Parametric Study for the Critical Tubular Joint of the Jacket Structure

By

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Final report submitted in partial fulfilment of
The requirements for the
Bachelor of Engineering (Hons)
(Civil Engineering)

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Civil Engineering Programme
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
BACHELOR OF ENGINEERING (Hons)
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Approved by,

DR. VICTOR R. MACAM JR.

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Ng Cheng Yee

Acknowledgement

First of all, I would like to express my deepest appreciation to my supervisor, Dr. Victor R. Macam Jr. for his keenness on teaching and providing guidance to me on the completion of my final year project. His effort on guidance and teaching are very much appreciated. Apart from the technical approaches, he as well encourages me to try new matters for polishing the personality and the communication skills.

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Abstract

The final year project titled 'Parametric Study for the Critical Tubular Joints of the Jacket Structure' was carried out with the aim of studying the trends of the joint of the submerged jacket structure accordingly to its conditions. To achieve the aim of the project, several objectives been designed. Firstly is to study different load case of the jacket and to determine the critical joint trends of the jacket when the jacket subjected to several different loading conditions. Extensive literature review was conducted in order to come up with ideas about the offshore structure, joint of the jacket structure, environmental forces and the SACS program review, which the software been used to run the analysis. The research been carried out for the five fixed jacket models with various loading conditions, as all the data been input to the SACS program, analysis been carried out on the jacket structure. The result of the joint can with the maximum unity check been focused and been analyzed. The results then been presented in the graphical form, which shows the relationship between depth of the critical joint and total weight of the model; and depth of the critical joint and the water depth. Environmental and the model weight were the significant elements that contribute to the depth of the critical joint. From the graphical results presented the trends of the critical joints been determined.

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CHAPTER 1
INTRODUCTION

1.1 Background Study

Platform structures are commonly utilized for various purposes including offshore drilling, processing and support of offshore operations. Jacket type structures are attractive in relatively shallow water regions. A jacket is supporting structure for deck facilities stabilized by leg piles through the seabed. The size of a jacket is dependent on deck size, pile dimensions and environmental loads. In jacket design, operational and environmental loads are very important and must be investigated intensively to secure during their operation life. To confirm the stability, several analysis including in-place, fatigue, dynamic, load-out, transportation, lifting, and launching are performed. Due to complexity of the operation, there is not a straightforward guideline or procedure for the analysis.

Offshore structures, as mentioned, are very much subjected to the oscillated forces such as wind, wave, current and tidal force. Damages that caused by these forces are concerned. Failure that might occur comprises member failure, joint failure as well as corrosion of the structure. Analysis was carried out from the fabrication stage, towards the load-out, transportation, upending and installation of the structure; this is to ensure the safety of the structure.

Joint is a location which prone to failure. In offshore engineering, tubular joints are widely encountered to be used as supporting structure. As this element is frequently subjected to cyclic loading, failure such as punching and fatigue were commonly found at the joint.

1.2 Problem Statement

For the design of the offshore structure, one of the main concerns is the checking of the jacket joints. The checking of the joints for tubular to tubular comprises punching shear check as well as the fatigue check.

The fatigue is mainly due to the small flaw occurring at the joint, with the cyclic loading this caused the joint prone to fail due to fatigue. Another reason fatigue occurs is due to the stress distribution at the joint. Joint is connected by connecting the brace to the chord, with the abrupt change in geometry, it will resulting the localized stress increase and cause failure. The location of the critical joints for a fixed jacket is a necessary determination during the design stage. Currently design of the jacket carried only a unity check which detail check needed such that in specific conditions, the location for the critical joints shall be in the specific range.

As mentioned, the joint failure is the most common found failure mode occurred for the jacket platform. The failure might due to human errors, which human errors are not modeled. Based on the results of the analyses by Kvitrud, 2001 and the historical data, human errors are probably the dominating cause of accidents connected to the structural failure. Current market, there are invalid of the proper guidance for the fresh person of the industry. Thus, this could be the main reason that the human errors occurred.

Besides, there are large uncertainties associated with the maximum load effects on an offshore structure due to environmental loading processes such as wind, waves, and sea ice and earth quakes. These uncertainties arise from variability in the loading process parameter, limitations in the quality and quantity of the data used to characterize these parameters, and inaccuracy of the idealized models used to estimate loads. The sources of uncertainty determine its sensitivity to the amount of information available to designer.

1.3 Objectives

i. To study different load case of the jacket structure.
ii. To study the effect of the in-place jacket when topside been removed.
iii. To determine the critical joint when different load combination been applied.
iv. To determine the trends of the critical joint trends when subjected to various water depth, environmental conditions as well as different loading.

1.4 Scope Of Study

The Final Year Project II was carried out in a variety of manner to achieve the project goal.

i. Literature review

Literature review of the research has been carried out through out the FYP II duration. Books, e-journal, internet resources, and codes such as API-RP-2A been used to gain a better understanding of the research. Information and knowledge of the basic load cases, loading combinations, offshore jacket, and the most significant the characteristic and other information of the jacket joint was gained from the resources.

ii. Software Analysis (SACS)

SACS IV is software with the general purpose three dimensional static structural analysis programs. It could model a large array of structures from simple two dimensional space frame analysis to complex three dimensional finite element analyses. The program could be used for nonlinear static analysis when coupled with PSI module or Dynamic Response Modules.

SACS IV refers to three of the program modules of the SACS system, namely the pre-processor module Pre, the solver module Solve and the post processor module Post. The post processor module, Post, can be executed as part of SACS IV or as an individual analysis step. This manual addresses the features and capabilities of the Pre and Solve modules and includes the procedure used to run Post as Part of SACS IV. The Post manual addresses the execution of the post processor as a separated step and includes a detail discussion of the program's capabilities.

iii. Analysis of Results

Results from series of analysis are analyzed. An attempt is also made to generate the trends of the critical joint depth, when subjected to different water depth, environmental conditions, and different loading conditions.

CHAPTER 2
LITERATURE REVIEWS

2.1 Malaysia Oil and Gas Industry

Oil and gas industry in Malaysia began on 1972, while the decline in contribution of tin, petroleum and natural gas were discovered in offshore oilfields at Sabah, Sarawak and Terengganu. The first onshore discovery of oil was in Miri. During 1950s, the very first offshore oilfield been discovered in Sarawak.

Before 1974, Malaysia offshore was divided into two concessions area; offshore of Peninsular Malaysia was awarded to Esso Production Malaysia Inc. (EPMI), while east Malaysia awarded to Sarawak Shell Berhad (SSB) and Sabah Shell Pet. Co. Ltd. This will allowed other oil companies to bid for any of the PSCs. As a return of these concessions, the oil companies paid a small royalty and taxes (5%) to the State Government, where by that time petroleum was under controlled by the State Government.

Under Petroleum Development Act 1974, Petroleum National Berhad in short PETRONAS, been awarded the right on the entire ownership and the exclusive rights, power, liberties and privileges of exploring, exploiting, winning and obtaining petroleum whether onshore or offshore of Malaysia.

It is been stated by PETRONAS that the PSC duration for exploration is 5-year, development for 4-year, and 20-year for production. After 29 years of operating, all of the facilities will be returned to and owned by PETRONAS.

The oil production rate in Malaysia increased from 81,000 bbl/day in 1974 to 770,000 bbl/day in 2005, while 53.5 billion cubic meters for natural-gas in 2005.

During 2004, Malaysia's oil reserves stood at 4.84 billion barrels while natural gas reserves increased to 89 trillion cubic feet (2,500 km^3). This was an increase of 7.2%. The government estimates that at current production rates Malaysia will be able to produce oil up to 18 years and gas for 35 years. 56% of the oil reserves exist in the Peninsula while 19% exist in East Malaysia. The government collects oil royalties of which 5% are passed to the states and the rest retained by the federal government.

2.2 Offshore structure

Offshore structure could be categorized based on the water depth, whereby it could be categorized as shallow water, deep water and ultra-deep water. Shallow water structure is the structure that sits on the seabed, which normally held in place by pile. The selection of offshore structure is based on the depth of water from the mean sea level to the seabed. There are several types of offshore structures, such as fixed steel platform; jack up rig; semi-submersible; drill ship; and tension leg platform.

Fixed steel platform structure consists of topsides; jackets, drilling; compression modules; process modules and living quarters.

Jacket is the substructure that submerges in the sea and anchored onto the seabed, supporting a deck with space for drilling rigs, production modules and living quarters (topside). The height of jacket is based on the water depth from mean sea level to the seabed, and the height of the 100-year return storm wave for the region. This part of the structure is subjected to the loading from topside, wind load, wave load as well as the current load. These are the reasons for the members of jacket to be designed as tubular sections instead of square sections, where it can reduce the force acting on the legs. Jacket is normally constructed by using steel. Due to the expose of steel to the sea water, the tendency for it to corrode is high.

2.3 Tubular Joints in Offshore Structures

In offshore structures, circular hollow sections or tubular members are used almost exclusively. The reasons are to reduce the drag coefficient to relatively low and smaller hydrodynamic loads, equal lateral strength in all directions, minimal stress concentrations in joints and outstanding buckling strength (Gandhi & Berge, 1998).

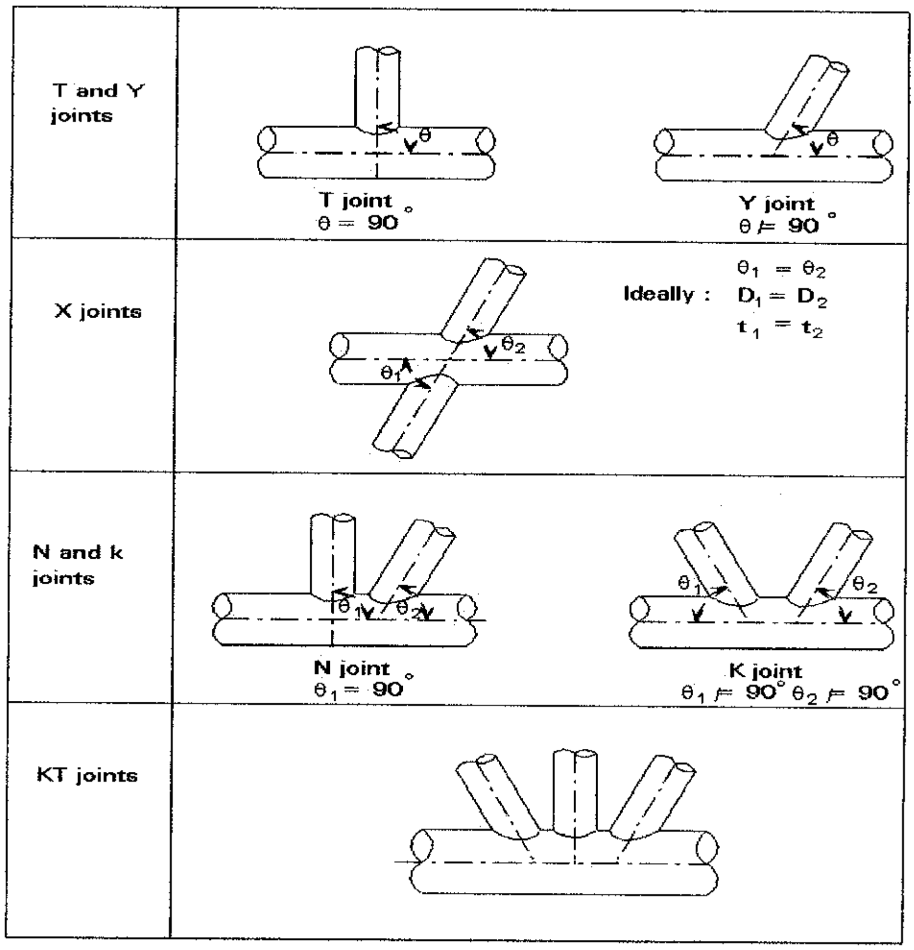
Offshore structures are made of welded tubular joint that display geometrical discontinuity. Joints of an offshore structure are formed at locations where cross members are welded onto the main legs of the structure. Under design wind and wave loadings, the forces in each cross member are seen to be transmitted directly to the wall of the leg.

