Parametric Studies in Push-Over Analysis

By

TAN SOCK LAM

Dissertation submitted in partial fulfilment of

the requirement for the

BACHELOR OF ENGINEERING (Hons)

(CIVIL ENGINEERING)

August 2014

Universiti Teknologi PETRONAS

Bandar Seri Iskandar

31750 Tronoh

Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

Parametric Studies in Push-Over Analysis

by

Tan Sock Lam

13842

A project dissertation submitted to the

Civil Engineering Programme

Universiti Teknologi PETRONAS

In partial fulfilment of the requirement for the

BACHELOR OF ENGINEERING (Hons)

(CIVIL)

Approved by,

____

(Dr. Kurian Velluruzhathil John)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

August 2014

CERTIFICATION OF ORGINALITY

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 the original contained herein have not been undertaken or done by unspecified sources or persons.

TAN SOCK LAM

Abstract

API Recommended Practice 2A-WSD is widely used in the industry to design fixed offshore platform. The design parameters in the API standards are used in all fixed offshore platform design. However, the effect of changing these design parameters upon offshore platform still remains unclear. Hence, the objective of this study is to identify the impact of design parameters on the serviceability of the offshore platforms. Besides, a trend regarding the changes of the design parameter is established to ease the further study on this matter. A push-over analysis is carried out on the selected platform based on the changed parameters. The Reserve Strength Ratio is calculated to determine the strength of the selected platform. From the result, it is safe to mention that the lower the grad of the steel used, the lower the strength of the platform. Besides that, the CdCm values are most optimum at 0.65 and 1.60 respectively. However, an increase of 20% of CdCm values shows interesting changes in the strength of the platform. Further study can be carried out regarding this aspect. Moreover, lower the allowable corrosion thickness, the lower the strength of the platform. Last but no least, the changes in the platform weight do not gives a significant change of the selected offshore platform.

ACKNOWLEDGEMENTS

This report is done through the help and support from everyone, including my parent, supervisors, and my friends. Here, please allow me to dedicate my acknowledgement of gratitude towards them:

First and foremost, I would like to thank Dr. Kurian Velluruzhathil John and Ir M. Mubarak bin A. Wahab for their most support and encouragement. Under their advises, I have gained alot of knowledge as an undergraduate student. Besides that, Ir Mubarak always forgives me even when I made mistakes in the work given to me. He always hopes that I can improve myself.

Next, sincere thanks to my parents and my friends who never fail to support me. They will always be by my side whenever I am unhappy or feeling stress. I appreciate their time. Without them, I will not be able to complete the report with full courage.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Background

Over the years, oil and gas play an crucial role in fuelling material as well as lighting purposes. In Malaysia domestic water, there are more than 200 offshore platforms are operated by several operating companies. Throughout this numbers, Petronas Carigali SDN BHD (PCSB) presently operates more than 150 platforms. Under PCSB, Penisular Malaysia Operation (PMO), Sabah Operations (SBO), and Sarawak Operations handle 35. 27, and 103 platforms respectively. Right the way through this numerous, there are roughly 20% platforms are approaching their service life which is 30 years. Besides that, there are approximately 23% platforms are over their in-service life. (Nichols, Goh et al. 2006)

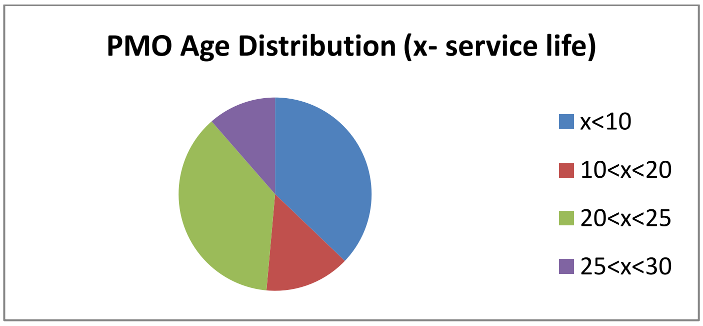


Figure 1.1. 1: The pie chart of age distribution of PMO platform

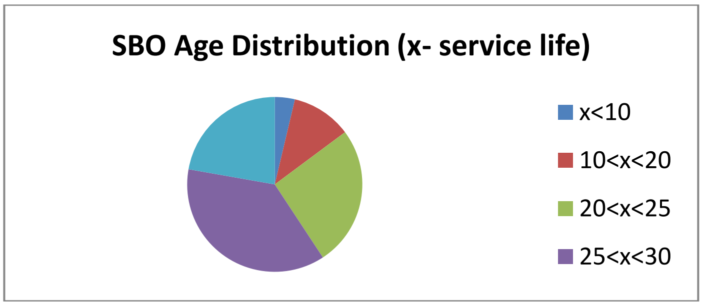


Figure 1.1. 2: The pie chart of age distribution of SBO platform

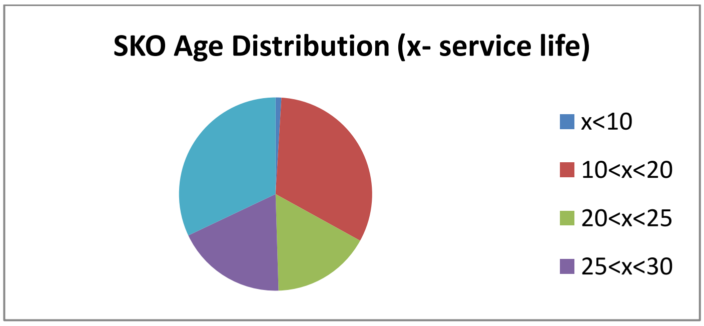


Figure 1.1. 3: The pie chart of age distribution of SKO platform

As the figure shown, there are quite a number platforms are extended beyond their service life as a result of oil and gas discoveries. By Enhanced Oil Recovery (EOR) programme, barrels of oil that can't be reached are exacted. EOR is a recovering method of petroleum that cannot be exacted by injecting fluid and modified liposome to displace petroleum underground. Hence, the displaced petroleum will be forced to the surface.

The design of offshore platforms is mainly based of the America Petroleum Institution (API) document. This document is approved to be used in designing and operation the offshore platforms throughout the world as it is prove be the best practise.

1.2 Problem Statement

Quite a number of design parameters were stated in the America Petroluem Institution (API) document. The document is widely used in the design of fixed platform, mostly jacket platform. However, the effect of changing design parameters in fixed jacket platform is still remain

1.3 Significant of the Project

This project is very important and significant as it will identify and studies the effect of design parameter on the fixed jacket platform. besides that, a trend can be established based of the changes of design parameters of the fixed jacket platform. Hence, through these studies, the impact of design parameters can be study wholly and reduce unnecessary cost of design as well as increase the reliability of the platforms.

1.4 Objectives and Scope of Studies

The objectives of parametric studies in push-over analysis for fixed jacket platform are:

1. To identify the effect of design parameters on the serviceability of fixed jacket platform.
2. To establish the trend of changes based on the parametric studies of fixed jacket platform.

The scopes of this study are:

1. Push-over analysis
   Other static and dynamic analysis will not be examined in this project.

2. The changes parameters in this studies are grade of material, CdCm values, weight of the platform and corrosion thickness.
   Other design parameters will not be included in this study.

Chapter 2

Literature Review

2.1 General

America Petroleum Institution (API) and ISO 19902 (LRFD) document are worldwide used codes for designing and operating offshore platform. Unlike ISO, API code does not account uncertainties of loads and materials. Hence, API code designed uneconomical design. (Nizamani 2013).

In API, all the standard designs, factors to be used, sizes and so on are stated clearly and the design of the structure, especially jacket must base on this API. This is due to jacket are made from tubular steel and it is serve as the main support of the topside. So, it very important to make sure that the jacket is well design with all load case and factors are taking into consideration. (Institution 2007)

Besides that, in the standard also stated clearly that the Probability of failure (P_f) need to be less than 1.0 $^{-4}$ or 10,000 years return environmental condition (manned platforms) and for unmanned platform, the Probability of Failure need to be less than 1.0 $^{-3}$ or 1,000 years return environmental condition. On the other hand, for Strength Reserve Ratio (RSR) the recommended from API is more than 1.32 or 1.5.

2.2 Strength analyses (Push-Over Analysis)

Engineering Dynamics, Inc. has developed the SACS system of software for general civil engineering and offshore structures applications. The structural data such as member dimensions, geometry, material properties as well as environmental conditions are generated by the input generating programs and then reside the common input files. The solution programs run on this input files and generate the common solution file which include joint displacement and element internal forces. The post processing programs then using this information will evaluate the performance of the structure with respect of certain structural code such as API. When any structural not satisfying the code, the structure is needed to be redesigned.

By using SACs software, a series of analysis can be carried out. One of the analyses is Push-over analysis by using Collapse analysis in the software. Push-over analysis is widely used as an analytical tool to evaluate the structural in the inelastic range and identify the weakest points of the structure as well as the failure mechanism. (Kurian, Wahab et al.)

According to Nabila, the structural is subjected to increment loads until a target displacement or failure is achieved. The structure is “pushed” with the increment of lateral environmental load until collapse. The behavior of structural collapse can be characterized using a plot of total based shear against displacement. By definition, the strength capacity of a structure is presented in terms of Reserve Strength Ratio (RSR), which is the ratio of collapse load of structure at failure to the total load of structure at 100-year design condition.(Iskandar 2013)

$$RSR = \frac{BS_{collapse}}{BS_{100-year}}$$

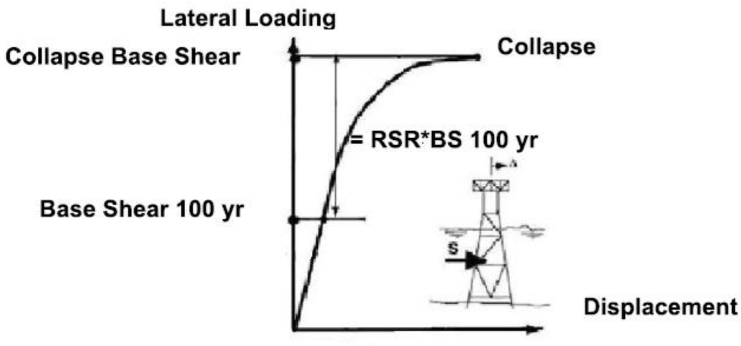


Figure 2.2.1: The RSR calculation method

In RBI assessment for 8 of the PCSB-SKO platforms, the Reserve Strength Ratio (RSR) is determined. The platforms are subjected to a combination of numerous basic loads. These loads are dead loads, functional loads, wave, wind and current loads. The analysis is carried out by subjecting loads in eight different directions. The 100-years wave, wind and current load combination for each direction is increased until the platforms collapse. In the report, Lai stated that the highest probability of failure is equal to 2.3 x 10 -3 (Lai 2007)

In detailed RBI assessment for twelve SKO platforms, the same analysis is carried out. According to Wong, RSR can be defined as the environmental load factor causing global collapse of the structure. Based on the result, the acceptance criterion is that the structural must be able to satisfy the acceptable annual failure probability, P_f = 1.0 $^{-4}$ or 10,000 years return environmental condition for manned platforms and

P_f = 1.0 $^{-3}$ or 1,000 years return environmental condition unmanned platform. Based on the finding, the highest Pf = 1.75 x 10 -4 and the RSR is equal to 2.73. (Wong 2009)

In an addition, in global ultimate strength analysis for SBO platforms, 4 jacket platforms is used. In order to control the platforms risk level over its remaining service life and to initiate cost efficient inspection, the platforms are subjected to Ultimate Strength Analysis-Push-Over method, Extreme Air Gap Analysis and Member Importance Analysis. The result of these analyses will be the input of RSR. The finding show that the highest Pf = 9.94 x 10 -9 and the RSR is 4.449. (Admad 2011)

On the other hand, Asgarian and Lesani proposed a pushover analysis of fixed jacket offshore platforms with the application of “Fiber Element” which is capable of modeling post-buckling behavior of braces. The study is carried out on two functional jacket offshore platforms in the Persian Gulf region. In this study, its showed that the ultimate strength of the platform in the non-linear pile stub case was very close to the base case. (Asgarian and Lesani 2009)

However, in another study, a relatively novel approach is established to estimate different limit states and accurate behavior of jacket platforms against environmental wave loading. This approach called Increment Wave Analysis (IWA). IWA is predicted to substitute to the current push-over analysis. IWA believed to cater the effects of variation in wave height and wave-in-deck loading in the estimating of platforms behavior. (Golafshani, Bagheri et al. 2011)

2.3 Manipulated Design Criteria

The design parameters are manipulated in this study is the grade of material, CdCm values, corrosion thickness as well as the weight of the platform.

2.3.1 Grade of Material

The most commonly used steel for designing an offshore platform are high grade steel which are 355MPa and mild steel. The combination of versatile grade of steel will ensure the strength of the platform as well as catered the economic aspect of design.

The usage of higher strength steels will produce a much lighter, simpler as well as slenderer platform. However, the increasing yield strength of steel will decrease in its fatigue resistance. (jesus, Matos et al. 2012).

Based of the studies carried out by Matos and his team, higher grade S690 steel have a higher resistance to fatigue crack initiation than a lower grade of steel, S355. On the other hands, S690 steel presents a much lower resistance for fatigue crack propagation as compared to S355. Hence, for higher yield strength steels, they should be protected from sharp notches and cuts. (jesus, Matos et al. 2012).

Furthermore, a research is carried out by Lindholm and his team in order to study the impact of strain rate on mild strength steel, St 52-3N. The result of their study shows that the strain rate effect is minor and can be neglected in the design of mild steel. (Langseth, Lindholm et al.). The result is significant and helps in ease the design of offshore platform.

2.3.2 Hydrodynamic forces coefficient (CdCm value)

According to Petronas Technical Standards, PTS 34. 19. 10. 30, the recommended value for Cd in clean member is 0.65 while Cm is 1.60 and for fouled member, the Cd is 1.05 while Cm is 1.20. ((PETRONAS) 2012)

2.3.3 Corrosion Thickness

According of Petronas Technical Standards, PTS 34.19.10.30, the minimum thickness of corrosion need to be at least 12mm ((PETRONAS) 2012)

Allowance thickness of corrosion need to be added in a design of steel that involving harsh condition such as offshore platform. This is because the needs to cater for structural failure when painting, catholic protection as well as galvanizing lose their function. (Melchers 2005)

On the other hands, based on a study carried out by Northeastern University, Shenyang of China, the corrosion characteristic of offshore platform steel can be divided into two stages. The first stages involved accumulation of corrosion products, followed by the second stage in which uniform and compact layer started to form and covered the steel substrate out of corrosion intermediate. (Yan-lei, Jun et al. 2013).

Hence, according to Zhou and his team, the formation of these compact inner rust layer and profoundly of Cr are extremely important to increase the resistance of corrosion, especially in offshore platform. (Yan-lei, Jun et al. 2013).

2.3.4 Increased in Platform Weight

The weight of offshore platform will affect its strength and serviceability. Based of API working stressed design standard, the heavier the weight of the jacket, the more load on the bottom soil. Hence, increase the surface failure probability of the soil by reduced in bearing capacity. (Institution 2007)

Chapter 3

Methodology

<u>3.1 Research Methodology</u>

In order to determine the acceptance criteria of offshore platform in Malaysia water, a few offshore platforms in Malaysia water is used to carried out analysis. These platforms are more than 30 years and still in operation.

There are some parameters in the design criteria are changed in order to study the influence of these parameters toward the strength of the targeted platform.

3.1.1 Grade of Material

The grades of the material, mostly steels are changed from high strength steel, 355MPa to mild strength steel, 275MPa. The platform then undergoes collapse analysis in order to determine its strength with the changes of the grade of the steel. The picture below shown an example of jacket leg group is changed to 275MPa.

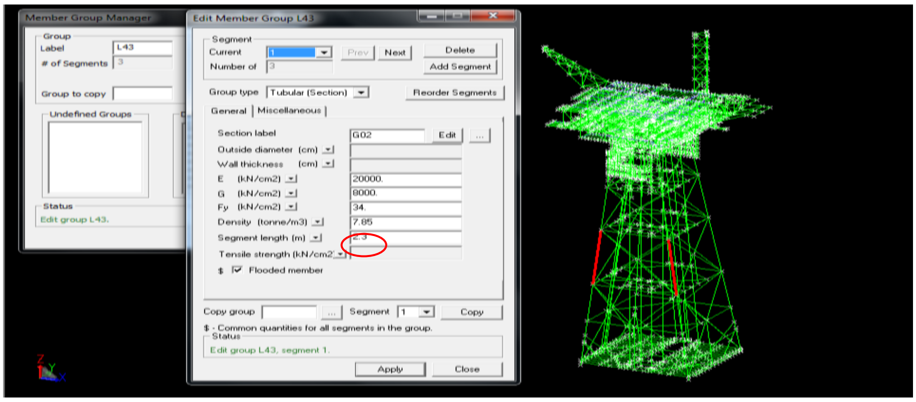


Figure 3.1.1.1 The example of original grade of steel (340Mpa)

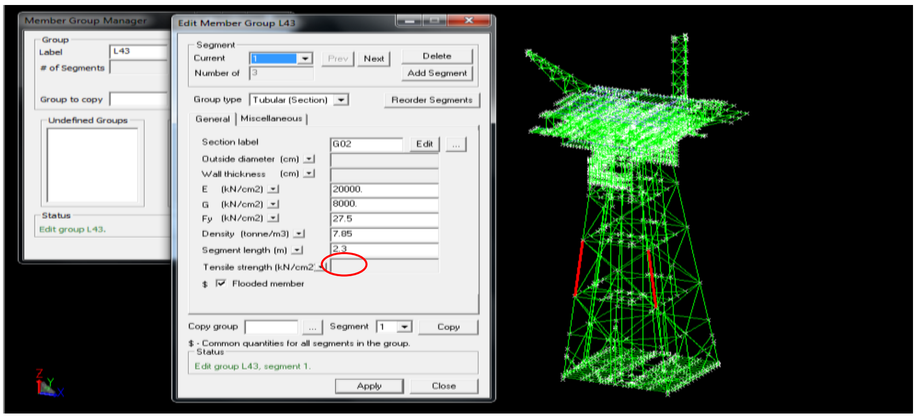


Figure 3.1.1.2 The example of changed grade of steel (275Mpa)

3.1.2 Hydrodynamic Forces Coefficient (CdCm values)

The CdCm values in the design are change by percentage of -10%, -20%, -30%, +10%, +20% as well as +30% based on the values recommended by PTS. The changed platform is then undergoes collapse analysis in order to determine the impact of CdCm value in the design.

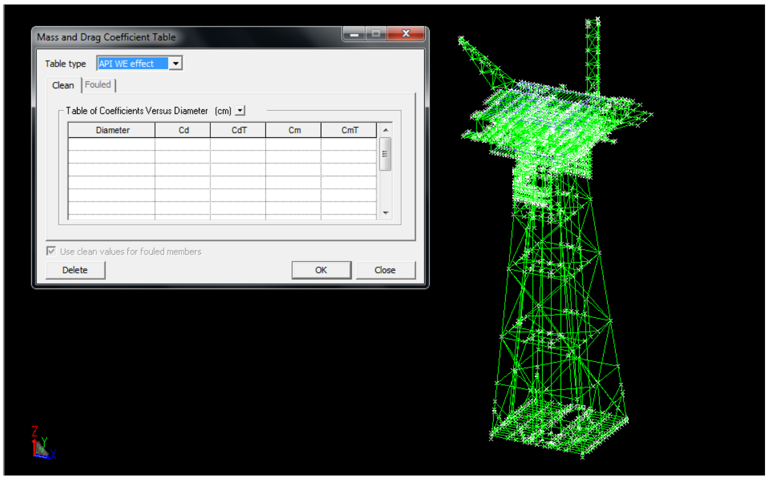


Figure 3.1.2.1 The example of original cdcm values for clean members

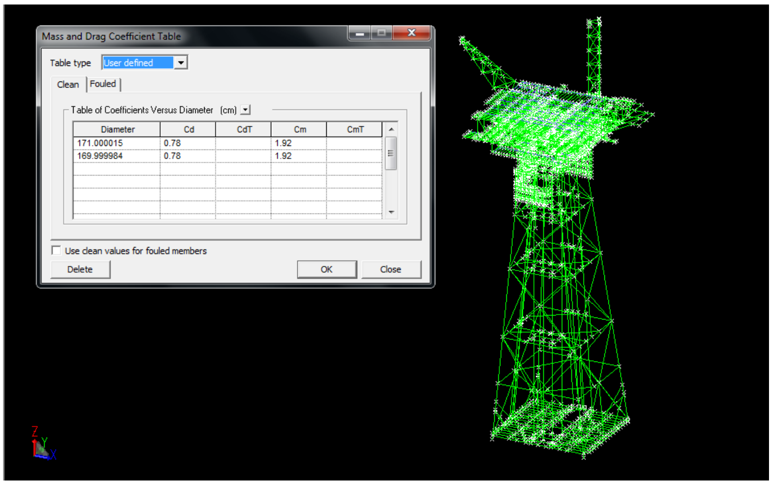


Figure 3.1.2.2 The example of increased cdcm values by 20% for clean members

3.1.3 Corrosion Thickness

According to PTS, the minimum thickness in design criteria needs to be 12mm. The corrosion thickness in the design is manipulated by reducing the recommended thickness from 12mm to 9mm, 6mm and 3mm. The changed platform is then undergoes collapse analysis to study the impact of corrosion thickness toward the design.

