Optimizing Decommissioning: Reuse of Fixed Steel Jacket

by

Amirul Ashraf Bin Othman

18824

Dissertation submitted in partial fulfilment of

The requirements for the

Bachelor of Engineering (Hons)

(Civil)

SEPTEMBER 2017

Universiti Teknologi PETRONAS

Bandar Seri Iskandar

31750 Tronoh

Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

Optimizing Decommissioning: Reuse of Fixed Steel Jacket

by

Amirul Ashraf Bin Othman

18824

A project dissertation submitted to the

Civil Engineering Programme

Universiti Teknologi PETRONAS

BACHELOR OF ENGINEERING (Hons)

(CIVIL)

Approved by,

____

(AP Dr Noor Amila Binti Wan Abdullah Zawawi)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

September 2017

CERTIFICATION OF ORIGINALITY

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

AMIRUL ASHRAF BIN OTHMAN

ABSTRACT

Now, in Malaysia, offshore decommissioning just began its era due to Malaysia contain a lot of ageing offshore platform which mostly consist of fixed platform but from time to time decommissioning will be increase to a level where it will be known as a practice for removal of offshore platforms in Malaysia. Decommissioning has a few methods such as complete removal, partial removal, reefing or reusing of the offshore structure. Reusing plan is said that it can be the optimum ways in a better aspect in term of sustainability which the steel jacket has its strength even though the platform is ageing. The typical problem which held in the jacket is the joint but not the entire steel member. Thus, with reused plan can possibly be the optimum way in decommissioning. In this project, it will be focused on to do assessment on a few platforms and the analysis from the results. Therefore, this project is being carried out in order to know the feasibility of reused plan for offshore structure in Malaysia.

TABLE OF CONTENT

ACKNOWLEGEMENT

First of all, I would like to thank God as finally I able to do my best in this project. This project is based on some research, assessment and analysis which I am very grateful to my supervisor, AP Dr. Noor Amila Binti Wan Abdullah Zawawi due to the encouragement and full support in my final year project. Without her support, it will be hard for me to finish this project.

I also owe so much with my co supervisor, Ir Dr Mohamed Mubarak Abdul Wahab who helping me a lot with my project. The journey in my final year project is not smooth until the end, but with his support, I gain strength to go through all the challenges which used to be on my shoulder during this semester. Thanks a lot to him that I can finish my final year project with the full support which he can give to me.

On the other hand, big thank also I addresses to my final year project coordinator, Dr Zulaikha who is a good coordinator that always reminds all the final year project students with all the important messages and dateline. Without her, maybe all of the students will not notice of the important dates and submissions. This helps the students so much in producing good projects results.

Lastly, I would like to thank my colleagues who are going through the same thing in this semester with me which is the final year project. They help me in giving some ideas with my project and they are helping me in suggesting me some good ways in going through this project. Some of my friends also teach me about the software which I had to use in my project.

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Decommissioning is a term for a removal process from an active status. Infrastructure, military are the example of types of decommissioning and there are others. In this offshore area, this project more focused on the decommissioning of offshore structure and fixed steel jacket platform is the type of platform which need to be used in this project. Moreover, in offshore decommissioning, there had to be three main types of alternatives in performing decommissioning.

The alternatives of decommissioning are listed as below:

1. Complete Removal
2. Partial Removal
3. Conversion to Reef
4. Re-use (New)

Malaysia has a lot of platforms which need to undergo decommissioning which their platform age had exceeded their design life. From the latest decommissioning fact, Malaysia has approximately 362 numbers of offshore platforms and approximately 180 of ageing platforms in Malaysia. Roughly in Malaysia, 40% of offshore platforms and 37% of pipelines had to be more than 30 years of services. Every platform has their own design life. From American Petroleum Institute (API), the standard design life of offshore platform is 25 years, and this is similar to Petronas Technical Standard (PTS) which is 25 years. So, different standards might have different standard of design life of offshore platform.

One type of platform was used in this project which is fixed platform as figure 1.1. This project is executed by doing the analysis on the platform itself and its steel jacket which is one of the concern. The analysis was carried out by using SACS Bently Engineering Software. The software was used to run some analysis and some parameter were changed in the assessment of the platform. In order to decide either the platform can be reused or not, a lot of analysis need to be done.

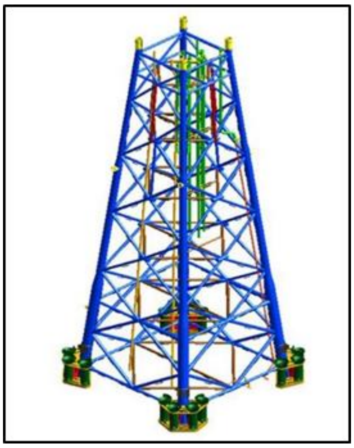


FIGURE 1.1 Fixed Platform Type - Piled Steel Jacket

In the reusing plan, decommissioning, assessment, refurbishment, modification and reusing are the processes needed in the plan. Decommissioning is the first plan need to be done which is take out the jacket from offshore field and bring it onshore. Then, the assessment need to do to have some physical checking on the jacket based on the actual condition. Next, the refurbishment of the jacket need to be done and lastly, the modification of jacket based on the new location of oil and gas field. As in figure 1.2 below, showing a platform topside had been gone through refurbishment.

FIGURE 1.2 Refurbished Topside

As for modification, the jacket that need to be used at a new location must be modified in order to suit the jacket with the new location. Some of the factors should be taken care in the modification of jacket like the water level, the condition of the field, the environmental loadings in the new field and many more. Some of the jacket is being used by the owner themselves and some of the owner, they sell to others as a refurbished jacket. In the processes of reused plan of jacket, different contract that award to different contractor which do the job. Decommissioning of the jacket platform is awarded one contract to one contractor and also refurbishment is awarded one contract to another contractor. The same concept is used for modification of jacket where one contract will be awarded to one contractor to do the job.

1.2 PROBLEM STATEMENT

Most of offshore platforms in Malaysia are jacket platform which indicates Malaysia's sea water level is shallow. Jackets are built from high quality tubular steel structures and these jackets are best candidate for recycle. There are issues on the reused of the steel jackets. There were assumptions on the steel jacket that the part of the jackets which are jacket legs, foundation piles and bracings are not subjected to fatigue but there was no proof whether the jacket can be reused in the aid of optimizing decommissioning.

When a platform is considered for reuse purpose, assessment of the structure need to be conducted whether it is acceptable or the contrast by referring to guideline. The steel jacket is used as the main concern where the steel has high strength and high durability and if the steel is not being reused, it will be just like scrap metal. So, this project proves whether the steel jacket is worth to be reused or not.

1.3 OBJECTIVES AND SCOPE OF STUDIES

1.3.1 Scope of Study

This project was done by using some research assessment and analysis on decommissioning of fixed jacket platform. It is conducted to identify the reused of fixed steel jacket is an optimum way to be performed. This considers all the factors that effects the reused plan as the optimum practice such as strength of the steel which can be determine in this project. Furthermore, this study aid to explore more ways to improve the offshore decommissioning in Malaysia.

1.3.2 Objectives

This project was aimed

- To identify and select fixed offshore platform as main subjects
- To gain the details of the fixed offshore platforms
- To do assessment on steel jacket of selected offshore platforms
- To determine the feasibility of reusing the fixed steel jacket

CHAPTER 2

LITERATURE REVIEW

Decommission is a process to remove or dismantle the offshore platform due to the oil and gas operation is over and returning the offshore and sea floor to its original condition. Therefore, the structures were needed to be dismantle after the design life period and dismantling had its own general sequence of operation. The sequences are survey and plan, soft strip, asbestos, LSAS and other hazardous materials removal, pipes, equipment and architectural materials and structural dismantling (Denney, 1998). In offshore platform, there are parts which can be decommissioned like top side facilities, abandoned or non-productive wells, decks, jackets, sub-sea pipelines, sub-sea wells, sank rigs and damaged offshore platforms. So, in this area of study, this project was done on jacket platform which consist of steel tubular members. Figure 2.1 below shows the parts of structure which can be decommissioned and the application of each part. For example, topsides can be refurbished or reused or act as artificial reef which one of the latest decommissioning project in Sarawak field.

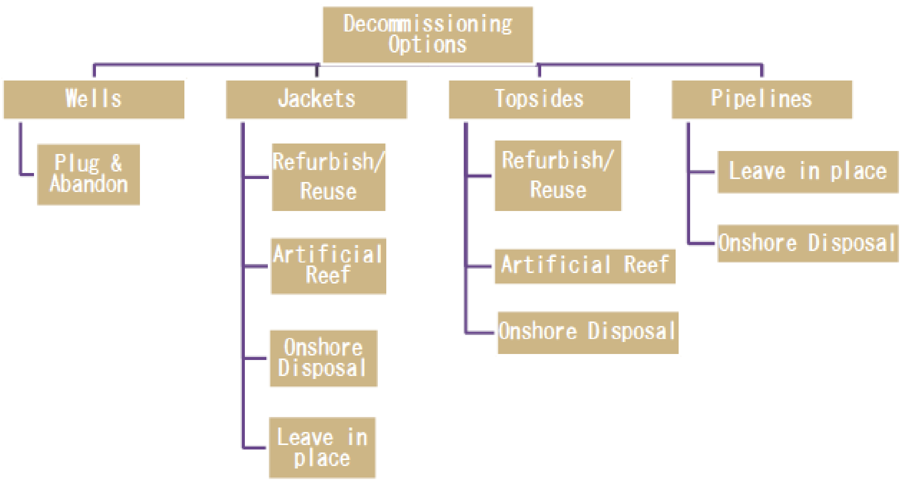


FIGURE 2.1 Decommissioning Options

Decommission has many alternatives in removing the platform such as complete removal, partial removal, conversion to reef and the new plan is the reusing plan. This project was done to show the reusing of fixed steel jacket can be practice in Malaysia or the contradict of it. For reused plan, it has different processes involve in the production of reused jacket. Firstly, decommissioning of jacket platform is the first process which the jacket structure and also the topside are being pulled out from the field.