The structural joints of a platform must be check to insure that each joint can withstand the forces transmitted by the members which make up the joint. Each joint comprises one or more members (branches or braces) which frame into a larger diameter member referred as the chord. The large variation in stress exists at the intersection of the branches and chord, which must be accounted for when determining the thickness of the chord. A lot of experimental and theoretical effort has gone into the development of stress analysis technique currently used to determine the stress distribution around a tubular joint. Computer programs have been developed to aid the designer in developing the data required to permit the proper design of tubular joints for both static and cyclic loading.

Joints subject to stresses which vary with time should be checked for resistance to fatigue. Fatigue analysis, such as dynamic analysis, is complex and involves considerable time and effort, but should be part of the design procedure for most areas of the world.

2.3.1 Types Of Offshore Structure Tubular Joint

Types of the tubular joint could be categorized as follow:



Source of Design of Offshore Structure Lecture Notes

Figure 2.1: Types of Tubular Joint

2.3.1.1 T-joint and Y-joint

T-joints made up of a single brace which perpendicular to the chord (T joint) the axial force acting in the brace is reacted by bending in the chord. Where by Y-joints made up of a single brace which inclined to it. In a Y joint, the axial force is reacted by bending and axial force in the chord.

2.3.1.2 X-joint

X joints include two coaxial braces on either side of the chord. Axial forces are balanced in the braces, which in an ideal X joint have the same diameter and thickness. In fact, other considerations such as brace length, which can be very different on each side of the chord, may lead to two slightly different braces. Angles may be slightly different as well.

The important point to note is the balance of forces in the braces. If the axial force in one brace is far higher than the one in the other brace, the joint may be classified as a Y (or a T) joint rather than an X joint. Where by the members whose perpendicular load components are reacted across the chord is treated as X joints.

2.3.1.3 N-joint and K-joint

N-joint and K-joint comprises two braces. The one of the braces of N-joint may be perpendicular to the chord. Both of the K-joint braces are inclined. The ideal load pattern of these joints is reached when axial forces are balanced in the braces, i.e. net force into chord member is low.

In the logic of the recommended classification scheme of API RP 2A, members whose axial load component perpendicular to the chord is essentially balanced by axial loads in other member of the same side of the joint are treated as K joints (Pecknold et. al., 2007).

2.3.1.4 KT-joint

KT-joint comprises 3 braces, which the load pattern for these joints is more complex. Ideally axial forces should be balanced within the braces, i.e. net force into chord member is low.

2.3.2 Failure Mode Of Joints

2.3.2.1 Punching shear

Joints of an offshore are formed at location where cross members are welded onto the main leg of the structure. Under design wind and wave loadings, the forces in each cross member are seen to be transmitted directly to the wall of leg. The possibility accordingly exists of punching shear failure through the wall if its thickness is too small (Dawson, 1983).

The acting punching shear is the shear stress developed in the chord by the brace load. Allowable punching shear values in the chord wall are determined from test results carried out on full scale or on reduced scale models. To ensure against punching shear failure of the joint, it is necessary that the shear stress be less than the shear yield stress of the material, with a suitable factor of safety. This may be roughly being 0.4 times the tensile yield stress.

2.3.2.2 Fatigue failure

Metals which are subject to continuously varying or alternating loads can fracture at values of stress considerably less than the ultimate value found during static tests. Experimental evidence has indicated that fluctuating stresses, in some cases smaller than the elastic limit, will induce fracture if repeated a sufficient numbers of time (McKenzie, 2004).

Thus damage can be initiated at any of these critical points due to fatigue, caused by repeated stress cycling and range of stress to which element is subjected, in spite of taking proper care in the design and fabrication of the joints (Alam and Swamidas, 2001; McKenzie, 2004). furthermore, the tubular joint of these structures are subjected to fatigue or corrosion fatigue damage due to high-stress concentration, possible weld defects, cyclic wave loading, and simultaneous corrosion (Murthy et. al., 1998).

Such failure could occur for the actual stress never exceeding the yield stress of the material. The higher the cyclic stress, the lower the number of cyclic needed for failure. Due to the abrupt change of the geometry at the end of the cross member framing into a joint, localized stress increased exist there so the fatigue failures can generally be expected at the end of cross member or in the weld material of the joints.

The crack may be initiated at the saddle or crown or any other location around the hot spot region, depending on the nature of loading in members meeting at the joint (Berge 1996). Also, fatigue life is found to reduce significantly under marine environment.

In other hand, it has been know for a long time that chord wall thickness influences the fatigue performance of tubular joints. The fatigue strength decreases with increasing chord wall thickness. Such an effect had long been recognized in welded plates. However, in the absence of sufficient information on tubular joints, the welded plate correction factor was adopted for all welded fabrications (Gurney, 1982). Various design guidance recommended different correction factors with respect to a reference thickness.

Fatigue design of tubular joint is based on S-N Curves. The design curves are essentially empirical, and have been derived by a procedure that on a notional basis corresponds to a lower confidence limit of experimental data. Various code authorities have recommended different S-N Curves for different types of joint detail. Most of there S-N Curves deal with hotspot stress definition (Gandhi & Berge, 1998).

2.4 Environmental Loading (Design Parameter)

Before the response of the proposed offshore structure can be analyzed, it is necessary to have quantitative estimates of all the significant loadings that the structure is likely to experience in the ocean environment. The environment may be characterized mainly by over water wind, by surface waves, and by currents that exist during severe storm conditions.

Environmental loads are dependent on conditions that change randomly with time. The structure should be design for the maximum load that occurs due to the loading process during its design life. Over water wind during storm conditions is significant in the design of offshore structures because of the large forces it can induce on the upper exposed parts of the structures. Surface waves during storm conditions are also of major importance in the design of offshore structures because of the large forces produced on submerged parts of the structure by the accompanying water motion. Finally, currents at a particular site can contribute significantly to the total forces exerted on the submerge parts of the structure. Currents refer generally to the motion of water that arises from sources other than surface waves. Tidal currents, arises from the astronomical forces exerted on the water by the moon and sun, wind-drift currents from the drag of local wind on the water surface, river currents from the discharge of rivers, and ocean currents from the drag of large scale wind system on the ocean (Dawson, 1983).

Basically, design of an offshore structure to withstand the maximum load that it will definitely experience during its planned lifetime due to extreme oceanographic factors (wind, waves, and currents) or other environmental conditions (earthquakes, ice, mud-slides). Environmental loads on offshore structures are calculated from inexact estimates if extreme environmental condition using mathematical models that are themselves inexact.

The basic design parameters provided through studies are:

- Wind
- Waves
- Currents
- Water levels

The relative importance of these parameters depends upon the types of activities or development involved, water depth and other environment factors. Some region of the world have such calm conditions that platform dead loads are the deciding factor for design and knowledge of water level change is used only to set deck elevations. Figure 2.2 shows the oceanographic design parameters.

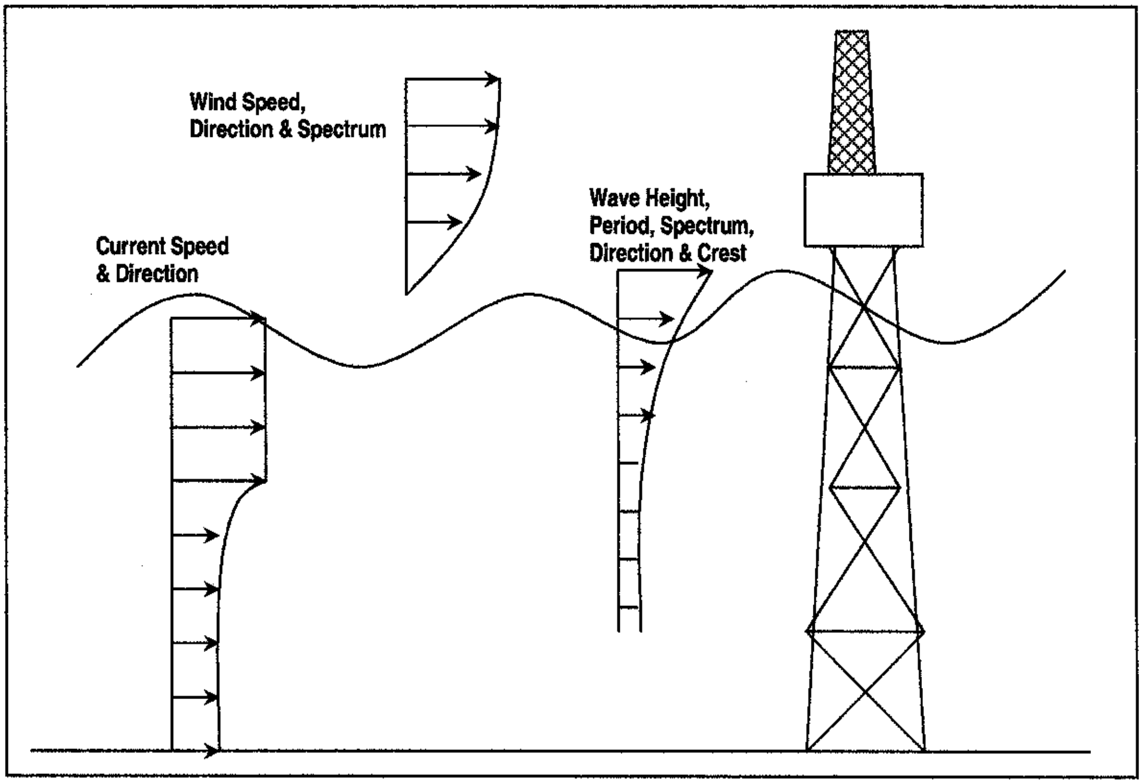


Figure 2.2: Oceanographic Design Parameters.

