FINAL PROJECT – MO141326

STATIC ANALYSIS OF STRESSES IN OFFSHORE PIPELINE DURING INSTALLATION USING S-LAY METHOD, CASE STUDY: PIPELINE OWNED BY PT. TRANS PACIFIC PETROCHEMICAL INDOTAMA TUBAN

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OCEAN ENGINEERING DEPARTMENT
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FINAL PROJECT

Submitted to Fulfill One of the Requirements for Achieving Bachelor of Engineering in Ocean Engineering Department Faculty of Marine Technology Institute of Technology Sepuluh Nopember Surabaya

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SURABAYA, JUNI 2016

STATIC ANALYSIS OF STRESSES IN OFFSHORE PIPELINE DURING INSTALLATION USING S-LAY METHOD, CASE STUDY: PIPELINE OWNED BY PT. TRANS PACIFIC PETROCHEMICAL INDOTAMA TUBAN

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Abstract

Oil and gas is one of the energy resources that is explored today. As the consumption of oil and gas increases, the exploration climbs as well. Offshore pipeline is one of the oil and gas transportation method that plays an important role in offshore industry due to its efficiency and effectiveness. During the installation of a pipeline, there are two categories to be analyzed, namely overbend and sagbend. These are two critical regions at pipeline shape when it is being installed. The analysis was performed with aid of OFFPIPE to determine the total stresses that occur along the pipeline during laying process, with tension and stinger-length variations. The case study that was used in this final project is pipeline owned by PT. Trans Pacific Petrochemical Indotama Tuban. The stinger-length variations used are 27m, 32m, 37m, and 42m, and each has five tension variations, which are 50kN, 100kN, 150kN, 200kN, and 250kN. From this research results, it was found that the most favorable combinations are the use of 32 meter long stinger with tension value of 100kN, and stinger-length of 32m with tension of 200kN, because they generated the lowest stresses in both overbend and sagbend regions. The stinger-length of 32m with tension of 100kN produced the lowest stress in overbend region, which is 250 .06 MPa or 69.46% of SMYS. Whereas the stinger-length of 32m with tension of 200kN produced the lowest stress in sagbend region, which is 202.39 MPa or 56.22% of SMYS. Also, the stresses that was generated by these two combinations are within the allowable SMYS defined by DNV code.

Keyword: Stresses, Pipeline, OFFPIPE, S-Lay, Stinger, Tension

PREFACE

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Assalamu'alaikum Warahmatullahi Wabarakatuh

Alhamdulillahi rabbil alamin, The writer sincerely expresses his gratitude to Allah SWT. Thanks to His abundance of mercy and guidance, the writer could finish this final project entitled Static Analysis of Stresses in Offshore Pipeline During Installation Using S-lay Method, Case Study: Pipeline Owned by PT. Trans Pacific Petrochemical Indotama Tuban

This final project was accomplished as one of requirements in order to obtain a title of Bachelor of Engineering in Ocean Engineering Department, Sepuluh Nopember Institute of Technology (ITS).

During the accomplishment of this final project, there were many obstacles and barriers the writer faced. However, he considered those obstacles and barriers as the strength. The writer believes in what Al Qur'an says, "Actually, behind a difficulty, there is an ease". Also, a lot of helps and supports from some people the writer knows motivated him so that he could finally complete this final project.

Many thanks and prayers were expressed by the writer for those all who had given so many helps and supports, especially for my beloved parents, Mr. Ir. H. Suardi Saleh, M.Si and Mrs. Drg. Hj. Hasnah Syam, MARS.

In the accomplishment of this final project, the writer received guidance and encouragements from some important people. The writer would like to give them special aknowledgements and appreciations.

1. Mr. Yoyok Styo Hadiwidodo, ST, MT, PhD, as the supervisor 1 of the writer, who gave guidance and directed the writer during the accomplishment of this final project. Without his helps, the writer would have undergone many difficulties and possibly could not complete this final project.

2. Mr. Ir. Imam Rochani M.Sc., as the supervisor 2 of the writer, who gave guidance during the accomplishment of this final project and shared his knowledges.
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5. My girlfriend, Nurhidayah, who ceaselessly helped and suppported the writer in the completion of this final project.
6. My friends, whose names the writer can not mention one by one, for their supports.

Finally, the writer wishes that Allah bless those who gave the writer chances, supports, and helps to him. The writer realizes that this final project is still far from perfection. Therefore, the writer wishes to receive any constructive critics and suggestions for the improvements of this final project. The writer hopes that this final project can be useful for readers.

Surabaya, December 2015

Nazwar Furqan

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CHAPTER I
INTRODUCTION

1.1 BACKGROUND

Pipeline engineering is a branch of engineering regarding pipe structures generally used for a distribution system for oil and gas. Pipeline is used for various purposes in developing offshore hydrocarbon resources, including transportation pipeline for export, and pipeline for carrying production from a platform to the shore (Soegiono, 2007).

The installation of offshore pipelines highly depends on the enviromental condition of the sea, which can cause stresses in pipe, where the main stresses take place in overbend and sagbend region (Soegiono, 2007). The installation process of an offshore pipeline requires a complex set of analyses to provide a high level of safety on the pipeline system and to avoid the occurrence of failure, either during installation process or when it is operating. One of the factors to be analysed is the installation method. The selection of the installation method depends on environmental state and the behaviour of the pipeline installation system which is subject to various kinds of load during the installation that may lead to failure. Such loads may come from laybarge motion, hydrostatic pressure, tension, and bending. The installation methods generally used today are S-Lay, J-Lay, reeling, and towing method.

Analysis being performed for installation process aims to estimate the minimum bending stress occur in the critical region so that it is in accordance with the design criteria. In pipe installation process, or pipelaying, the pipeline is subject to hydrodynamic load which pushes itdirectly, namely drag force, and internal forces, which push it undirectly. The internal forces include wave and current forces, that cause the laybarge to motion. Those types of loads may increase the stresses in the pipe spanning freely between the laybarge and the seabed.

PT. TPPI Tuban would develop a new route of pipeline in Java Sea, north of Tuban Regency, using a 36” pipe which can increase production to 3000 BOPD.

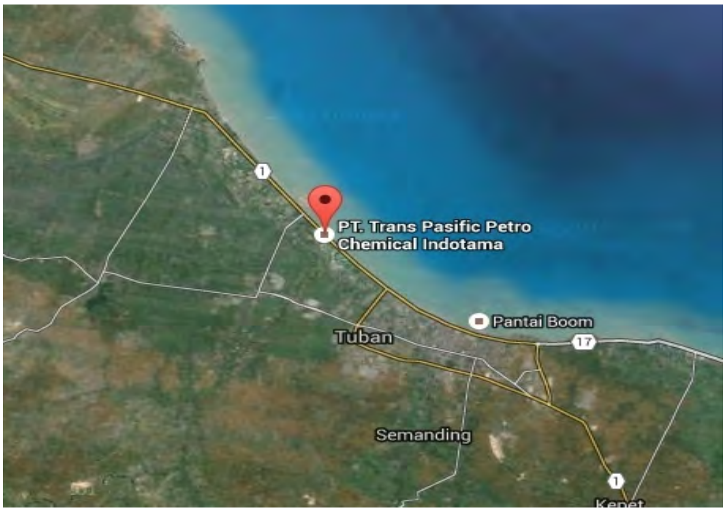

Figure.1.1 Location of PT. TPPI pipeline

In order to obtain a high level of safety and to avoid failure, pipeline designers need to carry out complex analyses. This research aims to analyse stresses which may occur in the pipeline during the installation or pipelaying process using S-Lay method. This is a static analysis. The stresses are influenced by tension on the tensioner and the length of the stinger - which is situated on the laybarge – especially in critical regions, which are overbend and sagbend region. In performing pipeline stress analysis, one needs software aid. One of the computer programs that can be relied on for such analysis is OFFPIPE. This kind of software is based on the basic principles of stresses for pipeline. The output one can obtain from OFFPIPE include the stress distribution in pipeline during the installation process.

It requires data necessary for stress analysis for pipeline during installation, such as pipe properties, laybarge, and environment. Data from PT. TPPI Tuban are shown below:

Table 1.1 Material Pipe Properties

Parameters	Units	36" OD Pipeline
Outside Diameter	Inch	36
Material	-	API 5L X52
Thickness	Inch	0.625
SMYS	Psi	52000
Young Modulus	Psi	3×10^{7}
Poisson's Ratio	-	0.3
Density	kg/m^3	7850
Coefficient of Thermal Expansion	$/^{o}C$	11.7×10^{-6}

Table 1.2. Pipeline Coating Properties

Parameters	Units	Value
Asphalt Enamel Thickness	Mm	5
Asphalt Enamel Density	kg/m^3	1842.12
Concrete Thickness	Mm	75
Concrete Density	kg/m^3	3043.51

Table 1.3 Laybarge Data

Parameters	Value
Length Overall	85 m
Breadth Overall	25 m
Depth	5.5 m
Draft	3 m
Pipelay Capacity	Pipe OD 6 - 48 inch
Number of Barge Roller	5
Number of Tensioner	2
Barge Tensioner	60 tons

Table 1.4 Enviromental Data

Parameters	Unit	Value
Water Depth	M	21.33
Sea Density	kg/m3	1025
Sea Temperature	^{o}C	26.67
Significant Wave Height	M	2.47 (100 year return period)
Significant Wave Period	S	6.3 (100 year return period)
Current Velocity	m/s	0.95
Kinematics Viscosity	m^2/s	1.13×10^{-5}

1.2 PROBLEMS

Problems to be examined in this final project are the following:

1. What are the stresses undergone by the pipeline on the critical region, overbend and sagbend, during the pipelaying process?
2. What is the value of tension and the stinger-length to be used, so that the pipeline can be laid on the seabed safely?

1.3 OBJECTIVES

The objectives of this final project are:

1. To know the stresses undergone by the pipeline on the critical region, overbend and sagbend, during the pipelaying process.
2. To know the value of tension and the stinger-length to be used, so that the pipeline can be laid on the seabed safely.

1.4 ADVANTAGES

The advantages that can be obtained from this final project include:

After obtaining the results of the analysis, the writer hopes that it can be used as a guide in determining the right value of tension and the suitable stinger-length to be used during the installation process, for given pipeline, laybarge, and environment data. Also, hopefully we can understand the effect of varying stinger-length and tension on stresses that occur along the pipeline.

1.5 SCOPE OF PROBLEMS

1. Analysis to be performed is a static analysis.
2. The pipeline installation method uses S-Lay method.
3. Data to be used is based on data from PT. TPPI Tuban.
4. It is assumed that the sea in which the pipelaying process goes is calm.
5. The tension variations are 50 kN, 100 kN, 150 kN, 200 kN and 250 kN.
6. The variations of stinger-length are 27 m, 32 m, 37 m, and 42 m.
7. The modelling of the pipeline system uses a software, namely OFFPIPE.
8. There is no analysis of mooring system during the installation.
9. Code to be used for checking the maximum allowable stress is DNV OS F101.

1.6 WRITING SISTEMATICS

The writing systematics which is used in this final project are the following:

Chapter I Introduction

This chapter explains about the background, the problem to be discussed, the objectives to be achieved, the advantages, and the scope of problems in this final project.

Chapter II Literature Review and Basic Theories

In this chapter, the writer will discuss about the literature review and the basic theories he uses as the references and guide in accomplishing this final project. This chapter consists of literature review, basic theories, equations and formulas, and code for checking the results.

Chapter IIIResearch Methodology

This chapter explains the steps in performing this research, started with literature study, data acquisition, and finally the modelling.

Chapter IV Results and Discussion

In this part, the writer will present the results obtained from computation and modelling. He will also display the code which is used, then evaluating and validating the results based on the code. Finally, the writer will discuss the the whole results.

Chapter V Conclusion and Suggestion

This chapter consists of the conclusion which is made based on the results, and the suggestion which can be used as a basis for what one is supposed to do further for related topics or subjects.

CHAPTER II
LITERATURE REVIEW AND BASIC THEORIES

2.1 Literature Review

In the field of offshore pipeline engineering, the most initial phase is the design phase. Offshore pipeline design phase generally includes the collection of information regarding environmental data, pipe material selection, determination of pipe diameter and thickness, and selection and determination of pipe coating material and thickness. Previous research (Asian, 2014) discusses about pipe design. The research deals with the design of pipeline owned by PT. Pertamina ONWJ. The research objectives are to determine the pipe wall thickness based on the content pressure, to decide the thickness of concrete coating, and to determine the the number of anodes necessary for preventing the external corrosion during the pipe service life. In order to avoid failure in the whole offshore pipeline system, another phase that is needed to be analyzed is the installation phase. One of the important aspect that must be paid attention to is stresses that occur in pipeline due to pipelaying process. Some previous publications discuss about such analyses. Wilhoit and Marwin (1966) performed analysis of pipe stresses due to laying process using numerical approach. According to their research, for S-Lay Method, attention must be focused on two critical regions of pipeline during pipelaying process, which are overbend and sagbend regions, since the larget stresses occur in those two regions.

Previous research (Ayu, 2014) deals with the analysis of pipeline stresses in overbend and sagbend regions, as the effect of varying the stinger angle and the water depth. Other factors affecting the value of pipe stress during pipelaying is the length of the stinger and the value of tension. InAyu’s research, it only uses one stinger-length and a constant tension. Whereas in this research, stinger length and tension are varied to see the effect on stresses induced in pipeline during installation.

2.2 Basic Theories

2.2.1 Introduction to S-Lay Method

The most common method of pipeline installation in shallow water is the S-Lay method. A typical S-Lay configuration is shown in Fig. 2.1. In the S-Lay method, the welded pipeline is supported on the rollers of the vessel and the stinger, forming the overbend region. Then it is suspended on the water all the way to the seabed, forming the sagbend region. The overbend and the sagbend form the shape of “S”.

In the S-Lay method, tensioners on the laybarge or layvessel pull on the pipeline, keeping the whole section to the seabed in tension. The reaction of this pull is taken up by anchors installed ahead of the barge or, in the case of a dynamically positioned (DP) vessel, by thruster. These barges/vessels are fitted with tension machines, abandonment, and recovery (A&R) winches, and pipe handling cranes. The firing line for welding the pipe may be placed in the center of the laybarge or to one side. The firing line consists of a number of stations for welding, NDE, and field joint application. The field joint location is located after the NDE station and the tension machines (tensioners).

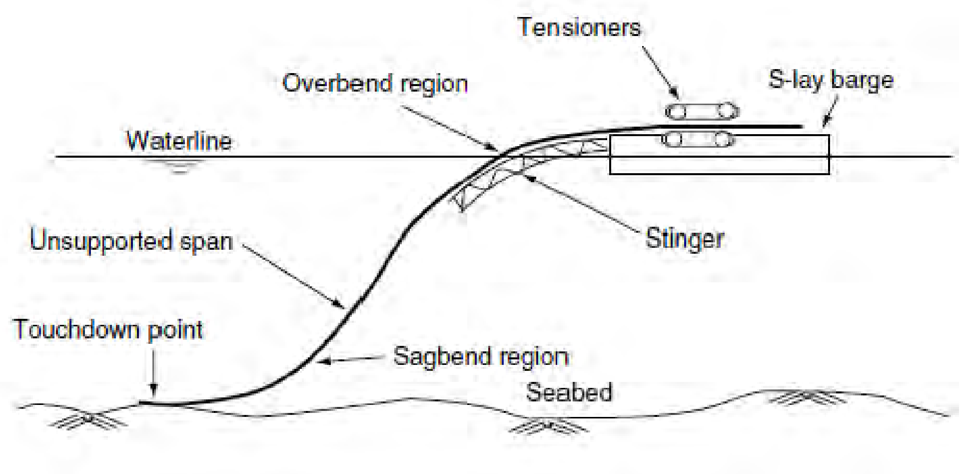

Figure 2.1 S-Lay configuration (Guo, 2005)

The main advantage with the S-Lay method is that the long firing line, running from bow to stern, enables parallel workstations for assembly of pipe joints, such that up to four pipe joints can be added at the time. This makes the method fast and economical, particularly for long pipelines. However, for large water depths, the pipe must be supported to a near vertical departure angle, which requires a very large stinger to avoid damaging the pipe. Also, with increasing water depth, the power needed to provide the required lay tension increases, which is directly transferable to high fuel expenses. These are the main disadvantages of the method.

2.2.2 Pipelaying process

Installation process using S-Lay Method consists of several phases, including (Ikhwani, 2009):

- Initation

  Pipeline is laid down to the seabed by controlling the amount of tension in the pipeline. Before performing that, one must determine first the coordinate of the seabed (fixity point), usually marked by means of an anchor or a pile. Then one pulls the cable or chain of the anchor from the fixity point to the front end of the pipeline that will be launched. After that, the vessel is slowly laying the pipeline on the seabed by maintaining the tension in the cable to ensure that the pipeline is subject to an appropriate amount of tension, so that the pipeline does not curve due to its self-weight.

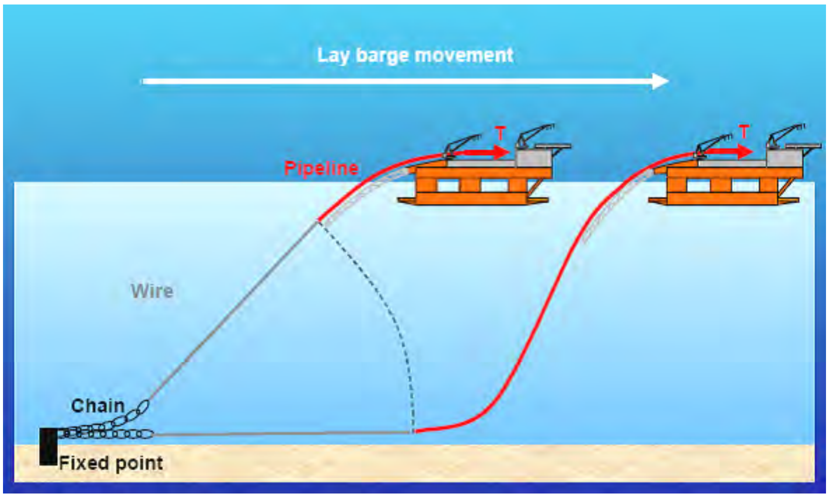

Figure 2.2 Initiation (Trevor Jee Associates, 2004)

- Loading and Storage

  To support the continuity of the pipeline installation process, it is necessary to supply pipes continuously. This is commonly used by small-size vessels carrying segments of pipes which are then moved to a lay vessel using a crane.

Figure 2.3 Loading and storage (Trevor Jee Associates, 2004)

- End preparation

  This phase is generally done on a laybarge just before welding process to repair the possible failures in pipes or to clean up the rust due to the processes of transportation and transfer of the pipes to the laybarge.

Figure 2.4 End preparation (Trevor Jee Associates, 2004)

- Double Jointing

  In order to improve welding efficiency, several laybarges generally performs a pair of weldings simultaneously, and the results are then inspected using NDT.

Figure 2.5 Double Jointing (Trevor Jee Associates, 2004)

- Tensioning

  Pipeline to be launched will first pass through the tension machine or tensioner before leaving the laybarge. The tensioner has the function to maintain the tension when the pipeline is sliding and forming a curve in the water, in order to prevent an excessive curvature, which can cause pipeline to fail. The tensioner must keep the tension constant by controlling the motions of the laybarge.

Figure 2.6 Tension machines/tensioners (Trevor Jee Associates, 2004)

- Laydown

  When most part of the pipeline has been launched, then the last part of the pipe, which is still on the laybarge, has to be laid down as well, to the seabed. The most important part in laying down the last part of pipe is to keep the tension constant. The procedure is done in this way: laydown head is welded to the last part of the pipe, and is then fastened on A&R winch. Finally, the tensioner is released from the pipeline, then the laybarge moves forward and the pipeline by itself slides into the water gradually.

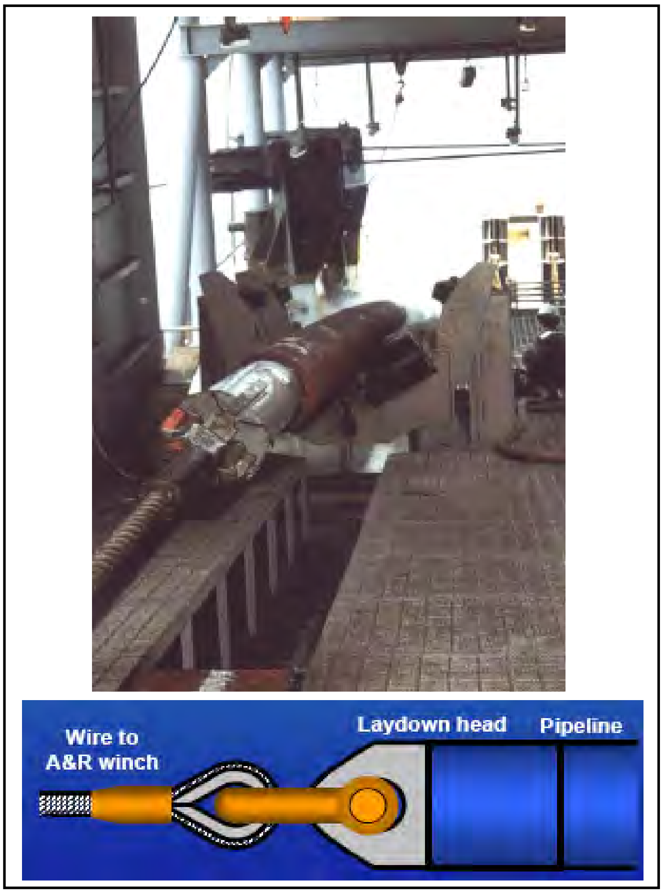

Figure 2.7 Laydown(Trevor Jee Associates, 2004)

2.2.3 Tensioner and Stinger

In offshore pipeline installation, the most common method is the use of conventional laybarges. It is a versatile technique, aplicable to most pipe sizes and most water depths. It is likely to continue to be the method used for most offshore pipeline construction. A key component of the laybarge is the tensioning system. Tensioners are required to hold the weight of the completed pipelinebehind the barge and allow pipe to move off the barge at the desired rate as each new joint is welded into the line. Maintaining tension on the pipeline as it goes into the water also reduces bending stresses. These tensioners have grippers that hold the pipe and let it move of the rear of the barge in a controlled manner. The amount of force that must be applied by the tensioners to hold the pipe on the barge varies with pipe size and weight and water depth. The capacity of the tensioning system is a key criterion in rating the laybarge for a particular project.

Tensioner capacity covers a wide range. Most laybarges have from one to three tensioner, with total tensioner capacity between 50,000 and 200,000 lb. A few large laybarges have higher tensioner capacity. Most laybarges are also equipped with a winch for abondoning and recovering the pipeline when it necessary suspend pipelay operations. Capacity of this winch is typically 150,000-300,000 lb.

Another important part of the conventional laybarge is the stinger. The stinger is used to support the completed pipeline as it moves off the lay barge into the water. Stinger design varies, there are straight, curved, and articulated stinger. The design required for a specific project is determined by water depth, pipe size and weight, and other condition. The overbend region, the upper curve of the S shape, and the sagbend, the lower curve, are critical areas of design and installation. Too great a curve can stress the pipe and cause damage during pipelaying.

Varying length and types of stingers have been design to ensure damages on the pipe does not occur. One approach to reducing the curvature of this overbend is the use of laybarge with a sloping ramp at the rear of the barge where the pipe enter the water. In general, the curvature of the overbend depends on the length of the stinger, and the curvature of the sagment depends on the tension being applied by the barge's tensioners.

Figure 2.8 Illustration of a stinger (http://www.gspoffshore.com)

In moderate water depths and calm weather, stingers up to 600 ft long may be used. In more severe environments, such the North Sea, shorter, heavier stingers are used because stingers are susceptible to damage in severe weather. Pipeline construction must often be suspended during severe weather to avoid stinger damage.

2.2.4 Overbend

In offshore pipeline installation, there are two regions where the pipeline floating, which are overbend and sagbend regions. Overbend region is the fully supported region from the tension equipment over the stinger and to the stinger tip. The radius of curvature is beneath the center of the pipeline. The stingers supports the pipe on rollers spaced out along its length, which fully controls the pipe geometry and curvature. The rollers contacts are monolateral and can be considered a boundary condition to the achievable possible configuration of the pipeline. From the third roller counted from the tip and up, the pipe is displacement-controlled. The stinger radius yields a certain overbend strain, and this strain has to be checked against allowable strain levels in international codes such as DNV OS-F101. One of the concerns arising from high overbend strains is potential rotation of the pipe during installation and consequent twisting on the seabed, so-called cork screwing.Overbend area generally extends from the tensioner on the deck barge, through the barge ramp and the stinger, and finally to the lift-off point where the pipe is no longer supported by the stinger. The overbend curvature is controlled by the roller and the stinger on the laybarge.

2.2.5. Sagbend

The sagbend region is the free span region that extends from the end of the stinger to the touchdown point on the seabed. The radius of curvature is now above the center line of the pipe. In the sagbend, the static load effect is governed by the following parameters:

- Tension
- Pipe submerged weight
- External pressure
- Bending stiffness

The equilibrium configuration is load-controlled since there are no physical boundaries for the deformations that the pipeline can experience, so that the configuration in the sagbend region is essentially the same for every deepwater installation method.

2.2.6 Structural Analysis of Pipeline During Installation

in order to comply with the structural integrity requirement of the pipelay, the pipe deformations during the pipelay should be linear elastic once the pipe has left the stinger of the pipelay vessel. For an elastic deformation, internal forces of bending, twisting, and shearing arise to counteract applied external forces, allowing the body to assume a new equilibrium state. If the external forces exceed the internal forces, a permanent deformation of the object, so-called plastic deformation, or even structural failure occurs. For pipelines this is frequently known as buckling.

Hence, we will limit our attention to linear elastic deformations, that are governed by Hooke’s law. This law linearly relates stress and strain of a deformation, and can be stated as:

$$\sigma = E\varepsilon \tag{2.1}$$

Where E is Young's modulus. Strain is the relative amount of deformation, which is a measure of how much a given displacement differs locally from a rigid body displacement. Strain is dimensionless, while Young's modulus and stress have dimension. Several quantities for measuring the strength of material arise in the generalizes Hooke's law:

- Young's modulus E - describes the material's response to linear strain, the so-called stiffness. Stiffness is the resistance of the elastic body to this deformation.
- Shear modulus G - describes the material's response to shearing strains, which occurs when a body experiences an opposing force.
- Bulk modulus K - describes the material's response to uniform pressure.

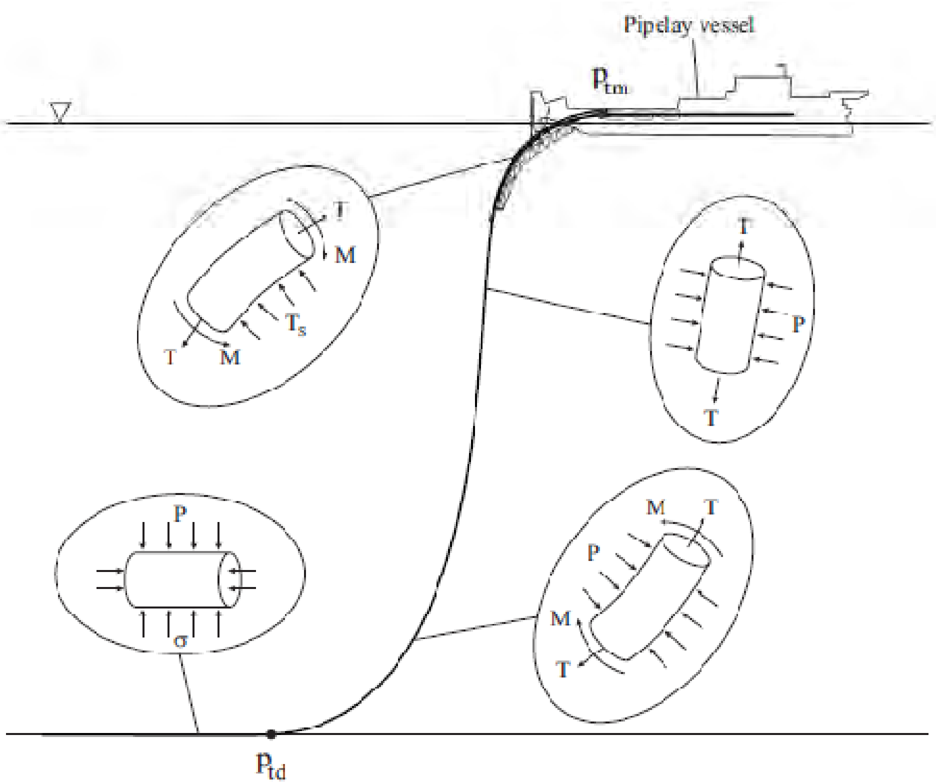

Figure 2.9 Loads on the equilibrium configuration for S-Lay pipe construction (Jensen, 2010)

$$EI = \frac{M}{\kappa} \tag{2.2}$$

Where I is the area moment of inertia of the beam cross-section, and κ is the resulting curvature of the beam.

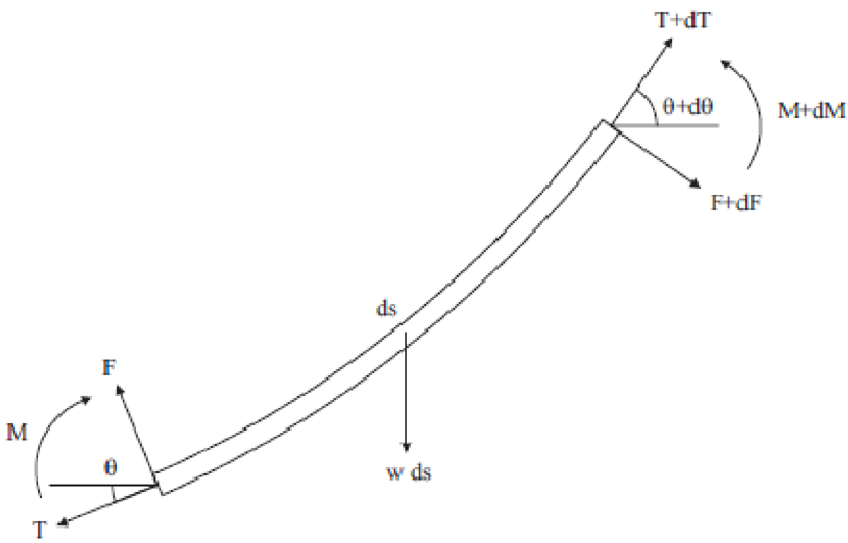

Figure 2.10 Equilibrium on forces on a catenary element of length ds (Jensen, 2010)

Assume that the pipe has uniform cross-sections and weight distribution along its length, then the governing equations for the pipe can be found by considering the static forces on a short segment of the tensioned pipe at equilibrium, see Fig. 2.10 the equilibrium of forces in the horizontal direction x, and vertical direction y yields, respectively:

$$(T + \delta T)\, cos(\theta + \delta\theta) - T\, cos(\theta)$$
$$+(F + \delta F)\, sin(\theta + \delta\theta) - F\, sin(\theta) = 0 \tag{2.3}$$
$$(T + \delta T)\, sin(\theta + \delta\theta) - T\, sin(\theta)$$
$$+(F + \delta F)\, cos(\theta + \delta\theta) - F\, cos(\theta) - w_s\delta_s = 0 \tag{2.4}$$

Where w_s is the unit weight of the pipe. Replacing small changes in value δ by the differential operator, and the approximation

$$cos(\theta + \delta\theta) \approx cos(\theta) - sin(\theta)\,\delta\theta \tag{2.5}$$

$$sin(\theta + \delta\theta) \approx sin(\theta) - cos(\theta)\,\delta\theta \tag{2.6}$$

which are valid for small values of δθ, Eq. 2.3 and 2.4 become:

$$-(T\sin(\theta) - F\cos(\theta))\,d\theta + dT\cos(\theta) + dF\sin(\theta) = 0 \tag{2.7}$$

$$(T\cos(\theta) - F\sin(\theta))d\theta + dT\sin(\theta) - dF\cos(\theta) - w_s\delta s = 0 \tag{2.8}$$

Multiplying (2.7) by (-sinθ), and (2.8) by (cosθ), before adding the two and divide byds gives

$$T\frac{d\theta}{ds} - \frac{dF}{ds} - w_s\cos(\theta) = 0 \tag{2.9}$$

where dθ/ds is the exact expression of curvature κ, also denoted 1/R, for radius R. From classical beam theory, also called Euler-Bernoulli beam theory, we have that

$$\kappa = \frac{1}{R} = \frac{M}{EI} = \frac{d\theta}{ds} \tag{2.10}$$

and the shear force equation

$$F = \frac{dM}{ds} \tag{2.11}$$

which inserted in (2.9) yields

$$T\frac{d\theta}{ds} - EI\frac{d^3\theta}{ds^3} - w_s\cos(\theta) = 0 \tag{2.12}$$

The equilibrium of horizontal forces between the two ends of the pipe element in Fig. 2.10 are

$$H_0 = T\cos(\theta) + F\sin(\theta) \tag{2.13}$$

which subtituting for F, and subtituted in for T in (2.12) yields the equation for a uniform beam under self weight including flexural effects to be

$$EI\frac{d}{ds}\left(\sec(\theta)\frac{d^2\theta}{ds^2}\right) - H_0 sec^2(\theta)\frac{d\theta}{ds} - w_s = 0 \tag{2.14}$$

This equation is also known as the nonlinear bending equation and is valid for both deep and shallow waters and small and large deflections. Equation 2.14 is of second order, with an unknown free pipe length and bottom reaction, so effectively the problem is fourth order. For this problem no exact solutions are known, and approximations must be considered either by numerical methods, or equation simplification. If the flexural rigidity vanishes, an exact analytical solution can be obtained for 320, known as the natural catenary. If the pipe weight vanishes too, the equation becomes equivalent to the nonlinear pendulum equation.

2.2.7 Stress in Overbend

Pipe curvature in the overbend region is usually controlled by proper positioning of the ramp supports and by controlling curvature of the stinger. In general, the overbend radius of curvature (including stinger) is selected such that the maximum bending stress in the pipe does not exceed 72% of the specified minimum yield stress (SMYS). The bending strain is given by:

$$\varepsilon = \frac{E}{2R} \tag{2.15}$$

Where:

D = Outside steel diameter of pipe, ft R
= Overbend radius of curvature, ft

And the corresponding axial bending stress is:

$$\sigma = \frac{ED}{2R} \tag{2.16}$$

Where E = Elastic modulus = 30 X 10^6 psi
Therefore, the minimum overbend radius can usually be selected from:

$$R = \frac{ED}{2\sigma_0 DF} \tag{2.17}$$

Where:
σ_0 = Specified minimum yield stress of pipe
DF = Design factor, usually 0.72

The above analysis assumes that the pipe has a uniform bending radius over the barge and stinger supports. In reality, the pipe bends moreover the supports than between the supports, and the overbend stress usually increases at the supports and decreases between the supports. Computer programs and elaborate methods are available for accurate overbend analysis. In these cases, a less conservative design criteria is used to determine the minimum overbend curvature. In certain cases, pipe is allowed to exceed the yield stress in the overbend, and stress criteria (since deflections can be controlled) are used in place of the limiting-stress criteria.

2.2.8 Stress in Sagbend

The sagbend stress analysis is mainly done to determine the tension and stinger-length requirement for safe laying. In general, the higher the tension is, the shorter the stinger that can be used. Often a plot of a pipe-sagbend stresses and required stinger-lengths are plotted versus tension, as shown in Fig 2.11. These plots are then used for a trade-off determination of tension and stinger-length.

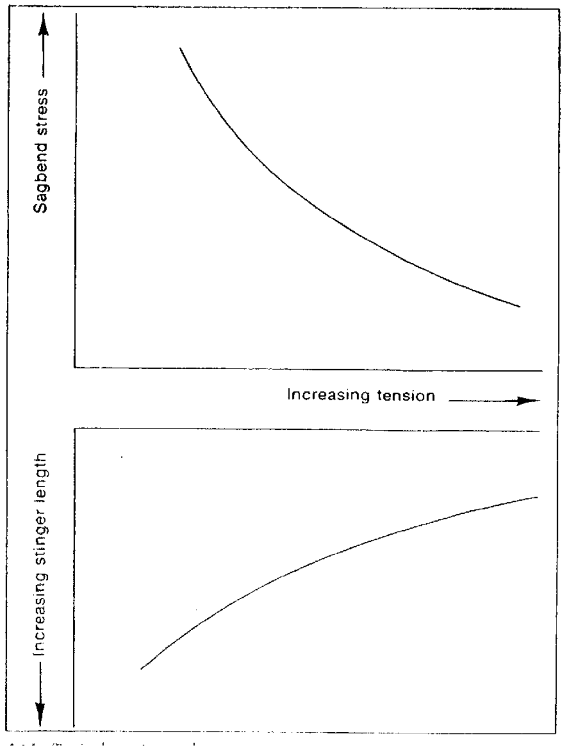

Figure 2.11 Typical tension and stinger-length variation (Mousselli, 1981)

Several methods exists for stress analysis of pipe in the sagbend region, including the beam method, catenary model, stiffened catenary, nonlinear beam method, and the finite-difference method. Generally, the beam method yields accurate results in shallow water, whereas the the catenary and stiffened-catenary theories yield accurate results deepwater applications. Both the nonlinear-beam method and the finite-element method yield accurate results for all water depths.

2.2.8.1 Beam Method (Small Deflections)

In this theory, the pipe suspended span in the sagbend is modelled as a beam segment as shown in Fig. 2.12. However, deflections are assumed small, i.e.:

$$\frac{dy}{dx} \ll 1 \tag{2.18}$$

The governing bending equation is:

$$-q = EI\frac{d^2y}{dx^2} - T_o\frac{d^2y}{dx^2} \tag{2.19}$$

Where:

q = Unit submerged weight of pipe, lb/ft

EI = Pipe bending stiffness, lb-ft^2

T_o = Effective lower pipe tension, lb

Boundary conditions:

$$y(o) = 0 \tag{2.20}$$

$$\frac{dy}{dx}(o) = \Theta\ \{slope\ of\ seabed\} \tag{2.21}$$

$$\frac{d^2y}{dx^2}(o) = 0 \tag{2.22}$$

$$y\ (L) = H \tag{2.23}$$

$$EI\frac{d^2y}{dx^2}(L) = M \tag{2.24}$$

(M = 0 at inflection point)

Note: $T = T_o + qH$ (2.25)

This theory is applicable for small deflection only, as in shallow water applications.

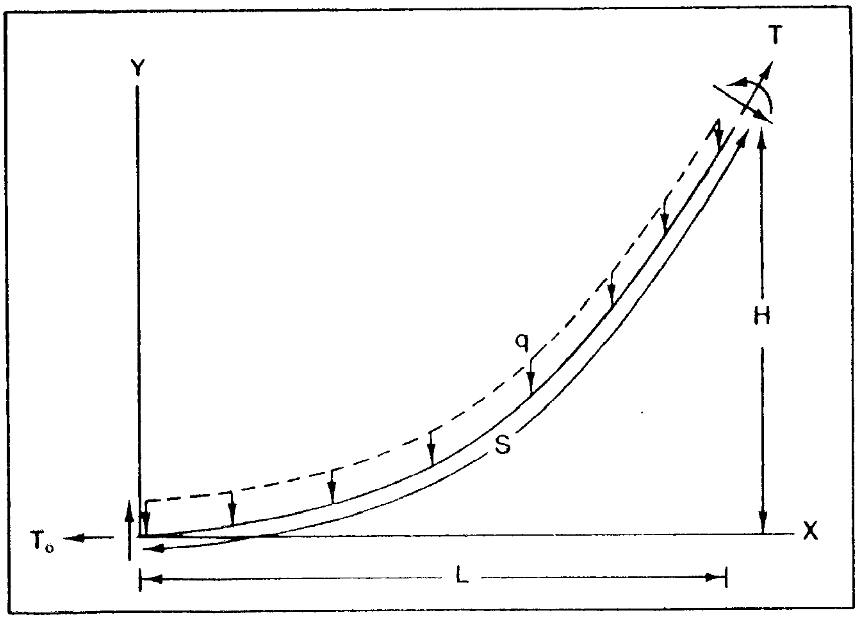

Figure 2.12 Free body diagram of pipe string (Mousselli, 1981)

2.2.8.2 Nonlinear Beam Method

This theory considers the nonlinear bending equation of a beam to describe the bending of pipe span. This theory is applicable in both shallow and deep water and is valid for small and large deflection as well.

The governing differential equation is:

$$-q = EI\frac{d}{ds}\left(Sec\,\theta\frac{d^2\theta}{ds^2}\right) - T_o\,2\theta\frac{d\theta}{ds} \tag{2.26}$$

Where

s = Distance along pipe span

θ = Angle at a distance s

$$sin\,\theta = \frac{dy}{ds} \tag{2.27}$$

Since boundary conditions normally include the displacement at either end of the pipe span, the above differential equation may be described in terms of y rather than θ. Substitution of θ in terms of y and s variables in Eq. 2.26 results in a more complex differential equation for y(s) than for θ(s).

Four boundary conditions are needed to solve the differential equation, and an additional boundary equation is needed to solve for the span length since it it not known.

The above differential equation and corresponding boundary equations are usually treated as a boundary-value problem and are solved numerically. The finite-difference method of approximations has been used successfully to provide the solution.

2.2.8.3 Catenary Shape Method

The catenary shape equation in sagbend region is expressed as:

$$z = \frac{T_h}{w_s}\left(\cosh\frac{xw_s}{T_h} - 1\right) \tag{2.28}$$

Where:

x = horizontal distance from touch down point

z = height from seabed to lift-off point

T_h = horizontal force on seabed

W_s = weight of submerged pipe

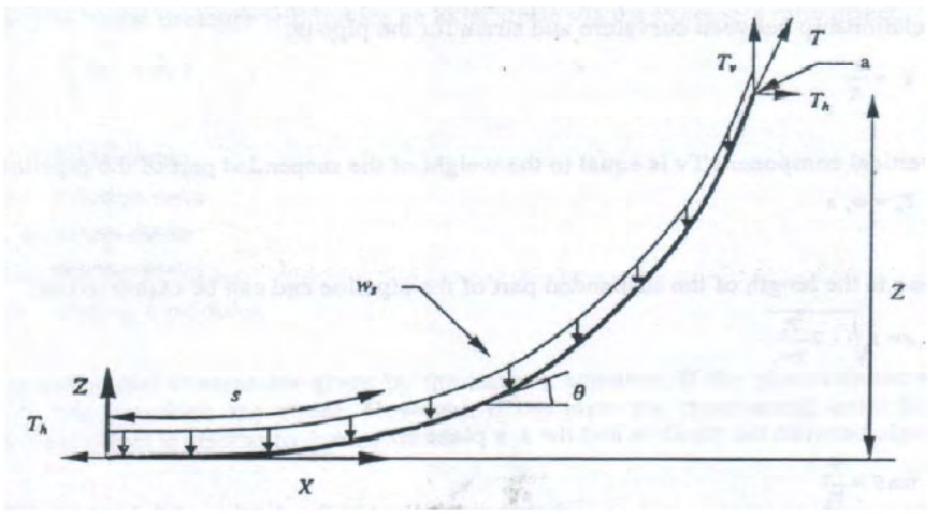

Figure 2.13Catenary shape model (Bai, 2001)

Then

$$\frac{d\theta}{ds} = \frac{d^2z}{dx^2}cos\theta = \frac{w_s}{T_h}cosh\frac{xw_s}{T_h}cos\theta \qquad (2.29)$$

Where:

θ = angle between x-axes

s = pipe span length

The curvature when touch down point is

$$\frac{1}{R} = \frac{w_s}{T_h} \qquad (2.30)$$

The relation between curvature and strain for the pipe is

$$\varepsilon = \frac{r}{R} \qquad (2.31)$$

Where r is the radius of curvature. Meanwhile, T_v equals the weight of the submerged pipe, that is

$$T_v = w_s \tag{2.32}$$

The span length of the pipe is given by

$$s = z\sqrt{1 + 2\frac{T_h}{zw_s}} \tag{2.33}$$

And the angle between pipeline and x-axes is

$$tan\theta = \frac{T_v}{T_h} \tag{2.34}$$

2.2.8.4 Natural Catenary Method

The natural catenary theory can be used to describe the pipe span configuration away from the two pipe ends, i.e., away from the lift-off point at seabed and the upper pipe point near stinger. The method is applicable where the pipe stiffness is very small, the boundary conditions on pipe span are not satisfied.

To illustrate the method, let EI = 0 in the nonlinear beam bending Eq. 2.26. the following equation is obtained

$$q = T_o Sec^2\theta \frac{d\theta}{ds} \tag{2.35}$$

This has the solution

$$\theta = tan^{-1}\frac{q_s}{T_o} + C \tag{2.36}$$

Where C = constant (C = 0, if pipe slope = 0 at sea bed), which is the familiar governing equation for a natural catenary.

The span length is given by

$$s = \sqrt{y^2 + \frac{2yT_o}{q}} = \frac{T_o}{q} sinh\left(\frac{qx}{T_o}\right) \quad (2.37)$$

The maximum sagbend strain can be approximated from the minimum curvature, where:

$$Maximum\ bending\ strain\colon\ \varepsilon = \frac{Dq}{2T_o} \quad (2.38)$$

D = Pipe outer steel diameter

The catenary equations can be used to estimate pipe configuration away from the ends where pipe stiffness is small, in deep water, or where the tension is very large.

2.2.8.5 Stiffened Catenary Method

The stiffened catenary method is different from the catenary method in that the boundary conditions are satisfied. In this method, the non-linear beam differential equation is solved assymptotically, but assuming that the nondimensional term (α^2) is very small

$$\alpha^2 = \frac{EI}{qS^3} \ll 1 \quad (2.39)$$

Where S = pipe span length.

This theory provides accurates results of the pipe configuration, including pipe regions near the ends. However, the theory is applicable where the pipe stiffness is small or in deep water.

2.2.9 Pipe Stress Formulae for OFFPIPE

There are several types of stresses in pipe during installataion that contribute its failure. The total stress is the combination of these stresses which is in the form of Von Mises stress. These stress are tensile, horizontal and vertical bending, and hoop stress.

