Performance test on Mechanical Properties of En19 Steel and En41b Steel Used In Diesel Engine Camshaft

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Abstract

Camshaft is one of the key parts or components in the engines of automobile and other vehicles. Due to the cyclic impact loading on the contacting surfaces of the cam and the follower, it often gives rise to premature wear of cam profile and affects a routine run of the valve gear such as the rotational speed, valve displacement and the torque. The objective of this work was to study experimentally the residual stresses at the surface layer of induction hardened cylindrical specimens. The diesel engine camshafts are generally made by EN19 Steel material. However, EN19 steel material has low wear resistance and its service life is shorter. ReplacingEN19 steel with EN41B steel. The results obtained from hardness test indicated that the hardness of the Nitride steel EN 41B is 31% higher than EN19 Steel before induction hardening and the hardness of the Nitride steel EN41B is 45% higher than EN19 steel after induction hardening. Impact test indicated that the toughness of Nitride steel EN41B is 38% higher than EN19 steel.

Keywords: *ANSYS, Induction Hardening, Pro/E model, Impact Test, Hardness Test*

1. Introduction

The camshaft is an apparatus often used in piston engines to operate poppet valves. It consists of a cylindrical rod running the length of the cylinder bank with a number of oblong lobes or cams protruding from it, one for each valve. The cams force the valves ¬open by pressing on the valve, or on some intermediate mechanism, as they rotate the relationship between the rotation of the camshaft and the rotation of the crankshaft is of critical importance. Since the valves control the flow of air/fuel mixture intake and exhaust gases, they must be opened and closed at the appropriate time during the stroke of the piston. For this reason, the camshaft is connected to the crankshaft either directly, via a gear mechanism, or indirectly via a belt or chain called a timing belt or timing chain. Duration can often be confusing because manufacturers may select any lift point to advertise a Camshaft's duration and sometimes will manipulate these numbers. The power and idle characteristics of a camshaft rated at .006" will be much different than one rated the same at .002". Whenever duration is quoted, be sure to note the lift at which it is given. In general, duration determines how many crankshaft degrees a camshaft maintains more than a given tappet lifts. Depending on the location of the camshaft, the cams operate the valves either directly or through a linkage of pushrods and rockers. Direct operation involves a simpler mechanism and leads to fewer failures, but requires the camshaft to be positioned at the top of the cylinders. The rockers or cam followers sometimes incorporate a mechanism to adjust and set the valve play through manual adjustment, but most modern auto engines have hydraulic lifters, eliminating the need to adjust the valve lash at regular intervals as the valve train wears, and in particular the valves and valve seats in the combustion chamber.

1.1 Classification of cams

The cam, as a means of producing a given type of motion, is simple and reasonable to design, provided the simple principles are understood. Another advantage is that, generally, a cam can easily be changed or modified to allow a change of motion, without interfering with the remainder of the mechanism.

1.2 Cam followers

There are three types of cam followers, and since the type of follower influences the profile of the cam it is worthwhile considering the advantages and disadvantages of each type. The three types are the knife-edge, the roller follower and the flatfoot or mushroom follower.

1.3 Diesel engine

Highly fuel efficient, Greaves lightweight diesel engines are ideal for automotive applications like 2-wheelers, 3wheelers, mini cars etc. These engines with high power-toweight ratio are also used extensively for portable agricultural pump sets, gensets, small boats, construction equipment and host of other applications. Available in a range of 4-10 HP models, Greaves light diesel

engines are widely used in Defense applications. These engines are manufactured at ISO 9001 certified Units in Aurangabad and Ranipet.

Table 1 Engine specifications

Bore	78 mm
Stroke	68mm
Displacement	325cm^3
Compression ratio	18:01
Rpm	1500 - 1800
Max. Torque	2.96(29.03nm)
S.F.C	205220gm/h.p/hr
Lub oil consumption	13gm/hr
Capacity of fuel tank	4.5 liter
Capacity of oil sump	1 liter
Dry weight	38kg

2. Problem identification

2.1 The diesel engine camshaft

The diesel engine camshafts are generally made by EN19 Steel material. However, EN19 steel material has low wear resistance and its service life is shorter. In camshaft, particularly lobes suffer wear over time to a point where valve lift is reduced and engine performance is degraded. Also it necessitates frequent replacement leading to loss of time and money.

Figure 1 Failure of the Camshaft

Table 2 Chemical Composition of EN19 Steel

Chemical	Composition
Fe	96.86%
C	0.38%
Si	0.21%
Mn	0.91%
P	0.01%
S	0.01%
Cr	1.04%
Mo	0.23%
Ni	0.23%
Al	4.21%

2.2 Nitride Steel EN 41B

To overcome above said, problem in camshaft an alternate material namely, Nitrite steel EN41B has been identified, chosen and analyzed for its performance.

