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Design and Analysis of Barrel Coupling

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ABSTRACT : *The A Barrel coupling system is the method of choice in transferring torque between rotating parts. The torque load is acting axially along the centreline of the shaft. The challenge in coupling design lies in Finite element structural analysis which leads to better results than current classical practices, because it permits a more accurate representation of the true structure. In this paper factors affecting on barrel coupling size like the Nominal transmission torque and Radial load are discussed. The methodology employed in this work will subsequently used to carry structural rigidity under load conditions. The emphasis in the work will be placed mostly to use a finite element method. Barrel Coupling was modeled in Catia V5 CAD software and analysis of this was done by using ANSYS work bench. The analysis of barrel coupling has been done by fixing different components of assembly, with application of radial force and transmission torque. We have found out stresses and deflection occurred in the barrel coupling.*

Keywords - *Barrel coupling, Radial load, Stresses & deflection, Transmission torque*

I. INTRODUCTION

A Barrel coupling is a device used for transferring torque between rotating parts. Barrel couplings are recommended for installation in crane lifting mechanisms, to connect the cable drum with the gearbox output shaft as well as in winch conveyors and platform hoists. When the gearbox output shaft is rigidly connected to the drum in a lifting mechanism, supported between points this originates a statically indeterminate case. This type of mounting requires special care in alignment and leveling, which is difficult to achieve in practice. Mounting inaccuracies, as well as deformation in structures and wear in moving parts, lead to enormous additional forces, above all in the gearbox output shaft which as a result of alternative bending loads can lead to breakage due to fatigue and faults in bearings and gear wheels. In the recommended mounting the barrel coupling, which is installed between the gearbox and cable drum, performs the function of an articulated joint, thus making the connection statically determinate and avoiding the occurrence of high bending moments. Considering the fact that this coupling allows axial displacement, a self-adjusting bearing must be mounted, fixed laterally, at the opposite end of the drum shaft in order to withstand the axial forces that may be generated.

1.1 Mounting with barrel coupling

Torque is transmitted to the drum's receiving flange, generally by two diametrically opposed flat driving surfaces, located at the periphery of the coupling flange, and also by means of a series of bolts which, at the same time, serve as connection with the drum. Other connection systems, such as adjusted spring pins or similar, can also be used following the adequate preparation of the flanges.

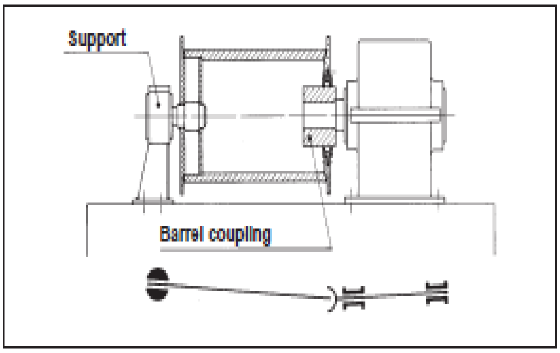

Fig. 1 mounting with barrel coupling

1.2. Components

The barrel coupling consists of a sleeve provided with semicircular toothing around its internal diameter and a hub that is externally toothed in a similar way. A series of cylindrical barrels, of hardened steel, are inserted in the holes formed by this toothing to act as power transmission elements. Covers with their corresponding special seals serve to assure the perfect tightness of the inner zone, preventing the penetration of dust and guaranteeing the continuity of the necessary lubrication. Two double-lamina elastic rings mounted on the hub, one on each side of the toothing, limit the axial displacement of the barrels.

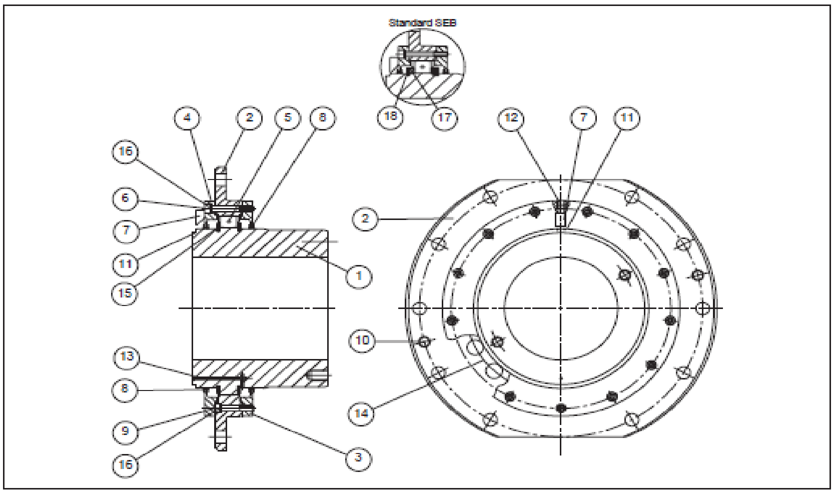

Fig.2 Components of barrel coupling

1. Hub	10. Threaded holes for disassembly
2. Sleeve	11. Wear limit grooves
3. Inner cover	12. Grease connection
4. Outer cover	13. Grease overflow
5. Barrel	14. Assembly reference
6. Allen screw	15. Barrel guide rings
7. Wear indicator	16. Grower washer
8. Special seal	17. SEB barrel guide ring
9. Allen screw	18. Seeger ring