After decommissioning of platform, the next step is the refurbishment of the jacket. The jacket is being assess by engineering team who do the assessment onshore by done the physical assessment and analysis. Refurbishment of jacket is done by beautify the jacket by do some welding, painting, assessing and many more. After refurbishment done, the modification is take place where the jacket will be modified based on the new field which means all the factor to design a jacket for the new field will be consider as the water level, marine life, soil condition, environmental loadings, field condition and more. So, these processes are about the production of reused jacket.

Figure 2.2 shows a condition where a platform had been used for a long time. The steel of the platform had been rusty due to the harsh condition in offshore field. Wind, wave and current are some of the loadings which the platform need to be withstand.

FIGURE 2.2 Condition of Ageing Offshore Platform

A way which feasible and sustainable way forward in Malaysia is by reusing the topsides and equipment as there is plenty of maturing platforms to be decommissioned (Na, Wan Abdullah Zawawi, Liew, & Abdul Razak, 2013). Reused plan can contribute a lot of positive impacts and especially in cost. Higher cost is spending in decommissioning of platform. Internationally there has been huge growth in the decommissioning market, although in Malaysia, the quest for complete removal of offshore platforms has few precedents (Ahmed & Wan Abdullah Zawawi, 2014).

This means that cost keep increasing in term of time. As time passed by, the decommissioning cost will keep increasing. Therefore, reused plan is one of the optimum plan which can improve the problem in cost of decommission. The reused plan allowed the operators to minimise the net cost of decommissioning and cost and time effective means developing a new field by the buyer (Na, Wan Abdullah Zawawi, Liew, & Abdul Razak, 2013). Thus, reused plan can be one of the alternatives which can minimise the net cost of decommissioning of offshore platform.

Figure 2.3 shows the decommissioning costs and tasks for 4-pile platform. The figure is an example where cost estimation of decommission will be calculated. Cost also vary as water depth increases as in figure 2.4 which shows the increment of cost is in line with the increment in water depth.

Task	Task Hours	% Hr	Task Cost	%$
Fab Explosive Charges	Lump Sum	0.00%	$74,400	1.82%
Platform Removal Preparation	504.00	19.89%	$504,000	12.35%
Mobilize DB 2000	6.61	0.26%	$80,763	1.98%
Mobilize CB 240 & Tug	21.00	0.83%	$27,860	0.68%
Mobilize CB 300 & Tug	21.00	0.83%	$34,580	0.85%
Setup Derrick Barge	6.75	0.27%	$75,836	1.86%
Cut Deck/Miscellaneous Equip	4.64	0.18%	$55,192	1.35%
Remove Equipment	4.00	0.16%	$47,580	1.17%
Remove 4 Pile Deck	9.35	0.37%	$111,218	2.73%
Demob CB 240 & Tug	21.00	0.83%	$13,860	0.34%
Jet/Airlift Pile Mud Plug	16.00	0.63%	$195,440	4.79%
Standby for Daylight Det.	8.00	0.32%	$97,720	2.39%
Pre/Post Detonation Survey	1.00	0.04%	$18,715	0.46%
Sever Piles- Explosive	2.92	0.12%	$35,667	0.87%
Sever Conductors- Explosive	6.22	0.25%	$75,977	1.86%
Remove Conductors (DB 2000)	61.50	2.43%	$743,473	18.22%
Remove Jacket	21.70	0.86%	$262,331	6.43%
Demob CB 300 & Tug	21.00	0.83%	$20,580	0.50%
Pick Up DB Anchors	6.75	0.27%	$74,986	1.84%
Demob DB 2000	6.61	0.26%	$79,930	1.96%
Site Clearance - with Trawler	273.29	10.78%	$149,489	3.66%
Site Clearance Verify	402.57	15.89%	$181,869	4.46%
Offload CB 240	384.00	15.15%	$77,600	1.90%
Offload CB 300	672.00	26.52%	$157,760	3.87%
TOTAL	2481.91	100%	$3,196,829	100%

FIGURE 2.3 Decommissioning Costs Based on Tasks of 4-Pile Platform

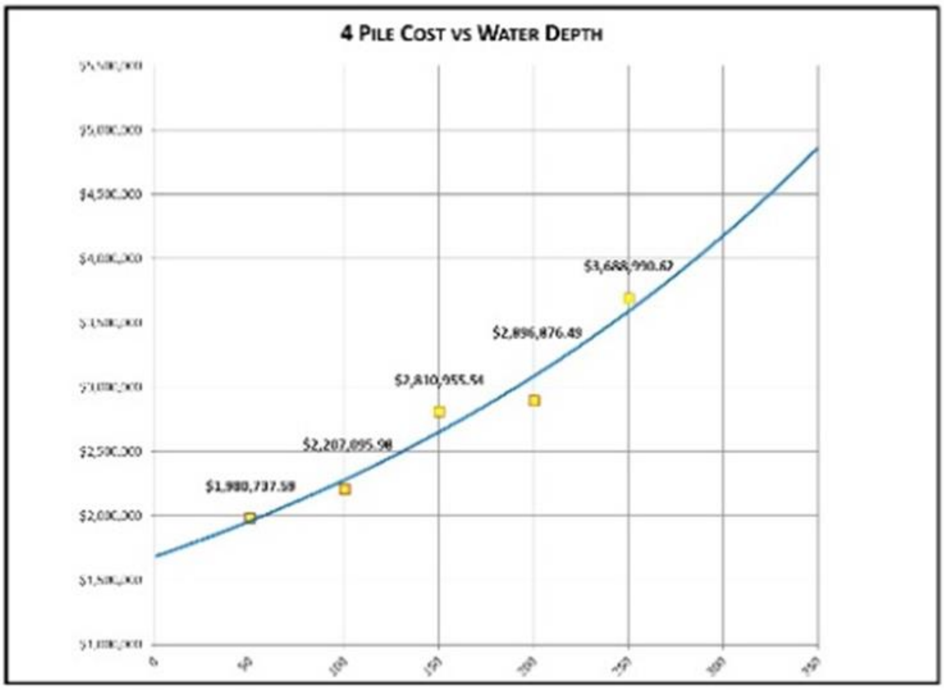


FIGURE 2.4 Graph of Water Depth against Costs

Finally, this indicates that reused plan can be possibly done but everything has its negative side. If the steel jackets are proved to be not cost effective enough to be refurbished, they will be scrapped (Na, Wan Abdullah Zawawi, Liew, & Abdul Razak, 2013). Thus, this project was done to know whether reused plan is feasible or not in Malaysia.

CHAPTER 3

METHODOLOGY

In methodology, four phases will be conducted in this project as shown in the flows below which show the flow of my methodology.

Flow of methodology

3.1 PHASE 1: DATA GATHERING

For data gathering, two steps were included which are step 3.1.1 and 3.1.2 which are identify and selecting platforms and platforms details respectively.

3.1.1 Identify and Selecting Platforms

In the first step in this project, a platform was selected based on its type, location and their age. A platform was selected based on the latest database of offshore platforms. The data was filtered by a few conditions like:

- Type of platform : Fixed platform
- Location of platform : Malaysia's oil and gas field
- Age of platform : platform which had exceeded design life

3.1.2 Platforms details

The details of platform had been gained in this step in order to continue the next method in this project. From this step, SACS analysis can be performed by getting all the data and file for the platform.

3.2 PHASE 2: ASSESSMENT AND ANALYSIS

In the second phases, assessment on the platform need to be performed by using the step 3.2.1 which is steel jacket assessment. All result and analysis will be conducted in this phase.

3.2.1 Steel Jacket Assessment

Next for the assessment of the jacket, the details of the fixed offshore platforms were used which all of the details had been selected in the first method above in the SACS software. Push over analysis is one of the method in analysing the jacket if the loading constantly give forces to the jacket until the jacket fails. Example of push over analysis can be shown in the figure 3.1 which reserve strength ratio (RSR) can be obtained by this analysis.

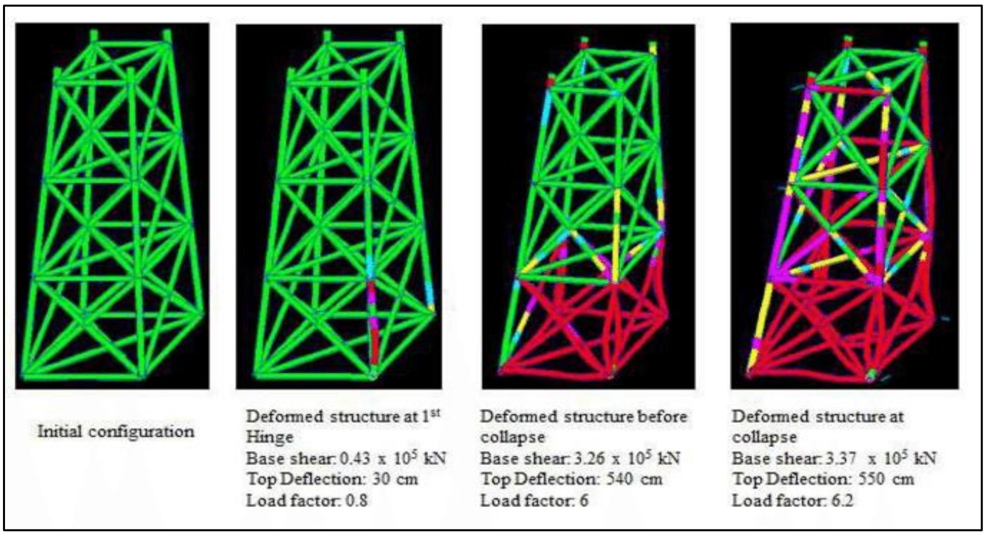


FIGURE 3.1 Pushover Analysis

Phase 1 and Phase 2 are steps which are conducted in order to gain the results of this project. The steps from both phases are the methods to achieve objectives and results for this project.

