



Design of a Counter-Balance Lifting Beam

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Introduction:

The aim of the project is to reduce the weight of a counter-balance beam, which is being used to lift X from point Y to Z.

Current weight of the steel is 1048kg, another designed aluminium beam is 780kg.

The tare weight required to achieve must be under 0.5 tonne or 500kg.

Topology optimization techniques has been used to obtained the required weight of the lifting beam.

A counter-weight basket has been designed to balance out the loads.

It is important to not lift any un-balanced loads, in order to avoid any mishap, injury or even death.

Project Aims:

- ❖ Design a counter-balance lifting beam i.e. to lift X from point A to B.
- ❖ To gain a good understanding of lifting equipment's.
- ❖ Reduce the mass of the current lifting beam.
- ❖ Keep the lifting beam tare weight under 0.5 tonne.
- ❖ Assembled weight must not exceeds 1 tonne.

Research:

- ❖ Optimisation Techniques.
- ❖ Finite element analysis.
- ❖ Lifting equipment's.
- ❖ Mass Reduction.
- ❖ Re-designing.

Standards:

To be tested @ Proof Load (Twice the safe working load.

BS EN 13155.

LEEA, LOLAR, DOC,

Machinery Directive

2006/42/EC2006/42

Methodology:

Original lifting beam is a steel beam holding a tare weight of 1048kg, new lifting beam is been designed with holding a tare weight of only 413kg, as per clients need.

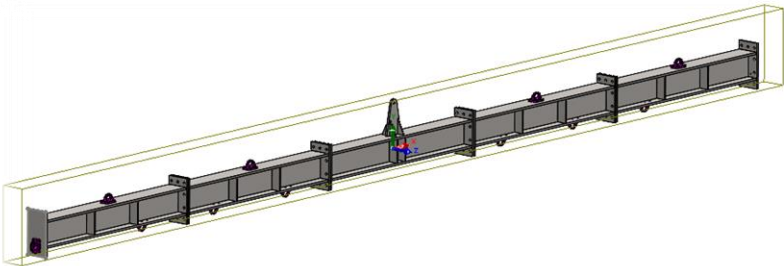
A lightest weight possible beam was required, so a lower capacity crane can be used.

Original beam have gone though topology analysis, also Undergone a FEA analysis to observe the reactions under applied load. Stress, Deflection & bending moment results were considered, in order to make sure that the design will perform well under applied load.

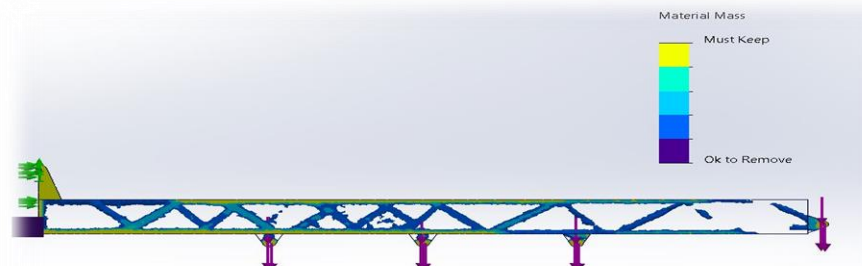
Several topology optimizations were conducted using solid works.

The new design would be manufactured using material steel S 355, whereas the current model used by client is aluminium beam T6 @ tare weight of 780kg.

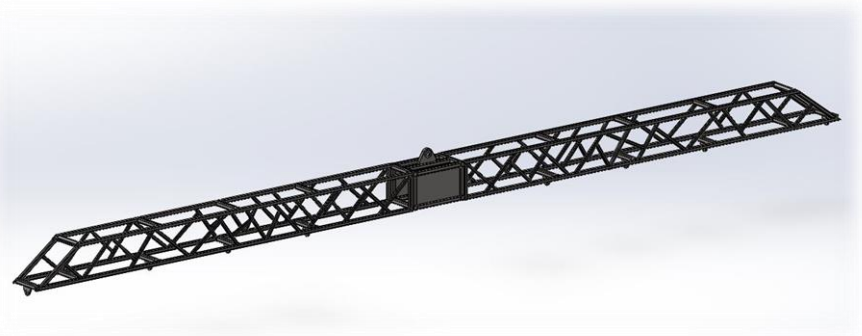
The new designed beam is counter balance beam, a counter weight basket is also designed with calibrated weights.



