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Underhull Material Transport Rig: Aircraft Carrier Maintenance Processes

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MECHANICAL AND NUCLEAR

Underhull Material Transport Rig

Aircraft Carrier Maintenance Processes

CAPSTONE DESIGN EXPO 2016

Design Process

Objective: Design a material transportation device that will transfer materials and tools from one area underneath an aircraft carrier to another, in an environment with many obstacles and a height which often prevents normal walking.

Requirements & Constraints:

- Carry materials safely up to 100 ft in a dirty and wet environment
- Height underneath hull limited to 62 in and floor clearance of > 24 in
- Turning radius less than 4 ft to avoid interference with keel blocks
- Carry a load of 150 lb with a Factor of Safety of 2.5
- Installation time of 8 hours or less

Beam Design: An I-beam & roller rail system was selected because it enables simple installation and maintenance. A steel S3 x 5.4 I-beam was used with 3 foot radius curve.

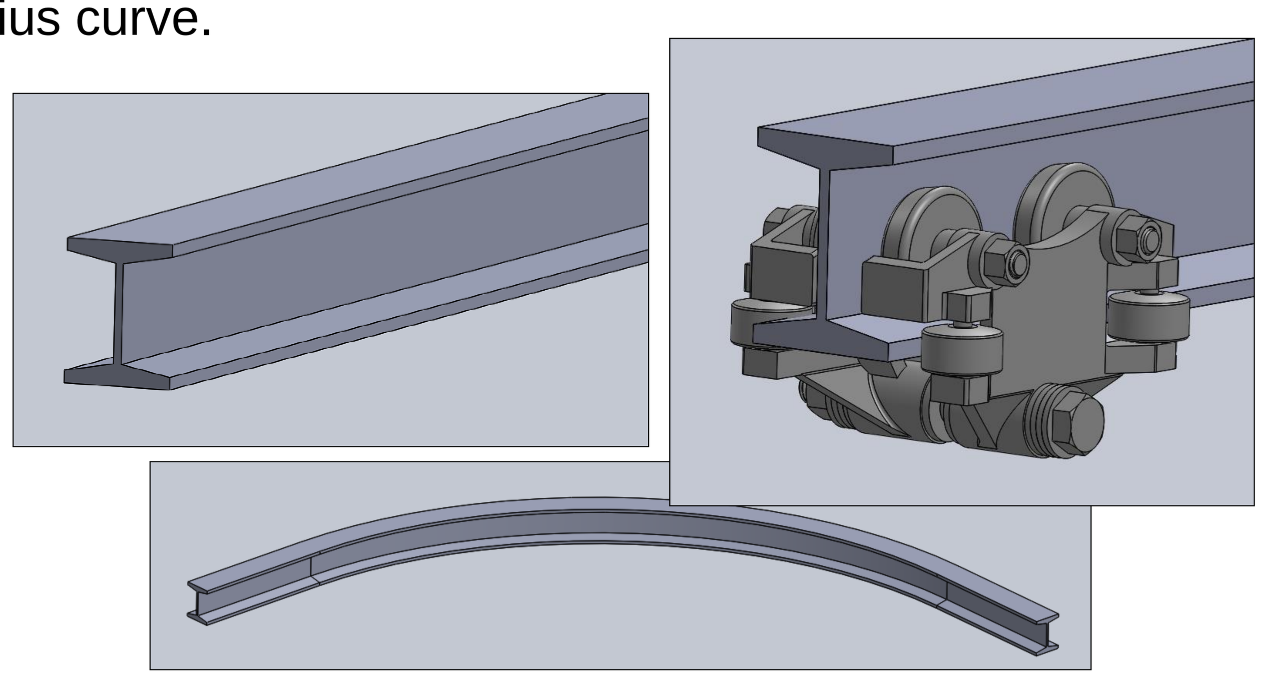

Figure 1: The straight I-beam (top left), I-beam and roller (top right), and the curved I-beam (bottom) designs

Cart Design: Two carts were designed, a welded aluminum cart and an industrial polypropylene cart. Both cart designs proved to be lightweight, inexpensive, and strong enough for the required load. For ease of loading and unloading, the aluminum design has hinged sides.

Figure 2: The aluminum cart (left) and the polypropylene cart (right)

Research & Analysis

Research:

- Several iterations of frame designs, propulsion methods, and cart materials were completed to develop the final design. Tight space constraints required careful consideration of the 3D design envelope.
- The initial design included a cable-and-pulley propulsion system, which was later replaced by a more simple electric trolley propulsion method.

Cart Analysis: ANSYS analysis for the aluminum cart (left) and the polypropylene cart (right) showed acceptable results for deformation. The maximum deformation for the aluminum cart is 0.03 in while the maximum deformation for the polypropylene cart is 0.25 in.

