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Varying Gas Pressure Effect on Connecting Rod

V. S. Konnur[1]
[1]Department of Mechanical Engineering, BLDEA's Engineering College, Bijapur, Karnataka, India

Abstract: The automotive industries in recent years are growing with a faster rate with an emphasis on the development of quieter engines to minimize noise and vibration. Hence by improving performance, contribution can be done to minimize the noise pollution. In present work the study of engine part, viz. piston is considered as main source of vibration and noise due to slap. The motion of piston in cylinder from TDC to BDC is of two types, primary motion and secondary motion. The CR top end is connected to piston pin and bottom end is connected to crank shaft, where the gas pressure effect will takes place. By using varying gas pressure it is possible to study the strress developed at the crank shaft contact surface. At different crank angle position the variation of stress developed wil be obtained in crank shaft. The pressure Vs crank angle curve will be compared with stress Vs crank angle graph. The gas pressure curve is obtained from the actual engine performance data of Kirloskar make. In this work the finite element model of the CR is developed and structural analysis is done in ANSYS11 software.
Keywords: Engines, piston, noise, vibration, secondary motion.

I. INTRODUCTION

The automotive industries in recent years is growing with faster rate with emphasis on the development of quieter engines to minimize noise and vibration, hence by improving performance contributions can be done to minimize the pollution In present work The study one engine parts VIZ Piston, Connecting Rod, crank Shaft etc are considered as the main source of vibration and noise.

The emphasis on the engine vibration and noise given rise to wide scope for methods of predicting and controlling the engine noise and vibration. Mainly noise and vibration in the IC engine is due to combustion and mechanical movement of engine part , here noise is due to combustion is primarily due to rapid pressure fluctuations in the combustion chamber those noise at most extend can be reduced with help of silencers but to reduce mechanical noise comprehensive study of Mechanical parts are required . Mechanical noise is produced by the primary and secondary motion of the engine part. Primary motion of engine part is due to combustion pressure in the combustion chamber which makes piston to move from TDC to BDC but this motion is linear in nature, this motion is desired in IC engine for transfer of motion from one part to another but this is not producing much vibration in engine as compare to secondary motion .

Secondary motion of engine parts is due to impact load due to combustion, secondary motion is transverse motion of engine part while piston moving from TDC to BDC Visa versa. transverse motion produced is not desired in IC engines because it produces piston slap , and twisting movement in the remaining engine part like pins , connecting rod & crank shaft

In the world today there are more vehicles as compared to other machines of two internal combustion engines namely petrol and diesel engines. IC diesel engines are now replacing the more expensive petrol engines. They are mostly being used as commercial engines due to high brake power and high fuel economy, although it has good economy but it produces bad noise. They are known to generate a lot of noise because of high impact of load due to combustion of diesel, as it produces secondary motion which cause piston slap and twisting in other engine parts piston slap which is the result of piston side thrust on the cylinder liners as it moves to and fro from TDC To BDC as the net effect of which makes cooling fluid in the cooling chamber to undergo in vibration . forces causing the cavities to form and failures are due to continuous series of high frequency pressure pulsation in the liquid it is fact that it s effect are very worrying The connecting rod and crank shaft assembly is one of the chief sources of engine vibration and hence will contribute to the noise. To understand this phenomenon a comprehensive study of this assembly is required, the finite element analysis is considered as one of the best numerical tools to model and analyze the physical systems. Hence the connecting rod assembly is modeled in CATIA V5 R18 and analyzed in Ls DYNA and ANSYS 11 solvers The results obtained are than compared with analytical results obtained by actual engine specifications. The noise is predicated by analyzing the deformation curves.

II. LITERATURE SURVEY

There are many technical contribution published in IC engines field and mainly the piston and piston ring dynamics in IC engines. The modeling of primary and secondary motion of piston and piston ring dynamics in IC engines. The modeling of primary and secondary motion of piston and piston ring especially FE models with 3D approach have been used to study the secondary motion with regards to predict the frictional losses and methods to reduce the friction were emphasized. Toshiaki Kobayashi et al.

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developed a new method of predicting the pistons slap noise [1]. The distortion of the cylinder liner at low temperature, the dynamic stiffness of the Piston and the cylinder block and oil film model enhancement was taken into consideration. It proved that relative change of cylinder linear vibration and subjective evaluation had high correlation with the measurement results of a real engine. The motion of the piston and rings are strongly influences lubrication and blow by in reciprocating engine [2]. The 3D finite element models of a single cylinder and four cylinders IC engines are developed to analyze the piston the piston and ring motions, the ring motion in radial and axial direction and ring twist, along with the end gap size variation are studied in details. Results are compared with those obtained by neglecting piston secondary motions. Comparative analysis of piston and ring motions between single and four cylinder engines has also been performed; it has been found that the predicted ring motion of a single cylinder engine is different from that of a multi cylinder engine [3]. The conclusion is that the piston tilt has a profound effect on the end gap variation, the ring twist and the ring lift. The piston slap is an important phenomenon in the engine, which governs the vibration, noise and the wear of the linear surfaces. It occurs due to transverse and rotational motion of the piston, which depends upon clearance between and linear is governed by geometry, mass and inertia properties of reciprocating parts and gaseous loads. The finite element method and piston transverse movement calculation technique is satisfactorily used to predict engine vibrations and noise due to piston slap [4]. S.N. Kurbet et al. presented the results of a finite element study of piston ring under assembly load in terms of induced stress and ring gap. The study included the stress analysis at the interface between the coating and substrate of ring for various lay design. Information from the analysis would serve to reduce the design performance testing cycle time and be useful in the development in the coating techniques [5].

