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Engine Crankshaft Damper failure Investigation and Redesign

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***Abstract**: Periodically changeable gas and inertia forces which occur during operation engine generate transverse, axial and torsional vibrations of crankshafts of combustion engines. Vibrations produced in crankshafts of combustion engine are very large in amount. In order to minimize their impact an axial vibration damper is installed between crankshaft's and casing. Its technical state directly influences lifetime and reliability of engine. In this project methods of diagnosing, designing and testing of axial vibration dampers used in engines will be discussed. In order to minimize impact of axial vibration damper is installed between crankshaft's and casing. Float of crankshaft will be 0.2 – 1.39 mm which will cause damage to casing. Hence a soft damper is used to maintain a soft cushioning between casing and crankshaft.*

***Keywords**: crankshaft; damper; crankcase; bearing; ANSYS; vibration etc.*

I. Introduction

Vibration is a repetitive, periodic, or oscillatory response of a mechanical system and its effects are very common in our daily life. Suppression or elimination of bad vibrations and generation of desired forms and levels of good vibration are general goals of vibration engineering. The performance of an damper depends on various system parameters such as mass ratio, Frequency of excitation and clearance. Due to the clearance gaps between the contacting body surfaces, e.g., in slider bearings, the corresponding components of a crank train move relative to each other. To reduce these relative motions, oil is pumped into the gap between the contacting bodies. This oil and the introduced hydrodynamic lubrication reduce friction and wear of the contacting components as well as structure borne noise. Different approaches can be used for representing these contacts. Periodically changeable gas and inertia forces which occur during operation engine generate transverse, axial and torsional vibrations of crankshafts of combustion engines. Vibrations produced in crankshafts of combustion engine are very large in amount. In order to minimize their impact a axial vibration damper is installed between crankshaft's and casing. Its technical state directly influences lifetime and reliability of engine. In this project methods of diagnosing, designing and testing of axial vibration dampers used in engines will be discussed.

II. Objective and Approach

The primary objective of this project is to effectively conduct design, Structural analysis and experimental of engine with crankshaft damper. The study focuses on the procedure to calculate damper compression and damping in system. A 3D finite element model of system is developed in ANSYS to determine the required results. This study is intended to provide tools that ensure better designing options for Vibrating Systems with Damper.

1. To Identification of failure and cause of Damper.
2. To Modelling of Engine crankcase, crankshaft and damper
3. To Existing damper FEA and result correlation.
4. To Crankcase modification for better compression of damper around 360deg.
5. To modified damper FEA with new stack-up of crank shaft and crankcase.

III. Problem Statement

Mostly all elements in their physical existence are vibrating at some frequencies due to which they fail before their designed life by imposing various ill-effects on its surrounding. For a frequency of excitation equal to their natural frequency, the element/ body is subjected to reach very high amplitude due to resonance. So various techniques to arrest that vibration are being developed. One of the techniques is to introduce Damper in between the vibration so that energy can be absorbed by free mass known as damper between them can be used. Dampers can be constructed in tiny size and can work for wide range of applications along with very small mass replacement to conventional viscous damping system.

IV. Theoretical Calculations and consideration

Table I below shows tolerance variation of parts of which will decide damper compression. A fixed available space between crankshaft and crankcase will be constraint for damper dimension. So only variation in shape of damper button can be done to achieve the compression percentage within 8 – 45% above or below which is unaccepted as either damper will be loosen while in work or will become hard due to high compression and will lose its characteristics. Table II shows preload calculations.

Table I Shows Damper Assembled stack up.

Damper Design	Description	Unit	Basic Dimn	Lower Tol	Higher Tol	Min	Max	Mean
Crankcase LH	Bearing resting face Dist from datum	mm	39.2	-0.1	0	39.1	39.2	39.15
Crankcse RH	Damper resting face Dist from datum	mm	44.8	0	0.1	44.8	44.9	44.85
Gasket	thickness	mm	0.4	-0.04	0.04	0.36	0.44	0.4
	C'Case RH + Gasket + C'Case LH	mm				84.26	84.54	84.4
Damper	Damper Width	mm	3.4	-0.2	0.2	3.2	3.6	3.4
	Steel Plate Thickness		0	0	0	0	0	0
	Rubber Thickness					3.2	3.6	3.4
Crankshaft RH	Brg rest face Dist from crankpin Boss	mm	18.8	-0.05	0	18.75	18.8	18.78
	Crank Pin boss Width	mm	18	-0.05	0.05	17.95	18.05	18
	Brg rest face Dist from Web (stem side) Face	mm				0.7	0.85	0.77
RH Side Brg	Bearing Width	mm	16	-0.15	0	15.85	16	15.93
Crankshaft Assly	Crank LH side brg to Crank RH Web face dist	mm				65.05	65.3	65.18
Crankshaft Assly	Crank Brg to Brg Dist	mm				81.6	82.15	81.88
	Damper Compression					0.26	1.49	0.88
	Damper Compression %	Only rubber will compress				8%	41%	26%

