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Contact and Transient Analysis of Cam and Follower Mechanism

V. Saran Tej, R. Naveen, P. Siva, T. Sateesh

Department of Mechanical Engineering, Avanthi Institute of Engineering& Technology,
Thagarapuvalasa Visakhapatnam, Andhra Pradesh, India

ABSTRACT

The objective of this project is to model the design and analysis of a cam and follower. The model is created by the basic needs of an engine with the available background, such as rotation acting over the cam using valve running. Here the approach becomes fully CAE-based, CAE-based process enriches the Research and limits the time duration. Most of the IC engines used in the market have roller cam and follower mechanisms, having a line contact between the cam and the roller follower. The software (CATIA and ANSYS) tool has mainly been developed to enhance learning. Still, can readily use it to design and analyze cam and follower mechanisms for industrial applications. The model will be constructed using CATIAV5 r21 software, which is a powerful modeling and simulating the environment of dynamic systems. Contact and Transient structural analysis will be done in Ansys14.5on the valve gear mechanism for existing material and composite material. The Transient Structural analysis generates detailed information about the stress, strain, displacement, velocity, etc., of the valve gear mechanism. The contact generates detailed information about contact status, gap, pressure, and penetration of the mechanism. It also provides animation of the cam and follower mechanism

KEYWORDS: *Cam and follower, CAE, stress, ANSYS, CATIA V5 R21, transient structural, contact*

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INTRODUCTION

Internal combustion engine valves are precision engine components. The valve train system is one of the major parts of internal combustion engine, which controls the amount of air-fuel mixture to be drawn into the cylinder and exhaust gas to be discharged. The fresh charge (air - fuel mixture in Spark Ignition Engines and air alone in Compression Ignition Engines) is induced through inlet valves and the products of combustion get discharged to atmosphere through exhaust valves. This seals the working space inside the cylinder against the manifolds [1, 2, and 3]. So design of valve lift profiles and valve train components is most important for the engine performance, valve train durability, and NVH. Therefore valve train system should be optimally designed so as to avoid an abnormal valve movement, such as valve jumping or bounce up to the maximum engine speed. There are different types of valves used by the manufactures; some common types of valves being poppet valves, slide valves, rotary valves and sleeve valve. [1].

Valve gear mechanism

Valve Mechanism means simply the sequence of operation of opening and closing of the valve. In a *four-stroke internal combustion engine*, the "Poppet Valve" performed the opening of the cylinder to inlet or exhaust manifold at the correct moment. Generally, the face of the valve is ground at 45 degrees but in some cases, it is also ground at 30 degrees.

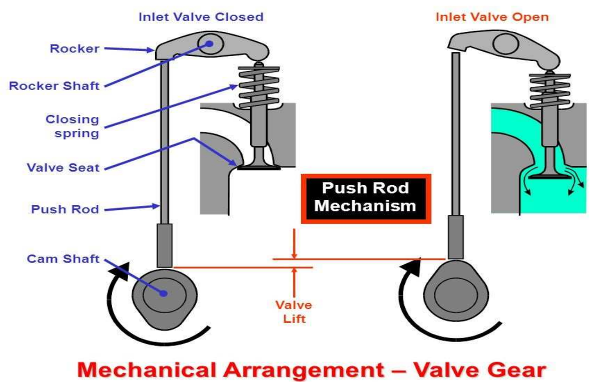

Figure.1 Mechanical Arrangement-valve gear

Figure.2.valve Gear Mechanism

Valve gear

The valve gear of an internal combustion engine provides timely admission of the fresh charge into the cylinders and exhaust gases from them. For this purpose the valves at definite moments open and close the intake and exhaust ports in the cylinder head, through which the cylinders communicate with the intake and exhaust manifolds. The valve gear consists of timing gears, a camshaft, tappets, push rods, rockers with fasteners, valves, springs with fasteners and valve guides in figure 3.