3.3 PHASE 3: RESULTS AND DISCUSSION

Results and discussion of results are stated in this phase. Results are gained by doing the analysis by using SACS engineering software and the results are explained in the discussion part which all the justification and reasons are stated in this part.

3.3.1 Analysing the feasibility of reusing plan

From the result gained, the feasibility and suitability of reused plan are discussed in step 3.3.1.

3.4 PHASE 4: CONCLUSION

For phase 4, conclusion is stated based on the results and discussion part. Hence, methodology of this project is stated as the four phases to complete this project. Flow of methodology of this project are showed in figure 3.2 which showing a flowchart.

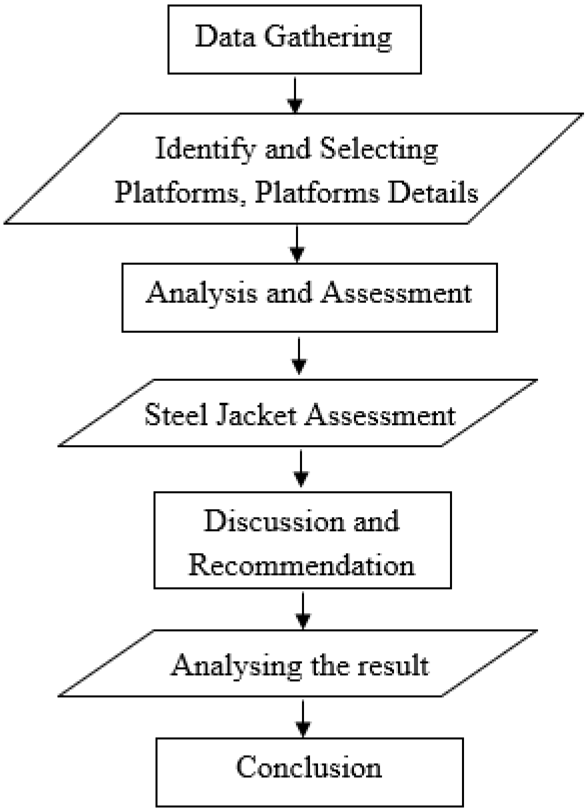


FIGURE 3.2 Flowchart of Project's Methodology

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 RESULTS

A platform had been identified in terms of its type, location and life. In this project, American Petroleum Institute (API) Standard had been used and 25 years of design life is stated in the standard. From the latest data of platforms, one platform had been selected and the details can be found in table 4.1.

1. Platform EF

Item	General Information	Value
1.	Year installed	1984
2.	Water depth (m)	63.148
3.	Design life (years)	25
4.	Brace type	K

TABLE 4.1 General Information of Platform EF

Next, platform age was calculated in order to know its remaining life based on the design life of 25 years.

Calculation of Platform Age and Remaining Life

1. Platform EF

Age of platform = 2017 – 1984 = 33 Years

Remaining Life = Design Life – Platform Age, where Design Life = 25 years

= 25 - 33

= -8 years

Next, the platform details were gained in order to know the information and parameters of the platform. The details of Platform EF are shown in table 4.2.

Platform EF

Particulars	Unit	Value
Water depth	Metre	63.148
Jacket Height	Metre	75.34
Air Gap	Metre	2.079
Deck Elevation	Metre	12.192
Long Framing	-	K
Tran Framing	-	K
No of Bays	-	-
No of Legs	-	4
Jacket Weight	Tonnes	-
Deck Weight	Tonnes	-
No of Deck	-	1
Base Length	Metre	38.80
Base Width	Metre	27.30
Design Life	years	25

TABLE 4.2 Details of Platform EF

For assessment and analysis, SACS Bently Engineering Software had been used. The platform's model file and collapse file were gained to execute the analysis. Model output was shown as in figure 4.1 which the structural of the platform can be seen in the 3D model output.

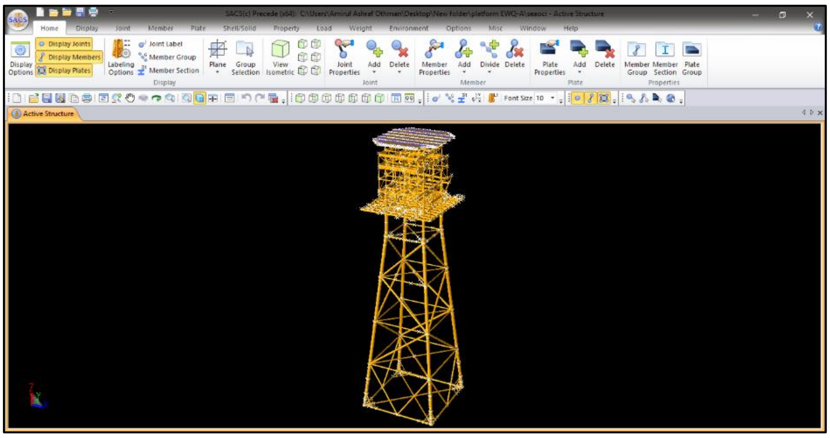


FIGURE 4.1 3D Model Output of Platform EF

The condition of loadings in the analysis was set as 100-year storm condition where the platform was undergone a harsh condition. Three different situations were used where the platform was assessed by three different topside loadings.

Topside loadings:

1. Topside loading 1: normal topside loading
2. Topside loading 2: 20% increase of the topside loading
3. Topside loading 3: 20% decrease of the topside loading

The pushover analysis was used in the SACS software to assess platform EF. The data of loading were changed in the load factor with load factor of 1 for normal condition, load factor of 1.2 for 20% increase of topside loading and load factor of 0.8 for 20% decrease of topside loading.

1. Normal Topside Loading

The design strength was determined in the analysis where its design strength was designed at load step 51. The design strength was determined as 2593.55 kN as in figure 4.2.

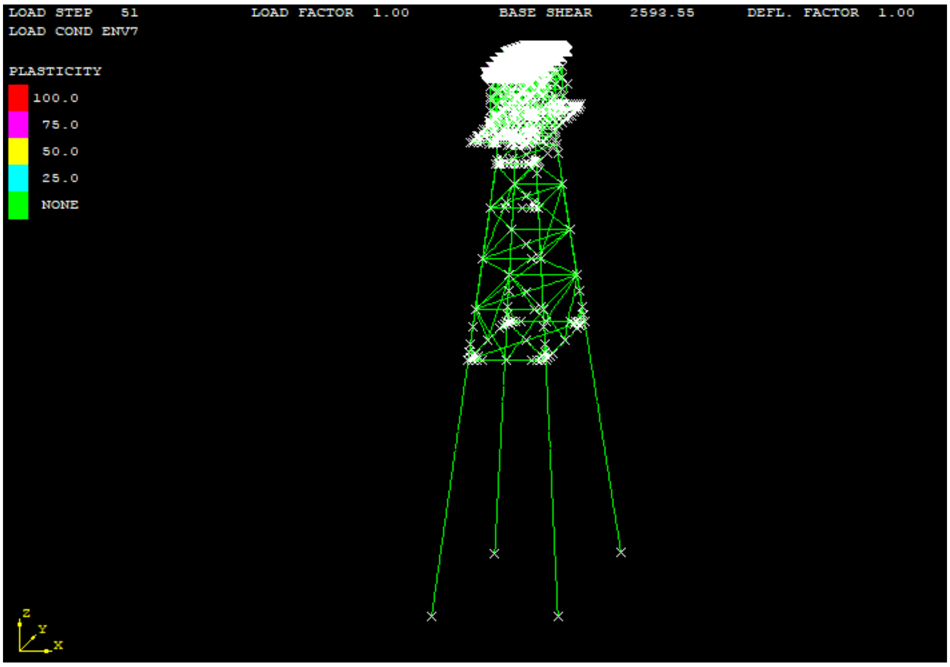


FIGURE 4.2 Design Strength in Collapse Output

The analysis was run until the platform fully fail with the 100-yaer storm condition. The fail condition of the platform can be seen in figure 4.3 as the platform fail to resist the loadings.

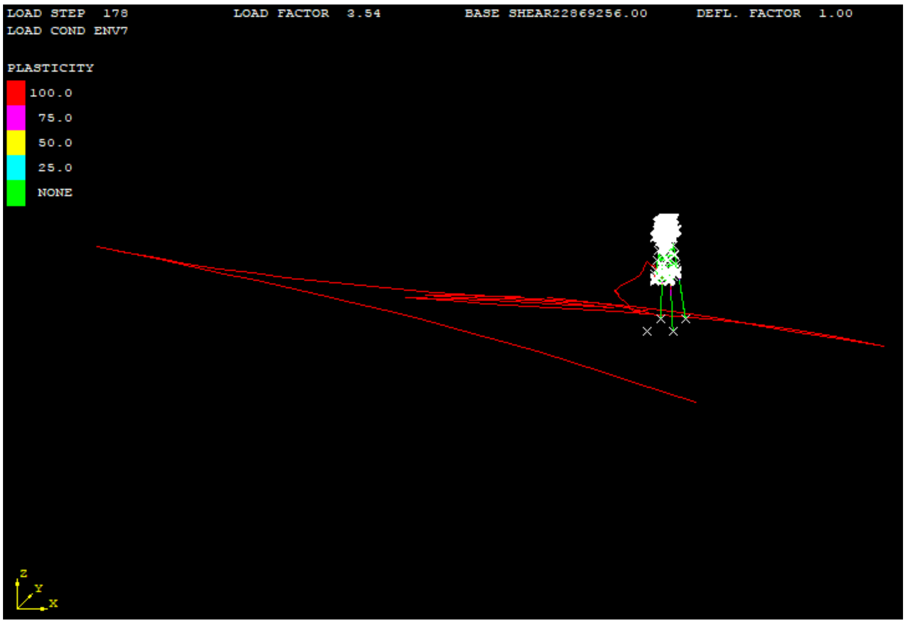


FIGURE 4.3 Platform EF Failure Condition in Collapse Output

The ultimate strength was determined by setting the load step of the analysis to the load step where before platform EF failure happened and this can be seen in figure 4.4 where the ultimate strength was determined. The ultimate strength for normal topside loading in 100-year storm condition was 9123.43 kN.

