Experimental and Numerical Analysis of Absorber Materials for Steel Decks

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ABSTRACT

Nowadays, comfort is becoming the principal goal for designers. But what does onboard comfort really mean? It is possible to define it as a sense of physical or psychological ease, often characterized as a lack of hardship, and it is therefore a subjective sensation. In fact, the perception of a comfort condition is due to a complex mechanism in which the different senses are involved and interact with each other. When trying to improve the comfort onboard, it should be considered that the interaction between the surrounding environment and the people on board is realized through the perception of stimuli related to hearing (noise), smell, breathing and transpiration (air quality and temperature), the sight (aspect of the environment), physical contact (vibration) and the sensation of movement of the body in space (ship motions). Until now, the most important Classification Societies impose severe rules and regulations only for the evaluation of noise and vibration maximum levels for different zones of the ship. Many other aspects that influence the comfort on board are currently under study.

The incentive to provide the market with more comfortable products gave rise to high awareness for the analysis of sound transmission and absorption of the main materials used in shipbuilding. There are two driving parameters to describe the behavior of sound absorber materials: Transmission Loss (TL) and Insertion Loss (IL). In case of metals, with particular reference to steel, it is well known that the internal damping is very low. In contrast, there are so-called viscoelastic materials, which show high dissipation of mechanical energy. In this paper, a measurement campaign in real scale, carried out to investigate the dynamic behavior of different materials used to absorb vibration and sound propagating through steel decks, is described. During the tests, a comparison of velocity level measured under the naked metal plate obtained from experimental data and from finite element analyses has been carried out. Furthermore, the TL and IL values of the four different floor configurations obtained from experimental data are compared to understand which type of floor shows the best damping behavior.

KEY WORDS: Floor, Viscoelastic material, Damping, Transmission Loss, Insertion Loss.

INTRODUCTION

The expectations of owners and the amount of papers published by Classification Societies on the issue of onboard comfort impose to designers to sensitize more and more towards the problems of predicting vibroacoustic of transport means. (Boote, Pais, Delle Piane, 2013). In addition to comfort aspects, the efficiency, safety and health of passengers and crew should be considered with attention. In order to correctly evaluate the influence that all parameters have on the dynamic behavior of any structure the determination of the vibration, noise, and their routes of transmission results to be necessary, (Biot et al., 2015). The demands of owners refer to reduce the noise level in some particular areas and to increase the confidence between a cabin and the other: such requests can arrive to limit the noise levels up to 10-20 [dB].

Cars, planes and ships are often very complex structures for which, in the field of audible frequencies ranging from 0 to 20 kHz, simple methods for the prediction of noise and vibration do not exist. On the other hand, weight saving has led to the creation of structures ever lighter with a consequent increase in the transmissibility of vibrations and noise. In the case of ships, vibration and noise are generated by several factors such as engines, propellers, pumps, compressors, air conditioning equipment, which passes to the hull through the connection points. These structural vibrations transmitted to the hull produce structure-borne noise radiated both within and into the water (Nilsson, 1978). The latter produces a distinct acoustic signature, decisive for the identification of each ship through passive sonar, its modification or reduction, as well as forecast in the design phase, is a matter of great interest and research, especially to meet the demands made by the Navies. The run therefore to provide the market with products most silent gave rise to a huge sensitization for the study of the analysis of sound transmission and absorption efficiency of the main materials used in the various fields. Compliance with regulations and owner requests take to the need to achieve ever-higher quality standards, offer in the meantime ships satisfying the demands of a public more demanding in terms of comfort and service; have led to the search of new solutions for the future.

The unanimous scientific interest is focused on the development of a technique already well known but which could not enjoy the proper attention until now: the active control. All these aspects have led to the