2.2.9.1 Tensile Stress

The tensile stress in the pipeline is given by the formula:

$$\sigma_t = \frac{T}{a} + \frac{1}{4}\pi D^2 w \frac{h}{a} \tag{2.40}$$

Where

σ_t = tensile stress

T = external pipe tension

π = 3.14159

D = outside diameter of the steel pipe

w = specific weight of sea water

h = depth of the pipe node

a = cross sectional area of the steel pipe

2.2.9.2 Horizontal and Vertical Bending Stresses

The horizontal and vertical bending stresses are calculated, from the horizontal and vertical bending moments, using the formula:

$$\sigma_{hor,ver} = \frac{1}{2} M_{h,v} \frac{D}{I} SIF \tag{2.41}$$

Where

$\sigma_{hor,ver}$ = horizontal or vertical bending stress

$M_{h,v}$ = horizontal or vertical bending moment

I = cross sectional moment of inertia of the steel pipe

SIF = an optional, user defined stress intensification factor

2.2.9.3 Combined Horizontal and Vertical Bending Stress

The combined horizontal and vertical bending stress is the vector sum of the horizontal and vertical bending stresses. Therefore, it is calculated by using the formula:

$$\sigma_c = \sqrt{\sigma_{hor}^2 + \sigma_{ver}^2} \tag{2.42}$$

2.2.9.4 Hoop Stress

The hoop stress in the pipeline is given by:

$$\sigma_h = \frac{1}{2} wD \frac{h}{t} \tag{2.43}$$

Where

σ_h= hoop stress

t = steel pipe wall thickness

2.2.9.5 Total Pipe Stress

As mentioned before, the total pipe stress is calculated from the given tensile, hoop, and bending stresses using the Von Mises or maximum distortion energy formula:

$$\sigma_{vm} = [(\sigma_c + \sigma_t)^2 + \sigma_h^2 - (\sigma_c + \sigma_t)\sigma_h]^{1/2} \tag{2.44}$$

Where

σ_{vm}= total pipe stress/Von Mises Stress

The total stress is calculated, at each pipe node, for both the maximum and minimum values of the total bending moment.

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CHAPTER III

RESEARCH METHODOLOGY

3.1 Flowchart of Research Method

In order to facilitate the work of this research, all forms of activity were performed systematically and in particular order. The work process and sequence of this final project can be seen in the following figure:

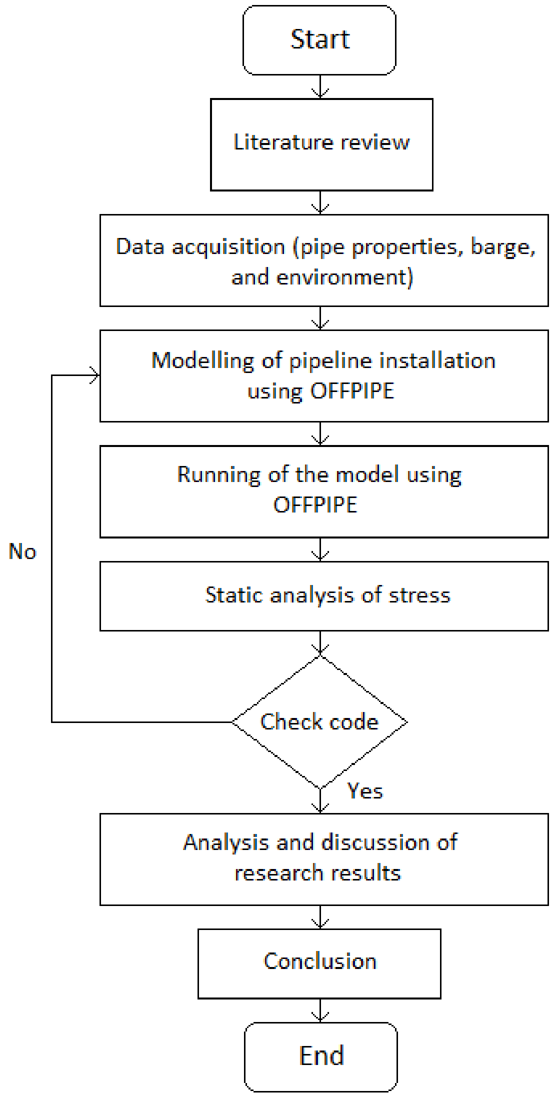

Figure3.1Flowchart of the work sequence

3.2 Research Procedure

The work steps of the research shown in the above flowchart are explained as following:

1. **Literature Study**

   In this chapter, the writer studies and learn the basic principles and theories about pipeline installation, especially for S-Lay Method. In this phase, writer also learn about stresses occur in the pipeline during the pipelaying process.

2. **Data Acquisition**

   The writer collects data necessary for the work of this final project. The data include the pipe properties, laybarge, and environment.

3. **Pipeline Installation Modelling using OFFPIPE**

   The modelling of the pipeline installation uses OFFPIPE, by inserting the data, such as pipe properties, laybarge, tension on the tensioner, and the stinger. In this modelling, tension and stinger-length vary in value.

4. **Running of the Model using OFFPIPE**

   The writer runs the model for each variations of tension and each variations of stinger-length in order to obtain the stresses occur along the pipeline during the pipelaying process.

5. **Static Analysis of Stress**

   After running the model, the output, which is stress, is obtained. The writer then performs a stress analysis, especially in critical regions of the pipeline, which are overbend and sagbend region.

6. **Code Check**

   The writer checks the allowable stress of pipe using the code.

7. **Result Analysis and Discussion**

   The writer analyse the result, which is stress in the pipeline, and then comparing it with the allowable stress written in the code.

8. **Conclusion**

   The writer takes conclusions related to the results that have been obtained, according to the topic of this research.

3.3 Modelling using OFFPIPE

3.3.1 Short Description about OFFPIPE

OFFPIPE is a computer program used for modelling and analysing a nonlinear structure of an offshore pipeline during the installation and operation. It uses the basics of finite element method in the analysis process. The problems which are able to be analysed by using OFFPIPE are the following:

a) Static and dynamic analysis of pipelaying process, including installation using S-Lay method.
b) Computations of pipeline stress, span length, and deflection during the installation.
c) Static analysis of davit-lift in riser installation process and subsea tie-in.

3.3.2 Pipeline System Modelling

In OFFPIPE, modelling for a pipeline system during installation uses a model of finite element method. Several case illustrations which are generally modeled on OFFPIPE include:

a) Pipe installation modelling using laybarge, layship, and semisubmersible.
b) Pipe installation modelling using J-Lay Method.
c) Stinger modelling. There are three types of stingers that are used, which are articulated, flexible, and fix stinger.
d) Pipe installation modelling without stinger.

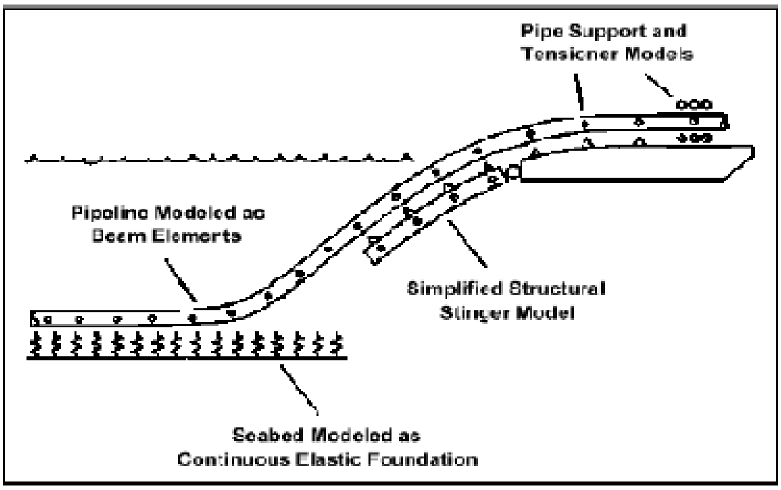

Figure 3.2 Pipelaying System Modelling (OFFPIPE Manual)

As shown in above figure, pipelaying modelling consists of laybarge, stinger, and pipelaying modelling.

3.3.3 Laybarge Modelling

Laybarge in OFFPIPE is modeled as a rigid body. OFFPIPE has two sort of analyses, which are static and dynamic analysis. It does too for laybarge modelling analysis. In static analysis, the position of the laybarge is determined by the input data: laybarge offset, trim angle, and heading. Meanwhile for dynamic analysis, a laybarge model has six kinds of motions. Those motions are then translated as the Response Amplitude Operator (RAO). An example of laybarge modelling using OFFPIPE is shown in Fig. 3.3.

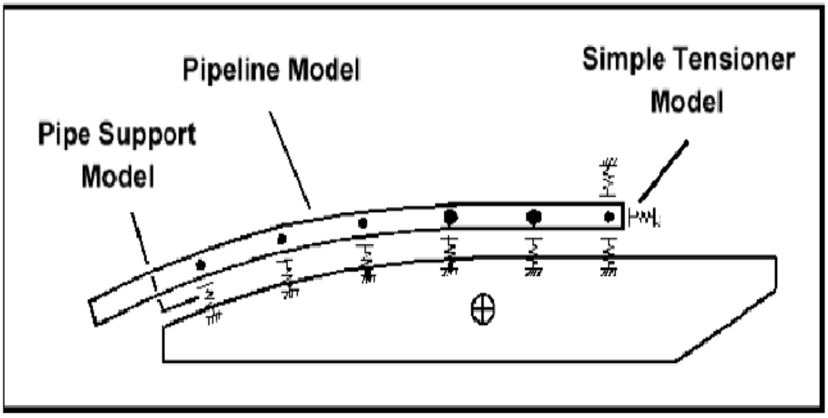

Figure 3.3 Laybarge modeling (OFFPIPE Manual)

3.3.4 Stinger Modelling

In OFFPIPE, there are three sorts of modellings, they are rigid body, fix stinger (on one system with the laybarge), and general stinger model. Cases that are generally encountered in modelling using OFFPIPE, include:

a) Fixed stern ramp
b) Conventional stinger
c) Fixed curvature stinger
d) Articulated stinger

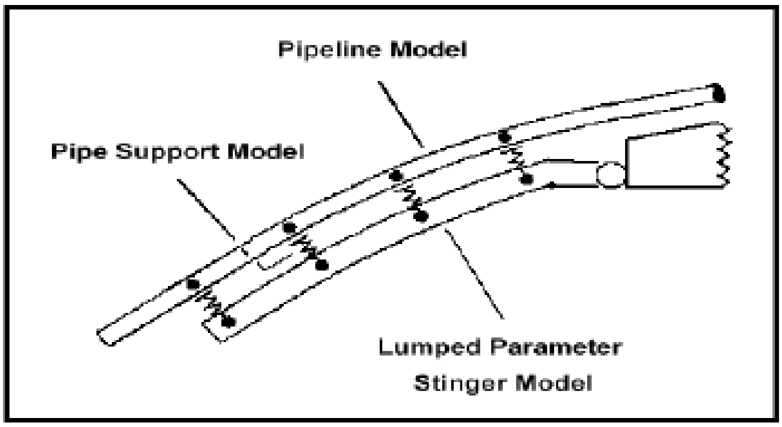

Figure 3.4 Stinger modelling (OFFPIPE Manual)

3.3.5 Pipelaying Analysis using OFFPIPE

The modelling of a pipeline installation in OFFPIPE is initiated by inserting the data of pipe properties, such as outside diameter (OD), wall thickness, pipe weight, *etc*. After modelling the pipe, one then models the laybarge, which is started by inserting the laybarge data, such as length, breadth, height, and draft of the laybarge. The modelling also inserts the supports types which is used during the installation, such as tensioner and simple pipe support.

CHAPTER IV
RESULTAND DISCUSSION

4.1 Laybarge Data

Laybarge to be used in this final project is Hafar Neptune Pipe Lay Barge (PLB). The picture of the laybarge can be seen in the Figure 4.1.

Figure 4.1 Hafar Neptune Pipe Lay Barge

Whereas the main dimension of the laybarge is given in the following table.

Table 4.1 Principal Dimension of Hafar Neptune PLB

Parameters	Value
Length Overall	85 m
Breadth Overall	25 m
Depth	5.5 m
Draft	3 m
Pipelay Capacity	Pipe OD 6 - 48 inch
Number of Barge Roller	5
Number of Tensioner	2
Barge Tensioner	60 tons

4.2 Pipeline Data

The pipeline used in this final project is own by PT. Trans Pacific Petrochemical Indotama Tuban. The material and coating properties of the pipeline are shown in Table 4.2 and Table 4.3, respectively.

Table 4.2 Material Properties of the Pipeline

Parameters	Units	36" OD Pipeline
Outside Diameter	inch	36
Material	-	API 5L X52
Thickness	inch	0.625
SMYS	psi	52000
Young Modulus	psi	3×10^7
Poisson's Ratio	-	0.3
Density	kg/m^3	7850
Coefficient of Thermal Expansion	$/^oC$	11.7×10^{-6}

Table 4.3Coating Properties of the Pipeline

Parameters	Units	Value
Asphalt Enamel Thickness	Mm	5
Asphalt Enamel Density	kg/m^3	1842.12
Concrete Thickness	Mm	75
Concrete Density	kg/m^3	3043.51

4.3 Static Analysis of Installation Process using OFFPIPE

4.3.1 Total Stresses Obtained

The definition of static analysis in OFFPIPE is to perform a modelling of pipeline installation without modelling the motions of the laybarge, or in other words, the laybarge is assumed to be still. In static analysis, we must consider the stresses that occur during installation process, especially in both overbend and sagbend region. Overbend region is the pipe segment which is still on the laybarge to the stinger (except the farthest roller of the stinger). Sagbend region starts at the farthest roller of the stinger to the pipe segment that touches the touchdown point on the seabed. Results obtained from OFFPIPE, according to the given data, is displayed as following.

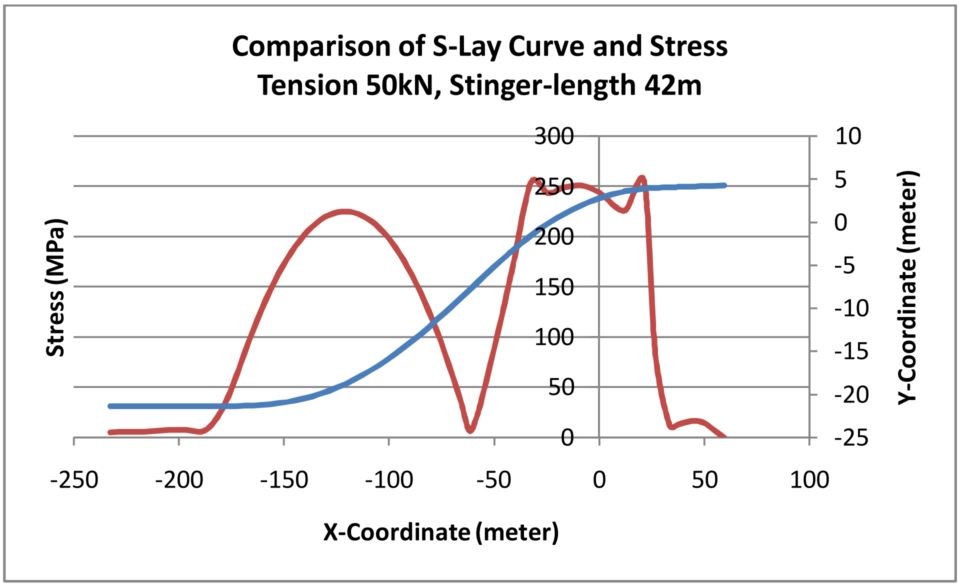

Figure 4.2Comparison between S-Lay Curve and Stress for Tension 50 kN and Stinger-length 42 m

Table 4.4 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 50 kN

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
1	LAYBARGE	59,44	4,32	0	0
3	LAYBARGE	48,01	4,22	15,92	4,42
5	TENSIONER	38,1	4,14	13,44	3,73
7	LAYBARGE	33,53	4,1	11,8	3,28
9	TENSIONER	26,67	4,04	84,11	23,36
11	LAYBARGE	21,34	3,95	255,21	70,89
13	LAYBARGE	12,19	3,62	226,12	62,81
15	LAYBARGE	0	2,82	244,06	67,8
18	STINGER	-8,63	1,98	251	69,72
20	STINGER	-16,57	1,02	249,12	69,2
122	STINGER	-24,49	-0,14	243,65	67,68
24	STINGER	-32,37	-1,5	254,62	70,73
26	STINGER	-40,22	-3,04	179,85	49,96
28	STINGER	-42,18	-3,44	160,65	44,62
30	SAGBEND	-46,09	-4,28	123,65	34,35
31	SAGBEND	-50	-5,15	88,51	24,59
32	SAGBEND	-53,9	-6,03	55,24	15,35

Table 4.4 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 50 kN (continued)

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
33	SAGBEND	-57,8	-6,92	23,89	6,64
34	SAGBEND	-61,7	-7,82	6,72	1,87
35	SAGBEND	-65,59	-8,72	34,06	9,46
36	SAGBEND	-69,49	-9,6	59,97	16,66
37	SAGBEND	-73,4	-10,48	84,05	23,35
38	SAGBEND	-77,3	-11,34	106,29	29,52
39	SAGBEND	-81,21	-12,19	126,65	35,18
40	SAGBEND	-85,13	-13	145,14	40,32
41	SAGBEND	-89,05	-13,79	161,75	44,93
42	SAGBEND	-92,98	-14,55	176,45	49,01
43	SAGBEND	-96,91	-15,27	189,25	52,57
44	SAGBEND	-100,85	-15,95	200,12	55,59
45	SAGBEND	-104,8	-16,6	209,07	58,07
46	SAGBEND	-108,75	-17,21	216,06	60,02
47	SAGBEND	-112,71	-17,77	221,11	61,42
48	SAGBEND	-116,68	-18,29	224,2	62,28
49	SAGBEND	-120,65	-18,77	225,32	62,59
50	SAGBEND	-124,63	-19,2	224,46	62,35
51	SAGBEND	-128,61	-19,58	221,63	61,56
52	SAGBEND	-132,59	-19,93	216,82	60,23
53	SAGBEND	-136,58	-20,23	210,02	58,34
54	SAGBEND	-140,58	-20,49	201,25	55,9
55	SAGBEND	-144,57	-20,71	190,5	52,92
56	SAGBEND	-148,57	-20,89	177,78	49,38
57	SAGBEND	-152,56	-21,03	163,1	45,31

Figure 4.2 and Table 4.4explains about the stresses undergone in each sections of the pipeline during installation process. In overbend region, we can understand the maximum stress that occurs, that is 255.21 MPa or 70.89% of SMYS. It is located on coordinate x = 21.34 and y = 3.95 . In sagbend region, the maximum stress that occurs is 225.32 MPa or 62.59% of SMYS. It is located on coordinate x = -120.65 and y = -18.77.

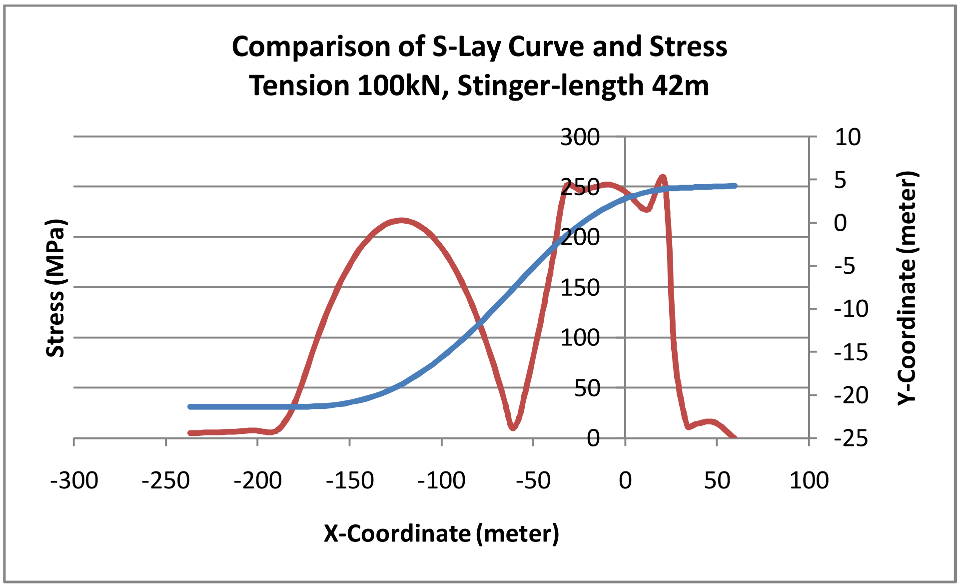

Figure 4.3Comparison between S-Lay Curve and Stress for Tension 100 kN and Stinger-length 42 m

Table 4.5 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 100 kN

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
1	LAYBARGE	59,44	4,32	0	0
3	LAYBARGE	48,01	4,22	15,92	4,42
5	TENSIONER	38,1	4,14	14	3,89
7	LAYBARGE	33,53	4,1	12,35	3,43
9	TENSIONER	26,67	4,04	85,24	23,68
11	LAYBARGE	21,34	3,95	256,38	71,22
13	LAYBARGE	12,19	3,62	227,38	63,16
15	LAYBARGE	0	2,82	245,29	68,14
18	STINGER	-8,63	1,98	252,27	70,08
20	STINGER	-16,57	1,02	249,95	69,43
22	STINGER	-24,49	-0,14	246,35	68,43
24	STINGER	-32,37	-1,5	250,04	69,46
26	STINGER	-40,22	-3,03	170,45	47,35
28	STINGER	-42,18	-3,44	151,82	42,17
30	SAGBEND	-46,09	-4,27	116,05	32,23
31	SAGBEND	-50	-5,13	82,23	22,84
32	SAGBEND	-53,9	-6	50,32	13,99
33	SAGBEND	-57,81	-6,88	20,45	5,68
34	SAGBEND	-61,71	-7,77	10,27	2,85
35	SAGBEND	-65,61	-8,66	36,22	10,06
36	SAGBEND	-69,51	-9,53	60,61	16,84

Table 4.5 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 100 kN (continued)

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
37	SAGBEND	-73,41	-10,4	83,22	23,12
38	SAGBEND	-77,32	-11,25	104,05	28,9
39	SAGBEND	-81,24	-12,08	123,1	34,2
40	SAGBEND	-85,15	-12,89	140,39	39
41	SAGBEND	-89,08	-13,67	155,9	43,31
42	SAGBEND	-93,01	-14,41	169,66	47,13
43	SAGBEND	-96,94	-15,13	181,66	50,46
44	SAGBEND	-100,88	-15,81	191,9	53,3
45	SAGBEND	-104,83	-16,45	200,38	55,66
46	SAGBEND	-108,79	-17,06	207,09	57,53
47	SAGBEND	-112,75	-17,62	212,04	58,9
48	SAGBEND	-116,71	-18,14	215,23	59,79
49	SAGBEND	-120,68	-18,62	216,64	60,18
50	SAGBEND	-124,66	-19,06	216,27	60,07
51	SAGBEND	-128,64	-19,45	214,12	59,48
52	SAGBEND	-132,62	-19,81	210,19	58,38
53	SAGBEND	-136,61	-20,12	204,46	56,79
54	SAGBEND	-140,6	-20,39	196,94	54,71
55	SAGBEND	-144,6	-20,62	187,62	52,12
56	SAGBEND	-148,59	-20,81	176,49	49,03
57	SAGBEND	-152,59	-20,97	163,56	45,43

Figure 4.3 and Table 4.5 explains about the stresses undergone in each sections of the pipeline during installation process. In overbend region, we can understand the maximum stress that occurs, that is 256.38 MPa or 71.22% of SMYS. It is located on coordinate x = 21.34 and y = 3.95. In sagbend region, the maximum stress that occurs is 216.64 MPa or 60.18% of SMYS. It is located on coordinate x = -120.68 and y = -18.62.

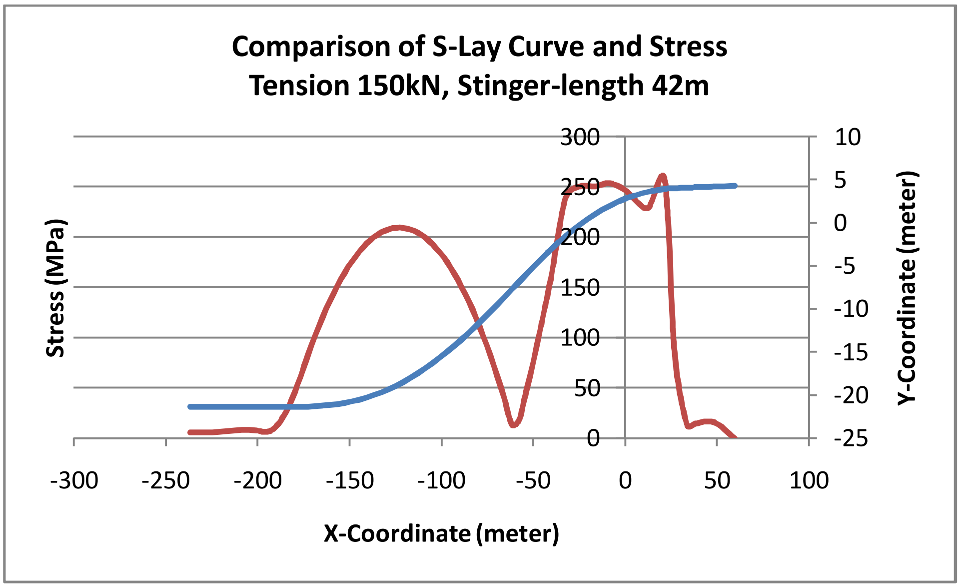

Figure 4.4Comparison between S-Lay Curve and Stress for Tension 150 kN and Stinger-length 42 m

Table 4.6 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 150 kN

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
1	LAYBARGE	59,44	4,32	0	0
3	LAYBARGE	48,01	4,22	15,91	4,42
5	TENSIONER	38,1	4,14	14,56	4,04
7	LAYBARGE	33,53	4,1	12,91	3,59
9	TENSIONER	26,67	4,04	86,37	23,99
11	LAYBARGE	21,34	3,95	257,55	71,54
13	LAYBARGE	12,19	3,62	228,65	63,51
15	LAYBARGE	0	2,82	246,51	68,47
18	STINGER	-8,63	1,98	253,63	70,45
20	STINGER	-16,57	1,02	250,41	69,56
22	STINGER	-24,49	-0,14	250,45	69,57
24	STINGER	-32,37	-1,5	240	66,67
26	STINGER	-40,22	-3,02	162,26	45,07
28	STINGER	-42,18	-3,43	144,18	40,05
30	SAGBEND	-46,1	-4,26	109,6	30,45
31	SAGBEND	-50,01	-5,1	77,07	21,41
32	SAGBEND	-53,91	-5,97	46,53	12,92
33	SAGBEND	-57,82	-6,84	18,02	5,01
34	SAGBEND	-61,72	-7,71	13,45	3,74
35	SAGBEND	-65,62	-8,59	38,12	10,59
36	SAGBEND	-69,53	-9,45	61,17	16,99

Table 4.6 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 150 kN (continued)

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
37	SAGBEND	-73,43	-10,31	82,48	22,91
38	SAGBEND	-77,35	-11,15	102,08	28,35
39	SAGBEND	-81,26	-11,97	119,98	33,33
40	SAGBEND	-85,18	-12,76	136,21	37,83
41	SAGBEND	-89,11	-13,53	150,78	41,88
42	SAGBEND	-93,04	-14,27	163,72	45,48
43	SAGBEND	-96,97	-14,98	175,03	48,62
44	SAGBEND	-100,92	-15,66	184,73	51,31
45	SAGBEND	-104,86	-16,3	192,82	53,56
46	SAGBEND	-108,82	-16,9	199,31	55,37
47	SAGBEND	-112,78	-17,46	204,21	56,72
48	SAGBEND	-116,74	-17,99	207,5	57,64
49	SAGBEND	-120,72	-18,47	209,2	58,11
50	SAGBEND	-124,69	-18,91	209,29	58,14
51	SAGBEND	-128,67	-19,31	207,78	57,72
52	SAGBEND	-132,65	-19,67	204,66	56,85
53	SAGBEND	-136,64	-19,99	199,92	55,53
54	SAGBEND	-140,63	-20,28	193,55	53,76
55	SAGBEND	-144,62	-20,52	185,55	51,54
56	SAGBEND	-148,62	-20,72	175,9	48,86
57	SAGBEND	-152,62	-20,9	164,58	45,72

Figure 4.4 and Table 4.6 explains about the stresses undergone in each sections of the pipeline during installation process. In overbend region, we can understand the maximum stress that occurs, that is 257.55 MPa or 71.54% of SMYS. It is located on coordinate x = 21.34 and y = 3.95 . In sagbend region, the maximum stress that occurs is 209.29 MPa or 58.14% of SMYS. It is located on coordinate x = -124.69 and y = -18.91.

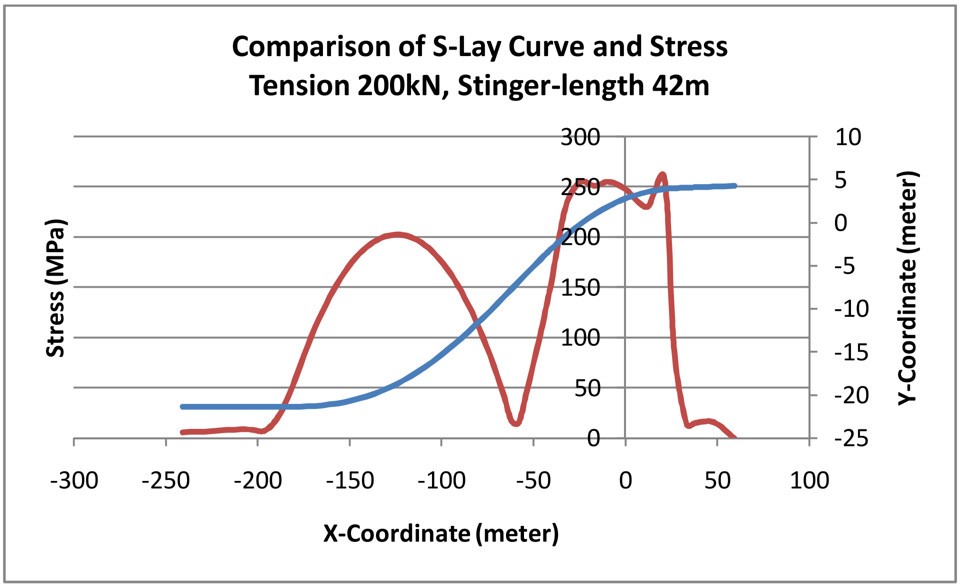

Figure 4.5Comparison between S-Lay Curve and Stress for Tension 200 kN and Stinger-length 42 m

Table 4.7 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 200 kN

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
1	LAYBARGE	59,44	4,32	0	0
3	LAYBARGE	48,01	4,22	15,91	4,42
5	TENSIONER	38,1	4,14	15,11	4,2
7	LAYBARGE	33,53	4,1	13,47	3,74
9	TENSIONER	26,67	4,04	87,5	24,31
11	LAYBARGE	21,34	3,95	258,72	71,87
13	LAYBARGE	12,19	3,62	229,92	63,87
15	LAYBARGE	0	2,82	247,72	68,81
18	STINGER	-8,63	1,98	254,99	70,83
20	STINGER	-16,57	1,02	250,88	69,69
22	STINGER	-24,49	-0,14	254,53	70,7
24	STINGER	-32,37	-1,5	230,1	63,92
26	STINGER	-40,23	-3,02	154,24	42,84
28	STINGER	-42,19	-3,42	136,71	37,98
30	SAGBEND	-46,1	-4,24	103,31	28,7
31	SAGBEND	-50,01	-5,08	72,83	20,01
32	SAGBEND	-53,92	-5,93	42,8	11,89
33	SAGBEND	-57,82	-6,79	15,64	4,35
34	SAGBEND	-61,73	-7,66	16,68	4,63
35	SAGBEND	-65,64	-8,52	40,1	11,14
36	SAGBEND	-69,54	-9,37	61,86	17,18

Table 4.7 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 200 kN (continued)

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
37	SAGBEND	-73,45	-10,22	81,93	22,76
38	SAGBEND	-77,37	-11,04	100,34	27,87
39	SAGBEND	-81,29	-11,85	117,14	32,54
40	SAGBEND	-85,21	-12,64	132,36	36,77
41	SAGBEND	-89,13	-13,4	146,02	40,56
42	SAGBEND	-93,07	-14,13	158,17	43,94
43	SAGBEND	-97	-14,84	168,81	46,89
44	SAGBEND	-100,95	-15,51	177,97	49,44
45	SAGBEND	-104,9	-16,14	185,66	51,57
46	SAGBEND	-108,85	-16,74	191,9	53,31
47	SAGBEND	-112,81	-17,31	196,69	54,64
48	SAGBEND	-116,78	-17,83	200,04	55,57
49	SAGBEND	-120,75	-18,31	201,95	56,1
50	SAGBEND	-124,72	-18,76	202,42	56,23
51	SAGBEND	-128,7	-19,17	201,45	55,96
52	SAGBEND	-132,68	-19,54	199,03	55,29
53	SAGBEND	-136,67	-19,87	195,15	54,21
54	SAGBEND	-140,66	-20,16	189,8	52,72
55	SAGBEND	-144,65	-20,41	182,97	50,83
56	SAGBEND	-148,65	-20,63	174,65	48,51
57	SAGBEND	-152,64	-20,82	164,81	45,78

Figure 4.5 and Table 4.7 explains about the stresses undergone in each sections of the pipeline during installation process. In overbend region, we can understand the maximum stress that occurs, that is 258.72 MPa or 71.87% of SMYS. It is located on coordinate x = 21.34 and y = 3.95. In sagbend region, the maximum stress that occurs is 202.42 MPa or 56.23% of SMYS. It is located on coordinate x = -124.72 and y = -18.76.

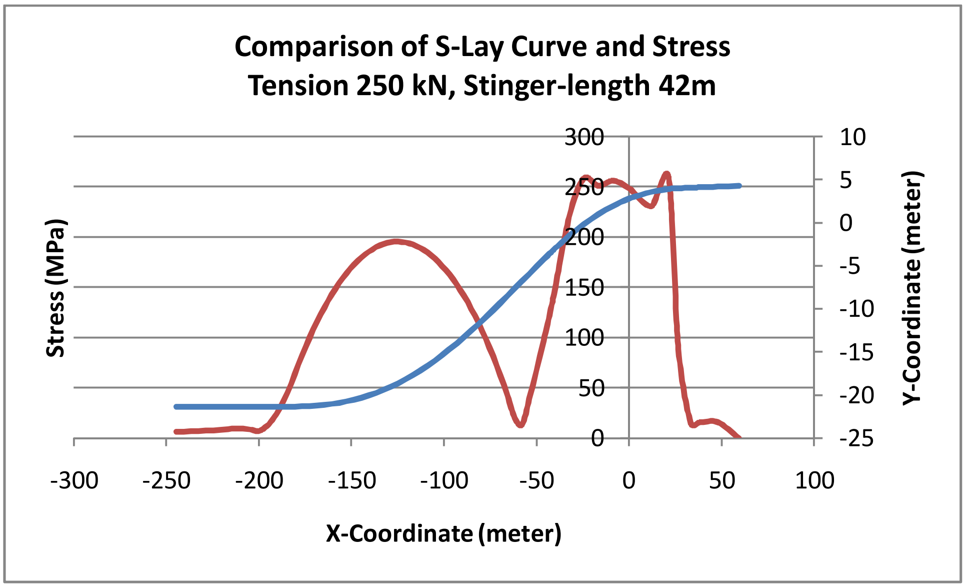

Figure 4.6Comparison between S-Lay Curve and Stress for Tension 250 kN and Stinger-length 42 m

Table 4.8 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 250 kN

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
1	LAYBARGE	59,44	4,32	0	0
3	LAYBARGE	48,01	4,22	15,91	4,42
5	TENSIONER	38,1	4,14	15,67	4,35
7	LAYBARGE	33,53	4,1	14,03	3,9
9	TENSIONER	26,67	4,04	88,63	24,62
11	LAYBARGE	21,34	3,95	259,89	72,19
13	LAYBARGE	12,19	3,62	231,19	64,22
15	LAYBARGE	0	2,82	248,93	69,15
18	STINGER	-8,63	1,98	256,35	71,21
20	STINGER	-16,57	1,02	251,35	69,82
22	STINGER	-24,49	-0,14	258,56	71,82
24	STINGER	-32,37	-1,5	220,35	61,21
26	STINGER	-40,23	-3,01	146,39	40,66
28	STINGER	-42,19	-3,41	129,42	35,95
30	SAGBEND	-46,1	-4,22	97,18	26,99
31	SAGBEND	-50,02	-5,06	67,12	18,64
32	SAGBEND	-53,93	-5,9	39,15	10,88
33	SAGBEND	-57,83	-6,75	13,33	3,7
34	SAGBEND	-61,74	-7,6	19,94	5,54
35	SAGBEND	-65,65	-8,45	42,13	11,7
36	SAGBEND	-69,56	-9,3	62,66	17,4

Table 4.8 PipelineTotal Stress and SMYS for 42m Stinger and Tension of 250 kN (continued)

NODE NO.	PIPE SECTION	X	Y	TOTAL STRESS	SMYS (%)
37	SAGBEND	-73,47	-10,13	81,54	22,65
38	SAGBEND	-77,39	-10,94	98,83	27,45
39	SAGBEND	-81,31	-11,74	114,57	31,83
40	SAGBEND	-85,23	-12,52	128,82	35,78
41	SAGBEND	-89,16	-13,27	141,62	39,34
42	SAGBEND	-93,1	-13,99	152,99	42,5
43	SAGBEND	-97,03	-14,69	162,98	45,27
44	SAGBEND	-100,98	-15,36	171,61	47,67
45	SAGBEND	-104,93	-15,99	178,89	49,69
46	SAGBEND	-108,88	-16,59	184,86	51,35
47	SAGBEND	-112,84	-17,15	189,52	52,64
48	SAGBEND	-116,81	-17,67	192,87	53,58
49	SAGBEND	-120,78	-18,16	194,93	54,15
50	SAGBEND	-124,75	-18,61	195,7	54,36
51	SAGBEND	-128,73	-19,03	195,18	54,22
52	SAGBEND	-132,71	-19,4	193,35	53,71
53	SAGBEND	-136,7	-19,74	190,22	52,84
54	SAGBEND	-140,69	-20,04	185,77	51,6
55	SAGBEND	-144,68	-20,3	179,98	50
56	SAGBEND	-148,67	-20,53	172,84	48,01
57	SAGBEND	-152,67	-20,73	164,32	45,65

Figure 4.6 and Table 4.8explains about the stresses undergone in each sections of the pipeline during installation process. In overbend region, we can understand the maximum stress that occurs, that is 259.89 MPa or 72.19% of SMYS. It is located on coordinate x = 21.34 and y = 3.95. In sagbend region, the maximum stress that occurs is 195.7 MPa or 54.36% of SMYS. It is located on coordinate x = -124.75 and y = -18.61.

4.3.2 Effect of Tension and Stinger-length Variation on Horizontal and Vertical Bending Moments

In this section, we will study the effect of varying tension value and length of the stinger on horizontal and vertical bending moments. In order to obtain the moments along the pipeline using these two variables, we use OFFPIPE. The results can be seen below.

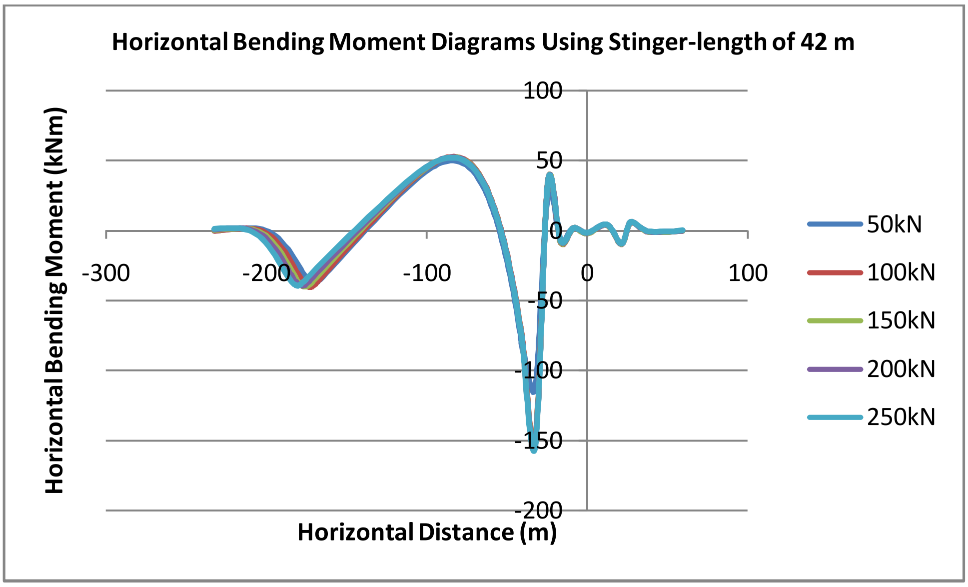

Figure 4.7 Horizontal bending moment diagrams when it use a constant stinger-length and is exposed to different values of tension

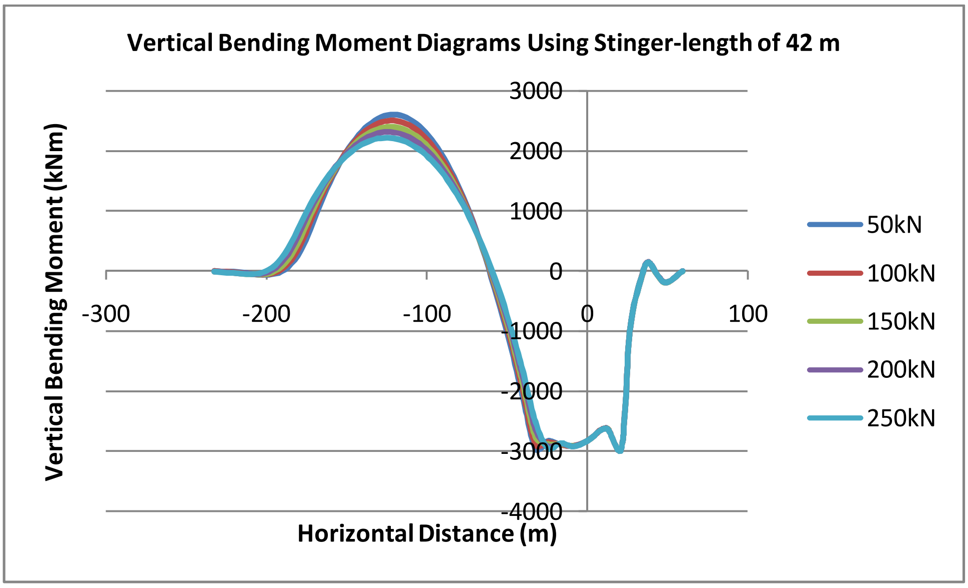

Figure 4.8 Vertical bending moment diagrams when it use a constant stinger-length and is exposed to different values of tension

In Fig. 4.7, we can explain that the horizontal bending moments that occur for the five variations of tension value are similar, except for at point x = 32.37 m (overbend region). At this point, there is a significant difference of moment. At this point, tension value of 50 kN generates the lowest bending moment, and is quite far compared to those generated from the other tension values. The highest negative horizontal bending moment occurs also in this point, which is -154.45 kNm, produced by tension value of 250 kN. In the sagbend region, the highest positive horizontal bending moment occurs at point x = -85.13 m, which is 52.93 kNm, generated from tension value of 100 kN. Still in the sagbend region, about point x = -145 m through x = -180 m, the higher the tension value, the lower the horizontal bending moment. From point x = -180 m onwards, the tension values changes opposite. The higher the tension, the higher the negative bending moment. Approaching seabed or the touchdown point, these values of bending moment are becoming equal.

Graph in Fig. 4.8 shows that, from point x = 59.44 m (overbend region) through about x = -25 m, the vertical bending moments generated by all the tension values are similar. The highest negative bending moment occurs at point x = 21.34 m (overbend region), which is -2948.96 kNm. This bending moment is generated from tension value of 250 kN, but there are no significant differences with the other four tension values, at this point. In the sagbend region, from about point x = -70 m through x = -155 m, the higher the tension value, the lower the positive vertical bending moment. From x = -155 onwards, the moment values change opposite, and become equal when approaching the seabed.

