ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

# Analysis of Rigid Flange Couplings

V.G.Vijaya

Department of Mechatronics Engineering, Bharath University, Chennai – 600073, India

**ABSTRACT:** This project deals with stress analysis of rigid flange couplings subjected to torsion using ansys. The theory related to the title will be studied from 'FUNDAMENTALS OF MACHINE DESIGN by T.J.PRABHU, page no-12.3Analytical solution will be obtained. To obtain computer solution ANSYS will be used. A comparison of results obtained from 2 & 3 will be presented.

## I.INTRODUCTION

A coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. Rigid flange coupling are designed for heavy loads or industrial equipment. When joining shafts within a machine, mechanics can choose between flexible and rigid couplings. The connecting methods for flange couplings are usually very strong because of either the pressure of the material or the sometimes hazardous nature of materials passed through many industrial piping systems.

## II.DESIGN AND CALCULATION

**Input Parameters**

Material: Mild Steel

Power transmit: 80 kw at 200 rpm

Allowable shear stress in shaft: 45 N/mm$^2$

Allowable shear stress for key material: 45 N/mm$^2$

Crushing stress for bolt and key: 160 N/mm$^2$

Shear stress for bolt material: 30 N/mm$^2$

Shear stress for cast iron: 8 N/mm$^2$

**Calculation**

**i)Design torque** $T_{d=Nominal\ torque\ \times service\ factor}$

Service factor is assumed to be 1.25

$$Nominal\ Torque = \frac{power\ in\ watts \times 60}{2\pi \times RPM}$$

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

$$=\frac{80\times1000\times60}{2\pi\times200} = 3819.7\ Nm$$

$$T_d = 3819.7 \times 1.25 = \mathbf{4774.65\ Nm}$$

**ii) Shaft diameter**

Induced shear stress $\tau = \frac{16T_d}{\pi d^3} \leq [\tau]$

$\frac{16\times4774.65\times10^3}{\pi d^3} \leq 45$ $\qquad\qquad$ $[\tau] = 45\ N/mm^2$

i.e. d=81.45mm≈85mm

**d=85mm**

**iii) Other dimensions of the coupling**

a) Hub diameter D=2d=2×85=**170mm**

b) Hub length l=1.5d=1.5×85=127.5mm≈**130mm**

c) Bolt circle diameter =3d=3×85=**255mm**

d) Key b=22mm,h=14mm from( Fundamentals of machine design by T.J.Prabhu Page No: 12.6 , Table 12.1)

e) Flange thickness $t_f = \frac{d}{2} = \frac{85}{2} = \mathbf{42.5mm}$

**iv) Design of hub as a hollow shaft**

$$\tau_{hub} = \frac{16T_d}{\pi(D^4 - d^4)}D = \frac{16 \times 4774.65 \times 10^3 \times 170^2}{\pi(170^4 - 85^4)}$$
$$= \frac{5.3N}{mm^2} < [\tau]_{CI} = \mathbf{8N/mm}$$

Satisfactory

**v) Design of bolts**

4 for shaft diameters from 40 to 100 mm

n = Number of bolts =4 for d = 85mm

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

$$f_t = \frac{t_d}{radius\ of\ the\ bolt\ circle} = \frac{t_d}{\frac{3d}{2}}$$

$$= \frac{4774.65 \times 10^3}{3 \times \frac{85}{2}} = 37{,}448.2N$$

$$Force\ /bolt = F_{tb} = \frac{F_1}{n} = \frac{37{,}448.2}{4} \approx \mathbf{9362N}$$

**Shear failure of bolts**

$$F_{tb} = \frac{\pi d_b^2}{4} \times [\tau]_{bolt}$$

$$9362 = \frac{\pi d_b^2}{4} \times 30, \ \ d_b = 19.93mm \approx 20mm$$

**M20 bolts can be used**

**Crushing failure of bolts**

Check the induced crushing stress.

$$\sigma_c = \frac{F_{tb}}{t_1 d_b} = \frac{9362}{42.5 \times 20}$$

$$= 11\ N/mm^2 < [\sigma_c] = \mathbf{160N/mm^2}$$

Satisfactory.

**vi) Failure of key**

**Shear failure**

Tangential force key= $F_{tk}$

$$= \frac{T_d}{\frac{d}{2}} = \frac{4774.65 \times 10^3}{85/2} = 112{,}344.7N$$

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

Induced shear stress, $\tau = \frac{F_{tk}}{b \times l} = \frac{112,344.7}{22 \times 130}$

$= 39.3 \ N/mm^2 < [\tau]_{key} = \mathbf{45}\, \boldsymbol{N/mm^2}$

Satisfactory.

