International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume – 02, Issue – 06, June – 2017, PP – 102-109

Selection of Bush Material for Link Coupling By Taber Abrasion and FEA Methods.

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Abstract: now a day's power transmitted in sugar mill from driver to top roller by coupling. There are two type of rope couplings, one is coupling having flexible member is polyester sling and other coupling flexible member is non metallic bush. In this study we have found the suitable material for this coupling bush, using table abrasion method to find the specific wear rate. Using that specify wear rate and actual boundary condition FEA is run to give the bush material life for design condition. By using this method we can predict the life of any bush in any similar application.

Keywords: Link coupling, specific wear rate, table abrasion and non-metallic wear simulation.

I. INTRODUCTION

In sugar mill power is transmitted as most efficient drive by means of rope coupling with plane spherical bush. This coupling has all most all desirable feature of wired rope coupling, new wired coupling, rope coupling with sling. It meets requirements of crushing process. We can say it is new intention period of this coupling in sugar mill.

Installed link coupling has problem with bush. Installed bearing/bush not meets the requirements of milling house. For that we have selected four categories bearing material for study 1) SKF Filament wound. 2) Vesconite and Vesconite Hi lube. 3) Nylon/Cast Nylon. 4) PEEK. Base on the data available from the 4 group we taken best 2 materials for the Taber abrasion test. For selection of material we applied analytic hierarchy process (AHP) to rank. Test is done as per ASTM D4060. From test we find the specific wear rate for both materials. FEA is done using ANSYS R18.0 Using this specific wear rate as constant in Arachad`s Model. Compare the result of both tests. Comparing result can suggest the good bearing material for the link coupling out of studied material.

In table abrasion test shaft material is used as the abrasive wheel to match the actual coupling condition. Table abrasion tested material is tested in lab and same property of it is feed for FEA data base. Almost all needs of milling house are fulfill by last coupling called as rope coupling with sphere-shaped plain bearings.

II. LITERATURE SURVEY OF SUGAR MILL DRIVE AND IT`S BUSH MATERIAL

In milling process mill coupling technology cal developments stages we can see in the fig 1. Starting of milling process 1st coupling used name as tail bar coupling. Strong metal surface wear patterns developed at the contact points of the tail bars and couplings which lead to developed thrust bearing arrangements. These bearing arrangements will absorb the axial and radial thrust developed by the coupling. But not able to reduce this axial and radial forces.

New sugar mill drive coupling we can call it as wire coupling [1]. It is shown in s-curve fig1 it starts at point 1. This wire coupling able to eliminated the axial and radial components of forces. As consist of wire as flexible member which leads to elongate permanently. It required changing it position one is 3 months.

Rope coupling with polyester sling as flexible member was installed in between 1987 - 1992.technologycal change from wire to rope coupling one polyester sling. For reduction in cost it changes connecting method, material of construction [3]. As it consist of polyester sling it means it need another member to transmit the force in opposite direction. These lead to again increase in the cost of coupling. All these coupling approx double the cost of tail bar coupling. In rope coupling need to have all sling of equal length if all sling is not of same length it lead to load more for small sling in length. Sling is difficult to manufacture and need to test destructive test frequently to ensure the reputability and design factor of safety. Overcome with rope coupling main two problems 1) another reversing member 2) Sling problem. It leads to develop the rope coupling with spherical pain bus. This consist of only one member i.e. link is the forward and reverse member for transmission. As shown in fig 1 rope coupling with sling and rope coupling with spherical plain bush is in red color. If we compare this two rope coupling then it is observed that rope coupling with spherical plain bush as superior than other. It is cost effective than rope coupling with sling.

