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3-D Modeling and FEA of an Improved Design of Axle of Hot Metal Ladle Transfer Car Bogie

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Abstract **– The paper imparts an idea about the repetitive failure of Axle of Hot Metal Ladle Transfer Car used in steel industries for carrying hot molten metal from blast furnace to steel melt shop. In earlier paper from same author in similar related subject a 3-D model was prepared and a solid mesh of the model of Wheel and Axle assembly was analysed by FEA techniques and the result was compared with conventional calculations for stress per wheel of hot metal transfer car bogie. An improved redesign of Axle is prepared in 3-D modeling and the results are compared with 3-D Basic model. The redesign results found satisfactory with less stress value and shown reduced bulkiness of axle.**

Index Terms- Finite Element Analysis, Locomotive, 3D Modeling.

I. INTRODUCTION

The hot metal Ladle Transport Car bogie is subjected for heavy loading. The conventionally designed Car bogies are more prone to fatigue and fracture failures due to extensive loading of molten metal. Conventional design calculations are made and that is compared by the results obtained by a Basic 3-D model with same specifications as of the conventional design. The stresses and displacement factors observed are quite close to approximation. In this paper a redesign idea is generated to change the shape of axle of the car bogie. A hollow structure is more reliable in reduction of stress as compared to a solid structure. The axle with changed design has to undergo in a computer software using Autodesk Inventor 2012 and later the results have to be compared for accuracy and refineent with the Basic 3-D Model.

II. ANALYSIS DETAILS

A. Modified Parts-Axle

The following are the shapes of hollow axle which has to be replaced instead of the basic solid axle. The technical specifications are kept as per the earlier standards.

The axle parts shown in Figure 1 & 2 are positioned and fitted with the wheel assembly as shown in Figure. 3. It prepares the complete 3-D model as in Figure 4. The complete 3-D solid model with improved design is ready to for solid mesh with the help of FEA techniques in Autodesk Inventor. The simulation will be carried out in this improved 3-D solid meshed model as shown in Figure. 5.

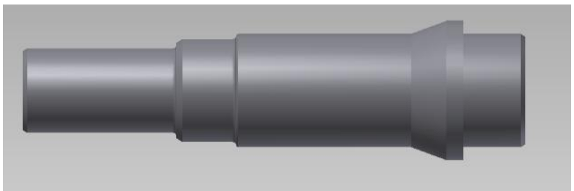

Figure .1 Modified Short Shaft

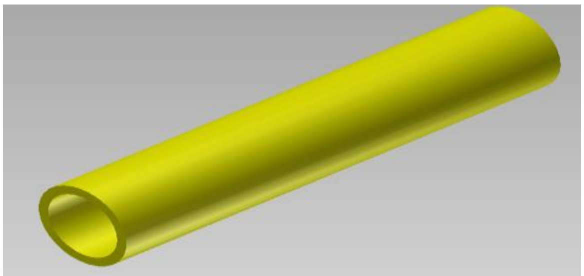

Figure.2 Modifies Hollow Shaft

These axle parts are press fitted with the Wheel Assembly as in Figure. 3 and a improved 3-D Solid model and a 3-D Solid meshed model is prepared as under ;