**Crushing Failure**

Induced contact stress $\sigma_c = \frac{F_{tk}}{lh/2} = \frac{112,344.7}{130 \times 14/2}$

$= 123.5\, N/mm^2 < [\sigma_c] = \mathbf{160}\, \boldsymbol{N/mm^2}$

Satisfactory.

**vii) Failure of flange by shearing from hub**

Tangential force on hub =shearing area$\times \tau$

$$\frac{T_d}{D/2} = \pi D t_f \times \tau$$

$$\frac{4774.65 \times 10^3}{170/2} = \pi \times 170 \times 42.5 \times \tau$$

i.e.
$\tau = 2.47\, N/mm^2 < [\tau] =$
$\mathbf{8}\, \boldsymbol{N/mm^2}$

Satisfactory.

IJIRSET

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

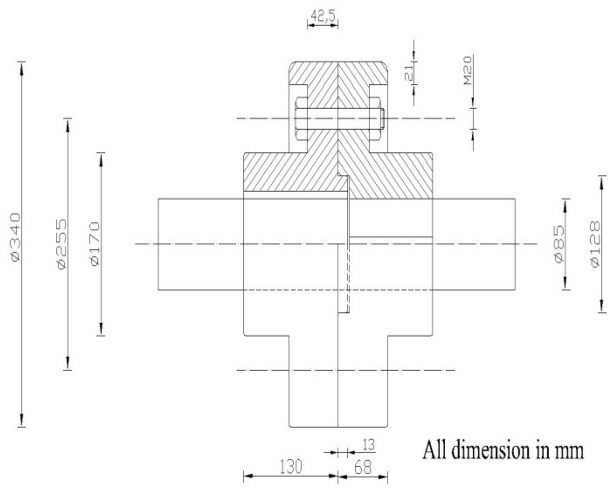



**Figure 1 Auto CAD sketch of coupling with calculated dimensions**

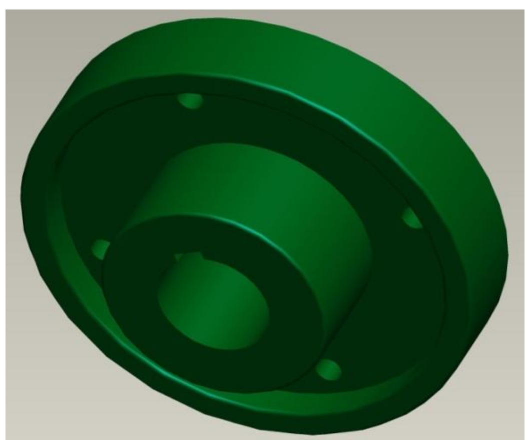


**Fig (a) Left flange**

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

Vol. 2, Issue 12, December 2013

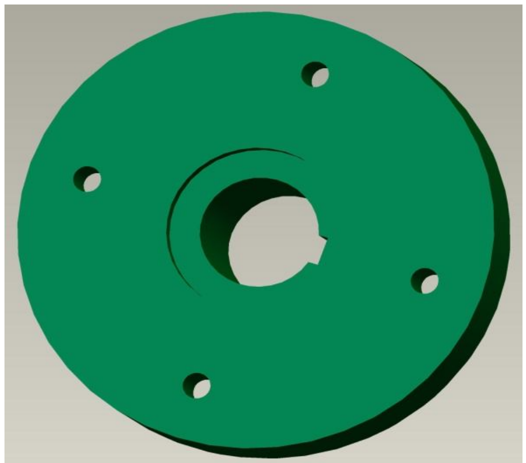


**Fig (b) Right flange**

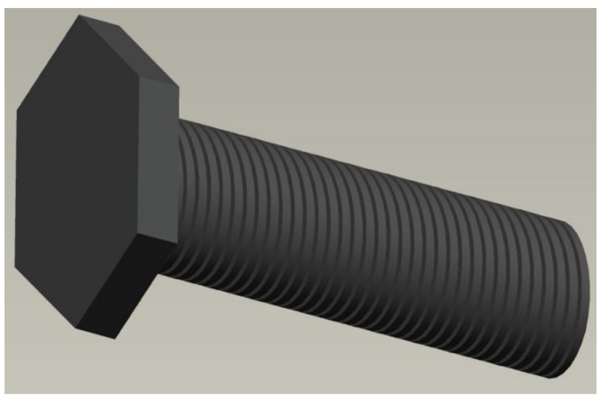
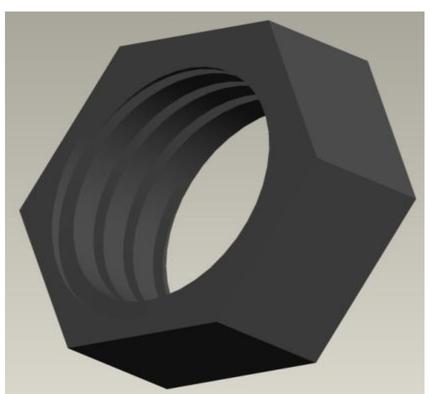