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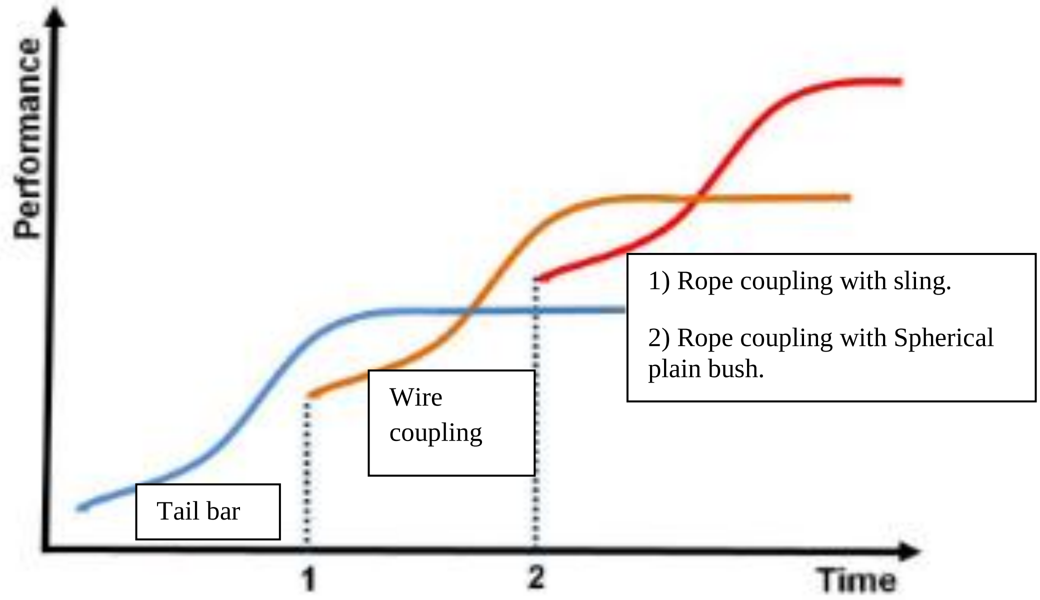

Fig. 1 Mill coupling developments over the time Vs performance.

Rope coupling with spherical plain bush is design for 60 mm axial displacement and less than 1deg of angular misalignment. It can be design to handle 100-150 mm vertical lift. As lift increase force components will change accordingly [1]. In fig 2 shown the hub design method. This shaft and coupling connecting method give the flexibility to connect to mill coupling [3].

Fig. 2 Link plates fitted with spherical plain bearings. [3].

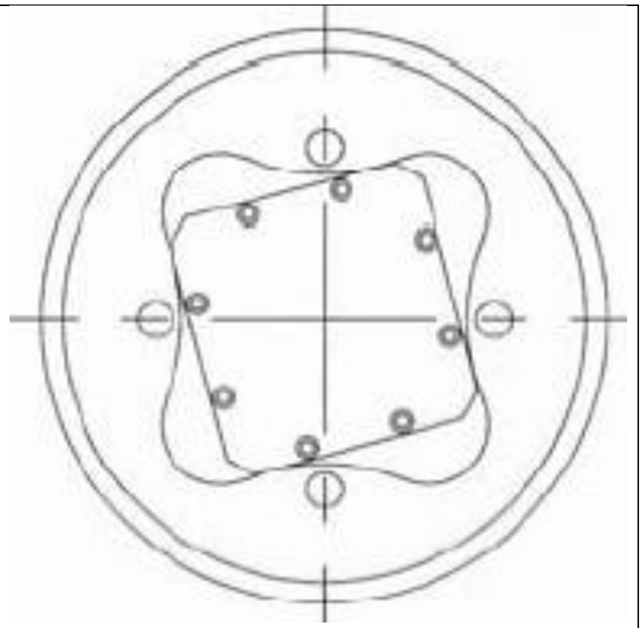

Fig. 3 connecting method [3].

Link coupling has superior feature than all other couplings. Bearings have not achieved the life predicted by the suppliers [3].

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Link coupling with spherical plain bush has following problem.
Objectives of the study as below:

1) Spherical bush life is not as per expectation.
2) Swing diameter is more than the tail bar coupling.
3) Cost is more than the tail bar coupling.

To find the best fit material for bush we have done the detail study on non metallic bushing material and apply the analytic hierarchy process. It gives ranking 1 to nylon impregnated with 6% of oil. Ranking number 2 to PBI/PEEK. So we take this 2 material for next study i.e. table abrasion test.

III. EXPERIMENTAL METHOD AND RESULTS FOR DETERMINATION OF A WEAR RATE OF SLEETED MATERIAL.

In link coupling total force acting on bush is 775 kN [1]. It is difficult to apply that huge amount of force is experimental set up. So deals with this type of problem we have choose to do the table abrasion test with define parameters.