Objectives To develop 3-Dimentional Finite Element Multi body dynamics Model of complete IC engine of real Kirlosker engine and applying Real boundary condition and working gas pressure curve of Kirlosker engine taken at 1500 rpm on piston head and observe the output. To build connecting rod model and analyze the transient dynamic analysis of connecting rod when gas force curve is applied on the connecting rod. To study stress distribution of connecting rod(CRTo build connecting rod model and analyze the transient dynamic analysis of connecting rod when inertia force of CR curve is applied on the connecting rod .To study stress distribution of connecting rod To build CR model to analyze it for Modal analysis and Harmonic Analysis.

III. FINITE ELEMENT MODELING AND PROCEDURE

An overview is given based on a literature survey of general theory for IC engine. The system is modeled using CAD software like CATIA V5 R 16 and then this model is discritized to get finite element model in meshing software like Hypermesh 9 and finite element model is then solved in LS dyna and results are observed.

Connecting rod model is imported into ANSYS 11 to do transient analysis for gas force and inertia force. After that connecting rod is analyzed for modal and harmonic analysis in ANSYS 11.Finally all results& graph are plotted in mat lab or MS office excel software

TABLE I
MATERIAL PROPERTIES

Sr. No.	Part Name	Material Name	Density	Young's Modulus		Poison Ratio
			In Kg/m3	In GPA	In N/mm2	
1	connecting rod	Forged steel (c 0.025/ en 24)	7200	206.7	206700	0.3

GAS PRESSURE

Gas pressure is taken from Kirlosker engine at 1500 rpm

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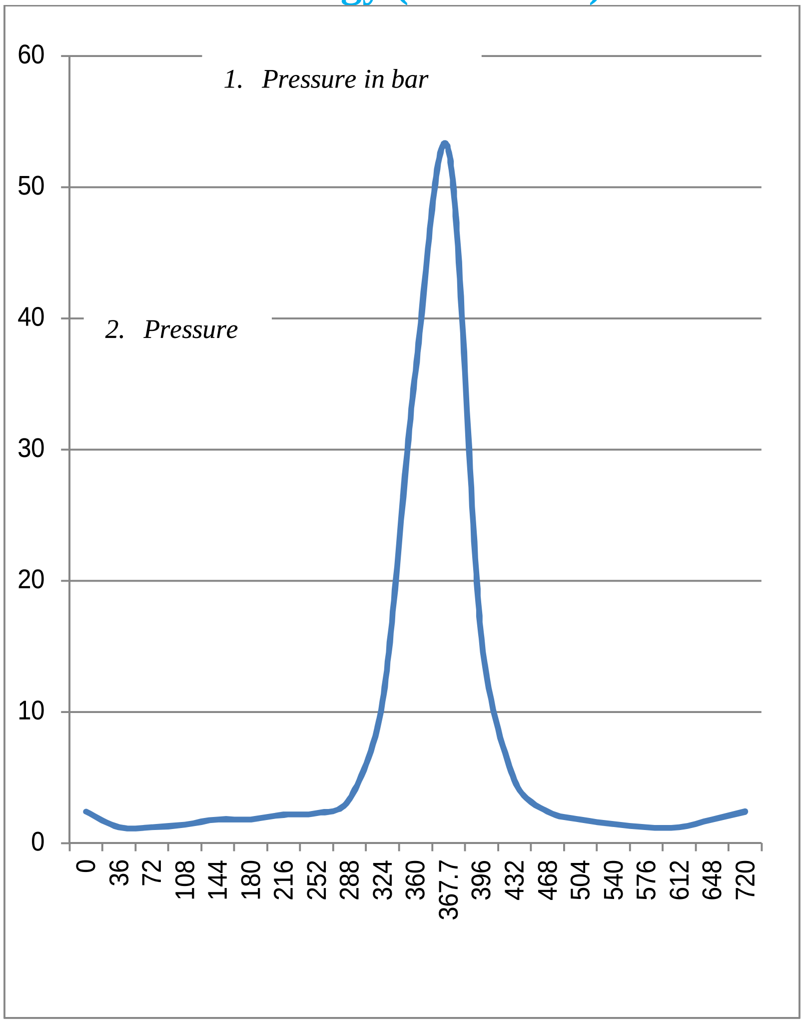

