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Design and static structural analysis of flange coupling by using Alloy steel

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Abstract
A coupling may be mechanical device that permanently joints two rotating shafts at specific speed. The most common application of coupling is joining of shafts of two separately built or purchased units so that a new machine can be formed. A coupling is used to join the output shaft of an engine to the input shaft of any work. A Coupling is utilized to interface two unique shafts at their end and can slip or come up short contingent on as far as possible. It is the essential piece of any force transmission and keeps going for long time whenever planned and looked after appropriately. The current investigation of this paper is to the most extreme pressure by choosing a reasonable material for flange coupling. We choose for design criteria CatiaV5R20 and analyze the work is ANSYS Workbench, with static structural load conditions and determined outcomes like deformation and stress values.

Keywords: shaft speed, flange coupling, catia, ansys

Introduction

A flange coupling typically used to join the two shafts of same diameter aligned in same axis. Flange couplings do not allows axis deviation between two shafts. It consists of two flanges generally made up of cast iron. Each flange is mounted on the shaft end and keyed to it. Two flanges are holds together in position with help of bolts. The number of bolts may depend on the perimeter of the pitch circle in turn the diameter of the shat used to connect.

Flange couplings generally classified into three types 1. Protected Flange Coupling, 2. Unprotected Flange Coupling, 3. Marine Flange Coupling. The difference between these coupling is in protected flange coupling an extra hollow shaft type layer is casted to protect the bolts, such layer is not provided in unprotected type and in marine type couplings tapered bolts are used instead of regular headed bolts. A good coupling, rigid or flexible should satisfy the following requirements: (i) The coupling should be capable of transmitting torque from the driving shaft to the driven shaft. (ii) The coupling should keep the two shafts in proper alignment. (iii) The coupling should be easy to assemble and disassemble for the purpose of repairs and alterations. (iv) The failure of revolving bolt heads, nuts, key heads and other projecting parts may cause accidents. They should be covered by giving suitable shape to the flanges or by providing guards. Coupling upkeep is by and large a basic matter, requiring a consistently planned investigation of each coupling. It comprises of: Performing visual investigations, checking for indications of wear or weakness, and cleaning couplings routinely. Checking and changing ointment routinely if the coupling is greased up. This upkeep is required every year for most couplings and all the more oftentimes for couplings in unfriendly conditions or in requesting working conditions. Reporting the support performed on each coupling, alongside the date. Indeed, even with legitimate support, nonetheless, couplings can come up short. Hidden purposes behind disappointment, other than support, include

- Inappropriate establishment
- Helpless coupling choice
- Activity past plan capacities

In current work involves in computing the dimensions of all three types of flange couplings, while computing the coupling and shaft materials are considered as cast iron and plain carbon steel. If the material of the coupling for which computing is made up of differ material from the default one can also be compute by giving the ultimate stress values.

Materials and methods

Design calculations

Considering a standard motor with Power =25kW and Speed = 500rpm
Assuming design torque to be 150% of the rated torque
Torque (M_t) = 716197 N-mm
Shaft diameter (d) = 40 mm
Hub diameter (D) = 2d = 2*40 = 80mm
Hub length (L) = 1.5d = 1.5*40 = 60mm
Pitch circle diameter (D_1) = 3d = 3*40 =120mm
Web thickness (t_p) = d/4 = 40/4 = 10mm
Outside diameter of flange (D_2) = 4d+2t_p = (4*40)+(2*10) = 180mm
Flange thickness (t_f) = d/2 = 40/2 = 20mm
Diameter of spigot and recess (d_r) = 1.5d =15*40 = 60mm
Number of bolts (n) = 4
Bolt diameter (d_1) = 8mm
Key dimensions = 12x8x60mm

Design Model

To design a flange coupling part model here created Catia V5 R20 software used. Open the Catia module and create required dimensions of flange part model and then assembled as an assembly design.