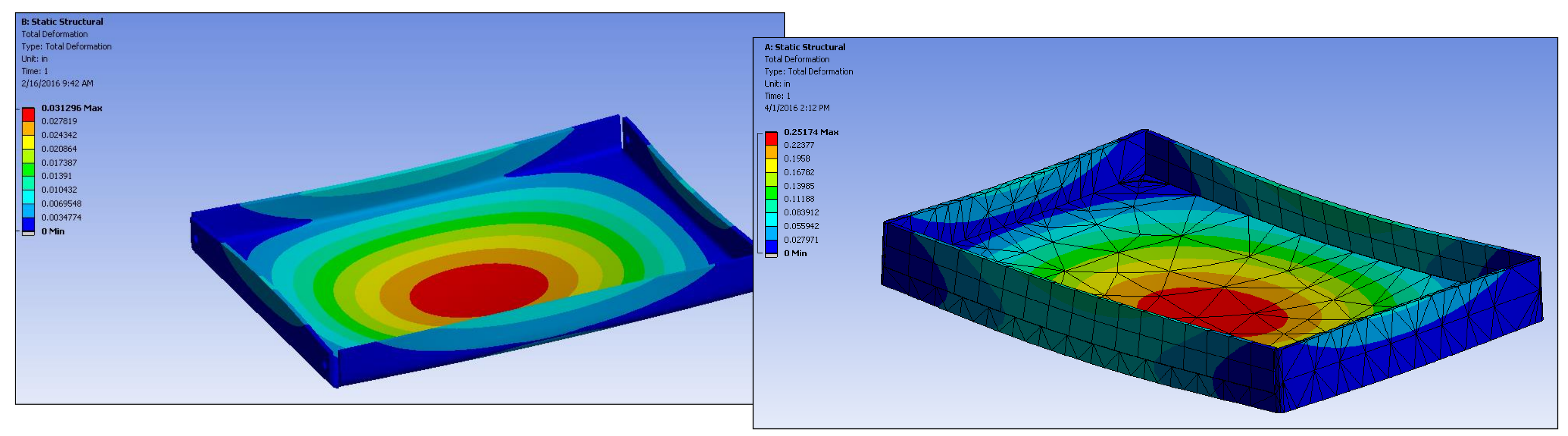

***Figure 3*:** Deformation results of the aluminum cart (left) and polypropylene cart (right)

Roller Connection Analysis: The milled roller connection allows the trollies to swivel, making navigation around curves possible. For the required load, an ANSYS analysis showed acceptable deformation (0.0004 in) and stress (2036 psi) results.

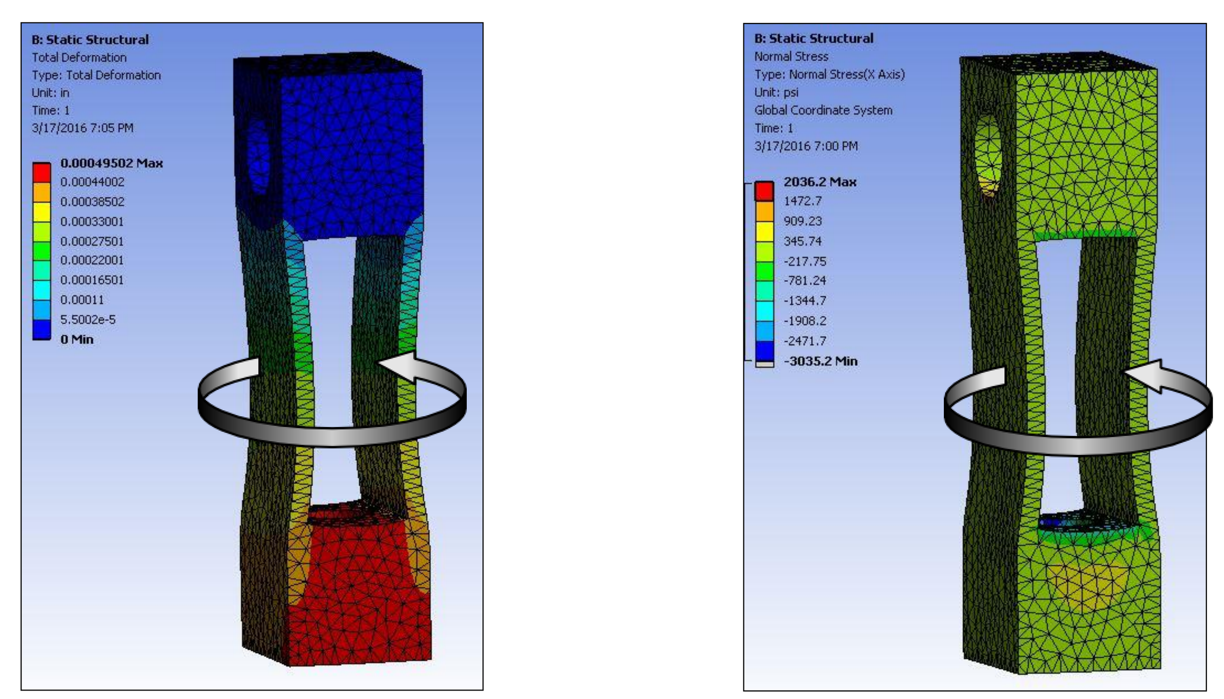

Figure 4: Connector deformation results (left) and stress results (right)

Final Design

Frame Supports: 2 in steel tubing forms the frame connecting the trollies to the support cables.

