Marine Growth Rate Prediction of Wellhead Offshore Platform

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Abstract

Marine growth, though a straightforward issue, which is can lead the significant problems for marine structures such as wellhead jacket platforms. The survey was conducted to measure the thickness of marine growth from the splash zone downward to the seabed elevation of the jacket platform. The growth rate was calculated and predicted for 10 years from initial conditions, while the initial conditions were set 3 years after the operation started. The result indicated that the prediction thickness exceeded the allowable thickness at 5 years starting from the survey. The results of these measurements and predictions can be used for management policy-making and followed up with an assessment of the effects of marine growth on structural performance such as seismic and structural fatigue analysis.

Keywords: *Assessment; Marine growth; Marine structure; Wellhead jacket platform*

1. Introduction

Marine growth, though a straightforward issue, can lead to significant problems. Since wave force on a structure depends on the diameter of its members, the accumulation of marine growth enlarges the member diameter and consequently amplifies the wave force [1]. Marine growth can include algae, aquatic weeds, and marine invertebrates like Asian clams, zebra mussels, and other small organisms capable of infiltrating the system. All marine structures, including ships with marine fouling, will be impacted by this marine growth. During sailing, the ship's hull often becomes overgrown with marine fouling, increasing surface roughness. This added roughness heightens frictional resistance, necessitating more engine power to maintain the ship's service speed, potentially requiring operation [2,3]. Marine fouling impacts the load on an offshore structure in at least five distinct ways: (1) Enlarging tube diameters, which increases the projected area and displaced volume, thereby raising hydrodynamic loading, (2) Elevating the drag coefficient, resulting in higher hydrodynamic loading, (3) Adding mass and hydrodynamic added mass, which lowers the natural frequency and thus boosts the dynamic amplification factor, (4) Increasing the structural weight both underwater and above water in the air, and (5) Affecting hydrodynamic instabilities, such as vortex shedding[4].

Research related to marine growth and fouling has been ongoing for a long time. The study on flow behavior around marine biofilms was conducted using CFD simulation [5]. The impact of surface biofouling texturing on turbulent flow was also presented [7]. Simulation and experimental study demonstrated the effects of soft marine growth on vortex-induced vibration [7]. Reliability-based inspection frameworks for optimizing inspection and maintenance were introduced for monopiles including modeling and computation[8]. Besides underwater diving carried out by humans, the marine growth measurement survey can also be used by Autonomous Underwater Vehicles (AUVs) [9], especially for the areas that cannot be reached by human diving. Based on the negative impact of marine growth, this paper presented the predicted rate of marine growth of the selected jacket offshore platform for management decision-making.

2. Method

A marine growth survey was performed along Leg B2 from the splash zone downward to the seabed elevation of the jacket platform. All surfaces observed were covered by soft and hard growth from 1.5 m to 62.5 m depth. The jacket platform is illustrated in Figure 1 and the marine growth thickness at the leg of the structure was measured using a direct measurement method with hand-held measurement tape and ROVS, the depth of water refers to global positioning system (GPS) data is represented in Table 1.

Direct measurements were performed by human diving strat from 1.5 m to 27.5 m depth. After 30 meters depth, the measurements survey was taken over by ROVs. Vernier calipers were used to measure the marine growth thickness, both for manually measuring and for measuring by using ROVs. After collecting data, the process continues to calculate and predict the thickness rate by using the following Equation (1) for calculating marine growth rate prediction. While the operating life of the platform was set to 20 years.

$$\text{Marine Growth Rate} = \frac{\text{Marine growth data survey} - \text{Initial marine growth data}}{\text{Operating life of the platform}} \quad (1)$$

