Design, Analysis and Optimization of Heavy Metal Roll Lifting Bracket Assembly for Steel Industry: Finite Element Analysis Results

[1]Mukul Bhalekar, [2]Prof.Ritesh Banapurka
[1]Student, [2]Assistant Professor
Department of Mechanical Engineering,
Abha Gaikwad Patil College of Engineering, Nagpur, India

Abstract— **The existing bracket causes localized pressure on the metal coil thus resulting in indentations on the sheets. Also, this high pressure causes high stresses in this region. The coils are stacked one above another and covered with a metal closure during annealing. The mechanical tong holds the coil at both inner and outer coil surfaces for lifting as shown in Fig.2. The defects (line marks) are observed after the annealing and are identified to happen always at places where the tongs hold the coil for lifting. Due to Tong mark defects, considerable length of steel coils from both the inner diameter (ID) and the outer diameter (OD) portions are scrapped. The line marks are observed running perpendicular to rolling direction in both inner and outer wraps of coils during inspection. They come in the form of lines or flowery pattern perpendicular to the rolling direction extending from one edge of the strip surface. The pitch of the defect is the circumferential distance of the inner wraps (about 2mts.) and gradually reduces in intensity towards center portion of the coil. Thus in this project, Design, Analysis and Optimization of heavy metal roll lifting bracket assembly for steel industry is performed.**

Keywords- **Coil, Bracket, Pattern, Sheets.**

I. INTRODUCTION

Expressed in simple language, materials handling is loading, moving and unloading of materials, i.e. raw material, semi/finished good, etc. To do it safely and economically, different types of tackles, gadgets and equipment are used, for mechanical handling of materials. Since primitive times men discovered the use of wheels and levers, they have been moving materials mechanically. Any human activity involving materials need materials handling. However, in the field of engineering and technology, the term materials handling is used with reference to industrial activity. In any industry, be it big or small, involving manufacturing or construction type work, materials have to be handled as raw materials, intermediate goods or finished products from the point of receipt and storage of raw materials, through production processes and up to finished goods storage and dispatch points. A material handling as such is not a production process and hence does not add to the value of the product. It also costs money; therefore it should be eliminated or at least reduced as much as possible. However, the important point in favor of materials handling is that it helps production. Depending on the weight, volume and through put of materials, mechanical handling of materials may become unavoidable. In many cases, mechanical handling reduces the cost of manual handling of materials, where such materials handling are highly desirable. All these facts indicate that the type and extent of use of materials handling should be carefully designed to suit the application and which becomes cost effective.

Overhead cranes are commonly employed in the transport industry for the loading and unloading of freight, in the construction industry for the movement of materials and in the manufacturing industry for the assembling of heavy equipment, because they can move loads far beyond the normal capability of a human. ***Hoist*** is a device used for lifting or lowering a load by means of a drum or lift-wheel around which rope or chain wraps. It may be manually operated, electrically or pneumatically driven and may use chain, fiber or wire rope as its lifting medium. The load is attached to the hoist by means of a lifting hook. ***Lifting hook*** is a device for grabbing and lifting loads by means of a device such as a hoist or crane. A lifting hook is usually equipped with a safety latch to prevent the disengagement of the lifting wire rope sling, chain or rope to which the load is attached. The existing bracket causes localized pressure on the metal coil thus resulting in indentations on the sheets. Also, this high pressure causes high stresses in this region. Thus in this project, Design, Analysis and Optimization of heavy metal roll lifting bracket assembly for steel industry is performed.

II. LITERATURE REVIEW

[1] ***G.Manikandan, MBN Raju*** The cold rolled IF coils are usually carried into Batch Annealing mechanical BAF, for annealing by means of mechanical tongs. On discharge of coils from BAF, a peculiar type of line marks (surface defect) on both inner and outer wraps of IF steel coils. These defects are causing significant appearance problem after painting. In the present work, the morphology of the defect was examined by visual inspection and optical microscopy. Surface topography analysis along with Finite element simulation was also performed to understand the mechanism.