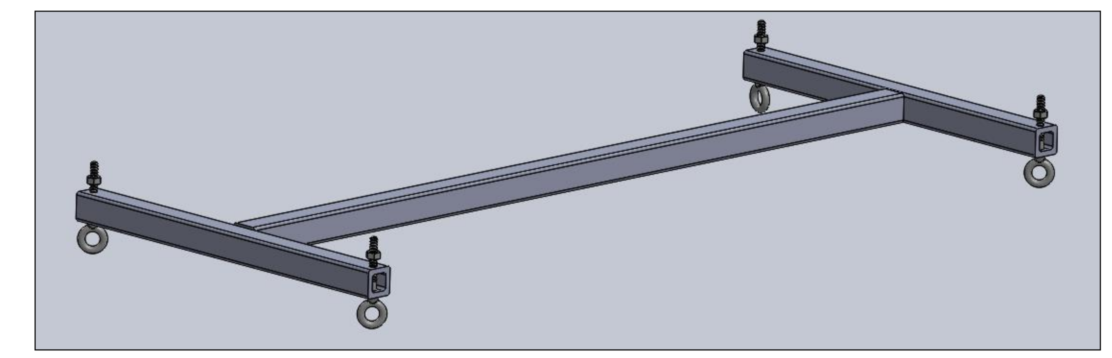

Figure 5: Overall frame support for the cart

Final Design: The final design incorporates a flexible system that will accommodate any load and tool system the cart is expected to transport. In addition, the system is designed to be simply and quickly assembled in the underhull environment.

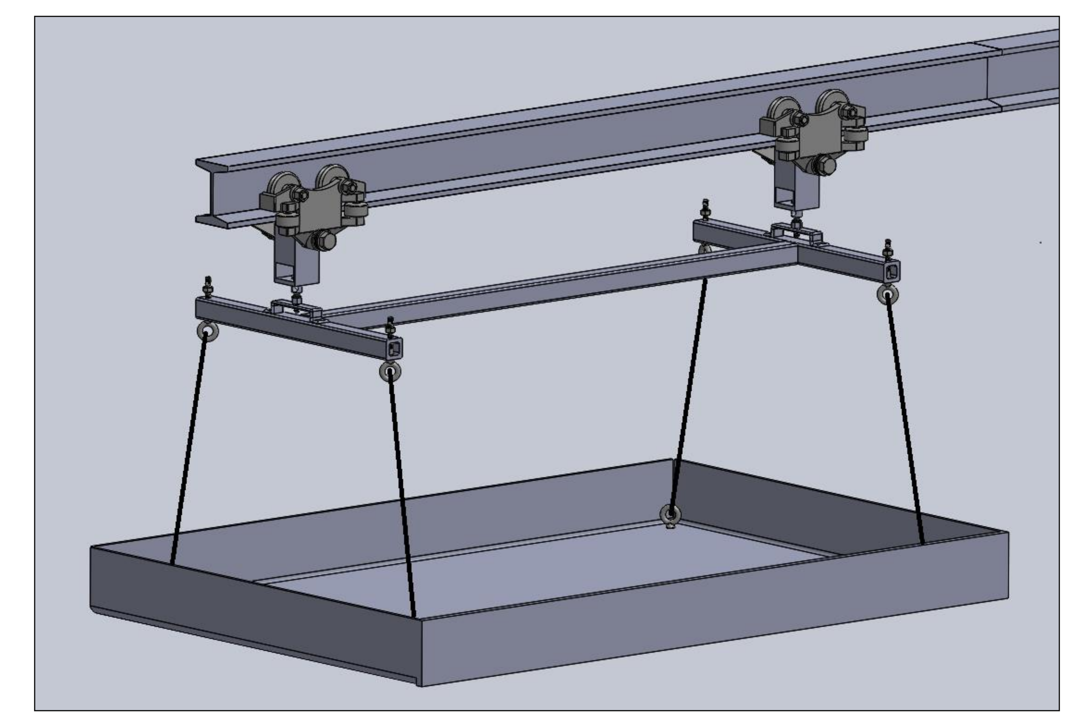

Figure 6: Final solid model design of transport system

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