Degradation Models – Offshore Environmental Conditions and Corrosion

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WP 3.1 – Loads due to Marine Growth and Sea State

- Marine growth at offshore structures can accumulate to a coverage thickness of up to 30 cm (Fig. 1), leading to an extended flow resistance and thus potential increase in loads.
- The seasonal change of marine growth is thereby inverse to the occurrence of significant wave loads (Fig. 2), resulting in a multitude of load combinations.
- To systematically investigate the influence of seasonal changes of marine growth and sea states on fatigue loads, physical model tests were carried out in the 3D wave basin of the Ludwig-Franzius-Institute.
- Artificial marine growth was attached to a monopile structure and long- as well as short-crested sea states in combination with current were simulated.
- As a result of the additional roughness increased loads on the monopile structure with marine growth were measured compared to those at a smooth pile.
- In addition, reduced loads due to short-crested sea states were found compared to long-crested conditions. Furthermore, superimposed currents lead to increased loads in cases were the current direction were opposing the wave direction.

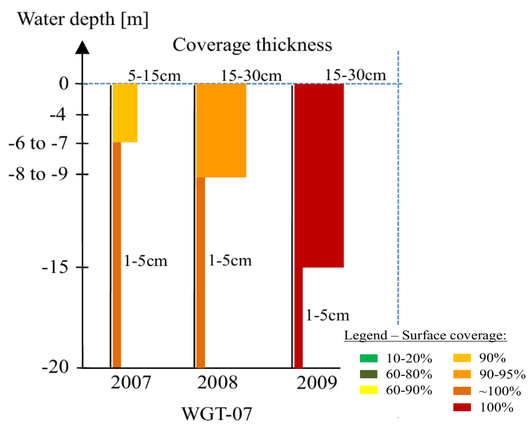


Fig. 1: Change of marine growth at monopiles in three years (after Buijs, 2010)

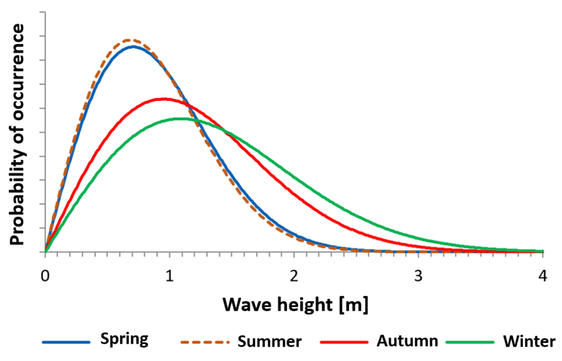


Fig. 2: Probability of occurrence of wave height, FINO1 2004-2013 (BSH)

WP 3.2 – Scour Development as Induced by Tidal Currents

- Investigations on the scour development due to unsteady tidal currents are limited, although tidal currents decisively depict a determining factor for scour progression in marine conditions.
- In order to describe the influence of tidal currents on the progression of scour and thereby further optimize the scour prediction for realistic marine conditions, physical model tests were carried out in the closed-circuit flume of the Ludwig-Franzius-Institute.
- The test program incorporated unidirectional and tidal currents in clear-water as well as live-bed conditions.
- Tidal signals were based on field measurements, acquired at the FINO I platform located in the North Sea, by the Federal Maritime and Hydrographic Agency of Germany (BSH).
- As a result of the altering tidal currents infilling and sediment displacement within the scour hole is taking place, leading to significant slower progression of the scour depth compared to unidirectional currents with flow intensities corresponding to the peak velocity of the tidal current (Fig. 3).
- By accounting for time varying flow conditions, the scour progression induced by tidal currents can be well predicted by a time discretized model.

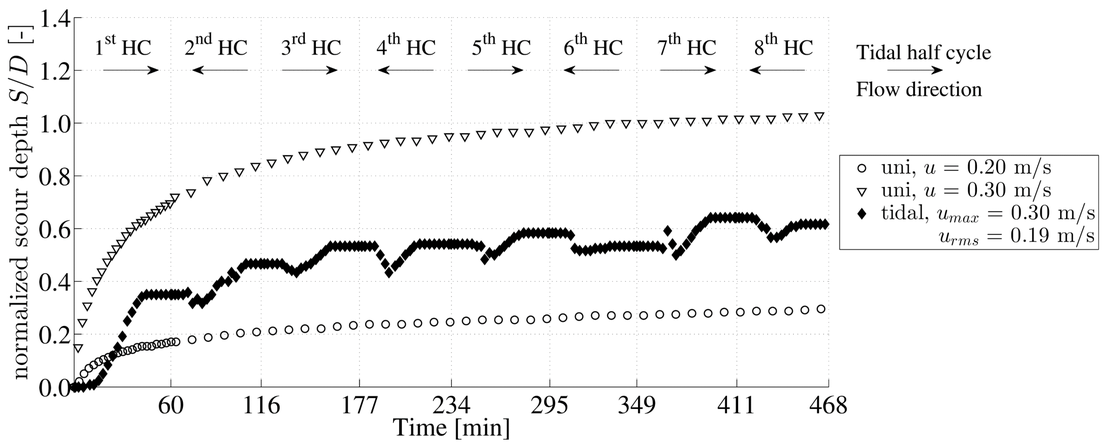


Fig. 3: Progression of maximum scour depth over time for unidirectional and tidal currents around a monopile structure

WP 3.5 – Notching Effect of Corrosion in Defected Coatings

- Corrosion protection of steel structures in off-shore environment is mostly gained by application of protective organic coatings.
- When the coating is defected by an mechanical impact (e. g. unexpected hitting), the corrosion under this defect will be different in shape and velocity in comparison to corrosion of free surfaces. Here, notching effects may effect the integrity of the steel structure more than expected by usual assessments.
- The influence of epoxy based coating material on the shape of the corrosive attack and therefore on the notch sharpness should be investigated.
- To reduce investigation time, coated samples with different commercially available coatings have been scribed to simulate mechanical defect and than be exposed to an accelerated corrosion test valid for offshore application, the ISO 20340 which takes 25 cycles resp. weeks to perform (Fig. 4).