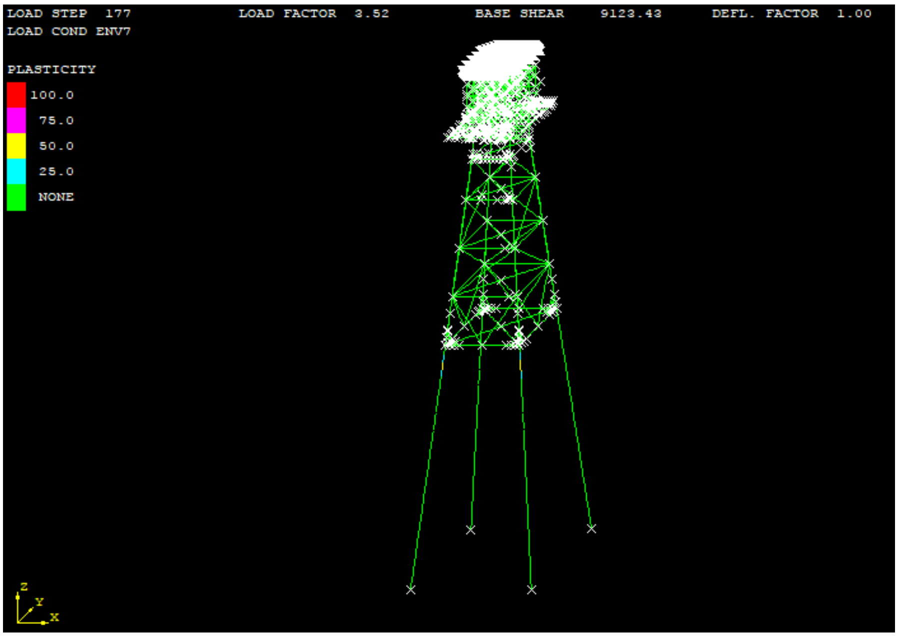


FIGURE 4.4 Ultimate Strength in Collapse Output

Two graphs were displayed after the analysis had finished which are graph of base shear against load factor and graph of base shear against load step as in figure 4.5 and 4.6.

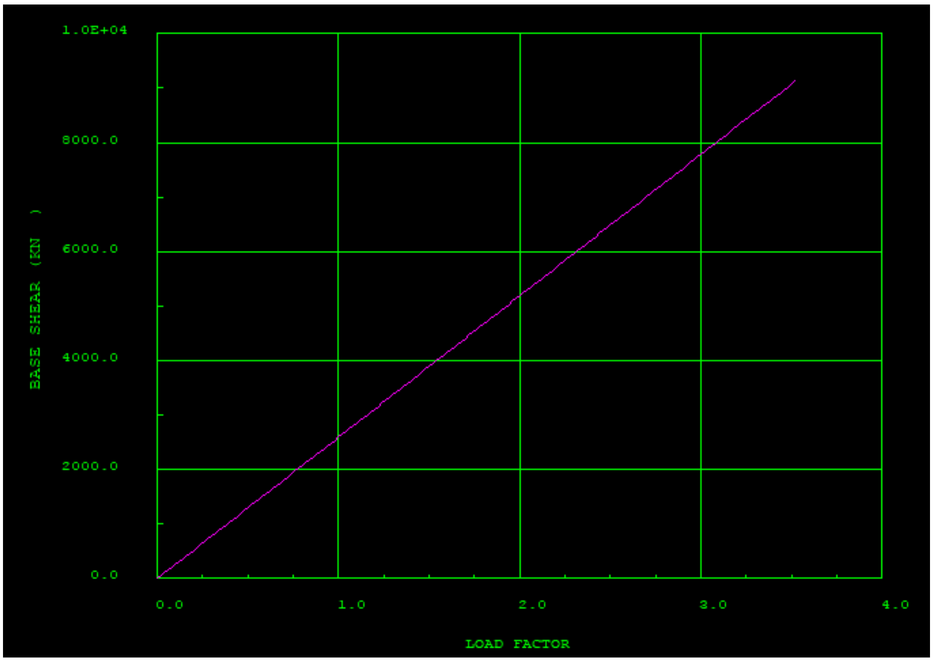


FIGURE 4.5 A Graph of Base Shear against Load Factor

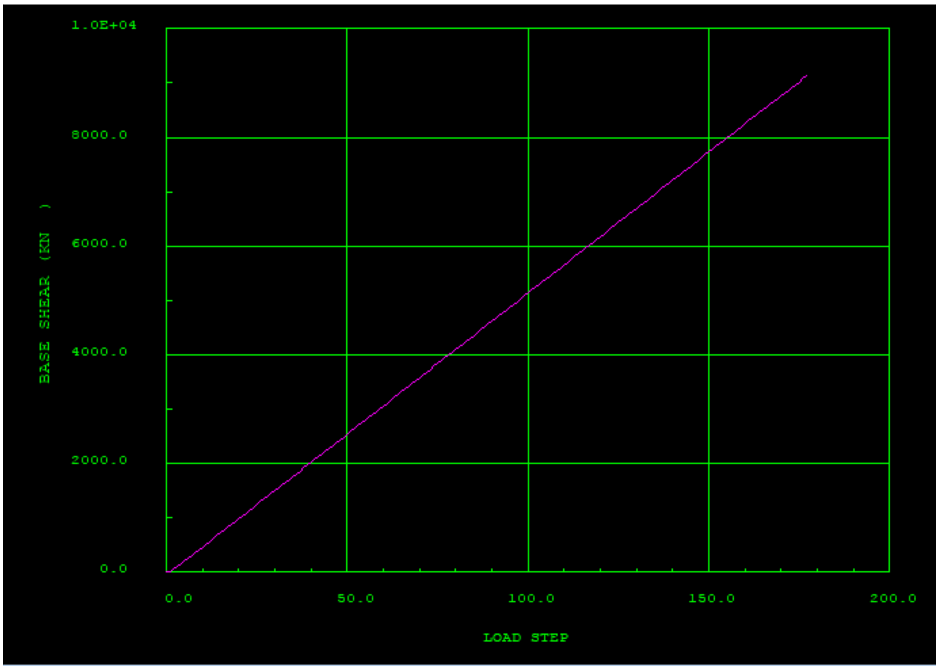


FIGURE 4.6 A Graph of Base Shear against Load Step

Reserve strength ratio was calculated by using the formula of:

Reserve Strength Ratio (RSR) = Ultimate Strength / Design Strength

= 9123.43 kN / 2593.55 kN

= 3.52

For normal topside loading with 100-year storm event, the RSR was 3.52 as shown in the calculation.

2. 20% increase of topside loading

The design strength again was determined at load step 51 as figure 4.7 that showing the design strength was 2593.79 kN. The topside loadings were increased with ratio of 1.2 in load factor of the loads. 100-year storm condition was used in this analysis.

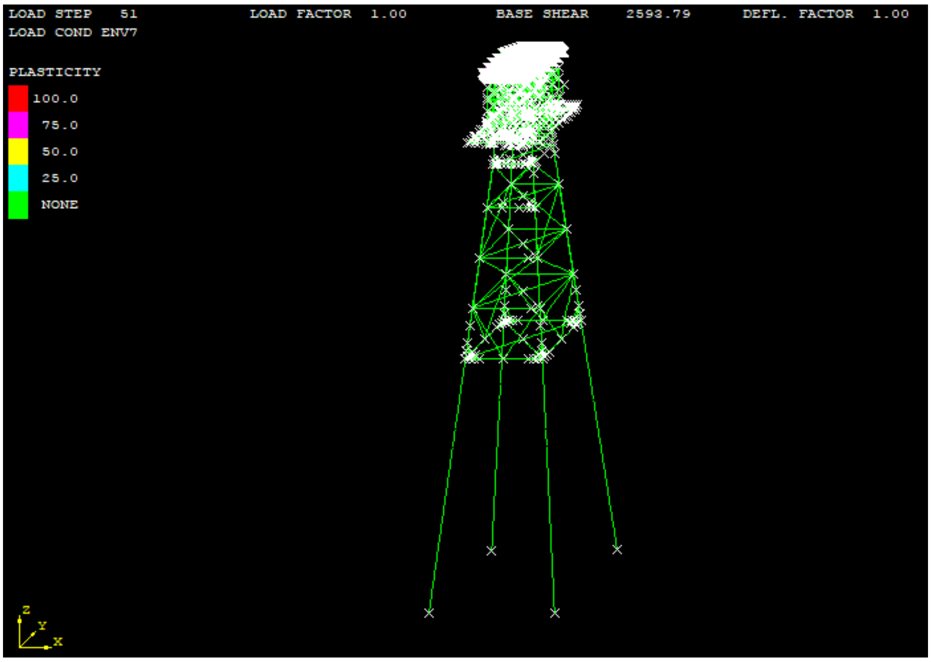


FIGURE 4.7 Design Strength in Collapse Output

The analysis was run until the platform failure had been showed in the output as figure 4.8 which platform EF fails.

