PREVENT MICROBIALLY INDUCED CORROSION (MIC) ON JETTY PILES WITH OCEAN-POWERED MGP-*i*

The Marine Growth Preventer (MGP) system has been providing marine growth control to over 9,000 jetty piles and consequently, increasing their structural integrity and enabling visual inspection, while preventing the possible onset of microbially induced corrosion (MIC). The MGPs are powered solely by ocean waves, tides and currents and designed for long term protection (>10 years) of jetty piles against marine colonisation

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Reducing Loads

Marine growth can hold some serious implications regarding the structural integrity of a jetty structure, mainly due to its adverse contribution to the structure's effective diameter, surface profile and static weight. The hydrodynamic loading a member is subjected to can be estimated using Morrison's equation (Equation 1):

$$F = \frac{1}{2}\rho D_e C_D U|U| + \frac{1}{4}\rho C_M \pi {D_e}^2 \dot{U}$$

Equation 1

The attachment of marine organisms, including hard-shell organisms like barnacles increases surface roughness and the effective diameter, D_e, of individual members. Which alters the drag, C_D, and inertia coefficients, C_M, in Morrison's equation and since, C_D could increase by up to 100% (Matten, 1977) with surface roughness and effective diameter (Jusoh & Wolfram, 1996) so does the magnitude of the hydrodynamic force faced by the member.

The formation of vortex shedding is also affected by the increase of effective diameter, D_e, and surface irregularity of a member. The strength of vortices increases, along with their spanwise coherence, increasing the cyclic lift forces on the member. On smaller diameter members this can severely reduce the estimated fatigue life of the member (Jusoh & Wolfram, 1996).

The increase in mass caused by marine growth decreases the natural frequency of the structure (Jusoh & Wolfram, 1996). Hence, closing the gap between the member's structural response and resonance, especially in members with small diameters (Jusoh & Wolfram, 1996).

By relieving individual members off marine growth, the MGP reduces loadings and adds life to jetty structures.

Aiding Inspection and Maintenance

The accumulation of marine growth on piles makes jetty inspection and maintenance especially difficult. Inspection may need to be coupled with cleaning of the members to check coating and substrate conditions, a time-consuming and costly burden, which often aggravates coating damage.

MGPs provide a zero-growth profile, hence once installed, jetty piles are ever ready for inspection, without hindering the operation or getting hindered by the weather.

Stopping MIC

Whether the member is steel or concrete it can be prone to MIC (Noel, 2016). MIC refers to the onset or propagation of corrosion under the influence of microorganisms.

MIC is a significant contributor to corrosion experienced by steel piles in jetty structures and ports (Javaderdashti, 2016). The biological organisms that initiate MIC can be anaerobic, like sulphate reducing bacteria which form sulphides and depolarise cathodes by consuming hydrogen, or aerobic like sulphur oxidizing bacteria which encourage corrosion by creating environments with sulphuric acid (A&E Group, 2010). The colonies formed by these organisms create crevices and add to the

metabolic activities which contribute heavily to oxygen and ion concentration cells, which accelerate corrosion (A&E Group, 2010).

In concrete, corrosion caused by microorganisms is also known as microbiologically induced deterioration or MID. Microorganisms can attach and then colonize on concrete structures and produce acids leading the degradation of the concrete compounds (Wei et al, 2013). The activities of microorganisms can decrease the service life of a concrete structure and accelerate damages such as cracking and spalling by increasing concrete porosity, decreasing protective cover depth, aiding erosion of the concrete surface and facilitating the transport of degrading materials into the concrete (Sanchez-Silva et al, 2008).

The factious contribution of microorganisms to the corrosion process means it needs to be diagnosed, assessed and monitored before a mitigation process can be recommended (Noel, 2016). Making the prevention and treatment of MIC extremely complicated and time consuming or even environmentally harmful in the case of biocides. By removing and then preventing marine growth from recurring, the MGP removes the source of MIC.

Easy to install

Marine Growth Preventers are self-cleaning and wave-powered devices which break down existing growth and prevent further growth from manifesting on marine piles. They are customizable to fit any jetty structure, in single-ring or multiple-ring configurations. MGPs are compatible with all types of jetty piles whether they are steel or concrete, coated or uncoated, cleaned or heavy with marine growth, new or existing.