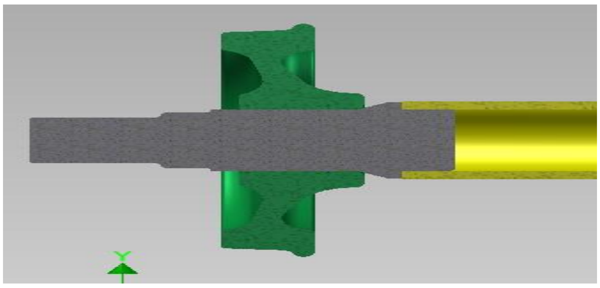

Figure. 3 Modified Hollow Axle and Wheel & Shaft Assembly

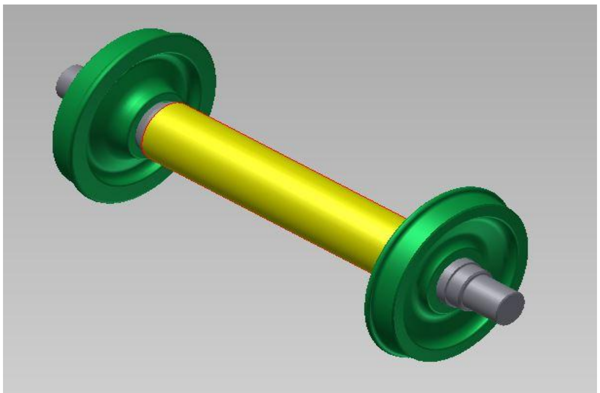

Figure.4 Re-designed Solid Model of Wheel & Axle

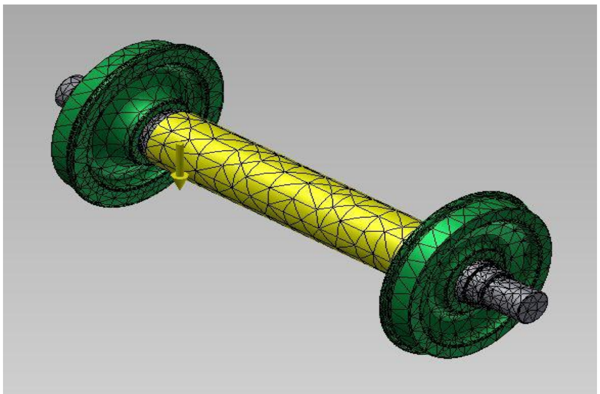

Figure. 5 Re-designed Solid Meshed Model of Wheel & Axle

The applied wheel loads, constraints and contacts of type bonded converts the problem to linear static structural solution and a direct solver is used. The solution took about 30-40mins and after a successful solution, there could be retrieved a multitude of results for the Wheel & axle static structural response are shown as the values of FEA on redesigned model as shown in Figure. 6, 7 & 8.

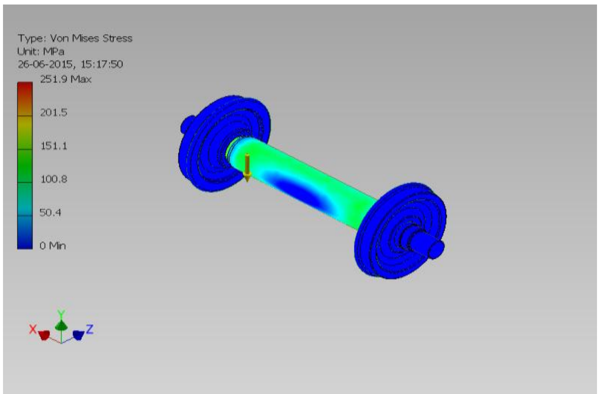

Figure.6 Maximum & Minimum Von Mises Stress of Re-designed Wheel & Axle

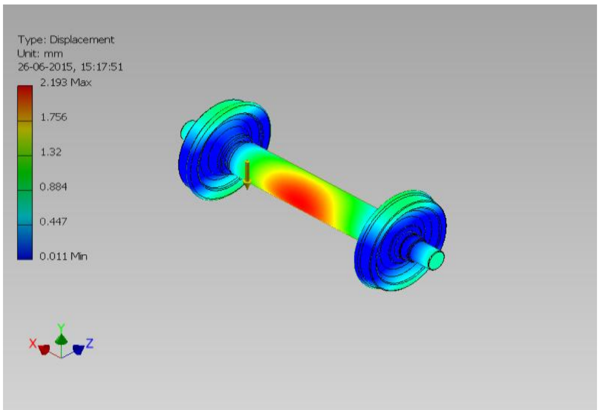

Figure.7 Max. & Min. Displacement Of Redesigned Wheel & Axle

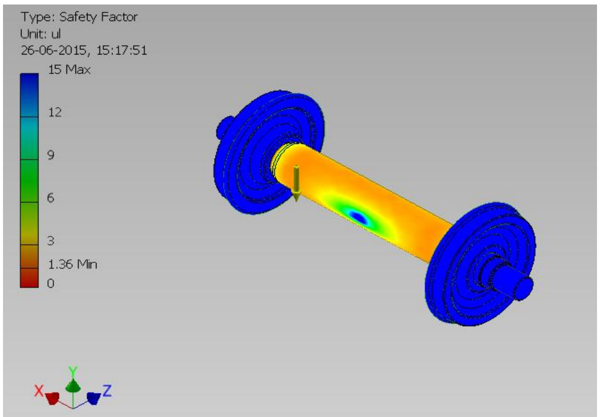

Figure.8 Minimum Safety Factor Of Redesigned Wheel & Axle

III. RESULTS

On the basis of the values of the FEA and simulation analysis a comparative result are drawn from the Figures 6, 7, & 8. The results of redesign model 3-D model with Basic 3-D conventional model are jointly charted as under:

TABLE 1

COMPARATIVE FEA ANALYSIS OF 3-D MODELS

Values of Finite Element Analysis for Conventional & Re Design Of Wheel & Axle			
Sr. No	Description	Conventional Model FEA Results	Re Designed Model FEA Results
1	Maximum Stress	540 Mpa	251.9 Mpa
2	Minimum Safety Factor	0.5	1.36
3	Maximum Displacement in Y-Direction	2.8 mm	2.193 mm
4	Mass of the Wheel & Axle	1310 Kg	1100 kg

IV. CONCLUSIONS

Thus from the above results, we can state that the design optimization of wheel & axle has been done without compromising the strength & rigidity of the wheel & axle. This new design succeeds in reducing the overall mass of the wheel & axle by 16%.

The results show that the redesign model is a success while keeping the intentions of the project intact and leaves behind a scope of studies for further more redesign in different conditions.

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