Design and Modeling of the Gyro Plate for Marine Gyrostabilizer Using Finite Element Analysis

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Abstract

Marine vessels experience motion in six degrees of freedom, particularly during adverse weather conditions such as storms, heavy rain, rough seas, and strong winds. Gyroscopic stabilizers offer a promising solution to mitigate these motions, as they are unaffected by hydrodynamic drag and external factors like seaweed. This study focuses on the development and optimization of the gyro plate, a critical component of the gyrostabilizer system. Five gyro plate models, inspired by a published design from prior research, were created and analyzed using Finite Element Analysis (FEA) in SOLIDWORKS. The methodology included a mesh curvature study to ensure the accuracy of stress, deformation, and strain predictions under static loads. The results demonstrated progressive improvements from Models 1 to 5, with Model 5 emerging as the optimal design. For PLA Pro material, Model 5 achieved the lowest stress (2.18 MPa), minimal deformation (0.618 mm), and reduced strain, enhancing structural efficiency by minimizing stress concentrations and evenly distributing loads. While Models 1 and 2 stood out for their simplicity and cost-effective manufacturability, Model 5 balanced superior performance with high compatibility for 3D printing,

requiring minimal post-processing. This study highlights the structural efficiency, reduced displacement, and manufacturability of the optimized gyro plate, paving the way for improved gyroscopic stabilization systems. The findings contribute to more efficient and reliable marine transportation, with potential applications for larger vessels.

Author keywords

Finite Element Analysis (FEA); Gyro plate; optimal design

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Abstract

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