

Engine Sudden Stopped after the Heavy Noise: Study on Crankshaft

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i. Abstract: The main engine shaft driven round by the piston is called Crankshaft. Crankshaft converts reciprocating motion of the piston into rotary motion. Crankshaft rotates at high speeds and bears the stresses due to power impulse during power stroke. Counterweight balance the forces caused due to out of balance of the crank offset from shaft axis.

Crankshaft of an engine has to be designed for strength and stiffness against bending and torsion stresses due to gas loads and also to take care of stress due to vibration and provide sufficient bearing area to suit the bearing pressure. Crankshafts have drilled oil passages through which oil flows from the main to the connecting rod bearings. The power impulses tend to setup twisting vibration in the crankshaft. When a piston makes down on its power stroke, it thrusts, through the connecting rod, against a crankpin with a force that may exceed 2 tones and this motion is called torsion vibration.

Experimental was conducted on Heavy Commercial Vehicle engine that excessive blow by as well as excessive engine oil consumption and as a result engine sudden stopped after the heavy noise.

Key words: ig end bearing, counter weight balance, Crankshaft, Parent Bore, Torsion vibration, whipping action.

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1. INTRODUCTION:

Crankshaft are usually made of steel, carbon steel, nickel steel, nickel chromium and it should passes the : it must be strong enough to take the downwards thrust ; and it must be well balanced to climate undue vibration resulting from the weight of the offset cranks.

For maximum bending stress moment is expected to occur when the crank shaft of TDC. The distance between the bearings usually about 1.5 times the cylinder bore (D).

$F = \text{Maximum force,}$

$$= \frac{\pi}{4} D^2$$

$= \text{Where, } P = \text{gas pressure intensity.}$

Maximum Bending B.M., will be under the load P and is equal to, $M = \frac{Fl}{4}$, Allowable bending stress, $f_b = \frac{M}{Z} = \frac{Fl}{4Z}$

Where, $Z = \text{Section modules}$,

$$= \frac{\pi(d)^3}{32}$$

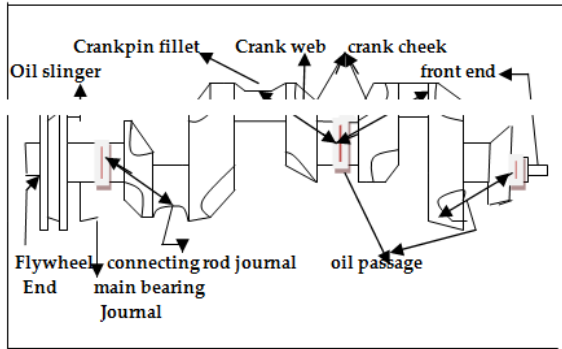


Fig: 1(a) Crankshaft carries lubricating oil. From the figure, crankshafts have drilled oil passages through which oil flows from the main to the connecting rod bearing.

2. LITERATURE REVIEW:

From the above, review is emphasized on connecting rod bearing and parent bore i.e. without bearing shells and with shells, because engine sudden stopped after the heavy noise.

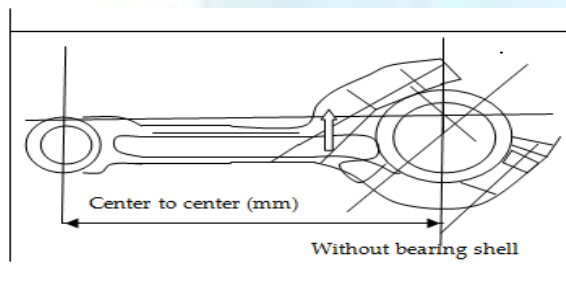


Fig: 2(a) Connecting Rod Bearing & Parent Bore.

At the review study, Big and bearing diameter (with shells installed) gauge set at 60.00 mm and for the connecting Rod Big end and Parent bore gauge set at 66.00 mm and measuring the following way (after 6755 kms):

Big end bearing diameter (with shells installed)						
Measuring Direction	1	2	3	4	5	6
A mm	60.20	60.09	60.10	60.25	60.10	60.20
B mm	60.25	60.09	60.15	60.20	60.15	60.20
C mm	60.20	60.15	60.12	60.16	60.05	60.28
Ovality mm						

Connecting Rod Big end Parent Bore						
A mm	65.98	65.98	65.99	65.99	65.98	65.97
B mm	65.99	66.00	66.01	66.00	66.01	66.01
C mm	60.01	65.99	66.00	66.00	66.00	65.98
Ovality mm						

Table No. 2(b) Engine Inspection Sheet. (Connecting Rod, TDV)

From the above data, Crankshaft provides sufficient bearing area to suit the bearing pressure. In terms of maximum shear stress, maximum torque on the shaft when crank makes approximately angle 90 ° with the connecting rod. The connecting rod constitutes the intermediate link between piston and crankshaft.

