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RESEARCH ARTICLE

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Comparative Study of an Offshore Fixed Jacket Structure with and without Corrosion Allowance

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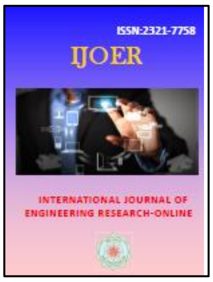

ABSTRACT
Jacket Structures are fixed structures which are used mainly in shallow water regions. They are used for drilling and production purposes. Structures in marine conditions are affected by corrosion which leads to decrease in strength of the structure. Corrosion occurs throughout the structure but the maximum loss of material is in the splash zone area where the members in the zone are subjected to alternate crests and troughs of incident wave and thus have an increased rate of corrosion. This decrease in dimensions leads to decrease in strength of material which reduces the ultimate strength and fatigue strength of the material. In order to prevent this corrosion allowance is given in this region so as to keep the members safe throughout the life cycle of the jacket. In the present case study, the analysis of a fixed jacket is done by giving a corrosion allowance which is followed by the analysis of the same structure in the condition where corrosion allowance has not been included. The results of the two conditions are compared and it is noted that there is a significant reduction in the strength of the member.

1. Introduction

Offshore structures have been used for the extraction of hydrocarbons for quite a few decades. They are located in water depths varying from shallow regions to deep water depths. Offshore structures are made such that it can house equipment's, housing facilities, storage facilities to house the products till they are offloaded and in some cases production facilities. Based on geometry and behaviour they are classified into fixed, compliant and floating structures.

Jacket structures are steel template structures which fall in the fixed category. They are the most commonly used among the offshore structures. They are mainly made up of steel tubular member which are connected in such a way so as to form a 3-D space frame. They are usually fixed to the seabed using tubular piles which may be driven through the legs of the piles or alternatively through skirts attached at the bottom portion of the legs.

Structural analysis and Computing Software (SACS) is software owned by Bentley Systems. This software is commonly used for modelling and analysis of offshore structures. Almost all energy companies requests their engineering department to incorporate SACS in the design and analysis of offshore structures.

Corrosion is a slow chemical process which leads to deterioration in the quality of the structure which is result of loss of material in the effected region. Corrosion occurs in areas which are exposed to a mixture of air and saline water. [1] T. Moan mentions in his studies that corrosion decreases the fatigue and ultimate strength of structure and has taken this factor while conducting a reliability study. The author has also mentioned about the various types of corrosion that occur. [2] Torrez and Ruiz has conducted a study on how corrosion leads to the degradation of the capacity of a jacket structure. They have studied degradation of the structure with respect to time.

2. Design Methodology

Initially the modelling of the structure is done by providing the structural configuration of the jacket with and without corrosion allowance. This is followed by assigning the member sections of the jacket structure. The environmental conditions for the region under consideration are given as input load data. The environmental conditions include wave and current data. Later the load combinations are created according to the given data. The analysis of the jacket is performed under the conditions and the resulting data are compared strength analysis of structure.

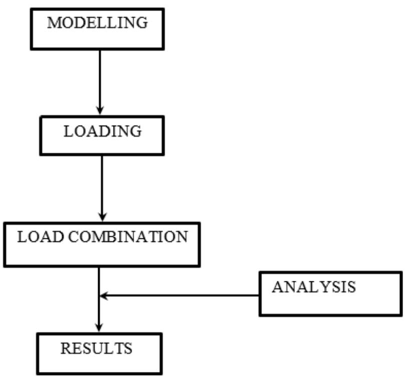

Figure1- Methodology Flowchart

3. Environmental Parameters

The wave and current loads are calculated according to API RP 2A WSD Standard provisions

Table 1- Wave Data

Direction (from)	Tide (m)		Max Wave	
	Highest AT	Storm	Height (m)	Period (sec)
North	4.36	0.00	4.878	6.70
North East	4.36	0.00	5.488	6.80
East	4.36	0.00	4.878	6.80
South East	4.36	0.00	4.878	6.80
South	4.36	0.427	8.537	9.20
South West	4.36	0.854	10.366	10.40
West	4.36	0.854	10.366	10.40
North West	4.36	0.00	4.573	6.50

The water depth is calculated from the wave height, highest astronomical tide and the tide caused due to storm surge. According to this data the Wave Theory is selected. The wave theory to be used is determined from The Region of Applicability graph given in API.

