FAILURE ANALYSIS OF TRACK WHEELS OF SPECIALIZED MINING EQUIPMENTS

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Abstract: Breakdown of any components in the machinery will affect the operation of the machinery. Breakdown of machinery will affect the operation of the total system. Every hour breakdown of the machinery will incur a loss in lakhs of rupees. So aim of the Operation and Maintenance departments should be Zero breakdowns. There are various reasons for SME Breakdowns. Break downs due to track wheels failure is also a vital. Failure of Track wheels will lead to breakdown of sub swing, Derailment of track wheels and grounding of track wheels it will increase the downtime of machine and affect the production. Replacing of Track wheels requires De- tensioning of the particular track plate and requires equipments like Bull Dozer, backhoe and Hydraulic jacks. Sometimes this work affects other maintenance works also. So we are addressing the problem of "REASONS FOR FAILURES OF TRACK WHEELS OF SME".

Key words: Breakdown,Derailment,De-tensioning,

I. INTRODUCTION OF TRACK WHEELS

The Bucket wheel excavators have the six track carriages are connected to the under carriage the pivots.

Six track carriages Viz.

FST-(I) Front steering track (Inner)

FST-(O) Front steering track (outer)

RST(I) Rear steering track (Inner)

RST(O) Rear steering track (Outer)

SAT(I) Self aligning track (Inner)

SAT(O) Self aligning track (outer)

Every track carriage contains one drive gear box and one return wheel and two 6 wheel equalisers. One 6 wheel equaliser contains one 2 wheel equaliser and one 4 wheel equaliser.

The purpose the equaliser is keeping the track wheel in contact with the track plates in all the ground conditions like undulations Totally 12 Track wheels fitted in one track carriage. Totally 72 Track wheels will take the total load of machine is (24, 13,478 kg).one wheel will take the load (33,520.5 kg)

Figure 1: Track wheel

1. TRACK PLATE

2. TRACK PLATE LINK

3. TRACK WHEELS

II .PARTS OF TRACK WHEELS

2.1 TWO WHEEL EQUILISERF

2.2 AXLE

2.3 LOCK PLATE

2.4 LABYRINTHS

2.5 TRACK WHEELS

2.6 BUSHES

2.7 ALLEN SOCKET BOLTS

2.1 TWO WHEEL EQUILISER-(1 No):

A bogie is a chassis or framework carrying Track wheels, attached to the4 wheel equaliser. Materials such as carbon (0.20%), silicon (0.45%), manganese (1.55%), phosphorus (0.04%), sulphur (0.04%). It weighs 343 kgs.

Figure 2: Two wheel equiliser

Table 1: Material composition of wheel bogie

1.	CARBON	0.20% (max)
2.	SILICON	0.45%(max)
3.	MANGANESE	1.55%(max)
4.	PHOSPHOROUS	0.04%(max)
5.	SULPHUR	0.04%(max)
6.	YEILD STRENGTH	320 N/Sq.mm (min)
7.	TENSILE STRENGTH	490 N/Sq.mm (min)
8.	ELONGATION	22% (min)

2.2 AXLE-(1 No):

An axle is a material which is made up of mixed compounds which is used to hold the roller wheel and the bogie. Pin has four supply lines in which it supplies grease only thorough two lines and the other two lines are permanently closed which arrests the grease from escaping. Pin has grease supply lines inside it which helps in supplying the grease to all over the length of the wheel. A pin has two supply lines one at the top and other at the bottom which supplies grease to groove inside the wheel. Pin is made up of material known as CK 45(heat treated). CK 45 is a combination of materials such as carbon (0.42 – 0.50%), silicon(0.17 – 0.37%), manganese(0.50 – 0.80%), phosphorous(0.04%), sulphur(0.04%). It weighs 44 Kgs.

