FEA Analysis of Stresses Induced in 3- Pass Roller of Re-Rolling Mill1

V. Talodikar[1] Tameshwar Sarwa[2] Shailesh Bunde[3] Shubham Kadam[4] Suraj Tembhrune[5]
[1]Associate Professor [2,3,4,5]Research Scholars
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]TGPCET, Nagpur, India

Abstract— FEM Analysis is a numerical method that can be used for the accurate solution of complex engineering problem. Rolling process is a very common and conventional process which is used in finishing shaping and designing of flat stripes, angles, rods, etc. In this process the product which is to be machined is passed through a set of heavy rollers which are rotating at some speed usually constant due to this rotation of roller the material which is to be machined gets shrinked and takes the shape as of that of the rotating rollers through which it is passed. Generally rolling process is having two types: - 1) Hot Rolling 2) Cold Rolling. Rollers of Re-Rolling milling are the rigid structural rotating elements used in production of different kinds of Geometry of products which are used in the various places like in Construction, in welding, etc. Rollers are also the main element of industry (mill) which is responsible for manufacturing of final products produced by mill. Rollers are the elements which are fixed from both the sides in the rolling stand & allow to reflect in upwards or downward direction like a simply supported beam. In this present research a structural analysis of roller of re-rolling mill by using FEA technique to get the range of deflection and stress for a definite force of 164.033 N is carried in the commercial software like Ansys.

Keywords: Rollers, Stress & Deflection

I. Introduction

Finite Element Method (FEM) Analysis is a numerical method that can be used for the accurate solution of complex engineering problems. The method was first developed in 1956 for the analysis of aircraft structural problems (In fact these method has become one of the active research areas for applied mathematics). In FEM analysis, once a general computer modelled is made it can be used for the solution of any problem simply by changing the input data. In addition, the reader will be in position to use commercial software such as NASTRAN and ANSYS. The basic idea in the finite element method is to find the solution of complicated problem by replacing it by simpler one. Therefore it will able to find only an approximate solution rather than perfect solution. And the basic idea of applying FEM method on rolling mills roller is to estimate the life of roller before it gets breaks (or goes to scrap). A roller is a structural rotating element which is like a brain of industries, all the final product depends on quality of rollers. We are applying the FEA analysis on an industrial roller of industry located at Nagpur. Our aim is to determine the maximum period up to which a roller can be continuously used in a proper way without harming the final product. The second reason for selecting this project among the various problems present in the industry mentioned above is that we want to save the industry from huge lose in the breakdown period which generally occurs in such industries because of roller break down & also to save the operators, operating the rollers from any harm when roller break down.

II. Material Used

The material used in the industry for the roller is European North 8 generally called as EN8, which is medium carbon usually supplied untreated. It has a good tensile strength in generally used in applying such as shafts, gears, bolts etc. EN8 is very propeller great and really machine able in any condition. The US grade of EN8 is SAE 1040.

A. Specification of EN8

Carbon	0.3624 – 0.44%
Si	0.10 to 0.40 %
MN	0.60 to 1%
S	0.05 Max
K	0.05 Max
Cr	-
Mo	-
Ni	-

Table 1: Chemical Composition

Maximum Stress	465 mpa
Yield Stress	650 mpa.
Elongation	16% min
Hardness	201 to 255 BHN
E	2e5
μ	0.3
Bulk modulus	
Shear modulus	

Table 2: Mechanical Propertie

Thermal Conductivity	50.7 W/m °C
Thermal Expansion Coefficient	μm/m°C

Table 3: Thermal Properties

III. Methodology

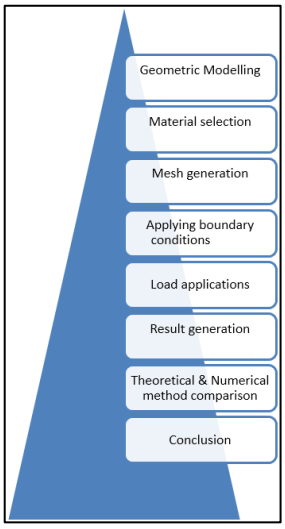

Fig. 1:

IV. DIFFERENT LOADING CONDITION

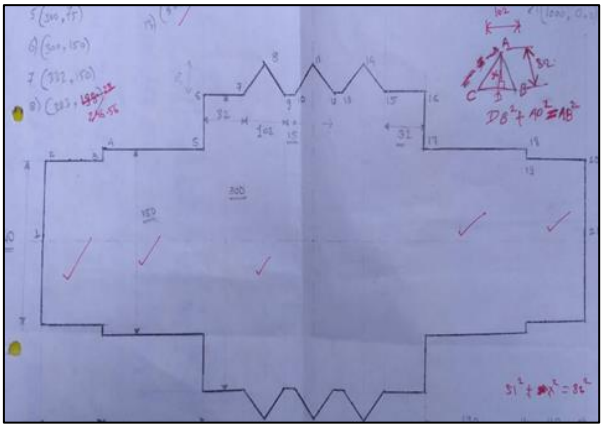

Fig. 2: Different Loading Condition

L.M.Galantucci, L.Tricarico [1] has carried out the study of hot rolling process & the approach is based on thermo-mechanical analysis using the Finite Element Method. The model can be used to speed up & improve the design & evaluation of the roughing & finishing phases in plate & sheet production. The congruence of the results has been evaluates using experimental & theoretical data available in the literature.

Shailendra Dwivedi, Dr. Geeta Agnihotri, Dr. K. K. Pathak[2] has carried out numerical Simulation which has become a quite important tool in the manufacturing industries .Rolling process is one of the most popular processes in manufacturing to make different parts with a long range variety of dimensions. In present research the influence of Modelling and Simulation of various parameter such as geometry of the slab, temp., friction between work-rolls and slab, percentage of the thickness reduction on process.

Charles Mansfield, All P. Gordon [3] has carried out study on Manufactures of rolled materials which are always striving to induce the costs associated with production by the time, material, or waste. A parametric study was conducts via ANSYS and LS -DYNA to numerical simulate symmetric hot rolling. Conditions that minimize edge cracking as predicted by a ductility model are presented.

D. Benasciutti, E. Brusa, and G. Brazzaro [4] has carried out the Finite Elements Prediction of thermal stresses in work roll of hot rolling mill. It consist of simplified numerical approach based on finite elements to compute thermal stresses occurring in work roll of hot rolling mills is here proposed.

Gargi Majunder and Kaushik Kumar [5] has carried out the measure to which a structural member get deviated from the initial position is called deflection The deflected distance of a member under a load is directly related to the slope of deflected shape of the member under that load, While the beam gets deflected under the load, bending occurs in the same plane due to which stress occur and the nodal solutions were analysed and compared. On comparing the analytical and computational solutions it was found that for stresses the 8 node brick element gives most consistent results for Tet 10node 187.

Seved Reza Motallebi [6] has said that Rolling process is one of the most popular processes in manufacturing industries in order to make different parts with long range variety of dimensions. In this procedure the internal raw material transform into desirable shape by at least two rolls.

A. Different Loading Conditions of Roller

- Point Load, UDL, UVL.
- Cyclic Loading.
- Combined Loading Consisting UDL and one vertical concentrated load.
- Dynamic forces.
- External forces taken as a point load.

V. FEA ANALYSIS

In modern World, the solution of modern structures by using som or tom techniques is quite difficult to carry out. Hence even though the numerical computational methods like FEM which are giving up an approximate solution are used in calculation and the analysis is called Finite element analysis.

Traditionally FEA is a branch of solid mechanics which is used to solve complex multiphysics problems. In these project we are applying these analysis on the rollers of the mahalaxmi dhatu udhyog industry, to calculate the value of stress and deflection acting on rollers.

As mention early FEA analysis can be used in commercial software line ANSYS, NASTRAN etc.

In these project we are using ansys software to obtain a range of stress and deflection by doing a structural & thermal analysis on roller in software like ansys. For that we are using Tet10node187 as our element. It is a solid in nature it is a higher order 3D, it consists of 10 nodes and it has a quadratic displacement behavior and is well suited for solving structural problems. The material properties that we used here is E (young's modulus of elasticity) = $2*10^5$ mpa & μ (Poisson's ratio) = 0.3 & thermal conductivity K=50.7W/mk.

The figure below shows the deflection and stress distribution & we are applying the Boundary condition, at the end of roller since they are fixed inside the bearing and no loading is applied at those regions (fig.2)

The analysis part is carried out by taking three independent parameters like Diameter of roller, Temperature of roller, Temperature of cold water.

- Diameter of roller: 170-300 mm.
- Temperature of roller: 600-300deg. Celcius.
- Temperature of cold water: 20-50deg. Celcius.

