin.

E = the elastic modulus of the material

I = the second moment of area of the beam cross-section.

M = the bending moment at the section, distance x from the origin.

y = the vertical deflection at the section distance x from the origin.

By integrating the above expression twice will give an expression for the deflection y. [6]

$$\frac{d^2y}{dx^2} = -\left(\frac{M}{EI} \right)$$

$$\frac{dy}{dx} = - \int \frac{M}{EI} dx$$

$$y = \int \frac{dy}{dx} dx$$

2.5 PIPE STRESS ANALYSIS

Pipe stress analysis addresses the loading resulting from the effects of weight, temperature changes, internal pressures, seismic, wind, ice settlement etc. Codes and standards establish the minimum requirements of stress analysis. [4]

The stresses acting on the pipe in sustain condition are:

Due to internal pressure:

σ_H = Hoop stress, (N/mm²)

σ_L = Longitudinal stress, (N/mm²)

σ_R = Radial stress, (N/mm²)

σ_T = Shear or torsional stress, (N/mm²)

Due to weight: Axial stress, bending stress and torsion shear stress. These can be controlled by proper supporting and weight distributions. [7]

The walls of a pipe line exposed to pressure, generally undergoes triaxial loading. From the symmetry of the circular cross section, there are two principal directions of stresses, axial and circumferential, developed uniformly along the circumference of the pipe wall.

Stress and pressure is in the term of units of force over area. To include stress and pressure in force equilibrium equation, one must multiply the stress and pressure times the area on which it acts.

In reality the stress is not uniform across the pipe thickness. The stress is greater near the inner surface and lower at the outside surface. The formulas for stresses are given by thin wall calculations.

2.5.1 HOOP STRESS

The stress in circumferential direction being perpendicular both to the axial and the radius of the pipe is called hoop stress and is caused primarily by internal pressure.

Hoop stress is statically determinate. [8]

$$\text{Pressure force} = \text{projected area} \times \text{Pressure} = d \cdot L \cdot P$$

$$\text{Stress force} = 2 \cdot L \cdot t \cdot \sigma_H$$

$$\text{Pressure force} = \text{Stress force}$$

$$\sigma_H = \frac{P \cdot d}{2 \cdot t}$$

2.5.2 LONGITUDINAL STRESS

The longitudinal stress works in the axial direction and is not statically determinate, and depends on whether the pipeline moves longitudinally. Longitudinal stress depends on the summation of the following three components [7][8]:

- Longitudinal stress induced by internal pressure.
- Bending stress induced by the weight of the pipe.
- Bending stress induced by thermal expansion or contraction.

Stress due to internal pressure

$$\text{Pressure force} = \text{projected area} \times \text{Pressure} = \pi \cdot \left(\frac{d}{2}\right)^2 \cdot P$$

$$\text{Stress force} = \left[\pi \cdot \left(\frac{D}{2}\right)^2 - \pi \cdot \left(\frac{d}{2}\right)^2 \right] \cdot \sigma_L$$

Pressure force = Stress force

$$\sigma_L = \frac{P \cdot d}{4 \cdot t}$$

Bending stress

$$\sigma_B := \frac{M}{W}$$

$$W := \frac{I}{y} = \frac{I}{\frac{h}{2}}$$

Pipe section modulus:

$$W := \frac{\pi}{32D} \cdot (D^4 - d^4)$$

2.5.3 RADIAL STRESS

The radial stress is in the direction towards or away from the central axis of the pipe, acting parallel to the pipe radius. Radial stress is caused by internal pressure and gives zero radial stress at the outer radius of the pipe, where bending stresses are maximized. For this reason, radial stress is neglected during stress calculations.

The hoop stress is roughly twice the value of the longitudinal stresses. Radial stresses are usually much smaller than hoop stress and longitudinal stresses. For thin walled pipe the radial stress is negligible. [8]

2.5.4 SHEAR OR TORSIONAL STRESS

Torsion is twisting of a structural member, when it is exposed to loads producing a rotation about its longitudinal axis. [9]

During twisting the element rotate a small angle $d\phi$

$$\theta = \frac{d\phi}{dx} \quad \text{Represent the rate of change of the angle of twist}$$

$$\theta \text{ is constant along the length} \quad \theta = \frac{\phi}{L}$$

Consider a bar subjected to pure torsion, the shear force acting on an element dA is τdA , the moment of this force about the axis of bar is $\tau p dA$

$$dM = \tau \cdot \rho \cdot dA$$

Equation of moment equilibrium

$$T = \int_A \tau \cdot \rho \cdot dA = \int_A G \cdot \theta \cdot \rho^2 \cdot dA = G \cdot \theta \cdot \int_A \rho^2 \cdot dA = G \cdot \theta \cdot I_p$$

$$\tau = G \cdot \theta \cdot \rho$$

$$G = \frac{E}{2 \cdot (1 + \nu)}$$

I_p is the polar moment of inertia

$$I_p = \int_A \rho^2 \cdot dA$$

Area torque is then $dA = (2\pi\rho) d\rho$

For thin wall pipes $t \ll r$, and the maximum shear stress τ_{max} at $\rho = r$, gives

$$I_p = 2\pi r^3 \cdot t$$

From the above relation it can be written

$$\theta = \frac{\phi}{L} = \frac{T}{G \cdot I_p}$$

$$T = \frac{G \cdot \phi \cdot I_p}{L} \quad (\text{N-m})$$

For maksimum shear stress

$$\tau = G \cdot \rho \cdot \theta = \frac{\rho}{r} \cdot \tau_{max}$$

$$\tau_{max} = \frac{T \cdot r}{I_p}$$

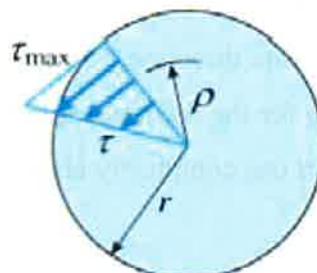
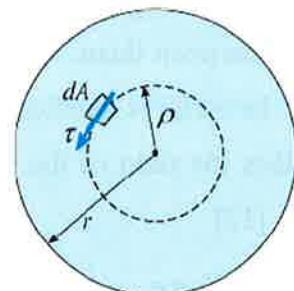


Figure 4 Max shear stress

2.6 THERMAL EXPANSION OR CONTRACTION

For most materials, thermal strain is proportional to the temperature change ΔT

$$\varepsilon_T = \alpha \Delta T$$

Thermal strain usually is reversible, expand when heated and contract when cooled.

For a pipe with length L the temperature-displacement relation will be $\delta_T = \alpha (\Delta T) L$

Displacements due to restraint forces is $\delta_R = RL/EA$

$$\delta = \delta_T - \delta_R = 0$$

The presence of temperature drives the friction

$$\alpha \cdot (\Delta T) \cdot L = \frac{R \cdot L}{E \cdot A}$$

$$\sigma_T = E \cdot \alpha \cdot (\Delta T) = \frac{R}{A}$$

2.7 FRICTION

Friction occurs between two bodies in contact with each other and counteracts with the relative motion between them. Friction is proportional to the perpendicular normal force (N) which presses the surfaces together as well as the coefficient of friction, μ . The coefficient of friction describes the ratio of the force of friction between two bodies and depends on the materials used. [12]

$$R = \mu \cdot N, \text{ Friction force}$$

Friction will occur in piping system exposed to temperature movements. The friction will act in direct opposite direction of the temperature expansion or contraction. The normal force is very decisive for the thermal expansion to create a friction resistance. Sometimes the friction at one support can completely change the acceptability of the piping system.

Support friction in a piping system can create a higher stress in the pipe and a higher load on the connecting equipment, but can prevent the pipe from free expansion.

The friction tends to prevent the pipe from moving in the lateral direction, which leads to a stiffer system thus resulting in higher bending moment at the bend. In certain instances the friction can help stabilize the system and dampens out potential vibration. [13]

2.8 PIPE WALL THICKNESS

This analysis is limited to «Thin walled pressure pipe». For a cylinder to be qualify as «Thin walled» the ratio of the pipe inside radius r_i to wall thickness t must be $r_i/t \geq 10$, according to the ASME B31.3. Most of the piping of standard schedules is of the sort «Thin walled». Piping with small diameter or specially made thick walls are the exceptions.

The pipe wall can be treated as a surface when the «Thin walled» assumption has been made, and can thereby use the Young–Laplace equation for estimating the hoop stress. Hoop stress is governing since it is roughly twice the longitudinal stress, and is therefore used for pipe wall thickness calculation. The piping is then supported sufficiently, such that the longitudinal axial stress is within the limits of the required code and the deflection also remains within acceptable limits. The deflection limits between supports is usually company defined. To prevent overstress, damage, collapse, or buckling due to superimposed loads from supports, ice formation or transportation, the wall thickness shall when necessary be increased. The internal pressure and corrosion allowance decides the minimum required wall thickness of the pipe. Corrosion or erosion can occur internal and/or external and adds additional required thickness to the total pipe thickness. The nature, temperature and velocity of the product in contact with the wall determine the corrosion / erosion allowance.

Pipe thickness is selected in three steps:

- From the design pressure, the minimum required net thickness is calculated.
- The net thickness is then added with allowances, such as corrosion and erosion allowance, thread allowance, and manufacturing mill- tolerance, to become the minimum nominal thickness.
- The final step is to select a commercially available nominal thickness that provides this minimum required nominal thickness. [4]

Nominal thicknesses are standardized and represented by weight grades as standard (Std), extra strong (Xs), double extra strong (Xxs) and by schedule numbers ranging from schedule 10 (Sch-10) to schedule 160 (Sch-160). Stainless steel pipes have separate schedule numbers appended with letter «S» such as Sch-5s, sch-10s etc.

According to ASME B31.3 section 304.1.2

The required wall thickness for a straight pipe under internal pressure shall not be less than the Lame's equations (1) or (2):

For $t < D/6$:

$$t := \frac{(P \cdot D)}{2(S \cdot E \cdot W + P \cdot Y)} \quad (1)$$

P= internal design pressure

D= Pipe outside diameter

S= the pipe material allowable stress, S is for the listed pipe material at hot temperature Tabel A-i

E = quality factor based on the method of manufacture of the pipe and will have a value ranging from E=0.6 for furnace butt welded to E= 1.0 for seamless pipe. Table A-1B

W= Weld joint strength reduction factor (not required for this thesis)

Y= Stress-temperature compensating factor is included to account for effects of creep. Table 304.1.1

2.9 PIPE SUPPORT DESIGN

All pipe lines shall be routed in such a way that a simple, neat and economical layout allowing for easy support and adequate flexibility is provided. No pipe supports shall be placed in a location likely to be a safety hazard to personnel e.g, tripping hazard, restricted headroom or blocking escape routes.

The function of the pipe support is to carry the weight and control the movement of the pipe as well as any equipment connected to the pipe. The job of the pipe support is to transfer the loads from the pipe to the surrounding structure, and generally remove or restrain one or more of the six degrees of freedom (3 translational and 3 rotational) at particular points on the pipe.

The positioning and the design of the pipe support shall be based on preventing:

- Excess piping stress
- Deflection of piping greater than the acceptance criterium, to avoid liquid pockets or leakage at joints
- Resonance from wind forces or contained fluid induced vibrations, wave forces etc.
- Resonance from mechanical or acoustically induced vibrations from reciprocating machines.
- Interference with free thermal expansion or contraction.
- Disconnection between pipe and support

In selection of supports the effect of deck deflections, platform sway and flexibility in structures and equipment must be considered and incorporated in design/calculation where relevant. Magnitude of deflection and sway shall be obtained from the structural disciplines.

[10]

Where increased flexibility is required within the pipe system, but can not be obtained by normal pipe route changes, gaps may be incorporated in the pipe support restraint, allowing the pipe to move within the incorporated gap.

2.10 LIMIT STATE DESIGN

A limit state is a condition of a structure beyond which it no longer fulfills the relevant design criteria. A structure designed by LSD is proportioned to sustain all actions likely to occur during its design life, and to remain fit for use, with an appropriate level of reliability for each limit state. Required reliability depends on consequence of failure:

Risk = Probability x Consequence.

Limit state design requires the structure to satisfy two principal criteria: the ultimate limit state (ULS) and the serviceability limit state (SLS).

The ultimate limit state (ULS) involves the structural integrity or strength, as such the structure is designed to have a very low probability reaching this limit state since the consequences are severe. This includes collapse due to fracture, rupture, instability, excessive inelastic deformation, and so on. In considering ULS, plastic theory could be used.

The serviceability limit state (SLS) involves the structure remaining functional for its intended use subjected to routine everyday loading and human comfort achieved. This include excessive elastic deformation and possible consequential damage to non-structural elements such as panels, excessive localized deformation such as cracking and spalling of concrete, excessive vibration and so on. In considering SLS, elastic theory should be used.

The accidental limit state (ALS) involves damage or failure due to unusual, accidental, or unplanned loading conditions such as incidental overpressure, explosion, fire or earthquake.

The fatigue limit state (FLS) involves the fatigue damage resulting from cyclic dynamic loads and accumulated throughout its life. The structure is designed such that its life, accounting for fatigue damage from all sources, meets or exceeds the design life. FLS will not be included in this thesis. [11]

The general form of the limit state design can be given as:

$$\phi \cdot R_c \geq \sum_{i=1}^m (\gamma_i \cdot S_c)$$

ϕ is the strength factor

R_c Characteristic strength

γ_i Load factor

S_c Characteristic value

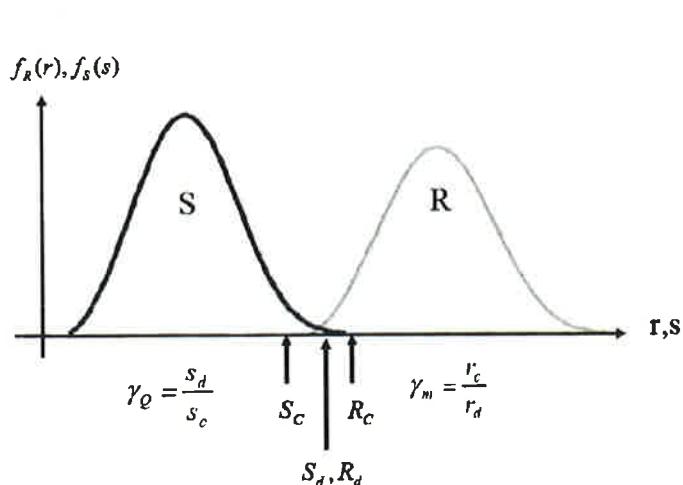


Figure 5 Limit state design

A ALLOWABLE STRESS DESIGN

The allowable stress in which the stresses caused by nominal or characteristic design loads, shall not exceed an allowable or limiting stress. The allowable stress is the yield stress or failure stress of the material divided by a safety factor. The factor of safety FS accounts for the entire variability. [11]

$$\frac{R}{FS} \geq \sum_{i=1}^m L_i$$

R resistance strength

L load effect

FS factor of safety

2.11 EXPERIMENTAL STRESS ANALYSIS

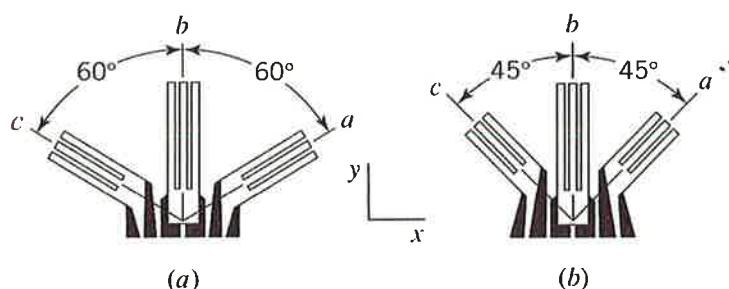
There are several methods of measuring strain. Numerical or experimental methods can be used to obtain approximate results, for instance when members of complex shape subjected to loads, makes it mathematically difficult to derive analytical load-stress relations.

Strain gages are used practical to measure expansion strains on the free surface of a member, but cannot be used to measure internal strain of a member. To measure internal strain (or stresses), other techniques such as photo elasticity, holographic or Moiré techniques can be used.

The gages are made of very fine wire, where three gages arranged in three different directions are cluster together in a point forming a strain rosette. A single gage is capable only of measuring the extensional strain in the direction that the gage is orientated in that point. Forces are applied to the object and as the object deforms, the gage deforms by elongation or contraction, causing the electrical resistance to change.

The electrical resistance varies in proportion to the amount of strain in the device. The change in resistance can be measured using a Wheatstone bridge, and calibrated to indicate the average extensional strain over a gage length.

Two common forms of rosettes are the delta rosette with three gages spaced at 60° angles and the rectangular rosette with three gages spaced at 45° angles. [18]



Rosette strain gages. (a) Delta rosette. (b) Rectangular rosette.

Figure 6 Rectangular Rosette strain gage mounted on pipe

2.12 STRESS ANALYSIS PROGRAMS

To be able to conduct this objective, different set of programs had to be used. Below the different programs are described.

2.12.1 CAESAR II

CAESAR II is pipe stress analysis software program used for designing and analysis of piping systems. The program creates a model of the piping system using simple beam elements and defines the loading conditions imposed on the system. With this input it produces results in the form of displacements, loads, and stresses throughout the system. Additionally the program then compares these results to limits specified by recognized codes and standards. For this case that will be ASME B31.3. [19]

2.12.2 STAAD.Pro

STAAD.Pro is a structural analysis and design computer program that supports several steel, concrete and timber design codes.

It can make use of various forms of analysis from the traditional 1st order static analysis, 2nd order p-delta analysis, geometric nonlinear analysis or a buckling analysis. It can also make use of various forms of dynamic analysis from modal extraction to time history and response spectrum analysis.

3.0 DESIGN BASIS

3.1 APPLICABLE CODES AND REGULATIONS

The piping and structural design must be based on the requirements given in:

ASME B31.3: Process Piping

BPV, section II, Part D

NS-EN 13480-3:2012 Metalliske industrielle rørsystemer Del 3: Konstruksjon og berekning

BD01-AK-P-06042. Pipe Support Procedure (AkerSolution)

BD01-AK-P-06043. Pipe Support Detail Standard (AkerSolution)

DNV-RP-D101: Structural analysis of piping systems

EN 1993-1-1: 2005. Eurocode 3: Design of steel structures

EN 1993-1-4: 2006. Eurocode 3: Supplementary rules for stainless steel

NORSOK L-002, rev.3: Piping system layout, design and structural analysis

NORSOK N-001, Rev.7: Integrity of offshore structures.

NORSOK N-003, Rev.2: Actions and action effects.

NORSOK N-004, Rev. 4: Design of steel structures.

EN 1993-1-8:2005 Eurocode 3: Design of structures. Part 1-8: Design of job.

EN 1991-1-4:2005 Eurocode 1: Actions on structures. Part 1-4: Wind actions

ASME B31.3: Process Piping

ASME – The American Society of Mechanical Engineers

The basic design code for engineers working with topside offshore projects is the ASME B31.3 Process Piping Code, originally a design code for process plants to be placed on land. ASME B31.3 piping code has some basic requirements regarding the integrity of the piping but leaves all other aspects of the functional design of the system to the designer/pipe stress engineer. [4]

3.2 ORIENTATION

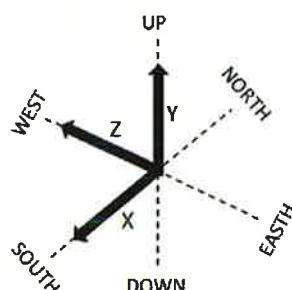


Figure 7 Orientation

3.3 PIPE DESIGN BASIS

The pipe line has been analyzed by using CAESAR II, and checked according to ASME B31.3. For hand calculations MathCAD has been used.

3.3.1 MATERIAL AND DATA

The pipe specifications used are AD20. The material is A790 UNS S31803.

Reference to piping and valve specification in the appendix.

The following material properties will be used for piping calculations:

SMYS (Specified Minimum Yield Strength)	448MPa ¹⁾
SMTS (Specified Minimum Tensile Strength)	621 MPa ¹⁾
Youngs modulus	E: 195830 N/mm ²
Density	ρ : 8027 kg/m ³
Poisson ratio	ν : 0,3

Table 1: Piping material data. Reference to APPENDIX A. ASME B31.3. Table A-1

3.3.2 MATERIAL BASIC ALLOWABLE STRESSES

Allowable stress	A790 UNS S31803
Allowable stress at max (100°C) metal temperature, S_h	205,9 MPa ¹⁾ (29,87ksi)
Allowable stress min (-7°C) metal temperature, S_c	206,84 MPa ¹⁾ (30ksi)
Yield Strength amb, S_{yc}	448 MPa ²⁾ (65ksi)
Yield Strength at temp Sy100	395 MPa ²⁾ (57,25ksi)

Table 2: Material basic allowable stresses. Reference to APPENDIX A. ASME B31.3 and BPV Code

1) ASME B31.3. Table A-1. Basic Allowable Stresses in Tension for Metals. Ref. Appendix A

2) BPV Code, section II, Part D. Table Y-1. Yield strength values S_Y . Ref. Appendix A

3.3.3 PIPING DIMENSIONS

Pipe sizes chosen for testing.

Nominal Pipe Size (inch)	OD (mm)	Wthk (mm)	Sch	Corr. Allow.	Mill. Tol.
20	508	4.78	5S	0	12.5%
20	508	12.70	30	0	12.5%
20	508	20.62	60	0	12.5%

Table 3: Piping dimensions. Reference to APPENDIX A. Table of dimensions of seamless and welded steel pipes

3.3.4 ENVIRONMENTAL TEMPERATURE

According to NORSOK – L002. Section 6.6.

The minimum/maximum environmental temperature for the North Sea shall unless otherwise specified in the project be:

- a) Installation temperature: 4 °C
- b) Minimum ambient temperature: -7 °C
- c) Maximum ambient temperature: 22 °C

Calculation of expansion stress shall be based on maximum/minimum design temperatures. The maximum design temperature shall not be lower than the maximum ambient temperature.

3.3.5 DESIGN PARAMETERS

Max design temperature	100°C
Min design temperature	-7°C
Installation temperature	+4°C
Max design pressure	12.1 bar

Table 4: Piping design parameters

3.3.6 WEIGHT OF CONTENT

Calculations were run with pipe contents of water with density of 1000 kg/m³

No insulation is included

3.3.7 BLAST CONSIDERATIONS

According to DNV-RP-D101: Structural analysis of piping system

Section 3.11.2.2 Blast drag loads.

Calculations of the blast drag load per unit length of the pipe F_D (N/m) can be calculated as follows:

$$F_D = \frac{1}{2} \cdot \rho \cdot v^2 \cdot D \cdot C_D \cdot DLF$$

$$\frac{1}{2} \cdot \rho \cdot v^2$$

Equals the dynamic drag pressure from table 3.1 in DNV-RP-D101

For this thesis the dynamic drag pressure is set to 0.3 bars

Drag coefficient for blast C_D is set to 1.0

Dynamic Load Factor DLF is set to 1.5

D is for the outside diameter (m) of the pipe

3.3.8 ACCEPTANCE CRITERIA

The limits for these code defined stresses (sustained, expansion range and occasional) are set by the piping codes.

The computed displacement stress range, $S_E \leq$ Allowable Displacement Stress Range, S_A
Stresses Due to Sustained Loads, $S_L \leq$ Allowable stress at max. metal temp. expected during the displ. Cycle, S_h . See chapter for hand calculations for more info.

According to ASME B31.3. Section: 320.2

The equation for the stress due to sustained loads, such as pressure and weight, S_L , is given:

$$S_L = \sqrt{(|S_a| + S_b)^2 + (2 \cdot S_t)^2}$$

According to ASME B31.3. Section: 319.4.4

The equation for the stress due to expansion loads, due to purely thermal loads, S_E , is given:

$$S_E = \sqrt{(|S_a| + S_b)^2 + (2 \cdot S_t)^2}$$

According to ASME B31.3. Section: 302.3.5

The Allowable Displacement Stress Range, S_A is given:

$$S_A = f \cdot (1.25 \cdot S_c + 0.25 \cdot S_h)$$

If S_h is greater than S_L

$$S_A = f \cdot [1.25 \cdot (S_c + S_h) - S_L]$$

S_a = axial stress range

S_b = bending stress range

S_t = torsional stress range

S_c = basic allowable stress at min metal temperature expected during the displacement cycle

S_h = basic allowable stress at max metal temperature expected during the displacement cycle

f = stress range factor. Set to 1.0 from fig. 302.3.5 in ASME B31.3.

ASME B31.3 does not consider the operating load cases a "stress allowance case", and therefore provides no equation for the allowable stress. For ASME B31.3, the "stress allowance cases" are: Sustained, expansion, and occasional. The operating case is used for generating structural restraint loads, overall displacement limits, and as a component to the expansion case determination. Pipe stresses for operating load cases can be generated in Caesar II but gives no result for the allowable stress. Operating load cases are therefore not used in any sort of pass/fail criterion.

According to NORSOK L-002. Section: 6.8. Explosion loads

Maximum allowable stress in blast case shall be the minimum of

$2.4 \times S_h$ or $1.5 \times S_Y$

Where S_h is the ASME B 31.3 allowable stress limit and S_Y is the pipe material yield stress.

In this case $2.4 \times S_h$ is relevant.

For this thesis the deflection limit for pipe span is set to $L/600$. [17]

The deflection limit is usually determined by the company project procedures.

3.4 STRUCTURAL DESIGN BASIS

The pipe support has been analyzed by using STAAD.Pro, and checked according to Eurocode 3. The load directions for the pipe supports calculations have the same coordinates as for the pipe stress calculations.

3.4.1 MATERIAL AND DATA

The steel profiles for pipe supports

Sections	Product type	Steel grade	Min. yield strength (Mpa)	Min. tensile Strength (Mpa)
Pipe support	SHS200x16	S355	355	510
Deck stringer	HP280X12	S355	355	510

Table 5: Structural material data

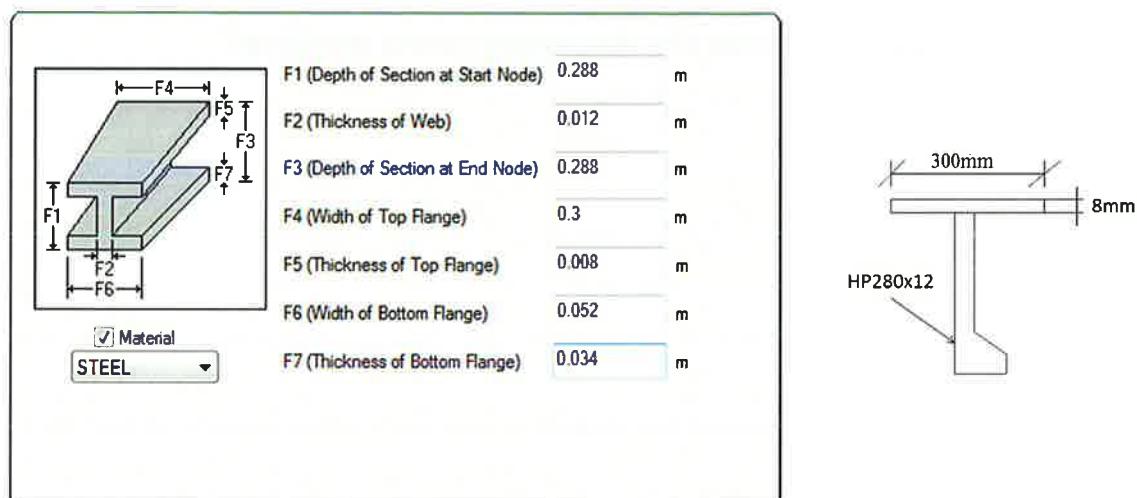


Figure 8: Input in STAAD.Pro for HP280X12 with effective width of deck plate

The following material properties will be used for structural calculations:

Young's modulus	E: 210000N/mm ²
Shear modulus	G: 80000N/mm ²
Poisson ratio	v: 0,3
Density	ρ : 7681.95 kg/m ³

Table 6: structural material properties

3.4.2 LOAD AND MATERIAL FACTORS

Pipe supports shall be proven to satisfy the limit states outlined in NORSO Standard N-001. The actions are to be combined in the most unfavorable way, provided the combination is physically feasible and permitted according to the action specifications.

The design condition considered is:

Ultimate limit states, ULS

Serviceability limit states, SLS (e.g. deflections)

Accidental limit states, ALS (e.g. blast)

Material factor:

- ULS: Material factor for the selected pipe support material shall be set to 1.15 for steel material. Material factors for welds and bolt connections shall be 1.3
- SLS/ALS: Material factor for the selected pipe support material shall be set to 1.0

Load factor:

- ULS: Load factor of 1.3 for design loads
- SLS/ALS: All combinations shall apply a load factor of 1.0.

Self-weight has a load factor of 1.2 because of connection plates, bolts, etc

Limit state	Action combinations	Permanent actions (G)	Variable actions (Q)	Environmental actions (E) ^d	Deformation actions (D) ^e
ULS	a ^a	1,3	1,3	0,7	1,0
ULS	b	1,0	1,0	1,3	1,0
SLS		1,0	1,0	1,0	1,0
ALS	Abnormal effect ^b	1,0	1,0	1,0	1,0
ALS	Damaged condition ^c	1,0	1,0	1,0	1,0
FLS		1,0	1,0	1,0	1,0

^a For permanent actions and/or variable actions, an action factor of 1,0 shall be used where this gives the most unfavourable action effect
^b Actions with annual probability of exceedance = 10^{-4}
^c Environmental actions with annual probability of exceedance = 10^{-2}
^d Earthquake shall be handled as environmental action within the limit state design for ULS and ALS (abnormal effect)
^e Applicable for concrete structures

Figure 9: Partial action factor for the limit states, ref. NORSO Standard N-001

Type of calculation	Material factor 1)	Value
Resistance of Class 1,2 or 3 cross-sections	γ_{M0}	1.15
Resistance of Class 4 cross-sections	γ_{M1}	1.15
Resistance of member to buckling	γ_{M1}	1.15
Resistance of net section at bolt holes	γ_{M2}	1.3
Resistance of fillet and partial penetration welds	γ_{M2}	1.3
Resistance of bolted connections	γ_{M2}	1.3

Figure 10: Material factors for ULS, Ref, NORSOK N-004

3.4.3 PIPE LINE LOADS

The reaction forces for pipe line loads are taken from operation loads in Caesar II and implemented into STAAD.Pro

3.4.4 BLAST CONSIDERATIONS

According to DNV-RP-D101: Structural analysis of piping system

Section 3.11.2.2 Blast drag loads.

Calculations of the blast drag load per unit length of SHS (N/m) can be calculated as follows:

$$F_D = \frac{1}{2} \cdot \rho \cdot v^2 \cdot B \cdot C_E \cdot DLF$$

$$\frac{1}{2} \cdot \rho \cdot v^2$$

Equals the dynamic drag pressure from table 3.1 in DNV-RP-D101

For this thesis the dynamic drag pressure is set to 0.3 bars

Dynamic Load Factor DLF is set to 1.

B is the width of the pipe support member

The shape factor for SHS, C_E is set to 1.4 according to Eurocode 1: Actions on structures.

Part 1-4: Wind actions, Section 7.6: Structural elements with rectangular sections

$$C_E = C_{f,0} \cdot \psi_r \cdot \psi_\lambda = 2 \cdot 0.75 \cdot 0.93 = 1.395$$

$C_{f,0}$ is the force coefficient of rectangular sections with sharp corners and without free-end flow

ψ_r is the reduction factor for square sections with rounded corners

ψ_λ is the end-effect factor for elements with free-end flow

3.4.5 ACCEPTANCE CRITERIA

The main criteria for the pipe supports reliability are the yield stress of material and deflection. The calculated stress of pipe supports from the applied (factored) loads must be under the limit of the material yield stress, all limit states included.

ULS: Material yield strength 355 / 1.15 material factors.

SLS/ALS: Material yield strength 355 / 1.0

Deflection limit in pipe support:

According to ConocoPhillips pipe support procedure, document number BD01-AK-P-06042:
Deflection shall not exceed the most conservative of L/360 or 3mm, where L is the span of the pipe support member in the restrained directions.

Deflection limit in the deck stringer (HP):

Condition	Limit for δ_{\max}	Limit for δ_2
Deck beams	L/200	L/300
Deck beams supporting plaster or other brittle finish or non-flexible partitions	L/250	L/350

Figure 11 -Limiting values for vertical deflections, ref. NORSOX N-001

4.0 LOADS AND LOAD CASES

A short summary of the design loads is given in the following.

The following loads have been considered:

- Design loads (pressure, temperature, weight)
- Occasional loads (blast Loads)

4.1 DESIGN LOADS

The following parameters have been used to calculate design loads on pipe:

LINE No.	Max. Design Temp. (°C)	Min. design Temp. (°C)	Inst. Temp (°C)	Max. design Pressure (barg)
20"	100	-7	4	12.1

Table 7: Piping parameters

The pipe support loads should be based on the following:

Vertical load: The weight of the pipe span carried by the actual support.

Horizontal load: For rest supports, the horizontal load may be assumed equal to the friction force. The friction coefficient set to 0.3 for surfaces steel to steel, shall be used to determine forces at sliding surfaces.

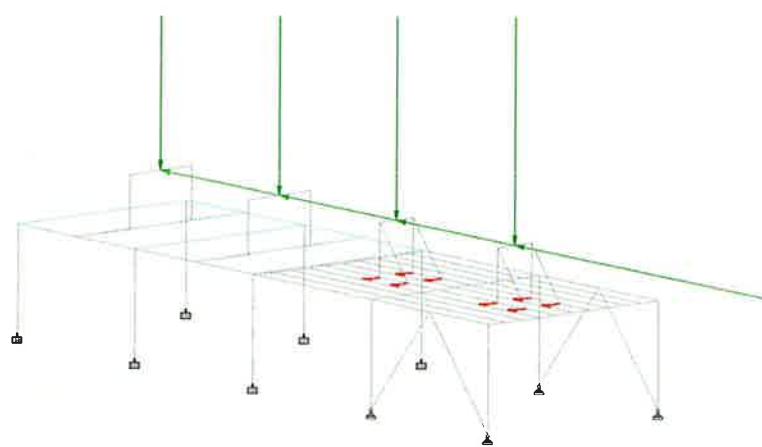


Figure 12: STAAD.Pro load case 101. Design load

4.2 OCCASIONAL LOADS

Blast drag loads per unit length of the pipe is set to:

$$F_D = \frac{1}{2} \cdot \rho \cdot v^2 \cdot D \cdot C_D \cdot DLF$$

$$F_D = 0.3 \text{bar} \cdot D \cdot 1.0 \cdot 1.5 = 0.45 \text{bar} \cdot D$$

$$F_D = 0.45 \text{bar} \cdot D = 45000 \frac{\text{N}}{\text{m}^2} \cdot D = 45000 \cdot 0.508 = 2.286 \times 10^4 \text{ N/m}$$

Blast loads on pipe line system is set from 6 directions

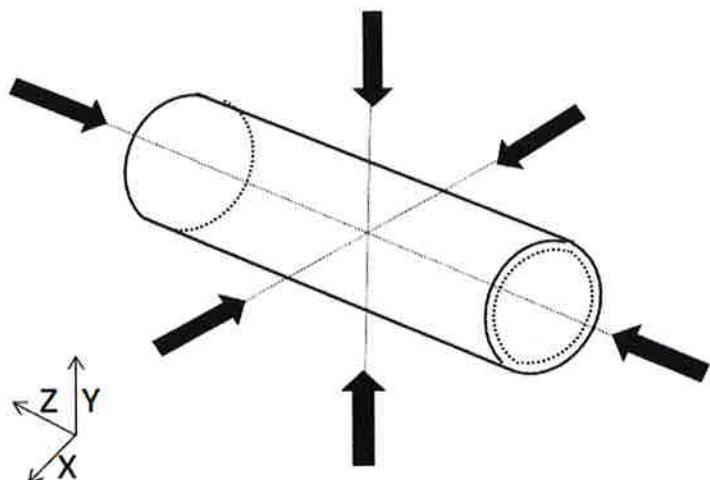


Figure 13: Blast load direction on piping

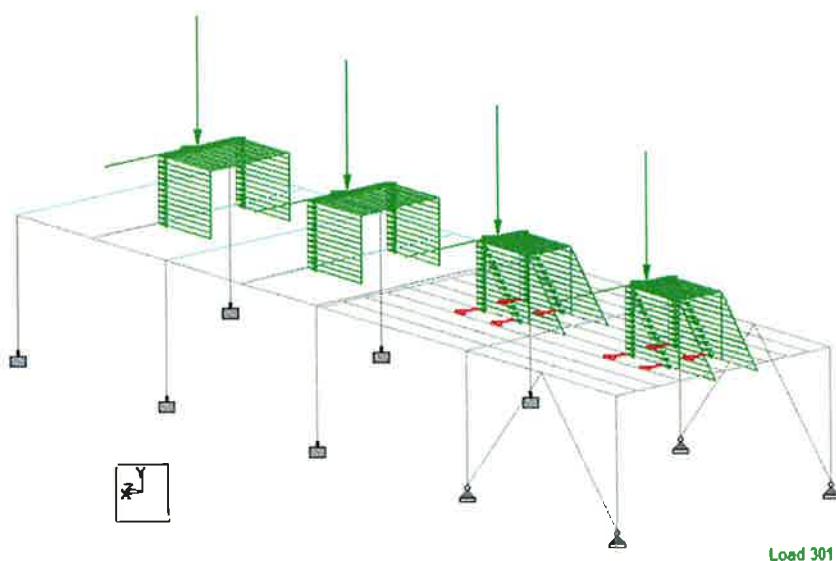


Figure 14: STAAD.Pro Load case 301. Design and blast loads

Blast drag loads per unit length of the support is set to:

$$F_D = \frac{1}{2} \cdot \rho \cdot v^2 \cdot B \cdot C_E \cdot DLF$$

$$F_D = 0.3\text{bar} \cdot B \cdot 1.4 \cdot 1.5 = 30 \cdot \frac{\text{kN}}{\text{m}^2} \cdot 0.2\text{m} \cdot 1.4 \cdot 1.5 = 12.6 \cdot \frac{\text{kN}}{\text{m}}$$

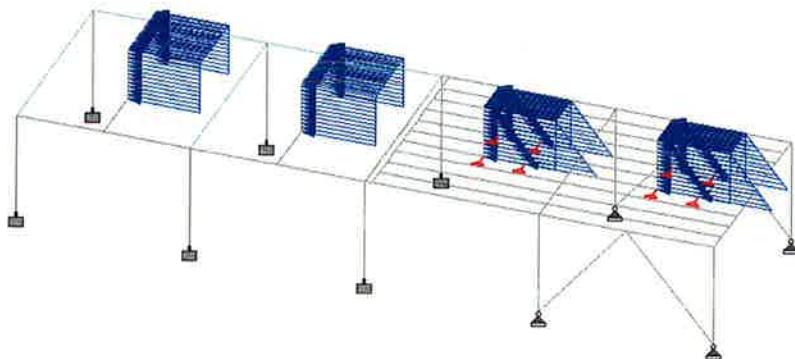


Figure 15: Blast loads on support in Z direction

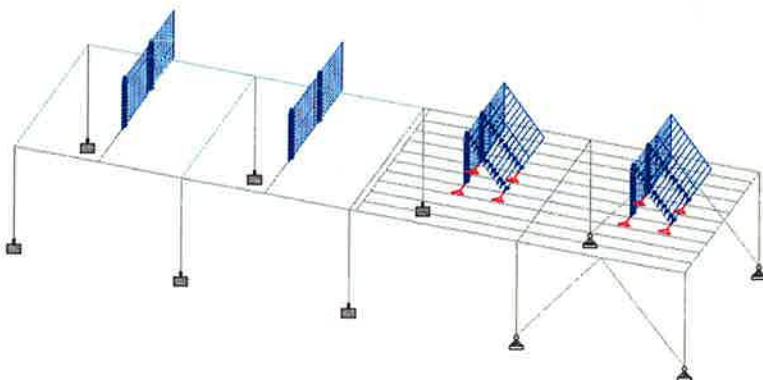


Figure 16: Blast loads on support in X direction

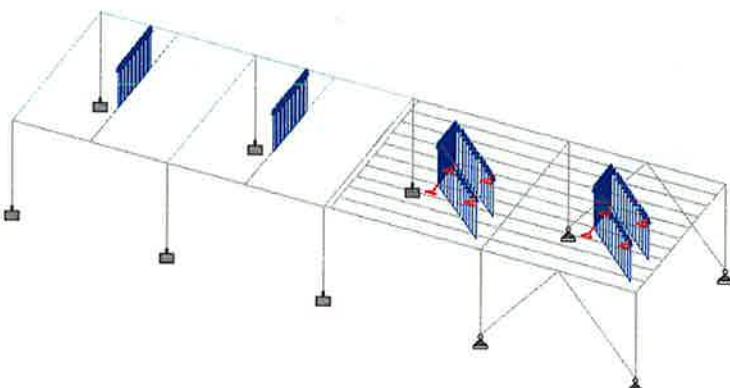


Figure 17: Blast loads on support in Y direction

4.3 HYDROSTATIC TEST LOADS

A hydrostatic test is a way in which pressure vessels such as pipelines, plumbing, gas cylinders, boilers and fuel tanks can be tested for strength and leaks. The test involves filling the vessel or pipe system with a liquid. Water is commonly used because it is cheap and easily available, and is usually harmless to the system to be tested. Water is a nearly incompressible liquid and therefore requiring relatively little work to develop a high pressure, and only a small volume will escape under high pressure in case of a failure. The location of a leak can more easily be visually detected if the water contains a red or fluorescent dye. To give a factor of safety the test pressure is always considerably higher than the operating pressure. This factor of safety is typically 166.66%, 143% or 150% of the designed working pressure, depending on the regulations that apply. Pressure tightness can be tested by shutting off the supply valve and observing whether there is a pressure loss. Strength is usually tested by measuring permanent deformation or changes in the shape.

Hydrotesting of pipes, pipelines and vessels is performed to expose defective materials that have missed prior detection, ensure that any remaining defects are insignificant enough to allow operation at design pressures, expose possible leaks, maintain safety standards and durability of a vessel over time and serve as a final validation of the integrity of the constructed system. Legislation requires pressure vessels to be regularly tested. ASME B31.3 requires this testing to ensure tightness and strength. [16]

Max. Design Pressure: 12.1 bar

Hydrostatic Pressure: $12.1 \text{ bar} \times 1.50 = 18.15 \text{ bar} \Rightarrow \text{rounded up to } \underline{20 \text{ bar}}$

4.4 OTHER LOADS

Other loads that may occur, but are not taken into considerations in this thesis. Dynamic loads such as slug loads, density variations in two-phase flow, water hammer or earth quake.

These dynamic loads may be taken into account by either estimating an equivalent static load combined with a conservative dynamic amplification factor. Other loads that might occur are wind, snow/ice, lifting and transportation.

In order to reduce the potential for dynamic movements, the lowest eigen frequency of the flow line should preferably be above 4 Hz. A too stiff supporting may on the other hand lead to unacceptable load and stress levels. If the system is too flexible it may be detrimental, because it vibrates at low frequency that can be induced by e.g. wind. [15]

It may not be sufficient to just use the design loads from the piping stress report.

When pipe supports are designed, possible loads from the piping construction, erection, installation, testing and demolition shall be included in the design.[10]

4.5 DEFINITION OF LOAD TYPES:

SUS = Sustained loads: These loads are always present and will allways be present in the system throughout its operating cycle. Weight of piping system and pressure inside the pipe are examples of sustained loads which generate sustained stresses.

OCC = Occasional loads: These loads are present at infrequent intervals during plant operation. e.g. earthquake, explosion, wind, etc.

EXP = Expansion loads: These are loads due to thermal displacements of piping.

OPE= Operational loads: These loads are restraint forces for structural supports. They include all the above load cases but are not code cases for stress.

4.6 DESIGN LOAD CASE DESCRIPTION AND CAESAR II LOAD IDENTIFICATION

Blast loads in CAESAR II are named WIN (as in wind) as a default.

Load	Description	CAESAR 2 Loads identifier
HYD	Hydrostatic pressure test	Hydrostatic test
WNC	Weight with no contents	Weight of pipe only
WW	Weight with water content	Weight of Water
W	(Weight) Normal operating weight with contents	Weight with Fluid contents
T1	(Thermal 1) Thermal expansion from ambient to maximum temperature +4° : +100°C	Temp 1
T2	(Thermal 1) Thermal expansion from ambient to maximum temperature +4° : -7°C	Temp 2
P1	(Pressure) Design Pressure	Pressure 1
WIN1	(Blast 1) Blast load in the +X direction	Wind load #1
WIN2	(Blast 2) Blast load in the -X direction	Wind load #2
WIN3	(Blast 3) Blast load in the +Y direction	Wind load #3
WIN4	(Blast 4) Blast load in the -Y direction	Wind load #4
WIN5	(Blast 5) Blast load in the +Z direction	Wind load #5
WIN6	(Blast 6) Blast load in the -Z direction	Wind load #6
D1	Imposed deflection	

Table 8: Caesar II load identification

4.7 LOAD CASES AND COMBINATION RUN THROUGH CAESAR II

For calculation of pipe line stress and loads created separate from structural influence.

