FAILURE ANALYSIS AND DESIGN OF DRIVE SHAFT IN HEAVY DUTY APRON FEEDER IN POWER PLANT

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Abstract- In modern era engineering application of composite material is increasing rapidly which advantage over conventional material due to their higher strength & stiffness demand for light weight composite material increase due to their promising solution in the field of heavy equipment automotive, aerospace and other small and heavy industry. The objective of this paper is design and analyze of composite drive shaft for apron feeder design modification over conventional drive shaft design with substituting higher strength composite over conventional material of construction drive shaft using for heavy duty apron feeder application . in this paper we have concentrated to reduce weight and cost of shaft by design optimization . for design optimization of drive shaft various design software i.e. solid work, ansys have been used in this paper various design parameter i.e. deformation stress, strain have been calculated under subjected load using FEA (ANSYS). Further compression for calculated design parameter are carried out for existing design and material with updated design and material further compassion carried out for both optimizes and stress intensity factor found for both steel and composite drive shafts.

Keywords-Conventional Shaft, Drive Shaft, Ansys, Fillet with Chamfer Shaft, EN19.

I INTRODUCTION

Apron feeder is heavy duty material handling equipment. This is used to carry material falling from chutes/ silos etc. Heavy Duty impact loading of material on to apron feeder increase failure chance of apron feeder mounting i.e. chain, sprocket and drive unit etc. Drive unit of apron feeder consist drive shaft on which drive sprocket mounted. Drive shaft directly coupled with gear box through low speed coupling gear box further coupled with motor by high speed coupling. drive shaft transmits drive to chain and sprocket arrangement drive shaft operates by constant RPM squirrel cage induction motor .reduction in motor RPM to drive shaft RPM by using of gearbox. Drive shaft rotates with uniform constant RPM. Drive shaft is generally made of EN-8 material of construction. Conventional rolled shaft design followed for shaft manufacturing, which is mounted on Plummer blocks and bearing, which increase weight of shaft assembly.

Power transmission can be improved by the reduction of moment of inertia, which also leads to reduction in shaft weight. Modification in shaft design caters with consideration to reduce moment of inertia , distribution of stress concentration in shaft. Shaft design modify from rolled shaft to stepped shaft and further stepped shaft to stepped with champers shaft material of shaft changes from EN-8 TO EN-19 which has stiffer and higher strength EN-19 material used to efficiently meet the design requirements of strength stiffness and composite drive shaft weight. It is possible to manufacture one piece of composite. Decrease stress on part of the drive train extending life.

Because of higher specific strength (strength/ density) and high specific modulus (modulus/ density) of EN-19 material estimated to suit for long heavy power drive shaft application. Elastic properties of EN-19 help to increase the torque carrying capacity as well as rotational speed of drive shaft. Design modification and optimization of drive shaft for apron feeder can be followed for other heavy equipment.

Many researchers have been investigated about hybrid drive to the yokes of universal joints but this project provides the analysis of the shaft design in many aspects.

II SPECIFICATIONS OF DRIVE SHAFT

The Drive shaft along with Sprocket mounted on Plummer Block & Bearing Arrangement. Material of shaft is generally Structural steel, which now a days changing to EN-8 suitably. In this Paper Existing Shaft Material is EN-8, which further changes to EN-9 & EN-19 under same Loading Condition. The Shaft Diameter Selection done based on Torisional, Bending Moment and Deflection, for Materials EN-8, EN-9 & EN-19. Shafts manufacturing also done under allowable tolerance limit. Shaft of Material EN-8, EN-9 & EN-19 compared for Total Deformation & Vibration Analysis under identical Loading & Boundary conditions.

A. Modeling of Drive shaft

Solid works used as Solid Modeler to Model Drive Shaft, which works on Parametric Feature based module to create Solid Models and Assemblies. Parameters are design Constraints to determine shape or geometry of Model & its Assembly. Parameters of Drive shafts are numeric values such as Length of Line, Diameter of Circle. Geometric Parameters of Drive shaft are such as Tangent to circle, parallel, concentric, Horizontal or Vertical etc. Numeric Parameters are associated with other parameters.