Fig. Pressure Vs Crank Angl Crank angle (θ)

θ in Deg	Time	Gas pres sure	Gas force on connecting rod
0	0	2.4	-1206.371568
36	0.004	1.2	-609.265522
72	0.008	1.2	-619.5044222
108	0.012	1.4	-722.7551592
144	0.016	1.8	-913.898283
180	0.02	1.8	-904.778676
216	0.024	2.16	-1096.702616

252	0.028	2.28	-1177.058652
288	0.032	3.36	-1734.612751
324	0.036	10.8	-5483.513078
360	0.04	36	-18095.57352
367.7	0.0408	52.8	-26807.68297
396	0.044	15.6	-8053.557488
432	0.048	4.8	-2478.017689
468	0.052	2.4	-1218.531044
504	0.056	1.8	-904.778676
540	0.06	1.44	-731.1350771
576	0.064	1.2	-619.5045538
612	0.068	1.2	-619.5045538
648	0.072	1.8	-913.9188463
720	0.076	2.4	-1206.371568

TABLE II
GAS PRESSURE TABLE

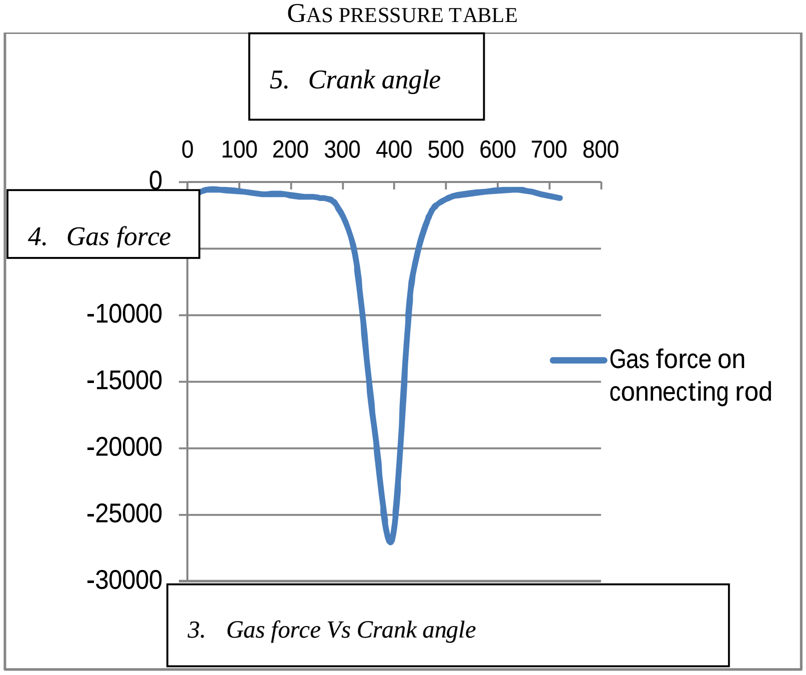

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Fig. 1 A sample line graph using colors which contrast well both on screen and on a black-and-white hardcopy