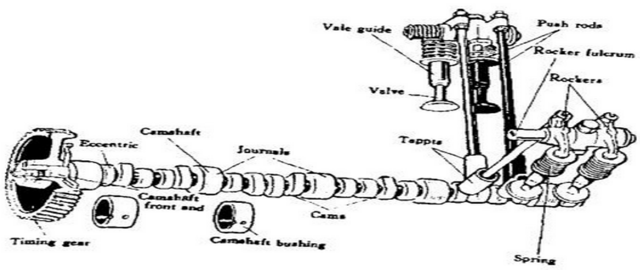

Figure.3valve gear

Timing gear

The timing gears in most engines are housed in a special case fitted at the front end of the engine. These are necessary to transmit rotation from the crank-shaft to the camshaft, fuel injection pump shaft, and to the oil pump, and other mechanisms. The gears are made of steel and use helical teeth to reduce noise.

Figure.4.Timing gear

Camshaft

Camshaft serves to open the engine valves positively and timely, in a definite sequence, and to control their closing against the return action of the valve springs. The shaft is made integral with its cams and bearing journals. Each cam controls a single valve, either intake or exhaust. The ring is 0. Ito 0.2 mm thicker than the plate, and it is this difference that determines the camshaft end play.

Figure.5.cam shaft

Computer aided modeling of valve gear mechanism

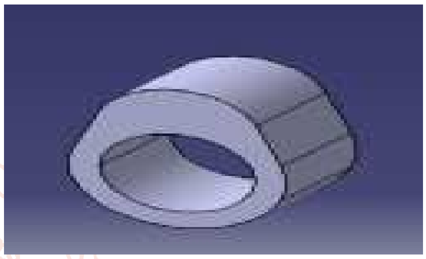

Figure.6.Cam

Rocker arm

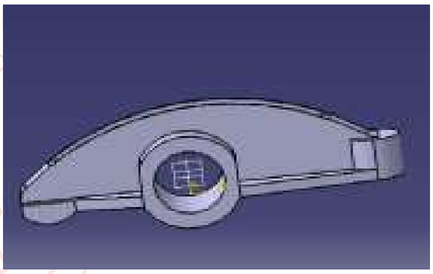

Figure.7. Rocker arm

Valve

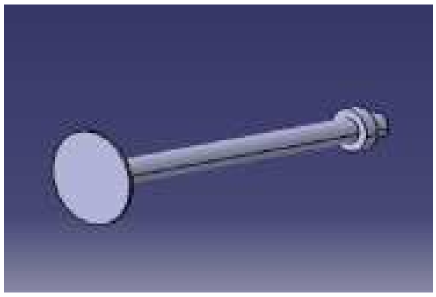

Figure.8: Valve

Cylindrical head

Figure.9. Cylindrical head

Spring

Figure.10. spring

Part assembly

Select start and go to mechanical design and then go to assembly design. Assemble all parts by using constraints (manipulators, point contact, base contact…etc)

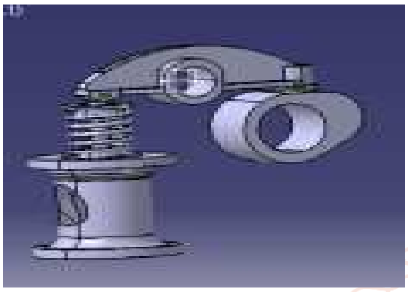

Figure.11.Assembly

METHODOLOGY

Transient Structural Analysis

There are no specific considerations for transient structural analysis.