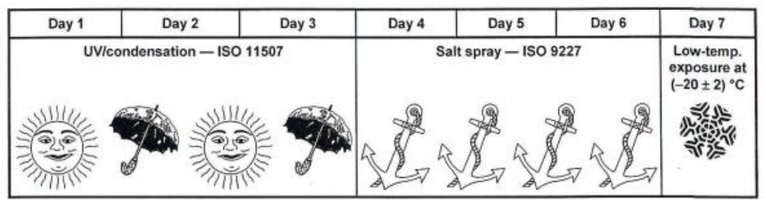
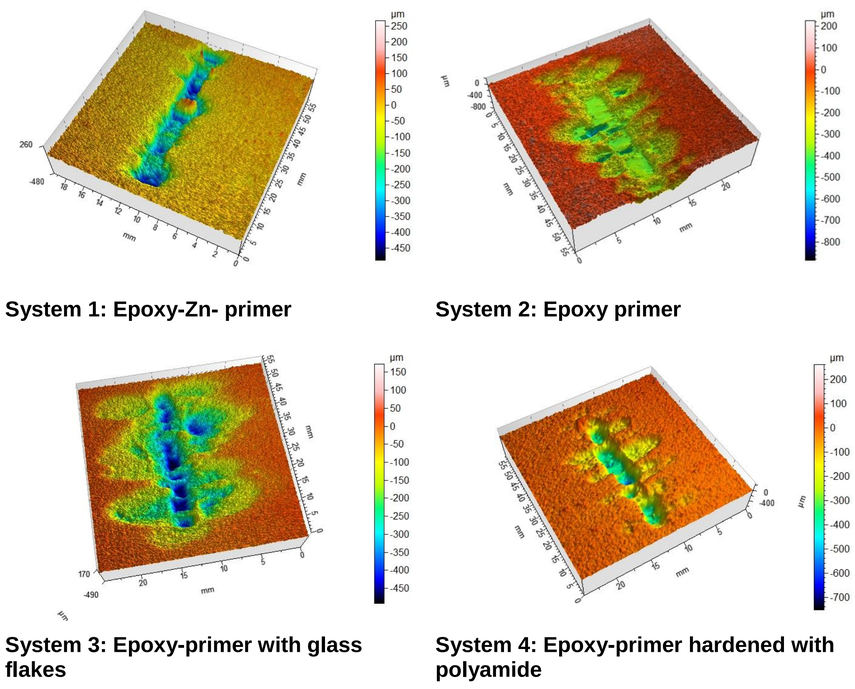


Fig. 4: Single cycle of ISO 20340 corrosion test

- The coating material was removed by pyrolysis at 600 °C in hydrogen atmosphere. The shape of the corrosion attack was determined by confocal profilometry (Fig. 5).
- The investigated systems show reproducible and specific behavior (Fig 6).
- It can already be stated that the coating systems have evident influence in the development of local corrosion attacks and therefore their notch sharpness.
- Further analysis will be performed to describe notch sharpness more precisely.



System 1: Epoxy-Zn- primer

System 2: Epoxy primer

System 3: Epoxy-primer with glass flakes

System 4: Epoxy-primer hardened with polyamide

Fig. 5: Corrosion attack under organic coatings near mechanical defects (here: scribe)

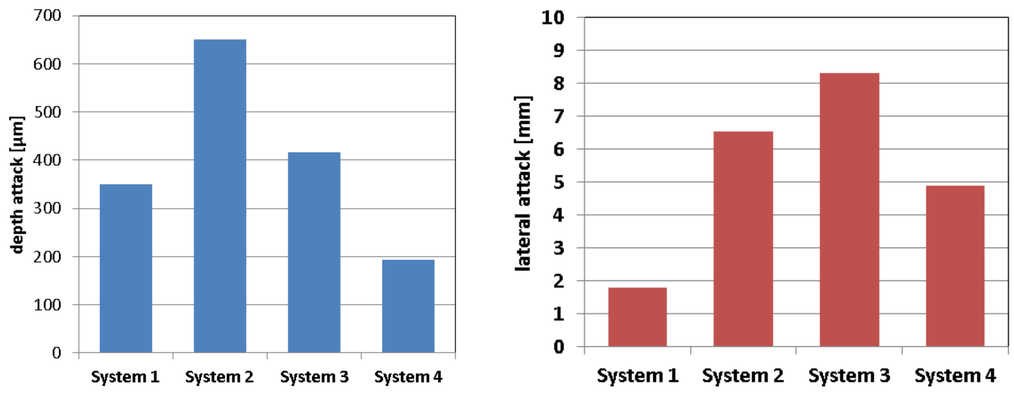


Fig. 6: Parameters to describe differences in the shape of the corrosion attack

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