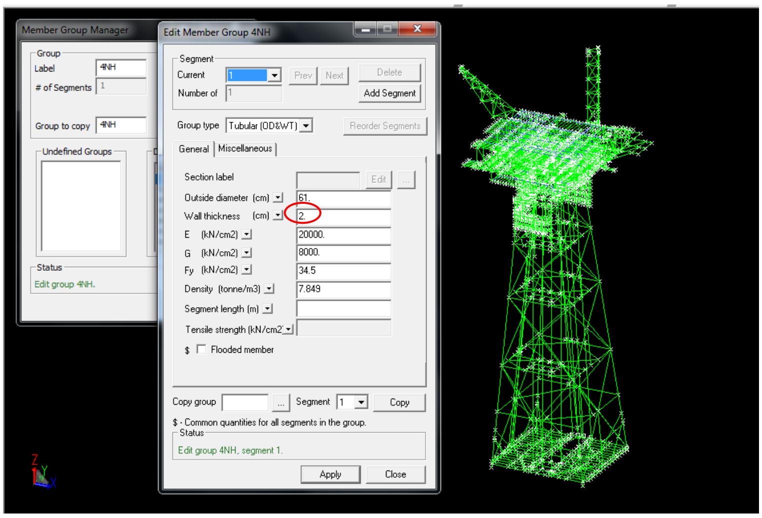


Figure 3.1.3.1 The example of original corrosion thickness

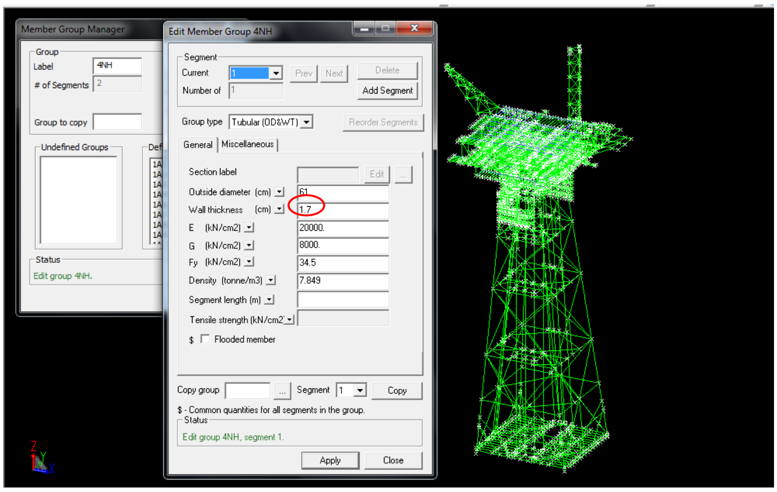


Figure 3.1.3.2 The example of reduced by 3mm of corrosion thickness

3.1.4 Increase in Platform Weight

The weight of the fixed jacket platform can be increase by flood the jacket legs by sea water. All four (4) jacket legs were entered water still the designed water height. The changed platform then is undergoes collapse analysis to determine the changes of weight toward the design.

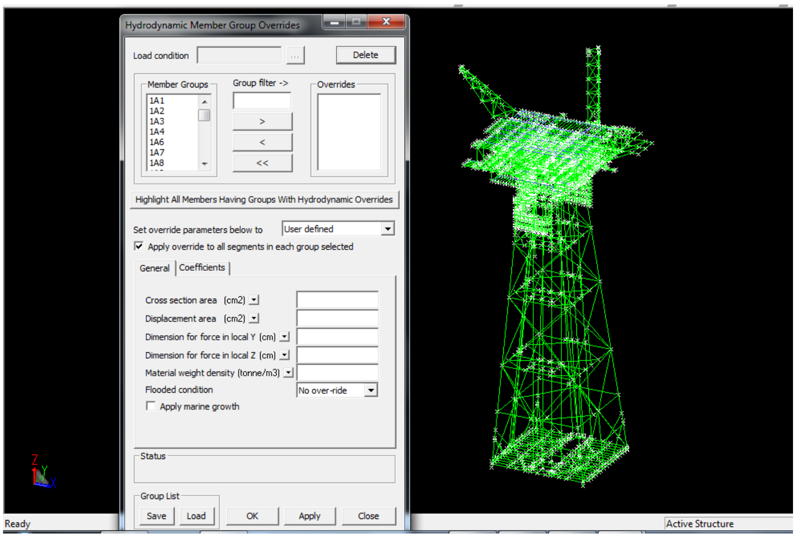


Figure 3.1.4.1 The example of jacket legs without members over-ride

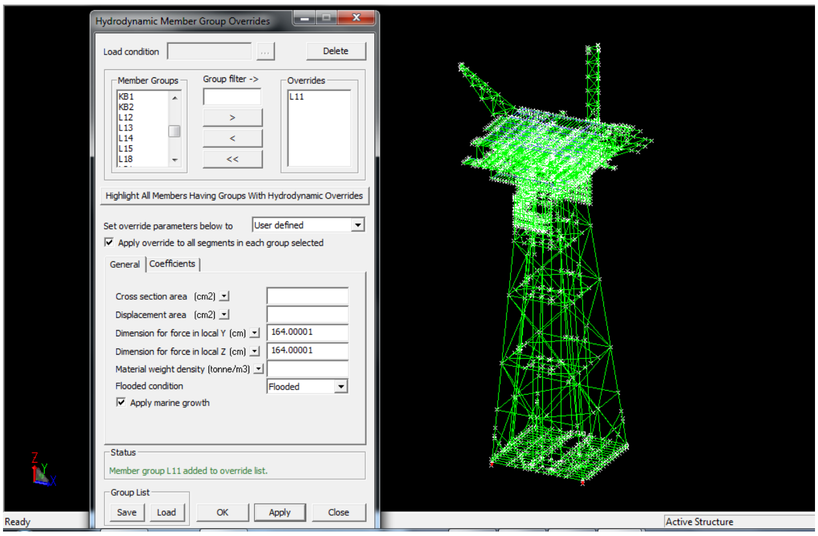
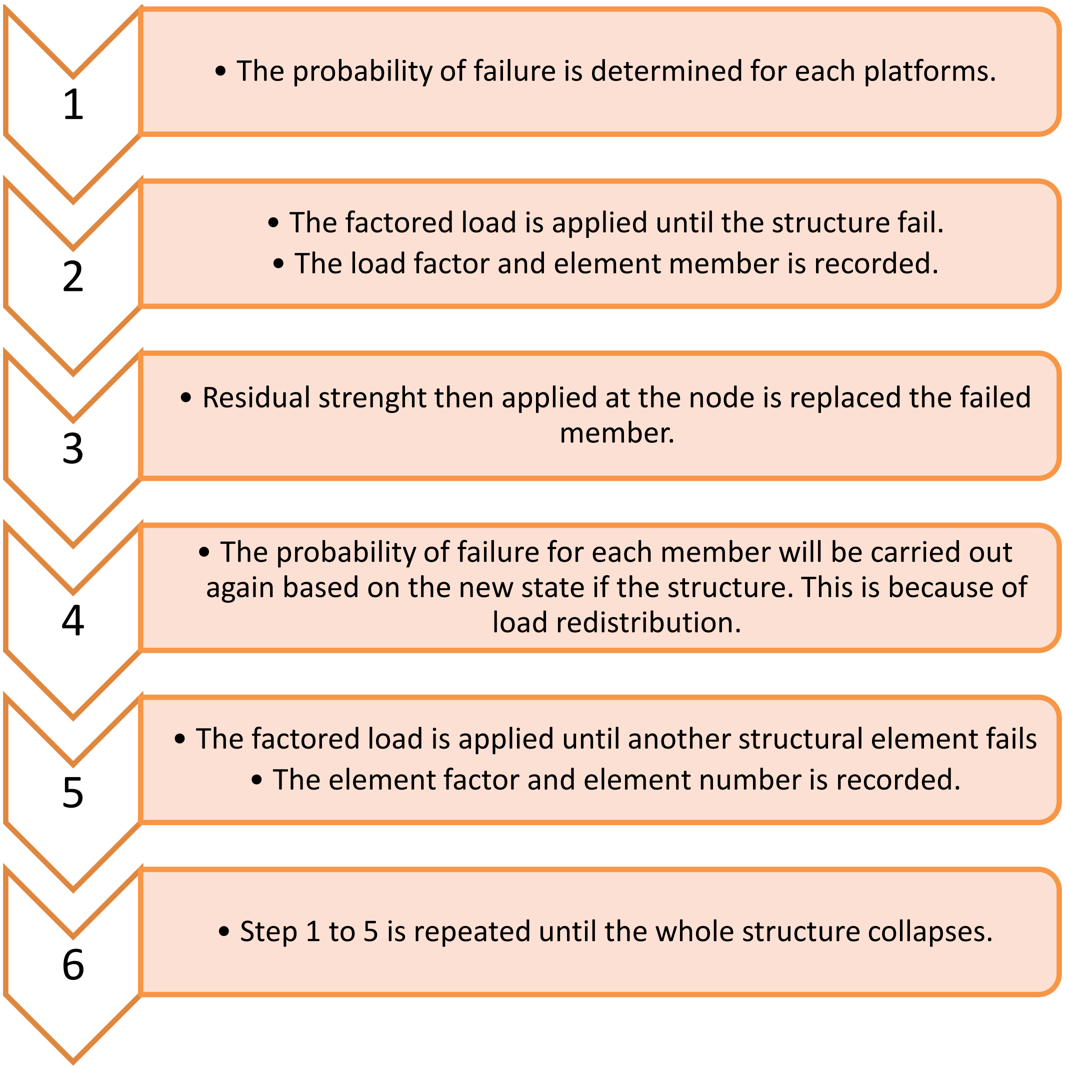


Figure 3.1.4.2 The example of jacket legs members over-ride

3.2 Pushover Analysis

In order to find out the failure mode, pushover analysis is carried out. The diagram below has shown the step in this analysis.



3.3 Project Milestone

Week 1 - 2
- Data gathering process.
- Narrow down the job scopes.

Week 3 - 5
- Running SACs analysis with the changing parameter

Week 6 - 7
- Interprete data obtained from the analysis.
- Prepare progress report.

Week 8 - 12
- Carried out further study on the parameter that affecting jacket behavoir.

week 13 - 14
- The report is generated.
- Report and result is presented.

3.4 Gantt Chart

	Weeks													
Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Data gathering														
Analysis														
Data interpretation														
Analysis and Data interpretation														
Report and presentation														
UTP Requirement														
Submission of progress report														
Pre- Sedax														
Submission of draft reports														
Submission of final reports														

Chapter 4

Result and Discussion

4.1 Collapse Analysis

The diagram below shows Kumang Cluster Development Project (F9JT-A) platform. It is a wellhead drilling platform which located at 200km from Malaysia LNG (MLNG) plant offshore of Bintulu, Sarawak. This platform was installed at the water depth of 60m to 100m at year 2009.

Figure 4.1.1: The 3D view of platform

A collapse analysis is carried out to study the Reserve Strength Ratio (RSR) of this platform. the input parameter used in this analysis based on available design report include platform age, water depth, air gap and wave height. For the collapse input file, the platform is subjected to three load cases, which are dead load (DL), live load (LL) and environmental loads (ST). The DL will be fixed in all direction while DL and ST will be subjected in eight (8) different directions. The environmental load will kept increased by 10% until the platform experience a total failure.

The diagram below shows the result of collapse analysis on the platform. The different colors on the members denote that some of the members have different plasticity. The members with green color do not experience plasticity.

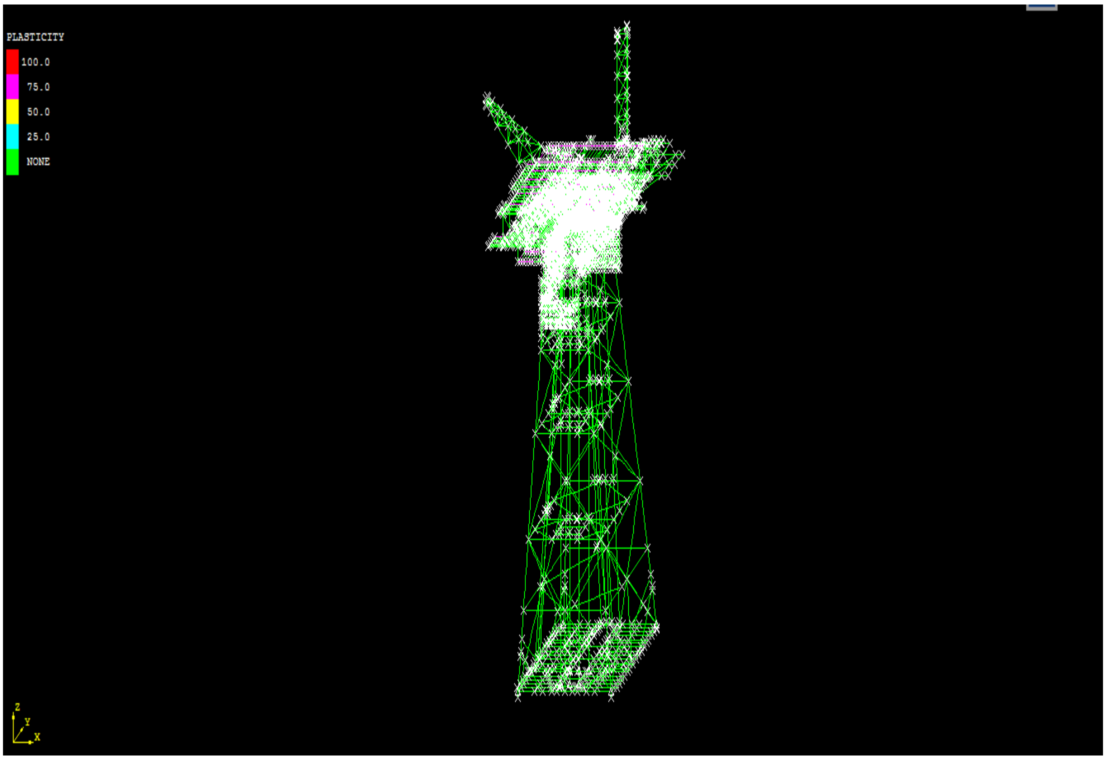


Figure 4.1.2: The collapse analysis result

From the result obtained, Reserve Strength Ratio (RSR) graphs are plotted for each direction. The RSR can be calculated by using:

$$RSR = \frac{BS\ collapse}{Bs\ 100\text{-}year}$$

Equation 4.1 : RSR equation

The collapse base shear and base shear for 100 years return period are determined on the graph.

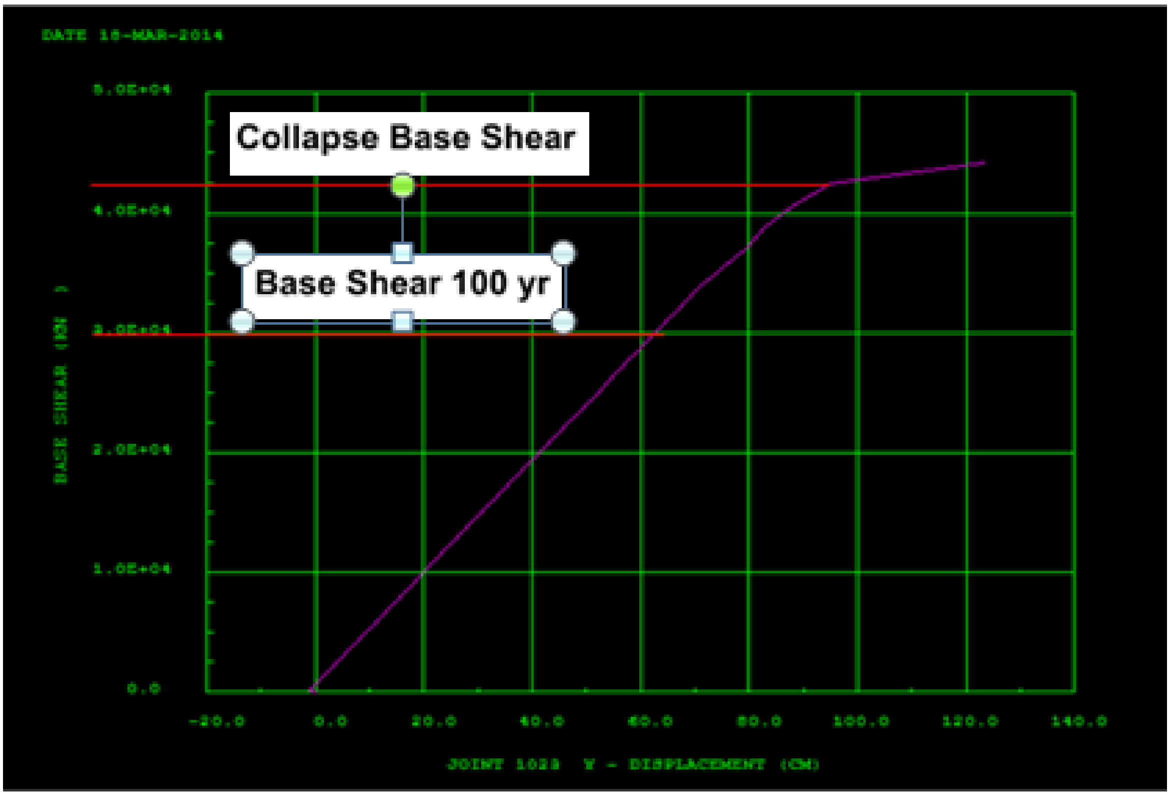


Figure 4.1.3: Example of RSR graph

Below show the result of RSR in eight different directions.

Direction	BS (KN)	BS collapse (KN)	RSR
0	33750	37500	1.111111
45	10000	43750	4.375
90	30000	42500	1.416667
135	30000	43500	1.45
180	37500	40000	1.066667
225	31500	45000	1.428571
270	25000	40000	1.6
315	32500	42500	1.307692

Table 4.1.1: RSR calculation for each direction

Based on the result, its shown that in 0 degree direction (To east), the RSR equal to 1.11 is lowest. On the other hand, in 45 degree (To south east), the highest RSR is recorded with 4.375.

Rooted in the current result, the platform most probably will be failed in the east direction when it is subjected to a huge storm load. However, the strongest direction of the platform is south east direction. Which mean, the platform will not fail easily if the load attacked the platform in south east direction.