Table 3 Chemical Composition of Nitride Steel EN 41B

Chemical	Composite
AL	1.20%
C	0.40%
Cr	1.60%
Fe	95.55%
Mn	0.60%
Mo	0.35%
Si	0.30%

Application of Nitride Steel EN 41B

- Die casting dies
- Gears
- Plungers and cylinders
- Abrasive wheels
- Plastic mould parts
- Spindles
- Extrusion screws and barrels

3. Specimen preparation

Table 4 Induction Hardening

TREATMENT CONDUCTED	BEST HEAT TREATMENT,COIMBATORE
Identification	EN19steel and Nitride Steel EN 41B
Specimen	DIAMETER-10.5mm
Case depth	1.5mm
Power	30KW
Spindle speed	2000mm/min

Table 5 Depth of Case Hardening

MATERIAL	DEPTH OF CASE HARDENING
EN19 steel	1.5mm
Nitride EN41B steel	1.5mm

Table 6 Cylindrical Surface Grinding Cutting

MATERIAL	BEFORE SUFACE GRINDING	AFTER SURFACE GRINDING
EN19 steel	10.5mm	10mm
Nitride EN41B steel	10.5mm	10mm

3.1 Specimen preparation for Toughness test

Table 7 Material Sizes

MATERIAL	DIAMETER	LENGTH
EN19 steel	16mm	300mm
Nitride EN41B steel	20mm	300mm

Table8 Milling, Cutting and Notching

OPERATION	EN19 STEEL	NITRITE En 41B STEEL
Milling	6mm	10mm
Cutting	55mm	55mm
Notching	2mm	2mm

Table 9 Specimens for Toughness Test

MATERIAL	LENGHT	WIDTH	BREATH
EN19 steel	55mm	10mm	10mm
Nitride EN41B steel	55mm	10mm	10mm

Figure 3 Specimens for impact test

4. Testing of Nitride Steel En41b Specimens

4.1Mechanical test

Mechanical test is an essential part of any engineering activity. Mechanical test is applied to the materials, components and assemblies.It consists of measurement of fundamental properties or measurement of responses to particular influences such as load, temperature, etc Types of mechanical tests carried out in Nitride steel

EN41B Materials are,

- Hardness test
- Impact test

These tests are conducted to analyze the hardness, toughness and wear resistance properties of Nitride steel EN41B Material. These tests are carried out in different types of testing machines. They are Rockwell Hardness Testing Machine

- Charpy Testing Machine

4.1.1 Impact test

In this project, the impact test was carried out by CHARPY TEST to find the impact energy.

Charpy Test

The Charpy test uses a test specimen of size 10mm x 10mm x 55mm (sub size specimen).The impact specimen received without notch and the depth of the notch is 2mm.

5. Result and Discussion

5 Modeling and Analysis of camshaft using Pro-E

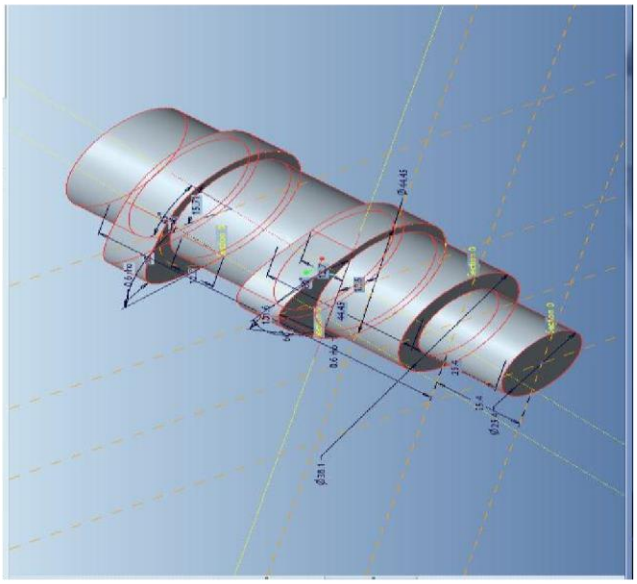


Figure 5 Modeling of camshaft

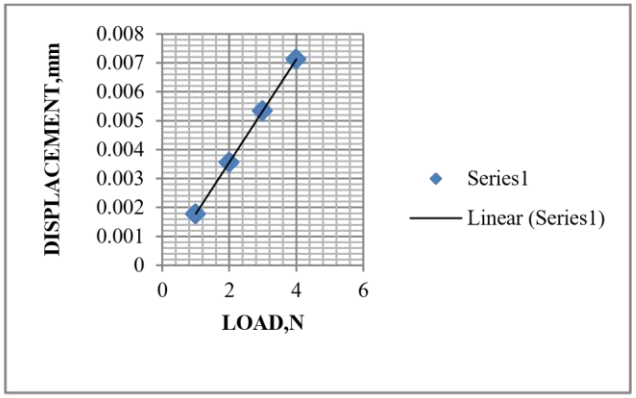
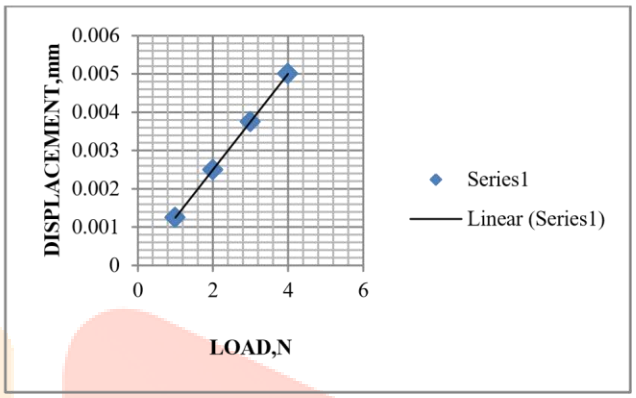