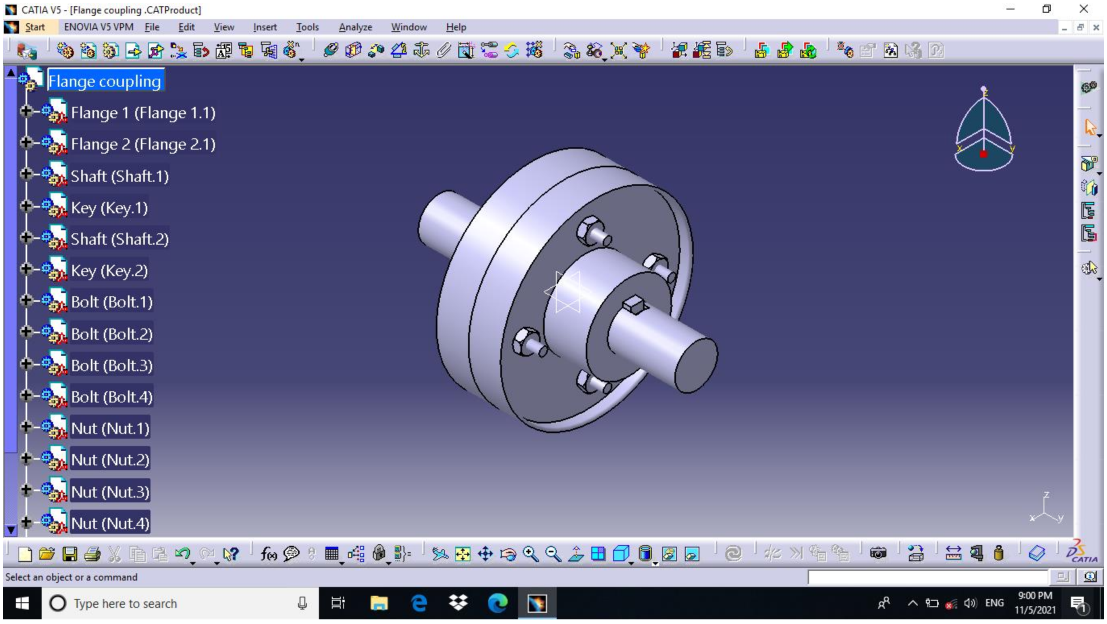

Fig 1: Assembly model of flange coupling

Material selection

In this paper consists of three different materials were selected. The plain carbon steels are existing material for shaft, key and bolts and the flange material has selected cast iron FG200. The next two materials are SAE J403 and Alloy steels grade 31Ni10Cr3Mo6 for shaft, key and bolt.

Analysis

ANSYS is the standard FEA teaching tool within the Mechanical Engineering Department at many colleges. This type of product development is termed virtual prototyping. With virtual prototyping techniques, users can iterate various scenarios to optimize the product long before the manufacturing is started. The multifaceted nature of ANSYS also provides a means to ensure that users are able to see the effect of a design on the whole behavior of the product, be it electromagnetic, thermal, mechanical etc.

Results and Discussion

The first step is engineering data that is apply the material properties and select the material then the next step is geometry, now import the new geometry of flange coupling. The torque applied in the model was 716197N-mm.