2.4.1 Winds

Knowledge of winds blowing over the ocean is important for the following factors:

- Wind loads
- Wave generations
- Surge generations
- Current generations

The large scale horizontal atmospheric circulation is caused by the distribution of high and low pressure cells around the earth. Due to the seasonal heating and cooling, the distribution and strength of these cells may change, caused reversal in the flow of air and severe changes in local weather. The northeast and southwest monsoons observed in the South East China Sea are results of these seasonal changes.

The atmosphere moves in response to pressure gradients and in the absence of other influences, moves from high to low pressure. The Coriolis acceleration, cause by rotation of the earth, deflects the wind to the right in the northern hemisphere and to the left in the southern hemisphere.

The "surface" wind is the wind at a reference height of 10m. Below 10m, wind direction changes very little but wind speed continue to decrease as the surface is approached. Due to atmospheric turbulence, wind speed is never constant, even over time periods as short as a few minutes. Thus the term "wind speed" always referred to the mean speed over some time interval. Within any relatively long time interval, say an hour, it is possible to find a relatively short time interval, say 15 minutes, over which the mean wind speed is greater than the mean over the longer interval. That is, for any particular storm, the maximum 15 minutes mean speed is greater than the maximum one hour mean speed, which in turn is greater than the maximum six hour speed. The "gust" speed is used in the calculation of maximum wind load on structures. For a fixed jacket structure, the wind may represent 10 percent or less of the total design load.

2.4.2 Waves

Waves are constant features of almost any natural body of water and this is particularly true of the ocean. The distribution of wave energy in the ocean is associated with the displacement of the ocean surface, and the wind is the primary source. Wave could basically categorize as follows:

- Simple harmonic waves that generated by wind. Wave generation occurs in the fetch area over which the wind blows more or less uniformly. The waves generated at fetch area are called seas and are very irregular.

- Waves that propagated out of the fetch area are called swell. Swell propagation is dispersive which the energy spreads directionally as it propagates. The wave energy dispersant is concern, which the wave refraction, for example, spreading the wave energy in the direction of wave travels. This is significant when loaded to the offshore structures.

- Irregular waves which real ocean waves are irregular. They might be thought of as a composite of many simple two-dimensional sinusoidal waves having different amplitudes, periods, phase angles and directions of propagations. Real seas are composed of many frequencies, thus the real wave spectrum obtained from a Fourier analysis of a wave record can be represented by a continuous curve.

2.4.3 Currents

Currents are important because they produce hydrodynamic forces on structures and floating systems. The significant of the current are the near-surface current may offset moored or dynamically positioned vessels, while the sub-surface current may impact the running of equipment through the water column and can exert large forces on the marine risers. Currents amplify wave forces through the nonlinear coupling in the drag force term of Morison's equation. Currents could be classified into three categories such that circulation, tidal and storm generated currents.

2.4.4 Load Combinations

Combinations of environmental processes are particularly relevant to offshore structures, for which combinations of wind, wave, current and ice loads often govern the design. Many design codes recognize this and allow for reductions in the maximum individual loads when the act in combinations. However, most codes give little guidance regarding the magnitude of reduction for combinations of environmental loads. The lack of definitive guidance in the codes on the required design criteria leaves the engineer with two choices; either to develop design criteria from site specific environmental data, or to use conservative solutions that ignore the potential reductions due to no simultaneous peaking of individual loads. The development of design criteria of combined environmental loads involves the derivation of the probability distributions of the maximum value of a random process that is defined as a combination of two or more random processes, which is then used to select a design combined load based on a specified probability of exceedances (Nessim. et. al., 1995).

CHAPTER 3
METHODOLOGY

3.1 Introduction

The in-place analysis would be conducted with module named SACS. This is a program well-known in the Oil and Gas industry where it is been used to run the analysis for the offshore structure in various stages such as load out, transportation, installation or upending, and in-place. This program can stimulate the motion of the structure being at the in-place condition. Thus this program been chosen to run the analysis for my research to determine the critical joint which subjected to various loading conditions.

3.2 SACS modeling

To conduct a parametric study, five jackets are modeled. The prime characteristics of the jackets are shown as shown in both table 3.1 and table 3.2. In the joint can input data, the allowable stress increase factor 2.0 is applied. To investigate the trends of jackets, various loading conditions are considered as summarized in table 3.2. Besides, a constant wind, wave, current respectively and constant for all the elements would be applied in the modeling.

Table 3.1 Characteristics of the jackets

Platform	Water Depth (m)	Mud line Elevation (m)	Water weight Density	Wave Height (m)	Wave Period (s)	Maximum Current (m/s)
TKJT-D	49.65	-48.77	1.028	8.78	12.0	2.04
TKJT-C	50.63	-48.77	1.028	8.81	12.0	2.04
BTJT-A	40.54	-40.54	1.020	5.10	6.6	0.82
WLDP-D	27.43	-27.43	1.020	6.80	9.4	1.01
F6DP-A	93.00	-85.65	1.020	5.30	11.6	0.41
F6P-A	93.00	-85.65	1.020	5.30	11.6	0.41

Table 3.2 Loading conditions

Platform	Topside Weight (kN)	Jacket Weight (kN)	Total Weight (kN)
TKJT-D	301.665	4436.931	4738.596
TKJT-C	714.448	4547.794	5262.242
BTJT-A	1561.416	11202.484	12763.900
WLDP-D	2302.380	13269.968	15572.348
F6DP-A	14733.184	56453.113	71186.297
F6P-A	8688.798	50381.51	59070.308

3.3 SACS analysis result

The result would be listed in the output listing files which list out the result for in-place and the joint can analysis. From the result, critical joint conditions as the unity check, acting stresses, and punching shear allowable stress for both models with and without topside would be studied. Unity check, critical joint depth, water depth and the weights of the model would be the consideration for the presentation of the parametric study.

3.4 Parametric study

From the results of the analysis, trends of the critical joints in terms of critical joint depth, water depth, total weight of the model would be presented in the graphical form.

CHAPTER 4
HAZARD ANALYSIS

4.1 Common Medical Problem

Through out the project, ergonomics is the main issue that need to concern on. Ergonomics is a way to work smarter but not harder by designing of tools, equipment, work stations and task to fit the jobs to the worker. Computer ergonomics is the most concern issue which more than 20 hours needed for a week to work at the computer for the analysis of this project. Following are some of the common medical problem and the ways to avoid it.

4.1.1 Eye Strain

- Position your terminal at right angles to the window if possible; avoid facing directly into bright light (coming at you from behind your computer screen).
- Install an anti-glare screen.
- Adjust the brightness controls on the screen until they are comfortable to your eyes.

4.1.2 Carpal Tunnel Syndrome:

- Adjust your chair or table height to have your elbow angle at 90-100 degrees.
- Position your keyboard so that you don't have to bend your hands uncomfortably upward to reach the keys; place a raised wrist rest on the table in front of the keyboard if necessary.
- Clinch your fists, hold for one second, then stretch your fingers out wide and hold for 5 seconds.

- Organize your workday, if possible, to intersperse other tasks with your computer work so that you're not sitting at the computer for several hours without a break.
- Hold the mouse loosely and click lightly.

4.1.3 Neck and Back Strain:

- Check your posture - sit up straight. Thanks Mom.
- The monitor screen surface should be approximately 18-24 inches away from your torso.
- Preferably chairs should be on wheels, have backrest tilt adjustment, and have arms.
- Be sure you have enough desktop space for work papers and other equipment.

4.1.4 Conjunctivitis (itchy, bloodshot eyes) and Dermatitis:

- Be sure the screen doesn't flicker or wave - this could indicate that service or adjustment is needed.
- Look away from the screen periodically.
- Don't forget to blink - your eyes need the moisture.

4.2 Ergonomic of Workstation

As the time spending on the workstation is extending, the design and the arrangement of the workstation can impact the comfort, health and productivity. Following are the concerns regarding ergonomics of the workstation and the ways to avoid it.

4.2.1 Work Area

The work area should be large enough for accommodation, allow the full range of activities involved in working out with the study.

- Place the items you use most frequently directly in front of you.
- Avoid overcrowding computer work areas.

4.2.2 Desk/Workstation

Standard furniture cannot accommodate everyone's needs. Adjustable furniture may be needed for the workstation that share or use by many peoples.

- The desktop should be organized so that frequently used objects are close to the user to avoid excessive extended reaching.
- The work surface should have a matte finish to minimize glare or reflections.
- The area underneath the desk should always be clean / uncluttered to accommodate the user's legs and allow for stretching.
- A document holder should be used if documents are referred to during keying. The document holder should:
- Be stable and adjustable (height, position, distance, and angle of view).
- Support your document on either side of the monitor.

- Be at the same distance from your eyes as the display screen to avoid frequent changes of focus and you should be able you to look from one to the other without moving your neck or back.

CHAPTER 5
RESULTS & DISCUSSION

5.1 Results

5.1.1 Variant Loading Conditions

Environmental forces are the most significant load that needs to be resisted by the jacket at the in-place conditions. The first consideration of the analysis is to subject the jacket structure to its location environmental forces. Where by the structures of the analysis is mainly structure surrounding Malaysia. Table 5.1 shows the results of the analysis by the SACS analysis software.

Table 5.1: Result summary of in-place analysis when subjected to various loading conditions

Platform	Water Depth	Total Weight	Depth of Critical Joint	Critical Joint Type
WLDP-D	27.43	15572.348	12.192	X
TKJT-D	49.65	4738.596	48.768	K
TKJT-C	50.63	5262.242	48.769	K
F6DP-A	93.00	71186.297	85.15	T
F6PA	93.00	50381.50	85.65	T

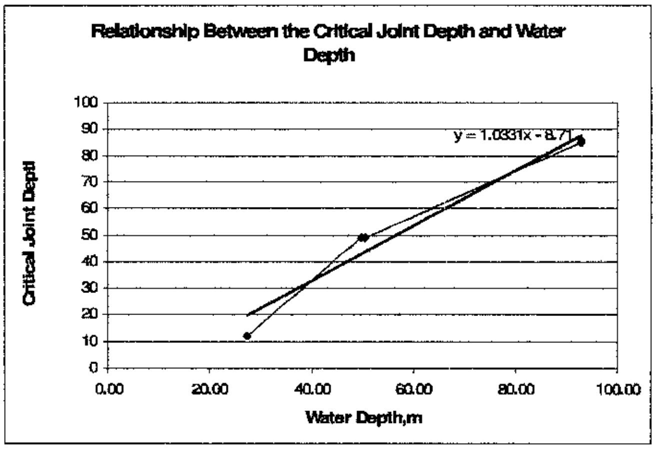


Figure 5.1: Relationship between the Critical Joint Depth and Water Depth When Subjected To Different Loading Conditions.

