CASE STUDY

STRESS ENGINEERING SERVICES INC. ESTABLISHED 1972

FITNESS FOR SERVICE ENGINEERING PRACTICE

# Design of Subsea Components with Finite Element Limit Analysis

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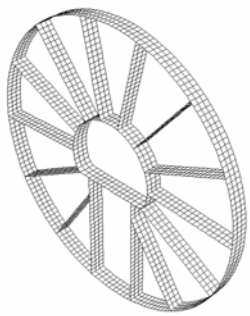
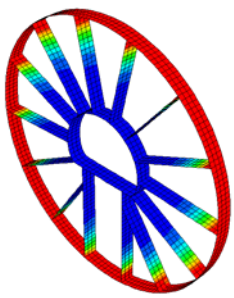
## GIVEN:

Fairfield Industries of Houston utilizes an aluminum housing to make measurements using its electronic equipment in subsea applications. Demands for drilling to deeper depths have required that Fairfield Industries design a subsea housing to operate at a water depth of 3,000 meters. Certain restrictions exist in maximizing the volume for battery storage as well as certain geometric restrictions related to electronic hardware.



## REQUIRED:

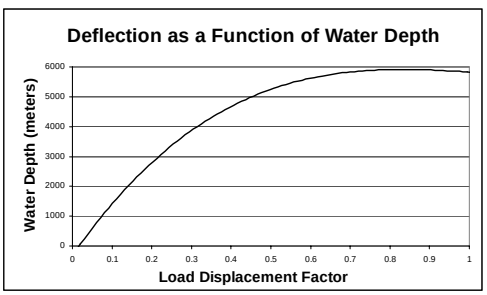
Fairfield Industries requested that Stress Engineering assist in designing the subsea housing to a water depth of 3,000 meters. Using an earlier design proven to a water depth of 1,000 meters, SES was charged with the task of determining the changes required to achieve the deeper water depth.

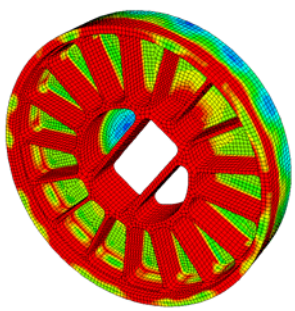


**Initial SHELL finite element model used for sizing initial design**

## SOLUTION:

Recognizing the need for initial sizing efforts, Stress Engineering elected to use a finite element model with shell elements to permit thickness changes in certain regions of the model. As shown in the figures to the right, the thickness of the outer rings and radial ligaments were modified to optimize the design. A limit analysis was performed that used elastic-plastic material properties that incrementally increased the external pressure to determine the lower bound collapse load where unbounded deflection increases with minimal increases in load.



Once initial sizing efforts using the shell model were completed, SES constructed a finite element using SOLID continuum elements. The lid of the design was analyzed and contact was modeled to address its interaction with the main body housing.

As in the previous analysis, external pressure on the subsea housing was increased to determine the lower bound collapse load. SES applied the rules of Division 3 of the ASME Boiler & Pressure Vessel Code with a design factor of 2.0 on the lower bound limit load without restrictions. Using this design factor, a design pressure of 4,704 psi is calculated that corresponds to a sea depth of 3,230 meters. This design depth value exceeds the minimum design requirements imposed by Fairfield Industries of 3,000 meters.

This case study shows the benefits of using limit analysis to design structures, especially those subjected to elevated external pressures found in subsea applications.

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