3.1 Test conditions/detail of test.

- Test done by : The Automotive Research Association of India.
- Abrading wheels : Material of construction SS 304 Ra 3.2 wheel OD= 50; ID 16; thickness=12.75 mm
- Test Cycles : 1000
- Weight : 1000 g
- Test temperature : 23+/-2 ? C
- Date of testing : 23/03/2017
- Service requirments : Taber abrasion test as per ASTM D4060.
- Test Report No. : AML/2017-03/11109/38 dated 23/03/2017

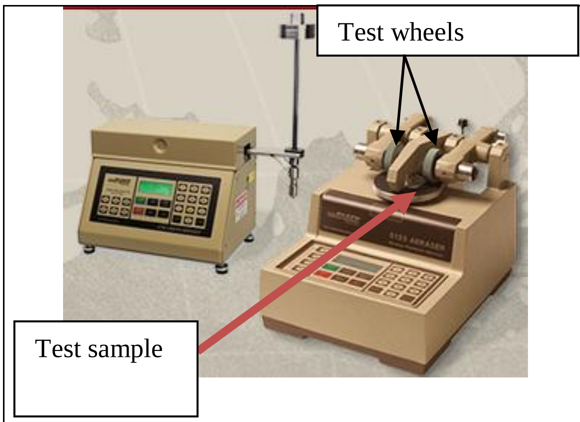

Fig. 4 Wear Testing machine image.

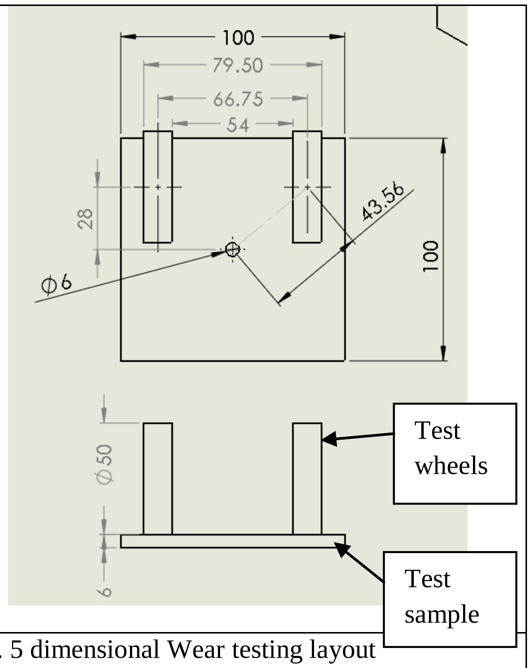

Fig. 5 dimensional Wear testing layout

In above test setup 1000 gram weights applied on each wheel. Wear sample is fix on round disc by nut bolt arrangements. Round disc is connected to drive motor. Drive motor rpm fix 60 or 80. This RPM option depends on the machine model. Wear sample max thickness 6 mm is accepted in this test.

3.2 TEST SAMPLE IDETIFICATION.

TABLE I

SELECTED 3 MATERIALS FOR TABER ABRASION TESTING.

Sample No	Sample ID
1	Peek Sample No 1
2	Cast Nylon impregnated with 6% of oil Sample No 2
3	Cast Nylon impregnated with 6% of oil Sample No 2

3.2.1 PROPERTIES OF SAMPLE MATERIAL.

For selected material we have testes the material for the following mechanical property. Actual test data is list down in following table.

TABLE 2

Selected Materials Mechanical Properties.

Sr. No.	Properties	Value for PBI /Peek	Value for Nylon	Unit
1	Density	1.32	1.14	g/cm3
2	Tensile Strength	97	78.33	Mpa
3	Compressive strength	153.8	180.88	Mpa
4	Friction Co-efficient	0.34	0.2125	-

3.3 TESTING RESULTS:

3.3.2 PHOTOGRPHS OF SAMPLE BEFORE TEST.

Following are the sample photo before testing. Raw material is available in different size. It cut to 100mmx100mmx6 mm thickness. Sample preparation is done for all 3 samples.

Fig. 6 Non tested side of sample 1

Fig. 7 Tested side of Sample 1

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3.3.2 PHOTOGRPHS OF SAMPLE AFTER TEST.

	
Fig. 8 Non tested side of sample 1	Fig. 9 Tested side of Sample 1

3.3.2 WEIGHT LOSS AFTER 1000 ROTATION.

Following test result take as average of 3 reading for same sample. Before test 3 reading taken for the each sample and after complition of 1000 cycle three reading avegarge taken.avergae of reselted is noted in following tabel.