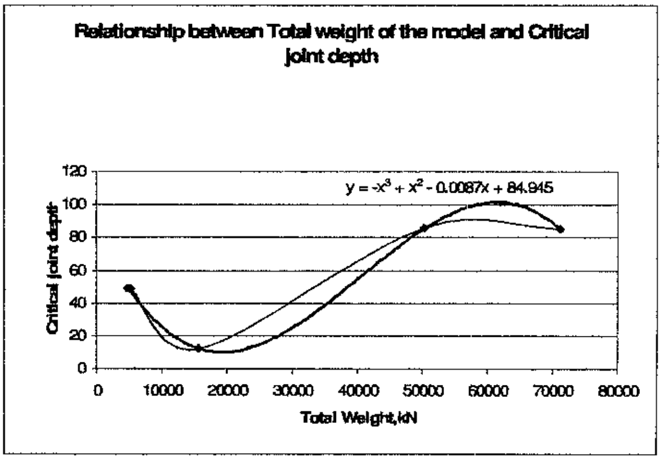


Figure 5.2: Relationship between the Total Weight of the Structure and the Critical Joint Depth.

5.1.2 Constant Wind

Previously, each of the jacket models subjected to the environmental force of the respective locations. To study in different trends of the critical joints, a constant wind load of x-direction and y-direction are 8.659kN and 19.393kN respectively. Table 5.2 shows the results of the analysis when loaded by constant wind load.

Table 5.2: Result summary of in-place analysis when subjected to constant wind load.

Platform	Water Depth	Total Weight	Critical joint Depth	Joint Type
BOV-A	72.21	3471.216	58.131	X
TKJT-D	49.65	4738.596	48.768	K
TKJT-C	50.63	5262.242	48.768	K
F6P-A	93.00	50381.50	85.650	T
F6DP-A	93.00	71186.297	85.150	T

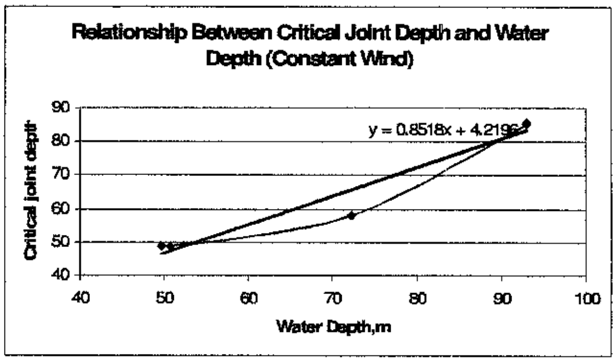


Figure 5.3: Relationship between Critical Joint Depth and Water Depth When Subjected to the Constant Wind Load.

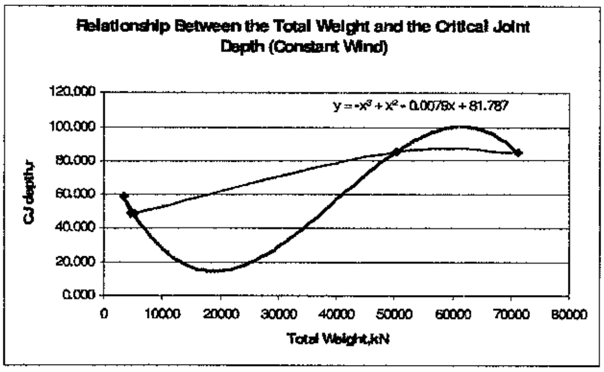


Figure 5.4: Relationship between the Total Weight of the Structure and the Critical joint depth When Subjected to the Constant Wind Load.

5.1.3 Constant Waves and Currents

Another consideration is constant the wave and current subjected to the jacket structures. To run the analysis wave height 11.8m and wave periods 12.6 seconds been considered. Following are the current forces subjected at the different depth fractions.

Table 5.3: Constant Current at Different Depth Fraction.

Depth Fraction	Constant Current (m/s)
0.00	0
0.01	0.52
0.05	0.66
0.10	0.73
0.30	0.85
0.50	0.91
0.75	0.97
1.00	1.01

From the analysis, table 5.4 shows the results of the analysis. Whilst figure 5.5 and 5.6 shows the trends of the critical joint depth related to the water depth and the total weight of the structures.

Table 5.4 : Result summary of in-place analysis when subjected to constant waves and currents.

Platform	Water Depth	Total Weight	Critical joint Depth	Joint Type
TKJT-D	49.65	4738.596	48.768	K
TKJT-C	50.63	5262.242	48.768	T
BOVA	72.21	3471.216	58.131	X
F6DP-A	93.00	71186.297	85.15	T
F6P-A	93.00	50381.50	85.65	T

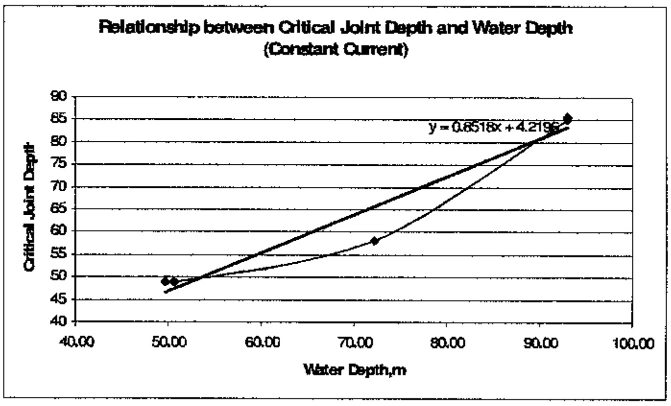


Figure 5.5: Relationship between Critical Joint Depth and Water Depth When Subjected to the Constant Wave and Current Load.

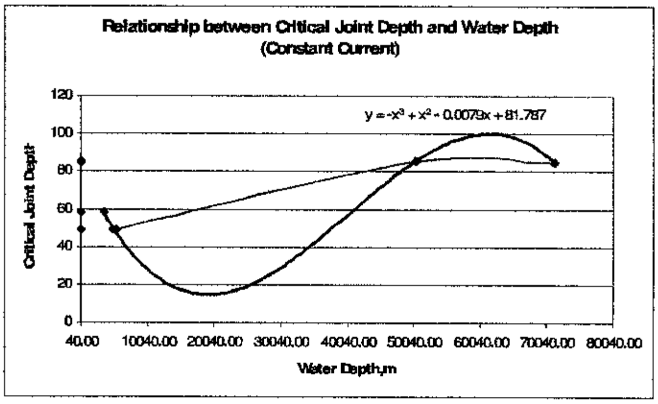


Figure 5.6: Relationship between the Total Weight of the Structure and the Critical joint depth When Subjected to the Constant Wave and Current Load.

5.1.4 Constant Wind, Wave and Current

By fixed the wind, wave and current to the entire models of analysis, the models could be set in the same conditions, which the wind, wave and current data of the previous analysis been considered for this analysis. Table 5.5 shows the results of the analysis when the loading been constant.

Table 5.5: Result summary of in-place analysis subjected to constant wind, waves and currents.

Platform	Water Depth	Total Weight	Critical Joint Depth	Joint Type
TKJT-D	49.65	4738.596	48.768	K
TKJT-C	50.63	5262.242	48.768	K
BOV-A	72.21	3471.216	58.131	X
F6DP-A	93.00	71186.297	85.150	T
F6P-A	93.00	50381.50	85.650	T

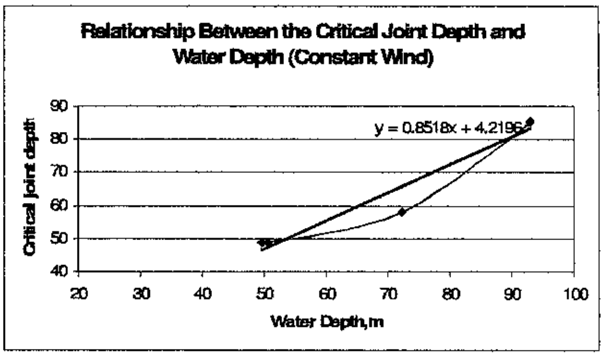


Figure 5.7: Relationship between Critical Joint Depth and Water Depth When Subjected to the Constant Wind, Wave and Current Load.

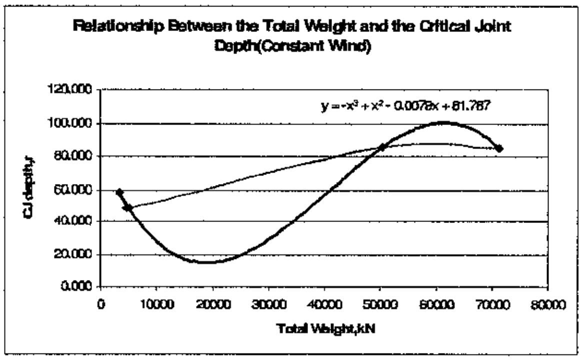


Figure 5.8: Relationship between the Total Weight of the Structure and the Critical joint depth When Subjected to the Constant Wind, Wave and Current Load.

5.2 Discussion

From the graphs that shows the relationship between critical joint depth and water depth, basically a similar graph form been determined. To analyst the graph, water depth is the concern. Where by as the water depth increased, the forces subjected to the jacket will increase. As mentioned the wind forces normally will contribute more or less 10 percent to the environmental forces. The 10 percent subjected to the shallower structure, as compared to the deeper structures, would give a more significant impact to the depth of the critical joints. The depth critical joint moved upwards to shallower water for the shallow water structures. In other hand, the deeper water structures with a greater load subjected would remain the critical joint at the nearly bottom of the structures.

It is most significant shown at the graphs of relationship between the total weight of the structure and the critical joint depth. From the graphs, it could be observed that the critical joint depth is proportional to the total weight of the jackets. Where by the critical joint of the shallow water, which the structures subjected to less force and total weight of the jackets, moved upward towards the water surface as compared to the deeper water jacket.

Thus, besides the total weight of the structures, the environmental forces as well, contribute a significant portion to the trends of the critical joints. As proved in The Overview Of Offshore Engineering – Vol. 1, the design of the platforms are influenced by a great number of factors including space, deck load, number of wells and the structural loading, but all must consider the oceanographically and meteorological environment.

On the other hand, the yield strength of structural steels varies with temperature and loading rate. According to Arrhenius shows that the yield strength increases with reduction if temperature or increase in strain or loading rate. Where as in term of fracture toughness, as a higher loading rate results in a higher yield strength, a lower toughness or an upwards shift obtained at higher loading rates (Zhao & Burdekin, 2004).

Thus the results of the analysis proven that the greater the loading rate would resultant higher yield strength.

