DESIGN OPTIMIZATION OF WORK ROLL CHOCK AND BACKUP ROLL CHOCK IN COLD ROLLING MILL

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Abstract - *Rolling is defined as a process in which metal is formed through a pair of revolving rolls with plain or grooved barrels. The metal changes its shape gradually during the period in which it is in contact with the two rolls. Rolling is a major and a most widely used mechanical working technique. A Rolling mill is a complex machine for deforming metal in rotary rolls and performing auxiliary operations such as transportation of stock to rolls, disposal after rolling, cutting, cooling, melting. The problem of failure of Rolling mill housing was there in industry, which can be efficiently solved by using CAE.*

The present work involves the design optimization of work roll chock and backup Roll chock in cold rolling mill, to control the failure of choke in the cold rolling mill for retain the material cost and longer life of the roll chock. The roll chock had stress distribution has been analyses by software ANSYS from which maximum static stress at critical areas have been calculated. Structural behavior of Roll chock under the given loading and boundary conditions using an analytical model are very difficult. Therefore 3D solid model was chosen in order to predict the stress and strain response detail.

We have made a prototype of chock of optimized design of scale so as to verify our results that have been given by the analysis of work roll chock and backup roll chock on analysis software.

Key Words: **Centeral Burst, Cold Rolling, Design Methodologies, Housing, Plastic Deformation, Rolls, Split End**

1.INTRODUCTION

Rolling is defined as a process in which metal is formed through a pair of revolving rolls with plain or grooved barrels. The metal changes its shape gradually during the period in which it is in contact with the two rolls. Rolling is a major and a most widely used mechanical working technique. A Rolling mill is a complex machine for deforming metal in rotary rolls and performing auxiliary operations such as transportation of stock to rolls, disposal after rolling, cutting, cooling and melting.

Chocks are almost invariably the highest stressed component in a manufactured item, and so are most susceptible to invariable the financial losses incurred as a result of chock failure will be far greater than the actual value of the chock instantiated delivery of chocks because of manufacturing presetting failure could stop a production failure at the assembly stage is almost certain to halt production if only one or two chocks out of a large batch tailback no manufacturer would willingly assemble goods that are suspecting failure in serviceableness the most catastrophic consequences example failure of cold rolling mill chock is very likely to result in the complete destruction of the cold rolling mill. Failure of chocks in a cold rolling mill is basically because of higher stressed generated during start up and shut down condition of rolling mill so for a design of chocks for a cold rolling mill it is essential to know the maximum load acting on a chock to prevent from a failure fatigue failure beachwear of cyclic loading is also a criteria of chocks design. Second most important function of to work as an isolator case of cold Rollin mill also it ha s to perform this function .so design chock hold have a required stiffness to transmit a vibration from a source to receiver.

So while designing a chock for cold rolling mill two factors is very important Ice. strength of chock to sustain a maximum load and stiffness of a chock to transmit lesser vibration.

Over the course of time, finite element models have gained significant importance, and research has been ongoing to establish supportive results to candor software calculation. Computer models have been develop to provide trimly and economical simulations for results of a component under extremely Sever loading conditionals simulations can be used to target sensitive parameters that affect the overall design, cost and safety.

1.1 MODELING OF ROLL CHOCK

The Roll Chocks were modeled in 3D Modeling Software "Solid Works 2009" for better visualization and interference checking. 3D Models are also required for Structural Analysis and Optimization; therefore accurate modeling of Roll Chokes is required.

The Order of the Models is according to their placement; from top to bottom; in the Rolling Mill:-

1) Top Back Up Roll Chock

2) Top Work Roll Chock

3) Bottom Work Roll Chock
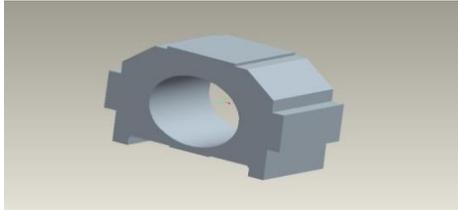
4) Bottom Back Up Roll Chock
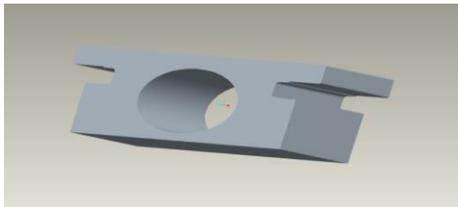
Fig 1.1 Top Back up Roll Chock
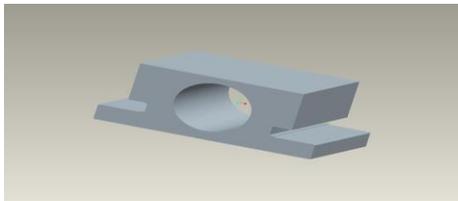