[2] F.T.S. ***Chan*** A key task in the material handling system design process is the selection and configuration of equipment for material transport and storage in a facility. Material handling equipment selection is a complex, tedious task. However, there are few tools other than checklists to assist engineers in the selection of appropriate, cost-effective material handling equipment. This paper describes the development of an intelligent material handling equipment selection system called MHESA (Material Handling Equipment Selection Advisor).

[3] ***kalyani sengar*** Lifting tongs have a pair of primary arms forming a pair of jaws for engagement with a work piece. A latch mechanism interlocks the two arms so that the tongs can be opened and closed automatically by successive movements opening the jaws. Following a first movement opening the jaws, the latch mechanism is engaged to hold the jaws open; the latch mechanism is disengaged by a subsequent movement opening the jaws whereupon it releases the arms to allow the jaws to close. The latch mechanism includes a pivoted latch member mounted on one arm, which latch member is movable between two equilibrium positions to define the engaged and disengaged positions of the latch mechanism.

III. IDENTIFIED GAPS IN THE LITERATURE

The aim of the project is to existing bracket causes localized pressure on the metal coil thus resulting in indentations on the sheets. Also, this high pressure causes high stresses in this region Design, Analysis and Optimization of heavy metal roll lifting bracket assembly for steel industry is performed.

IV. PROBLEM FORMULATION

The coils are stacked one above another and covered with a metal closure during annealing. The mechanical tong holds the coil at both inner and outer coil surfaces for lifting as shown in Figure 1. The defects (line marks) are observed after the annealing and are identified to happen always at places where the tongs hold the coil for lifting. Due to Tong mark defects, considerable length of steel coils from both the inner diameter (ID) and the outer diameter (OD) portions are scrapped.

Mechanical Tong

The line marks are observed running perpendicular to rolling direction in both inner and outer wraps of coils during inspection. They come in the form of lines or flowery pattern perpendicular to the rolling direction extending from one edge of the strip surface as shown in Figure 2. The pitch of the defect is the circumferential distance of the inner wraps (about 2mts.) and gradually reduces in intensity towards center portion of the coil.

