

DESIGN AND ANALYSIS OF MASTHEAD FOR A TWIN BOOM STACKER

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Abstract- Bulk material handling plays a vital role in effective operation in process industries. Steel plant is one such shore based process industry. Steel Plant is equipped with peripheral unloading yard for the first time in India to unload the bulk materials in plant premises by transporting by locos, to plant wagon pushers of railways. Raw material plant in Steel Plant is having unloading facilities like rotary wagon tripper, storage yard with machines for stacking and reclaiming and distribution belt conveyor system to feed various raw materials to different process plants by proportioning and by sizing. Thus stackers play a critical role in meeting the demand of bulk material. This project deals with strengthen of MAST HEAD of twin boom stacker by redesigning to avoid frequent failures. The twin boom stacker is used to stack the raw material in two parallel yards depending on the requirement. The reliability of the twin boom stacker is utmost important for stacking the materials in the storage yard for better logistics. The ageing of twin boom stacker with the prolonged operation resulted in uneven loads or jerks on MAST HEAD. This has resulted in frequent failures of MAST HEAD. The design modification has been verified by modelling the MAST HEAD using SOLIDWORKS Version 2012 and analyzed using FEM package ANSYS 14.5. The Necessary stress strengthening has been made based on the preliminary analysis by increasing the wall thickness and observed that the stresses are within the tolerable limits and are discussed in the RESULTS.

I. INTRODUCTION

When there is a need of transport of material in an organized and effective manner, we need assistance of a special branch of engineering known as MATERIAL HANDLING or BULK MATERIAL HANDLING SYSTEMS. This type of material handling system came to existence in the year 1965 for the transportation of iron and cement in the mid -west of South Africa. The easiest way to describe is that it moves the products from one location to another location. The other thing should be noted that material handling also deals with the storage, waste handling and assembly line management.

A stacker is a large machine used in bulk material handling applications. A stacker's function is to stack bulk material such as ores, base mix and cereals onto a stockpile. Stackers are nominally rated tph (tones per hour) for capacity and normally travel on a rail between stockpiles in the stockyard. A stacker can usually move in at least two directions. Typically: horizontally along the rail and vertical by luffing its boom. Luffing of the boom minimizes dust by reducing the height that the coal needs to fall to the top of the

stockpile. The boom is luffed upwards as the stockpile height grows.

Some stackers are able to rotate by slewing the boom. This allows a single stacker to form two stockpiles, one on either side of the conveyor. Stackers are used to stack in different patterns, such as cone stacking and chevron stacking.

Type of stacker	Twin boom stacker
Boom length	60 m
Unit weight	50 Tons
Motor	30 Kw
Carrier bag spacing	2.29 m
Material	All steel sturdy but light.
Loading conditions	1200TPh
Duty	20 hrs/day, 350days a year
Travel Speed	Forward 20m/min Reverse 30m/min
Length Of Travel	350m

Table: 1.1: Specification of Twin Boom Stacker

1.1 Raw Material Handling Plant

RMHP is raw material handling plant in Steel Plant. Its duty is to manage the raw material that they receive from the mines. First they crush the material into small pieces. Secondly they segregate the material as per to required ratio. Then the material is transported back to the dept which it is concerned based on the sizes. For the above duties to perform they use certain equipments to handle raw material like,

1. Crusher
2. Stacker
3. Reclaimer
4. Belt conveyors

Stacker is equipment used to stack the material from a pile (raw material) and transfer it to the department. There are different types of stacker as per to the application of the raw they are,

1. Single boom stacker
2. Twin boom stacker
3. Radial stacker
4. Slewing stackers
5. non-slewing stackers

Table 1.2 : Boom luff angles

Devices	Specifications
No. of rope falls (for each boom)	(2 independent rope systems each With 4 falls operated by a single winch)
Wire ropes	22mm dia, 180 kg/mm ² , Tensile quality, fibre core, galvanised.
Motor	2 no's GEC make, 30Kw.