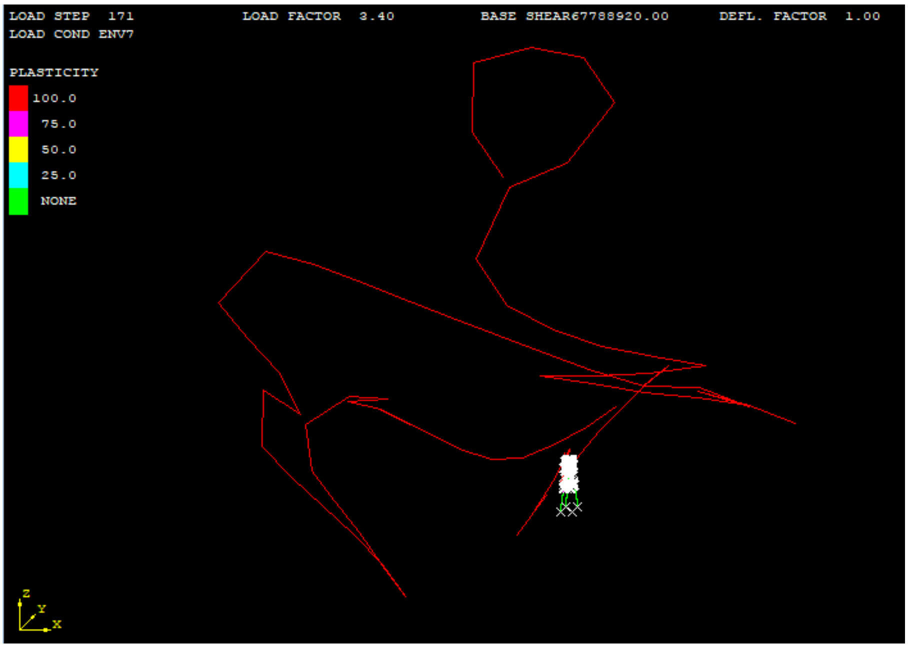


FIGURE 4.8 Platform EF Failure Condition in Collapse Output

The ultimate strength of the platform was determined again by setting the load step to the load step before the failure happened. From that condition, the ultimate strength of platform EF was determined as the strength was 8763.07 kN as shown in figure 4.9 that shows the ultimate strength of the platform before the platform failure happened.

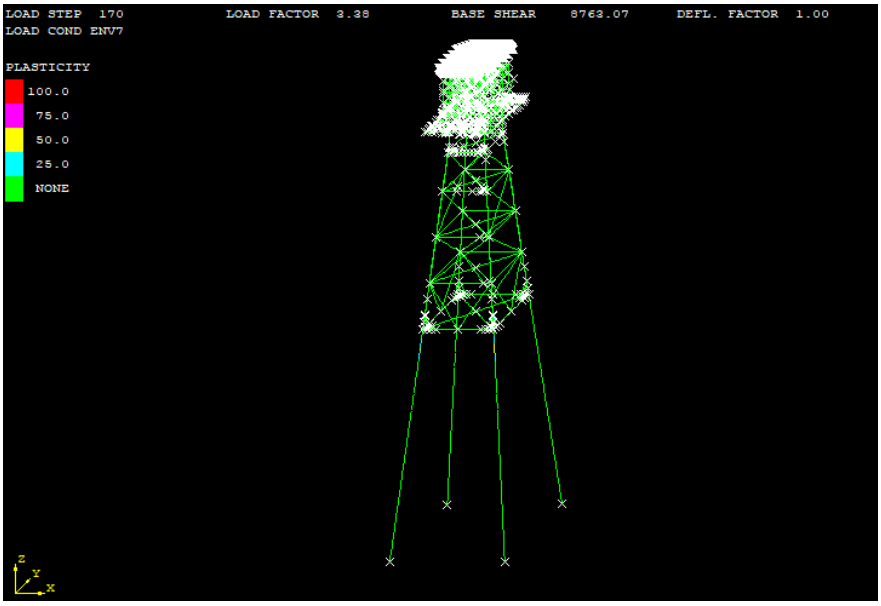


FIGURE 4.9 Ultimate Strength of Platform EF in Collapse Output

Two graphs were displayed as the result of the analysis which were graph of base shear against load factor and graph of base shear against load step as shown in figure 4.10 and 4.11.

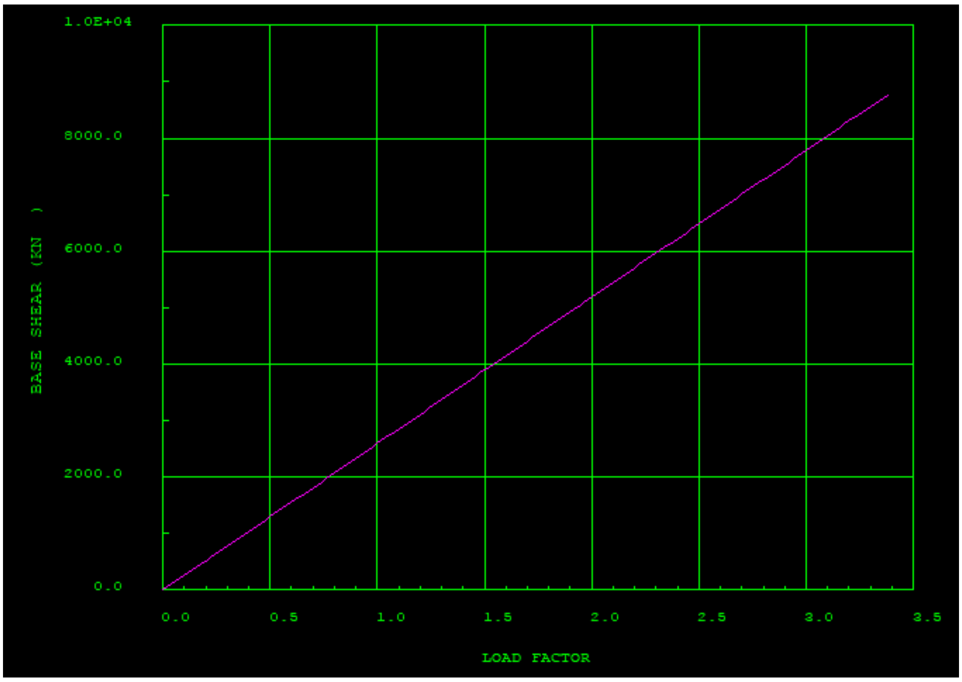


FIGURE 4.10 A Graph of Base Shear against Load Factor

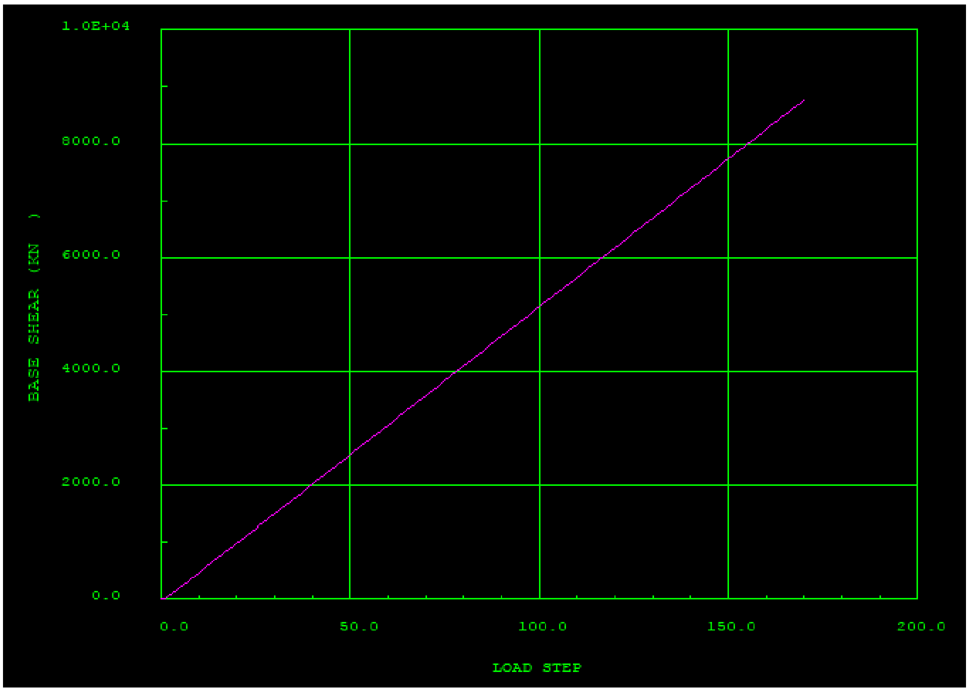


FIGURE 4.11 A Graph of Base Shear against Load Step

Reserve strength ratio was calculated by using the formula of:

Reserve Strength Ratio (RSR) = Ultimate Strength / Design Strength

= 8763.07 kN / 2593.79 kN

= 3.38

For 20% increase of topside loading with 100-year storm event, the RSR was 3.38 as shown in the calculation.

3. 20% decrease of topside loading

The same procedure was followed in this third condition but different of topside loading was used which 20% decrease of topside loadings. A load factor of 0.8 of topside loadings were set in the analysis. As the same procedure, at load step 51, the design strength was determined as 2594.44 kN like shown in figure 4.12.