4.1.1 Grade of Material

Direction	Ultimate Base Shear (KN x104)	
	Ori	Mild Steel
1	4	4
2	4.5	3.3
3	4.5	4.1
4	4.6	4.5
5	4.75	4.5
6	4.5	4.5
7	4.25	3.6
8	4.25	3.25

Table 4.1.1.1 : Ultimate Base Shear for Grade of Material

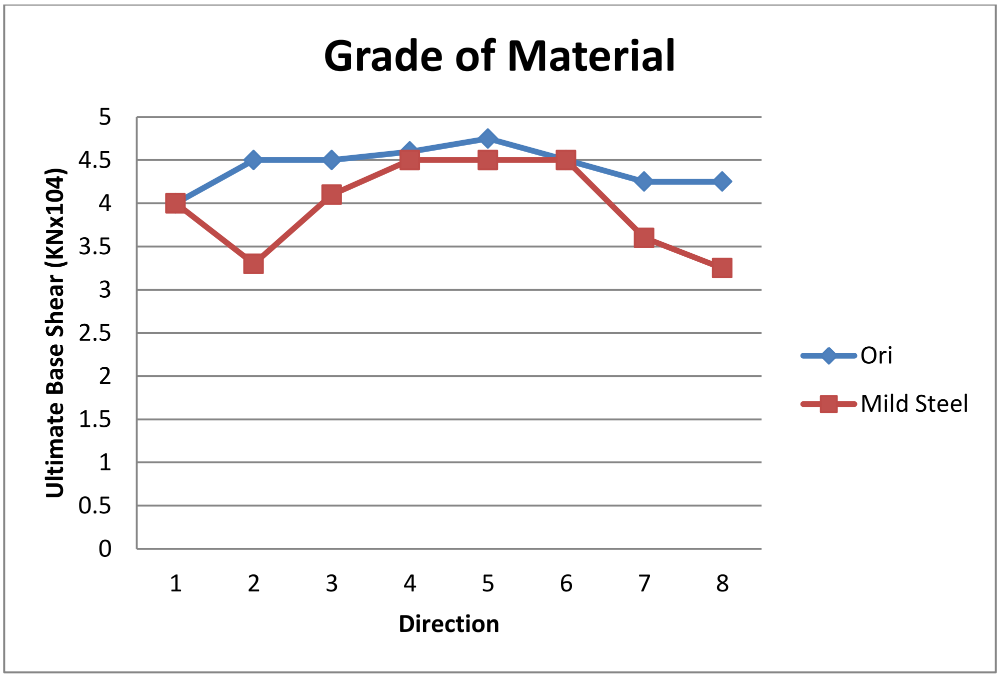


Figure 4.1.1.1 : Ultimate Base Shear for Different Grade of Material

Based on the result, the ultimate base shear reduces significantly when mild strength 275MPa is used to replace high yield strength 355MPa. From the Equation 4.1, the RSR value is directly proportional to Collapse Base Shear. Hence, the lower the values of ultimate base shear, the lower RSR value. From the graph, the direction number 2, 45' clockwise from the west is experienced a critical reduction in term of base shear. There is significant reduction about 12MN of base shear as compared to the high strength steel value. Hence, this direction will prone to failure as compare to other direction as the RSR will decrease in this direction.

From the result, it is obvious that higher strength of steel will caused a higher strength of the whole platform. This is most probably because higher strength of steel will have a higher ultimate strength, Fu, and yield strength, Fy. With a higher Fu and Fy, the platform can withstand a much higher load before its permanently deform and fail. As a conclusion, a higher grade of steel will definitely increase the strength of the whole platform.

4.1.2 Hydrodynamic Forces Coefficient (CdCm Values)

Direction	Ultimate Base Shear (KN x104)						
	Ori	-10%	-20%	-30%	10%	20%	30%
1	4	2.7	2.4	2.2	3.2	3.45	3.7
2	4.5	3.6	3.25	2.9	4.25	4.6	4.95
3	4.5	3.9	2.6	2.3	3.5	3.8	4.1
4	4.6	3.1	2.8	2.5	3.6	3.95	4.25
5	4.75	3.1	2.75	2.45	3.75	4	4.3
6	4.5	3	2.7	2.4	3.6	4.9	4.25
7	4.25	3	2.7	2.4	3.6	4.9	3.85
8	4.25	4.5	2.7	2.4	3.6	4.75	3.8

Table 4.1.1.2 : Ultimate Base Shear for CdCm values

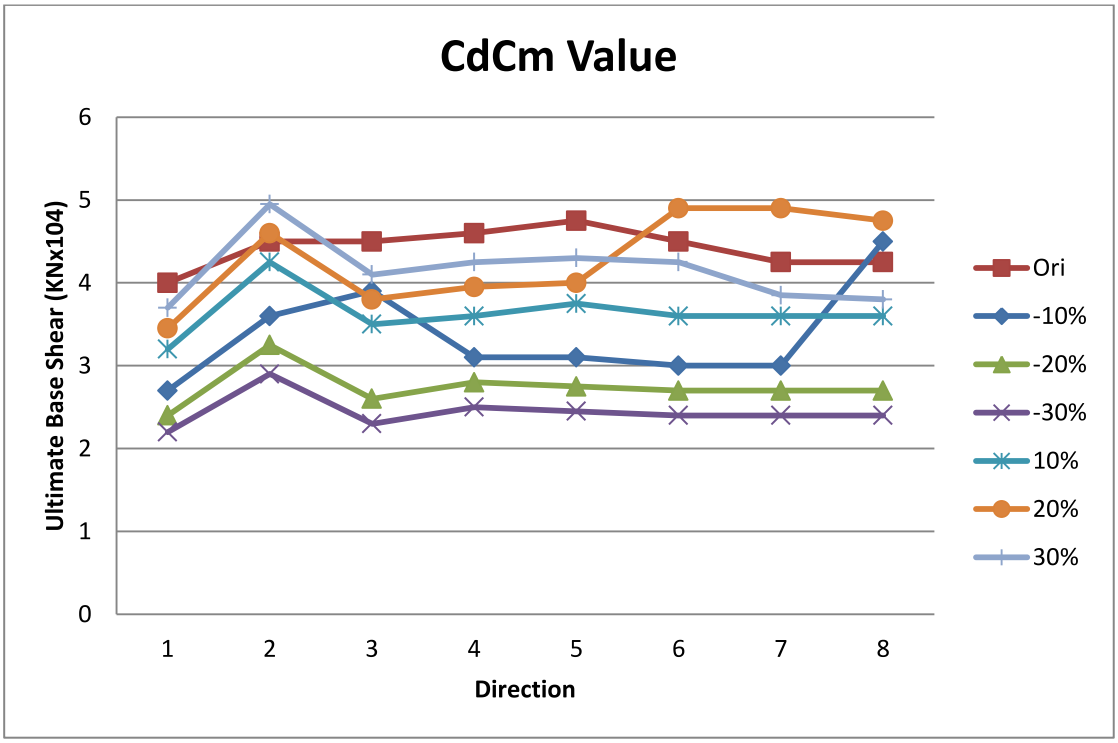


Figure 4.1.1.1 : Ultimate Base Shear for Different CdCm values

Based on the result, the ultimate base shear reduces significantly with the reduction of CdCm values from 10% to 30%. The original Cd value of 0.65 and Cm value of 1.6 are reduced by percentage from 10%, 20% as well as 30%. From the above table and graph, its shown clearly that the base shear value decrease significant with the reduction of the coefficient. As overall, the direction number 1, 0’, in west direction having the most critical reduction in base shear value. As mentioned early, ultimate base shear value also known as collapse base shear is directly proportional to RSR. In other words, this direction will prone to fail when the CdCm values are reduced.

On the other hand, the ultimate base shear experiences some increment when the CdCm values are increased by 10% to 30%. The original CdCm values are increased by 10%, 20% as well as 30%. However, in most cases, the ultimate base shear still experience reduction as compare to original CdCm values used in the design. So it is safe to said that, the recommended CdCm values are the most suitable values to be used in the design of offshore structure.

Generally, the strength of the platform are decreasing when the CdCm values are changed. This is most probably because CdCm values which are recommended in rhe API standard are the optimum values. The increase or the decrease of the values will caused the platform lose its strength. However, based on the graph, an increased in 20% of CdCm values will caused a major increased in platform strength for direction 6,7 and 8. However, for the direction 3, 4 and 5, the strength of platform decreased. This is because the different direction will be subjected to different level of forces and type of failure.

4.1.3 Corrosion Thickness

Direction	Ultimate Base Shear (KN x104)			
	Ori	1mm	3mm	6mm
1	4	4	4	3.6
2	4.5	4	5.2	2.7
3	4.5	4.5	4.15	3
4	4.6	4.6	4.24	2.6
5	4.75	4.15	4.75	2.8
6	4.5	4.5	4	3.5
7	4.25	4.25	3.5	2.75
8	4.25	4	3.3	2.75

Table4.1.1.3 : Ultimate Base Shear for Corrosion Thickness

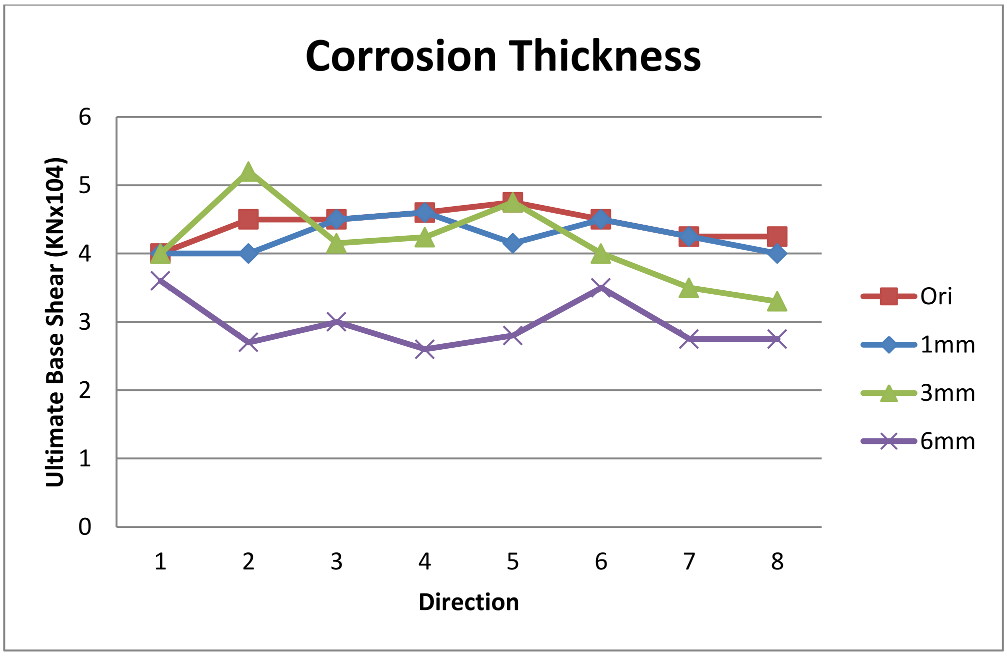


Figure 4.1.1.1 : Ultimate Base Shear for Different Corrosion Thickness

Based on the result, the ultimate base shear mostly reduces when the corrosion thickness are decreased 1mm, 3mm as well as 6mm. From the graph, the reductions in 1mm mostly do not make any changes in the base shear. As the reduction increased to 3mm, the ultimate base shear has drop considerably, especially in the 6,7 and 8 direction. Last but not least, when the reduction increased to 6mm, there are significantly drop in ultimate base shear. Hence, the 6mm corrosion thickness is not enough to support the structure.

Generally, the lower the allowable thickness of corrosion, the weaker the platform is. This is most probably a certain allowable thickness for corrosion is extremely important for a fixed offshore platform. Jacket platform is exposed to an extreme ocean condition with a high salinity level. The lower the allowable thickness for corrosion, the faster the steel of the platform subjected to rust. Once the steel start to rust, its strength drastically drop. As a conclusion, the a certain allowable corrosion thickness is needed to protect the platform steel from ocean extreme consider.

4.1.4 Increase in Platform Weight

Direction	Ultimate Base Shear (KN x104)	
	Ori	Flooded Members
1	4	4
2	4.5	5.5
3	4.5	4.5
4	4.6	4.65
5	4.75	4.7
6	4.5	4.5
7	4.25	4
8	4.25	4

Table4.1.1.4 : Ultimate Base Shear for different platform weight

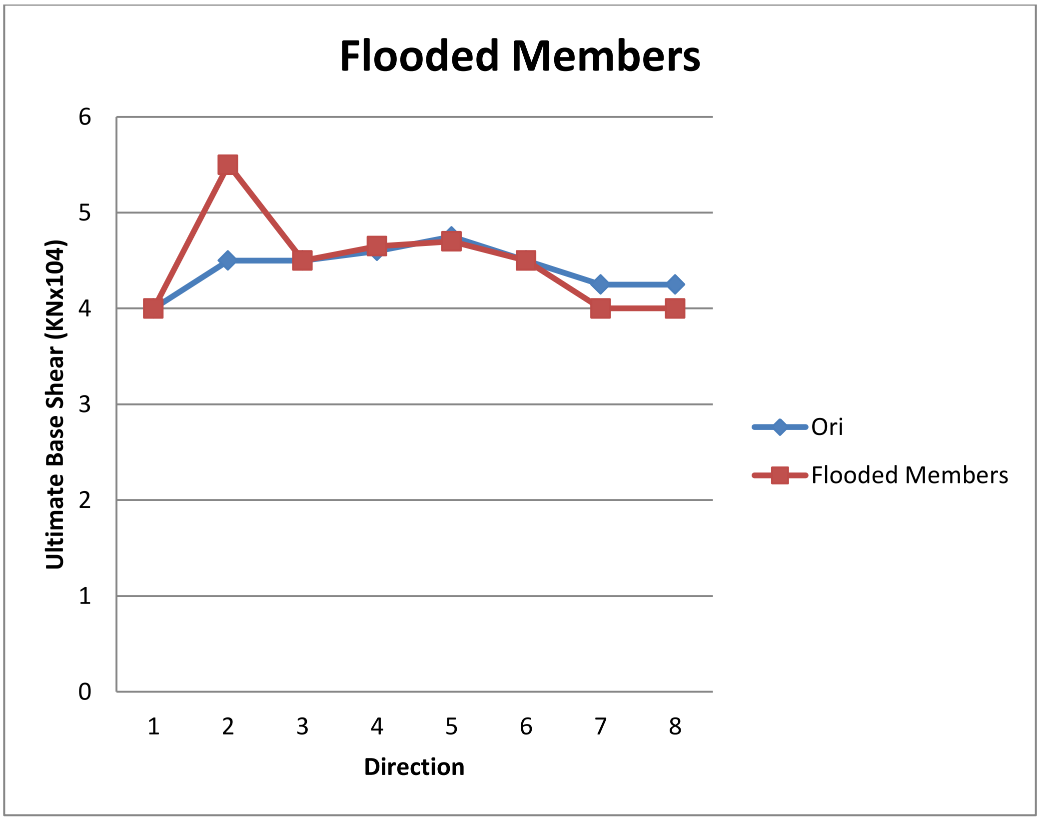


Figure 4.1.1.1 : Ultimate Base Shear for Different Weight of Platform

Based on the result, the increase in platform weight, mostly from the jacket did not caused a huge change in the ultimate base shear. However, in direction 2, 45’, clockwise from the west shown huge increments for ultimate base shear. The increment approximately 1.0MN. The platform is the strongest in this direction when the weight of the platform is increased.

Generally, the changes in platform weight do not make a major changes in the strength of fixed platform. From the result, an increase in offshore platform weight will caused a slightly reduce in strength of platform. Based on theory, an increase of weight for a structure will caused increase in the strength as well. However, in this case, the increase weight is due to the water flooded in the legs of the jacket. The flooded water might cause the jacket legs reduced in its strength.

Chapter 5

Conclusion and Recommendation

Kumang Cluster Development Project (F9JT-A) which located at 60m to 100m depth of water was subjected to push-over analysis in order to study the Reserve Strength Ratio (RSR) of the platform. For now, it is safe to say that to east direction having the lowest RSR and to south east direction have the highest RSR, In other words, to east direction will be the most critical direction for the platform to experience failure. Meanwhile, the platform is at its strongest at south east direction.

As for the manipulated parameter, the grade of steel will affect the strength of the platform. The lower the strength of the steel used, the lower the strength of the designed platforms.

Besides that, the increased or decreased hydrodynamic forces coefficient (CdCm) will reduce the strength of the designed platform. The most suitable CdCm values to be used during the design are 0.65 and 1.6 for clean members and 1.05 and 1.20 for folded members. An increased in 20% of CdCm values however does make a significant changes in the strength of the platform. A further studies can be carried of in this topic.

Moreover, the corrosion thickness will affect the strength of the platform. The lower the allowable corrosion thickness, the lower the strength of the jacket platform. Once the corrosion thickness reduced until half of the recommended values, the platform having a very low strength.

Finally, the increased of jacket weight did not really influence the strength of the platform.

Chapter 6

Reference

(PETRONAS), P. N. B. (2012). DESIGN OF FIXED OFFSHORE STRUCTURES (WORKING STRESS DESIGN). PTS 34. 19. 10. 30, PETRONAS**:** 65.

Ahmad, R. (2011). Global Ultimate Strength Analysis for SBO Platform: SMJT-E**:** 81.

Asgarian, B. and M. Lesani (2009). "Pile–soil-structure interaction in pushover analysis of jacket offshore platforms using fiber elements." Journal of Constructional Steel Research **65**(1): 209-218.

Golafshani, A. A., et al. (2011). "Incremental wave analysis and its application to performance-based assessment of jacket platforms." Journal of Constructional Steel Research **67**(10): 1649-1657.

Institution, A. P. (2007). Recommended Pratice for Planning, Designing and Constructing Fixed Offshore Platforms. Working Stress Design**:** 288.

Iskandar, N. A. b. (2013). Regression Analysis to Determine the Reserve Strength Ratio of Fixed Offshore Structures**:** 48.

jesus, A. M. P. d., et al. (2012). "A comparison of the fatigue behavior between S 355 and S 690 steel grades." Journal of Constructional Steel Research: 11.

Kurian, V. J., et al. Reliability of Jacket Platforms in Malaysian Waters, Sensitivity Study using Pushover Analysis. Civil Engineering Department. Bandar Seri Iskandar, Tronoh, Malaysia, Universiti Teknologi PETRONAS**:** 6.

Lai, T. k. (2007). Detailed RBI assessment for 8 SKO Platforms: BADP-C Substructure**:** 35.

Langseth, M., et al. "Strain-Rate Sensitivity of Mild Steel Grade St52-3N." 14.

Melchers, R. E. (2005). "The effect of corrosion on the structural reliability of steel offshore structures." Corrosion Science **47**: 20.

Nichols, N. W., et al. (2006). "Managing Structural Integrity for Aging Platform." 14.

Nizamani, Z. (2013). Environmental Load Factors and System Strength Evaluation of Jacket Platforms in Offshore Malaysia. Civil Engineering Department. Perak, Malaysia, Universiti Teknologi Petronas. **Doctor of Philosophy:** 337.

Wong, B. S. (2009). Detailed RBI Assessment for Twelve (12) SKO Platforms: BAJT-F Substructure**:** 42.

Yan-lei, Z., et al. (2013). "Corrosion Behavior of Rusted 550 MPa Grade Offshore Platform Steel." JOURNAL OF IRON AND STEEL RESEARCH, INTERNATIONAL **66-73**: 8.