Figure 3: Grease adapters

Table 2: Material composition of axle for track wheel

1.	CARBON	0.42-0.50%
2.	SILICON	0.17-0.37%
3.	MANGANESE	0.50-0.80%
4.	PHOSPHORUS	0.04%
5.	SULPHUR	0.04%
6.	YEILD POINT	36-48KG/mm^2
7.	TENSILE STRENGTH	60-90 KG/mm^2
8.	ELASTIC LIMIT	14-18%
9.	BHN	206(Basic)

2.3 LOCK PLATE-(1 No):

Lock plate is used to arrest the axial movement of the axle and also resisting the rotation of the axle on the bore of the bogie. Before providing lock bolts in lock plate sleeve to be inserted in the axle thro lock plate. Lock plate is made up of material known as DIN St 52-zzor SALIMA 350 H I. It weighs 5.2

Figure 4: Lock plate

Table 3: Material composition of bottom roller lock plate

1.	DIN St	52-3
2.	SAIL	350 H I

2.4 LABYRINTHS-(2 No's):

Labyrinth is to be fitted on both ends of the track wheels over the bushes, and it will seat on the grooves, which arrests grease from getting out and avoids soil particles entering inside the wheel bushes. Labyrinth is made up of material DIN St 37/ IS 2062 and it weighs 3.24 kg.

Figure 5: Labyrinths

Table 4: Material composition of labyrinths

1.	DIN St	37/ IS 2026

2.5 TRACK WHEEL-(1 No):

Wheel is used to move the machine in all surfaces. Wheel is assembled in the equaliser frame which moves in a continuous track path. Wheels is made up of GS-42CrMo4V MATERIAL. This material cosists of carbon(0.38-0.45%), silicon(0.60%), manganese(0.60%), phosphorous(0.020%), sulphur(0.015%), chromium(0.80-1.2%), molybdenum(0.20-0.30%). It weights 208 kgs.

Figure 6: Track wheel

Table 5: Material composition of track wheel

1.	CARBON	0.38-0.45%
2.	SILICON	0.17-0.37%
3.	MANGANESE	0.50-0.80%
4.	PHOSPHORUS	0.035%
5.	SULPHUR	0.035%
6.	CHROMIUM	0.90-1.2%
7.	MOLYBDENUM	0.15-0.25%
8.	YIELD STRENGTH	55-90 Kg/mm^2
9.	TENSILE STRENGTH	75-130 Kg/mm^2
10	ELASTIC LIMIT	10-14%
11.	B.H.N	217

2.6 BUSHES-(2 No's):

Bushes are pressed in the track wheel bore. Bushes avoid the direct contact of wheel bore and axle. Comparatively bushes are softer than axle and wheel wear of bushes will be more. Grooves inside the bushes will help the flow the grease it minimises the wear of bushes. Bush is made up of G – CuSn 10Zn (DIN 1705). This material consists of tin (9-11%), zinc (1-3%), copper (86-89%).it weighs 7.8 kg.

Figure 7: Bushes

Table 6: Material composition of bottom roller bush

1.	TIN	9-11%
2.	ZINC	1-3%
3.	COPPER	86-89%
4.	YEILD STRENGTH	130N per sq.mm (min)
5.	TENSILE STRENGTH	260N per sq.mm (min)
6.	ELONGATION	15% (min)
7.	BHN	75 (min)

2.7 ALLEN SOCKET BOLTS-(4 No's):

Bolts are also called as Allen socket bolts which is used to lock the lock plate with the axle .Bolts are made up of DIN St 37 material. It dimension is M16x50 Allen socket bolts

Figure 8: Allen socket bolt

III. SCOPE OF THE PROJECT

The use of SPECIALISED MINING EQUIPMENTS (SME) to excavate the overburden soil and Lignite. The Specialised Mining Equipments are Bucket Wheel Excavator, Mobile Transport Conveyor and Spreader. Wear focussing on the SME.

In the SME thousands of spare parts are there. In that we are concentrating on the Track Wheels which carries the full load of the machinery and also it rolls on the track plates.

From this project work there may be a scope of reducing the premature failures of Track wheels

IV.ANALYSIS AND FAILURES OF TRACK WHEELS

4.1 FINDINGS

Track wheels of SME transfer the full weight and load of the machine to the ground through the track plates. So track wheels always rotating in full load and there is always a possibility of soil and slush and it requires proper maintenance to improve the life span of the wheel and to avoid the break downs due to premature failure.

In the year 2016, nearly 233 numbers of track wheels were changed due to various failures, reasons for which are enumerated in this chapter.

In the year 2017, nearly 135 numbers of track wheels were changed due to various failures

In the year 2018, nearly 104 numbers of track wheels were changed due to various failures, reasons for which are enumerated in this chapter.