Table 3

Taber Abrasions Testing Result.

Sample ID	Average change in weight after 1000 cycle
Sample 1	0.019
Sample 2	0.0031
Sample 3	0.0052

Sample 2 and sample 3 is of same material so we will take the avaerage of result for further caulcation=(0.0031+0.0052)/2=0.00415

Wheel OD=50 mm, Perimeter= π x OD=3.14*50=157 mm=0.157 Meter.

So total distance travel in meter by 2 wheel=547.113 Meter

Wheel Weight=177.43 grams.

Applied weight=2000 grams.

Total applied weight (applied weight+ 2 wheel weight)=2354.86 grams.

Total Applied Load =23.28 Newton

Weight loss by nylon =3.6 mm3

Wear rate: is volume loss per unit distance and its unit is (m3/m). It is independent of load applied.

Specific wear rate: depends on applied on to cause wear; It is volume loss per unit meter per unit load. Its unit is (m3/Nm).

TABLE 4
Calculated Specific Wear Rates.

Sample Name	Weight loss in grams.	Density $^{g}/_{m3}$	Volume loss in m^3	Wear Rate $^{m3}/_{m}$	Specific wear rate $^{m3}/_{Nm}$
Peek	0.0109	1320000	8.25758^{-9}	2.88^{-13}	1.97928^{-12}
Cast Nylon	0.00415	1140000	3.64035^{-9}	6.535^{-13}	0.87256^{-12}

IV. FINITE ELEMENT MODELING AND SIMULATION

In this method used ANSYS R18.0 for the wear simulation. By keeping all the parameters' same used in the experimental test we done the FEA. Used same geometry, force is same. Input data for FEA is specific wear rate which we have found out in experimental method.

Ones we calculated the specific wear rate for two relative material and keeping all data same we can predict the life of bush in actual condition. Variable parameters are running length in meters, and force is in Newton. This test for to correlated the experimental method and FEA method along with % error. Ones this relation establishes we can find the life for any application provide remaining condition is same.

APDL command used to extract the eroded volume of the plate. The plate volume eroded for two complete rotations of the wheels.

Original volume of the Plate = 60,000 mm3
Remaining Volume after wear of the Plate = 59,997 mm3
Total Wear volume of the Plate = 3 mm3

