DESIGN AND ANALYSIS OF RIGID FLANGE COUPLING

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ABSTRACT:

A Coupling is a device which is responsible for the operative power transmission between two shafts rotating at particularRPM. Coupling is used to connect two different shafts at their end and can slip or fail depending upon the torque limit. It is the crucial part of any power transmission and may last for very long time if designed and maintained properly. The present study of this paper is to reduce the stress that acting on the bolts by making it uniform strengthens. The stress in the threaded part of the bolt will be higher than that in the shank. Hence a greater portion of the will be absorbed at the region of the threaded part which may fracture the threaded portion because of its small length. An axial hole is drilled at the center of the bolt through the head as far as thread portion such that the stress in the bolt is uniformly distributed along the length of the bolt. The present study of this paper is to reduce the maximum shear stress by selecting a suitable material for flange coupling. For this purpose, modeling of the rigid-flange coupling is carried out in Uni-graphics and analysed in ANSYS Workbench.

Keywords: *NX8.0, ANSYS Workbench, Rigid Flange Coupling, Finite Element*

1.0 INTRODUCTION:

Coupling is a device used to connect the shafts together for the purpose of transmitting power and torque. Generally, couplings are used for connection of shafts unit that are manufactured separately. Such as motor and generator; electric motor and centrifugal pump etc. Due to the inconvenience in transportation of shaft of greater length, it becomes necessary to join two or more shafts by means of coupling. The shafts that are connected by coupling should be easy enough to assemble and dismantle for the purpose of repair and alterations .The severe failure due to shearing of bolts head, key head, nuts and other projecting parts may cause accidents

Figure 1.1 flange coupling

Rigid and Flexible Coupling:

Rigid flange coupling consists of two separate grey cast iron flanges. One keyed to the driving shaft and the other to the driven shaft by means of nuts and bolts arranged on a circle concentric with the axes of the shafts. There are two types of rigid flange couplings; Protected and Unprotected rigid flange coupling. In a protected rigid flange coupling, a protective circumferential rim covers the nut and bolt head coupling maintenance is generally a simple matter, requiring a regularly scheduled inspection of each coupling. It consists of Performing visual inspections, checking for signs of wear or fatigue, and cleaning couplings regularly checking and changing lubricant regularly if the coupling is lubricated This maintenance is required annually for most couplings and more frequently for couplings in adverse environments or in demanding operating conditions

OBJECTIVE:

The objective of this paper is to reduce the shear-stress on the nuts and bolts section of a rigid-flange coupling by carrying out the stress-analysis using FEM. The 3-D NX MODEL model was designed in NX8.0 and the stress analysis was analysed in ANSYS15 workbench

2.0 LITERATURE REVIEW:

[1] PraveenaS,Lavakumar (2014) has conducted a survey in the area of dynamics of coupled rotations and coupled systems. Also, a survey of models and dynamics of coupled systems composed of a number of deformable bodies (plates, beams or belts) with different properties of materials and discrete layer properties is done. The constitutive stress–strain relations for materials of the coupled sandwich structure elements are described for different properties: elastic, viscoelastic and creeping

[2] Chandra SekharKatta,(2016)studied about the circularly coupled oscillator system that consist of many locally connected subsystems, especially oscillators, that produce linear state relations. The relations are defined between two connected subsystems, where their references are also assigned as a goal behavior simultaneously. A mathematical description of the subsystem interactions are clarified by extending a method based on the gradient dynamics. As an example of this formulation, the relative phase control of the circularly coupled oscillator system is considered, where the oscillation with the uniform phase lag should be achieved

[3] MaramVenkata Sunil Reddy (2016) wrote a note on phase synchronization in coupled chaotic fractional order systems. The control and reliable phase synchronization problem between two coupled chaotic fractional order systems is addressed in this paper. An active nonlinear feedback control scheme is constructed to achieve phase synchronization between two coupled chaotic fractional order systems. The necessary conditions for fractional order Lorenz, Lü and Rössler systems to exhibit chaotic attractor similar to their integer order counterpart.