5.3 Joint type of critical joints

Table 5.6: Results Summary of Joint Type with Different Loading Conditions

Platform	Various load	Constant Current & Wave	Constant Wind	Constant Load
WLDP-D	X	X	X	X
TKJT-D	K	K	K	K
TKJT-C	K	T	K	K
F6DP-A	T	T	T	T
F6PA	T	T	T	T

Besides the depth of critical joint, another consideration is the type of joint for the critical joints. According to API, HSE, ISO and NORSOK, which similarly defined that classification of the joint, should be based on a combination of geometry and axial load path within each plane on a conservative basis. Furthermore, the influence of the can in resisting overall bending and preventing ovalisation is more significant for T and X-joint whereas loads would transfer in the gap region for the K-joint. Thus it is necessary to identify the classification of the joint for further analysis (HSE, 2002). According to API, it has long recognized that joint classification should be based on load pattern as well as geometry. Classification is relevant to both fatigue and strength considerations.

After the analysis had been carried out for different loading conditions, it could be defined that the most of the critical joints is type T-joint. As observed, 45 percent of the critical joint for the models consist of T-joints. In a T joint, the axial force acting in the brace is reacted by bending in the chord. Thus it could be explained that the critical joints were mainly influenced by the resistance to the overall bending and the prevention of ovalisation of the joint. Besides, K-joint contributed 35 percent for the critical joints of the jacket structures, which the forces been balanced within the braces of the joint. Load path within a joint a very different, thus it is necessary to determine the joint geometry trend.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

From this study, the following conclusions are made for the trends of critical joints for the in-place condition.

- For the in-place condition, the depth of the critical joints affected by the environmental load and the total weight of the models.

- The trend of the critical joints when subjected to different load conditions been found.

- Relationship of the critical joint depth and water depth as follow:
  - Variant loading condition
    - $D_{water} = 1.0331 D_{critical\ joint} - 8.71$
  - Constant wind load, constant wave & current, and constant environmental load gives the same relationship:
    - $D_{water} = 0.8518 D_{critical\ joint} - 4.2196$
- Relationship of the critical joint depth and the total weight of the structure as follow:
  - Variant loading condition
    - $D_{water} = -W^3 + W^2 - 0.0087W + 84.945$
  - Constant wind load, constant wave & current, and constant environmental load gives the same relationship:
    - $D_{water} = -W^3 + W^2 - 0.0079W + 81.787$

- The results of this critical joint analysis can be very useful for the checking of the design of jacket structure especially for the inexperience designer.

6.2 Recommendations

As the analysis been carried out, it has been found some constraint and some recommendations to improve the research work. Following are some of the recommendations to improvise the project.

6.2.1 Models

Model is the main source of this analysis. The problem of the current work is lack of models for analysis. As we know that, the more results analyzed, the more accurate the reading will be. Only 5 models been used for the present work. In additions, the range of the water depth, loading and other properties were limited. Thus the graphs plotted lack of accuracy. It is recommended that more models should be used to work out with a more accurate reading. By having models with various loading conditions, water depth, environmental loads and other aspect, more accurate and more detail results could be determined.

Besides, models of the present work are focused around Malaysia. It is recommended that models around the world shall be used for the analysis, if possible. This is because by using models from various fields, the trend of the critical joint could be seen more clearly and more detailed results could be determined.

6.2.2 Results and analysis

As mentioned, due to lack of models, the analysis is limited. The analysis could be carried out for more conditions besides the locations of critical depth, classification of joints and loading conditions.

It was recommended to consider the models from various fields. By considering the various locations, data comparisons could be worked beyond the zone or region around the world. Comparison could be carried out such as comparing the data from Gulf of Mexico to the data from Persian Gulf.

The present work was focused on the in-place condition of the offshore steel jacket structure. It is recommend that the analysis could be carried out for the other stages such as load out, lifting, upending and even during operations conditions. The analysis could be carried out along the stages, as the design and checking had been carried out for the stages, the recommended trend of the critical joints could be referred.

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APPENDICES

*** JOINT CAN INPUT ECHO ***

```
LINE         1         2         3         4         5         6         7         8
     12345678901234567890123456789012345678901234567890123456789012345678901234567890

        F6P-A PLATFORM TOPSIDE INPLACE ANALYSIS (TOTAL SUBSIDENCE)
     *************************************************************************
     * COMPANY: AKER KVAERNER S.E.A. SDN BHD              DATE: JAN 2007     *
     * PROJECT: F6 FACILITIES REJUVENATION                                   *
     * CLIENT :  SARAWAK SHELL BERHAD                                        *
     *-----------------------------------------------------------------------*
     * CHANGES MADE TO THE MODEL:                                            *
     * 01) UPDATE SUBSTRUCTRE AND TOPSIDE MODEL AS TO BUILT DRAWING          *
     * 02) REVISE MEMBER LENGTH & FACTOR TO API 2A-LRFD                      *
     * 03) INCLUDE CURRENT SUBSIDENCE OF 7.35M                               *
     * 04) UPDATE NEW BOATLANDING MODEL AND ELEVATION (LOCATION)             *
     * 05) UPDATE MARINE GROWTH PROFILE                                      *
     * 06) UPDATE NEW PSI SACS INPUT FILE (REPORT: 587261/W0318, OCT 1996)   *
     * 07) UPDATE EXISTING EQUIPMENT LOAD AND INCLUDE NEW EQUIPMENT          *
     * 08) NEW DECK EXTENSIONS AND ACCESS PLATFORMS ARE MODELLED             *
     * 09) REVISE LIVELOADS: MAIN=10KPA, CELLAR=7.5KPA FOR TOPSIDE DESIGN    *
     * 10) REVISE LIVELOADS: 5KPA FOR UNOCCUPIED AREA FOR SUBSTUCTURE DESIGN *
     * 11) METAOCEAN DATA USED IS MRD 3.1 REV.1, MRD 5.1 REV.0               *
     * 12) UPDATE INERTIA WAVE LOADS                                         *
     *                                                                       *
     *************************************************************************
     JCNOPT API MN        7.5100.00  TC  NOD 0.10       FLUC0.95PT           1.75

     UMOD  35.0  32.7
     AMOD  CS01   2.OM02   2.OM03   2.OM04   2.OP01   2.OP02   2.OP03   2.
     AMOD  OP04   2.OP05   2.OP06   2.OP07   2.OP08   2.SE01   2.SE02   2.
     AMOD  SE03   2.SE04   2.SE05   2.SE06   2.SE07   2.SE08   2.SX01   2.
     AMOD  SX02   2.SX03   2.SX04   2.SX05   2.SX06   2.SX07   2.SX08   2.
     RELIEF
     END
```

* * J O I N T C A N O P T I O N S * * VERSION 6.0.0.1

*** JOINT CHECK PROGRAM OPTIONS ***

(BASED ON 2000 API CODE)

OUTPUT FOR ONLY UNITY CHECKS GREATER THAN 0.950 IN JOINT ORDER

FULL OUTPUT SELECTED (UNITY CHECK ORDER)

MINIMUM GAP ALLOWED = 7.50 CM.

MAXIMUM GAP ALLOWED = 100.00 CM.

NO REDESIGN SELECTED

API RP2A 21ST EDITION

FORMULAS 4.3.1-3A AND 4.3.1-3B USED FOR PUNCHING SHEAR UNITY CHECKS

SPECIAL UNITY CHECKS -
100 - SUM OF BENDING UNITY CHECKS IS GREATER THAN 1
200 - EXCESSIVE CHORD STRESS RESULTED IN A NEGATIVE ALLOWABLE

FORMULA 4.1-1 USED FOR MEMBER STRENGTH JOINT ANALYSIS

***** COORDINATE SYSTEM *****

THE LOCAL COORDINATE FOR BRACES IS DEFINED BY
LOCAL X - ALONG AXIS OF MEMBER
POSITIVE FROM JOINT ONE TO JOINT TWO
LOCAL Y - IN PLANE OF BRACE AND CHORD
POSITIVE FROM CHORD TO BRACE
LOCAL Z - DETERMINED BY RIGHT HAND RULE

***** JOINT CAN LOAD CASE REPORT *****

LOAD NO.	LOAD CASE	TYPE	PRINT OPTION	AMOD FACTOR	LC	FACTOR	LC	FACTOR	LC	FACTOR	LC	FACTOR	LC	FACTOR	LC	FACTOR
1	CS01	BASIC	YES	2.000												
2	OM02	BASIC	YES	2.000												
3	OM03	BASIC	YES	2.000												
4	OM04	BASIC	YES	2.000												
5	OP01	BASIC	YES	2.000												
6	OP02	BASIC	YES	2.000												
7	OP03	BASIC	YES	2.000												
8	OP04	BASIC	YES	2.000												
9	OP05	BASIC	YES	2.000												
10	OP06	BASIC	YES	2.000												
11	OP07	BASIC	YES	2.000												
12	OP08	BASIC	YES	2.000												
13	SE01	BASIC	YES	2.000												
14	SE02	BASIC	YES	2.000												
15	SE03	BASIC	YES	2.000												
16	SE04	BASIC	YES	2.000												
17	SE05	BASIC	YES	2.000												
18	SE06	BASIC	YES	2.000												
19	SE07	BASIC	YES	2.000												
20	SE08	BASIC	YES	2.000												
21	SX01	BASIC	YES	2.000												
22	SX02	BASIC	YES	2.000												

***** JOINT CAN LOAD CASE REPORT *****

LOAD NO.	LOAD CASE	TYPE	PRINT OPTION	AMOD FACTOR	LC	FACTOR	LC	FACTOR	LC	FACTOR	LC	FACTOR	LC	FACTOR	LC	FACTOR
23	SX03	BASIC	YES	2.000												
24	SX04	BASIC	YES	2.000												
25	SX05	BASIC	YES	2.000												
26	SX06	BASIC	YES	2.000												
27	SX07	BASIC	YES	2.000												
28	SX08	BASIC	YES	2.000												