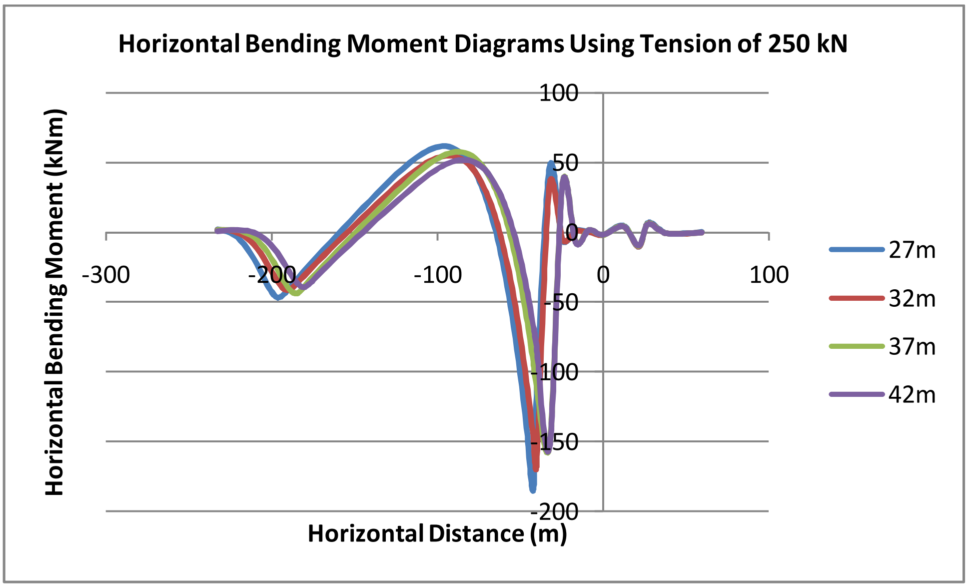

Figure 4.9 Horizontal Bending Moment Diagrams when it is exposed to constant tension and use different values of stinger-length

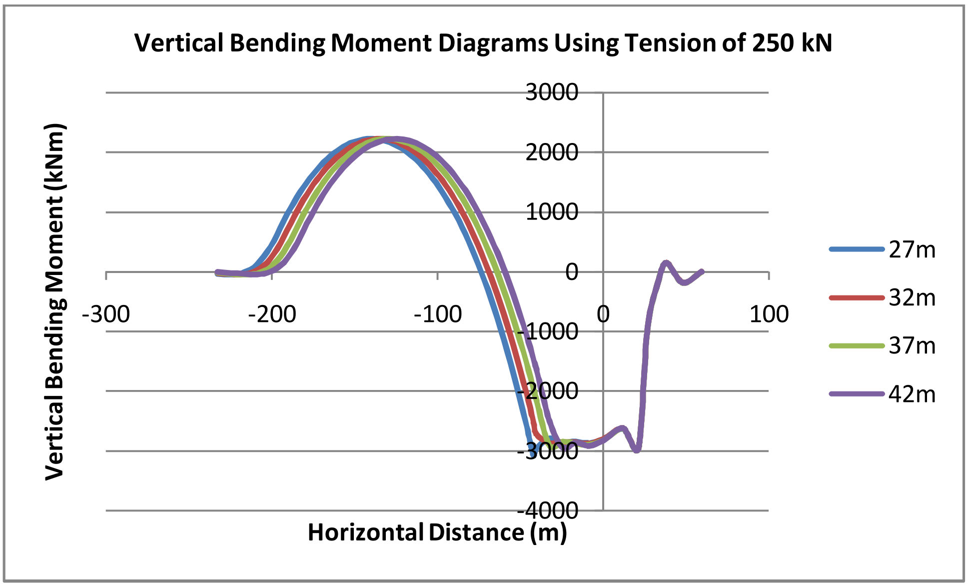

Figure 4.10 Vertical Bending Moment Diagrams when it is exposed to constant tension and use different values of stinger-length

In Fig. 4.9, It is obvious that the horizontal bending moments generated are very varying and keep changing opposite at several certain points. In the overbend region, specifically from point x = 59.44 m through x = -10 m, the moments are similar. In overbend region, the highest positive bending moment occurs at about point x = -32.37 m, which is 46.15 kNm. Whereas the highest negative bending moment occurs at location x = -42.18 m, which is -184.94 kNm. Both are generated from stinger-length of 27 m. In the sagbend region, the highest positive bending moment occurs at point x = -96.91 m, which is 61.38 kNm. For the highest negative bending moment, it is at x = -196.56 m, that is -46.77 kNm. Both are also generated from stinger-length of 27 m. According to the graph, the shorter the stinger, the higher the vertical bending moment.

Graph in Fig. 4.10 indicates that, in the overbend region, the four variations of stinger-length produce equal vertical bending moments. The highest positive bending moment occurs at point x = 38.1 m, which is 150.57 kNm. Whereas the highest negative bending moment occurs at location x = 21.34 m, which is about -2943 kNm. In the sagbend region, the highest positive bending moment occurs at point x = -140.58 m, which is 2223.63 kNm. For the highest negative bending moment, it is at x = -42.18 m, which is -3062.73 kNm. Both are generated from 27 m long stinger. Except for the sagbend region, specifically from point x = -60 m through x = -130 m, and for the overbend region, the shorter the stinger, the higher the vertical bending moment.

4.3.3 Effect of Tension and Stinger-length Variation on Axial, Horizontal and Vertical Bending Stresses

In previous section, we have learned the effects of varying tension and stinger-length on horizontal and vertical bending moments. Now, we will examine the similar effect for the axial stresses, also for the corresponding horizontal and vertical stresses. By means of OFFPIPE, we have obtained the following results:

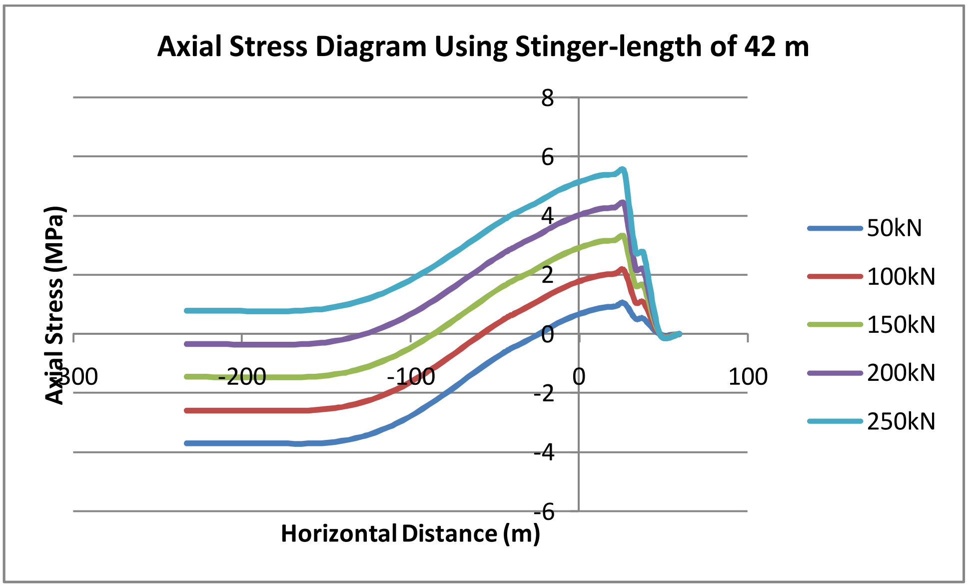

Figure 4.11 Axial stress diagrams when it uses constant stingerlength (42m) and is exposed to different values of tension

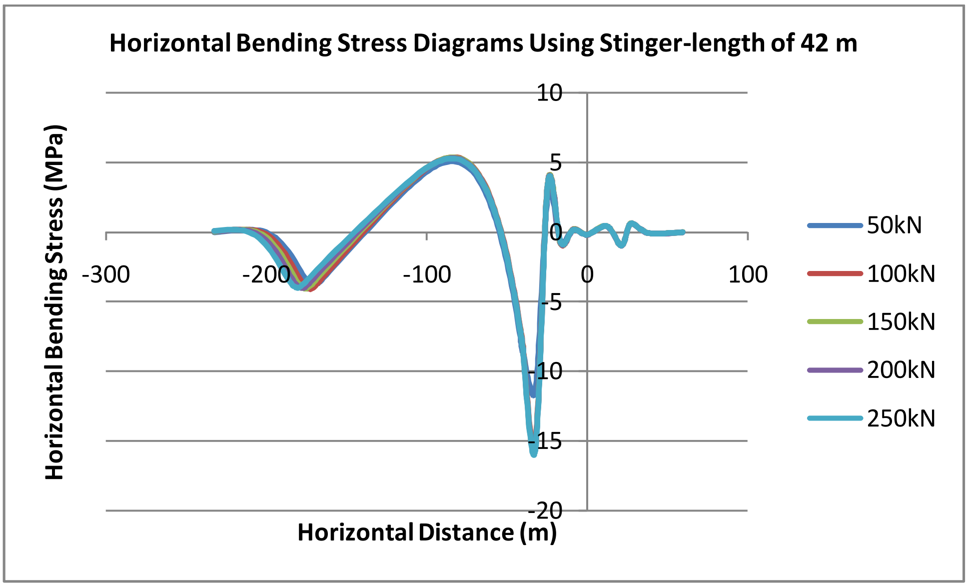

Figure 4.12 Horizontal bending stress diagrams when it uses constant stingerlength (42m) and is exposed to different values of tension

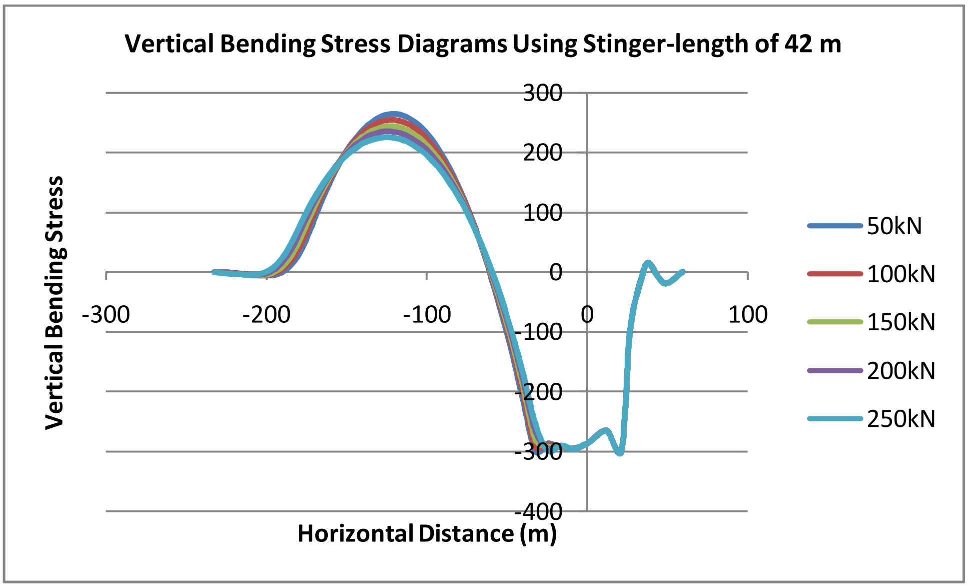

Figure 4.13 Vertical bending stress diagrams when it uses constant stingerlength (42m) and is exposed to different values of tension

In Fig. 4.11, we can see clearly that the higher the value of tension, the higher the tensile stress (positive sign). Then conversely, the lower the value of tension, the higher the compressive stress (negative sign). In this graph, the highest tensile stress is generated from tension value of 250 kN, which is 5.53 MPa. It occurs in overbend region. Whereas the highest compressive stress is produced by tension value of 50 kN, which is -3.71 MPa. In the figure, we can understand that stresses that occur in the overbend region are equal for the five tension variations, specifically at point x = 59.44 m through x = 48.01 m. From point x = 48.01 (overbend region) onwards, passing the sagbend region to the touchdown point, the stresses generated by all tension variations starts to change. It can be concluded that the use of tension value of 150 kN is the best option, because the stresses generated are in the middle, between tensile and compressive stresses. Graph in the Fig. 4.12 indicates that the horizontal bending stresses that occur for the five variations of tension value are similar, except for at point x = 32.37 m (overbend region). At this point, there is a significant difference of stress. At this point, tension value of 50 kN generates the lowest bending stress, and is fairly far compared to those generated from the other tension values. The highest negative horizontal bending stress occurs also in this point, which is -15.68 MPa, generated from tension value of 250 kN. In the sagbend region, the highest positive horizontal bending stress occurs at point x = -85.13 m, which is 5.37 MPa, generated from tension value of 100 kN. Still in the sagbend region, about point x = -145 m through x = -180 m, the higher the tension value, the lower the negative horizontal bending stress. From point x = -180 m onwards, the tension values switch opposite. The higher the tension, the higher the negative bending stress. Approaching seabed or the touchdown point, these values of bending stress are becoming equal. In Fig.4.13, we can see that, from point x = 59.44 m (overbend region) through about x = -25 m, the vertical bending stresses produced by the five tension values are equal. The highest negative bending stress occurs at point x = 21.34 m (overbend region), which is -299.38 MPa. This bending stress is generated from tension value of 250 kN, but there are no significant differences with the other four tension values, at this point. In the sagbend region, from about point x = -70 m through x = -155 m, the higher the tension value, the lower the positive vertical bending stress. From x = -155 onwards, the stress values change opposite, and become uniform when approaching the seabed.

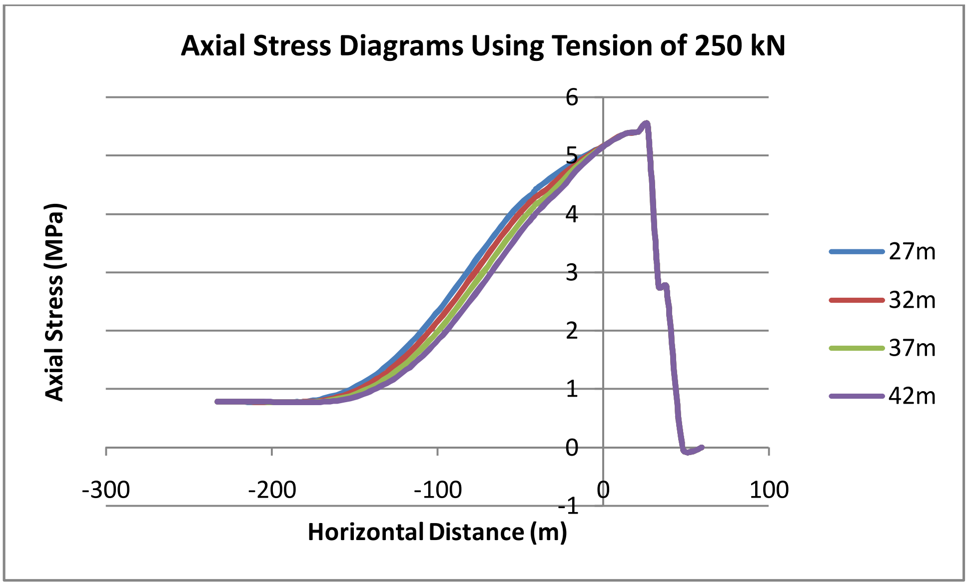

Figure 4.14 Axial stress diagrams when it is exposed to constant tension (250kN) and use different values of stinger-length

According to the graph in Fig. 4.14, we can see obviously that the use of the 42 m long stinger is the best option. It because the stinger-length of 42 m generates the lowest tensile stresses. In the overbend region , from point x = 59.44 m through x = -12 m, the five stinger-length variations generate equal stresses. The highest stress occurs at point x = 26.67 m, which is 5.53 MPa. However, from point x = -12 m through the touchdown point, which most part is sagbend region, the shorter the stinger, the highest the tensile stress. In the sagbend region, the highest tensile stress occurs at point x = -46.09 m, which is 4.27 MPa, generated from stinger-length of 27 m.

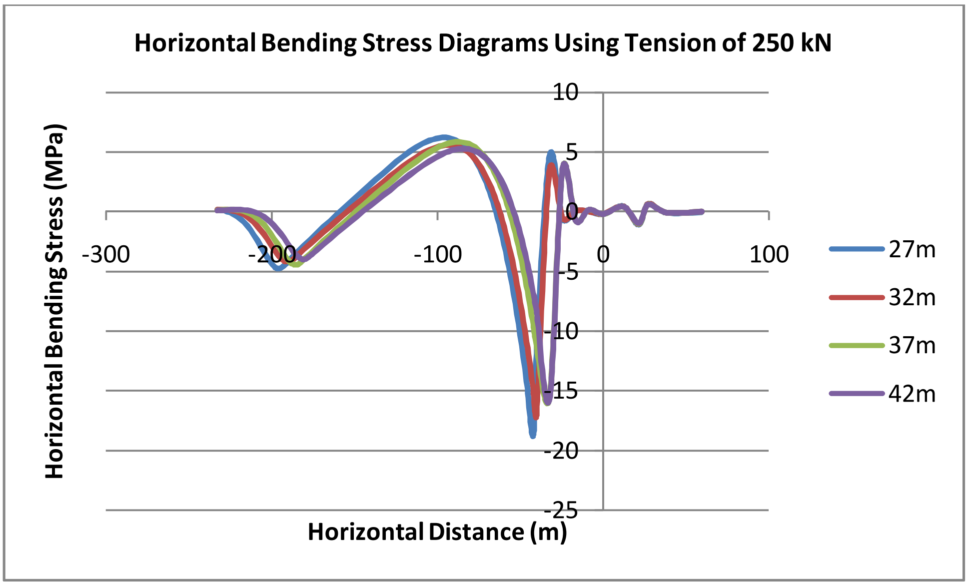

Figure 4.15 Horizontal bending stress diagrams when it is exposed to constant tension (250kN) and use different values of stinger-length

In Fig. 4.15, the horizontal bending stresses produced are very varying and keep changing opposite at several certain points. In the overbend region, specifically from point x = 59.44 m through x = -10 m, the stresses are equal. In overbend region, the highest positive bending stress occurs at about point x = -25 m, which is 5 MPa. Whereas the highest negative bending stress occurs at location x = -42.18 m, which is -18.78 MPa. Both are generated from stinger-length of 27 m. in the sagbend region, the highest positive bending stress occurs at point x = -96.91

m, which is 6.23 MPa. For the highest negative bending stress, it is at x = -196.56 m, that is -4.75 MPa. Both are also generated from stinger-length of 27 m. According to the graph, the shorter the stinger, the higher the vertical bending stress.

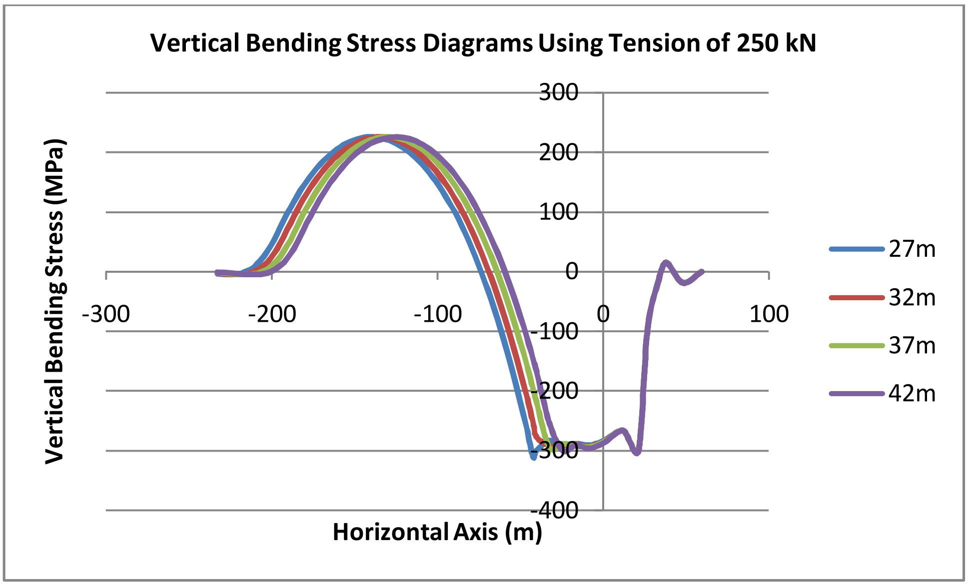

Figure 4.16 Vertical bending stress diagrams when it is exposed to constant tension (250kN) and use different values of stinger-length

Graph in Fig. 4.16 shows that, in the overbend region, the four variations of stinger-length produce equal vertical bending stresses. The highest positive bending stress occurs at point x = 38.1 m, which is 15.29 MPa. Whereas the highest negative bending stress occurs at location x = 21.34 m, which is about 299 MPa. In the sagbend region, the highest positive bending stress occurs at point x = -140.58 m, which is 225.75 MPa. For the highest negative bending stress, it is at x = -42.18 m, which is -310.93 MPa. Both are generated form 42 m long stinger. Except for the sagbend region, specifically from point x = -60 m through x = -130 m, and for the overbend region, the shorter the stinger, the highest the vertical bending stress.

4.4 Validation of Stresses Results

The pipeline stresses results are validated with the results of manual calculations. Similarly, the manual calculations is performed for stinger-length of 42 m, for each variation of tension value.

4.4.1 Pipe Stresses for Tension of 50 kN

For tension of 50 kN, stinger-length of 42 m, and pipe node depth, h, of -13 m, the pipe stresses are displayed below

OFFPIPE Results

σ_t = -1.93 MPa

σ_{hor} = 5.08 MPa

σ_{ver} = 170.21 MPa

σ_c = 170.28 MPa

σ_h = -3.78 MPa

σ_{vm} = 170.28 MPa

Manual Calculation

$$\sigma_t = \frac{50}{0.0448} + \frac{1}{4}(3.14)(0.9144)^2(10055.25)\left(\frac{-13}{0.0448}\right)$$

$$= -1.91\ MPa$$

$$\sigma_{hor} = \frac{1}{2}(50010)\frac{0.9144}{0.004532}(1)$$

$$= 5.04\ MPa$$

$$\sigma_{ver} = \frac{1}{2}(1676630)\frac{0.9144}{0.004532}(1)$$

$$= 169.14\ MPa$$

$$\sigma_c = \sqrt{(5.04)^2 + (169.14)^2}$$

$$= 169.22\ MPa$$

$$\sigma_h = \frac{1}{2}(10055.25)(0.9144)\frac{-13}{0.01588}$$

$$= -3.76\ MPa$$

$$\sigma_{vm} = \left[(169.22 + (-1.91))^2 + (-3.76)^2 - \big(169.22 + (-1.91)\big)(-3.76)\right]^{\frac{1}{2}}$$
$$= 169.22\ MPa$$

4.4.2 Pipe Stresses for Tension of 100 kN

For tension of 100 kN, stinger-length of 42 m, and pipe node depth, h, of -12.89 m, the pipe stresses are displayed below.

OFFPIPE Results

σ_t = -1.92 MPa

σ_{hor} = 5.37 MPa

σ_{ver} = 164.13 MPa

σ_c = 164.22 MPa

σ_h = -3.75 MPa

σ_{vm} = 164.20 MPa

$$\sigma_t \quad = \frac{100}{0.0448} + \frac{1}{4}(3.14)(0.9144)^2(10055.25)\left(\frac{-12.89}{0.0448}\right)$$

$$= -1.90\ MPa$$

$$\sigma_{hor} = \frac{1}{2}(52930)\frac{0.9144}{0.004532}(1)$$

$$= 5.34\ MPa$$

$$\sigma_{ver} = \frac{1}{2}(1616670)\frac{0.9144}{0.004532}(1)$$

$$= 163.10\ MPa$$

$$\sigma_c = \sqrt{(5.34)^2 + (163.10)^2}$$

$$= 163.18\ MPa$$

$$\sigma_h = \frac{1}{2}(10055.25)(0.9144)\frac{-12.89}{0.01588}$$

$$= -\ 3.73 MPa$$

$$\sigma_{vm} = \left[\left(163.18 + (-1.90)\right)^2 + (-3.73)^2 - \left(163.18 + (-1.90)\right)(-3.73)\right]^{\frac{1}{2}}$$

$$= 163.18\ MPa$$

4.4.3 Pipe Stresses for Tension of 150 kN

For tension of 150 kN, stinger-length of 42 m, and pipe node depth, h, of -12.76 m, the pipe stresses are displayed below.

OFFPIPE Results

σ_t = -1.90 MPa

σ_{hor} = 5.35 MPa

σ_{ver} = 157.88 MPa

σ_c = 157.97 MPa

σ_h = -3.71 MPa

σ_{vm} = 157.96 MPa

Manual Calculation

$$\sigma_t = \frac{150}{0.0448} + \frac{1}{4}(3.14)(0.9144)^2(10055.25)\left(\frac{-12.76}{0.0448}\right)$$

$$= -1.88\ MPa$$

$$\sigma_{hor} = \frac{1}{2}(52680)\frac{0.9144}{0.004532}(1)$$

$$= \ 5.31\ MPa$$

$$\sigma_{ver} = \frac{1}{2}(1555130)\frac{0.9144}{0.004532}(1)$$

$$= 156.88\ MPa$$

$$\sigma_c = \sqrt{(5.31)^2 + (156.88)^2}$$

$$= 156.97\ MPa$$

$$\sigma_h = \frac{1}{2}(10055.25)(0.9144)\frac{-12.76}{0.01588}$$

$$= -\ 3.69\ MPa$$

$$\sigma_{vm} = \left[\left(156.97 + (-1.88)\right)^2 + (-3.69)^2 - \left(156.97 + (-1.88)\right)(-3.69)\right]^{\frac{1}{2}}$$

$$= 156.97\ MPa$$

4.4.4 Pipe Stresses for Tension of 200 kN

For tension of 200 kN, stinger-length of 42 m, and pipe node depth, h, of -12.64 m, the pipe stresses are displayed below.

OFFPIPE Results

σ_t = -1.88 MPa

σ_{hor} = 5.32 MPa

σ_{ver} = 152.02 MPa

σ_c = 152.11 MPa

σ_h = -3.68 MPa

σ_{vm} = 152.11 MPa

Manual Calculation

$$\sigma_t = \frac{200}{0.0448} + \frac{1}{4}(3.14)(0.9144)^2(10055.25)\left(\frac{-12.64}{0.0448}\right)$$

$$= -1.86\ MPa$$

$$\sigma_{hor} = \frac{1}{2}(52370)\frac{0.9144}{0.004532}(1)$$

$$= 5.28\ MPa$$

$$\sigma_{ver} = \frac{1}{2}(1497440)\frac{0.9144}{0.004532}(1)$$

$$= 151.06\ MPa$$

$$\sigma_c = \sqrt{(5.28)^2 + (151.06)^2}$$

$$= 151.16\ MPa$$

$$\sigma_h = \frac{1}{2}(10055.25)(0.9144)\frac{-12.64}{0.01588}$$

$$= -\ 3.66\ MPa$$

$$\sigma_{vm} = \left[\left(151.16 + (-1.86)\right)^2 + (-3.66)^2 - \left(151.16 + (-1.86)\right)(-3.66)\right]^{\frac{1}{2}}$$

$$= 151.16\ MPa$$

4.4.5 Pipe Stresses for Tension of 250 kN

For tension of 250 kN, stinger-length of 42 m, and pipe node depth, h, of -12.52 m, the pipe stresses are displayed below.

OFFPIPE Results

σ_t = -1.86 MPa

σ_{hor} = 5.29 MPa

σ_{ver} = 146.54 MPa

σ_c = 146.63 MPa

σ_h = -3.64 MPa

σ_{vm} = 146.63 MPa

Manual Calculation

$$\sigma_t = \frac{250}{0.0448} + \frac{1}{4}(3.14)(0.9144)^2(10055.25)\left(\frac{-12.52}{0.0448}\right)$$

$$= -1.84\ MPa$$

$$\sigma_{hor} = \frac{1}{2}(52060)\frac{0.9144}{0.004532}(1)$$

$$= 5.25\ MPa$$

$$\sigma_{ver} = \frac{1}{2}(1443410)\frac{0.9144}{0.004532}(1)$$

$$= 145.61\ MPa$$

$$\sigma_c = \sqrt{(5.25)^2 + (145.61)^2}$$

$$= 145.71\ MPa$$

$$\sigma_h = \frac{1}{2}(10055.25)(0.9144)\frac{-12.52}{0.01588}$$

$$= -\ 3.62\ MPa$$

$$\sigma_{vm} = \left[\left(145.71 + (-1.84)\right)^2 + (-3.62)^2 - \left(145.71 + (-1.84)\right)(-3.62)\right]^{\frac{1}{2}}$$

$$= 145.72\ MPa$$

Table 4.9 Stresses Comparison between OFFPIPE and Manual Calculation Results

Stress Type	Tension (kN)									
	50		100		150		200		250	
	Sofware	Manual	Sofware	Manual	Sofware	Manual	Sofware	Manual	Sofware	Manual
σ_t(MPa)	-1.93	-1.91	-1.92	-1.90	-1.90	-1.88	-1.88	-1.86	-1.86	-1.84
σ_{hor}(MPa)	5.08	5.04	5.37	5.34	5.35	5.31	5.32	5.28	5.29	5.25
σ_{ver} (MPa)	170.21	169.14	164.13	163.10	157.88	156.88	152.02	151.06	146.54	145.61
σ_c(MPa)	170.28	169.22	164.22	163.18	157.97	156.97	152.11	151.16	146.63	145.71
σ_h(MPa)	-3.78	-3.76	-3.75	-3.73	-3.71	-3.69	-3.68	-3.66	-3.64	-3.62
σ_{vm}(MPa)	170.28	169.22	164.20	163.18	157.96	156.97	152.11	151.16	146.63	145.72

Based on the table above, we can see that the stresses results obtained from OFFPIPE software and those obtained from manual calculation are almost similar, therefore, the validity of OFFPIPE results are acceptable.

4.5 Discussion and Conclusion of Static Analysis

The summary of S-Lay curves for all tension variations using one stinger-length value, that is 42m, is shown in Fig. 4.21 below

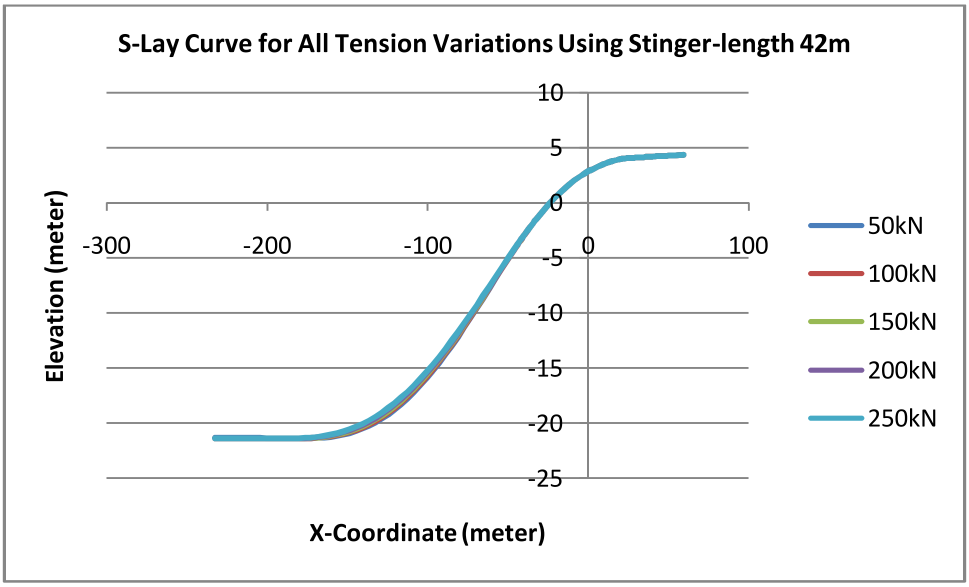

Figure 4.17 S-Lay Shape for each Tension Variation Using 42m Long Stinger

Similarly, the stress distribution for all tension variations using 42m long stinger-length is displayed in Fig. 4.8 below

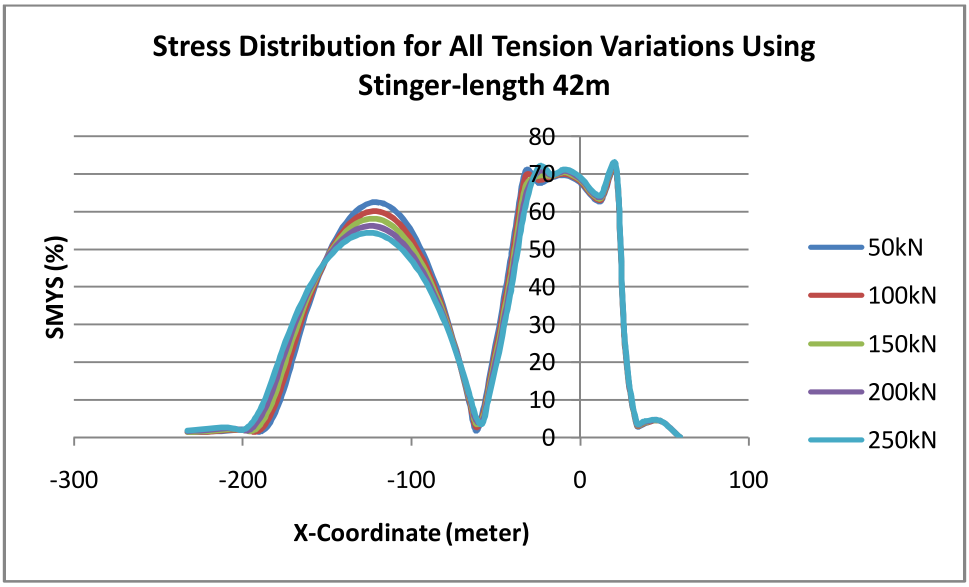

Fig.4.18 Stress Distribution for each Tension Variation Using 42m Long Stinger

Conversely, the summary of S-Lay curves for all Stinger-length variations using one tension value, that is 50 kN, can be seen in the following figure

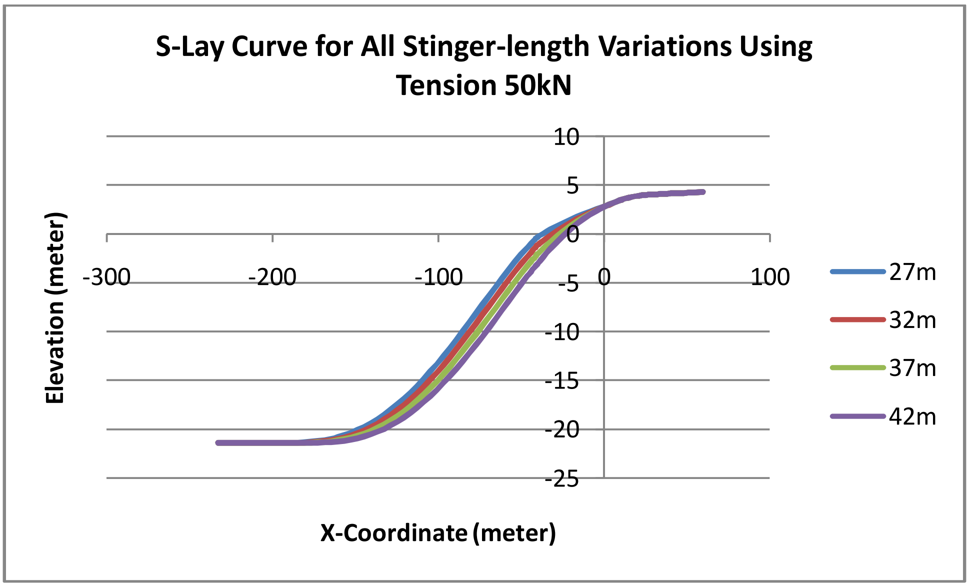

Figure 4.19 S-Lay Shape for each Stinger-length Variation Using Tension of 50kN

Whereas the stress distribution for each stinger-length variation using tension of 50 kN is displayed in Fig. 4.10 below

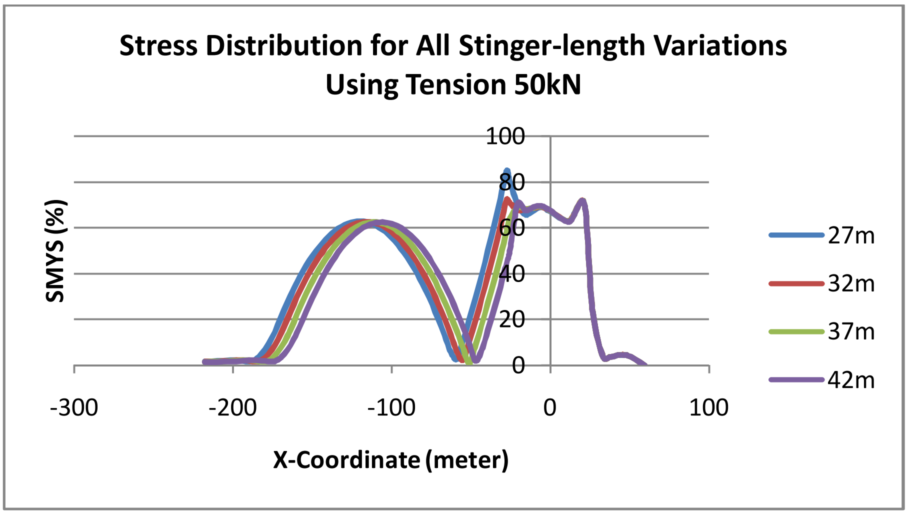

Figure 4.20 Stress Distribution for each Stinger-length Variation Using Tension of50 kN

In Fig. 4.17, we can see that all pipeline shapes generated by the five tension variation show that there are no significant differences. However, stresses generated by these values of tension are quite different. Graph in Fig. 4.18 explains about the Specified Minimum Yield Stress (SMYS) at each node along the pipeline. In overbend region, the maximum SMYS that occurs is 72.19 %, generated by tension of 250 kN. It is situated at point x = 21.34 m. However, in this region, specifically from point x = 59.44 m through about x = -15 m, stresses produced by all tension variations are similar. In sagbend region, the maximum SMYS that occurs is 62.59 %, which is located at point x = -120.65 m. It is produced from tension of 50 kN. From point x = -50 m through x = -150 m, the higher the tension, the lower the stress. From point x = -150 m through x = -200 m, the stress values change opposite, and become equal when approaching the seabed.

Conversely, using a constant value of tension yields different shapes of pipeline for each stinger-lenght variation, as shown in Fig. 4.19. In Fig. 4.20, we can see that the stresses generated by the four stinger-length variations are quite varying. In overbend region, the highest SMYS occurs at point x = -27.45 m, which is 84.88 %. It is generated by stinger-length of 27 m. In sagbend region, the highest SMYS occurs at point x = -121.63 m, which is 62.82 %. It is also generated from stinger-length of 27 m. According to the graph, except for a certain part in sagbend region, the shorter the stinger, the higher the stress or the SMYS.

The maximum stressess that occur in both overbend and sagbend region for all stinger-length variations for each tension variation are summarized in Table 4.10 through 4.13.

Table 4.10Maximum Stresses for each Tension Variation, Stinger-length 27m

TENSION	STINGER:	27m			
	CRITICAL POINT	STRESS (MPa)	%SMYS	ALLOWABLE SMYS	CONDITION
50kN	Overbend	305.58	84.88		not safe
	Sagbend	226.16	62.82		
100kN	Overbend	296.22	82.28		not safe
	Sagbend	217.37	60.38		
150kN	Overbend	287.21	79.78	72%	not safe
	Sagbend	209.89	58.3		
200kN	Overbend	278.12	77.26		not safe
	Sagbend	202.59	56.27		
250kN	Overbend	269.23	74.79		not safe
	Sagbend	195.86	54.4		

Table 4.11Maximum Stresses for each Tension Variation, Stinger-length 32m

TENSION	STINGER:	32m			
	CRITICAL POINT	STRESS (MPa)	%SMYS	ALLOWABLE SMYS	CONDITION
50kN	Overbend	260.12	72.26		not safe
	Sagbend	225.25	62.57		
100kN	Overbend	250.06	69.46		Safe
	Sagbend	216.68	60.19		
150kN	Overbend	257.2	71.45	72%	Safe
	Sagbend	209.45	58.18		
200kN	Overbend	258.38	71.77		Safe
	Sagbend	202.39	56.22		
250kN	Overbend	259.55	72.1		not safe
	Sagbend	195.63	54.34		

Table 4.12 Maximum Stresses for each Tension Variation, Stinger-length 37m

TENSION	STINGER: 37m				
	CRITICAL POINT	STRESS (MPa)	%SMYS	ALLOWABLE SMYS	CONDITION
50kN	Overbend	255.03	70.84	72%	Safe
	Sagbend	225.11	62.53		
100kN	Overbend	256.21	71.17		Safe
	Sagbend	216.44	60.12		
150kN	Overbend	257.38	71.49		Safe
	Sagbend	209.39	58.16		
200kN	Overbend	258.55	71.82		Safe
	Sagbend	202.46	56.24		
250kN	Overbend	259.72	72.15		not safe
	Sagbend	195.7	54.36		

Table 4.13 Maximum Stresses for each Tension Variation, Stinger-length 42m

TENSION	STINGER: 42m				
	CRITICAL POINT	STRESS (MPa)	%SMYS	ALLOWABLE SMYS	CONDITION
50kN	Overbend	255.21	70.89	72%	Safe
	Sagbend	225.32	62.59		
100kN	Overbend	256.38	71.22		Safe
	Sagbend	216.64	60.18		
150kN	Overbend	257.55	71.54		Safe
	Sagbend	209.29	58.14		
200kN	Overbend	258.72	71.87		Safe
	Sagbend	202.42	56.23		
250kN	Overbend	259.89	72.19		not safe
	Sagbend	195.7	54.36		

Based on above tables, Table 4.10 is the only one that produces dangerous installation. None of the tension variation delivers a safe pipelaying process. Therefore, the use of 27 meter stinger must be avoided. According to the results shown in those tables, we can make the following conclusions.

- We can not use the 27 meter long stinger.
- In overbend region, the maximum stress undergone by the pipeline is 305.58 MPa, that is, the one that uses 27 meter stinger and tension of 50

kN. Whereas the minimum stress is 250.06 MPa, that is, the one that uses 32 meter stinger and tension of 100 kN.

- In sagbend region, the maximum stress undergone by the pipeline is 226.16 MPa, that is, the one that uses 27 meter stinger and tension of 50 kN. Whereas the minimum stress is 195.63 MPa, that is, the one that uses 32 meter stinger and tension of 250 kN.
- Among all safe variations, the lowest stress that occurs in overbend region is the one that uses stinger-length of32m and tension of 100kN. Whereas the lowest stress that occurs in sagbend region is the one that uses stinger-length of 32m and tension of 200kN.

Overall, based on Fig. 4.7 through 4.10 and Table 4.10 through 4.13, one should use one of these two options for the most efficient pipeline installation process:

1) Using 32 meter long stinger and tension of 100 kN.
2) Using 32 meter long stinger and tension of 200 kN.

APPENDICES

APPENDIX A. Calculation of Radius of Curvature

In order to compute the overbend radius of curvature, we use the following equation:

$$R = \frac{ED}{2\sigma_0 DF}$$

Where:

E = Elastic modulus = 207692.31 MPa

D = Outside steel diameter of pipe = 0.9144 m

σ_0 = Specified minimum yield stress of pipe = 360 MPa

DF = Design factor = 0.72

Then

$$R = \frac{(207692.31)(0.9144)}{2(360)(0.72)}$$

$R =$ 366.35 m

The overbend radius of curvature of 366.35 m is then inserted as OFFPIPE input to compute the total stresses along the pipeline.