LC.	Load case Comb.	Type	Description
1	WW+HP	HYD	Hydro test Load case
2	WNC	SUS	Weight of pipe only
3	W+P1	SUS	Sustained Stress
4	W+T1+P1	OPE	Max Design Temp. Load case
5	W+T2+P1	OPE	Min Design Temp. Load case
6	W+T1+P1+WIN1	OPE	Design case with blast in +X direction
7	W+T1+P1-WIN1	OPE	Design case with blast in -X direction
8	W+T1+P1+WIN2	OPE	Design case with blast in +Y direction
9	W+T1+P1-WIN2	OPE	Design case with blast in -Y direction
10	W+T1+P1+WIN3	OPE	Design case with blast in +Z direction
11	W+T1+P1-WIN3	OPE	Design case with blast in -Z direction
12	W+T2+P1+WIN1	OPE	Design case with blast in +X direction
13	W+T2+P1-WIN1	OPE	Design case with blast in -X direction
14	W+T2+P1+WIN2	OPE	Design case with blast in +Y direction
15	W+T2+P1-WIN2	OPE	Design case with blast in -Y direction
16	W+T2+P1+WIN3	OPE	Design case with blast in +Z direction
17	W+T2+P1-WIN3	OPE	Design case with blast in -Z direction
18	L18=L6-L4	OCC	Blast in +X direction
19	L19=L7-L4	OCC	Blast in -X direction
20	L20=L8-L4	OCC	Blast in +Y direction
21	L21=L9-L4	OCC	Blast in -Y direction
22	L22=L10-L4	OCC	Blast in +Z direction
23	L23=L11-L4	OCC	Blast in -Z direction
24	L24=L18+L3	OCC	Blast in +X direction + Sustained load Ln.3
25	L25=L19+L3	OCC	Blast in -X direction + Sustained load Ln.3
26	L26=L20+L3	OCC	Blast in +Y direction + Sustained load Ln.3
27	L27=L21+L3	OCC	Blast in -Y direction + Sustained load Ln.3
28	L28=L22+L3	OCC	Blast in +Z direction + Sustained load Ln.3
29	L29=L23+L3	OCC	Blast in -Z direction + Sustained load Ln.3
30	L30=L4-L3	EXP	Expansion Stress; Temp Max Design-Temp installation
31	L31=L5-L3	EXP	Expansion Stress; Temp Min Design-Temp installation

Table 9: Caesar II load case description

For calculation of pipe line stress and loads created with forced deflections from structural influence

Ln.	Load case Comb.	Type	Description
1	WW+HP	HYD	Hydro test Load case
2	WNC	SUS	Weight of pipe only
3	W+P1	SUS	Sustained Stress
4	W+T1+P1+D1	OPE	Max Design Temp. Load case
5	W+T2+P1+D1	OPE	Min Design Temp. Load case
6	W+T1+P1+WIN1+D1	OPE	Design case with blast in +X direction
7	W+T1+P1-WIN1+D1	OPE	Design case with blast in -X direction
8	W+T1+P1+WIN2+D1	OPE	Design case with blast in +Y direction
9	W+T1+P1-WIN2+D1	OPE	Design case with blast in -Y direction
10	W+T1+P1+WIN3+D1	OPE	Design case with blast in +Z direction
11	W+T1+P1-WIN3+D1	OPE	Design case with blast in -Z direction
12	W+T2+P1+WIN1+D1	OPE	Design case with blast in +X direction
13	W+T2+P1-WIN1+D1	OPE	Design case with blast in -X direction
14	W+T2+P1+WIN2+D1	OPE	Design case with blast in +Y direction
15	W+T2+P1-WIN2+D1	OPE	Design case with blast in -Y direction
16	W+T2+P1+WIN3+D1	OPE	Design case with blast in +Z direction
17	W+T2+P1-WIN3+D1	OPE	Design case with blast in -Z direction
18	L18=L6-L4	OCC	Blast in +X direction
19	L19=L7-L4	OCC	Blast in -X direction
20	L20=L8-L4	OCC	Blast in +Y direction
21	L21=L9-L4	OCC	Blast in -Y direction
22	L22=L10-L4	OCC	Blast in +Z direction
23	L23=L11-L4	OCC	Blast in -Z direction
24	L24=L18+L3	OCC	Blast in +X direction + Sustained load Ln.3
25	L25=L19+L3	OCC	Blast in -X direction + Sustained load Ln.3
26	L26=L20+L3	OCC	Blast in +Y direction + Sustained load Ln.3
27	L27=L21+L3	OCC	Blast in -Y direction + Sustained load Ln.3
28	L28=L22+L3	OCC	Blast in +Z direction + Sustained load Ln.3
29	L29=L23+L3	OCC	Blast in -Z direction + Sustained load Ln.3
30	L30=L4-L3	EXP	Expansion Stress; Temp Max Design-Temp installation
31	L31=L5-L3	EXP	Expansion Stress; Temp Min Design-Temp installation

Table 10: Caesar II load case description with deflection

4.8 LOAD CASE DESCRIPTION AND STAAD PRO LOAD IDENTIFICATION

Load Case	Load Type	Description	Load factors	Direction coordinates
1		Self-weight	1.3ULS/1.0SLS	-1.2y
2	Design load	Vertical rest load	1.3	-Fy
3	Design load	Line stop west load	1.3	+Fz
4	Design load	Line stop east load	1.3	-Fz
5	Blast+Design	Rest load	1.0	-Fy
6	Blast+Design	Hold down rest load	1.0	+Fy
7	Blast load	Blast load Line guide N	1.0	-Fx
8	Blast load	Blast load Line guide S	1.0	+Fx
9	Blast load	Blast load on members Z	1.0	z
10	Blast load	Blast load on members X	1.0	x
11	Blast load	Blast load on members Y	1.0	y

Table 11: STAAD.Pro load case description

4.9 LOAD CASES AND COMBINATIONS RUN THROUGH STAAD.Pro

Load Case	Load Case Comb.	Load Type	Description
101	1,2,3	ULS	
102	1,2,4	ULS	
201	1,2,3	SLS	
202	1,2,4	SLS	
301	1,5,7,9	ALS	(DESIGN+ BLAST)
302	1,5,7,-9	ALS	(DESIGN+ BLAST)
303	1,5,7,10	ALS	(DESIGN+ BLAST)
304	1,5,7,-10	ALS	(DESIGN+ BLAST)
305	1,5,7,11	ALS	(DESIGN+ BLAST)
306	1,5,7,-11	ALS	(DESIGN+ BLAST)
307	1,5,8,9	ALS	(DESIGN+ BLAST)
308	1,5,8,-9	ALS	(DESIGN+ BLAST)
309	1,5,8,10	ALS	(DESIGN+ BLAST)
310	1,5,8,-10	ALS	(DESIGN+ BLAST)
311	1,5,8,11	ALS	(DESIGN+ BLAST)
312	1,5,8,-11	ALS	(DESIGN+ BLAST)
313	1,6,7,9	ALS	(DESIGN+ BLAST)
314	1,6,7,-9	ALS	(DESIGN+ BLAST)
315	1,6,7,10	ALS	(DESIGN+ BLAST)
316	1,6,7,-10	ALS	(DESIGN+ BLAST)
317	1,6,7,11	ALS	(DESIGN+ BLAST)
318	1,6,7,-11	ALS	(DESIGN+ BLAST)
319	1,6,8,9	ALS	(DESIGN+ BLAST)
320	1,6,8,-9	ALS	(DESIGN+ BLAST)
321	1,6,8,10	ALS	(DESIGN+ BLAST)
322	1,6,8,-10	ALS	(DESIGN+ BLAST)
323	1,6,8,11	ALS	(DESIGN+ BLAST)
324	1,6,8,-11	ALS	(DESIGN+ BLAST)

Table 12: STAAD.Pro load case combinations

4.10 INPUT UNITS FOR CAESAR II

INPUT UNITS USED...

UNITS= ELDFISK- NOM/SCH	INPUT= ON					
LENGTH	inches	x	25.400	=	mm.	
FORCE	pounds	x	4.448	=	N.	
MASS (dynamics)	pounds	x	0.454	=	kg.	
MOMENTS (INPUT)	inch-pounds	x	0.113	=	N.m.	
MOMENTS (OUTPUT)	inch-pounds	x	0.113	=	N.m.	
STRESS	lbs./sq.in.	x	0.007	=	N./sq.mm.	
TEMP. SCALE	degrees F.	x	0.556	=	C	
PRESSURE	psig	x	0.069	=	bars	
ELASTIC MODULUS	lbs./sq.in.	x	0.007	=	N./sq.mm.	
PIPE DENSITY	lbs./cu.in.	x	27680.000	=	kg/cu.m.	
INSULATION DENS.	lbs./cu.in.	x	27680.000	=	kg/cu.m.	
FLUID DENSITY	lbs./cu.in.	x	27680.000	=	kg/cu.m.	
TRANSL. STIF	lbs./in.	x	0.175	=	N./mm.	
ROTATIONAL STIF	in.lb./deg.	x	0.113	=	N.m./deg	
UNIFORM LOAD	lb./in.	x	0.175	=	N./mm.	
G LOAD	g's	x	1.000	=	g's	
WIND LOAD	lbs./sq.in.	x	6.895	=	KN./sq.m.	
ELEVATION	inches	x	25.400	=	mm.	
COMPOUND LENGTH	inches	x	25.400	=	mm.	
DIAMETER	inches	x	25.400	=	mm.	
WALL THICKNESS	inches	x	25.400	=	mm.	

SETUP FILE PARAMETERS

CONNECT GEOMETRY THRU CNODES =	YES
MIN ALLOWED BEND ANGLE =	5.00000
MAX ALLOWED BEND ANGLE =	95.0000
BEND LENGTH ATTACHMENT PERCENT =	1.00000
MIN ANGLE TO ADJACENT BEND PT =	5.00000
LOOP CLOSURE TOLERANCE =	25.4000 mm.
THERMAL BOWING HORIZ TOLERANCE =	0.100000E-03
AUTO NODE NUMBER INCREMENT=	10.0000
Z AXIS UP=	NO
USE PRESSURE STIFFENING =	NO
ALPHA TOLERANCE =	0.500000E-01
RESLD-FORCE =	NO
HGR DEF RESWGT STIF =	0.175120E+12 N./mm.
DECOMP SNG TOL =	0.100000E+11
BEND AXIAL SHAPE =	YES
FRICT STIF =	175120. N./mm.
FRICT NORM FORCE VAR =	0.150000
FRICT ANGLE VAR =	15.0000
FRICT SLIDE MULT =	1.00000
ROD TOLERANCE =	1.00000
ROD INC =	2.00000
INCORE NUMERICAL CHECK =	NO
OUTCORE NUMERICAL CHECK =	NO
DEFAULT TRANS RESTRAINT STIFF=	0.175120E+12 N./mm.
DEFAULT ROT RESTRAINT STIFF=	0.112980E+12 N.m./deg
IGNORE SPRING HANGER STIFFNESS =	NO
MISSING MASS ZPA =	EXTRACTED
MIN WALL MILL TOLERANCE =	12.5000
WRC-107 VERSION =	MAR 79 1B1/2B1
WRC-107 INTERPOLATION =	LAST VALUE

DEFAULT AMBIENT TEMPERATURE= 4.00174 C
 BOURDON PRESSURE= NONE
 COEFFICIENT OF FRICTION (MU) = 0.000000
 INCLUDE SPRG STIF IN HGR OPE = NO
 INCLUDE INSULATION IN HYDROTEST = NO
 REDUCED INTERSECTION = B31.1 (POST1980)
 USE WRC329 NO
 NO REDUCED SIF FOR RFT AND WLT NO
 B31.1 REDUCED Z FIX = YES
 CLASS 1 BRANCH FLEX NO
 ALL STRESS CASES CORRODED = YES
 ADD TORSION IN SL STRESS = DEFAULT
 ADD F/A IN STRESS = DEFAULT
 OCCASIONAL LOAD FACTOR = 0.000000
 DEFAULT CODE = B31.3
 B31.3 SUS CASE SIF FACTOR = 1.000000
 ALLOW USERS BEND SIF = NO
 USE SCHNEIDER NO
 YIELD CRITERION STRESS = MAX 3D SHEAR
 USE PD/4T NO
 BASE HOOP STRESS ON ? = ID
 EN13480 USE IN OUTPLANE SIFS= YES
 LIBERAL EXPANSION ALLOWABLE= YES
 B31.3 SEC 319.2.3C SAXIAL= NO
 B31.3 WELDING/CONTOUR TEE ISB16.9 FALSE
 PRESSURE VARIATION IN EXP CASE= DEFAULT
 IMPLEMENT B313 APP-P NO
 IMPLEMENT B313 CODE CASE 178 NO
 IGNORE B31.1/B31.3 Wc FACTOR= YES
 USE FRP SIF = YES
 USE FRP FLEX = YES
 BS 7159 Pressure Stiffening= Design Strain
 FRP Emod (axial) = 22062.7 N./sq.mm.
 FRP Ratio Gmod/Emod (axial) = 0.250000
 FRP Ea/Eh*Vh/a = 0.152730
 FRP Laminate Type = THREE
 FRP Alpha = 21.5983 C
 FRP Density = 1660.80 kg/cu.m.
 EXCLUDE f2 FROM UKOOA BENDING = NO

EXECUTION CONTROL PARAMETERS

Rigid/ExpJt Print Flag	1.000
Bourdon Option .....	.000
Loop Closure Flag	2.000
Thermal Bowing Delta Temp ..	.000 C
Liberal Allowable Flag	1.000
Uniform Load Option .....	.000
Ambient Temperature	4.000 C
Plastic (FRP) Alpha	21.598
Plastic (FRP) GMOD/EMODa ...	.250
Plastic (FRP) Laminate Type.	3.000
Eqn Optimizer .....	.000
Node Selection .....	.000
Eqn Ordering .....	.000
Collins .....	.000
Degree Determination .....	.000
User Eqn Control .....	.000

5.0 MODEL AND CASE STUDIES

5.1 MODEL IN CAESAR II

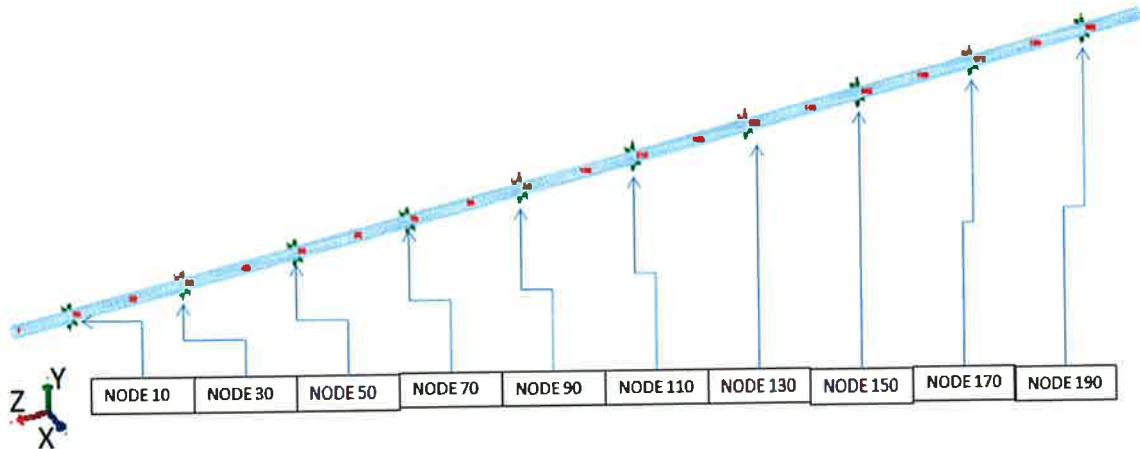


Figure 18: Caesar II model

A pipe of size 20-inch and material A790 UNS S31803 is used in a simplified straight pipeline system of total length 50m. Three pipe thicknesses are chosen, the smallest for pipe size 20 inch, 4.73mm and the biggest thickness approved for thin wall calculations, 20.62mm and the size in between the two, 12.70mm.

The pipe line dimensions, densities, nodes and parameters are set in an input sheet in Caesar. The pipe line is modeled in the -Z direction and is supported in ten equally spaced locations of 5m. The pipelines restraint positions for the locations of pipe supports are by piping calculations named as node 10, 30, 50, 70, 90, 110, 130, 150, 170 and 190. Before node 10 and after node 190 there is a 2,5m long pipe length to simulate the behavior of a long pipe length with evenly distributed restraint loads.

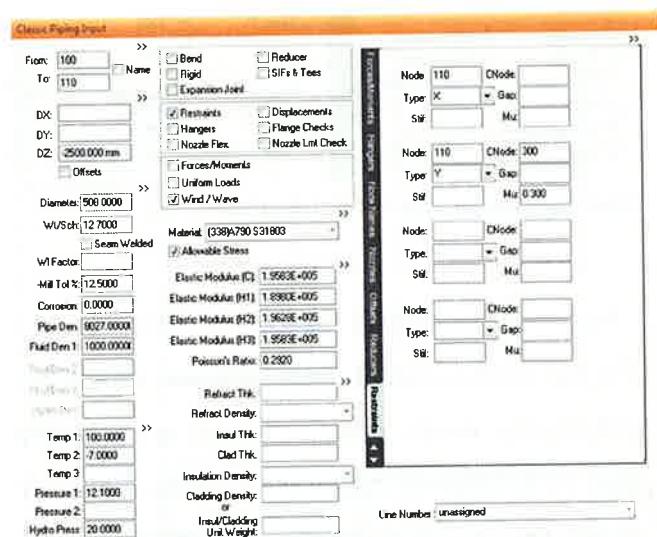


Figure 19: Caesar II input

All of the restraint nodes are set as sliding restraints with reactions in x and y directions. The restraints used are called double-acting restraints, because they act in both directions along the line of action. The reaction force in the y direction is multiplied with 0.3 to give friction force in z direction. For the nodes exposed to forced deflection, friction is set for these nodes in Caesar but gives zero in results. Since there is a restraint force in the Y direction, friction has been calculated manually and given in STAAD.Pro. The function in Caesar II is that the friction coefficient is set on the nodes, and therefore is applied to all load cases. The friction force is only applicable for load cases where thermal expansion occurs. Friction is of course not relevant for blast loads, since the blast is an overly rapid load to be developing friction. The piping analysis will be run with friction, to simplify and avoid dividing the load cases into multiple runs. Friction is in other words included in Caesar results for restraint loads, but is not included in STAAD.Pro for further calculations of blast loads. For pipe stress and utilization, friction is not required and is therefore run in separate files.

For the cases of forced deflections a connection node called Cnode is used. A unique node number for the Cnode and the forced displacement is entered and the restraint node connected to the Cnode.

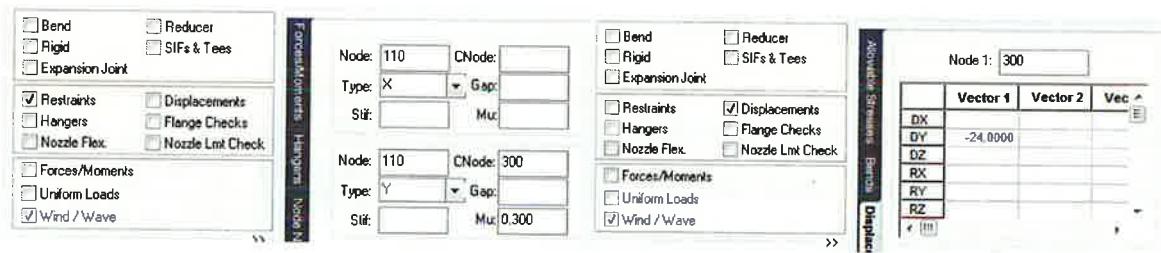


Figure 20: Caesar II input forced deflection

The design parameters for the pipe line refer to as T1 for 100°C, T2 for -7°C, P1 for 12.1bar. For the temperature it gives different modulus of elasticity that the load cases that includes temperature needs to be connected to in the program. The blast load is implemented on the pipe in 6 different directions, referred to as +WIN1 for X, -WIN1 for -X, +WIN2 for Y, -WIN2 for -Y, +WIN3 for Z and -WIN3 for -Z. Other factors that need to be implemented are the Yield Strength at temp Sy100 =395 Mpa.

The pipe weight with content (W), design parameters and blast loads are then combined into load cases as for different purposes. The load cases marked as operating cases are the cases from where restraint forces are generated from. In this case we need design loads and design+blast loads. The combination of W + T + P are the design loads, which generally are the vertical load of the operating pipe. In this case we have two temperatures T1 and T2 which gives two load cases referred to as LC.4 and LC.5. These load cases also have friction force in the z direction. The pipe support also requires to be designed to withstand blast loads. For explosion in the +y direction the restraint y force will be blast load minus design load of the pipe. For the explosion in the -y direction the restraint y force will be negative blast load minus design load of the pipe. The highest restraint force will of course be used further in STAAD.Pro calculations.

5.2 MODEL IN STAAD.PRO

With reference to Caesar II, for the restraint force created at node 70 and 90 the support is fixed to a concrete deck, and for the restraint force created at node 110 and 130 the support is fixed to a steel deck supported by stringers. Sections used in all four pipe supports are 200X16SHS for all members. The design loads and design+blast loads for these nodes are taken from Caesar files and put in to STAAD.Pro. The deflection is based on load type of limit state SLS.

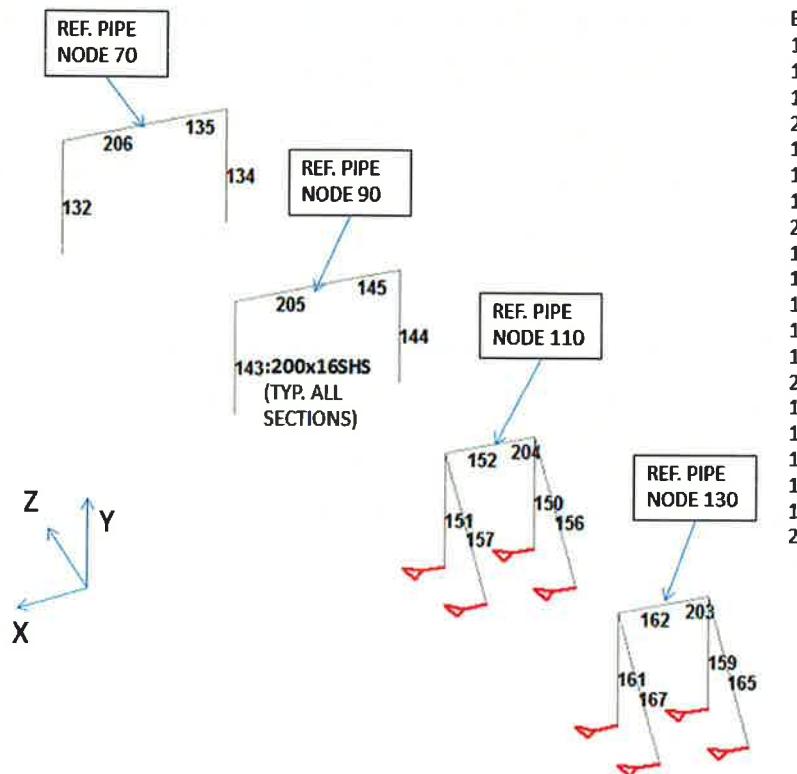


Figure 21: STAAD.Pro. Beam numbers

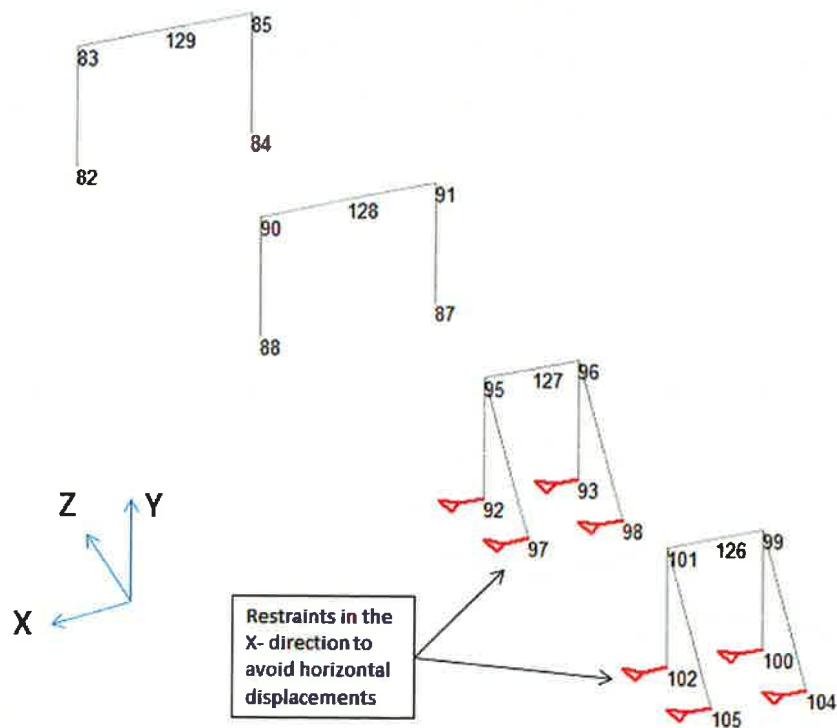


Figure 22: STAAD.Pro. Nodes on the supports

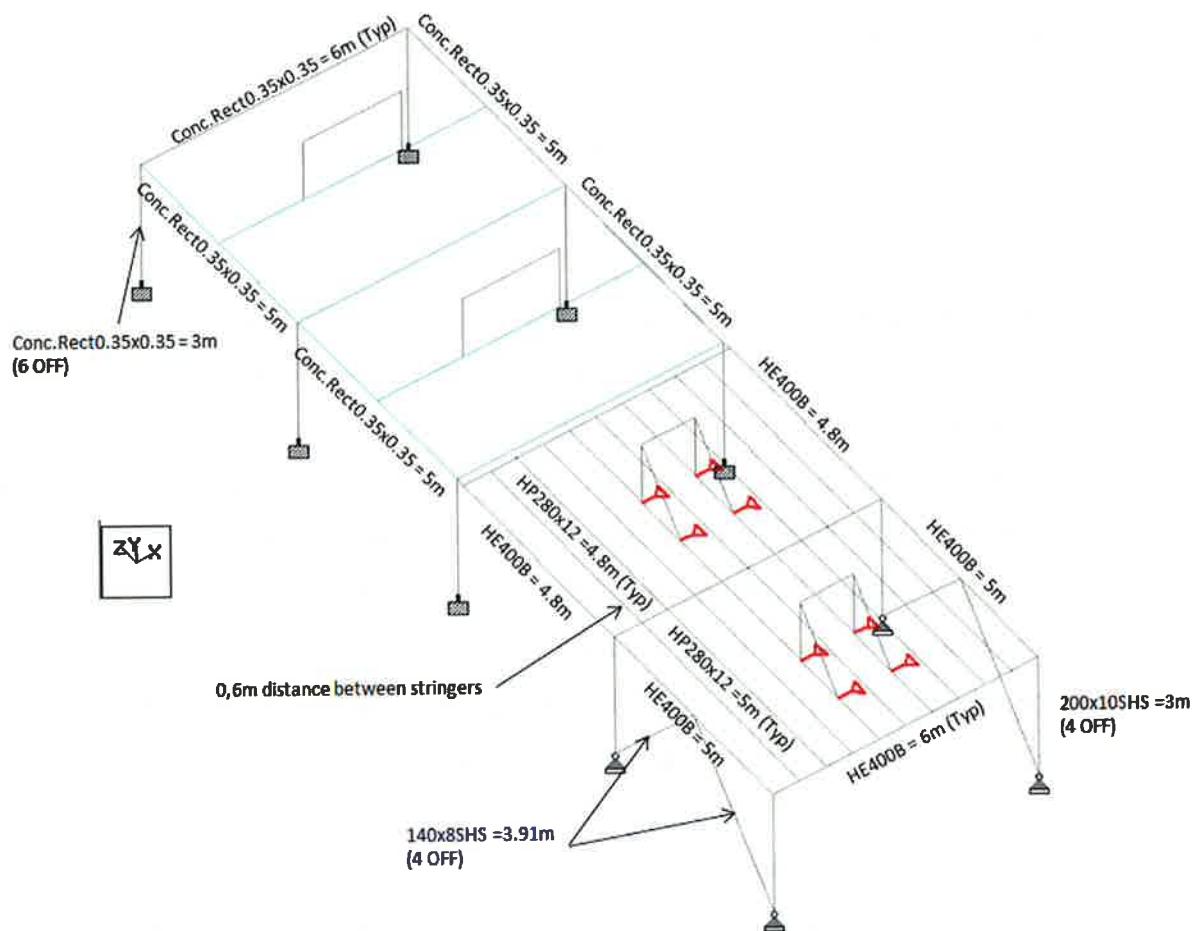


Figure 23: STAAD.Pro material and dimension

5.3 CASE STUDIES

This thesis will be separated into four cases.

1. **The first case:** The established practice where structural and piping stress analyses are run separately.

Pipe analysis: For the calculation of pipe stress and loads on the pipe lines restraint positions, the sliding supports are assumed without considering the structural stiffness, like deflection.

Structural analysis: The pipe support loads generated at the pipe lines restraints in Caesar in the first case will be used for analyzing the supports in Staad.Pro

2. **The second case:** Structural and piping stress analyses will be run combined

Pipe analysis: For the calculation of pipe stress and loads on the pipe lines restraint positions, the deck deflection calculated in the first case in node 110 and 130, for structural analysis will be taken into considerations. The supports for node 70 and 90 are fixed to concrete deck and are assumed to be zero.

Structural analysis: The pipe support loads generated at the pipe lines restraints in Caesar in the second case will be used for analyzing the supports in Staad.Pro

3. **The third case:** Structural and piping stress analyses will be run combined

Pipe analysis: For the calculation of pipe stress and loads on the pipe lines restraint positions, the max acceptable deck deflection ($L/200$) for structural analysis will be taken into considerations in node 110 and node 130.

Structural analysis: The pipe support loads generated at the pipe lines restraints in Caesar in the third case will be used for analyzing the supports in Staad.Pro.

4. **The fourth case:** In this case the pipe support for node 110 and 130 are set to fail, which means that these two pipe supports will not take any loads from the pipe.

Pipe analysis: For the calculation of pipe stress and loads on the pipe lines restraint positions, the sliding supports are assumed without considering the structural stiffness, like deflection.

Structural analysis: The pipe support loads generated at the pipe lines restraints in Caesar in the fourth case will be used for analyzing the supports in Staad.Pro

Piping analysis:

Reaction forces on the pipe line restraints

Utilization of the pipe line for load cases hydro test, sustained, occasional and expansion stress.

Deflection between supports.

Structural analysis:

Deck deflection to be checked for node 92, 93, 100 and 102 (STAAD.Pro reference).

Utilization of support beams.

Displacements in the pipe support connection between support and pipe line. Nodes to be checked are node 129, 128, 127 and 126 (STAAD.pro reference)

6.0 COMPARISON OF RESULTS

6.1 PIPE STRESS RESULT AND UTILIZATION

- Pipe size: 508mm, 4.78mm wall thickness. Table 13 - 16

Table 13: The first case: Without structural influence.

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	60	395	10	15.2	L1
Sustained Stress (max overall)	39,6	205,9	10	19,2	L3
Occasional (max overall)	115,4	494,2	10	23,4	L24-L27
Expansion Stress (max overall)	0	479,9		0	

Table 13: Reference APPENDIX C. 508.4.78. Without structural influence, stress report

Table 14: The second case: With structural influence.

Forced deflection -2,23mm in node 110 and -2,24mm in node 130. Reference table 25

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	60	395	10	15,2	L1
Sustained Stress (max overall)	39,6	205,9	10	19,2	L3
Occasional (max overall)	115,4	494,2	10	23,4	L24-L27
Expansion Stress (max overall)	8,7	480,1	150	1,8	L31

Table 14: Reference APPENDIX C. 508.4.78. With structural influence, stress report

Table 15: The third case: With structural influence.

Max forced deflection -24mm in node 110 and node 130.

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	60	395	10	15,2	L1
Sustained Stress (max overall)	39,6	205,9	10	19,2	L3
Occasional (max overall)	115,4	494,2	10	23,4	L24-L27
Expansion Stress (max overall)	93,6	480,3	90	19,5	L31

Table 15: Reference APPENDIX C. 508.4.78. With structural influence, max deflection. Stress report

Table 16: The fourth case: The support in node 110 and 130 is failing / removed.

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	94,2	395	150	23,8	L1
Sustained Stress (max overall)	73,8	205,9	150	35,8	L3
Occasional (max overall)	461,6	494,2	150	93,4	L24-L27
Expansion Stress (max overall)	0	481		0	

Table 16: Reference APPENDIX C. 508.4.78. Failing support in node 110 and 130, stress report

- Pipe size: 508mm, 12.70 mm wall thickness. Table 17 – 20.

Table 17: The first case: Without structural influence.

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	22,9	395	10	5,8	L1
Sustained Stress (max overall)	15,6	205,9	10	7,6	L3
Occasional (max overall)	45,5	494,2	10	9,2	L24-L27
Expansion Stress (max overall)	0	502,2		0	

Table 17: 508.12.70. Without structural influence, stress report

Table 18: The second case: With structural influence.

Forced deflection -2.5mm in node 110 and -2.5mm in node 130. Reference table 26

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	22,9	395	10	5,8	L1
Sustained Stress (max overall)	15,6	205,9	10	7,6	L3
Occasional (max overall)	45,5	494,2	10	9,2	L24-L27
Expansion Stress (max overall)	9,8	503	90	1,9	L31

Table 18: 508.12.70. With strucrural influence, stress report

Table 19: The third case: With structural influence.

Max forced deflection -24mm in node 110 and node 130.

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	22,9	395	10	5,8	L1
Sustained Stress (max overall)	15,6	205,9	10	7,6	L3
Occasional (max overall)	45,5	494,2	10	9,2	L24-L27
Expansion Stress (max overall)	93,7	503	90	18,6	L31

Table 19: 508.12.70. With structural influence, max deflection. Stress report

Table 20: The fourth case: The support in node 110 and 130 is failing / removed.

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	40,9	395	150	10,4	L1
Sustained Stress (max overall)	33,6	205,9	150	16,3	L3
Occasional (max overall)	186,6	494,2	150	37,8	L24-L27
Expansion Stress (max overall)	0	503,9		0	

Table 20: 508.12.70. Failing support in node 110 and 130, stress report

- Pipe size: 508mm, 20.62 mm wall thickness. Table 21- 24

Table 21: The first case: Without structural influence

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	14,4	395	10	3,6	L1
Sustained Stress (max overall)	10,1	205,9	10	4,9	L3
Occasional (max overall)	29,4	494,2	10	5,9	L24-L27
Expansion Stress (max overall)	0	508,5		0	

Table 21: 508.20.62. Without structural influence, stress report

Table 22: The second case: With structural influence

Forced deflection -2.75mm in node 110 and node 130. Reference table 27

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	14,4	395	10	3,6	L1
Sustained Stress (max overall)	10,1	205,9	10	4,9	L3
Occasional (max overall)	29,4	494,2	10	5,9	L24-L27
Expansion Stress (max overall)	10,7	508,2	90	2,1	L31

Table 22: 508.20.62. With strucrural influence, stress report

Table 23: The third case: With structural influence

Max forced deflection -24mm in node 110 and node 130

Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	14,4	395	10	3,6	L1
Sustained Stress (max overall)	10,1	205,9	10	4,9	L3
Occasional (max overall)	29,4	494,2	10	5,9	L24-L27
Expansion Stress (max overall)	93,8	508,2	90	18,5	L31

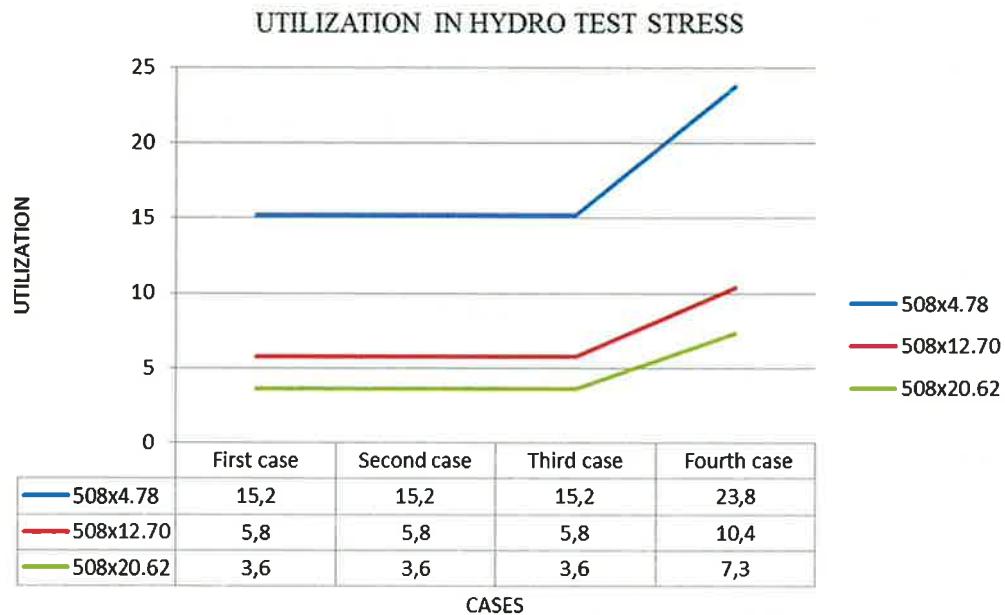
Table 23: 508.20.62. With structural influence, max deflection. Stress report

Table 24: The fourth case: The support in node 110 and 130 is failing / removed

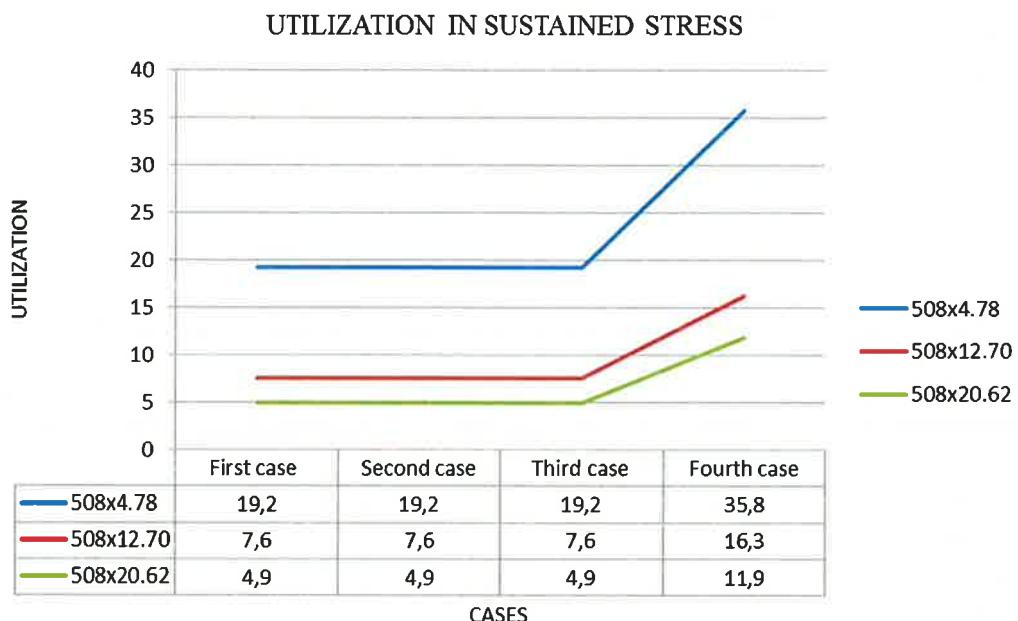
Check	Code Stress (MPa)	Allow. (MPa)	Node	Utilization %	Load case
Hydro test Stress (max overall)	28,8	395	150	7,3	L1
Sustained Stress (max overall)	24,6	205,9	150	11,9	L3
Occasional (max overall)	123,4	494,2	150	25	L24-L27
Expansion Stress (max overall)	0	508,9		0	

Table 24: 508.20.62. Failing support in node 110 and 130, stress report

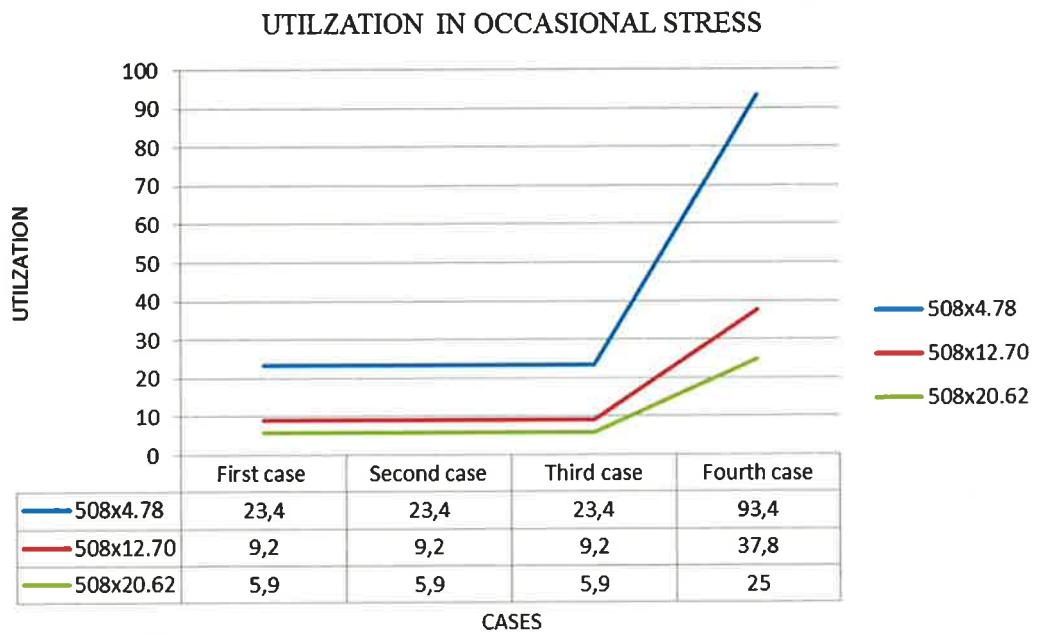
The results of utilizations in table 13-24 is presented in graphs 1-4 for hydro test, sustained, occasional and expansion stress, for all four case studies and all three pipe wall thicknesses.