APPENDIX A

SACS collapse output file

**** NON-LINEAR COLLAPSE ANALYSIS (LOAD SEQUENCE 1) ****

				LOAD	LOAD	*DEFLECTION*		ROTATION	** DEFLECTION **			% OF IMPACT
NSLV	INC.	LOOP	CASE	FACTOR	DIFF.	JNT	DOF	DIFFERENCE	MAXIMUM	JNT	DOF	ENERGY
2	1	1	DL	0.200	0.0012	351	DX	0.0000004	-0.664	8013	DZ	
2	1	2	DL	0.200	0.0000	8013	DZ	0.0000000	-0.664	8013	DZ	
4	2	1	DL	0.400	0.0024	351	DX	0.0000009	-1.327	8013	DZ	
4	2	2	DL	0.400	0.0000	8013	DZ	0.0000000	-1.327	8013	DZ	
6	3	1	DL	0.600	0.0036	351	DX	0.0000013	-1.990	8013	DZ	
6	3	2	DL	0.600	0.0000	8013	DZ	0.0000000	-1.990	8013	DZ	
8	4	1	DL	0.800	0.0049	351	DX	0.0000017	-2.653	8013	DZ	
8	4	2	DL	0.800	0.0000	8013	DZ	0.0000000	-2.653	8013	DZ	
10	5	1	DL	1.000	0.0061	351	DX	0.0000022	-3.316	8013	DZ	
10	5	2	DL	1.000	0.0000	8013	DZ	0.0000000	-3.316	8013	DZ	
12	6	1	LL01	0.200	0.0051	7406	DX	0.0000103	-3.399	8013	DZ	
12	6	2	LL01	0.200	0.0000	7406	DZ	0.0000000	-3.399	8013	DZ	
14	7	1	LL01	0.400	0.0115	7406	DX	0.0000187	-4.856	7422	DZ	
14	7	2	LL01	0.400	0.0000	7406	DZ	0.0000000	-4.857	7422	DZ	
16	8	1	LL01	0.600	0.0179	7406	DX	0.0000284	-7.134	7406	DZ	
16	8	2	LL01	0.600	0.0000	7406	DZ	0.0000000	-7.137	7406	DZ	
18	9	1	LL01	0.800	0.0244	7406	DX	0.0000382	-9.411	7406	DZ	
18	9	2	LL01	0.800	0.0000	7406	DZ	0.0000000	-9.415	7406	DZ	
20	10	1	LL01	1.000	0.0308	7406	DX	0.0000480	-11.685	7406	DZ	
20	10	2	LL01	1.000	0.0000	7406	DZ	0.0000000	-11.691	7406	DZ	
22	11	1	ST01	0.200	0.0069	1025	DX	0.0000054	-11.567	7406	DZ	
22	11	2	ST01	0.200	0.0000	1025	DX	0.0000000	-11.567	7406	DZ	
24	12	1	ST01	0.400	0.0069	1025	DX	0.0000058	-11.448	7406	DZ	
24	12	2	ST01	0.400	0.0000	1025	DX	0.0000000	-11.449	7406	DZ	
26	13	1	ST01	0.600	0.0070	1025	DX	0.0000057	-11.330	7406	DZ	

26	13	2	ST01	0.600	0.0000	1025	DX	0.0000000	-11.331	7406	DZ
28	14	1	ST01	0.800	0.0070	1025	DX	0.0000057	-11.213	7406	DZ
28	14	2	ST01	0.800	0.0000	1025	DX	0.0000000	-11.213	7406	DZ
30	15	1	ST01	1.000	0.0071	1025	DX	0.0000062	-11.096	7406	DZ
30	15	2	ST01	1.000	0.0000	1025	DX	0.0000000	-11.096	7406	DZ
32	16	1	ST01	1.200	0.0071	1023	DX	0.0000074	-10.979	7406	DZ
32	16	2	ST01	1.200	0.0000	1025	DX	0.0000000	-10.979	7406	DZ
34	17	1	ST01	1.400	0.0072	1023	DX	0.0000085	12.576	1025	DX
34	17	2	ST01	1.400	0.0000	1025	DX	0.0000000	12.569	1025	DX
36	18	1	ST01	1.600	0.0073	1023	DX	0.0000096	14.897	1025	DX
36	18	2	ST01	1.600	0.0000	1025	DX	0.0000000	14.890	1025	DX
38	19	1	ST01	1.800	0.0073	1023	DX	0.0000108	17.219	1025	DX
38	19	2	ST01	1.800	0.0000	1025	DX	0.0000000	17.212	1025	DX
40	20	1	ST01	2.000	0.0074	1023	DX	0.0000119	19.541	1025	DX
40	20	2	ST01	2.000	0.0000	1025	DX	0.0000000	19.534	1025	DX
42	21	1	ST01	2.200	0.0075	1023	DX	0.0000131	21.863	1025	DX
42	21	2	ST01	2.200	0.0000	1025	DX	0.0000000	21.855	1025	DX
44	22	1	ST01	2.400	0.0075	1023	DX	0.0000143	24.185	1025	DX
44	22	2	ST01	2.400	0.0000	1025	DX	0.0000000	24.177	1025	DX
46	23	1	ST01	2.600	0.0076	1023	DX	0.0000155	26.507	1025	DX
46	23	2	ST01	2.600	0.0000	1025	DX	0.0000000	26.499	1025	DX
48	24	1	ST01	2.800	0.0078	1023	DX	0.0000167	28.829	1025	DX

*** MEMBER A045-501X HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

49	24	1	ST01	2.800	3.6614	A031	DX	0.0066640	28.682	1025	DX
50	24	2	ST01	2.800	1.0424	A031	DX	0.0018751	28.635	1025	DX
51	24	3	ST01	2.800	0.3081	A031	DX	0.0005432	28.622	1025	DX
52	24	4	ST01	2.800	0.0963	A031	DX	0.0001654	28.618	1025	DX
52	24	5	ST01	2.800	0.3081	A031	DX	0.0005432	28.622	1025	DX
54	25	1	ST01	3.000	0.1131	A031	DX	0.0001918	30.925	1025	DX
55	25	2	ST01	3.000	0.0343	A031	DX	0.0000582	30.923	1025	DX

55	25	3	ST01	3.000	0.1131	A031	DX	0.0001918	30.925	1025	DX
57	26	1	ST01	3.200	0.0920	A031	DX	0.0001568	33.231	1025	DX
57	26	2	ST01	3.200	0.0000	1025	DX	0.0000000	33.228	1025	DX
59	27	1	ST01	3.400	0.1074	A031	DX	0.0001837	35.538	1025	DX
60	27	2	ST01	3.400	0.0323	A031	DX	0.0000548	35.536	1025	DX
60	27	3	ST01	3.400	0.1074	A031	DX	0.0001837	35.538	1025	DX
62	28	1	ST01	3.600	0.0903	A031	DX	0.0001541	37.844	1025	DX
62	28	2	ST01	3.600	0.0000	1025	DX	0.0000000	37.841	1025	DX
64	29	1	ST01	3.800	0.1101	A031	DX	0.0001849	40.150	1025	DX
65	29	2	ST01	3.800	0.0344	A031	DX	0.0000567	40.149	1025	DX
65	29	3	ST01	3.800	0.1101	A031	DX	0.0001849	40.150	1025	DX
67	30	1	ST01	4.000	0.1002	A031	DX	0.0001617	42.454	1025	DX
68	30	2	ST01	4.000	0.0305	A031	DX	0.0000497	42.453	1025	DX

*** MEMBER 649- 650 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

69	30	1	ST01	4.000	0.7343	660	DZ	0.0016932	42.419	1025	DX
70	30	2	ST01	4.000	0.0983	660	DZ	0.0002332	42.413	1025	DX
70	30	3	ST01	4.000	0.7343	660	DZ	0.0016932	42.419	1025	DX
72	31	1	ST01	4.200	0.1261	A031	DX	0.0001930	44.717	1025	DX
73	31	2	ST01	4.200	0.0400	A031	DX	0.0000616	44.715	1025	DX
73	31	3	ST01	4.200	0.1261	A031	DX	0.0001930	44.717	1025	DX
75	32	1	ST01	4.400	0.1258	A031	DX	0.0001793	47.024	1025	DX
76	32	2	ST01	4.400	0.0407	A031	DX	0.0000594	47.023	1025	DX

*** MEMBER 649- 633 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

77	32	1	ST01	4.400	0.3259	A031	DX	0.0009186	47.007	1025	DX
78	32	2	ST01	4.400	0.0652	A031	DX	0.0001238	47.003	1025	DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

79	32	1	ST01	4.400	3.6293	459	DY	0.0038108	47.382	1025	DX
80	32	2	ST01	4.400	6.0000	459	DY	0.0068246	48.015	1025	DX
81	32	3	ST01	4.400	6.9487	459	DY	0.0082710	48.554	1025	DX
82	32	4	ST01	4.400	6.1396	459	DY	0.0076458	49.198	1025	DX

83 32 5 ST01 4.400 2.8038 459 DY 0.0052770 49.758 1025 DX

84 32 6 ST01 4.400 1.4875 9047 DY 0.0018583 50.136 1025 DX

85 32 7 ST01 4.400 2.5034 459 DY 0.0038921 50.347 1025 DX

86 32 8 ST01 4.400 2.1946 459 DY 0.0036046 50.547 1025 DX

87 32 9 ST01 4.400 2.0371 459 DY 0.0038648 50.697 1025 DX

88 32 10 ST01 4.400 1.4199 459 DY 0.0031286 50.840 1025 DX

89 32 11 ST01 4.400 1.0443 459 DY 0.0025736 50.954 1025 DX

90 32 12 ST01 4.400 0.9809 459 DY 0.0023036 51.035 1025 DX

91 32 13 ST01 4.400 0.5065 459 DY 0.0016402 51.089 1025 DX

92 32 14 ST01 4.400 0.4304 459 DY 0.0011059 51.170 1025 DX

93 32 15 ST01 4.400 0.4777 459 DY 0.0009841 51.228 1025 DX

94 32 16 ST01 4.400 0.4294 459 DY 0.0008085 51.282 1025 DX

95 32 17 ST01 4.400 0.3841 459 DY 0.0007013 51.328 1025 DX

96 32 18 ST01 4.400 0.3441 459 DY 0.0006362 51.367 1025 DX

97 32 19 ST01 4.400 0.2957 459 DY 0.0005615 51.401 1025 DX

97 32 20 ST01 4.400 0.1721 459 DY 0.0003181 51.321 1025 DX

99 33 1 ST01 4.600 10.7321 459 DY 0.0142461 53.197 1025 DX

100 33 2 ST01 4.600 16.1583 459 DY 0.0162770 54.030 1025 DX

101 33 3 ST01 4.600 1.8301 459 DY 0.0016924 53.651 1025 DX

102 33 4 ST01 4.600 0.3100 459 DY 0.0004977 53.732 1025 DX

103 33 5 ST01 4.600 0.2419 459 DY 0.0009252 53.737 1025 DX

104 33 6 ST01 4.600 0.1851 459 DY 0.0006380 53.733 1025 DX

105 33 7 ST01 4.600 0.0619 9888 DX 0.0003504 53.760 1025 DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 9

106 33 1 ST01 4.600 8.4919 459 DY 0.0043367 51.686 1025 DX

107 33 2 ST01 4.600 13.8575 459 DY 0.0114426 52.868 1025 DX

108 33 3 ST01 4.600 1.0695 459 DX 0.0016037 52.883 1025 DX

109 33 4 ST01 4.600 0.8607 459 DY 0.0003155 52.833 1025 DX

110 33 5 ST01 4.600 0.4394 459 DY 0.0001925 52.730 1025 DX

111 33 6 ST01 4.600 0.0886 459 DY 0.0001008 52.723 1025 DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 2

112	33	1	ST01	4.600	8.9473	459	DY	0.0048716	54.685	1025 DX
113	33	2	ST01	4.600	7.8566	459	DY	0.0061302	55.643	1025 DX
114	33	3	ST01	4.600	4.9978	459	DY	0.0021636	55.686	1025 DX
115	33	4	ST01	4.600	3.1948	459	DY	0.0013364	55.874	1025 DX
116	33	5	ST01	4.600	2.0861	459	DY	0.0007945	55.942	1025 DX
117	33	6	ST01	4.600	1.1428	459	DY	0.0003443	56.051	1025 DX
118	33	7	ST01	4.600	0.6912	459	DY	0.0003124	56.093	1025 DX
119	33	8	ST01	4.600	0.4499	459	DY	0.0001154	56.147	1025 DX
120	33	9	ST01	4.600	0.2974	459	DY	0.0001180	56.173	1025 DX
121	33	10	ST01	4.600	0.1844	459	DY	0.0000573	56.202	1025 DX
122	33	11	ST01	4.600	0.1273	459	DY	0.0000433	56.217	1025 DX
123	33	12	ST01	4.600	0.1070	459	DY	0.0000946	56.231	1025 DX
124	33	13	ST01	4.600	0.0672	459	DY	0.0000191	56.239	1025 DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 3

125	33	1	ST01	4.600	5.7072	9047	DY	0.0182590	59.532	1025 DX
126	33	2	ST01	4.600	15.2413	459	DY	0.0190614	59.040	1025 DX
127	33	3	ST01	4.600	1.2953	459	DY	0.0129053	59.722	1025 DX
128	33	4	ST01	4.600	0.6822	459	DZ	0.0091121	59.489	1025 DX
129	33	5	ST01	4.600	0.8785	459	DX	0.0062525	59.155	1025 DX
130	33	6	ST01	4.600	1.0239	459	DX	0.0043046	58.826	1025 DX
131	33	7	ST01	4.600	1.0807	9047	DY	0.0023503	58.419	1025 DX
132	33	8	ST01	4.600	3.0703	459	DY	0.0017251	58.367	1025 DX
133	33	9	ST01	4.600	1.1527	459	DY	0.0010720	58.119	1025 DX
134	33	10	ST01	4.600	3.7367	459	DY	0.0022521	57.955	1025 DX
135	33	11	ST01	4.600	1.4664	459	DY	0.0017342	57.800	1025 DX
136	33	12	ST01	4.600	0.8996	9047	DY	0.0016561	57.584	1025 DX
137	33	13	ST01	4.600	2.6018	459	DY	0.0016788	57.521	1025 DX
138	33	14	ST01	4.600	0.9922	459	DY	0.0012266	57.409	1025 DX
139	33	15	ST01	4.600	6.5499	9047	DY	0.0225427	61.390	1025 DX

140	33	16	ST01	4.600	3.5839	459	DY	0.0024073	58.000	1025	DX
141	33	17	ST01	4.600	2.6478	459	DY	0.0019608	57.943	1025	DX
142	33	18	ST01	4.600	3.7566	459	DY	0.0027024	57.788	1025	DX
143	33	19	ST01	4.600	5.5655	459	DY	0.0027330	58.547	1025	DX
143	33	20	ST01	4.600	1.8783	459	DY	0.0013512	57.975	1025	DX
145	34	1	ST01	4.800	9.0364	459	DY	0.0025078	60.666	1025	DX
146	34	2	ST01	4.800	6.6740	459	DY	0.0034806	60.706	1025	DX
147	34	3	ST01	4.800	5.5078	459	DY	0.0015797	60.385	1025	DX
148	34	4	ST01	4.800	9.7499	459	DY	0.0040510	61.225	1025	DX
149	34	5	ST01	4.800	0.3834	459	DX	0.0007744	60.621	1025	DX
150	34	6	ST01	4.800	7.5129	459	DY	0.0016848	60.327	1025	DX
151	34	7	ST01	4.800	6.7318	459	DY	0.0015027	60.298	1025	DX
152	34	8	ST01	4.800	6.0310	459	DY	0.0013371	60.269	1025	DX
153	34	9	ST01	4.800	3.1537	459	DY	0.0015746	60.459	1025	DX
154	34	10	ST01	4.800	2.8284	459	DY	0.0014989	60.441	1025	DX
155	34	11	ST01	4.800	2.5347	459	DY	0.0014218	60.424	1025	DX
156	34	12	ST01	4.800	2.2848	459	DY	0.0013531	60.405	1025	DX
157	34	13	ST01	4.800	2.0502	459	DY	0.0012867	60.386	1025	DX
158	34	14	ST01	4.800	1.8385	459	DY	0.0012252	60.367	1025	DX
159	34	15	ST01	4.800	1.6476	459	DY	0.0011658	60.347	1025	DX
160	34	16	ST01	4.800	1.4959	459	DY	0.0011140	60.325	1025	DX
161	34	17	ST01	4.800	1.3151	459	DY	0.0010945	60.321	1025	DX
162	34	18	ST01	4.800	1.1806	459	DY	0.0010490	60.302	1025	DX
163	34	19	ST01	4.800	1.0496	459	DY	0.0010150	60.281	1025	DX
163	34	20	ST01	4.800	0.0603	459	DY	0.0000535	60.537	1025	DX
165	35	1	ST01	5.000	5.6935	459	DY	0.0021000	62.781	1025	DX
166	35	2	ST01	5.000	5.0026	459	DY	0.0007657	62.882	1025	DX
167	35	3	ST01	5.000	3.3538	459	DY	0.0006382	63.064	1025	DX
168	35	4	ST01	5.000	5.6486	459	DY	0.0020709	62.880	1025	DX
169	35	5	ST01	5.000	2.0221	459	DY	0.0004476	63.086	1025	DX

170 35 6 ST01 5.000 0.4348 459 DY 0.0002700 63.022 1025 DX

171 35 7 ST01 5.000 0.1262 558 DY 0.0002349 63.044 1025 DX

172 35 8 ST01 5.000 0.1287 558 DY 0.0002379 63.048 1025 DX

173 35 9 ST01 5.000 0.1215 558 DY 0.0002186 63.059 1025 DX

174 35 10 ST01 5.000 0.1096 558 DY 0.0001992 63.065 1025 DX

175 35 11 ST01 5.000 0.1141 558 DY 0.0001916 63.073 1025 DX

176 35 12 ST01 5.000 0.1061 558 DY 0.0001790 63.080 1025 DX

177 35 13 ST01 5.000 0.0991 558 DY 0.0001670 63.087 1025 DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 8

178 35 1 ST01 5.000 0.6380 459 DY 0.0063629 63.149 1025 DX

179 35 2 ST01 5.000 2.7718 459 DY 0.0035014 63.251 1025 DX

180 35 3 ST01 5.000 1.7357 459 DY 0.0029778 63.300 1025 DX

181 35 4 ST01 5.000 1.1825 459 DY 0.0024473 63.346 1025 DX

182 35 5 ST01 5.000 0.8763 459 DY 0.0021865 63.422 1025 DX

183 35 6 ST01 5.000 0.8435 459 DY 0.0019475 63.479 1025 DX

184 35 7 ST01 5.000 0.6319 459 DY 0.0017386 63.539 1025 DX

185 35 8 ST01 5.000 0.5669 459 DY 0.0016725 63.598 1025 DX

186 35 9 ST01 5.000 1.0338 459 DY 0.0018274 63.711 1025 DX

187 35 10 ST01 5.000 0.4948 9881 DX 0.0012122 63.896 1025 DX

188 35 11 ST01 5.000 1.7296 459 DY 0.0023809 64.065 1025 DX

189 35 12 ST01 5.000 0.6401 459 DY 0.0019354 64.225 1025 DX

190 35 13 ST01 5.000 0.6890 9880 DX 0.0015449 64.394 1025 DX

191 35 14 ST01 5.000 0.8640 9881 DX 0.0007359 64.726 1025 DX

192 35 15 ST01 5.000 0.9659 9878 DX 0.0007992 65.070 1025 DX

193 35 16 ST01 5.000 1.0350 9878 DX 0.0008787 65.431 1025 DX

194 35 17 ST01 5.000 1.1852 9878 DX 0.0009840 65.853 1025 DX

195 35 18 ST01 5.000 1.2833 9878 DX 0.0011040 66.299 1025 DX

196 35 19 ST01 5.000 1.4192 9878 DX 0.0012227 66.803 1025 DX

196 35 20 ST01 5.000 0.6417 9878 DX 0.0005520 65.886 1025 DX

APPENDIX B

SACS collapse output file (Changed grade of material)