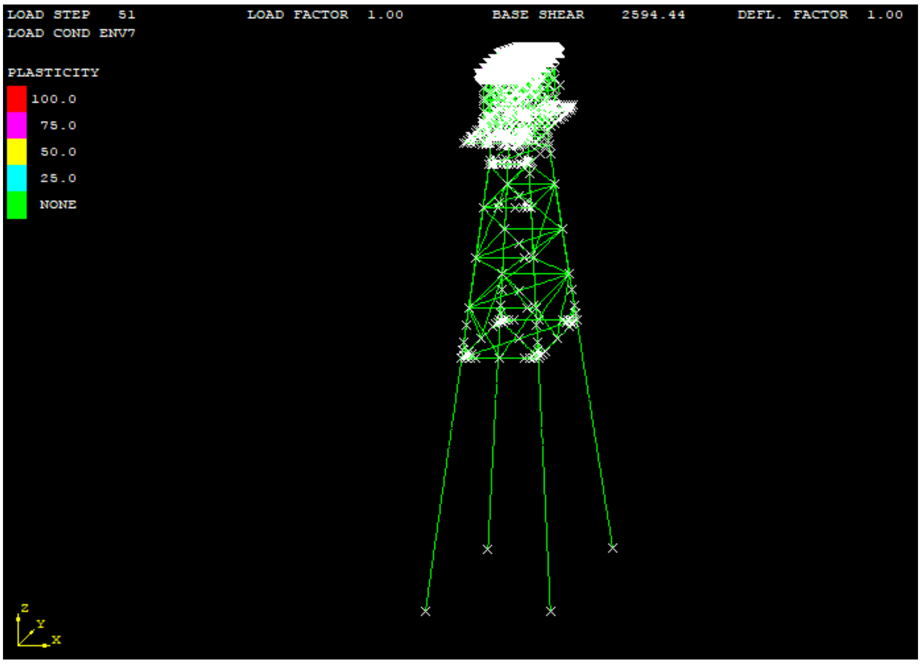


FIGURE 4.12 Design Strength of Platform EF in Collapse Output

The condition in figure 4.13 shows that platform EF had failed in the analysis where the platform failure can be seen in the collapse output.

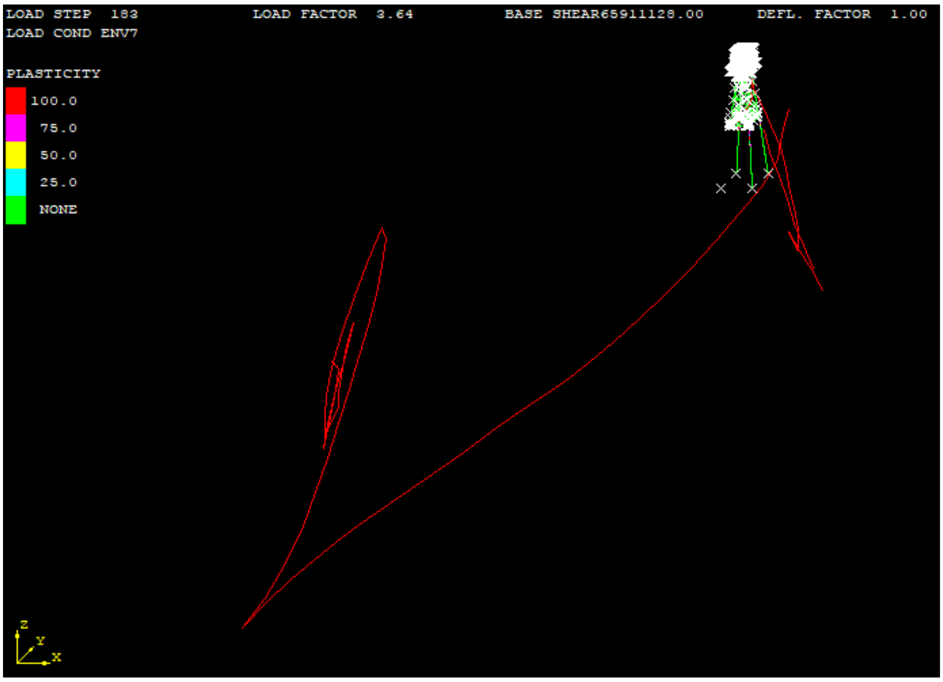


FIGURE 4.13 Failure Condition of Platform EF in Collapse Output

So, the analysis was set to prior condition where the ultimate strength of platform EF was determined. The ultimate strength was 9383.85 kN for the third analysis which shown in the figure 4.14.

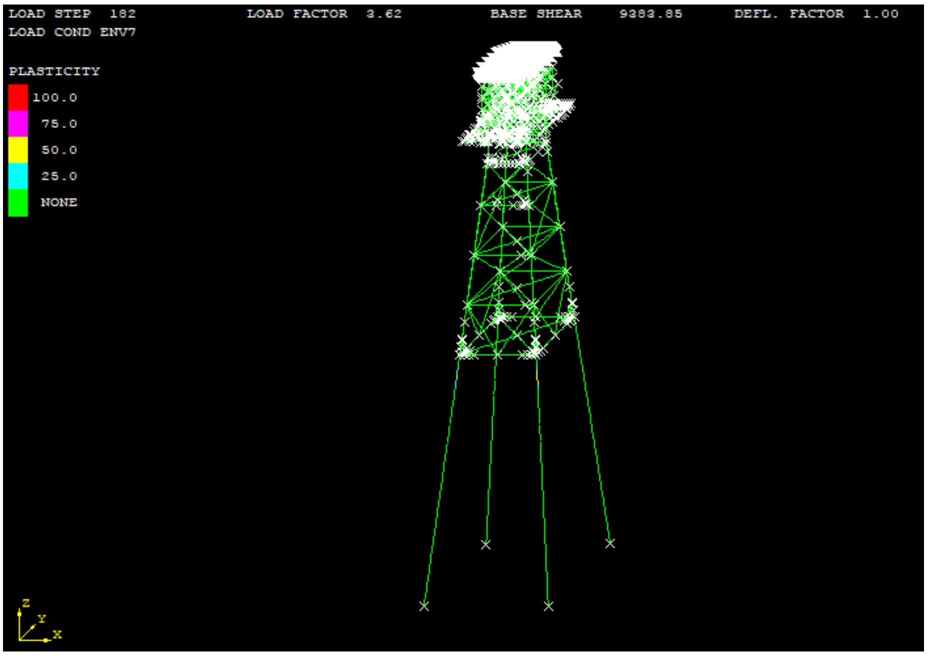


FIGURE 4.14 Ultimate Strength of Platform EF in Collapse Output

Two graphs were displayed as the output of the analysis which were graph of base shear against load factor and graph of base shear against load step. Both graphs are shown in figure 4.15 and 4.16.

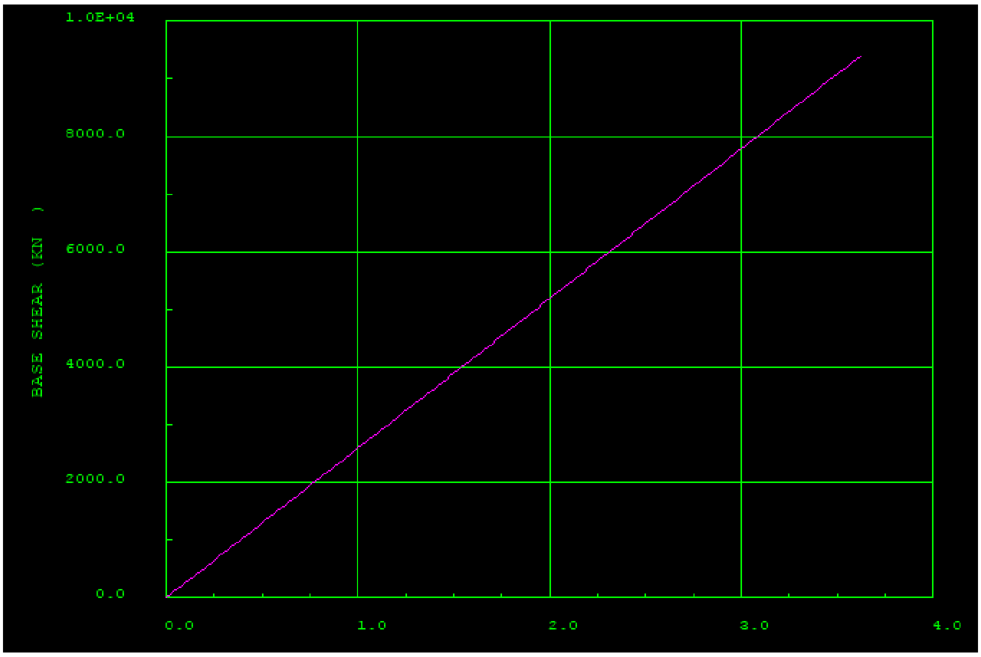


FIGURE 4.15 A Graph of Base Shear against Load Factor

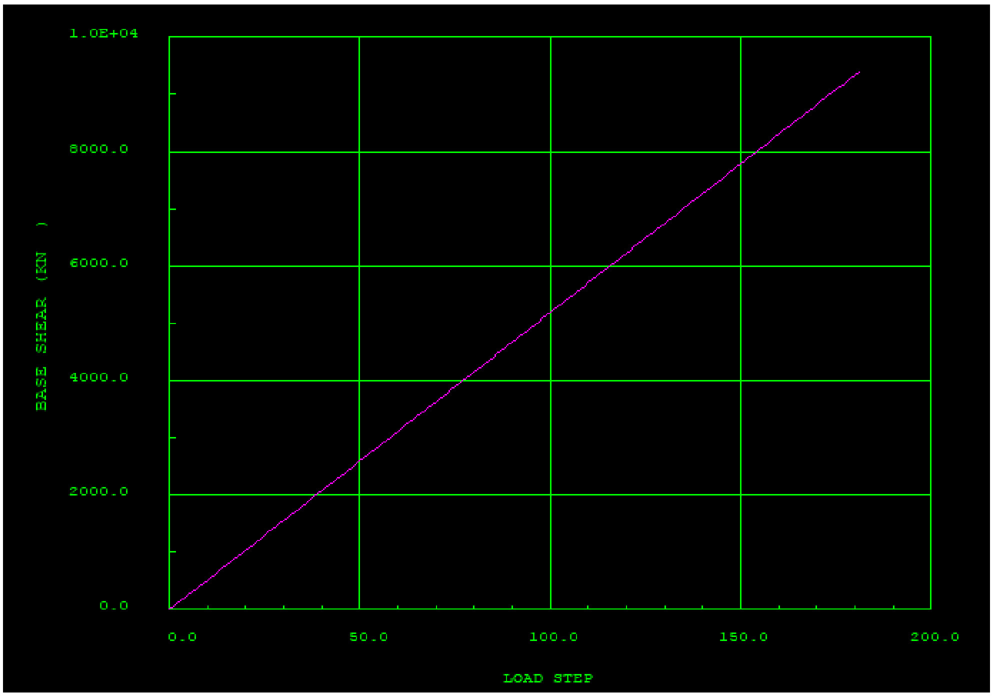


FIGURE 4.16 A Graph of Base Shear against Load Step

Reserve strength ratio was calculated by using the formula of:

Reserve Strength Ratio (RSR) = Ultimate Strength / Design Strength

= 9383.85 kN / 2594.44 kN

= 3.62

For 20% decrease of topside loading with 100-year storm event, the RSR was 3.62 as shown in the calculation.

The results were continued by comparing the reserve strength ratio of platform EF with two standards which are American Petroleum Institute (API) standard and Petronas Technical Standard (PTS). Both comparison was shown in table 4.3 and 4.4.

1. Comparison with API Standard

In section 17, for RSR of other area that U.S was stated, and platform EF was manned platform which stated in the table in section 17.5.2b, the reserve strength ratio (RSR) was 1.6 for the two conditions.

PLATFORM EF				
Load Condition	Condition of Topside Loading	RSR based on API	RSR based on SACS analysis	Status
100-Year Storm Condition	-20%	1.6	3.62	OK
	Normal		3.52	OK
	+20%		3.38	OK

TABLE 4.3 RSR Status for Platform EF in Comparison with API Standard

PLATFORM EF				
Load Condition	Condition of Topside Loading	RSR based on PTS	RSR based on SACS analysis	Status
100-Year Storm Condition	-20%	1.5	3.62	OK
	Normal		3.52	OK
	+20%		3.38	OK

TABLE 4.4 RSR Status for Platform EF in Comparison with PTS Standard

4.2 DISCUSSION

In the first phase, a platform was selected based on these criteria which help much into this project:

1. Type of platform
2. Location of platform
3. Life of platform

These criteria were used to gain a suitable platform such as platform EF to be used in the assessment and analysis, and results and discussion part. Platform EF was used due to its suitability as a fixed platform, the location of platform EF in Malaysia and the life of the platform is 33 years. Platform EF was the suitable platform as this platform is one of the ageing platform in Malaysia.

The details of platform EF were gained by using the latest database and information of offshore platforms in Malaysia. The details as water depth, year installed, jacket height, deck elevation and many more were gained. From the years installed of platform EF, the remaining life of the platform was calculated in order to know whether the platform already had exceeded design life or not. From the calculation, the remaining life of platform EF is -8 years which means that the platform had exceeded design life of 25 years by 8 years. The platform was claimed as an ageing platform.

Next results were analysed by using pushover analysis in SACS software. The three assessments were conducted as:

1. Original topside loadings
2. 20% increase of topside loadings
3. 20% decrease of topside loadings

The assessments were conducted by using 100-year storm event which the condition was a harsh condition. This is because the result is based on the worst-case scenario of the platform can handle. Therefore, the results of the analysis were gained by using those conditions.

For the normal topside loadings, the RSR had been calculated which showing the RSR was 3.52. As the topside loadings were increased, the RSR reduces. As shown in the result, the RSR for 20% increase of topside loadings were lower than the normal loadings with the RSR of 3.38. As the topside loadings were decreased, the RSR increases as shown for the RSR which had been calculated for 20% decrease of topside loadings. The RSR for 20% decrease of topside loadings was 3.62 which was higher than the normal one. This is shown in the figure 4.17, graph of RSR against topside loading which the line decreasing.

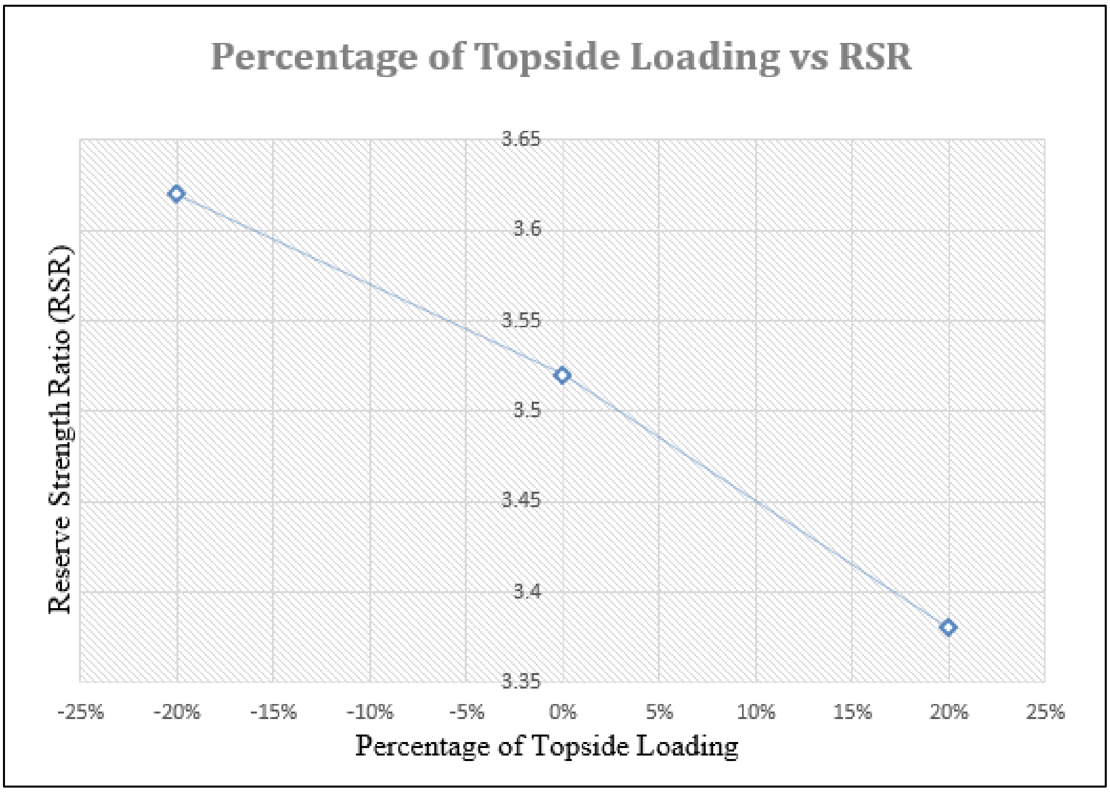


FIGURE 4.17 A Graph of RSR against Percentage of Topside Loading

From the comparison of RSR calculated in the analysis with the standards, the RSR calculated had exceeded the minimum requirements and the comparisons also were meant to be a decision where the platform should be abandonment or the contrast of it. From the results gained from the analysis, the platform should be abandoned.

Some further analysis was required to gain more results in the decision on reusing plan. Some of the analysis are like fatigue analysis and assessment on the joint. In order to do further analysis, data of the new location which be the location of the jacket to be reuse, are needed in this analysis. Thus, the platform should be abandoned due to the result of pushover analysis and further analysis were required to continue in deciding the reusing of the jacket of platform EF.

CHAPTER 5

CONCLUSION

As a conclusion, a platform was managed to be identified and selected to be used in the pushover analysis in SACS Bently Engineering Software. The platform was the suitable platform to be used with due to its details were same as the requirements. Basically, this project was done by using an ageing platform which suitable for the reusing purpose in the offshore decommissioning.

The analysis was done by three different topside loadings and the loadings affected the reserve strength ratio of the platform. If the loadings were higher, the reserve strength ratio was lower. From the results gained, the platform should be abandoned. Most of Malaysia offshore platforms are ageing platform so, a lot of decommissioning of offshore platforms will be expected in the coming years. Therefore, this project was able to achieve most objectives, but further analysis need to be done to determine the reusing plan for the jacket is feasible.

REFERENCES

(API), A. P. (25 June, 2015). *International Standards for Tubing*. Retrieved from PetroWiki: http://petrowiki.org/International_standards_for_tubing#API_grades

Ahmed, A. B., & Wan Abdullah Zawawi, A. (2014). Offshore Platform Decommissioning: The Need For A Cost Index. *Sustainable Solutions in Structural Engineering and Construction*, 793-798.

Denney, D. (1998). Onshore Decommissioning of Offshore Structures. *Journal of Petroleum Technology*, 70-71.

Gration, D., Daly, M., Jackson, G., Free, M., Lavelle, C., Feltham, I., . . . Francis , B. (2015). *Offshore Decommissioning.* Ireland: ARUP.

International, A. (2016). *Steel Standards*. Retrieved from ASTM International Web site: https://www.astm.org/Standards/steel-standards.html#A01.10

Mat Soom, E., Abu Husain, M., Mohd Zaki, N., Mohd Nor, M., Ayob, M., & Najafian, G. (2015). Global Ultimate Strength Assessment (GUSA) for Lifetime Extension of Ageing Offshore Structures. *International Ocean and Polar Engineering Conference* (pp. 431-435). Kona, Big Island, Hawaii, USA: International Society of Offshore and Polar Engineers (ISOPE).