Case (i) Material: Plain carbon steel

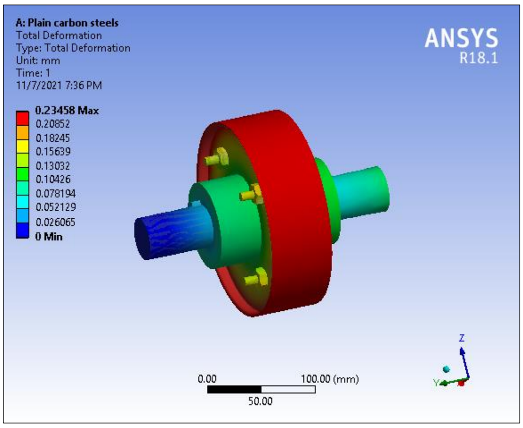

Fig 2: Total deformation of Plain carbon steel

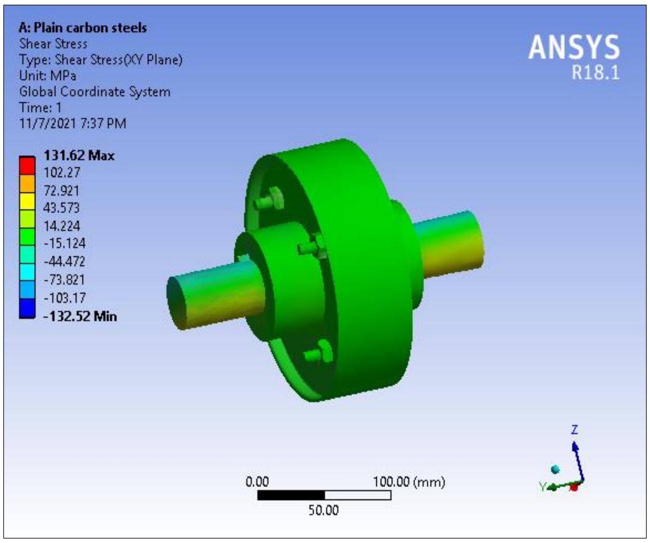

Fig 3: Shear stress of Plain carbon steels

Case (ii) Material: SAE J403

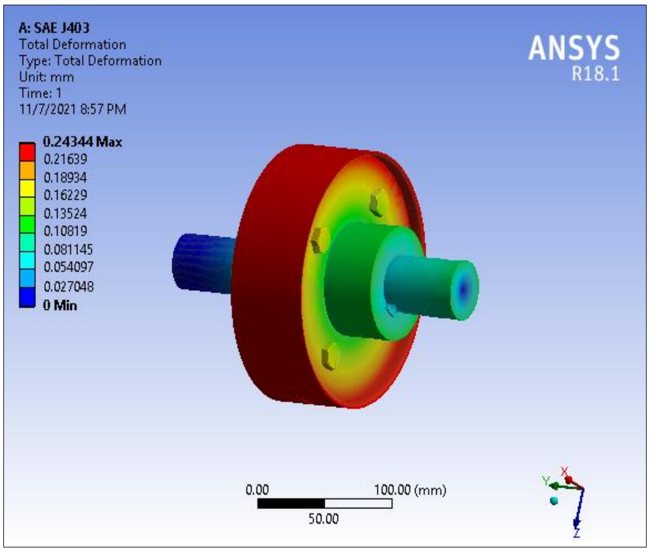

Fig 4: Total deformation of SAE J403

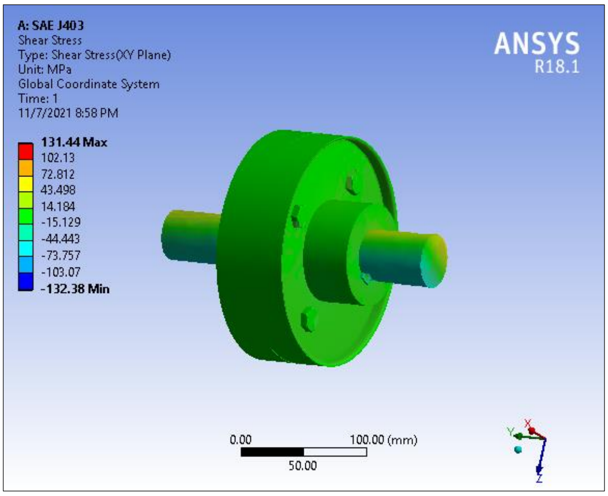

Fig 5: Shear stress of SAE J403

Case (iii) Material: Alloy steel

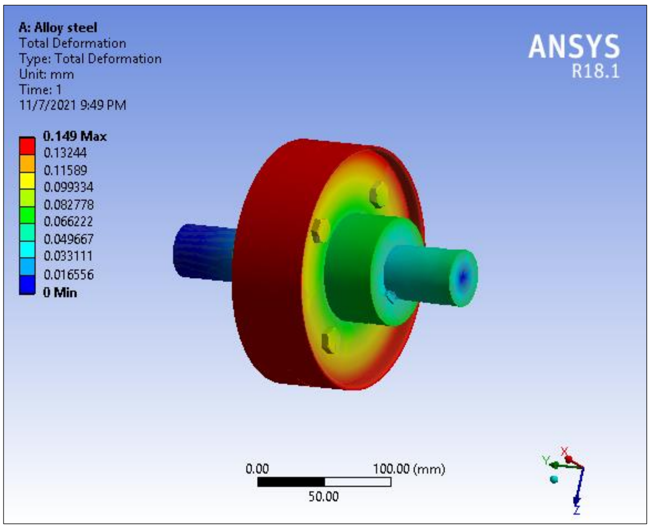

Fig 6: Total deformation of Alloy steel

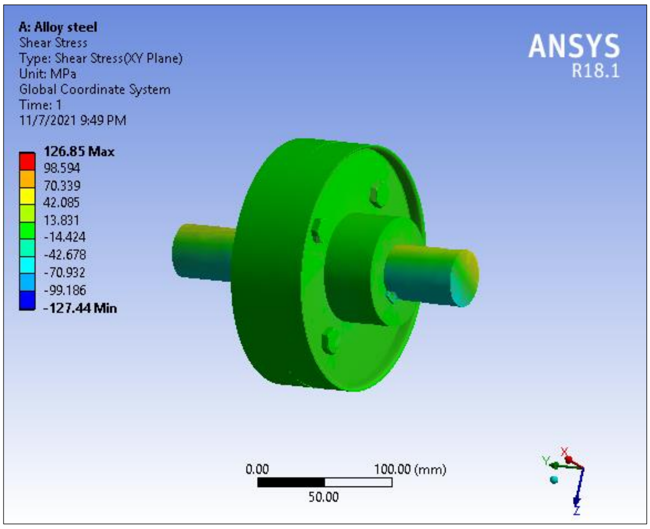

Fig 7: Shear stress of Alloy steel

Table 1: Result Comparison of flange coupling

S.No	Parameters	Plain carbon steels	SAE J403	Alloy steel
1.	Deformation (mm)	0.23458	0.24344	0.149
2.	Shear stress (MPa)	131.62	131.44	126.85

Conclusions

In this paper flange coupling was developed and analyzed with 3 different materials in this plain carbon steel is an existing material and remaining two are SAE J403 and Alloy steel, in order to develop the model here cad tool Catia were used to design the model and Ansys 18.1 tool were used for analyzing static analysis the static results plain carbon steel materials is better than SAE J403 in stress values. This Alloy steel material reduces the stress values on the body and also increases the strength of the model Alloy steel not only good at static load conditions, material has better strength than two materials and also highest safety factor values it means to get more accurate results here we performed model analysis and calculated natural frequency values for each material and this value shows the strength of the material to withstand at vibrating conditions, in this case also Alloy steel has very good frequency values compare to two other material, finally we can conclude our model can also manufacture with Alloy steel grade 31Ni10Cr3Mo6 instead of plain carbon steel.

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