

Replacement of Grid Coupling with Bush Pin Coupling in Blower

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ABSTRACT: Couplings are used to connect the driving shaft to the driven shaft in rotating equipment. This direct connection will help for the transmission of power between the shafts. Grid couplings are type of coupling which is connected by means of metallic grid. This metallic grid takes up the load and will breaks down on overload conditions and misalignment conditions. Grid coupling will take up a misalignment of 3 mm, to reduce the failure rate of equipment due to the failure of grid coupling, bush pin coupling is introduced. It can take up a misalignment of 5 mm and will help in damping the vibration. All dimensions of bush pin coupling is calculated and analysed the same with ANSYS workbench 15

KEYWORDS: Coupling, Bush pin Coupling, Design and analysis

I. INTRODUCTION

A coupling is device used connect driving shaft to the driven shaft to transmit power. Coupling connects the shafts during operation. Coupling joints shaft with torque by allowing some misalignment. Or end movement or both.. Coupling used is grid coupling. Connecting two grooved discs or hub, one on the driving shaft and other on the driven side of the shaft. The teeth are cut axially around the hubs and is specially designed to suit a particular characteristics. The grooved hubs are connected together by means of flexible grid springs. The stiffness of spring is varies according to the unsupported length of each flexible span, and since this changes according to the changes in torque and vibration cycle

The work in this paper is divided in to two stages. 1) Study of failure in grid coupling 2) Design and analysis of Bush pin coupling.

II. RELATED WORK

Blowers are working 24x 7. It may have failure at any time. The main reasons for failure is failure of bearings and grid coupling. The studies have been done before for the analysis of failure in bearings and couplings. The frequent failure occurs in grid couplings. The grid coupling fails due to misalignment and over loading conditions. Vibration analysis are done to find out the points and cause of failures. As per the previous analysis done, it is found that misalignment is the root cause for coupling failure

The grid coupling can only withstand a misalignment of 3 mm. and we have to design a coupling which can withstand more misalignment than grid coupling bush pin coupling is the best option.

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III. STUDY ABOUT GRID COUPLING

The basic metallic coupling consist of two hubs are connected by a “serpent”- style metallic grid usually composed of all metal, they have some degree of resilience. They have two hubs with teeth. The teeth are connected by a steel grid. A cover keeps the lubrication. Grid coupling do not transmit as much power (for per the same outside diameter).. The hub is connected to the shafts and these hubs are connected together with help of metallic grid. The load affects the grid. When misalignment and overload occurs, grid fails. The load is affected on the grid and will deforms according to the intensity of load. Figure 1 (a) shows the final assembly of the grid coupling and (b) shows the parts of the grid coupling