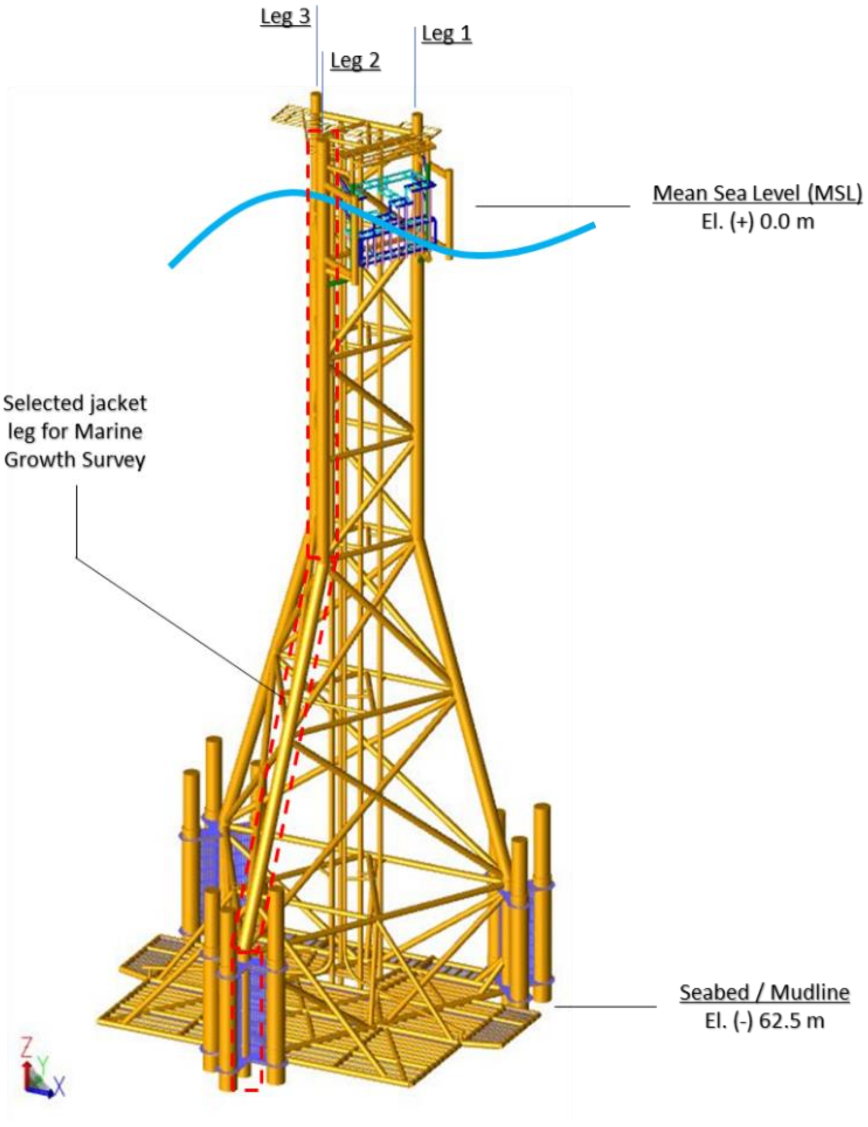
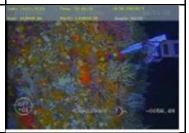


Figure 1. Jacket platform

Table 1. The marine growth measurement result

No	Depth	12 o/c thickness		3 o/c thickness		6 o/c thickness		9 o/c thickness		Coverage %		Photo
		Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft	
1	1.50 m	3 cm	1 cm	3 cm	1 cm	2 cm	4 cm	2 cm	1 cm	80 cm	90 cm	
2	3.00 m	4 cm	1 cm	5 cm	2 cm	3 cm	2 cm	3 cm	1 cm	80 cm	50 cm	
…	…	…	…	…	…	…	…	…	…	…	…	…
15	57.50 m	2 cm	20 cm	2 cm	20 cm	2 cm	16 cm	2 cm	20 cm	80 cm	50 cm	
16	62.5 m	2 cm	20 cm	2 cm	20 cm	2 cm	20 cm	2 cm	16 cm	80 cm	30 cm	

3. Results and Discussion

The marine growth (MG) rate was calculated based on marine growth thickness measured in 3 years after the operation started as the initial condition. With the design marine growth thickness allowable is 4.0 inches (uniform), After two years from the initial condition, MG thickness will exceed the allowable thickness at several elevations. The marine growth prediction result is presented in Table 2 with the overall MG average thickness of 2.7 inches for two years of prediction. The overall marine growth average thickness has reached 4.4 inches after five years. The overall thickness was steadily increasing by year until 7.1 Inches in ten years prediction. The plot of marine growth thickness profile prediction is presented in Figure 2, where the initial conditions are set at 2021.