Table 1.3: Mechanical devices mounted on MAST HEAD

Luffing speed	4m/min at discharge pulley centre	
Boom angles	long boom	short boom
Maximum angle of declination (Operating)	-12.32 °	-13.39 °
Maximum angle of inclination(Operating)	+14.34 °	+15.59 °
Maximum angle of inclination(Non-Operating)	+39 °	+39 °

II. PROBLEM DEFINITION

The raw material handling department, which manages the storage and supply of raw materials for the plant is one of the prime departments. The detailed view of the RMHP is given in the layout. It consists of 12 beds each of dimensions 33m x350m .In this it has 3 beds allotted for iron ore fines 1 bed for lumped iron ore and 2 beds for sized iron ore.

In general case the stacking capacity of the Twin Boom Stacker is 10 M T per annum but they are lifting up to 12 MTA. The plant has 4 TWIN BOOM STACKERS out of which 3 will be in operation and 1 will be under maintenance.

The TWIN BOOM STACKER now is working under excess loading condition. Thus the idea is to maintain the strength of the MAST HEAD by performing necessary analysis so that the working condition of the stacker will be in safe condition by reducing the stress and deformation in mast head and also by increasing the life period.

III. WORK METHODOLOGY

3.1 Geometry Creation and Meshing

Geometry of the MAST HEAD is needed to carry out this analysis. Solid model of the MAST HEAD was created in solid modelling environment called "SOLIDWORKS Ver. 2012".Solid model is the base for carrying out any FEA analysis. Solid model of the MAST HEAD that was created in SOLIDWORKS Version 2012 solid modelling environment is shown in the figure. The created solid model of the unit cell was imported in to the HYPERMESH and ANSYS. Solid model used in any FEA analysis can be very simple and at the same time it reflects the physical reality of the MAST HEAD. Solid model will have to be turned into to FEM model by dividing the solid model into number of small elements. This process is called discretization. Discretization is the process of dividing the solid model into finite number of elements. And the figure 3.1 shows the CAD Model of MAST HEAD.

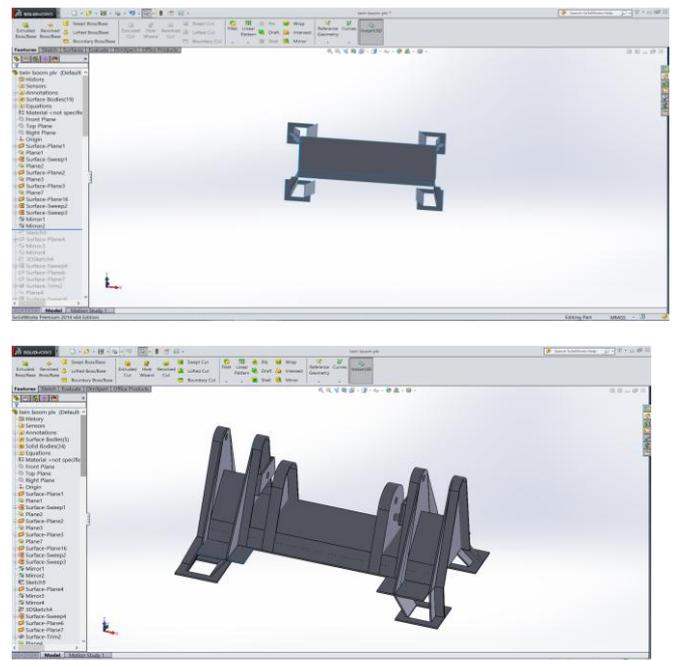


Fig: 3.1: Solid model of mast head

3.2 Typical Fem Procedure to Carry Out This Analysis

- 1 Dividing the solid model into number of elements and then connecting these elements with each other meshing and thereby obtaining the finite element model.
- 2 Applying boundary conditions.
- 3 Solving the problem.