APPENDIX B. Calculation of Weight of Submerged Pipeline

The unit submerged weight for a cylindrical pipe, where the unit volume is given by (pi/4)d_o^2, is

$$w_s = \frac{\pi}{4}(d_o^2(\rho_s - \rho_w) - d_i^2\rho_s)g$$

Where:

d_o = Outside diameter of steel pipe = 0.9144 m

d_i = Inner diameter of steel pipe = 0.8826 m

ρ_s = Steel density of pipe = 7850 kg/m^3

ρ_w = Sea water density = 1025 kg/m^3

g = Gravity acceleration = 9.81 m/s^2

So we have

$w_s = \frac{3.14}{4}((0{,}9144)^2(7850 - 1025) - (0.8826)^2 7850)9.81$

w_s = 3145.38 N/m

APPENDIX C. OFFPIPE Input Data

```
=============================================================================
OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X         PAGE   3
ANALISA STATIS PIPA TPPI
JOB NO. - 113                   LICENSED TO: MCDERMOTT, INCORPORATED
USER ID - N.FURQON              DATE -  7/28/2016  TIME - 20:23:35    CASE   1
=============================================================================

                        I N P U T   D A T A   E C H O


PRINTED OUTPUT SELECTED
=======================
   STATIC PIPE FORCES AND STRESSES ...YES
   STATIC SOLUTION SUMMARY ...........YES
   OVERBEND PIPE SUPPORT GEOMETRY ....YES
   STINGER BALLAST SCHEDULE DATA .....YES
   DYNAMIC PIPE FORCES AND STRESSES ..YES
   DYNAMIC RANGE OF PIPE DATA ........NO
   DYNAMIC TRACKING OF PIPE DATA .....NO
   PLOT DATA FILE SUMMARY TABLES .....NO

   PRINT PIPE STRAINS IN OUTPUT ......NO
   USE DNV STRESS FORMULA ............YES
   USE THICK WALL CYLINDER FORMULA ...NO
   DISABLE WARNING MESSAGE PAUSE .....NO

PROFILE PLOT TABLE ENTRIES
==========================
   PLOT TABLE INDEX .................         1
   PLOT NUMBER ......................         1
   PLOT TYPE OPTION NUMBER ..........         1
   DYNAMIC PROFILE TIME POINT ........      .000
   DYNAMIC PROFILE TIME INCREMENT ....      .000
   ORDINATE PARAMETER CODE NUMBER ....       15
   AXIS LABEL FOR ORDINATE ........... "STRESS % OF SMYS             "
   ABSCISSA PARAMETER CODE NUMBER ....        1
   AXIS LABEL FOR ABSCISSA ........... "GLOBAL X COORDINTE           "

   PLOT TITLE ....................... "DNV STRESS                                         "
   MINIMUM HORIZONTAL AXIS RANGE .....      .000
   MAXIMUM HORIZONTAL AXIS RANGE .....      .000
   MINIMUM VERTICAL AXIS RANGE .......      .000
   MAXIMUM VERTICAL AXIS RANGE .......      .000


=============================================================================
OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X         PAGE   4
ANALISA STATIS PIPA TPPI
JOB NO. - 113                   LICENSED TO: MCDERMOTT, INCORPORATED
USER ID - N.FURQON              DATE -  7/28/2016  TIME - 20:23:35    CASE   1
=============================================================================

                        I N P U T   D A T A   E C H O


PROFILE PLOT TABLE ENTRIES
==========================
   PLOT TABLE INDEX .................         2
   PLOT NUMBER ......................         1
   PLOT TYPE OPTION NUMBER ..........         1
   DYNAMIC PROFILE TIME POINT ........      .000
   DYNAMIC PROFILE TIME INCREMENT ....      .000
   ORDINATE PARAMETER CODE NUMBER ....        2
   AXIS LABEL FOR ORDINATE ........... "ELEVATION                    "
   ABSCISSA PARAMETER CODE NUMBER ....        1
   AXIS LABEL FOR ABSCISSA ........... "GLOBAL X COORDINATE          "

   PLOT TITLE ....................... "PIPELINE PROFILE                                   "
   MINIMUM HORIZONTAL AXIS RANGE .....      .000
```

```
   MAXIMUM HORIZONTAL AXIS RANGE .....      .000
   MINIMUM VERTICAL AXIS RANGE .......      .000
   MAXIMUM VERTICAL AXIS RANGE .......      .000

PROFILE PLOT TABLE ENTRIES
==========================
   PLOT TABLE INDEX .................         1
   PLOT NUMBER ......................         1
   PLOT TYPE OPTION NUMBER ..........         1
   DYNAMIC PROFILE TIME POINT ........      .000
   DYNAMIC PROFILE TIME INCREMENT ....      .000
   ORDINATE PARAMETER CODE NUMBER ....        2
   AXIS LABEL FOR ORDINATE ........... "PIPE ELEVATION Y COORDINATE     "
   ABSCISSA PARAMETER CODE NUMBER ....        1
   AXIS LABEL FOR ABSCISSA ........... "PIPE HORIZONTAL X COORDINATE    "

   PLOT TITLE ....................... "PIPE ELEVATION AND TOTAL PIPE STRESS                    "
   MINIMUM HORIZONTAL AXIS RANGE .....      .000
   MAXIMUM HORIZONTAL AXIS RANGE .....      .000
   MINIMUM VERTICAL AXIS RANGE .......      .000
   MAXIMUM VERTICAL AXIS RANGE .......      .000


===============================================================================
OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X         PAGE   5
ANALISA STATIS PIPA TPPI
JOB NO. - 113                  LICENSED TO: McDERMOTT, INCORPORATED
USER ID - N.FURQON             DATE -  7/28/2016  TIME - 20:23:35    CASE   1
===============================================================================

                        I N P U T   D A T A   E C H O


PROFILE PLOT TABLE ENTRIES
==========================
   PLOT TABLE INDEX .................         2
   PLOT NUMBER ......................         1
   PLOT TYPE OPTION NUMBER ..........         1
   DYNAMIC PROFILE TIME POINT ........      .000
   DYNAMIC PROFILE TIME INCREMENT ....      .000
   ORDINATE PARAMETER CODE NUMBER ....       14
   AXIS LABEL FOR ORDINATE ........... "TOTAL STRESS VON MISSES         "
   ABSCISSA PARAMETER CODE NUMBER ....        1
   AXIS LABEL FOR ABSCISSA ........... "PIPE HORIZONTAL X COORDINATE    "

   PLOT TITLE ....................... "PIPE ELEVATION AND TOTAL PIPE STRESS                    "
   MINIMUM HORIZONTAL AXIS RANGE .....      .000
   MAXIMUM HORIZONTAL AXIS RANGE .....      .000
   MINIMUM VERTICAL AXIS RANGE .......      .000
   MAXIMUM VERTICAL AXIS RANGE .......      .000

PROFILE PLOT TABLE ENTRIES
==========================
   PLOT TABLE INDEX .................         3
   PLOT NUMBER ......................         2
   PLOT TYPE OPTION NUMBER ..........         1
   DYNAMIC PROFILE TIME POINT ........      .000
   DYNAMIC PROFILE TIME INCREMENT ....      .000
   ORDINATE PARAMETER CODE NUMBER ....       10
   AXIS LABEL FOR ORDINATE ........... "Vertical Bending Moment         "
   ABSCISSA PARAMETER CODE NUMBER ....        1
   AXIS LABEL FOR ABSCISSA ........... "Pipe Horizontal X Coordinate    "

   PLOT TITLE ....................... "Vertical Bending Moment & Pipe Support Reaction         "
   MINIMUM HORIZONTAL AXIS RANGE .....      .000
   MAXIMUM HORIZONTAL AXIS RANGE .....      .000
   MINIMUM VERTICAL AXIS RANGE .......      .000
   MAXIMUM VERTICAL AXIS RANGE .......      .000
```

```
                        I N P U T   D A T A   E C H O


PROFILE PLOT TABLE ENTRIES
==========================
   PLOT TABLE INDEX ..................        4
   PLOT NUMBER .......................        2
   PLOT TYPE OPTION NUMBER ...........        1
   DYNAMIC PROFILE TIME POINT ........     .000
   DYNAMIC PROFILE TIME INCREMENT ....     .000
   ORDINATE PARAMETER CODE NUMBER ....        7
   AXIS LABEL FOR ORDINATE ........... "Vertical Pipe Support Reaction  "
   ABSCISSA PARAMETER CODE NUMBER ....        1
   AXIS LABEL FOR ABSCISSA ........... "Pipe Horizontal X Coordinate    "

   PLOT TITLE ........................ "Vertical Bending Moment & Pipe Support Reaction        "
   MINIMUM HORIZONTAL AXIS RANGE .....     .000
   MAXIMUM HORIZONTAL AXIS RANGE .....     .000
   MINIMUM VERTICAL AXIS RANGE .......     .000
   MAXIMUM VERTICAL AXIS RANGE .......     .000

PLOTTER CONFIGURATION
=====================
   PLOTTER TYPE OPTION NUMBER ........        3
   DATA RANGE OPTION NUMBER ..........        2
   PLOT PAGE WIDTH ( IN ) ............     .000
   PLOT PAGE HEIGHT ( IN ) ...........     .000

PIPE PROPERTIES
===============
   PIPE PROPERTY TABLE ROW INDEX .....        1
   PIPE SECTION LENGTH ...............     .000 M
   STEEL MODULUS OF ELASTICITY .......  207000. MPA
   STEEL CROSS SECTIONAL AREA ........     .000 CM**2
   COATED PIPE AVG MOMENT OF INERTIA .      .00 CM**4
   WEIGHT PER-UNIT-LENGTH IN AIR .....      .00 N/M
   WEIGHT PER-UNIT-LENGTH SUBMERGED ..      .00 N/M
   MAXIMUM ALLOWABLE PIPE STRAIN .....  .000000 PCT

   STEEL OUTSIDE DIAMETER ............  91.4400 CM
   STEEL WALL THICKNESS ..............   1.5800 CM
   YIELD STRESS ......................   360.00 MPA
   STRESS/STRAIN INTENSE FACTOR ......    .0000
   HYDRODYNAMIC OUTSIDE DIAMETER .....     .000 CM
   DRAG COEFFICIENT ..................    .0000
   HYDRODYNAMIC TOTAL AREA ...........     .000 CM**2
   ADDED MASS COEFFICIENT ............    .0000
   POISSON'S RATIO ...................    .3000
   COEFFICIENT OF THERMAL EXPANSION .. .00000000 1/DEG C
```



```
                        I N P U T   D A T A   E C H O


PIPE COATING PROPERTIES
=======================
   PIPE PROPERTY TABLE INDEX .........        1
```

CORROSION COATING THICKNESS .... .500 CM
CONCRETE COATING THICKNESS .... 7.500 CM
STEEL WEIGHT DENSITY 76985. N/M**3
CORROSION COATING WEIGHT DENSITY .. 18053. N/M**3
CONCRETE COATING WEIGHT DENSITY ... 29831. N/M**3
DESIRED PIPE SPECIFIC GRAVITY ..... .0000

AVERAGE PIPE JOINT LENGTH .... 12.200 M
FIELD JOINT LENGTH .... .620 M
JOINT FILL WEIGHT DENSITY 9807. N/M**3
DENSITY OF PIPE CONTENTS 0. N/M**3

LAYBARGE DESCRIPTION
====================
NUMBER OF PIPE NODES 8
BARGE GEOMETRY SPECIFIED BY .... 2 RADIUS AND TANGENT POINT
OVERBEND PIPE SUPPORT RADIUS ...... 360.000 M
TANGENT POINT X-COORDINATE .... 26.670 M
TANGENT POINT Y-COORDINATE .... 1.600 M
PIPE ANGLE RELATIVE TO DECK .... .5000 DEG
HEIGHT OF DECK ABOVE WATER .... 2.438 M
LAYBARGE FORWARD (X) OFFSET .... .000 M
BARGE TRIM ANGLE .... .0000 DEG

STERN SHOE X COORDINATE .... .000 M
STERN SHOE Y COORDINATE .... .000 M
ROTATION CENTER X COORDINATE ...... 42.380 M
ROTATION CENTER Y COORDINATE ...... -1.400 M
ROTATION CENTER Z COORDINATE ...... .000 M
BARGE HEADING .... .0000 DEG
BARGE OFFSET FROM RIGHT-OF-WAY .... .000 M
PIPE RAMP PIVOT X COORDINATE ...... .000 M
PIPE RAMP PIVOT Y COORDINATE ...... .000 M
PIPE RAMP PIVOT ROTATION ANGLE .... .000 DEG

==
OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X PAGE 8
ANALISA STATIS PIPA TPPI
JOB NO. - 113 LICENSED TO: MCDERMOTT, INCORPORATED
USER ID - N.FURQON DATE - 7/28/2016 TIME - 20:23:35 CASE 1
==

I N P U T D A T A E C H O

NODE X COORD (M)	NODE Y COORD (M)	SUPPORT TYPE	DAVIT SPACING (M)
59.436	.000	1 SIMPLE SUPPORT	.000
48.006	.000	1 SIMPLE SUPPORT	.000
38.100	.000	2 PIPE TENSIONER	.000
33.528	.000	1 SIMPLE SUPPORT	.000
26.670	1.600	2 PIPE TENSIONER	.000
21.336	.000	1 SIMPLE SUPPORT	.000
12.192	.000	1 SIMPLE SUPPORT	.000
.000	.000	1 SIMPLE SUPPORT	.000

SUPPORT ELEMENT PROPERTIES
==========================
SUPPORT PROPERTY TABLE INDEX 1
SUPPORT ELEMENT TYPE .... 1 SIMPLE SUPPORT
TENSIONER AXIAL STIFFNESS (F/L) ... 0.000E+00 KN/M
VERTICAL STIFFNESS (F/L) .... 0.000E+00 KN/M
STATIC VERTICAL DEFLECTION .... .0000 CM
LATERAL STIFFNESS (F/L) .... 0.000E+00 KN/M
BOTTOM ROLLER ANGLE TO HORIZONTAL . 30.000 DEG

SIDE ROLLER ANGLE TO VERTICAL ..... 60.000 DEG
SIDE ROLLER OFFSET FROM C.L. ...... 1.000 M

```
   BED ROLLER LENGTH ................        .000 M
   HEIGHT OF TOP ROLLER ABOVE BED ....       .000 M
   TENSIONER X-AXIS ROTATIONAL STIF. .       .000 KN/DEG
   TENSIONER Y-AXIS ROTATIONAL STIF. .       .000 KN/DEG
   TENSIONER Y-AXIS ROTATIONAL STIF. .       .000 KN/DEG

STINGER DESCRIPTION
===================
   NUMBER OF PIPE/STINGER NODES ......        6
   STINGER GEOMETRY SPECIFIED BY .....        4 RADIUS AND MATCH POINT
   STINGER TYPE .....................         1 FIXED GEOMETRY OR RAMP
   OVERBEND PIPE SUPPORT RADIUS ......    330.00 M
   HITCH X-COORDINATE ...............      -.502 M
   HITCH Y-COORDINATE ...............     -1.626 M

   X COORDINATE OF LOCAL ORIGIN ......     -.502 M
   Y COORDINATE OF LOCAL ORIGIN ......    -1.626 M
   ROTATION ABOUT STINGER HITCH ......      .000 DEG
   TANGENT POINT X-COORDINATE ........      .000 M
   TANGENT POINT Y-COORDINATE ........      .000 M
   TANGENT POINT ANGLE ..............       .000 DEG


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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X         PAGE   9
ANALISA STATIS PIPA TPPI
JOB NO. - 113                   LICENSED TO: McDERMOTT, INCORPORATED
USER ID - N.FURQON              DATE -  7/28/2016  TIME - 20:23:35    CASE   1
==============================================================================

                        I N P U T   D A T A   E C H O


    NODE X     NODE Y          SUPPORT                 ELEMENT          ELEMENT
     COORD      COORD            TYPE                    TYPE            LENGTH
    (M   )     (M   )                                                    (M   )
   ========   ========   ====================   ===================   =======
       .000       .000   1  SIMPLE SUPPORT       0  HINGED END          8.000
       .000       .000   1  SIMPLE SUPPORT       0  FIXED END           8.000
       .000       .000   1  SIMPLE SUPPORT       0  FIXED END           8.000
       .000       .000   1  SIMPLE SUPPORT       0  FIXED END           8.000
       .000       .000   1  SIMPLE SUPPORT       0  FIXED END           8.000
       .000       .000   1  SIMPLE SUPPORT       0  FIXED END           2.000

STINGER SECTION WEIGHTS AND DISPLACEMENTS
=========================================
   SECTION      SECTION      DISPLACE
    NUMBER       WEIGHT        -MENT
                 (KN  )       (KN  )
    ======       ======       ======
      1         622.000      783.200
      2         608.269      765.800
      3         550.603      693.200
      4         560.452      705.600
      5         640.040      805.800
      6         324.945      409.100

STINGER SECTION BALLAST SCHEDULE
================================
   SECTION      BALLAST
    NUMBER      CONTENTS
                 (KN  )
   =======      ========
      1         151.723
      2         147.962
      3         125.356
      4         127.356
      5          95.342
      6          13.737
```

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==============================================================================
OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X         PAGE  10
ANALISA STATIS PIPA TPPI
JOB NO. - 113                    LICENSED TO: McDERMOTT, INCORPORATED
USER ID - N.FURQON               DATE -  7/28/2016  TIME - 20:23:35    CASE   1
==============================================================================

                        I N P U T   D A T A   E C H O


SAGBEND GEOMETRY
================
   SAGBEND PIPE ELEMENT LENGTH .......    4.000 M
   WATER DEPTH ......................    21.33 M
   ESTIMATED SAGBEND X LENGTH ........      .00 M
   ESTIMATED PIPE LENGTH ON SEABED ...      .00 M
   X-COORD OF PIPE FREE END ON SEABED       .00 M
   ESTIMATED SPAN DEPTH FOR BOW LINE .      .00 M
   PIPE VERTICAL ANGLE AT SEABED .....     .000 DEG
   X-COORDINATE OF SPECIFIED DEPTH ...      .00 M
   MAXIMUM SLOPE (ANGLE) OF SEABED ...     .000 DEG
   DIRECTION OF MAXIMUM SLOPE ........     .000 DEG

PIPE TENSION
============
   STATIC PIPE TENSION ON LAYBARGE ...  250.000 KN
   MINIMUM DYNAMIC PIPE TENSION ......     .000 KN
   MAXIMUM DYNAMIC PIPE TENSION ......  300.000 KN

CURRENT VELOCITIES
==================
    WATER      CURRENT      DIRECTION
    DEPTH       SPEED       OF TRAVEL
   (M   )      (M/S )        (DEG )
   ======      =======      =========
     .000         .950        90.000
   10.000         .520        90.000
   21.330         .020        90.000

END OF INPUT DATA
```

APPENDIX D. OFFPIPE Output Data

Tension: 50 kN; Stinger-length: 27 m

```
OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X        DATE -  7/28/2016    TIME - 21: 3:15     PAGE   11
          PROJECT - ANALISA STATIS PIPA TPPI                                                        JOB NO. - 113
USER ID - N.FURQON                                            LICENSED TO: McDERMOTT, INCORPORATED                 CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.10	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	.52	.00	15.30	-.07	13.52	3.76
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	.51	.00	-13.36	.21	11.87	3.30
9	TENSIONR	26.67	4.04	.00	.001	.668	32.767	1.04	.00	-98.07	.65	84.40	23.44
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	.93	.00	-298.52	-1.06	254.67	70.74
13	LAYBARGE	12.19	3.62	.00	-.001	2.822	47.252	.87	.00	-265.95	.45	226.93	63.04
15	LAYBARGE	.00	2.82	.00	.000	4.756	59.471	.67	.00	-283.56	-.10	241.70	67.14
18	STINGER	-5.65	2.30	.00	-.002	5.734	65.142	.55	.00	-291.92	-.97	248.68	69.08
20	STINGER	-10.62	1.76	.00	.007	6.600	70.142	.42	.00	-285.07	6.36	242.79	67.44
22	STINGER	-15.58	1.15	.00	.016	7.446	75.142	.28	.00	-278.03	-.40	236.61	65.73
24	STINGER	-20.53	.46	.00	.004	8.310	80.142	.11	.00	-297.46	-7.17	253.03	70.29
26	STINGER	-25.47	-.30	.00	-.028	9.269	85.142	-.08	-.09	-338.76	-14.15	288.24	80.07
28	STINGER	-27.45	-.63	.00	-.047	9.691	87.142	-.16	-.18	-359.02	-17.12	305.58	84.88
30	SAGBEND	-31.38	-1.33	.00	-.084	10.498	91.142	-.24	-.39	-307.85	-12.76	261.95	72.76
31	SAGBEND	-35.31	-2.08	.01	-.111	11.184	95.142	-.35	-.61	-258.86	-8.95	220.21	61.17
32	SAGBEND	-39.23	-2.88	.02	-.129	11.754	99.142	-.46	-.84	-212.04	-5.66	180.34	50.10
33	SAGBEND	-43.15	-3.71	.03	-.139	12.213	103.142	-.59	-1.08	-167.39	-2.85	142.36	39.54
34	SAGBEND	-47.05	-4.57	.04	-.143	12.566	107.142	-.73	-1.33	-124.91	-.48	106.25	29.51
35	SAGBEND	-50.95	-5.45	.05	-.142	12.819	111.142	-.88	-1.58	-84.59	1.48	72.01	20.00
36	SAGBEND	-54.85	-6.34	.06	-.136	12.978	115.142	-1.03	-1.84	-46.43	3.08	39.70	11.03
37	SAGBEND	-58.75	-7.24	.07	-.127	13.046	119.142	-1.19	-2.11	-10.44	4.35	9.92	2.75
38	SAGBEND	-62.65	-8.15	.07	-.115	13.030	123.142	-1.35	-2.37	23.39	5.32	20.66	5.74
39	SAGBEND	-66.55	-9.05	.08	-.100	12.934	127.142	-1.51	-2.63	55.05	6.03	47.33	13.15
40	SAGBEND	-70.45	-9.94	.09	-.085	12.765	131.142	-1.68	-2.89	84.55	6.51	72.35	20.10
41	SAGBEND	-74.35	-10.81	.09	-.068	12.527	135.142	-1.84	-3.14	111.85	6.79	95.56	26.54
42	SAGBEND	-78.25	-11.67	.10	-.051	12.225	139.142	-2.00	-3.39	136.97	6.90	116.92	32.48
43	SAGBEND	-82.17	-12.50	.10	-.034	11.865	143.142	-2.16	-3.64	159.89	6.86	136.41	37.89
44	SAGBEND	-86.08	-13.31	.10	-.017	11.452	147.142	-2.31	-3.87	180.60	6.69	154.03	42.79
45	SAGBEND	-90.01	-14.09	.10	-.001	10.992	151.142	-2.46	-4.10	199.08	6.43	169.75	47.15
46	SAGBEND	-93.94	-14.84	.10	.014	10.490	155.142	-2.60	-4.31	215.32	6.07	183.58	50.99
47	SAGBEND	-97.87	-15.55	.10	.029	9.951	159.142	-2.73	-4.52	229.31	5.65	195.49	54.30
48	SAGBEND	-101.82	-16.22	.10	.042	9.381	163.142	-2.86	-4.72	241.04	5.17	205.47	57.08
49	SAGBEND	-105.77	-16.85	.10	.054	8.786	167.142	-2.98	-4.90	250.49	4.65	213.52	59.31
50	SAGBEND	-109.72	-17.44	.09	.065	8.170	171.142	-3.09	-5.07	257.65	4.09	219.62	61.01
51	SAGBEND	-113.69	-17.99	.09	.074	7.540	175.142	-3.19	-5.23	262.51	3.51	223.77	62.16
52	SAGBEND	-117.65	-18.49	.08	.082	6.900	179.142	-3.28	-5.38	265.06	2.90	225.95	62.76
53	SAGBEND	-121.63	-18.95	.08	.088	6.258	183.142	-3.36	-5.51	265.29	2.28	226.16	62.82
54	SAGBEND	-125.61	-19.36	.07	.093	5.617	187.142	-3.43	-5.63	263.20	1.65	224.40	62.33
55	SAGBEND	-129.59	-19.73	.06	.096	4.985	191.142	-3.50	-5.74	258.79	1.01	220.66	61.29
56	SAGBEND	-133.58	-20.06	.06	.098	4.366	195.142	-3.55	-5.83	252.05	.36	214.94	59.70
57	SAGBEND	-137.57	-20.34	.05	.098	3.766	199.142	-3.60	-5.92	242.98	-.29	207.23	57.57
58	SAGBEND	-141.56	-20.58	.04	.097	3.191	203.142	-3.63	-5.99	231.58	-.94	197.55	54.88
59	SAGBEND	-145.55	-20.79	.04	.093	2.646	207.142	-3.66	-6.05	217.86	-1.59	185.90	51.64
60	SAGBEND	-149.55	-20.95	.03	.089	2.138	211.142	-3.69	-6.09	201.82	-2.25	172.28	47.86
61	SAGBEND	-153.55	-21.09	.02	.083	1.671	215.142	-3.70	-6.13	183.47	-2.90	156.70	43.53
62	SAGBEND	-157.55	-21.19	.02	.075	1.251	219.142	-3.71	-6.16	162.82	-3.56	139.16	38.66
63	SAGBEND	-161.55	-21.26	.01	.065	.884	223.142	-3.72	-6.18	139.88	-4.21	119.69	33.25
64	SAGBEND	-165.55	-21.31	.01	.054	.575	227.142	-3.72	-6.20	114.65	-4.86	98.30	27.31
65	SEABED	-169.55	-21.34	.00	.042	.330	231.142	-3.72	-6.21	87.28	-5.31	75.13	20.87
66	SEABED	-173.55	-21.36	.00	.029	.152	235.142	-3.71	-6.21	60.43	-4.93	52.42	14.56
67	SEABED	-177.55	-21.37	.00	.019	.034	239.142	-3.71	-6.21	37.51	-4.03	33.12	9.20
68	SEABED	-181.55	-21.37	.00	.010	-.034	243.142	-3.71	-6.21	19.90	-2.97	18.51	5.14
69	SEABED	-185.55	-21.36	.00	.004	-.066	247.142	-3.71	-6.21	7.61	-1.99	9.06	2.52
70	SEABED	-189.55	-21.36	.00	.000	-.075	251.142	-3.71	-6.21	-.10	-1.17	5.61	1.56
71	SEABED	-193.55	-21.35	.00	-.002	-.069	255.142	-3.71	-6.21	-4.25	-.57	6.85	1.90
72	SEABED	-197.55	-21.35	.00	-.003	-.056	259.142	-3.71	-6.21	-5.90	-.16	7.78	2.16
73	SEABED	-201.55	-21.34	.00	-.003	-.041	263.142	-3.71	-6.21	-5.97	.08	7.82	2.17
74	SEABED	-205.55	-21.34	.00	-.002	-.028	267.142	-3.71	-6.21	-5.17	.20	7.34	2.04
75	SEABED	-209.55	-21.34	.00	-.002	-.017	271.142	-3.71	-6.21	-4.00	.24	6.71	1.86
76	SEABED	-213.55	-21.34	.00	-.001	-.008	275.142	-3.71	-6.21	-2.80	.23	6.15	1.71
77	SEABED	-217.55	-21.34	.00	-.001	-.003	279.142	-3.71	-6.21	-1.76	.19	5.77	1.60
78	SEABED	-221.55	-21.34	.00	.000	.000	283.142	-3.71	-6.21	-.95	.14	5.56	1.54
79	SEABED	-225.55	-21.34	.00	.000	.002	287.142	-3.71	-6.21	-.40	.09	5.46	1.52
80	SEABED	-229.55	-21.34	.00	.000	.002	291.142	-3.71	-6.21	-.09	.05	5.42	1.51
81	SEABED	-233.55	-21.34	.00	.000	.002	295.142	-3.71	-6.21	.00	.00	5.41	1.50

Tension: 50 kN; Stinger-length: 32 m

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=========================================================================================================================
OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X        DATE - 7/28/2016    TIME - 21: 9: 0    PAGE   11
          PROJECT - ANALISA STATIS PIPA TPPI                                                JOB NO. - 113
USER ID - N.FURQON                                          LICENSED TO: McDERMOTT, INCORPORATED              CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	.52	.00	15.26	-.07	13.49	3.75
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	.51	.00	-13.33	.21	11.84	3.29
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	1.04	.00	-97.94	.62	84.30	23.42
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	.93	.00	-298.74	-1.03	254.86	70.79
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	.87	.00	-265.63	.46	226.66	62.96
15	LAYBARGE	.00	2.82	.00	.000	4.758	59.471	.67	.00	-284.49	-.19	242.49	67.36
18	STINGER	-6.64	2.20	.00	.000	5.906	66.142	.52	.00	-292.01	.15	248.73	69.09
20	STINGER	-12.60	1.52	.00	-.001	6.951	72.142	.36	.00	-289.98	-.76	246.85	68.57
22	STINGER	-18.55	.74	.00	.005	7.990	78.142	.18	.00	-288.17	3.94	245.15	68.10
24	STINGER	-24.49	-.14	.00	.008	9.024	84.142	-.02	-.04	-286.87	-2.06	243.85	67.74
26	STINGER	-30.40	-1.14	.00	-.016	10.089	90.142	-.20	-.33	-300.10	-11.30	255.31	70.92
28	STINGER	-32.37	-1.50	.00	-.032	10.455	92.142	-.27	-.44	-305.60	-14.70	260.12	72.26
30	SAGBEND	-36.30	-2.25	.00	-.063	11.136	96.142	-.37	-.65	-256.75	-10.89	218.48	60.69
31	SAGBEND	-40.22	-3.04	.01	-.086	11.701	100.142	-.49	-.88	-210.07	-7.58	178.72	49.65
32	SAGBEND	-44.13	-3.87	.01	-.101	12.155	104.142	-.62	-1.12	-165.56	-4.74	140.84	39.12
33	SAGBEND	-48.04	-4.72	.02	-.110	12.504	108.142	-.76	-1.37	-123.21	-2.34	104.82	29.12
34	SAGBEND	-51.95	-5.60	.03	-.113	12.754	112.142	-.90	-1.63	-83.03	-.33	70.68	19.63
35	SAGBEND	-55.85	-6.48	.04	-.112	12.908	116.142	-1.06	-1.89	-45.01	1.32	38.42	10.67
36	SAGBEND	-59.74	-7.38	.04	-.107	12.973	120.142	-1.21	-2.15	-9.16	2.64	8.45	2.35
37	SAGBEND	-63.64	-8.28	.05	-.099	12.954	124.142	-1.37	-2.41	24.54	3.68	21.36	5.93
38	SAGBEND	-67.54	-9.17	.06	-.089	12.856	128.142	-1.54	-2.67	56.06	4.46	48.06	13.35
39	SAGBEND	-71.44	-10.06	.06	-.077	12.684	132.142	-1.70	-2.92	85.41	5.02	73.00	20.28
40	SAGBEND	-75.35	-10.93	.07	-.064	12.444	136.142	-1.86	-3.18	112.57	5.38	96.11	26.70
41	SAGBEND	-79.25	-11.78	.07	-.050	12.141	140.142	-2.02	-3.43	137.55	5.57	117.36	32.60
42	SAGBEND	-83.17	-12.61	.08	-.036	11.780	144.142	-2.18	-3.67	160.32	5.62	136.74	37.98
43	SAGBEND	-87.09	-13.41	.08	-.023	11.366	148.142	-2.33	-3.90	180.88	5.55	154.24	42.84
44	SAGBEND	-91.01	-14.18	.08	-.009	10.906	152.142	-2.48	-4.12	199.22	5.38	169.85	47.18
45	SAGBEND	-94.94	-14.92	.08	.004	10.403	156.142	-2.62	-4.34	215.31	5.12	183.55	50.99
46	SAGBEND	-98.88	-15.63	.08	.016	9.865	160.142	-2.75	-4.54	229.15	4.80	195.34	54.26
47	SAGBEND	-102.82	-16.29	.08	.028	9.295	164.142	-2.87	-4.74	240.73	4.42	205.20	57.00
48	SAGBEND	-106.77	-16.92	.07	.038	8.701	168.142	-2.99	-4.92	250.02	4.00	213.12	59.20
49	SAGBEND	-110.73	-17.50	.07	.047	8.086	172.142	-3.10	-5.09	257.03	3.55	219.10	60.86
50	SAGBEND	-114.69	-18.04	.07	.055	7.458	176.142	-3.20	-5.25	261.74	3.07	223.11	61.98
51	SAGBEND	-118.66	-18.54	.06	.062	6.820	180.142	-3.29	-5.39	264.14	2.57	225.17	62.55
52	SAGBEND	-122.64	-18.99	.06	.068	6.180	184.142	-3.37	-5.52	264.22	2.05	225.25	62.57
53	SAGBEND	-126.62	-19.40	.05	.072	5.543	188.142	-3.44	-5.64	261.98	1.53	223.36	62.04
54	SAGBEND	-130.60	-19.77	.05	.075	4.913	192.142	-3.50	-5.75	257.41	.99	219.49	60.97
55	SAGBEND	-134.59	-20.09	.04	.077	4.298	196.142	-3.56	-5.84	250.52	.45	213.64	59.34
56	SAGBEND	-138.58	-20.37	.04	.077	3.702	200.142	-3.60	-5.92	241.30	-.09	205.81	57.17
57	SAGBEND	-142.57	-20.61	.03	.077	3.131	204.142	-3.64	-5.99	229.75	-.64	196.00	54.44
58	SAGBEND	-146.56	-20.81	.03	.074	2.591	208.142	-3.67	-6.05	215.88	-1.19	184.21	51.17
59	SAGBEND	-150.56	-20.97	.02	.071	2.087	212.142	-3.69	-6.10	199.69	-1.73	170.46	47.35
60	SAGBEND	-154.56	-21.10	.02	.066	1.626	216.142	-3.70	-6.14	181.19	-2.28	154.75	42.99
61	SAGBEND	-158.56	-21.20	.01	.060	1.211	220.142	-3.71	-6.16	160.39	-2.83	137.09	38.08
62	SAGBEND	-162.56	-21.27	.01	.052	.851	224.142	-3.72	-6.18	137.30	-3.38	117.49	32.64
63	SAGBEND	-166.56	-21.32	.01	.043	.548	228.142	-3.72	-6.20	111.93	-3.92	95.97	26.66
64	SEABED	-170.56	-21.35	.00	.033	.310	232.142	-3.72	-6.21	84.50	-4.28	72.73	20.20
65	SEABED	-174.56	-21.36	.00	.023	.138	236.142	-3.71	-6.21	57.97	-3.95	50.29	13.97
66	SEABED	-178.56	-21.37	.00	.015	.026	240.142	-3.71	-6.21	35.57	-3.21	31.42	8.73
67	SEABED	-182.56	-21.37	.00	.008	-.038	244.142	-3.71	-6.21	18.50	-2.36	17.32	4.81
68	SEABED	-186.56	-21.36	.00	.003	-.068	248.142	-3.71	-6.21	6.70	-1.56	8.40	2.33
69	SEABED	-190.56	-21.36	.00	.000	-.074	252.142	-3.71	-6.21	-.61	-.92	5.60	1.55
70	SEABED	-194.56	-21.35	.00	-.002	-.068	256.142	-3.71	-6.21	-4.48	-.44	6.97	1.94
71	SEABED	-198.56	-21.35	.00	-.002	-.055	260.142	-3.71	-6.21	-5.95	-.12	7.81	2.17
72	SEABED	-202.56	-21.34	.00	-.002	-.040	264.142	-3.71	-6.21	-5.91	.07	7.78	2.16
73	SEABED	-206.56	-21.34	.00	-.002	-.027	268.142	-3.71	-6.21	-5.06	.16	7.28	2.02
74	SEABED	-210.56	-21.34	.00	-.001	-.016	272.142	-3.71	-6.21	-3.89	.19	6.65	1.85
75	SEABED	-214.56	-21.34	.00	-.001	-.008	276.142	-3.71	-6.21	-2.70	.18	6.11	1.70
76	SEABED	-218.56	-21.34	.00	-.001	-.003	280.142	-3.71	-6.21	-1.68	.15	5.75	1.60
77	SEABED	-222.56	-21.34	.00	.000	.001	284.142	-3.71	-6.21	-.90	.11	5.55	1.54
78	SEABED	-226.56	-21.34	.00	.000	.002	288.142	-3.71	-6.21	-.38	.07	5.45	1.52
79	SEABED	-230.56	-21.34	.00	.000	.003	292.142	-3.71	-6.21	-.09	.04	5.42	1.50
80	SEABED	-234.56	-21.34	.00	.000	.003	296.142	-3.71	-6.21	.00	.00	5.41	1.50

Tension: 50 kN; Stinger-length: 37 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X        DATE - 7/28/2016    TIME - 21:13:59    PAGE   11
          PROJECT - ANALISA STATIS PIPA TPPI                                                JOB NO. - 113
USER ID - N.FURQON                                          LICENSED TO: McDERMOTT, INCORPORATED               CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.462	21.337	.52	.00	15.23	-.07	13.46	3.74
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	.51	.00	-13.30	.20	11.82	3.28
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	1.04	.00	-97.83	.60	84.20	23.39
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	.93	.00	-298.94	-.99	255.03	70.84
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	.87	.00	-265.33	.44	226.41	62.89
15	LAYBARGE	.00	2.82	.00	.000	4.759	59.471	.67	.00	-285.34	-.16	243.21	67.56
18	STINGER	-7.64	2.09	.00	.000	6.079	67.142	.50	.00	-293.35	.02	249.85	69.40
20	STINGER	-14.59	1.28	.00	.000	7.299	74.142	.31	.00	-291.05	.10	247.70	68.80
22	STINGER	-21.52	.31	.00	-.001	8.509	81.142	.08	.00	-289.02	-.63	245.75	68.26
24	STINGER	-28.43	-.80	.00	.004	9.733	88.142	-.14	-.23	-291.73	2.96	248.01	68.89
26	STINGER	-35.32	-2.05	.00	-.018	10.924	95.142	-.35	-.60	-271.15	-13.54	230.82	64.12
28	STINGER	-37.28	-2.44	.00	-.033	11.237	97.142	-.40	-.71	-247.22	-11.73	210.42	58.45
30	SAGBEND	-41.20	-3.24	.00	-.058	11.780	101.142	-.52	-.94	-200.98	-8.48	171.04	47.51
31	SAGBEND	-45.11	-4.07	.01	-.076	12.213	105.142	-.65	-1.18	-156.92	-5.68	133.53	37.09
32	SAGBEND	-49.02	-4.93	.01	-.087	12.541	109.142	-.79	-1.43	-115.02	-3.31	97.89	27.19
33	SAGBEND	-52.92	-5.80	.02	-.092	12.771	113.142	-.94	-1.69	-75.28	-1.32	64.11	17.81
34	SAGBEND	-56.82	-6.69	.03	-.093	12.908	117.142	-1.09	-1.95	-37.71	.32	32.22	8.95
35	SAGBEND	-60.72	-7.59	.03	-.091	12.956	121.142	-1.25	-2.21	-2.30	1.64	3.19	.89
36	SAGBEND	-64.62	-8.48	.04	-.085	12.921	125.142	-1.41	-2.47	30.94	2.69	26.67	7.41
37	SAGBEND	-68.52	-9.37	.04	-.078	12.808	129.142	-1.57	-2.73	62.02	3.48	53.06	14.74
38	SAGBEND	-72.42	-10.26	.05	-.068	12.622	133.142	-1.74	-2.98	90.92	4.06	77.65	21.57
39	SAGBEND	-76.33	-11.12	.05	-.058	12.369	137.142	-1.90	-3.23	117.63	4.45	100.38	27.88
40	SAGBEND	-80.24	-11.97	.06	-.046	12.054	141.142	-2.06	-3.48	142.16	4.68	121.25	33.68
41	SAGBEND	-84.15	-12.79	.06	-.035	11.682	145.142	-2.21	-3.72	164.47	4.77	140.25	38.96
42	SAGBEND	-88.07	-13.59	.06	-.023	11.259	149.142	-2.36	-3.95	184.58	4.75	157.36	43.71
43	SAGBEND	-92.00	-14.35	.06	-.011	10.790	153.142	-2.51	-4.17	202.45	4.63	172.58	47.94
44	SAGBEND	-95.93	-15.08	.06	.000	10.281	157.142	-2.64	-4.39	218.08	4.43	185.89	51.64
45	SAGBEND	-99.87	-15.78	.06	.010	9.736	161.142	-2.78	-4.59	231.45	4.16	197.29	54.80
46	SAGBEND	-103.81	-16.44	.06	.020	9.161	165.142	-2.90	-4.78	242.56	3.85	206.75	57.43
47	SAGBEND	-107.77	-17.05	.06	.029	8.563	169.142	-3.01	-4.96	251.38	3.49	214.27	59.52
48	SAGBEND	-111.72	-17.63	.06	.037	7.946	173.142	-3.12	-5.13	257.92	3.10	219.85	61.07
49	SAGBEND	-115.69	-18.16	.06	.045	7.316	177.142	-3.22	-5.28	262.15	2.69	223.46	62.07
50	SAGBEND	-119.66	-18.64	.05	.051	6.678	181.142	-3.31	-5.42	264.07	2.25	225.11	62.53
51	SAGBEND	-123.64	-19.09	.05	.056	6.039	185.142	-3.39	-5.55	263.67	1.81	224.79	62.44
52	SAGBEND	-127.62	-19.49	.04	.059	5.403	189.142	-3.46	-5.67	260.95	1.35	222.49	61.80
53	SAGBEND	-131.60	-19.84	.04	.062	4.777	193.142	-3.52	-5.77	255.90	.89	218.21	60.61
54	SAGBEND	-135.59	-20.15	.04	.064	4.165	197.142	-3.57	-5.86	248.53	.42	211.95	58.87
55	SAGBEND	-139.58	-20.42	.03	.064	3.575	201.142	-3.61	-5.94	238.83	-.06	203.71	56.59
56	SAGBEND	-143.57	-20.65	.03	.063	3.010	205.142	-3.64	-6.01	226.80	-.53	193.49	53.75
57	SAGBEND	-147.57	-20.84	.02	.062	2.478	209.142	-3.67	-6.06	212.45	-1.01	181.30	50.36
58	SAGBEND	-151.56	-21.00	.02	.058	1.983	213.142	-3.69	-6.11	195.79	-1.49	167.14	46.43
59	SAGBEND	-155.56	-21.12	.01	.054	1.532	217.142	-3.70	-6.14	176.81	-1.96	151.03	41.95
60	SAGBEND	-159.56	-21.21	.01	.049	1.129	221.142	-3.71	-6.17	155.54	-2.44	132.96	36.93
61	SAGBEND	-163.56	-21.28	.01	.042	.780	225.142	-3.72	-6.19	131.98	-2.92	112.96	31.38
62	SAGBEND	-167.56	-21.32	.00	.035	.492	229.142	-3.72	-6.20	106.14	-3.40	91.04	25.29
63	SEABED	-171.56	-21.35	.00	.026	.268	233.142	-3.72	-6.21	78.56	-3.60	67.67	18.80
64	SEABED	-175.56	-21.36	.00	.018	.110	237.142	-3.71	-6.21	52.73	-3.21	45.83	12.73
65	SEABED	-179.56	-21.37	.00	.011	.009	241.142	-3.71	-6.21	31.44	-2.55	27.94	7.76
66	SEABED	-183.56	-21.37	.00	.006	-.047	245.142	-3.71	-6.21	15.55	-1.84	14.92	4.14
67	SEABED	-187.56	-21.36	.00	.002	-.071	249.142	-3.71	-6.21	4.79	-1.19	7.21	2.00
68	SEABED	-191.56	-21.36	.00	.000	-.074	253.142	-3.71	-6.21	-1.69	-.68	5.79	1.61
69	SEABED	-195.56	-21.35	.00	-.001	-.065	257.142	-3.71	-6.21	-4.96	-.30	7.23	2.01
70	SEABED	-199.56	-21.35	.00	-.002	-.052	261.142	-3.71	-6.21	-6.04	-.06	7.87	2.19
71	SEABED	-203.56	-21.34	.00	-.002	-.037	265.142	-3.71	-6.21	-5.79	.08	7.71	2.14
72	SEABED	-207.56	-21.34	.00	-.002	-.024	269.142	-3.71	-6.21	-4.85	.14	7.16	1.99
73	SEABED	-211.56	-21.34	.00	-.001	-.014	273.142	-3.71	-6.21	-3.67	.16	6.54	1.82
74	SEABED	-215.56	-21.34	.00	-.001	-.006	277.142	-3.71	-6.21	-2.54	.15	6.04	1.68
75	SEABED	-219.56	-21.34	.00	.000	-.001	281.142	-3.71	-6.21	-1.59	.12	5.72	1.59
76	SEABED	-223.56	-21.34	.00	.000	.002	285.142	-3.71	-6.21	-.88	.09	5.54	1.54
77	SEABED	-227.56	-21.34	.00	.000	.003	289.142	-3.71	-6.21	-.41	.06	5.46	1.52
78	SEABED	-231.56	-21.34	.00	.000	.004	293.142	-3.71	-6.21	-.14	.04	5.42	1.51
79	SEABED	-235.56	-21.34	.00	.000	.004	297.142	-3.71	-6.21	-.03	.02	5.41	1.50
80	SEABED	-239.56	-21.34	.00	.000	.004	301.142	-3.71	-6.21	.00	.00	5.41	1.50

Tension: 50 kN; Stinger-length: 42 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X          DATE -  7/28/2016    TIME - 21:16:28    PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                          JOB NO. - 113
USER ID - N.FURQON                                                LICENSED TO: McDERMOTT, INCORPORATED              CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.70	-.09	15.92	4.42
5	TENSIONR	38.10	4.14	.00	.000	.462	21.337	.52	.00	15.20	-.07	13.44	3.73
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	.51	.00	-13.28	.19	11.80	3.28
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	1.04	.00	-97.72	.58	84.11	23.36
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	.93	.00	-299.15	-.96	255.21	70.89
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	.87	.00	-264.99	.43	226.12	62.81
15	LAYBARGE	.00	2.82	.00	.000	4.761	59.471	.67	.00	-286.34	-.18	244.06	67.80
18	STINGER	-8.63	1.98	.00	.000	6.251	68.142	.47	.00	-294.74	.18	251.00	69.72
20	STINGER	-16.57	1.02	.00	-.001	7.647	76.142	.24	.00	-292.80	-.66	249.12	69.20
22	STINGER	-24.49	-.14	.00	.004	9.026	84.142	-.02	-.04	-286.63	2.70	243.65	67.68
24	STINGER	-32.37	-1.50	.00	-.016	10.441	92.142	-.27	-.44	-299.27	-11.38	254.62	70.73
26	STINGER	-40.22	-3.04	.01	-.065	11.674	100.142	-.49	-.88	-211.36	-8.60	179.85	49.96
28	STINGER	-42.18	-3.44	.01	-.074	11.916	102.142	-.55	-1.00	-188.80	-7.11	160.65	44.62
30	SAGBEND	-46.09	-4.28	.01	-.088	12.321	106.142	-.69	-1.25	-145.32	-4.45	123.65	34.35
31	SAGBEND	-50.00	-5.15	.02	-.097	12.622	110.142	-.83	-1.50	-104.00	-2.21	88.51	24.59
32	SAGBEND	-53.90	-6.03	.03	-.100	12.826	114.142	-.98	-1.75	-64.85	-.34	55.24	15.35
33	SAGBEND	-57.80	-6.92	.03	-.099	12.938	118.142	-1.13	-2.01	-27.86	1.19	23.89	6.64
34	SAGBEND	-61.70	-7.82	.04	-.094	12.963	122.142	-1.29	-2.27	6.97	2.41	6.72	1.87
35	SAGBEND	-65.59	-8.72	.05	-.087	12.906	126.142	-1.45	-2.53	39.63	3.36	34.06	9.46
36	SAGBEND	-69.49	-9.60	.05	-.078	12.773	130.142	-1.62	-2.79	70.12	4.07	59.97	16.66
37	SAGBEND	-73.40	-10.48	.06	-.067	12.568	134.142	-1.78	-3.05	98.43	4.57	84.05	23.35
38	SAGBEND	-77.30	-11.34	.06	-.055	12.298	138.142	-1.94	-3.30	124.56	4.88	106.29	29.52
39	SAGBEND	-81.21	-12.19	.06	-.043	11.967	142.142	-2.10	-3.54	148.49	5.05	126.65	35.18
40	SAGBEND	-85.13	-13.00	.07	-.030	11.580	146.142	-2.25	-3.78	170.21	5.08	145.14	40.32
41	SAGBEND	-89.05	-13.79	.07	-.018	11.144	150.142	-2.40	-4.01	189.72	5.00	161.75	44.93
42	SAGBEND	-92.98	-14.55	.07	-.006	10.663	154.142	-2.54	-4.23	206.99	4.83	176.45	49.01
43	SAGBEND	-96.91	-15.27	.07	.006	10.143	158.142	-2.68	-4.44	222.01	4.58	189.25	52.57
44	SAGBEND	-100.85	-15.95	.07	.017	9.590	162.142	-2.81	-4.64	234.78	4.27	200.12	55.59
45	SAGBEND	-104.80	-16.60	.07	.027	9.008	166.142	-2.93	-4.83	245.27	3.91	209.07	58.07
46	SAGBEND	-108.75	-17.21	.06	.036	8.404	170.142	-3.04	-5.00	253.48	3.52	216.06	60.02
47	SAGBEND	-112.71	-17.77	.06	.044	7.782	174.142	-3.15	-5.17	259.40	3.09	221.11	61.42
48	SAGBEND	-116.68	-18.29	.06	.051	7.149	178.142	-3.24	-5.32	263.01	2.65	224.20	62.28
49	SAGBEND	-120.65	-18.77	.05	.057	6.510	182.143	-3.33	-5.46	264.30	2.18	225.32	62.59
50	SAGBEND	-124.63	-19.20	.05	.062	5.871	186.143	-3.41	-5.58	263.28	1.70	224.46	62.35
51	SAGBEND	-128.61	-19.58	.05	.065	5.237	190.143	-3.47	-5.70	259.94	1.22	221.63	61.56
52	SAGBEND	-132.59	-19.93	.04	.068	4.614	194.143	-3.53	-5.80	254.26	.72	216.82	60.23
53	SAGBEND	-136.58	-20.23	.04	.069	4.007	198.143	-3.58	-5.88	246.26	.22	210.02	58.34
54	SAGBEND	-140.58	-20.49	.03	.069	3.423	202.143	-3.62	-5.96	235.93	-.28	201.25	55.90
55	SAGBEND	-144.57	-20.71	.03	.068	2.867	206.143	-3.65	-6.02	223.28	-.79	190.50	52.92
56	SAGBEND	-148.57	-20.89	.02	.065	2.343	210.143	-3.68	-6.07	208.31	-1.29	177.78	49.38
57	SAGBEND	-152.56	-21.03	.02	.061	1.859	214.143	-3.70	-6.12	191.02	-1.80	163.10	45.31
58	SAGBEND	-156.56	-21.15	.01	.056	1.420	218.143	-3.71	-6.15	171.43	-2.30	146.46	40.68
59	SAGBEND	-160.56	-21.23	.01	.050	1.031	222.143	-3.71	-6.18	149.54	-2.81	127.87	35.52
60	SAGBEND	-164.56	-21.29	.01	.043	.698	226.143	-3.72	-6.19	125.36	-3.31	107.35	29.82
61	SEABED	-168.56	-21.33	.00	.034	.426	230.143	-3.72	-6.20	98.91	-3.74	84.92	23.59
62	SEABED	-172.56	-21.35	.00	.025	.220	234.143	-3.71	-6.21	71.38	-3.74	61.60	17.11
63	SEABED	-176.56	-21.36	.00	.016	.078	238.143	-3.71	-6.21	46.58	-3.21	40.65	11.29
64	SEABED	-180.56	-21.37	.00	.010	-.010	242.143	-3.71	-6.21	26.68	-2.47	23.99	6.66
65	SEABED	-184.56	-21.36	.00	.005	-.056	246.143	-3.71	-6.21	12.22	-1.72	12.33	3.42
66	SEABED	-188.56	-21.36	.00	.001	-.073	250.143	-3.71	-6.21	2.69	-1.08	6.19	1.72
67	SEABED	-192.56	-21.35	.00	-.001	-.072	254.143	-3.71	-6.21	-2.83	-.58	6.19	1.72
68	SEABED	-196.56	-21.35	.00	-.002	-.062	258.143	-3.71	-6.21	-5.42	-.23	7.49	2.08
69	SEABED	-200.56	-21.35	.00	-.002	-.048	262.143	-3.71	-6.21	-6.05	.00	7.87	2.19
70	SEABED	-204.56	-21.34	.00	-.002	-.033	266.143	-3.71	-6.21	-5.54	.12	7.56	2.10
71	SEABED	-208.56	-21.34	.00	-.001	-.021	270.143	-3.71	-6.21	-4.47	.17	6.95	1.93
72	SEABED	-212.56	-21.34	.00	-.001	-.012	274.143	-3.71	-6.21	-3.24	.17	6.34	1.76
73	SEABED	-216.56	-21.34	.00	-.001	-.005	278.143	-3.71	-6.21	-2.10	.15	5.88	1.63
74	SEABED	-220.56	-21.34	.00	.000	-.002	282.143	-3.71	-6.21	-1.17	.11	5.61	1.56
75	SEABED	-224.56	-21.34	.00	.000	.000	286.143	-3.71	-6.21	-.51	.08	5.47	1.52
76	SEABED	-228.56	-21.34	.00	.000	.001	290.143	-3.71	-6.21	-.12	.04	5.42	1.51
77	SEABED	-232.56	-21.34	.00	.000	.001	294.143	-3.71	-6.21	.00	.00	5.41	1.50

