"MODIFICATION OF ROLLERS IN TRACKS OF ROCK BORING MACHINES"

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ABSTRACT

Rock Boring Machines are large crawler mounted mining machines which have various component assemblies like boom, Feed assembly and rotation assembly, Track Assembly etc. While doing work in mines, for making a hole in rocks, machine has to take different positions. So machine require to move about various positions by tramming operation for completing the hole in rock. Shifting machine from one location to other is known as tramming process. To transmit weight of machine to the track crawler frame are mounted with roller wheels. The weight of the machine is allocated evenly along the track across the ground through the wheels, which acts as contact point. Directing of the track is also assisted by the roller wheels. Roller wheels are a wear article and necessitate replacement from time to time or after wear. At present weight of rig is: 15.5 ton. As per the pre study report it is essential to make some upgradation on crawler.

Keywords: Feed assembly, Tramming.

I. INTRODUCTION

Rock Boring Machines are mining machines, which are mounted on crawler comprising various constituent assemblies like Track assembly, Feed assembly, Boom and Rotation assembly etc. While doing work in mines, for making a hole in rocks, machine has to take different positions. **.** So machine requires to move about various positions by tramming operation for completing the hole in rock. Shifting machine from one location to other is known as tramming process. Drilling is the procedure of making a opening into a stiff surface where, as compared to the diameter the span of opening is extensive. In the context of mining engineering drilling refers to making holes into a rock mass. Rock boring requires drilling for different purposes that include:

1. Production or Manufacture drilling i.e. for making openings for situating explosives for blasting. The purpose of drilling and blasting is to prepare well -fragmented loose rock amenable to excavation with better productivity from the excavation machinery. The holes drilled for this purpose are defined as blast hole.
2. Examination drilling – for collection of test sample to calculate approximately the quality and quantity of a mineral reserve. It is also called as diamond drilling because diamond drills are used for drilling operations.
3. Technological drilling – at the phase of development of a mine for drainage, slope steadiness and testing foundation purposes.

Opencast mining engage in mineral exploration by removing waste rock. Where mineral deposits are underlying solid and compact rock it makes necessary loosening of the rock mass before excavation. Thus drilling as well as blasting is the essential grounding job. Where the rock mass is not weathered and extremely unconsolidated drilling of openings for placement of explosives and detonating them for blasting is required for any mining operation. Contemporary machines like continuous surface miner can however get rid of the need of drilling and blasting in some surface mining operations. Successful drilling under specific site circumstances requires combination many technologies and services into a coherent professional team, particularly if it is for deep examination drilling. Blast hole drilling is relatively easier. However, to minimize costs and optimize the performance and post drilling operations technical managers and decision managers must understand the language and technology of drilling operations.

The modern hydraulically operated drills have number of advantages over pneumatic drills. These are:

1. The self-contained diesel powered hydraulic percussive drills do not require auxiliary compressor for drill operation.
2. Energy delivered per stroke being higher, hydraulic percussive drills offer higher penetration rate compared to the pneumatic drill.
3. Less noisy
4. Many hydraulic drill claims energy saving as high as 66% than pneumatic drilling. Vertical blast holes are most common. However, to avoid formation of hard toes and to obtain better fragmentation and reduced vibration

level inclined blast holes are more useful in many situations. A hard strata occurring at depth in the lower horizon of a high bench is better blasted by horizontal blast holes. However, horizontal drilling is not normally carried out in opencast mining due to the difficulties associated with drilling and charging.

II. PROBLEM IDENTIFICATION

Safety standards for drilling rig necessitate modification of rollers in current tracks to sustain ground pressure. Current machine is provided with 6 nos of roller per track. So there are 12 nos of rollers on the both tracks of machine. Wear of rollers is reported after few hours working of machine during company's field report. Field inspection brought to notice some drawback. From reported drawbacks it is recommended to modify the size of rollers together with no of rollers for each track. Fewer number of rollers was responsible for the unequal allocation of load in sprocket mechanism of track. This unequal distribution increased the failure chances. Increased wear and tear of rollers and lesser life of them. The rationale behind the modification of roller for track frame was to prevail over the malfunction problem at a variety of worst load environment and to build up a universal track assembly that would sustain the maximum weight with superior capacity. So the requirement of project is to modify the roller for track frame to sustain the increased weight of new modified technologies on the machine. And by keeping minimum cost of manufacturing of machine so making it compatible to all Rock Boring machines. Some design changes are also required to validate this part of modification as per specifications.