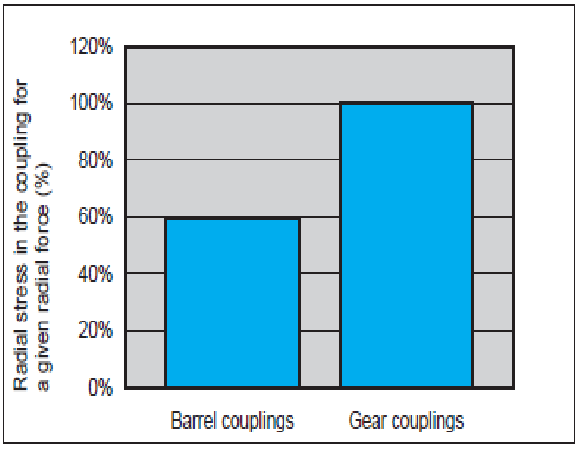

Fig. 3 Bending stress comparison of Barrel coupling and gear coupling

1.3. Comparison between hoist gear and Barrel couplings

Due to the barrel and gear profile, barrel couplings are subjected to lower bending stress on the root of the teeth. Therefore, increased safety factor is obtained against bending and peak radial loads. As barrel couplings have increased contact area, the radial load is better distributed and hence the life of the coupling is increased. See graph below comparing stresses due to the radial load. This radial load is even better distributed with coupling wear.

II. CALCULATION OF TRANSMISSION TORQUE & RADIAL FORCE

2.1. Calculation of nominal transmission torque T (Nm)

(a)Based on installed power

$$T=9550.P_i/N.K_1 \quad (1)$$

$$T = 9550*30*1.6/8 = 57300 \text{ Nm}$$

(b) Based on consumed power

$$P_c=F_pV_r/60000 \quad (2)$$

$$T=P_c . K_1 .9550/N$$

$$T= K_1 F_p D/2$$

$$F_p =(Q+G)/i_r$$

$$F_p = (300000+10000)/4*.95 = 81600N$$

(c) The consumed power

$$P_c=F_pV_r/60000 \quad (3)$$

$$P_c =81600.20/60000 = 27.2 \text{ kw}$$

(d) Thus, the transmission torque T is

$$T=9550.Pc/N.K_1 \quad (4)$$

$$T =27.2*9550*1.6/8 = 51950Nm$$

For preselected size

$$T_N =70000 \text{ Nm}$$

Higher than the torque calculated by means of installed power: 57300 Nm
Higher than the torque calculated by means of consumed power: 51950 Nm.

2.2. Calculation of radial force

$$F= [F_P (1- b/l)] + w/2 \quad (5)$$

$$F=[81600(1-400/1.2)]+14000/2$$

$$F=61400 \text{ N}$$

For preselected size, $F_r = 115000$ N

2.3. Option of corrected radial load F_A

Let us suppose that the radial load Fr turns out to be 130000 N. In this case, in a preliminary selection, this load is greater than that featured. It is possible to make a second check by means of the corrected radial load F_A, prior to selecting a larger coupling size.

$$F_A = F_r + [(T_N - T) . C] \quad (6)$$

$$F_A = 115000 + [(70000 - 51950) * 3.7] = 181785 \text{ N}$$

The coupling could withstand a radial load F_A of up to 181785 N, for the transmission data considered.

As 181785 N > 130000 N,

The selection of would be correct.

III. ANALYSIS OF COUPLING

3.1. Material Selection

Ranking and selection of the optimal material is an important stage in the engineering design process. However, most of the methods proposed for ranking in materials selection have tended to focus on cost and benefit criteria, with target values receiving much less attention in spite of their importance in many practical decision-making problems such as selecting materials to best match the properties of human tissue in biomedical engineering applications. In response to this perceived gap, the development of anew normalization technique is considered in this paper that provides an extension of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method and objective weighting in materials selection. There are four example cases included to validate the accuracy of outcomes from the proposed model. It is believed that the proposed decision-making model is suitable for linking to material databases. Materials selection is a task normally carried out by design and materials engineers. Gutteridge and Water-described the aim of materials selection as the identification of materials, which after appropriate manufacturing operations, will have the dimensions, shape and properties necessary for the product or component to demonstrate its required function at the lowest cost. For the purpose of material selection, thousands of data would be needed to characterize all the grades of materials. Many selection systems are available to help design engineers to choose the most suitable materials. At the most basic level, design engineers could use tables of material properties in data books. So material Selected as follows:

