AXIOMATIC DESIGN BASED ASSESSMENT OF OFFSHORE WIND TURBINE SUPPORT STRUCTURES

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ABSTRACT

Axiomatic design theory has been used widely in the development of new products, processes and systems. The aim of using such a method is the development of solutions that satisfies design requirements while ensuring minimal impact on the environment. In the present paper axiomatic design theory is used for developing offshore wind turbine support structures and assesses different configurations. The method is combined with multi-criterial decision making method TOPSIS for the benchmarking of different structures.

Keywords: axiomatic design, multi-criteria decision making, TOPSIS, offshore wind turbines.

INTRODUCTION

Axiomatic design is based on mapping the customer needs on functions that the product is expected to perform (defined as functional requirements), then derive design parameters indicating how the product can satisfy such functional requirements and finally describe the process variables for the manufacturing of the object (figure 1). This process is usually implemented through zigzag decomposition having in mind two fundamental design axioms: the independence axiom stating that each functional requirement should be independent and the information axiom for the selection of the design alternative with the minimum information content (Suh, 2001). Axiomatic design has been widely used for the design of products and their manufacturing processes, as an example the reader can refer to recent study by Salonitis (2015) for the design of components for additive manufacturing. However, such a method has never been used for the case of designing structures for offshore wind turbines, that are characterized of high complexity.

Offshore wind turbines (Lorazo-Minguez et al., 2011) can be supported in number of ways, such as monopile, tripod and jacket (figure 2). Each of these methods present specific advantages and limitations, for example monopile structure is a simple design, the foundation of which consists of a tubular structure that extends into the seabed, but can be used for installations at water depths of up to 25 m. The design of offshore structures is based on a combination of the Finite Element Method (FEM) and the provisions of design standards, indicatively CEN (2005) and DNV (2010).

Within the present paper, a number of aspects are collected and documented such as the functional requirements for an offshore wind turbine support structure (such as support structure weight and operating loads, minimum impact on the environment etc), the economic limitations and the manufacturing capabilities. Axiomatic design method is use for the desing a structure that will be able to meet such requirements. Additionally, axiomatic design is employed for assessing the design of the existing approaches, through the independence
axiom. The information theorem is afterwards used for assessing the designs and the results are compared with the TOPSIS results.

Fig. 1 - Axiomatic design approach
Fig. 2 - Different support structures

RESULTS AND CONCLUSIONS
This study shows that axiomatic design can be used for the development of new designs and that the use of information theorem can be used in tandem to TOPSIS comparative analysis.

REFERENCES
[1]-CEN. Eurocode 3-Design of steel structures. BS EN 1993-1-1:2005