$F = \text{Force on the Piston} = \frac{\pi}{4} D^2 p_e$

Where, $F_e = \text{Gas Pressure on the piston for the above crank position,}$

$F_e = \text{connecting rod thrust} = \frac{F_e}{\cos \theta}$

And, $T = \text{Maximum torque} = F_e \times r$

$f_s = \text{allowable shear stress} = \frac{T \times 16}{\pi(d)^3}$

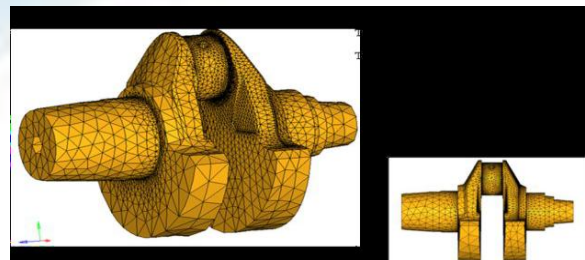


Fig2©:finite element meshing of crankshaft (Source: Volume 3, Issue 2, February-2016, pp. 81-86 www.ijcert.org)

3. METHODOLOGY:

Experimental study as complain reported,
 "Engine stopped after the heavy noise".

- 3.1. Engine No: 692 DOI 4 398 76
- 3.2. Chassis No: 364073 424566.
- 3.3. R.L.W. kgs : 15600
- 3. 4. K.M: 060755
- 3.5. Model: 1210 B
- 3.6. Type: SE/42
- 3.7. Crankshaft No: 49130906
- 3.8. Observation:

During the study, the following crankshaft Main & Big End Bearing Journals found that.....

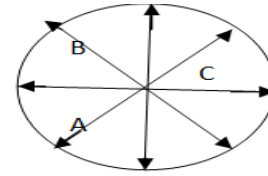


Fig: 4(a) Direction A,B, & C - 60° APART.

Item Checked	Investigation	Remarks
1. Engine	Found water & Oil leaking from all The side of the engine, after dismaltng And on follow.	
2. Cylinder Block	Found checked from camshaft bas and 2 nd parent bore rib.	
3. Cranks-Shaft	Found Ist counter weight both screws shared off from its head. Counterweight Found between into 3 pieces. Both the Broken piece of screw found into three Hole. Torque on other counter weight Found 10 mkg. Heavy hitting mark on Crankshaft web.	
4. Camshaft	Found having heavy hitting mark of Ist , 2nd and 3rd cam lobes.	
5. Timing Gear hou.	Found teeth damaged of timing Gear housing.	
6. Tappet	No.1, found broken.	
7. Push rod	Found all bent.	
8. A.C. Connecting Rod bearing	Found scored.	

Table No 3(a) : observation report. (TDV)

4. RESULT AND DISCUSSION:

Replace damaged parts and refit aligns same and found OK.

However, in terms of design of cap for big end bearing, he cap is usually treated as a beam simply supported at the bolt centre and loaded in the manner intermediate between uniformly distributed and centrally concentrated load.