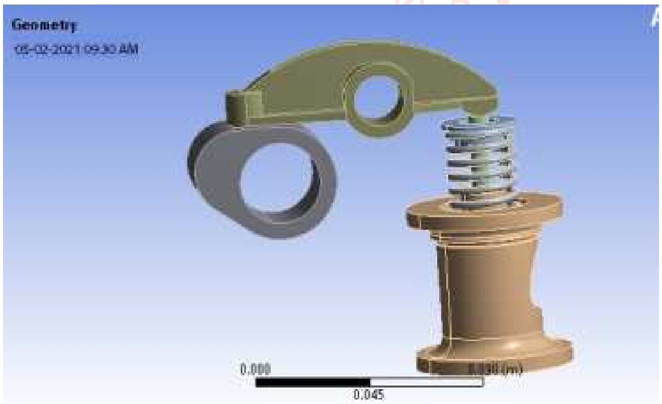

Figure.12.Geometry

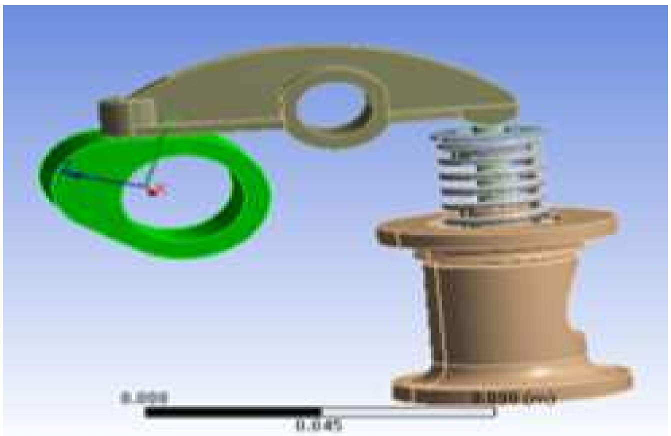

Figure.13.Part behaviour

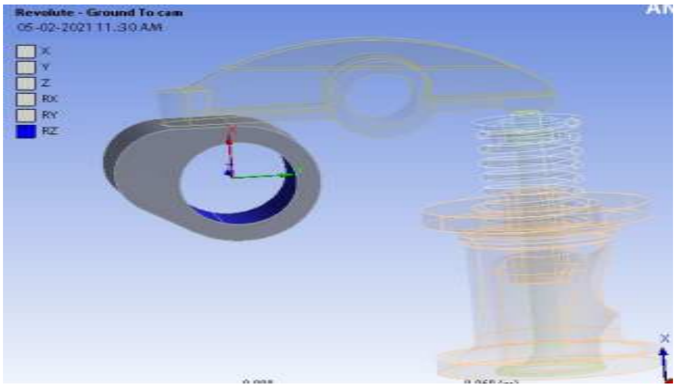

Figure.14.Joint connection of cam and rocker arm

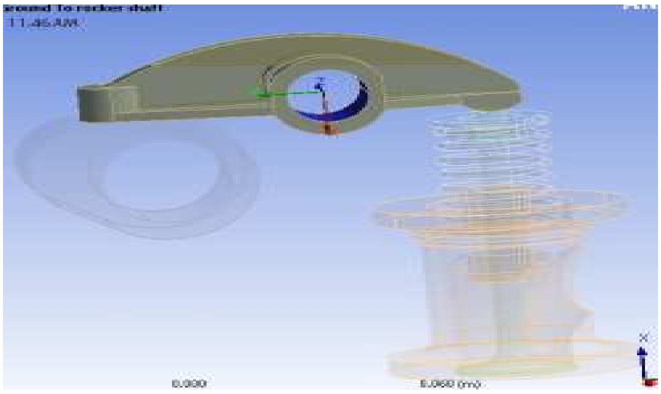

Figure.15.Joint connection of rocker arm and valve

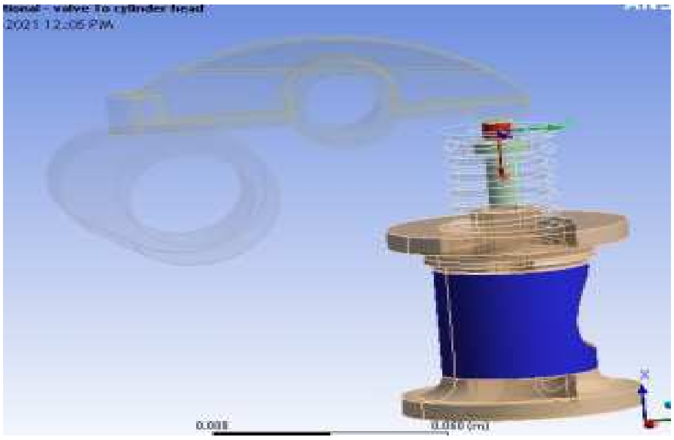

Figure.16. Joint connection of valve and cylindrical

