Static Structure Analysis of Diesel Engine Camshaft

Engineering

KEYWORDS : Static structure analysis, diesel engine, camshaft

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ABSTRACT

The main objective of this research work is experimentally quantify the cam stress, strain and total deformation values. A cam–follower kinematic pair works under complicated conditions of mechanical load, and wears during operation. This research presents an investigation of the most important contact surfaces of a modern diesel cam follower system. The factors influences the camshaft and its follower performance are the material properties, lubrication system, system operating, and the mechanical contact stress. It will generate the friction, temperature and caused it to wear. The analysis is done by finite element analysis.

INTRODUCTION

In the automobile industry the environment demands of lower emissions, lower fuel consumption, longer service intervals and longer lifecycles are growing tougher. Therefore product development of existing parts and product systems is important. However, when making calculation models of engine parts, all aspects of the environment in which these parts work cannot be foreseen [1].

A cam–follower kinematic pair works under complicated conditions of mechanical load, and wears during operation. The contact surfaces of the cam and the follower are usually surface hardened. The hardening may be due to phase transformation or precipitation processes occurring in the material during heat treatment or thermo chemical treatment [2]. The automotive sector has reached a very high production capacity in the last decades. Depending on this increasing capacity, its stable growth is anticipated in the world economy. In high cycle fatigue, as the cyclic stress is comparatively low, a large fraction of the fatigue life is used in micro crack initiation. Wear is another major failure of engine camshaft material [3].

Here, diesel engine camshaft is made up from the EN 8D (Mild steel) material which is one of the ductile material, so we apply von-meshes criteria. For the purpose of static structural analysis we are using ANSYS 12.1 workbench. By using this software we show the maximum stress, maximum strain and total deformation.

MATERIAL:

1, MATERIAL: EN 8D
2, Chemical Composition:

Carbon :	0.36-0.44%
Silicon :	0.10-0.40%
Manganese :	0.60-1.00%
Sulphur :	0.050 Max
Phosphorus :	0.050 Max

3, Density[5]: 7.85 gm/cc
4, young's Modulus: 210 GPa
5, Poisson's Ratio: 0.3
6, Ultimate Tensile Strength: 620 MPa

MATHEMATICAL CALCULATIONS:

1, For Fuel Cam:

1, Change in spring length: 6mm
2, C = = 8
3, Spring Constant, ks = + = 1.1840
4, Spring Load= change in spring length x ks
= 6 x 1.1840 = 7.104 kgf
5, Roller weight = 40 gm
6, Total force on cam= 7.144 kgf = 70.058 N
7, Hydraulic Pressure = 250 kg/cm^2
8, Diameter of cylinder = 6.5mm
9, Total pressure:
= (∏/4) x (Diameter of cylinder)^2 x Hydraulic Pressure
= 8.134 MPa

2, For Inlet/ Exhaust Cam:

1, Change in spring length: 5.6mm
2, Spring Load= change in spring length x ks
= 5.6 x 1.1840 = 6.6304 kgf
3, Roller weight = 50 gm
4, Push rod weight = 0.0382 kg
5, Total force on cam[6]= 6.7186 kgf = 65.88 N
s6, Gas Pressure = 2 MPa

ANALYSIS OF CAM:

For the purpose of Finite Element Analysis we are using the ANSYS WORKBENCH 12.1. For the three cams we follow the step by step procedure given below and generate the maximum stress, strain and total deformation of camshaft under the loading conditions.

1, Draw the geometry of cam shaft in PRO-E 5.0/ Creo.

2, Generate Mesh in ANSYS Workbench. For any finite element analysis the total work piece divided in to finite number of small element.

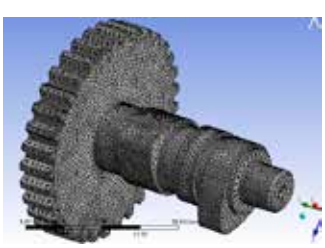


Figure :1 Mesh of Diesel Engine Camshaft

Size of elements = 1mm.
Number of nodes =80980

3, After Generate Mesh in ANSYS Workbench. We apply displacement, force and pressure conditions on all three cam, i.e.- Fuel cam, Inlet and Exhaust cam.

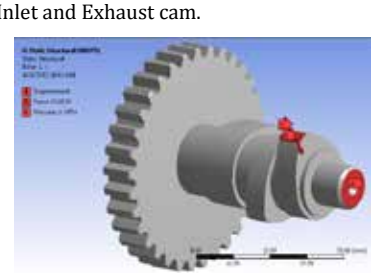
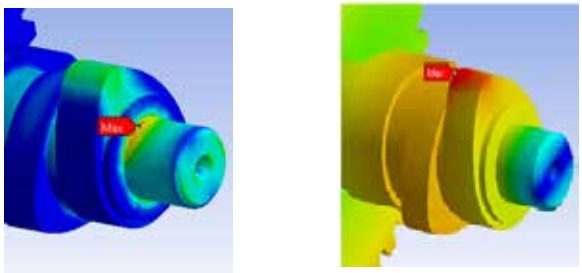


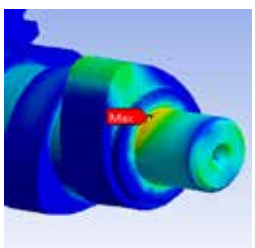
Figure:2 Force, displacement and pressure conditions (Inlet cam)

4, For solution select von-mises theory and apply total deformation, maximum stress and maximum strain.

5, Solution for inlet-cam



(A) **(B)**



(C)

Figure: 3 (A) Total deformation (B) Maximum stress (C) Maximum strain [4]

6, Results for all Cams:

	FUEL CAM	INLET CAM	EXHAUST CAM
MAXIMUM STRESS (MPa)	35.62	6.90	4.41
MAXIMUM STRAIN	0.00017	3.2×10^{-5}	2.1×10^{-5}
TOTAL DEFORMATION (mm)	0.0069	0.0008	0.0008

Table : 1 Result of camshaft Analysis

All steps show the procedure for the finite element analysis for diesel engine camshaft. And Table 1 shows the Result of Maximum stress, Maximum strain and total deformation for all three cams on camshaft.

CONCLUSION:

We can say that the material EN 8D (Mild Steel) is applicable for the manufacturing of diesel engine camshaft. From the above finite element analysis (static structure analysis) procedure for the diesel engine camshaft results show the values of Maximum stress, Maximum strain and Total deformation. Also Factor of safety calculation is done from the above results.

FUTURE SCOPE:

This Result is applicable for the further analysis as well as for the manufacturing processes can be decided from results. Another application of this analysis is material selection related to camshaft which becomes easier for the manufacturer.

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