Table 2. Marine growth rate and prediction

No	Rate (inch/year)	Elev. (m)	Initial condition (inch)	Prediction thickness (inch) in year									
				1	2	3	4	5	6	7	8	9	10
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1	0.3	1.5	1.0	1.3	1.6	2.0	2.3	2.6	3.0	3.3	3.6	3.9	4.3
2	0.5	3.0	1.5	2.0	2.5	3.0	3.4	3.9	4.4	4.9	5.4	5.9	6.4
3	0.5	4.5	1.4	1.8	2.3	2.8	3.2	3.7	4.1	4.6	5.1	5.5	6.0
4	0.5	6.0	1.5	2.0	2.5	3.0	3.4	3.9	4.4	4.9	5.4	5.9	6.4
5	0.6	7.5	1.8	2.4	3.0	3.5	4.1	4.7	5.3	5.9	6.5	7.1	7.7
6	0.8	12.5	2.4	3.1	3.9	4.7	5.5	6.3	7.1	7.9	8.7	9.4	10.2
7	0.8	17.5	2.5	3.3	4.1	4.9	5.7	6.6	7.4	8.2	9.0	9.8	10.7
8	0.9	22.5	2.8	3.7	4.6	5.5	6.4	7.3	8.3	9.2	10.1	11.0	11.9
9	0.7	27.5	2.2	2.9	3.6	4.3	5.1	5.8	6.5	7.2	7.9	8.7	9.4
10	0.7	32.5	2.2	2.9	3.6	4.3	5.1	5.8	6.5	7.2	7.9	8.7	9.4
11	0.9	37.5	2.8	3.7	4.6	5.5	6.4	7.3	8.3	9.2	10.1	11.0	11.9
12	0.3	42.5	1.0	1.3	1.6	2.0	2.3	2.6	3.0	3.3	3.6	3.9	4.3
13	0.4	47.5	1.1	1.4	1.8	2.2	2.5	2.9	3.2	3.6	4.0	4.3	4.7
14	0.3	52.5	1.0	1.3	1.6	2.0	2.3	2.6	3.0	3.3	3.6	3.9	4.3
15	0.3	57.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.9	3.1	3.4
16	0.3	62.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.9	3.1	3.4
MG average (Inch)			**1.6**	**2.2**	**2.7**	**3.3**	**3.8**	**4.4**	**4.9**	**5.5**	**6.0**	**6.6**	**7.1**
Design Marine Growth (Inch)			**4.0**										

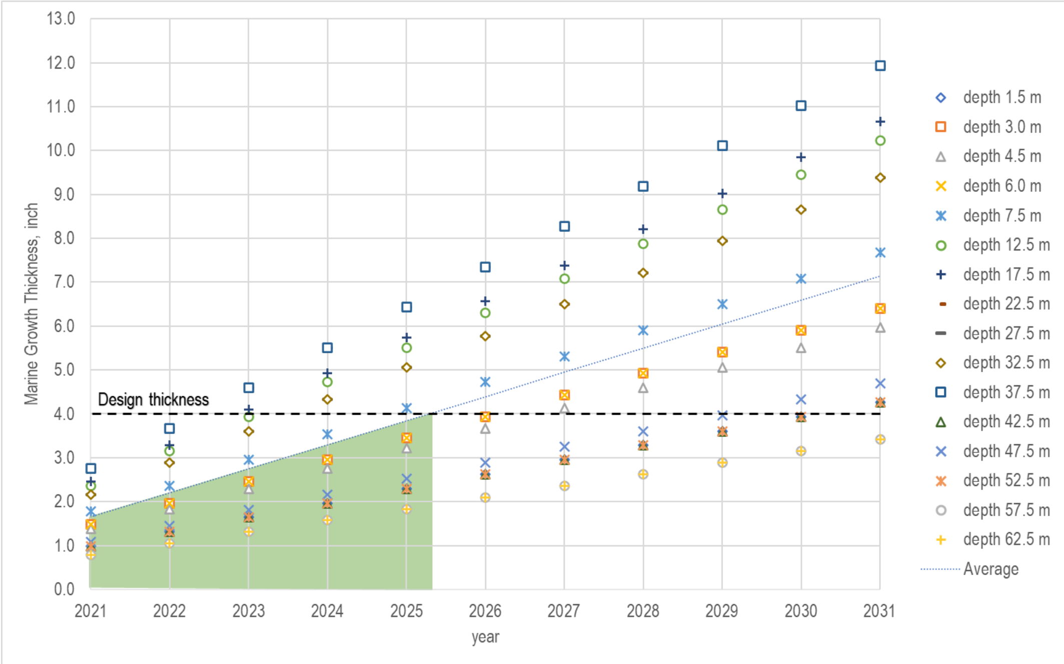


Figure 2. Marine Growth Prediction

According to Table 2, the average thickness value exceeded the threshold in the fifth year, so this year the design marine growth thickness was 4 inches for 20 years of design life, indicating that the platform was located in an excessive marine growth environment. It is necessary to perform mitigation measures for example marine growth thickness monitoring and cleaning of the wellhead platform jacket to avoid negative impacts on the structure.

4. Conclusion

It is important to measure the thickness of marine growth in underwater structures as a tool for policy-making to ensure the reliability of marine structures, especially offshore structures such as oil and natural gas drilling facilities. The results of these measurements can be followed up with an assessment of the effects of MG on structural performance such as seismic and structural fatigue analysis.

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