**** NON-LINEAR COLLAPSE ANALYSIS (LOAD SEQUENCE 1) ****

NSLV	INC.	LOOP	LOAD CASE	LOAD FACTOR	*DEFLECTION* DIFF.	JNT	DOF	ROTATION DIFFERENCE	** DEFLECTION ** MAXIMUM	JNT	DOF	% OF IMPACT ENERGY
2	1	1	DL	0.200	0.0012	351	DX	0.0000004	-0.664	8013	DZ	
2	1	2	DL	0.200	0.0000	8013	DZ	0.0000000	-0.664	8013	DZ	
4	2	1	DL	0.400	0.0024	351	DX	0.0000009	-1.327	8013	DZ	
4	2	2	DL	0.400	0.0000	8013	DZ	0.0000000	-1.327	8013	DZ	
6	3	1	DL	0.600	0.0036	351	DX	0.0000013	-1.990	8013	DZ	
6	3	2	DL	0.600	0.0000	8013	DZ	0.0000000	-1.990	8013	DZ	
8	4	1	DL	0.800	0.0049	351	DX	0.0000017	-2.653	8013	DZ	
8	4	2	DL	0.800	0.0000	8013	DZ	0.0000000	-2.653	8013	DZ	
10	5	1	DL	1.000	0.0061	351	DX	0.0000022	-3.316	8013	DZ	
10	5	2	DL	1.000	0.0000	8013	DZ	0.0000000	-3.316	8013	DZ	
12	6	1	LL01	0.200	0.0051	7406	DX	0.0000103	-3.399	8013	DZ	
12	6	2	LL01	0.200	0.0000	7406	DZ	0.0000000	-3.399	8013	DZ	
14	7	1	LL01	0.400	0.0115	7406	DX	0.0000187	-4.856	7422	DZ	
14	7	2	LL01	0.400	0.0000	7406	DZ	0.0000000	-4.857	7422	DZ	
16	8	1	LL01	0.600	0.0179	7406	DX	0.0000284	-7.134	7406	DZ	
16	8	2	LL01	0.600	0.0000	7406	DZ	0.0000000	-7.137	7406	DZ	
18	9	1	LL01	0.800	0.0244	7406	DX	0.0000382	-9.411	7406	DZ	
18	9	2	LL01	0.800	0.0000	7406	DZ	0.0000000	-9.415	7406	DZ	
20	10	1	LL01	1.000	0.0308	7406	DX	0.0000480	-11.685	7406	DZ	
20	10	2	LL01	1.000	0.0000	7406	DZ	0.0000000	-11.691	7406	DZ	
22	11	1	ST01	0.200	0.0069	1025	DX	0.0000054	-11.567	7406	DZ	
22	11	2	ST01	0.200	0.0000	1025	DX	0.0000000	-11.567	7406	DZ	
24	12	1	ST01	0.400	0.0069	1025	DX	0.0000058	-11.448	7406	DZ	
24	12	2	ST01	0.400	0.0000	1025	DX	0.0000000	-11.449	7406	DZ	
26	13	1	ST01	0.600	0.0070	1025	DX	0.0000057	-11.330	7406	DZ	

26 13 2 ST01 0.600 0.0000 1025 DX 0.0000000 -11.331 7406 DZ

28 14 1 ST01 0.800 0.0070 1025 DX 0.0000057 -11.213 7406 DZ

28 14 2 ST01 0.800 0.0000 1025 DX 0.0000000 -11.213 7406 DZ

30 15 1 ST01 1.000 0.0071 1025 DX 0.0000062 -11.096 7406 DZ

30 15 2 ST01 1.000 0.0000 1025 DX 0.0000000 -11.096 7406 DZ

32 16 1 ST01 1.200 0.0071 1023 DX 0.0000074 -10.979 7406 DZ

32 16 2 ST01 1.200 0.0000 1025 DX 0.0000000 -10.979 7406 DZ

34 17 1 ST01 1.400 0.0072 1023 DX 0.0000085 12.576 1025 DX

34 17 2 ST01 1.400 0.0000 1025 DX 0.0000000 12.569 1025 DX

36 18 1 ST01 1.600 0.0073 1023 DX 0.0000096 14.897 1025 DX

36 18 2 ST01 1.600 0.0000 1025 DX 0.0000000 14.890 1025 DX

38 19 1 ST01 1.800 0.0073 1023 DX 0.0000108 17.219 1025 DX

38 19 2 ST01 1.800 0.0000 1025 DX 0.0000000 17.212 1025 DX

40 20 1 ST01 2.000 0.0074 1023 DX 0.0000119 19.541 1025 DX

40 20 2 ST01 2.000 0.0000 1025 DX 0.0000000 19.534 1025 DX

42 21 1 ST01 2.200 0.0075 1023 DX 0.0000131 21.863 1025 DX

*** MEMBER A045-501X HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

43 21 1 ST01 2.200 2.9010 A031 DX 0.0052720 21.748 1025 DX

44 21 2 ST01 2.200 0.8322 A031 DX 0.0014933 21.711 1025 DX

45 21 3 ST01 2.200 0.2458 A031 DX 0.0004344 21.701 1025 DX

46 21 4 ST01 2.200 0.0760 A031 DX 0.0001316 21.698 1025 DX

46 21 5 ST01 2.200 0.2458 A031 DX 0.0004344 21.701 1025 DX

48 22 1 ST01 2.400 0.1072 A031 DX 0.0001823 24.005 1025 DX

49 22 2 ST01 2.400 0.0317 A031 DX 0.0000545 24.003 1025 DX

49 22 3 ST01 2.400 0.1072 A031 DX 0.0001823 24.005 1025 DX

51 23 1 ST01 2.600 0.0925 A031 DX 0.0001573 26.311 1025 DX

51 23 2 ST01 2.600 0.0000 1025 DX 0.0000000 26.308 1025 DX

53 24 1 ST01 2.800 0.1087 A031 DX 0.0001857 28.618 1025 DX

54 24 2 ST01 2.800 0.0321 A031 DX 0.0000550 28.616 1025 DX

54 24 3 ST01 2.800 0.1087 A031 DX 0.0001857 28.618 1025 DX

56 25 1 ST01 3.000 0.0975 A031 DX 0.0001609 30.923 1025 DX

56 25 2 ST01 3.000 0.0000 1025 DX 0.0000000 30.921 1025 DX

58 26 1 ST01 3.200 0.1217 A031 DX 0.0001952 33.229 1025 DX

59 26 2 ST01 3.200 0.0371 A031 DX 0.0000603 33.227 1025 DX

*** MEMBER 649- 650 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

60 26 1 ST01 3.200 0.5915 660 DZ 0.0013605 33.201 1025 DX

61 26 2 ST01 3.200 0.0801 A031 DX 0.0001859 33.196 1025 DX

61 26 3 ST01 3.200 0.5915 660 DZ 0.0013605 33.201 1025 DX

63 27 1 ST01 3.400 0.1353 A031 DX 0.0001954 35.504 1025 DX

64 27 2 ST01 3.400 0.0431 A031 DX 0.0000638 35.503 1025 DX

*** MEMBER 649- 633 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

65 27 1 ST01 3.400 0.2625 A031 DX 0.0007353 35.490 1025 DX

66 27 2 ST01 3.400 0.0521 A031 DX 0.0000949 35.487 1025 DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

67 27 1 ST01 3.400 2.5061 459 DY 0.0025974 35.759 1025 DX

68 27 2 ST01 3.400 3.6896 459 DY 0.0041013 36.138 1025 DX

69 27 3 ST01 3.400 4.5227 459 DY 0.0050588 36.433 1025 DX

70 27 4 ST01 3.400 5.0036 459 DY 0.0061064 36.807 1025 DX

71 27 5 ST01 3.400 4.9471 459 DY 0.0061058 37.256 1025 DX

72 27 6 ST01 3.400 3.5467 459 DY 0.0054007 37.711 1025 DX

73 27 7 ST01 3.400 1.8367 459 DY 0.0035936 38.109 1025 DX

74 27 8 ST01 3.400 1.1471 9047 DY 0.0017850 38.420 1025 DX

75 27 9 ST01 3.400 1.9124 459 DY 0.0025281 38.631 1025 DX

76 27 10 ST01 3.400 1.7930 459 DY 0.0025362 38.814 1025 DX

77 27 11 ST01 3.400 1.5730 459 DY 0.0021927 38.981 1025 DX

78 27 12 ST01 3.400 1.7828 459 DY 0.0029461 39.113 1025 DX

79 27 13 ST01 3.400 1.1853 459 DY 0.0022427 39.243 1025 DX

80 27 14 ST01 3.400 0.9874 459 DY 0.0019299 39.353 1025 DX

81 27 15 ST01 3.400 0.8109 459 DY 0.0015983 39.449 1025 DX

82 27 16 ST01 3.400 0.8119 459 DY 0.0014766 39.527 1025 DX

83 27 17 ST01 3.400 0.6045 459 DY 0.0010764 39.609 1025 DX

84 27 18 ST01 3.400 0.5401 459 DY 0.0009356 39.678 1025 DX

85 27 19 ST01 3.400 0.4863 459 DY 0.0009388 39.719 1025 DX

85 27 20 ST01 3.400 0.2700 459 DY 0.0004678 39.599 1025 DX

87 28 1 ST01 3.600 9.6663 459 DY 0.0134234 41.595 1025 DX

88 28 2 ST01 3.600 12.8673 459 DY 0.0133821 42.247 1025 DX

89 28 3 ST01 3.600 0.5747 459 DY 0.0011560 42.027 1025 DX

90 28 4 ST01 3.600 0.3067 459 DY 0.0006308 42.075 1025 DX

91 28 5 ST01 3.600 0.3065 459 DY 0.0004834 42.123 1025 DX

92 28 6 ST01 3.600 0.4791 459 DY 0.0006144 42.131 1025 DX

93 28 7 ST01 3.600 0.1080 9047 DY 0.0003478 42.170 1025 DX

94 28 8 ST01 3.600 0.0975 459 DY 0.0003961 42.191 1025 DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 3

95 28 1 ST01 3.600 3.9625 459 DY 0.0039101 44.482 1025 DX

96 28 2 ST01 3.600 9.3334 459 DY 0.0074718 43.723 1025 DX

97 28 3 ST01 3.600 4.0502 459 DY 0.0036695 43.515 1025 DX

98 28 4 ST01 3.600 3.2327 459 DY 0.0036185 45.392 1025 DX

99 28 5 ST01 3.600 3.9731 459 DY 0.0014777 44.148 1025 DX

100 28 6 ST01 3.600 4.4895 459 DY 0.0028586 46.013 1025 DX

101 28 7 ST01 3.600 4.8565 459 DY 0.0057649 44.228 1025 DX

102 28 8 ST01 3.600 0.4478 459 DY 0.0010548 44.549 1025 DX

103 28 9 ST01 3.600 0.1946 459 DX 0.0005710 44.499 1025 DX

104 28 10 ST01 3.600 5.2573 459 DY 0.0036582 46.131 1025 DX

105 28 11 ST01 3.600 0.2812 459 DY 0.0002703 44.499 1025 DX

106 28 12 ST01 3.600 0.2627 459 DY 0.0002608 44.496 1025 DX

107 28 13 ST01 3.600 0.2453 459 DY 0.0002515 44.493 1025 DX

108 28 14 ST01 3.600 0.2290 459 DY 0.0002427 44.490 1025 DX

109 28 15 ST01 3.600 0.2136 459 DY 0.0002341 44.487 1025 DX

110 28 16 ST01 3.600 4.5022 459 DY 0.0029564 46.242 1025 DX

111 28 17 ST01 3.600 0.5235 459 DY 0.0002091 44.541 1025 DX

112	28	18	ST01	3.600	0.4816	459	DY	0.0001998	44.536	1025	DX
113	28	19	ST01	3.600	0.4429	459	DY	0.0001908	44.532	1025	DX
113	28	20	ST01	3.600	0.0229	459	DY	0.0000095	44.663	1025	DX
115	29	1	ST01	3.800	6.9841	459	DY	0.0038059	49.113	1025	DX
116	29	2	ST01	3.800	13.3344	459	DY	0.0098455	47.877	1025	DX
117	29	3	ST01	3.800	1.7255	459	DX	0.0023013	47.571	1025	DX
118	29	4	ST01	3.800	0.7078	9047	DY	0.0014264	47.591	1025	DX
119	29	5	ST01	3.800	7.6022	459	DY	0.0056933	49.908	1025	DX
120	29	6	ST01	3.800	1.0217	459	DY	0.0005316	47.561	1025	DX
121	29	7	ST01	3.800	0.8945	459	DY	0.0004629	47.572	1025	DX
122	29	8	ST01	3.800	0.7494	459	DY	0.0004100	47.549	1025	DX
123	29	9	ST01	3.800	0.6299	9047	DY	0.0003887	47.496	1025	DX
124	29	10	ST01	3.800	0.6114	9047	DY	0.0003641	47.471	1025	DX
125	29	11	ST01	3.800	0.5936	9047	DY	0.0003393	47.447	1025	DX
126	29	12	ST01	3.800	7.1397	459	DY	0.0054266	49.892	1025	DX
127	29	13	ST01	3.800	1.2793	459	DY	0.0005099	47.521	1025	DX
128	29	14	ST01	3.800	1.1874	459	DY	0.0007018	47.537	1025	DX
129	29	15	ST01	3.800	1.0193	459	DY	0.0006352	47.516	1025	DX
130	29	16	ST01	3.800	0.8748	459	DY	0.0005751	47.496	1025	DX
131	29	17	ST01	3.800	0.7425	459	DY	0.0004962	47.476	1025	DX
132	29	18	ST01	3.800	0.6349	459	DY	0.0004459	47.457	1025	DX
133	29	19	ST01	3.800	6.9916	459	DY	0.0053224	49.890	1025	DX
133	29	20	ST01	3.800	0.0528	459	DY	0.0000371	47.773	1025	DX
135	30	1	ST01	4.000	14.4796	459	DY	0.0064354	51.040	1025	DX
136	30	2	ST01	4.000	13.1931	459	DY	0.0054080	52.255	1025	DX
137	30	3	ST01	4.000	11.7671	459	DY	0.0034733	51.234	1025	DX
138	30	4	ST01	4.000	13.4450	459	DY	0.0052313	52.435	1025	DX
139	30	5	ST01	4.000	1.7035	459	DY	0.0021947	51.046	1025	DX
140	30	6	ST01	4.000	1.0658	9047	DY	0.0011865	50.795	1025	DX
141	30	7	ST01	4.000	1.9804	459	DY	0.0017630	51.158	1025	DX

142	30	8	ST01	4.000	0.7200	459	DY	0.0008009	50.875	1025 DX
143	30	9	ST01	4.000	0.8398	459	DY	0.0009475	51.043	1025 DX
144	30	10	ST01	4.000	0.9104	459	DY	0.0005890	50.743	1025 DX
145	30	11	ST01	4.000	0.8804	459	DY	0.0007834	50.955	1025 DX
146	30	12	ST01	4.000	0.9050	459	DY	0.0006502	50.687	1025 DX
147	30	13	ST01	4.000	0.8595	459	DY	0.0007006	50.914	1025 DX
148	30	14	ST01	4.000	0.2462	461	DY	0.0007242	50.948	1025 DX
149	30	15	ST01	4.000	0.9972	459	DY	0.0010083	50.689	1025 DX
150	30	16	ST01	4.000	0.4363	459	DY	0.0010315	50.956	1025 DX
151	30	17	ST01	4.000	0.7440	459	DY	0.0008499	50.681	1025 DX
152	30	18	ST01	4.000	1.0164	459	DY	0.0009157	50.932	1025 DX
153	30	19	ST01	4.000	0.9985	459	DY	0.0008619	50.680	1025 DX
153	30	20	ST01	4.000	0.5082	459	DY	0.0004578	50.855	1025 DX
155	31	1	ST01	4.200	2.0848	459	DY	0.0016744	53.579	1025 DX
156	31	2	ST01	4.200	1.7620	459	DY	0.0022459	53.808	1025 DX
157	31	3	ST01	4.200	0.8254	558	DY	0.0025554	53.963	1025 DX
158	31	4	ST01	4.200	1.4006	459	DY	0.0028844	54.419	1025 DX
159	31	5	ST01	4.200	1.4637	459	DY	0.0030470	54.253	1025 DX
160	31	6	ST01	4.200	0.8788	558	DY	0.0032270	54.340	1025 DX
161	31	7	ST01	4.200	1.1022	558	DY	0.0034537	54.449	1025 DX
162	31	8	ST01	4.200	1.1202	902	DX	0.0057361	54.469	1025 DX
163	31	9	ST01	4.200	1.3577	902	DX	0.0068062	54.555	1025 DX
164	31	10	ST01	4.200	1.5228	902	DX	0.0072788	54.657	1025 DX
165	31	11	ST01	4.200	1.6989	902	DX	0.0074965	54.777	1025 DX
166	31	12	ST01	4.200	1.5868	459	DY	0.0044159	54.495	1025 DX
167	31	13	ST01	4.200	1.4813	459	DY	0.0050990	54.905	1025 DX
168	31	14	ST01	4.200	1.5888	459	DY	0.0058009	54.855	1025 DX
169	31	15	ST01	4.200	1.1165	88N	DX	0.0063879	55.038	1025 DX
170	31	16	ST01	4.200	1.6918	459	DY	0.0069093	55.609	1025 DX
171	31	17	ST01	4.200	1.4858	459	DY	0.0065922	55.688	1025 DX

172	31	18	ST01	4.200	1.0898	3523	DX	0.0062235	55.916	1025	DX
173	31	19	ST01	4.200	1.1522	3523	DX	0.0061614	56.179	1025	DX
173	31	20	ST01	4.200	0.5449	3523	DX	0.0031118	55.696	1025	DX
175	32	1	ST01	4.400	3.0895	3523	DX	0.0029111	60.357	1025	DX
176	32	2	ST01	4.400	6.8738	459	DY	0.0054057	60.116	A031	DX
177	32	3	ST01	4.400	1.7594	558	DY	0.0034849	61.024	A031	DX
178	32	4	ST01	4.400	1.3353	558	DY	0.0022325	61.378	A031	DX
179	32	5	ST01	4.400	1.3008	3096	DX	0.0018499	61.850	A031	DX
180	32	6	ST01	4.400	1.5815	4016	DX	0.0030254	62.394	A031	DX
181	32	7	ST01	4.400	1.8823	4016	DX	0.0053401	63.076	A031	DX
182	32	8	ST01	4.400	2.1632	4016	DX	0.0054338	63.837	A031	DX
183	32	9	ST01	4.400	1.8232	4016	DX	0.0033688	64.299	A031	DX
184	32	10	ST01	4.400	1.7584	560	DY	0.0059129	64.740	A031	DX
185	32	11	ST01	4.400	1.8557	560	DY	0.0060112	65.289	A031	DX
186	32	12	ST01	4.400	1.9254	4016	DX	0.0066479	65.949	A031	DX
187	32	13	ST01	4.400	2.0366	4016	DX	0.0071779	66.575	A031	DX
188	32	14	ST01	4.400	2.1121	4016	DX	0.0073586	67.226	A031	DX
189	32	15	ST01	4.400	2.1792	560	DY	0.0092593	67.790	A031	DX
190	32	16	ST01	4.400	4.7550	560	DY	0.0073484	67.998	A031	DX
191	32	17	ST01	4.400	5.2477	558	DY	0.0199432	69.025	A031	DX
192	32	18	ST01	4.400	4.6857	560	DY	0.0077904	68.943	A031	DX
193	32	19	ST01	4.400	3.8504	560	DY	0.0127643	69.757	A031	DX
193	32	20	ST01	4.400	2.3429	560	DY	0.0038952	68.618	A031	DX
195	33	1	ST01	4.600	5.8801	560	DY	0.0039681	74.005	A031	DX
196	33	2	ST01	4.600	2.6132	558	DY	0.0157845	75.168	A031	DX
197	33	3	ST01	4.600	4.7146	558	DY	0.0207936	76.663	A031	DX
198	33	4	ST01	4.600	2.5011	558	DY	0.0101444	76.852	A031	DX
199	33	5	ST01	4.600	1.4758	560	DY	0.0042555	77.534	A031	DX
200	33	6	ST01	4.600	1.3153	3523	DX	0.0030178	78.026	A031	DX
201	33	7	ST01	4.600	2.6745	9047	DY	0.0112111	78.173	A031	DX