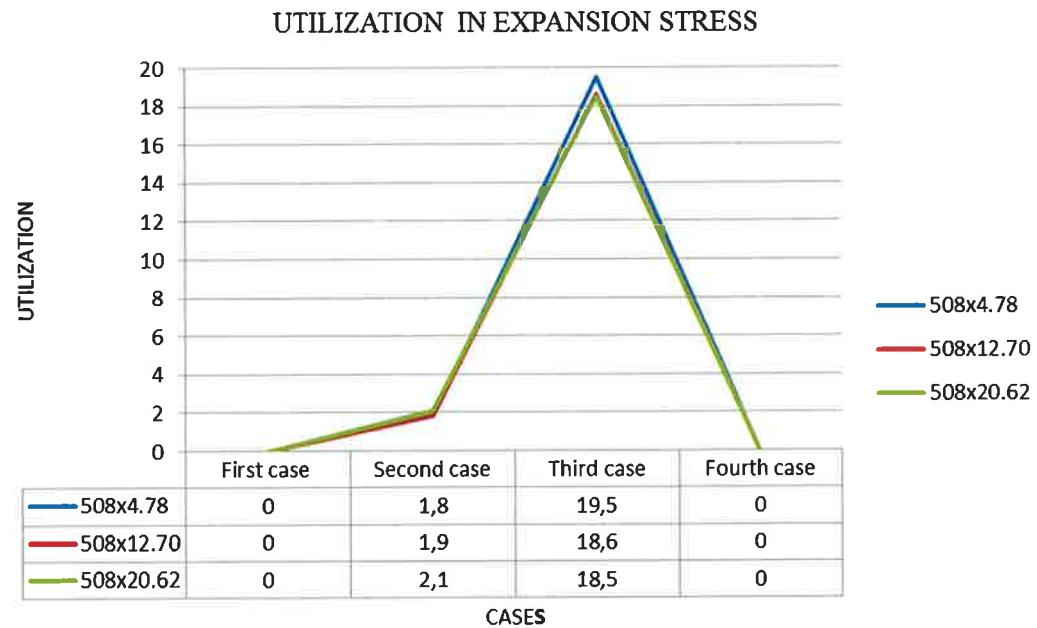
Graph 1: Utilization of pipe in hydro test stress



Graph 2: Utilization of pipe in sustained stress



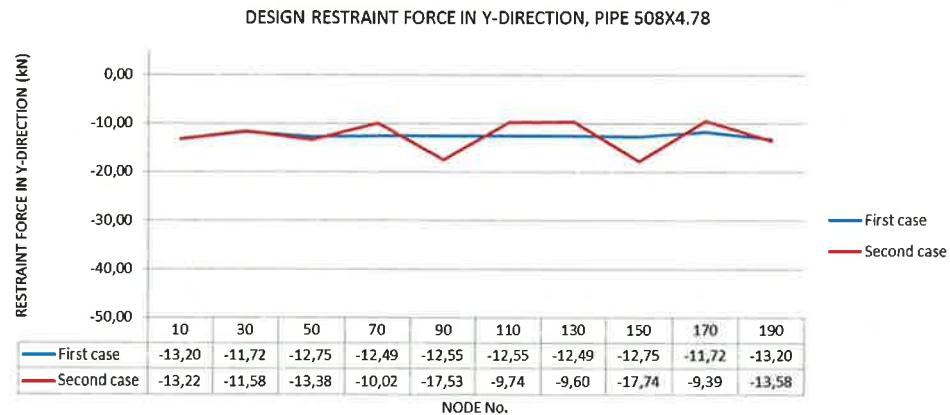
Graph 3: Utilization of pipe in occasional stress



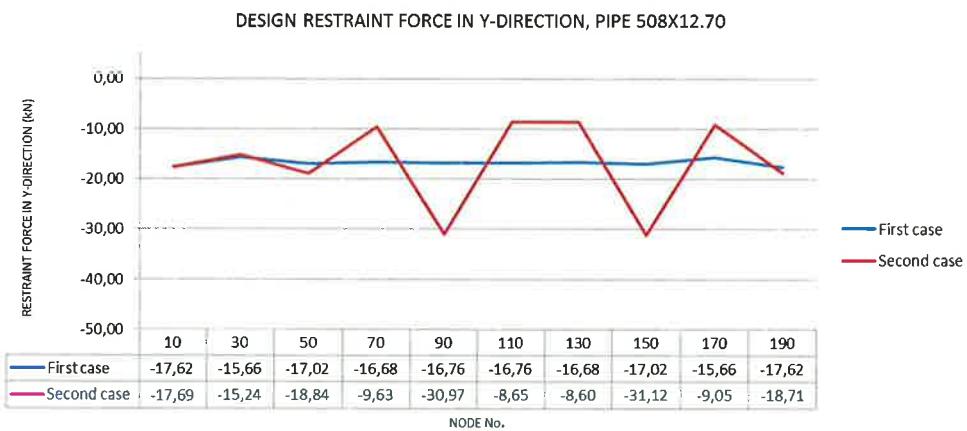
Graph 4: Utilization of pipe in expansion stress

6.2 RESTRAINT FORCES IN Y-DIRECTION

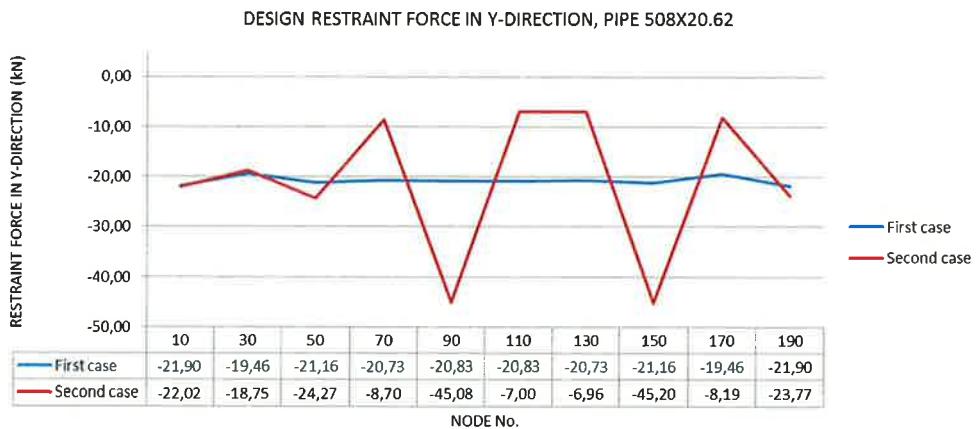
Graph 5-7 is restraining forces in y-direction due to design load (W+T+P), for comparison of first case and second case. Ref. LC.4 and LC.5 in appendix for restrain loads



Graph 5: Reference APPENDIX C for design restraint force in y-direction, pipe 508x4.78

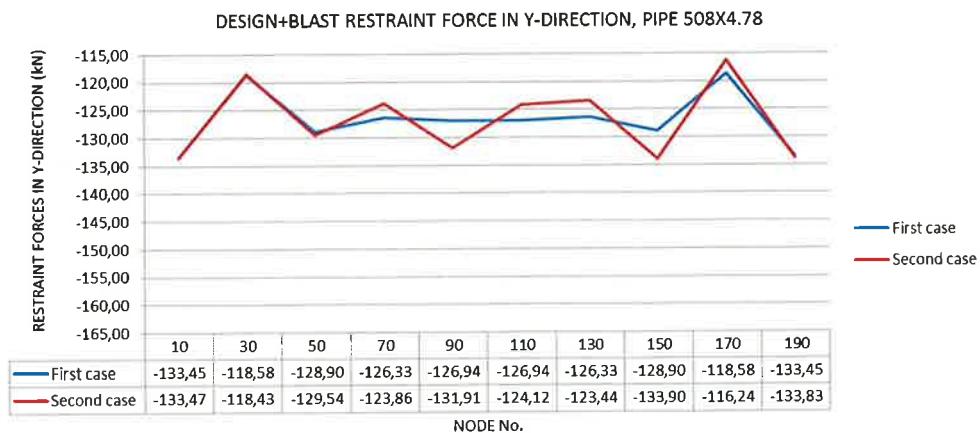


Graph 6: design restraint force in y-direction, pipe 508x12.70

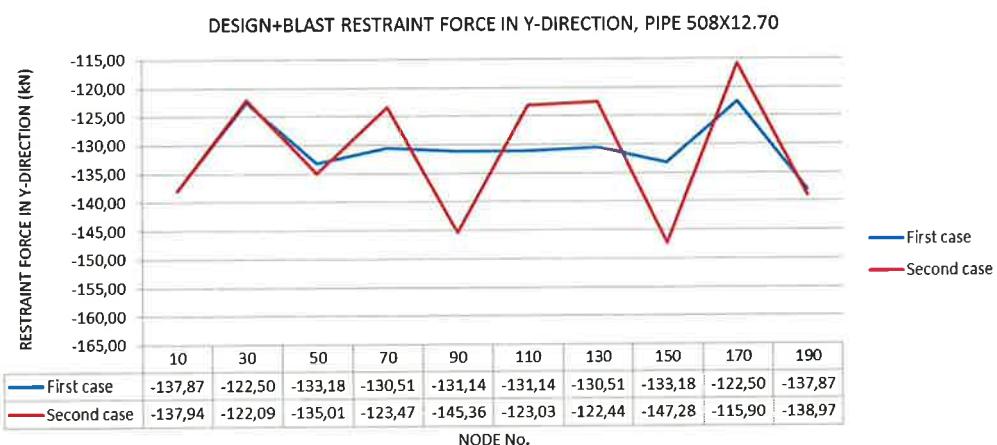


Graph 7: design restraint force in y-direction, pipe 508x20.62

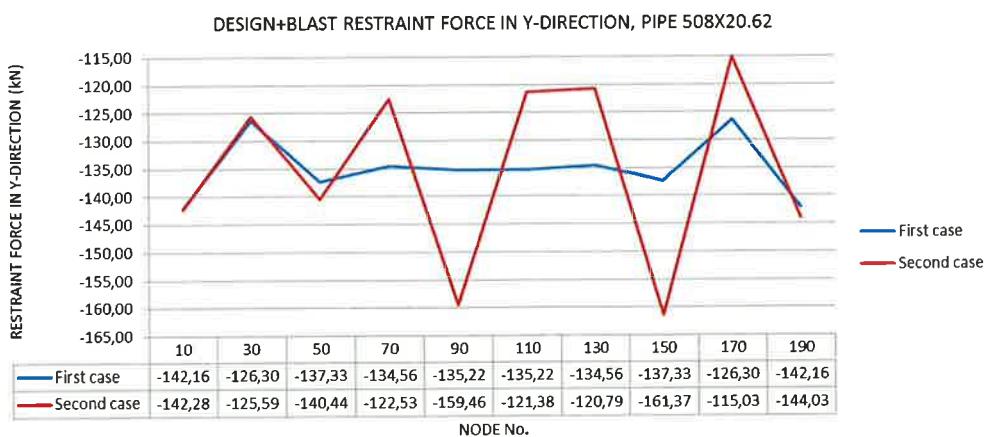
Graph 8-10 is restraining forces in y-direction due to design with blast load (W+T+P-WIN2), for comparison of first case and second case. Ref. LC.9 and LC.15 in appendix for restrain loads.



Graph 8: Reference APPENDIX C for design+blast restraint force in y-direction, pipe 508x4.78

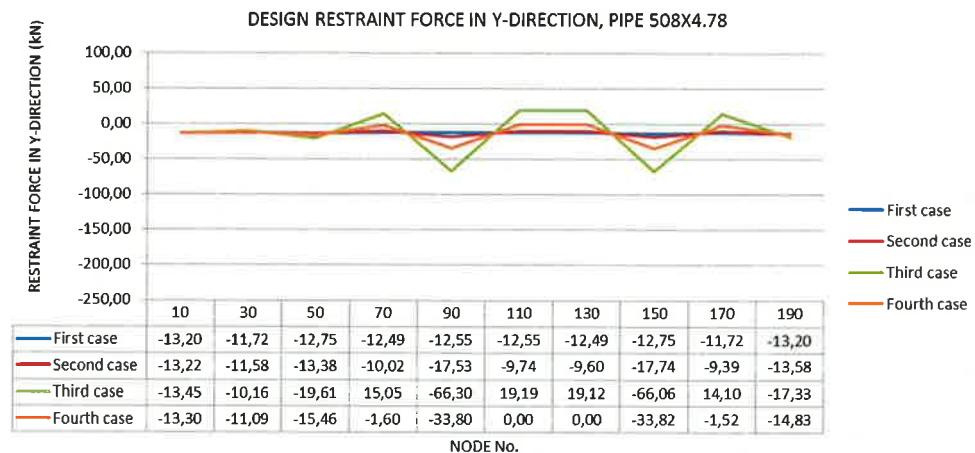


Graph 9: design+blast restraint force in y-direction, pipe 508x12.70

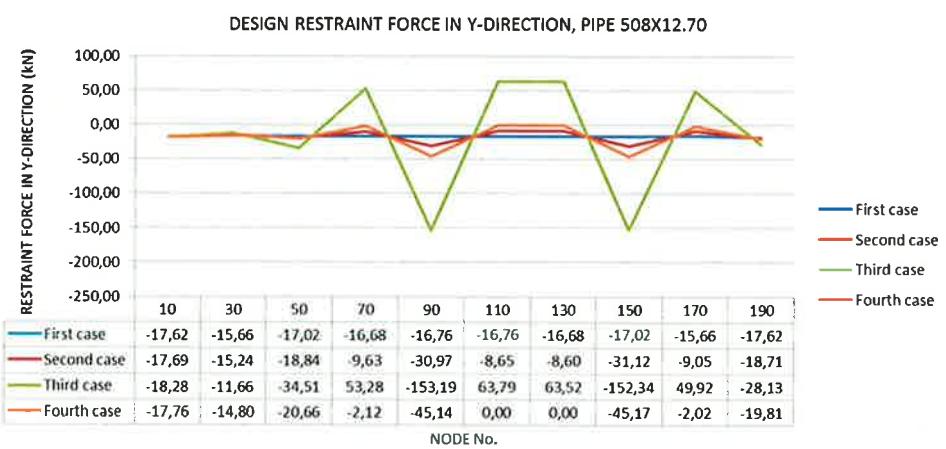


Graph 10: design+blast restraint force in y-direction, pipe 508x20.62

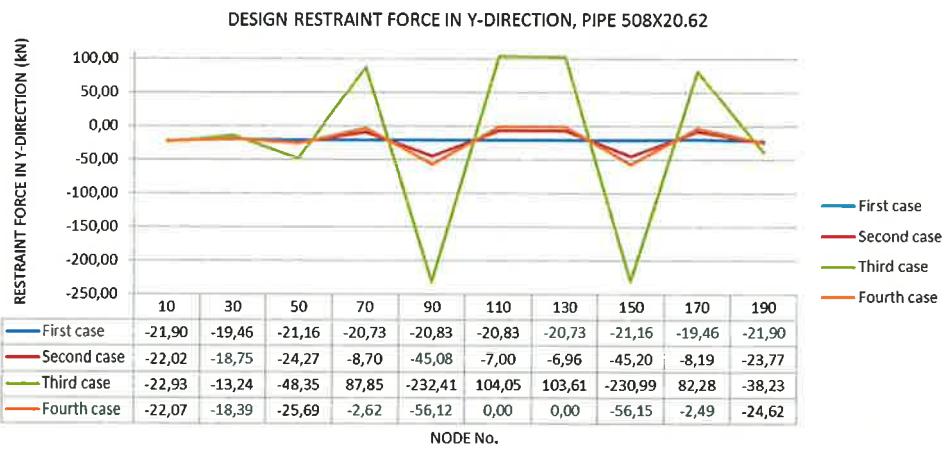
Graph 11-13 is restraining forces in y-direction due to design load (W+T+P), for comparison of all four case studies. Ref. LC.4 and LC.5 in appendix for restrain loads.



Graph 11: Reference APPENDIX C for design restraint force in y-direction, pipe 508x4.78

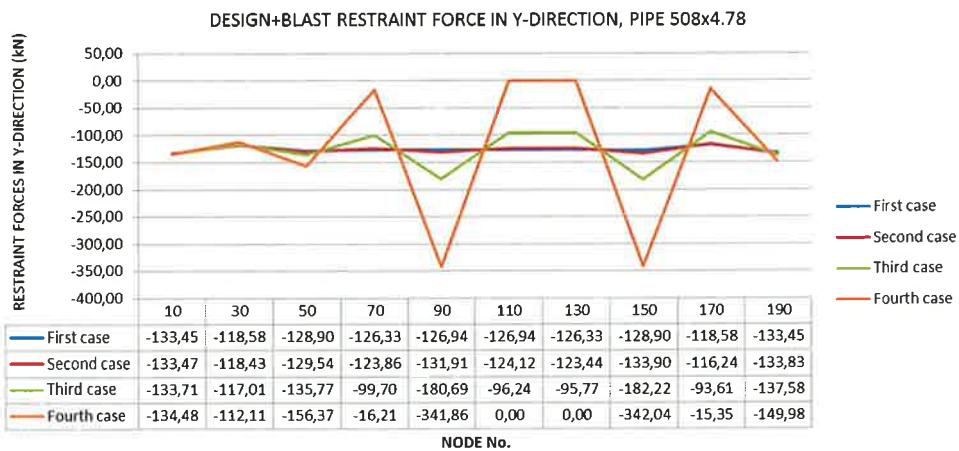


Graph 12: design restraint force in y-direction, pipe 508x12.70

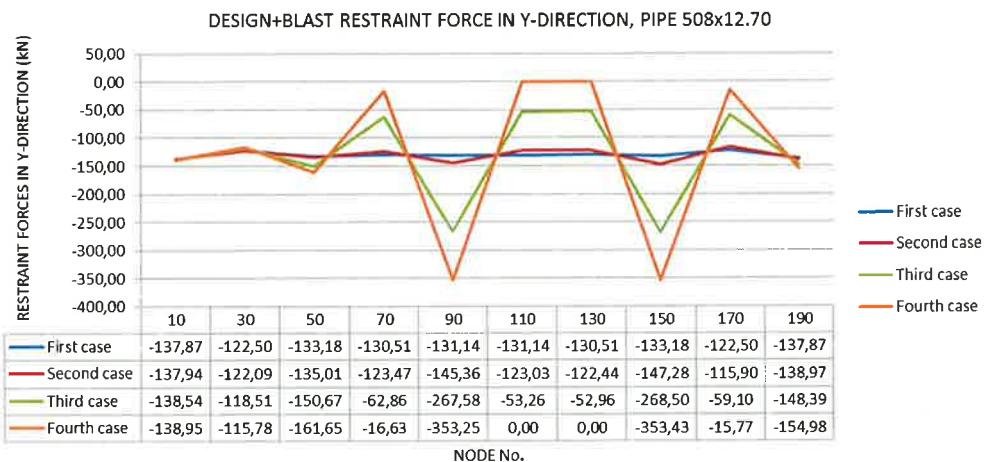


Graph 13: design restraint force in y-direction, pipe 508x20.62

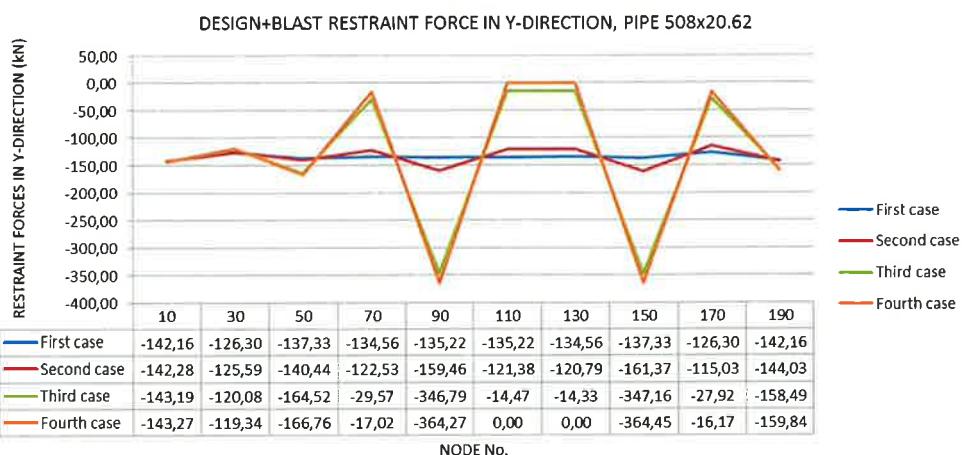
Graph 14-16 is restraining forces in y-direction due to design with blast load (W+T+P-WIN2) for comparison of all four case studies. Ref. LC.9 and LC.15 in appendix for restrain loads.



Graph 14: Reference APPENDIX C for design+blast restraint force in y-direction, pipe 508x4.78



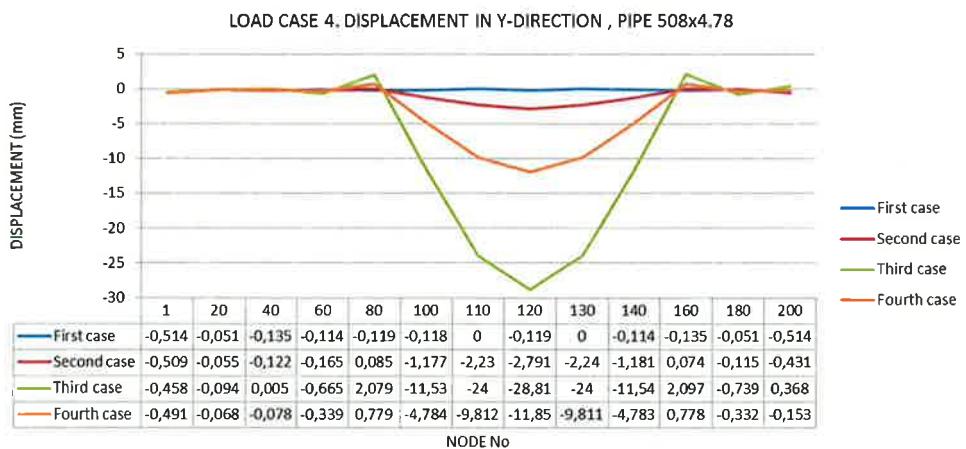
Graph 15: design+blast restraint force in y-direction, pipe 508x12.70



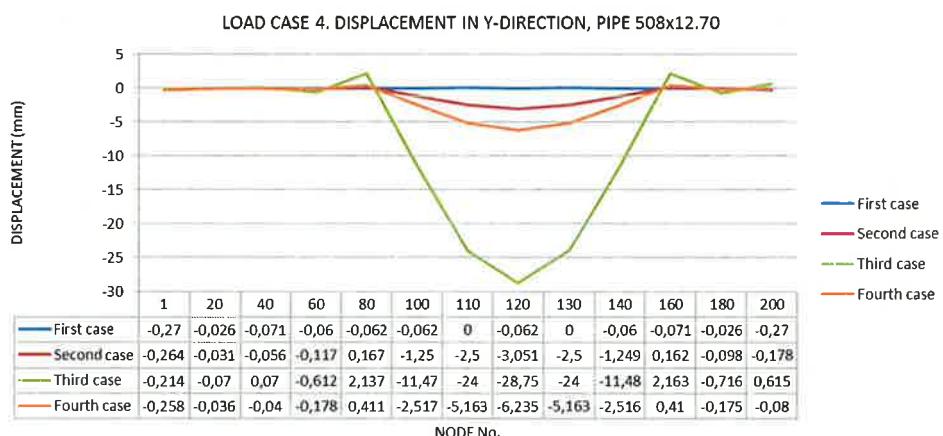
Graph 16: design+blast restraint force in y-direction, pipe 508x20.62

6.3 DISPLACEMENTS IN Y-DIRECTION

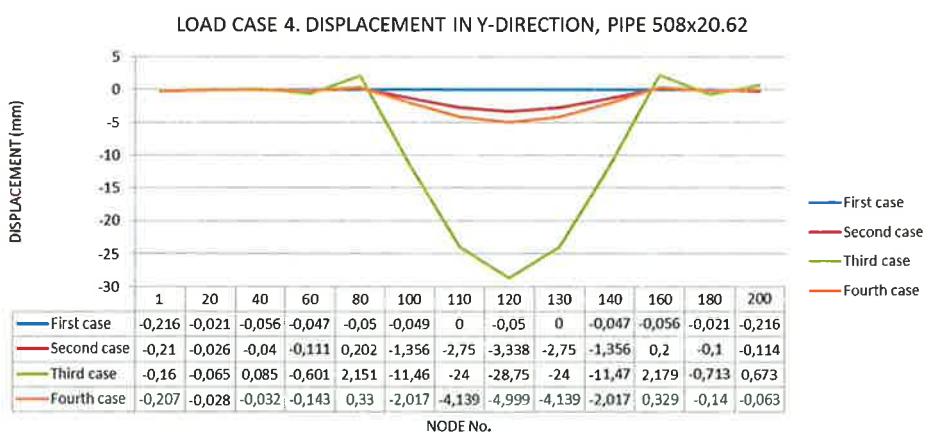
For design loads, LC.4 gives the highest deflections and is described in graphs 17-19 for comparison of all four case studies for the pipe wall sizes.



Graph 17: Reference APPENDIX C for design displacement in y-direction, pipe 508x4.78

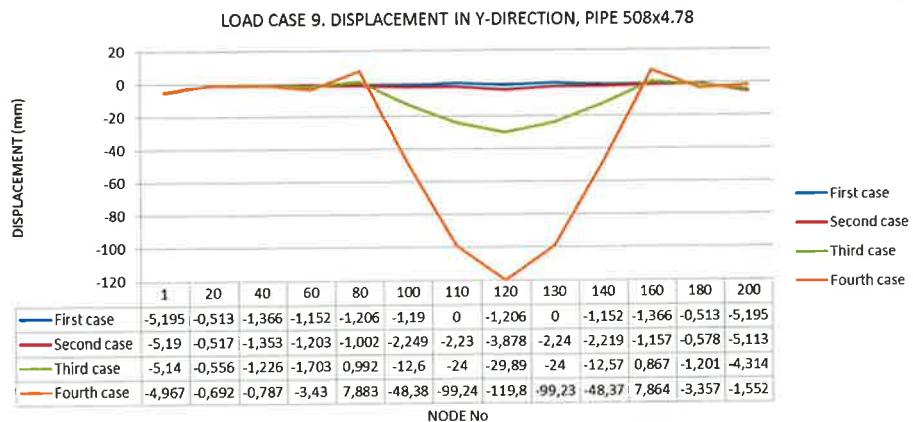


Graph 18: design displacement in y-direction, pipe 508x12.70

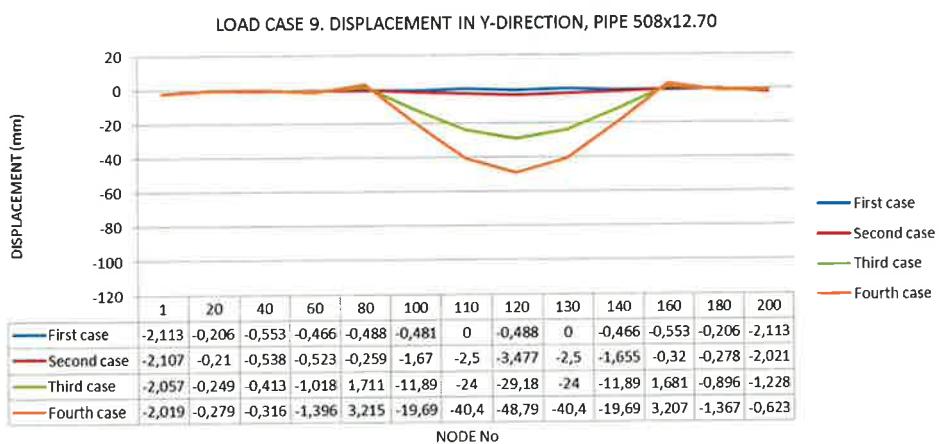


Graph 19: for design displacement in y-direction, pipe 508x20.62

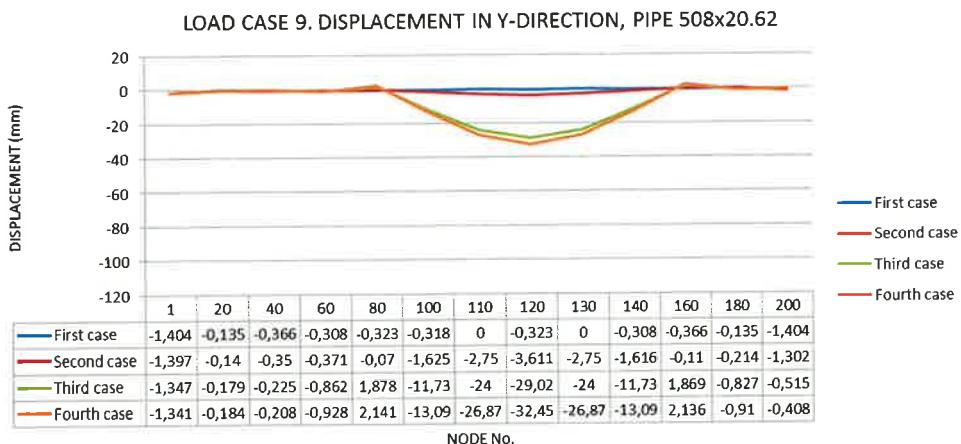
For design with blast loads, LC.9 gives the highest deflections and is described in graphs 20-22 for comparison of all four case studies for the pipe wall sizes.



Graph 20: Reference APPENDIX C for design+blast displacement in y-direction, pipe 508x4.78



Graph 21: design+blast displacement in y-direction, pipe 508x12.70



Graph 22: design+blast displacement in y-direction, pipe 508x20.62



Figure 24: Pipe 508x4.78. The third case. LC.9 (OPE) W+D1+T1+P1-WIN2

6.4 STRUCTURAL DECK DEFLECTION

Deck deflection is taken from load type SLS for nodes #92, #93, #100 and #102.

Reference figure 22 in chapter 5.2 for locations of nodes.

Table 25-27 and graph 23 describes deck deflection result from STAAD.Pro.

- Pipe size: 508mm, 4.78 mm wall thk

Pipe size	Node	L/C	Absolute mm	Max. Vertical deflection, (mm)	Node	L/C	Absolute mm	Max. Vertical deflection, (mm)	Result from case
508x4.78	92	201	2,233	-2,23	102	201	2,236	-2,24	First case
508x4.78	92	202	2,098		102	202	2,161		First case
508x4.78	93	201	2,233		100	201	2,236		First case
508x4.78	93	202	2,098		100	202	2,161		First case
508x4.78	92	201	2,057	-2,00	102	201	2,057	-2,00	Second case
508x4.78	92	202	1,949		102	202	1,996		Second case
508x4.78	93	201	2,057		100	201	2,057		Second case
508x4.78	93	202	1,949		100	202	1,996		Second case

Table 25: Pipe size 508x4.78. Deck deflection

- Pipe size: 508mm, 12.70 mm wall thk

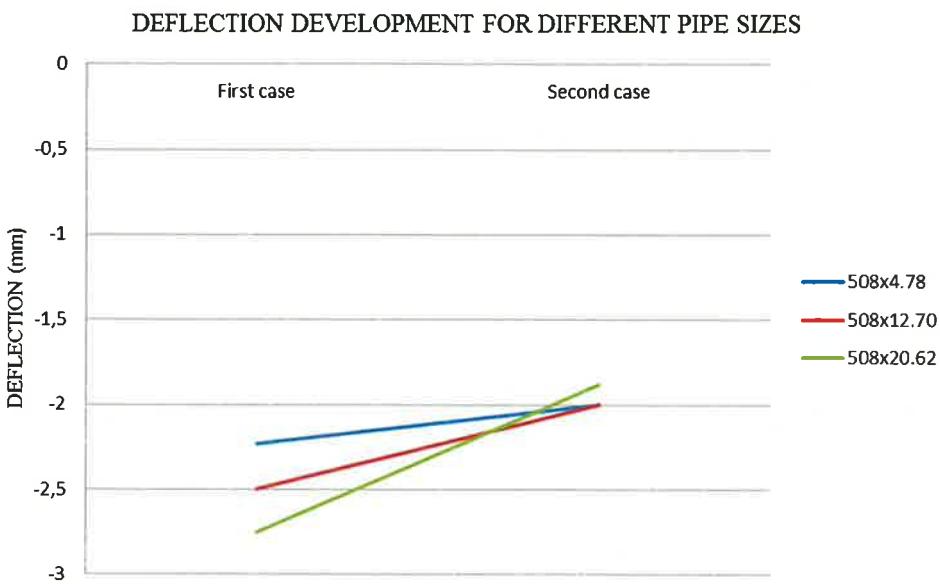
Pipe size	Node	L/C	Absolute mm	Max. Vertical deflection, (mm)	Node	L/C	Absolute mm	Max. Vertical deflection, (mm)	Result from case
508x12.70	92	201	2,496	-2,50	102	201	2,498	-2,50	First case
508x12.70	92	202	2,316		102	202	2,397		First case
508x12.70	93	201	2,496		100	201	2,498		First case
508x12.70	93	202	2,316		100	202	2,397		First case
508x12.70	92	201	1,987	-2,00	102	201	1,993	-2,00	Second case
508x12.70	92	202	1,893		102	202	1,94		Second case
508x12.70	93	201	1,987		100	201	1,993		Second case
508x12.70	93	202	1,893		100	202	1,94		Second case

Table 26: Pipe size 508x12.70. Deck deflection

- Pipe size: 508mm, 20.62 mm wall thk

Pipe size	Node	L/C	Absolute mm	Max. Vertical deflection, (mm)	Node	L/C	Absolute mm	Max. Vertical deflection, (mm)	Result from case
508x20.62	92	201	2,75	-2,75	102	201	2,747	-2,75	First case
508x20.62	92	202	2,525		102	202	2,622		First case
508x20.62	93	201	2,75		100	201	2,747		First case
508x20.62	93	202	2,525		100	202	2,622		First case
508x20.62	92	201	1,886	-1,89	102	201	1,892	-1,89	Second case
508x20.62	92	202	1,811		102	202	1,85		Second case
508x20.62	93	201	1,886		100	201	1,892		Second case
508x20.62	93	202	1,811		100	202	1,85		Second case

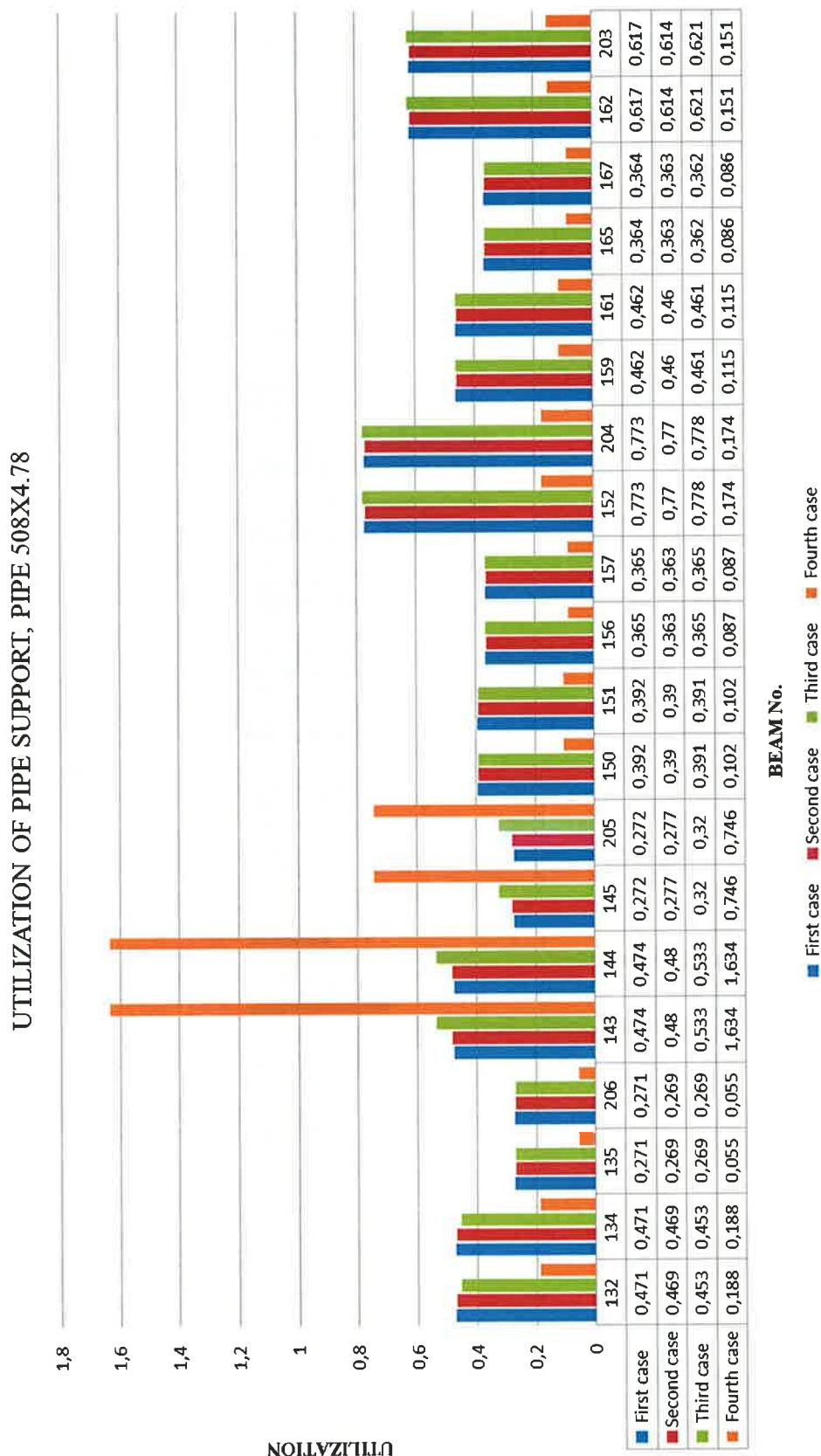
Table 27: Pipe size 508x20.62. Deck deflection



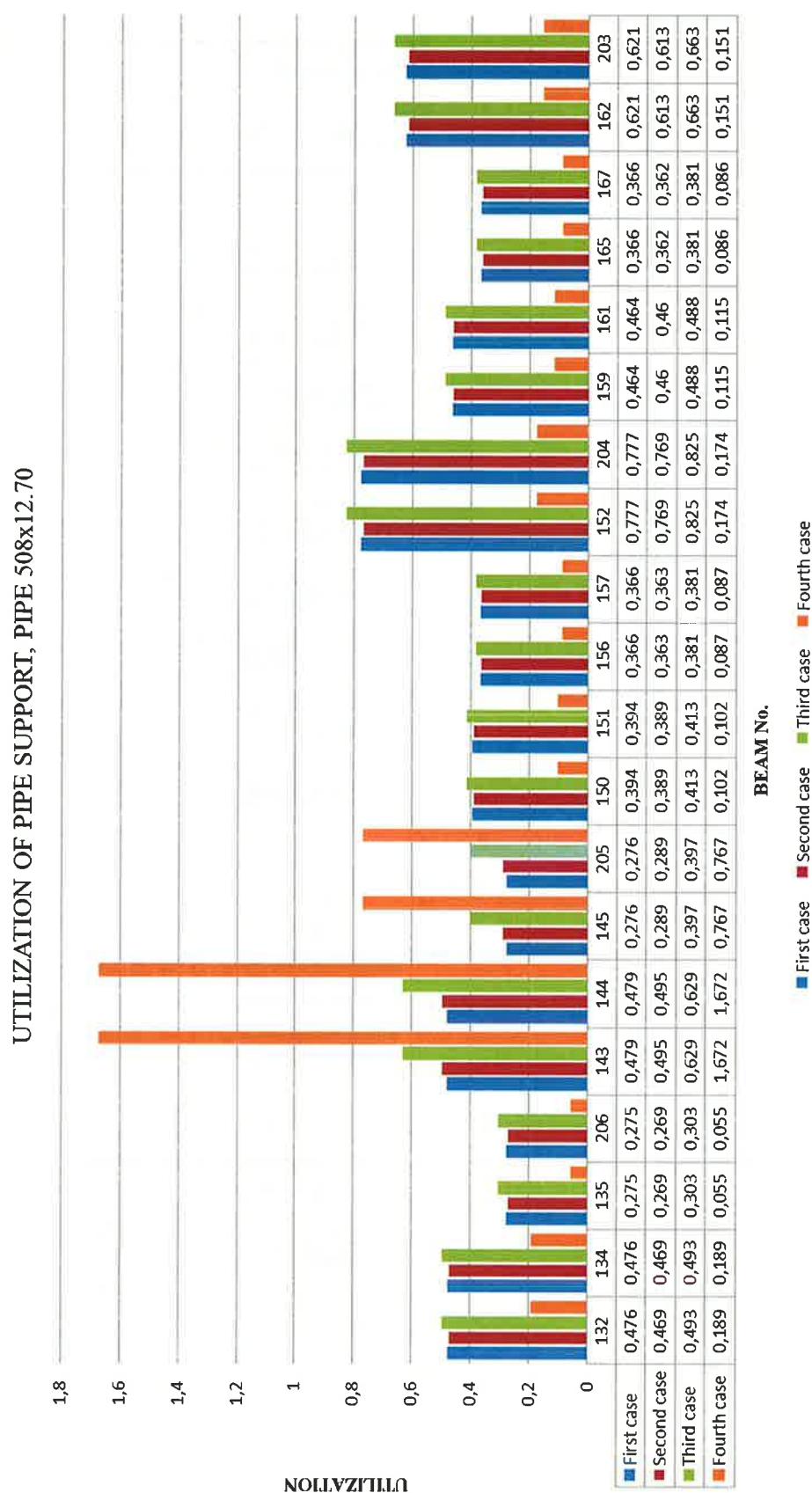
Graph 23: Deck deflection development for different pipe sizes

6.5 PIPE SUPPORT UTILIZATION

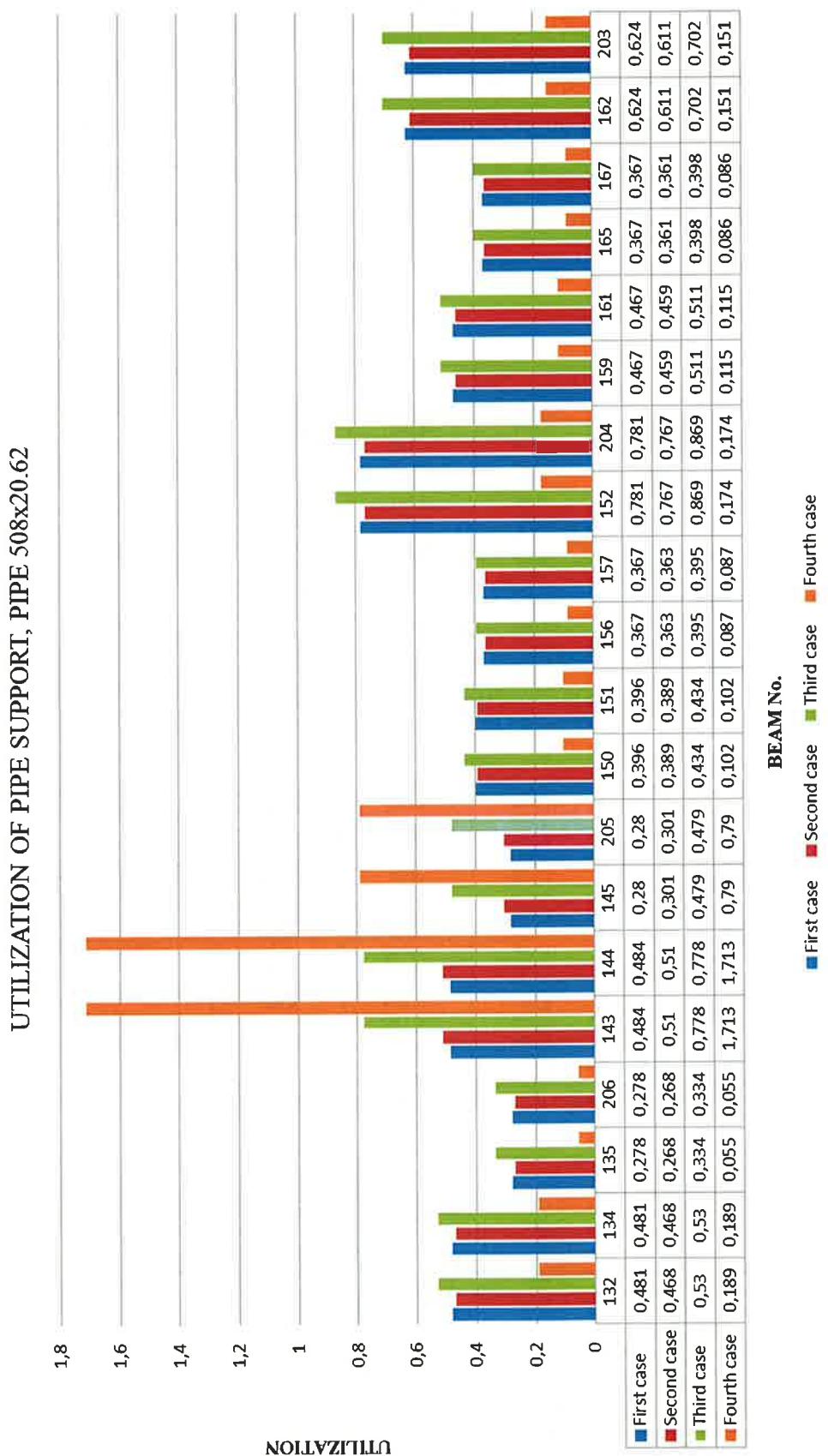
Graph 24-26 is utilization of all beam members in all four pipe supports for comparison of all four case studies for the pipe wall sizes. The pipe supports are exposed to design and blast loads from the pipe and direct blast loads on the supports. Reference figure 21 in chapter 5.2 for locations of beam numbers.



Graph 24: Utilization of pipe support, pipe 508x4.78



Graph 25: Utilization of pipe support, pipe 508x12.70



Graph 26: Utilization of pipe support, pipe 508x20.62

6.6 STRUCTURAL PIPE SUPPORT DISPLACEMENT

Pipe support displacements are taken from load type SLS for nodes #129, #128, #127 and #126. The nodes are in the location of connection between pipe and pipe supports. Reference figure 22 in chapter 5.2 for locations of nodes. The pipe supports are exposed to design and blast loads from the pipe and direct blast loads on the supports. Table 28-30 and graph 27-29 describes the pipe support displacement results from STAAD.Pro comparing all four case studies for the pipe wall sizes.