Its installation can be summarized into assembly and installation onto the jetty piles; in a single deployment, without the need of divers, interruption to operation or special equipment (Figure 1). Once installed the MGP harnesses the power from the waves to achieve a zero-growth profile on the jetty structures without the need of any further intervention.

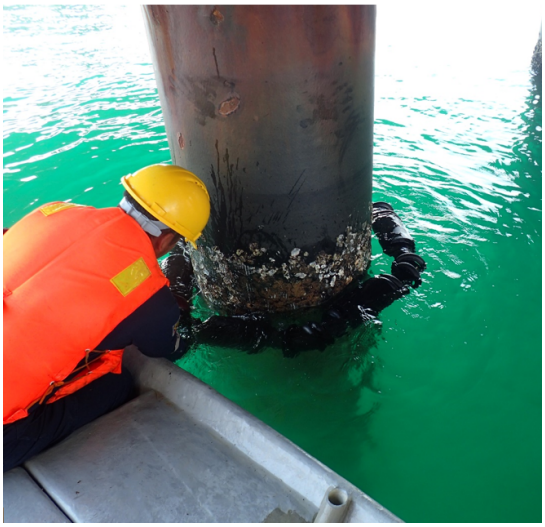

Figure 1 : Single-ring MGP installation onto a Jetty pile

Immediate Results

The MGP gets to work immediately, breaking away large masses of marine growth (Figure 2).

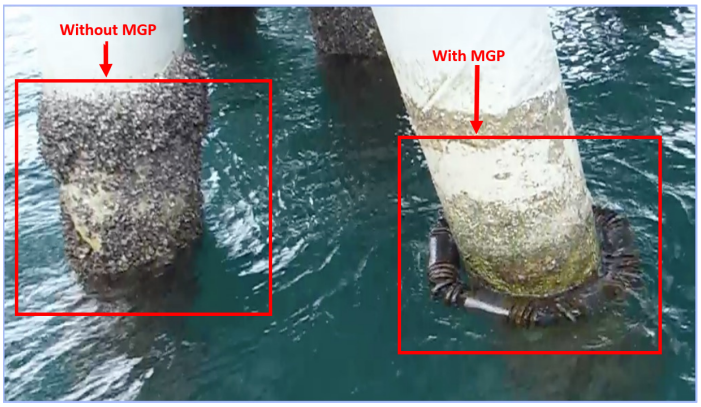

Figure 2 : Single Ring MGP comparison

Results after 20 years

MGPs' durability has stood the test of time and harsh marine conditions, providing over 20 years of marine growth prevention (Figure 3).

Figure 3 Single-ring MGP 20 years after installation

References

A&E Group (2010). Technical Paper. *"Accelerated Low Water Corrosion"*. Available at http://www.ae-sys.com/techpapers/mic.pdf

Javaherdashti R. (2016). Examples of Some Systems Vulnerable to MIC. *"Microbiologically Influenced Corrosion: An Engineering insight"*. 2nd End. Springer. pp. 130

Jusoh I and Wolfram J. (1996). *"Effects of Marine Growth and Hydrodynamic Loading on Offshore Structures"* Jurnal Mekanikal Jilid *1,* 77-98.

Larson, K.R. (2018). *"Characterizing Severe Bridge Corrosion in a Marine Environment."* Materials Performance Magazine, Houston TX

Matten R. B. (1977). *"The influence of surface roughness upon the drag of circular cylinders in waves"* National Maritime Institute, OTC 2902

Noel, N. (9 Nov 2016). *"Microbiologically induced Corrosion MIC How microorganisms attack different materials*" [PowerPoint presentation] Retrieved from: https://www.corrosie.info/documents/2016/11/how-microorganisms-attack-different-materials-endures.pdf/

Sanchez-Silva M, Rosowsky D. (2008). Biodeterioration of construction materials: state of the art and future challenges. J Mater Civil Eng. 20:352–365.

Wei, S., Jiang, Z., Liu, H., Zhou, D., & Sanchez-Silva, M. (2014). Microbiologically induced deterioration of concrete--a review. Brazilian journal of microbiology: [publication of the Brazilian Society for Microbiology], 44(4), 1001–1007. https://doi.org/10.1590/S1517-83822014005000006