Measurement in Direction									
Journal No.	Main Journal	Gaug set 73.00 mm	Big end	Gauge set 60.00 mm					
		A	B	C	ovaility	A	B	C	ovaility
1	aa	73.00	72.99	73.00	.01	59.99	59.98	59.98	
	bb	72.99	73.00	73.00	.01	60.00	59.99	59.99	
	cc	72.99	72.99	72.99	.00	59.99	59.99	59.98	
Tapper									
2	aa	73.00	72.99	72.00	1.00	60.00	59.98	59.99	
	bb	73.00	72.00	73.00	1.00	59.99	59.99	59.99	
	cc	72.99	72.99	72.00	0.01	59.98	59.99	59.99	
Tapper									
3	aa	73.00	72.99	73.00	0.01	59.98	59.98	59.99	
	bb	73.00	73.00	73.00	0.00	60.00	59.99	59.99	
	cc	72.99	72.00	73.00	0.01	59.98	59.98	60.00	
Tapper									
4	aa	73.00	73.00	73.00	0.00	59.99	60.00	60.00	
	bb	72.99	72.99	72.99	0.00	60.00	60.01	60.00	
	cc	73.00	73.00	72.99	0.01	60.00	60.00	60.00	
Tapper									
5	aa	73.00	73.00	73.00	0.00	59.99	59.99	60.00	
	bb	72.99	72.00	72.99	0.99	60.00	59.98	60.00	
	cc	72.99	72.99	72.99	0.00	59.99	59.99	60.00	
Tapper									
6.	aa	73.00	73.00	72.99		59.99	59.99	60.00	
	bb	72.00	72.99	72.99		60.00	60.00	59.99	
	cc	72.99	72.99	72.99		59.99	60.00	59.99	
Tapper									
7.	aa	73.00	72.00	73.00					
	bb	72.99	72.99	72.00					
	cc	72.99	72.99	72.00					
Tapper									

(Crankshaft, TDV)

Referring from the above as example:

The crankpin of an automobile crankshaft is 5 cm in diameter and 7 cm long. Design and prepare a working sketch of the big end bearing of the connecting rod to be made of steel forging having a permissible tensile strength of 700 kg/cm². The distance between the centre lines of the holding down bolts is to be kept 7.5 cm and the maximum load on the cap is limited to 450 kg. The working stress in the bolts is not exceeding 400 kg/cm². Collar thickness of brasses may take as 1 cm.

Solution:

$$\text{B.M.} = \frac{450 \times 7.5}{6} = 663 \text{ kg.cm}$$

$$\text{And } Z \text{ of the section} = \frac{1}{6} lt^2$$

Where, b = width of the cap,
 = length of the bearing – thickness collars,
 = $7 - 2 \times 1 = 5 \text{ cm}$.

And, t = thickness of the cap

$$\text{B.M.} = f_t \times Z$$

$$\therefore 663 = 700 \times \frac{1}{6} \times 5 \times t^2$$

$$\therefore t^2 = 0.968$$

$$\therefore t = 0.982 \text{ c, say } 1 \text{ cm.}$$

The general practice is to design the bolts assuming that each bolt takes 1.3 cm times its usual shear of load.

$$\therefore \text{Load per bolt} = 1.3 \times \frac{450}{2} = 292.5 \text{ kgf,}$$

$$\therefore 292.5 = \frac{\pi}{4} d_e^2 \times f_t$$

$$= \frac{\pi}{4} \times d_c^2 \times 400$$

$$\therefore d_c^2 = \frac{292.5 \times 4}{\pi \times 400}$$

$$= 0.93$$

$$\therefore d_c = 1 \text{ cm (say).}$$

However, the connecting rod constitutes the intermediate link between piston and crank. It is made up of essential parts such as big end fitted over crank pin, small end fitted over gudgeon pin and shank. First theoretical section. It is to be remembered in designing the section that in the plane of rotation of the rod the ends are direction free at the crank pin and at the gudgeon pin and so the strut may be taken as a

free hinged one for buckling about the neutral axis. For buckling about y-y axis the rod is 4 times as long as for buckling about X-X.

$$I_{xx} = 4I_{yy}$$

$$K_{yy}^2 = \frac{1}{4} K_{xx}^2$$

When the web thickness is 't', flange width = '4t' and the depth = 5t. The value of K_{yy}^2 should not be less than $0.84t^2$.

In high speed engines the connecting rod of the engine has a lateral oscillation in addition to its longitudinal motion. As a result inertia forces are set up in the rod which tends to bend it in the plane of oscillation and in this regard, engine sudden stopped after the heavy noise.

5. TYPE OF DATA:

Crank shaft bearing and parent bore:

Bearing is needed for engine rotary motion between engine parts and it's called sleeve bearing and located around the rotating shaft. Connecting rod and crankshaft, which is called as main bearing i.e. split or half type and part of the shaft that rotates in the bearing is called a journal. Thrust bearing located in the clutch, a bearing that pushes against the diaphragm spring to release the clutch. Oil from the engine oil pumps flows onto the bearing surfaces. The rotating shaft journals are supported on layers of oil. The connecting rod bearings are lubricated through the oil holes drilled in the crankshaft. As the oil moves across the faces of the bearing.