* * J O I N T C A N D E T A I L R E P O R T * *
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	FA N/MM2	BRACE OPB N/MM2	* IPB N/MM2	* *** PUNCHING SHEAR ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
1530	2030	1630	149.86	3.810	248.0	T		76.20	2.540	82.91	CS01	3.74	25.60	4.18	5.03	62.76	112.97	198.40	0.436
						T					OM02	3.55	21.84	2.59	8.01	66.10	112.97	198.40	0.360
						T					OM03	3.18	32.97	4.35	8.07	64.82	112.97	198.40	0.544
						T					OM04	3.06	44.57	6.41	7.70	63.24	112.97	198.40	0.749
						T					OP01	5.48	19.69	3.20	6.66	62.76	112.96	198.40	0.342
						T					OP02	3.96	21.95	2.67	8.09	66.28	112.96	198.40	0.361
						T					OP03	3.54	33.07	4.43	8.15	64.94	112.97	198.40	0.545
						T					OP04	3.38	44.68	6.49	7.78	63.33	112.97	198.40	0.750
						T					OP05	4.39	48.11	7.98	6.35	62.76	112.96	198.40	0.816
						T					OP06	6.00	45.62	8.43	4.94	62.76	112.95	198.40	0.777
						T					OP07	6.52	34.46	6.43	5.12	62.75	112.95	198.40	0.589
						T					OP08	6.75	22.97	4.53	5.57	62.75	112.95	198.40	0.397
						T					SE01	5.77	0.83	1.73	5.77	64.01	112.96	198.40	0.034
						K	7.50				SE02	2.72	8.03	0.39	8.18	91.27	112.97	198.40	0.114
						T					SE03	2.45	26.98	1.43	9.77	72.48	112.97	198.40	0.405
						T					SE04	2.41	46.92	6.94	7.77	66.11	112.97	198.40	0.756
						T					SE05	3.25	55.47	10.95	5.24	62.77	112.97	198.40	0.948
						T					SE06	6.22	48.34	9.09	2.90	62.75	112.95	198.40	0.822
						T					SE07	7.41	29.18	7.72	1.80	62.75	112.94	198.40	0.509
						T					SE08	7.50	9.65	2.26	4.18	62.75	112.94	198.40	0.172
						T					SX01	4.80	-4.88	2.68	4.77	62.76	112.96	198.40	0.099
						K	7.50				SX02	1.96	2.33	0.55	7.19	100.63	112.97	198.40	0.046
						T					SX03	2.17	20.51	0.45	8.78	76.40	112.97	198.40	0.297
						T					SX04	2.17	39.68	5.93	6.80	67.24	112.97	198.40	0.630
						T					SX05	2.47	48.22	9.93	4.26	62.77	112.97	198.40	0.826
						T					SX06	5.20	41.34	8.07	1.91	62.76	112.96	198.40	0.705
						T					SX07	6.38	22.69	6.72	0.80	62.75	112.95	198.40	0.400
						T					SX08	6.46	3.92	1.29	3.17	62.75	112.95	198.40	0.075

** J O I N T C A N D E T A I L R E P O R T **
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	BRACE FA N/MM2	BRACE OPB N/MM2	IPB N/MM2	* *** PUNCHING SHEAR * ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
1900	2400	1800	149.86	3.810	248.0	T		76.20	2.540	82.91	CS01	4.40	25.06	3.97	4.78	62.76	112.96	198.40	0.426
						T					OM02	6.25	45.03	6.99	4.21	62.75	112.95	198.40	0.759
						T					OM03	6.73	33.82	4.91	4.39	62.75	112.95	198.40	0.570
						T					OM04	6.90	22.18	2.89	4.77	62.75	112.95	198.40	0.376
						T					OP01	5.27	47.52	7.82	6.03	62.76	112.96	198.40	0.805
						T					OP02	6.38	44.98	7.57	4.47	62.75	112.95	198.40	0.762
						T					OP03	6.86	33.77	5.49	4.65	62.75	112.95	198.40	0.573
						T					OP04	7.04	22.13	3.47	5.03	62.75	112.95	198.40	0.378
						T					OP05	6.36	18.89	2.73	6.33	62.75	112.95	198.40	0.327
						T					OP06	5.29	21.68	2.95	7.93	64.63	112.96	198.40	0.366
						T					OP07	4.84	32.91	4.79	7.97	63.76	112.96	198.40	0.553
						T					OP08	4.71	44.53	6.94	7.65	62.76	112.96	198.40	0.756
						T					SE01	3.86	55.04	11.41	4.86	62.76	112.97	198.40	0.943
						T					SE02	6.20	47.91	8.06	2.47	62.75	112.95	198.40	0.810
						T					SE03	7.44	28.89	6.83	1.50	62.75	112.94	198.40	0.499
						T					SE04	7.46	9.10	1.34	3.75	62.75	112.94	198.40	0.159
						T					SE05	6.62	0.45	2.53	5.63	62.75	112.95	198.40	0.030
						K	7.50				SE06	4.00	7.88	1.24	8.13	90.99	112.96	198.40	0.114
						T					SE07	3.14	26.85	2.09	9.54	71.11	112.97	198.40	0.410
						T					SE08	3.14	46.75	7.56	7.61	65.31	112.97	198.40	0.765
						T					SX01	3.04	48.39	10.43	3.89	62.77	112.97	198.40	0.831
						T					SX02	5.30	41.26	7.16	1.52	62.76	112.96	198.40	0.698
						T					SX03	6.55	23.01	5.96	0.55	62.75	112.95	198.40	0.400
						T					SX04	6.59	3.99	0.55	2.81	62.75	112.95	198.40	0.073
						T					SX05	5.73	-4.66	3.40	4.66	65.79	112.96	198.40	0.095
						K	7.50				SX06	3.10	2.51	0.30	7.14	100.62	112.97	198.40	0.048
						T					SX07	2.38	20.97	1.09	8.55	74.15	112.97	198.40	0.311
						T					SX08	2.37	40.09	6.50	6.62	66.12	112.97	198.40	0.649

** J O I N T C A N D E T A I L R E P O R T **
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	BRACE FA N/MM2	BRACE OPB N/MM2	IPB N/MM2	* *** PUNCHING SHEAR * ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
1500	2000	1600	149.86	3.810	248.0	T		76.20	2.540	82.91	CS01	3.15	24.98	4.17	4.64	62.77	112.97	198.40	0.426
						T					OM02	3.58	44.12	7.52	7.38	65.91	112.97	198.40	0.718
						T					OM03	3.26	32.80	5.61	7.74	69.07	112.97	198.40	0.515
						T					OM04	3.26	21.23	4.15	7.77	74.08	112.97	198.40	0.321
						T					OP01	4.32	47.43	7.76	5.84	62.76	112.96	198.40	0.803
						T					OP02	3.54	44.18	6.90	7.20	64.68	112.97	198.40	0.728
						T					OP03	3.22	32.87	4.99	7.56	67.40	112.97	198.40	0.525
						T					OP04	3.20	21.30	3.53	7.59	71.50	112.97	198.40	0.329
						T					OP05	4.19	18.77	3.61	6.21	64.95	112.96	198.40	0.317
						T					OP06	5.05	22.27	4.26	5.11	62.76	112.96	198.40	0.384
						T					OP07	5.36	33.61	5.94	4.70	62.76	112.96	198.40	0.572
						T					OP08	5.38	45.15	7.65	4.47	62.76	112.96	198.40	0.765
						T					SE01	3.73	55.03	10.69	4.73	62.76	112.97	198.40	0.939
						T					SE02	2.56	46.56	7.09	7.02	66.66	112.97	198.40	0.744
						T					SE03	2.15	27.13	1.83	8.90	74.30	112.97	198.40	0.396
						K	7.50				SE04	1.91	7.66	1.47	7.52	100.63	112.97	198.40	0.102
						K	7.50				SE05	3.95	0.33	1.64	5.40	100.62	112.96	198.40	0.023
						T					SE06	5.14	9.13	1.92	3.86	62.76	112.96	198.40	0.162
						T					SE07	6.03	28.48	7.08	1.76	62.76	112.95	198.40	0.494
						T					SE08	5.81	48.05	7.74	2.66	62.76	112.96	198.40	0.810
						T					SX01	3.06	48.39	9.75	3.86	62.77	112.97	198.40	0.827
						T					SX02	2.05	39.94	6.07	6.12	67.55	112.97	198.40	0.631
						T					SX03	1.91	21.27	0.87	7.99	77.84	112.97	198.40	0.299
						K	7.50				SX04	1.52	2.57	0.50	6.60	100.63	112.97	198.40	0.047
						T					SX05	3.31	-4.77	2.54	4.50	62.77	112.97	198.40	0.096
						T					SX06	4.46	3.76	1.07	2.97	62.76	112.96	198.40	0.071
						T					SX07	5.32	22.60	6.25	0.89	62.76	112.96	198.40	0.395
						T					SX08	5.07	41.40	6.89	1.80	62.76	112.96	198.40	0.699

** J O I N T C A N D E T A I L R E P O R T **
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	BRACE FA N/MM2	BRACE OPB N/MM2	BRACE IPB N/MM2 *	*** PUNCHING SHEAR ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
1930	2430	1830	149.86	3.810	248.0	T		76.20	2.540	82.91	CS01	3.89	25.59	4.64	4.39	62.76	112.97	198.40	0.437
						T					OM02	7.19	22.72	5.55	5.02	62.75	112.95	198.40	0.397
						T					OM03	7.38	33.92	6.90	4.61	62.75	112.94	198.40	0.582
						T					OM04	7.25	45.41	8.23	4.37	62.75	112.95	198.40	0.772
						T					OP01	5.31	19.72	4.50	5.88	62.76	112.96	198.40	0.346
						T					OP02	6.73	22.67	5.47	4.94	62.75	112.95	198.40	0.396
						T					OP03	6.94	33.88	6.82	4.54	62.75	112.95	198.40	0.581
						T					OP04	6.82	45.37	8.14	4.30	62.75	112.95	198.40	0.771
						T					OP05	5.15	48.06	7.95	5.50	62.76	112.96	198.40	0.814
						T					OP06	3.83	44.88	6.79	6.73	62.76	112.97	198.40	0.759
						T					OP07	3.56	33.63	5.24	7.08	64.43	112.97	198.40	0.559
						T					OP08	3.65	22.26	4.21	7.07	66.60	112.97	198.40	0.367
						K	7.50				SE01	5.15	0.92	0.75	5.21	100.61	112.96	198.40	0.026
						T					SE02	7.23	9.35	3.55	3.86	62.75	112.95	198.40	0.172
						T					SE03	7.79	28.61	7.80	1.59	62.75	112.94	198.40	0.500
						T					SE04	7.16	48.18	7.73	2.46	62.75	112.95	198.40	0.812
						T					SE05	4.06	55.30	9.61	4.37	62.76	112.96	198.40	0.937
						T					SE06	2.43	46.94	6.61	6.52	64.69	112.97	198.40	0.768
						T					SE07	2.08	27.47	2.31	8.54	71.76	112.97	198.40	0.413
						K	7.50				SE08	1.95	8.30	2.84	7.08	95.34	112.97	198.40	0.115
						T					SX01	4.25	-4.78	0.28	4.33	62.76	112.96	198.40	0.090
						T					SX02	6.24	3.64	2.51	2.97	62.75	112.95	198.40	0.075
						T					SX03	6.79	22.14	6.71	0.70	62.75	112.95	198.40	0.391
						T					SX04	6.10	40.93	6.60	1.58	62.76	112.95	198.40	0.690
						T					SX05	3.19	48.06	8.49	3.50	62.77	112.97	198.40	0.815
						T					SX06	2.06	39.95	5.51	5.65	65.50	112.97	198.40	0.646
						T					SX07	1.92	21.00	1.24	7.68	75.34	112.97	198.40	0.304
						K	7.50				SX08	1.40	2.60	1.82	6.21	100.63	112.97	198.40	0.048