Table 7: Failure of track wheel in bwe 1420, bwe1421, bwe1422

YEAR/MACHINE	BWE 1420	BWE 1421	BWE 1422
2016	84	56	57
2017	56	12	67
2018	51	12	41

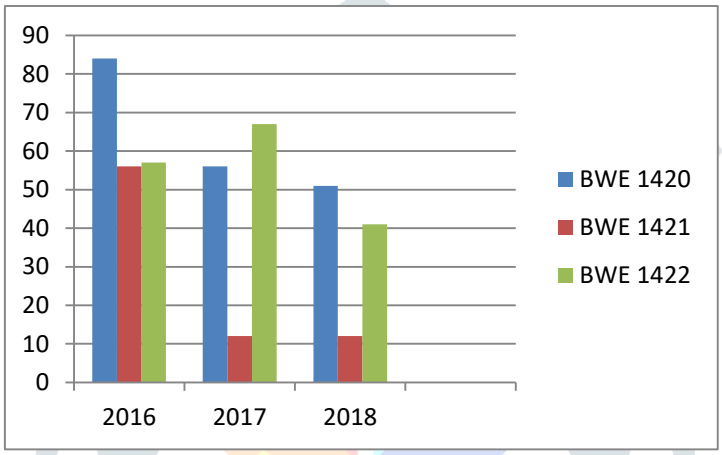

Figure 9: column chart for failure of track wheel in bwe 1420,bwe1421,bwe1422

Table 8:Failure of track wheel within three months period in bwe 1420,bwe1421,bwe1422

YEAR/MACHINE	BWE 1420	BWE 1421	BWE 1422
2016	23	08	13
2017	11	18	21
2018	08	04	05

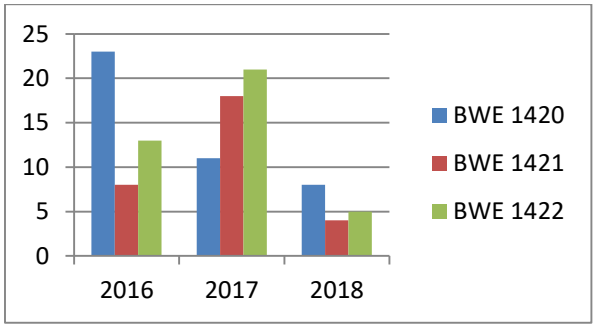

Figure 10:column chart for failure of track wheel within three months period in bwe 1420,bwe1421,bwe1422

4.2 TYPES OF FAILURES OF TRACK WHEEL ARE:

4.2.1 Wear of Track wheels on the periphery
4.2.2 Flattening of the periphery
4.2.3 Wear of Bushes
4.2.4 Wear of track wheel bore
4.2.5 Lock plate bolts shear or missing
4.2.6 Wear of roller Axle

4.2.1 WEAR OF TRACK WHEELS ON PERIPHERY:

Figure 11: Wear of track wheels on periphery

This is a normal type of wear on the periphery nothing but reduction of outer diameter of the Track wheels due to rolling of Track wheels on track plate Links. Track wheels are normally having hardened peripheral surface for 4mm deep to reduce the wear. Poor ground conditions will accelerate the wear of periphery.

4.2.2 FLATTENING OF THE PERIPHERY:

Figure 12: Flattening of the periphery

This failure is changing of round shape into unshaped like square, hexagon…etc., because of Track wheels fails to rotate.

4.2.3 WEAR OF BUSHES:

Figure 13: Wear of bushes

Bushes wear due to several reasons, once bushes are worn out fully then Track wheel bore and axle start wearing and Track wheel and axle cannot be reconditioned for further usage by changing the bushes.

REASONS FOR BUSHES FAILURE:

- Soil entry
- Improper assembling of Track wheels in the two wheel equaliser
- Improper Lubrication
- In sufficient Lubrication
- Lack of Lubrication

FAILURES DUE TO SOIL ENTRY:

As we discussed above, in the mines due to the slushy ground conditions there is always a possibility of soil entering into the bush area and it will accelerate the wear of the bushes.

Proper grease supply to the bushes will prevent the soil or slush entry and pressurised grease will evacuate the soil and the dust in the bush area. Proper assembly that is maintaining correct gap between fork and labyrinth will also prevent the soil entry.

Improper assembling of Track wheels in the two wheel equaliser

Improper assembling of Track wheels in the two wheel equaliser will accelerate

- The Failure Of Bushes
- Lock plate Bolts Shear
- Soil Entry In The Bushes
- Labyrinth Worn-out
- Pin rotation causes Lubrication pipes and hoses disconnection

IMPROPER LUBRICATION:

Before assembling the track wheels, axle greasing hole should be ensured. It is free from blockage. If there is any blockage there will not be proper grease flow or sometimes grease supply fully blocked and it accelerates wear of bushes results in failure of Track wheels.