Staad.Pro Node	L/C	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	Case
129	201	0	-2,097	0,833	2,256	First case
128	202	0	-1,871	-0,845	2,053	
127	201	0	-2,263	0,332	2,287	
126	201	0	-2,267	0,771	2,394	
129	201	0	-1,997	0,674	2,108	Second case
128	202	0	-2,06	-0,542	2,13	
127	201	0	-2,081	0,259	2,097	
126	201	0	-2,081	0,671	2,187	
129	202	0	-0,999	-0,958	1,384	Third case
128	202	0	-3,923	-3,301	5,127	
127	202	0	-0,216	-0,583	0,622	
126	202	0	-0,238	-0,43	0,492	
129	201	0	-1,661	0,142	1,668	Fourth case
128	202	0	-2,681	-0,581	2,744	
127	202	0	-1,454	-0,027	1,454	
126	201	0	-1,462	0,314	1,495	

Table 28: Displacements in connection between pipe 508x4.78 and pipe support

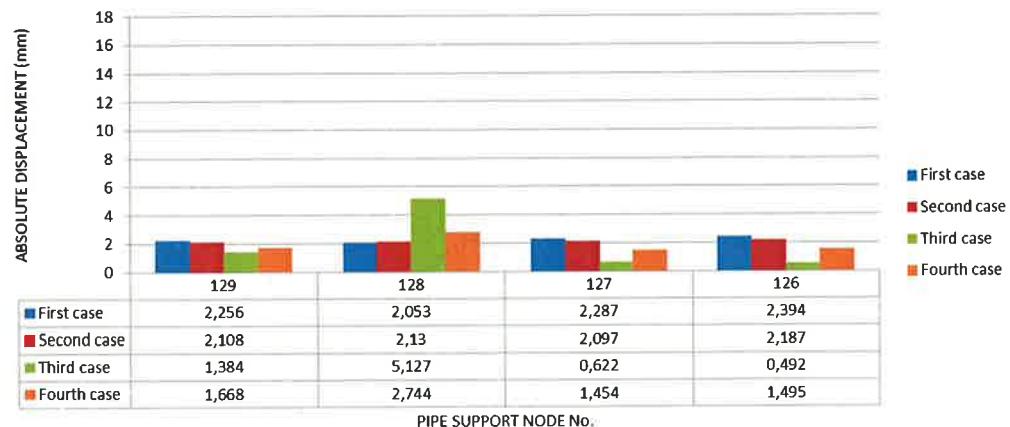
Staad.Pro Node	L/C	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	Case
129	201	0	-2,262	1,097	2,514	First case
128	202	0	-2,03	-1,107	2,312	
127	201	0	-2,534	0,45	2,574	
126	201	0	-2,536	0,928	2,701	
129	201	0	-1,978	0,67	2,088	Second case
128	201	0	-2,571	0,481	2,616	
127	201	0	-2,008	0,226	2,021	
126	201	0	-2,015	0,629	2,111	
129	202	0	0,534	-3,469	3,51	Third case
128	202	0	-7,242	-9,53	11,97	
127	202	0	2,655	-1,872	3,248	
126	202	0	2,63	-2,134	3,387	
129	201	0	-1,679	0,18	1,689	Fourth case
128	201	0	-3,106	1,047	3,278	
127	202	0	-1,454	-0,029	1,454	
126	201	0	-1,461	0,32	1,496	

Table 29: Displacements in connection between pipe 508x12.70 and pipe support

Staad.Pro Node	L/C	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	Case
129	201	0	-2,418	1,35	2,77	First case
128	202	0	-2,183	-1,37	2,577	
127	201	0	-2,795	0,566	2,852	
126	201	0	-2,793	1,077	2,993	
129	201	0	-1,939	0,59	2,027	Second case
128	201	0	-3,104	1,062	3,28	
127	201	0	-1,905	0,189	1,914	
126	201	0	-1,911	0,576	1,996	
129	202	0	1,917	-5,731	6,043	Third case
128	202	0	-10,267	-14,431	17,71	
127	202	0	5,248	-3,036	6,063	
126	202	0	5,213	-3,665	6,372	
129	201	0	-1,695	0,214	1,709	Fourth case
128	201	0	-3,524	1,331	3,767	
127	202	0	-1,454	-0,031	1,454	
126	201	0	-1,46	0,324	1,496	

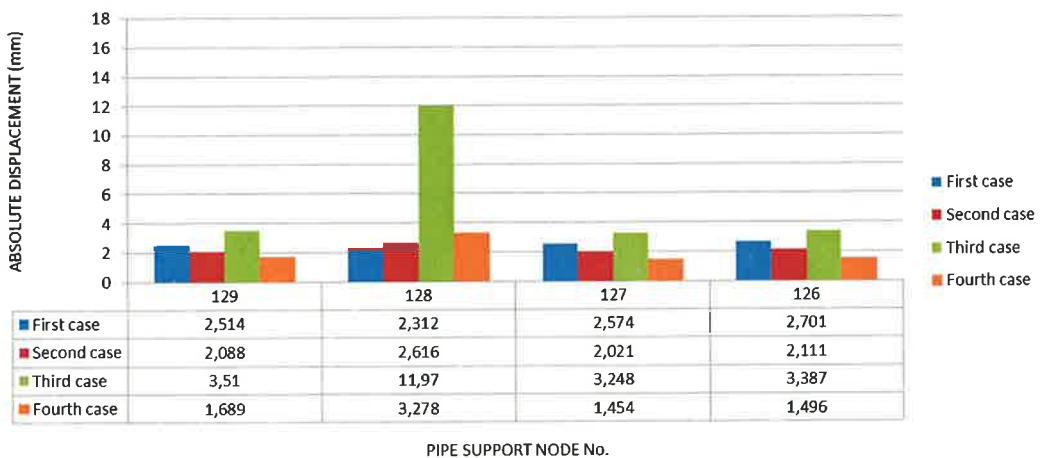
Table 30: Displacements in connection between pipe 508x20.62 and pipe support

DISPLACEMENT IN PIPE SUPPORT, PIPE 508x4.78



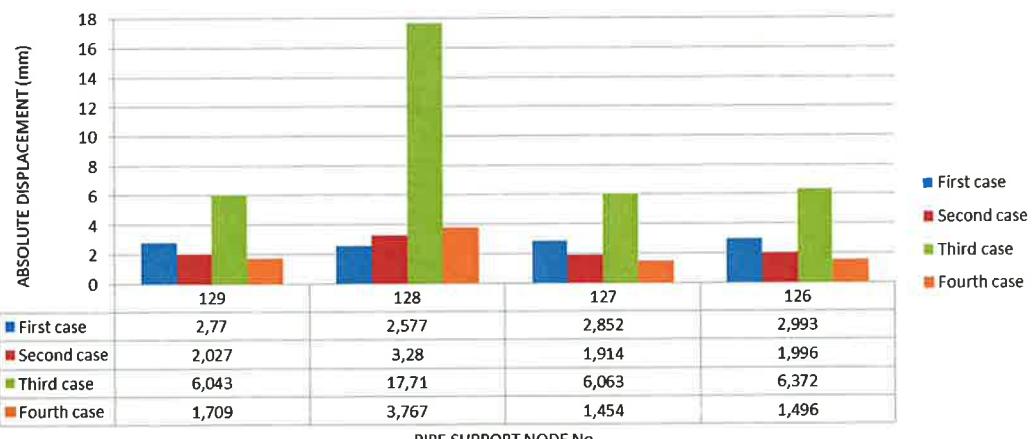
Graph 27: Displacements in connection between pipe 508x4.78 and pipe support

DISPLACEMENT IN PIPE SUPPORT, PIPE 508x12.70



Graph 28: Displacements in connection between pipe 508x12.70 and pipe support

DISPLACEMENT IN PIPE SUPPORT, PIPE 508x20.62



Graph 29: Displacements in connection between pipe 508x20.62 and pipe support

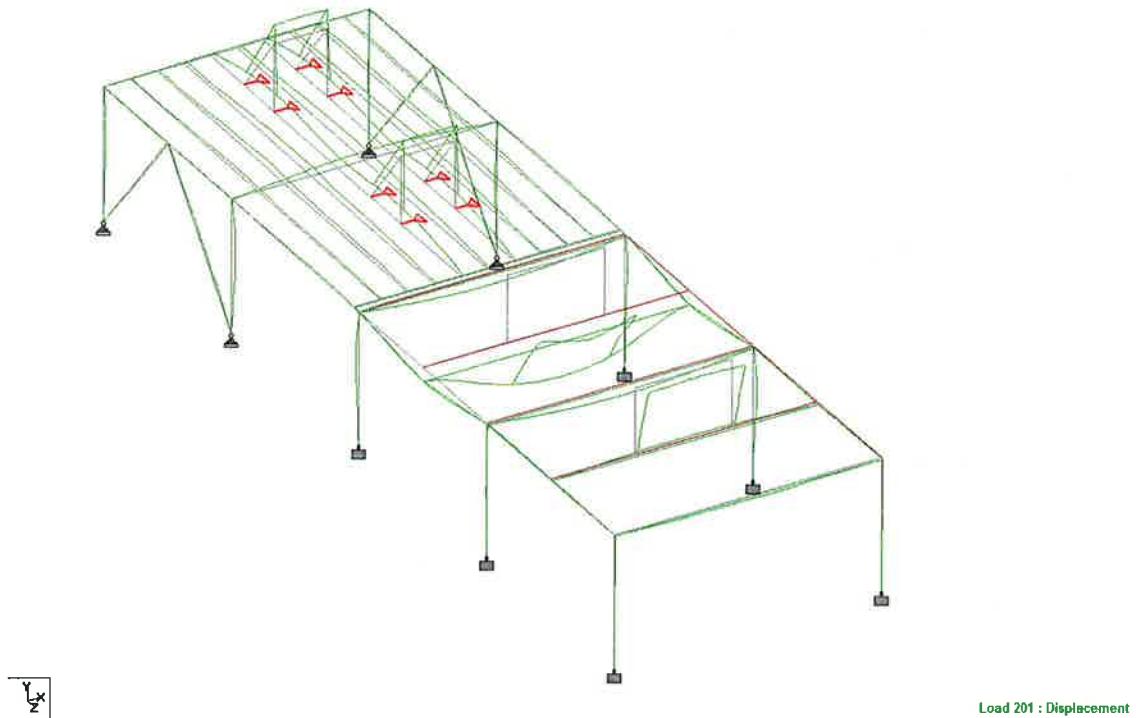


Figure 25: Displacements in pipe support. Load case 201: STAAD.Pro

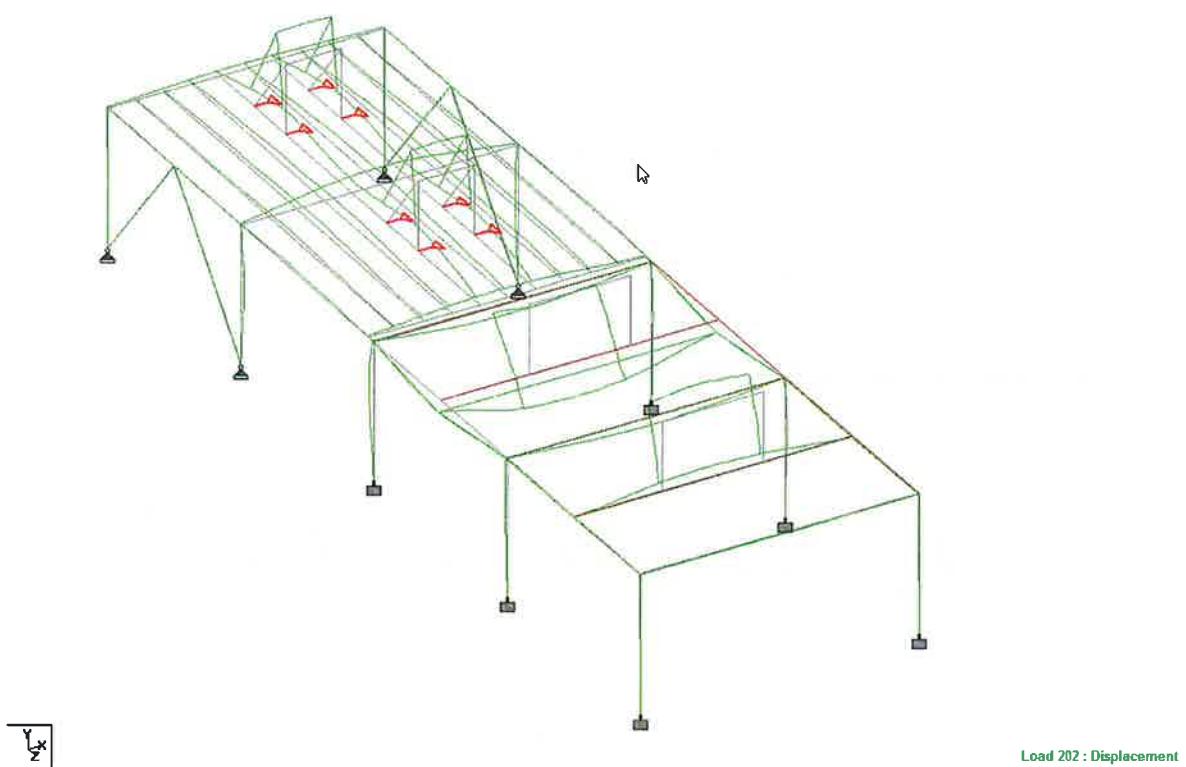


Figure 26: Displacements in pipe support. Load case 202: STAAD.Pro

7.0 THEORETICAL CALCULATIONS

7.1 PIPE ANALYSIS

Thin wall qualifications. $\frac{r_i}{t} \geq 10$

Smallest wall thickness chosen, 508×4.78 : $\frac{249.22}{4.78} = 52.138$

Biggest wall thickness chosen 508×20.62 : $\frac{233.38}{20.62} = 11.318$

Minimum required net thickness calculated:

$$t = \frac{(P \cdot D)}{2 \cdot (S_h \cdot E \cdot W + P \cdot Y)} = \frac{kPa \cdot mm}{kPa} = \frac{1210 \cdot 508}{2 \cdot (205946 \cdot 1 + 1210 \cdot 0.4)} = 1.489 \text{ mm}$$

Pipe size chosen for calculations: 508x4.78 (mm):

Cross sectional area of pipe

$$A_p = \frac{\pi}{4} \cdot (D^2 - d^2) = \frac{\pi}{4} \cdot (508^2 - 498.44^2) = 7.557 \times 10^3 \text{ mm}^2$$

Section modulus of pipe

$$W = \frac{\pi}{32 \cdot D} \cdot (D^4 - d^4) = \frac{\pi}{32 \cdot 508} \cdot (0.508^4 - 0.49844^4) = 9.418 \times 10^{-4} \text{ m}^3$$

Area moment of inertia of pipe

$$I = \frac{\pi}{64} \cdot (D^4 - d^4) = \frac{\pi}{64} \cdot (0.508^4 - 0.49844^4) = 2.392 \times 10^{-4} \text{ m}^4$$

Weight of pipe 508 x 4.78:

$$\frac{\pi}{4} \cdot (D^2 - d^2) \cdot \rho_{\text{pipe}} = \frac{\pi}{4} \cdot (0.508^2 - 0.49844^2) \cdot 8027 \cdot 9.81 = 595.056 \text{ N/m}$$

Weight of water:

$$\frac{\pi}{4} \cdot (d^2) \cdot \rho_{\text{water}} = \frac{\pi}{4} \cdot 0.49844^2 \cdot 1000 \cdot 9.81 = 1.914 \times 10^3 \text{ N/m}$$

Total weight pipe + content (w):

$$595.056 + 1914 = 2.509 \times 10^3 \text{ N/m}$$

7.2 PIPE STRESS CALCULATIONS

Calculations done for pipe 508 x 4.78:

$$\text{Hoop stress: } \sigma_H = \frac{P \cdot d}{2 \cdot t} = \frac{\frac{N}{mm^2} \cdot mm}{mm} = \frac{1.21 \cdot 498.44}{2 \cdot 4.78} = 63.087 \text{ N/mm}^2$$

7.2.1 FIRST CASE

Without structural influence. For data reference to APPENDIX C

Max bending stress due to design load, occur in node 10 and 190, ref Appendix

$$S_b = \frac{M}{W} = \frac{kN \cdot m}{m^3} = 8.32 \text{ N/mm}^2$$

HYDROSTATIC PRESSURE TEST

Axial stress induced by internal pressure in hydrostatic condition: Case 1 (HYD) WW+HP

$$S_{a_{hyd}} = \frac{F}{A} = \frac{P \cdot d^2}{D^2 - d^2} = \frac{\frac{N}{mm^2} \cdot mm^2}{mm^2} = \frac{2.0 \cdot 498.44^2}{508^2 - 498.44^2} = 51.643$$

Code stress in hydrostatic pressure test node 10 and 190

$$S_{hyd} = \sqrt{(|S_{a_{hyd}}| + S_b)^2 + (2 \cdot S_t)^2} = \sqrt{(|51.643| + 8.32)^2 + (2 \cdot 0)^2} = 59.963 \text{ N/mm}^2$$

Hydrostatic code stress: 59.963 N/mm² < Allowable stress: S_y = 395 N/mm²

SUSTAINED CONDITION

Axial stress induced by internal pressure in sustained condition: Case 3 (SUS) W+P1

$$S_{a_{sus}} = \frac{F}{A} = \frac{P \cdot d^2}{D^2 - d^2} = \frac{\frac{N}{mm^2} \cdot mm^2}{mm^2} = \frac{1.21 \cdot 498.44^2}{508^2 - 498.44^2} = 31.244 \text{ N/mm}^2$$

Code stress in sustained condition node 10 and 190

$$S_L = \sqrt{(|S_{a_{sus}}| + S_b)^2 + (2 \cdot S_t)^2} = \sqrt{(|31.244| + 8.32)^2 + (2 \cdot 0)^2} = 39.564 \text{ N/mm}^2$$

Sustained code stress: $39.6 \text{ N/mm}^2 < \text{Allowable stress: } S_h = 205.9 \text{ N/mm}^2$

OPERATIONAL CONDITION

ASME B31.3 does not consider the operating load case a "stress compliance case", and therefore provides no equation for the allowable stress. The pipe stresses determined for operating load cases are not "code" stresses and are therefore not used in any sort of pass/fail criterion.

OCCASIONAL CONDITION

Occasional load cases taken into consideration of stress compliance is L18 – L29

From the result in chapter 6.1.1, the highest stress occurs in load case L24-L27

Reference to APPENSIX C: Load Case 27 (OCC) L27=L21+L3 (W+P1-WIN2)

Max bending stress due to design and blast load occur in node 10 and 190

$$S_{b_{occ}} = \frac{M_{occ}}{W} = \frac{kN \cdot m}{m^3} = 84.17 \text{ N/mm}^2$$

Axial stress induced by internal pressure in sustained condition: Case 3 (SUS) W+P1

$$S_{a_{sus}} = \frac{F}{A} = \frac{P \cdot d^2}{D^2 - d^2} = \frac{\frac{N}{mm^2} \cdot mm^2}{mm^2} = \frac{1.21 \cdot 498.44^2}{508^2 - 498.44^2} = 31.244 \text{ N/mm}^2$$

Code stress in occasional condition node 10 and 190

$$S_O = \sqrt{\left(|S_{a_{sus}}| + S_{b_{occ}} \right)^2 + (2 \cdot S_t)^2} = \sqrt{(|31.244| + 84.17)^2 + (2 \cdot 0)^2} = 115.414 \text{ N/mm}^2$$

According to NORSO L-002. Section: 6.8. Explosion loads

Maximum allowable stress in blast case shall be the minimum of

$2.4 \times S_h$ or $1.5 \times S_Y$

Where S_h is the ASME B 31.3 allowable stress limit and S_Y is the pipe material yield stress.

In this case $2.4 \times S_h$ is relevant.

The Allowable stress in blast case is given: $2.4 \cdot 205.9 = 494.16 \text{ N/mm}^2$

Occasional code stress: $115.4 \text{ N/mm}^2 < \text{Allowable stress: } 494.2 \text{ N/mm}^2$

EXPANSION CONDITION

For this case the pipe is straight and without any bends leading to bending stress for the expansion condition. There is also no axial stress occurring in expansion condition.

7.2.2 SECOND CASE

With structural influence in the form of forced deflection -2.23mm in node 110 and -2.24mm in node 130 for pipe size 508x4.78

Max bending stress still occurs in node 10 and node 190 for hydrostatic, sustained and occasional condition. The forced deflection is small and located almost in the middle of the pipe and has no impact on the bending stress and axial stress for hydrostatic, sustained and occasional condition.

For data reference to APPENDIX C.

EXPANSION CONDITION

Because the deflection is forced and widespread from a point on the pipe creating a sharper bend than for a natural deflection, bending stress will occur.

Max bending stress will occurs in node 150 of the pipe for case 31 (EXP) L5-L3 (=T2)

$$S_E = \sqrt{(|S_{a_{exp}}| + S_{b_{exp}})^2 + (2 \cdot S_t)^2} = \sqrt{(|0| + 8.71)^2 + (2 \cdot 0)^2} = 8.71 \text{ N/mm}^2$$

The Allowable Displacement Stress Range, S_A is given:

$$S_h \geq S_L$$

S_L is code stress in sustained condition for node 150

$$S_L = \sqrt{(|S_{a_{sus}}| + S_{b_{sus}})^2 + (2 \cdot S_t)^2} = \sqrt{(|31.244| + 5.72)^2 + (2 \cdot 0)^2} = 36.964 \text{ N/mm}^2$$

$$S_A = f \cdot |1.25 \cdot (S_c + S_h) - S_L| = 1.0 \cdot |1.25 \cdot (206.84 + 205.9) - 36.964| = 478.961 \text{ N/mm}^2$$

Expansion code stress S_E : $8.71 \text{ N/mm}^2 < \text{Allowable stress } S_A: 479 \text{ N/mm}^2$

7.2.3 THIRD CASE

With structural influence in the form of maximum forced deflection -24mm in node 110/111 and -24mm in node 130/131 for pipe size 508x4.78

Max bending stress still occurs in node 10 and node 190 for hydrostatic, sustained and occasional condition. The forced deflection has no impact on the bending stress and axial stress for hydrostatic, sustained and occasional condition.

For data reference to APPENDIX.

EXPANSION CONDITION

Max bending stress will occurs in node 90 of the pipe for case 31 (EXP) L5-L3 (=T2)

$$S_E = \sqrt{\left(\left|S_{a_{exp}}\right| + S_{b_{exp}}\right)^2 + (2 \cdot S_t)^2} = \sqrt{(|0| + 93.55)^2 + (2 \cdot 0)^2} = 93.55 \text{ N/mm}^2$$

The Allowable Displacement Stress Range, S_A is given:

$$S_h \geq S_L$$

S_L is code stress in sustained condition for node 90

$$S_L = \sqrt{\left(\left|S_{a_{sus}}\right| + S_{b_{sus}}\right)^2 + (2 \cdot S_t)^2} = \sqrt{(|31.244| + 5.56)^2 + (2 \cdot 0)^2} = 36.804 \text{ N/mm}^2$$

$$S_A = f \cdot |1.25 \cdot (S_c + S_h) - S_L| = 1.0 \cdot |1.25 \cdot (206.84 + 205.9) - 36.804| = 479.121 \text{ N/mm}^2$$

Expansion code stress S_E : 93.55 N/mm² < Allowable stress S_A : 479N/mm²

7.2.4 FOURTH CASE

The contact between supports in node 110 and pipe is failing. The support in node 110 and 130 is experiencing deflection, leading to a gap between support and pipe
 For data reference to APPENDIX C.

Max bending stress due to design load, occur in node 150, ref Appendix

$$S_b = \frac{M}{W} = \frac{kN \cdot m}{m^3} = 42.54 \text{ N/mm}^2$$

HYDROSTATIC PRESSURE TEST

Axial stress induced by internal pressure in hydrostatic condition: Case 1 (HYD) WW+HP

$$S_{a_{hyd}} = \frac{F}{A} = \frac{P \cdot d^2}{D^2 - d^2} = \frac{\frac{N}{mm^2} \cdot mm^2}{mm^2} = \frac{2.0 \cdot 498.44^2}{508^2 - 498.44^2} = 51.643$$

Code stress in hydrostatic pressure test node 10 and 190

$$S_{hyd} = \sqrt{(|S_{a_{hyd}}| + S_b)^2 + (2 \cdot S_t)^2} = \sqrt{(|51.643| + 42.54)^2 + (2 \cdot 0)^2} = 94.183 \text{ N/mm}^2$$

Hydrostatic code stress: 94.2 N/mm² < Allowable stress: S_y = 395 N/mm²

SUSTAINED CONDITION

Axial stress induced by internal pressure in sustained condition: Case 3 (SUS) W+P1

$$S_{a_{sus}} = \frac{F}{A} = \frac{P \cdot d^2}{D^2 - d^2} = \frac{\frac{N}{mm^2} \cdot mm^2}{mm^2} = \frac{1.21 \cdot 498.44^2}{508^2 - 498.44^2} = 31.244 \text{ N/mm}^2$$

Code stress in sustained condition node 150

$$S_L = \sqrt{(|S_{a_{sus}}| + S_b)^2 + (2 \cdot S_t)^2} = \sqrt{(|31.244| + 42.56)^2 + (2 \cdot 0)^2} = 73.804 \text{ N/mm}^2$$

Sustained code stress: $73.8 \text{ N/mm}^2 < \text{Allowable stress: } S_h = 205.9 \text{ N/mm}^2$

OCCASIONAL CONDITION

Occasional load cases taken into consideration of stress compliance is L18 – L29

From the result in chapter 6.1.1, the highest stress occurs in load case L24-L27

Reference to appendix: Load Case 27 (OCC) L27=L21+L3 (=WIN4+W+P1)

Max bending stress due to design and blast load occur in node 150

$$S_{b_{occ}} = \frac{M_{occ}}{W} = \frac{kN \cdot m}{m^3} = 430.4 \text{ N/mm}^2$$

Axial stress induced by internal pressure in sustained condition: Case 3 (SUS) W+P1

$$S_{a_{sus}} = \frac{F}{A} = \frac{P \cdot d^2}{D^2 - d^2} = \frac{\frac{N}{mm^2} \cdot mm^2}{mm^2} = \frac{1.21 \cdot 498.44^2}{508^2 - 498.44^2} = 31.244 \text{ N/mm}^2$$

Code stress in occasional condition node 150

$$S_O = \sqrt{(|S_{a_{sus}}| + S_{b_{occ}})^2 + (2 \cdot S_t)^2} = \sqrt{(|31.244| + 430.4)^2 + (2 \cdot 0)^2} = 461.644 \text{ N/mm}^2$$

Occasional code stress: $461.64 \text{ N/mm}^2 < \text{Allowable stress: } 494.2 \text{ N/mm}^2$

EXPANSION CONDITION

For this case the pipe is straight and without any bends leading to bending stress for the expansion condition. There is also no axial stress occurring in expansion condition.

8.0 CONCLUSION AND DISCUSSION

PIPE STRESS UTILIZATION

For the results of pipe stress utilization the thinnest wall size has a significantly higher utilization for all cases in hydro test stress, sustained stress and occasional stress, compared to the two larger wall sizes. Especially there is an increase in the fourth case, where the smallest pipe size has almost twice as high incline than the two large pipe sizes that behaves more parallel to each other. The expectation was that the three pipe wall thicknesses would behave more by the ratio of the area, but the combination of the different stiffnesses of the pipe wall sizes, weight of content and pressure is decisive for the results.

In the occasional stress where both design load and blast load has an impact on the case of two failing supports (node 110 and node 130), gives a high 93,4% utilization for pipe thickness 4.79mm, compared to a much less utilization of 35,8% for sustained stress. The fourth case is not necessarily a realistic situation, but it shows that an increase in the bending moment which in this case is due to the addition of blast load can have a huge effect on pipe stress for lines with small wall thicknesses. In general comparing the first, second and third case for hydrotest stress, sustained stress and occasional stress within the pipe thickness sizes there is not any changes on the utilization.

For expansion stress to occur, a change in direction in the form of an elbow needs to be included. For expansion stress, the only cases that give any results are the forced deflection cases. The fourth case that has large natural deflection gives zero results for expansion. The results for expansion stress are not very high, and give little difference between the pipe sizes. The driving influence is the size of the deflection.

RESTRAINT FORCES AND DISPLACEMENT IN Y-DIRECTION FOR PIPELINE

In graphs 5-10 the results shows that in the second case, the restraint forces in the nodes exposed to forced deflection are decreasing as the pipe thickness is increasing. This leads to a higher fluctuating restraint forces for the nodes next to the nodes exposed to the forced deflection. By using ten supports in this thesis the results shows the impact radius from the forced deflection in node 110 and 130. The restraint load in node 10 which is the fifth support from node 110 has no impact from the deflection.

Graphs 11-13 shows that an input of maximum accepted structural deck deflection limit in node 110 and 130 (the third case) leads to large hold down loads in node 110 and 130, and the larger the pipe wall thickness the more increasing is the hold down force. This leads to a higher fluctuating restraint forces for the nodes next to node 110 and 130.

By comparing the third case results in graphs 11-13 with graphs 17-19 in chapter 6.3, the design restraint force in y-direction for node 110 and 130 will be zero for approximately:

- 11mm deck deflection for pipe wall thickness 4.78mm,
- 5.5mm deck deflection for pipe wall thickness 12.70mm and
- 4.5mm deck deflection for pipe wall thickness 20.62mm

Larger forced deflection for these pipe wall thicknesses will lead to hold down restraint force for node 110 and 130 and eventually for node 70 and 170. The smallest pipe wall thickness in this thesis can then handle almost twice as much deck deflection as the two largest pipe wall thicknesses before node 110 and 130 becomes hold down restraints.

From the graphs in chapter 6.2 and 6.3 the results shows the connection between the increasing fluctuations in the restraint forces and the reduction in natural deflection that unfolds with regard to increasing wall thickness. A larger pipe wall thickness has a larger moment of inertia, which reduces the flexibility. A small pipe wall thickness is flexible and will therefore experience a larger deflection in the pipe span than thicker wall pipes. The lack of flexibility in a pipe line will lead to higher restraint forces.

As an acceptance criterion, the deflection limit for pipe span is set to:

For the first and the second case:

$$\delta_{\max} = \frac{L(\text{mm})}{600} = \frac{5000}{600} = 8.333 \text{ mm}$$

For the fourth case:

$$\frac{15000}{600} = 25 \text{ mm}$$

For LC. 4, the first, second and fourth case is below the deflection limit for all pipe wall thicknesses.

For LC. 9, the first and the second case is below the deflection limit for all pipe wall thicknesses.

The third case is not acceptable in any load case or for any pipe wall thickness because the deflection in node 120 is higher than 25mm

Reference graph 17-22.

STRUCTURAL DECK DEFLECTION

For a straight pipe line divided over ten supports, the first case gives restraint loads that are very even for the pipe supports located at the four nodes in the middle of the pipe.

The two supports located at steel deck structure, reference node 110 and node 130 is experiencing deflection, the larger the pipe thickness the greater weight and thus greater deflection. These deflections which are then inserted into node 110 and node 130 for case two will then lead to a reduction of the restraint forces and thus reduce the deflection in these nodes. The nodes next to the nodes experiencing forced deflection will increase in reaction force and maybe deflection, depending on what surface the support is mounted on.

In this case of testing, the two supports next to the nodes exposed to forced deflection, reference node 70 and node 90 is mounted to a concrete deck.

$$\delta_{\max} = \frac{L}{200} = \frac{4800}{200} = 24\text{mm}$$

All the deflections are below the deflection limit.

PIPE SUPPORT UTILIZATION

In the first case and the second case there is not much differences in the utilization of the pipe support members. But when comparing the first case with the third case there is an increasing utilization as the pipe wall thickness is increasing, especially for the pipe support in node 90, but not by much. The highest increase in utilization is approxametly 27% for beam number 143 and 144 (node 90) with loads from pipe wall size 20.62mm.

Since the utilization of the pipe supports are calculated based on design and blast loads from the pipe and direct blast loads on the supports, the utilization of the beam members in node 90 in the fourth case will lead to failure, because pipe support in node 110 and 130 are not taking any load from the pipe, only direct blast load on the pipe support members.

STRUCTURAL PIPE SUPPORT DISPLACEMENT

Comparing the first case and the second case the differences in the displacements in the nodes are increasing as the pipe wall thickness is increasing. In the third case the displacements are increasing for all nodes as the pipe wall thickness is increasing. Especially for node 128 where the displacements increases with 15mm from first to third case with loads from pipe wall size 20.62mm.

Deflection limit in pipe support shall not exceed the most conservative of L/360 or 3mm.

In this case 3mm is the most conserative

The first case: All pipe supports are below the deflection limit for all three pipe wall sizes.

The second case: All pipe supports are below the deflection limit for pipe wall size 4.78 and 12.70. Fore pipe wall size 20.62 the pipe support node 129, 127 and 126 are below the deflection limit

The third case: Pipe support node 129, 127 and 126 are below the deflection limit for pipe wall size 4.78

The fourth case: All pipe supports are below the deflection limit for pipe wall size 4.78. Fore pipe wall size 12.70 and 20.62 the pipe support node 129, 127 and 126 are below the deflection limit

As a conclusion on the results from this thesis it can be stated that pipe lines with large stiffness can have a very big impact on the pipe supports when included the variation in deck deflection. On the other hand deflection did not seem to have any large impact on the pipe stress other than expansion in this thesis. If a bend was put in, maybe the results would have been different which is a problem that could have been looked into further. A flexible pipe line seems to be more beneficial for a pipe support considering the restraint loads, thus leading to a higher utilization and deflection in pipe stress analysis. Pipe lines of lesser wall size are very prone to local buckling. The Caesar II software does not check for buckling, and finite element software such as ANSYS or ABAQUS should be used for this type of check. For future studies and research it could be worth looking at variation of the pipe span between the supports, different pipe sizes, temperature and pressure.

As I experienced in performing this thesis, interacting piping and structural is very time consuming and as current engineering schedule often means that structural deflection are not available at the time of pipe stress analysis, it will result in additional analysis, where the results might not give a result that makes any significance in the end.

As a guide it is important to take in to consideration possible large deck deflections that can occur and have an impact on piping as well as structural.

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10.0 APPENDIX

APPENDIX A

PIPING AND VALVE SPECIFICATION

TABLE A-1 BASIC ALLOWABLE STRESSES IN TENSION. ASME B31.3

TABLE Y-1 YIELD STRENGTH VALUES SY, SECTION II PART D

TABLE DIMENSIONS OF SEAMLESS AND WELDED STEEL PIPES

APPENDIX B

INPUT FILE STAAD.PRO 508.4.78.-FIRST CASE

APPENDIX C

508.4.78. WITHOUT STRUCTURAL INFLUENCE, RESTRAINT LOADS

508.4.78. WITHOUT STRUCTURAL INFLUENCE, STRESS REPORT

508.4.78. WITH STRUCTURAL INFLUENCE, RESTRAINT LOADS

508.4.78. WITH STRUCTURAL INFLUENCE, STRESS REPORT

508.4.78. WITH STRUCTURAL INFLUENCE, MAX DEFLECTION. RESTRAINT LOADS

508.4.78. WITH STRUCTURAL INFLUENCE, MAX DEFLECTION. STRESS REPORT

508.4.78. FAILING SUPPORT IN NODE 110 AND 130, RESTRAINT LOADS.

508.4.78. FAILING SUPPORT IN NODE 110 AND 130, STRESS REPORT.

APPENDIX A

Title Piping and Valve Specification									Doc.no. 5060	Operator	Sec.no. 3	ConocoPhillips			
Piping Class Sheet: AD20 CL150									Project	Rev.no.	Rev.date	Page: Of:			
										04	01.10.2010	1	2		

DESIGN CODE: ASME B31.3	Corr. Allow: 0.0 mm	Material Selection : TCD 4650
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Maximum Design Pressure: Barg	20.0	20.0	19.5	17.7	15.8	13.8	12.1						
At Temperature: °C	-46	38	50	100	150	200	250						

PIPE SIZE AND WALL THICKNESS

Nom.Size(in)	0.5	0.75	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	30	36			
Dia.(mm)	21.3	26.7	33.4	48.3	60.3	88.9	114.3	168.3	219.1	273.1	323.9	355.6	406.4	457.2	508.0	609.6	762.0	914.0			
Wall th.(mm)	2.77	2.87	3.38	3.68	2.77	3.05	3.05	3.40	3.76	4.19	4.57	4.78	4.78	4.78	5.54	6.35	7.92	7.92			
Schedule	40S					10S										10					

WALL THICKNESS UNDER TOLERANCES: **12.5%**, see note c)

LONGITUDINAL WELD EFFICIENCY: **0.9**

ELEMENT NAME	DIMENSION STANDARDS				NOM. SIZE FROM TO incl incl	TYPE			MATERIAL NAME			MDS	EDS
PIPE	ASME B36.19M ASME B36.19M ASME B36.10M				0.5 8 1 30 36 36	Seamless, PE Welded, >8" BE Welded, >8" BE			A790 S31803 _____ A928 S31803 CL 1, 3 or A928 S31803 CL 1, 3 or			D41	
BENDING	Made from pipe												NBE1
FITTINGS	ASME B16.9				0.5 36				A815 S31803 S/WX			D43	EFI1
BRANCHES	Olets, lightweight ASME B16.9								A182 F51 A815 S31803 S/WX			D44	EBR3/ NOL1 EBR3
PIPE NIPPLE	ASTM A733				0.5 1.5	Sch 160 BOE/TOE Bev to match sch 40S			A790 S31803 SMLS			D41	EPI1
REINFORCED NIPOFLANGE	Drilled to ASME B16.5								A182 F51			D44	EBR3/ NOL1
FLANGES	ASME B16.5 ASME B16.47 Series A				0.5 24 30 36	CL150 RF WN CL150 RF WN			A182 F51 A182 F51			D44	NAF1 NAF1
FLG. BLIND	ASME B16.5 ASME B16.47 Series A				0.5 24 30 36	CL150 RF CL150 RF			A182 F51 A182 F51			D44	NAF1 NAF1
ORIF.FLANGE	ASME B16.36				1 24	CL300 RF NPT (F)			A182 F51			D44	NAF1
RED. THR'D FLANGE	ASME B16.5				d) 0.75 2	CL150 RF NPT (F)			A182 F51			D44	NAF1
LINE BLINDS	Spect bl. Spect bl. Spade/spacer Spade/spacer				0.5 12 0.5 12 14 36 14 36	CL150 RF CL150 RF CL150 RF CL150 RF			A182 F51 A240 S31803 A182 F51 A240 S31803			D44	NLB1 NLB1 NLB1 NLB1
BOLTING f)	ASME B16.5/B16.47 Series A				0.5 36 0.5 36 0.5 36 0.5 36	Stud bolts galv. Hex. nuts galv. Stud bolts Hex. Nuts			A320 L7 A194 7 A276 S32750/760 A276 S32750/760			C100 C100 D57X D57X	NBO1 NBO1 NBO1 NBO1
GASKET	ASME B16.20				0.5 36	4.5 mm thk. SPW 316L w/Exp. Graphite int/ext. ring 316L SS							EGA1
PLUGS	ASME B16.11				0.5 1	Hex. head			A182 F51			D44	EPI1
SAFETY BLEED PLUG					d) 0.5 0.75	NPT (M)			B446 N06625 Annealed				EFI4/ EPI1

NOTES: See page 2

(14)

Table A-1 Basic Allowable Stresses in Tension for Metals (Cont'd)

Numbers in Parentheses Refer to Notes for Appendix A Tables; Specifications Are ASTM Unless Otherwise Indicated

Material	Product Form	Spec. No.	Type/Grade	UNS No.	Class/Condition/ Temper	Size, in. (5)	P-No. (5)	Notes	Min. Temp., °F (6)	Specified Min. Strength, ksi	Min. Temp.	Min. to 100 200 300 400
Stainless Steel (3)(4a) (Cont'd)												
Pipes and Tubes (2) (Cont'd)												
18Cr-8Ni	Tube	A213	TP304	S30400	...	...	8	(14)(26)(28)(31)(36)	-425	75 30 20.0	20.0 20.0 18.6	
18Cr-8Ni	Tube	A269	TP304	S30400	...	...	8	(14)(26)(28)(31)(36)	-425	75 30 20.0	20.0 20.0 18.6	
18Cr-8Ni	Pipe	A312	TP304	S30400	...	...	8	(26)(28)	-425	75 30 20.0	20.0 20.0 18.6	
A240 Type 304	Pipe	A358	304	S30400	...	...	8	(26)(28)(31)(36)	-425	75 30 20.0	20.0 20.0 18.6	
18Cr-8Ni	Pipe	A376	TP304	S30400	...	...	8	(20)(26)(28)(31)(36)	-425	75 30 20.0	20.0 20.0 18.6	
18Cr-8Ni	Pipe	A376	TP304H	S30409	...	...	8	(26)(31)(36)	-325	75 30 20.0	20.0 20.0 18.6	
18Cr-8Ni	Pipe	A409	TP304	S30400	...	...	8	(26)(28)(31)(36)	-425	75 30 20.0	20.0 20.0 18.6	
18Cr-8Ni	Pipe	A312	TP304H	S30409	...	...	8	(26)	-325	75 30 20.0	20.0 20.0 18.6	
18Cr-10Ni-Mo	...	A451	CPF8M	J92900	...	...	8	(26)(28)	-425	70 30 20.0	20.0 18.9	17.0
44Fe-25Ni-21Cr-Mo	Tube	A249	904L	N08904	...	...	45	...	-325	71 31 20.7	20.7 20.4	18.7
44Fe-25Ni-21Cr-Mo	Pipe	A312	904L	N08904	...	...	45	...	-325	71 31 20.7	20.7 20.4	18.7
20Cr-Cu	Tube	A268	TP443	S44300	...	...	10	(35)	-20	70 40 23.3	23.3 23.3	23.3
27Cr	Tube	A268	TP446	S44600	...	...	10f	(35)	-20	70 40 23.3	23.3 22.5	21.9
12Cr	Wld. pipe	A1053	50	S41003	...	...	7	...	-20	70 50 23.3	23.3 23.3	22.8
24Cr-9Ni-N	...	A451	CPE20N	...	...	...	8	(35)(39)	-325	80 40 26.7	26.7 26.7	26.7
23Cr-4Ni-N	...	A789	...	S32304	...	...	10H	(25)	-60	87 58 29.0	27.9 26.1	24.7
23Cr-4Ni-N	...	A790	...	S32304	...	...	10H	(25)	-60	87 58 29.0	27.9 26.1	24.7
20Cr-18Ni-6Mo	Pipe	A813	...	S31254	...	...	8	(8)	-325	94 44 29.3	29.3 28.9	26.7
20Cr-18Ni-6Mo	Pipe	A814	...	S31254	...	...	8	(8)	-325	94 44 29.3	29.3 28.9	26.7
12 $\frac{3}{4}$ Cr	...	A426	CPCA-15	J91150	...	...	6	(10)(35)	-20	90 65 30.0	...	...
22Cr-5Ni-3Mo	...	A789	...	S31803	...	...	10H	(25)	-60	90 65 30.0	30.0 28.9	27.8
22Cr-5Ni-3Mo	...	A790	...	S31803	...	...	10H	(25)	-60	90 65 30.0	30.0 28.9	27.8
20Cr-18Ni-6Mo	Tube	A249	...	S31254	...	$>\frac{3}{16}$ thk.	8	(8)	-325	95 45 30.0	30.0 29.5	27.3
20Cr-18Ni-6Mo	Tube	A249	...	S31254	...	$\leq\frac{3}{16}$ thk.	8	(8)	-325	98 45 30.0	30.0 29.5	27.3
20Cr-18Ni-6Mo	Pipe	A312	...	S31254	...	$>\frac{3}{16}$ thk.	8	(8)	-325	95 45 30.0	30.0 29.5	27.3
20Cr-18Ni-6Mo	Pipe	A312	...	S31254	...	$\leq\frac{3}{16}$ thk.	8	(8)	-325	98 45 30.0	30.0 29.5	27.3
26Cr-4Ni-Mo	...	A789	...	S32900	...	...	10H	(25)	-20	90 70 30.0	...	...
26Cr-4Ni-Mo	...	A790	...	S32900	...	...	10H	(25)	-20	90 70 30.0	...	...
46Fe-24Ni-21Cr-6Mo-Cu-N Smls. & wld. pipe	A312	...	N08367	...	$>\frac{3}{16}$	45	(26)	-325	95 45 30.0	30.0 29.9	28.6	
46Fe-24Ni-21Cr-6Mo-Cu-N Wld. pipe	A358	...	N08367	...	$>\frac{3}{16}$	45	(26)	-325	95 45 30.0	30.0 29.9	28.6	
46Fe-24Ni-21Cr-6Mo-Cu-N Wld. pipe	A813	...	N08367	...	$>\frac{3}{16}$	45	(26)	-325	95 45 30.0	30.0 29.9	28.6	
46Fe-24Ni-21Cr-6Mo-Cu-N Wld. pipe	A814	...	N08367	...	$>\frac{3}{16}$	45	(26)	-325	95 45 30.0	30.0 29.9	28.6	
46Fe-24Ni-21Cr-6Mo-Cu-N Smls. & wld. pipe	A312	...	N08367	...	$\leq\frac{3}{16}$	45	(26)	-325	100 45 30.0	30.0 30.0	29.6	
46Fe-24Ni-21Cr-6Mo-Cu-N Wld. pipe	A358	...	N08367	...	$\leq\frac{3}{16}$	45	(26)	-325	100 45 30.0	30.0 30.0	29.6	
46Fe-24Ni-21Cr-6Mo-Cu-N Wld. pipe	A813	...	N08367	...	$\leq\frac{3}{16}$	45	(26)	-325	100 45 30.0	30.0 30.0	29.6	
46Fe-24Ni-21Cr-6Mo-Cu-N Wld. pipe	A814	...	N08367	...	$\leq\frac{3}{16}$	45	(26)	-325	100 45 30.0	30.0 30.0	29.6	
21Cr-5Mn-15Ni-Cu-N	Tube	A789	...	S32101	...	$>\frac{3}{16}$	10H	(25)	-20	94 65 31.3	31.3 29.8	28.5
21Cr-5Mn-15Ni-Cu-N	Pipe	A790	...	S32101	...	$>\frac{3}{16}$	10H	(25)	-20	94 65 31.3	31.3 29.8	28.5
22Cr-5.5Ni-3Mo-N	Tube	A789	2205	S32205	...	...	10H	(25)	-60	95 70 31.7	31.7 30.6	29.4
22Cr-5.5Ni-3Mo-N	Pipe	A790	2205	S32205	...	...	10H	(25)	-60	95 70 31.7	31.7 30.6	29.4
21Cr-5Mn-15Ni-Cu-N	Tube	A789	...	S32101	...	$\leq\frac{3}{16}$	10H	(25)	-20	101 77 33.7	33.7 32.1	31.0
21Cr-5Mn-15Ni-Cu-N	Pipe	A790	...	S32101	...	$\leq\frac{3}{16}$	10H	(25)	-20	101 77 33.7	33.7 32.1	31.0
21Cr-3Ni-Mo	...	A790	...	S32003	...	$>\frac{3}{16}$	10H	(25)	-60	95 65 31.7	30.7 28.9	28.6
21Cr-3Ni-Mo	...	A789	...	S32003	...	$\leq\frac{3}{16}$	10H	(25)	-60	100 70 33.3	32.3 30.4	30.1

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2007 SECTION II, PART D (CUSTOMARY)

TABLE Y-1 (CONT'D)
YIELD STRENGTH VALUES S_y FOR FERROUS AND NONFERROUS MATERIALS

Line No.	Nominal Composition	Product Form	Spec No.	Type/Grade	Alloy Designation/UNS No.	Class/Condition/Temper
Ferrous Materials (Cont'd)						
1	19Cr-9Ni- $\frac{1}{2}$ Mo	Castings	SA-351	CF10	J92590	...
2	19Cr-9Ni-Mo-W	Bolting	SA-453	651	S63198	B
3	19Cr-9Ni-Mo-W	Bolting	SA-453	651	S63198	B
4	19Cr-9Ni-Mo-W	Bolting	SA-453	651	S63198	A
5	19Cr-9Ni-Mo-W	Bolting	SA-453	651	S63198	A
6	19Cr-9Ni-2Mo	Castings	SA-351	CF10M	...	...
7	19Cr-10Ni-3Mo	Castings	SA-351	CG8M	J93000	...
8	19Cr-15Ni-4Mo	Smls. tube	SA-213	...	S31725	...
9	19Cr-15Ni-4Mo	Plate	SA-240	...	S31725	...
10	19Cr-15Ni-4Mo	Wld. tube	SA-249	...	S31725	...
11	19Cr-15Ni-4Mo	Smls. & wld. pipe	SA-312	...	S31725	...
12	19Cr-15Ni-4Mo	Wld. pipe	SA-358	...	S31725	...
13	19Cr-15Ni-4Mo	Smls. pipe	SA-376	...	S31725	...
14	19Cr-15Ni-4Mo	Wld. pipe	SA-409	...	S31725	...
15	19Cr-15Ni-4Mo	Bar	SA-479	...	S31725	...
16	20Cr-10Ni	Bar	SA-479	ER308	S30880	...
17	20Cr-18Ni-6Mo	Castings	SA-351	CK3MCuN	J93254	...
18	20Cr-18Ni-6Mo	Forgings	SA-182	F44	S31254	...
19	20Cr-18Ni-6Mo	Wld. tube	SA-249	...	S31254	...
20	20Cr-18Ni-6Mo	Smls. & wld. pipe	SA-312	...	S31254	...
21	20Cr-18Ni-6Mo	Wld. pipe	SA-358	...	S31254	...
22	20Cr-18Ni-6Mo	Plate	SA-240	...	S31254	...
23	21Cr-6Ni-9Mn	Forgings	SA-182	FXM-11	S21904	...
24	21Cr-6Ni-9Mn	Smls. & wld. pipe	SA-312	TPXM-11	S21904	...
25	21Cr-6Ni-9Mn	Plate	SA-666	XM-11	S21904	...
07 26	21Cr-6Ni-9Mn	Forgings	SA-965	FXM-11	S21904	...
27	21Cr-11Ni-N	Forgings	SA-182	F45	S30815	...
28	21Cr-11Ni-N	Smls. tube	SA-213	...	S30815	...
29	21Cr-11Ni-N	Plate	SA-240	...	S30815	...
30	21Cr-11Ni-N	Wld. tube	SA-249	...	S30815	...
31	21Cr-11Ni-N	Smls. & wld. pipe	SA-312	...	S30815	...
32	21Cr-11Ni-N	Bar	SA-479	...	S30815	...
33	22Cr-5Ni-3Mo-N	Forgings	SA-182	F51	S31803	...
34	22Cr-5Ni-3Mo-N	Plate	SA-240	...	S31803	...
35	22Cr-5Ni-3Mo-N	Bar	SA-479	...	S31803	...
36	22Cr-5Ni-3Mo-N	Smls. & wld. tube	SA-789	...	S31803	...
37	22Cr-5Ni-3Mo-N	Smls. & wld. pipe	SA-790	...	S31803	...
38	22Cr-5Ni-3Mo-N	Smls. & wld. fittings	SA-815	...	S31803	...