III. INTRODUCTION TO UNDERCARRIAGE AND ROLLER

I) Undercarriage Assembly-The whole undercarriage assembly of a dresser crawler is consisting of machinery that transfers tractive effort from the tractor to create forward and reverse motion.

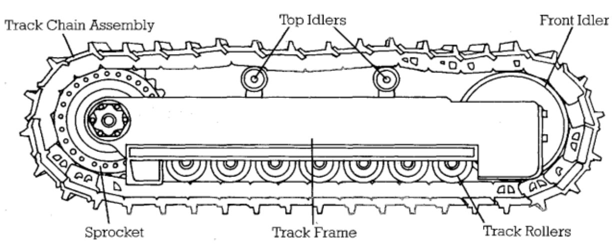

Fig.1 Undercarriage Assembly

A) Front Idler- It is fundamentally used for building chain in tension. Shock load is absorbed and the track is guided by the large wheel at the front. It is modifiable for appropriate track chain tension.

B) Sprocket- hunting tooth design sprocket is used by all dresser crawlers, consisting of an odd number of sprocket teeth. This design allows every tooth to make contact on every further revolution. The same sprocket is used for the dry seal and the lubricated track system.

C) Top Idlers- Track chain is supported by using top idlers. The top of the undercarriage consist of metal wheels which support and guide the track chain assembly between the sprocket and front idler.

D) Track Rollers- From track frame to track chain load is delivered by the rollers, which are mounted in series. Tractors weight is supported by the metal wheels which are located at the bottom of track frame and which rolls over the rail portion of the track chain.

II) Roller Wheels -Roller wheels which distribute machine weight to the track are located at the undercarriage frame. The wheel, which acts as contact points, helps to distribute machine weight equally across the ground through the track. As a evaluation, a skid steer loader concentrates machine weight on the four points where tires contact the ground. Roller wheels also facilitate to guide the track. Track lugs travel between or outside the roller wheels and are kept in alignment when the machine turns or works on slopes. High-density plastic core with rubber bonded to the circumference is used to form roller wheels. The bonded rubber provides a cushioned surface to reduce track wear where the rollers contact the rubber track.

Fig.2 Roller Wheel

The rubber acts as a cushion to facilitate resisting track damage when rocks or debris are jammed between the roller and track. This prevents pushing the debris into the belt and damaging it. Roller wheels are a wear article and necessitate replacement from time to time or after wear. Operation in rough conditions, in addition to inappropriate operating technique, can cause the rollers to wear faster. Because of the open design of the

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undercarriage, replacement of a worn wheel can be easily accomplished.
The important functions of undercarriage roller wheels are:
1. From frame to track distribution of weight.
2. Guiding the track.
3. Provide a cushion between the tracks

IV. EXISTING TRACKFRAME AND ROLLER

I) Current Track Specifications

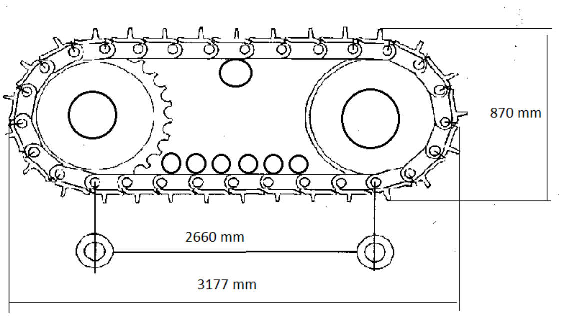

Fig.3 Schematic Diagram of track frame

Total weight of m/c is 15.5 ton.
No. of roller is 6
Total Length (L) = 3177 mm
Total Height (H) = 870 mm
Total Width (W) = 320 mm
Centre distance between Sprocket and Idler Gear (C) = 2660 mm

II) Overall Dimensions of Existing Roller

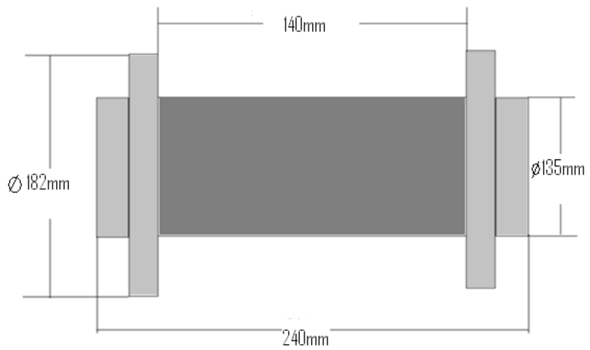

Fig.4 Schematic Diagram of existing Roller

V. PRELIMINARY CHANGES SUGGESTED

1. Raise no. of roller from 6 no. to 7 no..
2. As per the size available in market and viable to machine raise the diameter of roller.
3. Accordingly make changes in track frame.