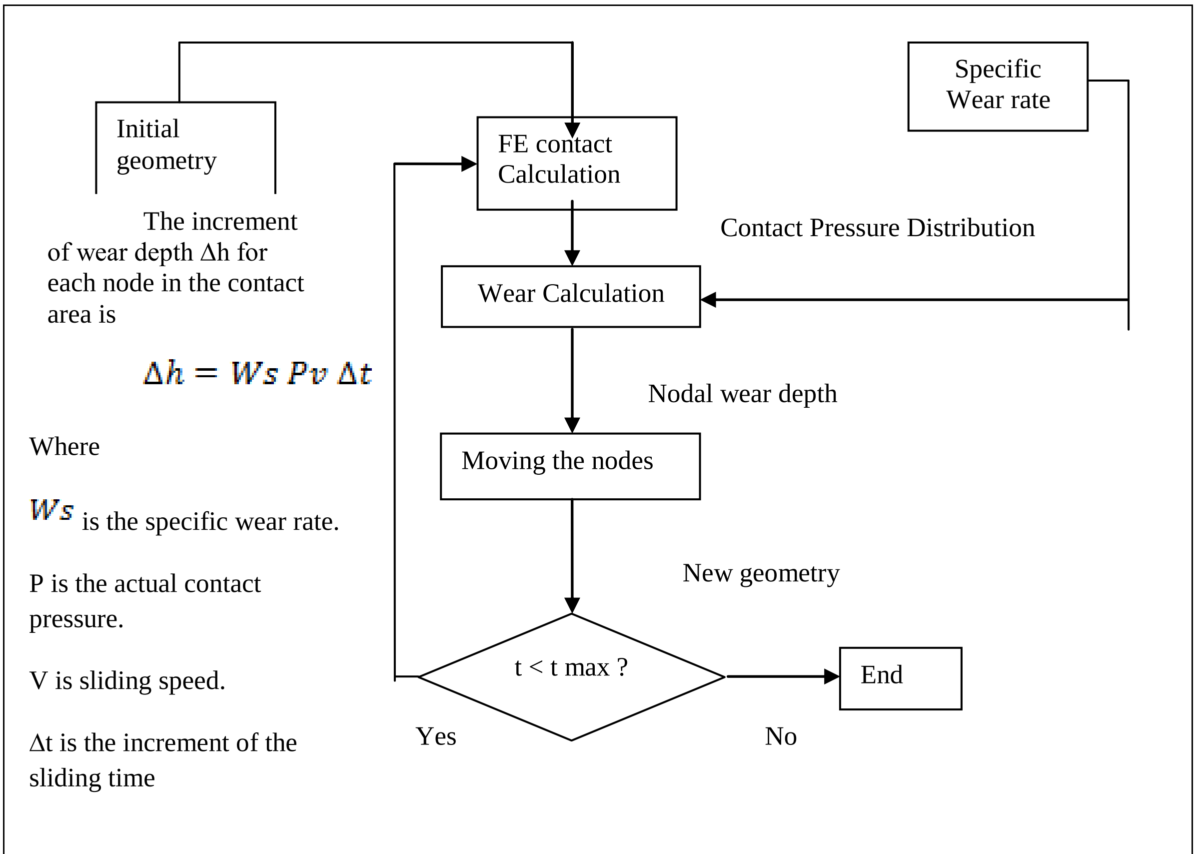

Fig. 10 Flowchart of simulation[16]

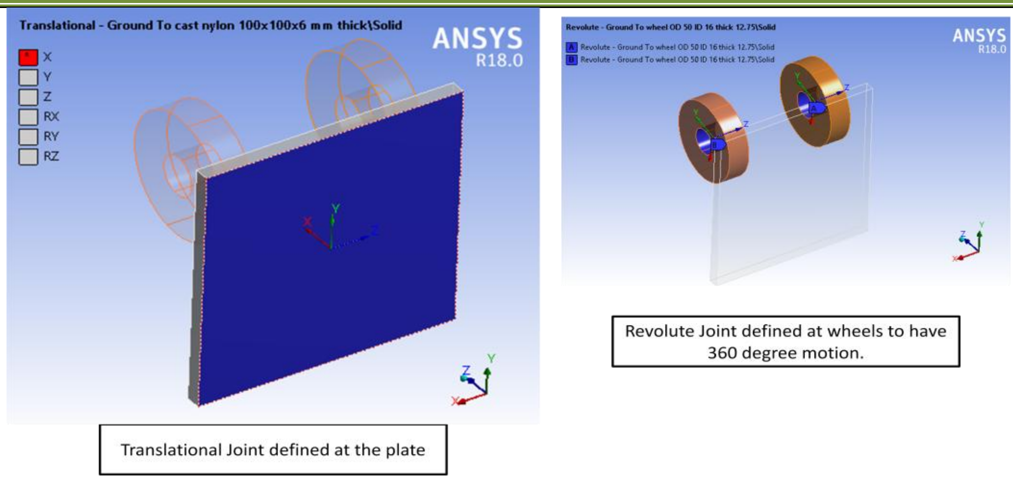

Fig. 11 FEA Boundary condition.

In fig 11 wear part is fix at bottom, roller are in contact with wear part, force applied on roller and roller revolution joint for 360 deg is define.

V. CONCLUSION

In experimental testing we have total Applied Load =23.28 Newton which give us the Weight loss by nylon =3.6 mm3. In FEA keep all parameters are same like with of wheel, nylon material mechaical property, coefficient of friction. Weight loss found in FEA =3 mm3. It means 16.66 % result variation found in between two methods. By using this parameters and applying actual load we can find the bush life in actual coupling. Cast Nylon impregnated with 6% of oil we be the best material for the rope coupling bush as compare to the all material we study.

Acknowledgements

I would like to express my special thanks to my Guide Prof. Gandidgude A.U. Department of Mechanical Engineering ZES D.C.O.E.R. Special thanks to The Automotive Research Association of India to do the table abrasion test.I would like to express my special thanks to my Guide Prof. Gandidgude A.U. Department of Mechanical Engineering ZES D.C.O.E.R. Special thanks to The Automotive Research Association of India to do the table abrasion test.

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