2007 SECTION II, PART D (CUSTOMARY)

**TABLE Y-1 (CONT'D)
YIELD STRENGTH VALUES S_y FOR FERROUS AND NONFERROUS MATERIALS**

Line No.	Size/Thickness, in.	Min. Tensile Strength, ksi	Min. Yield Strength, ksi	Notes
Ferrous Materials (Cont'd)				
1	...	70	30	...
2	> 3	95	50	...
3	≤ 3	95	60	...
4	> 3	100	60	...
5	≤ 3	100	70	...
6	...	70	30	...
7	...	75	35	...
8	...	75	30	...
9	...	75	30	...
10	...	75	30	...
11	...	75	30	...
12	...	75	30	...
13	...	75	30	...
14	...	75	30	...
15	...	75	30	...
16	...	75	30	...
17	...	80	38	...
18	...	94	44	...
19	...	94	44	...
20	...	94	44	...
21	...	94	44	...
22	...	100	45	...
23	...	90	50	...
24	...	90	50	...
25	...	90	50	...
26	...	90	50	... 07
27	...	87	45	...
28	...	87	45	...
29	...	87	45	...
30	...	87	45	...
31	...	87	45	...
32	...	87	45	...
33	...	90	65	...
34	...	90	65	...
35	...	90	65	...
36	...	90	65	...
37	...	90	65	...
38	...	90	65	...

2007 SECTION II, PART D (CUSTOMARY)

**TABLE Y-1 (CONT'D)
YIELD STRENGTH VALUES S_y FOR FERROUS AND NONFERROUS MATERIALS**

Line No.	Yield Strength, ksi (Multiply by 1000 to Obtain psi), for Metal Temperature, °F, Not Exceeding								
	-20 to 100	150	200	250	300	350	400	450	500
Ferrous Materials (Cont'd)									
1	30.0	26.7	25.0	23.6	22.4	...	20.6	...	19.3
2	50.0	...	46.4	...	44.3	...	42.5	...	41.1
3	60.0	...	55.7	...	53.1	...	51.1	...	49.4
4	60.0	...	55.7	...	53.1	...	51.1	...	49.4
5	70.0	...	65.0	...	62.0	...	59.6	...	57.6
6	30.0	27.7	26.2	24.8	23.5	...	21.4	...	19.9
7	35.0	30.5	28.1	26.2	24.5	...	22.1	...	20.5
8	30.0	27.0	25.3	24.0	22.8	...	21.0	...	19.7
9	30.0	27.0	25.3	24.0	22.8	...	21.0	...	19.7
10	30.0	27.0	25.3	24.0	22.8	...	21.0	...	19.7
11	30.0	27.0	25.3	24.0	22.8	...	21.0	...	19.7
12	30.0	27.0	25.3	24.0	22.8	...	21.0	...	19.7
13	30.0	27.0	25.3	24.0	22.8	...	21.0	...	19.7
14	30.0	27.0	25.3	24.0	22.8	...	21.0	...	19.7
15	30.0	27.0	25.3	24.0	22.8	...	21.0	...	19.7
16	30.0	26.7	25.0	23.6	22.4	...	20.7	...	19.4
17	38.0	33.3	31.0	29.2	27.8	...	25.6	...	24.2
18	44.0	38.5	35.9	33.8	32.1	...	29.7	...	28.0
19	44.0	38.5	35.9	33.8	32.1	...	29.7	...	28.0
20	44.0	38.5	35.9	33.8	32.1	...	29.7	...	28.0
21	44.0	38.5	35.9	33.8	32.1	...	30.4	...	28.6
22	45.0	39.4	36.7	34.6	32.9	...	29.7	...	28.0
23	50.0	42.5	38.6	35.5	33.0	...	29.4	...	27.1
24	50.0	42.5	38.6	35.5	33.0	...	29.4	...	27.1
25	50.0	42.5	38.6	35.5	33.0	...	29.4	...	27.1
07 26	50.0	42.5	38.6	35.5	33.0	...	29.4	...	27.1
27	45.0	40.2	37.5	35.1	33.0	...	29.9	...	27.8
28	45.0	40.2	37.5	35.1	33.0	...	29.9	...	27.8
29	45.0	40.2	37.5	35.1	33.0	...	29.9	...	27.8
30	45.0	40.2	37.5	35.1	33.0	...	29.9	...	27.8
31	45.0	40.2	37.5	35.1	33.0	...	29.9	...	27.8
32	45.0	40.2	37.5	35.1	33.0	...	29.9	...	27.8
33	65.0	60.5	57.8	55.5	53.7	...	51.2	...	49.6
34	65.0	60.5	57.8	55.5	53.7	...	51.2	...	49.6
35	65.0	60.5	57.8	55.5	53.7	...	51.2	...	49.6
36	65.0	60.5	57.8	55.5	53.7	...	51.2	...	49.6
37	65.0	60.5	57.8	55.5	53.7	...	51.2	...	49.6
38	65.0	60.5	57.8	55.5	53.7	...	51.2	...	49.6

$$C_{1,2} = \frac{100}{\pi D^2} \cdot \frac{\left(\text{Outer Thickness} \right)^2 - 2}{T} = \frac{100}{\pi D^2} \cdot \frac{\left(\text{Outer Thickness} \right)^2 - 2}{T}$$

TABLE I. DIMENSIONS OF SEAMLESS AND WELDED STEEL PIPES
All dimensions are in millimetres

Nominal pipe size	Outside diameter	Nominal wall thickness															
		Schedule 5S*	Schedule 10S*	Schedule 20	Schedule 30	Schedule 40	Schedule 60	Schedule 80	Schedule 100	Schedule 120	Schedule 140	Schedule 160	Double extra strong				
1	1	1.24	1.65	2.11	2.77	3.56	4.85	6.08	7.73	9.73	11.73	14.41	2.41	—	—	—	—
	1.25	1.24	1.65	2.11	2.77	3.56	4.85	6.08	7.73	9.73	11.73	14.41	2.41	—	—	—	—
	1.37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1.71	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	2	2.13	1.65	2.11	2.77	3.56	4.85	6.08	7.73	9.73	11.73	14.41	2.41	—	—	—	—
	2.67	1.65	2.11	2.77	3.56	4.85	6.08	7.73	9.73	11.73	14.41	2.41	—	—	—	—	—
	3.34	1.65	2.11	2.77	3.56	4.85	6.08	7.73	9.73	11.73	14.41	2.41	—	—	—	—	—
	42.2	1.65	2.11	2.77	3.56	4.85	6.08	7.73	9.73	11.73	14.41	2.41	—	—	—	—	—
	48.3	1.65	2.11	2.77	3.56	4.85	6.08	7.73	9.73	11.73	14.41	2.41	—	—	—	—	—
	60.3	1.65	2.11	2.77	3.56	4.85	6.08	7.73	9.73	11.73	14.41	2.41	—	—	—	—	—
	73.0	2.11	3.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	88.9	2.11	3.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	101.6	2.11	3.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	114.3	2.11	3.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	141.3	2.77	3.40	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	168.3	2.77	3.40	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	219.1	2.77	3.76	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	273.0	3.40	4.19	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	323.9	3.96	4.57	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	355.6	3.96	4.78	6.35	7.92	9.52	11.13	14.27	17.04	20.62	24.61	28.62	—	—	—	—	—
	406.4	4.19	4.78	6.35	7.92	9.52	11.13	14.27	17.04	20.62	24.61	28.62	—	—	—	—	—
	457.2	4.19	4.78	6.35	7.92	9.52	11.13	14.27	17.04	20.62	24.61	28.62	—	—	—	—	—
	508.0	4.78	5.54	6.35	7.92	9.52	11.13	14.27	17.04	20.62	24.61	28.62	—	—	—	—	—
	558.8	4.78	5.54	6.35	7.92	9.52	11.13	14.27	17.04	20.62	24.61	28.62	—	—	—	—	—
	609.6	5.54	6.35	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	660.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	711.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	762.0	6.35	7.92	7.92	12.70	15.88	—	—	—	—	—	—	—	—	—	—	—
	812.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	863.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	914.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

* Schedule 5S, 10S, 40S and 80S apply to austenitic chromium-nickel steel pipe only.

Except when marked † standard, extra strong and double extra strong wall thicknesses have pipe of corresponding wall thickness listed under one of the schedule numbers.

† The use of these sizes should be avoided wherever possible.

NOTE 1. For nominal pipe sizes greater than 36 inches, see API Std. SLS, Spiral weld line pipe (obtainable through the British Standards Institution).

NOTE 2. Dimensions in this table are based on ANSI B36.10 and ANSI B36.19.

NOTE 3. For tolerance on outside diameter and wall thickness see appropriate specifications.

APPENDIX B


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*****
*          STAAD.Pro V8i SELECTseries2
*          Version 20.07.07.32
*          Proprietary Program of
*          Bentley Systems, Inc.
*          Date= JUN 10, 2015
*          Time= 10:27:56
*
*          USER ID: Bergen Group
*****
```

1. STAAD SPACE

INPUT FILE: Pipesupport 508.4.78-FIRST CASE.STD

2. START JOB INFORMATION

3. ENGINEER DATE 23-MAR-15

4. END JOB INFORMATION

5. INPUT WIDTH 79

6. UNIT METER KN

7. JOINT COORDINATES

8. 1 -0.5 0 0; 2 -0.5 0 -5; 3 -0.5 -3 0; 4 -0.5 -3 -5; 5 -0.5 0 -10
 9. 7 -0.5 -3 -10; 9 -0.5 0 5; 10 -0.5 -3 5; 12 5.5 0 0; 13 5.5 0 -5; 14 5.5 -3 0
 10. 15 5.5 -3 -5; 16 5.5 0 -10; 18 5.5 -3 -10; 20 5.5 0 5; 21 5.5 -3 5
 11. 23 5.5 0 -7.5; 24 -0.5 0 -7.5; 26 2.5 0 0; 27 0.1 0 0; 28 0.1 0 -5
 12. 30 0.1 0 -10; 32 0.7 0 0; 33 0.7 0 -5; 35 0.7 0 -10; 37 1.3 0 0; 38 1.3 0 -5
 13. 40 1.3 0 -10; 42 1.9 0 0; 43 1.9 0 -5; 45 1.9 0 -10; 47 2.5 0 -5; 49 2.5 0 -10
 14. 51 3.1 0 0; 52 3.1 0 -5; 54 3.1 0 -10; 56 3.7 0 0; 57 3.7 0 -5; 59 3.7 0 -10
 15. 61 4.3 0 0; 62 4.3 0 -5; 64 4.3 0 -10; 66 4.9 0 0; 67 4.9 0 -5; 69 4.9 0 -10
 16. 71 -0.5 0 10; 72 -0.5 -3 10; 74 5.5 0 10; 75 5.5 -3 10; 78 2.5 0 -2.5
 17. 80 -0.5 0 7.5; 81 5.5 0 7.5; 82 3.6 0 7.5; 83 3.6 1.5 7.5; 84 1.4 0 7.5
 18. 85 1.4 1.5 7.5; 86 -0.5 0 2.5; 87 1.4 0 2.5; 88 3.6 0 2.5; 89 5.5 0 2.5
 19. 90 3.6 1.5 2.5; 91 1.4 1.5 2.5; 92 3.1 0 -2.5; 93 1.9 0 -2.5; 95 3.1 1.5 -2.5
 20. 96 1.9 1.5 -2.5; 97 3.1 0 -3.7; 98 1.9 0 -3.7; 99 1.9 1.5 -7.5; 100 1.9 0 -7.5
 21. 101 3.1 1.5 -7.5; 102 3.1 0 -7.5; 104 1.9 0 -8.7; 105 3.1 0 -8.7
 22. 115 -0.5 0 -0.2; 116 0.1 0 -0.2; 117 0.7 0 -0.2; 118 1.3 0 -0.2
 23. 119 1.9 0 -0.2; 120 2.5 0 -0.2; 121 3.1 0 -0.2; 122 3.7 0 -0.2; 123 4.3 0 -0.2
 24. 124 4.9 0 -0.2; 125 5.5 0 -0.2; 126 2.5 1.5 -7.5; 127 2.5 1.5 -2.5
 25. 128 2.5 1.5 2.5; 129 2.5 1.5 7.5

26. MEMBER INCIDENCES

27. 1 1 115; 2 1 3; 3 2 4; 4 2 24; 6 5 7; 8 9 10; 9 9 86; 11 1 27; 12 2 28
 28. 15 5 30; 19 9 20; 22 12 14; 23 13 15; 24 13 23; 26 16 18; 28 20 21; 29 20 89
 29. 31 12 125; 32 23 16; 33 15 23; 34 23 18; 35 24 5; 36 4 24; 37 24 7; 39 26 51
 30. 43 27 32; 44 28 33; 46 28 30; 47 30 35; 51 32 37; 52 33 38; 54 33 35; 55 35 40
 31. 59 37 42; 60 38 43; 62 38 40; 63 40 45; 67 42 26; 68 43 47; 70 43 100
 32. 71 45 49; 75 47 52; 77 47 49; 78 49 54; 82 51 56; 83 52 57; 85 52 102
 33. 86 54 59; 90 56 61; 91 57 62; 93 57 59; 94 59 64; 98 61 66; 99 62 67
 34. 101 62 64; 102 64 69; 106 66 12; 107 67 13; 109 67 69; 110 69 16; 114 71 72
 35. 115 71 74; 116 74 75; 118 71 80; 119 74 81; 125 78 47; 127 80 9; 128 81 20
 36. 129 80 84; 130 82 84; 131 82 81; 132 82 83; 134 84 85; 135 85 129; 138 86 1
 37. 139 86 87; 140 88 87; 141 89 12; 142 88 89; 143 88 90; 144 87 91; 145 91 128
 38. 148 92 97; 149 43 98; 150 96 93; 151 95 92; 152 95 127; 154 97 52; 156 96 98
 39. 157 95 97; 158 100 104; 159 99 100; 160 102 105; 161 101 102; 162 101 126
 40. 164 104 45; 165 99 104; 166 105 54; 167 101 105; 180 115 2; 181 116 28

41. 182 115 116; 183 117 33; 184 116 117; 185 118 38; 186 117 118; 188 118 119
 42. 189 120 78; 190 119 120; 191 121 92; 192 120 121; 193 122 57; 194 121 122
 43. 195 123 62; 196 122 123; 197 124 67; 198 123 124; 199 125 13; 200 124 125
 44. 201 93 119; 202 98 93; 203 126 99; 204 127 96; 205 128 90; 206 129 83
 45. ELEMENT INCIDENCES SHELL
 46. 136 71 74 81 80; 137 80 9 20 81; 146 9 20 89 86; 147 86 1 12 89
 47. ELEMENT PROPERTY
 48. 136 137 146 147 THICKNESS 0.2
 49. DEFINE MATERIAL START
 50. ISOTROPIC CONCRETE
 51. E 2.17185E+007
 52. POISSON 0.17
 53. DENSITY 23.5616
 54. ALPHA 1E-005
 55. DAMP 0.05
 56. TYPE CONCRETE
 57. STRENGTH FCU 27579
 58. ISOTROPIC STEEL
 59. E 2.05E+008
 60. POISSON 0.3
 61. DENSITY 76.8195
 62. ALPHA 1.2E-005
 63. DAMP 0.03
 64. TYPE STEEL
 65. STRENGTH FY 355000 FU 510000 RY 1.5 RT 1.2
 66. END DEFINE MATERIAL
 67. MEMBER PROPERTY AMERICAN
 68. 2 8 9 11 19 22 28 29 39 43 51 59 67 82 90 98 106 114 TO 116 118 119 -
 69. 127 TO 131 138 TO 142 PRIS YD 0.35 ZD 0.35
 70. MEMBER PROPERTY EUROPEAN
 71. 1 4 12 15 24 31 32 35 44 47 52 55 60 63 68 71 75 78 83 86 91 94 99 102 107 -
 72. 110 180 182 184 186 188 190 192 194 196 198 TO 200 TABLE ST HE400B
 73. 3 6 23 26 TABLE ST 200X10SHS
 74. MEMBER PROPERTY EUROPEAN
 75. 46 54 62 70 77 85 93 101 109 158 160 164 166 181 183 185 193 195 -
 76. 197 TAPERED 0.288 0.012 0.288 0.3 0.008 0.052 0.034
 77. 125 TAPERED 0.288 0.012 0.288 0.3 0.008 0.052 0.034
 78. 189 TAPERED 0.288 0.012 0.288 0.3 0.008 0.052 0.034
 79. 132 134 135 143 TO 145 150 TO 152 156 157 159 161 162 165 167 203 TO 205 -
 80. 206 TABLE ST 200X16SHS
 81. 148 154 TAPERED 0.288 0.012 0.288 0.3 0.008 0.052 0.034
 82. 191 TAPERED 0.288 0.012 0.288 0.3 0.008 0.052 0.034
 83. 149 TAPERED 0.288 0.012 0.288 0.3 0.008 0.052 0.034
 84. 33 34 36 37 TABLE ST 140X8SHS
 85. 201 TAPERED 0.288 0.012 0.288 0.3 0.008 0.052 0.034
 86. 202 TAPERED 0.288 0.012 0.288 0.3 0.008 0.052 0.034
 87. CONSTANTS
 88. MATERIAL CONCRETE MEMB 2 8 9 11 19 22 28 29 39 43 51 59 67 82 90 98 106 114 -
 89. 115 TO 116 118 119 127 TO 131 136 TO 142 146 147
 90. MATERIAL STEEL MEMB 1 3 4 6 12 15 23 24 26 31 TO 37 44 46 47 52 54 55 60 62 -
 91. 63 68 70 71 75 77 78 83 85 86 91 93 94 99 101 102 107 109 110 125 132 134 -
 92. 135 143 TO 145 148 TO 152 154 156 TO 162 164 TO 167 180 TO 186 188 TO 206
 93. SUPPORTS
 94. 3 10 14 21 72 75 FIXED
 95. 4 7 15 18 PINNED
 96. 92 93 97 98 100 102 104 105 FIXED BUT FY FZ MX MY MZ

97. ****
98. LOAD 1 LOADTYPE DEAD TITLE SELF-WEIGHT
99. SELFWEIGHT Y -1.2
100. *
101. LOAD 2 LOADTYPE NONE TITLE VERTICAL REST LOAD
102. JOINT LOAD
103. 126 129 FY -12.5
104. 127 128 FY -12.55
105. LOAD 3 LOADTYPE NONE TITLE LINE STOP WEST LOAD
106. JOINT LOAD
107. 126 129 FZ 3.75
108. 127 FZ 3.76
109. 128 FZ 2.6
110. LOAD 4 LOADTYPE NONE TITLE LINE STOP EAST LOAD
111. JOINT LOAD
112. 126 129 FZ -3.75
113. 127 128 FZ -3.76
114. LOAD 5 LOADTYPE NONE TITLE DESIGN+BLAST REST LOAD
115. JOINT LOAD
116. 126 129 FY -126.3
117. 127 128 FY -127
118. LOAD 6 LOADTYPE NONE TITLE DESIGN+BLAST HOLD DOWN LOAD
119. JOINT LOAD
120. 126 129 FY 101.35
121. 127 128 FY 101.8
122. LOAD 7 LOADTYPE NONE TITLE BLAST LOAD LINE GUIDE S
123. JOINT LOAD
124. 126 129 FX -113.84
125. 127 128 FX -114.4
126. LOAD 8 LOADTYPE NONE TITLE BLAST LOAD LINE GUIDE N
127. JOINT LOAD
128. 126 129 FX 113.84
129. 127 128 FX 114.4
130. LOAD 9 LOADTYPE NONE TITLE BLAST LOAD ON MEMBERS Z
131. MEMBER LOAD
132. 132 134 135 143 TO 145 150 TO 152 156 157 159 161 162 165 167 203 TO 205 -
133. 206 UNI GZ 12.6
134. LOAD 10 LOADTYPE NONE TITLE BLAST LOAD ON MEMBERS X
135. MEMBER LOAD
136. 132 134 143 144 150 151 156 157 159 161 165 167 UNI GX 12.6
137. LOAD 11 LOADTYPE NONE TITLE BLAST LOAD ON MEMBERS Y
138. MEMBER LOAD
139. 135 145 152 156 157 162 165 167 203 TO 206 UNI GY 12.6
140. LOAD COMB 101 LC. ULS 101
141. 1 1.3 2 1.3 3 1.3
142. LOAD COMB 102 LC. ULS 102
143. 1 1.3 2 1.3 4 1.3
144. LOAD COMB 201 LC. SLS 201
145. 1 1.0 2 1.0 3 1.0
146. LOAD COMB 202 LC. SLS 202
147. 1 1.0 2 1.0 4 1.0
148. LOAD COMB 301 LC. ALS 301
149. 1 1.0 5 1.0 7 1.0 9 1.0
150. LOAD COMB 302 LC. ALS 302
151. 1 1.0 5 1.0 7 1.0 9 -1.0
152. LOAD COMB 303 LC. ALS 303

153. 1 1.0 5 1.0 7 1.0 10 1.0
154. LOAD COMB 304 LC. ALS 304
155. 1 1.0 5 1.0 7 1.0 10 -1.0
156. LOAD COMB 305 LC. ALS 305
157. 1 1.0 5 1.0 7 1.0 11 1.0
158. LOAD COMB 306 LC. ALS 306
159. 1 1.0 5 1.0 7 1.0 11 -1.0
160. LOAD COMB 307 LC. ALS 307
161. 1 1.0 5 1.0 8 1.0 9 1.0
162. LOAD COMB 308 LC. ALS 308
163. 1 1.0 5 1.0 8 1.0 9 -1.0
164. LOAD COMB 309 LC. ALS 309
165. 1 1.0 5 1.0 8 1.0 10 1.0
166. LOAD COMB 310 LC. ALS 310
167. 1 1.0 5 1.0 8 1.0 10 -1.0
168. LOAD COMB 311 LC. ALS 311
169. 1 1.0 5 1.0 8 1.0 11 1.0
170. LOAD COMB 312 LC. ALS 312
171. 1 1.0 5 1.0 8 1.0 11 -1.0
172. LOAD COMB 313 LC. ALS 313
173. 1 1.0 6 1.0 7 1.0 9 1.0
174. LOAD COMB 314 LC. ALS 314
175. 1 1.0 6 1.0 7 1.0 9 -1.0
176. LOAD COMB 315 LC. ALS 315
177. 1 1.0 6 1.0 7 1.0 10 1.0
178. LOAD COMB 316 LC. ALS 316
179. 1 1.0 6 1.0 7 1.0 10 -1.0
180. LOAD COMB 317 LC. ALS 317
181. 1 1.0 6 1.0 7 1.0 11 1.0
182. LOAD COMB 318 LC. ALS 318
183. 1 1.0 6 1.0 7 1.0 11 -1.0
184. LOAD COMB 319 LC. ALS 319
185. 1 1.0 6 1.0 8 1.0 9 1.0
186. LOAD COMB 320 LC. ALS 320
187. 1 1.0 6 1.0 8 1.0 9 -1.0
188. LOAD COMB 321 LC. ALS 321
189. 1 1.0 6 1.0 8 1.0 10 1.0
190. LOAD COMB 322 LC. ALS 322
191. 1 1.0 6 1.0 8 1.0 10 -1.0
192. LOAD COMB 323 LC. ALS 323
193. 1 1.0 6 1.0 8 1.0 11 1.0
194. LOAD COMB 324 LC. ALS 324
195. 1 1.0 6 1.0 8 1.0 11 -1.0
196. PERFORM ANALYSIS PRINT STATICS CHECK

APPENDIX C

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 21:37
 Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78WITH FRICTION
 Licensed To: Seat -- ID #61

Job Description: Pipe 508x4.78

PROJECT: MASTER THESIS

CLIENT :

ANALYST: S.TVEIT

NOTES : WITHOUT STRUCTURAL INFLUENCE, WITH FRICTION

PIPE DATA

From 1 To 10 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm. Cor= .0000 mm.

GENERAL

T1= 100 C T2= -7 C P1= 12.1000 bars PHyd= 20.0000 bars
 Mat= (338)A790 S31803 E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm.
 EH2= 196,280 N./sq.mm. EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm.
 EH5= 195,825 N./sq.mm. EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm.
 EH8= 195,825 N./sq.mm. EH9= 195,825 N./sq.mm. v = .292
 Pipe Den=8027.0000000 kg/cu.m. Fluid Den=1000.0000000 kg/cu.m.

Insul Thk= .000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
 Sy= 395 N./sq.mm.

From 10 To 20 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 10 X
 Node 10 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
 Sy= 395 N./sq.mm.

From 20 To 30 DZ= -2,500.000 mm.

GENERAL

E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm. EH2= 196,280 N./sq.mm.
 EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm. EH5= 195,825 N./sq.mm.
 EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm. EH8= 195,825 N./sq.mm.
 EH9= 195,825 N./sq.mm. v = .292 Pipe Den=8027.0000000 kg/cu.m.

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 21:37
Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78WITH FRICTION
Licensed To: Seat -- ID #61

2

RESTRAINTS

Node 30 X
Node 30 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

From 30 To 40 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm.

GENERAL

Insul Thk= .000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

From 40 To 50 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 50 X
Node 50 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 50 To 60 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 60 To 70 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 70 X
Node 70 Y Mu = .30

WIND

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 Licensed To: Seat -- ID #61

Wind Shape= 1.000
 ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 70 To 80 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000
 ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 80 To 90 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 90 X
 Node 90 Y Mu = .30

WIND

Wind Shape= 1.000
 ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 90 To 100 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000
 ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 100 To 110 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 110 X
 Node 110 Y Mu = .30

WIND

Wind Shape= 1.000
 ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

PIPE DATA

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From 110 To 120 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 120 To 130 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 130 X	
Node 130 Y	Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 130 To 140 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 140 To 150 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 150 X	
Node 150 Y	Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 150 To 160 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

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From 160 To 170 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 170 X

Node 170 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 170 To 180 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 180 To 190 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 190 X

Node 190 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 190 To 200 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints Various Load Cases

LOAD CASE DEFINITION KEY

CASE 4 (OPE)	W+T1+P1
CASE 5 (OPE)	W+T2+P1
CASE 6 (OPE)	W+T1+P1+WIN1
CASE 7 (OPE)	W+T1+P1-WIN1
CASE 8 (OPE)	W+T1+P1+WIN2
CASE 9 (OPE)	W+T1+P1-WIN2
CASE 10 (OPE)	W+T1+P1+WIN3
CASE 11 (OPE)	W+T1+P1-WIN3
CASE 12 (OPE)	W+T2+P1+WIN1
CASE 13 (OPE)	W+T2+P1-WIN1
CASE 14 (OPE)	W+T2+P1+WIN2
CASE 15 (OPE)	W+T2+P1-WIN2
CASE 16 (OPE)	W+T2+P1+WIN3
CASE 17 (OPE)	W+T2+P1-WIN3

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
10	Rigid X; Rigid Y									
4(OPE)	0	-13195	3958	0	0	0	0	0.000	-0.000	23.613
5(OPE)	0	-13195	-3958	0	0	0	0	0.000	0.000	-2.640
6(OPE)	120251	-13195	3958	0	0	0	0	0.000	0.000	23.613
7(OPE)	-120251	-13195	3958	0	0	0	0	-0.000	-0.000	23.613
8(OPE)	0	107057	32117	0	0	0	0	0.000	0.000	27.165
9(OPE)	0	-133446	40034	0	0	0	0	0.000	0.000	25.744
10(OPE)	0	-13195	3958	0	0	0	0	0.000	0.000	23.613
11(OPE)	0	-13195	3958	0	0	0	0	0.000	0.000	23.613
12(OPE)	120251	-13195	-3958	0	0	0	0	0.000	0.000	-2.640
13(OPE)	-120251	-13195	-3958	0	0	0	0	-0.000	-0.000	-2.640
14(OPE)	0	107057	-32117	0	0	0	0	0.000	0.000	-1.478
15(OPE)	0	-133446	-40034	0	0	0	0	0.000	0.000	-1.222
16(OPE)	0	-13195	-3958	0	0	0	0	0.000	0.000	-2.640
17(OPE)	0	-13195	-3958	0	0	0	0	0.000	0.000	-2.640
MAX								0.000/L6	-0.000/L9	

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
		120251/L6	133446/L9	40034/L9						27.165/L8
30	Rigid X; Rigid Y									
4(OPE)	0	-11724	3517	0	0	0	0	0.000	-0.000	17.694
5(OPE)	0	-11724	-3517	0	0	0	0	0.000	-0.000	-2.044
6(OPE)	106852	-11724	3517	0	0	0	0	0.000	-0.000	17.694
7(OPE)	-106852	-11724	3517	0	0	0	0	-0.000	-0.000	17.694
8(OPE)	0	95128	28538	0	0	0	0	0.000	0.000	21.339
9(OPE)	0	-118577	35573	0	0	0	0	0.000	-0.000	19.943
10(OPE)	0	-11724	3517	0	0	0	0	0.000	-0.000	17.694
11(OPE)	0	-11724	3517	0	0	0	0	0.000	-0.000	17.694
12(OPE)	106852	-11724	-3517	0	0	0	0	0.000	-0.000	-2.044
13(OPE)	-106852	-11724	-3517	0	0	0	0	-0.000	-0.000	-2.044
14(OPE)	0	95128	-28538	0	0	0	0	0.000	0.000	-0.977
15(OPE)	0	-118577	-35573	0	0	0	0	0.000	-0.000	-0.748
16(OPE)	0	-11724	-3517	0	0	0	0	0.000	-0.000	-2.044
17(OPE)	0	-11724	-3517	0	0	0	0	0.000	-0.000	-2.044
MAX	106852/L6	118577/L9	35573/L9					0.000/L6	-0.000/L9	21.339/L8
50	Rigid X; Rigid Y									
4(OPE)	0	-12746	3824	0	0	0	0	0.000	-0.000	11.787
5(OPE)	0	-12746	-3824	0	0	0	0	0.000	-0.000	-1.460
6(OPE)	116159	-12746	3824	0	0	0	0	0.000	-0.000	11.787
7(OPE)	-116159	-12746	3824	0	0	0	0	-0.000	-0.000	11.787
8(OPE)	0	103413	31024	0	0	0	0	0.000	0.000	15.610
9(OPE)	0	-128904	38671	0	0	0	0	0.000	-0.000	14.261
10(OPE)	0	-12746	3824	0	0	0	0	0.000	-0.000	11.787
11(OPE)	0	-12746	3824	0	0	0	0	0.000	-0.000	11.787
12(OPE)	116159	-12746	-3824	0	0	0	0	-0.000	-0.000	-1.460
13(OPE)	-116159	-12746	-3824	0	0	0	0	-0.000	-0.000	-1.460
14(OPE)	0	103413	-31024	0	0	0	0	0.000	0.000	-0.573

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
	15(OPE)	0	-128904	-38671	0	0	0	0.000	-0.000	-0.394
	16(OPE)	0	-12746	-3824	0	0	0	0.000	-0.000	-1.460
	17(OPE)	0	-12746	-3824	0	0	0	0.000	-0.000	-1.460
MAX	116159/L6	128904/L9	38671/L9					0.000/L6	-0.000/L9	15.610/L8
<hr/>										
70										
	Rigid X;									
	Rigid Y									
	4(OPE)	0	-12491	3747	0	0	0	0.000	-0.000	5.894
	5(OPE)	0	-12491	-3747	0	0	0	0.000	-0.000	-0.888
	6(OPE)	113838	-12491	3747	0	0	0	0.000	-0.000	5.894
	7(OPE)	-113838	-12491	3747	0	0	0	-0.000	-0.000	5.894
	8(OPE)	0	101347	30404	0	0	0	0.000	0.000	9.985
	9(OPE)	0	-126329	37899	0	0	0	0.000	-0.000	8.708
	10(OPE)	0	-12491	3747	0	0	0	0.000	-0.000	5.894
	11(OPE)	0	-12491	3747	0	0	0	0.000	-0.000	5.894
	12(OPE)	113838	-12491	-3747	0	0	0	0.000	-0.000	-0.888
	13(OPE)	-113838	-12491	-3747	0	0	0	-0.000	-0.000	-0.888
	14(OPE)	0	101347	-30404	0	0	0	0.000	0.000	-0.273
	15(OPE)	0	-126329	-29844	0	0	0	0.000	-0.000	-0.170
	16(OPE)	0	-12491	-3747	0	0	0	0.000	-0.000	-0.888
	17(OPE)	0	-12491	-3747	0	0	0	0.000	-0.000	-0.888
MAX	113838/L6	126329/L9	37899/L9					0.000/L6	-0.000/L9	9.985/L8
<hr/>										
90										
	Rigid X;									
	Rigid Y									
	4(OPE)	0	-12551	2642	0	0	0	0.000	-0.000	0.015
	5(OPE)	0	-12551	-3765	0	0	0	0.000	-0.000	-0.327
	6(OPE)	114384	-12551	2642	0	0	0	0.000	-0.000	0.015
	7(OPE)	-114384	-12551	2642	0	0	0	-0.000	-0.000	0.015
	8(OPE)	0	101834	30550	0	0	0	0.000	0.000	4.462
	9(OPE)	0	-126935	38081	0	0	0	0.000	-0.000	3.278
	10(OPE)	0	-12551	2642	0	0	0	0.000	-0.000	0.015

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
11(OPE)	0	-12551	2642	0	0	0	0	0.000	-0.000	0.015
12(OPE)	114384	-12551	-3765	0	0	0	0	0.000	-0.000	-0.327
13(OPE)	-114384	-12551	-3765	0	0	0	0	-0.000	-0.000	-0.327
14(OPE)	0	101834	-13335	0	0	0	0	0.000	0.000	-0.076
15(OPE)	0	-126935	-8312	0	0	0	0	0.000	-0.000	-0.047
16(OPE)	0	-12551	-3765	0	0	0	0	0.000	-0.000	-0.327
17(OPE)	0	-12551	-3765	0	0	0	0	0.000	-0.000	-0.327
MAX	114384/L6	126935/L9	38081/L9					0.000/L12	-0.000/L9	4.462/L8
110	Rigid X; Rigid Y									
4(OPE)	0	-12551	-3765	0	0	0	0	0.000	-0.000	-5.854
5(OPE)	0	-12551	3765	0	0	0	0	0.000	-0.000	0.221
6(OPE)	114384	-12551	-3765	0	0	0	0	0.000	-0.000	-5.854
7(OPE)	-114384	-12551	-3765	0	0	0	0	-0.000	-0.000	-5.854
8(OPE)	0	101834	-30550	0	0	0	0	0.000	0.000	-0.959
9(OPE)	0	-126935	-38081	0	0	0	0	0.000	-0.000	-2.029
10(OPE)	0	-12551	-3765	0	0	0	0	0.000	-0.000	-5.854
11(OPE)	0	-12551	-3765	0	0	0	0	0.000	-0.000	-5.854
12(OPE)	114384	-12551	3765	0	0	0	0	0.000	-0.000	0.221
13(OPE)	-114384	-12551	3765	0	0	0	0	-0.000	-0.000	0.221
14(OPE)	0	101834	13335	0	0	0	0	0.000	0.000	0.076
15(OPE)	0	-126935	8312	0	0	0	0	0.000	-0.000	0.047
16(OPE)	0	-12551	3765	0	0	0	0	0.000	-0.000	0.221
17(OPE)	0	-12551	3765	0	0	0	0	0.000	-0.000	0.221
MAX	114384/L12	126935/L9	38081/L9					0.000/L12	-0.000/L9	-5.854/L4
130	Rigid X; Rigid Y									
4(OPE)	0	-12491	-3747	0	0	0	0	0.000	-0.000	-11.737
5(OPE)	0	-12491	3747	0	0	0	0	0.000	-0.000	0.781
6(OPE)	113838	-12491	-3747	0	0	0	0	0.000	-0.000	-11.737

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 21:37
Job: C:\MASTERICAESAR\PIPE LOADS\CASE 1\508X4.78WITH FRICTION
Licensed To: Seat - [ID: #61]

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints Various Load Cases

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 21:37
 Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78WITH FRICTION
 Licensed To: Seat - ID #61

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases

NODE	Load Case	FX N. Rigid Y	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
	4(OPE)	0	-11724	-3517	0	0	0	0.000	0.000	-23.542
	5(OPE)	0	-11724	3517	0	0	0	0.000	0.000	1.938
	6(OPE)	106852	-11724	-3517	0	0	0	0.000	0.000	-23.542
	7(OPE)	-106852	-11724	-3517	0	0	0	-0.000	-0.000	-23.542
	8(OPE)	0	95128	-28538	0	0	0	0.000	0.000	-17.825
	9(OPE)	0	-118577	-35573	0	0	0	0.000	0.000	-18.692
	10(OPE)	0	-11724	-3517	0	0	0	0.000	0.000	-23.542
	11(OPE)	0	-11724	-3517	0	0	0	0.000	0.000	-23.542
	12(OPE)	106852	-11724	3517	0	0	0	0.000	0.000	1.938
	13(OPE)	-106852	-11724	3517	0	0	0	-0.000	-0.000	1.938
	14(OPE)	0	95128	28538	0	0	0	0.000	0.000	0.977
	15(OPE)	0	-118577	35573	0	0	0	0.000	0.000	0.748
	16(OPE)	0	-11724	3517	0	0	0	0.000	0.000	1.938
	17(OPE)	0	-11724	3517	0	0	0	0.000	0.000	1.938
	MAX	106852/L6	118577/L9	35573/L9				0.000/L6	-0.000/L9	23.542/L4
	190		Rigid X; Rigid Y							
	4(OPE)	0	-13195	-3958	0	0	0	0.000	0.000	-29.463
	5(OPE)	0	-13195	3958	0	0	0	0.000	0.000	2.534
	6(OPE)	120251	-13195	-3958	0	0	0	0.000	0.000	-29.463
	7(OPE)	-120251	-13195	-3958	0	0	0	-0.000	-0.000	-29.463
	8(OPE)	0	107057	-32117	0	0	0	0.000	0.000	-23.648
	9(OPE)	0	-133446	-40034	0	0	0	0.000	0.000	-24.492
	10(OPE)	0	-13195	-3958	0	0	0	0.000	0.000	-29.463
	11(OPE)	0	-13195	-3958	0	0	0	0.000	0.000	-29.463
	12(OPE)	120251	-13195	3958	0	0	0	0.000	0.000	2.534
	13(OPE)	-120251	-13195	3958	0	0	0	-0.000	-0.000	2.534
	14(OPE)	0	107057	32117	0	0	0	0.000	0.000	1.478
	15(OPE)	0	-133446	40034	0	0	0	0.000	0.000	1.222
	16(OPE)	0	-13195	3958	0	0	0	0.000	0.000	2.534
	17(OPE)	0	-13195	3958	0	0	0	0.000	0.000	2.534

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 21:37
Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 11508X4.78\WITH FRICTION
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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
MAX	120251/L6	133446/L9	-	-	40034/L9			0.000/L6	-0.000/L9	29.463/L4

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 21:37

Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78WITH FRICTION

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DISPLACEMENTS REPORT: Nodal Movements
CASE 4 (OPE) W+T1+P1

NODE	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
1	0.000	-0.514	26.581	0.0132	0.0000	0.0000
10	0.000	-0.000	23.613	0.0049	0.0000	0.0000
20	0.000	-0.051	20.653	-0.0007	0.0000	0.0000
30	0.000	-0.000	17.694	-0.0012	0.0000	0.0000
40	0.000	-0.135	14.740	0.0002	0.0000	0.0000
50	0.000	-0.000	11.787	0.0003	0.0000	0.0000
60	0.000	-0.114	8.840	-0.0000	0.0000	0.0000
70	0.000	-0.000	5.894	-0.0001	0.0000	0.0000
80	0.000	-0.119	2.954	0.0000	0.0000	0.0000
90	0.000	-0.000	0.015	0.0000	0.0000	0.0000
100	0.000	-0.118	-2.920	0.0000	0.0000	0.0000
110	0.000	-0.000	-5.854	-0.0000	0.0000	0.0000
120	0.000	-0.119	-8.796	-0.0000	0.0000	0.0000
130	0.000	-0.000	-11.737	0.0001	0.0000	0.0000
140	0.000	-0.114	-14.685	0.0000	0.0000	0.0000
150	0.000	-0.000	-17.633	-0.0003	0.0000	0.0000
160	0.000	-0.135	-20.587	-0.0002	0.0000	0.0000
170	0.000	-0.000	-23.542	0.0012	0.0000	0.0000
180	0.000	-0.051	-26.502	0.0007	0.0000	0.0000
190	0.000	-0.000	-29.463	-0.0049	0.0000	0.0000
200	0.000	-0.514	-32.430	-0.0132	0.0000	0.0000

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 21:37
 Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78WITH FRICTION
 Licensed To: Seat -- ID #61

DISPLACEMENTS REPORT: Nodal Movements
CASE 9 (OPE) W+T1+P1-WIN2

NODE	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
1	0.000	-5.195	28.711	0.1334	0.0000	0.0000
10	0.000	-0.000	25.744	0.0500	0.0000	0.0000
20	0.000	-0.513	22.844	-0.0073	0.0000	0.0000
30	0.000	-0.000	19.943	-0.0125	0.0000	0.0000
40	0.000	-1.366	17.102	0.0018	0.0000	0.0000
50	0.000	-0.000	14.261	0.0031	0.0000	0.0000
60	0.000	-1.152	11.484	-0.0005	0.0000	0.0000
70	0.000	-0.000	8.708	-0.0008	0.0000	0.0000
80	0.000	-1.206	5.993	0.0001	0.0000	0.0000
90	0.000	-0.000	3.278	0.0002	0.0000	0.0000
100	0.000	-1.190	0.624	0.0000	0.0000	0.0000
110	0.000	-0.000	-2.029	-0.0002	0.0000	0.0000
120	0.000	-1.206	-4.743	-0.0001	0.0000	0.0000
130	0.000	-0.000	-7.458	0.0008	0.0000	0.0000
140	0.000	-1.152	-10.234	0.0005	0.0000	0.0000
150	0.000	-0.000	-13.011	-0.0031	0.0000	0.0000
160	0.000	-1.366	-15.851	-0.0018	0.0000	0.0000
170	0.000	-0.000	-18.692	0.0125	0.0000	0.0000
180	0.000	-0.513	-21.592	0.0073	0.0000	0.0000
190	0.000	-0.000	-24.492	-0.0500	0.0000	0.0000
200	0.000	-5.195	-27.459	-0.1334	0.0000	0.0000

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 29, 2015 Time: 12:2

Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78NO FRICTION

Licensed To: Seat -- ID #61

Job Description: Pipe 508x4.78

PROJECT: MASTER THESIS

CLIENT :

ANALYST: S.TVEIT

NOTES : WITHOUT STRUCTURAL INFLUENCE, NO FRICTION

PIPE DATA

From 1 To 10 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm. Cor= .0000 mm.

GENERAL

T1= 100 C T2= -7 C P1= 12.1000 bars PHyd= 20.0000 bars
 Mat= (338)A790 S31803 E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm.
 EH2= 196,280 N./sq.mm. EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm.
 EH5= 195,825 N./sq.mm. EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm.
 EH8= 195,825 N./sq.mm. EH9= 195,825 N./sq.mm. v = .292
 Pipe Den=8027.0000000 kg/cu.m. Fluid Den=1000.0000000 kg/cu.m.
 Insul Thk= .000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch = ON	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.		

From 10 To 20 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 10 X
 Node 10 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch = ON	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.		

From 20 To 30 DZ= -2,500.000 mm.

GENERAL

E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm. EH2= 196,280 N./sq.mm.
 EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm. EH5= 195,825 N./sq.mm.
 EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm. EH8= 195,825 N./sq.mm.
 EH9= 195,825 N./sq.mm. v = .292 Pipe Den=8027.0000000 kg/cu.m.

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 29, 2015 Time: 12:2
Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78NO FRICTION
Licensed To: Seat -- ID #61

RESTRAINTS

Node 30 X
Node 30 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

From 30 To 40 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm.

GENERAL

Insul Thk= .000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

From 40 To 50 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 50 X
Node 50 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 50 To 60 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 60 To 70 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 70 X
Node 70 Y

WIND

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 29, 2015 Time: 12:2
 Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78NO FRICTION
 Licensed To: Seat -- ID #61

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 70 To 80 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 80 To 90 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 90 X

Node 90 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 90 To 100 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 100 To 110 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 110 X

Node 110 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

PIPE DATA

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From 110 To 120 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 120 To 130 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 130 X

Node 130 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 130 To 140 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 140 To 150 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 150 X

Node 150 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 150 To 160 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

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From 160 To 170 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 170 X

Node 170 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 170 To 180 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 180 To 190 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 190 X

Node 190 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 190 To 200 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

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**STRESS SUMMARY REPORT: Highest Stresses Mini Statement
 Various Load Cases**

LOAD CASE DEFINITION KEY

