SESM6047 - Finite Element Analysis in Solid Mechanics 2025 Coursework

Introduction

This report details the outcomes of a series of FE analyses conducted on a canting keel design for use on racing yachts. As requested by the technical director, a series analyses were conducted on the design, these were two static structural simulations of the keel under its own weight and when subjected to a forward grounding/impact event and a modal analysis of the keels natural modes of vibration. The report presents figures of the simulations, verification and verification of the results and critiques of the keel design.

Analysis 1: Static Structural Simulation of Keel Self Weight

For this analyses, a sweep method was used to generate a mesh with size set to 0.1m. The keel was constrained through the Ram bearing as well as the rotation pivot bearing and an acceleration of $9.81m/s^2$ was applied to all bodies in the negative y direction. The lateral deformation of the fin under its own weight is shown in **Figure 1**.

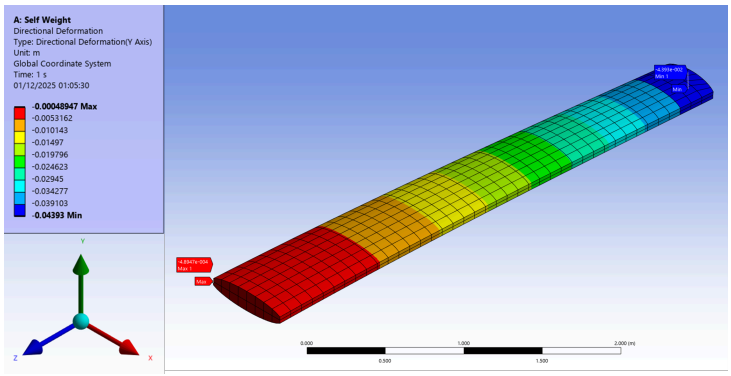

Figure 1: Lateral (y direction) displacement of the fin under its own weight, visualized using a rainbow contour.

For the analyses shown in **Figure 1**, the magnitude of the largest lateral deformation was obtained to be $w_{\max} \approx 0.04393m$ shown by the blue probe in **Figure 1**. This is coherent with the loading of the keel as the keel is only supported from the left side and the majority of the weight of the keel is in the bulb situated at the far right, meaning the far right of the fin would see the most deformation. The next output of the analysis is

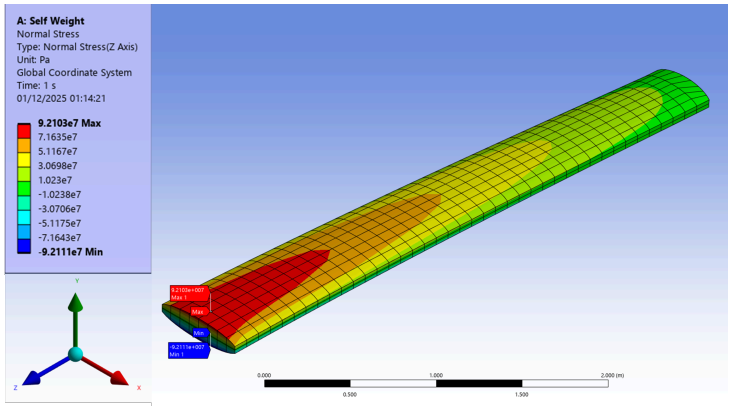

Figure 2: Contour plot of longitudinal (z direction) normal stress of the fin under under the keel's self weight.