IN SUFFICIENT LUBRICATION

Track wheel axle having two grease inputs in which grease lines are connected. One grease line supplies to one half of the bush and another line is for other half of the bush. If one line got cut or there is no supply of grease in one line and insufficient grease will be supplied to the bushes results in wear of bushes causes failure of Track wheels.

LACK OF LUBRICATION

- Problems in the Automatic greasing system results non supply of grease to the Track wheels.
- Axle rotation due to lock plate bolts shear causes grease lines cut.
- Main grease supply line puncture or cut.
- Grease distributor failure

Are the reasons for lack of lubrication major cause of Track wheel failure

4.2.4 WEAR OF TRACK WHEEL BORE:

This wear occurs when operation the machine after bush worn out fully. When the bore of the wheel worn-out it cannot be reconditioned by changing the bushes. The wheel becomes scrap. So when bushes worn-out immediately wheel should be renewed.

Figure 14: Wear of track wheel bore

4.2.5. LOCK PLATE BOLTS SHEAR OR MISSING:

Figure 15: Lock plate bolt shear or missing

When the lock plate bolts sheared the plate will fall down and axle starts moving causing damage of two wheel equaliser resulting in breakdown of SME.

4.2.6. WEAR OF ROLLER AXLE:

Figure 16: Wear of roller axle

When bushes fully worn-out due to any reasons axle will contact with roller bore and axle and track wheel bore starts wearing.

V. RECOMMENDATIONS

5.1. RECOMMENDATIONS TO MINIMISE WEAR OF TRACK WHEELS PERIPHERY:

This wear can be minimized by restricting the unnecessary movement of the machines and maintaining good ground conditions.

5.2 RECOMMENDATIONS TO AVOID FLATTENING OF PERIPHERY OF TRACK WHEELS:

This failure is due to the roller failing to rotate over the track plate due to lack of lubrications or improper assembly of track wheels in the equalizer.

- Proper pre - greasing while assembling.
- Maintaining proper spacers between equaliser frame and labyrinth.
- Checking the track for free rotation after assembly will prevent this failure.

5.3 RECOMMENDATIONS TO MINIMISE THE WEAR OF BUSHES:

- Pre greasing to wheels during assembly.
- Checking the grease flow before connecting the grease lines or grease hoses.
- Putting dummy in the opposite side to grease lines.

5.4 CORRECT SPACE BETWEEN LABYRINTH & EQUALIZER FORK TO BE MAINTAINED:

- If Excess gap exists, where grease will escape out & wear will be accelerated.
- Excess gap will allow soil inside the assembly.
- Grease flow to the bushes to be inspected visually on daily basis.

5.5 RECOMMENDATIONS TO AVOID TRACK WHEEL BORE WEAR:

- Changing the track wheel immediately after the bushes worn out will prevent the track wheel bore wear.

5.6 RECOMMENDATIONS TO AVOID LOCK PLATE BOLT SHEAR:

- When assembling of track wheel lock plate sleeves and spacer to be used to avoid shearing of bolts.
- The lock plate should be properly arrested to avoid rotation.
- **ENSURE PROPER FIT BETWEEN FORK BORE & AXLE.**

5.8 RECOMMENDATIONS TO AVOID FAILURE DUE TO THE WEAR OF AXLE:

- Lubrication to the track wheels to be maintained at regular intervals.
- Renewal of track wheel immediately after bushes are worn out.

VI. SUGGESTIONS

Suggestions to reduce the failures of track wheels:

- Exclusively one person may be identified and allocated for checking the grease flow of the SMEcomponents and if any problems observed it should be addressed immediately.
- Track wheel lock bolts to be modified by providing next higher size M20x50 Allen socket bolts to avoid shearing of bolts.
- Peripheral hardness depth may be increased to 10 mm depth to reduce peripheral wear.

VII. CONCLUSIONS

After continuous observation on site and interaction with the Executives and staff, many findings and respective recommendations and suggestions were recorded. This will help to minimise the failures of track wheels of bucket wheel excavators and it may be followed for other track wheels of SME.By minimising the failures of track wheels, SME breakdowns will be minimised and the availability of the bucket wheel excavator will be improved.

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