```
CASE 1 (HYD) WW+HP
CASE 2 (SUS) WNC
CASE 3 (SUS) W+P1
CASE 18 (OCC) L18=L6-L4
CASE 19 (OCC) L19=L7-L4
CASE 20 (OCC) L20=L8-L4
CASE 21 (OCC) L21=L9-L4
CASE 22 (OCC) L22=L10-L4
CASE 23 (OCC) L23=L11-L4
CASE 24 (OCC) L24=L18+L3
CASE 25 (OCC) L25=L19+L3
CASE 26 (OCC) L26=L20+L3
CASE 27 (OCC) L27=L21+L3
CASE 28 (OCC) L28=L22+L3
CASE 29 (OCC) L29=L23+L3
CASE 30 (EXP) L30=L4-L3
CASE 31 (EXP) L31=L5-L3
```

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 1 (HYD) WW+HP

Highest Stresses: (N./sq.mm.)	LOADCASE 1 (HYD)	WW+HP
CodeStress Ratio (%):	15.2	@Node 10
Code Stress:	60.0	Allowable: 395.0
Axial Stress:	51.6	@Node 10
Bending Stress:	8.3	@Node 10
Torsion Stress:	0.0	@Node 10
Hoop Stress:	104.3	@Node 10
3D Max Intensity:	107.3	@Node 10

CODE STRESS CHECK PASSED : LOADCASE 2 (SUS) WNC

Highest Stresses: (N./sq.mm.)	LOADCASE 2 (SUS)	WNC
CodeStress Ratio (%):	1.0	@Node 10
Code Stress:	2.0	Allowable: 205.9
Axial Stress:	0.0	@Node 10
Bending Stress:	2.0	@Node 10
Torsion Stress:	0.0	@Node 10
Hoop Stress:	0.0	@Node 10
3D Max Intensity:	2.0	@Node 10

CODE STRESS CHECK PASSED : LOADCASE 3 (SUS) W+P1

Highest Stresses: (N./sq.mm.)	LOADCASE 3 (SUS)	W+P1
CodeStress Ratio (%):	19.2	@Node 10
Code Stress:	39.6	Allowable: 205.9
Axial Stress:	31.2	@Node 10
Bending Stress:	8.3	@Node 10

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	64.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 18 (OCC) L18=L6-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 18 (OCC)	L18=L6-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 19 (OCC) L19=L7-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 19 (OCC)	L19=L7-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 20 (OCC) L20=L8-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 20 (OCC)	L20=L8-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 21 (OCC) L21=L9-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 21 (OCC)	L21=L9-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 22 (OCC) L22=L10-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 22 (OCC)	L22=L10-L4	
CodeStress Ratio (%):	0.0	@Node	10
Code Stress:	0.0	Allowable:	494.2

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

Axial Stress:	0.0	@Node	10
Bending Stress:	0.0	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 23 (OCC) L23=L11-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 23 (OCC)	L23=L11-L4	
CodeStress Ratio (%):	0.0	@Node	10
Code Stress:	0.0	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	0.0	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 24 (OCC) L24=L18+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 24 (OCC)	L24=L18+L3	
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 25 (OCC) L25=L19+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 25 (OCC)	L25=L19+L3	
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 26 (OCC) L26=L20+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 26 (OCC)	L26=L20+L3	
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 27 (OCC) L27=L21+L3

Highest Stresses: (N./sq.mm.) LOADCASE 27 (OCC) L27=L21+L3

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 Job: C:\MASTER\CAESAR\PIPE LOADS\CASE 1\508X4.78NO FRICTION
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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 28 (OCC) L28=L22+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 28 (OCC)	L28=L22+L3	
CodeStress Ratio (%):	8.0	@Node	10
Code Stress:	39.6	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	8.3	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	64.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 29 (OCC) L29=L23+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 29 (OCC)	L29=L23+L3	
CodeStress Ratio (%):	8.0	@Node	10
Code Stress:	39.6	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	8.3	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	64.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 30 (EXP) L30=L4-L3

Highest Stresses: (N./sq.mm.)	LOADCASE 30 (EXP)	L30=L4-L3	
CodeStress Ratio (%):	0.0	@Node	170
Code Stress:	0.0	Allowable:	479.9
Axial Stress:	0.0	@Node	140
Bending Stress:	0.0	@Node	170
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	170

CODE STRESS CHECK PASSED : LOADCASE 31 (EXP) L31=L5-L3

Highest Stresses: (N./sq.mm.)	LOADCASE 31 (EXP)	L31=L5-L3	
CodeStress Ratio (%):	0.0	@Node	30
Code Stress:	0.0	Allowable:	481.0
Axial Stress:	0.0	@Node	150
Bending Stress:	0.0	@Node	30
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	170

STRESSES EXTENDED REPORT: Stresses on Elements CASE 1 (HYD) WW+HP

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 1 (HYD) WW+HP

Highest Stresses: (N./sq.mm.)			
Code Stress Ratio (%) :	15.2	@Node	10
Code Stress:	60.0	Allowable:	395.0
Axial Stress:	51.6	@Node	10
Bending Stress:	8.3	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	104.3	@Node	10
3D Max Intensity:	107.3	@Node	10

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
1	51.64	0.00	0.00	104.28	107.29	1.000	1.000	51.64	395.00	13.07	B31.3
10	51.64	8.32	0.00	104.28	107.29	1.000	1.000	59.96	395.00	15.18	B31.3
10	51.64	8.32	0.00	104.28	107.29	1.000	1.000	59.96	395.00	15.18	B31.3
20	51.64	1.73	0.00	104.28	107.29	1.000	1.000	53.38	395.00	13.51	B31.3
20	51.64	1.73	0.00	104.28	107.29	1.000	1.000	53.38	395.00	13.51	B31.3
30	51.64	4.85	0.00	104.28	107.29	1.000	1.000	56.50	395.00	14.30	B31.3
30	51.64	4.85	0.00	104.28	107.29	1.000	1.000	56.50	395.00	14.30	B31.3
40	51.64	3.03	0.00	104.28	107.29	1.000	1.000	54.68	395.00	13.84	B31.3
40	51.64	3.03	0.00	104.28	107.29	1.000	1.000	54.68	395.00	13.84	B31.3
50	51.64	5.72	0.00	104.28	107.29	1.000	1.000	57.36	395.00	14.52	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 1 (HYD) WW+HP

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
50	51.64	5.72	0.00	104.28	107.29	1.000	1.000	57.36	395.00	14.52	B31.3
60	51.64	2.71	0.00	104.28	107.29	1.000	1.000	54.35	395.00	13.76	B31.3
60	51.64	2.71	0.00	104.28	107.29	1.000	1.000	54.35	395.00	13.76	B31.3
70	51.64	5.50	0.00	104.28	107.29	1.000	1.000	57.15	395.00	14.47	B31.3
70	51.64	5.50	0.00	104.28	107.29	1.000	1.000	57.15	395.00	14.47	B31.3
80	51.64	2.79	0.00	104.28	107.29	1.000	1.000	54.43	395.00	13.78	B31.3
80	51.64	2.79	0.00	104.28	107.29	1.000	1.000	54.43	395.00	13.78	B31.3
90	51.64	5.55	0.00	104.28	107.29	1.000	1.000	54.43	395.00	13.78	B31.3
90	51.64	5.55	0.00	104.28	107.29	1.000	1.000	57.20	395.00	14.48	B31.3
100	51.64	2.77	0.00	104.28	107.29	1.000	1.000	54.41	395.00	13.77	B31.3
100	51.64	2.77	0.00	104.28	107.29	1.000	1.000	57.20	395.00	14.48	B31.3
110	51.64	5.55	0.00	104.28	107.29	1.000	1.000	54.41	395.00	13.77	B31.3
110	51.64	5.55	0.00	104.28	107.29	1.000	1.000	57.20	395.00	14.48	B31.3
120	51.64	2.79	0.00	104.28	107.29	1.000	1.000	54.43	395.00	14.48	B31.3
120	51.64	2.79	0.00	104.28	107.29	1.000	1.000	54.43	395.00	13.78	B31.3
130	51.64	5.50	0.00	104.28	107.29	1.000	1.000	57.15	395.00	14.47	B31.3
130	51.64	5.50	0.00	104.28	107.29	1.000	1.000	57.15	395.00	13.76	B31.3
140	51.64	2.71	0.00	104.28	107.29	1.000	1.000	54.35	395.00	13.76	B31.3
140	51.64	2.71	0.00	104.28	107.29	1.000	1.000	57.36	395.00	14.52	B31.3
150	51.64	5.72	0.00	104.28	107.29	1.000	1.000	57.36	395.00	14.52	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 1 (HYD) WW+HP

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
160	51.64	3.03	0.00	104.28	107.29	1.000	1.000	54.68	395.00	13.84	B31.3
160	51.64	3.03	0.00	104.28	107.29	1.000	1.000	54.68	395.00	13.84	B31.3
170	51.64	4.85	0.00	104.28	107.29	1.000	1.000	56.50	395.00	14.30	B31.3
170	51.64	4.85	0.00	104.28	107.29	1.000	1.000	56.50	395.00	14.30	B31.3
180	51.64	1.73	0.00	104.28	107.29	1.000	1.000	53.38	395.00	13.51	B31.3
180	51.64	1.73	0.00	104.28	107.29	1.000	1.000	53.38	395.00	13.51	B31.3
190	51.64	8.32	0.00	104.28	107.29	1.000	1.000	59.96	395.00	15.18	B31.3
190	51.64	8.32	0.00	104.28	107.29	1.000	1.000	59.96	395.00	15.18	B31.3
200	51.64	0.00	0.00	104.28	107.29	1.000	1.000	51.64	395.00	13.07	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 3 (SUS) W+P1

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 3 (SUS) W+P1

Highest Stresses: (N./sq.mm.)								
Code Stress Ratio (%):	19.2	@Node 10						
Code Stress:	39.6	Allowable: 205.9						
Axial Stress:	31.2	@Node 10						
Bending Stress:	8.3	@Node 10						
Torsion Stress:	0.0	@Node 10						
Hoop Stress:	63.1	@Node 10						
3D Max Intensity:	64.9	@Node 10						

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
1 31.24	0.00	0.00	63.09	64.91	1.000	1.000	31.24	205.93	15.17	B31.3	
10 31.24	8.32	0.00	63.09	64.91	1.000	1.000	39.57	205.93	19.21	B31.3	
10 31.24	8.32	0.00	63.09	64.91	1.000	1.000	39.57	205.93	19.21	B31.3	
20 31.24	1.73	0.00	63.09	64.91	1.000	1.000	32.98	205.93	16.01	B31.3	
20 31.24	1.73	0.00	63.09	64.91	1.000	1.000	32.98	205.93	16.01	B31.3	
30 31.24	4.85	0.00	63.09	64.91	1.000	1.000	36.10	205.93	17.53	B31.3	
30 31.24	4.85	0.00	63.09	64.91	1.000	1.000	36.10	205.93	17.53	B31.3	
40 31.24	3.03	0.00	63.09	64.91	1.000	1.000	34.28	205.93	16.65	B31.3	
40 31.24	3.03	0.00	63.09	64.91	1.000	1.000	34.28	205.93	16.65	B31.3	
50 31.24	5.72	0.00	63.09	64.91	1.000	1.000	36.97	205.93	17.95	B31.3	

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 3 (SUS) W+P1

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
50	31.24	5.72	0.00	63.09	64.91	1.000	1.000	36.97	205.93	17.95	B31.3
60	31.24	2.71	0.00	63.09	64.91	1.000	1.000	33.95	205.93	16.49	B31.3
60	31.24	2.71	0.00	63.09	64.91	1.000	1.000	33.95	205.93	16.49	B31.3
70	31.24	5.51	0.00	63.09	64.91	1.000	1.000	36.75	205.93	17.85	B31.3
70	31.24	5.51	0.00	63.09	64.91	1.000	1.000	36.75	205.93	17.85	B31.3
80	31.24	2.79	0.00	63.09	64.91	1.000	1.000	34.04	205.93	16.53	B31.3
80	31.24	2.79	0.00	63.09	64.91	1.000	1.000	34.04	205.93	16.53	B31.3
90	31.24	5.56	0.00	63.09	64.91	1.000	1.000	36.80	205.93	17.87	B31.3
90	31.24	5.56	0.00	63.09	64.91	1.000	1.000	36.80	205.93	17.87	B31.3
100	31.24	2.77	0.00	63.09	64.91	1.000	1.000	34.01	205.93	16.52	B31.3
110	31.24	5.56	0.00	63.09	64.91	1.000	1.000	36.80	205.93	17.87	B31.3
100	31.24	2.77	0.00	63.09	64.91	1.000	1.000	34.01	205.93	16.52	B31.3
110	31.24	5.56	0.00	63.09	64.91	1.000	1.000	36.80	205.93	17.87	B31.3
120	31.24	2.79	0.00	63.09	64.91	1.000	1.000	34.04	205.93	16.53	B31.3
120	31.24	2.79	0.00	63.09	64.91	1.000	1.000	34.04	205.93	16.53	B31.3
130	31.24	5.51	0.00	63.09	64.91	1.000	1.000	36.75	205.93	17.85	B31.3
140	31.24	2.71	0.00	63.09	64.91	1.000	1.000	33.95	205.93	16.49	B31.3
140	31.24	2.71	0.00	63.09	64.91	1.000	1.000	36.97	205.93	17.95	B31.3
150	31.24	5.72	0.00	63.09	64.91	1.000	1.000	36.97	205.93	17.95	B31.3
150	31.24	5.72	0.00	63.09	64.91	1.000	1.000	36.97	205.93	17.95	B31.3

STRESSES EXTENDED REPORT: Stressess on Elements
CASE 3 (SUS) W+P1

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
160 31.24	3.03	0.00	63.09	64.91	1.000	1.000	34.28	205.93	16.65	B31.3	
160 31.24	3.03	0.00	63.09	64.91	1.000	1.000	34.28	205.93	16.65	B31.3	
170 31.24	4.85	0.00	63.09	64.91	1.000	1.000	36.10	205.93	17.53	B31.3	
170 31.24	4.85	0.00	63.09	64.91	1.000	1.000	36.10	205.93	17.53	B31.3	
180 31.24	1.73	0.00	63.09	64.91	1.000	1.000	32.98	205.93	16.01	B31.3	
180 31.24	1.73	0.00	63.09	64.91	1.000	1.000	32.98	205.93	16.01	B31.3	
190 31.24	8.32	0.00	63.09	64.91	1.000	1.000	39.57	205.93	19.21	B31.3	
190 31.24	8.32	0.00	63.09	64.91	1.000	1.000	39.57	205.93	19.21	B31.3	
200 31.24	0.00	0.00	63.09	64.91	1.000	1.000	31.24	205.93	15.17	B31.3	

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 29, 2015 Time: 12:2
 Job: C:\MASTER\CAESAR\PIPE LOADS\CASE1\508X4.78NO FRICTION
 Licensed To: Seat -- ID #61

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 27 (OCC) L27=L21+L3

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 27 (OCC) L27=L21+L3

Highest Stresses: (N./sq.mm.)		Code Stress Ratio (%):		Allowable:	
Code Stress:	23.4	Node	10	Allowable:	494.2
Axial Stress:	115.4	Node	10	Axial Stress:	31.2
Bending Stress:	84.2	Node	10	Bending Stress:	84.2
Torsion Stress:	0.0	Node	10	Torsion Stress:	0.0
Hoop Stress:	63.1	Node	10	Hoop Stress:	63.1
3D Max Intensity:	140.8	Node	10	3D Max Intensity:	140.8

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
1	31.24	0.00	0.00	63.09	64.91	1.000	1.000	31.24	494.23	6.32	B31.3
10	31.24	84.17	0.00	63.09	140.76	1.000	1.000	115.42	494.23	23.35	B31.3
10	31.24	84.17	0.00	63.09	140.76	1.000	1.000	115.42	494.23	23.35	B31.3
20	31.24	17.54	0.00	63.09	80.71	1.000	1.000	48.78	494.23	9.87	B31.3
20	31.24	17.54	0.00	63.09	80.71	1.000	1.000	48.78	494.23	9.87	B31.3
30	31.24	49.09	0.00	63.09	109.15	1.000	1.000	80.34	494.23	16.25	B31.3
30	31.24	49.09	0.00	63.09	109.15	1.000	1.000	80.34	494.23	16.25	B31.3
40	31.24	30.69	0.00	63.09	92.56	1.000	1.000	61.94	494.23	12.53	B31.3
40	31.24	30.69	0.00	63.09	92.56	1.000	1.000	61.94	494.23	12.53	B31.3
50	31.24	57.87	0.00	63.09	117.06	1.000	1.000	89.12	494.23	18.03	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 27 (OCC) L27=L21+L3

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
50	31.24	57.87	0.00	63.09	117.06	1.000	1.000	89.12	494.23	18.03	B31.3
60	31.24	27.40	0.00	63.09	89.60	1.000	1.000	58.64	494.23	11.86	B31.3
60	31.24	27.40	0.00	63.09	89.60	1.000	1.000	58.64	494.23	11.86	B31.3
70	31.24	55.68	0.00	63.09	115.08	1.000	1.000	86.93	494.23	17.59	B31.3
70	31.24	55.68	0.00	63.09	115.08	1.000	1.000	86.93	494.23	17.59	B31.3
80	31.24	28.23	0.00	63.09	90.35	1.000	1.000	59.48	494.23	12.03	B31.3
80	31.24	28.23	0.00	63.09	90.35	1.000	1.000	59.48	494.23	12.03	B31.3
90	31.24	56.20	0.00	63.09	115.55	1.000	1.000	87.44	494.23	12.03	B31.3
90	31.24	56.20	0.00	63.09	115.55	1.000	1.000	87.44	494.23	12.03	B31.3
100	31.24	27.98	0.00	63.09	90.12	1.000	1.000	59.22	494.23	11.98	B31.3
100	31.24	27.98	0.00	63.09	90.12	1.000	1.000	59.22	494.23	11.98	B31.3
110	31.24	56.20	0.00	63.09	115.55	1.000	1.000	87.44	494.23	12.03	B31.3
110	31.24	56.20	0.00	63.09	115.55	1.000	1.000	87.44	494.23	12.03	B31.3
120	31.24	28.23	0.00	63.09	90.35	1.000	1.000	59.48	494.23	12.03	B31.3
120	31.24	28.23	0.00	63.09	90.35	1.000	1.000	59.48	494.23	12.03	B31.3
130	31.24	55.68	0.00	63.09	115.08	1.000	1.000	86.93	494.23	17.59	B31.3
130	31.24	55.68	0.00	63.09	115.08	1.000	1.000	86.93	494.23	17.59	B31.3
140	31.24	27.40	0.00	63.09	89.60	1.000	1.000	58.64	494.23	11.86	B31.3
140	31.24	27.40	0.00	63.09	117.06	1.000	1.000	89.12	494.23	18.03	B31.3
150	31.24	57.87	0.00	63.09	117.06	1.000	1.000	89.12	494.23	18.03	B31.3

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 29, 2015 Time: 12:2
Job: C:\MASTER\CAESAR\PIPE LOADS\CASE1\508X4.78NO FRICTION
Licensed To: Seat -- ID #61

STRESSES EXTENDED REPORT: Stressess on Elements
CASE 27 (OCC) L27=L21+L3

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
160	31.24	30.69	0.00	63.09	92.56	1.000	1.000	61.94	494.23	12.53	B31.3
160	31.24	30.69	0.00	63.09	92.56	1.000	1.000	61.94	494.23	12.53	B31.3
170	31.24	49.09	0.00	63.09	109.15	1.000	1.000	80.34	494.23	16.25	B31.3
170	31.24	49.09	0.00	63.09	109.15	1.000	1.000	80.34	494.23	16.25	B31.3
180	31.24	17.54	0.00	63.09	80.71	1.000	1.000	48.78	494.23	9.87	B31.3
180	31.24	17.54	0.00	63.09	80.71	1.000	1.000	48.78	494.23	9.87	B31.3
190	31.24	84.17	0.00	63.09	140.76	1.000	1.000	115.42	494.23	23.35	B31.3
190	31.24	84.17	0.00	63.09	140.76	1.000	1.000	115.42	494.23	23.35	B31.3
200	31.24	0.00	0.00	63.09	64.91	1.000	1.000	31.24	494.23	6.32	B31.3

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: JUN 6, 2015 Time: 20:36
 Job: C:\MASTER\CAESAR\...\508X4.78WITH FRICTION-FORCED DEFLECTION
 Licensed To: Seat -- ID #61

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases

Job Description: Pipe 508x4.78

PROJECT: MASTER THESIS

CLIENT :

ANALYST: S.TVEIT

NOTES : WITH STRUCTURAL INFLUENCE, WITH FRICTION

PIPE DATA

From 1 To 10 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm. Cor= .0000 mm.

GENERAL

T1= 100 C T2= -7 C P1= 12.1000 bars PHyd= 20.0000 bars
 Mat= (338)A790 S31803 E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm.
 EH2= 196,280 N./sq.mm. EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm.
 EH5= 195,825 N./sq.mm. EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm.
 EH8= 195,825 N./sq.mm. EH9= 195,825 N./sq.mm. v = .292
 Pipe Den=8027.0000000 kg/cu.m. Fluid Den=1000.0000000 kg/cu.m.
 Insul Thk= .000 mm.

RESTRAINTS

Node 10 X
 Node 10 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch = ON	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.		

From 10 To 20 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 20 To 30 DZ= -2,500.000 mm.

GENERAL

E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm. EH2= 196,280 N./sq.mm.
 EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm. EH5= 195,825 N./sq.mm.
 EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm. EH8= 195,825 N./sq.mm.
 EH9= 195,825 N./sq.mm. v = .292 Pipe Den=8027.0000000 kg/cu.m.

RESTRAINTS

Node 30 X
 Node 30 Y Mu = .30

WIND

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: JUN 6, 2015 Time: 20:36
 Job: C:\MASTER\CAESAR\..\508X4.78WITH FRICTION-FORCED DEFLECTION
 Licensed To: Seat -- ID #61

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints Various Load Cases

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch = ON	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.		

From 30 To 40 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm.

GENERAL

Insul Thk= .000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.		

From 40 To 50 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 50 X

Node 50 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 50 To 60 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 60 To 70 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 70 X

Node 70 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: JUN 6, 2015 Time: 20:36
 Job: C:\MASTER\CAESAR\...\508X4.78WITH FRICTION-FORCED DEFLECTION
 Licensed To: Seat -- ID #61

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases

From 70 To 80 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 80 To 90 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 90 X

Node 90 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 90 To 100 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 100 To 110 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 110 X

Node 110 Y Cnode 300 Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

PIPE DATA

From 110 To 120 DZ= -2,500.000 mm.

GENERAL

DISPLACEMENTS

Node 300 DY1= -2.230 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints Various Load Cases

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 120 To 130 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 130 X
 Node 130 Y Cnode 400 Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 130 To 140 DZ= -2,500.000 mm.

GENERAL

DISPLACEMENTS

Node 400 DY1= -2.240 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 140 To 150 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 150 X
 Node 150 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 150 To 160 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 160 To 170 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 170 X
 Node 170 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints

Various Load Cases

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 170 To 180 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 180 To 190 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 190 X	
Node 190 Y	Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 190 To 200 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

LOAD CASE DEFINITION KEY

CASE 4 (OPE) W+D1+T1+P1	
CASE 5 (OPE) W+D1+T2+P1	
CASE 6 (OPE) W+D1+T1+P1+WIN1	
CASE 7 (OPE) W+D1+T1+P1-WIN1	
CASE 8 (OPE) W+D1+T1+P1+WIN2	
CASE 9 (OPE) W+D1+T1+P1-WIN2	
CASE 10 (OPE) W+D1+T1+P1+WIN3	
CASE 11 (OPE) W+D1+T1+P1-WIN3	
CASE 12 (OPE) W+D1+T2+P1+WIN1	
CASE 13 (OPE) W+D1+T2+P1-WIN1	
CASE 14 (OPE) W+D1+T2+P1+WIN2	
CASE 15 (OPE) W+D1+T2+P1-WIN2	
CASE 16 (OPE) W+D1+T2+P1+WIN3	
CASE 17 (OPE) W+D1+T2+P1-WIN3	

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
10	Rigid X; Rigid Y									
	4(OPE)	0	-13218	3965	0	0	0	0.000	-0.000	23.597
	5(OPE)	0	-13219	-3966	0	0	0	0.000	-0.000	-2.297
	6(OPE)	120251	-13218	3965	0	0	0	0.000	-0.000	23.597
	7(OPE)	-120251	-13218	3965	0	0	0	-0.000	-0.000	23.597
	8(OPE)	0	107033	32110	0	0	0	0.000	0.000	22.524
	9(OPE)	0	-133469	40041	0	0	0	0.000	-0.000	22.202
	10(OPE)	0	-13218	3965	0	0	0	0.000	-0.000	23.597
	11(OPE)	0	-13218	3965	0	0	0	0.000	-0.000	23.597
	12(OPE)	120251	-13219	-3966	0	0	0	0.000	-0.000	-2.297
	13(OPE)	-120251	-13219	-3966	0	0	0	-0.000	-0.000	-2.297
	14(OPE)	0	107033	-32110	0	0	0	0.000	0.000	-1.319
	15(OPE)	0	-133470	-40041	0	0	0	0.000	-0.000	-1.139
	16(OPE)	0	-13219	-3966	0	0	0	0.000	-0.000	-2.297
	17(OPE)	0	-13219	-3966	0	0	0	0.000	-0.000	-2.297
	MAX	120251/L6	133470/L5	40041/L5				0.000/L6	0.000/L5	23.597/L4
30	Rigid X; Rigid Y									
	4(OPE)	0	-11579	3474	0	0	0	0.000	-0.000	17.676
	5(OPE)	0	-11574	-3472	0	0	0	0.000	-0.000	-1.701
	6(OPE)	106852	-11579	3474	0	0	0	0.000	-0.000	17.676
	7(OPE)	-106852	-11579	3474	0	0	0	-0.000	-0.000	17.676
		0	95273	28582				0.000	0.000	16.688

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints

Various Load Cases

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
	8(OPE)				0	0	0			
	9(OPE)	0	-118432	35529	0	0	0	0.000	-0.000	16.406
	10(OPE)	0	-11579	3474	0	0	0	0.000	-0.000	17.676
	11(OPE)	0	-11579	3474	0	0	0	0.000	-0.000	17.676
	12(OPE)	106852	-11574	-3472	0	0	0	0.000	-0.000	-1.701
	13(OPE)	-106852	-11574	-3472	0	0	0	-0.000	-0.000	-1.701
	14(OPE)	0	95278	-28583	0	0	0	0.000	0.000	-0.819
	15(OPE)	0	-118427	-35528	0	0	0	0.000	-0.000	-0.665
	16(OPE)	0	-11574	-3472	0	0	0	0.000	-0.000	-1.701
	17(OPE)	0	-11574	-3472	0	0	0	0.000	-0.000	-1.701
	MAX	106852/L6	-118432/L9	35529/L9				0.000/L6	-0.000/L9	17.676/L4
50	Rigid X; Rigid Y									
	4(OPE)	0	-13362	4009	0	0	0	0.000	-0.000	11.767
	5(OPE)	0	-13383	-4015	0	0	0	0.000	-0.000	-1.118
	6(OPE)	116159	-13362	4009	0	0	0	0.000	-0.000	11.767
	7(OPE)	-116159	-13362	4009	0	0	0	-0.000	-0.000	11.767
	8(OPE)	0	102797	30839	0	0	0	0.000	0.000	10.952
	9(OPE)	0	-129521	38856	0	0	0	0.000	-0.000	10.735
	10(OPE)	0	-13362	4009	0	0	0	0.000	-0.000	11.767
	11(OPE)	0	-13362	4009	0	0	0	0.000	-0.000	11.767
	12(OPE)	116159	-13383	-4015	0	0	0	0.000	-0.000	-1.118

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**RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases**

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
)									
	13(OPE)	-116159	-13383	-4015	0	0	0	-0.000	-0.000	-1.118
	14(OPE)	0	102776	-30833	0	0	0	0.000	0.000	-0.415
	15(OPE)	0	-129542	-38862	0	0	0	0.000	-0.000	-0.311
	16(OPE)	0	-13383	-4015	0	0	0	0.000	-0.000	-1.118
	17(OPE)	0	-13383	-4015	0	0	0	0.000	-0.000	-1.118
	MAX	116159/L6	129542/L15	38862/L15				0.000/L6	0.000/L15	11.767/L4
70	Rigid X; Rigid Y									
	4(OPE)	0	-10020	3006	0	0	0	0.000	-0.000	5.872
	5(OPE)	0	-9936	-2981	0	0	0	0.000	-0.000	-0.547
	6(OPE)	113838	-10020	3006	0	0	0	0.000	-0.000	5.872
	7(OPE)	-113838	-10020	3006	0	0	0	-0.000	-0.000	5.872
	8(OPE)	0	103818	31145	0	0	0	0.000	0.000	5.324
	9(OPE)	0	-123858	37157	0	0	0	0.000	-0.000	5.198
	10(OPE)	0	-10020	3006	0	0	0	0.000	-0.000	5.872
	11(OPE)	0	-10020	3006	0	0	0	0.000	-0.000	5.872
	12(OPE)	113838	-9936	-2981	0	0	0	0.000	-0.000	-0.547
	13(OPE)	-113838	-9936	-2981	0	0	0	-0.000	-0.000	-0.547
	14(OPE)	0	103902	-20015	0	0	0	0.000	0.000	-0.114
	15(OPE)	0	-123773	-15363	0	0	0	0.000	-0.000	-0.088
		0	-9936	-2981				0.000	-0.000	-0.547

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints

Various Load Cases

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
	4(OPE)	0	-9736	0	0	0	0	0.000	-2.230	-5.906
	5(OPE)	0	-9639	0	0	0	0	0.000	-2.230	0.581
	6(OPE)	114384	-9736	0	0	0	0	0.000	-2.230	-5.906
	7(OPE)	-114384	-9736	0	0	0	0	-0.000	-2.230	-5.906
	8(OPE)	0	104649	0	0	0	0	0.000	-2.230	-5.803
	9(OPE)	0	-124120	0	0	0	0	0.000	-2.230	-5.742
	10(OPE)	0	-9736	0	0	0	0	0.000	-2.230	-5.906
	11(OPE)	0	-9736	0	0	0	0	0.000	-2.230	-5.906
	12(OPE)	114384	-9639	0	0	0	0	0.000	-2.230	0.581
	13(OPE)	-114384	-9639	0	0	0	0	-0.000	-2.230	0.581
	14(OPE)	0	104745	0	0	0	0	0.000	-2.230	0.421
	15(OPE)	0	-124024	0	0	0	0	0.000	-2.230	0.304
	16(OPE)	0	-9639	0	0	0	0	0.000	-2.230	0.581
	17(OPE)	0	-9639	0	0	0	0	0.000	-2.230	0.581
	MAX	114384/L6	124120/L9					0.000/L6	2.230/L9	5.906/L4
130	Rigid X; Rigid Y									
	4(OPE)	0	-9602	0	0	0	0	0.000	-2.240	-11.798
	5(OPE)	0	-9503	0	0	0	0	0.000	-2.240	1.148
	6(OPE)	113838	-9602	0	0	0	0	0.000	-2.240	-11.798
	7(OPE)	-113838	-9602	0	0	0	0	-0.000	-2.240	-11.798
	8(OPE)	0	104236	0	0	0	0	0.000	-2.240	-11.411
		0	-123440	0				0.000	-2.240	-11.275

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**RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases**

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
	9(OPE)				0	0	0			
	10(OPE)	0	-9602	0	0	0	0	0.000	-2.240	-11.798
	11(OPE)	0	-9602	0	0	0	0	0.000	-2.240	-11.798
	12(OPE)	113838	-9503	0	0	0	0	0.000	-2.240	1.148
	13(OPE)	-113838	-9503	0	0	0	0	-0.000	-2.240	1.148
	14(OPE)	0	104334	0	0	0	0	0.000	-2.240	0.724
	15(OPE)	0	-123341	0	0	0	0	0.000	-2.240	0.525
	16(OPE)	0	-9503	0	0	0	0	0.000	-2.240	1.148
	17(OPE)	0	-9503	0	0	0	0	0.000	-2.240	1.148
	MAX	113838/L6	123440/L9					0.000/L6	2.240/L9	11.798/L4
150	Rigid X; Rigid Y									
	4(OPE)	0	-17572	-5272	0	0	0	0.000	-0.000	-17.691
	5(OPE)	0	-17737	5321	0	0	0	0.000	-0.000	1.716
	6(OPE)	116159	-17572	-5272	0	0	0	0.000	-0.000	-17.691
	7(OPE)	-116159	-17572	-5272	0	0	0	-0.000	-0.000	-17.691
	8(OPE)	0	98587	-29576	0	0	0	0.000	0.000	-17.019
	9(OPE)	0	-133731	-40119	0	0	0	0.000	-0.000	-16.809
	10(OPE)	0	-17572	-5272	0	0	0	0.000	-0.000	-17.691
	11(OPE)	0	-17572	-5272	0	0	0	0.000	-0.000	-17.691
	12(OPE)	116159	-17737	5321	0	0	0	0.000	-0.000	1.716
		-116159	-17737	5321				-0.000	-0.000	1.716

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
	13(OPE)				0	0	0			
	14(OPE)	0	98422	29527	0	0	0	0.000	0.000	1.027
	15(OPE)	0	-133895	40169	0	0	0	0.000	-0.000	0.745
	16(OPE)	0	-17737	5321	0	0	0	0.000	-0.000	1.716
	17(OPE)	0	-17737	5321	0	0	0	0.000	-0.000	1.716
	MAX	116159/L6	133895/L15	40169/L15				0.000/L6	0.000/L15	17.691/L4
170	Rigid X; Rigid Y									
	4(OPE)	0	-9391	-2817	0	0	0	0.000	-0.000	-23.602
	5(OPE)	0	-9311	2793	0	0	0	0.000	-0.000	2.302
	6(OPE)	106852	-9391	-2817	0	0	0	0.000	-0.000	-23.602
	7(OPE)	-106852	-9391	-2817	0	0	0	-0.000	-0.000	-23.602
	8(OPE)	0	97462	-29239	0	0	0	0.000	0.000	-22.735
	9(OPE)	0	-116243	-34873	0	0	0	0.000	-0.000	-22.482
	10(OPE)	0	-9391	-2817	0	0	0	0.000	-0.000	-23.602
	11(OPE)	0	-9391	-2817	0	0	0	0.000	-0.000	-23.602
	12(OPE)	106852	-9311	2793	0	0	0	0.000	-0.000	2.302
	13(OPE)	-106852	-9311	2793	0	0	0	-0.000	-0.000	2.302
	14(OPE)	0	97541	29262	0	0	0	0.000	0.000	1.429
	15(OPE)	0	-116163	34849	0	0	0	0.000	-0.000	1.101
	16(OPE)	0	-9311	2793	0	0	0	0.000	-0.000	2.302

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RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
	17(OPE)	0	-9311	2793	0	0	0	0.000	-0.000	2.302
	MAX	106852/L 6	116243/L9	34873/L9				0.000/L 6	0.000/L9	23.602/L 4
190	Rigid X; Rigid Y									
	4(OPE)	0	-13568	-4070	0	0	0	0.000	-0.000	-29.523
	5(OPE)	0	-13581	4074	0	0	0	0.000	-0.000	2.897
	6(OPE)	120251	-13568	-4070	0	0	0	0.000	-0.000	-29.523
	7(OPE)	-120251	-13568	-4070	0	0	0	-0.000	-0.000	-29.523
	8(OPE)	0	106683	-32005	0	0	0	0.000	0.000	-28.557
	9(OPE)	0	-133820	-40146	0	0	0	0.000	-0.000	-28.278
	10(OPE)	0	-13568	-4070	0	0	0	0.000	-0.000	-29.523
	11(OPE)	0	-13568	-4070	0	0	0	0.000	-0.000	-29.523
	12(OPE)	120251	-13581	4074	0	0	0	0.000	-0.000	2.897
	13(OPE)	-120251	-13581	4074	0	0	0	-0.000	-0.000	2.897
	14(OPE)	0	106670	32001	0	0	0	0.000	0.000	1.930
	15(OPE)	0	-133832	40150	0	0	0	0.000	-0.000	1.575
	16(OPE)	0	-13581	4074	0	0	0	0.000	-0.000	2.897
	17(OPE)	0	-13581	4074	0	0	0	0.000	-0.000	2.897
	MAX	120251/L 6	133832/L1 5	40150/L1 5				0.000/L 6	0.000/L1 5	29.523/L 4
300	Displ. Reaction									
	4(OPE)	0	-9736	0	0	0	0	0.000	-2.230	-5.906

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: JUN 6, 2015 Time: 20:36
 Job: C:\MASTER\CAESAR\...\508X4.78WITH FRICTION-FORCED DEFLECTION
 Licensed To: Seat -- ID #61

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
	5(OPE)	0	-9639	0	0	0	0	0.000	-2.230	0.581
	6(OPE)	0	-9736	0	0	0	0	0.000	-2.230	-5.906
	7(OPE)	0	-9736	0	0	0	0	-0.000	-2.230	-5.906
	8(OPE)	0	104649	0	0	0	0	0.000	-2.230	-5.803
	9(OPE)	0	-124120	0	0	0	0	0.000	-2.230	-5.742
	10(OPE)	0	-9736	0	0	0	0	0.000	-2.230	-5.906
	11(OPE)	0	-9736	0	0	0	0	0.000	-2.230	-5.906
	12(OPE)	0	-9639	0	0	0	0	0.000	-2.230	0.581
	13(OPE)	0	-9639	0	0	0	0	-0.000	-2.230	0.581
	14(OPE)	0	104745	0	0	0	0	0.000	-2.230	0.421
	15(OPE)	0	-124024	0	0	0	0	0.000	-2.230	0.304
	16(OPE)	0	-9639	0	0	0	0	0.000	-2.230	0.581
	17(OPE)	0	-9639	0	0	0	0	0.000	-2.230	0.581
	MAX		124120/L9					0.000/L6	2.230/L9	5.906/L4
400	Displ. Reaction									
	4(OPE)	0	-9602	0	0	0	0	0.000	-2.240	-11.798
	5(OPE)	0	-9503	0	0	0	0	0.000	-2.240	1.148
	6(OPE)	0	-9602	0	0	0	0	0.000	-2.240	-11.798
	7(OPE)	0	-9602	0	0	0	0	-0.000	-2.240	-11.798
	8(OPE)	0	104236	0	0	0	0	0.000	-2.240	-11.411
	9(OPE)	0	-123440	0	0	0	0	0.000	-2.240	-11.275
		0	-9602	0				0.000	-2.240	-11.798

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Licensed To: Seat -- ID #61

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints

Various Load Cases

NOD E	Load Case	FX N.	FY N.	FZ N.	MX N.m	MY N.m	MZ N.m	DX mm.	DY mm.	DZ mm.
	10(OPE)				0	0	0			
	11(OPE)	0	-9602	0	0	0	0	0.000	-2.240	-11.798
	12(OPE)	0	-9503	0	0	0	0	0.000	-2.240	1.148
	13(OPE)	0	-9503	0	0	0	0	-0.000	-2.240	1.148
	14(OPE)	0	104334	0	0	0	0	0.000	-2.240	0.724
	15(OPE)	0	-123341	0	0	0	0	0.000	-2.240	0.525
	16(OPE)	0	-9503	0	0	0	0	0.000	-2.240	1.148
	17(OPE)	0	-9503	0	0	0	0	0.000	-2.240	1.148
	MAX		-123440/L9					0.000/L 6	-2.240/L 9	-11.798/L 4

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Job: C:\MASTER\CAESAR\...\508X4.78WITH FRICTION-FORCED DEFLECTION

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DISPLACEMENTS REPORT: Nodal Movements

CASE 4 (OPE) W+D1+T1+P1

NODE	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
1	0.000	-0.509	26.564	0.0131	0.0000	0.0000
10	0.000	-0.000	23.597	0.0048	0.0000	0.0000
20	0.000	-0.055	20.636	-0.0007	0.0000	0.0000
30	0.000	-0.000	17.676	-0.0010	0.0000	0.0000
40	0.000	-0.122	14.721	0.0003	0.0000	0.0000
50	0.000	-0.000	11.767	-0.0006	0.0000	0.0000
60	0.000	-0.165	8.819	-0.0006	0.0000	0.0000
70	0.000	-0.000	5.872	0.0037	0.0000	0.0000
80	0.000	0.085	2.929	0.0022	0.0000	0.0000
90	0.000	-0.000	-0.013	-0.0149	0.0000	0.0000
100	0.000	-1.177	-2.959	-0.0287	0.0000	0.0000
110	0.000	-2.230	-5.906	-0.0201	0.0000	0.0000
120	0.000	-2.791	-8.852	-0.0002	0.0000	0.0000
130	0.000	-2.240	-11.798	0.0200	0.0000	0.0000
140	0.000	-1.181	-14.745	0.0289	0.0000	0.0000
150	0.000	-0.000	-17.691	0.0148	0.0000	0.0000
160	0.000	0.074	-20.646	-0.0024	0.0000	0.0000
170	0.000	-0.000	-23.602	-0.0028	0.0000	0.0000
180	0.000	-0.115	-26.562	0.0011	0.0000	0.0000
190	0.000	-0.000	-29.523	-0.0031	0.0000	0.0000
200	0.000	-0.431	-32.490	-0.0113	0.0000	0.0000
300	0.000	-2.230	-5.906	0.0000	0.0000	0.0000
400	0.000	-2.240	-11.798	0.0000	0.0000	0.0000

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DISPLACEMENTS REPORT: Nodal Movements
CASE 9 (OPE) W+D1+T1+P1-WIN2

NODE	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
1	0.000	-5.190	25.169	0.1332	0.0000	0.0000
10	0.000	-0.000	22.202	0.0499	0.0000	0.0000
20	0.000	-0.517	19.304	-0.0073	0.0000	0.0000
30	0.000	-0.000	16.406	-0.0123	0.0000	0.0000
40	0.000	-1.353	13.570	0.0020	0.0000	0.0000
50	0.000	-0.000	10.735	0.0022	0.0000	0.0000
60	0.000	-1.203	7.966	-0.0010	0.0000	0.0000
70	0.000	-0.000	5.198	0.0029	0.0000	0.0000
80	0.000	-1.002	2.495	0.0023	0.0000	0.0000
90	0.000	-0.000	-0.208	-0.0147	0.0000	0.0000
100	0.000	-2.249	-2.975	-0.0287	0.0000	0.0000
110	0.000	-2.230	-5.742	-0.0203	0.0000	0.0000
120	0.000	-3.878	-8.509	-0.0002	0.0000	0.0000
130	0.000	-2.240	-11.275	0.0208	0.0000	0.0000
140	0.000	-2.219	-14.042	0.0293	0.0000	0.0000
150	0.000	-0.000	-16.809	0.0120	0.0000	0.0000
160	0.000	-1.157	-19.646	-0.0040	0.0000	0.0000
170	0.000	-0.000	-22.482	0.0085	0.0000	0.0000
180	0.000	-0.578	-25.380	0.0077	0.0000	0.0000
190	0.000	-0.000	-28.278	-0.0481	0.0000	0.0000
200	0.000	-5.113	-31.245	-0.1315	0.0000	0.0000
300	0.000	-2.230	-5.742	0.0000	0.0000	0.0000
400	0.000	-2.240	-11.275	0.0000	0.0000	0.0000

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: JUN 6, 2015 Time: 20:42

Job: C:\MASTER\CAESAR\PI...\508X4.78NO FRICTION-FORCED DEFLECTION

Licensed To: Seat -- ID #61

Job Description: Pipe 508x4.78

PROJECT: MASTER THESIS

CLIENT :

ANALYST: S.TVEIT

NOTES : WITH STRUCTURAL INFLUENCE, NO FRICTION

PIPE DATA

From 1 To 10 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm. Cor= .0000 mm.

GENERAL

T1= 100 C T2= -7 C P1= 12.1000 bars PHyd= 20.0000 bars
 Mat= (338)A790 S31803 E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm.
 EH2= 196,280 N./sq.mm. EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm.
 EH5= 195,825 N./sq.mm. EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm.
 EH8= 195,825 N./sq.mm. EH9= 195,825 N./sq.mm. v = .292
 Pipe Den=8027.0000000 kg/cu.m. Fluid Den=1000.0000000 kg/cu.m.

Insul Thk= .000 mm.

RESTRAINTS

Node 10 X

Node 10 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
 Sy= 395 N./sq.mm.

From 10 To 20 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 20 To 30 DZ= -2,500.000 mm.

GENERAL

E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm. EH2= 196,280 N./sq.mm.
 EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm. EH5= 195,825 N./sq.mm.
 EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm. EH8= 195,825 N./sq.mm.
 EH9= 195,825 N./sq.mm. v = .292 Pipe Den=8027.0000000 kg/cu.m.

RESTRAINTS

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Node 30 X
Node 30 Y
WIND
Wind Shape= 1.000
ALLOWABLE STRESSES
B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

From 30 To 40 DZ= -2,500.000 mm.

PIPE
Dia= 508.000 mm. Wall= 4.780 mm.

GENERAL
Insul Thk= .000 mm.

WIND
Wind Shape= 1.000
ALLOWABLE STRESSES
B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

From 40 To 50 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 50 X
Node 50 Y

WIND
Wind Shape= 1.000
ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 50 To 60 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000
ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 60 To 70 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 70 X
Node 70 Y

WIND

Wind Shape= 1.000

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 Job: C:\MASTER\CAESAR\PI...\508X4.78NO FRICTION-FORCED DEFLECTION
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ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 70 To 80 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 80 To 90 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 90 X

Node 90 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 90 To 100 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 100 To 110 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 110 X

Node 110 Y Cnode 300

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

PIPE DATA

From 110 To 120 DZ= -2,500.000 mm.

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GENERAL

DISPLACEMENTS

Node 300 DY1= -2.230 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 120 To 130 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 130 X

Node 130 Y Cnode 400

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 130 To 140 DZ= -2,500.000 mm.

GENERAL

DISPLACEMENTS

Node 400 DY1= -2.240 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 140 To 150 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 150 X

Node 150 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 150 To 160 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
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Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 160 To 170 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 170 X
Node 170 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 170 To 180 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 180 To 190 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 190 X
Node 190 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 190 To 200 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

LOAD CASE DEFINITION KEY

CASE 1 (HYD) WW+HP
CASE 2 (SUS) WNC
CASE 3 (SUS) W+P1
CASE 18 (OCC) L18=L6-L4
CASE 19 (OCC) L19=L7-L4
CASE 20 (OCC) L20=L8-L4
CASE 21 (OCC) L21=L9-L4
CASE 22 (OCC) L22=L10-L4
CASE 23 (OCC) L23=L11-L4
CASE 24 (OCC) L24=L18+L3
CASE 25 (OCC) L25=L19+L3
CASE 26 (OCC) L26=L20+L3
CASE 27 (OCC) L27=L21+L3
CASE 28 (OCC) L28=L22+L3
CASE 29 (OCC) L29=L23+L3
CASE 30 (EXP) L30=L4-L3
CASE 31 (EXP) L31=L5-L3

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 1 (HYD) WW+HP

Highest Stresses: (N./sq.mm.) LOADCASE 1 (HYD) WW+HP
CodeStress Ratio (%): 15.2 @Node 10
Code Stress: 60.0 Allowable: 395.0
Axial Stress: 51.6 @Node 10
Bending Stress: 8.3 @Node 10
Torsion Stress: 0.0 @Node 10
Hoop Stress: 104.3 @Node 10
3D Max Intensity: 107.3 @Node 10

CODE STRESS CHECK PASSED : LOADCASE 2 (SUS) WNC

Highest Stresses: (N./sq.mm.) LOADCASE 2 (SUS) WNC
CodeStress Ratio (%): 1.0 @Node 10
Code Stress: 2.0 Allowable: 205.9
Axial Stress: 0.0 @Node 10
Bending Stress: 2.0 @Node 10
Torsion Stress: 0.0 @Node 10
Hoop Stress: 0.0 @Node 10
3D Max Intensity: 2.0 @Node 10

CODE STRESS CHECK PASSED : LOADCASE 3 (SUS) W+P1

Highest Stresses: (N./sq.mm.) LOADCASE 3 (SUS) W+P1
CodeStress Ratio (%): 19.2 @Node 10
Code Stress: 39.6 Allowable: 205.9
Axial Stress: 31.2 @Node 10
Bending Stress: 8.3 @Node 10

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 Job: C:\MASTER\CAESARPI...\508X4.78NO FRICTION-FORCED DEFLECTION
 Licensed To: Seat -- ID #61

STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	64.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 18 (OCC) L18=L6-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 18 (OCC)	L18=L6-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 19 (OCC) L19=L7-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 19 (OCC)	L19=L7-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 20 (OCC) L20=L8-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 20 (OCC)	L20=L8-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 21 (OCC) L21=L9-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 21 (OCC)	L21=L9-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 22 (OCC) L22=L10-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 22 (OCC)	L22=L10-L4	
CodeStress Ratio (%):	0.0	@Node	10
Code Stress:	0.0	Allowable:	494.2

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

Axial Stress:	0.0	@Node	10
Bending Stress:	0.0	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 23 (OCC) L23=L11-L4

Highest Stresses: (N./sq.mm.) LOADCASE 23 (OCC) L23=L11-L4			
CodeStress Ratio (%):	0.0	@Node	10
Code Stress:	0.0	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	0.0	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 24 (OCC) L24=L18+L3

Highest Stresses: (N./sq.mm.) LOADCASE 24 (OCC) L24=L18+L3			
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 25 (OCC) L25=L19+L3

Highest Stresses: (N./sq.mm.) LOADCASE 25 (OCC) L25=L19+L3			
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 26 (OCC) L26=L20+L3

Highest Stresses: (N./sq.mm.) LOADCASE 26 (OCC) L26=L20+L3			
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 27 (OCC) L27=L21+L3

Highest Stresses: (N./sq.mm.) LOADCASE 27 (OCC) L27=L21+L3

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

CodeStress Ratio (%) :	23.4	@Node	10	
Code Stress:	115.4	Allowable:	494.2	
Axial Stress:	31.2	@Node	10	
Bending Stress:	84.2	@Node	10	
Torsion Stress:	0.0	@Node	10	
Hoop Stress:	63.1	@Node	10	
3D Max Intensity:	140.8	@Node	10	

CODE STRESS CHECK PASSED : LOADCASE 28 (OCC) L28=L22+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 28 (OCC)	L28=L22+L3		
CodeStress Ratio (%) :	8.0	@Node	10	
Code Stress:	39.6	Allowable:	494.2	
Axial Stress:	31.2	@Node	10	
Bending Stress:	8.3	@Node	10	
Torsion Stress:	0.0	@Node	10	
Hoop Stress:	63.1	@Node	10	
3D Max Intensity:	64.9	@Node	10	

CODE STRESS CHECK PASSED : LOADCASE 29 (OCC) L29=L23+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 29 (OCC)	L29=L23+L3		
CodeStress Ratio (%) :	8.0	@Node	10	
Code Stress:	39.6	Allowable:	494.2	
Axial Stress:	31.2	@Node	10	
Bending Stress:	8.3	@Node	10	
Torsion Stress:	0.0	@Node	10	
Hoop Stress:	63.1	@Node	10	
3D Max Intensity:	64.9	@Node	10	

CODE STRESS CHECK PASSED : LOADCASE 30 (EXP) L30=L4-L3

Highest Stresses: (N./sq.mm.)	LOADCASE 30 (EXP)	L30=L4-L3		
CodeStress Ratio (%) :	1.8	@Node	150	
Code Stress:	8.4	Allowable:	479.0	
Axial Stress:	0.0	@Node	140	
Bending Stress:	8.4	@Node	150	
Torsion Stress:	0.0	@Node	10	
Hoop Stress:	0.0	@Node	10	
3D Max Intensity:	8.4	@Node	150	

CODE STRESS CHECK PASSED : LOADCASE 31 (EXP) L31=L5-L3

Highest Stresses: (N./sq.mm.)	LOADCASE 31 (EXP)	L31=L5-L3		
CodeStress Ratio (%) :	1.8	@Node	150	
Code Stress:	8.7	Allowable:	480.1	
Axial Stress:	0.0	@Node	150	
Bending Stress:	8.7	@Node	150	
Torsion Stress:	0.0	@Node	10	
Hoop Stress:	0.0	@Node	10	
3D Max Intensity:	8.7	@Node	150	

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STRESSES EXTENDED REPORT: Stresses on Elements
CASE 31 (EXP) L31=L5-L3

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 31 (EXP) L31=L5-L3

Highest Stresses: (N./sq.mm.)
 Code Stress Ratio (%): 1.8 @Node 150
 Code Stress: 8.7 Allowable: 480.1
 Axial Stress: 0.0 @Node 150
 Bending Stress: 8.7 @Node 150
 Torsion Stress: 0.0 @Node 10
 Hoop Stress: 0.0 @Node 10
 3D Max Intensity: 8.7 @Node 150

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
1	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	485.85	0.00	B31.3
10	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	477.53	0.00	B31.3
10	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	477.53	0.00	B31.3
20	-0.00	0.06	0.00	0.00	0.06	1.000	1.000	0.06	484.12	0.01	B31.3
20	-0.00	0.06	0.00	0.00	0.06	1.000	1.000	0.06	484.12	0.01	B31.3
30	-0.00	0.13	0.00	0.00	0.13	1.000	1.000	0.13	481.00	0.03	B31.3
30	-0.00	0.13	0.00	0.00	0.13	1.000	1.000	0.13	481.00	0.03	B31.3
40	-0.00	0.21	0.00	0.00	0.21	1.000	1.000	0.21	482.82	0.04	B31.3
40	0.00	0.21	0.00	0.00	0.21	1.000	1.000	0.21	482.82	0.04	B31.3
50	0.00	0.54	0.00	0.00	0.54	1.000	1.000	0.54	480.13	0.11	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 31 (EXP) L31=L5-L3

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
50	-0.00	0.54	0.00	0.00	0.54	1.000	1.000	0.54	480.13	0.11	B31.3
60	-0.00	0.82	0.00	0.00	0.82	1.000	1.000	0.82	483.14	0.17	B31.3
60	0.00	0.82	0.00	0.00	0.82	1.000	1.000	0.82	483.14	0.17	B31.3
70	0.00	2.17	0.00	0.00	2.17	1.000	1.000	2.17	480.35	0.45	B31.3
70	-0.00	2.17	0.00	0.00	2.17	1.000	1.000	2.17	480.35	0.45	B31.3
80	-0.00	3.25	0.00	0.00	3.25	1.000	1.000	3.25	483.06	0.67	B31.3
80	0.00	3.25	0.00	0.00	3.25	1.000	1.000	3.25	483.06	0.67	B31.3
90	0.00	8.68	0.00	0.00	8.68	1.000	1.000	8.68	480.29	1.81	B31.3
90	0.00	8.68	0.00	0.00	8.68	1.000	1.000	8.68	480.29	1.81	B31.3
100	0.00	0.89	0.00	0.00	0.89	1.000	1.000	0.89	483.09	0.18	B31.3
100	0.00	0.89	0.00	0.00	0.89	1.000	1.000	0.89	483.09	0.18	B31.3
110	0.00	6.90	0.00	0.00	6.90	1.000	1.000	6.90	480.29	1.44	B31.3
110	-0.00	6.90	0.00	0.00	6.90	1.000	1.000	6.90	480.29	1.44	B31.3
120	-0.00	6.96	0.00	0.00	6.96	1.000	1.000	6.96	483.06	1.44	B31.3
120	0.00	6.96	0.00	0.00	6.96	1.000	1.000	6.96	483.06	1.44	B31.3
130	0.00	7.03	0.00	0.00	7.03	1.000	1.000	7.03	480.35	1.46	B31.3
130	-0.00	7.03	0.00	0.00	7.03	1.000	1.000	7.03	480.35	1.46	B31.3
140	0.00	0.84	0.00	0.00	0.84	1.000	1.000	0.84	483.14	0.17	B31.3
150	0.00	8.71	0.00	0.00	8.71	1.000	1.000	8.71	480.13	1.81	B31.3
150	-0.00	8.71	0.00	0.00	8.71	1.000	1.000	8.71	480.13	1.81	B31.3

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Licensed To: Seat -- ID #61

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 31 (EXP) L31=L5-L3

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
160	-0.00	3.33	0.00	0.00	3.33	1.000	1.000	3.33	482.82	0.69	B31.3
160	0.00	3.33	0.00	0.00	3.33	1.000	1.000	3.33	482.82	0.69	B31.3
170	0.00	2.05	0.00	0.00	2.05	1.000	1.000	2.05	481.00	0.43	B31.3
170	-0.00	2.05	0.00	0.00	2.05	1.000	1.000	2.05	481.00	0.43	B31.3
180	-0.00	1.03	0.00	0.00	1.03	1.000	1.000	1.03	484.12	0.21	B31.3
180	0.00	1.03	0.00	0.00	1.03	1.000	1.000	1.03	484.12	0.21	B31.3
190	0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	477.53	0.00	B31.3
190	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	477.53	0.00	B31.3