202 33 8 ST01 4.600 2.8162 461 DY 0.0043303 78.855 A031 DX

203 33 9 ST01 4.600 2.4035 3523 DX 0.0039678 80.051 A031 DX

204 33 10 ST01 4.600 2.2761 3523 DX 0.0037501 80.771 A031 DX

205 33 11 ST01 4.600 1.5902 3523 DX 0.0032889 81.081 A031 DX

206 33 12 ST01 4.600 2.1613 558 DY 0.0028611 81.440 A031 DX

207 33 13 ST01 4.600 1.5840 3523 DX 0.0035066 82.142 A031 DX

208 33 14 ST01 4.600 1.3970 9047 DY 0.0033727 82.430 A031 DX

209 33 15 ST01 4.600 1.4125 88N DX 0.0035222 82.947 A031 DX

210 33 16 ST01 4.600 2.4238 558 DY 0.0052343 83.439 A031 DX

211 33 17 ST01 4.600 1.3770 929 DX 0.0038920 83.773 A031 DX

212 33 18 ST01 4.600 3.6188 560 DY 0.0152437 84.803 A031 DX

213 33 19 ST01 4.600 2.5196 902 DX 0.0057876 85.395 A031 DX

213 33 20 ST01 4.600 1.3770 560 DY 0.0058004 83.912 A031 DX

215 34 1 ST01 4.800 4.2575 459 DY 0.0103158 90.780 A031 DX

216 34 2 ST01 4.800 10.1558 459 DY 0.0070809 93.360 A031 DX

217 34 3 ST01 4.800 6.2504 459 DY 0.0072958 94.751 A031 DX

218 34 4 ST01 4.800 3.7328 459 DY 0.0083005 95.404 A031 DX

219 34 5 ST01 4.800 3.6866 902 DX 0.0069554 96.796 A031 DX

220 34 6 ST01 4.800 4.5364 459 DY 0.0074320 96.762 A031 DX

221 34 7 ST01 4.800 4.4992 459 DY 0.0044635 98.103 A031 DX

222 34 8 ST01 4.800 4.0915 459 DY 0.0043616 98.702 A031 DX

223 34 9 ST01 4.800 4.3663 461 DY 0.0085804 99.278 A031 DX

224 34 10 ST01 4.800 3.3298 461 DY 0.0052661 100.088 A031 DX

225 34 11 ST01 4.800 3.6564 459 DY 0.0026612 100.853 A031 DX

226 34 12 ST01 4.800 4.1585 459 DY 0.0060098 101.439 A031 DX

227 34 13 ST01 4.800 6.6514 461 DY 0.0098123 102.286 A031 DX

228 34 14 ST01 4.800 11.2447 461 DY 0.0046322 103.115 A031 DX

229 34 15 ST01 4.800 7.4393 461 DY 0.0053137 103.448 A031 DX

230 34 16 ST01 4.800 5.7371 459 DY 0.0047483 104.264 A031 DX

231 34 17 ST01 4.800 6.5747 459 DY 0.0045091 104.655 A031 DX

232 34 18 ST01 4.800 7.6612 459 DY 0.0127414 104.886 A031 DX

233 34 19 ST01 4.800 8.9686 459 DY 0.0047287 106.254 A031 DX

233 34 20 ST01 4.800 3.8306 459 DY 0.0063707 104.500 A031 DX

235 35 1 ST01 5.000 33.3900 459 DY 0.0155841 111.522 A031 DX

236 35 2 ST01 5.000 119.3096 459 DY 0.0328635 117.001 A031 DX

237 35 3 ST01 5.000 37.7829 459 DY 0.0136384 115.768 A031 DX

238 35 4 ST01 5.000 21.3642 459 DY 0.0108880 116.597 A031 DX

239 35 5 ST01 5.000 22.3914 459 DY 0.0126121 117.084 A031 DX

240 35 6 ST01 5.000 33.8795 459 DY 0.0271469 120.005 A031 DX

241 35 7 ST01 5.000 50.4851 459 DY 0.0179677 120.569 A031 DX

242 35 8 ST01 5.000 81.3506 459 DY 0.0288531 124.815 A031 DX

243 35 9 ST01 5.000 131.0320 459 DY 0.0444093 127.635 A031 DX

244 35 10 ST01 5.000 213.2081 459 DY 0.0711785 172.341 459 DY

245 35 11 ST01 5.000 438.1344 459 DY 0.1931357 -372.397 459 DY

246 35 12 ST01 5.0001134.7873 459 DY 0.1844826 987.316 459 DY

247 35 13 ST01 5.0001309.6580 459 DY 6.7250661 -1018.995 459 DY

247 35 14 ST01 5.000 654.8290 459 DY 3.3625331 418.655 459 DX

APPENDIX C

SACS collapse output file (Changed in CdCm values)

```
**** NON-LINEAR COLLAPSE ANALYSIS (LOAD SEQUENCE 1) ****

           LOAD  LOAD    *DEFLECTION*     ROTATION    ** DEFLECTION **  % OF IMPACT

 NSLV INC. LOOP CASE FACTOR   DIFF. JNT DOF   DIFFERENCE   MAXIMUM  JNT DOF    ENERGY

  2    1    1   DL   0.200   0.0026 9463 DX   0.0000066    -1.474 8013 DZ

  2    1    2   DL   0.200   0.0000 8013 DZ   0.0000000    -1.474 8013 DZ

  4    2    1   DL   0.400   0.0055 9463 DX   0.0000126    -2.949 8013 DZ

  4    2    2   DL   0.400   0.0000 8013 DZ   0.0000000    -2.949 8013 DZ

  6    3    1   DL   0.600   0.0083 9463 DX   0.0000187    -4.425 8013 DZ

  6    3    2   DL   0.600   0.0000 8013 DZ   0.0000000    -4.424 8013 DZ

  8    4    1   DL   0.800   0.0112 9463 DX   0.0000247    -5.901 8013 DZ

  8    4    2   DL   0.800   0.0000 8013 DZ   0.0000000    -5.900 8013 DZ

 10    5    1   DL   1.000   0.0141 9463 DX   0.0000307    -7.377 8013 DZ

 10    5    2   DL   1.000   0.0000 8013 DZ   0.0000000    -7.376 8013 DZ

 12    6    1 LL01   0.200   0.0133 7406 DX   0.0000386    -7.461 8013 DZ

 12    6    2 LL01   0.200   0.0000 7406 DZ   0.0000000    -7.460 8013 DZ

 14    7    1 LL01   0.400   0.0197 7406 DX   0.0000487    -8.759 7406 DZ

 14    7    2 LL01   0.400   0.0000 7406 DZ   0.0000000    -8.761 7406 DZ

 16    8    1 LL01   0.600   0.0261 7406 DX   0.0000587   -11.036 7406 DZ

 16    8    2 LL01   0.600   0.0000 7406 DZ   0.0000000   -11.040 7406 DZ

 18    9    1 LL01   0.800   0.0326 7406 DX   0.0000688   -13.312 7406 DZ

 18    9    2 LL01   0.800   0.0000 7406 DZ   0.0000000   -13.317 7406 DZ

 20   10    1 LL01   1.000   0.0389 7406 DX   0.0000789   -15.585 7406 DZ

 20   10    2 LL01   1.000   0.0000 7406 DZ   0.0000000   -15.592 7406 DZ

 22   11    1 ST01   0.200   0.0105 1025 DX   0.0000134   -15.475 7406 DZ

 22   11    2 ST01   0.200   0.0000 1025 DX   0.0000000   -15.477 7406 DZ

 24   12    1 ST01   0.400   0.0104 1025 DX   0.0000191   -15.366 7406 DZ

 24   12    2 ST01   0.400   0.0000 1025 DX   0.0000000   -15.367 7406 DZ

 26   13    1 ST01   0.600   0.0105 1025 DX   0.0000269   -15.258 7406 DZ
```

26	13	2	ST01	0.600	0.0000	1025	DX	0.0000000	-15.259	7406	DZ
28	14	1	ST01	0.800	0.0105	1023	DX	0.0000312	-15.149	7406	DZ
28	14	2	ST01	0.800	0.0000	1025	DX	0.0000000	-15.150	7406	DZ
30	15	1	ST01	1.000	0.0105	1023	DX	0.0000200	-15.041	7406	DZ
30	15	2	ST01	1.000	0.0000	1025	DX	0.0000000	-15.042	7406	DZ
32	16	1	ST01	1.200	0.0106	1023	DX	0.0000180	-14.933	7406	DZ
32	16	2	ST01	1.200	0.0000	1025	DX	0.0000000	-14.934	7406	DZ
34	17	1	ST01	1.400	0.0106	1023	DX	0.0000121	-14.825	7406	DZ
34	17	2	ST01	1.400	0.0000	1025	DX	0.0000000	-14.826	7406	DZ
36	18	1	ST01	1.600	0.0107	1023	DX	0.0000090	-14.718	7406	DZ
36	18	2	ST01	1.600	0.0000	1025	DX	0.0000000	-14.718	7406	DZ
38	19	1	ST01	1.800	0.0107	1023	DX	0.0000105	-14.611	7406	DZ
38	19	2	ST01	1.800	0.0000	1025	DX	0.0000000	-14.611	7406	DZ
40	20	1	ST01	2.000	0.0107	1023	DX	0.0000089	16.513	1025	DX
40	20	2	ST01	2.000	0.0000	1025	DX	0.0000000	16.502	1025	DX
42	21	1	ST01	2.200	0.0108	1023	DX	0.0000088	18.585	1025	DX
42	21	2	ST01	2.200	0.0000	1025	DX	0.0000000	18.575	1025	DX
44	22	1	ST01	2.400	0.0108	1023	DX	0.0000091	20.658	1025	DX
44	22	2	ST01	2.400	0.0000	1025	DX	0.0000000	20.647	1025	DX
46	23	1	ST01	2.600	0.0109	1023	DX	0.0000099	22.730	1025	DX
46	23	2	ST01	2.600	0.0000	1025	DX	0.0000000	22.720	1025	DX
48	24	1	ST01	2.800	0.0109	1023	DX	0.0000106	24.803	1025	DX
48	24	2	ST01	2.800	0.0000	1025	DX	0.0000000	24.792	1025	DX
50	25	1	ST01	3.000	0.0109	1023	DX	0.0000113	26.875	1025	DX
50	25	2	ST01	3.000	0.0000	1025	DX	0.0000000	26.865	1025	DX
52	26	1	ST01	3.200	0.0110	1023	DX	0.0000121	28.948	1025	DX
52	26	2	ST01	3.200	0.0000	1025	DX	0.0000000	28.937	1025	DX
54	27	1	ST01	3.400	0.0110	1023	DX	0.0000128	31.021	1025	DX
54	27	2	ST01	3.400	0.0000	1025	DX	0.0000000	31.010	1025	DX
56	28	1	ST01	3.600	0.0113	1023	DX	0.0000136	33.094	1025	DX

*** MEMBER A045-501X HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

57 28 1 ST01 3.600 3.6749 A031 DX 0.0066727 32.947 1025 DX

58 28 2 ST01 3.600 1.0701 A031 DX 0.0019034 32.898 1025 DX

59 28 3 ST01 3.600 0.3214 A031 DX 0.0005599 32.884 1025 DX

60 28 4 ST01 3.600 0.1022 A031 DX 0.0001734 32.880 1025 DX

61 28 5 ST01 3.600 0.0342 A031 DX 0.0000566 32.879 1025 DX

61 28 6 ST01 3.600 0.1022 A031 DX 0.0001734 32.880 1025 DX

63 29 1 ST01 3.800 0.0748 A031 DX 0.0001217 34.940 1025 DX

63 29 2 ST01 3.800 0.0000 1025 DX 0.0000000 34.933 1025 DX

65 30 1 ST01 4.000 0.0847 A031 DX 0.0001390 37.002 1025 DX

65 30 2 ST01 4.000 0.0000 1025 DX 0.0000000 36.995 1025 DX

67 31 1 ST01 4.200 0.0874 A031 DX 0.0001437 39.063 1025 DX

67 31 2 ST01 4.200 0.0000 1025 DX 0.0000000 39.056 1025 DX

69 32 1 ST01 4.400 0.0903 A031 DX 0.0001463 41.124 1025 DX

*** MEMBER 649- 650 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

70 32 1 ST01 4.400 0.7347 660 DZ 0.0016959 41.090 1025 DX

71 32 2 ST01 4.400 0.1013 A031 DX 0.0002333 41.084 1025 DX

72 32 3 ST01 4.400 0.0286 A031 DX 0.0000448 41.082 1025 DX

72 32 4 ST01 4.400 0.1013 A031 DX 0.0002333 41.084 1025 DX

74 33 1 ST01 4.600 0.0824 A031 DX 0.0001250 43.141 1025 DX

74 33 2 ST01 4.600 0.0000 1025 DX 0.0000000 43.136 1025 DX

76 34 1 ST01 4.800 0.0975 A031 DX 0.0001491 45.200 1025 DX

76 34 2 ST01 4.800 0.0000 1025 DX 0.0000000 45.195 1025 DX

78 35 1 ST01 5.000 0.1046 A031 DX 0.0001581 47.258 1025 DX

79 35 2 ST01 5.000 0.0341 A031 DX 0.0000520 47.256 1025 DX

*** MEMBER 649- 633 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

80 35 1 ST01 5.000 0.3223 653 DZ 0.0009155 47.239 1025 DX

81 35 2 ST01 5.000 0.0615 A031 DX 0.0001269 47.234 1025 DX

81 35 3 ST01 5.000 0.3223 653 DZ 0.0009155 47.239 1025 DX

APPENDIX D

SACS collapse output file (Changed in allowable corrosion thickness)

**** NON-LINEAR COLLAPSE ANALYSIS (LOAD SEQUENCE 1) ****

LOAD LOAD *DEFLECTION* ROTATION ** DEFLECTION ** % OF IMPACT

NSLV INC. LOOP CASE FACTOR DIFF. JNT DOF DIFFERENCE MAXIMUM JNT DOF ENERGY

2 1 1 DL 0.200 0.0037 348 DY 0.0000067 -1.475 8013 DZ

2 1 2 DL 0.200 0.0000 8013 DZ 0.0000000 -1.474 8013 DZ

4 2 1 DL 0.400 0.0074 348 DY 0.0000127 -2.949 8013 DZ

4 2 2 DL 0.400 0.0000 8013 DZ 0.0000000 -2.949 8013 DZ

6 3 1 DL 0.600 0.0110 348 DY 0.0000187 -4.425 8013 DZ

6 3 2 DL 0.600 0.0000 8013 DZ 0.0000000 -4.425 8013 DZ

8 4 1 DL 0.800 0.0147 9463 DX 0.0000247 -5.901 8013 DZ

8 4 2 DL 0.800 0.0000 8013 DZ 0.0000000 -5.900 8013 DZ

10 5 1 DL 1.000 0.0185 9463 DX 0.0000307 -7.377 8013 DZ

10 5 2 DL 1.000 0.0000 8013 DZ 0.0000000 -7.377 8013 DZ

12 6 1 LL01 0.200 0.0140 7406 DX 0.0000382 -7.460 8013 DZ

12 6 2 LL01 0.200 0.0000 7406 DZ 0.0000000 -7.459 8013 DZ

14 7 1 LL01 0.400 0.0208 7406 DX 0.0000483 -8.842 7406 DZ

14 7 2 LL01 0.400 0.0000 7406 DZ 0.0000000 -8.844 7406 DZ

16 8 1 LL01 0.600 0.0275 7406 DX 0.0000583 -11.145 7406 DZ

16 8 2 LL01 0.600 0.0000 7406 DZ 0.0000000 -11.149 7406 DZ

18 9 1 LL01 0.800 0.0343 7406 DX 0.0000683 -13.447 7406 DZ

18 9 2 LL01 0.800 0.0000 7406 DZ 0.0000000 -13.452 7406 DZ

20 10 1 LL01 1.000 0.0410 7406 DX 0.0000783 -15.745 7406 DZ

20 10 2 LL01 1.000 0.0000 7406 DZ 0.0000000 -15.753 7406 DZ

22 11 1 ST01 0.200 0.0152 559 DX 0.0000245 -15.652 7406 DZ

22 11 2 ST01 0.200 0.0000 1025 DX 0.0000000 -15.654 7406 DZ

24 12 1 ST01 0.400 0.0153 559 DX 0.0000374 -15.560 7406 DZ

24 12 2 ST01 0.400 0.0000 1025 DX 0.0000000 -15.561 7406 DZ

26 13 1 ST01 0.600 0.0152 559 DX 0.0000358 -15.469 7406 DZ

```
 26  13   2 ST01   0.600   0.0000 1025 DX   0.0000000   -15.469 7406 DZ
 28  14   1 ST01   0.800   0.0151  559 DX   0.0000275   -15.377 7406 DZ
 28  14   2 ST01   0.800   0.0000 1025 DX   0.0000000   -15.378 7406 DZ
 30  15   1 ST01   1.000   0.0149  559 DX   0.0000172   -15.287 7406 DZ
 30  15   2 ST01   1.000   0.0000 1025 DX   0.0000000   -15.287 7406 DZ
 32  16   1 ST01   1.200   0.0147  559 DX   0.0000131   -15.196 7406 DZ
 32  16   2 ST01   1.200   0.0000 1025 DX   0.0000000   -15.196 7406 DZ
 34  17   1 ST01   1.400   0.0144  559 DX   0.0000131   -15.107 7406 DZ
*** MEMBER A045-501X HAS LOCAL BUCKLING FAILURE AT SEGMENT  1
 35  17   1 ST01   1.400   2.5880 A031 DX   0.0050116    15.171 A031 DX
 36  17   2 ST01   1.400   0.6792 A031 DX   0.0012686    15.850 A031 DX
 37  17   3 ST01   1.400   0.1825 A031 DX   0.0003345    16.033 A031 DX
 38  17   4 ST01   1.400   0.0522 A031 DX   0.0000931    16.085 A031 DX
 38  17   5 ST01   1.400   0.1825 A031 DX   0.0003345    16.033 A031 DX
 40  18   1 ST01   1.600   0.1176 A031 DX   0.0001993    18.258 A031 DX
 41  18   2 ST01   1.600   0.0295 A031 DX   0.0000530    18.287 A031 DX
 41  18   3 ST01   1.600   0.1176 A031 DX   0.0001993    18.258 A031 DX
 43  19   1 ST01   1.800   0.1096 A031 DX   0.0001858    20.451 A031 DX
 44  19   2 ST01   1.800   0.0271 A031 DX   0.0000488    20.479 A031 DX
 44  19   3 ST01   1.800   0.1096 A031 DX   0.0001858    20.451 A031 DX
 46  20   1 ST01   2.000   0.1078 A031 DX   0.0001832    22.641 A031 DX
 47  20   2 ST01   2.000   0.0268 A031 DX   0.0000481    22.668 A031 DX
 47  20   3 ST01   2.000   0.1078 A031 DX   0.0001832    22.641 A031 DX
 49  21   1 ST01   2.200   0.1071 A031 DX   0.0001820    24.829 A031 DX
 50  21   2 ST01   2.200   0.0270 A031 DX   0.0000478    24.856 A031 DX
 50  21   3 ST01   2.200   0.1071 A031 DX   0.0001820    24.829 A031 DX
 52  22   1 ST01   2.400   0.1088 A031 DX   0.0001819    27.019 A031 DX
 53  22   2 ST01   2.400   0.0278 A031 DX   0.0000484    27.047 A031 DX
*** MEMBER  649- 650 HAS LOCAL BUCKLING FAILURE AT SEGMENT  1
 54  22   1 ST01   2.400   0.7369  660 DZ   0.0016982    27.649 A031 DX
```