Tension: 100 kN; Stinger-length: 27 m

OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X DATE - 7/28/2016 TIME - 21:19:51 PAGE 11
PROJECT - ANALISA STATIS PIPA TPPI JOB NO. - 113
USER ID - N.FURQON LICENSED TO: McDERMOTT, INCORPORATED CASE 1

S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.10	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	1.08	.00	15.30	-.07	14.08	3.91
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	1.07	.00	-13.36	.22	12.42	3.45
9	TENSIONR	26.67	4.04	.00	.001	.668	32.767	2.16	.00	-98.08	.65	85.53	23.76
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	2.05	.00	-298.59	-1.06	255.85	71.07
13	LAYBARGE	12.19	3.62	.00	-.001	2.822	47.252	1.99	.00	-266.09	.45	228.17	63.38
15	LAYBARGE	.00	2.82	.00	.000	4.756	59.471	1.79	.00	-283.78	-.13	243.01	67.50
18	STINGER	-5.65	2.30	.00	-.001	5.733	65.142	1.67	.00	-291.40	-.72	249.36	69.27
20	STINGER	-10.62	1.76	.00	.005	6.602	70.142	1.54	.00	-287.40	4.83	245.87	68.30
22	STINGER	-15.58	1.15	.00	.014	7.454	75.142	1.40	.00	-279.98	.96	239.39	66.50
24	STINGER	-20.53	.46	.00	.005	8.315	80.142	1.23	.00	-293.25	-6.48	250.55	69.60
26	STINGER	-25.47	-.30	.00	-.026	9.252	85.142	1.05	-.09	-328.76	-14.14	280.79	78.00
28	STINGER	-27.45	-.63	.00	-.045	9.661	87.142	.97	-.18	-346.81	-17.39	296.22	82.28
30	SAGBEND	-31.39	-1.33	.00	-.082	10.439	91.142	.89	-.39	-296.27	-12.99	253.15	70.32
31	SAGBEND	-35.31	-2.08	.01	-.110	11.098	95.142	.78	-.60	-248.17	-9.16	212.17	58.94
32	SAGBEND	-39.24	-2.86	.02	-.128	11.643	99.142	.67	-.83	-202.45	-5.85	173.24	48.12
33	SAGBEND	-43.15	-3.69	.03	-.139	12.080	103.142	.54	-1.07	-159.08	-3.03	136.32	37.87
34	SAGBEND	-47.06	-4.54	.04	-.143	12.415	107.142	.40	-1.32	-118.01	-.65	101.38	28.16
35	SAGBEND	-50.96	-5.41	.05	-.143	12.654	111.142	.25	-1.57	-79.21	1.32	68.39	19.00
36	SAGBEND	-54.87	-6.29	.06	-.137	12.801	115.142	.10	-1.83	-42.64	2.92	37.38	10.38
37	SAGBEND	-58.77	-7.18	.07	-.128	12.862	119.142	-.06	-2.09	-8.27	4.19	9.05	2.51
38	SAGBEND	-62.67	-8.07	.07	-.117	12.843	123.142	-.22	-2.35	23.92	5.17	21.85	6.07
39	SAGBEND	-66.57	-8.95	.08	-.103	12.748	127.142	-.38	-2.60	53.97	5.89	47.12	13.09
40	SAGBEND	-70.47	-9.83	.09	-.088	12.583	131.142	-.54	-2.86	81.88	6.38	70.75	19.65
41	SAGBEND	-74.37	-10.69	.09	-.071	12.353	135.142	-.70	-3.11	107.69	6.67	92.61	25.72
42	SAGBEND	-78.28	-11.54	.10	-.055	12.063	139.142	-.86	-3.36	131.40	6.79	112.70	31.30
43	SAGBEND	-82.20	-12.36	.10	-.038	11.718	143.142	-1.01	-3.60	153.02	6.77	131.02	36.39
44	SAGBEND	-86.12	-13.16	.10	-.021	11.324	147.142	-1.16	-3.83	172.56	6.62	147.57	40.99
45	SAGBEND	-90.04	-13.93	.10	-.005	10.884	151.142	-1.31	-4.05	190.02	6.37	162.37	45.10
46	SAGBEND	-93.97	-14.67	.10	.010	10.405	155.142	-1.44	-4.27	205.42	6.05	175.41	48.72
47	SAGBEND	-97.91	-15.38	.10	.025	9.891	159.142	-1.58	-4.47	218.74	5.65	186.69	51.86
48	SAGBEND	-101.85	-16.05	.10	.038	9.347	163.142	-1.70	-4.67	229.99	5.20	196.21	54.50
49	SAGBEND	-105.80	-16.68	.10	.050	8.779	167.142	-1.82	-4.85	239.16	4.70	203.97	56.66
50	SAGBEND	-109.76	-17.27	.09	.061	8.191	171.142	-1.93	-5.02	246.26	4.18	209.97	58.33
51	SAGBEND	-113.72	-17.82	.09	.071	7.588	175.142	-2.03	-5.18	251.27	3.62	214.21	59.50
52	SAGBEND	-117.69	-18.32	.08	.079	6.975	179.142	-2.12	-5.33	254.20	3.05	216.68	60.19
53	SAGBEND	-121.66	-18.79	.08	.085	6.358	183.142	-2.21	-5.46	255.04	2.47	217.37	60.38
54	SAGBEND	-125.64	-19.21	.07	.091	5.742	187.142	-2.28	-5.59	253.78	1.87	216.28	60.08
55	SAGBEND	-129.62	-19.59	.07	.095	5.131	191.142	-2.35	-5.70	250.42	1.26	213.42	59.28
56	SAGBEND	-133.61	-19.93	.06	.097	4.531	195.142	-2.40	-5.79	244.95	.65	208.76	57.99
57	SAGBEND	-137.60	-20.22	.05	.098	3.946	199.142	-2.45	-5.88	237.37	.04	202.32	56.20
58	SAGBEND	-141.59	-20.48	.05	.097	3.383	203.142	-2.49	-5.95	227.67	-.58	194.07	53.91
59	SAGBEND	-145.58	-20.69	.04	.095	2.845	207.142	-2.52	-6.02	215.84	-1.20	184.03	51.12
60	SAGBEND	-149.58	-20.87	.03	.091	2.339	211.142	-2.55	-6.07	201.89	-1.82	172.18	47.83
61	SAGBEND	-153.58	-21.02	.03	.086	1.869	215.142	-2.57	-6.11	185.79	-2.45	158.51	44.03
62	SAGBEND	-157.58	-21.14	.02	.079	1.441	219.142	-2.58	-6.15	167.56	-3.07	143.04	39.73
63	SAGBEND	-161.57	-21.22	.02	.071	1.059	223.142	-2.59	-6.17	147.17	-3.70	125.74	34.93
64	SAGBEND	-165.57	-21.28	.01	.061	.730	227.142	-2.59	-6.19	124.62	-4.33	106.62	29.62
65	SAGBEND	-169.57	-21.33	.01	.050	.458	231.142	-2.60	-6.20	99.90	-4.97	85.69	23.80
66	SEABED	-173.57	-21.35	.00	.038	.247	235.142	-2.59	-6.21	73.62	-5.21	63.47	17.63
67	SEABED	-177.57	-21.36	.00	.026	.099	239.142	-2.59	-6.21	49.19	-4.63	42.85	11.90
68	SEABED	-181.57	-21.37	.00	.015	.006	243.142	-2.59	-6.21	29.15	-3.66	26.05	7.24
69	SEABED	-185.57	-21.36	.00	.008	-.046	247.142	-2.59	-6.21	14.27	-2.62	13.93	3.87
70	SEABED	-189.57	-21.36	.00	.003	-.067	251.142	-2.59	-6.21	4.24	-1.70	6.95	1.93
71	SEABED	-193.57	-21.35	.00	.000	-.070	255.142	-2.59	-6.21	-1.77	-.96	5.82	1.62
72	SEABED	-197.57	-21.35	.00	-.002	-.061	259.142	-2.59	-6.21	-4.77	-.42	7.07	1.96
73	SEABED	-201.57	-21.35	.00	-.003	-.048	263.142	-2.59	-6.21	-5.73	-.08	7.61	2.11
74	SEABED	-205.57	-21.34	.00	-.003	-.035	267.142	-2.59	-6.21	-5.45	.12	7.44	2.07
75	SEABED	-209.57	-21.34	.00	-.002	-.022	271.142	-2.59	-6.21	-4.53	.21	6.93	1.92
76	SEABED	-213.57	-21.34	.00	-.002	-.013	275.142	-2.59	-6.21	-3.41	.23	6.37	1.77
77	SEABED	-217.57	-21.34	.00	-.001	-.006	279.142	-2.59	-6.21	-2.32	.21	5.93	1.65
78	SEABED	-221.57	-21.34	.00	-.001	-.001	283.142	-2.59	-6.21	-1.42	.17	5.65	1.57
79	SEABED	-225.57	-21.34	.00	.000	.001	287.142	-2.59	-6.21	-.74	.13	5.50	1.53
80	SEABED	-229.57	-21.34	.00	.000	.002	291.142	-2.59	-6.21	-.30	.08	5.43	1.51
81	SEABED	-233.57	-21.34	.00	.000	.003	295.142	-2.59	-6.21	-.07	.04	5.41	1.50
82	SEABED	-237.57	-21.34	.00	.000	.003	299.142	-2.59	-6.21	.00	.00	5.40	1.50

Tension: 100 kN; Stinger-length: 32 m

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 OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X          DATE -  7/28/2016   TIME - 21:23:13    PAGE   11
 PROJECT - ANALISA STATIS PIPA TPPI                                                          JOB NO. - 113
 USER ID - N.FURQON                                         LICENSED TO: McDERMOTT, INCORPORATED                CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	1.08	.00	15.26	-.07	14.05	3.90
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	1.07	.00	-13.33	.21	12.40	3.44
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	2.16	.00	-97.96	.62	85.43	23.73
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	2.05	.00	-298.80	-1.03	256.03	71.12
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	1.99	.00	-265.80	.45	227.92	63.31
15	LAYBARGE	.00	2.82	.00	.000	4.757	59.471	1.79	.00	-284.60	-.17	243.70	67.70
18	STINGER	-6.64	2.20	.00	.000	5.906	66.142	1.64	.00	-292.21	.01	250.02	69.45
20	STINGER	-12.60	1.52	.00	.000	6.950	72.142	1.49	.00	-289.36	.14	247.44	68.73
22	STINGER	-18.55	.74	.00	-.001	7.992	78.142	1.30	.00	-290.72	-.66	248.41	69.00
24	STINGER	-24.49	-.14	.00	.004	9.030	84.142	1.10	-.04	-285.97	3.36	244.22	67.84
26	STINGER	-30.40	-1.14	.00	-.005	10.079	90.142	.92	-.33	-292.78	-8.76	250.06	69.46
28	STINGER	-32.37	-1.50	.00	-.020	10.433	92.142	.86	-.44	-292.42	-15.34	249.97	69.44
30	SAGBEND	-36.30	-2.24	.00	-.053	11.083	96.142	.76	-.65	-244.53	-11.48	209.16	58.10
31	SAGBEND	-40.22	-3.03	.01	-.077	11.620	100.142	.64	-.88	-199.02	-8.13	170.39	47.33
32	SAGBEND	-44.14	-3.85	.01	-.094	12.049	104.142	.51	-1.12	-155.86	-5.26	133.63	37.12
33	SAGBEND	-48.05	-4.70	.02	-.104	12.376	108.142	.37	-1.37	-115.00	-2.83	98.84	27.46
34	SAGBEND	-51.95	-5.56	.03	-.108	12.608	112.142	.23	-1.62	-76.40	-.80	66.00	18.33
35	SAGBEND	-55.85	-6.44	.03	-.108	12.748	116.142	.07	-1.87	-40.04	.87	35.09	9.75
36	SAGBEND	-59.76	-7.33	.04	-.104	12.803	120.142	-.08	-2.13	-5.87	2.22	6.58	1.83
37	SAGBEND	-63.66	-8.21	.05	-.097	12.778	124.142	-.24	-2.39	26.12	3.28	23.42	6.51
38	SAGBEND	-67.56	-9.10	.05	-.088	12.678	128.142	-.40	-2.65	55.97	4.08	48.68	13.52
39	SAGBEND	-71.46	-9.97	.06	-.077	12.509	132.142	-.56	-2.90	83.69	4.66	72.18	20.05
40	SAGBEND	-75.37	-10.83	.07	-.065	12.275	136.142	-.72	-3.15	109.30	5.05	93.89	26.08
41	SAGBEND	-79.28	-11.67	.07	-.052	11.981	140.142	-.88	-3.39	132.81	5.26	113.83	31.62
42	SAGBEND	-83.19	-12.49	.07	-.039	11.633	144.142	-1.03	-3.63	154.23	5.34	132.00	36.67
43	SAGBEND	-87.11	-13.28	.07	-.026	11.236	148.142	-1.18	-3.86	173.57	5.30	148.39	41.22
44	SAGBEND	-91.04	-14.04	.08	-.013	10.794	152.142	-1.33	-4.08	190.84	5.16	163.03	45.29
45	SAGBEND	-94.97	-14.78	.08	.000	10.313	156.142	-1.46	-4.30	206.03	4.94	175.90	48.86
46	SAGBEND	-98.91	-15.48	.08	.012	9.798	160.142	-1.59	-4.50	219.15	4.65	187.02	51.95
47	SAGBEND	-102.86	-16.14	.07	.023	9.254	164.142	-1.72	-4.69	230.20	4.31	196.38	54.55
48	SAGBEND	-106.81	-16.76	.07	.033	8.685	168.142	-1.84	-4.87	239.17	3.93	203.97	56.66
49	SAGBEND	-110.76	-17.35	.07	.042	8.097	172.142	-1.94	-5.04	246.07	3.51	209.80	58.28
50	SAGBEND	-114.73	-17.89	.07	.050	7.495	176.142	-2.04	-5.20	250.88	3.07	213.87	59.41
51	SAGBEND	-118.70	-18.39	.06	.057	6.884	180.142	-2.13	-5.35	253.60	2.61	216.16	60.05
52	SAGBEND	-122.67	-18.85	.06	.063	6.268	184.142	-2.22	-5.48	254.23	2.14	216.68	60.19
53	SAGBEND	-126.65	-19.26	.05	.067	5.654	188.142	-2.29	-5.60	252.77	1.65	215.42	59.84
54	SAGBEND	-130.63	-19.64	.05	.071	5.046	192.142	-2.35	-5.71	249.20	1.16	212.38	58.99
55	SAGBEND	-134.62	-19.97	.04	.073	4.449	196.142	-2.41	-5.81	243.52	.66	207.55	57.65
56	SAGBEND	-138.61	-20.26	.04	.074	3.868	200.142	-2.46	-5.89	235.73	.16	200.92	55.81
57	SAGBEND	-142.60	-20.51	.03	.074	3.309	204.142	-2.50	-5.96	225.82	-.34	192.50	53.47
58	SAGBEND	-146.59	-20.72	.03	.072	2.776	208.142	-2.53	-6.03	213.78	-.85	182.27	50.63
59	SAGBEND	-150.59	-20.89	.02	.069	2.275	212.142	-2.55	-6.08	199.61	-1.36	170.24	47.29
60	SAGBEND	-154.59	-21.04	.02	.066	1.811	216.142	-2.57	-6.12	183.31	-1.87	156.40	43.44
61	SAGBEND	-158.58	-21.15	.02	.060	1.389	220.142	-2.58	-6.15	164.85	-2.38	140.73	39.09
62	SAGBEND	-162.58	-21.23	.01	.054	1.014	224.142	-2.59	-6.17	144.25	-2.90	123.25	34.24
63	SAGBEND	-166.58	-21.29	.01	.046	.692	228.142	-2.59	-6.19	121.48	-3.41	103.94	28.87
64	SAGBEND	-170.58	-21.33	.00	.037	.428	232.142	-2.60	-6.20	96.55	-3.93	82.81	23.00
65	SEABED	-174.58	-21.35	.00	.028	.226	236.142	-2.59	-6.21	70.32	-4.01	60.62	16.84
66	SEABED	-178.58	-21.36	.00	.019	.085	240.142	-2.59	-6.21	46.38	-3.50	40.41	11.23
67	SEABED	-182.58	-21.37	.00	.011	-.003	244.142	-2.59	-6.21	27.00	-2.72	24.19	6.72
68	SEABED	-186.58	-21.36	.00	.005	-.050	248.142	-2.59	-6.21	12.77	-1.92	12.69	3.53
69	SEABED	-190.58	-21.36	.00	.002	-.068	252.142	-2.59	-6.21	3.31	-1.22	6.43	1.78
70	SEABED	-194.58	-21.35	.00	-.001	-.069	256.142	-2.59	-6.21	-2.27	-.67	5.94	1.65
71	SEABED	-198.58	-21.35	.00	-.002	-.060	260.142	-2.59	-6.21	-4.97	-.28	7.17	1.99
72	SEABED	-202.58	-21.35	.00	-.002	-.046	264.142	-2.59	-6.21	-5.74	-.03	7.62	2.12
73	SEABED	-206.58	-21.34	.00	-.002	-.033	268.142	-2.59	-6.21	-5.36	.11	7.39	2.05
74	SEABED	-210.58	-21.34	.00	-.002	-.021	272.142	-2.59	-6.21	-4.41	.17	6.86	1.91
75	SEABED	-214.58	-21.34	.00	-.001	-.012	276.142	-2.59	-6.21	-3.29	.18	6.32	1.75
76	SEABED	-218.58	-21.34	.00	-.001	-.005	280.142	-2.59	-6.21	-2.24	.16	5.90	1.64
77	SEABED	-222.58	-21.34	.00	.000	-.001	284.142	-2.59	-6.21	-1.38	.13	5.64	1.57
78	SEABED	-226.58	-21.34	.00	.000	.002	288.142	-2.59	-6.21	-.75	.09	5.50	1.53
79	SEABED	-230.58	-21.34	.00	.000	.003	292.142	-2.59	-6.21	-.34	.06	5.44	1.51
80	SEABED	-234.58	-21.34	.00	.000	.004	296.142	-2.59	-6.21	-.11	.04	5.41	1.50
81	SEABED	-238.58	-21.34	.00	.000	.004	300.142	-2.59	-6.21	-.02	.02	5.40	1.50
82	SEABED	-242.58	-21.34	.00	.000	.004	304.142	-2.59	-6.21	.00	.00	5.40	1.50

Tension: 100 kN; Stinger-length: 37 m

OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X DATE - 7/28/2016 TIME - 21:25:19 PAGE 11
PROJECT - ANALISA STATIS PIPA TPPI JOB NO. - 113
USER ID - N.FURQON LICENSED TO: McDERMOTT, INCORPORATED CASE 1

S T A T I C P I P E C O O R D I N A T E S, F O R C E S A N D S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.462	21.337	1.08	.00	15.23	-.07	14.02	3.90
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	1.07	.00	-13.30	.20	12.37	3.44
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	2.16	.00	-97.84	.60	85.33	23.70
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	2.05	.00	-299.00	-.99	256.21	71.17
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	1.99	.00	-265.49	.44	227.66	63.24
15	LAYBARGE	.00	2.82	.00	.000	4.759	59.471	1.79	.00	-285.50	-.16	244.46	67.91
18	STINGER	-7.64	2.09	.00	.000	6.079	67.142	1.62	.00	-293.36	.03	250.97	69.71
20	STINGER	-14.59	1.28	.00	.000	7.299	74.142	1.43	.00	-291.33	.08	249.05	69.18
22	STINGER	-21.52	.31	.00	-.001	8.508	81.142	1.20	.00	-288.22	-.57	246.19	68.39
24	STINGER	-28.43	-.80	.00	.005	9.738	88.142	.98	-.23	-295.32	2.89	252.13	70.04
26	STINGER	-35.32	-2.05	.00	-.018	10.906	95.142	.78	-.60	-257.40	-13.64	220.18	61.16
28	STINGER	-37.28	-2.44	.00	-.034	11.204	97.142	.73	-.71	-234.03	-11.82	200.26	55.63
30	SAGBEND	-41.20	-3.23	.00	-.059	11.716	101.142	.61	-.94	-189.07	-8.54	161.95	44.99
31	SAGBEND	-45.12	-4.06	.01	-.076	12.121	105.142	.48	-1.18	-146.43	-5.73	125.63	34.90
32	SAGBEND	-49.02	-4.91	.01	-.087	12.427	109.142	.34	-1.43	-106.09	-3.35	91.28	25.36
33	SAGBEND	-52.93	-5.78	.02	-.093	12.637	113.142	.19	-1.68	-68.01	-1.36	58.86	16.35
34	SAGBEND	-56.83	-6.66	.03	-.094	12.758	117.142	.04	-1.94	-32.15	.28	28.38	7.88
35	SAGBEND	-60.73	-7.54	.03	-.092	12.795	121.142	-.12	-2.19	1.52	1.61	3.43	.95
36	SAGBEND	-64.63	-8.43	.04	-.087	12.752	125.142	-.28	-2.45	33.02	2.65	29.18	8.11
37	SAGBEND	-68.54	-9.31	.05	-.079	12.636	129.142	-.44	-2.71	62.38	3.45	54.07	15.02
38	SAGBEND	-72.44	-10.18	.05	-.070	12.452	133.142	-.60	-2.96	89.62	4.03	77.17	21.44
39	SAGBEND	-76.35	-11.03	.05	-.059	12.204	137.142	-.76	-3.21	114.74	4.42	98.49	27.36
40	SAGBEND	-80.26	-11.87	.06	-.048	11.898	141.142	-.92	-3.45	137.78	4.65	118.02	32.78
41	SAGBEND	-84.18	-12.68	.06	-.036	11.538	145.142	-1.07	-3.69	158.72	4.75	135.79	37.72
42	SAGBEND	-88.10	-13.46	.06	-.025	11.131	149.142	-1.22	-3.92	177.59	4.73	151.78	42.16
43	SAGBEND	-92.03	-14.22	.06	-.013	10.680	153.142	-1.36	-4.14	194.38	4.62	166.02	46.12
44	SAGBEND	-95.96	-14.95	.06	-.002	10.191	157.142	-1.49	-4.35	209.10	4.43	178.49	49.58
45	SAGBEND	-99.90	-15.64	.06	.009	9.669	161.142	-1.62	-4.55	221.74	4.17	189.20	52.56
46	SAGBEND	-103.85	-16.29	.06	.019	9.119	165.142	-1.75	-4.74	232.31	3.87	198.16	55.04
47	SAGBEND	-107.80	-16.90	.06	.028	8.545	169.142	-1.86	-4.92	240.81	3.52	205.35	57.04
48	SAGBEND	-111.76	-17.48	.06	.036	7.954	173.142	-1.97	-5.08	247.23	3.15	210.78	58.55
49	SAGBEND	-115.72	-18.01	.06	.043	7.350	177.142	-2.07	-5.24	251.56	2.75	214.44	59.57
50	SAGBEND	-119.69	-18.50	.05	.049	6.737	181.142	-2.15	-5.38	253.80	2.33	216.33	60.09
51	SAGBEND	-123.67	-18.95	.05	.054	6.122	185.142	-2.23	-5.51	253.95	1.90	216.44	60.12
52	SAGBEND	-127.64	-19.35	.05	.059	5.509	189.142	-2.31	-5.63	252.00	1.46	214.77	59.66
53	SAGBEND	-131.63	-19.72	.04	.062	4.903	193.142	-2.37	-5.73	247.95	1.01	211.32	58.70
54	SAGBEND	-135.62	-20.04	.04	.063	4.310	197.142	-2.42	-5.83	241.79	.56	206.07	57.24
55	SAGBEND	-139.61	-20.32	.03	.064	3.734	201.142	-2.47	-5.91	233.51	.10	199.04	55.29
56	SAGBEND	-143.60	-20.56	.03	.064	3.181	205.142	-2.50	-5.98	223.11	-.36	190.20	52.83
57	SAGBEND	-147.59	-20.76	.02	.063	2.655	209.142	-2.53	-6.04	210.58	-.82	179.56	49.88
58	SAGBEND	-151.59	-20.93	.02	.060	2.163	213.142	-2.56	-6.09	195.93	-1.28	167.11	46.42
59	SAGBEND	-155.59	-21.07	.02	.056	1.708	217.142	-2.57	-6.13	179.13	-1.75	152.85	42.46
60	SAGBEND	-159.59	-21.17	.01	.052	1.297	221.142	-2.59	-6.16	160.18	-2.21	136.76	37.99
61	SAGBEND	-163.59	-21.25	.01	.046	.934	225.142	-2.59	-6.18	139.08	-2.68	118.86	33.02
62	SAGBEND	-167.59	-21.30	.01	.039	.625	229.142	-2.59	-6.19	115.82	-3.15	99.13	27.54
63	SEABED	-171.58	-21.34	.00	.030	.375	233.142	-2.59	-6.20	90.39	-3.54	77.58	21.55
64	SEABED	-175.58	-21.36	.00	.022	.188	237.142	-2.59	-6.21	64.38	-3.42	55.58	15.44
65	SEABED	-179.58	-21.36	.00	.014	.060	241.142	-2.59	-6.21	41.38	-2.88	36.18	10.05
66	SEABED	-183.58	-21.37	.00	.008	-.017	245.142	-2.59	-6.21	23.20	-2.18	21.02	5.84
67	SEABED	-187.58	-21.36	.00	.004	-.056	249.142	-2.59	-6.21	10.15	-1.49	10.69	2.97
68	SEABED	-191.58	-21.36	.00	.001	-.070	253.142	-2.59	-6.21	1.69	-.91	5.79	1.61
69	SEABED	-195.58	-21.35	.00	-.001	-.067	257.142	-2.59	-6.21	-3.11	-.47	6.25	1.74
70	SEABED	-199.58	-21.35	.00	-.002	-.057	261.142	-2.59	-6.21	-5.24	-.17	7.33	2.03
71	SEABED	-203.58	-21.35	.00	-.002	-.043	265.142	-2.59	-6.21	-5.63	.02	7.55	2.10
72	SEABED	-207.58	-21.34	.00	-.002	-.030	269.142	-2.59	-6.21	-5.01	.12	7.19	2.00
73	SEABED	-211.58	-21.34	.00	-.001	-.019	273.142	-2.59	-6.21	-3.90	.16	6.60	1.83
74	SEABED	-215.58	-21.34	.00	-.001	-.011	277.142	-2.59	-6.21	-2.69	.15	6.06	1.68
75	SEABED	-219.58	-21.34	.00	-.001	-.006	281.142	-2.59	-6.21	-1.59	.13	5.69	1.58
76	SEABED	-223.58	-21.34	.00	.000	-.003	285.142	-2.59	-6.21	-.73	.09	5.50	1.53
77	SEABED	-227.58	-21.34	.00	.000	-.002	289.142	-2.59	-6.21	-.19	.05	5.42	1.50
78	SEABED	-231.58	-21.34	.00	.000	-.002	293.142	-2.59	-6.21	.00	.00	5.40	1.50

Tension: 100 kN; Stinger-length: 42 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X        DATE - 7/28/2016   TIME - 21:27:59    PAGE  11
PROJECT - ANALISA STATIS PIPA TPPI                                                       JOB NO. - 113
USER ID - N.FURQON                                            LICENSED TO: McDERMOTT, INCORPORATED                CASE   1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.70	-.09	15.92	4.42
5	TENSIONR	38.10	4.14	.00	.000	.462	21.337	1.08	.00	15.20	-.07	14.00	3.89
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	1.07	.00	-13.28	.19	12.35	3.43
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	2.16	.00	-97.73	.58	85.24	23.68
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	2.05	.00	-299.21	-.96	256.38	71.22
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	1.99	.00	-265.16	.43	227.38	63.16
15	LAYBARGE	.00	2.82	.00	.000	4.761	59.471	1.79	.00	-286.47	-.19	245.29	68.14
18	STINGER	-8.63	1.98	.00	.000	6.252	68.142	1.59	.00	-294.92	.21	252.27	70.08
20	STINGER	-16.57	1.02	.00	-.001	7.646	76.142	1.36	.00	-292.45	-.84	249.95	69.43
22	STINGER	-24.49	-.14	.00	.006	9.028	84.142	1.10	-.04	-288.48	3.61	246.35	68.43
24	STINGER	-32.37	-1.50	.00	-.022	10.431	92.142	.86	-.44	-292.50	-15.28	250.04	69.46
26	STINGER	-40.22	-3.03	.01	-.079	11.618	100.142	.64	-.88	-199.09	-8.04	170.45	47.35
28	STINGER	-42.18	-3.44	.01	-.088	11.846	102.142	.58	-1.00	-177.22	-6.55	151.82	42.17
30	SAGBEND	-46.09	-4.27	.02	-.100	12.224	106.142	.44	-1.24	-135.21	-3.91	116.05	32.23
31	SAGBEND	-50.00	-5.13	.02	-.107	12.503	110.142	.30	-1.49	-95.48	-1.69	82.23	22.84
32	SAGBEND	-53.90	-6.00	.03	-.109	12.688	114.142	.15	-1.75	-58.00	.15	50.35	13.99
33	SAGBEND	-57.81	-6.88	.04	-.107	12.785	118.142	.00	-2.00	-22.74	1.65	20.45	5.68
34	SAGBEND	-61.71	-7.77	.05	-.101	12.800	122.142	-.16	-2.26	10.34	2.85	10.27	2.85
35	SAGBEND	-65.61	-8.66	.05	-.093	12.737	126.142	-.32	-2.52	41.26	3.77	36.22	10.06
36	SAGBEND	-69.51	-9.53	.06	-.083	12.602	130.142	-.48	-2.77	70.05	4.45	60.61	16.84
37	SAGBEND	-73.41	-10.40	.06	-.071	12.399	134.142	-.64	-3.02	96.71	4.93	83.22	23.12
38	SAGBEND	-77.32	-11.25	.07	-.058	12.135	138.142	-.80	-3.27	121.27	5.22	104.05	28.90
39	SAGBEND	-81.24	-12.08	.07	-.045	11.814	142.142	-.96	-3.51	143.74	5.36	123.10	34.20
40	SAGBEND	-85.15	-12.89	.07	-.032	11.440	146.142	-1.11	-3.75	164.13	5.37	140.39	39.00
41	SAGBEND	-89.08	-13.67	.08	-.019	11.020	150.142	-1.25	-3.97	182.43	5.28	155.90	43.31
42	SAGBEND	-93.01	-14.41	.08	-.006	10.559	154.142	-1.40	-4.19	198.67	5.09	169.66	47.13
43	SAGBEND	-96.94	-15.13	.08	.006	10.060	158.142	-1.53	-4.40	212.83	4.83	181.66	50.46
44	SAGBEND	-100.88	-15.81	.08	.018	9.530	162.142	-1.66	-4.60	224.91	4.51	191.90	53.30
45	SAGBEND	-104.83	-16.45	.07	.028	8.972	166.142	-1.78	-4.79	234.93	4.14	200.38	55.66
46	SAGBEND	-108.79	-17.06	.07	.038	8.393	170.142	-1.89	-4.96	242.86	3.73	207.09	57.53
47	SAGBEND	-112.75	-17.62	.07	.047	7.798	174.142	-1.99	-5.12	248.72	3.30	212.04	58.90
48	SAGBEND	-116.71	-18.14	.07	.054	7.190	178.142	-2.09	-5.28	252.49	2.85	215.23	59.79
49	SAGBEND	-120.68	-18.62	.06	.060	6.577	182.143	-2.18	-5.42	254.17	2.37	216.64	60.18
50	SAGBEND	-124.66	-19.06	.06	.066	5.961	186.143	-2.25	-5.54	253.76	1.89	216.27	60.07
51	SAGBEND	-128.64	-19.45	.05	.070	5.349	190.143	-2.32	-5.66	251.24	1.40	214.12	59.48
52	SAGBEND	-132.62	-19.81	.05	.072	4.746	194.143	-2.38	-5.76	246.62	.90	210.19	58.38
53	SAGBEND	-136.61	-20.12	.04	.074	4.157	198.143	-2.43	-5.85	239.89	.39	204.46	56.79
54	SAGBEND	-140.60	-20.39	.04	.074	3.586	202.143	-2.48	-5.93	231.04	-.12	196.94	54.71
55	SAGBEND	-144.60	-20.62	.03	.073	3.039	206.143	-2.51	-6.00	220.07	-.63	187.62	52.12
56	SAGBEND	-148.59	-20.81	.03	.071	2.522	210.143	-2.54	-6.05	206.97	-1.14	176.49	49.03
57	SAGBEND	-152.59	-20.97	.02	.068	2.039	214.143	-2.56	-6.10	191.74	-1.65	163.56	45.43
58	SAGBEND	-156.59	-21.10	.02	.063	1.595	218.143	-2.58	-6.14	174.36	-2.17	148.81	41.33
59	SAGBEND	-160.58	-21.19	.01	.057	1.196	222.143	-2.59	-6.16	154.84	-2.68	132.23	36.73
60	SAGBEND	-164.58	-21.26	.01	.050	.847	226.143	-2.59	-6.18	133.16	-3.20	113.84	31.62
61	SAGBEND	-168.58	-21.31	.01	.042	.553	230.143	-2.60	-6.20	109.31	-3.72	93.63	26.01
62	SEABED	-172.58	-21.34	.00	.032	.319	234.143	-2.59	-6.21	83.41	-4.09	71.69	19.91
63	SEABED	-176.58	-21.36	.00	.023	.148	238.143	-2.59	-6.21	57.90	-3.80	50.12	13.92
64	SEABED	-180.58	-21.36	.00	.014	.035	242.143	-2.59	-6.21	36.07	-3.11	31.75	8.82
65	SEABED	-184.58	-21.36	.00	.008	-.030	246.143	-2.59	-6.21	19.26	-2.30	17.84	4.95
66	SEABED	-188.58	-21.36	.00	.003	-.062	250.143	-2.59	-6.21	7.50	-1.54	8.85	2.46
67	SEABED	-192.58	-21.36	.00	.000	-.070	254.143	-2.59	-6.21	.10	-.91	5.53	1.54
68	SEABED	-196.58	-21.35	.00	-.001	-.065	258.143	-2.59	-6.21	-3.91	-.44	6.62	1.84
69	SEABED	-200.58	-21.35	.00	-.002	-.053	262.143	-2.59	-6.21	-5.54	-.13	7.50	2.08
70	SEABED	-204.58	-21.34	.00	-.002	-.040	266.143	-2.59	-6.21	-5.64	.06	7.55	2.10
71	SEABED	-208.58	-21.34	.00	-.002	-.027	270.143	-2.59	-6.21	-4.90	.15	7.13	1.98
72	SEABED	-212.58	-21.34	.00	-.001	-.016	274.143	-2.59	-6.21	-3.80	.18	6.56	1.82
73	SEABED	-216.58	-21.34	.00	-.001	-.008	278.143	-2.59	-6.21	-2.67	.17	6.06	1.68
74	SEABED	-220.58	-21.34	.00	-.001	-.003	282.143	-2.59	-6.21	-1.68	.15	5.72	1.59
75	SEABED	-224.58	-21.34	.00	.000	.000	286.143	-2.59	-6.21	-.91	.11	5.53	1.54
76	SEABED	-228.58	-21.34	.00	.000	.002	290.143	-2.59	-6.21	-.39	.07	5.44	1.51
77	SEABED	-232.58	-21.34	.00	.000	.002	294.143	-2.59	-6.21	-.09	.03	5.41	1.50
78	SEABED	-236.58	-21.34	.00	.000	.002	298.143	-2.59	-6.21	.00	.00	5.40	1.50

Tension: 150 kN; Stinger-length: 27 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X         DATE -  7/28/2016   TIME - 21:32:41    PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                        JOB NO. - 113
USER ID - N.FURQON                                         LICENSED TO: McDERMOTT, INCORPORATED                CASE   1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.10	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	1.64	.00	15.29	-.07	14.64	4.07
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	1.63	.00	-13.35	.22	12.98	3.61
9	TENSIONR	26.67	4.04	.00	.001	.668	32.767	3.28	.00	-98.09	.65	86.66	24.07
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	3.17	.00	-298.66	-1.07	257.03	71.40
13	LAYBARGE	12.19	3.62	.00	-.001	2.822	47.252	3.11	.00	-266.21	.47	229.39	63.72
15	LAYBARGE	.00	2.82	.00	.000	4.756	59.471	2.91	.00	-284.06	-.20	244.37	67.88
18	STINGER	-5.65	2.30	.00	.000	5.732	65.142	2.79	.00	-290.64	.12	249.83	69.40
20	STINGER	-10.62	1.76	.00	-.001	6.605	70.142	2.66	.00	-290.53	-.91	249.61	69.34
22	STINGER	-15.58	1.15	.00	.006	7.464	75.142	2.52	.00	-281.29	5.96	241.67	67.13
24	STINGER	-20.53	.46	.00	.010	8.319	80.142	2.36	.00	-288.76	-3.77	247.82	68.84
26	STINGER	-25.47	-.30	.00	-.017	9.234	85.142	2.17	-.09	-318.84	-13.73	273.49	75.97
28	STINGER	-27.45	-.63	.00	-.036	9.630	87.142	2.10	-.18	-334.84	-17.89	287.21	79.78
30	SAGBEND	-31.39	-1.32	.00	-.075	10.380	91.142	2.02	-.39	-284.95	-13.45	244.69	67.97
31	SAGBEND	-35.32	-2.07	.01	-.103	11.012	95.142	1.91	-.60	-237.73	-9.58	204.45	56.79
32	SAGBEND	-39.24	-2.85	.02	-.122	11.534	99.142	1.79	-.83	-193.10	-6.25	166.43	46.23
33	SAGBEND	-43.16	-3.66	.03	-.134	11.950	103.142	1.67	-1.07	-150.98	-3.40	130.57	36.27
34	SAGBEND	-47.07	-4.50	.04	-.139	12.267	107.142	1.53	-1.31	-111.28	-1.01	96.78	26.88
35	SAGBEND	-50.97	-5.36	.05	-.139	12.491	111.142	1.38	-1.56	-73.95	.97	65.04	18.07
36	SAGBEND	-54.88	-6.23	.05	-.135	12.627	115.142	1.23	-1.81	-38.90	2.58	35.31	9.81
37	SAGBEND	-58.78	-7.11	.06	-.127	12.681	119.142	1.08	-2.07	-6.09	3.87	8.44	2.34
38	SAGBEND	-62.68	-7.99	.07	-.116	12.658	123.142	.92	-2.32	24.54	4.86	23.43	6.51
39	SAGBEND	-66.59	-8.86	.08	-.103	12.564	127.142	.76	-2.58	53.05	5.59	47.44	13.18
40	SAGBEND	-70.49	-9.73	.09	-.088	12.403	131.142	.60	-2.83	79.47	6.09	69.80	19.39
41	SAGBEND	-74.40	-10.58	.09	-.073	12.180	135.142	.44	-3.08	103.84	6.40	90.45	25.13
42	SAGBEND	-78.31	-11.41	.10	-.057	11.901	139.142	.29	-3.32	126.20	6.54	109.40	30.39
43	SAGBEND	-82.23	-12.23	.10	-.041	11.571	143.142	.14	-3.56	146.58	6.54	126.67	35.19
44	SAGBEND	-86.15	-13.02	.10	-.025	11.193	147.142	-.01	-3.79	164.99	6.42	142.27	39.52
45	SAGBEND	-90.08	-13.78	.10	-.009	10.773	151.142	-.15	-4.01	181.47	6.20	156.23	43.40
46	SAGBEND	-94.01	-14.51	.10	.006	10.316	155.142	-.29	-4.22	196.03	5.90	168.56	46.82
47	SAGBEND	-97.95	-15.21	.10	.020	9.825	159.142	-.42	-4.42	208.68	5.53	179.27	49.80
48	SAGBEND	-101.89	-15.87	.10	.033	9.307	163.142	-.55	-4.62	219.43	5.11	188.38	52.33
49	SAGBEND	-105.84	-16.50	.10	.045	8.764	167.142	-.66	-4.80	228.30	4.65	195.87	54.41
50	SAGBEND	-109.80	-17.09	.09	.056	8.202	171.142	-.77	-4.97	235.27	4.16	201.77	56.05
51	SAGBEND	-113.76	-17.64	.09	.065	7.626	175.142	-.87	-5.13	240.37	3.64	206.08	57.24
52	SAGBEND	-117.73	-18.15	.08	.074	7.040	179.142	-.97	-5.28	243.58	3.10	208.78	58.00
53	SAGBEND	-121.70	-18.62	.08	.081	6.448	183.142	-1.05	-5.42	244.90	2.55	209.89	58.30
54	SAGBEND	-125.68	-19.05	.07	.086	5.855	187.142	-1.13	-5.54	244.34	2.00	209.40	58.17
55	SAGBEND	-129.66	-19.44	.07	.090	5.266	191.142	-1.19	-5.65	241.89	1.43	207.30	57.58
56	SAGBEND	-133.64	-19.79	.06	.093	4.685	195.142	-1.25	-5.75	237.53	.86	203.59	56.55
57	SAGBEND	-137.63	-20.09	.05	.094	4.117	199.142	-1.31	-5.84	231.26	.28	198.25	55.07
58	SAGBEND	-141.62	-20.36	.05	.094	3.567	203.142	-1.35	-5.92	223.07	-.30	191.29	53.14
59	SAGBEND	-145.61	-20.59	.04	.093	3.038	207.142	-1.38	-5.99	212.95	-.88	182.69	50.75
60	SAGBEND	-149.61	-20.79	.04	.090	2.537	211.142	-1.41	-6.05	200.88	-1.47	172.44	47.90
61	SAGBEND	-153.61	-20.95	.03	.086	2.067	215.142	-1.44	-6.09	186.84	-2.05	160.52	44.59
62	SAGBEND	-157.60	-21.08	.02	.080	1.634	219.142	-1.45	-6.13	170.82	-2.65	146.93	40.81
63	SAGBEND	-161.60	-21.18	.02	.073	1.241	223.142	-1.46	-6.16	152.80	-3.24	131.63	36.57
64	SAGBEND	-165.60	-21.25	.01	.065	.895	227.142	-1.47	-6.18	132.75	-3.84	114.63	31.84
65	SAGBEND	-169.60	-21.30	.01	.054	.600	231.142	-1.47	-6.20	110.65	-4.45	95.90	26.64
66	SEABED	-173.60	-21.34	.01	.043	.361	235.142	-1.47	-6.20	86.48	-4.95	75.45	20.96
67	SEABED	-177.60	-21.35	.00	.031	.182	239.142	-1.47	-6.21	61.71	-4.82	54.51	15.14
68	SEABED	-181.60	-21.36	.00	.020	.060	243.142	-1.47	-6.21	39.76	-4.07	36.01	10.00
69	SEABED	-185.60	-21.36	.00	.012	-.015	247.142	-1.47	-6.21	22.39	-3.09	21.53	5.98
70	SEABED	-189.60	-21.36	.00	.005	-.053	251.142	-1.47	-6.21	9.89	-2.13	11.56	3.21
71	SEABED	-193.60	-21.36	.00	.001	-.066	255.142	-1.47	-6.21	1.77	-1.31	6.42	1.78
72	SEABED	-197.60	-21.35	.00	-.001	-.064	259.142	-1.47	-6.21	-2.87	-.68	6.79	1.89
73	SEABED	-201.60	-21.35	.00	-.002	-.054	263.142	-1.47	-6.21	-4.97	-.25	7.96	2.21
74	SEABED	-205.60	-21.35	.00	-.003	-.041	267.142	-1.47	-6.21	-5.42	.02	8.24	2.29
75	SEABED	-209.60	-21.34	.00	-.002	-.029	271.142	-1.47	-6.21	-4.90	.16	7.91	2.20
76	SEABED	-213.60	-21.34	.00	-.002	-.018	275.142	-1.47	-6.21	-3.95	.21	7.34	2.04
77	SEABED	-217.60	-21.34	.00	-.001	-.010	279.142	-1.47	-6.21	-2.88	.21	6.76	1.88
78	SEABED	-221.60	-21.34	.00	-.001	-.004	283.142	-1.46	-6.21	-1.91	.19	6.29	1.75
79	SEABED	-225.60	-21.34	.00	.000	.000	287.142	-1.46	-6.21	-1.13	.15	5.97	1.66
80	SEABED	-229.60	-21.34	.00	.000	.002	291.142	-1.46	-6.21	-.58	.10	5.78	1.61
81	SEABED	-233.60	-21.34	.00	.000	.003	295.142	-1.46	-6.21	-.23	.07	5.68	1.58
82	SEABED	-237.60	-21.34	.00	.000	.003	299.142	-1.46	-6.21	-.05	.03	5.63	1.56
83	SEABED	-241.60	-21.34	.00	.000	.003	303.142	-1.47	-6.21	.00	.00	5.62	1.56