** J O I N T C A N D E T A I L R E P O R T **
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	BRACE FA N/MM2	BRACE OPB N/MM2	BRACE IPB N/MM2 *	*** PUNCHING SHEAR ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
516	5702	5703	45.12	0.970	248.0	T		45.12	0.970	84.84	CS01	10.88	-1.84	15.79	7.07	46.16	130.17	155.82	0.123
						T					OM02	19.52	-6.69	25.82	1.67	46.07	129.98	155.33	0.273
						T					OM03	45.51	-2.60	17.70	4.69	45.45	128.77	152.22	0.147
						T					OM04	65.02	1.89	0.19	5.60	44.67	127.22	148.24	0.066
						T					OP01	28.03	-9.18	0.12	11.17	45.92	129.69	154.59	0.246
						T					OP02	19.19	-7.54	27.75	1.63	46.07	129.99	155.36	0.301
						T					OP03	44.62	-3.45	19.63	1.39	45.48	128.83	152.37	0.173
						T					OP04	64.05	1.03	2.12	2.29	44.71	127.31	148.47	0.038
						T					OP05	52.34	5.83	44.68	6.71	45.21	128.29	150.99	0.357
						T					OP06	14.71	2.60	71.29	17.89	46.13	130.10	155.64	0.435
						T					OP07	27.38	-1.80	61.37	20.76	45.93	129.72	154.65	0.367
						T					OP08	43.94	-5.89	43.90	20.97	45.50	128.87	152.48	0.369
						T					SE01	57.14	-14.50	19.68	10.89	45.02	127.91	150.02	0.431
						T					SE02	23.18	-13.13	79.70	7.22	46.01	129.87	155.05	0.707
						T					SE03	63.26	-3.78	48.24	9.29	44.75	127.38	148.66	0.335
						T					SE04	112.10	4.05	29.11	12.37	41.63	121.23	132.87	0.263
						T					SE05	76.53	11.22	54.79	5.32	44.07	126.05	145.24	0.542
						T					SE06	19.00	8.46	115.62	26.08	46.08	130.00	155.37	0.904
						T					SE07	48.79	-1.11	81.98	27.04	45.34	128.55	151.65	0.485
						T					SE08	95.33	-8.64	63.89	29.63	42.90	123.73	139.28	0.579
						T					SX01	58.01	-13.80	22.39	8.23	44.98	127.84	149.83	0.424
						T					SX02	21.67	-12.58	82.93	9.35	46.04	129.92	155.17	0.716
						T					SX03	61.89	-3.19	51.35	11.53	44.81	127.50	148.97	0.340
						T					SX04	110.68	4.59	32.44	14.36	41.75	121.46	133.45	0.296
						T					SX05	75.11	11.90	51.99	2.80	44.15	126.20	145.63	0.540
						T					SX06	16.70	9.25	113.19	23.18	46.11	130.06	155.52	0.890
						T					SX07	48.68	-0.26	79.75	23.92	45.34	128.55	151.67	0.448
						T					SX08	95.79	-7.79	61.71	26.44	42.87	123.66	139.12	0.540

** JOINT CAN DETAIL REPORT**
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	BRACE FA N/MM2	BRACE OPB N/MM2	BRACE IPB N/MM2 *	*** PUNCHING SHEAR ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
1725	1622	1656	66.04	1.905	248.0	X		66.04	1.905	67.45	CS01	27.17	25.88	6.41	16.58	62.00	174.78	198.40	0.476
						X					OM02	25.19	29.08	8.30	21.37	62.00	174.78	198.40	0.544
						X					OM03	32.62	36.75	7.96	23.18	62.00	174.78	198.40	0.673
						X					OM04	41.16	43.99	7.64	24.84	62.00	174.78	198.40	0.794
						X					OP01	26.16	25.09	8.67	20.39	62.00	174.78	198.40	0.478
						X					OP02	25.44	28.84	8.43	21.24	62.00	174.78	198.40	0.540
						X					OP03	32.88	36.51	8.10	23.06	62.00	174.78	198.40	0.669
						X					OP04	41.41	43.75	7.78	24.72	62.00	174.78	198.40	0.790
						X					OP05	46.07	43.47	7.90	22.85	62.00	174.78	198.40	0.780
						X					OP06	46.46	39.59	8.21	22.26	62.00	174.78	198.40	0.716
						X					OP07	39.00	31.93	8.50	20.76	62.00	174.78	198.40	0.589
						X					OP08	30.76	24.79	8.76	18.90	62.00	174.78	198.40	0.469
						X					SE01	12.88	10.88	7.76	21.01	62.00	174.78	198.40	0.249
						X					SE02	11.83	19.95	7.35	16.97	62.00	174.78	198.40	0.382
						X					SE03	24.41	33.20	6.67	21.27	62.00	174.78	198.40	0.608
						X					SE04	38.94	45.79	6.24	23.66	62.00	174.78	198.40	0.818
						X					SE05	49.88	45.90	6.31	14.23	62.00	174.78	198.40	0.792
						X					SE06	48.64	36.96	6.92	18.91	62.00	174.78	198.40	0.662
						X					SE07	36.02	23.60	7.46	15.23	62.00	174.78	198.40	0.437
						X					SE08	22.41	11.39	7.75	12.49	62.00	174.78	198.40	0.233
						X					SX01	8.43	4.91	6.50	17.22	61.97	174.73	198.40	0.139
						X					SX02	5.95	13.95	6.11	13.17	62.00	174.78	198.40	0.273
						X					SX03	17.76	26.71	5.45	17.19	62.00	174.78	198.40	0.490
						X					SX04	31.71	38.79	5.05	19.29	62.00	174.78	198.40	0.690
						X					SX05	42.60	38.93	5.10	9.87	62.00	174.78	198.40	0.665
						X					SX06	41.44	30.18	5.69	14.65	62.00	174.78	198.40	0.538
						X					SX07	29.23	17.16	6.21	11.18	62.00	174.78	198.40	0.319
						X					SX08	16.37	5.45	6.47	8.72	62.00	174.78	198.40	0.125

** JOINT CAN DETAIL REPORT**
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	BRACE FA N/MM2	BRACE OPB N/MM2	BRACE IPB N/MM2 *	*** PUNCHING SHEAR ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
1705	1608	1654	66.04	1.905	248.0	X		66.04	1.905	67.45	CS01	26.88	25.23	6.27	15.44	62.00	174.78	198.40	0.462
						X					OM02	39.71	44.63	7.92	23.72	62.00	174.78	198.40	0.802
						X					OM03	31.30	37.65	8.38	22.47	62.00	174.78	198.40	0.686
						X					OM04	23.40	29.80	8.91	20.63	62.00	174.78	198.40	0.555
						X					OP01	45.71	42.83	7.55	21.16	62.00	174.78	198.40	0.764
						X					OP02	40.71	43.67	7.72	23.42	62.00	174.78	198.40	0.785
						X					OP03	32.32	36.69	8.19	22.17	62.00	174.78	198.40	0.669
						X					OP04	24.44	28.83	8.71	20.33	62.00	174.78	198.40	0.538
						X					OP05	25.57	24.18	8.74	19.07	62.00	174.78	198.40	0.459
						X					OP06	30.93	23.48	8.49	17.37	62.00	174.78	198.40	0.443
						X					OP07	39.12	30.47	8.05	18.88	62.00	174.78	198.40	0.559
						X					OP08	46.92	38.32	7.57	20.41	62.00	174.78	198.40	0.689
						X					SE01	49.79	45.24	5.92	11.98	62.00	174.78	198.40	0.774
						X					SE02	38.36	45.68	6.15	22.62	62.00	174.78	198.40	0.813
						X					SE03	24.23	33.68	6.77	20.95	62.00	174.78	198.40	0.615
						X					SE04	10.95	20.45	7.79	16.69	62.00	174.78	198.40	0.391
						X					SE05	12.80	10.25	7.78	21.22	62.00	174.78	198.40	0.239
						X					SE06	23.04	9.98	7.41	11.20	62.00	174.78	198.40	0.206
						X					SE07	36.42	21.96	6.89	13.33	62.00	174.78	198.40	0.404
						X					SE08	49.54	35.31	5.99	17.02	62.00	174.78	198.40	0.628
						X					SX01	42.91	38.77	4.76	8.14	62.00	174.78	198.40	0.657
						X					SX02	31.62	39.09	4.97	18.75	62.00	174.78	198.40	0.693
						X					SX03	18.02	27.63	5.56	17.37	62.00	174.78	198.40	0.505
						X					SX04	5.41	14.87	6.53	13.39	62.00	174.78	198.40	0.289
						X					SX05	8.57	4.78	6.55	17.95	61.97	174.72	198.40	0.140
						X					SX06	17.14	4.42	6.20	7.86	62.00	174.78	198.40	0.105
						X					SX07	29.92	16.10	5.71	9.80	62.00	174.78	198.40	0.297
						X					SX08	42.45	28.95	4.85	13.21	62.00	174.78	198.40	0.513

* * J O I N T C A N D E T A I L R E P O R T * *
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	CHORD FA N/MM2	BRACE OPB N/MM2	BRACE IPB N/MM2 *	* *** PUNCHING SHEAR ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
1725	1756	1822	66.04	1.905	248.0	X		66.04	1.270	67.45	CS01	33.83	24.94	4.61	0.08	62.00	174.78	198.40	0.419
						X					OM02	34.26	27.94	5.48	2.99	62.00	174.78	198.40	0.473
						X					OM03	40.95	35.55	5.85	1.58	62.00	174.78	198.40	0.595
						X					OM04	48.81	42.76	6.22	0.04	62.00	174.78	198.40	0.712
						X					OP01	36.18	23.87	5.50	2.23	62.00	174.78	198.40	0.406
						X					OP02	34.53	27.70	5.65	2.84	62.00	174.78	198.40	0.469
						X					OP03	41.25	35.31	6.01	1.44	62.00	174.78	198.40	0.592
						X					OP04	49.11	42.51	6.38	0.11	62.00	174.78	198.40	0.709
						X					OP05	53.50	42.23	6.52	2.16	62.00	174.78	198.40	0.706
						X					OP06	55.10	38.25	6.37	2.74	62.00	174.78	198.40	0.642
						X					OP07	48.11	30.63	5.95	1.26	62.00	174.78	198.40	0.516
						X					OP08	40.25	23.55	5.58	0.31	62.00	174.78	198.40	0.400
						X					SE01	27.63	9.51	3.96	6.35	61.72	174.23	198.40	0.179
						X					SE02	20.14	19.10	4.64	4.70	61.85	174.49	198.40	0.331
						X					SE03	30.47	32.28	5.36	3.23	62.00	174.78	198.40	0.543
						X					SE04	44.58	44.74	5.87	0.00	62.00	174.78	198.40	0.743
						X					SE05	51.84	45.27	6.45	6.52	62.00	174.78	198.40	0.762
						X					SE06	56.08	35.75	5.73	4.92	62.00	174.78	198.40	0.603
						X					SE07	44.19	22.43	4.85	3.22	62.00	174.78	198.40	0.382
						X					SE08	30.35	10.40	4.34	0.05	62.00	174.78	198.40	0.183
						X					SX01	21.28	3.76	3.08	6.30	61.84	174.45	198.40	0.084
						X					SX02	13.22	13.32	3.78	4.63	61.94	174.65	198.40	0.235
						X					SX03	22.15	26.03	4.48	3.21	62.00	174.78	198.40	0.439
						X					SX04	35.63	37.99	5.00	0.01	62.00	174.78	198.40	0.631
						X					SX05	43.18	38.55	5.55	6.49	62.00	174.78	198.40	0.651
						X					SX06	47.27	29.20	4.82	4.89	62.00	174.78	198.40	0.495
						X					SX07	35.75	16.22	3.94	3.21	62.00	174.78	198.40	0.279
						X					SX08	22.69	4.68	3.43	0.02	61.81	174.41	198.40	0.088