In this Paper 3 Shaft Design are analyzed for 3 Types of Materials EN-8, EN-9 & EN-19.

FEA Analysis done on ANSYS 14.0 & 15.0 for Total 9 Cases.

Case-1:- Existing Rolled Shaft with Shaft Material of Construction EN-8

Case-2:- Existing Rolled Shaft with Shaft Material of Construction EN-9

Case-3:- Existing Rolled Shaft with Shaft Material of Construction EN-19

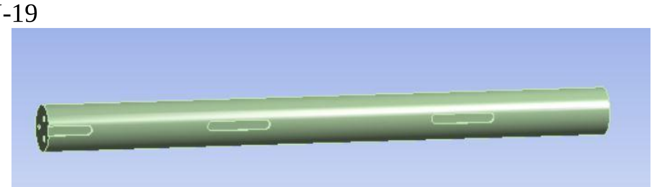

Fig.1 Existing Shaft Design-1 Model for above Case-1, Case-2, Case-3

Case-4:- Modified Stepped Shaft with Shaft Material of Construction EN-8
Case-5:- Modified Stepped Shaft with Shaft Material of Construction EN-9
Case-6:- Modified Stepped Shaft with Shaft Material of Construction EN-19

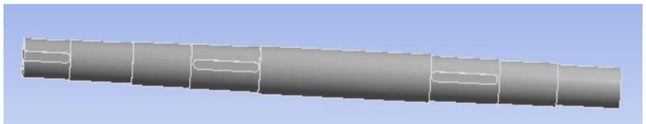

Fig.2 Modified Shaft Design-2 Model for above Case-4, Case-5, Case-6

Case-7:- Modified Stepped Shaft with Fillet & Champer for Shaft Material of Construction EN-8
Case-8:- Modified Stepped Shaft with Fillet & Champer for Shaft Material of Construction EN-9
Case-9:- Modified Stepped Shaft with Fillet & Champer for Shaft Material of Construction EN-19

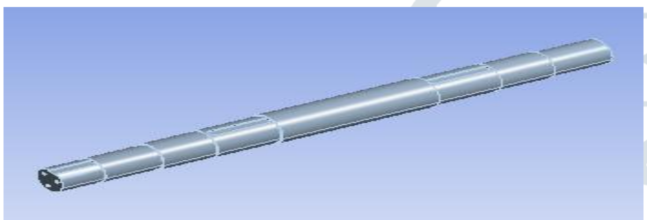

Fig.3 Modified Shaft Design-3 Model for above Case-7, Case-8, Case-9

B. Drive Shaft Material

Table1-Material Properties

S. No.	Engineering Data Properties	EN8	EN9	EN19
1	Density (Kg/m3)	7850	7750	7700
2	Young's Modulus (Pa)	2.00E+11	2.10+11	2.10+11
3	Poisson Ratio	0.3	0.3	0.3
4	Bulk Modulus (Pa)	1.67E+11	1.75E+11	1.75E+11
5	Shear Modulus (Pa)	7.69E+10	8.08E+10	8.08E+10
6	Coefficient of thermal expansion	11	11	11
7	Ultimate Tensile Strength (Pa)	6.60E+08	7.50E+08	8.00E+08
8	Yield Strength (Pa)	5.60E+08	4.50E+08	8.00E+08

C. Geometry specification and Boundary Conditions

Table-2

S.no.	Parameter	Value
1	Remote Force	158219.4
2	Force	158219.4
3	Length X	310. mm
4	Length Y	310. mm
5	Length Z	3845. mm
6	Volume	2.8877e+008 mm³
7	Mass	2.2668 t
8	Centroid X	2.3708e-003 mm
9	Centroid Y	-0.65429 mm
10	Centroid Z	-1622.6 mm
11	Moment of Inertia Ip1	2.7943e+006 t·mm²
12	Moment of Inertia Ip2	2.7945e+006 t·mm²
13	Moment of Inertia Ip3	26941 t·mm²
14	Nodes	75644
15	Elements	47700

III RESULT AND ANALYSIS

D. Static Structural

Static Structural analysis shows static conditions result of the body. It is shows by shape deformations. The paper shows total deformations of drive shaft for all 3 Designs (For Design-1, Design-2, Design-3) for all 3 Materials (EN-8, EN-9 & EN-19). The Results are Tabulated for all 9-Cases, which shows that the Lowest Deformation under Static Condition & under uniform Loading is for Case-9. Which results that the Modified Shaft Design-3 (Stepped, Champer & Fillet Shaft) with Material of Shaft EN-19 works best under similar Loading Condition.