[4] Salunkhe R.T., Mr. Patil (2013) The search for reasons of machine tool vibrations and instabilities appeared at the beginning of the 20th century. This is a result of vast improvement in metal removal process. In the last century machine tools witnessed a considerable evolution and became more powerful, precise, rigid and automatic. This growth was fuelled by general industry development, especially in the case of aerospace, moulding and automotive industries. But with all these improvements in the manufacturing sector, new limitations and challenges also appeared

DESIGN AND CALCULATION:

This paper the evaluation of the influence of two different types of flexible coupling over the vibrational behavior of the engine is executed. These couplings are mounted between the flywheel of the marine diesel engine and the propeller shaft. It is inadequate to carry out a meaningful comparison among couplings spectrum analysis, led in different operating conditions. On the other hand, the use of time-frequency analysis method is well suited. In particular, the application of the wavelet transform is considered in the present work. The high sensitivity of the wavelet transform technique to transient phenomena makes it suitable to provide monitoring features of the couplingsIn order to precisely localize in time-frequency domain these phenomena for monitoring purposes, the wavelet transform amplitude for a frequency range is taken into considerations. In addition the discrete wavelet transform is used in order to point out the impulsive phenomena in signals where the signal to noise ratio is low.Cconsidering a standard motor with Power = 37.5 kW and RPM = 180 Assuming design torque to be 1.5 times the rated torque

MATERIAL OF PROPERTIES:

The shafts are subjected to torsional shear stress. So, on the basis of strength, plain carbon steel of grade 40C8 (Syt = 380 N/mm2) is used as shaft material. The factor of safety for the shafts is assumed to be 2.5.

The keys and bolts are subjected to shear and compressive stresses. On the basis of stress condition, plain carbon steel of grade 30C8 (Syt = 400 N/mm2) is selected for the keys and the bolts. It is assumed that the compressive yield strength is 150% of the tensile yield strength. The factor of safety for the keys and the bolts is also taken as 2.5.

Permissible stresses:

(i) Shaft τ = Ssyfs = 0.5 380 2.5 = 76 N/mm2

(ii) Keys and bolts τ = Ssyfs = 0.5Syt fs = 0.5 400 2.5 = 80 N/mm2 σc = Sycfs = 1.5Syt fs = 1.5(400) (2.5) = 240 N/mm2

(iii) Flanges τ = Ssufs = 0.5Sut fs = 0.5 200 6 = 16.67 N/mm2

Design specification of coupling:

Part specification	Dimensions in mm.
Hub diameter (d_h)	120
Hub length (l_h)	90
Bolt circle diameter (D)	180
Flange thickness (t)	30
Web thickness	15
Diameter of spigot and recess (d_r)	90
Outside diameter of flange (D_o)	270

DIAMETER OF SHAFTS:

Taking into consideration the service factor of 1.5, the design torque is given by,

Td = 60 × 106 kW 2πn × 1.5

= 60 × 106 37.5 1.5 2π 180

= 2984155.18 N− mm

τ = 16Td πd 3 or 76 = 16 2984155.18 πd 3

∴ Diameter of shaft, d = 58.48 or 60 mm

DIMENSIONS OF FLANGES:

The torsional shear stress in the hub is given by

τ = Td ∗ r J = 2984155.18 ∗ 60 19085175.37

= 9.38 N/mm2

∴ τ < τ i. e 16.67 N/mm2 , where [τ] is allowable shear stress

The stresses in the flange are within limits. hubdaimeter, dh = 2d = 2 60 = 120 mm hub length, lh = 1.5d = 1.5 60 = 90 mm bolt circle diameter, D = 3d = 3 60 = 180 mm

Flange thickness = 0.5d = 0.5 60 = 30 mm

web thickness,t1 = 0.25d = 0.25 60 = 15 mm

Diameter of spigot and recess, dr = 1.5d = 1.5 60 = 90 mm

Outside diameter of flange, D0 = 4d +2t1 = 4 60 +2 15 = 270 mm

The above dimensions of the flange

The thickness of recess is assumed as 5 mm.

The hub is treated as a hollow shaft subjected to torsional moment.