VI. METHODOLOGY

1. Theoretical calculation for roller
2. Based on calculation selection of rollers.
3. Formation of 3D model and drawing using Pro Engineer software
4. Substantiation of projected design by FEA analysis using analysis software ANSYS.
5. On the basis of FEA Analysis improvement of Design Model.
6. Make changes and issue the Drawing for Fabrication.
7. Model fabrication.
8. Assemblage of roller and track on machine.
9. Trial and validation of actual component on site.

VII. THEORETICAL CALCULATION

Static Load Case

One track pulls at maximum traction force, Ft. when other track is not permitted to move with respect to ground. The stationary track is subjected to a bending moment Ms and the shear force Ft at the shaft and the forces R1 & R2 form a couple at mainframe shaft from the ground.

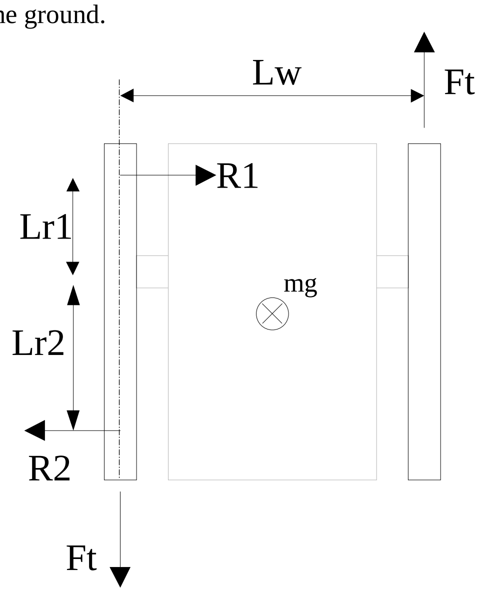

Fig.5 Schematic Diagram Various load acting on track frame.

At shaft pivot bending moment (at the side of the locked track) becomes

$M_s = F_t L_w$ = (52000X2.4) =124800Nm --------------- (*gear box torque=15490Nm, sprocket R=0.3m hence Ft=52000N*)

The force couple size becomes

$$R1 = \frac{F_t L_w}{L_{r1}} = 124800/1.25 = 99840\text{N}$$

$$R2 = \frac{F_t L_w}{L_{r2}} = 124800/1.325 = 94188.6\text{N}$$

Contact surface area of idler for R1 reaction is – Ai = 15127.535mm2.

And same time 1st three rollers will may have contact with track chain, then total surface area of roller contact is – Ar = 2550 mm2

$$\sigma_b = \frac{R1\frac{L_r}{2}}{W_b} = \frac{F_t L_w}{Atotal} \quad and \quad \tau = \frac{R}{A} = \frac{F_t L_w}{AL_r}$$

= 99840/ 17677.5 = 5.64 N/mm2 = 0.564 kg/mm2.

Material is SAE 1541, Yield stress value is 520 Mpa= 520 N/mm2.

VIII. VERIFICATION OF PROPOSED DESIGN BY FEA

I) Load Cases

Sr. No.	Load at Center Support	Load at the Outer Hinges			
	Load (N) downward	Angel	Load	Hor.(N)	Ver(N)
1	40000	0	0	0	0
2	40000	41	203.53	153606	133528
3	40000	41	-152.74	-115274	-100206