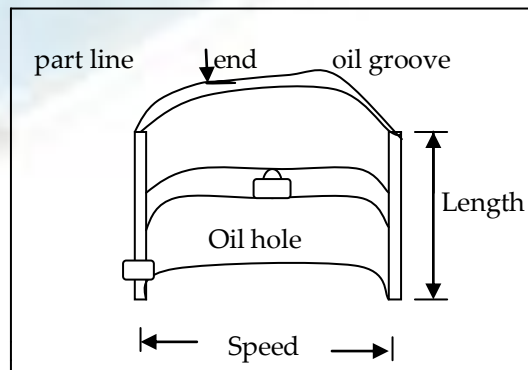


Fig: 5(a) Sleeve type bearing,

Referring the following data has been received by observation as complaint received that Oil pressure low.

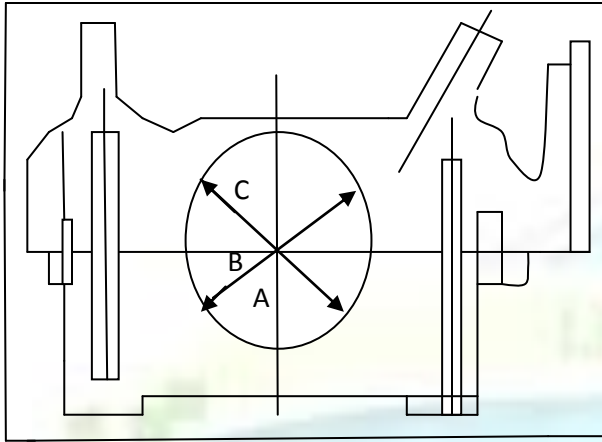


Fig: 5(b) Crankshaft with Bearing Seal.

Measurement with Bearing Shells.

Dial Gauge Set at 73.00 mm

Measuring Direction	Crankshaft Bearing No:						
	1	2	3	4	5	6	7
A mm	73.15	73.45	73.16	73.80	73.35	73.14	73.15
B mm	73.11	73.16	73.14	73.80	73.12	73.10	73.12
C mm	73.22	73.26	73.11	73.10	73.27	73.12	73.04
Ovality mm							

Measurement without bearing shells.

Dial Gauge set at 78.00

Measuring Direction	Parent Bore No.						
	1	2	3	4	5	6	7
A mm	78.03	78.05	78.05	78.02	78.05	78.05	78.05
C mm	78.04	78.05	78.02	78.03	78.04	78.05	78.05
D mm	78.05	78.05	78.05	78.01	78.04	78.05	78.05
Ovality mm							

5(c): Measurement with Bearing Shells & Without Bearing shells

6. CONCLUSION:

Oscillation, this is due to the fact that one end of rod having a motion of pure translation while the other and is fastened to the crankpin which is rotating about the fixed axis. Such an action known as whipping action, which is depending to create of the rod. The connecting rod contains bearings in its big and small end and making connection with the piston through gudgeon pin. Some connecting rods contain a direct drilled hole from big end to small end for providing passage for lubricating oil.

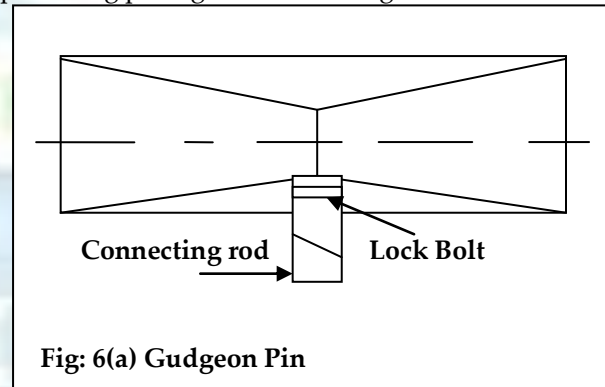


Fig: 6(a) Gudgeon Pin

As per ranking formula, towards determining the necessary dimension for end thrust on the rod:

$$Q = \frac{f_e \times A}{1 + a \left(\frac{l_e}{K} \right)^2}$$

Where, Q = buckling load,

A = cross sectional area of connecting rod,

f_e = safe compressive stress,

a = Ranking constant which depends upon the material and end condition of rod.

K = radius of gyration,

l_e = equivalent length which is equal to actual length of rod for both ends pin jointed.

7. REFERENCES:

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