Original steel beam



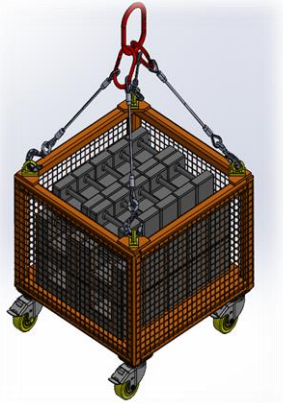
Topology optimization @ 95 %



Fully Assembled Lifting Beam

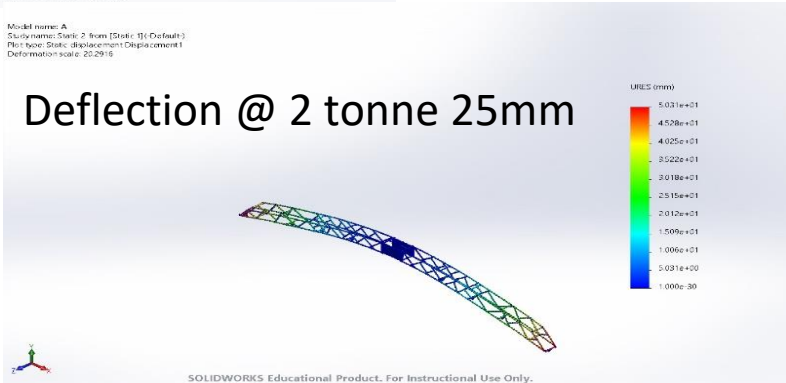
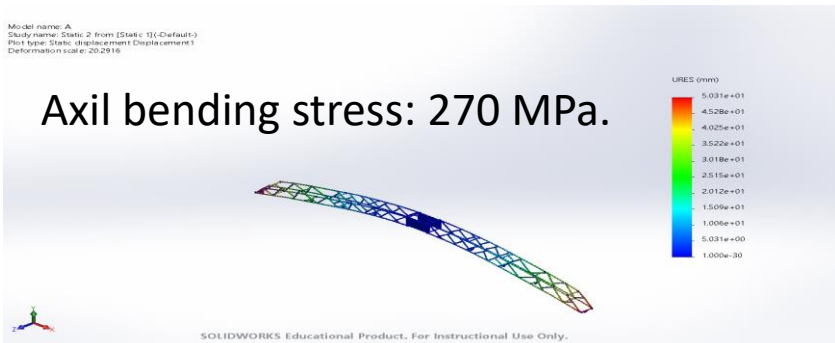
Counter-weight basket

With calibrated weights



Results:

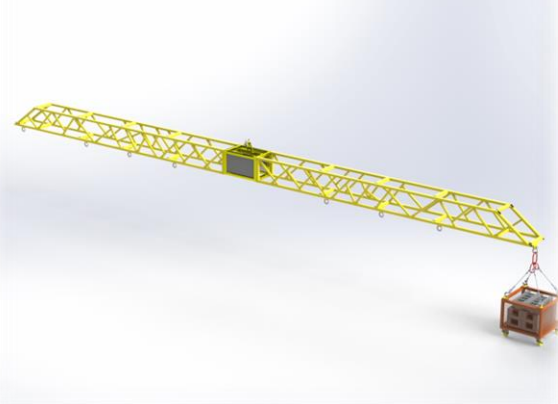
Topology optimization is used to obtain the final best design. Designed 3D model in solidworks gone under FEA analysis where 2 tonne is SWL, 4 tonne is applied as a proof load. And the results were:



Comparison Table

	Lifting Beam Previous Design	Lifting Beam Current Design
Stress	120 MPa	130 MPa
Displacement	32mm	25mm
Tare Weight	1048kg (steel Beam)	413
	780 Aluminium Bema	Approximately
Safe Working Load	0.7 Tonne	2 Tonne

Fully Assembled 3D Model



Conclusion:

The initial mass of the beam was 1048kg, the aluminium beam was 780kg, which is now reduced to 413kg.

The topology optimization has been success in reducing the over all mass of the beam, this was made possible by identifying the critical load paths of the structure while under 2 tonne.

Therefore, the goal of reducing the mass has been achieved. Counterweight basket weight is 554kg with hooks, slings & calibrated weights, add up to total of 967kg which is under 1 tonne.

3d model new design is just a 39% the weight of the original steel beam & 52% the weight of the Aluminium beam. So, there is a massive mass reduction.

References:

Abou-Ali, Aliaa M, et al, 2022. On the Effect of Lattice Topology on Mechnaical Properties of SLS Additively Manufactured Sheet-, Ligament-, and Strut-Based Plomeric Metamaterials. *Polymers*, 14(14214583), pp. 4583-4583.

Binder, Andreas, et al, 2022. Input Parameters and Thermal Load Representation Uncertainties Effects on the Buckling and Dynamic Characteristics of Cylindrical Tubes. *European Journal of Mechanics- A/ Solids*, 96(104716), pp. 104716-104716.