Fig.1.2 Top Work Roll Chock
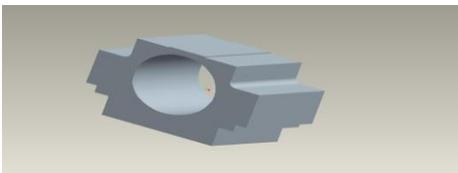

Fig.1.3 Bottom Work Roll Chock

Fig.1.4 Bottom Back up Roll Chock

1.2 Model Analysis

Sample Modal Analysis is done to find out the Natural Frequency of the Top Roll Choke and to check if the natural frequency of the machine does not match the natural frequency of the Top Roll Choke to avoid resonance.

1) **Material**
   Material Used – Fe 410
   a. Young's Modulus – 200GPa
   b. Poisson's Ratio – 0.3

2) **Element**
   a. Element Used – Solid 10 Node Tetrahedral (Solid 187)
   b. Element Size – 30

3) **Constraint**
   a. The bottom surfaces of the Top Roll Choke were constrained as shown in figure 1.1

Table 1.1 Von Misses Contour Plot for Top Roll Chock

Mode	Frequency (Hz.)
1	7.0637
2	8.2337
3	13.896
4	24.336
5	27.757
6	28.280
7	29.517
8	30.709
9	40.672
10	43.793

Also, the deformation for various Modes was plotted as shown in Figure 2.2

2. STRUCTURAL & MODEL ANALYSIS OF TOP BACK UP ROLL CHOCK

1) **Material**
   Material Used – Fe 410
   a. Young's Modulus – 200GPa
   b. Poisson's Ratio – 0.3

2) **Element**
   a. Element Used – Solid 10 Node Tetrahedral (Solid 187)
   b. Element Size – The appropriate Element Size was found out by using an Initial Element Edge Length to be 50 and then gradually reducing Element Size until the Stress remained constant even if the Element Size reduced. The Table 1.1 clearly indicates the above

Table 2.1 Element Size vs. Deformation

Sr. No.	Element Size (mm)	Deformation (mm)
1	50	0.197729
2	35	0.198522
3	30	0.198749

Therefore, Element Size 30 can be considered to be the ideal Element Size for the Following Analysis. Also, the Computer Available would require additional hardware to solve the number of equations for Element Size less than 30 is a constraint.

3) Forces

a. The Forces Acting on the Top Roll Choke is the Force of the Hydraulic Cylinder transferred through the Bottom Rolls through the material to be rolled and through the top work roll.

b. The Top Roll Choke is constrained at the top of the Rolling Mills by an adjustable Power Screw Mechanism.

c. The Reaction force is considered as the actual force acting on the choke and the bottom surfaces are considered to be constrained as shown in the figure 2.1

d. Therefore, the cylinder pressure is converted to force and applied on the particular area as shown in the figure 2.1

4) Constraint

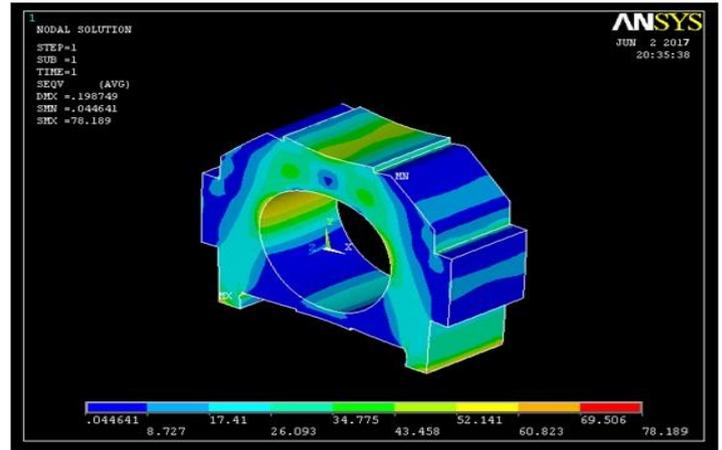a) The bottom surfaces of the Top Roll Choke were constrained as shown in figure 2.1
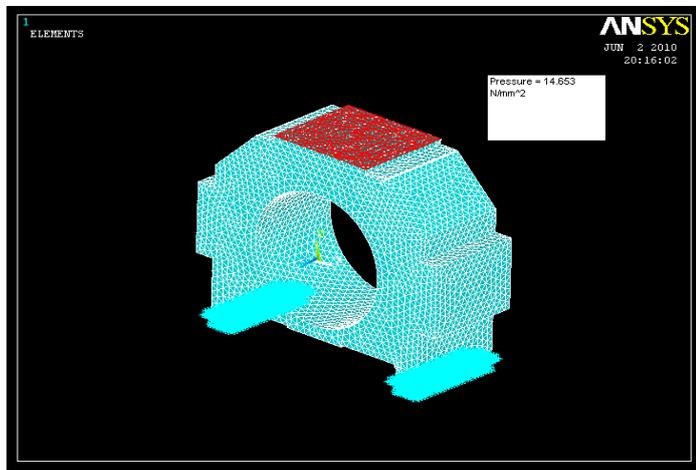