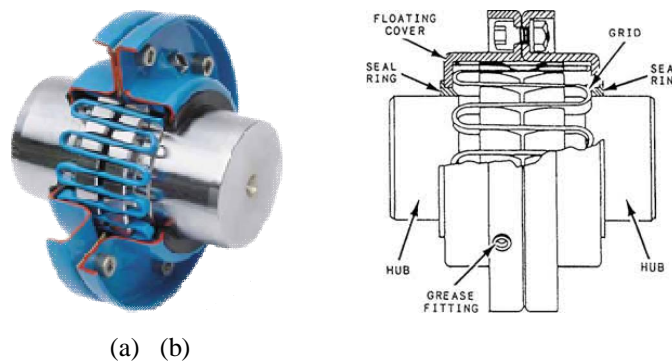


Fig.1 grid coupling (a) final assembly (b) Parts of grid coupling

IV. FAILURES IN GRID COUPLINGS

Grid fails due to several reasons, the grid fails on misalignment, overload and higher torques. When shock load occurs, it will experience torque and cannot withstand the higher torque, and fails. The location of the grid fracture on grid rung along with permanent operating data such as number of load cycles before failure can often be a guide to the probable failure load cycles could be the frequency of a vibratory load. The number of start-ups or speed changes, or when misalignment in a load favour it could be in the number of shaft revolutions. The grid failure occurs on the 130% of load capacity of the grid. Grid fatigues are result of overloads due to torque of misalignment, or a combination of the two. Starting high inertia mass, impact and vibratory loads will cause torque overloads in a system. Grid failures can be prevented by removing either overload condition from the system or selecting a coupling size which has the capacity to handle loads. Grid coupling hub teeth are having twice the fatigue strength of the grid. Hub tooth fatigue failures are rare with grid couplings because of this doubled value of fatigue strength. Occasionally a grid coupling hub shank failure is encountered. Hub shank failures generally consist of cracks initiates from the screw holes and propagates through the hub shank. Another form of hub failure consist of wear and fretting corrosion in bore.Wear will occur on the surface that are subjected to a sliding actiondue to inadequate lubrication. Figure 2 shows the failures of grid coupling.

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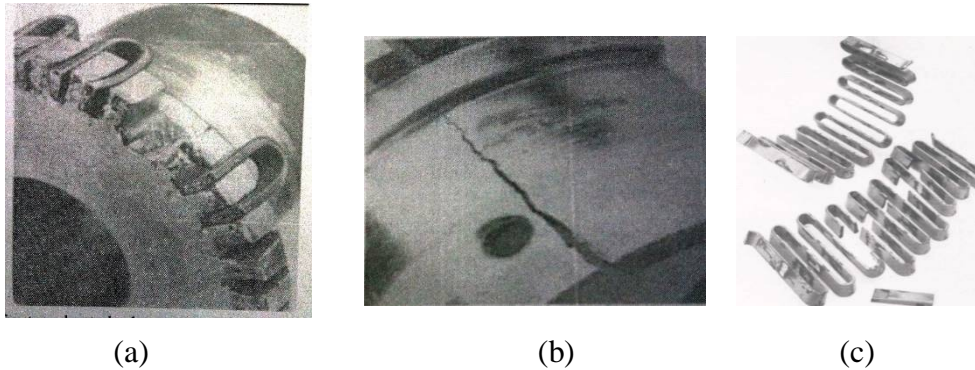


Fig. 2 Failures in grid coupling (a) Hub tooth failure (b) Hub shank failure (c) Grid failure

V. RESULT AND SIMULATION

Blower is equipped with a grid coupling, it can only withstand a misalignment of only 3 mm. as the looseness of the foundation bolt is getting higher, and the misalignment also increases. This misalignment will affect the coupling and results in grid failure. The new coupling introduced to the system should have the capacity to withstand higher misalignment than grid couplings. Bush pin flexible coupling is desired for the replacement of grid coupling. Bush pin couplings are highly suitable for transmitting torque from one shaft to another. It is a cushion type coupling. The coupling absorb shock loads minimises tensional vibrations and accommodate slight angular and parallel misalignment.

TABLE 11.3 Comparison of couplings

Property	Grid coupling	Bush pin coupling
Misalignment	Controlled with a grid	Controlled with a pin and bush
Lubrication	Vital for proper function	No lubrication
Misalignment tolerance	Up to 3 mm	Up to 5 mm
Vibration damping	Not dampens	Dampens the vibration

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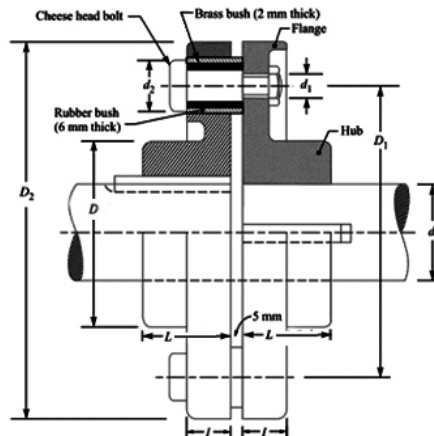