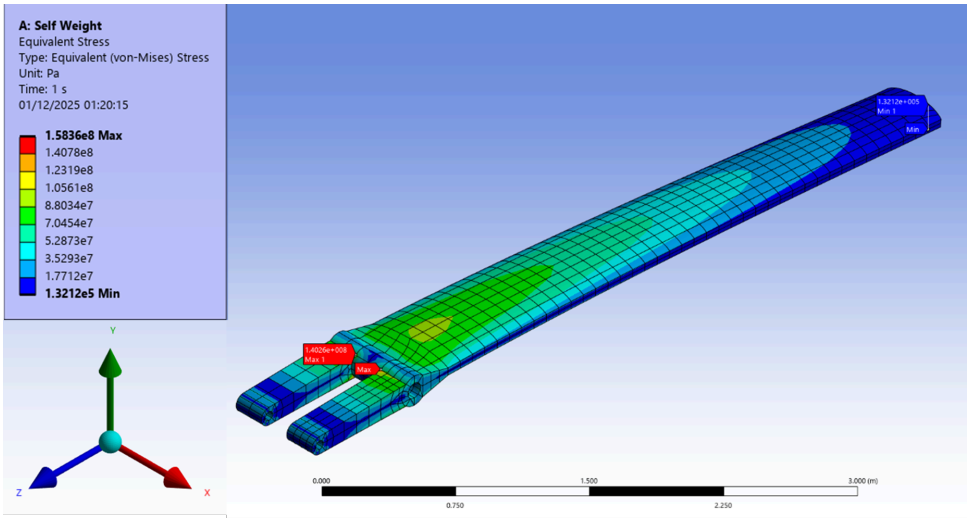

Figure 3: Contour plot of equivalent Von-Mises stress of all Steel parts under the keel's self weight.

Analysis 2: Static Structural Simulation of an Impact or Grounding Event

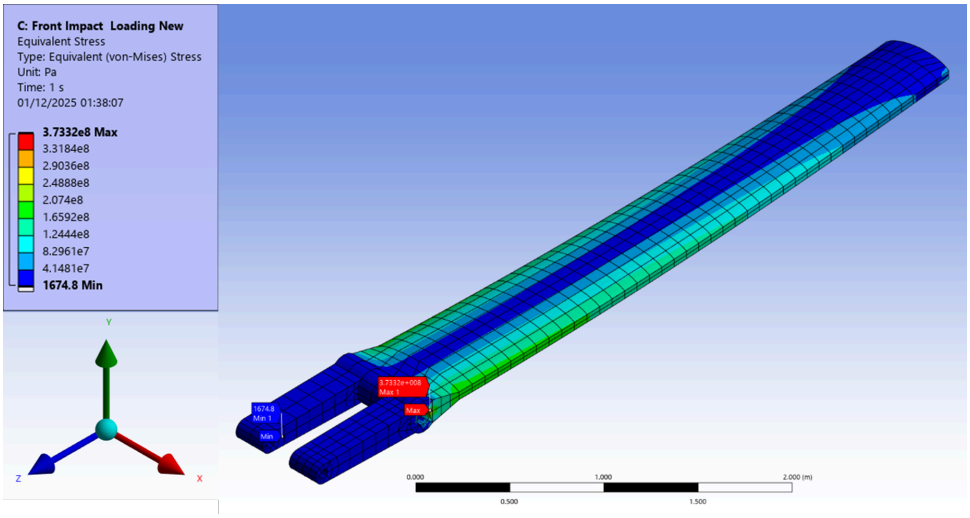

Figure 4: Contour plot of equivalent Von-Mises stress of all Steel parts under impact/grounding load.

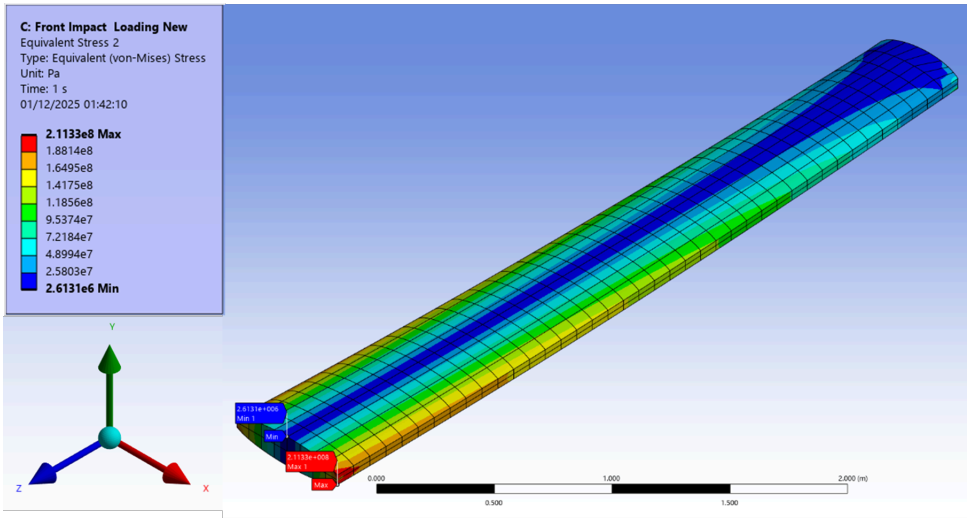

Figure 5: Contour plot of equivalent Von-Mises stress of the fin under impact/grounding load.