Tension: 150 kN; Stinger-length: 32 m

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 OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X         DATE - 7/28/2016    TIME - 21:39:57     PAGE   11
           PROJECT - ANALISA STATIS PIPA TPPI                                                    JOB NO. - 113
 USER ID - N.FURQON                                          LICENSED TO: McDERMOTT, INCORPORATED                CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	1.64	.00	15.26	-.07	14.61	4.06
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	1.63	.00	-13.32	.21	12.96	3.60
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	3.28	.00	-97.97	.62	86.56	24.04
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	3.17	.00	-298.86	-1.03	257.20	71.45
13	LAYBARGE	12.19	3.62	.00	-.001	2.822	47.252	3.11	.00	-265.96	.45	229.18	63.66
15	LAYBARGE	.00	2.82	.00	.000	4.757	59.471	2.91	.00	-284.75	-.17	244.95	68.04
18	STINGER	-6.64	2.20	.00	.000	5.906	66.142	2.76	.00	-292.20	.02	251.14	69.76
20	STINGER	-12.60	1.52	.00	.000	6.951	72.142	2.61	.00	-289.58	.07	248.75	69.10
22	STINGER	-18.55	.74	.00	.000	7.991	78.142	2.42	.00	-290.07	-.32	248.98	69.16
24	STINGER	-24.49	-.14	.00	.002	9.033	84.142	2.22	-.04	-288.99	1.63	247.89	68.86
26	STINGER	-30.40	-1.14	.00	-.007	10.073	90.142	2.05	-.33	-284.62	-6.61	244.21	67.84
28	STINGER	-32.37	-1.50	.00	-.020	10.414	92.142	1.99	-.44	-279.27	-15.48	239.95	66.65
30	SAGBEND	-36.30	-2.24	.00	-.053	11.033	96.142	1.88	-.65	-232.38	-11.58	199.98	55.55
31	SAGBEND	-40.22	-3.02	.01	-.078	11.542	100.142	1.77	-.88	-188.06	-8.21	162.21	45.06
32	SAGBEND	-44.14	-3.84	.01	-.094	11.946	104.142	1.64	-1.12	-146.24	-5.33	126.59	35.16
33	SAGBEND	-48.05	-4.68	.02	-.104	12.252	108.142	1.50	-1.36	-106.85	-2.89	93.04	25.84
34	SAGBEND	-51.96	-5.53	.03	-.109	12.465	112.142	1.35	-1.61	-69.80	-.86	61.51	17.09
35	SAGBEND	-55.86	-6.40	.03	-.109	12.592	116.142	1.20	-1.86	-35.04	.82	31.97	8.88
36	SAGBEND	-59.77	-7.28	.04	-.105	12.637	120.142	1.05	-2.12	-2.51	2.16	5.25	1.46
37	SAGBEND	-63.67	-8.15	.05	-.098	12.606	124.142	.89	-2.37	27.85	3.22	25.99	7.22
38	SAGBEND	-67.57	-9.02	.06	-.089	12.504	128.142	.73	-2.62	56.09	4.03	49.89	13.86
39	SAGBEND	-71.48	-9.88	.06	-.079	12.336	132.142	.57	-2.87	82.25	4.61	72.07	20.02
40	SAGBEND	-75.39	-10.73	.07	-.067	12.107	136.142	.42	-3.12	106.36	5.00	92.52	25.70
41	SAGBEND	-79.30	-11.56	.07	-.054	11.822	140.142	.26	-3.36	128.46	5.23	111.26	30.91
42	SAGBEND	-83.22	-12.37	.07	-.041	11.487	144.142	.11	-3.60	148.58	5.31	128.32	35.65
43	SAGBEND	-87.14	-13.15	.08	-.028	11.104	148.142	-.03	-3.82	166.75	5.28	143.72	39.92
44	SAGBEND	-91.07	-13.91	.08	-.015	10.681	152.142	-.18	-4.04	182.97	5.15	157.47	43.74
45	SAGBEND	-95.00	-14.63	.08	-.003	10.220	156.142	-.31	-4.26	197.28	4.94	169.60	47.11
46	SAGBEND	-98.94	-15.33	.08	.009	9.727	160.142	-.44	-4.46	209.68	4.66	180.10	50.03
47	SAGBEND	-102.89	-15.98	.08	.020	9.206	164.142	-.56	-4.65	220.18	4.34	188.99	52.50
48	SAGBEND	-106.84	-16.60	.08	.031	8.662	168.142	-.68	-4.83	228.79	3.97	196.28	54.52
49	SAGBEND	-110.80	-17.19	.07	.040	8.099	172.142	-.79	-5.00	235.52	3.57	201.97	56.10
50	SAGBEND	-114.76	-17.73	.07	.048	7.523	176.142	-.89	-5.16	240.36	3.15	206.06	57.24
51	SAGBEND	-118.73	-18.23	.07	.055	6.937	180.142	-.98	-5.30	243.32	2.70	208.56	57.93
52	SAGBEND	-122.70	-18.70	.06	.061	6.346	184.142	-1.06	-5.44	244.39	2.25	209.45	58.18
53	SAGBEND	-126.68	-19.12	.06	.066	5.754	188.142	-1.14	-5.56	243.57	1.78	208.74	57.98
54	SAGBEND	-130.66	-19.50	.05	.070	5.167	192.142	-1.20	-5.67	240.86	1.31	206.42	57.34
55	SAGBEND	-134.65	-19.84	.05	.072	4.589	196.142	-1.26	-5.77	236.24	.84	202.49	56.25
56	SAGBEND	-138.64	-20.14	.04	.074	4.025	200.142	-1.31	-5.86	229.72	.36	196.94	54.71
57	SAGBEND	-142.63	-20.40	.04	.074	3.478	204.142	-1.35	-5.93	221.26	-.13	189.75	52.71
58	SAGBEND	-146.62	-20.63	.03	.073	2.955	208.142	-1.39	-6.00	210.87	-.61	180.93	50.26
59	SAGBEND	-150.62	-20.81	.03	.071	2.459	212.142	-1.42	-6.05	198.53	-1.10	170.45	47.35
60	SAGBEND	-154.61	-20.97	.02	.068	1.995	216.142	-1.44	-6.10	184.22	-1.59	158.30	43.97
61	SAGBEND	-158.61	-21.09	.02	.063	1.568	220.142	-1.45	-6.13	167.93	-2.09	144.46	40.13
62	SAGBEND	-162.61	-21.19	.01	.058	1.183	224.142	-1.46	-6.16	149.63	-2.59	128.93	35.81
63	SAGBEND	-166.61	-21.26	.01	.051	.845	228.142	-1.47	-6.18	129.30	-3.09	111.68	31.02
64	SAGBEND	-170.61	-21.31	.01	.043	.559	232.142	-1.47	-6.20	106.91	-3.59	92.70	25.75
65	SEABED	-174.61	-21.34	.00	.034	.329	236.142	-1.47	-6.21	82.48	-4.00	72.03	20.01
66	SEABED	-178.61	-21.36	.00	.024	.159	240.142	-1.47	-6.21	57.99	-3.83	51.31	14.25
67	SEABED	-182.61	-21.36	.00	.015	.045	244.142	-1.47	-6.21	36.71	-3.19	33.39	9.28
68	SEABED	-186.61	-21.36	.00	.009	-.022	248.142	-1.47	-6.21	20.11	-2.40	19.61	5.45
69	SEABED	-190.61	-21.36	.00	.004	-.056	252.142	-1.47	-6.21	8.36	-1.63	10.38	2.88
70	SEABED	-194.61	-21.36	.00	.001	-.066	256.142	-1.47	-6.21	.84	-.99	6.04	1.68
71	SEABED	-198.61	-21.35	.00	-.001	-.063	260.142	-1.47	-6.21	-3.33	-.51	7.01	1.95
72	SEABED	-202.61	-21.35	.00	-.002	-.052	264.142	-1.47	-6.21	-5.12	-.17	8.05	2.24
73	SEABED	-206.61	-21.34	.00	-.002	-.039	268.142	-1.47	-6.21	-5.38	.03	8.21	2.28
74	SEABED	-210.61	-21.34	.00	-.002	-.027	272.142	-1.47	-6.21	-4.77	.13	7.83	2.18
75	SEABED	-214.61	-21.34	.00	-.001	-.016	276.142	-1.47	-6.21	-3.78	.17	7.24	2.01
76	SEABED	-218.61	-21.34	.00	-.001	-.009	280.142	-1.47	-6.21	-2.72	.17	6.67	1.85
77	SEABED	-222.61	-21.34	.00	-.001	-.003	284.142	-1.46	-6.21	-1.78	.15	6.23	1.73
78	SEABED	-226.61	-21.34	.00	.000	.000	288.142	-1.46	-6.21	-1.04	.11	5.94	1.65
79	SEABED	-230.61	-21.34	.00	.000	.002	292.142	-1.46	-6.21	-.52	.08	5.76	1.60
80	SEABED	-234.61	-21.34	.00	.000	.003	296.142	-1.46	-6.21	-.20	.05	5.67	1.58
81	SEABED	-238.61	-21.34	.00	.000	.003	300.142	-1.47	-6.21	-.04	.02	5.63	1.56
82	SEABED	-242.61	-21.34	.00	.000	.003	304.142	-1.47	-6.21	.00	.00	5.62	1.56

Tension: 150 kN; Stinger-length: 37 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X          DATE -  7/28/2016   TIME - 21:43: 1    PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                          JOB NO. - 113
USER ID - N.FURQON                                           LICENSED TO: McDERMOTT, INCORPORATED                CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.462	21.337	1.64	.00	15.23	-.07	14.58	4.05
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	1.63	.00	-13.30	.20	12.93	3.59
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	3.28	.00	-97.85	.60	86.46	24.02
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	3.17	.00	-299.07	-.99	257.38	71.49
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	3.12	.00	-265.65	.44	228.92	63.59
15	LAYBARGE	.00	2.82	.00	.000	4.759	59.471	2.91	.00	-285.65	-.17	245.71	68.25
18	STINGER	-7.64	2.09	.00	.000	6.079	67.142	2.74	.00	-293.39	.07	252.12	70.03
20	STINGER	-14.59	1.28	.00	.000	7.299	74.142	2.55	.00	-291.46	-.13	250.29	69.52
22	STINGER	-21.52	.31	.00	.001	8.508	81.142	2.32	.00	-288.06	.47	247.18	68.66
24	STINGER	-28.43	-.80	.00	-.001	9.739	88.142	2.10	-.23	-296.23	-1.63	254.02	70.56
26	STINGER	-35.32	-2.05	.00	-.033	10.881	95.142	1.91	-.60	-244.20	-13.13	210.08	58.36
28	STINGER	-37.28	-2.43	.00	-.048	11.163	97.142	1.85	-.71	-221.40	-11.30	190.64	52.96
30	SAGBEND	-41.20	-3.23	.01	-.071	11.646	101.142	1.73	-.94	-177.70	-8.03	153.40	42.61
31	SAGBEND	-45.12	-4.05	.01	-.088	12.026	105.142	1.60	-1.18	-136.47	-5.23	118.28	32.86
32	SAGBEND	-49.03	-4.89	.02	-.098	12.309	109.142	1.46	-1.42	-97.65	-2.87	85.22	23.67
33	SAGBEND	-52.94	-5.75	.03	-.102	12.500	113.142	1.32	-1.67	-61.17	-.90	54.17	15.05
34	SAGBEND	-56.84	-6.62	.03	-.102	12.607	117.142	1.16	-1.93	-26.96	.72	25.10	6.97
35	SAGBEND	-60.74	-7.49	.04	-.099	12.633	121.142	1.01	-2.18	5.04	2.02	6.98	1.94
36	SAGBEND	-64.65	-8.37	.05	-.093	12.584	125.142	.85	-2.43	34.88	3.04	31.90	8.86
37	SAGBEND	-68.55	-9.24	.05	-.084	12.466	129.142	.69	-2.69	62.61	3.81	55.40	15.39
38	SAGBEND	-72.46	-10.09	.06	-.074	12.282	133.142	.53	-2.94	88.27	4.37	77.16	21.43
39	SAGBEND	-76.37	-10.94	.06	-.063	12.040	137.142	.38	-3.18	111.89	4.74	97.20	27.00
40	SAGBEND	-80.28	-11.76	.07	-.050	11.742	141.142	.23	-3.42	133.50	4.96	115.53	32.09
41	SAGBEND	-84.20	-12.56	.07	-.038	11.395	145.142	.08	-3.65	153.15	5.03	132.18	36.72
42	SAGBEND	-88.12	-13.34	.07	-.026	11.002	149.142	-.07	-3.88	170.84	5.00	147.18	40.88
43	SAGBEND	-92.05	-14.09	.07	-.014	10.569	153.142	-.21	-4.10	186.60	4.87	160.54	44.59
44	SAGBEND	-95.99	-14.81	.07	-.002	10.100	157.142	-.34	-4.31	200.44	4.67	172.27	47.85
45	SAGBEND	-99.93	-15.49	.07	.009	9.600	161.142	-.47	-4.50	212.37	4.40	182.38	50.66
46	SAGBEND	-103.88	-16.14	.07	.020	9.073	165.142	-.59	-4.69	222.41	4.09	190.88	53.02
47	SAGBEND	-107.83	-16.75	.07	.029	8.524	169.142	-.71	-4.87	230.57	3.73	197.78	54.94
48	SAGBEND	-111.79	-17.33	.07	.038	7.958	173.142	-.81	-5.04	236.83	3.35	203.08	56.41
49	SAGBEND	-115.75	-17.86	.06	.046	7.378	177.142	-.91	-5.19	241.21	2.95	206.78	57.44
50	SAGBEND	-119.72	-18.35	.06	.053	6.791	181.142	-1.00	-5.34	243.71	2.52	208.89	58.02
51	SAGBEND	-123.70	-18.80	.06	.058	6.200	185.142	-1.08	-5.47	244.32	2.09	209.39	58.16
52	SAGBEND	-127.68	-19.22	.05	.063	5.609	189.142	-1.15	-5.59	243.04	1.64	208.29	57.86
53	SAGBEND	-131.66	-19.59	.05	.066	5.024	193.142	-1.22	-5.70	239.87	1.19	205.58	57.11
54	SAGBEND	-135.64	-19.92	.04	.068	4.449	197.142	-1.28	-5.79	234.79	.74	201.25	55.90
55	SAGBEND	-139.63	-20.21	.04	.070	3.888	201.142	-1.32	-5.88	227.79	.28	195.30	54.25
56	SAGBEND	-143.63	-20.46	.03	.070	3.347	205.142	-1.36	-5.95	218.86	-.19	187.72	52.14
57	SAGBEND	-147.62	-20.68	.03	.069	2.830	209.142	-1.40	-6.01	208.00	-.65	178.49	49.58
58	SAGBEND	-151.62	-20.86	.02	.067	2.341	213.142	-1.42	-6.07	195.18	-1.12	167.60	46.55
59	SAGBEND	-155.61	-21.00	.02	.063	1.886	217.142	-1.44	-6.11	180.39	-1.59	155.04	43.07
60	SAGBEND	-159.61	-21.12	.02	.059	1.469	221.142	-1.46	-6.14	163.61	-2.06	140.79	39.11
61	SAGBEND	-163.61	-21.21	.01	.053	1.096	225.142	-1.47	-6.17	144.81	-2.54	124.84	34.68
62	SAGBEND	-167.61	-21.27	.01	.047	.770	229.142	-1.47	-6.19	123.98	-3.02	107.17	29.77
63	SAGBEND	-171.61	-21.32	.01	.039	.497	233.142	-1.47	-6.20	101.08	-3.50	87.76	24.38
64	SEABED	-175.61	-21.34	.00	.030	.282	237.142	-1.47	-6.21	76.32	-3.82	66.80	18.55
65	SEABED	-179.61	-21.36	.00	.021	.126	241.142	-1.47	-6.21	52.37	-3.52	46.56	12.93
66	SEABED	-183.61	-21.36	.00	.013	.025	245.142	-1.47	-6.21	32.17	-2.86	29.58	8.22
67	SEABED	-187.61	-21.36	.00	.007	-.033	249.142	-1.47	-6.21	16.78	-2.10	16.90	4.69
68	SEABED	-191.61	-21.36	.00	.003	-.060	253.142	-1.47	-6.21	6.14	-1.40	8.82	2.45
69	SEABED	-195.61	-21.36	.00	.000	-.066	257.142	-1.47	-6.21	-.45	-.82	5.90	1.64
70	SEABED	-199.61	-21.35	.00	-.001	-.060	261.142	-1.47	-6.21	-3.95	-.39	7.35	2.04
71	SEABED	-203.61	-21.35	.00	-.002	-.049	265.142	-1.47	-6.21	-5.27	-.11	8.14	2.26
72	SEABED	-207.61	-21.34	.00	-.002	-.036	269.142	-1.47	-6.21	-5.22	.06	8.11	2.25
73	SEABED	-211.61	-21.34	.00	-.002	-.024	273.142	-1.47	-6.21	-4.44	.15	7.63	2.12
74	SEABED	-215.61	-21.34	.00	-.001	-.015	277.142	-1.47	-6.21	-3.35	.17	7.00	1.95
75	SEABED	-219.61	-21.34	.00	-.001	-.008	281.142	-1.46	-6.21	-2.25	.16	6.44	1.79
76	SEABED	-223.61	-21.34	.00	-.001	-.004	285.142	-1.46	-6.21	-1.30	.13	6.04	1.68
77	SEABED	-227.61	-21.34	.00	.000	-.002	289.142	-1.46	-6.21	-.59	.09	5.79	1.61
78	SEABED	-231.61	-21.34	.00	.000	-.001	293.142	-1.46	-6.21	-.15	.04	5.66	1.57
79	SEABED	-235.61	-21.34	.00	.000	-.001	297.142	-1.46	-6.21	.00	.00	5.62	1.56

Tension: 150 kN; Stinger-length: 42 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X        DATE - 7/28/2016    TIME - 21:44:41     PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                       JOB NO. - 113
USER ID - N.FURQON                                          LICENSED TO: McDERMOTT, INCORPORATED                  CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	.000	.462	21.337	1.64	.00	15.20	-.07	14.56	4.04
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	1.63	.00	-13.27	.19	12.91	3.59
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	3.28	.00	-97.75	.58	86.37	23.99
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	3.17	.00	-299.27	-.96	257.55	71.54
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	3.12	.00	-265.33	.43	228.65	63.51
15	LAYBARGE	.00	2.82	.00	.000	4.761	59.471	2.91	.00	-286.58	-.18	246.51	68.47
18	STINGER	-8.63	1.98	.00	.000	6.252	68.142	2.71	.00	-295.20	.20	253.63	70.45
20	STINGER	-16.57	1.02	.00	-.001	7.645	76.142	2.49	.00	-291.67	-.82	250.41	69.56
22	STINGER	-24.49	-.14	.00	.006	9.033	84.142	2.22	-.04	-291.99	3.61	250.45	69.57
24	STINGER	-32.37	-1.50	.00	-.022	10.413	92.142	1.99	-.44	-279.34	-15.44	240.00	66.67
26	STINGER	-40.22	-3.02	.01	-.080	11.540	100.142	1.77	-.88	-188.12	-8.14	162.26	45.07
28	STINGER	-42.18	-3.43	.01	-.089	11.755	102.142	1.70	-1.00	-166.90	-6.65	144.18	40.05
30	SAGBEND	-46.10	-4.26	.02	-.102	12.110	106.142	1.57	-1.24	-126.30	-4.00	109.60	30.45
31	SAGBEND	-50.01	-5.10	.02	-.109	12.369	110.142	1.43	-1.48	-88.09	-1.77	77.07	21.41
32	SAGBEND	-53.91	-5.97	.03	-.111	12.538	114.142	1.28	-1.74	-52.19	.08	46.53	12.92
33	SAGBEND	-57.82	-6.84	.04	-.109	12.624	118.142	1.12	-1.99	-18.54	1.58	18.02	5.01
34	SAGBEND	-61.72	-7.71	.05	-.103	12.630	122.142	.97	-2.24	12.90	2.78	13.45	3.74
35	SAGBEND	-65.62	-8.59	.05	-.095	12.563	126.142	.81	-2.50	42.19	3.71	38.12	10.59
36	SAGBEND	-69.53	-9.45	.06	-.085	12.427	130.142	.65	-2.75	69.39	4.39	61.17	16.99
37	SAGBEND	-73.43	-10.31	.06	-.074	12.228	134.142	.50	-3.00	94.52	4.88	82.48	22.91
38	SAGBEND	-77.35	-11.15	.07	-.061	11.971	138.142	.34	-3.24	117.63	5.18	102.08	28.35
39	SAGBEND	-81.26	-11.97	.07	-.048	11.660	142.142	.19	-3.48	138.74	5.33	119.98	33.33
40	SAGBEND	-85.18	-12.76	.08	-.035	11.301	146.142	.04	-3.71	157.88	5.35	136.21	37.83
41	SAGBEND	-89.11	-13.53	.08	-.022	10.897	150.142	-.11	-3.94	175.07	5.26	150.78	41.88
42	SAGBEND	-93.04	-14.27	.08	-.009	10.454	154.142	-.25	-4.15	190.34	5.09	163.72	45.48
43	SAGBEND	-96.97	-14.98	.08	.003	9.977	158.142	-.38	-4.36	203.70	4.84	175.03	48.62
44	SAGBEND	-100.92	-15.66	.08	.015	9.469	162.142	-.50	-4.55	215.15	4.54	184.73	51.31
45	SAGBEND	-104.86	-16.30	.08	.026	8.936	166.142	-.62	-4.74	224.71	4.19	192.82	53.56
46	SAGBEND	-108.82	-16.90	.07	.035	8.383	170.142	-.74	-4.91	232.38	3.80	199.31	55.37
47	SAGBEND	-112.78	-17.46	.07	.044	7.813	174.142	-.84	-5.08	238.16	3.39	204.21	56.72
48	SAGBEND	-116.74	-17.99	.07	.052	7.231	178.142	-.93	-5.23	242.06	2.95	207.50	57.64
49	SAGBEND	-120.72	-18.47	.06	.059	6.642	182.142	-1.02	-5.37	244.08	2.50	209.20	58.11
50	SAGBEND	-124.69	-18.91	.06	.064	6.050	186.142	-1.10	-5.50	244.21	2.04	209.29	58.14
51	SAGBEND	-128.67	-19.31	.06	.069	5.460	190.142	-1.17	-5.62	242.45	1.57	207.78	57.72
52	SAGBEND	-132.65	-19.67	.05	.072	4.877	194.143	-1.23	-5.72	238.79	1.09	204.66	56.85
53	SAGBEND	-136.64	-19.99	.05	.074	4.306	198.143	-1.29	-5.81	233.22	.61	199.92	55.53
54	SAGBEND	-140.63	-20.28	.04	.075	3.749	202.143	-1.33	-5.90	225.73	.13	193.55	53.76
55	SAGBEND	-144.62	-20.52	.04	.075	3.214	206.143	-1.37	-5.97	216.31	-.36	185.55	51.54
56	SAGBEND	-148.62	-20.72	.03	.073	2.703	210.143	-1.40	-6.03	204.95	-.84	175.90	48.86
57	SAGBEND	-152.62	-20.90	.03	.070	2.223	214.143	-1.43	-6.08	191.63	-1.34	164.58	45.72
58	SAGBEND	-156.61	-21.04	.02	.067	1.777	218.143	-1.45	-6.12	176.33	-1.83	151.60	42.11
59	SAGBEND	-160.61	-21.15	.02	.062	1.370	222.143	-1.46	-6.15	159.04	-2.33	136.92	38.03
60	SAGBEND	-164.61	-21.23	.01	.055	1.008	226.143	-1.47	-6.17	139.73	-2.83	120.53	33.48
61	SAGBEND	-168.61	-21.29	.01	.048	.695	230.143	-1.47	-6.19	118.37	-3.33	102.42	28.45
62	SAGBEND	-172.61	-21.33	.01	.039	.437	234.143	-1.47	-6.20	94.95	-3.84	82.58	22.94
63	SEABED	-176.61	-21.35	.00	.029	.237	238.143	-1.47	-6.21	70.01	-4.05	61.48	17.08
64	SEABED	-180.61	-21.36	.00	.020	.096	242.143	-1.47	-6.21	46.83	-3.61	41.90	11.64
65	SEABED	-184.61	-21.36	.00	.012	.007	246.143	-1.47	-6.21	27.80	-2.86	25.95	7.21
66	SEABED	-188.61	-21.36	.00	.006	-.043	250.143	-1.47	-6.21	13.66	-2.05	14.42	4.01
67	SEABED	-192.61	-21.36	.00	.002	-.063	254.143	-1.47	-6.21	4.12	-1.33	7.57	2.10
68	SEABED	-196.61	-21.35	.00	.000	-.066	258.143	-1.47	-6.21	-1.60	-.75	6.23	1.73
69	SEABED	-200.61	-21.35	.00	-.002	-.058	262.143	-1.47	-6.21	-4.46	-.34	7.65	2.12
70	SEABED	-204.61	-21.35	.00	-.002	-.046	266.143	-1.47	-6.21	-5.37	-.06	8.21	2.28
71	SEABED	-208.61	-21.34	.00	-.002	-.033	270.143	-1.47	-6.21	-5.10	.09	8.03	2.23
72	SEABED	-212.61	-21.34	.00	-.002	-.021	274.143	-1.47	-6.21	-4.21	.17	7.49	2.08
73	SEABED	-216.61	-21.34	.00	-.001	-.013	278.143	-1.47	-6.21	-3.11	.18	6.88	1.91
74	SEABED	-220.61	-21.34	.00	-.001	-.006	282.143	-1.46	-6.21	-2.05	.16	6.35	1.76
75	SEABED	-224.61	-21.34	.00	.000	-.002	286.143	-1.46	-6.21	-1.17	.13	5.99	1.66
76	SEABED	-228.61	-21.34	.00	.000	-.001	290.143	-1.46	-6.21	-.52	.09	5.76	1.60
77	SEABED	-232.61	-21.34	.00	.000	.000	294.143	-1.46	-6.21	-.13	.04	5.65	1.57
78	SEABED	-236.61	-21.34	.00	.000	.000	298.143	-1.46	-6.21	.00	.00	5.62	1.56

Tension: 200 kN; Stinger-length: 27 m

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 OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X          DATE -  7/28/2016    TIME - 21:48:36     PAGE   11
          PROJECT - ANALISA STATIS PIPA TPPI                                                  JOB NO. - 113
 USER ID - N.FURQON                                           LICENSED TO: McDERMOTT, INCORPORATED                 CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.10	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	2.20	.00	15.29	-.07	15.19	4.22
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	2.19	.00	-13.35	.22	13.54	3.76
9	TENSIONR	26.67	4.04	.00	.001	.668	32.767	4.41	.00	-98.10	.65	87.79	24.39
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	4.29	.00	-298.72	-1.07	258.20	71.72
13	LAYBARGE	12.19	3.62	.00	-.001	2.822	47.252	4.24	.00	-266.38	.47	230.66	64.07
15	LAYBARGE	.00	2.82	.00	.000	4.756	59.471	4.04	.00	-284.18	-.19	245.58	68.22
18	STINGER	-5.65	2.30	.00	.000	5.732	65.142	3.91	.00	-290.83	.09	251.12	69.75
20	STINGER	-10.62	1.76	.00	-.001	6.604	70.142	3.78	.00	-289.61	-.86	249.95	69.43
22	STINGER	-15.58	1.15	.00	.007	7.468	75.142	3.64	.00	-285.76	5.98	246.59	68.50
24	STINGER	-20.53	.46	.00	.010	8.326	80.142	3.48	.00	-286.09	-3.82	246.67	68.52
26	STINGER	-25.47	-.30	.00	-.017	9.223	85.142	3.30	-.09	-309.40	-13.85	266.60	74.06
28	STINGER	-27.45	-.63	.00	-.037	9.606	87.142	3.23	-.18	-322.79	-18.05	278.12	77.26
30	SAGBEND	-31.39	-1.32	.00	-.075	10.327	91.142	3.14	-.38	-273.60	-13.57	236.18	65.61
31	SAGBEND	-35.32	-2.06	.01	-.104	10.933	95.142	3.04	-.60	-227.29	-9.67	196.71	54.64
32	SAGBEND	-39.24	-2.84	.02	-.123	11.430	99.142	2.92	-.82	-183.75	-6.33	159.61	44.34
33	SAGBEND	-43.16	-3.64	.03	-.135	11.825	103.142	2.79	-1.06	-142.86	-3.48	124.79	34.66
34	SAGBEND	-47.07	-4.47	.04	-.141	12.124	107.142	2.66	-1.30	-104.50	-1.08	92.15	25.60
35	SAGBEND	-50.98	-5.32	.05	-.141	12.333	111.142	2.51	-1.55	-68.59	.90	61.61	17.11
36	SAGBEND	-54.89	-6.18	.06	-.137	12.458	115.142	2.36	-1.80	-35.02	2.51	33.14	9.21
37	SAGBEND	-58.79	-7.05	.06	-.129	12.505	119.142	2.21	-2.05	-3.71	3.80	7.95	2.21
38	SAGBEND	-62.70	-7.91	.07	-.118	12.478	123.142	2.05	-2.30	25.42	4.79	25.27	7.02
39	SAGBEND	-66.60	-8.77	.08	-.105	12.383	127.142	1.90	-2.55	52.45	5.52	48.05	13.35
40	SAGBEND	-70.51	-9.63	.09	-.091	12.226	131.142	1.74	-2.80	77.43	6.03	69.20	19.22
41	SAGBEND	-74.42	-10.47	.09	-.076	12.010	135.142	1.59	-3.04	100.43	6.34	88.68	24.63
42	SAGBEND	-78.34	-11.29	.10	-.060	11.741	139.142	1.43	-3.28	121.49	6.49	106.53	29.59
43	SAGBEND	-82.26	-12.09	.10	-.044	11.423	143.142	1.28	-3.52	140.67	6.50	122.78	34.10
44	SAGBEND	-86.18	-12.87	.10	-.028	11.061	147.142	1.14	-3.74	158.00	6.39	137.46	38.18
45	SAGBEND	-90.11	-13.63	.10	-.012	10.659	151.142	1.00	-3.96	173.52	6.18	150.60	41.83
46	SAGBEND	-94.04	-14.35	.11	.003	10.222	155.142	.86	-4.17	187.25	5.89	162.23	45.06
47	SAGBEND	-97.98	-15.05	.10	.017	9.754	159.142	.73	-4.38	199.22	5.54	172.37	47.88
48	SAGBEND	-101.93	-15.71	.10	.030	9.259	163.142	.61	-4.57	209.46	5.14	181.03	50.29
49	SAGBEND	-105.88	-16.33	.10	.042	8.741	167.142	.50	-4.75	217.97	4.70	188.23	52.29
50	SAGBEND	-109.83	-16.92	.10	.053	8.204	171.142	.39	-4.92	224.77	4.23	193.98	53.88
51	SAGBEND	-113.79	-17.47	.09	.063	7.653	175.142	.28	-5.08	229.87	3.73	198.29	55.08
52	SAGBEND	-117.76	-17.99	.09	.071	7.092	179.142	.19	-5.23	233.27	3.22	201.16	55.88
53	SAGBEND	-121.73	-18.46	.08	.078	6.525	183.142	.11	-5.37	234.97	2.70	202.59	56.27
54	SAGBEND	-125.71	-18.90	.08	.084	5.956	187.142	.03	-5.50	234.98	2.16	202.57	56.27
55	SAGBEND	-129.69	-19.29	.07	.089	5.388	191.142	-.04	-5.61	233.29	1.62	201.12	55.87
56	SAGBEND	-133.67	-19.65	.07	.092	4.827	195.142	-.10	-5.71	229.88	1.08	198.22	55.06
57	SAGBEND	-137.66	-19.96	.06	.094	4.276	199.142	-.16	-5.81	224.76	.53	193.85	53.85
58	SAGBEND	-141.65	-20.24	.05	.095	3.740	203.142	-.20	-5.89	217.89	-.02	188.02	52.23
59	SAGBEND	-145.64	-20.49	.05	.094	3.222	207.142	-.24	-5.96	209.28	-.57	180.70	50.19
60	SAGBEND	-149.64	-20.69	.04	.092	2.728	211.142	-.27	-6.02	198.89	-1.13	171.88	47.74
61	SAGBEND	-153.64	-20.87	.03	.089	2.261	215.142	-.30	-6.07	186.71	-1.69	161.53	44.87
62	SAGBEND	-157.63	-21.01	.03	.084	1.825	219.142	-.32	-6.11	172.71	-2.26	149.64	41.57
63	SAGBEND	-161.63	-21.12	.02	.078	1.426	223.142	-.33	-6.14	156.85	-2.83	136.19	37.83
64	SAGBEND	-165.63	-21.21	.02	.070	1.067	227.142	-.34	-6.17	139.11	-3.41	121.14	33.65
65	SAGBEND	-169.63	-21.27	.01	.061	.753	231.142	-.35	-6.19	119.44	-4.00	104.46	29.02
66	SAGBEND	-173.63	-21.32	.01	.051	.490	235.142	-.35	-6.20	97.81	-4.59	86.14	23.93
67	SEABED	-177.63	-21.34	.00	.039	.281	239.142	-.35	-6.21	74.32	-4.99	66.28	18.41
68	SEABED	-181.63	-21.36	.00	.027	.130	243.142	-.35	-6.21	51.37	-4.60	46.91	13.03
69	SEABED	-185.63	-21.36	.00	.017	.030	247.142	-.35	-6.21	31.85	-3.75	30.50	8.47
70	SEABED	-189.63	-21.36	.00	.009	-.028	251.142	-.35	-6.21	16.90	-2.75	18.13	5.04
71	SEABED	-193.63	-21.36	.00	.004	-.056	255.142	-.35	-6.21	6.48	-1.83	10.04	2.79
72	SEABED	-197.63	-21.35	.00	.000	-.063	259.142	-.35	-6.21	-.05	-1.08	6.52	1.81
73	SEABED	-201.63	-21.35	.00	-.002	-.058	263.142	-.35	-6.21	-3.56	-.52	7.92	2.20
74	SEABED	-205.63	-21.35	.00	-.002	-.047	267.142	-.35	-6.21	-4.96	-.15	8.81	2.45
75	SEABED	-209.63	-21.34	.00	-.003	-.035	271.142	-.34	-6.21	-5.02	.07	8.85	2.46
76	SEABED	-213.63	-21.34	.00	-.002	-.024	275.142	-.34	-6.21	-4.35	.18	8.40	2.33
77	SEABED	-217.63	-21.34	.00	-.002	-.014	279.142	-.34	-6.21	-3.37	.22	7.78	2.16
78	SEABED	-221.63	-21.34	.00	-.001	-.007	283.142	-.34	-6.21	-2.36	.21	7.19	2.00
79	SEABED	-225.63	-21.34	.00	-.001	-.003	287.142	-.34	-6.21	-1.48	.17	6.72	1.87
80	SEABED	-229.63	-21.34	.00	.000	.000	291.142	-.34	-6.21	-.80	.13	6.39	1.77
81	SEABED	-233.63	-21.34	.00	.000	.001	295.142	-.34	-6.21	-.34	.08	6.18	1.72
82	SEABED	-237.63	-21.34	.00	.000	.002	299.142	-.34	-6.21	-.08	.04	6.08	1.69
83	SEABED	-241.63	-21.34	.00	.000	.002	303.142	-.34	-6.21	.00	.00	6.04	1.68

Tension: 200 kN; Stinger-length: 32 m

OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X   DATE - 7/28/2016   TIME - 21:51:34   PAGE 11
PROJECT - ANALISA STATIS PIPA TPPI   JOB NO. - 113
USER ID - N.FURQON   LICENSED TO: McDERMOTT, INCORPORATED   CASE 1

S T A T I C   P I P E   C O O R D I N A T E S ,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	2.20	.00	15.26	-.07	15.17	4.21
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	2.19	.00	-13.32	.21	13.51	3.75
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	4.41	.00	-97.98	.63	87.69	24.36
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	4.29	.00	-298.92	-1.03	258.38	71.77
13	LAYBARGE	12.19	3.62	.00	-.001	2.822	47.252	4.24	.00	-266.12	.45	230.44	64.01
15	LAYBARGE	.00	2.82	.00	.000	4.757	59.471	4.03	.00	-284.89	-.17	246.19	68.39
18	STINGER	-6.64	2.20	.00	.000	5.906	66.142	3.88	.00	-292.23	.02	252.28	70.08
20	STINGER	-12.60	1.52	.00	.000	6.951	72.142	3.73	.00	-289.67	.08	249.95	69.43
22	STINGER	-18.55	.74	.00	-.001	7.991	78.142	3.54	.00	-289.93	-.44	249.99	69.44
24	STINGER	-24.49	-.14	.00	.003	9.034	84.142	3.34	-.04	-289.94	2.62	249.82	69.40
26	STINGER	-30.40	-1.14	.00	-.014	10.069	90.142	3.17	-.33	-281.18	-12.19	242.57	67.38
28	STINGER	-32.37	-1.50	.00	-.030	10.401	92.142	3.12	-.43	-266.04	-15.15	229.84	63.84
30	SAGBEND	-36.30	-2.24	.00	-.063	10.989	96.142	3.01	-.65	-220.20	-11.24	190.75	52.99
31	SAGBEND	-40.23	-3.02	.01	-.086	11.469	100.142	2.89	-.88	-177.09	-7.88	154.01	42.78
32	SAGBEND	-44.14	-3.83	.02	-.102	11.849	104.142	2.76	-1.11	-136.62	-5.01	119.53	33.20
33	SAGBEND	-48.06	-4.66	.02	-.111	12.133	108.142	2.62	-1.35	-98.67	-2.58	87.21	24.23
34	SAGBEND	-51.96	-5.51	.03	-.115	12.328	112.142	2.48	-1.60	-63.15	-.56	56.98	15.83
35	SAGBEND	-55.87	-6.36	.04	-.115	12.441	116.142	2.33	-1.85	-29.95	1.09	28.78	7.99
36	SAGBEND	-59.78	-7.23	.05	-.110	12.475	120.142	2.18	-2.10	.99	2.42	5.75	1.60
37	SAGBEND	-63.68	-8.09	.05	-.103	12.438	124.142	2.02	-2.35	29.77	3.46	28.75	7.99
38	SAGBEND	-67.59	-8.95	.06	-.093	12.333	128.142	1.87	-2.60	56.46	4.24	51.34	14.26
39	SAGBEND	-71.50	-9.80	.07	-.082	12.166	132.142	1.71	-2.85	81.11	4.81	72.24	20.07
40	SAGBEND	-75.41	-10.63	.07	-.070	11.942	136.142	1.56	-3.09	103.78	5.18	91.47	25.41
41	SAGBEND	-79.33	-11.45	.08	-.056	11.665	140.142	1.40	-3.33	124.53	5.40	109.06	30.29
42	SAGBEND	-83.24	-12.25	.08	-.043	11.340	144.142	1.26	-3.56	143.40	5.47	125.05	34.74
43	SAGBEND	-87.17	-13.02	.08	-.029	10.972	148.142	1.11	-3.79	160.42	5.43	139.48	38.74
44	SAGBEND	-91.10	-13.77	.08	-.016	10.564	152.142	.97	-4.01	175.64	5.29	152.37	42.33
45	SAGBEND	-95.03	-14.49	.08	-.003	10.122	156.142	.84	-4.21	189.07	5.08	163.76	45.49
46	SAGBEND	-98.97	-15.18	.08	.009	9.650	160.142	.71	-4.41	200.75	4.80	173.65	48.24
47	SAGBEND	-102.92	-15.83	.08	.020	9.152	164.142	.59	-4.60	210.69	4.47	182.06	50.57
48	SAGBEND	-106.87	-16.45	.08	.031	8.631	168.142	.47	-4.78	218.91	4.10	189.02	52.51
49	SAGBEND	-110.83	-17.03	.08	.040	8.093	172.142	.37	-4.95	225.42	3.70	194.53	54.04
50	SAGBEND	-114.79	-17.58	.08	.049	7.541	176.142	.27	-5.11	230.23	3.28	198.59	55.16
51	SAGBEND	-118.76	-18.08	.07	.056	6.979	180.142	.17	-5.26	233.34	2.84	201.21	55.89
52	SAGBEND	-122.73	-18.55	.07	.063	6.412	184.142	.09	-5.39	234.76	2.39	202.39	56.22
53	SAGBEND	-126.71	-18.97	.06	.068	5.843	188.142	.01	-5.52	234.47	1.93	202.14	56.15
54	SAGBEND	-130.69	-19.36	.06	.072	5.278	192.142	-.05	-5.63	232.48	1.47	200.43	55.68
55	SAGBEND	-134.68	-19.71	.05	.075	4.719	196.142	-.11	-5.73	228.78	1.00	197.28	54.80
56	SAGBEND	-138.66	-20.02	.05	.077	4.171	200.142	-.17	-5.82	223.35	.53	192.66	53.52
57	SAGBEND	-142.66	-20.29	.04	.078	3.639	204.142	-.21	-5.90	216.19	.05	186.57	51.82
58	SAGBEND	-146.65	-20.53	.04	.077	3.125	208.142	-.25	-5.97	207.26	-.43	178.98	49.72
59	SAGBEND	-150.64	-20.73	.03	.075	2.636	212.142	-.28	-6.03	196.57	-.91	169.90	47.19
60	SAGBEND	-154.64	-20.90	.03	.073	2.175	216.142	-.30	-6.08	184.07	-1.40	159.28	44.24
61	SAGBEND	-158.64	-21.03	.02	.069	1.746	220.142	-.32	-6.12	169.74	-1.89	147.12	40.87
62	SAGBEND	-162.64	-21.14	.02	.064	1.354	224.142	-.34	-6.15	153.55	-2.38	133.38	37.05
63	SAGBEND	-166.63	-21.22	.01	.057	1.004	228.142	-.34	-6.17	135.47	-2.88	118.04	32.79
64	SAGBEND	-170.63	-21.28	.01	.050	.700	232.142	-.35	-6.19	115.46	-3.39	101.07	28.08
65	SAGBEND	-174.63	-21.32	.01	.041	.446	236.142	-.35	-6.20	93.47	-3.90	82.45	22.90
66	SEABED	-178.63	-21.35	.00	.031	.249	240.142	-.35	-6.21	69.82	-4.15	62.44	17.34
67	SEABED	-182.63	-21.36	.00	.021	.107	244.142	-.35	-6.21	47.38	-3.74	43.49	12.08
68	SEABED	-186.63	-21.36	.00	.013	.016	248.142	-.35	-6.21	28.68	-2.99	27.80	7.72
69	SEABED	-190.63	-21.36	.00	.007	-.035	252.142	-.35	-6.21	14.61	-2.16	16.23	4.51
70	SEABED	-194.63	-21.36	.00	.002	-.058	256.142	-.35	-6.21	4.99	-1.41	8.96	2.49
71	SEABED	-198.63	-21.35	.00	.000	-.063	260.142	-.35	-6.21	-.90	-.81	6.58	1.83
72	SEABED	-202.63	-21.35	.00	-.002	-.056	264.142	-.35	-6.21	-3.96	-.37	8.16	2.27
73	SEABED	-206.63	-21.35	.00	-.002	-.045	268.142	-.34	-6.21	-5.05	-.09	8.87	2.46
74	SEABED	-210.63	-21.34	.00	-.002	-.033	272.142	-.34	-6.21	-4.95	.08	8.80	2.44
75	SEABED	-214.63	-21.34	.00	-.002	-.022	276.142	-.34	-6.21	-4.20	.16	8.31	2.31
76	SEABED	-218.63	-21.34	.00	-.001	-.013	280.142	-.34	-6.21	-3.22	.18	7.69	2.14
77	SEABED	-222.63	-21.34	.00	-.001	-.006	284.142	-.34	-6.21	-2.25	.17	7.13	1.98
78	SEABED	-226.63	-21.34	.00	-.001	-.002	288.142	-.34	-6.21	-1.43	.14	6.69	1.86
79	SEABED	-230.63	-21.34	.00	.000	.001	292.142	-.34	-6.21	-.80	.10	6.39	1.77
80	SEABED	-234.63	-21.34	.00	.000	.002	296.142	-.34	-6.21	-.38	.07	6.20	1.72
81	SEABED	-238.63	-21.34	.00	.000	.003	300.142	-.34	-6.21	-.14	.04	6.10	1.69
82	SEABED	-242.63	-21.34	.00	.000	.003	304.142	-.34	-6.21	-.02	.02	6.05	1.68
83	SEABED	-246.63	-21.34	.00	.000	.003	308.142	-.34	-6.21	.00	.00	6.04	1.68

