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Failure Analysis of Cam gear & Auxiliary gear

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ABSTRACT

Failure itself is a human concept. Materials do not fail in and of themselves. They follow the laws of nature perfectly. If a part is loaded beyond its tensile strength, it breaks. Until that stress level is reached, it does not break. When a part fails in service, it was under-designed or poorly manufactured for the circumstances in which it was used in present study failure analysis of cam gear and auxiliary gear is carried out.

Key words: Root cause, gear, carburizing,

I INTRODUCTION

Gear is used in most of the engineering purpose forpower transmission,for easily transmission&simplification in operation without any complex handling its suits to all engineering operation. Here we took the failure analysis of Cam gear & Auxiliary gear. For testingofthree 1616 CR BS III Enginefor various investigation have done[1]. in this paper we analyses of failure of Cam gear & Auxiliary gearand tested itby different testing procedure and run this engine in different types of H series vehicle at different different speed. First we consider a table of gear module and design the gear at the given specificationAfter testingitsfoundshaft wasbent and gear has come out of engagement from camshaft gear. Theteeth failure on endurance engine after running of engine at certain period also occurred. With this testing procedure we examined the main causes of failure of gear. Wecan eliminate thesereasonsto some extent by applying

II FAILURE ANALYSIS PROCEDURES

The primary objective of any failure analysis is to determine the primary root cause of failure and to establish the appropriate corrective action. There are several stages of an analysis, which can proceed one after the other or occur at the same time. There is no set “fixed-in-stone” procedure, because it is highly dependent on the part and procedures/capabilities of the specific laboratory.

These stages of analysis are:

- Collection of background data
- Preliminary visual examination
- Non-destructive testing
- Selection and preservation of specimens
- Mechanical testing

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- Macro examination
- Micro examination
- Metallographic examination
- Determination of the fracture mechanism
- Chemical analysis (bulk and microanalysis)
- Analysis and writing the report
-

Lab. Identification No. & Marking

Table No1

S. No.	Lab Identification No.	Item
1.	232/09/1	Cam gear having wear teeth
2.	232/09/2	AG Gear without any apparent damage

Visual Examination

Sample No. 232/09/1 (Cam Gear)

The top portion of cam gear was found worn out partially to a length of 51.5 mm and up to a depth of 0.5 mm in all the teeth as shown in (fig.1)

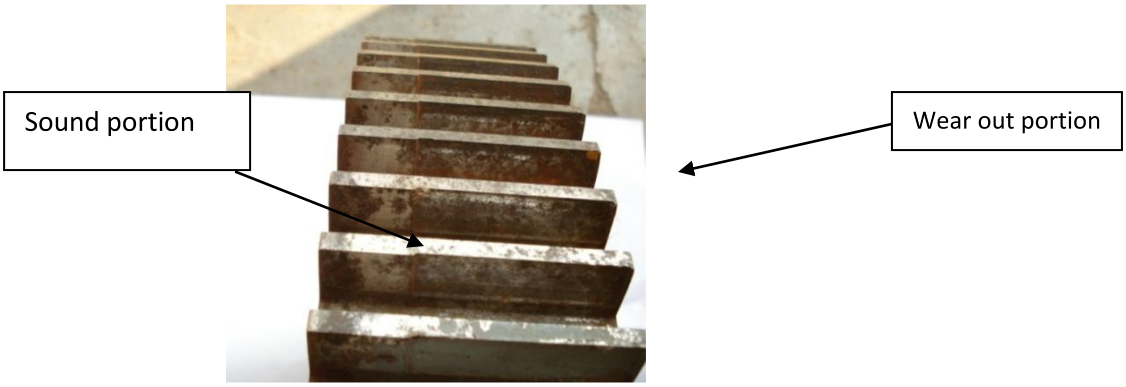

Fig.1 photograph showing wear teeth of cam gear

Sample No. 232/09/2:

There was not any deformation or breakage noticed in this sample. Gear was received in assembled condition.

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Fig.2 photograph showing auxiliary gear.

