Stress Scrutiny of Reject Handling Components for Coal Mills

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Abstract— Scraper Assembly is a prime component of a coal mill, which is considered as the reject handling component, to take out the un-grinded material from the mill which gets collected in the pyrite box. The main purpose of this paper is to focus upon the stress Scrutiny (Analysis) for different scrapers and to give a precise reason which scraper design is having a safe working condition and its behaviour with respect to the specified loading conditions. The component has been analysed for the failure criteria – Von-Mises Stress. The software packages used for 3D modelling of the component is Solid Works and stress scrutiny was carried out in ANSYS-14.

Key words: Scraper, Stiffeners, Stresses, Coal Mill, Solid Works, ANSYS-14

I. INTRODUCTION

Scraper assembly is light in weight which is used to take out the un-grinded material from the mill which gets collected in the pyrite box. Wear blades with adjustable settings are loaded in the sweep position by torsion spring which is integral. Scraper blade is hinged on the horizontal journal and swings like a car wiper if necessary. Scraper assembly creates a required turbulence for the vane wheel.

Scraper assembly acts like the swiping out system for the rejects of the mill. The rejects coming out from the vane wheel of the bowl and bowl hub assembly will be collect on the floor plate of the mill side assembly. These rejects will be in the form of un-grinded coal particles, bolts, nuts, ceramic tiles or any other kind of foreign particles. These will be collect and will be swiped from the scraper assembly from an opening given in the floor plate of the mill side which is called as tramp iron spout. This opening is in-turn connected to the pyrite tank which is also called as reject tank and from this reject tank it will be taken out from the mill system. See Fig. 1.

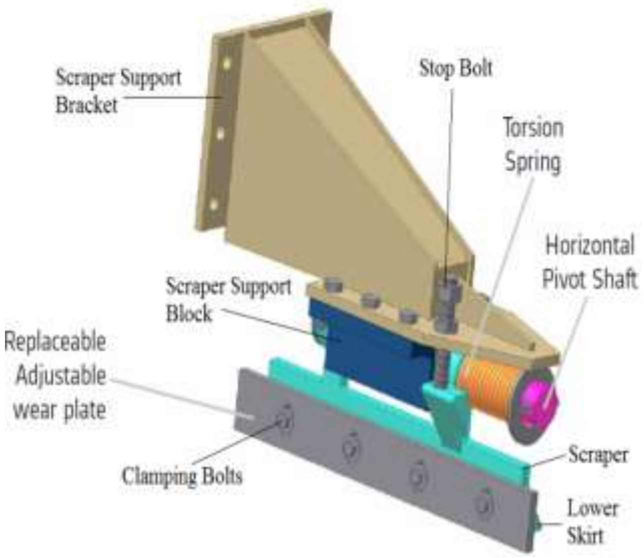

Fig. 1: Scraper Assembly

There were some previous developments done by few researchers for the most technically advanced mill and its component like Scraper Assemblies. Some of the major persons who were responsible for this development and their scope of work were:

A. Harun Bilirgen [1]:

Came to the conclusion that flow designs inside the pulveriser, evolve an adjustable control of coal mechanism through an external design which can be utilized in controlling flow of coal of the pipes which act as an outlet. Eventually the particular essential design requirement being a control flow mechanism which affects the flow of particle.

B. L.Canadas, Inerco.V.Cortes, P.Otero, J.L.Albaladejo [2]:

They came to the conclusion that the design and operation of a system to make it as good as possible for a milling system is aiming of the reduction of the costs came across during operation and the influence of surrounding of the power plants which are coal fired so as to sustain the abilities in the sector of electricity.

C. C. Bhasker [3]:

Changes of performance to a lower state or progress in the development of stations of power which are fired with coal rely on particular operation of equipment which is pulveriser and accuracy in the boilers of combustion.

D. CH. Priyanka, Kandi. Reddy, Mounika[4]:

Pulverisers usually present in the recent days – both the ball mill types and shaft vertical in nature – involves belonging to the criticism for making apart the particles of coal which are coarse in nature from particles of coal which are fine in nature being provided to the boiler of the plant of power which is operated thermally.

II. PROPOSED METHODOLOGY

The software packages used for the 3D Modeling and Static Analysis are:

- Solid Works V-12.
- ANSYS V-14

A. Solid Works V-12

SOLID WORKS is basically a modelling and simulation software package which is used in many applications to get a desired shape of the component which is to be modelled and accuracy or precision in the exporting format.

