Topology Optimization of Traverser for Rail Coach Shifting Applications

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Abstract— In the present work, a traverser is built based on available dimensions. So analysis is carried out on existing structure for better product development based on finite element solutions. The results for stress and deformation are captured. The initial weight of the structure is observed to be around 46 tons. Later the structure is optimized based on the visual observation of the stress distribution in the member, the corresponding elements are removed using Hypermesh software and the same structure will topology optimization is analyzed for structural strength conditions. The results shows increase in the stress of the assembly as well as components. But a weight reduction is observed from initial 46 tons to 37 tons. This reduction helps in lesser inventory along with lesser maintenance. Generally higher material requirements reduce the efficiency of the system by increasing procurement, maintenance and handling expenses. Also higher weight increases the mechanical inertia of the parts and large driving mechanism is required for its operation. So finite element analysis is carried out to improve the problem by virtual simulation.

Key words: Topology Optimization, Deformation, Stress, Hypermesh

I. INTRODUCTION

A traverse is piece of the railway method equipment. The purpose is same as that of turntable, although this cannot be used to carry out turning function. The transfer table is recognized as the traverser. It consists of the solitary span track that can go side to side or in meticulous perpendicular way to track. Frequently there are numerous tracks on the one side of bench and solo track on the other end.

Railways are the main transport Service in India transportation passenger and commodities to the dissimilar location. But throughout this procedure, the amenities are necessary for loading and unloading of the commodities at different location. So the wagon carrying this particular equipment want to be disconnected from the major arrangement for proficient operational. Even Engines need to fix to the configuration in different locations. Shunting is the older name specified for this modify of track of the wagons and the Engines. But this process is difficult procedure along with time.

Fig. 1: Traverser

II. FINITE ELEMENT MODEL

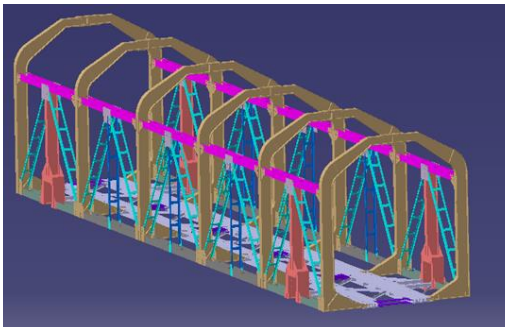

Fig. 2: CATIA Model

The traverser model built using CATIA model is shown in figure 2, this model is developed in software based the two dimensional drawings obtained as per the company standards.

III. MATERIAL DATA

Properties	Structural steel
Material Name	SAILMA450
Elastic or Young's Modulus	200 Gpa
Poison's ratio	0.3
Density	7800kg/m^3
Yield Stress	450 N/mm^3
Factor of Safety	3
Allowable Stress	150 N/mm^2
Allowable Deflection	1mm per 750 mm

Table 1: Material Data

IV. MESHED MODELS

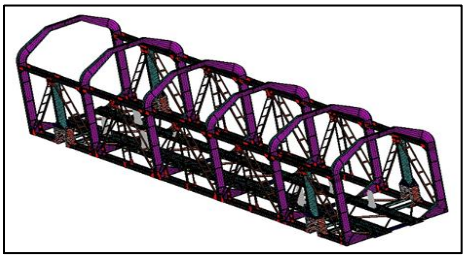

Fig. 3: Meshed model before optimization

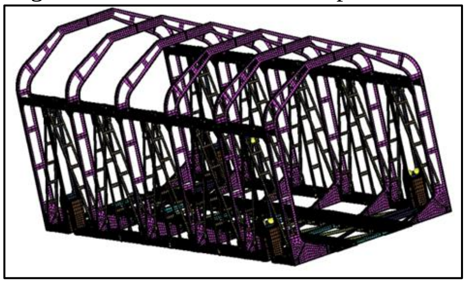

Fig. 4: Meshed model after optimization

Figures 3 and 4 shows the meshed model view of the traverser before and after topology optimization. Since it is a big structure it is very difficult to directly on the software. Using hypermesh, the sections are removed and sectional properties are increased to keep the strength of the structure.