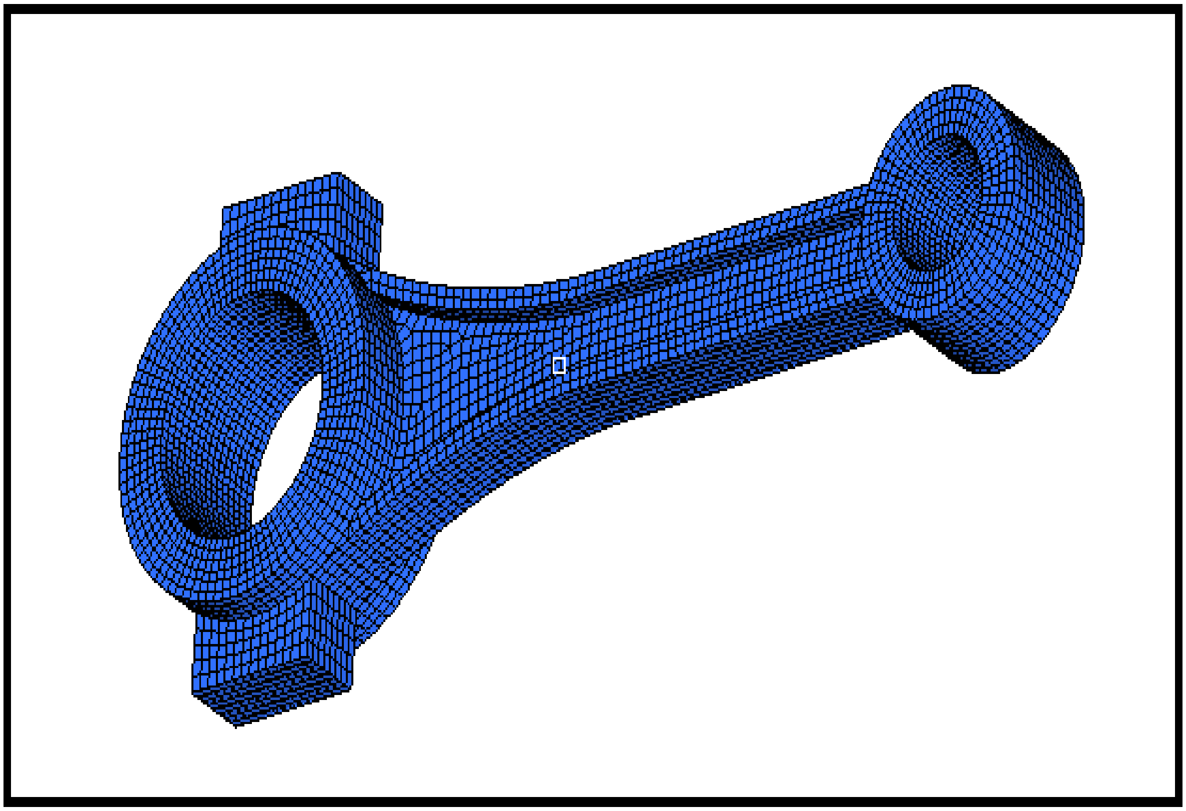

Fig. 2 Exampe of an image with acceptable resolution

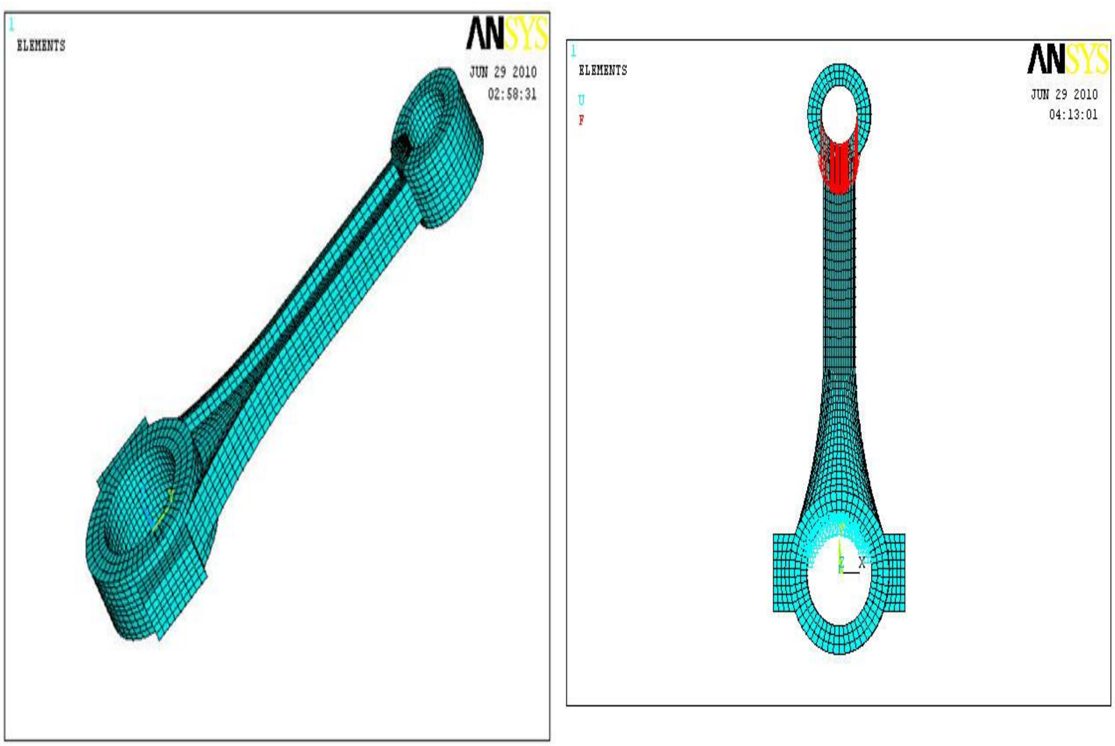

Fig. 3 Example of an unacceptable low-resolution image

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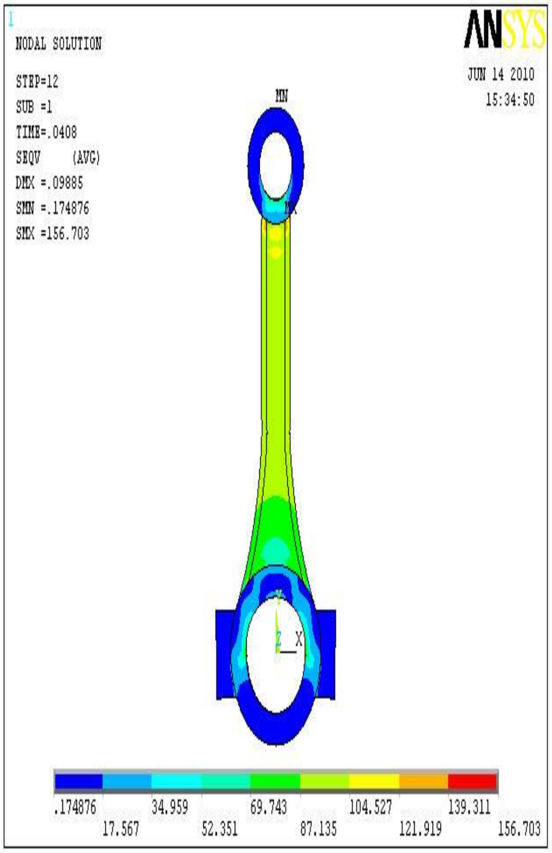

