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Finite Element Strength Assessment of a Crane Foundation Deck in a Multi-Cat Fish Farm Support Vessel

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Abstract This study evaluates the structural strength of the forecastle deck in the crane foundation area of a Multi-Cat vessel using the finite element method. A three-dimensional finite element model was established to simulate the deck structure under crane operating loads. The analysis considered the most critical lifting condition and included eight crane rotation angles. Stress results were assessed according to the allowable stress requirements of the ABS Rules for Building and Classing Steel Vessels under 90 Meters. The results show that the maximum Von Mises stress occurs at a rotation angle of 180°, with a value of 160.4 MPa, which is lower than the allowable limit of 165 MPa. Therefore, the deck structure in the crane foundation region satisfies the strength requirement under the examined operating conditions. The study confirms that finite element analysis is an effective tool for verifying the structural safety of crane-supported deck structures.
Keywords FEM; Crane; Forecastle; Deck; ABAQUS; Foundation

1 Introduction

The structural integrity of ship decks subjected to concentrated loads is a key issue in marine structural design, especially in regions supporting crane foundations. During lifting operations, crane loads generate significant local stresses and deformation in the deck plating, stiffeners, girders, and supporting substructure. If these effects are not properly evaluated at the design stage, they may lead to excessive deformation, local yielding, fatigue damage, or even structural failure in service. Therefore, local strength assessment of deck structures under crane loading is an essential part of structural verification for crane-mounted marine vessels.

Recent studies have shown that finite element analysis has become an effective approach for evaluating local reinforcement schemes and structural responses in crane-supported marine structures. For example, Dragatogiannis et al. (2024) analyzed deck reinforcement arrangements for crane installation on a composite yacht and showed that local strengthening has a significant influence on stress distribution and structural safety. Hernández-Ménez et al. (2023) proposed a structural assessment methodology for an FPSO main deck supporting an offshore crane and demonstrated that different crane operating conditions may substantially affect deck behavior. In addition, Abdullah et al. (2023) carried out a finite element strength analysis of a deck crane barge and confirmed that numerical simulation is a practical tool for identifying critical stress locations in crane-bearing deck structures. These studies indicate that finite element-based assessment has become an important method for evaluating the structural adequacy of crane foundation regions in marine applications.

With the development of computational mechanics, the finite element method (FEM) has been widely adopted to simulate complex structural responses under localized marine loading conditions with high accuracy. Compared with simplified analytical approaches, FEM can represent the interaction between deck plating, stiffeners, girders, supporting bulkheads, and pillars more realistically, making it particularly suitable for crane foundation regions where load transfer is highly localized and structurally discontinuous. In practical ship design, classification society rules provide the basis for determining whether the calculated stresses are acceptable. Consequently, combining finite element analysis with rule-based acceptance criteria offers a rational and reliable framework for assessing deck strength in crane installation areas.