Table 1. Load cases

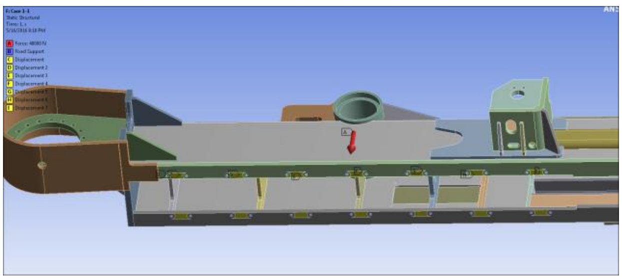

Fig 6. Load Case 1

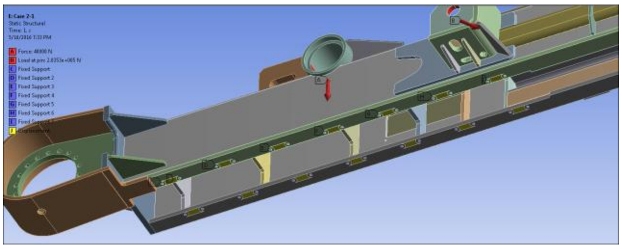

Fig 7. Load Case 2

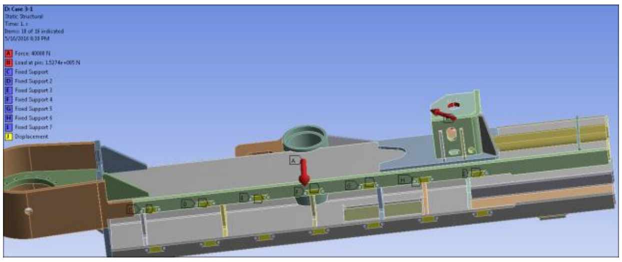

Fig 8. Load Case 3

If we convert the physical model BC to mathematical, we find that at the bolting of the roller there will be fixed contact (constrained in all direction) and at the roller bar pin and bearing holder area will be having zero displacement

II) Displacement Plots

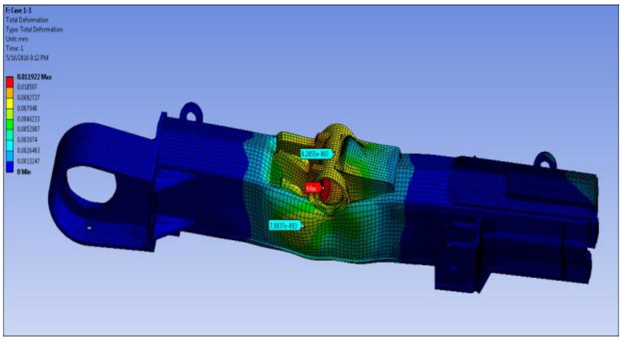

Fig 9. Displacement plot for load case 1

Max displacement observed at the centre where the load is applied ~0.0119mm which is very small.

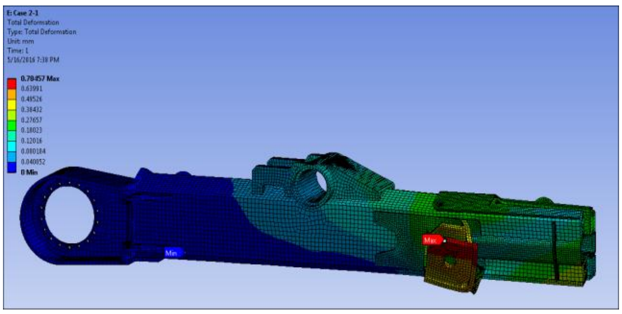

Fig 10. Displacement plot for load case 2

At welded support displacement observed is 0.78 mm

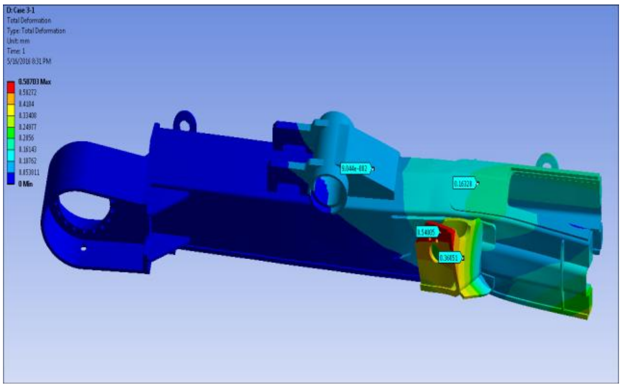

Fig 11. Displacement plot for load case 3

Displacement observed is 0.587mm

III) Equivalent Stress Plot (Von-Mises Stress)

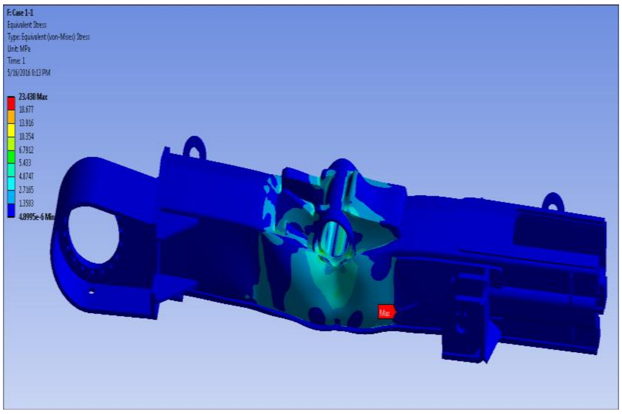

Fig 12. Stress plot for load case 1

Max equivalent stress observed at the boundary condition at fixed support which can be neglected.
Stresses are very small for the given load condition, frame is safe for the given load condition.