Tension: 200 kN; Stinger-length: 37 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X          DATE -  7/28/2016    TIME - 21:56: 1     PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                          JOB NO. - 113
USER ID - N.FURQON                                         LICENSED TO: McDERMOTT, INCORPORATED                 CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.462	21.337	2.20	.00	15.22	-.07	15.14	4.21
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	2.19	.00	-13.29	.20	13.49	3.75
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	4.41	.00	-97.86	.60	87.59	24.33
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	4.29	.00	-299.13	-.99	258.55	71.82
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	4.24	.00	-265.81	.44	230.18	63.94
15	LAYBARGE	.00	2.82	.00	.000	4.759	59.471	4.03	.00	-285.79	-.18	246.96	68.60
18	STINGER	-7.64	2.09	.00	.000	6.079	67.142	3.86	.00	-293.44	.13	253.29	70.36
20	STINGER	-14.59	1.28	.00	-.001	7.299	74.142	3.67	.00	-291.51	-.44	251.46	69.85
22	STINGER	-21.52	.31	.00	.003	8.508	81.142	3.44	.00	-288.27	2.05	248.48	69.02
24	STINGER	-28.43	-.80	.00	-.011	9.738	88.142	3.22	-.23	-295.63	-8.64	254.74	70.76
26	STINGER	-35.32	-2.05	.00	-.055	10.852	95.142	3.04	-.60	-231.39	-12.18	200.29	55.64
28	STINGER	-37.28	-2.43	.01	-.069	11.118	97.142	2.98	-.71	-209.16	-10.37	181.34	50.37
30	SAGBEND	-41.21	-3.22	.01	-.090	11.573	101.142	2.86	-.94	-166.73	-7.13	145.18	40.33
31	SAGBEND	-45.12	-4.03	.02	-.104	11.928	105.142	2.73	-1.17	-126.90	-4.38	111.25	30.90
32	SAGBEND	-49.03	-4.87	.03	-.112	12.189	109.142	2.59	-1.42	-89.56	-2.06	79.46	22.07
33	SAGBEND	-52.94	-5.72	.03	-.115	12.364	113.142	2.44	-1.66	-54.63	-.13	49.73	13.81
34	SAGBEND	-56.85	-6.58	.04	-.113	12.456	117.142	2.29	-1.91	-22.01	1.44	22.06	6.13
35	SAGBEND	-60.75	-7.44	.05	-.108	12.472	121.142	2.14	-2.17	8.39	2.69	10.87	3.02
36	SAGBEND	-64.66	-8.31	.06	-.100	12.417	125.142	1.98	-2.42	36.64	3.66	34.55	9.60
37	SAGBEND	-68.57	-9.16	.06	-.090	12.296	129.142	1.83	-2.66	62.81	4.39	56.73	15.76
38	SAGBEND	-72.48	-10.01	.07	-.079	12.114	133.142	1.67	-2.91	86.96	4.91	77.20	21.45
39	SAGBEND	-76.39	-10.84	.07	-.066	11.877	137.142	1.52	-3.15	109.15	5.24	96.02	26.67
40	SAGBEND	-80.30	-11.65	.08	-.053	11.587	141.142	1.37	-3.39	129.42	5.42	113.20	31.45
41	SAGBEND	-84.23	-12.45	.08	-.039	11.251	145.142	1.22	-3.62	147.83	5.46	128.80	35.78
42	SAGBEND	-88.15	-13.21	.08	-.026	10.873	149.142	1.08	-3.84	164.39	5.39	142.85	39.68
43	SAGBEND	-92.08	-13.96	.08	-.013	10.457	153.142	.94	-4.06	179.16	5.24	155.36	43.16
44	SAGBEND	-96.02	-14.67	.08	.000	10.007	157.142	.80	-4.27	192.16	5.00	166.37	46.21
45	SAGBEND	-99.96	-15.34	.08	.012	9.527	161.142	.68	-4.46	203.40	4.71	175.89	48.86
46	SAGBEND	-103.91	-15.99	.08	.023	9.023	165.142	.56	-4.65	212.91	4.37	183.94	51.09
47	SAGBEND	-107.86	-16.60	.08	.033	8.498	169.142	.45	-4.83	220.70	4.00	190.53	52.93
48	SAGBEND	-111.82	-17.17	.08	.043	7.955	173.142	.34	-4.99	226.78	3.60	195.67	54.35
49	SAGBEND	-115.78	-17.71	.07	.051	7.401	177.142	.24	-5.15	231.17	3.17	199.38	55.38
50	SAGBEND	-119.75	-18.20	.07	.058	6.837	181.142	.15	-5.29	233.85	2.73	201.64	56.01
51	SAGBEND	-123.73	-18.66	.07	.064	6.269	185.142	.07	-5.43	234.84	2.28	202.46	56.24
52	SAGBEND	-127.71	-19.08	.06	.069	5.701	189.142	.00	-5.55	234.13	1.82	201.84	56.07
53	SAGBEND	-131.69	-19.45	.06	.073	5.137	193.142	-.07	-5.66	231.71	1.35	199.78	55.49
54	SAGBEND	-135.67	-19.79	.05	.076	4.580	197.142	-.13	-5.76	227.58	.88	196.25	54.52
55	SAGBEND	-139.66	-20.09	.05	.077	4.036	201.142	-.18	-5.84	221.72	.41	191.27	53.13
56	SAGBEND	-143.65	-20.35	.04	.078	3.508	205.142	-.22	-5.92	214.11	-.07	184.80	51.33
57	SAGBEND	-147.65	-20.58	.04	.077	3.000	209.142	-.26	-5.99	204.75	-.55	176.85	49.12
58	SAGBEND	-151.64	-20.77	.03	.075	2.518	213.142	-.29	-6.04	193.60	-1.03	167.38	46.49
59	SAGBEND	-155.64	-20.93	.03	.072	2.064	217.142	-.31	-6.09	180.65	-1.52	156.38	43.44
60	SAGBEND	-159.64	-21.06	.02	.068	1.644	221.142	-.33	-6.13	165.86	-2.01	143.82	39.95
61	SAGBEND	-163.64	-21.16	.02	.062	1.262	225.142	-.34	-6.15	149.20	-2.50	129.69	36.02
62	SAGBEND	-167.64	-21.24	.01	.056	.923	229.142	-.35	-6.18	130.64	-3.00	113.94	31.65
63	SAGBEND	-171.63	-21.29	.01	.048	.631	233.142	-.35	-6.19	110.14	-3.51	96.56	26.82
64	SAGBEND	-175.63	-21.33	.01	.039	.391	237.142	-.35	-6.20	87.65	-4.02	77.52	21.53
65	SEABED	-179.63	-21.35	.00	.029	.208	241.142	-.35	-6.21	63.95	-4.12	57.48	15.97
66	SEABED	-183.63	-21.36	.00	.019	.080	245.142	-.35	-6.21	42.28	-3.59	39.20	10.89
67	SEABED	-187.63	-21.36	.00	.011	.000	249.142	-.35	-6.21	24.72	-2.80	24.50	6.81
68	SEABED	-191.63	-21.36	.00	.006	-.043	253.142	-.35	-6.21	11.81	-1.98	14.01	3.89
69	SEABED	-195.63	-21.36	.00	.002	-.061	257.142	-.35	-6.21	3.20	-1.26	7.82	2.17
70	SEABED	-199.63	-21.35	.00	-.001	-.062	261.142	-.35	-6.21	-1.90	-.69	7.00	1.94
71	SEABED	-203.63	-21.35	.00	-.002	-.054	265.142	-.35	-6.21	-4.38	-.29	8.43	2.34
72	SEABED	-207.63	-21.35	.00	-.002	-.042	269.142	-.34	-6.21	-5.12	-.04	8.91	2.48
73	SEABED	-211.63	-21.34	.00	-.002	-.030	273.142	-.34	-6.21	-4.80	.11	8.70	2.42
74	SEABED	-215.63	-21.34	.00	-.002	-.019	277.142	-.34	-6.21	-3.97	.17	8.16	2.27
75	SEABED	-219.63	-21.34	.00	-.001	-.011	281.142	-.34	-6.21	-2.97	.18	7.54	2.09
76	SEABED	-223.63	-21.34	.00	-.001	-.005	285.142	-.34	-6.21	-2.03	.16	7.00	1.95
77	SEABED	-227.63	-21.34	.00	.000	-.001	289.142	-.34	-6.21	-1.26	.13	6.60	1.83
78	SEABED	-231.63	-21.34	.00	.000	.002	293.142	-.34	-6.21	-.69	.10	6.33	1.76
79	SEABED	-235.63	-21.34	.00	.000	.003	297.142	-.34	-6.21	-.31	.06	6.17	1.71
80	SEABED	-239.63	-21.34	.00	.000	.003	301.142	-.34	-6.21	-.10	.04	6.09	1.69
81	SEABED	-243.63	-21.34	.00	.000	.003	305.142	-.34	-6.21	-.02	.02	6.05	1.68
82	SEABED	-247.63	-21.34	.00	.000	.003	309.142	-.34	-6.21	.00	.00	6.04	1.68

Tension: 200 kN; Stinger-length: 42 m

OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X   DATE - 7/28/2016   TIME - 21:57:57   PAGE 11
PROJECT - ANALISA STATIS PIPA TPPI   JOB NO. - 113
USER ID - N.FURQON   LICENSED TO: McDERMOTT, INCORPORATED   CASE 1

S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	.000	.462	21.337	2.20	.00	15.19	-.07	15.11	4.20
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	2.19	.00	-13.27	.19	13.47	3.74
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	4.41	.00	-97.76	.58	87.50	24.31
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	4.29	.00	-299.32	-.96	258.72	71.87
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	4.24	.00	-265.51	.43	229.92	63.87
15	LAYBARGE	.00	2.82	.00	.000	4.761	59.471	4.03	.00	-286.69	-.18	247.72	68.81
18	STINGER	-8.63	1.98	.00	.000	6.252	68.142	3.83	.00	-295.48	.19	254.99	70.83
20	STINGER	-16.57	1.02	.00	-.001	7.644	76.142	3.61	.00	-290.90	-.79	250.88	69.69
22	STINGER	-24.49	-.14	.00	.006	9.038	84.142	3.34	-.04	-295.47	3.57	254.53	70.70
24	STINGER	-32.37	-1.50	.00	-.023	10.394	92.142	3.12	-.44	-266.33	-15.53	230.10	63.92
26	STINGER	-40.23	-3.02	.01	-.080	11.464	100.142	2.89	-.88	-177.35	-8.19	154.24	42.84
28	STINGER	-42.19	-3.42	.01	-.089	11.666	102.142	2.83	-.99	-156.78	-6.69	136.71	37.98
30	SAGBEND	-46.10	-4.24	.02	-.103	11.998	106.142	2.69	-1.23	-117.57	-4.03	103.31	28.70
31	SAGBEND	-50.01	-5.08	.02	-.110	12.238	110.142	2.55	-1.48	-80.83	-1.80	72.03	20.01
32	SAGBEND	-53.92	-5.93	.03	-.112	12.391	114.142	2.41	-1.73	-46.47	.05	42.80	11.89
33	SAGBEND	-57.82	-6.79	.04	-.110	12.465	118.142	2.25	-1.98	-14.40	1.55	15.64	4.35
34	SAGBEND	-61.73	-7.66	.05	-.104	12.463	122.142	2.10	-2.23	15.47	2.74	16.68	4.63
35	SAGBEND	-65.64	-8.52	.05	-.096	12.391	126.142	1.94	-2.48	43.21	3.67	40.10	11.14
36	SAGBEND	-69.54	-9.37	.06	-.086	12.255	130.142	1.79	-2.73	68.88	4.35	61.86	17.18
37	SAGBEND	-73.45	-10.22	.07	-.075	12.059	134.142	1.63	-2.97	92.54	4.83	81.93	22.76
38	SAGBEND	-77.37	-11.04	.07	-.063	11.809	138.142	1.48	-3.21	114.26	5.14	100.34	27.87
39	SAGBEND	-81.29	-11.85	.07	-.050	11.508	142.142	1.33	-3.45	134.07	5.29	117.14	32.54
40	SAGBEND	-85.21	-12.64	.08	-.037	11.161	146.142	1.18	-3.68	152.02	5.32	132.36	36.77
41	SAGBEND	-89.13	-13.40	.08	-.023	10.773	150.142	1.04	-3.90	168.15	5.24	146.02	40.56
42	SAGBEND	-93.07	-14.13	.08	-.011	10.348	154.142	.90	-4.11	182.48	5.07	158.17	43.94
43	SAGBEND	-97.00	-14.84	.08	.001	9.890	158.142	.77	-4.31	195.04	4.83	168.81	46.89
44	SAGBEND	-100.95	-15.51	.08	.013	9.405	162.142	.65	-4.51	205.86	4.54	177.97	49.44
45	SAGBEND	-104.90	-16.14	.08	.024	8.895	166.142	.53	-4.69	214.95	4.20	185.66	51.57
46	SAGBEND	-108.85	-16.74	.08	.034	8.365	170.142	.42	-4.87	222.32	3.83	191.90	53.31
47	SAGBEND	-112.81	-17.31	.07	.042	7.819	174.142	.32	-5.03	227.99	3.43	196.69	54.64
48	SAGBEND	-116.78	-17.83	.07	.050	7.262	178.142	.22	-5.19	231.96	3.01	200.04	55.57
49	SAGBEND	-120.75	-18.32	.07	.057	6.697	182.143	.13	-5.33	234.23	2.57	201.95	56.10
50	SAGBEND	-124.72	-18.76	.06	.063	6.129	186.143	.05	-5.46	234.80	2.13	202.42	56.23
51	SAGBEND	-128.70	-19.17	.06	.067	5.562	190.143	-.02	-5.58	233.67	1.67	201.45	55.96
52	SAGBEND	-132.68	-19.54	.05	.071	4.999	194.143	-.08	-5.68	230.83	1.22	199.03	55.29
53	SAGBEND	-136.67	-19.87	.05	.073	4.445	198.143	-.14	-5.78	226.28	.75	195.15	54.21
54	SAGBEND	-140.66	-20.16	.04	.075	3.904	202.143	-.19	-5.86	219.99	.29	189.80	52.72
55	SAGBEND	-144.65	-20.41	.04	.075	3.381	206.143	-.23	-5.94	211.96	-.18	182.97	50.83
56	SAGBEND	-148.65	-20.63	.03	.074	2.879	210.143	-.27	-6.00	202.16	-.65	174.65	48.51
57	SAGBEND	-152.64	-20.82	.03	.072	2.403	214.143	-.29	-6.05	190.57	-1.12	164.81	45.78
58	SAGBEND	-156.64	-20.97	.02	.068	1.958	218.143	-.31	-6.10	177.17	-1.60	153.43	42.62
59	SAGBEND	-160.64	-21.09	.02	.064	1.547	222.143	-.33	-6.13	161.93	-2.08	140.49	39.02
60	SAGBEND	-164.64	-21.19	.01	.058	1.175	226.143	-.34	-6.16	144.81	-2.57	125.96	34.99
61	SAGBEND	-168.64	-21.26	.01	.051	.847	230.143	-.35	-6.18	125.78	-3.06	109.82	30.50
62	SAGBEND	-172.64	-21.30	.01	.043	.567	234.143	-.35	-6.20	104.79	-3.56	92.03	25.56
63	SEABED	-176.64	-21.34	.00	.034	.341	238.143	-.35	-6.20	81.82	-3.98	72.58	20.16
64	SEABED	-180.64	-21.35	.00	.025	.172	242.143	-.35	-6.21	58.32	-3.85	52.71	14.64
65	SEABED	-184.64	-21.36	.00	.016	.056	246.143	-.35	-6.21	37.54	-3.24	35.20	9.78
66	SEABED	-188.64	-21.36	.00	.009	-.014	250.143	-.35	-6.21	21.11	-2.45	21.51	5.97
67	SEABED	-192.64	-21.36	.00	.004	-.050	254.143	-.35	-6.21	9.31	-1.68	12.07	3.35
68	SEABED	-196.64	-21.36	.00	.001	-.062	258.143	-.35	-6.21	1.65	-1.03	6.96	1.93
69	SEABED	-200.64	-21.35	.00	-.001	-.060	262.143	-.35	-6.21	-2.71	-.54	7.42	2.06
70	SEABED	-204.64	-21.35	.00	-.002	-.051	266.143	-.35	-6.21	-4.69	-.19	8.63	2.40
71	SEABED	-208.64	-21.34	.00	-.002	-.039	270.143	-.34	-6.21	-5.09	.02	8.90	2.47
72	SEABED	-212.64	-21.34	.00	-.002	-.027	274.143	-.34	-6.21	-4.59	.13	8.56	2.38
73	SEABED	-216.64	-21.34	.00	-.001	-.017	278.143	-.34	-6.21	-3.66	.17	7.96	2.21
74	SEABED	-220.64	-21.34	.00	-.001	-.009	282.143	-.34	-6.21	-2.64	.17	7.34	2.04
75	SEABED	-224.64	-21.34	.00	-.001	-.004	286.143	-.34	-6.21	-1.69	.15	6.82	1.90
76	SEABED	-228.64	-21.34	.00	.000	-.001	290.143	-.34	-6.21	-.94	.11	6.45	1.79
77	SEABED	-232.64	-21.34	.00	.000	.001	294.143	-.34	-6.21	-.41	.08	6.21	1.72
78	SEABED	-236.64	-21.34	.00	.000	.001	298.143	-.34	-6.21	-.10	.04	6.08	1.69
79	SEABED	-240.64	-21.34	.00	.000	.001	302.143	-.34	-6.21	.00	.00	6.04	1.68

Tension: 250 kN; Stinger-length: 27 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X        DATE -  7/28/2016    TIME - 22: 1:59     PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                        JOB NO. - 113
USER ID - N.FURQON                                           LICENSED TO: McDERMOTT, INCORPORATED                CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.10	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	2.76	.00	15.29	-.07	15.75	4.38
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	2.75	.00	-13.35	.22	14.10	3.92
9	TENSIONR	26.67	4.04	.00	.001	.668	32.767	5.53	.00	-98.11	.65	88.92	24.70
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	5.41	.00	-298.77	-1.07	259.37	72.05
13	LAYBARGE	12.19	3.62	.00	-.001	2.822	47.252	5.36	.00	-266.56	.47	231.93	64.42
15	LAYBARGE	.00	2.82	.00	.000	4.756	59.471	5.16	.00	-284.28	-.19	246.79	68.55
18	STINGER	-5.65	2.30	.00	.000	5.733	65.142	5.03	.00	-291.11	.02	252.47	70.13
20	STINGER	-10.62	1.76	.00	.000	6.603	70.142	4.91	.00	-288.46	.11	250.10	69.47
22	STINGER	-15.58	1.15	.00	-.001	7.472	75.142	4.76	.00	-290.47	-.59	251.66	69.91
24	STINGER	-20.53	.46	.00	.006	8.333	80.142	4.60	.00	-283.30	4.68	245.44	68.18
26	STINGER	-25.47	-.30	.00	-.005	9.212	85.142	4.43	-.09	-300.06	-11.93	259.73	72.15
28	STINGER	-27.45	-.63	.00	-.024	9.581	87.142	4.36	-.18	-310.93	-18.78	269.23	74.79
30	SAGBEND	-31.39	-1.32	.00	-.065	10.275	91.142	4.27	-.38	-262.46	-14.22	227.88	63.30
31	SAGBEND	-35.32	-2.05	.01	-.095	10.855	95.142	4.17	-.60	-217.07	-10.28	189.18	52.55
32	SAGBEND	-39.24	-2.82	.02	-.116	11.329	99.142	4.05	-.82	-174.61	-6.88	153.00	42.50
33	SAGBEND	-43.16	-3.62	.02	-.129	11.703	103.142	3.92	-1.05	-134.93	-4.00	119.19	33.11
34	SAGBEND	-47.08	-4.44	.03	-.136	11.984	107.142	3.78	-1.29	-97.88	-1.57	87.65	24.35
35	SAGBEND	-50.99	-5.28	.04	-.137	12.179	111.142	3.64	-1.54	-63.35	.44	58.27	16.19
36	SAGBEND	-54.90	-6.13	.05	-.134	12.293	115.142	3.49	-1.78	-31.19	2.07	31.00	8.61
37	SAGBEND	-58.81	-6.98	.06	-.127	12.332	119.142	3.34	-2.03	-1.32	3.38	7.65	2.12
38	SAGBEND	-62.71	-7.84	.07	-.117	12.301	123.142	3.19	-2.28	26.38	4.39	27.13	7.54
39	SAGBEND	-66.62	-8.69	.08	-.106	12.206	127.142	3.03	-2.53	51.99	5.15	48.76	13.54
40	SAGBEND	-70.53	-9.53	.08	-.092	12.051	131.142	2.88	-2.77	75.61	5.68	68.76	19.10
41	SAGBEND	-74.45	-10.36	.09	-.078	11.841	135.142	2.73	-3.01	97.30	6.02	87.13	24.20
42	SAGBEND	-78.36	-11.17	.09	-.062	11.581	139.142	2.58	-3.25	117.13	6.20	103.94	28.87
43	SAGBEND	-82.28	-11.96	.10	-.047	11.275	143.142	2.43	-3.48	135.16	6.23	119.22	33.12
44	SAGBEND	-86.21	-12.73	.10	-.032	10.928	147.142	2.29	-3.70	151.45	6.15	133.02	36.95
45	SAGBEND	-90.14	-13.48	.10	-.017	10.543	151.142	2.15	-3.92	166.04	5.97	145.37	40.38
46	SAGBEND	-94.07	-14.19	.10	-.002	10.125	155.142	2.02	-4.13	178.97	5.72	156.32	43.42
47	SAGBEND	-98.01	-14.88	.10	.011	9.678	159.142	1.89	-4.33	190.28	5.40	165.89	46.08
48	SAGBEND	-101.96	-15.54	.10	.024	9.205	163.142	1.77	-4.52	199.99	5.03	174.11	48.36
49	SAGBEND	-105.91	-16.16	.10	.036	8.710	167.142	1.65	-4.70	208.13	4.63	181.00	50.28
50	SAGBEND	-109.87	-16.75	.10	.047	8.198	171.142	1.54	-4.87	214.71	4.19	186.57	51.82
51	SAGBEND	-113.83	-17.30	.09	.056	7.672	175.142	1.44	-5.03	219.76	3.74	190.83	53.01
52	SAGBEND	-117.80	-17.82	.09	.065	7.135	179.142	1.35	-5.18	223.28	3.26	193.80	53.83
53	SAGBEND	-121.77	-18.29	.08	.072	6.592	183.142	1.26	-5.32	225.27	2.78	195.47	54.30
54	SAGBEND	-125.74	-18.73	.08	.079	6.045	187.142	1.18	-5.45	225.75	2.28	195.86	54.40
55	SAGBEND	-129.72	-19.14	.07	.084	5.500	191.142	1.11	-5.57	224.69	1.79	194.95	54.15
56	SAGBEND	-133.71	-19.50	.07	.087	4.958	195.142	1.05	-5.67	222.10	1.28	192.73	53.54
57	SAGBEND	-137.69	-19.83	.06	.090	4.425	199.142	.99	-5.77	217.96	.78	189.21	52.56
58	SAGBEND	-141.68	-20.12	.05	.091	3.904	203.142	.94	-5.85	212.27	.27	184.37	51.21
59	SAGBEND	-145.67	-20.37	.05	.091	3.398	207.142	.90	-5.93	204.99	-.24	178.18	49.49
60	SAGBEND	-149.67	-20.59	.04	.090	2.912	211.142	.87	-5.99	196.11	-.75	170.63	47.40
61	SAGBEND	-153.66	-20.78	.04	.087	2.450	215.142	.84	-6.04	185.60	-1.27	161.70	44.92
62	SAGBEND	-157.66	-20.94	.03	.084	2.015	219.142	.81	-6.09	173.42	-1.79	151.36	42.05
63	SAGBEND	-161.66	-21.06	.02	.079	1.611	223.142	.80	-6.13	159.54	-2.32	139.58	38.77
64	SAGBEND	-165.66	-21.16	.02	.072	1.244	227.142	.78	-6.15	143.92	-2.86	126.33	35.09
65	SAGBEND	-169.66	-21.24	.01	.065	.916	231.142	.78	-6.18	126.50	-3.41	111.56	30.99
66	SAGBEND	-173.66	-21.29	.01	.056	.632	235.142	.77	-6.19	107.24	-3.96	95.24	26.46
67	SAGBEND	-177.66	-21.33	.01	.046	.398	239.142	.77	-6.20	86.09	-4.53	77.33	21.48
68	SEABED	-181.66	-21.35	.00	.034	.217	243.142	.77	-6.21	63.53	-4.75	58.27	16.19
69	SEABED	-185.66	-21.36	.00	.023	.089	247.142	.77	-6.21	42.55	-4.21	40.58	11.27
70	SEABED	-189.66	-21.36	.00	.014	.008	251.142	.77	-6.21	25.33	-3.33	26.15	7.26
71	SEABED	-193.66	-21.36	.00	.007	-.037	255.142	.77	-6.21	12.52	-2.39	15.67	4.35
72	SEABED	-197.66	-21.36	.00	.002	-.056	259.142	.77	-6.21	3.88	-1.54	9.17	2.55
73	SEABED	-201.66	-21.35	.00	.000	-.059	263.142	.78	-6.21	-1.33	-.87	7.50	2.08
74	SEABED	-205.66	-21.35	.00	-.002	-.052	267.142	.78	-6.21	-3.95	-.39	9.03	2.51
75	SEABED	-209.66	-21.35	.00	-.002	-.041	271.142	.78	-6.21	-4.81	-.07	9.61	2.67
76	SEABED	-213.66	-21.34	.00	-.002	-.030	275.142	.78	-6.21	-4.61	.11	9.47	2.63
77	SEABED	-217.66	-21.34	.00	-.002	-.019	279.142	.78	-6.21	-3.85	.19	8.95	2.49
78	SEABED	-221.66	-21.34	.00	-.001	-.011	283.142	.78	-6.21	-2.90	.21	8.32	2.31
79	SEABED	-225.66	-21.34	.00	-.001	-.005	287.142	.78	-6.21	-1.99	.19	7.75	2.15
80	SEABED	-229.66	-21.34	.00	-.001	-.001	291.142	.78	-6.21	-1.22	.15	7.29	2.02
81	SEABED	-233.66	-21.34	.00	.000	.001	295.142	.78	-6.21	-.64	.11	6.97	1.94
82	SEABED	-237.66	-21.34	.00	.000	.002	299.142	.78	-6.21	-.26	.07	6.77	1.88
83	SEABED	-241.66	-21.34	.00	.000	.002	303.142	.78	-6.21	-.06	.04	6.66	1.85
84	SEABED	-245.66	-21.34	.00	.000	.002	307.142	.78	-6.21	.00	.00	6.63	1.84

Tension: 250 kN; Stinger-length: 32 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X         DATE -  7/28/2016    TIME - 22:12:35     PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                         JOB NO. - 113
USER ID - N.FURQON                                             LICENSED TO: McDERMOTT, INCORPORATED                 CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.461	21.337	2.76	.00	15.25	-.07	15.72	4.37
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	2.75	.00	-13.32	.21	14.07	3.91
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	5.53	.00	-97.99	.63	88.82	24.67
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	5.41	.00	-298.98	-1.03	259.55	72.10
13	LAYBARGE	12.19	3.62	.00	-.001	2.822	47.252	5.36	.00	-266.28	.45	231.70	64.36
15	LAYBARGE	.00	2.82	.00	.000	4.757	59.471	5.16	.00	-285.04	-.17	247.44	68.73
18	STINGER	-6.64	2.20	.00	.000	5.906	66.142	5.01	.00	-292.25	.02	253.41	70.39
20	STINGER	-12.60	1.52	.00	.000	6.951	72.142	4.85	.00	-289.78	.09	251.16	69.77
22	STINGER	-18.55	.74	.00	-.001	7.991	78.142	4.67	.00	-289.72	-.53	250.93	69.70
24	STINGER	-24.49	-.14	.00	.005	9.035	84.142	4.46	-.04	-291.15	3.47	251.98	70.00
26	STINGER	-30.40	-1.14	.00	-.020	10.064	90.142	4.30	-.33	-276.60	-17.01	240.01	66.67
28	STINGER	-32.37	-1.50	.00	-.039	10.385	92.142	4.25	-.43	-253.07	-14.85	219.94	61.10
30	SAGBEND	-36.30	-2.24	.00	-.071	10.943	96.142	4.14	-.65	-208.29	-10.94	181.76	50.49
31	SAGBEND	-40.23	-3.01	.01	-.094	11.396	100.142	4.02	-.88	-166.41	-7.58	146.05	40.57
32	SAGBEND	-44.15	-3.81	.02	-.109	11.751	104.142	3.89	-1.11	-127.27	-4.72	112.70	31.31
33	SAGBEND	-48.06	-4.64	.03	-.117	12.015	108.142	3.75	-1.35	-90.74	-2.31	81.59	22.66
34	SAGBEND	-51.97	-5.48	.03	-.121	12.193	112.142	3.61	-1.59	-56.70	-.31	52.62	14.62
35	SAGBEND	-55.88	-6.33	.04	-.119	12.291	116.142	3.46	-1.84	-25.02	1.32	25.72	7.15
36	SAGBEND	-59.79	-7.18	.05	-.114	12.316	120.142	3.31	-2.09	4.40	2.63	8.89	2.47
37	SAGBEND	-63.70	-8.03	.06	-.106	12.272	124.142	3.15	-2.34	31.67	3.65	31.48	8.75
38	SAGBEND	-67.60	-8.88	.06	-.096	12.164	128.142	3.00	-2.58	56.87	4.42	52.82	14.67
39	SAGBEND	-71.52	-9.72	.07	-.085	11.998	132.142	2.85	-2.83	80.08	4.97	72.50	20.14
40	SAGBEND	-75.43	-10.54	.08	-.072	11.778	136.142	2.69	-3.07	101.39	5.33	90.56	25.16
41	SAGBEND	-79.35	-11.35	.08	-.059	11.508	140.142	2.54	-3.30	120.85	5.53	107.06	29.74
42	SAGBEND	-83.27	-12.14	.08	-.045	11.194	144.142	2.40	-3.53	138.52	5.59	122.04	33.90
43	SAGBEND	-87.20	-12.90	.09	-.031	10.839	148.142	2.26	-3.75	154.45	5.54	135.54	37.65
44	SAGBEND	-91.13	-13.64	.09	-.017	10.447	152.142	2.12	-3.97	168.69	5.40	147.61	41.00
45	SAGBEND	-95.06	-14.35	.09	-.004	10.023	156.142	1.99	-4.17	181.29	5.18	158.27	43.96
46	SAGBEND	-99.00	-15.03	.09	.008	9.570	160.142	1.86	-4.37	192.26	4.90	167.56	46.55
47	SAGBEND	-102.95	-15.68	.09	.020	9.093	164.142	1.74	-4.56	201.65	4.57	175.51	48.75
48	SAGBEND	-106.90	-16.29	.09	.030	8.595	168.142	1.63	-4.74	209.46	4.20	182.12	50.59
49	SAGBEND	-110.86	-16.87	.08	.040	8.080	172.142	1.52	-4.91	215.73	3.81	187.42	52.06
50	SAGBEND	-114.82	-17.42	.08	.049	7.552	176.142	1.42	-5.07	220.46	3.39	191.41	53.17
51	SAGBEND	-118.79	-17.93	.08	.057	7.014	180.142	1.33	-5.21	223.66	2.96	194.11	53.92
52	SAGBEND	-122.76	-18.39	.07	.063	6.470	184.142	1.24	-5.35	225.33	2.51	195.52	54.31
53	SAGBEND	-126.74	-18.83	.07	.069	5.923	188.142	1.17	-5.48	225.48	2.06	195.63	54.34
54	SAGBEND	-130.72	-19.22	.06	.073	5.379	192.142	1.10	-5.59	224.11	1.60	194.45	54.01
55	SAGBEND	-134.71	-19.58	.06	.077	4.839	196.142	1.03	-5.69	221.19	1.14	191.96	53.32
56	SAGBEND	-138.69	-19.90	.05	.079	4.309	200.142	.98	-5.79	216.73	.68	188.16	52.27
57	SAGBEND	-142.68	-20.18	.05	.080	3.791	204.142	.93	-5.87	210.70	.21	183.04	50.84
58	SAGBEND	-146.68	-20.42	.04	.080	3.290	208.142	.89	-5.94	203.09	-.26	176.56	49.05
59	SAGBEND	-150.67	-20.64	.04	.079	2.809	212.142	.86	-6.00	193.87	-.73	168.73	46.87
60	SAGBEND	-154.67	-20.82	.03	.076	2.352	216.142	.83	-6.05	183.00	-1.21	159.50	44.31
61	SAGBEND	-158.66	-20.97	.03	.073	1.924	220.142	.81	-6.10	170.47	-1.69	148.86	41.35
62	SAGBEND	-162.66	-21.09	.02	.068	1.528	224.142	.79	-6.13	156.22	-2.18	136.77	37.99
63	SAGBEND	-166.66	-21.18	.02	.062	1.168	228.142	.78	-6.16	140.22	-2.67	123.19	34.22
64	SAGBEND	-170.66	-21.25	.01	.055	.850	232.142	.78	-6.18	122.42	-3.17	108.09	30.03
65	SAGBEND	-174.66	-21.30	.01	.047	.577	236.142	.77	-6.19	102.76	-3.69	91.43	25.40
66	SEABED	-178.66	-21.33	.00	.038	.354	240.142	.77	-6.20	81.19	-4.13	73.17	20.33
67	SEABED	-182.66	-21.35	.00	.027	.185	244.142	.77	-6.21	58.70	-4.11	54.16	15.04
68	SEABED	-186.66	-21.36	.00	.018	.068	248.142	.77	-6.21	38.42	-3.52	37.06	10.30
69	SEABED	-190.66	-21.36	.00	.011	-.005	252.142	.77	-6.21	22.15	-2.70	23.47	6.52
70	SEABED	-194.66	-21.36	.00	.005	-.043	256.142	.77	-6.21	10.30	-1.88	13.86	3.85
71	SEABED	-198.66	-21.36	.00	.001	-.058	260.142	.77	-6.21	2.48	-1.18	8.22	2.28
72	SEABED	-202.66	-21.35	.00	-.001	-.058	264.142	.78	-6.21	-2.07	-.63	7.85	2.18
73	SEABED	-206.66	-21.35	.00	-.002	-.050	268.142	.78	-6.21	-4.21	-.25	9.20	2.56
74	SEABED	-210.66	-21.35	.00	-.002	-.039	272.142	.78	-6.21	-4.75	-.01	9.57	2.66
75	SEABED	-214.66	-21.34	.00	-.002	-.028	276.142	.78	-6.21	-4.33	.13	9.28	2.58
76	SEABED	-218.66	-21.34	.00	-.002	-.018	280.142	.78	-6.21	-3.43	.18	8.67	2.41
77	SEABED	-222.66	-21.34	.00	-.001	-.011	284.142	.78	-6.21	-2.40	.18	8.00	2.22
78	SEABED	-226.66	-21.34	.00	-.001	-.006	288.142	.78	-6.21	-1.44	.15	7.41	2.06
79	SEABED	-230.66	-21.34	.00	.000	-.004	292.142	.78	-6.21	-.67	.11	6.98	1.94
80	SEABED	-234.66	-21.34	.00	.000	-.003	296.142	.78	-6.21	-.18	.05	6.72	1.87
81	SEABED	-238.66	-21.34	.00	.000	-.003	300.142	.78	-6.21	.00	.00	6.63	1.84

Tension: 250 kN; Stinger-length: 37 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X        DATE - 7/28/2016    TIME - 22:14:11     PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                       JOB NO. - 113
USER ID - N.FURQON                                         LICENSED TO: McDERMOTT, INCORPORATED                 CASE    1
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S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	-.001	.462	21.337	2.76	.00	15.22	-.07	15.70	4.36
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	2.75	.00	-13.29	.20	14.05	3.90
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	5.53	.00	-97.88	.60	88.72	24.65
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	5.41	.00	-299.19	-.99	259.72	72.15
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	5.36	.00	-265.97	.44	231.44	64.29
15	LAYBARGE	.00	2.82	.00	.000	4.759	59.471	5.15	.00	-285.94	-.19	248.20	68.95
18	STINGER	-7.64	2.09	.00	.000	6.079	67.142	4.98	.00	-293.50	.18	254.45	70.68
20	STINGER	-14.59	1.28	.00	-.001	7.299	74.142	4.79	.00	-291.55	-.73	252.61	70.17
22	STINGER	-21.52	.31	.00	.005	8.509	81.142	4.57	.00	-288.49	3.58	249.80	69.39
24	STINGER	-28.43	-.80	.00	-.020	9.737	88.142	4.34	-.23	-295.03	-15.54	255.59	71.00
26	STINGER	-35.32	-2.05	.01	-.077	10.823	95.142	4.17	-.60	-218.74	-11.19	190.64	52.96
28	STINGER	-37.28	-2.43	.01	-.090	11.074	97.142	4.11	-.71	-197.10	-9.41	172.19	47.83
30	SAGBEND	-41.21	-3.21	.02	-.109	11.501	101.142	3.99	-.93	-155.95	-6.22	137.12	38.09
31	SAGBEND	-45.12	-4.02	.02	-.121	11.832	105.142	3.85	-1.17	-117.50	-3.51	104.37	28.99
32	SAGBEND	-49.04	-4.85	.03	-.126	12.072	109.142	3.71	-1.41	-81.64	-1.25	73.83	20.51
33	SAGBEND	-52.95	-5.69	.04	-.127	12.229	113.142	3.57	-1.66	-48.22	.62	45.41	12.61
34	SAGBEND	-56.86	-6.54	.05	-.124	12.308	117.142	3.42	-1.90	-17.14	2.14	19.12	5.31
35	SAGBEND	-60.76	-7.40	.06	-.117	12.314	121.142	3.27	-2.15	11.72	3.34	14.82	4.12
36	SAGBEND	-64.67	-8.25	.07	-.107	12.253	125.142	3.11	-2.40	38.44	4.26	37.24	10.35
37	SAGBEND	-68.58	-9.09	.07	-.096	12.129	129.142	2.96	-2.64	63.11	4.94	58.14	16.15
38	SAGBEND	-72.49	-9.93	.08	-.083	11.949	133.142	2.81	-2.89	85.83	5.41	77.39	21.50
39	SAGBEND	-76.41	-10.75	.08	-.069	11.715	137.142	2.66	-3.13	106.64	5.71	95.03	26.40
40	SAGBEND	-80.33	-11.55	.09	-.055	11.434	141.142	2.51	-3.36	125.63	5.84	111.13	30.87
41	SAGBEND	-84.25	-12.33	.09	-.040	11.108	145.142	2.36	-3.59	142.85	5.85	125.71	34.92
42	SAGBEND	-88.18	-13.09	.09	-.026	10.743	149.142	2.22	-3.81	158.34	5.75	138.84	38.57
43	SAGBEND	-92.11	-13.82	.09	-.012	10.343	153.142	2.08	-4.02	172.15	5.57	150.54	41.82
44	SAGBEND	-96.05	-14.53	.09	.001	9.911	157.142	1.95	-4.22	184.32	5.31	160.85	44.68
45	SAGBEND	-99.99	-15.20	.09	.014	9.451	161.142	1.83	-4.42	194.88	4.99	169.78	47.16
46	SAGBEND	-103.94	-15.84	.09	.026	8.968	165.142	1.71	-4.61	203.85	4.63	177.38	49.27
47	SAGBEND	-107.89	-16.45	.09	.037	8.465	169.142	1.60	-4.78	211.27	4.24	183.65	51.01
48	SAGBEND	-111.85	-17.02	.09	.046	7.946	173.142	1.49	-4.95	217.13	3.82	188.61	52.39
49	SAGBEND	-115.82	-17.55	.08	.055	7.415	177.142	1.40	-5.10	221.47	3.38	192.27	53.41
50	SAGBEND	-119.78	-18.05	.08	.063	6.875	181.142	1.31	-5.25	224.27	2.92	194.63	54.06
51	SAGBEND	-123.76	-18.51	.08	.070	6.330	185.142	1.22	-5.38	225.55	2.46	195.70	54.36
52	SAGBEND	-127.74	-18.93	.07	.075	5.784	189.142	1.15	-5.51	225.31	1.99	195.48	54.30
53	SAGBEND	-131.72	-19.32	.07	.079	5.240	193.142	1.08	-5.62	223.54	1.51	193.96	53.88
54	SAGBEND	-135.70	-19.66	.06	.082	4.702	197.142	1.02	-5.72	220.22	1.03	191.14	53.09
55	SAGBEND	-139.69	-19.97	.05	.084	4.175	201.142	.97	-5.81	215.36	.55	186.99	51.94
56	SAGBEND	-143.68	-20.24	.05	.085	3.661	205.142	.92	-5.89	208.92	.06	181.52	50.42
57	SAGBEND	-147.67	-20.48	.04	.085	3.164	209.142	.88	-5.96	200.90	-.43	174.70	48.53
58	SAGBEND	-151.67	-20.69	.04	.083	2.689	213.142	.85	-6.02	191.25	-.92	166.51	46.25
59	SAGBEND	-155.66	-20.86	.03	.080	2.239	217.142	.83	-6.07	179.96	-1.42	156.92	43.59
60	SAGBEND	-159.66	-21.00	.03	.076	1.819	221.142	.81	-6.11	166.99	-1.92	145.90	40.53
61	SAGBEND	-163.66	-21.11	.02	.071	1.432	225.142	.79	-6.14	152.29	-2.43	133.43	37.06
62	SAGBEND	-167.66	-21.20	.02	.064	1.083	229.142	.78	-6.17	135.83	-2.94	119.47	33.19
63	SAGBEND	-171.66	-21.27	.01	.056	.775	233.142	.77	-6.18	117.56	-3.47	103.97	28.88
64	SAGBEND	-175.66	-21.31	.01	.047	.515	237.142	.77	-6.20	97.41	-4.00	86.91	24.14
65	SEABED	-179.66	-21.34	.00	.037	.305	241.142	.77	-6.21	75.38	-4.44	68.27	18.96
66	SEABED	-183.66	-21.35	.00	.027	.150	245.142	.77	-6.21	53.18	-4.24	49.51	13.75
67	SEABED	-187.66	-21.36	.00	.017	.045	249.142	.77	-6.21	33.82	-3.53	33.22	9.23
68	SEABED	-191.66	-21.36	.00	.010	-.017	253.142	.77	-6.21	18.69	-2.65	20.64	5.73
69	SEABED	-195.66	-21.36	.00	.004	-.049	257.142	.77	-6.21	7.93	-1.80	12.06	3.35
70	SEABED	-199.66	-21.36	.00	.001	-.059	261.142	.78	-6.21	1.03	-1.09	7.45	2.07
71	SEABED	-203.66	-21.35	.00	-.001	-.056	265.142	.78	-6.21	-2.83	-.56	8.30	2.31
72	SEABED	-207.66	-21.35	.00	-.002	-.047	269.142	.78	-6.21	-4.49	-.19	9.39	2.61
73	SEABED	-211.66	-21.34	.00	-.002	-.036	273.142	.78	-6.21	-4.74	.04	9.56	2.66
74	SEABED	-215.66	-21.34	.00	-.002	-.025	277.142	.78	-6.21	-4.17	.15	9.17	2.55
75	SEABED	-219.66	-21.34	.00	-.002	-.016	281.142	.78	-6.21	-3.23	.19	8.54	2.37
76	SEABED	-223.66	-21.34	.00	-.001	-.009	285.142	.78	-6.21	-2.22	.19	7.89	2.19
77	SEABED	-227.66	-21.34	.00	-.001	-.005	289.142	.78	-6.21	-1.31	.15	7.34	2.04
78	SEABED	-231.66	-21.34	.00	.000	-.003	293.142	.78	-6.21	-.60	.11	6.95	1.93
79	SEABED	-235.66	-21.34	.00	.000	-.002	297.142	.78	-6.21	-.16	.05	6.71	1.86
80	SEABED	-239.66	-21.34	.00	.000	-.002	301.142	.78	-6.21	.00	.00	6.63	1.84

Tension: 250 kN; Stinger-length: 42 m

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OFFPIPE - OFFSHORE PIPELINE ANALYSIS SYSTEM - VER. NO: 2.04 X        DATE - 7/28/2016    TIME - 22:15:55      PAGE   11
PROJECT - ANALISA STATIS PIPA TPPI                                                       JOB NO. - 113
USER ID - N.FURQON                                        LICENSED TO: McDERMOTT, INCORPORATED                    CASE    1
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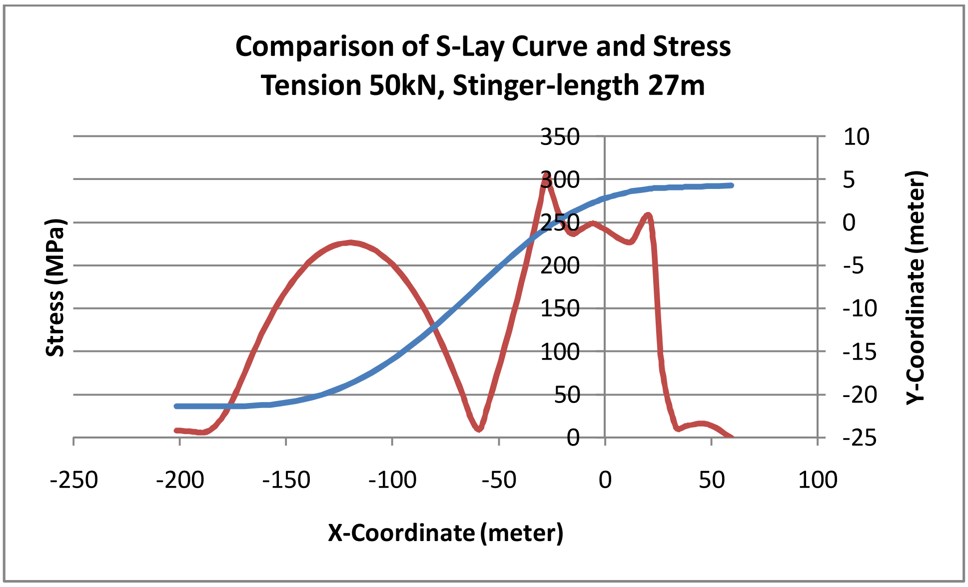
S T A T I C   P I P E   C O O R D I N A T E S,   F O R C E S   A N D   S T R E S S E S

