DYNAMIC RESPONSE OF MARINE PROPULSION SYSTEMS UNDER MULTIAXIAL RANDOM LOADS

VIKASH KUMAR SATYAM

DEPARTMENT OF APPLIED MECHANICS

INDIAN INSTITUTE OF TECHNOLOGY DELHI

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By

Vikash Kumar Satyam

DEPARTMENT OF APPLIED MECHANICS

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Vikash Kumar Satyam

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ABSTRACT

Engineering design of real systems consists of breaking the system into smaller components in time and space, analyzing them under different types of loads and synthesis of the system. Such practice has evolved with experience in design. In order to benefit from past experience, time tested standards and engineering codes are used. However, actual simulation of the design in real time in natural working conditions considering multiaxial loads under random environment remains a serious challenge.

As the technological innovations in the field of digital computation and computer simulation are growing, possibility to analyze service life under different loading scenario for component design has improved. Powerful simulation supported by finite element methods with mathematical techniques make it possible to take better decisions at very early stages of design resulting in better utilization of resources.

This thesis is study about dynamic response of the marine propulsion system under multiaxial random loads. Components of propulsion shafting system are subjected to torsion, axial, bending and lateral loadings during operations. Torsional vibration analysis of the propulsive shaft is an important task in the ship design in order to ensure smooth propulsion power transmission to the propeller from the prime mover and the thrust generated by propeller to move the ship. Propeller shaft undergoes severe loading during conversion of rotational motion by propeller to translatory motion of the ship. Torque, thrust, self-weights of shaft and weight of the propeller has to be supported by the outer most part of the shafting system creating a multiaxial loading scenario. Designers have been using limited analysis using transfer matrix method or analytical and numerical combined methods. Structural designs based on correlations with uniaxial test data or limited multiaxial test data supplemented with safety

factor based on statistics is nonconservative as far as reliability of the system is concerned. A detailed analysis covering multiaxial loads can equip designer with better information in respect of the service life of the component under design. A three-dimensional finite element analysis complemented by reliability assessment has been carried out to study the durability of the propeller shaft.

Based on the propeller induced vibrations and available means to improve stealth of a submarine has been examined. Interesting facts have emerged out for the future research on the subject. Using basics of the dynamic response under multiaxial loading propulsion system of a powerful nuclear submarine has been investigated.

Reliability studies include the comparative service life grading based on the reliability index and probability of failure. At early stages of design such reliability analysis can ensure specified performance of the propulsion system or probable failure can be predicted and future surprises can be avoided.

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