Fig. 2.1 Meshing Diagram for Top Roll Chock

Fig. 2.2 Total Deformation Contour Plot for Top Roll Chock

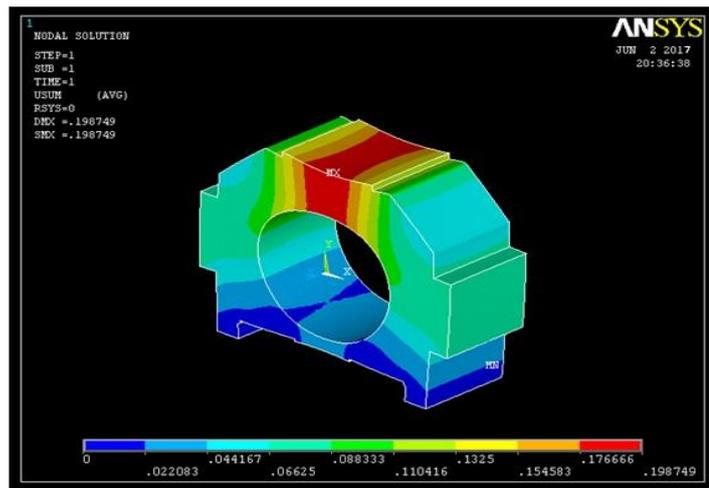**Fig. 2.3** Misses Contour Plot for Top Roll Chock

3. OPTIMIZATION OF TOP BACK UP ROLL CHOCK

The Top Roll Choke is optimized to a minimum size with Stress Constraints, Bearing Size Constraints. The Initial Stress Contour Plots Obtained in Chapter 2 was observed and studied. It was found out that parts of the roll choke had very little stress induced in them and could be removed.

The Following Iterations were carried out on the Roll Choke and a considerable weight reduction and thus cost savings was obtained.
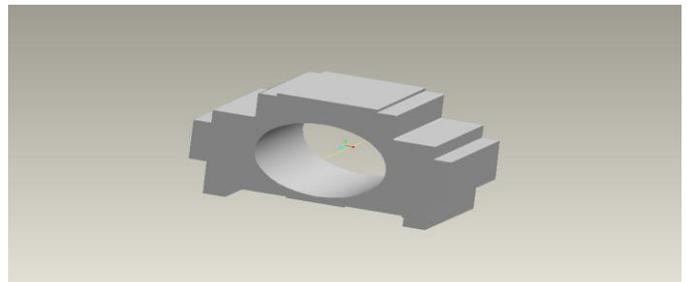
Iteration 1:-

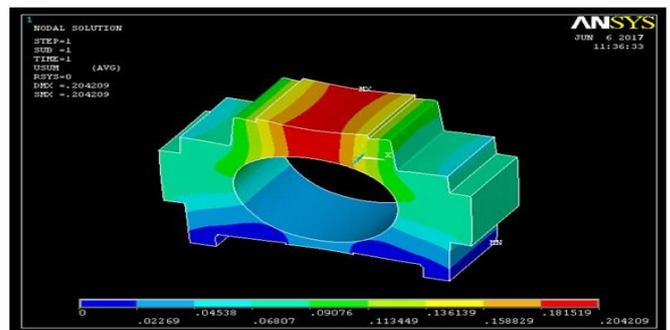**Fig. 3.1** 3D Model of 1st Iteration of Optimization of Top Back up Roll Chock

Fig. 3.2 Deformation Contour of 1st Iteration of Optimization of Top Back up Roll Chock

Fig. 3.3 Von Misses Stress Contour of 1st Iteration of Optimization of Top Back up Roll Chock

Table 3.1 Comparison of 1st Iteration and Existing Roll Chock

Sr. No.	Item	Old	New
1	**Weight**	1816.49	**1693.79**
2	**Deformation**	0.198596	0.204209
3	**Von Misses Stress**	78.444	84.507