Figure 6 Displacements vs. Load for EN19 steel



6.Result

Hardening

Table 16 Hardness Test Result before Induction

The percentage of hardness $= \frac{17-13}{13}$ x 100

= 31%

There Therefore, the Nitride steel EN41B has 31% higher hardness than EN19 Steel.

After induction hardening

The percentage of hardness $= \frac{58-40}{40}$ x 100

= 45%

Therefore, the Nitride steel EN41B has 45% higher hardness than EN19 Steel.

Toughness test

Table 17 Toughness Test Result

MATERIAL	IMPACT ENERGY IN (J)
EN19 steel	29
Nitride Steel EN 41B	40

The percentage of toughness $= \frac{40-29}{29}$ x 100

=38%

Therefore, the Nitride steel has 38% higher toughness than

EN19 steel.

Conclusion

In this project the suitable alternate material Nitride steel EN41B has been identified and analyzed for the diesel engine camshaft instead of EN19 Steel material. Since the existing material necessitates frequent replacement leading to loss of time and money. Mechanical properties such as hardness, toughness and wear resistance of Nitride steel EN 41B were studied. In addition stress analysis was carried out using ANSYS.

The results obtained from hardness test indicated that the hardness of the Nitride steel EN 41B is 31% higher than EN19 Steel before induction hardening and the hardness of the Nitride steel EN41B is 45% higher than EN19 steel after induction hardening with 1.5mm case depth. Impact test indicated that the toughness of Nitride steel EN41B is 38% higher than EN19 steel. In addition, ANSYS results showed that Nitride steel EN41B camshaft suffered lower displacement than EN19 steel camshaft for all load conditions. From these results it can be observed that camshaft made using Nitride steel EN41B has higher service life.

References

A.S.Dhavale, V.R.Muttagi, (2012) Study of Modeling and Fracture Analysis of Camshaft, *International Journal of Engineering Research and Applications*, Vol. 2, Issue 6.
A.Gopichand, Dr.M.Muralidhara rao, Prof A.V.N.L.Sharma V.Samuel tony,(2012) Analysis and Estimation of Attenuation
Coefficient of Aging EN-19 Steel, *International Journal of Engineering Research and Applications* (IJERA) ISSN: 2248-
9622, Ivo Dolezela, Jerzy Barglikb, Bohus Ulrychc,(2005)"Continual induction hardening of axi-symmetric bodies", *Journal of Materials Processing Technology* 161 269–275.
R. V. Wanjari, T. C. Parshiwanikar, (2013)"Design and Analysis of Camshaft by Changing Parameters which Causes Failure",
International Journal of Science and Modern Engineering (IJISME) ISSN: 2319-6386, Volume-1, Issue-6,
H. Kristoffersen, P. Vomacka,(2001) "Influence of process parameters for induction hardening on residual stresses", *Materials and Design*. 637_644.
Y. Totik1, R. Sadeler, H. Altun, M. Gavgali,(2002) "The effects of induction hardening on wear properties of AISI 4140 steel in dry sliding conditions", *Materials and Design*.
Khamlichi,A.,Bezzazi,M.,Jabbouri,A.,ReisP.andDavim,J.P(2008) ,"Optimizing friction behavior of clutch facing using pin ondisk test", *International journal of physical sciences* Vol.3(2).
Wafaa M.Salih,Sanaa M.Salih and Myada M.Salih and Myada M.Salih(2008),"The effect of time variation on the wear sliding Behavior of composite", *Journal of Engineering and Applied Sciences*.
R.Singha Roy, Dr.A.Chanda, D Basu,(2005),"A Comparative study of Alumina Wear in Air and Distilled Water"
R.Choteborsky,P.Hrabe,M.Muller,J.Savkova,M.Jirka(2005),"Abr asive wear of high Chromium Fe-Cr-C hard facing alloys".
M.Ignatiev,I.Smurov,V.Martino,G.Flamant and C.Duty(1994),"Application of Laser surface alloying for improvement of wear resistance of bearing steel working at severe conditions and of light titanium alloys", *Journal De Physique IV*.
A.Wiengmoon,T.Chairuangsri,N.Chomsang,N.Poolthong,J.T.H. Pece,"Effect of Heat Treatment on Hardness and Dry Properties of A Semi-Solid Processed Fe-27wt%Cr-2.9wt%c Cast Iron".
Th.Gradt, H.Borner, W.Hubner, Low Temperature Tribology at the Federal Institute For Material Research And Testing, Federal Institutes for Materials Research and Testing. M.Arumugam, 2002,"materialscience", anuradh agencies, kumbakonam.