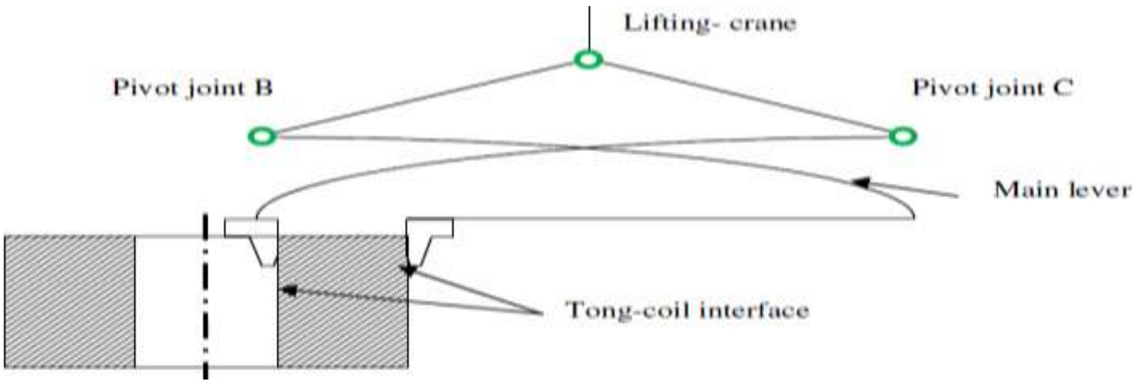

Fig.1. Line diagram of mechanical tong

Fig.2. Tong mark defect as seen at Recoiling

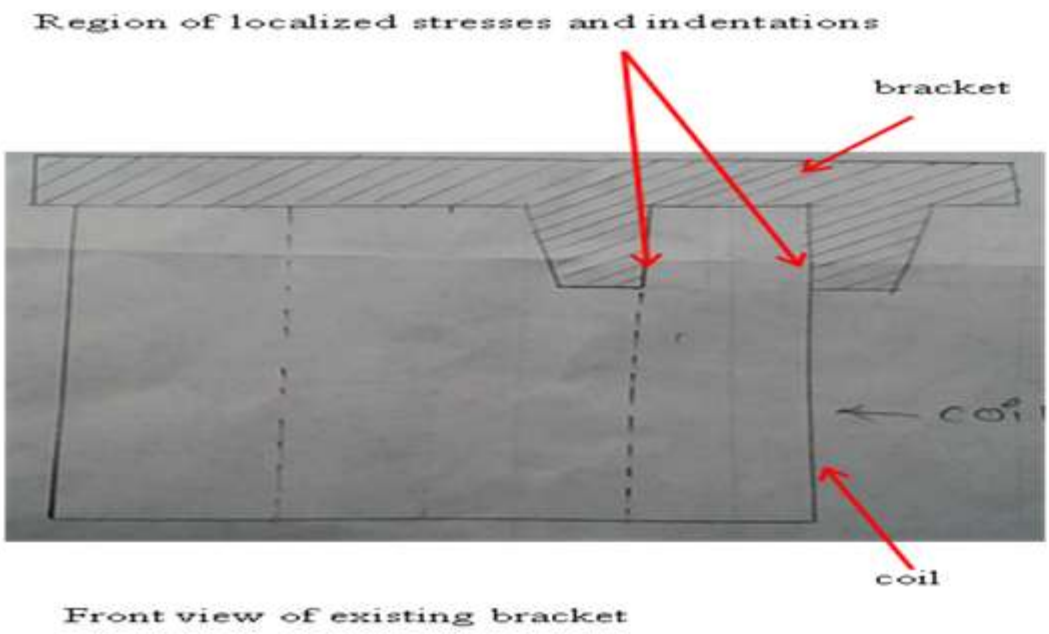

Fig.3. Front View of existing bracket

V. PROJECT OBJECTIVE

By redesigning this bracket so that pressure is evenly distributed on the coil leading to less indentations and better quality of coil. To achieve this bracket which can hold the coil from inside is suggested. This will cause evenly distributed pressure across the coil and reduce the stresses.

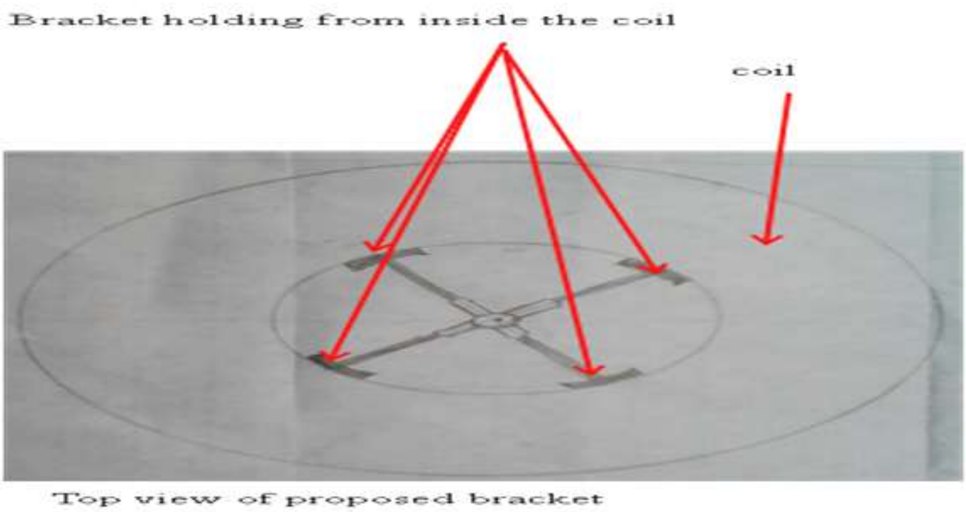

Fig.4.