Table III Calculations of Preload

Type M	Class	Pitch (mm)	Dkm (mm)	Torque (kg.m)	Axial_Force(Fsp) (N)	Co-eff of Thread Friction	Describtion
M6X1	4.6	1	18	1.20	3,700	0.120	Head Cover Bolts (4)
M6X1	4.6	1	8	1.20	11,503	0.120	Tensioner bolts (2)
M6X1	4.6	1	8	1.10	10,544	0.120	All Flange Bolts M(6)
M10X1.25	4.6	1.25	14	6.20	37,303	0.120	Mounting Bolts (4)

V. Finite Element Analysis

Structural Analysis is solved with Bolt Tightening effect by applying preload to all bolts in crank case. Contact pressure and contour is observed for damper for distribution of tightening load on damper. Below image shows damper buttons of existing damper is non-uniformly loaded. This will lead to uneven loading to damper and high wear will in result. Actual wear from field is simulated by FEA. Comparatively can be observed from field issue in next image.

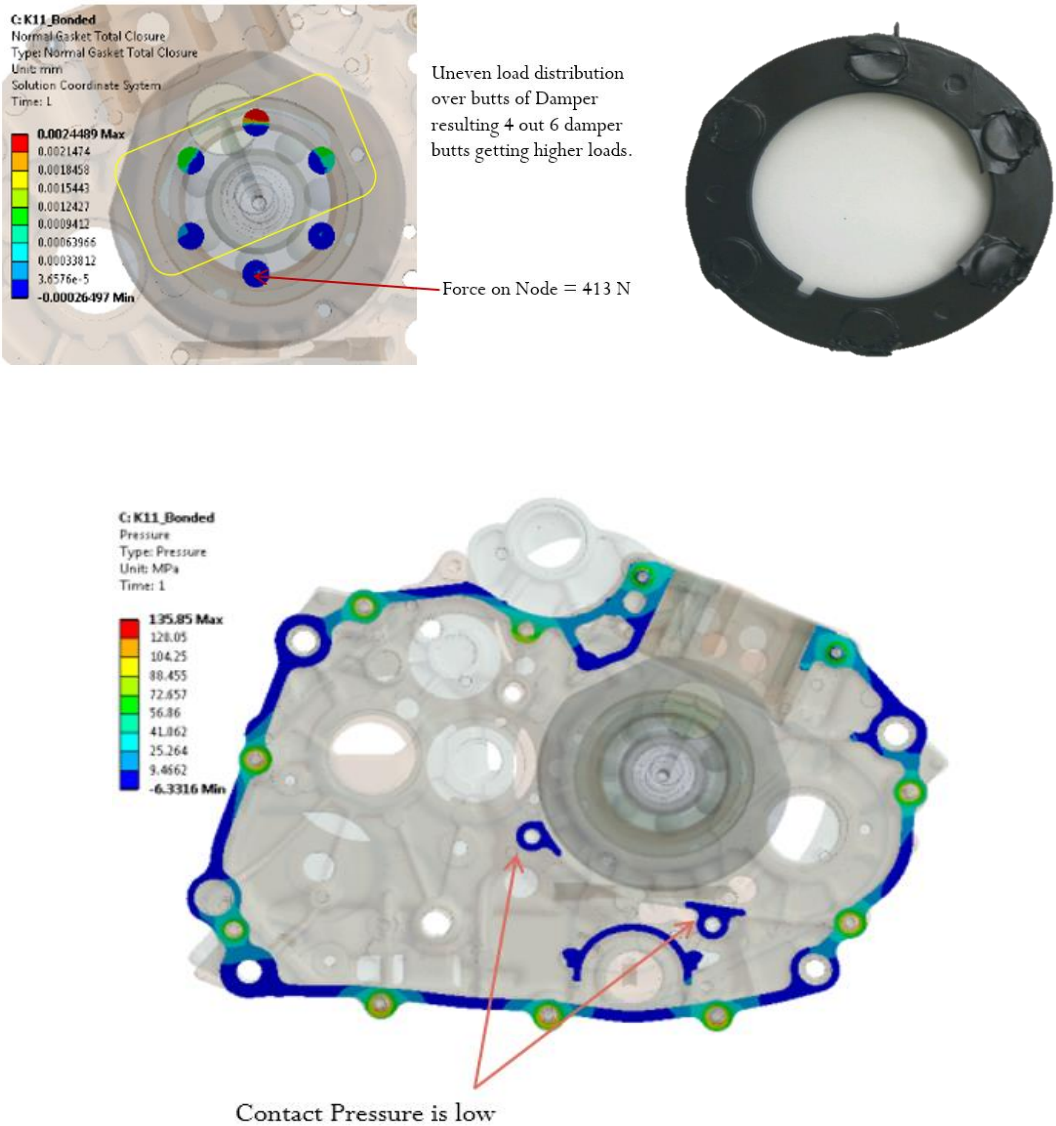