55 22 2 ST01 2.400 0.1005 660 DZ 0.0002375 27.733 A031 DX

56 22 3 ST01 2.400 0.0206 A031 DX 0.0000334 27.754 A031 DX

56 22 4 ST01 2.400 0.1005 660 DZ 0.0002375 27.733 A031 DX

58 23 1 ST01 2.600 0.1236 A031 DX 0.0001923 29.960 A031 DX

59 23 2 ST01 2.600 0.0322 A031 DX 0.0000530 29.993 A031 DX

*** MEMBER 649- 633 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

60 23 1 ST01 2.600 0.3268 653 DZ 0.0009336 30.313 A031 DX

61 23 2 ST01 2.600 0.0530 A031 DX 0.0001266 30.366 A031 DX

61 23 3 ST01 2.600 0.3268 653 DZ 0.0009336 30.313 A031 DX

63 24 1 ST01 2.800 0.1345 A031 DX 0.0002059 32.597 A031 DX

64 24 2 ST01 2.800 0.0362 A031 DX 0.0000580 32.633 A031 DX

64 24 3 ST01 2.800 0.1345 A031 DX 0.0002059 32.597 A031 DX

66 25 1 ST01 3.000 0.1449 A031 DX 0.0002132 34.873 A031 DX

67 25 2 ST01 3.000 0.0428 A031 DX 0.0000646 34.916 A031 DX

67 25 3 ST01 3.000 0.1449 A031 DX 0.0002132 34.873 A031 DX

69 26 1 ST01 3.200 0.1581 A031 DX 0.0002243 37.169 A031 DX

70 26 2 ST01 3.200 0.0481 A031 DX 0.0000706 37.217 A031 DX

70 26 3 ST01 3.200 0.1581 A031 DX 0.0002243 37.169 A031 DX

72 27 1 ST01 3.400 0.1725 A031 DX 0.0002352 39.484 A031 DX

73 27 2 ST01 3.400 0.0527 A031 DX 0.0000755 39.537 A031 DX

*** MEMBER 518- 521 HAS LOCAL BUCKLING FAILURE AT SEGMENT 9

74 27 1 ST01 3.400 0.3979 505 DX 0.0012794 39.585 A031 DX

75 27 2 ST01 3.400 0.0402 505 DX 0.0000680 39.595 A031 DX

*** MEMBER 514- 519 HAS LOCAL BUCKLING FAILURE AT SEGMENT 9

76 27 1 ST01 3.400 0.5807 511 DX 0.0014940 39.627 A031 DX

77 27 2 ST01 3.400 0.0552 514 DX 0.0000795 39.630 A031 DX

*** MEMBER 514- 519 HAS LOCAL BUCKLING FAILURE AT SEGMENT 3

78 27 1 ST01 3.400 1.6755 511 DX 0.0076244 39.661 A031 DX

79 27 2 ST01 3.400 0.4987 511 DX 0.0012029 39.668 A031 DX

80 27 3 ST01 3.400 0.3679 514 DZ 0.0006422 39.675 A031 DX

81 27 4 ST01 3.400 0.4280 514 DZ 0.0007640 39.682 A031 DX

82 27 5 ST01 3.400 0.4383 514 DZ 0.0007919 39.685 A031 DX

83 27 6 ST01 3.400 0.4452 514 DZ 0.0008114 39.688 A031 DX

84 27 7 ST01 3.400 0.4500 514 DZ 0.0008248 39.692 A031 DX

85 27 8 ST01 3.400 0.4544 514 DZ 0.0008358 39.695 A031 DX

86 27 9 ST01 3.400 0.4594 514 DZ 0.0008463 39.698 A031 DX

87 27 10 ST01 3.400 0.4643 514 DZ 0.0008563 39.701 A031 DX

88 27 11 ST01 3.400 0.4666 514 DZ 0.0008622 39.705 A031 DX

89 27 12 ST01 3.400 0.4630 514 DZ 0.0008594 39.708 A031 DX

90 27 13 ST01 3.400 0.4567 514 DZ 0.0008511 39.711 A031 DX

91 27 14 ST01 3.400 0.4466 514 DZ 0.0008359 39.714 A031 DX

92 27 15 ST01 3.400 0.4357 514 DZ 0.0008178 39.717 A031 DX

93 27 16 ST01 3.400 0.4236 514 DZ 0.0007965 39.720 A031 DX

94 27 17 ST01 3.400 0.4087 514 DZ 0.0007705 39.723 A031 DX

95 27 18 ST01 3.400 0.3935 514 DZ 0.0007431 39.725 A031 DX

96 27 19 ST01 3.400 0.3755 514 DZ 0.0007112 39.728 A031 DX

96 27 20 ST01 3.400 0.1967 514 DZ 0.0003715 39.723 A031 DX

98 28 1 ST01 3.600 0.3252 514 DZ 0.0006316 41.984 A031 DX

99 28 2 ST01 3.600 0.3104 514 DZ 0.0005688 42.038 A031 DX

100 28 3 ST01 3.600 0.2903 514 DZ 0.0005396 42.059 A031 DX

101 28 4 ST01 3.600 0.2655 514 DZ 0.0004965 42.070 A031 DX

102 28 5 ST01 3.600 0.2380 514 DZ 0.0004458 42.076 A031 DX

103 28 6 ST01 3.600 0.2116 514 DZ 0.0003970 42.081 A031 DX

104 28 7 ST01 3.600 0.1857 514 DZ 0.0003480 42.084 A031 DX

105 28 8 ST01 3.600 0.1010 514 DZ 0.0001696 42.083 A031 DX

106 28 9 ST01 3.600 0.0542 514 DZ 0.0000915 42.085 A031 DX

*** MEMBER 518- 521 HAS LOCAL BUCKLING FAILURE AT SEGMENT 3

107 28 1 ST01 3.600 5.0042 508 DX 0.0135035 42.194 A031 DX

108 28 2 ST01 3.600 1.4345 514 DZ 0.0027329 42.183 A031 DX

109 28 3 ST01 3.600 1.4474 508 DX 0.0018768 42.208 A031 DX

110 28 4 ST01 3.600 0.9938 508 DX 0.0012913 42.206 A031 DX

111 28 5 ST01 3.600 0.7397 508 DX 0.0009780 42.207 A031 DX

112 28 6 ST01 3.600 0.5872 508 DX 0.0007960 42.209 A031 DX

113 28 7 ST01 3.600 0.4681 508 DX 0.0006907 42.211 A031 DX

114 28 8 ST01 3.600 0.3862 518 DZ 0.0006604 42.213 A031 DX

115 28 9 ST01 3.600 0.4292 518 DZ 0.0007257 42.217 A031 DX

116 28 10 ST01 3.600 0.4634 518 DZ 0.0007866 42.220 A031 DX

117 28 11 ST01 3.600 0.4787 518 DZ 0.0008268 42.222 A031 DX

118 28 12 ST01 3.600 0.4911 518 DZ 0.0008599 42.225 A031 DX

119 28 13 ST01 3.600 0.4918 518 DZ 0.0008716 42.228 A031 DX

120 28 14 ST01 3.600 0.5102 518 DZ 0.0009141 42.230 A031 DX

121 28 15 ST01 3.600 0.4755 518 DZ 0.0008602 42.232 A031 DX

122 28 16 ST01 3.600 0.4742 518 DZ 0.0008562 42.234 A031 DX

123 28 17 ST01 3.600 0.4637 518 DZ 0.0008393 42.236 A031 DX

124 28 18 ST01 3.600 0.4510 518 DZ 0.0008190 42.238 A031 DX

125 28 19 ST01 3.600 0.6556 518 DZ 0.0011153 42.242 A031 DX

125 28 20 ST01 3.600 0.2255 518 DZ 0.0004095 42.236 A031 DX

127 29 1 ST01 3.800 0.1969 514 DZ 0.0005390 44.536 A031 DX

128 29 2 ST01 3.800 1.0183 518 DZ 0.0016077 44.618 A031 DX

129 29 3 ST01 3.800 0.7693 518 DZ 0.0012083 44.619 A031 DX

130 29 4 ST01 3.800 0.6180 518 DZ 0.0009672 44.621 A031 DX

131 29 5 ST01 3.800 0.5307 518 DZ 0.0008649 44.624 A031 DX

132 29 6 ST01 3.800 0.4791 518 DZ 0.0008059 44.628 A031 DX

133 29 7 ST01 3.800 0.4443 518 DZ 0.0007656 44.631 A031 DX

134 29 8 ST01 3.800 0.4287 518 DZ 0.0007455 44.635 A031 DX

135 29 9 ST01 3.800 0.4140 518 DZ 0.0007274 44.638 A031 DX

136 29 10 ST01 3.800 0.4039 518 DZ 0.0007157 44.641 A031 DX

137 29 11 ST01 3.800 0.3974 518 DZ 0.0007094 44.644 A031 DX

138 29 12 ST01 3.800 0.3904 518 DZ 0.0007000 44.646 A031 DX

139 29 13 ST01 3.800 0.3836 518 DZ 0.0006903 44.649 A031 DX

140	29	14	ST01	3.800	0.3803	518	DZ	0.0006840	44.651	A031	DX
141	29	15	ST01	3.800	0.3700	518	DZ	0.0006708	44.653	A031	DX
142	29	16	ST01	3.800	0.3645	518	DZ	0.0006621	44.655	A031	DX
143	29	17	ST01	3.800	0.3586	518	DZ	0.0006527	44.657	A031	DX
144	29	18	ST01	3.800	0.3525	518	DZ	0.0006429	44.659	A031	DX
145	29	19	ST01	3.800	0.3462	518	DZ	0.0006327	44.661	A031	DX
145	29	20	ST01	3.800	0.0682	518	DZ	0.0001243	44.648	A031	DX
147	30	1	ST01	4.000	0.4068	514	DZ	0.0009737	47.044	A031	DX
148	30	2	ST01	4.000	1.0072	518	DZ	0.0016055	47.183	A031	DX
149	30	3	ST01	4.000	0.1502	518	DZ	0.0006820	47.192	A031	DX
150	30	4	ST01	4.000	0.1692	518	DZ	0.0006384	47.216	A031	DX
151	30	5	ST01	4.000	0.1777	518	DZ	0.0005927	47.242	A031	DX
152	30	6	ST01	4.000	0.1740	518	DZ	0.0005532	47.265	A031	DX
153	30	7	ST01	4.000	0.1677	518	DZ	0.0005193	47.286	A031	DX
154	30	8	ST01	4.000	0.1928	459	DY	0.0007343	47.306	A031	DX
155	30	9	ST01	4.000	0.1666	459	DY	0.0006778	47.327	A031	DX
156	30	10	ST01	4.000	0.1482	459	DY	0.0006314	47.348	A031	DX
157	30	11	ST01	4.000	0.1369	459	DY	0.0005852	47.370	A031	DX
158	30	12	ST01	4.000	0.1268	459	DY	0.0005605	47.391	A031	DX
159	30	13	ST01	4.000	0.1213	459	DY	0.0005385	47.411	A031	DX
160	30	14	ST01	4.000	0.1260	459	DY	0.0005205	47.430	A031	DX
161	30	15	ST01	4.000	0.1089	459	DY	0.0004846	47.447	A031	DX
162	30	16	ST01	4.000	0.1089	459	DY	0.0004688	47.464	A031	DX
163	30	17	ST01	4.000	0.1093	459	DY	0.0004544	47.481	A031	DX
164	30	18	ST01	4.000	0.1105	459	DY	0.0004414	47.497	A031	DX
165	30	19	ST01	4.000	0.1116	459	DY	0.0004283	47.514	A031	DX
165	30	20	ST01	4.000	0.0552	459	DY	0.0002207	47.481	A031	DX
167	31	1	ST01	4.200	0.7890	518	DZ	0.0022245	50.096	A031	DX
168	31	2	ST01	4.200	1.1270	518	DZ	0.0022921	50.440	A031	DX
169	31	3	ST01	4.200	0.7476	459	DY	0.0027302	50.571	A031	DX

170	31	4	ST01	4.200	0.7958	459	DY	0.0028276	50.743	A031	DX
171	31	5	ST01	4.200	0.8610	459	DY	0.0029609	50.892	A031	DX
172	31	6	ST01	4.200	0.8775	459	DY	0.0031218	51.066	A031	DX
173	31	7	ST01	4.200	0.9682	459	DY	0.0033049	51.246	A031	DX
174	31	8	ST01	4.200	1.3998	459	DY	0.0031962	51.307	A031	DX
175	31	9	ST01	4.200	1.2884	459	DY	0.0032382	51.455	A031	DX
176	31	10	ST01	4.200	1.1508	459	DY	0.0031008	51.623	A031	DX
177	31	11	ST01	4.200	1.1048	459	DY	0.0033267	51.803	A031	DX
178	31	12	ST01	4.200	1.4041	459	DY	0.0036444	52.012	A031	DX
179	31	13	ST01	4.200	1.4295	459	DY	0.0039743	52.240	A031	DX
180	31	14	ST01	4.200	1.5937	459	DY	0.0041503	52.493	A031	DX
181	31	15	ST01	4.200	1.6691	459	DY	0.0047381	52.780	A031	DX
182	31	16	ST01	4.200	1.8395	459	DY	0.0052832	53.127	A031	DX
183	31	17	ST01	4.200	1.7178	9047	DY	0.0049497	53.730	A031	DX
184	31	18	ST01	4.200	1.6600	9047	DY	0.0032733	54.162	A031	DX
185	31	19	ST01	4.200	1.5519	9047	DY	0.0023745	54.569	A031	DX
185	31	20	ST01	4.200	0.8300	9047	DY	0.0016366	53.719	A031	DX
187	32	1	ST01	4.400	1.8800	459	DY	0.0018743	57.905	A031	DX
188	32	2	ST01	4.400	1.8038	508	DX	0.0023720	58.844	A031	DX
189	32	3	ST01	4.400	4.0453	518	DZ	0.0063717	59.418	A031	DX
190	32	4	ST01	4.400	2.2722	508	DX	0.0031225	59.853	A031	DX
191	32	5	ST01	4.400	1.0474	518	DZ	0.0024446	59.900	A031	DX
192	32	6	ST01	4.400	0.9056	508	DX	0.0021824	60.115	A031	DX
193	32	7	ST01	4.400	0.5724	9880	DX	0.0021773	60.240	A031	DX
194	32	8	ST01	4.400	0.5230	9880	DX	0.0020818	60.392	A031	DX
195	32	9	ST01	4.400	0.4782	9880	DX	0.0019191	60.519	A031	DX
196	32	10	ST01	4.400	0.4461	3523	DX	0.0017700	60.649	A031	DX
197	32	11	ST01	4.400	0.4215	3523	DX	0.0016000	60.769	A031	DX
198	32	12	ST01	4.400	0.4064	3523	DX	0.0014577	60.890	A031	DX
199	32	13	ST01	4.400	0.4200	3523	DX	0.0014617	61.022	A031	DX

200	32	14	ST01	4.400	0.4123	461	DY	0.0013725	61.154	A031	DX
201	32	15	ST01	4.400	0.3797	902	DX	0.0015141	61.284	A031	DX
202	32	16	ST01	4.400	0.3837	461	DY	0.0015568	61.415	A031	DX
203	32	17	ST01	4.400	0.4013	461	DY	0.0016005	61.548	A031	DX
204	32	18	ST01	4.400	0.3996	461	DY	0.0016254	61.685	A031	DX
205	32	19	ST01	4.400	0.3769	902	DX	0.0022698	61.825	A031	DX
205	32	20	ST01	4.400	0.1998	461	DY	0.0008127	61.550	A031	DX
207	33	1	ST01	4.600	1.2464	3523	DX	0.0030913	65.055	A031	DX
208	33	2	ST01	4.600	2.0684	508	DX	0.0043423	65.903	A031	DX
209	33	3	ST01	4.600	1.0551	518	DZ	0.0048708	66.202	A031	DX
210	33	4	ST01	4.600	1.4377	508	DX	0.0064814	66.778	A031	DX
211	33	5	ST01	4.600	1.6165	902	DX	0.0079898	67.335	A031	DX
212	33	6	ST01	4.600	2.1100	902	DX	0.0094639	68.150	A031	DX
213	33	7	ST01	4.600	2.4183	902	DX	0.0099574	69.014	A031	DX
214	33	8	ST01	4.600	2.4575	902	DX	0.0045796	69.870	A031	DX
215	33	9	ST01	4.600	2.4345	88N	DX	0.0054823	70.697	A031	DX
216	33	10	ST01	4.600	2.3021	88N	DX	0.0062926	71.495	A031	DX
217	33	11	ST01	4.600	2.3340	88N	DX	0.0072890	72.365	A031	DX
218	33	12	ST01	4.600	2.6761	560	DX	0.0085041	73.596	A031	DX
219	33	13	ST01	4.600	2.7332	3523	DX	0.0096861	74.626	A031	DX
220	33	14	ST01	4.600	2.9264	560	DX	0.0049382	75.699	A031	DX
221	33	15	ST01	4.600	2.9561	560	DX	0.0052716	76.768	A031	DX
222	33	16	ST01	4.600	2.7197	3096	DX	0.0079694	77.729	A031	DX
223	33	17	ST01	4.600	2.8153	3096	DX	0.0086863	78.793	A031	DX
224	33	18	ST01	4.600	2.9669	4016	DX	0.0091887	79.915	A031	DX
225	33	19	ST01	4.600	3.1296	4016	DX	0.0093726	81.082	A031	DX
225	33	20	ST01	4.600	1.4834	4016	DX	0.0045943	78.835	A031	DX
227	34	1	ST01	4.800	4.8099	560	DY	0.0045489	86.691	A031	DX
228	34	2	ST01	4.800	3.0337	88N	DX	0.0097196	89.488	A031	DX
229	34	3	ST01	4.800	3.3783	560	DY	0.0075195	91.799	A031	DX

230	34	4	ST01	4.800	2.8692	560	DY	0.0067264	92.949	A031	DX
231	34	5	ST01	4.800	3.2053	3523	DX	0.0052027	94.229	A031	DX
232	34	6	ST01	4.800	2.7590	560	DX	0.0042123	95.293	A031	DX
233	34	7	ST01	4.800	2.9128	3523	DX	0.0035449	96.598	A031	DX
234	34	8	ST01	4.800	2.3400	558	DY	0.0055289	97.359	A031	DX
235	34	9	ST01	4.800	3.5991	560	DX	0.0112961	99.110	A031	DX
236	34	10	ST01	4.800	2.6658	3523	DX	0.0047731	99.933	A031	DX
237	34	11	ST01	4.800	2.8696	558	DY	0.0078897	100.862	A031	DX
238	34	12	ST01	4.800	6.0817	459	DY	0.0077382	100.580	A031	DX
239	34	13	ST01	4.800	7.2137	459	DY	0.0221942	100.883	A031	DX
240	34	14	ST01	4.800	4.0730	459	DY	0.0126745	101.788	A031	DX
241	34	15	ST01	4.800	2.7169	901	DX	0.0079186	103.228	A031	DX
242	34	16	ST01	4.800	6.0890	459	DY	0.0086112	102.380	A031	DX
243	34	17	ST01	4.800	7.5532	459	DY	0.0089794	105.040	A031	DX
244	34	18	ST01	4.800	4.9585	459	DY	0.0107190	104.681	A031	DX
245	34	19	ST01	4.800	3.4388	560	DX	0.0144700	106.473	A031	DX
245	34	20	ST01	4.800	2.4792	459	DY	0.0053595	104.170	A031	DX
247	35	1	ST01	5.000	10.3569	459	DY	0.0167352	110.550	A031	DX
248	35	2	ST01	5.000	35.2466	459	DY	0.0137038	114.431	A031	DX
249	35	3	ST01	5.000	5.0285	459	DY	0.0052117	115.344	A031	DX
250	35	4	ST01	5.000	4.4651	4003	DX	0.0102537	116.190	A031	DX
251	35	5	ST01	5.000	4.2518	4001	DX	0.0024151	117.246	A031	DX
252	35	6	ST01	5.000	4.0093	4001	DX	0.0026563	118.044	A031	DX
253	35	7	ST01	5.000	3.7813	4001	DX	0.0030337	118.844	A031	DX
254	35	8	ST01	5.000	3.6187	4001	DX	0.0033558	119.667	A031	DX
255	35	9	ST01	5.000	3.4945	88M	DX	0.0036790	120.495	A031	DX
256	35	10	ST01	5.000	3.4122	88M	DX	0.0083625	121.156	A031	DX
257	35	11	ST01	5.000	3.3510	88M	DX	0.0080161	121.957	A031	DX
258	35	12	ST01	5.000	4.9193	459	DY	0.0094706	121.504	A031	DX
259	35	13	ST01	5.000	12.3691	459	DY	0.0098476	122.501	A031	DX

