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Failure Investigation of a Bus Gas Engine Cam Thrust Plate

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Abstract - *A failure investigation has been conducted on a bus diesel engine cam thrust plate wear that is located behind the camshaft pulley in the timing chain area of system that were used in a bus. The cam plate are made from chill-cast gray iron. Adjacent wear appeared on the plate after 1166:29 running hours. In this case Mo is not sufficiently present which can increase the wear rate as Mo increases hardenability, wear resistance and promotes martensitic transformation of the steel and higher percentage of Ni improves the hardenability to a certain extent but too much of soft phase as it will not dissolve completely and remain as Iceland as white colour which can prone to wear of the part*.

***Key Words*: Cam Thrust Plate; Hardness; Chemical Composition; Camshaft; Wear**

1. INTRODUCTION

It was reported that the failed cam thrust plates were assembled a Bus diesel engine. Adjacent wear appeared on the plate after 1166:29 running hours. The cam plate are made from chill-cast gray iron. It is designed to control camshaft movement within engine block and provide ultimate protection to the cam. Wear on the cam thrust plate affects the camshaft movement hence retard or advance the ignition timing and affects efficiency of fuel delivery. The paper describes the fractographic study and the possible reasons for the failure

2. EXPERIMENT METHODS

The chemical composition of the failed gear materials was determined by wet chemical analysis method. The microstructure of the sectional specimens was observed by Optical Microscope. The wear surfaces were analyzed by visual and by optical microscope observation. Hardness testing were made using Rockwell system with a load of 150 kg.

3. RESULTS AND DISCUSSIONS

3.1. Visual Observations

The failed cam thrust plate is shown in Fig. 1, which is located behind the camshaft pulley in the timing chain area of your system as shown in fig. 2. Wear is observed on cam thrust plate on the side facing cam gear hub. Wear marks were observed at 50X as shown in figure 3. Contact extrusion marks and circumferential traces were found on surface. From observation it was deducted that circumferential traces were originated from imprint by the cam gear hub. We neither observed any kind of heat distortion or colorization on failed thrust plate due to lack of lubrication nor we witnessed camshaft bearing journal running dry due to poor supply of oil. So, Oil feed is sufficient.

Fig- 1. Failed cam thrust plate due to wear

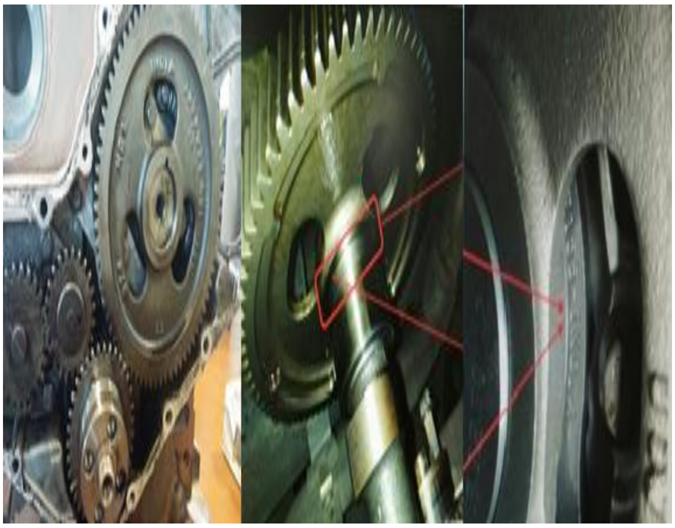

Fig- 2. Position of cam thrust plate in engine

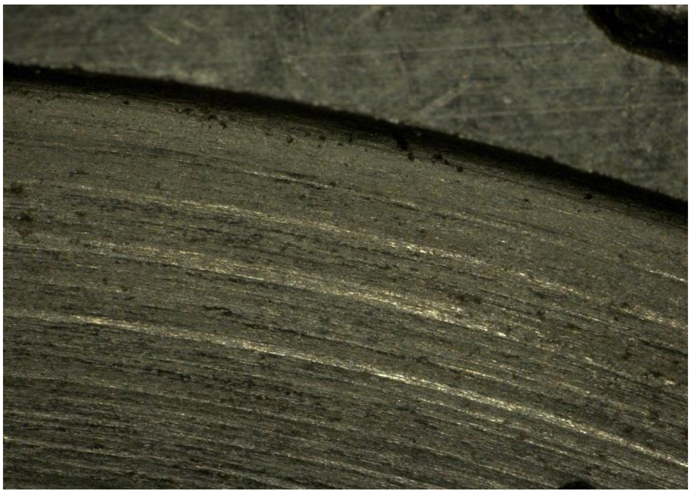

Fig -3. Wear Marks Observed At 50X

3.2. Microstructure Observation

Microstructure on the wear surface was observed by Optical Microscope (Fig. 4). The observation results show that the core microstructure of the cam thrust plate.
Specification- Surface structure to be an even distribution of tempered martensite extending to a 0.25 mm [0.010 in] minimum depth. The core is to contain a mixture of pearlite and tempered martensite. No interconnected carbide network is permitted. The metallurgical features basically correspond to the technical specification.
Result- Tempered martensitic structure with evidence of porosity (Black coloured) and soft phase (White colour) at 500X

