FAILURE ANALYSIS AND COMPARISON OF FLANGE COUPLINGS USED IN INDUSTRY

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Abstract: **A coupling is a device which is responsible for the effective power transmission between two shafts rotating at a certain rpm. Couplings are connected at the ends of the shafts and these may slip or get disconnected depending upon the torque limits. In fact, these are critical parts of any transmission system, providing the smooth transmission of power and they can last long if maintained properly. This paper deals with the possible causes of failure for a flange coupling which occur mostly at the areas of contact, analysis of such failures and suggestions to minimize the failures occurred thereof. In this regard, a model of the flange coupling would be prepared and with the help of an analysis workbench, proper material would be assigned to that particular flange coupling and points of failure would be noted accordingly. Secondly, a different material in fact, a better one which would withstand more amount of stress would be assigned and failure results would be noted again. Finally, from the results obtained comparison would be made between the two results and suggestions would also be prescribed**

Keywords: Modeling, Analysis, Suggestions, Failure;

I. Introduction

Shaft couplings play a key role in any power transmission system. Couplings can be used for several purposes which include connection of two shafts or they can used as the alternative whenever the connection between to shafts are subjected to any sort of repair. Along with it, couplings also find application in providing the alignment for misaligned shafts and to impart the mechanical flexibility. One of the major uses of couplings is it provides resistance to the material when it is subjected to over loads. To perform all these actions effectively, a coupling must have high torsional rigidity. It must be noted that the coupling which we design must not have any sharp edges or corners.

Powar et al. described about flexible coupling in for power transmission in light load condition [1]. Song Described the failure analysis of propulsion shafting coupling bolts [2]. Jaiswal and Pasarkar analyzed about causes of failures of flange couplings in the industry[3].

II. *Parameters Involved in Choosing the Right Coupling*

The common and primary requisite for all the coupling applications is that a good quality shaft coupling must be chosen. Coupling two shafts together might sound very simple but in real, it is very much different and difficult. Most of the shafts in the market are subjected to a greater or lesser amount of misalignment but they are being used for accurate transmission of power.Maintaining the Integrity of the Specifications

The type of coupling that is best suited for an application depends upon shaft diameter, power transmitted, misalignment present in the shaft and also taking the operating conditions into consideration. Therefore, unless the designer is aware of the working conditions of the coupling, it becomes highly difficult for him to produce a proper design. The following specifications govern the selection of a coupling:

A. Horsepower

Most of the couplings are selected based upon the horsepower they transmit. Hence, it is very important to design the dimensions of the coupling accordingly.

B. Type of drive

If the power source, we will have a higher service factor. If the engine is less than four cylinders you may have to consult the factory for design assistance. The problem here is torsional vibration in a continuous steady form that can be transmitted directly into the driven machine. The elastomeric design coupling can help to dampen this vibration.

C. Type of driven equipment

Driven machines are many in number depending upon the load characteristics and service factor is also selected relatively. Multiplication of service factor by the input horsepower gives you the design horsepower upon which most couplings are designed.

D. Operating conditions

Selection of couplings is made largely depending upon the operating speed (RPM). As speed increases, Torque also increases respectively. It is always essential to ensure that operating speed doesn't exceed maximum Speed of the coupling selected. Along with the speed, temperature at which the coupling operates also plays a key Role. If the temperature is high, it can change the operating characteristics of the some couplings (elastomeric). In Some cases, it also affects the lubrication.

E. Space limitations & shaft sizes

We need to ensure that the coupling's length & diameter will fit within the necessary confines. Also, bore size
Is one of the limiting factors in selecting the coupling since often, larger coupling than what design indicates are selected to match with the bore size.

III. CAUSES OF FAILURE

This can be one of the primary causes of failure in couplings. In several cases, coupling fails due to the incorrect size and type which cannot be fit within the environment constraints. Hence, it is advisable to follow the Proper selection criteria because often replacement might prove to be expensive. In case of oversized couplings, radial loads might be increased if there is any misalignment. Therefore, care must be taken while using them.

A. Improper manufacturing

Along with the selection of coupling, one must also pay attention towards the manufacturing methods of couplings. Bore and keyways with appropriate tolerances as per industrial requirements also need to be maintained.

B. Incorrect installation

This can also be considered to be a cause of failure in couplings. Often, this can be attributed to the usage of low quality keys, bolts or improper tightening of bolts. For every coupling, there exists a specification by name "Initial Alignment Limit" given by the manufacturer. Installation errors may lead to vibration and additional loads which in turn could pose serious disorders like permanent failure, wear and tear.

C. Irregular & improper maintenance

Maintenance is not as simple as we think of. It includes a regular scheduled inspection of each coupling, identification of defects and replacing them with the better ones. Apart from these, checking alignment of the couplings is important to avoid any further disorders. There are several methods and tools available into check the alignment but eyeball alignment is used mostly.

D. Other causes of failure

Along with the above mentioned factors, there are other reasons of failure and they are:

- Human errors
- Corrosion
- Wear
- Fatigue
- Hardware failure
- Shaft failure

IV. RESULTS ANALYSIS

Power Transmission by Coupling 25 KW at 1000 Rpm

The allowable shear stresses are:

For Shaft 70 Mpa
For Key 60 Mpa

For Bolt 15Mpa

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The Shaft Diameter Based On The Strength May Be Given By

$$d = \sqrt[3]{\frac{16T}{\pi \tau_y}}$$

Where T is the Torque transmitted and Ty is the allowable Yield stress in shear.