Chemical Composition

Table No 02

	%C	%Mn	%P	%S	%Si	%Cr	%Mo
232/09/1 (cam gear)	0.44	0.75	0.034	0.027	0.30	1.01	0.20
Specified as per SAE 4140 H	0.37 - 0.44	0.65-1.10	0.035 max.	0.040 max.	0.15-0.35	0.75-1.20	0.15-0.25

Table No 03

Sample No.	%C	%Mn	%P	%S	%Si	%Ni	%Cr	%Mo
232/09/2 (auxiliary gear)	0.23	0.93	0.030	0.007	0.32	0.59	0.53	0.28
Specified as per AISI 8620 H	0.17-0.23	0.60-0.95	0.035 max.	0.040 max.	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25

Macro Examination

Slice of each sample containing two/three teeth were nital etched and case depth was observed. Results are given as under:

Table No 04

Sample No.	Case Depth (mm)	Specified
232/09/1 (cam gear)	Nil	Not specified
232/09/2 (auxiliary gear)	1.2	Not specified

Fig.3 Photograph showing case depth of sample no.232/09/2.

Hardness Test

Hardness was conducted on each sample at different locations and the results are given as under:

Table No 05

Sample No.	Hardness (R_C)
232/09/1	Observed : 41-38 HR_C (From case to core in through hardened gear) Specified as per SAE 4140 H: 34-38 HR_C
232/09/2	Observed Case : 51, 51 HR_C Specified as per AISI 8620 H: 50 HRC min. Core : 34, 34 HR_C Specified as per AISI 8620 H : 27-35 HRC for 1 inch diameter. Specified as per AISI 8620 H : 35-40 HRC for 1/2 inch diameter.

Micro Examination

Table No 06 Microstructure

Sample No.	Observation
232/09/1 (cam gear)	Revealed tempered martensite (fig.4)
232/09/2 (auxiliary gear)	Case –Revealed martensite (fig.5). Core – Revealed mixture of bainite and martensite. (fig.6)..

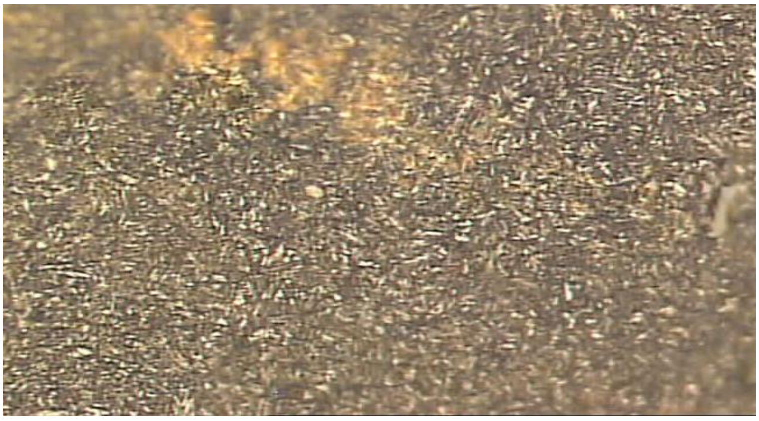

Fig.4 Photomicrograph showing tempered martensite structure in X500 sample no.232/09/1 (cam gear).

