Reliability assessment of offshore structures subjected to bio-colonisation process

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Summary
The paper focuses on the random effect of marine growth and illustrates it through an example of a monopole foundation. A Finite Element Analysis (FEA) model was built to study the structural performance with consideration of hydrodynamic of structural and environmental conditions. A Dynamic Bayesian Network (DBN) is constructed for assessment and updating of structural reliability from data obtained from periodically inspection during operational stage.

1. Introduction

Generally, it would be unrealistic to envisage a complete model involving a multilayer of various marine organisms that have complex interaction for survival, growth and reproduction. Hence, we focus on the growth of single dominant species in Atlantic coasts, the blue mussel *Mytilus edulis*. To account for the hydrodynamic of structural and environmental conditions, a FEA model was developed. By considering some input parameters as random variables, it is possible to perform Monte Carlo simulations to obtain the output database for structural performance. The input and output data are used to construct the DBN which presented structural performance over its lifetime. By introducing inspection data as evidences in DBN, structural reliability is then updated.

2. Methodology

We propose a stochastic modelling of mussel's growth with available average and variance values from spares available data. For modelling the thickness trend, a simplified growth model (Bayne et al. 1980) is considered:

$$L_t = 0.08[1 - e^{-0.222t}] \quad (1)$$

with L_t is the mussel's average thickness (m) and t is the time (year).

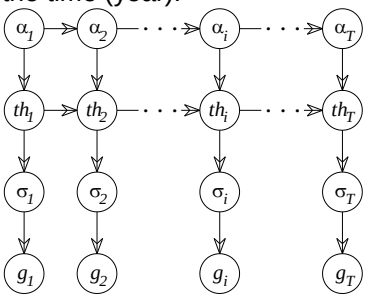

Fig. 1: DBN modelling of bio-colonisation process

The DBN is built from input parameter (α) and output parameters (thicknes (th_i), stress of elasticity (σ_i) and limit state (σ_i))
The observations which are the measurements of thickness, were introduce in DBN as evidence to update reliability of structure.

3. Results

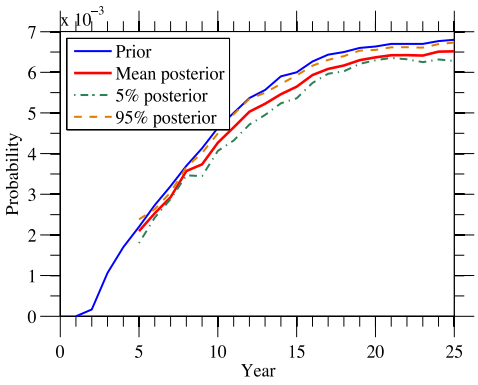

Fig. 2: DBN updating

Numerical observations were generated at different inspection times (5 years, 10 years) with assumption that real value of α was smaller than its prior. The updating was performed with various number of measurements to evaluate the relative errors of identification. The results was shown that DBN was successful to update the reliability of structures subjected to bio-colonisation of marine growth. Based on results, it is possible to define number of measurements that can satisfy a given range of identification errors.

4. References

[1]Bayne, B.L. & Worrall, C.M., 1980. Growth and Production of Mussels Mytilus edulis from

Two Populations. Marine Ecology, 3, pp.317–328.