Fig.3 Bush pin coupling (a) Dimensions

Design calculation of coupling

The bush pin coupling for the blower is designed and the calculations are follows

$$\text{Power in shaft of blower} = \frac{2\pi NT}{60}$$

$$193.2 \times 10^3 = \frac{2\pi \times 2980 \times T}{60}$$

$$\text{Torque (T)} = 619 \times 10^3 \text{ Nmm}$$

Assuming 20 % overload

$$T = 619 \times 10^3 \times 1.2$$

$$T = 743.29 \times 10^3 \text{ Nmm}$$

Material used is mild steel (A 36), and Factor of safety 2.5

$$\text{Yield strength} = 237.33 \text{ N/mm}^2$$

$$\sigma_{design} = (237.5/2.5)$$

$$= 94.92 \text{ N/mm}^2$$

$$\tau_{design} = \sigma_{design}/2$$

$$= 94.92/2$$

$$= 47.46$$

$$\sigma_{crushing} = 1.2 \times \sigma_{design}$$

$$= 1.2 \times 94.92$$

$$= 113.90$$

$$\text{Bearing stress } (\sigma_b) = \frac{1}{4} \sigma_{design}$$

$$= 23.37 \text{ N/mm}^2$$

Keyway is provided in the shaft, so τ is considered to be decreased by 25%

So

$$\tau_{design} = 0.75 \times \tau_{max}$$

$$= 0.75 \times 47.46$$

$$= 35.959 \text{ N/mm}^2$$

$$\frac{T}{J} = \frac{\tau}{R}$$

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$$\frac{743.29}{\frac{\pi}{32} D^4} = \frac{35.52}{\frac{D}{2}}$$

$$d = 59.6 \text{ mm}$$

Design of pins

Standardise it to the value 80 mm

Number of pins to be added $= \frac{3}{80} \times D + 2$
 $= 5$

Taking 8 pins for more safety and standardising it

Preliminary diameter of pin $d_1 = \left(\frac{0.423D}{\sqrt{i}} \right) + 7.5$
 $= \left(\frac{0.423 \times 80}{\sqrt{8}} \right) + 7.5$
 $= 19.46 = 20 \text{ mm}$

The diameter of pin circle

$$D_1 = D + 3.2d_2$$

$$= 164 + 3.2 \times 20$$

$$= 228 \text{ mm} = \text{pitch circle diameter}$$

Design of flange and hub

Material used is stainless steel (304 H)

Yield strength $= 205 \text{ Mpa}$
 $\sigma_{design} = 205/3$
 $= 68.33 \text{ N/mm}^2$

$\tau_{design} = 68.33/2$
 $= 34.16 \text{ N/mm}^2$

$\sigma_{crushing} = 1.2 \times \sigma_{design}$
 $= 1.2 \times 68.33$
 $= 81.99 \text{ N/mm}^2$

$\sigma_b = \frac{1}{4} \sigma_{design}$
 $= 17.08 \text{ N/mm}^2$

Length of hub (L) $= 1.2 \times D + 20$
 $= 1.2 \times 80 + 20$
 $= 116 \text{ mm}$

Hub diameter (D) $= 1.8 \times D + 20$
 $= 1.8 \times 80 + 20$
 $= 164 \text{ mm}$

Flange design

Thickness (l) $= .35 \times D + 9$
 $= 0.35 \times 80 + 9$
 $= 37 \text{ mm}$

Outside diameter of flange (D_2) $= D_1 + 6d$
 $= 164 + 6 \times 20$
 $= 284 \text{ mm}$

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To withstand vibration and provide damping neoprene rubber bushes are used
Thickness of rubber bush is 6 mm

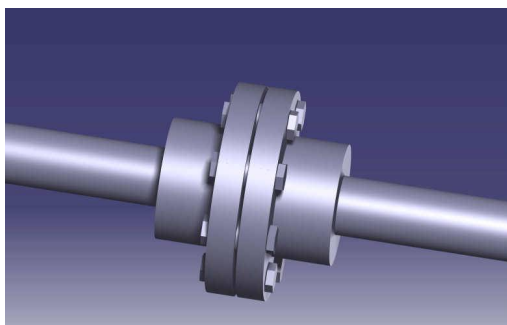
Usually enlarged diameter = 1.4 d

Final diameter d_2 = $1.4 \times 20 + 20 + 12 + 4$
= 64 mm

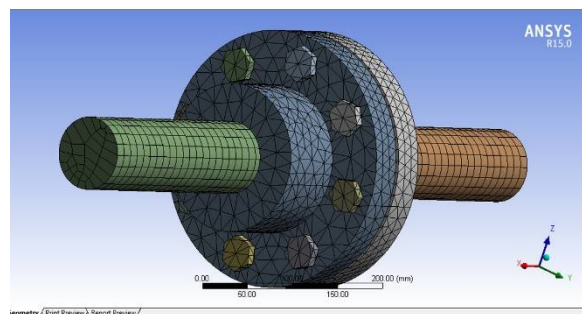
TABLE 11.4 Specification for the proposed coupling