The figure 5 shows major changes in the vertical frame structure. This was developed after observing the existing structural analysis. The distributions of stresses are the main source for topology optimization. In the present mesh total of 94399 elements and 106413 nodes are used.

The main aim of the work is do the optimization by reducing the actual weight of the structure, hence the sections and regions which are at lower stresses are eliminated using Hypermesh. Figure 5 shows the main frame of the structure in which the middle region materials are removed.

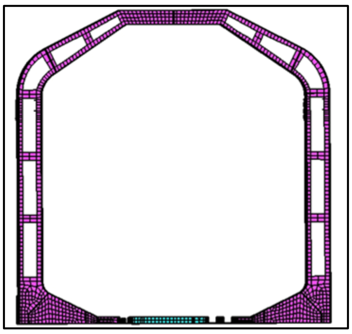

Fig. 5: Optimized frame

V. NUMERICAL ANALYSIS

Self weight analysis of the structure is done both traverser with and without optimization and the comparison of the results are shown, both deformation and vonmises stress are calculated for the traverser.

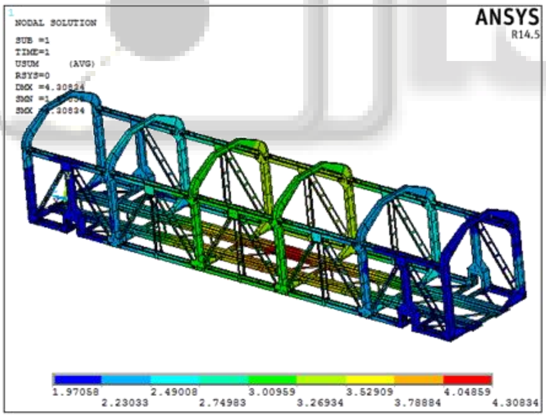

Fig. 6: Deformation due to self-weight of traverser before optimization (4.308 mm)

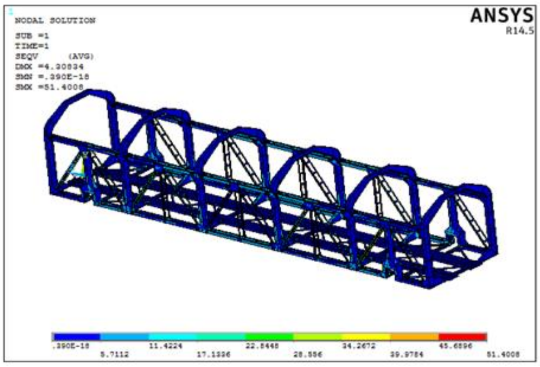

Fig. 7: Vonmises Stress due to self-weight before optimization (51.008 Mpa)

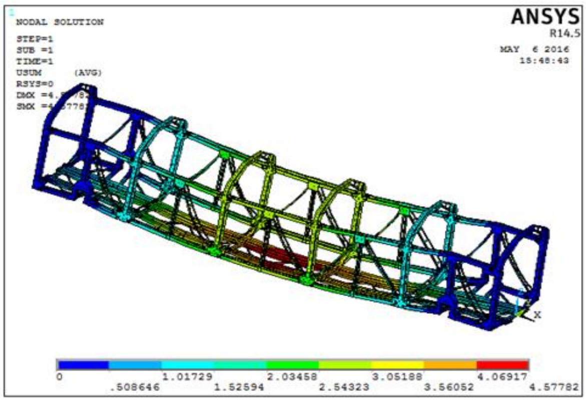

Fig. 8: Deformation due to self-weight after topology optimization (4.577 mm)

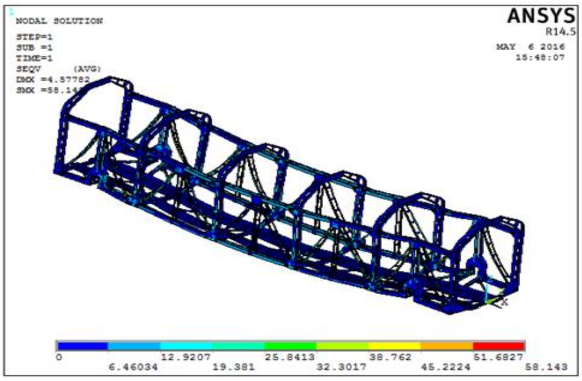

Fig. 9: Vonmises stress due to self-weight after topology optimization (58.143 Mpa)