Table 2- Current Data

Dir	Current (m/sec) y-1/4=75% depth; y-1/2=50% depth, y-3/4=25% depth: from surface				
	Bottom	Y-1/4	Y-1/2	Y-3/4	Surface
N	0.579	0.884	1.036	1.158	1.280
NE	0.671	1.021	1.189	1.311	1.463
E	0.579	0.884	1.001	1.128	1.249
SE	0.366	0.533	0.640	0.731	0.820
S	0.579	0.884	1.036	1.158	1.280
SW	0.579	0.914	1.067	1.204	1.341
W	0.579	0.899	1.067	1.204	1.341
NW	0.366	0.549	0.671	0.762	0.853

The loads due caused due to current are calculated. By selecting linear wave theory we get the effect on wave loads due to the current in the same direction. Marine growth is also considered as an environmental load. Marine growth is given as 10 mm between the elevations -1.8m and 6m.

4. Structural Analysis of Jacket

The static analysis of the jacket is done initially for the condition where the corrosion allowance is given in splash zone region which is followed by the analysis of the jacket where the corrosion allowance has not been given. The members of the splash zone in the second case will be comparatively smaller than that of the first case.

Table 3- member dimensions with corrosion allowance

Member	**Member Dimensions(mm)**	
	O.D	Thickness
X08-615	660	28
X08-617	610	25
X08-611	610	25
X08-613	660	28
X01-624	660	28
X01-618	660	28

The size of the members in the splash zone in the first case will be heavier than that of the same members for the second case. This is due to loss of material by corrosion.

Table 4- member dimensions without corrosion allowance

Member	Member Dimensions(mm)	
	O.D	THICK
X08-615	634	15
X08-617	584	12
X08-611	584	12
X08-613	634	15
X01-624	634	15
X01-618	634	15

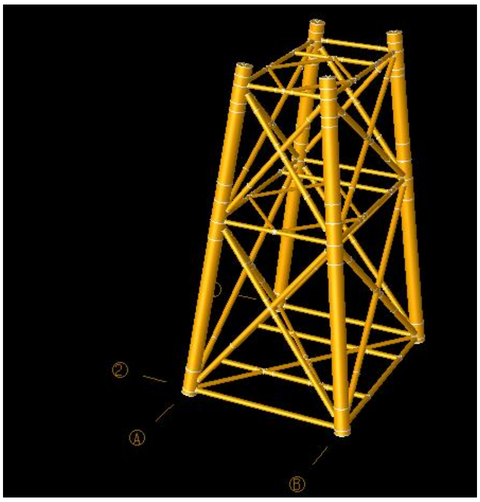

Figure 2- Image of Modeled Jacket

5. Results and Discussions

The main region under consideration is the Splash Zone. The strength of the member with the highest U.C ratio in the splash zone considering corrosion allowance is 2319 Newton per square metre. The strength of the same member in the second case where the corrosion allowance has not been given is 1340 newton per Square metre. The U.C ratios are 0.0577 and 0.0998 respectively. On comparison it is seen that the U.C. ratio has increased by 42.8%.The weight of the member decreases from 2094.76 Kg to 1099.11Kg. This indicates that there is loss of material resulting in decrease of strength which can lead to failure of the structure before its intended operation life. Extra allowance is therefore given to prevent failure of the structure caused due decrease in strength of the members by effect of corrosion.

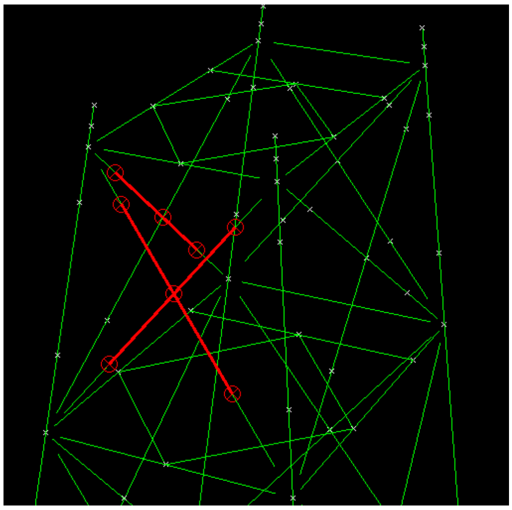

Figure 3- Critical Members in the Splash Zone

6. References

[1]. API RP 2A WSD Standard Provision

[2]. Reliability-based management of inspection, maintenance and repair of offshore structures by T.Moan Structure and Infrastructure Engineering, Vol. 1, No. 1, March 2005, 33–62.

[3]. Structural reliability evaluation considering capacity degradation over time by Torrez and Ruiz. / Engineering Structures 29 (2007) 2183–2192.