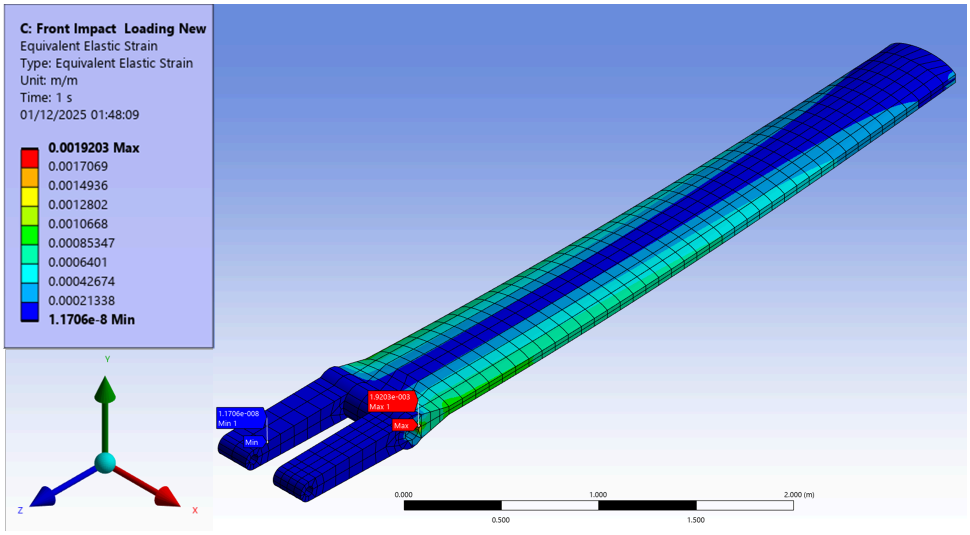

Figure 6: Contour plot of equivalent Von-Mises strain of all Steel parts under impact/grounding load.

Analysis 3: Modal Analysis of Keel Natural Frequency

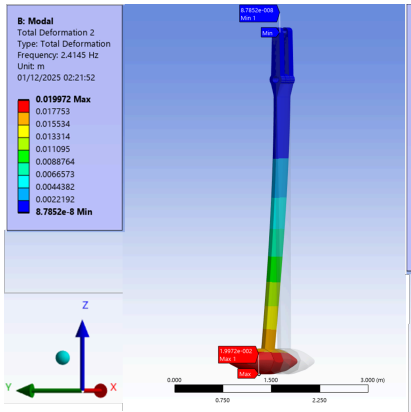

Figure 7: Contour plot of equivalent Von-Mises strain of all Steel parts under impact/grounding load.

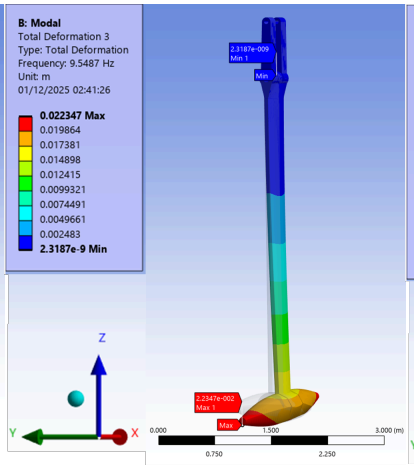

Figure 8: Contour plot of equivalent Von-Mises strain of all Steel parts under impact/grounding load.

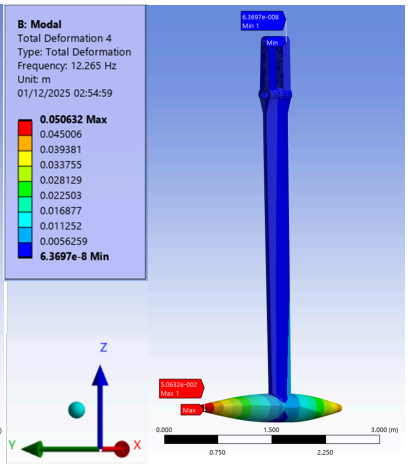

Figure 9: Contour plot of equivalent Von-Mises strain of all Steel parts under impact/grounding load.