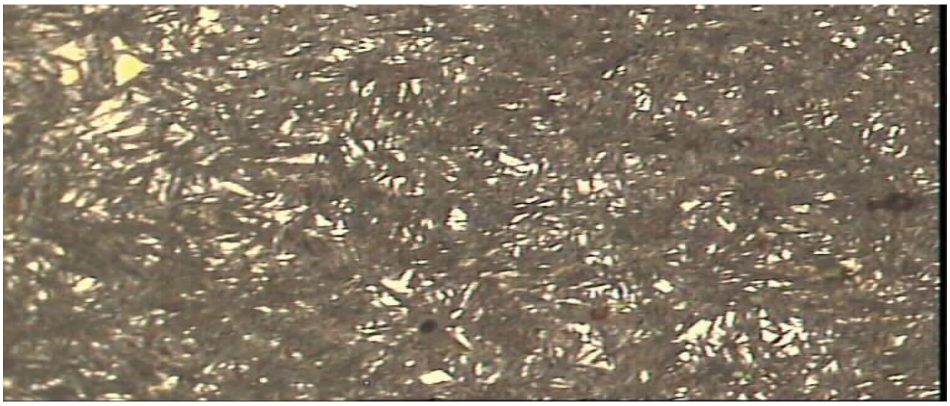

Fig.5 Photomicrograph showing martensite in the case of X500 sample no.232/09/2 (auxiliary gear).

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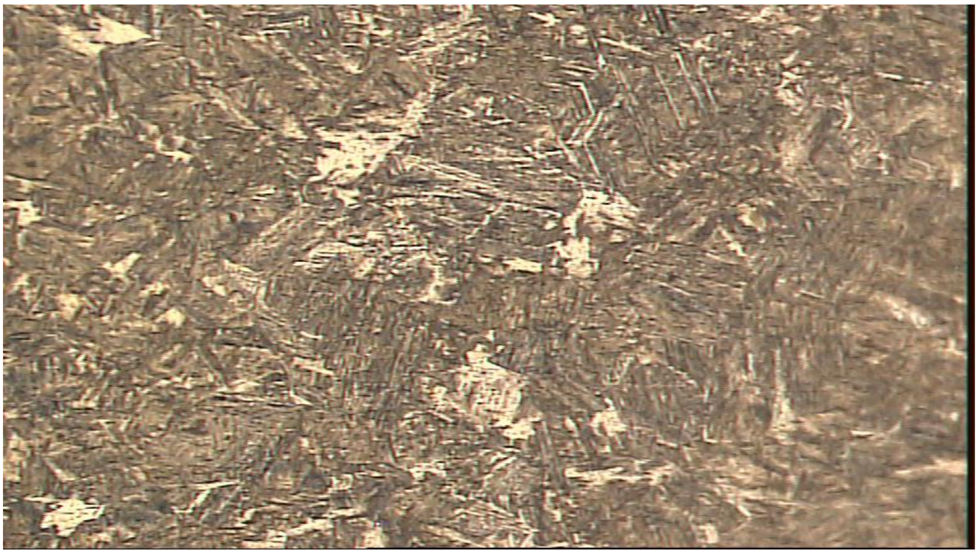

Fig.6 Photomicrograph showing mixture of bainite & martensite X500 in core of sample no.232/09/09/2 (auxiliary gear).

III DISCUSSION

The findings indicate that medium carbon chromium alloyed steel having the ability to harden throughout the section was used for cam gear. This gear was found be through hardened where the hardness varied from 41-38 HRC. The findings in respect of auxiliary gear reveal that a low carbon, Ni-Cr alloyed steel of case carburising quality was used for manufacturing auxiliary gear and the gear was found to be case hardened up to the depth of 1.20 mm with the surface hardness of 51 HRC. Thus, the cam gear with a surface hardness of about 41 HRC on the teeth and the auxiliary gear with the surface hardness of 51 HRC on teeth were mating each other during service. However, the wear on the top surface of all the teeth of cam gear covering partial length shows some mismatch between the two. Had the difference in hardness and chemical composition been the predominant factors for wear of cam gear, the gear should have been worn out on the entire surface and length of all the teeth.

IV CONCLUSION

1. The partial wear on up to certain length of all the teeth of cam gear may be attributable to the combined effect of mismatch between the mating gears and lower hardness of cam gear as compared to the auxiliary gear.
2. It is advised to modify the heat treatment of cam gear so as to approximately match the teeth hardness with the mating auxiliary gear. The cam gear made out of medium carbon chromium alloyed steel can be subjected to hardening and tempering in the core and induction hardening in the teeth to achieve about 30-35 HRC in the core and 40+5 HRC in the case of teeth.
3. The fitments aspects need to be looked into so as to avoid wear due to mismatch of gears.

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