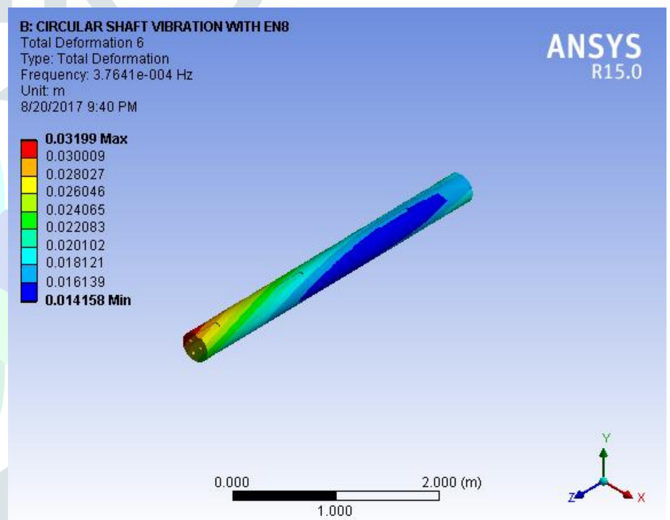

Fig.4 Total Deformation of Case-1, Existing Shaft Design with Material EN-8

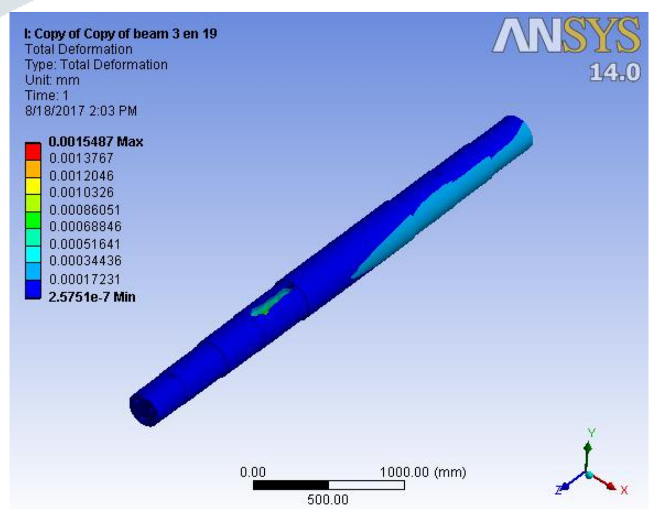

Fig.5 Total Deformation of Case-9, Modified Stepped Shaft with Fillet & Champers for Material of Shaft EN-19

Table3-Total Deformation of drive shaft

S. No.	Material	Design	Total Deformation(mm)
1	EN8	Shaft 1	**0.0023008**
2	EN8	Shaft 2	**0.0017637**
3	EN8	Shaft 3	**0.0016261**
4	EN9	Shaft 1	**0.0021913**
5	EN9	Shaft 2	**0.0016798**
6	EN9	Shaft 3	**0.0015487**
7	EN19	Shaft 1	**0.0021913**
8	EN19	Shaft 2	**0.0016798**
9	EN19	Shaft 3	**0.0015487**

E. Result and Conclusion

1. The Results are Tabulated for all 9-Cases, which shows that the Lowest Deformation under Static Analysis for uniform Loading is for Case-9.
2. Results that the Modified Shaft Design-3 (Stepped, Champer & Fillet Shaft) with Material of Shaft EN-19 works best under similar Loading Condition, with Lowest Deformation
3. Results also Shows that the Material of Shaft for Construction EN-19 hold best under deformation. Which have higher Stress values & also help to reduce shaft Diameter under identical Loading Condition. Reduction in Shaft Diameter also reduce its weight & Costing.

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