2nd Iteration: -

Fig. 3.4 3D Model of 2nd Iteration of Optimization of Top Back up Roll Chock
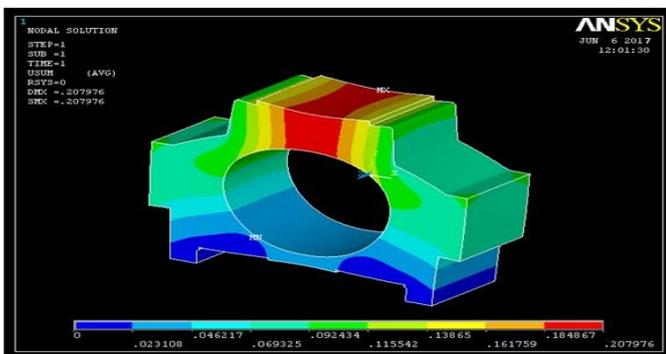
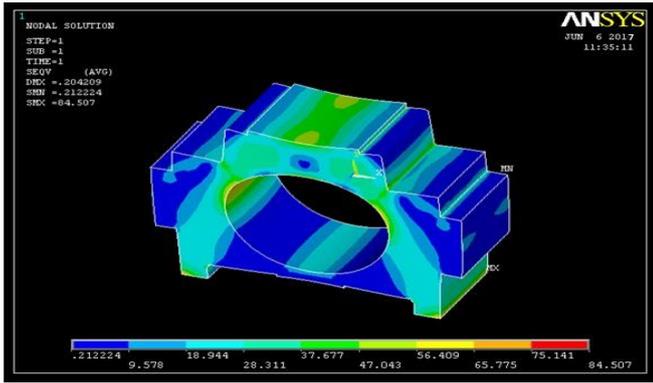**Fig. 3.5** Deformation Contour of 1st Iteration of Optimization of Top Back up Roll Chock

Fig. 3.6 Von Misses Stress Contour of 2nd Iteration of Optimization of Top Back up Roll Chock
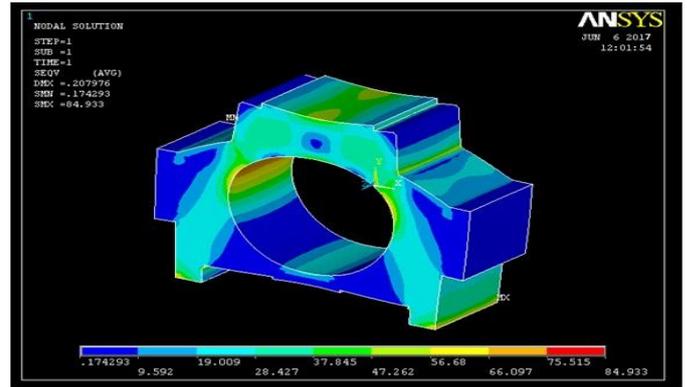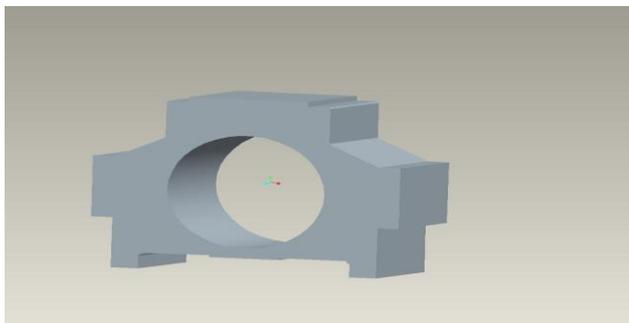
Table 3.2 Comparison of 1st Iteration and 2nd Iteration Roll Chock

Sr. No.	Item	1st Iteration	2nd Iteration
1	**Weight**	1693.79	**1633.4**
2	**Deformation**	0.204209	0.207976
3	**Von Misses Stress**	84.507	84.933

Thus a considerable weight saving is obtained as given below:-

Weight of Existing Roll Choke   – 1816.49 kgs

Weight of Optimized Roll Choke   - **1633.4 kgs**

Cost Savings – Wt. Reduced x Rs. 50

183.495 x 50

Rs. 9154.5

Modal Analysis of Optimized Roll Choke

The Modes and their frequencies are given in Table 3.3:-

Mode	Frequency (Hz.)	Deformation (mm.)
1	7.5964	0.048917
2	7.6924	0.035799
3	15.710	0.051504
4	22.976	0.05069
5	24.667	0.060074
6	29.020	0.043498
7	29.047	0.071935
8	32.248	0.038319
9	37.795	0.043885
10	43.152	0.077078

4. CONCLUSIONS

This is the totally new concept introduces by me in the company where we r going to save the cost and time by giving more life to roll chock. By simulation of the actual chock model on the software it was revealed that the

chock of the machine experienced higher stresses at the place where the holding of work role and back role occur. In the company there is failure of chock occurs during the process of operation so we designed the new chock for rolling machine by improving the all over safety factor. The new chocks have good life compare to failure one and from that chock company daily saving. Design Optimizations of Critical Component Roll Chocks in Cold Rolling Mill is really good project where designs of roll chock is totally new part.

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