**Fig (c) Bolt**



ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

**Fig (d) Nut**

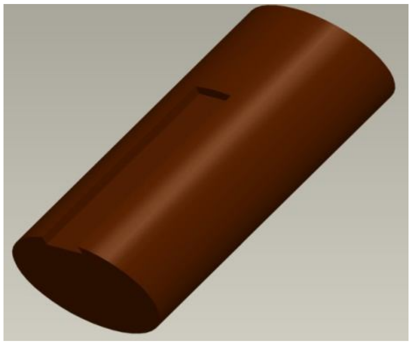


**Fig (e) Shaft**

## IV. ANALYSIS

There are several methods analysis software's have been used for analyzing. In this project we are using Ansys software for analyzing. Ansys is a leading finite element analysis software developed by ansys inc. it is use friendly graphical user interface package. In a linear static we determine the stresses, displacements, strain and reaction in the fem. Static analysis deals with computation of displacement and stress due to static loads refers to loading but doesn't cause inertial or damping effects to be significant for consideration in the analysis.

The material used here is grey cast iron, the Poisson's Ratio of grey cast iron is 0.28 and the Young's Modulus is 1.1e+005 Mpa

| **Material** | Grey cast iron |
|---|---|
| **Nodes** | 126611 |
| **Elements** | 66427 |
| **Mesh Metric** | None |
| **Type of element** | Brick 8 node 185 |

**Table 1 Mesh Statistics**

IJIRSET

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

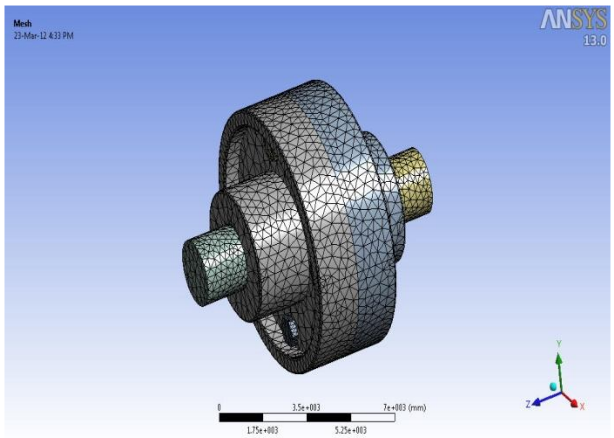



**Figure 1 Mesh model of the coupling**

| Object Name | Fixed Support | Moment |
|---|---|---|
| State | Fully defined | |
| Scoping method | Geometry selection | |
| Geometry | 1 Face | |
| Suppressed | No | |
| Coordinate System | | Global Coordinate System |
| X Component | | 0. N·mm (ramped) |
| Y Component | | 0. N·mm (ramped) |
| Z Component | | 4.7747e+006 N·mm (ramped) |

**Table 2 Analysis Settings**

| S.No | Comparison | Shear stress of bolts | Crushing stress of bolts |
|---|---|---|---|
| 1 | Theoretical results | 30 N/mm$^2$ | 160 N/mm$^2$ |
| 2 | Analytical results | 17.684 N/mm$^2$ | 123.24 N/mm$^2$ |

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 12, December 2013

**Table 3 comparison results of bolts**

| S.No | Comparison | Shear stress of key | Crushing stress of key |
|---|---|---|---|
| 1 | Theoretical results | 45 $N/mm^2$ | 160 $N/mm^2$ |
| 2 | Analytical results | 11.262 $N/mm^2$ | 57.458 $N/mm^2$ |

**Table 4 comparison results of key**

| S.No | Comparison | Shear stress in hub flange |
|---|---|---|
| 1 | Theoretical results | 8 $N/mm^2$ |
| 2 | Analytical results | 11.262 $N/mm^2$ |

**Table 5 Shear stress in hub flange**

## IV.CONCLUSION

It was found that the stress obtained from the Ansys software is slightly less than the stress obtained in the theoretical calculation. The shear stress and crushing results obtained from Ansys was compared with the theoretical calculation as tabulated. Hence the results obtained from Ansys matches theoretical calculations so the design is safe

## REFERENCES

1. T.J.PRABHU ,“ FUNDAMENTALS OF MACHINE DESIGN”,2009
2. PSG College of Technology, “DESIGN DATA BOOK OF ENGINEERS” April 2010