

Case Study

Whittaker Engineering

Static and Impact Structural Analysis of a Deployment Skid

Company Profile

Since being founded in 1983 Whittaker Engineering has rapidly developed into a respected and reliable contributor in the offshore oil and gas industry. Whittaker Engineering specialises in designing and manufacturing innovative solutions that are designed to work in extreme environments - offshore topside and subsea.

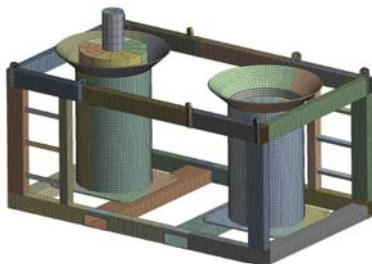
Whittaker Engineering is based in the south of Aberdeen, Scotland and employs over 100 people. In 2009 Whittaker opened a new branch of the company in Mexico.



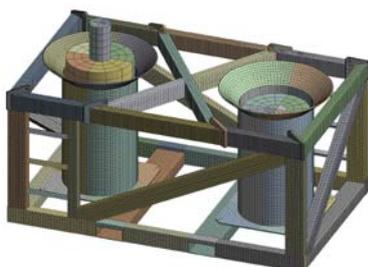
Background

A Deployment Skid is a frame which is used to lift equipment from a vessel onto a rig. The Deployment Skid analysed in this project was required to lift Subsea Control Modules (SCM) and Module Running Tools (MRT). Both the SCM and MRT contain electronics, instrumentation and hydraulics, so it is imperative that they are transported safely with minimum displacement to the skid. Both static and dynamic analyses were carried out. The dynamic analysis was an Occupant Safety type of analysis where the SCM and MRT modules were considered to be the occupants. This was done to ensure that the cargo did not experience any detrimental displacements.

Analysis



Base Design



Braced Design

IDAC were required to analyse, and hence evaluate, two designs of the skid; a base model (as shown in the graphic to the left) and a braced model incorporating additional braces on the top and sides, and a modified pad-eye design (below left), under two different analysis conditions; static and impact. For each design the loadcases that were considered are detailed as follows:

Static Loadcases:

- 2.5 x Max Gross Weight (MGW) using 4 outer pad-eyes
- 1.5 x MGW using 2 outer pad-eyes
- 3.0 x MGW using 3 outer pad-eyes

Dynamic Loadcases:

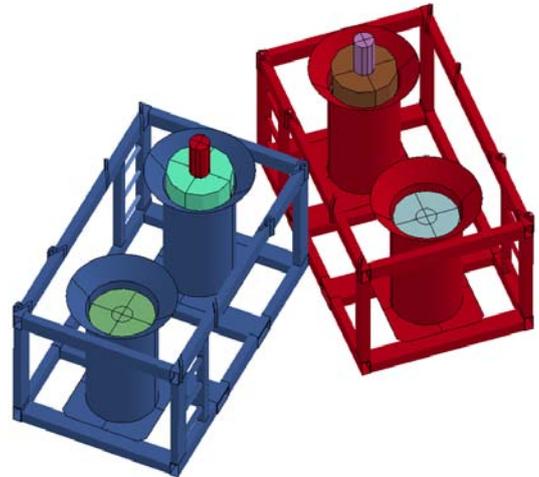
- Impact at 3.5m/s with a rigid cylinder
- Impact at 3.5m/s with an identical skid

The impact velocity was supplied by Whittaker, but was based on the skid unit being suspended from a Knuckle crane on a dynamically positioned support vessel. The rigid cylinder for impact was modelled as having a diameter of 200mm and a height of 2000mm, and was positioned to impact the midpoint

of the long side of the skid. For the skid to skid impact the corner of the moving skid hit the midpoint of the long side of the stationary skid as shown in the graphic below.

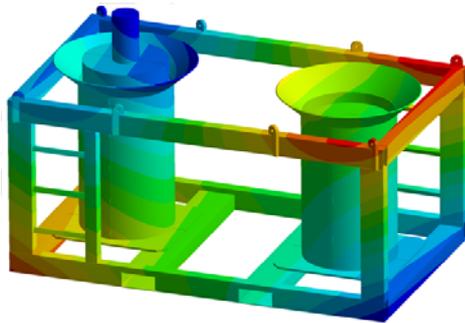
The geometry of each of the skid components was determined from drawings supplied by the customer and using these, a model was created by **IDAC** within ANSYS Workbench DesignModeler. All the skid components were made from S355 J2 Steel; this material was modelled as elastic in the static analysis and elastic-plastic in the Dynamic (Impact) analysis. The analyses were carried out using ANSYS (static) and ANSYS LS-DYNA (Impact).

The pad-eyes, SCMs and MRT were meshed using higher order 3D hexahedral elements with all the other components being meshed using higher order 3D shell elements. The skid components were connected using bonded contacts and frictionless contact was used between the pad-eyes and the shackle bolts. Frictionless contact elements were also used between the SCMs and the container base plate. The centre-points of each pair of SCM's and base plate were rigidly fixed together. However, a coefficient of friction of 0.3 was used for the contact between the two skids in the dynamic analysis.



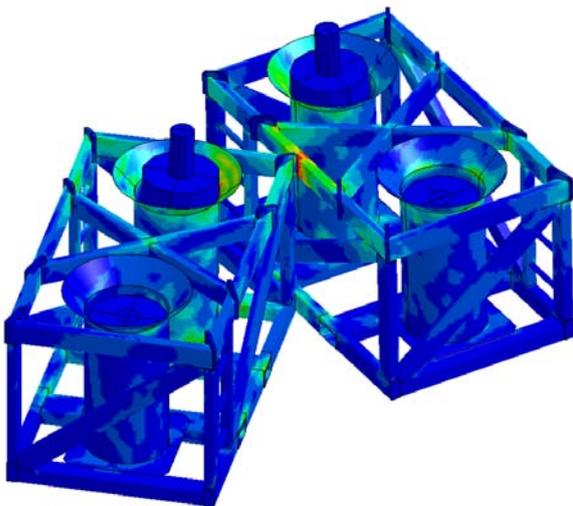
Results – Static Analysis

From the static analyses it could be seen that the braced design showed a significant reduction in stresses and deflections compared to the base model in all three static load cases. The peak stresses were found to be in the base model pad-eyes for all three loadcases.



Results – Dynamic Analysis

The braced design showed a significant reduction in deflections compared to the base model in both the impact loadcases. The addition of bracing reduced the maximum plastic strain for both the rigid cylinder impact and the skid to skid impact although the bracing was found to have less effect in the skid to skid impact. The braced design had higher levels of plastic strain in the payload canisters. This was due to the stiffening of the frame creating greater relative motion of the payload. LS-DYNA provided a solution for Occupant Safety simulation, giving a realistic prediction of how the electronic modules behaved under impact.



Design Benefit

The skids have to be designed to withstand the rigours of the offshore environment and as such the braced design of the skid was developed to compare with the existing base design. From the work carried out in the analyses it was demonstrated that the bracing had a significant effect on the behaviour of the skid in both the static and dynamic analyses. A full crash test to reproduce the dynamic conditions of a real life crash would be very expensive, however, carrying out the finite element analyses and testing the 'virtual' prototype meant that Whittaker did not have to manufacture and test a prototype. **IDAC** were able to reproduce results at a fraction of the cost of a full crash test. Ken Whittaker says of **IDAC** "Once again **IDAC** demonstrates that an FE model can do a better job of crash simulation than building and destroying actual hardware."