3.2. Material EN19 (%)

C=.35 to .45, Mn =.5 to .8, Cr=.9 to 1.5, Mo=.2 to.4
Tensile Yield Strength =495MPa
Tensile Ultimate Strength =850MPa

3.3. Method of Meshing

The hex-dominant mesh generation problem has long been a difficult problem. The proposed method will conform to a prescribed quadrilateral surface mesh, is general purpose, and is able to mesh without the need to decompose or recognize special classes of geometry. The approach proposed for the generation of hexahedral elements begins with an initial tetrahedral mesh and systematically transforms the tetrahedral into a topology appropriate for the formation of well-shaped hexahedra. For two-dimensional quad meshes, utilizes an advancing front approach. Beginning at the boundary surface mesh, quadrilateral fronts are classified and processed, replacing tetrahedral with hexahedra. The proposed method is also able to maintain a valid mixed hexahedral-tetrahedral mesh throughout the entire procedure.
Element size =5 mm, Method used –Automatic method, Element used-Tetra-hadrons

3.4. Static Structural Analysis

1) Radial Force
Radial Force is uniformly distributed over the 30 barrels so force applied on single barrel is given by
Radial force = 115000/30 =3833.3 N
2) Boundary Condition [i.e. Fixed Support]
Boundary Conditions are determining by using working of Barrel coupling.

3.5. Equivalent Stress (Von-mises)

By applying above conditions of meshing, radial force and boundary conditions. Stresses comes after the analysis in software ANSYS software are ranges from Min. Stress=8445.1 Pa & Max. Stress=6.2649e+007 Pa. From Fig.5. &. Fig. 6 it is seen that the maximum stress occurs at same area of barrel where the radial load is applied.

IV. CONCLUSION

From the above calculations for barrel coupling following results are found,
Allowable Stress =495/6 = 82.5MPa., Max. Stress by using ANSYS Soft. =62.64MPa
Allowable Stress for Barrels is greater than that of Max. Stress comes from Ansys software.

So we can conclude that our Design is safe for given loading Condition.

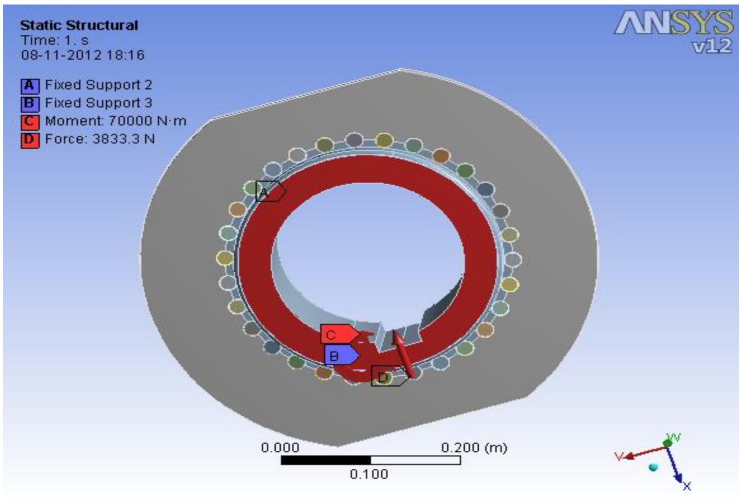

Fig. 4 Radial force Location

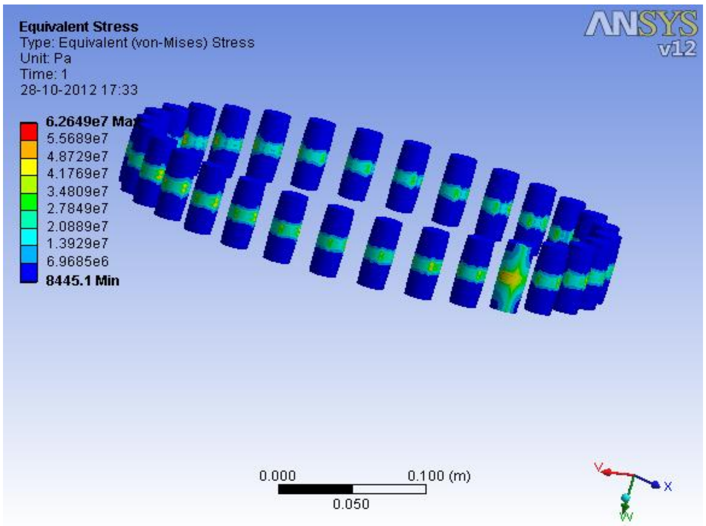

Fig. 5 Stress distribution in ANSYS

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