Top view of proposed bracket (Bracket holding from inside the coil)

. **VI. MATERIAL SPECIFICATION FOR EXISTING SYSTEM:**

Table.1. Material Specification

MATERIAL	PROPERTY
Material	IS 8500/1991 Fe 570
Yield stress	450MPa
Ultimate tensile stress	570 Mpa
Elongation	20

VI. MATERIAL SPECIFICATION FOR NEWLY DESIGN MODEL:

Table.2. Material Specification

MATERIAL	PROPERTY
Material	SAILMA 450
Yield stress	450MPa
Ultimate tensile stress	570 – 720 Mpa
Density	7890 Kg/m3
Considering the factor of safety as	2. 5
Actual lifting load	20 tons
Coefficient of friction for plates	0.1

VII. EXPERIMENTAL DESIGN

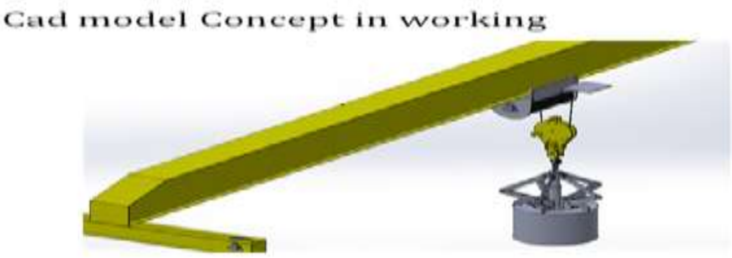

Fig.5. Working model

Fig.6. Lifting tong with coil

Fig.7. Lifting tong CAD model