Here T=143 N

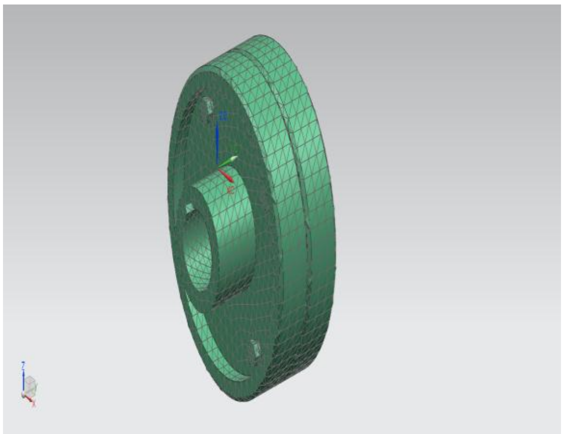

Figure1:Meshed Flange

A. Modeling & Analysis

Flange coupling of suitable dimensions has been collected and it was modeled using NX CAD, a premier CAD software being promoted by Siemens. After it has been modeled, meshing operation has been performed and as per the above mentioned stress conditions and proper constraints; failure analysis was performed to know the values of Von Mises stresses and also respective displacements.

Two different materials have been applied to the same flange and the corresponding images of analysis results have been mentioned below. Figure 1 shows the meshed model of the flange coupling.

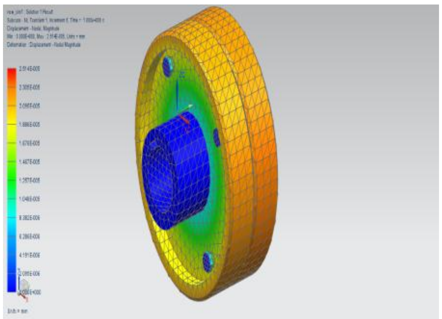

Figure2:Model of Iron

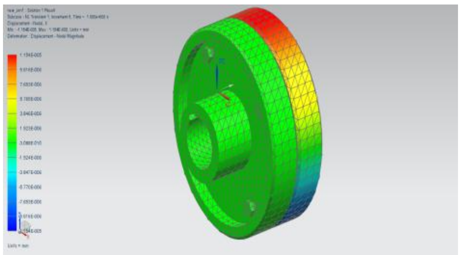

Figure3: Model of Iron

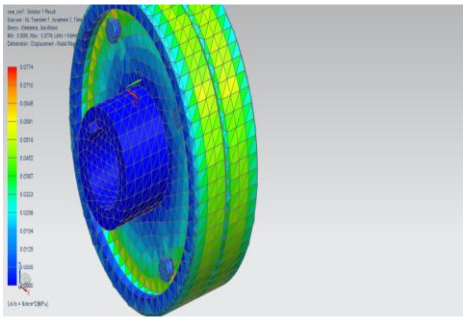

Figure4: Model of Steel

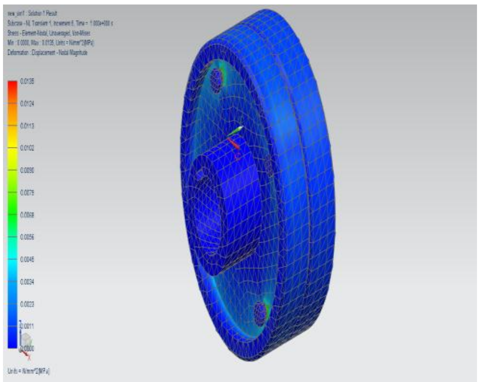

Figure5: Model of Steel

B. Properties of Two Different Materials

Table1 descibes the properties of two materials Iron and Steel.

Table 1: Properties of materials

For Iron		For Steel	
Young's Modulus	2.5e + 015 Pa	Young's Modulus	1.9e + 015 Pa
Density	7950 kg/m^3	Density	7700 kg/m^3

C. *Results Comparison*

Table 2 describes the comparisons between displacement and von misses stress at min and max conditions of materials Iron and steel.

Table 2: Displacement and stress analysis of materials

For Iron		For Steel	
Displacement (Max)	1.154e-005 mm	Displacement (Max)	2.514e-005 mm
Displacement (Min)	0.0000 mm	Displacement (Min)	0.0000 mm
Von Mises Stress (Max)	0.0135 N/ mm^2	Von Mises Stress (Max)	0.0774 N/ mm^2
Von Mises Stress (Min)	0.0000 N/ mm^2	Von Mises Stress (Min)	0.0000 N/ mm^2

V. CONCLUSIONS

From the results it has been observed that there is significant improvement in the stress and displacements values. The maximum stress that the flange can withstand has been increased enormously to 0.0774N/ mm^2 from a previous value of 0.0135 N/ mm^2 and same effect is observed in the case of displacement also. Hence, it is advisable to replace the first material with second material for better life of flange.

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