Na, K., Wan Abdullah Zawawi, N., Liew, M., & Abdul Razak, Z. (2013). Adaptive Reuse of Offshore Structure Steel: The Way Forward for Malaysia? 1-4.

Øen, S., Iversen, P., Stokke, R., Nielsen, F., Henrikson, T., Natvig, H., . . . Bakke, G. (2011). *Decommissioning of Offshore Installations.* Oslo: Climate and Polution Agency.

Potty, N. S., & Ahmad Sohaimi, A. (2013). Ultimate Strength Assessment for Fixed Steel Offshore Platform. *Malaysian Journal of Civil Engineering*, 128-153.

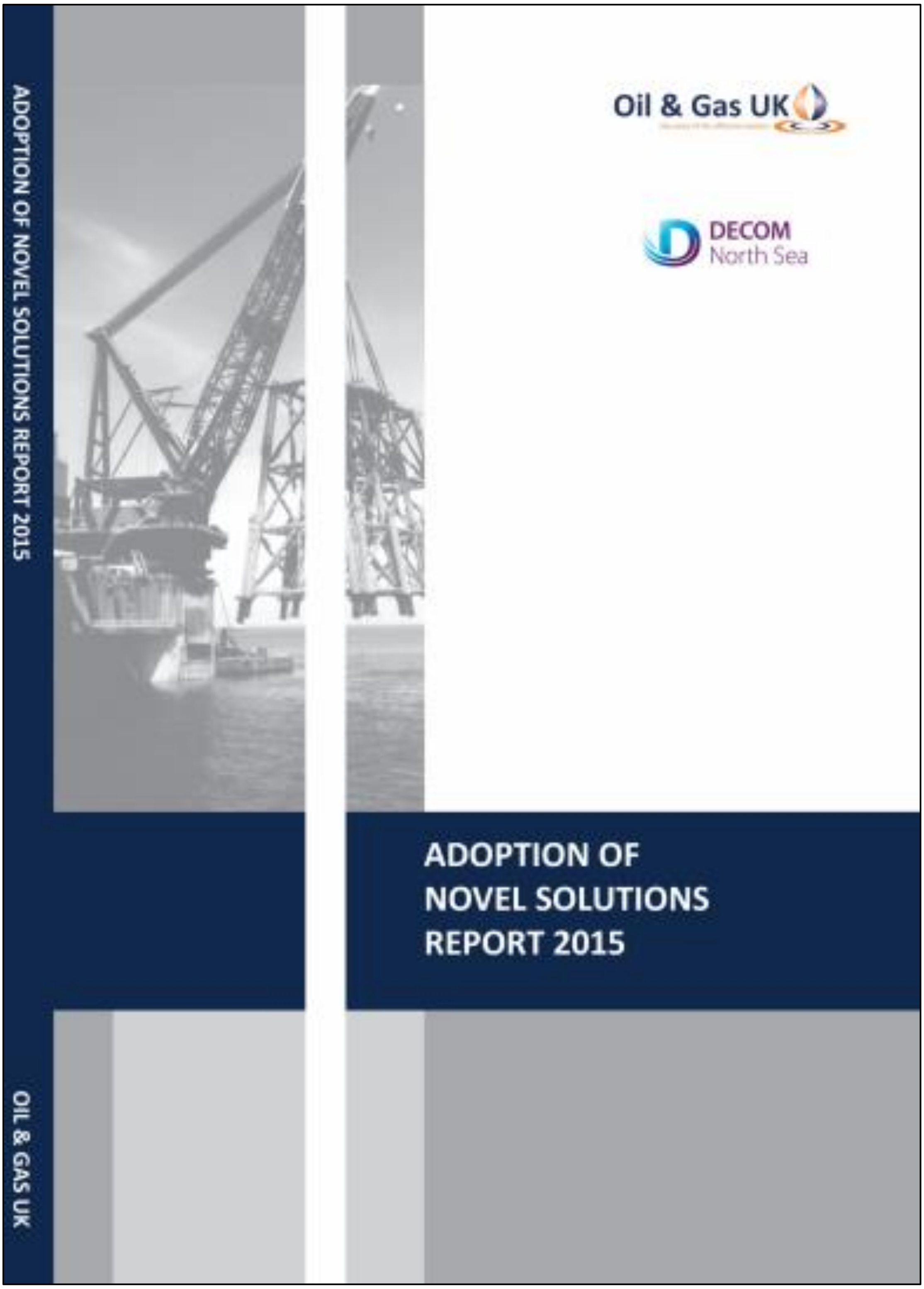
Wan Abdullah Zawawi, N. A., Liew, M. S., & Na, K. L. (December, 2012). Decommissioning of Offshore Platform: A Sustainable Framework. *IEEE Colloquium on Humanities, Science & Engineering Research*, (pp. 26-31). Kota Kinabalu, Sabah, Malaysia.

APPENDICES

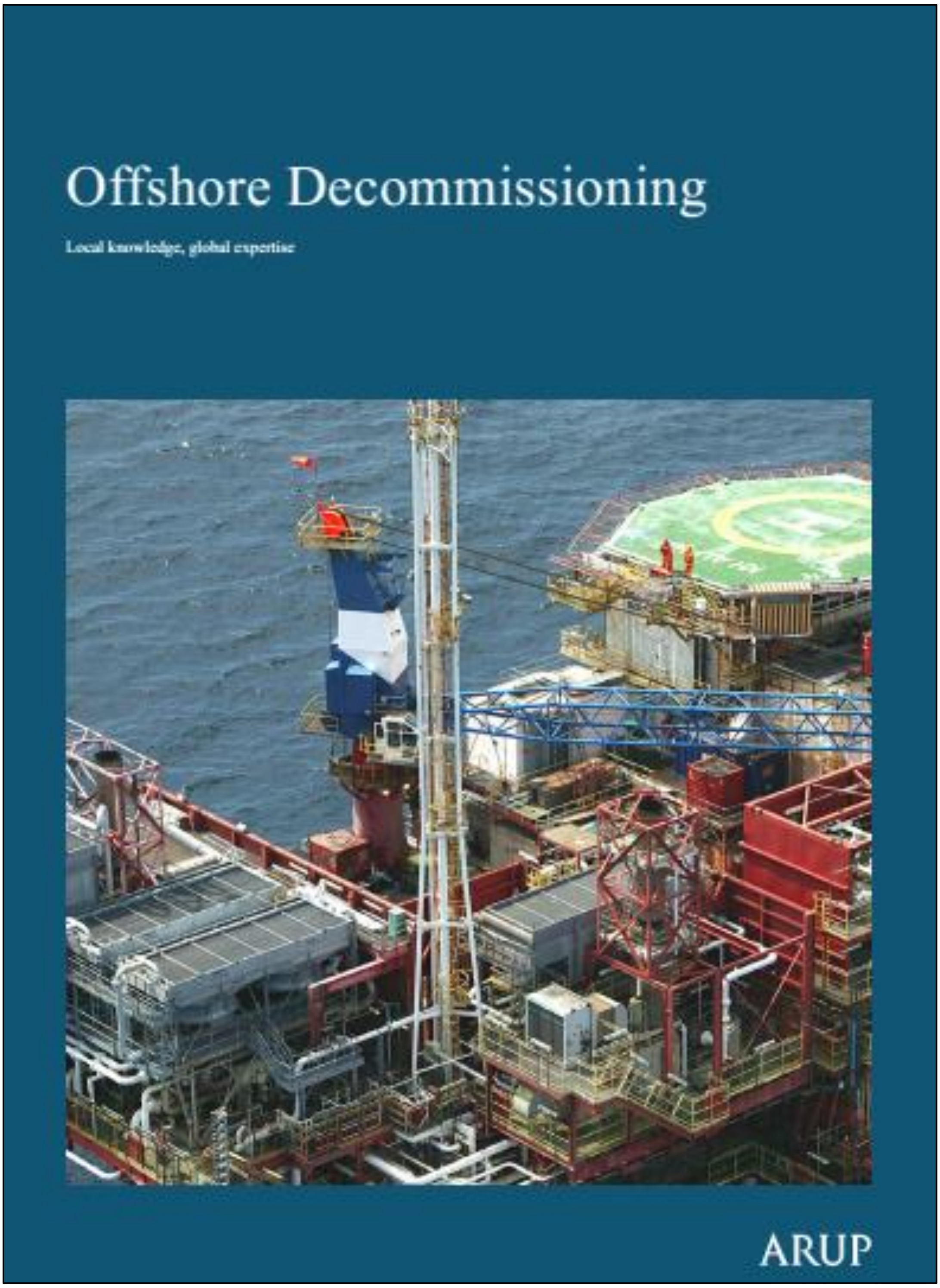
Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms—Working Stress Design

API RECOMMENDED PRACTICE 2A-WSD (RP 2A-WSD)
TWENTY-FIRST EDITION, DECEMBER 2000
ERRATA AND SUPPLEMENT 1, DECEMBER 2002
ERRATA AND SUPPLEMENT 2, SEPTEMBER 2005
ERRATA AND SUPPLEMENT 3, OCTOBER 2007

American Petroleum Standard (API), 2000



Arup Adoption of Novel Solutions Report October 2015



Arup Offshore Decommissioning Brochure

Report of Decommissioning of Offshore Installations, 2011

PETRONAS TECHNICAL STANDARDS

TECHNICAL SPECIFICATION

DESIGN OF FIXED OFFSHORE STRUCTURES

(WORKING STRESS DESIGN)

PTS 34.19.10.30

REVISION 7

APRIL 2012

PETRONAS

Petronas Technical Standards

Interview Session with Industry People