

Title of Diploma Thesis

Experimental Investigation of the Application/Behaviour of Nanomaterials on Offshore Structures' Steel

Authors

Eleni Valatsou, Maria Karageorgou

Academic Year

2014-2015

ABSTRACT

Marine structures present a very important part in engineering, which poses many manufacturing challenges due to the specific nature and complexity of the marine environment. These structures consist of a wide range of engineering facilities which are categorized according to their usage, material and supporting system.

Steel structures and structures consisted of steel parts are one of the main categories of marine structures. Steel is one of the most popular materials in marine construction; therefore, its protection from mechanical and environmental damage is a very important subject of study.

To achieve the optimum protection of steel from various environmental actions in the marine area, coating materials with increasingly enhanced properties related to their behavior in stress are being used. These materials are applied as a coating on steel surfaces and prevent the phenomenon of corrosion, which is the most important environmental deterioration factor, as well as the phenomenon of marine growth on the structures. A revolutionary step towards this optimal protective action has been taken through the use of nanoproducts as coating materials. The composition of these products has been reinforced with nanostructures, an intervention in the material at the base of the nanoscale, which gives them improved properties compared to those of the macroscale.

In the present thesis, the behavior of this new material technology has been experimentally investigated in comparison to other conventional steel coatings. More specifically, the objective of the thesis is the assessment/evaluation of the application and of the behavior of nanomaterials used as coatings in the case of steel marine structures for protection against corrosion and marine growth. For implementing the aforementioned assessment and evaluation, the behavior of selected nanomaterials was compared with the behavior of other conventional and widely used materials, by performing suitable laboratory experiments. To draw conclusions about the behavior of the applied materials, two main parameters were examined, always based on the physical problem: (a) the rate of corrosion observed on the metal members in the marine environment and (b) the amount of marine growth onto the metal surfaces, which eventually stresses the structure. Two types of experiments were totally performed. Each type examined one of the aforementioned parameters of the physical problem.

Conclusions were drawn based on: (a) a qualitative analysis of macroscopic and microscopic scale and (b) a quantitative evaluation using image processing analysis. Cost analysis along with the estimated lifetime of the materials was taken under consideration. Nanoproducts showed superior performance against corrosion and marine growth in each of the examined conditions. This was attributed to the existence of the nanoparticles, which contact the steel surface, not just by creating a protective cover, but basically by penetrating the metal in depth, covering the pores

and making the material impermeable to moisture and resistant to the presence of microorganisms. An important observation concerning the prevention of marine growth is that, unlike the case of conventional materials, there has not been any indication of disorder in then normal morphology of the population of microorganisms and only their increasing rate was affected.

Keywords: Marine Structures, Steel, Nanomaterials, Corrosion, Marine Growth, Laboratory experiments, Image processing.