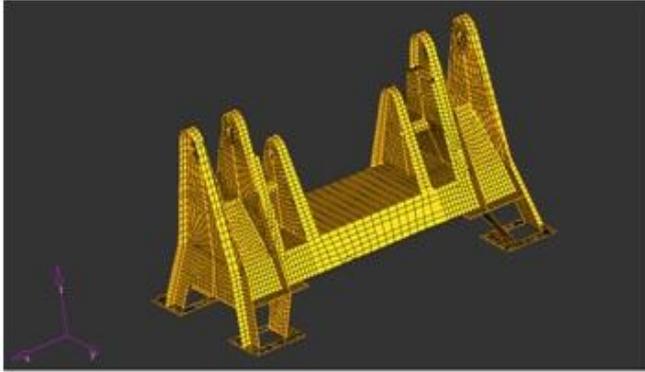


Fig. 3.2: Meshed model of the mast head using HYPERMESH

Material used	Mild steel
Poissons ratio	0.3
Young’s modulus	210x10 ³ MPa
Element Type	shell 63

Table 3.1 : Mesh material properties

3.3 Loading the Mast Head

The application of boundary conditions plays a vital role in the finite element analysis. The bottom portion of the MAST HEAD is fully constrained as it is bolted to the lower portion. The rope on the pulleys is subjected to tension.

Static Analysis

Static analysis calculates the effect of steady load conditions on a structure while ignoring inertia and damping effects, such as those caused by time varying loads. A static analysis therefore can include steady inertia loads (such as gravitational and rotational velocity). Static analysis is used to determine the displacements, stresses, strains and forces in the structures or components caused by loads that do not induce significant inertia and damping effects. The kind of loading that can be included in static analysis are

1. Externally applied forces and pressure

2. Steady state inertia forces (such as gravity and rotational velocity)

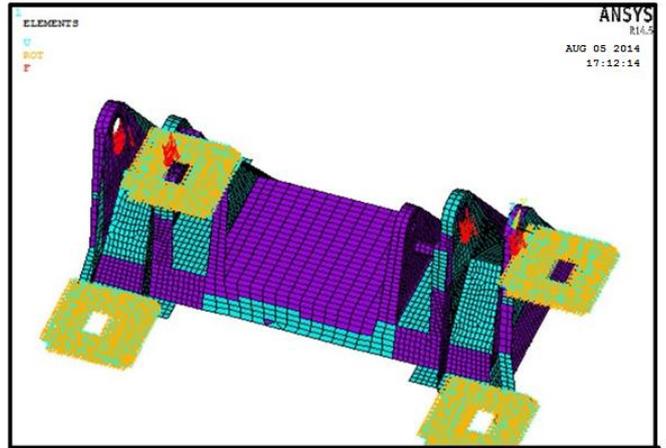


Fig. 3.3: Applying the boundary conditions to the mast head.

IV. RESULTS AND DISCUSSIONS

4.1 Static Analysis

After applying the boundary conditions, the problem was solved by the ANSYS Iterative Solver. ANSYS solver formulates the governing structural stress strain equations for each and every element and these formulated governing equations were solved for the deformations from which all the other quantities such stresses, strains etc can be calculated.

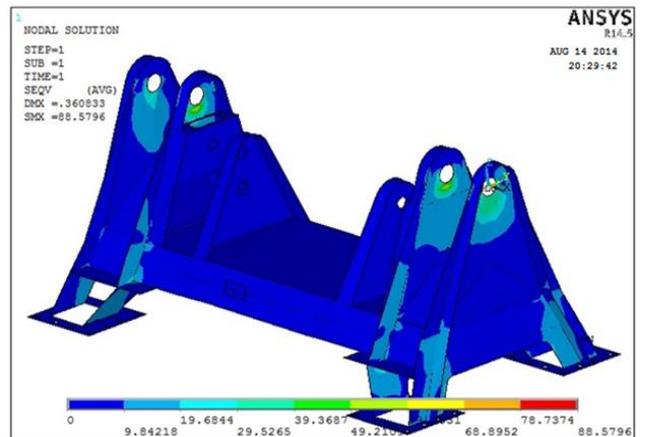


Fig 4.1 Von misses Stress distribution at the point of loading (8mm wall thickness)

