



Re-Engineered Foretravel ih-45 Aluminium Roof Superstructure

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Problem Identification

- Max weight set by D.O.T. for entire coach is 54,000 lbs.
- Coach is now very close to exceeding max weight which leaves little to no room for cargo capacity for the customer.
- Roof is significant amount of total weight now and is over engineered so there is a lot of room in the roof to save weight.
- Current assembled roof weight: 1880 lbs

Original Design

- Original design was over engineered due to design rollover from the prior year's model to design reduce time.
- Never tested with FEA
- Overweight (areas that have excessive amount of tubing and have no consistent pattern)
- Expensive and time consuming to build

Current and Re-Engineered Design



Current Design
(Arrow = Change)



Re-Engineered

Project Goals

- The main goal of this project is to reduce weight as much as possible to give Foretravel more room to add more features and more cargo carrying capacity.
- Maintain sufficient structure for roof items so that it can withstand excessive stress.
- Remove any structure that is not needed and is adding unnecessary weight.
- Reduce the amount of materials used to create less overhead cost while maintaining long lasting stability.
- Reduce cost of labor as much as possible by simplifying the assembly and complexity of the overall design.

Engineering Test Results

- Originally the tubing was 1.5" square tubing but can be downsized to 1.5"x1" 16 ga. tubing in order to reduce weight and cost.
- Number of roof bows can be reduced from 35 to 22 total.
- Remove roof bows in non-essential areas and added roof bows to support roof items such as satellite dishes, air conditioners, and vent fans.
- Make all roof bows uniform throughout design to simplify the assembly and reduce time.
- A random vibration dynamic test showed that the new design will perform well under the dynamic loadings the motor coach will experience when driving down the road
- The roof bows' max stress under the dynamic loading was about 35% less than yield strength

Top Engineering Characteristics

- Weight
- Durability
- Cost

Top Customer Requirements

- Lightweight
- Long Lasting
- Simple Assembly



Figure 1. Foretravel ih-45 exterior



Figure 2. Foretravel ih-45 interior



Figure 3. Foretravel ih-45 aluminum frame

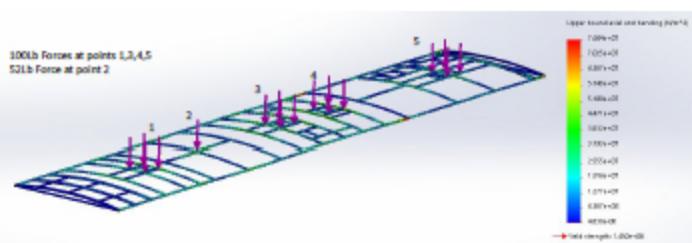


Figure 4. Dynamic Test Image

Design Changes

- New design has reduced number of roof bows
- Smaller roof bows
- Redesigned overengineered areas of structure
- Reduced aluminum weight 73%

Beam	Thickness(inches)	Weight(pounds)	Cost per foot
1.5" Square	1/8	6.41	\$7.39
1.5" Square	1/16	3.352	\$3.06
1.5"X1.0"	1/8	5.25	\$5.85
1.5"X1.0"	1/16	2.77	\$3.42
1.5" round tube	1/8	5.04	\$19.16
1.5" round tube	1/16	2.64	\$19.24

Chart One: Material Specifications

Conclusions

Final Design of Foretravel Roof Frame

- Reduced Weight by reducing the amount of material being used in the design. The current frame's weight of 222.6 lbs decreased to 60.28 lbs.
- Reduced man hours by creating a simpler design to assemble.
- Reduced material by using 1.5"X1.0" while maintaining durability.
- Reduced cost by reducing man hours and material used.

References

- Foretravel Confidentiality Agreement <https://www.foretravel.com/>
- Foretravel Roof Design Project Brief <https://www.foretravel.com/>
- 2018 Foretravel ih-45 Description <https://www.foretravel.com/ih-45/>
- Foretravel ih-45 Floorplan <https://www.foretravel.com/ih-45/>
- Online Metals <https://www.onlinemetals.com/price/price-metals/price-aluminum/price-aluminum-1500-series/>
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