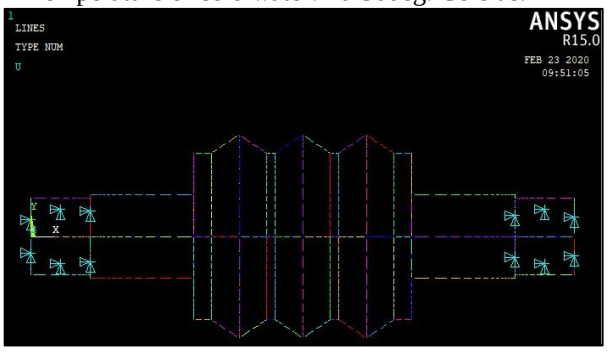

Fig. 3: Boundary Condition

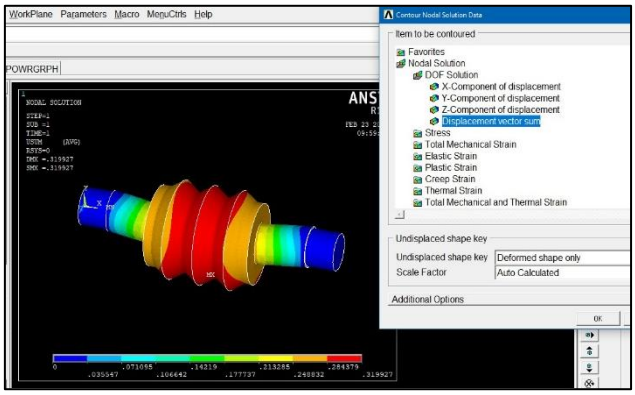

Fig. 4: Deflection distribution

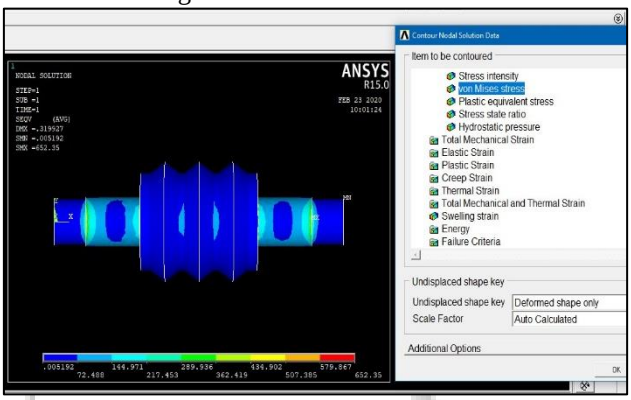

Fig. 5: Stress Distribution

VI. THEORETICAL CALCULATION

Given

Power Range (P): 720 KW to 650 Kwatts = 720000000 mW to 650000000 mW.

Speed range (N): 350 rpm to 400 rpm

Length (L): 400 mm= 0.4 m

Inner Diameter range (D_i): 300 mm to 230 mm = 0.3 m to 0.23 m

Outer Diameter range (D_o): 494 mm to 424 mm = 0.494 m to 0.424 m

Mass of roller (M): 250 kg to 242 kg

A] To Calculate Torque:

$$T=\frac{P*60}{2*3.14*N}$$

B] To Calculate K:

$K = D_o /2$

C] To Calculate Moment of Inertia:

$I = 0.5*M*K^2$

D] To Calculate Stress:

$F_s = \{(D_o/2) * T\} / I$

E] To calculate θ:

$$\theta = \frac{F*L}{R_O\, G}$$

F] To Calculate Deflection:

Deflection = θ * K

Calculations for 1st Observation:

A] To Calculate Torque:

$$T=\frac{P*60}{2*3.14*N} = \frac{72*10^6*60}{2*3.14*350} = 19654231 \text{ N-mm}$$

B] To Calculate K:

$K = D_o /2 = 494/2 = 247$ mm

C] To Calculate Moment of Inertia:

$I = 0.5*M*K^2 = 0.5*250*247^2 = 7626125$ kg-mm^2

D] To Calculate Stress:

$F_s = \{(D_o/2) * T\} / I = \{(494/2) *19654231\} / 7626125 = 636.5743$ mpa

VII. CONCLUSION

The above results conclude that, stress value for roller of mill for 10 node tetrahedral elements is more accurate. It also states that it is applicable to general loading conditions. After comparing results from Ansys with Theoretical values validates the result, we got from ANSYS are showing that the maximum stress of 635.36 Mpa.

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