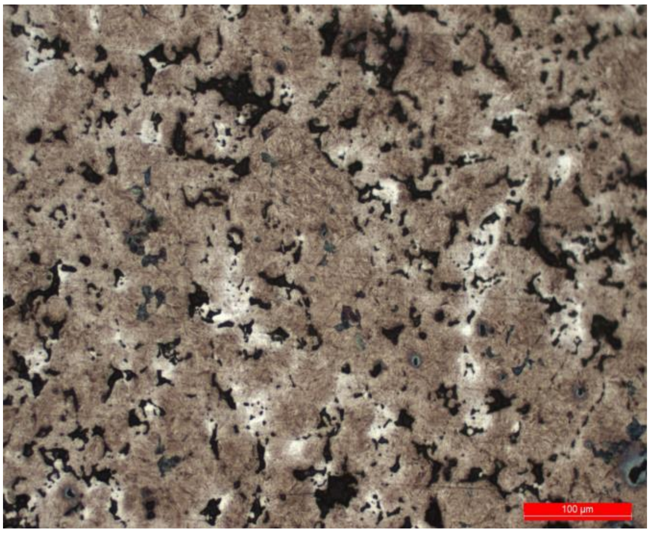

Fig -4. Tempered Martensitic Structure with Evidence of Porosity (Black Coloured) And Soft Phase (White Colour) At 500X

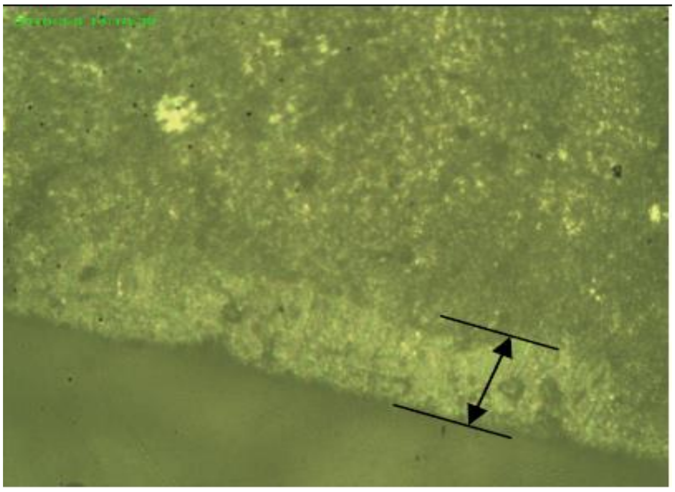

Fig-5. Tempered martensite upto depth of 0.25 mm. Even distribution from surface to core

3.3. Examination of Hardness

The values of the surface hardness cam thrust plate are shown in Table 3. It can be seen that the surface hardness of the cam thrust plate corresponds to the specified.

Table- 1: Hardness Examination Results

Specimen	Surface Hardness		Specification
	Readings	Average Value	
Cam thrust plate	1. 44 HRC 2. 34 HRC 1. 44 HRC	40.67 HRC	35- 45 HRC

3.4 Examination of Surface Roughness

The values of surface roughness on both sides of cam thrust plate (S1, S2) are taken as shown in table 2. It can be seen that surface roughness meets the specification.

Table- 2: Roughness of Cam Thrust Plate

Characteristics	Specification	Measurements (μm)
Ra (Surface Finish)S1	Ra 3.2	0.395
Ra (Surface Finish)S2	Ra 3.2	0.395

3.5 Examination of Chemical Composition

The values of the chemical composition of cam thrust plate are shown in Table 3. It can be seen that the Molybdenum (Mo) is very low while Nickel (Ni) is on higher side corresponds to the specified.

Table- 3: Chemical Composition of Cam Thrust Plate (Wt. %).

	Carbon	Molybdenum	Copper	Nickel	Iron
Actual Data	As per spec.	70% less	As per spec.	27% more	By difference

4. ANALYSIS OF FAILURE CAUSES

From the examination in Section 3, we found roughness and microstructure as per specification. Chemical composition results vary. It can be seen that the Molybdenum (Mo) is very low while Nickel (Ni) is on higher side corresponds to the specified.
A sufficient content of Mo and Carbon can improve intrinsic wear resistance of the matrix, but in this case Mo is not sufficiently present which can increase the wear rate. Ni improves the hardenability to a certain extent but high percentage of Ni will not dissolve completely and remain as Iceland as white colour which can prone to wear of the part. Under the action of load by the camshaft gear, it is difficult for the soft matrix of the cam thrust plate to perform an effective support which results in wear of the part.
Improper mixing of powders is responsible for the irregular composition in the cam thrust plate. Proper mixing of powders and adding as per suitable alloy contents as per specification will decrease the wear on the cam thrust plate.

5. CONCLUSIONS

1. The materials of the cam thrust plate are chill-cast gray iron, which corresponds to the specified material. Hardness, roughness and Surface structure to be an even distribution of tempered martensite extending to a 0.25 mm [0.010 in] minimum depth were found to be within specification. The chemical composition report shows that Molybdenum (Mo) is very low while Nickel (Ni) is on higher side.
2. Usually Mo increases hardenability, wear resistance and promotes martensitic transformation of the steel. Ni also increase hardenability, but also add softening phases, it will not dissolve completely and remain as Iceland as white colour which can prone to wear of the part
Universally higher hardness does not mean higher wear resistance. A sufficient content of Mo and Carbon can improve intrinsic wear resistance of the matrix, but in this case Mo is not sufficiently present which can increase the wear rate.
It is well known that Mo and Ni improves the hardenability to a certain extent but too much of soft phase like Ni would lower the hardness of the part and increase the wear rate as Ni remain in the microstructure as isolated islands

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