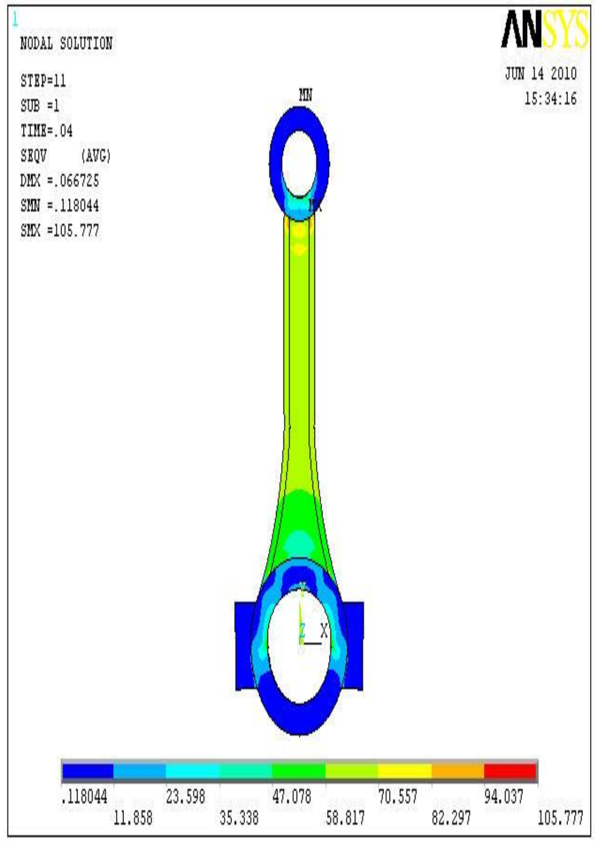

Fig shows von mises stress of connecting rod when gas force is applied on CR at 0.0408 times
Fig shows Von mises stress of connecting rod when gas force is applied on CR at 0.04 time step