After the 3D models have been done in parts, then these individual parts are assembled in assembly section.

3D models modelled in SOLIDWORKS package are.

1) Scraper without Stiffeners

Fig. 2 Scraper without Stiffeners

2) Scraper with Fabricated Stiffeners

Fig. 3 Scraper with Fabricated Stiffeners

3) Scraper with Casted Stiffeners

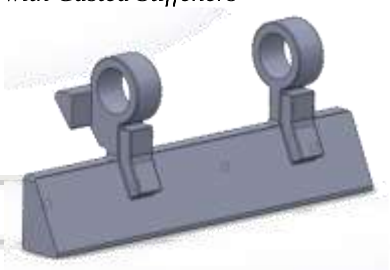

Fig. 4 Scraper with Casted Stiffeners

B. ANSYS V-14

ANSYS is basically simulation software. Simulation as a design imperative and tools that gives engineers the power to predict.

Simulation is driving this product development transformation and now more than anyone ANSYS is taking it to the next level in through multi physics.

Today ANSYS is shaping the future of simulations into a clear competitive advantage providing you the power to realize the product.

III. ANALYSIS MODEL & BOUNDARY CONDITIONS

Reject Handling Components (Scraper Assemblies).

In this topic the detail boundary condition is show to give a clear picture of understanding.

A. ANSYS Model (Scraper without Stiffeners)

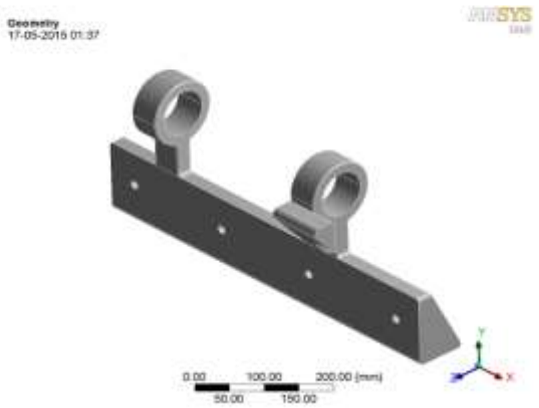

Fig. 5 ANSYS Model for Scraper without Stiffeners

B. ANSYS Model (Scraper with Fabricated Stiffeners)

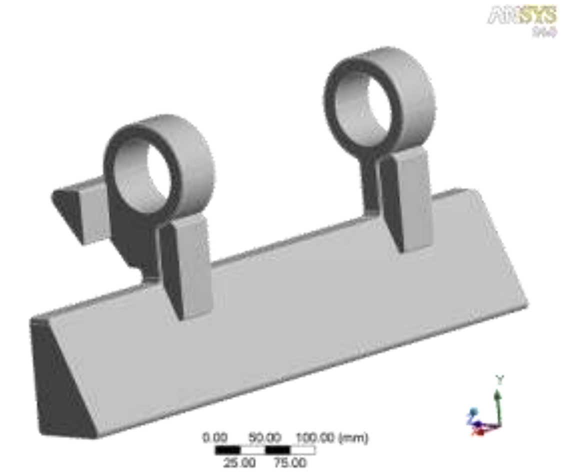

Fig. 6 ANSYS Model for Scraper with Fabricated Stiffeners

C. ANSYS Model (Scraper with casted Stiffeners)

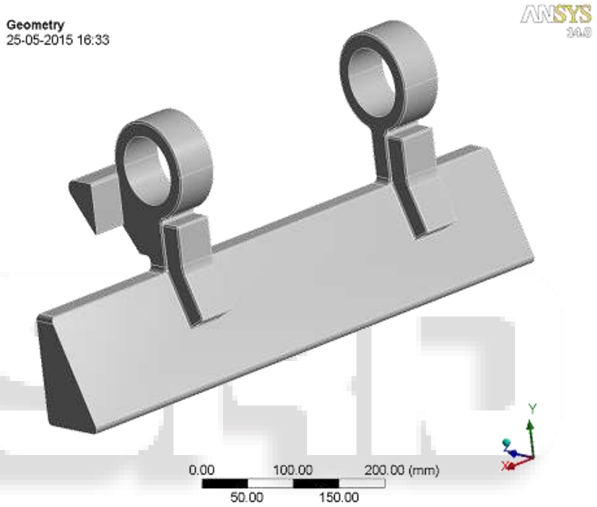

Fig. 7 ANSYS Model for Scraper with Casted Stiffeners

D. Meshed Models

1) Scraper without Stiffeners:

Fig. 8 Meshed Model (Scraper without Stiffeners)

2) Mesh Detail of Scraper without Stiffeners

Mesh Type	Relevance Centre	Body Sizing (mm)	Number of Elements	Number of Nodes
Tetrahedron	Fine	05	509642	358041

Table 1 Observation for Meshed Model (Scraper without Stiffeners)

3) Scraper with Fabricated Stiffeners

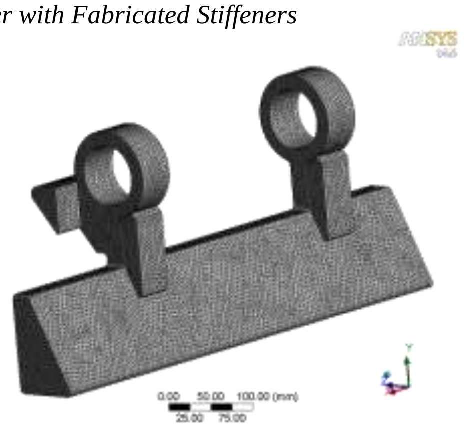

Fig. 9 Meshed Model (Scraper with Fabricated Stiffeners)

4) Mesh Detail of Scraper with Fabricated Stiffeners.

Mesh Type	**Relevance Centre**	**Body Sizing (mm)**	**Number of Elements**	**Number of Nodes**
Tetrahedron	Fine	05	529040	371989

Table 2 Observation for Meshed Model (Scraper with Fabricated Stiffeners)

5) Scraper with Casted Stiffeners

Fig. 10: Meshed Model (Scraper with Casted Stiffeners)

6) Mesh Detail of Scraper with Casted Stiffeners

Mesh Type	**Relevance Centre**	**Body Sizing (mm)**	**Number of Elements**	**Number of Nodes**
Tetrahedron	Fine	05	538589	377984

Table 3 Observation for Meshed Model (Scraper with Casted Stiffeners)

E. Boundary Conditions considered for the Static-Structural Scrutiny of Scraper Assemblies in brief.

1) Scraper without Stiffeners

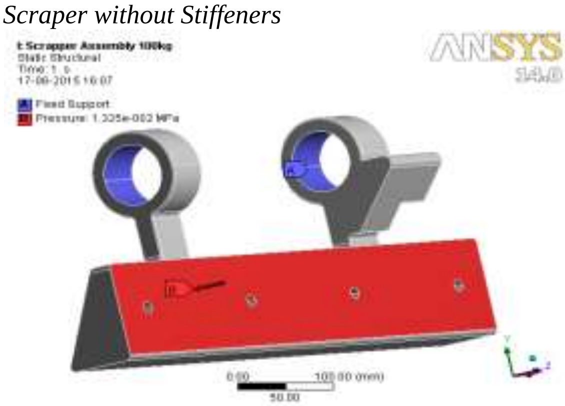

Fig. 11 Boundary Conditions (Scraper without Stiffeners)

2) Scraper with Fabricated Stiffeners

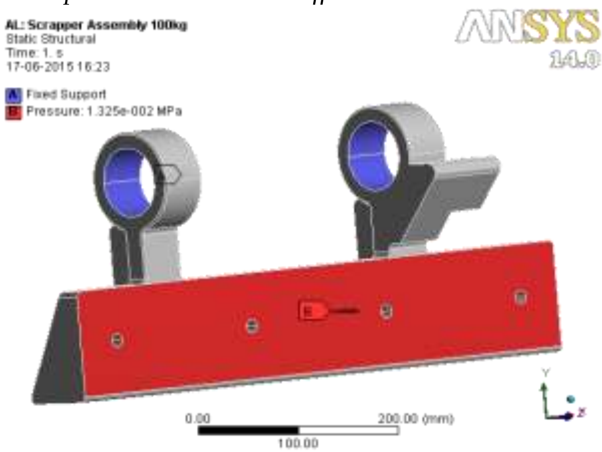

Fig. 12 Boundary Conditions (Scraper with Fabricated Stiffeners)