Fig.1: Non-Uniform Contact Pressure Plot

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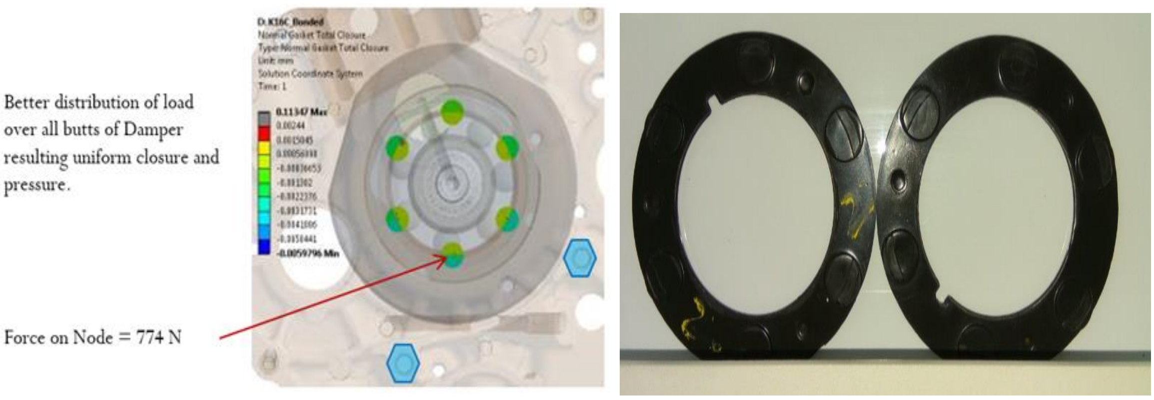
After modification in cases: Below image shows damper buttons of existing damper is uniformly loaded after addition of 2 bolts to crank case. This lead even loading to damper. But even with betterment in loading of damper high compression was observed and cut marks observed in actual engine endurance test carried on for 2 engines.



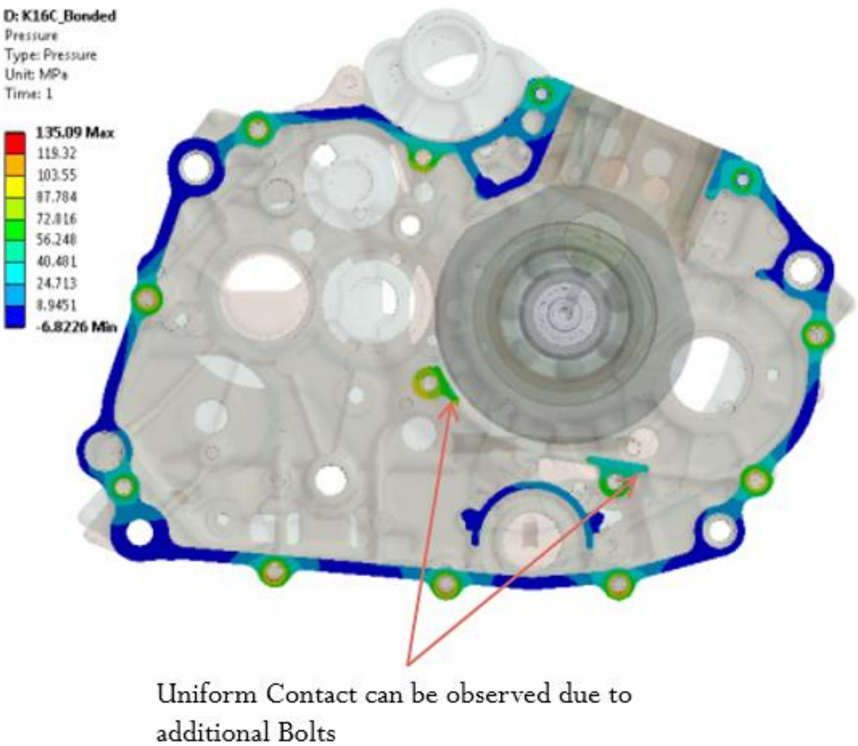


Fig. 2: Uniform Contact Pressure Plot

Uniform Load distribution observed in modified crankcase having additional 2 Bolts in vicinity of Damper. Compression of all butts of Damper observed in modified crankcase. All 6 Butts evenly loaded. Whereas for baseline crankcase load is unevenly distributed in all butts of damper. Four Butts sharing maximum load. Hence we go for new design.