Diameter of shaft (d)	80 mm
Outer diameter of hub (D)	164 mm
Length of hub (L)	116 mm
Pitch circle diameter of pins(D_1)	228mm
Outer diameter of flange(D_4)	284 mm
Thickness of flange(l)	37 mm
Pin diameter (d_1)	20 mm
Numbers of pin used	8 pins
Final diameter with neoprene rubber bush (d_2)	64 mm

The coupling is designed and analysed using soft wares. For design purpose CATIA V5 is used. Analysis is done by ANSYS work bench 15. The design is done as assembly drawing format. Parts are drawn in the part design section and assembled to get the final assembly design of the coupling. The analysis done is rigid dynamics, to find out what is the maximum stress occurs in the coupling, where the stress is acting and whether the coupling can withstand more misalignment than grid coupling. Analysis is done with 2980 rpm and 2800 N axial load. The model is analysed with help of Ansys workbench 15. Fine meshing is done for the analysis since it have curved surfaces. Analysis is done for 3 mm parallel misalignment. The analysis shows the coupling can withstand a stress of 648 Mpa. And the higher stress are acting on the pins of the coupling. Analysis shows that the higher stress acting is 648 MPa and grid coupling can withstand only up to 320 MPa for the same misalignment condition. So the coupling can withstand more misalignment the analysis is repeated for three times to get the consistent result.



(a)



(b)

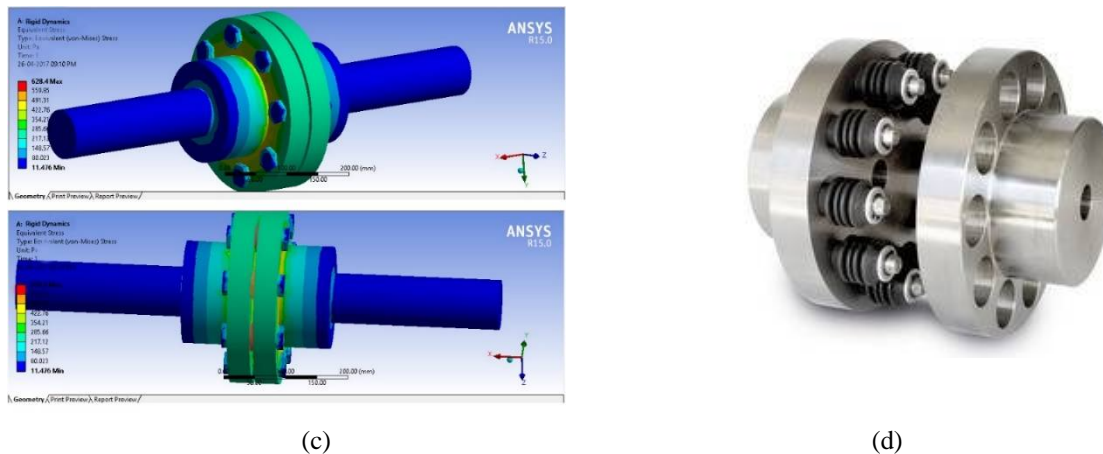


Fig. 2 Bush pin coupling (a) CATIA modelled design (b) Meshed model (c) Stress Distribution (d) Bush pin coupling

VI. CONCLUSION

The grid coupling is having higher rate of failure and it can only withstand a small misalignment. But Bush pin couplings can withstand misalignment of 5 mm. and this coupling is designed and analysed with help of ANSYS. By the analysis we found that bush pin coupling can withstand a misalignment of about 5 mm. it can withstand a stress of 648 Mpa

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