VIII. FINITE ELEMENT RESULT (STATIC)

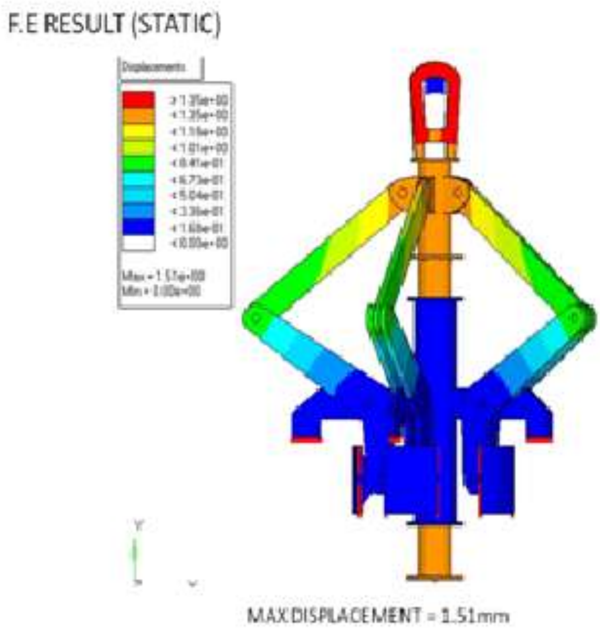

Fig.8. Maximum Displacement

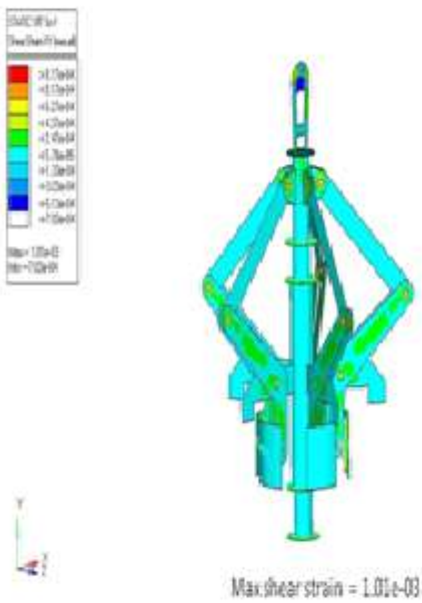

Fig.9. Maximum Shear Strain

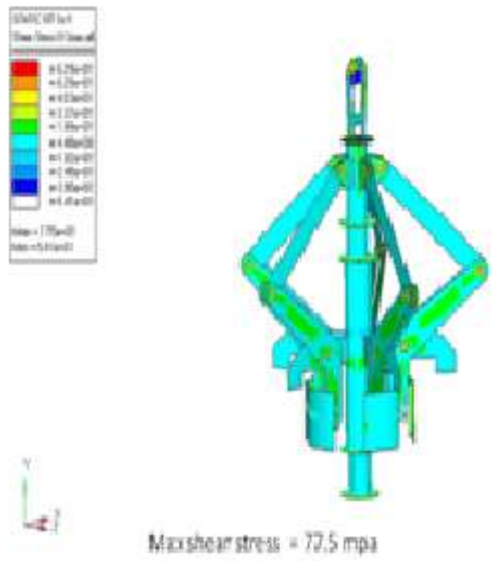

Fig.10. Maximum Shear Stress

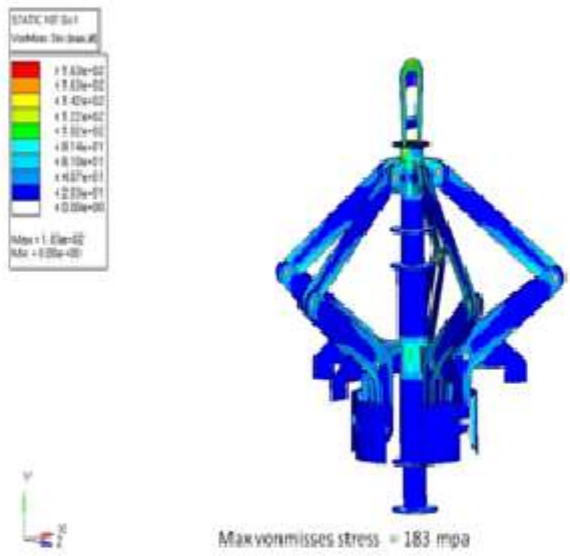

Fig.11. Maximum Vonmisses Stress

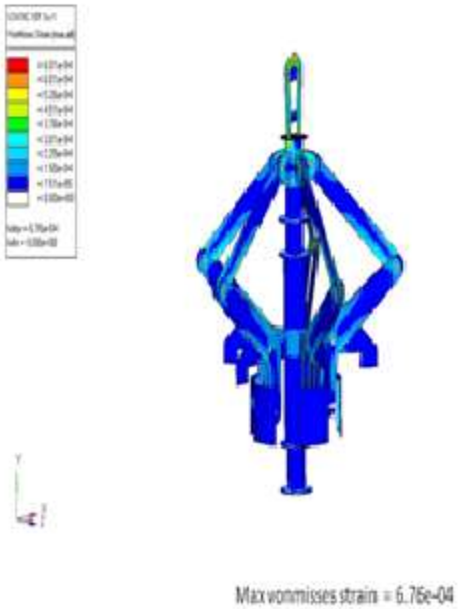

Fig.12. Maximum Vonmisses Strain

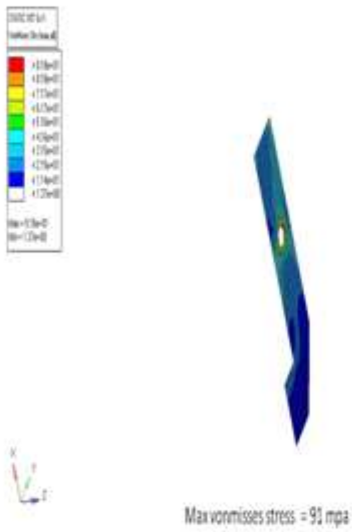

Fig.13. Maximum Vonmisses Stress

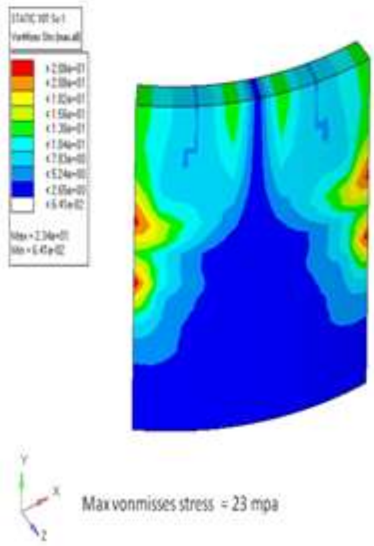

Fig.14. Maximum Vonmisses Stress

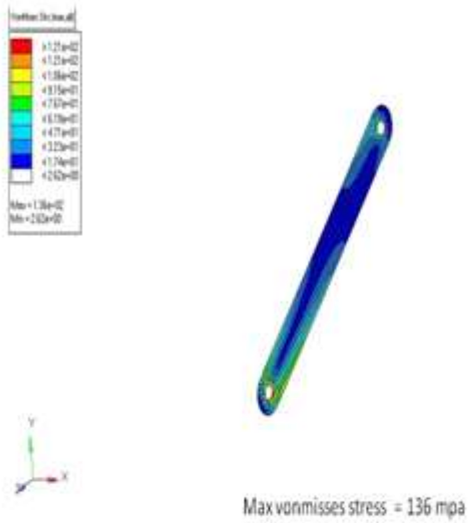

Fig.15. Maximum Vonmisses Stress

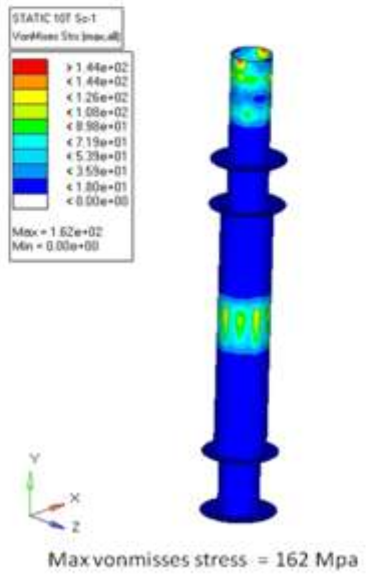

Fig.16. Maximum Vonmisses Stress

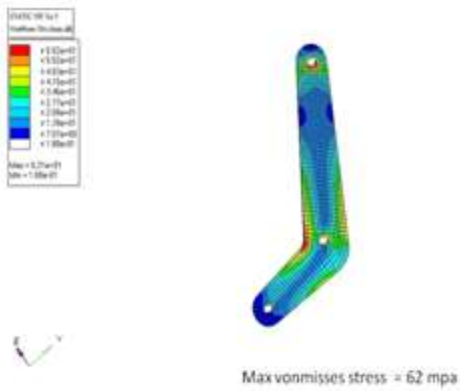