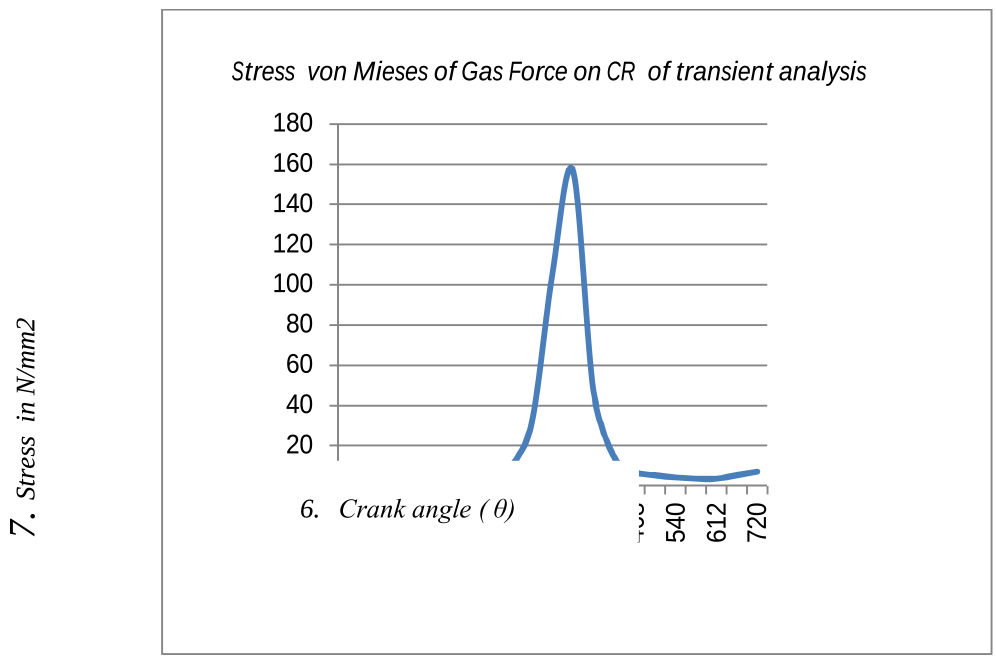

Fig Shows Von Mises Stress Vs Crank Angle when gas force as input

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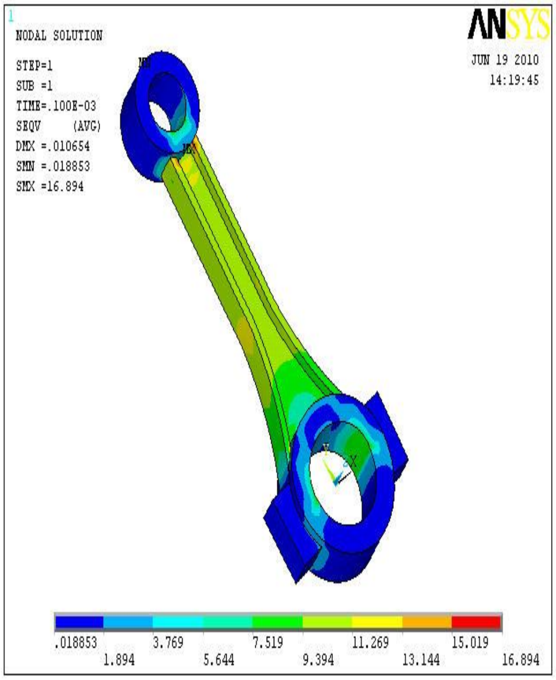
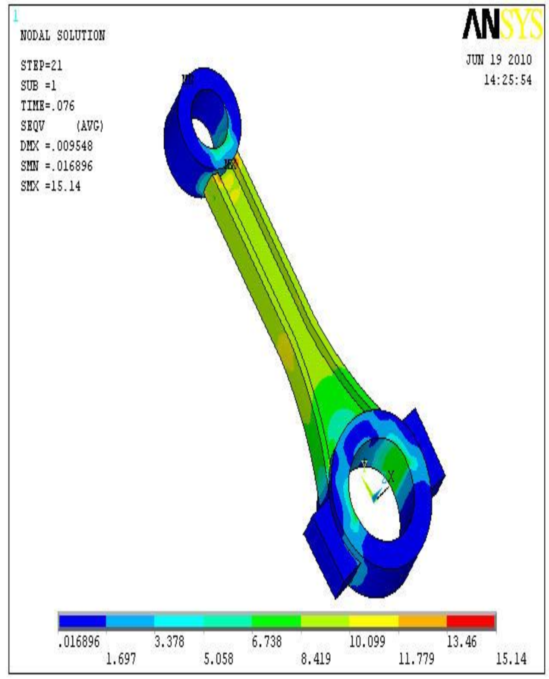




Transient Analysis Of Connecting Rod Using Gas Force Is
Fig Shows Von Mises Stress of CR when gas force is applied on CR at 0 deg or at 0.0001 t time step
Fig Shows Von Mises Stress of CR when gas force is applied on CR at 720 deg or at 0.076 time step

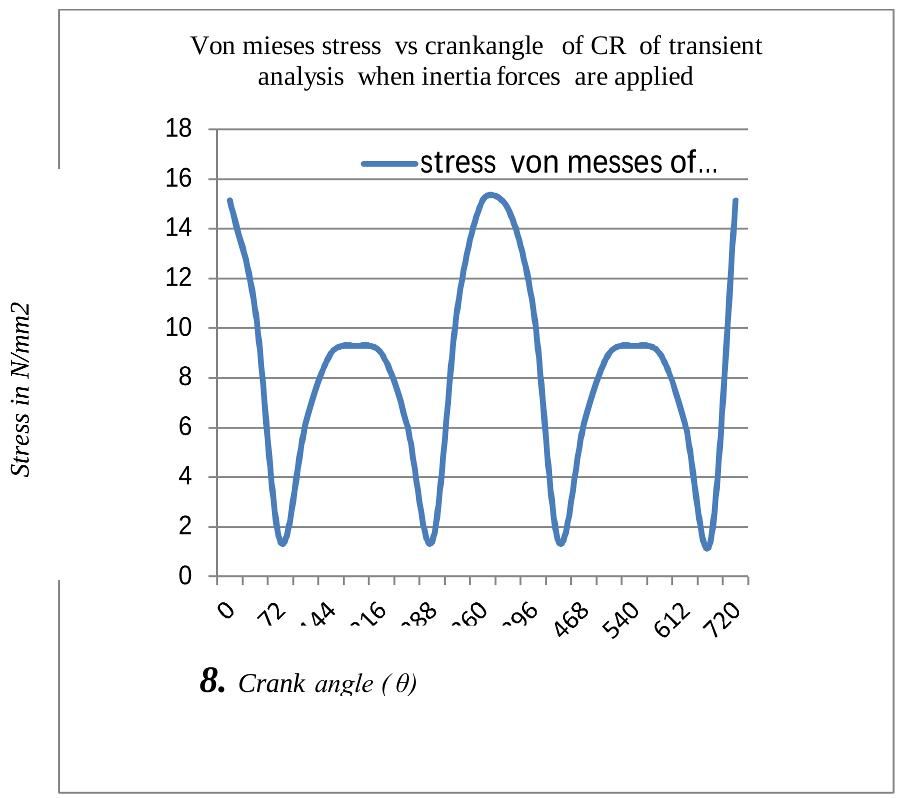
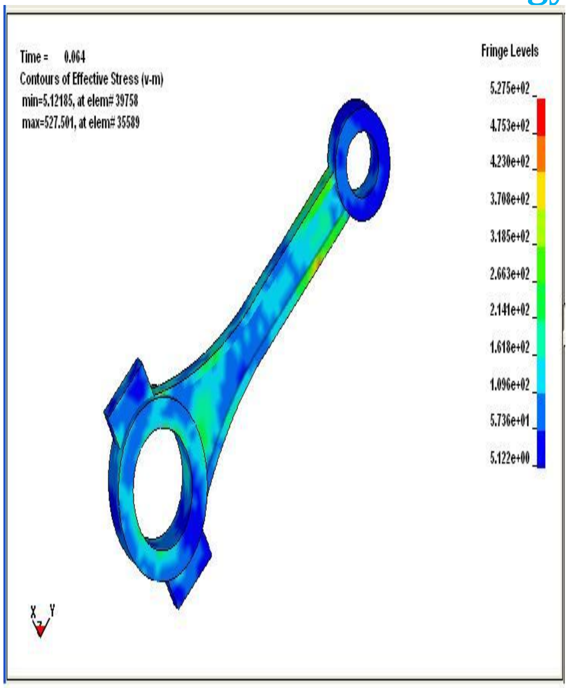