260	35	14	ST01	5.000	9.3715	459	DY	0.0081603	124.735	A031 DX
261	35	15	ST01	5.000	5.7556	459	DY	0.0071322	125.577	A031 DX
262	35	16	ST01	5.000	4.7154	459	DY	0.0064337	127.043	A031 DX
263	35	17	ST01	5.000	7.4040	558	DY	0.0230842	128.343	A031 DX
264	35	18	ST01	5.000	11.2236	558	DY	0.0141944	127.263	A031 DX
265	35	19	ST01	5.000	13.4707	459	DY	0.0122832	129.897	A031 DX
265	35	20	ST01	5.000	5.6118	558	DY	0.0070972	127.002	A031 DX

APPENDIX E

SACS collapse output file (Changed in flooded members)

**** NON-LINEAR COLLAPSE ANALYSIS (LOAD SEQUENCE 1) ****

			LOAD	LOAD	*DEFLECTION*			ROTATION	** DEFLECTION **			% OF IMPACT
NSLV	INC.	LOOP	CASE	FACTOR	DIFF.	JNT	DOF	DIFFERENCE	MAXIMUM	JNT	DOF	ENERGY
2	1	1	DL	0.200	0.0026	9463	DX	0.0000066	-1.474	8013	DZ	
2	1	2	DL	0.200	0.0000	8013	DZ	0.0000000	-1.474	8013	DZ	
4	2	1	DL	0.400	0.0055	9463	DX	0.0000126	-2.949	8013	DZ	
4	2	2	DL	0.400	0.0000	8013	DZ	0.0000000	-2.949	8013	DZ	
6	3	1	DL	0.600	0.0083	9463	DX	0.0000187	-4.425	8013	DZ	
6	3	2	DL	0.600	0.0000	8013	DZ	0.0000000	-4.424	8013	DZ	
8	4	1	DL	0.800	0.0112	9463	DX	0.0000247	-5.901	8013	DZ	
8	4	2	DL	0.800	0.0000	8013	DZ	0.0000000	-5.900	8013	DZ	
10	5	1	DL	1.000	0.0141	9463	DX	0.0000307	-7.377	8013	DZ	
10	5	2	DL	1.000	0.0000	8013	DZ	0.0000000	-7.376	8013	DZ	
12	6	1	LL01	0.200	0.0133	7406	DX	0.0000386	-7.461	8013	DZ	
12	6	2	LL01	0.200	0.0000	7406	DZ	0.0000000	-7.460	8013	DZ	
14	7	1	LL01	0.400	0.0197	7406	DX	0.0000487	-8.759	7406	DZ	
14	7	2	LL01	0.400	0.0000	7406	DZ	0.0000000	-8.761	7406	DZ	
16	8	1	LL01	0.600	0.0261	7406	DX	0.0000587	-11.036	7406	DZ	
16	8	2	LL01	0.600	0.0000	7406	DZ	0.0000000	-11.040	7406	DZ	
18	9	1	LL01	0.800	0.0326	7406	DX	0.0000688	-13.312	7406	DZ	
18	9	2	LL01	0.800	0.0000	7406	DZ	0.0000000	-13.317	7406	DZ	
20	10	1	LL01	1.000	0.0389	7406	DX	0.0000789	-15.585	7406	DZ	
20	10	2	LL01	1.000	0.0000	7406	DZ	0.0000000	-15.592	7406	DZ	
22	11	1	ST01	0.200	0.0120	1024	DX	0.0000170	-15.466	7406	DZ	
22	11	2	ST01	0.200	0.0000	1025	DX	0.0000000	-15.467	7406	DZ	
24	12	1	ST01	0.400	0.0120	1025	DX	0.0000265	-15.347	7406	DZ	
24	12	2	ST01	0.400	0.0000	1025	DX	0.0000000	-15.348	7406	DZ	
26	13	1	ST01	0.600	0.0120	1023	DX	0.0000389	-15.229	7406	DZ	

26 13 2 ST01 0.600 0.0000 1025 DX 0.0000000 -15.230 7406 DZ

28 14 1 ST01 0.800 0.0121 1023 DX 0.0000316 -15.112 7406 DZ

28 14 2 ST01 0.800 0.0000 1025 DX 0.0000000 -15.112 7406 DZ

30 15 1 ST01 1.000 0.0121 1023 DX 0.0000238 -14.995 7406 DZ

30 15 2 ST01 1.000 0.0000 1025 DX 0.0000000 -14.995 7406 DZ

32 16 1 ST01 1.200 0.0122 1023 DX 0.0000152 -14.878 7406 DZ

32 16 2 ST01 1.200 0.0000 1025 DX 0.0000000 -14.878 7406 DZ

34 17 1 ST01 1.400 0.0123 1023 DX 0.0000097 -14.761 7406 DZ

34 17 2 ST01 1.400 0.0000 1025 DX 0.0000000 -14.761 7406 DZ

36 18 1 ST01 1.600 0.0124 1023 DX 0.0000116 -14.645 7406 DZ

36 18 2 ST01 1.600 0.0000 1025 DX 0.0000000 -14.645 7406 DZ

38 19 1 ST01 1.800 0.0124 1023 DX 0.0000111 16.690 1025 DX

38 19 2 ST01 1.800 0.0000 1025 DX 0.0000000 16.678 1025 DX

40 20 1 ST01 2.000 0.0125 1023 DX 0.0000123 19.012 1025 DX

40 20 2 ST01 2.000 0.0000 1025 DX 0.0000000 19.000 1025 DX

42 21 1 ST01 2.200 0.0126 1023 DX 0.0000135 21.335 1025 DX

42 21 2 ST01 2.200 0.0000 1025 DX 0.0000000 21.322 1025 DX

44 22 1 ST01 2.400 0.0126 1023 DX 0.0000146 23.657 1025 DX

44 22 2 ST01 2.400 0.0000 1025 DX 0.0000000 23.645 1025 DX

46 23 1 ST01 2.600 0.0127 1023 DX 0.0000159 25.980 1025 DX

*** MEMBER A045-501X HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

47 23 1 ST01 2.600 3.6509 A031 DX 0.0066258 25.835 1025 DX

48 23 2 ST01 2.600 1.0654 A031 DX 0.0018924 25.786 1025 DX

49 23 3 ST01 2.600 0.3194 A031 DX 0.0005568 25.772 1025 DX

50 23 4 ST01 2.600 0.1010 A031 DX 0.0001718 25.768 1025 DX

51 23 5 ST01 2.600 0.0336 A031 DX 0.0000558 25.767 1025 DX

51 23 6 ST01 2.600 0.1010 A031 DX 0.0001718 25.768 1025 DX

53 24 1 ST01 2.800 0.0985 A031 DX 0.0001600 28.075 1025 DX

53 24 2 ST01 2.800 0.0000 1025 DX 0.0000000 28.066 1025 DX

55 25 1 ST01 3.000 0.1166 A031 DX 0.0001894 30.382 1025 DX

56 25 2 ST01 3.000 0.0344 A031 DX 0.0000574 30.381 1025 DX

*** MEMBER 649- 650 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

57 25 1 ST01 3.000 0.8118 660 DZ 0.0018739 30.347 1025 DX

58 25 2 ST01 3.000 0.1106 660 DZ 0.0002673 30.342 1025 DX

59 25 3 ST01 3.000 0.0254 A031 DX 0.0000408 30.341 1025 DX

59 25 4 ST01 3.000 0.1106 660 DZ 0.0002673 30.342 1025 DX

61 26 1 ST01 3.200 0.1041 A031 DX 0.0001616 32.646 1025 DX

62 26 2 ST01 3.200 0.0313 A031 DX 0.0000500 32.645 1025 DX

62 26 3 ST01 3.200 0.1041 A031 DX 0.0001616 32.646 1025 DX

64 27 1 ST01 3.400 0.1130 A031 DX 0.0001698 34.949 1025 DX

65 27 2 ST01 3.400 0.0337 A031 DX 0.0000533 34.947 1025 DX

*** MEMBER 649- 633 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

66 27 1 ST01 3.400 0.3619 653 DZ 0.0010256 34.931 1025 DX

67 27 2 ST01 3.400 0.0608 A031 DX 0.0001451 34.927 1025 DX

67 27 3 ST01 3.400 0.3619 653 DZ 0.0010256 34.931 1025 DX

69 28 1 ST01 3.600 0.1233 A031 DX 0.0001817 37.229 1025 DX

70 28 2 ST01 3.600 0.0372 A031 DX 0.0000576 37.227 1025 DX

70 28 3 ST01 3.600 0.1233 A031 DX 0.0001817 37.229 1025 DX

72 29 1 ST01 3.800 0.1226 A031 DX 0.0001791 39.529 1025 DX

73 29 2 ST01 3.800 0.0398 A031 DX 0.0000596 39.526 1025 DX

73 29 3 ST01 3.800 0.1226 A031 DX 0.0001791 39.529 1025 DX

75 30 1 ST01 4.000 0.1345 A031 DX 0.0001886 41.827 1025 DX

76 30 2 ST01 4.000 0.0462 A031 DX 0.0000663 41.824 1025 DX

76 30 3 ST01 4.000 0.1345 A031 DX 0.0001886 41.827 1025 DX

78 31 1 ST01 4.200 0.1402 A031 DX 0.0001928 44.125 1025 DX

79 31 2 ST01 4.200 0.0472 A031 DX 0.0000674 44.122 1025 DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 1

80 31 1 ST01 4.200 3.4322 459 DY 0.0035763 44.482 1025 DX

81 31 2 ST01 4.200 5.4461 459 DY 0.0063238 45.050 1025 DX

82 31 3 ST01 4.200 6.5400 459 DY 0.0075507 45.530 1025 DX

83	31	4 ST01	4.200	6.3432	459 DY	0.0074464	46.125	1025 DX
84	31	5 ST01	4.200	3.7488	459 DY	0.0056993	46.680	1025 DX
85	31	6 ST01	4.200	1.4753	9047 DY	0.0025731	47.079	1025 DX
86	31	7 ST01	4.200	1.6164	459 DY	0.0025734	47.336	1025 DX
87	31	8 ST01	4.200	2.2547	459 DY	0.0036220	47.503	1025 DX
88	31	9 ST01	4.200	2.1124	459 DY	0.0040174	47.655	1025 DX
89	31	10 ST01	4.200	1.4184	459 DY	0.0031170	47.790	1025 DX
90	31	11 ST01	4.200	1.1571	459 DY	0.0026862	47.904	1025 DX
91	31	12 ST01	4.200	1.0419	459 DY	0.0023906	47.985	1025 DX
92	31	13 ST01	4.200	0.6457	459 DY	0.0017157	48.069	1025 DX
93	31	14 ST01	4.200	0.4417	459 DY	0.0014410	48.100	1025 DX
94	31	15 ST01	4.200	0.3288	459 DY	0.0009097	48.168	1025 DX
95	31	16 ST01	4.200	0.3796	459 DY	0.0008243	48.214	1025 DX
96	31	17 ST01	4.200	0.3398	459 DY	0.0006702	48.257	1025 DX
97	31	18 ST01	4.200	0.3091	459 DY	0.0005695	48.294	1025 DX
98	31	19 ST01	4.200	0.2694	459 DY	0.0004795	48.326	1025 DX
98	31	20 ST01	4.200	0.1545	459 DY	0.0002848	48.251	1025 DX
100	32	1 ST01	4.400	10.4426	459 DY	0.0137698	50.158	1025 DX
101	32	2 ST01	4.400	15.0430	459 DY	0.0152821	50.956	1025 DX
102	32	3 ST01	4.400	1.4828	459 DY	0.0016408	50.589	1025 DX
103	32	4 ST01	4.400	0.1261	502 DX	0.0006593	50.636	1025 DX
104	32	5 ST01	4.400	0.2228	459 DY	0.0006841	50.659	1025 DX
105	32	6 ST01	4.400	0.1177	9888 DX	0.0003236	50.704	1025 DX
106	32	7 ST01	4.400	0.1503	459 DY	0.0004640	50.716	1025 DX
107	32	8 ST01	4.400	0.0741	9888 DX	0.0002737	50.738	1025 DX

*** MEMBER 403- 459 HAS LOCAL BUCKLING FAILURE AT SEGMENT 5

108	32	1 ST01	4.400	24.2935	459 DY	0.0355052	50.362	1025 DX
109	32	2 ST01	4.400	33.4837	459 DY	0.0371192	52.121	1025 DX
110	32	3 ST01	4.400	11.2785	459 DY	0.0246336	46.013	1025 DX
111	32	4 ST01	4.400	16.4075	459 DY	0.0149592	50.418	1025 DX

112	32	5	ST01	4.400	10.6601	459	DY	0.0164307	48.168	1025	DX
113	32	6	ST01	4.400	13.1947	459	DY	0.0136171	50.455	1025	DX
114	32	7	ST01	4.400	8.0381	459	DY	0.0103446	48.378	1025	DX
115	32	8	ST01	4.400	13.9446	459	DY	0.0191019	50.259	1025	DX
116	32	9	ST01	4.400	21.0736	459	DY	0.0269593	47.509	1025	DX
117	32	10	ST01	4.400	13.8790	459	DY	0.0120030	50.420	1025	DX
118	32	11	ST01	4.400	3.1379	459	DY	0.0092523	48.838	1025	DX
119	32	12	ST01	4.400	3.6401	459	DY	0.0031490	49.516	1025	DX
120	32	13	ST01	4.400	0.7869	459	DY	0.0027366	49.304	1025	DX
121	32	14	ST01	4.400	1.7663	459	DY	0.0027504	49.092	1025	DX
122	32	15	ST01	4.400	2.0676	459	DY	0.0036328	49.582	1025	DX
123	32	16	ST01	4.400	5.5575	459	DY	0.0079164	48.704	1025	DX
124	32	17	ST01	4.400	4.2938	459	DY	0.0055875	49.997	1025	DX
125	32	18	ST01	4.400	3.2839	459	DY	0.0044484	48.761	1025	DX
126	32	19	ST01	4.400	3.5622	459	DY	0.0053718	49.846	1025	DX
126	32	20	ST01	4.400	1.2217	459	DY	0.0016550	49.200	1025	DX
128	33	1	ST01	4.600	20.7118	459	DY	0.0301345	49.797	1025	DX
129	33	2	ST01	4.600	26.9480	459	DY	0.0309642	52.036	1025	DX
130	33	3	ST01	4.600	4.2872	459	DY	0.0036123	52.639	1025	DX
131	33	4	ST01	4.600	5.8998	459	DY	0.0046549	53.051	1025	DX
132	33	5	ST01	4.600	1.5530	9047	DY	0.0050018	53.338	1025	DX
133	33	6	ST01	4.600	0.9904	459	DX	0.0047133	53.400	1025	DX
134	33	7	ST01	4.600	6.2664	459	DX	0.0234707	49.357	1025	DX
135	33	8	ST01	4.600	2.3253	459	DY	0.0040568	53.173	1025	DX
136	33	9	ST01	4.600	4.7663	459	DY	0.0134242	50.647	1025	DX
137	33	10	ST01	4.600	3.0096	459	DY	0.0090357	53.201	1025	DX
138	33	11	ST01	4.600	6.4037	459	DY	0.0093875	51.247	1025	DX
139	33	12	ST01	4.600	3.1745	459	DY	0.0089443	53.251	1025	DX
140	33	13	ST01	4.600	3.4245	459	DY	0.0108664	50.935	1025	DX
141	33	14	ST01	4.600	2.6293	459	DY	0.0057774	52.167	1025	DX

142 33 15 ST01 4.600 2.3291 459 DX 0.0091544 53.286 1025 DX

143 33 16 ST01 4.600 5.8260 459 DY 0.0170368 49.998 1025 DX

144 33 17 ST01 4.600 12.2225 459 DY 0.0173756 52.982 1025 DX

145 33 18 ST01 4.600 19.1939 459 DY 0.0264747 50.501 1025 DX

146 33 19 ST01 4.600 10.7427 459 DY 0.0078668 52.712 1025 DX

146 33 20 ST01 4.600 9.5970 459 DY 0.0132373 51.372 1025 DX

148 34 1 ST01 4.800 17.6144 459 DY 0.0226692 52.148 1025 DX

149 34 2 ST01 4.800 15.7366 459 DY 0.0172980 53.843 1025 DX

150 34 3 ST01 4.800 2.3376 9047 DY 0.0084621 55.208 1025 DX

151 34 4 ST01 4.800 6.2161 459 DY 0.0067941 55.930 1025 DX

152 34 5 ST01 4.800 3.9406 459 DY 0.0152827 56.293 1025 DX

153 34 6 ST01 4.800 9.6765 459 DY 0.0231915 56.511 1025 DX

154 34 7 ST01 4.800 6.2415 459 DY 0.0155030 56.413 1025 DX

155 34 8 ST01 4.800 11.8339 459 DY 0.0186973 56.558 1025 DX

156 34 9 ST01 4.800 10.9649 459 DY 0.0246320 56.698 1025 DX

157 34 10 ST01 4.800 11.2299 459 DY 0.0200259 56.891 1025 DX

158 34 11 ST01 4.800 12.9848 459 DY 0.0200877 56.975 1025 DX

159 34 12 ST01 4.800 14.3159 459 DY 0.0221042 57.060 1025 DX

160 34 13 ST01 4.800 15.9858 459 DY 0.0236762 57.075 1025 DX

161 34 14 ST01 4.800 13.6344 459 DY 0.0215390 57.020 1025 DX

162 34 15 ST01 4.800 15.9690 459 DY 0.0218579 57.365 1025 DX

163 34 16 ST01 4.800 14.9986 459 DY 0.0190275 57.268 1025 DX

164 34 17 ST01 4.800 14.1127 459 DY 0.0187696 57.676 1025 DX

165 34 18 ST01 4.800 15.8958 459 DY 0.0194602 57.550 1025 DX

166 34 19 ST01 4.800 13.8189 459 DY 0.0164808 57.946 1025 DX

166 34 20 ST01 4.800 7.9479 459 DY 0.0097301 57.501 1025 DX

168 35 1 ST01 5.000 29.8343 459 DY 0.0320875 60.292 1025 DX

169 35 2 ST01 5.000 43.6986 459 DY 0.0523300 60.149 1025 DX

170 35 3 ST01 5.000 16.3871 459 DY 0.0237446 60.230 1025 DX

171 35 4 ST01 5.000 0.8976 459 DX 0.0148104 60.644 1025 DX

172	35	5	ST01	5.000	3.8235	459	DY	0.0081039	61.187	1025	DX
173	35	6	ST01	5.000	5.4798	459	DY	0.0063623	61.118	1025	DX
174	35	7	ST01	5.000	18.0738	459	DY	0.0303603	60.089	1025	DX
175	35	8	ST01	5.000	17.0673	459	DY	0.0146511	61.144	1025	DX
176	35	9	ST01	5.000	8.6445	459	DY	0.0141627	61.355	1025	DX
177	35	10	ST01	5.000	24.5688	459	DY	0.0356748	60.090	1025	DX
178	35	11	ST01	5.000	20.7254	459	DY	0.0209687	61.214	1025	DX
179	35	12	ST01	5.000	4.6098	459	DY	0.0123802	61.418	1025	DX
180	35	13	ST01	5.000	9.0008	459	DY	0.0032191	61.473	1025	DX
181	35	14	ST01	5.000	7.3177	459	DY	0.0116145	61.556	1025	DX
182	35	15	ST01	5.000	19.3175	459	DY	0.0420605	60.229	1025	DX
183	35	16	ST01	5.000	20.9449	459	DY	0.0247348	61.338	1025	DX
184	35	17	ST01	5.000	15.2569	459	DY	0.0085195	61.766	1025	DX
185	35	18	ST01	5.000	11.0789	459	DY	0.0177722	61.633	1025	DX
186	35	19	ST01	5.000	21.2430	459	DY	0.0510980	60.048	1025	DX
186	35	20	ST01	5.000	5.5394	459	DY	0.0088861	61.546	1025	DX