Fig.17. Maximum Vonmisses Stress

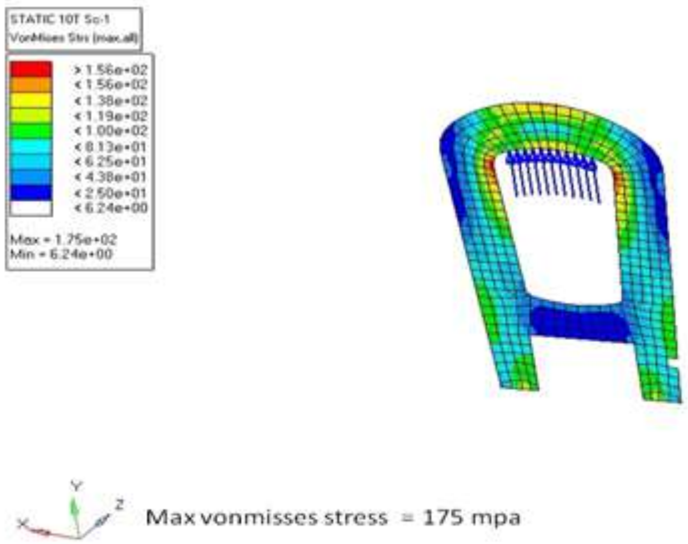

Fig.18. Maximum Vonmisses Stress

As we can see in the FEA results, the stress in the component are well within the limit (Yield Stress-450 MPa) We can further reduces the thickness of the component through optimization.This will further improve the existing solution.

IX. CONCLUSION

The existing bracket causes localized pressure on the metal coil thus resulting in indentations on the sheets. Also, this high pressure causes high stresses in this region. Thus in this project, Design, Analysis and Optimization of heavy metal roll lifting bracket assembly for steel industry is performed.

X. ACKNOWLEDGMENTS

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