* * J O I N T C A N D E T A I L R E P O R T * *
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE ** O.D. CM	BRACE WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	CHORD FA N/MM2	BRACE OPB N/MM2	BRACE IPB N/MM2 *	* *** PUNCHING SHEAR ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
1705	1754	1808	66.04	1.905	248.0	X		66.04	1.270	67.45	CS01	32.99	24.34	4.52	0.30	62.00	174.78	198.40	0.409
						X					OM02	46.80	43.46	6.39	0.23	62.00	174.78	198.40	0.724
						X					OM03	39.26	36.50	6.17	1.37	62.00	174.78	198.40	0.612
						X					OM04	32.15	28.71	6.00	2.83	62.00	174.78	198.40	0.487
						X					OP01	52.35	41.68	6.24	2.69	62.00	174.78	198.40	0.697
						X					OP02	47.82	42.50	6.24	0.51	62.00	174.78	198.40	0.708
						X					OP03	40.25	35.54	6.02	1.09	62.00	174.78	198.40	0.595
						X					OP04	33.11	27.74	5.85	2.55	62.00	174.78	198.40	0.470
						X					OP05	34.95	23.03	5.61	1.77	62.00	174.78	198.40	0.393
						X					OP06	39.61	22.32	5.50	0.31	62.00	174.78	198.40	0.380
						X					OP07	47.28	29.26	5.72	1.93	62.00	174.78	198.40	0.494
						X					OP08	54.66	37.07	5.95	3.45	62.00	174.78	198.40	0.622
						X					SE01	50.96	44.73	6.04	7.13	62.00	174.78	198.40	0.753
						X					SE02	43.62	44.69	5.50	0.32	62.00	174.78	198.40	0.741
						X					SE03	30.20	32.78	5.18	3.02	62.00	174.78	198.40	0.550
						X					SE04	19.24	19.62	4.90	4.59	61.87	174.51	198.40	0.340
						X					SE05	28.02	8.86	4.08	6.17	61.71	174.21	198.40	0.168
						X					SE06	30.23	9.05	4.35	0.56	62.00	174.78	198.40	0.162
						X					SE07	43.56	20.89	4.69	3.91	62.00	174.78	198.40	0.358
						X					SE08	56.12	34.19	5.13	5.68	62.00	174.78	198.40	0.578
						X					SX01	42.95	38.48	5.16	7.01	62.00	174.78	198.40	0.650
						X					SX02	35.39	38.32	4.59	0.23	62.00	174.78	198.40	0.635
						X					SX03	22.56	26.94	4.28	3.08	62.00	174.78	198.40	0.453
						X					SX04	12.99	14.24	3.99	4.60	61.94	174.66	198.40	0.251
						X					SX05	22.25	3.58	3.19	6.21	61.82	174.42	198.40	0.081
						X					SX06	22.91	3.69	3.47	0.49	62.00	174.78	198.40	0.072
						X					SX07	35.67	15.23	3.81	3.80	62.00	174.78	198.40	0.264
						X					SX08	47.64	28.04	4.26	5.53	62.00	174.78	198.40	0.476

** JOINT CAN DETAIL REPORT **
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE O.D. CM	BRACE ** WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	FA N/MM2	BRACE OPB N/MM2	IPB N/MM2	* *** PUNCHING SHEAR * ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
2006	1500	2500	71.12	1.900	248.0	X		71.12	1.588	77.80	CS01	4.77	9.58	0.01	6.48	57.41	161.85	193.86	0.188
						X					OM02	13.83	31.69	3.05	9.06	57.35	161.73	193.55	0.585
						X					OM03	18.33	30.88	0.93	8.54	57.30	161.63	193.28	0.567
						X					OM04	20.73	27.25	1.02	7.83	57.26	161.56	193.11	0.502
						X					OP01	9.92	15.83	3.38	9.32	57.38	161.80	193.72	0.309
						X					OP02	10.50	27.42	2.95	8.73	57.38	161.79	193.70	0.509
						X					OP03	14.36	26.61	0.84	8.21	57.35	161.72	193.52	0.491
						X					OP04	16.61	22.98	1.12	7.50	57.32	161.67	193.40	0.426
						X					OP05	6.50	10.01	2.78	7.54	57.40	161.84	193.83	0.201
						X					OP06	11.61	-1.68	2.71	7.81	75.38	161.87	193.90	0.050
						X					OP07	17.21	-1.11	1.00	8.41	75.38	161.87	193.90	0.043
						X					OP08	20.07	2.42	1.26	9.32	57.42	161.87	193.90	0.073
						X					SE01	14.81	16.74	11.00	8.82	57.42	161.87	193.90	0.344
						X					SE02	16.82	36.76	4.63	7.92	57.32	161.66	193.38	0.673
						X					SE03	26.73	36.62	2.04	5.36	57.16	161.35	192.59	0.660
						X					SE04	28.16	28.02	1.21	5.67	57.13	161.30	192.44	0.510
						X					SE05	10.80	3.94	10.46	4.85	57.38	161.78	193.69	0.113
						X					SE06	19.20	-16.20	3.88	5.05	75.38	161.87	193.90	0.238
						X					SE07	29.87	-16.27	2.30	8.06	75.38	161.87	193.90	0.244
						X					SE08	32.82	-8.14	1.64	8.14	75.38	161.87	193.90	0.135
						X					SX01	13.51	14.88	11.07	7.47	57.42	161.87	193.90	0.309
						X					SX02	17.10	34.49	4.69	6.55	57.31	161.66	193.36	0.630
						X					SX03	27.04	34.59	2.07	4.03	57.15	161.34	192.56	0.621
						X					SX04	28.16	25.94	1.20	4.37	57.13	161.30	192.44	0.469
						X					SX05	10.97	2.26	10.45	3.57	57.38	161.78	193.68	0.082
						X					SX06	18.16	-17.64	3.86	3.78	75.38	161.87	193.90	0.254
						X					SX07	28.54	-17.64	2.26	6.77	75.38	161.87	193.90	0.258
						X					SX08	31.12	-9.60	1.72	6.82	75.38	161.87	193.90	0.151

** JOINT CAN DETAIL REPORT **
(UNITY CHECK ORDER)

COMMON JOINT	CHORD JOINT	BRACE JOINT	****** CHORD O.D. CM	CHORD WT CM	***** FY N/MM2	JOINT TYPE	GAP CM	*** BRACE O.D. CM	BRACE ** WT CM	CHORD BRACE ANGLE DEG	LOAD CASE	* ACTING STRESSES *CHORD** SRSS N/MM2	FA N/MM2	BRACE OPB N/MM2	IPB N/MM2	* *** PUNCHING SHEAR * ALLOWABLE STRESSES FA N/MM2	OPB N/MM2	IPB N/MM2	*** UNITY CHECK
3036	2530	3530	60.96	1.580	248.0	X		60.96	1.270	83.21	CS01	3.10	-1.57	0.85	0.73	70.63	157.03	188.10	0.026
						X					OM02	18.03	6.80	2.16	0.20	55.59	156.81	187.52	0.131
						X					OM03	20.36	12.01	1.52	0.58	55.56	156.74	187.36	0.223
						X					OM04	17.46	12.42	5.46	0.86	55.60	156.82	187.56	0.246
						X					OP01	6.21	-5.64	4.41	0.04	72.55	157.01	188.05	0.096
						X					OP02	19.44	8.16	1.98	0.11	55.57	156.77	187.42	0.155
						X					OP03	21.75	13.37	1.71	0.67	55.54	156.70	187.25	0.248
						X					OP04	18.75	13.78	5.64	0.95	55.58	156.79	187.47	0.271
						X					OP05	6.80	0.94	7.04	1.47	55.69	157.01	188.04	0.046
						X					OP06	16.24	-12.65	4.37	1.60	72.88	157.04	188.12	0.192
						X					OP07	17.86	-17.44	0.24	0.55	73.00	157.04	188.12	0.241
						X					OP08	14.15	-17.52	2.91	0.01	73.06	157.04	188.12	0.252
						X					SE01	16.14	-10.10	17.49	2.23	73.01	156.85	187.64	0.210
						X					SE02	36.70	20.29	3.68	1.00	55.22	156.07	185.64	0.383
						X					SE03	43.04	31.27	2.30	0.46	55.03	155.71	184.70	0.578
						X					SE04	37.91	32.35	8.83	1.68	55.18	156.01	185.47	0.623
						X					SE05	16.03	6.41	18.38	2.74	55.61	156.85	187.65	0.191
						X					SE06	33.89	-23.52	5.98	1.54	73.07	157.04	188.12	0.347
						X					SE07	39.10	-34.14	0.93	1.30	73.13	157.04	188.12	0.473
						X					SE08	32.81	-34.06	5.67	2.68	73.13	157.04	188.12	0.490
						X					SX01	16.09	-9.50	17.64	2.37	73.01	156.85	187.64	0.202
						X					SX02	36.38	21.05	3.83	1.13	55.23	156.09	185.68	0.397
						X					SX03	42.80	31.97	2.16	0.58	55.04	155.72	184.74	0.590
						X					SX04	37.90	33.10	8.70	1.58	55.18	156.01	185.47	0.636
						X					SX05	15.85	6.98	18.23	2.62	55.62	156.86	187.66	0.200
						X					SX06	34.15	-23.05	5.82	1.41	73.11	157.04	188.12	0.339
						X					SX07	39.59	-33.73	1.09	1.16	73.13	157.04	188.12	0.467
						X					SX08	33.48	-33.64	5.85	2.83	73.13	157.04	188.12	0.486