J = π dh 4 − d 4 32 = π 1204 − 604 32 = 19085175.37 mm

4 r = dh 2 = 120 2 = 60 mm

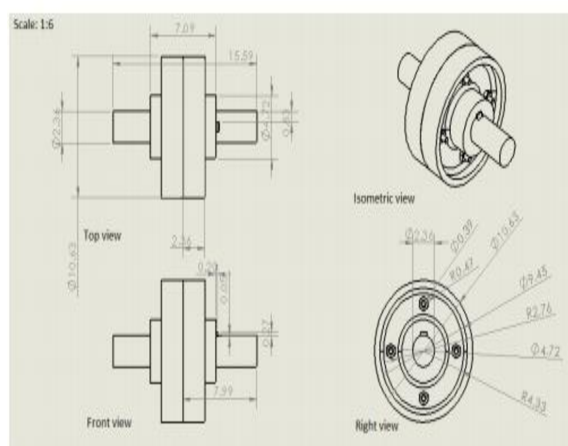


Figure: Sketch of Rigid flange Coupling

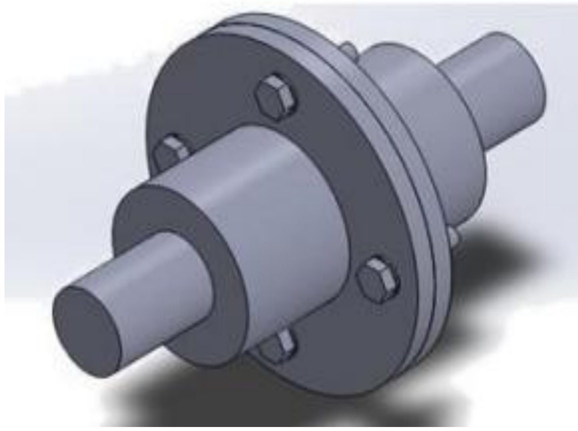


Figure: Model of rigid flange coupling

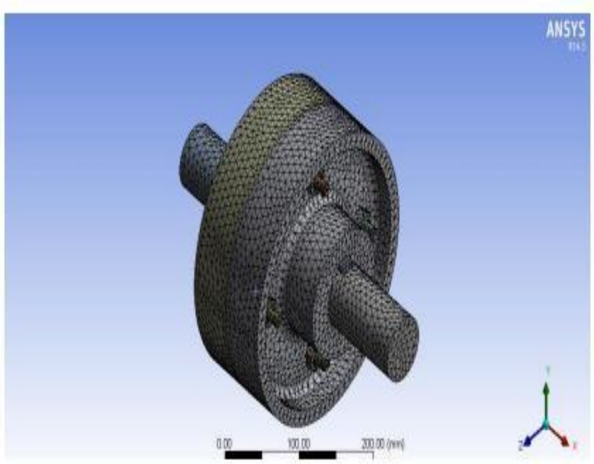


Figure: meshed view

4.0RESULTS:

There are several methods for analyzing. In this project we are using Ansys software for analyzing. Ansys is leading finite element analysis software developed by Ansys inc.it is widely used worldwide graphical user interface package. In a linear static we determine the stresses, displacements, strain. Static analysis deals with computation of displacement and stress due to static loads refers to loading but doesn't cause inertial or damping effects. The material used for coupling is grey cast iron, the Poisson's Ratio of material is 0.28 and the Young's Modulus is 1.1X1011N/mm

4.1 aluminium alloy-static structural:

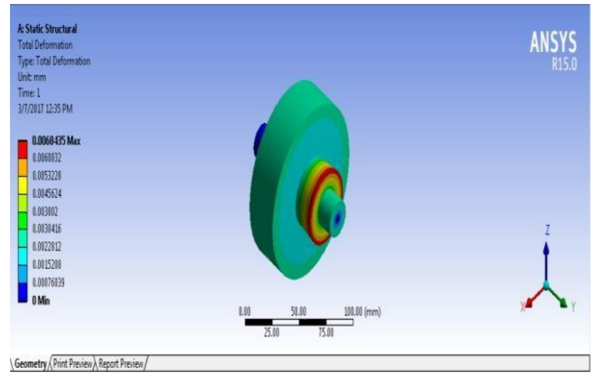


Figure: Total Deformation

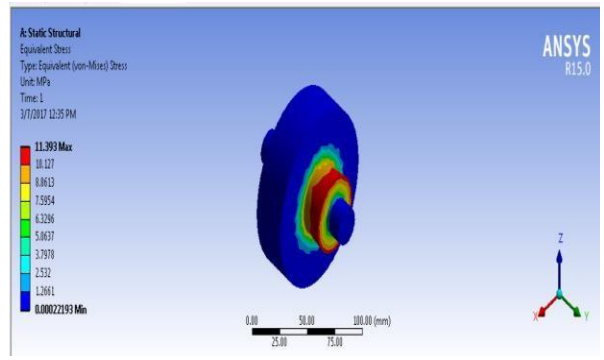


Figure: Equivalent stresses

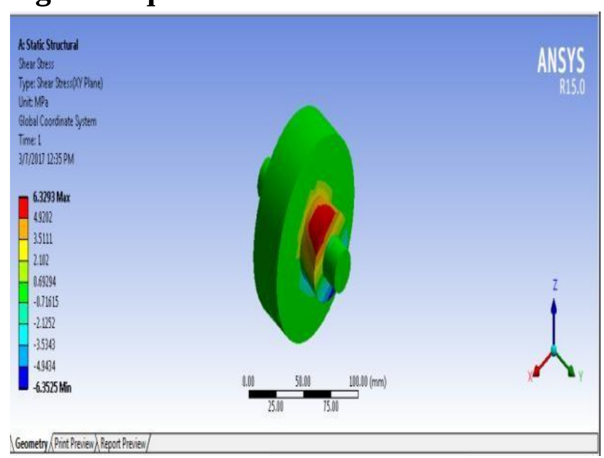


Figure: Shear stresses

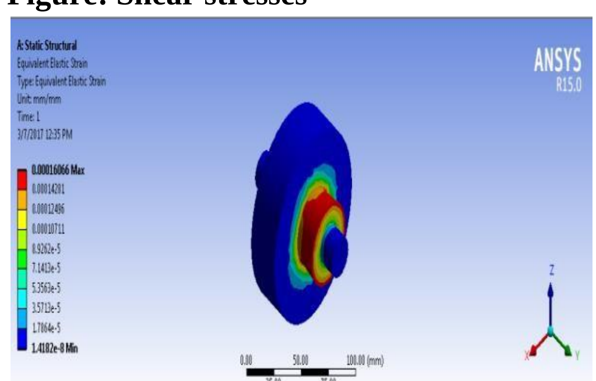


Figure: Equivalent elastic strain

STEEL STATIC STRUCTURAL FLANGE COUPLING

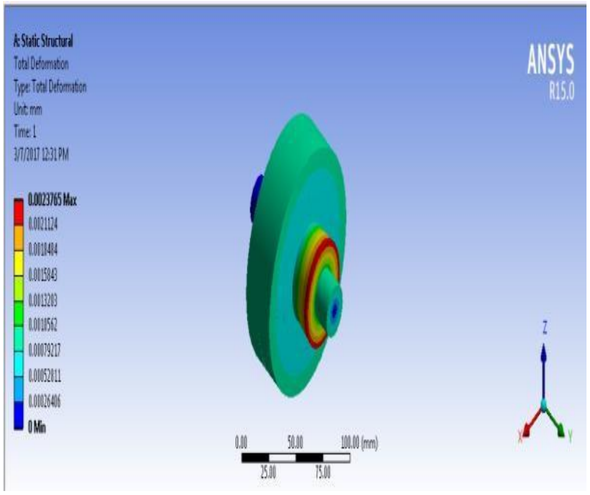


Figure: total deformation

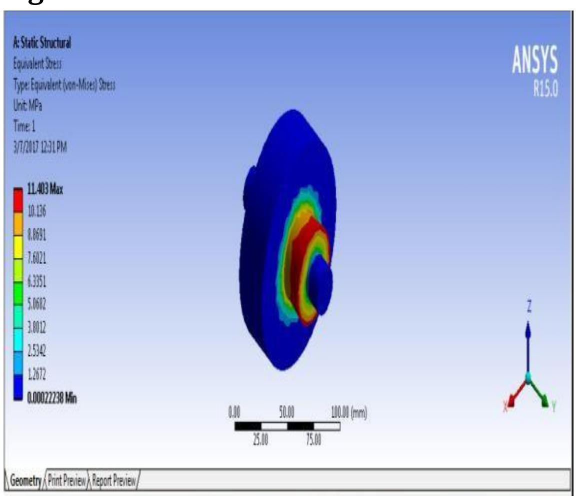


Figure: equivalent stresses

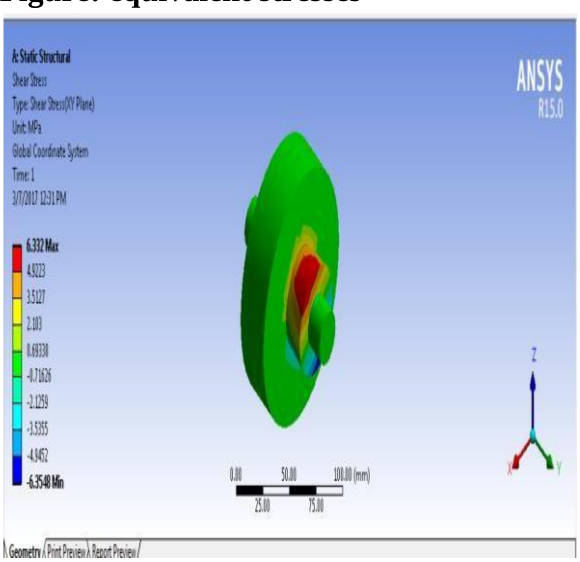


Figure: shear stresses

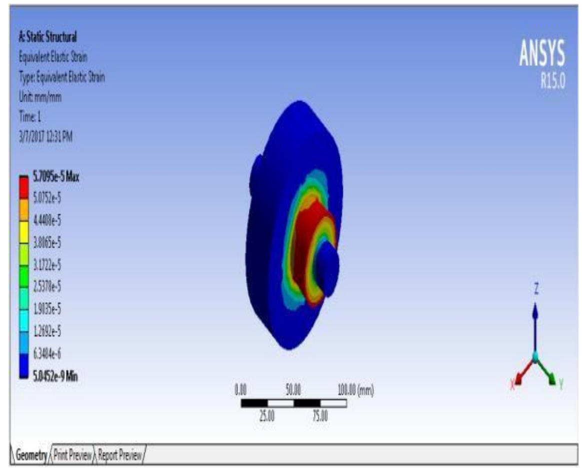
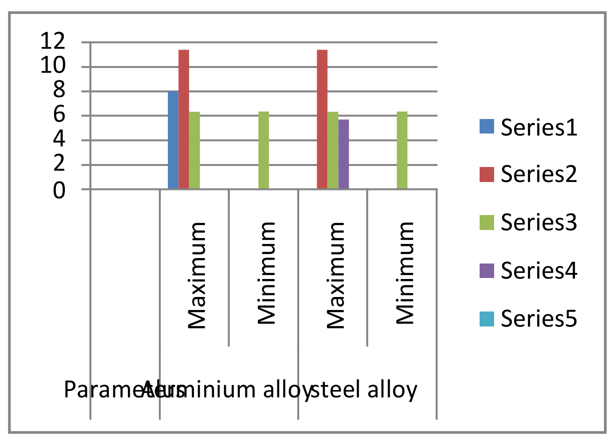


Figure: Equivalent Elastic Strain

Table: Comparison of steel alloy, Aluminium alloy different variations

Parameters	Aluminium alloy		steel alloy	
	Maximum	Min	Maximum	Min
Total deformation	8.0068435	0	0.0023765	0
Equivalent stresses	11.393	0.0002 2193	11.403	0.000222 38
shear stress	6.3293	6.3525	6.332	6.3548
Equivalent elastic strain	0.0001606 6	1.4182 E-8	5.7095	5.0452e-9



Graph: Comparison of steel alloy, Aluminium alloy different variations

CONCLUSION:

The result obtained from the analysis of the bolts and keys of a rigid-flange coupling using

ANSYS workbench is better than that of calculation using analytical method. It was found that the crushing stress for bolts and shear stress in bolts, keys obtained from the Ansys software is slightly less than the crushing and shear stress obtained in the theoretical calculation. Hence the results obtained from Ansys matches theoretical calculations so the design is safe. From this comparison we can conclude that the design of coupling done using nx8.0 is more suitable and safe.Compared with theoretical solution of the problemFrom the above table it is seen that various stress induced in different parts of the flange coupling are less than the theoretical value

- Flange coupling is designed and analyzed in step-wise manner
- Flange coupling is modeled in nx8.0
- The model designed in nx8.0 is imported to ansys workbench
- Such as aluminum silicon steel alloy are applied and stress, strain deformations of respective materials is noted
- From the structural analysis results stresses generated in aluminum silicon carbide is high compared to grey cast iron but obtained stress is within the critical stress
- So main advantage of using composite is it reduces the weight of the component and withstand maximum applied loads

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