Fig Shows Von Mises Stress Vs Crank Angle when inertia force as input



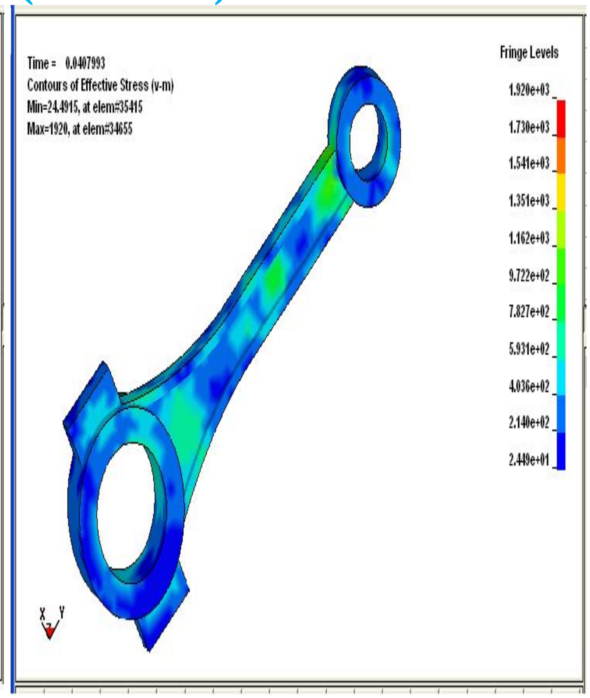


Fig von mises stress of CR from MBD analysis at time step of .064

Fig von mises stress of CR from MBD analysis at time step .0408

Von mises stress are observed for all time step and are tabulated and drawn graph of von mises stress vs crank angle

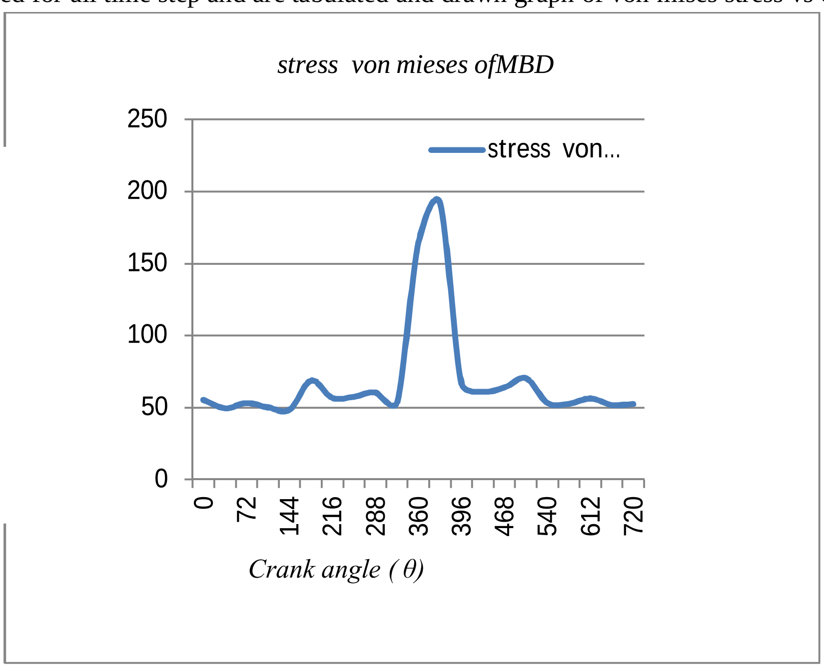


Fig Shows Von Mises Stress Vs Crank Angle of MBD analysis

IV. CONCLUSION

Detailed 3d FE model can be built to analyze the effect of vibration of cr on piston slap. The Maximum stress induced in IC engine is at 367 degree of crank angle and its corresponds to the maximum Gas pressure induced near TDC