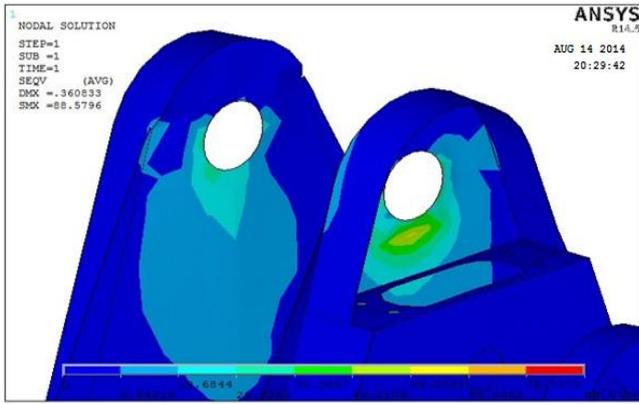


Fig 4.2 Deformation at the point of loading (8mm wall thickness)

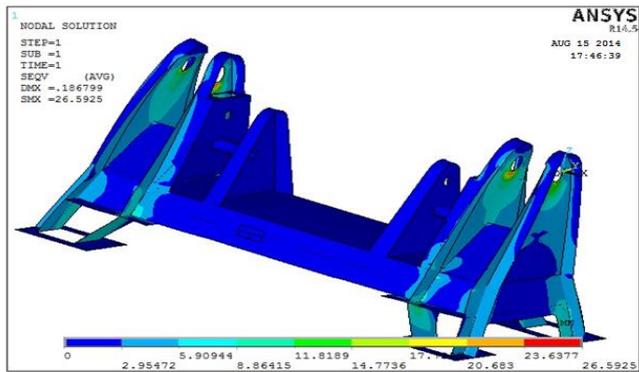


Fig 4.3 Von misses Stress distribution at the point of loading (16mm wall thickness)

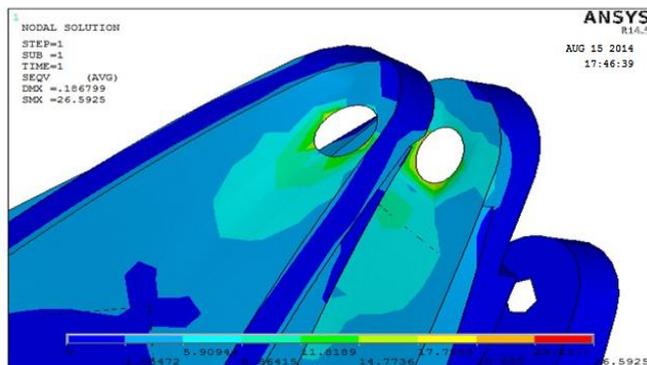


Fig 4.4 Deformation at the point of loading (16mm wall thickness)

4.2 Comparison Of Results

A review on the analysis of both models has been carried out to ensure the performance of both models. From the observation it is clear that the performances of modified model of the MAST HEAD on the given loading and boundary condition slightly varying from the base model. So the objective is achieved by utilizing the finite element optimization techniques. The comparison of analysis results are tabulated in the table below.

Mast Head Wall Thickness (mm)	Static Case			Factor Of Safety
	Deformation (mm)	Stress Distribution (MPa)	Allowable Stress (MPa)	
8 (Previous Model)	0.36	88.58	240	2.70
16 (Modified Model)	0.18	26.59	240	9.02

Table 4.1 Comparison Of Results

Mast Head Wall Thickness (mm)	Load Applied (MTA)	Life Period (Yrs)
8 (Previous Model)	12	4
16 (Modified Model)	12	8

Table 4.2 Comparison Of Life Period

V. CONCLUSIONS

- The results of the structural analysis of the proposed model are compared. It shows that the stresses developed are within the allowable stress limit of 240 MPa
- It is observed that stresses developed in the Previous model is 88.58, where as stress developed in Modified Model is 26.59.
- The Deformation has been reduced from 0.36 to 0.18.
- The Life Period has been doubled. i.e; 4yrs to 8yrs.

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