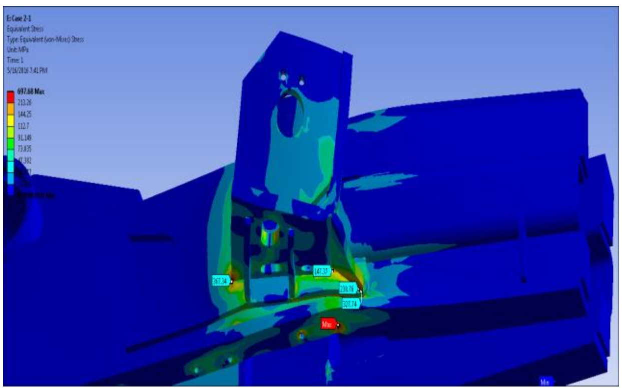

Fig 13. Stress plot for load case 2

Max stress observed at BC which is neglected and other critical areas which needs stiffening for making frame safe.

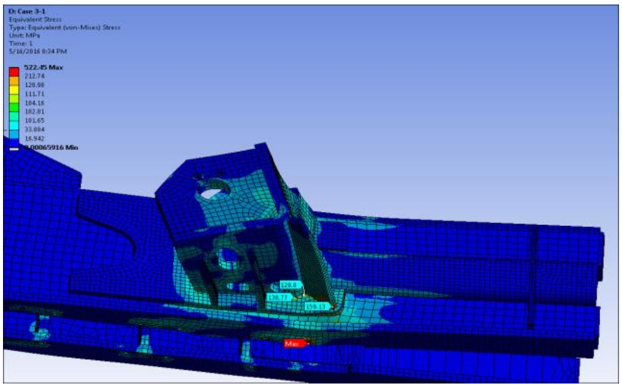

Fig 14. Stress plot for load case 3

IX. CONCLUSION

1. Cost effective solution for the highly under stressed Track
2. Solutions for the Weakest part of the machine which must be very strong
3. Track frame design & selection of roller to sustain the load without fracture and wear at its extreme downward position of drilling.
4. Newly design track will also be applicable for the machine which will going to use for 6” drilling Hole Applications

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REFERENCES

[1]. Mohamed A Omar; “Modular Multibody Formulation for Simulating Off-Road Tracked Vehicles ”; Studies in Engineering and Technology, vol no. 1 (2014).
[2]. Abdelmotalab Fadlelmola Kheiralla; “Conceptual Design of a Rubber Tracked Mini-Vehicle for Small Holders Using Off-Road Vehicle Engineering Techniques”; International Conference on Trends in Industrial and Mechanical Engineering (ICTIME'2012) March 24-25, 2012 Dubai.
[3]. D. Rubinstein a, R. Hitron, “A detailed multi-body model for dynamic simulation of off-road tracked vehicles”; Journal of Terramechanics 41 (2004) 163–173.
[4]. E. Rusinski*, J. Czmochowski, P. Moczko; “Failure reasons investigations of dumping conveyor breakdown’;

Journal of Achievements in Materials and Manufacturing Engineering; VOLUME 23, ISSUE 1 July 2007
[5]. Arindam Pal, Sumit Sharma, Abhinav Jain, C.D.Naiju ; “Optimized Suspension Design of an Off-RoadVehicle”; The International Journal Of Engineering And Science (IJES) , vol no. 2 Issue 6 (2006) pp 57-62.
[6]. B J Robinson & A J Scarlett; “Development of technical requirements / performance specifications for a) tracksand b) exterior and accessories of agricultural and forestry vehicles”; Transport Research Laboratory, (2013).
[7]. Z. -D. Ma; “A Track-Wheel-Terrain Interaction Model for Dynamic Simulation of Tracked Vehicles”, VEHICLE SYSTEM DYNAMICS · AUGUST 2010.
[8]. Kenjiro Tadakuma, Riichiro Tadakuma, Hiroaki Kinoshita; “Mechanical Design Of Cylindrical Track for Sideways Motion”; Proceedings of 2008 IEEE International Conference on Mechatronics and Automation,.

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