It is observed that maximum piston –slap occurs where maximum stress occurs from MBD.When comparing MBD and transient analysis it is observed that Connecting rod has effect on piston slap when both gas force and inertia forces are applied. Means maximum stress induced in transient and MBD are at 367 degree of crank angle hence maximum Slap.It is observed from analysis that inertia force produces is less significant than Gas force. From modal analysis it is observed that CR is safe to resonance and it remains safe up to 8000 rpm. From modal analysis it is evident that CR displacement produces lateral movement of CR at all frequencies and hence piston- slap.

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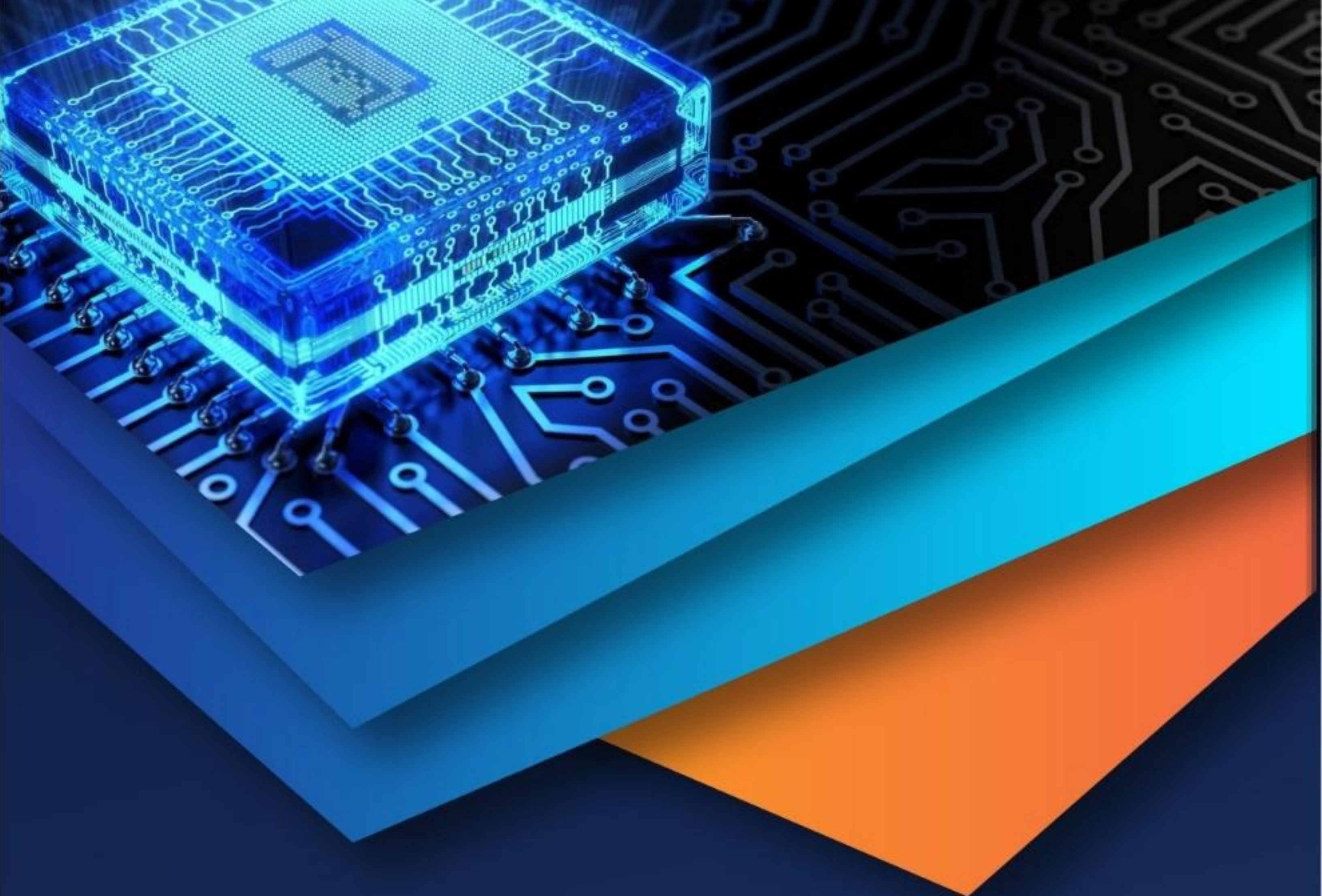

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