200	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	485.85	0.00	B31.3

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Job: C:\MASTER\CAE...\508X4.78WITH FRICTION-FORCED DEFLECTION.MAX
Licensed To: Seat -- ID #61

Job Description: Pipe 508x4.78

PROJECT: MASTER THESIS

CLIENT :

ANALYST: S.TVEIT

NOTES : WITH STRUCTURAL INFLUENCE, MAX DEFLECTION, WITH FRICTION

PIPE DATA

From 1 To 10 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm. Cor= .0000 mm.

GENERAL

T1= 100 C T2= -7 C P1= 12.1000 bars PHyd= 20.0000 bars
Mat= (338)A790 S31803 E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm.
EH2= 196,280 N./sq.mm. EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm.
EH5= 195,825 N./sq.mm. EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm.
EH8= 195,825 N./sq.mm. EH9= 195,825 N./sq.mm. v = .292
Pipe Den=8027.0000000 kg/cu.m. Fluid Den=1000.0000000 kg/cu.m.
Insul Thk= .000 mm.

RESTRAINTS

Node 10 X
Node 10 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

From 10 To 20 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 20 To 30 DZ= -2,500.000 mm.

GENERAL

E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm. EH2= 196,280 N./sq.mm.
EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm. EH5= 195,825 N./sq.mm.
EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm. EH8= 195,825 N./sq.mm.
EH9= 195,825 N./sq.mm. v = .292 Pipe Den=8027.0000000 kg/cu.m.

RESTRAINTS

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Node 30 X
 Node 30 Y Mu = .30
WIND
 Wind Shape= 1.000
ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
 Sy= 395 N./sq.mm.

From 30 To 40 DZ= -2,500.000 mm.

PIPE
 Dia= 508.000 mm. Wall= 4.780 mm.

GENERAL
 Insul Thk= .000 mm.

WIND
 Wind Shape= 1.000
ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
 Sy= 395 N./sq.mm.

From 40 To 50 DZ= -2,500.000 mm.

GENERAL
RESTRAINTS

Node 50 X
 Node 50 Y Mu = .30

WIND
 Wind Shape= 1.000

ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 50 To 60 DZ= -2,500.000 mm.

GENERAL
WIND

Wind Shape= 1.000

ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 60 To 70 DZ= -2,500.000 mm.

GENERAL
RESTRAINTS

Node 70 X
 Node 70 Y Mu = .30

WIND
 Wind Shape= 1.000

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ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 70 To 80 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 80 To 90 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 90 X

Node 90 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 90 To 100 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 100 To 110 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 110 X

Node 110 Y Cnode 300 Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

PIPE DATA

From 110 To 120 DZ= -2,500.000 mm.

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 18:41
Job: C:\MASTER\CAE...\508X4.78WITH FRICTION-FORCED DEFLECTION.MAX
Licensed To: Seat -- ID #61

GENERAL

DISPLACEMENTS

Node 300 DY1= -24.000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 120 To 130 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 130 X
Node 130 Y Cnode 400 Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 130 To 140 DZ= -2,500.000 mm.

GENERAL

DISPLACEMENTS

Node 400 DY1= -24.000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 140 To 150 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 150 X
Node 150 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 150 To 160 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

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Licensed To: Seat -- ID #61

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 160 To 170 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 170 X
Node 170 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 170 To 180 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 180 To 190 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 190 X
Node 190 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 190 To 200 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

LOAD CASE DEFINITION KEY

CASE 4 (OPE) W+D1+T1+P1
 CASE 5 (OPE) W+D1+T2+P1
 CASE 6 (OPE) W+D1+T1+P1+WIN1
 CASE 7 (OPE) W+D1+T1+P1-WIN1
 CASE 8 (OPE) W+D1+T1+P1+WIN2
 CASE 9 (OPE) W+D1+T1+P1-WIN2
 CASE 10 (OPE) W+D1+T1+P1+WIN3
 CASE 11 (OPE) W+D1+T1+P1-WIN3
 CASE 12 (OPE) W+D1+T2+P1+WIN1
 CASE 13 (OPE) W+D1+T2+P1-WIN1
 CASE 14 (OPE) W+D1+T2+P1+WIN2
 CASE 15 (OPE) W+D1+T2+P1-WIN2
 CASE 16 (OPE) W+D1+T2+P1+WIN3
 CASE 17 (OPE) W+D1+T2+P1-WIN3

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
10		Rigid X: Rigid Y:								
	4(OPE)	0	-13445	4034	0	0	0	0.000	-0.000	23.700
	5(OPE)	0	-13454	-4036	0	0	0	0.000	-0.000	-2.395
	6(OPE)	120251	-13445	4034	0	0	0	0.000	-0.000	23.700
	7(OPE)	-120251	-13445	4034	0	0	0	-0.000	-0.000	23.700
	8(OPE)	0	106806	32042	0	0	0	0.000	0.000	17.323
	9(OPE)	0	-133696	40109	0	0	0	0.000	-0.000	22.298
	10(OPE)	0	-13445	4034	0	0	0	0.000	-0.000	23.700
	11(OPE)	0	-13445	4034	0	0	0	0.000	-0.000	23.700
	12(OPE)	120251	-13454	-4036	0	0	0	0.000	-0.000	-2.395
	13(OPE)	-120251	-13454	-4036	0	0	0	-0.000	-0.000	-2.395
	14(OPE)	0	106798	-32039	0	0	0	0.000	0.000	-1.247
	15(OPE)	0	-133705	-40112	0	0	0	0.000	-0.000	-1.148
	16(OPE)	0	-13454	-4036	0	0	0	0.000	-0.000	-2.395
	17(OPE)	0	-13454	-4036	0	0	0	0.000	-0.000	-2.395
	MAX		-					0.000/L6	-	-

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
		120251/L6	133705/L15	40112/L15					0.0000/L15	23.700/L4
30	Rigid X; Rigid Y									
4(OPE)	0	-10160	3048	0	0	0	0	0.000	-0.000	17.778
5(OPE)	0	-10106	-3032	0	0	0	0	0.000	-0.000	-1.799
6(OPE)	106852	-10160	3048	0	0	0	0	0.000	-0.000	17.778
7(OPE)	-106852	-10160	3048	0	0	0	0	-0.000	-0.000	17.778
8(OPE)	0	96693	29008	0	0	0	0	0.000	0.000	11.494
9(OPE)	0	-117012	35104	0	0	0	0	0.000	0.000	16.503
10(OPE)	0	-10160	3048	0	0	0	0	0.000	0.000	17.778
11(OPE)	0	-10160	3048	0	0	0	0	0.000	-0.000	17.778
12(OPE)	106852	-10106	-3032	0	0	0	0	0.000	-0.000	-1.799
13(OPE)	-106852	-10106	-3032	0	0	0	0	-0.000	-0.000	-1.799
14(OPE)	0	96746	-29024	0	0	0	0	0.000	0.000	-0.746
15(OPE)	0	-116959	-35088	0	0	0	0	0.000	-0.000	-0.675
16(OPE)	0	-10106	-3032	0	0	0	0	0.000	-0.000	-1.799
17(OPE)	0	-10106	-3032	0	0	0	0	0.000	-0.000	-1.799
MAX	106852/L6	117012/L9	35104/L9					0.0000/L6	-0.0000/L9	17.778/L4
50	Rigid X; Rigid Y									
4(OPE)	0	-19388	5816	0	0	0	0	0.000	-0.000	11.866
5(OPE)	0	-19614	-5884	0	0	0	0	0.000	-0.000	-1.212
6(OPE)	116159	-19388	5816	0	0	0	0	0.000	-0.000	11.866
7(OPE)	-116159	-19388	5816	0	0	0	0	-0.000	-0.000	11.866
8(OPE)	0	96771	29031	0	0	0	0	0.000	0.000	5.763
9(OPE)	0	-135546	40664	0	0	0	0	0.000	-0.000	10.830
10(OPE)	0	-19388	5816	0	0	0	0	0.000	-0.000	11.866
11(OPE)	0	-19388	5816	0	0	0	0	0.000	-0.000	11.866
12(OPE)	116159	-19614	-5884	0	0	0	0	0.000	-0.000	-1.212
13(OPE)	-116159	-19614	-5884	0	0	0	0	-0.000	-0.000	-1.212
14(OPE)	0	96544	-28963	0	0	0	0	0.000	0.000	-0.343

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
	15(OPE)	0	-135773	-40732	0	0	0	0.000	-0.000	-0.319
	16(OPE)	0	-19614	-5884	0	0	0	0.000	-0.000	-1.212
	17(OPE)	0	-19614	-5884	0	0	0	0.000	-0.000	-1.212
	MAX	116159/L6	135773/L15	40732/L15				0.000/L6	0.000/L15	11.866/L4
70										
Rigid X; Rigid Y										
	4(OPE)	0	14141	4242	0	0	0	0.000	0.000	5.973
	5(OPE)	0	15051	-4515	0	0	0	0.000	0.000	-0.645
	6(OPE)	113838	14141	4242	0	0	0	0.000	0.000	5.973
	7(OPE)	-113838	14141	4242	0	0	0	-0.000	0.000	5.973
	8(OPE)	0	127979	21595	0	0	0	0.000	0.000	0.123
	9(OPE)	0	-99697	29909	0	0	0	0.000	-0.000	5.299
	10(OPE)	0	14141	4242	0	0	0	0.000	0.000	5.973
	11(OPE)	0	14141	4242	0	0	0	0.000	0.000	5.973
	12(OPE)	113838	15051	-4515	0	0	0	0.000	0.000	-0.645
	13(OPE)	-113838	15051	-4515	0	0	0	-0.000	0.000	-0.645
	14(OPE)	0	128889	-6589	0	0	0	0.000	0.000	-0.038
	15(OPE)	0	-98787	-17762	0	0	0	0.000	-0.000	-0.101
	16(OPE)	0	15051	-4515	0	0	0	0.000	0.000	-0.645
	17(OPE)	0	15051	-4515	0	0	0	0.000	0.000	-0.645
	MAX	113838/L12	128889/L14	29909/L9				0.000/L6	0.000/L14	5.973/L4
90										
Rigid X; Rigid Y										
	4(OPE)	0	-64526	16237	0	0	0	0.000	-0.000	0.093
	5(OPE)	0	-66302	-15798	0	0	0	0.000	-0.000	-0.090
	6(OPE)	114384	-64526	16237	0	0	0	0.000	-0.000	0.093
	7(OPE)	-114384	-64526	16237	0	0	0	-0.000	-0.000	0.093
	8(OPE)	0	49858	-14957	0	0	0	0.000	0.000	-5.441
	9(OPE)	0	-178911	-22333	0	0	0	0.000	-0.000	-0.128
	10(OPE)	0	-64526	16237	0	0	0	0.000	-0.000	0.093

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
11(OPE)	0	-64526	16237	0	0	0	0	0.000	-0.000	0.093
12(OPE)	114384	-66302	-15798	0	0	0	0	0.000	-0.000	-0.090
13(OPE)	-114384	-66302	-15798	0	0	0	0	-0.000	-0.000	-0.090
14(OPE)	0	48082	14425	0	0	0	0	0.000	0.000	0.245
15(OPE)	0	-180687	9926	0	0	0	0	0.000	-0.000	0.057
16(OPE)	0	-66302	-15798	0	0	0	0	0.000	-0.000	-0.090
17(OPE)	0	-66302	-15798	0	0	0	0	0.000	-0.000	-0.090
MAX	114384/L6	180687/L15	22333/L9	"	"	"	"	0.000/L6	0.000/L15	-5.441/L8
<hr/>										
110	Rigid X; Rigid Y									
4(OPE)	0	18141	0	0	0	0	0	0.000	-24.000	-5.731
5(OPE)	0	19190	0	0	0	0	0	0.000	-24.000	0.411
6(OPE)	114384	18141	0	0	0	0	0	0.000	-24.000	-5.731
7(OPE)	-114384	18141	0	0	0	0	0	-0.000	-24.000	-5.731
8(OPE)	0	132526	0	0	0	0	0	0.000	-24.000	-11.058
9(OPE)	0	-96243	0	0	0	0	0	0.000	-24.000	-5.632
10(OPE)	0	18141	0	0	0	0	0	0.000	-24.000	-5.731
11(OPE)	0	18141	0	0	0	0	0	0.000	-24.000	-5.731
12(OPE)	114384	19190	0	0	0	0	0	0.000	-24.000	0.411
13(OPE)	-114384	19190	0	0	0	0	0	-0.000	-24.000	0.411
14(OPE)	0	133574	0	0	0	0	0	0.000	-24.000	0.577
15(OPE)	0	-95194	0	0	0	0	0	0.000	-24.000	0.248
16(OPE)	0	19190	0	0	0	0	0	0.000	-24.000	0.411
17(OPE)	0	19190	0	0	0	0	0	0.000	-24.000	0.411
MAX	114384/L6	133574/L14	"	"	"	"	"	0.000/L6	24.000/L9	11.058/L8
<hr/>										
130	Rigid X; Rigid Y									
4(OPE)	0	18071	0	0	0	0	0	0.000	-24.000	-11.554
5(OPE)	0	19115	0	0	0	0	0	0.000	-24.000	0.912
6(OPE)	113838	18071	0	0	0	0	0	0.000	-24.000	-11.554

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints Various Load Cases

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
	Rigid Y									
4(OPE)	0	13243	-3973	0	0	0	0	0.000	0.000	-23.279
5(OPE)	0	14096	4229	0	0	0	0	0.000	0.000	1.989
6(OPE)	106852	13243	-3973	0	0	0	0	0.000	0.000	-23.279
7(OPE)	-106852	13243	-3973	0	0	0	0	0.000	0.000	-23.279
8(OPE)	0	120096	-36029	0	0	0	0	0.000	0.000	-27.971
9(OPE)	0	-93609	-28083	0	0	0	0	0.000	0.000	-22.335
10(OPE)	0	13243	-3973	0	0	0	0	0.000	0.000	-23.279
11(OPE)	0	13243	-3973	0	0	0	0	0.000	0.000	-23.279
12(OPE)	106852	14096	4229	0	0	0	0	0.000	0.000	1.989
13(OPE)	-106852	14096	4229	0	0	0	0	-0.000	0.000	1.989
14(OPE)	0	120949	36285	0	0	0	0	0.000	0.000	1.623
15(OPE)	0	-92756	27827	0	0	0	0	0.000	-0.000	1.007
16(OPE)	0	14096	4229	0	0	0	0	0.000	0.000	1.989
17(OPE)	0	14096	4229	0	0	0	0	0.000	0.000	1.989
MAX	106852/L6	120949/L14	36285/L14					0.000/L6	0.000/L14	27.971/L8
190	Rigid X:									
	Rigid Y									
4(OPE)	0	-17193	-5158	0	0	0	0	0.000	-0.000	-29.196
5(OPE)	0	-17329	5199	0	0	0	0	0.000	-0.000	2.580
6(OPE)	120251	-17193	-5158	0	0	0	0	0.000	-0.000	-29.196
7(OPE)	-120251	-17193	-5158	0	0	0	0	-0.000	-0.000	-29.196
8(OPE)	0	103059	-30918	0	0	0	0	0.000	0.000	-33.780
9(OPE)	0	-137444	-41233	0	0	0	0	-0.000	-0.000	-28.126
10(OPE)	0	-17193	-5158	0	0	0	0	0.000	-0.000	-29.196
11(OPE)	0	-17193	-5158	0	0	0	0	0.000	-0.000	-29.196
12(OPE)	120251	-17329	5199	0	0	0	0	0.000	-0.000	2.580
13(OPE)	-120251	-17329	5199	0	0	0	0	-0.000	-0.000	2.580
14(OPE)	0	102922	30877	0	0	0	0	0.000	0.000	2.128
15(OPE)	0	-137580	41274	0	0	0	0	-0.000	-0.000	1.477
16(OPE)	0	-17329	5199	0	0	0	0	-0.000	-0.000	2.580
17(OPE)	0	-17329	5199	0	0	0	0	-0.000	-0.000	2.580

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
	MAX	120251/L6	137580/L15	41274/L15				0.000/L6	0.000/L15	-33.780/L8
300	Displ. Reaction									
4(OPE)	0	18141	0	0	0	0	0	-24.000	-5.731	
5(OPE)	0	19190	0	0	0	0	0	-24.000	0.411	
6(OPE)	0	18141	0	0	0	0	0	-24.000	-5.731	
7(OPE)	0	18141	0	0	0	0	0	-24.000	-5.731	
8(OPE)	0	132526	0	0	0	0	0	-24.000	-5.731	
9(OPE)	0	-96243	0	0	0	0	0	-24.000	-11.058	
10(OPE)	0	18141	0	0	0	0	0	-24.000	-5.632	
11(OPE)	0	18141	0	0	0	0	0	-24.000	-5.731	
12(OPE)	0	19190	0	0	0	0	0	-24.000	0.411	
13(OPE)	0	19190	0	0	0	0	0	-24.000	0.411	
14(OPE)	0	133574	0	0	0	0	0	-24.000	0.577	
15(OPE)	0	-95194	0	0	0	0	0	-24.000	0.248	
16(OPE)	0	19190	0	0	0	0	0	-24.000	0.411	
17(OPE)	0	19190	0	0	0	0	0	-24.000	0.411	
MAX		133574/L14					0.000/L6	24.000/L4	11.058/L8	
400	Displ. Reaction									
4(OPE)	0	18071	0	0	0	0	0	-24.000	-11.554	
5(OPE)	0	19115	0	0	0	0	0	-24.000	0.912	
6(OPE)	0	18071	0	0	0	0	0	-24.000	-11.554	
7(OPE)	0	18071	0	0	0	0	0	-24.000	-11.554	
8(OPE)	0	131909	0	0	0	0	0	-24.000	-16.676	
9(OPE)	0	-95767	0	0	0	0	0	-24.000	-11.137	
10(OPE)	0	18071	0	0	0	0	0	-24.000	-11.554	
11(OPE)	0	18071	0	0	0	0	0	-24.000	-11.554	
12(OPE)	0	19115	0	0	0	0	0	-24.000	0.912	
13(OPE)	0	19115	0	0	0	0	-0.000	-24.000	0.912	

AESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 18:41
Job: C:\MASTER\CAE...\508X4.78WITH FRICTION-FORCED DEFLECTION.MAX
Licensed To: Seat -- ID #61

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
	14(OPE)	0	132953	0	0	0	0	0.000	-24.000	0.909
	15(OPE)	0	-94722	0	0	0	0	0.000	-24.000	0.440
	16(OPE)	0	19115	0	0	0	0	0.000	-24.000	0.912
	17(OPE)	0	19115	0	0	0	0	0.000	-24.000	0.912
	MAX		132953/L14					0.000/L6	24.000/L4	16.676/L8

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 Job: C:\MASTER\CAE...\508X4.78WITH FRICTION-FORCED DEFLECTION.MAX
 Licensed To: Seat -- ID #61

DISPLACEMENTS REPORT: Nodal Movements
 CASE 4 (OPE) W+D1+T1+P1

NODE	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
1	0.000	-0.458	26.667	0.0119	0.0000	0.0000
10	0.000	-0.000	23.700	0.0037	0.0000	0.0000
20	0.000	-0.094	20.739	-0.0010	0.0000	0.0000
30	0.000	-0.000	17.778	0.0014	0.0000	0.0000
40	0.000	0.005	14.822	0.0016	0.0000	0.0000
50	0.000	-0.000	11.866	-0.0098	0.0000	0.0000
60	0.000	-0.665	8.919	-0.0059	0.0000	0.0000
70	0.000	0.000	5.973	0.0403	0.0000	0.0000
80	0.000	2.079	3.033	0.0236	0.0000	0.0000
90	0.000	-0.000	0.093	-0.1611	0.0000	0.0000
100	0.000	-11.531	-2.819	-0.3090	0.0000	0.0000
110	0.000	-24.000	-5.731	-0.2150	0.0000	0.0000
120	0.000	-28.807	-8.642	0.0000	0.0000	0.0000
130	0.000	-24.000	-11.554	0.2149	0.0000	0.0000
140	0.000	-11.536	-14.466	0.3090	0.0000	0.0000
150	0.000	-0.000	-17.377	0.1615	0.0000	0.0000
160	0.000	2.097	-20.328	-0.0234	0.0000	0.0000
170	0.000	0.000	-23.279	-0.0416	0.0000	0.0000
180	0.000	-0.739	-26.238	0.0052	0.0000	0.0000
190	0.000	-0.000	-29.196	0.0153	0.0000	0.0000
200	0.000	0.368	-32.164	0.0070	0.0000	0.0000
300	0.000	-24.000	-5.731	0.0000	0.0000	0.0000
400	0.000	-24.000	-11.554	0.0000	0.0000	0.0000

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DISPLACEMENTS REPORT: Nodal Movements
 CASE 9 (OPE) W+D1+T1+P1-WIN2

NODE	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
1	0.000	-5.140	25.266	0.1321	0.0000	0.0000
10	0.000	-0.000	22.298	0.0487	0.0000	0.0000
20	0.000	-0.556	19.401	-0.0076	0.0000	0.0000
30	0.000	-0.000	16.503	-0.0098	0.0000	0.0000
40	0.000	-1.226	13.667	0.0033	0.0000	0.0000
50	0.000	-0.000	10.830	-0.0070	0.0000	0.0000
60	0.000	-1.703	8.065	-0.0064	0.0000	0.0000
70	0.000	-0.000	5.299	0.0396	0.0000	0.0000
80	0.000	0.992	2.586	0.0237	0.0000	0.0000
90	0.000	-0.000	-0.128	-0.1609	0.0000	0.0000
100	0.000	-12.603	-2.880	-0.3090	0.0000	0.0000
110	0.000	-24.000	-5.632	-0.2152	0.0000	0.0000
120	0.000	-29.894	-8.384	-0.0001	0.0000	0.0000
130	0.000	-24.000	-11.137	0.2156	0.0000	0.0000
140	0.000	-12.574	-13.889	0.3094	0.0000	0.0000
150	0.000	-0.000	-16.641	0.1587	0.0000	0.0000
160	0.000	0.867	-19.488	-0.0251	0.0000	0.0000
170	0.000	-0.000	-22.335	-0.0304	0.0000	0.0000
180	0.000	-1.201	-25.230	0.0118	0.0000	0.0000
190	0.000	-0.000	-28.126	-0.0298	0.0000	0.0000
200	0.000	-4.314	-31.094	-0.1132	0.0000	0.0000
300	0.000	-24.000	-5.632	0.0000	0.0000	0.0000
400	0.000	-24.000	-11.137	0.0000	0.0000	0.0000

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Job Description: Pipe 508x4.78

PROJECT: MASTER THESIS

CLIENT :

ANALYST: S.TVEIT

NOTES : WITH STRUCTURAL INFLUENCE, MAX DEFLECTION, NO FRICTION

PIPE DATA

From 1 To 10 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm. Cor= .0000 mm.

GENERAL

T1= 100 C T2= -7 C P1= 12.1000 bars PHyd= 20.0000 bars

Mat= (338)A790 S31803 E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm.

EH2= 196,280 N./sq.mm. EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm.

EH5= 195,825 N./sq.mm. EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm.

EH8= 195,825 N./sq.mm. EH9= 195,825 N./sq.mm. v = .292

Pipe Den=8027.0000000 kg/cu.m. Fluid Den=1000.0000000 kg/cu.m.

Insul Thk= .000 mm.

RESTRAINTS

Node 10 X

Node 10 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

Sy= 395 N./sq.mm.

From 10 To 20 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 20 To 30 DZ= -2,500.000 mm.

GENERAL

E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm. EH2= 196,280 N./sq.mm.

EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm. EH5= 195,825 N./sq.mm.

EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm. EH8= 195,825 N./sq.mm.

EH9= 195,825 N./sq.mm. v = .292 Pipe Den=8027.0000000 kg/cu.m.

RESTRAINTS

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Node 30 X
Node 30 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch = ON	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.		

From 30 To 40 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm.

GENERAL

Insul Thk= .000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.		

From 40 To 50 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 50 X
Node 50 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 50 To 60 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 60 To 70 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 70 X
Node 70 Y

WIND

Wind Shape= 1.000

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ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 70 To 80 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 80 To 90 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 90 X

Node 90 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 90 To 100 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 100 To 110 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 110 X

Node 110 Y Cnode 300

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

PIPE DATA

From 110 To 120 DZ= -2,500.000 mm.

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GENERAL

DISPLACEMENTS

Node 300 DY1= -24.000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 120 To 130 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 130 X

Node 130 Y Cnode 400

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 130 To 140 DZ= -2,500.000 mm.

GENERAL

DISPLACEMENTS

Node 400 DY1= -24.000 mm.

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 140 To 150 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 150 X

Node 150 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 150 To 160 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

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Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 160 To 170 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 170 X
Node 170 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 170 To 180 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 180 To 190 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 190 X
Node 190 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 190 To 200 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

LOAD CASE DEFINITION KEY

CASE 1 (HYD) WW+HP
 CASE 2 (SUS) WNC
 CASE 3 (SUS) W+P1
 CASE 18 (OCC) L18=L6-L4
 CASE 19 (OCC) L19=L7-L4
 CASE 20 (OCC) L20=L8-L4
 CASE 21 (OCC) L21=L9-L4
 CASE 22 (OCC) L22=L10-L4
 CASE 23 (OCC) L23=L11-L4
 CASE 24 (OCC) L24=L18+L3
 CASE 25 (OCC) L25=L19+L3
 CASE 26 (OCC) L26=L20+L3
 CASE 27 (OCC) L27=L21+L3
 CASE 28 (OCC) L28=L22+L3
 CASE 29 (OCC) L29=L23+L3
 CASE 30 (EXP) L30=L4-L3
 CASE 31 (EXP) L31=L5-L3

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 1 (HYD) WW+HP

Highest Stresses: (N./sq.mm.) LOADCASE 1 (HYD) WW+HP
 CodeStress Ratio (%): 15.2 @Node 10
 Code Stress: 60.0 Allowable: 395.0
 Axial Stress: 51.6 @Node 10
 Bending Stress: 8.3 @Node 10
 Torsion Stress: 0.0 @Node 10
 Hoop Stress: 104.3 @Node 10
 3D Max Intensity: 107.3 @Node 10

CODE STRESS CHECK PASSED : LOADCASE 2 (SUS) WNC

Highest Stresses: (N./sq.mm.) LOADCASE 2 (SUS) WNC
 CodeStress Ratio (%): 1.0 @Node 10
 Code Stress: 2.0 Allowable: 205.9
 Axial Stress: 0.0 @Node 10
 Bending Stress: 2.0 @Node 10
 Torsion Stress: 0.0 @Node 10
 Hoop Stress: 0.0 @Node 10
 3D Max Intensity: 2.0 @Node 10

CODE STRESS CHECK PASSED : LOADCASE 3 (SUS) W+P1

Highest Stresses: (N./sq.mm.) LOADCASE 3 (SUS) W+P1
 CodeStress Ratio (%): 19.2 @Node 10
 Code Stress: 39.6 Allowable: 205.9
 Axial Stress: 31.2 @Node 10
 Bending Stress: 8.3 @Node 10

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	64.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 18 (OCC) L18=L6-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 18 (OCC)	L18=L6-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 19 (OCC) L19=L7-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 19 (OCC)	L19=L7-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 20 (OCC) L20=L8-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 20 (OCC)	L20=L8-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 21 (OCC) L21=L9-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 21 (OCC)	L21=L9-L4	
CodeStress Ratio (%):	15.3	@Node	10
Code Stress:	75.9	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	75.9	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	75.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 22 (OCC) L22=L10-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 22 (OCC)	L22=L10-L4	
CodeStress Ratio (%):	0.0	@Node	10
Code Stress:	0.0	Allowable:	494.2

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

Axial Stress:	0.0	@Node	10
Bending Stress:	0.0	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 23 (OCC) L23=L11-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 23 (OCC)	L23=L11-L4	
CodeStress Ratio (%):	0.0	@Node	10
Code Stress:	0.0	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	0.0	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 24 (OCC) L24=L18+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 24 (OCC)	L24=L18+L3	
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 25 (OCC) L25=L19+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 25 (OCC)	L25=L19+L3	
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 26 (OCC) L26=L20+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 26 (OCC)	L26=L20+L3	
CodeStress Ratio (%):	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 27 (OCC) L27=L21+L3

Highest Stresses: (N./sq.mm.) LOADCASE 27 (OCC) L27=L21+L3

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

CodeStress Ratio (%) :	23.4	@Node	10
Code Stress:	115.4	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	84.2	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	140.8	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 28 (OCC) L28=L22+L3

Highest Stresses: (N./sq.mm.) LOADCASE 28 (OCC) L28=L22+L3			
CodeStress Ratio (%) :	8.0	@Node	10
Code Stress:	39.6	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	8.3	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	64.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 29 (OCC) L29=L23+L3

Highest Stresses: (N./sq.mm.) LOADCASE 29 (OCC) L29=L23+L3			
CodeStress Ratio (%) :	8.0	@Node	10
Code Stress:	39.6	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	8.3	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	64.9	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 30 (EXP) L30=L4-L3

Highest Stresses: (N./sq.mm.) LOADCASE 30 (EXP) L30=L4-L3			
CodeStress Ratio (%) :	18.9	@Node	90
Code Stress:	90.5	Allowable:	479.2
Axial Stress:	0.0	@Node	140
Bending Stress:	90.5	@Node	90
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	90.5	@Node	90

CODE STRESS CHECK PASSED : LOADCASE 31 (EXP) L31=L5-L3

Highest Stresses: (N./sq.mm.) LOADCASE 31 (EXP) L31=L5-L3			
CodeStress Ratio (%) :	19.5	@Node	90
Code Stress:	93.6	Allowable:	480.3
Axial Stress:	0.0	@Node	150
Bending Stress:	93.6	@Node	90
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	93.6	@Node	90

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 31 (EXP) L31=L5-L3

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 31 (EXP) L31=L5-L3

Highest Stresses: (N./sq.mm.)		Code Stress Ratio (%) :		Code Stress: (N./sq.mm.)		Axial Stress: (N./sq.mm.)		Bending Stress: (N./sq.mm.)		Torsion Stress: (N./sq.mm.)		Hoop Stress: (N./sq.mm.)		3D Max Intensity:	
1	-0.00	0.00	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6
10	-0.00	0.00	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6
10	-0.00	0.00	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6
20	-0.00	0.69	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6
20	-0.00	0.69	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6
30	-0.00	1.38	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6
40	-0.00	2.23	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6
40	0.00	2.23	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6
50	0.00	5.84	19.5	@Node 90	93.6	Allowable: 480.3	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	93.6

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
1	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	485.85	0.00	B31.3
10	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	477.53	0.00	B31.3
10	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	477.53	0.00	B31.3
20	-0.00	0.69	0.00	0.69	1.000	1.000	1.000	0.69	484.12	0.14	B31.3
20	-0.00	0.69	0.00	0.69	1.000	1.000	1.000	0.69	484.12	0.14	B31.3
30	-0.00	1.38	0.00	1.38	1.000	1.000	1.000	1.38	481.00	0.29	B31.3
30	-0.00	1.38	0.00	1.38	1.000	1.000	1.000	1.38	481.00	0.29	B31.3
40	-0.00	2.23	0.00	2.23	1.000	1.000	1.000	2.23	482.82	0.46	B31.3
40	0.00	2.23	0.00	2.23	1.000	1.000	1.000	2.23	482.82	0.46	B31.3
50	0.00	5.84	0.00	5.84	1.000	1.000	1.000	5.84	480.13	1.22	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 31 (EXP) L31=L5-L3

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
50	-0.00	5.84	0.00	0.00	5.84	1.000	1.000	5.84	480.13	1.22	B31.3
60	-0.00	8.79	0.00	0.00	8.79	1.000	1.000	8.79	483.14	1.82	B31.3
60	0.00	8.79	0.00	0.00	8.79	1.000	1.000	8.79	483.14	1.82	B31.3
70	0.00	23.41	0.00	0.00	23.41	1.000	1.000	23.41	480.35	4.87	B31.3
70	-0.00	23.41	0.00	0.00	23.41	1.000	1.000	23.41	480.35	4.87	B31.3
80	-0.00	35.07	0.00	0.00	35.07	1.000	1.000	35.07	483.06	7.26	B31.3
80	0.00	35.07	0.00	0.00	35.07	1.000	1.000	35.07	483.06	7.26	B31.3
90	0.00	93.55	0.00	0.00	93.55	1.000	1.000	93.55	480.29	19.48	B31.3
90	0.00	93.55	0.00	0.00	93.55	1.000	1.000	93.55	483.06	7.26	B31.3
100	0.00	9.36	0.00	0.00	9.36	1.000	1.000	9.36	483.09	1.94	B31.3
110	0.00	74.84	0.00	0.00	74.84	1.000	1.000	74.84	480.29	15.58	B31.3
110	-0.00	74.84	0.00	0.00	74.84	1.000	1.000	74.84	483.09	1.94	B31.3
120	-0.00	74.79	0.00	0.00	74.79	1.000	1.000	74.79	483.06	15.48	B31.3
120	0.00	74.79	0.00	0.00	74.79	1.000	1.000	74.79	483.06	15.48	B31.3
130	0.00	74.73	0.00	0.00	74.73	1.000	1.000	74.73	480.35	15.56	B31.3
130	-0.00	74.73	0.00	0.00	74.73	1.000	1.000	74.73	480.35	15.56	B31.3
140	0.00	9.23	0.00	0.00	9.23	1.000	1.000	9.23	483.14	1.91	B31.3
150	0.00	93.18	0.00	0.00	93.18	1.000	1.000	93.18	480.13	19.41	B31.3
150	-0.00	93.18	0.00	0.00	93.18	1.000	1.000	93.18	480.13	19.41	B31.3

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STRESSES EXTENDED REPORT: Stresses on Elements
CASE 31 (EXP) L31=L5-L3

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
160	-0.00	35.62	0.00	0.00	35.62	1.000	1.000	35.62	482.82	7.38	B31.3
160	0.00	35.62	0.00	0.00	35.62	1.000	1.000	35.62	482.82	7.38	B31.3
170	0.00	21.95	0.00	0.00	21.95	1.000	1.000	21.95	481.00	4.56	B31.3
170	-0.00	21.95	0.00	0.00	21.95	1.000	1.000	21.95	481.00	4.56	B31.3
180	-0.00	10.98	0.00	0.00	10.98	1.000	1.000	10.98	484.12	2.27	B31.3
180	0.00	10.98	0.00	0.00	10.98	1.000	1.000	10.98	484.12	2.27	B31.3
190	0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	477.53	0.00	B31.3
190	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	477.53	0.00	B31.3
200	-0.00	0.00	0.00	0.00	0.00	1.000	1.000	0.00	485.85	0.00	B31.3

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Job: C:\MASTER\CAESAR\PI...\508X4.78WITH FRICTION-FAILING SUPPORT
Licensed To: Seat -- ID #61

Job Description: Pipe 508x4.78

PROJECT: MASTER THESIS

CLIENT :

ANALYST: S.TVEIT

NOTES : FAILING SUPPORT IN NODE 110 AND 130, WITH FRICTION

PIPE DATA

From 1 To 10 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm. Cor= .0000 mm.

GENERAL

T1= 100 C T2= -7 C P1= 12.1000 bars PHyd= 20.0000 bars

Mat= (338)A790 S31803 E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm.

EH2= 196,280 N./sq.mm. EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm.

EH5= 195,825 N./sq.mm. EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm.

EH8= 195,825 N./sq.mm. EH9= 195,825 N./sq.mm. v = .292

Pipe Den=8027.0000000 kg/cu.m. Fluid Den=1000.0000000 kg/cu.m.

Insul Thk= .000 mm.

RESTRAINTS

Node 10 X

Node 10 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

Sy= 395 N./sq.mm.

From 10 To 20 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 20 To 30 DZ= -2,500.000 mm.

GENERAL

E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm. EH2= 196,280 N./sq.mm.

EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm. EH5= 195,825 N./sq.mm.

EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm. EH8= 195,825 N./sq.mm.

EH9= 195,825 N./sq.mm. v = .292 Pipe Den=8027.0000000 kg/cu.m.

RESTRAINTS

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Node 30 X
 Node 30 Y Mu = .30
 WIND
 Wind Shape= 1.000
 ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
 Sy= 395 N./sq.mm.

From 30 To 40 DZ= -2,500.000 mm.

PIPE
 Dia= 508.000 mm. Wall= 4.780 mm.

GENERAL
 Insul Thk= .000 mm.

WIND
 Wind Shape= 1.000
 ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
 Sy= 395 N./sq.mm.

From 40 To 50 DZ= -2,500.000 mm.

GENERAL
 RESTRAINTS

Node 50 X
 Node 50 Y Mu = .30

WIND
 Wind Shape= 1.000

ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 50 To 60 DZ= -2,500.000 mm.

GENERAL
 WIND

Wind Shape= 1.000

ALLOWABLE STRESSES
 B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
 Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
 Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
 Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 60 To 70 DZ= -2,500.000 mm.

GENERAL
 RESTRAINTS

Node 70 X
 Node 70 Y Mu = .30

WIND
 Wind Shape= 1.000

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ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 70 To 80 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 80 To 90 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 90 X

Node 90 Y Mu = .30

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 90 To 100 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 100 To 110 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 110 To 120 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

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PIPE DATA

Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 120 To 130 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 130 To 140 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 140 To 150 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 150 X		
Node 150 Y	Mu = .30	

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 150 To 160 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 160 To 170 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 170 X		
Node 170 Y	Mu = .30	

WIND

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: JUN 1, 2015 Time: 7:58
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Licensed To: Seat -- ID #61

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 170 To 180 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 180 To 190 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 190 X		
Node 190 Y	Mu = .30	

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 190 To 200 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints Various Load Cases

LOAD CASE DEFINITION KEY

CASE 4	(OPE)	W+T1+P1
CASE 5	(OPE)	W+T2+P1
CASE 6	(OPE)	W+T1+P1+WIN1
CASE 7	(OPE)	W+T1+P1-WIN1
CASE 8	(OPE)	W+T1+P1+WIN2
CASE 9	(OPE)	W+T1+P1-WIN2
CASE 10	(OPE)	W+T1+P1+WIN3
CASE 11	(OPE)	W+T1+P1-WIN3
CASE 12	(OPE)	W+T2+P1+WIN1
CASE 13	(OPE)	W+T2+P1-WIN1
CASE 14	(OPE)	W+T2+P1+WIN2
CASE 15	(OPE)	W+T2+P1-WIN2
CASE 16	(OPE)	W+T2+P1+WIN3
CASE 17	(OPE)	W+T2+P1-WIN3

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
10		Rigid X; Rigid Y								
	4(OPE)	0	-13297	3989	0	0	0	0.000	-0.000	23.631
	5(OPE)	0	-13297	-3989	0	0	0	0.000	-0.000	-2.330
	6(OPE)	121185	-13297	3989	0	0	0	0.000	-0.000	23.631
	7(OPE)	-121185	-13297	3989	0	0	0	-0.000	-0.000	23.631
	8(OPE)	0	107888	32366	0	0	0	0.000	0.000	22.852
	9(OPE)	0	-134482	40345	0	0	0	0.000	-0.000	22.633
	10(OPE)	0	-13297	3989	0	0	0	0.000	-0.000	23.631
	11(OPE)	0	-13297	3989	0	0	0	0.000	-0.000	23.631
	12(OPE)	121185	-13297	-3989	0	0	0	0.000	-0.000	-2.330
	13(OPE)	-121185	-13297	-3989	0	0	0	-0.000	-0.000	-2.330
	14(OPE)	0	107888	-32366	0	0	0	0.000	0.000	-1.580
	15(OPE)	0	-134482	-40345	0	0	0	0.000	-0.000	-1.250
	16(OPE)	0	-13297	-3989	0	0	0	0.000	-0.000	-2.330
	17(OPE)	0	-13297	-3989	0	0	0	0.000	-0.000	-2.330
	MAX		-					0.000/L6	-0.000/L9	

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
		121185/L6	134482/L9	40345/L9						23.631/L4
30	Rigid X; Rigid Y									
4(OPE)	0	-11085	3325	0	0	0	0	0.000	-0.000	17.709
5(OPE)	0	-11085	-3325	0	0	0	0	0.000	-0.000	-1.734
6(OPE)	101023	-11085	3325	0	0	0	0	0.000	-0.000	17.709
7(OPE)	-101023	-11085	3325	0	0	0	0	-0.000	-0.000	17.709
8(OPE)	0	89938	26981	0	0	0	0	0.000	0.000	17.030
9(OPE)	0	-112107	33632	0	0	0	0	0.000	-0.000	16.838
10(OPE)	0	-11085	3325	0	0	0	0	-0.000	-0.000	17.709
11(OPE)	0	-11085	3325	0	0	0	0	-0.000	-0.000	17.709
12(OPE)	101023	-11085	-3325	0	0	0	0	0.000	-0.000	-1.734
13(OPE)	-101023	-11085	-3325	0	0	0	0	-0.000	-0.000	-1.734
14(OPE)	0	89938	-26981	0	0	0	0	0.000	0.000	-1.081
15(OPE)	0	-112107	-33632	0	0	0	0	0.000	-0.000	-0.777
16(OPE)	0	-11085	-3325	0	0	0	0	0.000	-0.000	-1.734
17(OPE)	0	-11085	-3325	0	0	0	0	-0.000	-0.000	-1.734
MAX	101023/L6	112107/L9	33632/L9					0.000/L6	-0.000/L9	17.709/L4
50	Rigid X; Rigid Y									
4(OPE)	0	-15461	4638	0	0	0	0	0.000	-0.000	11.800
5(OPE)	0	-15461	-4638	0	0	0	0	0.000	-0.000	-1.150
6(OPE)	140907	-15461	4638	0	0	0	0	0.000	-0.000	11.800
7(OPE)	-140907	-15461	4638	0	0	0	0	-0.000	-0.000	11.800
8(OPE)	0	125446	37634	0	0	0	0	0.000	0.000	11.301
9(OPE)	0	-156368	46910	0	0	0	0	0.000	-0.000	11.161
10(OPE)	0	-15461	4638	0	0	0	0	0.000	-0.000	11.800
11(OPE)	0	-15461	4638	0	0	0	0	0.000	-0.000	11.800
12(OPE)	140907	-15461	-4638	0	0	0	0	-0.000	-0.000	-1.150
13(OPE)	-140907	-15461	-4638	0	0	0	0	-0.000	-0.000	-1.150
14(OPE)	0	125446	-37634	0	0	0	0	0.000	0.000	-0.672

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
15(OPE)	0	-156368	0	-46910	0	0	0	0.000	-0.000	-0.418
16(OPE)	0	-15461	0	-4638	0	0	0	0.000	-0.000	-1.150
17(OPE)	0	-15461	0	-4638	0	0	0	0.000	-0.000	-1.150
MAX	140907/L6	156368/L9	46910/L9					0.000/L6	-0.000/L9	11.800/L4
70										
Rigid X;										
Rigid Y										
4(OPE)	0	-1603	481	0	0	0	0	0.000	-0.000	5.907
5(OPE)	0	-1603	-481	0	0	0	0	0.000	-0.000	-0.582
6(OPE)	14605	-1603	481	0	0	0	0	0.000	-0.000	5.907
7(OPE)	-14605	-1603	-481	0	0	0	0	-0.000	-0.000	5.907
8(OPE)	0	13003	3901	0	0	0	0	0.000	0.000	5.705
9(OPE)	0	-16208	4862	0	0	0	0	0.000	-0.000	5.648
10(OPE)	0	-1603	481	0	0	0	0	0.000	-0.000	5.907
11(OPE)	0	-1603	-481	0	0	0	0	0.000	-0.000	5.907
12(OPE)	14605	-1603	-481	0	0	0	0	0.000	-0.000	-0.582
13(OPE)	-14605	-1603	-481	0	0	0	0	-0.000	-0.000	-0.582
14(OPE)	0	13003	-3901	0	0	0	0	0.000	0.000	-0.390
15(OPE)	0	-16208	-4862	0	0	0	0	0.000	-0.000	-0.217
16(OPE)	0	-1603	-481	0	0	0	0	0.000	-0.000	-0.582
17(OPE)	0	-1603	-481	0	0	0	0	0.000	-0.000	-0.582
MAX	14605/L6	16208/L9		4862/L9				0.000/L6	-	5.907/L4
90										
Rigid X;										
Rigid Y										
4(OPE)	0	-33801	2616	0	0	0	0	0.000	-0.000	0.015
5(OPE)	0	-33801	-2616	0	0	0	0	0.000	-0.000	-0.015
6(OPE)	308054	-33801	2616	0	0	0	0	0.000	-0.000	0.015
7(OPE)	-308054	-33801	2616	0	0	0	0	-0.000	-0.000	0.015
8(OPE)	0	274253	21227	0	0	0	0	0.000	0.000	0.121
9(OPE)	0	-341855	26459	0	0	0	0	0.000	-0.000	0.151
10(OPE)	0	-33801	2616	0	0	0	0	0.000	-0.000	0.015

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
11(OPE)	0	-33801	2616	0	0	0	0	-0.000	0.015	
12(OPE)	308054	-33801	-2616	0	0	0	0	-0.000	-0.015	
13(OPE)	-308054	-33801	-2616	0	0	0	-0.000	-0.000	-0.015	
14(OPE)	0	274253	-21227	0	0	0	0	0.000	-0.121	
15(OPE)	0	-341855	-5563	0	0	0	0	-0.000	-0.032	
16(OPE)	0	-33801	-2616	0	0	0	0	-0.000	-0.015	
17(OPE)	0	-33801	-2616	0	0	0	0	-0.000	-0.015	
MAX	308054/L6	341855/L9	26459/L9					0.000/L6	-0.000/L9	0.151/L9
150										
Rigid X; Rigid Y										
4(OPE)	0	-33819	-10146	0	0	0	0	0.000	-17.633	
5(OPE)	0	-33819	10146	0	0	0	0	0.000	1.659	
6(OPE)	308217	-33819	-10146	0	0	0	0	-0.000	-17.633	
7(OPE)	-308217	-33819	10146	0	0	0	0	-0.000	-17.633	
8(OPE)	0	274397	-82319	0	0	0	0	0.000	-16.407	
9(OPE)	0	-342036	-102611	0	0	0	0	-0.000	-16.062	
10(OPE)	0	-33819	-10146	0	0	0	0	-0.000	-17.633	
11(OPE)	0	-33819	-10146	0	0	0	0	-0.000	-17.633	
12(OPE)	308216	-33819	10146	0	0	0	0	0.000	1.659	
13(OPE)	-308216	-33819	10146	0	0	0	-0.000	-0.000	1.659	
14(OPE)	0	274397	82319	0	0	0	0	0.000	0.470	
15(OPE)	0	-342036	81715	0	0	0	0	-0.000	0.467	
16(OPE)	0	-33819	10146	0	0	0	0	-0.000	1.659	
17(OPE)	0	-33819	10146	0	0	0	0	-0.000	1.659	
MAX	308217/L6	342036/L9	-					0.000/L6	-0.000/L9	17.633/L4
170										
Rigid X; Rigid Y										
4(OPE)	0	-1518	-455	0	0	0	0	0.000	-0.000	-23.551
5(OPE)	0	-1518	455	0	0	0	0	0.000	-0.000	2.252
6(OPE)	13833	-1518	-455	0	0	0	0	-0.000	-0.000	-23.551

RESTRAINT SUMMARY EXTENDED REPORT: Loads On Restraints
 Various Load Cases

NODE	Load Case	FX N.	FY N.	FZ N.	MX N.m.	MY N.m.	MZ N.m.	DX mm.	DY mm.	DZ mm.
7(OPE)	-13833	-1518	-455	0	0	0	0	-0.000	-0.000	-23.551
8(OPE)	0	12315	-3695	0	0	0	0	0.000	0.000	-22.203
9(OPE)	0	-15351	-4605	0	0	0	0	0.000	0.000	-21.824
10(OPE)	0	-1518	-455	0	0	0	0	0.000	0.000	-23.551
11(OPE)	0	-1518	-455	0	0	0	0	0.000	0.000	-23.551
12(OPE)	13833	-1518	455	0	0	0	0	0.000	0.000	2.252
13(OPE)	-13833	-1518	455	0	0	0	0	-0.000	-0.000	2.252
14(OPE)	0	12315	3695	0	0	0	0	0.000	0.000	0.945
15(OPE)	0	-15351	4605	0	0	0	0	0.000	0.000	0.908
16(OPE)	0	-1518	455	0	0	0	0	0.000	0.000	2.252
17(OPE)	0	-1518	455	0	0	0	0	0.000	0.000	2.252
MAX	13833/L6	15351/L9	-4605/L9				0.000/L6	-0.000/L9	-0.000/L9	23.551/L4
190	Rigid X; Rigid Y									
4(OPE)	0	-14829	-4449	0	0	0	0	0.000	0.000	-29.470
5(OPE)	0	-14829	4449	0	0	0	0	0.000	0.000	2.845
6(OPE)	135146	-14829	-4449	0	0	0	0	0.000	0.000	-29.470
7(OPE)	-135146	-14829	-4449	0	0	0	0	-0.000	-0.000	-29.470
8(OPE)	0	120317	-36095	0	0	0	0	0.000	0.000	-28.012
9(OPE)	0	-149975	-44992	0	0	0	0	0.000	0.000	-27.602
10(OPE)	0	-14829	-4449	0	0	0	0	0.000	0.000	-29.470
11(OPE)	0	-14829	-4449	0	0	0	0	0.000	0.000	-29.470
12(OPE)	135146	-14829	4449	0	0	0	0	0.000	0.000	2.845
13(OPE)	-135146	-14829	4449	0	0	0	0	-0.000	-0.000	2.845
14(OPE)	0	120317	36095	0	0	0	0	0.000	0.000	1.432
15(OPE)	0	-149975	44992	0	0	0	0	0.000	0.000	1.365
16(OPE)	0	-14829	4449	0	0	0	0	0.000	0.000	2.845
17(OPE)	0	-14829	4449	0	0	0	0	-0.000	-0.000	2.845
MAX	135146/L6	149975/L9	-44992/L9				0.000/L6	-0.000/L9	-0.000/L9	29.470/L4

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: JUN 1, 2015 Time: 7:58

Job: C:\MASTER\CAESAR\PI...\508X4.78WITH FRICTION-FAILING SUPPORT

Licensed To: Seat -- ID #61

DISPLACEMENTS REPORT: Nodal Movements

CASE 4 (OPE) W+T1+P1

NODE	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
1	0.000	-0.491	26.598	0.0127	0.0000	0.0000
10	0.000	-0.000	23.631	0.0044	0.0000	0.0000
20	0.000	-0.068	20.670	-0.0008	0.0000	0.0000
30	0.000	-0.000	17.709	-0.0001	0.0000	0.0000
40	0.000	-0.078	14.755	0.0008	0.0000	0.0000
50	0.000	-0.000	11.800	-0.0038	0.0000	0.0000
60	0.000	-0.339	8.853	-0.0025	0.0000	0.0000
70	0.000	-0.000	5.907	0.0164	0.0000	0.0000
80	0.000	0.779	2.961	0.0097	0.0000	0.0000
90	0.000	-0.000	0.015	-0.0659	0.0000	0.0000
100	0.000	-4.784	-2.926	-0.1263	0.0000	0.0000
110	0.000	-9.812	-5.868	-0.0879	0.0000	0.0000
120	0.000	-11.847	-8.809	0.0000	0.0000	0.0000
130	0.000	-9.811	-11.750	0.0879	0.0000	0.0000
140	0.000	-4.783	-14.691	0.1263	0.0000	0.0000
150	0.000	-0.000	-17.633	0.0658	0.0000	0.0000
160	0.000	0.778	-20.592	-0.0097	0.0000	0.0000
170	0.000	-0.000	-23.551	-0.0163	0.0000	0.0000
180	0.000	-0.332	-26.510	0.0025	0.0000	0.0000
190	0.000	-0.000	-29.470	0.0033	0.0000	0.0000
200	0.000	-0.153	-32.438	-0.0049	0.0000	0.0000

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: JUN 1, 2015 Time: 7:58

Job: C:\MASTER\CAESAR\PI...\508X4.78WITH FRICTION-FAILING SUPPORT

Licensed To: Seat -- ID #61

DISPLACEMENTS REPORT: Nodal Movements

CASE 9 (OPE) W+T1+P1-WIN2

NODE	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
1	0.000	-4.967	25.600	0.1281	0.0000	0.0000
10	0.000	-0.000	22.633	0.0448	0.0000	0.0000
20	0.000	-0.692	19.736	-0.0085	0.0000	0.0000
30	0.000	-0.000	16.838	-0.0014	0.0000	0.0000
40	0.000	-0.787	14.000	0.0079	0.0000	0.0000
50	0.000	-0.000	11.161	-0.0388	0.0000	0.0000
60	0.000	-3.430	8.405	-0.0249	0.0000	0.0000
70	0.000	-0.000	5.648	0.1661	0.0000	0.0000
80	0.000	7.883	2.899	0.0977	0.0000	0.0000
90	0.000	-0.000	0.151	-0.6662	0.0000	0.0000
100	0.000	-48.384	-2.551	-1.2777	0.0000	0.0000
110	0.000	-99.235	-5.253	-0.8889	0.0000	0.0000
120	0.000	-119.820	-7.955	0.0001	0.0000	0.0000
130	0.000	-99.227	-10.658	0.8890	0.0000	0.0000
140	0.000	-48.374	-13.360	1.2776	0.0000	0.0000
150	0.000	-0.000	-16.062	0.6658	0.0000	0.0000
160	0.000	7.864	-18.943	-0.0979	0.0000	0.0000
170	0.000	-0.000	-21.824	-0.1647	0.0000	0.0000
180	0.000	-3.357	-24.713	0.0256	0.0000	0.0000
190	0.000	-0.000	-27.602	0.0335	0.0000	0.0000
200	0.000	-1.552	-30.570	-0.0499	0.0000	0.0000

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 20:13
Job: C:\MASTER\CAESAR\PIPE...\508X4.78NO FRICTION-FAILING SUPPORT
Licensed To: Seat -- ID #61

Job Description: Pipe 508x4.78

PROJECT: MASTER THESIS

CLIENT :

ANALYST: S.TVEIT

NOTES : FAILING SUPPORT IN NODE 110 AND 130, NO FRICTION

PIPE DATA

From 1 To 10 DZ= -2,500.000 mm.

PIPE

Dia= 508.000 mm. Wall= 4.780 mm. Cor= .0000 mm.

GENERAL

T1= 100 C T2= -7 C P1= 12.1000 bars PHyd= 20.0000 bars

Mat= (338)A790 S31803 E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm.

EH2= 196,280 N./sq.mm. EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm.

EH5= 195,825 N./sq.mm. EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm.

EH8= 195,825 N./sq.mm. EH9= 195,825 N./sq.mm. v = .292

Pipe Den=8027.0000000 kg/cu.m. Fluid Den=1000.0000000 kg/cu.m.

Insul Thk= .000 mm.

RESTRAINTS

Node 10 X

Node 10 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

Sy= 395 N./sq.mm.

From 10 To 20 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.

Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.

Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.

Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

From 20 To 30 DZ= -2,500.000 mm.

GENERAL

E= 195,825 N./sq.mm. EH1= 189,795 N./sq.mm. EH2= 196,280 N./sq.mm.

EH3= 195,825 N./sq.mm. EH4= 195,825 N./sq.mm. EH5= 195,825 N./sq.mm.

EH6= 195,825 N./sq.mm. EH7= 195,825 N./sq.mm. EH8= 195,825 N./sq.mm.

EH9= 195,825 N./sq.mm. v = .292 Pipe Den=8027.0000000 kg/cu.m.

RESTRAINTS

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```

Node 30 X
Node 30 Y
WIND
Wind Shape= 1.000
ALLOWABLE STRESSES
B31.3 (2008) Cycle Max Switch = ON Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

-----
From 30 To 40 DZ= -2,500.000 mm.
PIPE
Dia= 508.000 mm. Wall= 4.780 mm.
GENERAL
Insul Thk= .000 mm.
WIND
Wind Shape= 1.000
ALLOWABLE STRESSES
B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.
Sy= 395 N./sq.mm.

-----
From 40 To 50 DZ= -2,500.000 mm.
GENERAL
RESTRAINTS
Node 50 X
Node 50 Y
WIND
Wind Shape= 1.000
ALLOWABLE STRESSES
B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

-----
From 50 To 60 DZ= -2,500.000 mm.
GENERAL
WIND
Wind Shape= 1.000
ALLOWABLE STRESSES
B31.3 (2008) Cycle Max Switch = Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm. Sh2= 207 N./sq.mm. Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm. Sh5= 207 N./sq.mm. Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm. Sh8= 207 N./sq.mm. Sh9= 207 N./sq.mm.

-----
From 60 To 70 DZ= -2,500.000 mm.
GENERAL
RESTRAINTS
Node 70 X
Node 70 Y
WIND
Wind Shape= 1.000