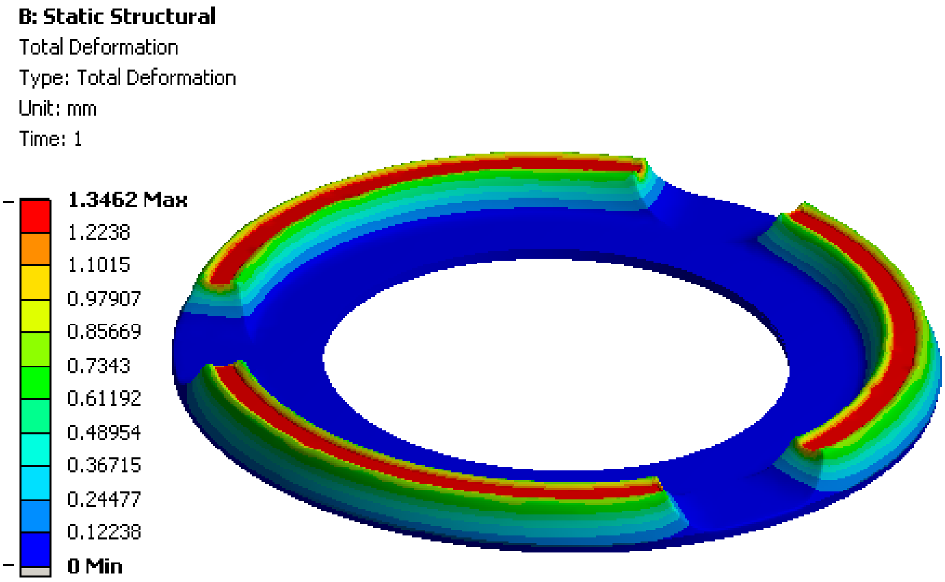


Fig. 3: Total Deformation Plot

VI. Results and Discussion

The response of different damper compression is investigated with Transient analysis to get vibration amplitude variation. More than 100 Simulations are repeated for different. As the damping increases the Velocity is increased up to certain extent and remains constant after 1 mm of compression. Below graph shows as damper height (Damper compression) is increased to certain extent the effectiveness in vibration reduction is observed, after certain level the effectiveness rapidly decreases.

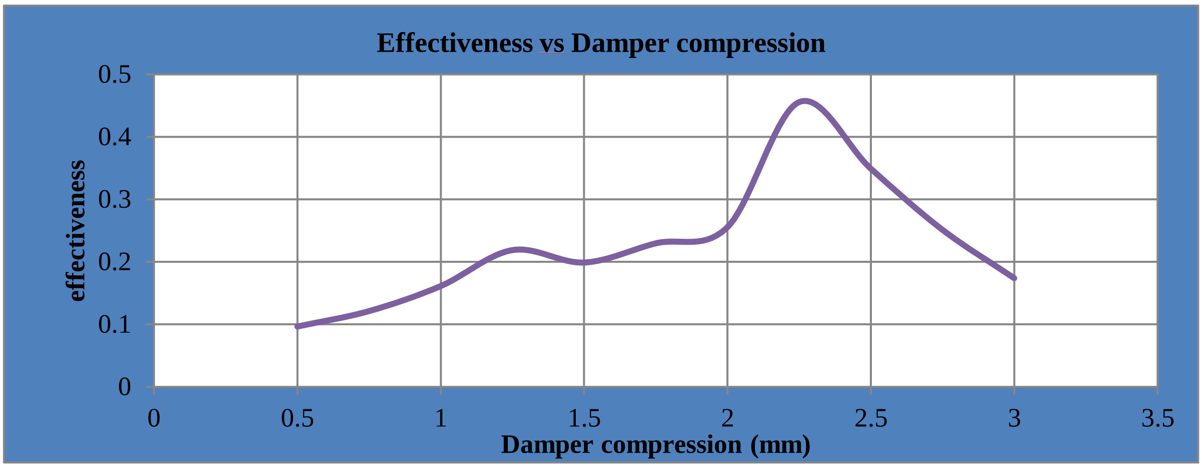


Fig.4: Plot of damper height on effectiveness

VII. Conclusion

It is concluded from survey of industry, major failure mode of engine crankshaft damper. Following conclusion have been drawn from the theoretical, software work. We have successfully find the Failure Investigation of Damper in Engine due to uneven load distribution Uniform Load distribution observed in modified crankcase having additional two Bolts in vicinity of Damper. We have successfully optimized the shape of the engine crankshaft damper.

VIII. Acknowledgments

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