3) Scraper with Casted Stiffeners

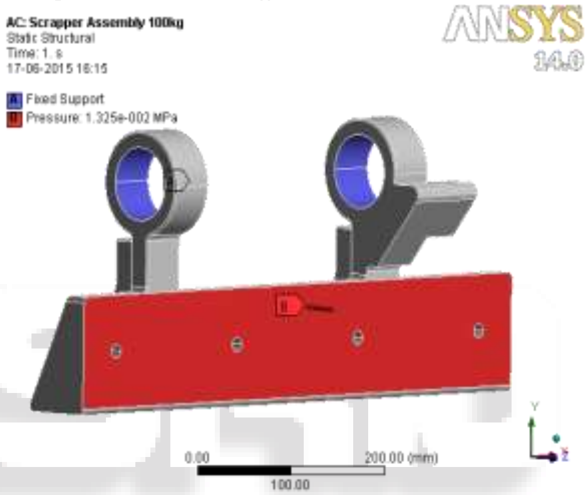

Fig. 13 Boundary Conditions (Scraper with Casted Stiffeners)

4) The Dimension System considered for the Static-Structural Scrutiny for the Bowl and Bowl Hub Assemblies is

Unit System	**Metric (mm, t, N, s, mV, mA) Degrees rad/s Celsius**
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

Table 4 Observations for Measurement System

5) Connections

Since the Existing Scraper without Stiffeners and Scraper with Casted Stiffeners are single entities so there are no connections.

For Scraper with Fabricated Stiffeners is three entities the connections between them are shown in the table below:

CB - CONTACT BODIES
TB - TARGET BODIES

Sl. No.	**Contact Region**	**Type of Contact**	**Co-efficient of Friction**
1	**CB-** Fabricated Stiffener – 1. **TB-** Scraper.	Bonded	--

2	**CB-** Fabricated Stiffener – 2. **TB-** Scraper.	Bonded	--

Table 5 Observations for Connections of Scraper with Fabricated Stiffeners

6) Constraints considered

In this Scrutiny of scraper assembly, the scraper is fixed at two portions i.e. the two inner faces of the scraper pin hole, where the pin is assembled to hold the scraper tightly. The fixed portions are same for all the scraper assemblies (Existing Scraper without Stiffeners, Re-Designed Scraper with Fabricated Stiffeners and Re-Designed Scraper with Casted Stiffeners). As shown in figures 11, 12 &13.

7) Loading Conditions

In Vertical type coal mills the scraper assembly acts as the pyrite system where the un-grinded materials are wiped out by the scraper in the millside of the coal mills. In working conditions the scraper is subjected to 150kgs.

This force of 150kgs was transformed into pressure (MPa) and applied on the entire scraper face as shown in figures 11, 12 & 13.

The formula used to transform the force in Kgs to pressure (MPa) was:

$$Pressure = P = \frac{F}{A} \qquad \ldots\ldots\ldots\ (1)$$

Where,

$P = Pressure$

$F = Force$

$A = Area$

Sl. No	Force (Kgs)	Force (Newton)	Pressure (MPA)
1.	150	1471.5	0.01987

Table 6 Loading Conditions for Scraper Assemblies

The above table-6 shown the pressure values in "MPA", the scraper face areas remains the same for different geometries (Scraper without Stiffeners, Scraper with Fabricated Stiffeners and Scraper with Casted Stiffeners).

The pressure values are applied to different geometries in this analysis to obtain the desired answers.

IV. FEA RESULTS

A. Scraper without Stiffeners:

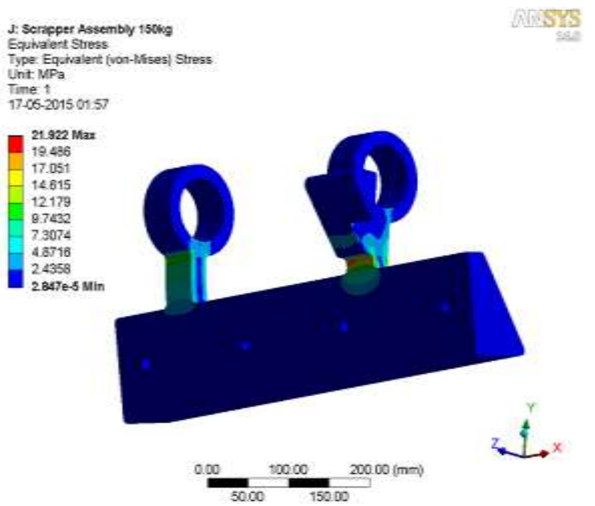

Fig. 14 Von-Mises Stress (without Stiffeners)