```

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ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 70 To 80 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 80 To 90 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 90 X

Node 90 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 90 To 100 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 100 To 110 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 110 To 120 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
--------------	--------------------	-------------------

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PIPE DATA

Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 120 To 130 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 130 To 140 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 140 To 150 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 150 X

Node 150 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 150 To 160 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 160 To 170 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 170 X

Node 170 Y

WIND

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Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 170 To 180 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 180 To 190 DZ= -2,500.000 mm.

GENERAL

RESTRAINTS

Node 190 X

Node 190 Y

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

From 190 To 200 DZ= -2,500.000 mm.

GENERAL

WIND

Wind Shape= 1.000

ALLOWABLE STRESSES

B31.3 (2008)	Cycle Max Switch =	Sc= 207 N./sq.mm.
Sh1= 206 N./sq.mm.	Sh2= 207 N./sq.mm.	Sh3= 207 N./sq.mm.
Sh4= 207 N./sq.mm.	Sh5= 207 N./sq.mm.	Sh6= 207 N./sq.mm.
Sh7= 207 N./sq.mm.	Sh8= 207 N./sq.mm.	Sh9= 207 N./sq.mm.

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

LOAD CASE DEFINITION KEY

```
CASE 1 (HYD) WW+HP
CASE 2 (SUS) WNC
CASE 3 (SUS) W+P1
CASE 18 (OCC) L18=L6-L4
CASE 19 (OCC) L19=L7-L4
CASE 20 (OCC) L20=L8-L4
CASE 21 (OCC) L21=L9-L4
CASE 22 (OCC) L22=L10-L4
CASE 23 (OCC) L23=L11-L4
CASE 24 (OCC) L24=L18+L3
CASE 25 (OCC) L25=L19+L3
CASE 26 (OCC) L26=L20+L3
CASE 27 (OCC) L27=L21+L3
CASE 28 (OCC) L28=L22+L3
CASE 29 (OCC) L29=L23+L3
CASE 30 (EXP) L30=L4-L3
CASE 31 (EXP) L31=L5-L3
```

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 1 (HYD) WW+HP

Highest Stresses: (N./sq.mm.)	LOADCASE 1 (HYD)	WW+HP
CodeStress Ratio (%):	23.8	@Node 150
Code Stress:	94.2	Allowable: 395.0
Axial Stress:	51.6	@Node 10
Bending Stress:	42.5	@Node 150
Torsion Stress:	0.0	@Node 10
Hoop Stress:	104.3	@Node 10
3D Max Intensity:	107.3	@Node 10

CODE STRESS CHECK PASSED : LOADCASE 2 (SUS) WNC

Highest Stresses: (N./sq.mm.)	LOADCASE 2 (SUS)	WNC
CodeStress Ratio (%):	4.9	@Node 150
Code Stress:	10.1	Allowable: 205.9
Axial Stress:	0.0	@Node 10
Bending Stress:	10.1	@Node 150
Torsion Stress:	0.0	@Node 10
Hoop Stress:	0.0	@Node 10
3D Max Intensity:	10.1	@Node 150

CODE STRESS CHECK PASSED : LOADCASE 3 (SUS) W+P1

Highest Stresses: (N./sq.mm.)	LOADCASE 3 (SUS)	W+P1
CodeStress Ratio (%):	35.8	@Node 150
Code Stress:	73.8	Allowable: 205.9
Axial Stress:	31.2	@Node 10
Bending Stress:	42.6	@Node 150

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	74.2	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 18 (OCC) L18=L6-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 18 (OCC)	L18=L6-L4	
CodeStress Ratio (%):	78.5	@Node	150
Code Stress:	387.8	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	387.8	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	387.8	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 19 (OCC) L19=L7-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 19 (OCC)	L19=L7-L4	
CodeStress Ratio (%):	78.5	@Node	150
Code Stress:	387.8	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	387.8	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	387.8	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 20 (OCC) L20=L8-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 20 (OCC)	L20=L8-L4	
CodeStress Ratio (%):	78.5	@Node	150
Code Stress:	387.8	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	387.8	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	387.8	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 21 (OCC) L21=L9-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 21 (OCC)	L21=L9-L4	
CodeStress Ratio (%):	78.5	@Node	150
Code Stress:	387.8	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	387.8	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	387.8	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 22 (OCC) L22=L10-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 22 (OCC)	L22=L10-L4	
CodeStress Ratio (%):	0.0	@Node	10
Code Stress:	0.0	Allowable:	494.2

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

Axial Stress:	0.0	@Node	10
Bending Stress:	0.0	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 23 (OCC) L23=L11-L4

Highest Stresses: (N./sq.mm.)	LOADCASE 23 (OCC)	L23=L11-L4	
CodeStress Ratio (%):	0.0	@Node	10
Code Stress:	0.0	Allowable:	494.2
Axial Stress:	0.0	@Node	10
Bending Stress:	0.0	@Node	10
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	10

CODE STRESS CHECK PASSED : LOADCASE 24 (OCC) L24=L18+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 24 (OCC)	L24=L18+L3	
CodeStress Ratio (%):	93.4	@Node	150
Code Stress:	461.6	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	430.4	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	462.0	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 25 (OCC) L25=L19+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 25 (OCC)	L25=L19+L3	
CodeStress Ratio (%):	93.4	@Node	150
Code Stress:	461.6	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	430.4	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	462.0	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 26 (OCC) L26=L20+L3

Highest Stresses: (N./sq.mm.)	LOADCASE 26 (OCC)	L26=L20+L3	
CodeStress Ratio (%):	93.4	@Node	150
Code Stress:	461.6	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	430.4	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	462.0	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 27 (OCC) L27=L21+L3

Highest Stresses: (N./sq.mm.) LOADCASE 27 (OCC) L27=L21+L3

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STRESS SUMMARY REPORT: Highest Stresses Mini Statement
Various Load Cases

CodeStress Ratio (%) :	93.4	@Node	150
Code Stress:	461.6	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	430.4	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	462.0	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 28 (OCC) L28=L22+L3

Highest Stresses: (N./sq.mm.) LOADCASE 28 (OCC) L28=L22+L3			
CodeStress Ratio (%) :	14.9	@Node	150
Code Stress:	73.8	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	42.6	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	74.2	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 29 (OCC) L29=L23+L3

Highest Stresses: (N./sq.mm.) LOADCASE 29 (OCC) L29=L23+L3			
CodeStress Ratio (%) :	14.9	@Node	150
Code Stress:	73.8	Allowable:	494.2
Axial Stress:	31.2	@Node	10
Bending Stress:	42.6	@Node	150
Torsion Stress:	0.0	@Node	10
Hoop Stress:	63.1	@Node	10
3D Max Intensity:	74.2	@Node	150

CODE STRESS CHECK PASSED : LOADCASE 30 (EXP) L30=L4-L3

Highest Stresses: (N./sq.mm.) LOADCASE 30 (EXP) L30=L4-L3			
CodeStress Ratio (%) :	0.0	@Node	70
Code Stress:	0.0	Allowable:	481.0
Axial Stress:	0.0	@Node	140
Bending Stress:	0.0	@Node	70
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	70

CODE STRESS CHECK PASSED : LOADCASE 31 (EXP) L31=L5-L3

Highest Stresses: (N./sq.mm.) LOADCASE 31 (EXP) L31=L5-L3			
CodeStress Ratio (%) :	0.0	@Node	70
Code Stress:	0.0	Allowable:	482.1
Axial Stress:	0.0	@Node	150
Bending Stress:	0.0	@Node	70
Torsion Stress:	0.0	@Node	10
Hoop Stress:	0.0	@Node	10
3D Max Intensity:	0.0	@Node	70

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 1 (HYD) WW+HP

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 1 (HYD) WW+HP

Highest Stresses: (N./sq.mm.)	
Code Stress Ratio (%) :	23.8 @Node 150
Code Stress:	94.2 Allowable: 395.0
Axial Stress:	51.6 @Node 10
Bending Stress:	42.5 @Node 150
Torsion Stress:	0.0 @Node 10
Hoop Stress:	104.3 @Node 10
3D Max Intensity:	107.3 @Node 10

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
1	51.64	0.00	0.00	104.28	107.29	1.000	1.000	51.64	395.00	13.07	B31.3
10	51.64	8.32	0.00	104.28	107.29	1.000	1.000	59.96	395.00	15.18	B31.3
10	51.64	8.32	0.00	104.28	107.29	1.000	1.000	59.96	395.00	15.18	B31.3
20	51.64	2.01	0.00	104.28	107.29	1.000	1.000	53.65	395.00	13.58	B31.3
20	51.64	2.01	0.00	104.28	107.29	1.000	1.000	53.65	395.00	13.58	B31.3
30	51.64	4.31	0.00	104.28	107.29	1.000	1.000	55.95	395.00	14.16	B31.3
30	51.64	4.31	0.00	104.28	107.29	1.000	1.000	55.95	395.00	14.16	B31.3
40	51.64	2.15	0.00	104.28	107.29	1.000	1.000	53.79	395.00	13.62	B31.3
40	51.64	2.15	0.00	104.28	107.29	1.000	1.000	53.79	395.00	13.62	B31.3
50	51.64	8.03	0.00	104.28	107.29	1.000	1.000	59.67	395.00	15.11	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 1 (HYD) WW+HP

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
50	51.64	8.03	0.00	104.28	107.29	1.000	1.000	59.67	395.00	15.11	B31.3
60	51.64	6.18	0.00	104.28	107.29	1.000	1.000	57.82	395.00	14.64	B31.3
60	51.64	6.18	0.00	104.28	107.29	1.000	1.000	57.82	395.00	14.64	B31.3
70	51.64	3.75	0.00	104.28	107.29	1.000	1.000	55.39	395.00	14.02	B31.3
70	51.64	3.75	0.00	104.28	107.29	1.000	1.000	55.39	395.00	14.02	B31.3
80	51.64	11.07	0.00	104.28	107.29	1.000	1.000	62.71	395.00	15.88	B31.3
80	51.64	11.07	0.00	104.28	107.29	1.000	1.000	62.71	395.00	15.88	B31.3
90	51.64	42.53	0.00	104.28	107.29	1.000	1.000	94.17	395.00	23.84	B31.3
90	51.64	42.53	0.00	104.28	107.29	1.000	1.000	94.17	395.00	23.84	B31.3
100	51.64	0.93	0.00	104.28	107.29	1.000	1.000	52.57	395.00	13.31	B31.3
100	51.64	0.93	0.00	104.28	107.29	1.000	1.000	52.57	395.00	13.31	B31.3
110	51.64	24.03	0.00	104.28	107.29	1.000	1.000	75.67	395.00	19.16	B31.3
110	51.64	24.03	0.00	104.28	107.29	1.000	1.000	75.67	395.00	19.16	B31.3
120	51.64	32.34	0.00	104.28	107.29	1.000	1.000	83.99	395.00	21.26	B31.3
120	51.64	32.34	0.00	104.28	107.29	1.000	1.000	83.99	395.00	21.26	B31.3
130	51.64	24.02	0.00	104.28	107.29	1.000	1.000	75.67	395.00	19.16	B31.3
130	51.64	24.02	0.00	104.28	107.29	1.000	1.000	75.67	395.00	19.16	B31.3
140	51.64	0.94	0.00	104.28	107.29	1.000	1.000	52.58	395.00	13.31	B31.3
140	51.64	0.94	0.00	104.28	107.29	1.000	1.000	52.58	395.00	13.31	B31.3
150	51.64	42.54	0.00	104.28	107.29	1.000	1.000	94.18	395.00	23.84	B31.3

CAESAR II 2011 R1 Ver.5.31.00.0000, (Build 120525) Date: MAY 31, 2015 Time: 20:13
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 Licensed To: Seat -- ID #61

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 1 (HYD) WW+HP

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
160	51.64	11.04	0.00	104.28	107.29	1.000	1.000	62.68	395.00	15.87	B31.3
160	51.64	11.04	0.00	104.28	107.29	1.000	1.000	62.68	395.00	15.87	B31.3
170	51.64	3.82	0.00	104.28	107.29	1.000	1.000	55.46	395.00	14.04	B31.3
170	51.64	3.82	0.00	104.28	107.29	1.000	1.000	55.46	395.00	14.04	B31.3
180	51.64	6.07	0.00	104.28	107.29	1.000	1.000	57.71	395.00	14.61	B31.3
180	51.64	6.07	0.00	104.28	107.29	1.000	1.000	57.71	395.00	14.04	B31.3
190	51.64	8.32	0.00	104.28	107.29	1.000	1.000	59.96	395.00	15.18	B31.3
190	51.64	8.32	0.00	104.28	107.29	1.000	1.000	59.96	395.00	15.18	B31.3
200	51.64	0.00	0.00	104.28	107.29	1.000	1.000	51.64	395.00	13.07	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 3 (SUS) W+P1

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED :: LOADCASE 3 (SUS) W+P1

Highest Stresses: (N./sq.mm.)	
Code Stress Ratio (%) :	35.8 @Node 150
Code Stress:	73.8 Allowable: 205.9
Axial Stress:	31.2 @Node 10
Bending Stress:	42.6 @Node 150
Torsion Stress:	0.0 @Node 10
Hoop Stress:	63.1 @Node 10
3D Max Intensity:	74.2 @Node 150

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
1	31.24	0.00	0.00	63.09	64.91	1.000	1.000	31.24	205.93	15.17	B31.3
10	31.24	8.32	0.00	63.09	64.91	1.000	1.000	39.57	205.93	19.21	B31.3
10	31.24	8.32	0.00	63.09	64.91	1.000	1.000	39.57	205.93	19.21	B31.3
20	31.24	2.01	0.00	63.09	64.91	1.000	1.000	33.25	205.93	16.15	B31.3
20	31.24	2.01	0.00	63.09	64.91	1.000	1.000	33.25	205.93	16.15	B31.3
30	31.24	4.31	0.00	63.09	64.91	1.000	1.000	35.55	205.93	17.27	B31.3
30	31.24	4.31	0.00	63.09	64.91	1.000	1.000	35.55	205.93	17.27	B31.3
40	31.24	2.15	0.00	63.09	64.91	1.000	1.000	33.40	205.93	16.22	B31.3
40	31.24	2.15	0.00	63.09	64.91	1.000	1.000	33.40	205.93	16.22	B31.3
50	31.24	8.03	0.00	63.09	64.91	1.000	1.000	39.27	205.93	19.07	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 3 (SUS) W+P1

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
50	31.24	8.03	0.00	63.09	64.91	1.000	1.000	39.27	205.93	19.07	B31.3
60	31.24	6.18	0.00	63.09	64.91	1.000	1.000	37.43	205.93	18.17	B31.3
60	31.24	6.18	0.00	63.09	64.91	1.000	1.000	37.43	205.93	18.17	B31.3
70	31.24	3.75	0.00	63.09	64.91	1.000	1.000	34.99	205.93	16.99	B31.3
70	31.24	3.75	0.00	63.09	64.91	1.000	1.000	34.99	205.93	16.99	B31.3
80	31.24	11.07	0.00	63.09	64.91	1.000	1.000	42.32	205.93	20.55	B31.3
80	31.24	11.07	0.00	63.09	64.91	1.000	1.000	42.32	205.93	20.55	B31.3
90	31.24	42.54	0.00	63.09	74.20	1.000	1.000	73.79	205.93	35.83	B31.3
90	31.24	42.54	0.00	63.09	74.20	1.000	1.000	73.79	205.93	35.83	B31.3
100	31.24	0.93	0.00	63.09	64.91	1.000	1.000	32.17	205.93	15.62	B31.3
110	31.24	24.04	0.00	63.09	64.91	1.000	1.000	55.28	205.93	26.84	B31.3
110	31.24	24.04	0.00	63.09	64.91	1.000	1.000	32.17	205.93	15.62	B31.3
120	31.24	32.36	0.00	63.09	64.91	1.000	1.000	63.60	205.93	30.88	B31.3
120	31.24	32.36	0.00	63.09	64.91	1.000	1.000	55.27	205.93	26.84	B31.3
130	31.24	24.03	0.00	63.09	64.91	1.000	1.000	55.27	205.93	26.84	B31.3
140	31.24	0.94	0.00	63.09	64.91	1.000	1.000	32.18	205.93	15.63	B31.3
150	31.24	42.56	0.00	63.09	74.21	1.000	1.000	73.80	205.93	35.84	B31.3
150	31.24	42.56	0.00	63.09	74.21	1.000	1.000	73.80	205.93	35.84	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 3 (SUS) W+P1

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
160	31.24	11.04	0.00	63.09	64.91	1.000	1.000	42.29	205.93	20.54	B31.3
160	31.24	11.04	0.00	63.09	64.91	1.000	1.000	42.29	205.93	20.54	B31.3
170	31.24	3.82	0.00	63.09	64.91	1.000	1.000	35.07	205.93	17.03	B31.3
170	31.24	3.82	0.00	63.09	64.91	1.000	1.000	35.07	205.93	17.03	B31.3
180	31.24	6.07	0.00	63.09	64.91	1.000	1.000	37.32	205.93	18.12	B31.3
180	31.24	6.07	0.00	63.09	64.91	1.000	1.000	37.32	205.93	18.12	B31.3
190	31.24	8.32	0.00	63.09	64.91	1.000	1.000	39.57	205.93	19.21	B31.3
190	31.24	8.32	0.00	63.09	64.91	1.000	1.000	39.57	205.93	19.21	B31.3
200	31.24	0.00	0.00	63.09	64.91	1.000	1.000	31.24	205.93	15.17	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
CASE 27 (OCC) L27=L21+L3

Piping Code: B31.3 = B31.3 -2008, December 31, 2008

CODE STRESS CHECK PASSED : LOADCASE 27 (OCC) L27=L21+L3

Highest Stresses: (N./sq.mm.)
 CodeStress Ratio (%) : 93.4 @Node 150
 Code Stress: 461.6 Allowable: 494.2
 Axial Stress: 31.2 @Node 10
 Bending Stress: 430.4 @Node 150
 Torsion Stress: 0.0 @Node 10
 Hoop Stress: 63.1 @Node 10
 3D Max Intensity: 462.0 @Node 150

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Piping Code
1	31.24	0.00	0.00	63.09	64.91	1.000	1.000	31.24	494.23	B31.3
10	31.24	84.17	0.00	63.09	140.76	1.000	1.000	115.42	494.23	B31.3
10	31.24	84.17	0.00	63.09	140.76	1.000	1.000	115.42	494.23	B31.3
20	31.24	20.29	0.00	63.09	83.19	1.000	1.000	51.53	494.23	B31.3
20	31.24	20.29	0.00	63.09	83.19	1.000	1.000	51.53	494.23	B31.3
30	31.24	43.59	0.00	63.09	104.19	1.000	1.000	74.84	494.23	B31.3
30	31.24	43.59	0.00	63.09	104.19	1.000	1.000	74.84	494.23	B31.3
40	31.24	21.77	0.00	63.09	84.52	1.000	1.000	53.01	494.23	B31.3
40	31.24	21.77	0.00	63.09	84.52	1.000	1.000	53.01	494.23	B31.3
50	31.24	81.22	0.00	63.09	138.10	1.000	1.000	112.46	494.23	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 27 (OCC) L27=L21+L3

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
50	31.24	81.22	0.00	63.09	138.10	1.000	1.000	112.46	494.23	22.76	B31.3
60	31.24	62.53	0.00	63.09	121.25	1.000	1.000	93.77	494.23	18.97	B31.3
60	31.24	62.53	0.00	63.09	121.25	1.000	1.000	93.77	494.23	18.97	B31.3
70	31.24	37.93	0.00	63.09	99.09	1.000	1.000	69.17	494.23	14.00	B31.3
70	31.24	37.93	0.00	63.09	99.09	1.000	1.000	69.17	494.23	14.00	B31.3
80	31.24	111.99	0.00	63.09	165.83	1.000	1.000	143.23	494.23	28.98	B31.3
80	31.24	111.99	0.00	63.09	165.83	1.000	1.000	143.23	494.23	28.98	B31.3
90	31.24	430.26	0.00	63.09	461.91	1.000	1.000	461.50	494.23	93.38	B31.3
90	31.24	430.26	0.00	63.09	461.91	1.000	1.000	461.50	494.23	93.38	B31.3
100	31.24	9.41	0.00	63.09	73.39	1.000	1.000	40.66	494.23	8.23	B31.3
110	31.24	243.08	0.00	63.09	283.96	1.000	1.000	274.33	494.23	55.51	B31.3
110	31.24	243.08	0.00	63.09	283.96	1.000	1.000	274.33	494.23	55.51	B31.3
120	31.24	327.23	0.00	63.09	359.78	1.000	1.000	358.48	494.23	72.53	B31.3
120	31.24	327.23	0.00	63.09	359.78	1.000	1.000	358.48	494.23	72.53	B31.3
130	31.24	243.04	0.00	63.09	283.91	1.000	1.000	274.28	494.23	55.50	B31.3
130	31.24	243.04	0.00	63.09	283.91	1.000	1.000	274.28	494.23	55.50	B31.3
140	31.24	9.51	0.00	63.09	73.47	1.000	1.000	40.75	494.23	8.25	B31.3
140	31.24	430.40	0.00	63.09	462.05	1.000	1.000	461.64	494.23	93.41	B31.3
150	31.24	430.40	0.00	63.09	462.05	1.000	1.000	461.64	494.23	93.41	B31.3

STRESSES EXTENDED REPORT: Stresses on Elements
 CASE 27 (OCC) L27=L21+L3

NODE	Axial Stress N./sq.mm.	Bending Stress N./sq.mm.	Torsion Stress N./sq.mm.	Hoop Stress N./sq.mm.	Max Stress Intensity N./sq.mm.	SIF In Plane	SIF Out Plane	Code Stress N./sq.mm.	Allowable Stress N./sq.mm.	Ratio %	Piping Code
160	31.24	111.70	0.00	63.09	165.56	1.000	1.000	142.94	494.23	28.92	B31.3
160	31.24	111.70	0.00	63.09	165.56	1.000	1.000	142.94	494.23	28.92	B31.3
170	31.24	38.66	0.00	63.09	99.74	1.000	1.000	69.90	494.23	14.14	B31.3
170	31.24	38.66	0.00	63.09	99.74	1.000	1.000	69.90	494.23	14.14	B31.3
180	31.24	61.42	0.00	63.09	120.25	1.000	1.000	92.66	494.23	18.75	B31.3
180	31.24	61.42	0.00	63.09	120.25	1.000	1.000	92.66	494.23	18.75	B31.3
190	31.24	84.17	0.00	63.09	140.76	1.000	1.000	115.42	494.23	23.35	B31.3
190	31.24	84.17	0.00	63.09	140.76	1.000	1.000	115.42	494.23	23.35	B31.3
200	31.24	0.00	0.00	63.09	64.91	1.000	1.000	31.24	494.23	6.32	B31.3