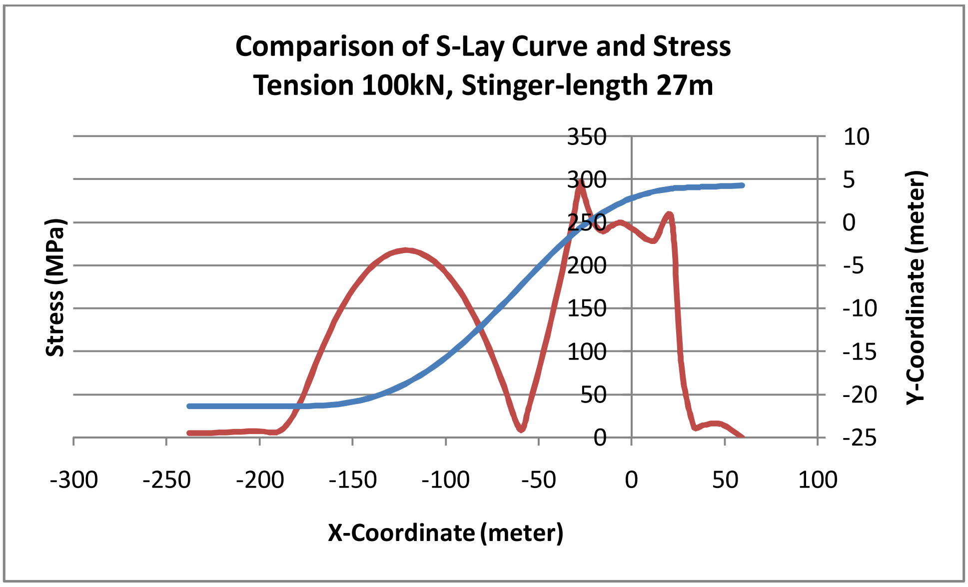
NODE NO.	PIPE SECTION	X COORD (M)	Y COORD (M)	Z COORD (M)	HORIZ ANGLE (DEG)	VERT ANGLE (DEG)	PIPE LENGTH (M)	TENSILE STRESS (MPA)	HOOP STRESS (MPA)	BENDING STRESSES VERT (MPA)	BENDING STRESSES HORIZ (MPA)	TOTAL STRESS (MPA)	PERCNT YIELD (PCT)
1	LAYBARGE	59.44	4.32	.00	.000	.519	.000	.00	.00	.00	.00	.00	.00
3	LAYBARGE	48.01	4.22	.00	.000	.503	11.430	-.02	.00	-18.69	-.09	15.91	4.42
5	TENSIONR	38.10	4.14	.00	.000	.462	21.337	2.76	.00	15.19	-.07	15.67	4.35
7	LAYBARGE	33.53	4.10	.00	.000	.454	25.909	2.75	.00	-13.27	.19	14.03	3.90
9	TENSIONR	26.67	4.04	.00	.001	.667	32.767	5.53	.00	-97.77	.58	88.63	24.62
11	LAYBARGE	21.34	3.95	.00	.001	1.300	38.102	5.41	.00	-299.38	-.96	259.89	72.19
13	LAYBARGE	12.19	3.62	.00	-.001	2.821	47.252	5.36	.00	-265.68	.43	231.19	64.22
15	LAYBARGE	.00	2.82	.00	.000	4.761	59.471	5.15	.00	-286.80	-.18	248.93	69.15
18	STINGER	-8.63	1.98	.00	.000	6.253	68.142	4.95	.00	-295.76	.17	256.35	71.21
20	STINGER	-16.57	1.02	.00	-.001	7.642	76.142	4.73	.00	-290.14	-.75	251.35	69.82
22	STINGER	-24.49	-.14	.00	.006	9.043	84.142	4.46	-.04	-298.90	3.55	258.56	71.82
24	STINGER	-32.37	-1.50	.00	-.023	10.376	92.142	4.25	-.44	-253.49	-15.68	220.35	61.21
26	STINGER	-40.23	-3.01	.01	-.081	11.389	100.142	4.02	-.88	-166.78	-8.28	146.39	40.66
28	STINGER	-42.19	-3.41	.01	-.090	11.579	102.142	3.95	-.99	-146.86	-6.78	129.42	35.95
30	SAGBEND	-46.10	-4.22	.02	-.104	11.888	106.142	3.82	-1.23	-109.02	-4.10	97.18	26.99
31	SAGBEND	-50.02	-5.06	.02	-.111	12.109	110.142	3.68	-1.47	-73.73	-1.86	67.12	18.64
32	SAGBEND	-53.93	-5.90	.03	-.113	12.247	114.142	3.53	-1.72	-40.86	-.01	39.15	10.88
33	SAGBEND	-57.83	-6.75	.04	-.111	12.308	118.142	3.38	-1.96	-10.31	1.49	13.33	3.70
34	SAGBEND	-61.74	-7.60	.05	-.106	12.299	122.142	3.23	-2.21	18.04	2.69	19.94	5.54
35	SAGBEND	-65.65	-8.45	.05	-.098	12.223	126.142	3.08	-2.46	44.28	3.61	42.13	11.70
36	SAGBEND	-69.56	-9.30	.06	-.088	12.086	130.142	2.92	-2.70	68.50	4.30	62.66	17.40
37	SAGBEND	-73.47	-10.13	.07	-.077	11.893	134.142	2.77	-2.95	90.77	4.79	81.54	22.65
38	SAGBEND	-77.39	-10.94	.07	-.065	11.648	138.142	2.62	-3.18	111.15	5.09	98.83	27.45
39	SAGBEND	-81.31	-11.74	.08	-.052	11.356	142.142	2.47	-3.41	129.73	5.25	114.57	31.83
40	SAGBEND	-85.23	-12.52	.08	-.039	11.021	146.142	2.33	-3.64	146.54	5.29	128.82	35.78
41	SAGBEND	-89.16	-13.27	.08	-.026	10.647	150.142	2.19	-3.86	161.63	5.21	141.62	39.34
42	SAGBEND	-93.10	-13.99	.08	-.013	10.239	154.142	2.05	-4.07	175.06	5.06	152.99	42.50
43	SAGBEND	-97.03	-14.69	.08	-.001	9.801	158.142	1.92	-4.27	186.85	4.83	162.98	45.27
44	SAGBEND	-100.98	-15.36	.08	.010	9.336	162.142	1.80	-4.47	197.04	4.55	171.61	47.67
45	SAGBEND	-104.93	-15.99	.08	.021	8.848	166.143	1.68	-4.65	205.65	4.23	178.89	49.69
46	SAGBEND	-108.88	-16.59	.08	.031	8.341	170.143	1.57	-4.82	212.70	3.87	184.86	51.35
47	SAGBEND	-112.84	-17.15	.08	.040	7.819	174.143	1.47	-4.99	218.21	3.49	189.52	52.64
48	SAGBEND	-116.81	-17.67	.07	.048	7.285	178.143	1.37	-5.14	222.19	3.09	192.87	53.58
49	SAGBEND	-120.78	-18.16	.07	.055	6.744	182.143	1.29	-5.28	224.64	2.67	194.93	54.15
50	SAGBEND	-124.75	-18.61	.07	.061	6.199	186.143	1.20	-5.41	225.56	2.25	195.70	54.36
51	SAGBEND	-128.73	-19.03	.06	.066	5.653	190.143	1.13	-5.53	224.96	1.81	195.18	54.22
52	SAGBEND	-132.71	-19.40	.06	.070	5.110	194.143	1.07	-5.64	222.83	1.38	193.35	53.71
53	SAGBEND	-136.70	-19.74	.05	.073	4.575	198.143	1.01	-5.74	219.15	.94	190.22	52.84
54	SAGBEND	-140.69	-20.04	.05	.074	4.050	202.143	.96	-5.83	213.92	.49	185.77	51.60
55	SAGBEND	-144.68	-20.30	.04	.075	3.540	206.143	.91	-5.90	207.11	.05	179.98	50.00
56	SAGBEND	-148.67	-20.53	.04	.075	3.048	210.143	.87	-5.97	198.71	-.40	172.84	48.01
57	SAGBEND	-152.67	-20.73	.03	.073	2.579	214.143	.84	-6.03	188.68	-.85	164.32	45.65
58	SAGBEND	-156.67	-20.90	.03	.071	2.136	218.143	.82	-6.08	177.00	-1.30	154.40	42.89
59	SAGBEND	-160.66	-21.03	.02	.067	1.723	222.143	.80	-6.12	163.63	-1.76	143.05	39.74
60	SAGBEND	-164.66	-21.14	.02	.062	1.345	226.143	.79	-6.15	148.52	-2.23	130.23	36.17
61	SAGBEND	-168.66	-21.22	.01	.056	1.005	230.143	.78	-6.17	131.64	-2.70	115.90	32.20
62	SAGBEND	-172.66	-21.28	.01	.049	.709	234.143	.77	-6.19	112.93	-3.19	100.04	27.79
63	SAGBEND	-176.66	-21.32	.01	.041	.460	238.143	.77	-6.20	92.33	-3.68	82.59	22.94
64	SEABED	-180.66	-21.34	.00	.031	.263	242.143	.77	-6.21	69.98	-4.00	63.68	17.69
65	SEABED	-184.66	-21.36	.00	.022	.121	246.143	.77	-6.21	48.24	-3.69	45.32	12.59
66	SEABED	-188.66	-21.36	.00	.014	.027	250.143	.77	-6.21	29.83	-2.99	29.85	8.29
67	SEABED	-192.66	-21.36	.00	.007	-.027	254.143	.77	-6.21	15.75	-2.20	18.21	5.06
68	SEABED	-196.66	-21.36	.00	.003	-.053	258.143	.77	-6.21	5.97	-1.46	10.58	2.94
69	SEABED	-200.66	-21.35	.00	.000	-.059	262.143	.78	-6.21	-.13	-.86	7.09	1.97
70	SEABED	-204.66	-21.35	.00	-.001	-.055	266.143	.78	-6.21	-3.40	-.42	8.67	2.41
71	SEABED	-208.66	-21.35	.00	-.002	-.044	270.143	.78	-6.21	-4.69	-.12	9.53	2.65
72	SEABED	-212.66	-21.34	.00	-.002	-.033	274.143	.78	-6.21	-4.73	.06	9.56	2.65
73	SEABED	-216.66	-21.34	.00	-.002	-.022	278.143	.78	-6.21	-4.09	.15	9.11	2.53
74	SEABED	-220.66	-21.34	.00	-.001	-.013	282.143	.78	-6.21	-3.16	.17	8.49	2.36
75	SEABED	-224.66	-21.34	.00	-.001	-.007	286.143	.78	-6.21	-2.21	.17	7.88	2.19
76	SEABED	-228.66	-21.34	.00	-.001	-.002	290.143	.78	-6.21	-1.39	.14	7.39	2.05
77	SEABED	-232.66	-21.34	.00	.000	.000	294.143	.78	-6.21	-.75	.10	7.02	1.95
78	SEABED	-236.66	-21.34	.00	.000	.001	298.143	.78	-6.21	-.32	.07	6.79	1.89
79	SEABED	-240.66	-21.34	.00	.000	.002	302.143	.78	-6.21	-.07	.03	6.67	1.85
80	SEABED	-244.66	-21.34	.00	.000	.002	306.143	.78	-6.21	.00	.00	6.63	1.84

APPENDIX E. Comparison of S-Lay Curve and Stress for All Tension and Stinger-length Variations Calculated by OFFPIPE

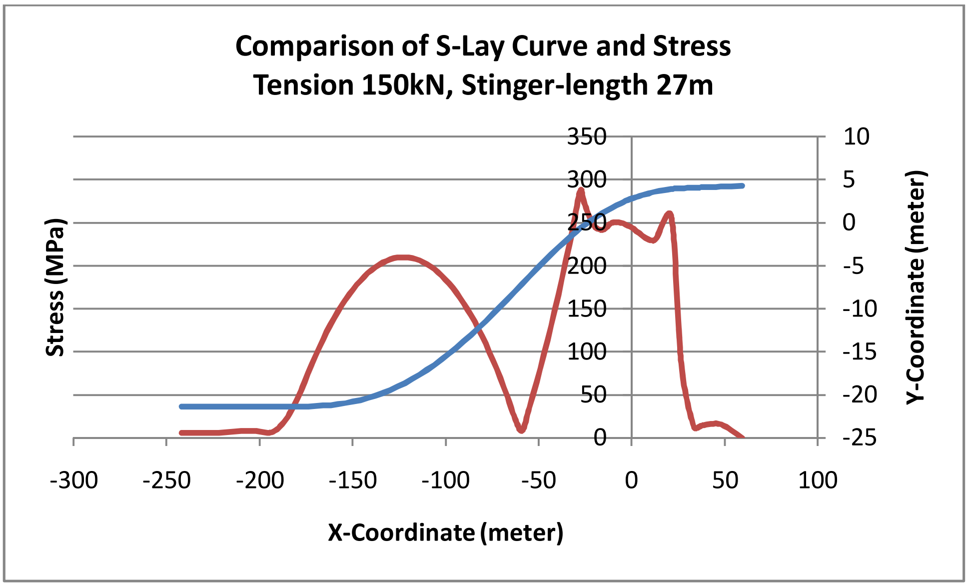
Tension: 50 kN; Stinger-length: 27 m



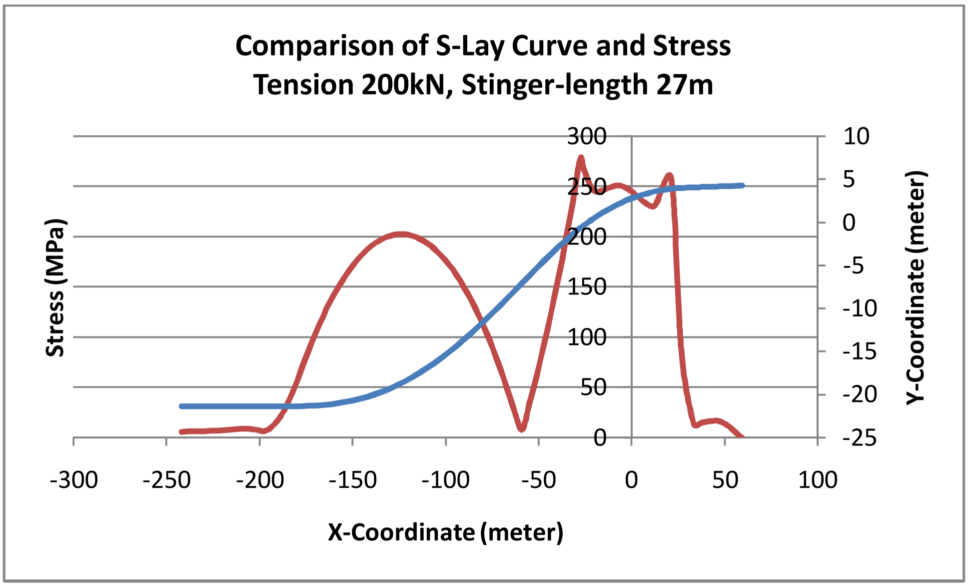
Tension: 100 kN; Stinger-length: 27 m



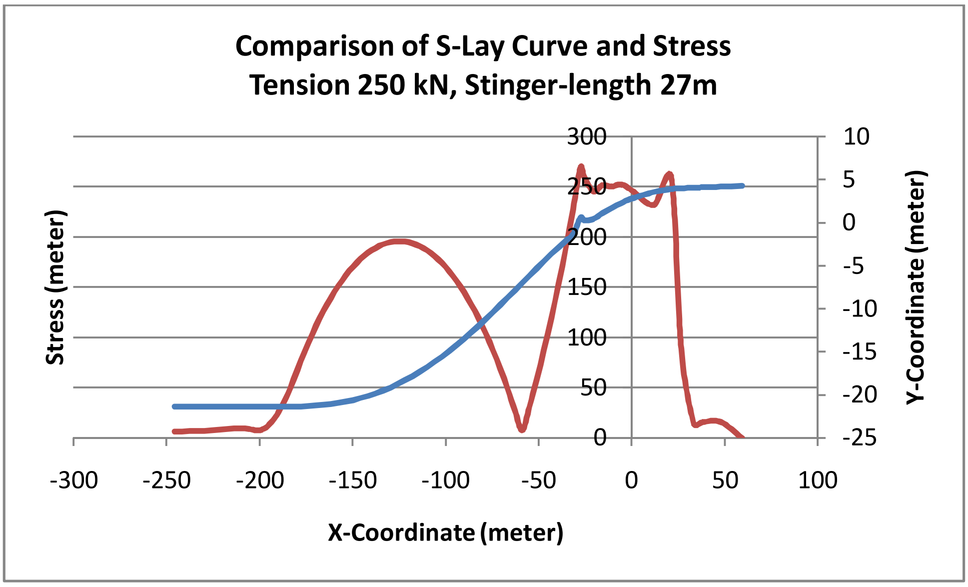
Tension: 150 kN; Stinger-length: 27 m



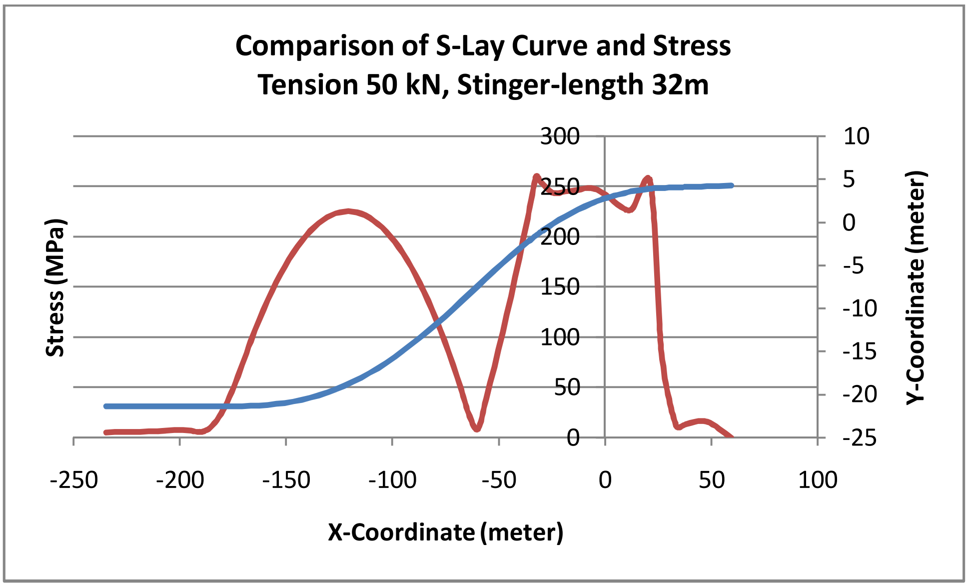
Tension: 200 kN; Stinger-length: 27 m



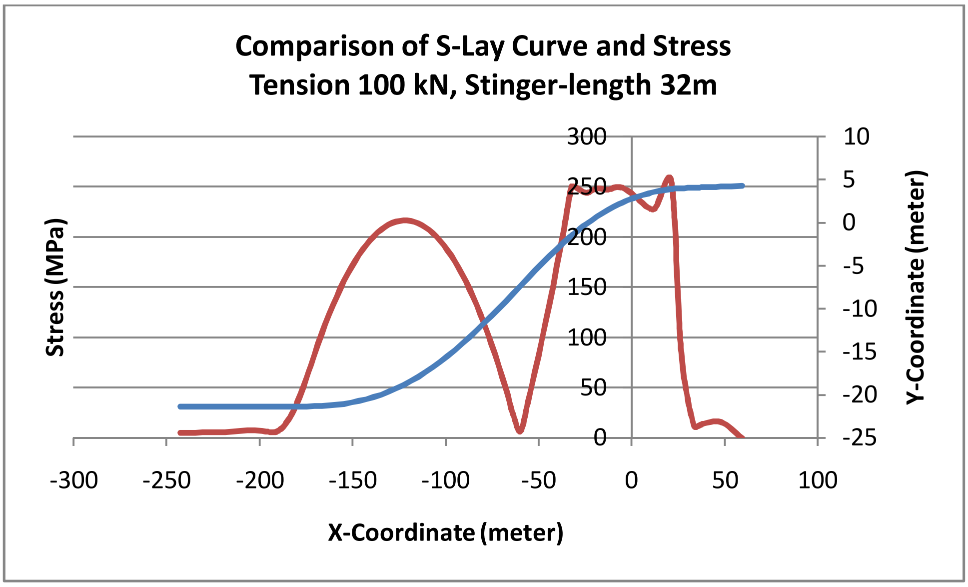
Tension: 250 kN; Stinger-length: 27 m



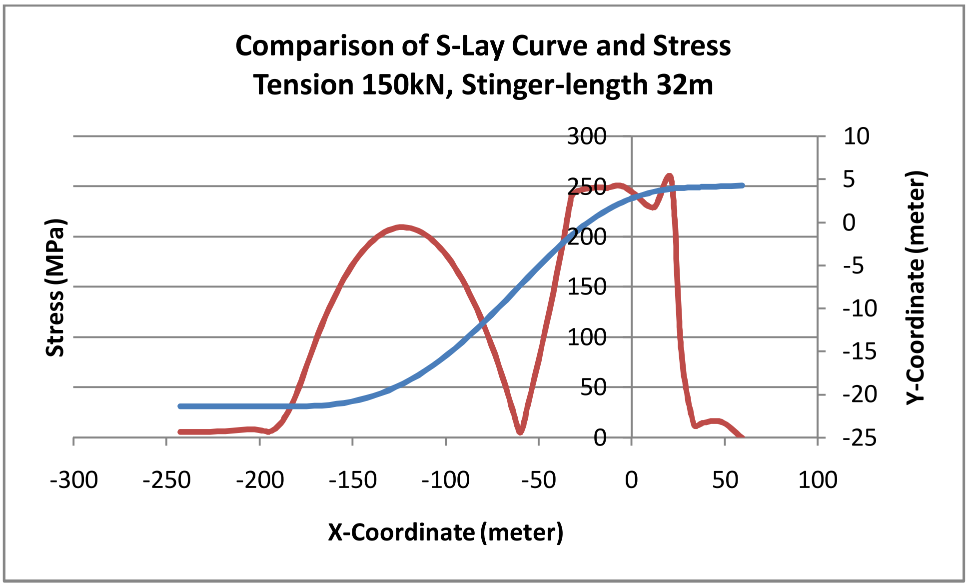
Tension: 50 kN; Stinger-length: 32 m



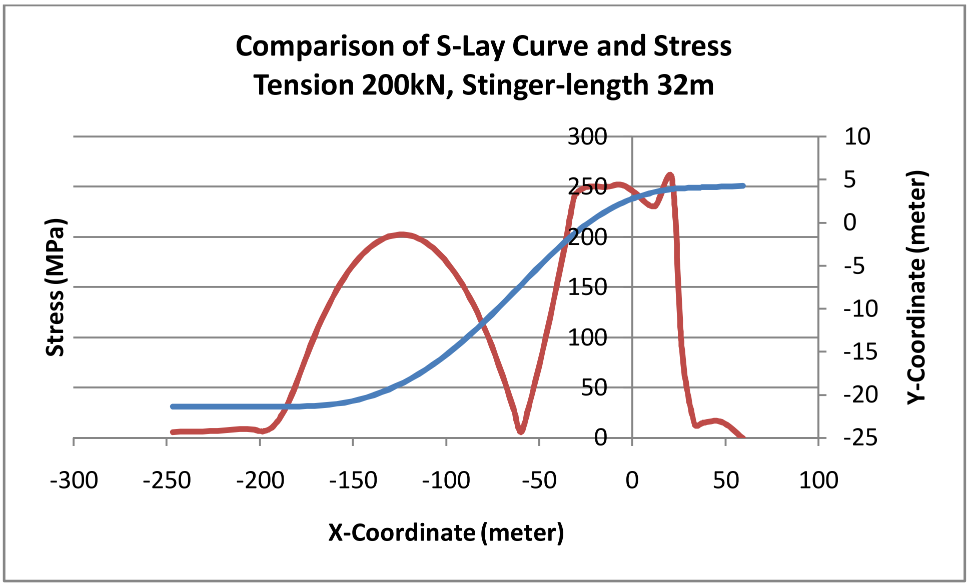
Tension: 100 kN; Stinger-length: 32 m



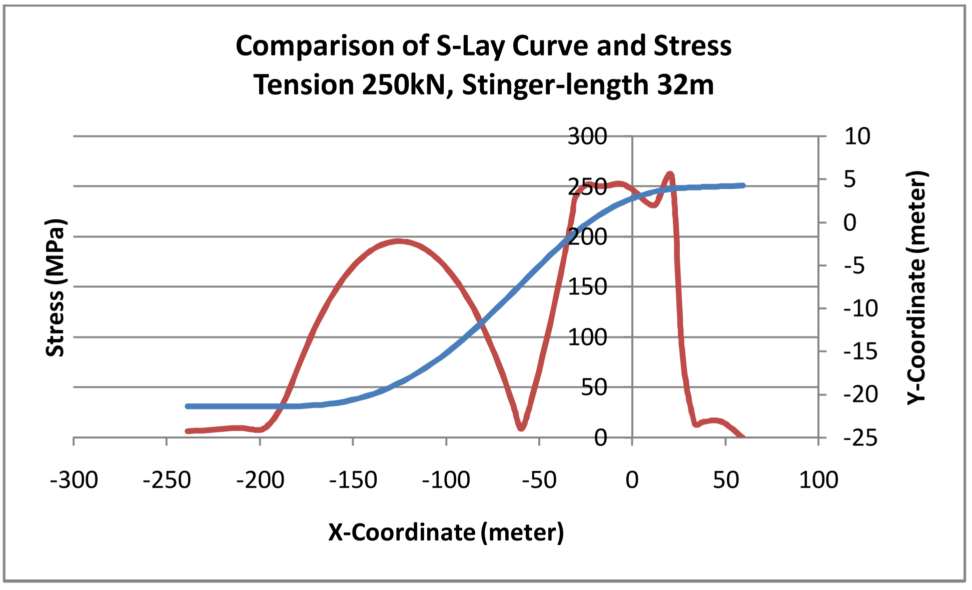
Tension: 150 kN; Stinger-length: 32 m



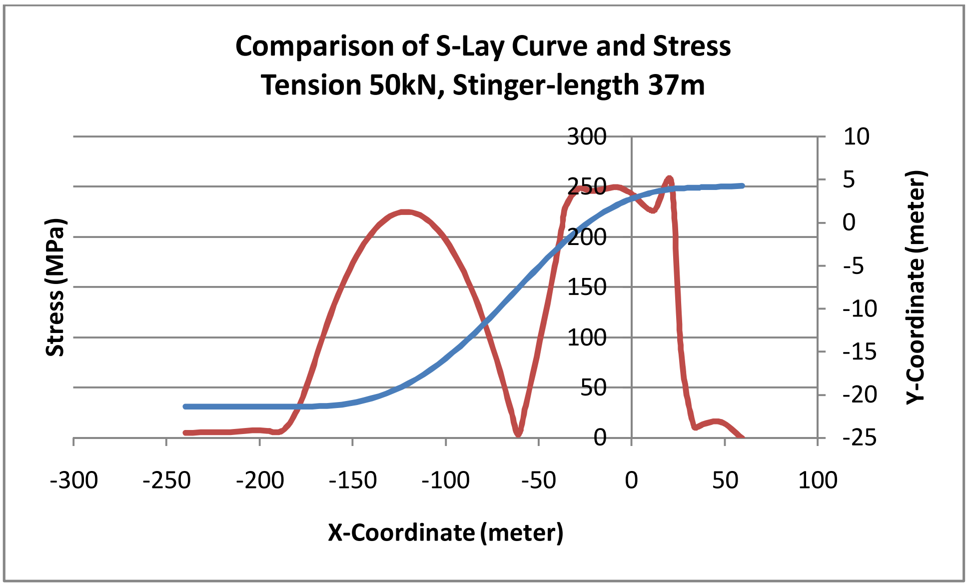
Tension: 200 kN; Stinger-length: 32 m



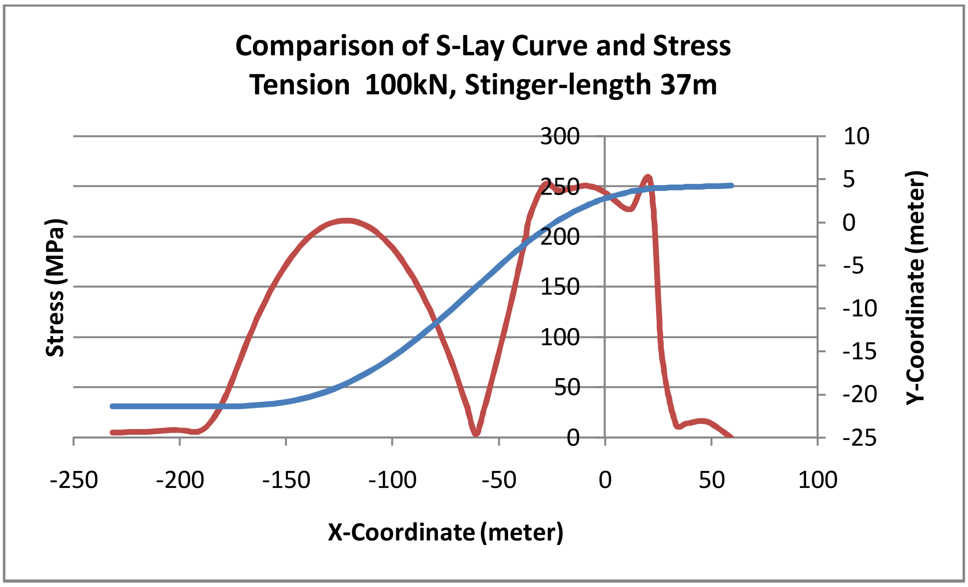
Tension: 250 kN; Stinger-length: 32 m



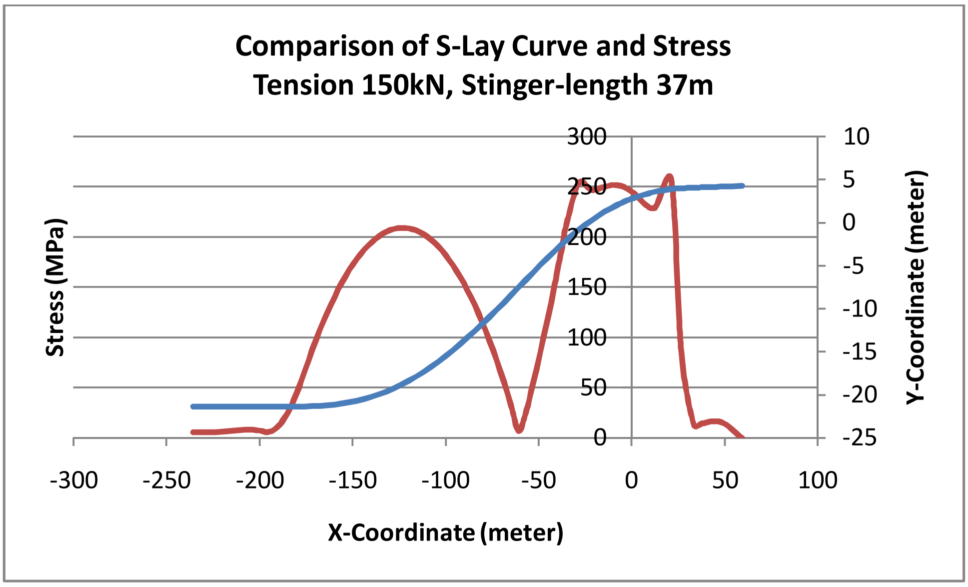
Tension: 50 kN; Stinger-length: 37 m



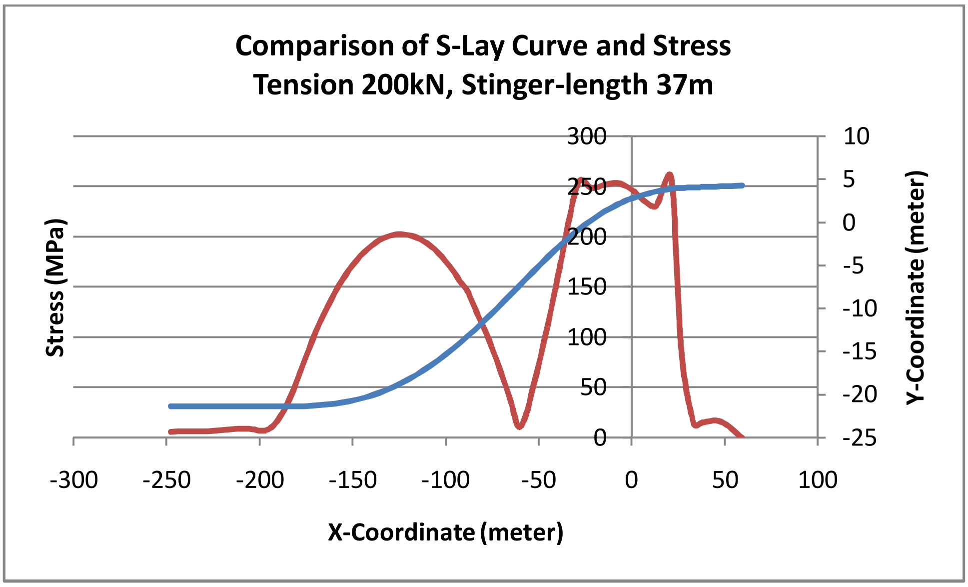
Tension: 100 kN; Stinger-length: 37 m



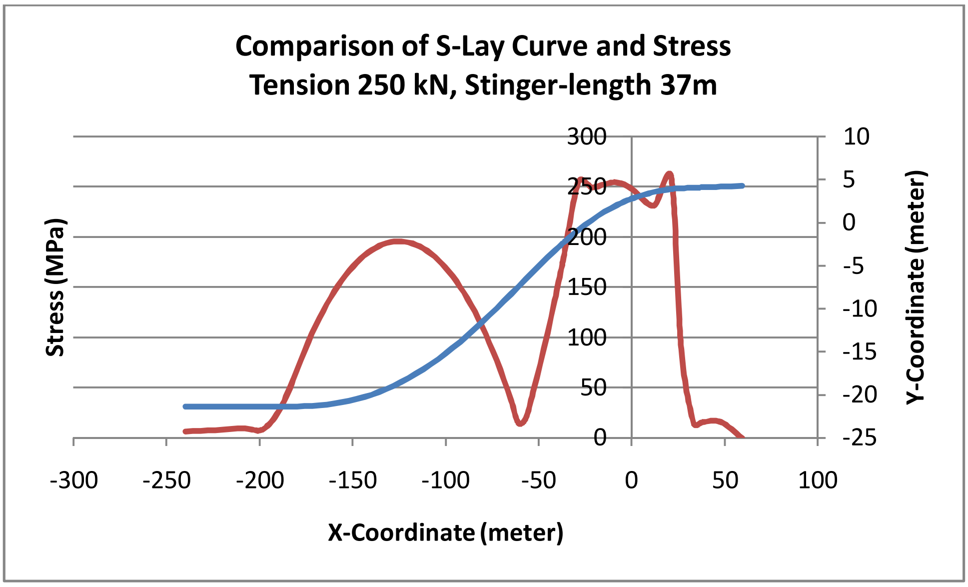
Tension: 150 kN; Stinger-length: 37 m



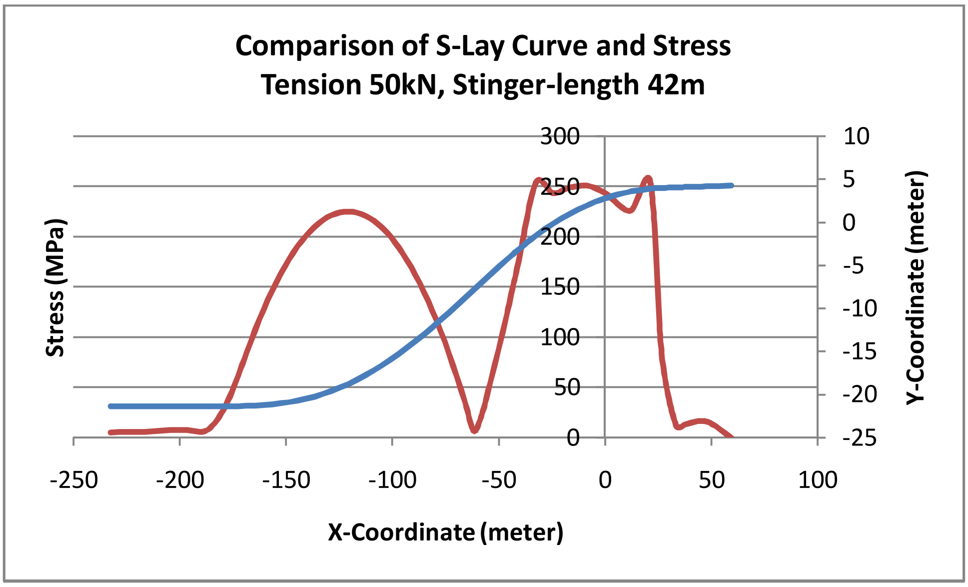
Tension: 200 kN; Stinger-length: 37 m



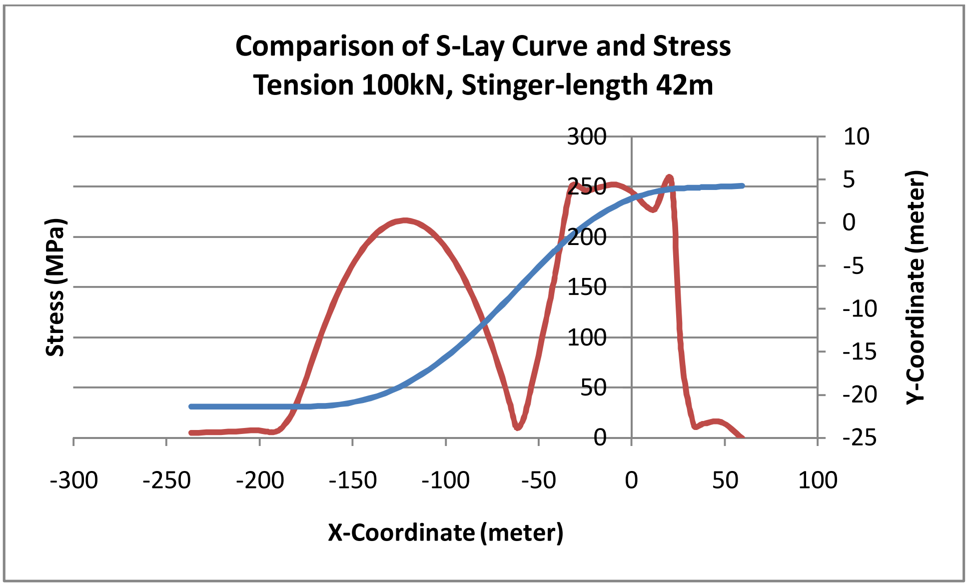
Tension: 250 kN; Stinger-length: 37 m



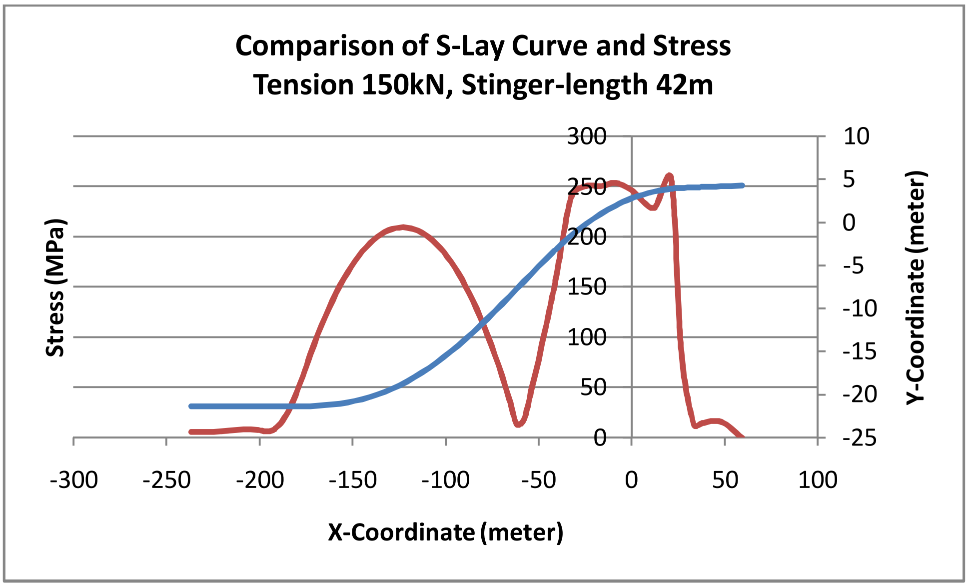
Tension: 50 kN; Stinger-length: 42 m



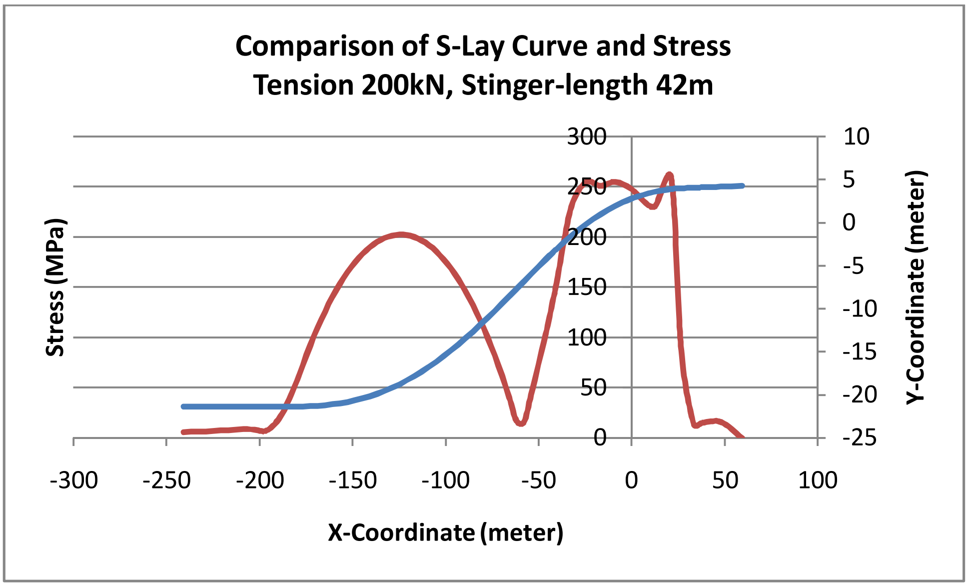
Tension: 100 kN; Stinger-length: 42 m



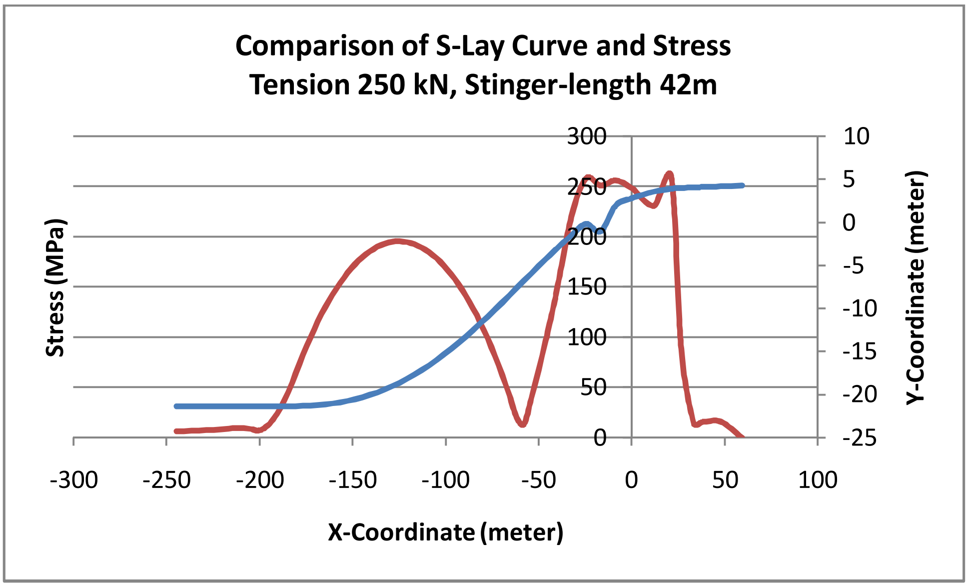
Tension: 150 kN; Stinger-length: 42 m



Tension: 200 kN; Stinger-length: 42 m



Tension: 250 kN; Stinger-length: 42 m



CHAPTER V
CONCLUSION AND SUGGESTION

5.1 Conclusion

Based on the analyses and results that have been done and obtained from the work of this final project, we can make several conclusions. The conclusions are the following:

1) In overbend region, the maximum stress undergone by the pipeline is 305.58 MPa, that is, the one that uses 27 meter stinger and tension of 50 kN. Whereas the minimum stress is 250.06 MPa, that is, the one that uses 32 meter stinger and tension of 100 kN.In sagbend region, the maximum stress undergone by the pipeline is 226.16 MPa, that is, the one that uses 27 meter stinger and tension of 50 kN. Whereas the minimum stress is 195.63 MPa, that is, the one that uses 32 meter stinger and tension of 250 kN.
2) For safe installation process, we should use one of the following options:
   - Using 32 meter long stinger and tension of 100 kN.
   - Using 32 meter long stinger and tension of 200 kN.

5.2 Suggestion

For further researches, the writer suggests that one should consider the dynamic analysis for pipeline installation, that is the motions of the laybarge, in order to obtain more precise and accurate stress results.

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Nazwar Furqan was born on January 13, 1989 in Makassar, South Sulawesi. He is the second oldest child out of four, of the couple Ir. H. Suardi Saleh, M.Si and Drg. Hj. Hasnah Syam, MARS. He has passed his educational period, from elementary school to senior high school in Pinrang, South Sulawesi. His education record: He graduated from SD Negeri 1 Pinrang (elementary school), SMP Negeri 1 Pinrang (junior high school), and SMA Negeri 1 Pinrang (senior high school) in 2000, 2003, and 2006, respectively. The writer pursued his study at Institute of Technology Sepuluh Nopember Surabaya in 2007, majoring in Ocean Engineering. He was active in several activities and seminars. Activities the writer has joined for self-development include: seminar entitled *"Studi Kasus Aplikasi Pemodelan Geofisika Dalam Industri Perminyakan"* (Case Study, Application of Geophysical Modelling in Oil Industry), which was held by PERTAMINA, a contest of making of offshore platform scale model held by Ocean Engineering Department ITS, and *Kerja Praktek* (Practical Study) in *Badan Meteorologi, Klimatologi, dan Geofisika* (Department of Meteorology, Climatology, and Geophysics) Surabaya for two months. He has interest in structural analysis and offshore engineering field such as design of jacket structure, offshore pipeline, hydrodynamics, *etc*. Therefore, he took his final project topic related to offshore pipeline, entitled "Static Analysis of Stresses in Offshore Pipeline during Installation Using S-Lay Method, Case Study: Pipeline Owned by PT. Trans Pacific Petrochemical Indotama Tuban". Beyond the academic activities, the writer is interested in playing football, listening music, reading comic books, and watching movies in cinema.

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