VI. RESULTS

Parameters	Deformation (mm)	Vonmises Stress (Mpa)	Weight Reduction (%)
Without optimization	4.308	51.008	0
With Optimization	4.577	58.143	19

Table 1: overall comparison of the parameters

The above table shows overall comparison of the stress, deformation, weight reduction and self weight of the both traverser structure which is optimized and not optimized. We can clearly observer that the main aim of the project has been accomplished by reducing the weight of the structure by 19% from 46tons to the 37tons without making the structure fail in any condition. Both analyses were done for the structure due to self-weight and the results are captured and shown in the table for easy view of overall work done in this project. The optimized part is acceptable because the vonmises stress falls lower than the allowable stress of the material.

VII. CONCLUSION

The optimization of the traverser structure of the reduction of the weight is done.

- Due to heavy weight (46 tons) self weight analysis is carried out for the initial structure and material is removed in the unwanted region to reduce the weight.

- Based on the vonmises stress and deformation obtained for the initial case the structure is optimized.
- The vonmises stress is below the allowable stress of the material hence the structure is optimized and reduction of 9tons of material is done.
- Based on the pattern of stress from the initial analysis, topology optimization is carried out for reducing the weight and to redistribute the loads or for even distribution of stress. So these geometries are identified in ansys and corresponding elements are eliminated using hypermesh software. Further analysis is carried out for the self-weight. The topology optimized structure shows a weight of around 37 tons compared to the initial structure which is 46tons.
- So by using topology optimisation, weight can be reduced along with redistribution of stresses in the members which helps the organisation for better products.

VIII. SCOPE FOR FUTURE WORK

- Analysis can be done for the structure by applying the actual load of the bogey/coach.
- Analysis can be carried out with possible thermal loads which effects the joints strength in the hot environment.
- Size optimisation can be carried out to reduce the weight.
- Composite material replacement can be explored for better strength.
- Spectrum loads from earth quake can be analysed due to heavier weight.
- Material optimisation can be carried out.

REFERENCES

[1] Michele Perrella, Pasquale Franciosa and Salvatore Gerbin, "FEM and BEM Stress Analysis of Mandibular Bone Surrounding a Dental Implant", The Open Mechanical Engineering Journal, 2015, 9, 282-292
[2] Zhiyi Pan, Xin Wang, Rumin Teng and Shunde Gao, "A Synchronous CAD/CAE Modeling Method and Applications in Parametric Parts Library", School of Mechanical Engineering, Dalian University of Technology, Dalian, Liaoning, 116024, P.R. China.
[3] Bin Zheng, Yongqi Liu and Ruixiang Liu, "Stress and Fatigue of Connecting Rod in Light Vehicle Engine", School of Transportation and Vehicle Engineering, Shandong University of Technology, Zibo 255049.
[4] Hai-Feng Fang, Li-Hua Cai1, Ming-Qiang Wang, Qi Wang and De-Fang He, "Optimization Design of I-Type Plastic Extrusion Die Based on Flow Balance", The Open Mechanical Engineering Journal, 2014, 8, 694-698.
[5] Jiao Shi, Zhengzhong Wang and Aijun Zhang, "Topology optimization method for materials zoning of a concrete face rockfill dam", Northwest A&F University, Yangling, China, Vol. 5(5), pp. 245-254, May, 2013.
[6] Yan Zhang, Fenfen Xiong and Shuxing Yang, "Numerical Simulation for Composite Wing Structure Design Optimization of a Minitype Unmanned Aerial Vehicle", School of Aerospace Engineering, Beijing Institute of Technology, Beijing 100081.
[7] Ke Zhang, Xuan Mu, Dehong Zhao and Yuhou Wu, "Advanced Optimization Design of Cross Beams Structure", School of Traffic and Mechanical Engineering, Shenyang Jianzhu University Shenyang China, 100168.
[8] Kosala Bandara, Thomas Rüberg, Fehmi Cirak, "Shape optimisation with multiresolution subdivision surfaces and immersed finite elements", Volume 300, 1 March 2016, Pages 510–539.