B. Scarper with Fabricated Stiffeners:

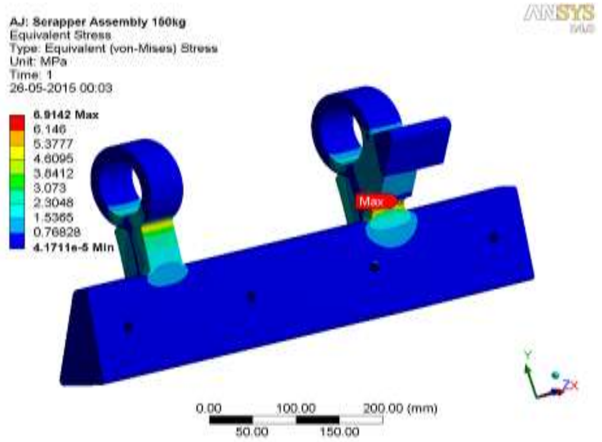

Fig. 15 Von-Mises Stress (Fabricated Stiffeners)

C. Scraper with Casted Stiffeners:

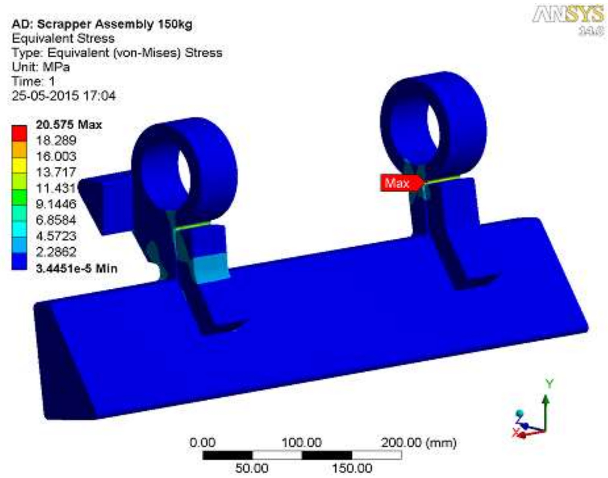

Fig. 16 Von-Mises Stress (Casted Stiffeners)

D. Observations for the ANSYS Scrutiny results for the Scraper Assemblies:

Sl. No	Component	Equivalent (Von-Mises) Stress. (MPa)
1	Scraper without Stiffeners	21.922
2	Scraper with Fabricated Stiffeners	6.9142
3.	Scraper with Casted Stiffeners	20.575

Table 7 Observations for Scrutiny Results.

V. RESULTS AND DISCUSSIONS

A. Scraper without Stiffeners.

Sl no	Model	Analytical Results	Analysis Results	% Error	Design Condition
1	Scraper without Stiffeners	20.74	21.92	5.6	SAFE
2	Scraper with Fabricated Stiffeners	6.56	6.91	5.3	SAFE

3	Scraper with Casted Stiffeners	19.98	20.57	2.97	SAFE

Table 8 Von-Mises Stress Comparison

By applying a load of 150kgs (1471.5N) to scraper face the above results were obtained. Here we can observe that the Analytical results and the ANSYS results are within the permissible limit of percentage error. The values obtained both from Analytical and ANSYS results of stress are within the permissible limit of 50MPa

VI. CONCLUSION

The failure scrutiny through Von-Mises stress criterion for the applied load of 150kgs for Scraper without stiffeners, Scraper with fabricated stiffeners and Scraper with casted stiffeners result in 21.92 MPa, 6.91 MPa and 20.57 MPa respectively which lies within the permissible limit of 50MPa.

Hence we conclude that the results obtained through this scrutiny done on Pyrite Scraper Assembly without Stiffeners, with fabricated stiffeners and with casted stiffeners are adequate and the design is in SAFE working conditions.

Out of all the three types of Scrapers that is without stiffeners, Fabricated & Casted we are using Casted Stiffeners so as to AVOID the Welding on the Scraper and to make a scraper with stiffeners an SINGLE Entity. Without stiffeners scraper is AVOIDED because in case if the sudden impact load is occurred on scraper face due to the un-grinded coal particles, there will be a failure on scraper shoulders.

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