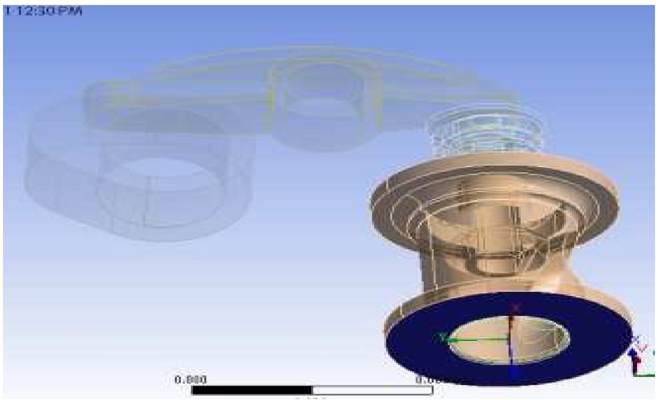

Figure.17. Base

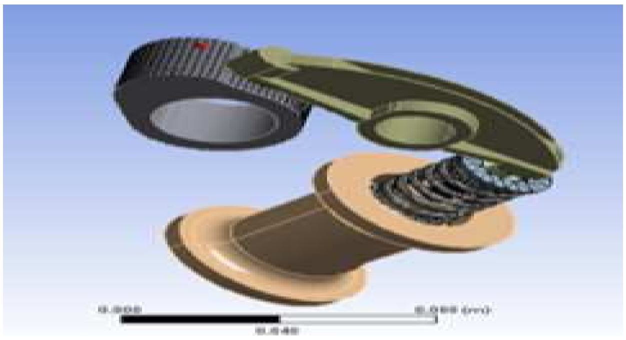

Figure.19. Meshing

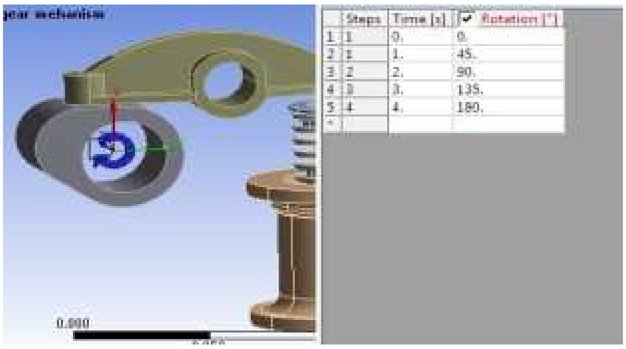

Figure.20.Loads and supports

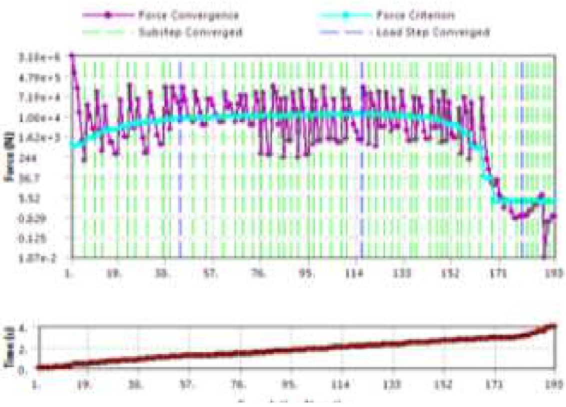

Figure.21.Solve

Case I: existing material Total deformation

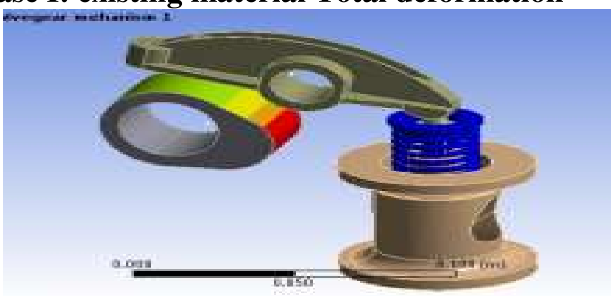

Figure.22. Total deformation

Equivalent elastic strain:

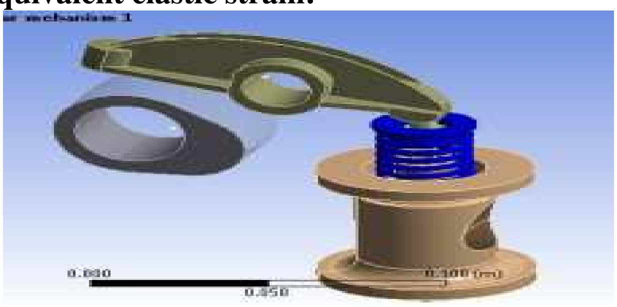

Figure.23. Equivalent elastic strain

Equivalent stress

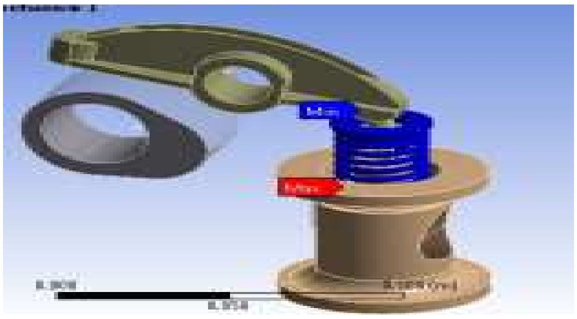

Figure.24.Equivalent stress

Safety factor

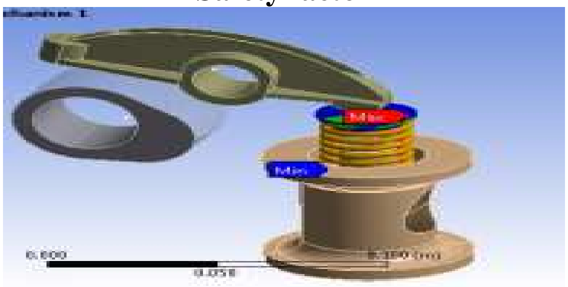

Figure.25.Safety factor

Directional deformation:

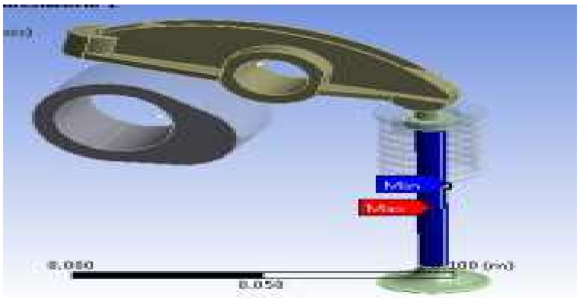

Figure.26.Directional deformation

Directional velocity:

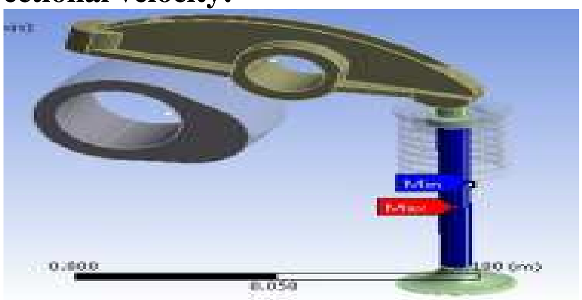

Figure.27.Directional velocity

Case II: Composite material

Total deformation:

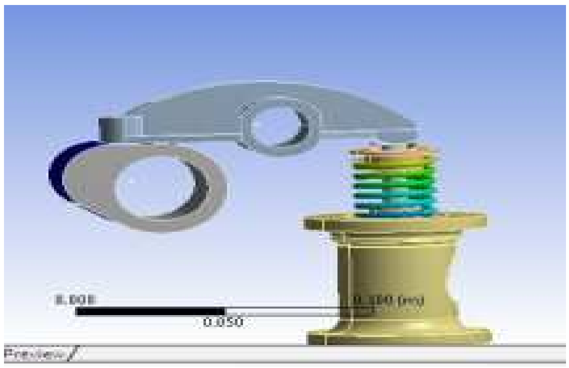

Figure.28.Total deformation

Equivalent elastic strain:

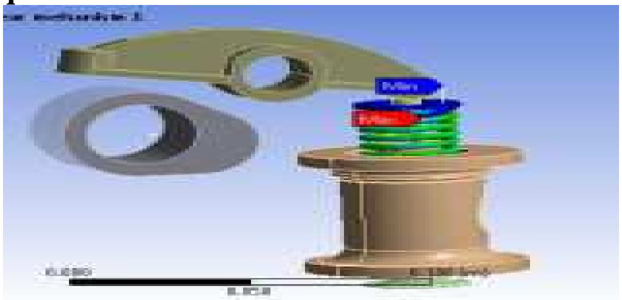

Figure.29.Equivalent elastic strain

Equivalent stress:

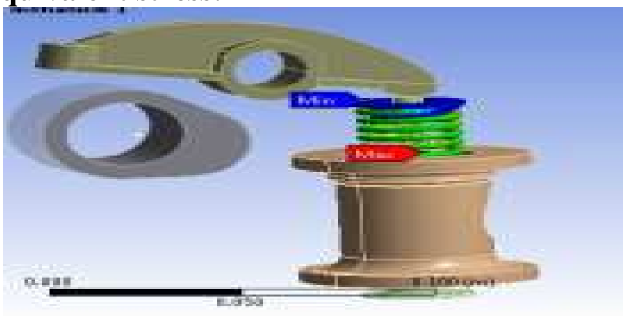

Figure.30.Equivalent stress

Directional deformation:

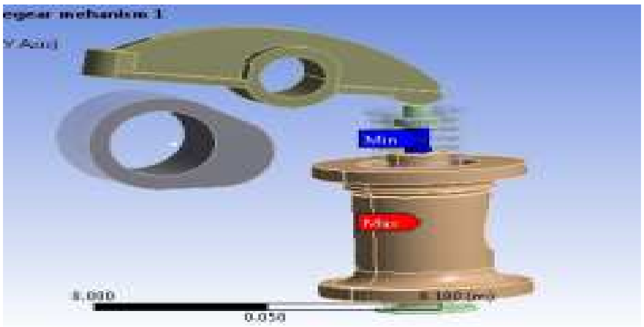

Figure.31.Directional deformation

Directional velocity:

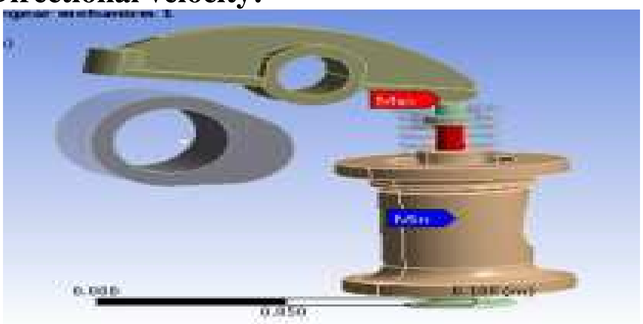

Figure.32.Directional velocity

Factor of safety:

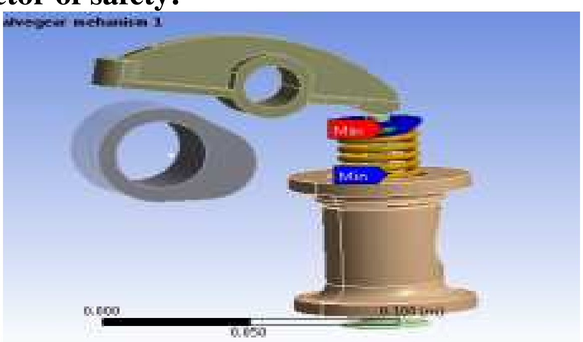

Figure.33.Factor of safety

Results of contact analysis:

Case I: existing material status:

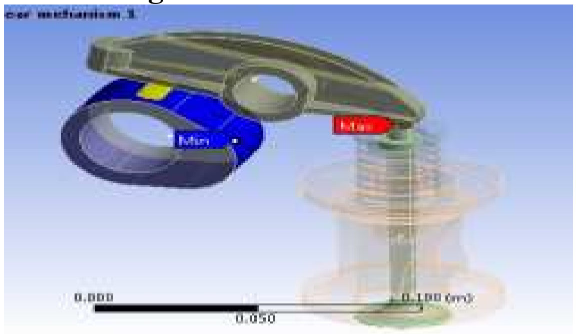

Figure.34. contact analysis

Case 2: Composite material

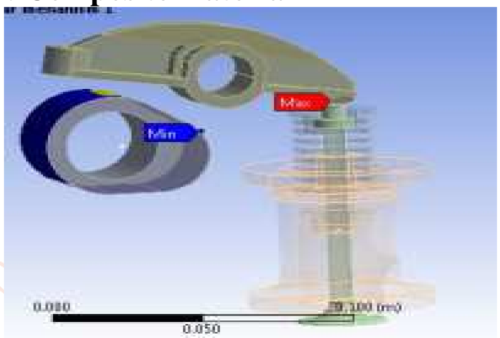

Figure.35.status of composite material

Pressure:

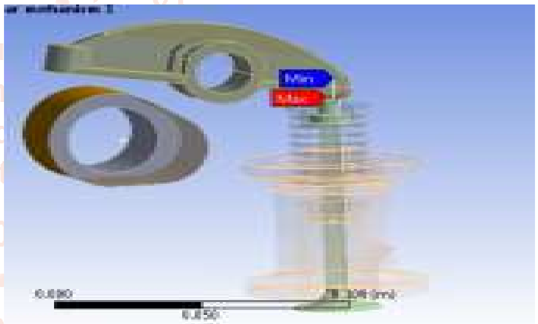

Figure.36: pressure

Penetration:

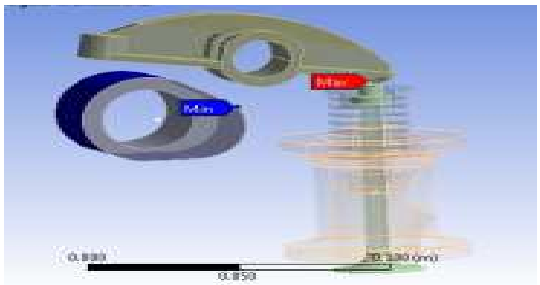

Figure.37.penetration

RESULTS& CONCLUSION

In this project, the valve gear mechanism is designed according to the design consideration and analyzed for its strength using finite element analysis. Transient structural and contact analysis is done in Ansys 14.5 on the valve gear mechanism for existing material and composite material. By observing the transient structural analysis the deformation value on existing material is high comparing to composite material.

Transient structural analysis results:

Table 1: Stress results obtained from the F.E.A.

S. NO.	valve gear mechanism	Ansys workbench value	
		existing material	composite material
1	total deformation	0.069	0.0049283
2	equivalent stress	1.12E+10	3.96E+08
3	equivalent elastic strain	0.060252	0.0024855
4	directional deformation	1.37E-11	1.37E-11
5	factor of safety	0.048919	1.3931

Stress results obtained from the F.E.A. analysis indicated the valve gear train is within acceptable levels. It was attempted to compare the F.E.A. results with that of the existing material and composite material. It was concluded the composite material in the valve train mechanism is not over stressed and fit for purpose.

Contact analysis results:

Table 2: Stress results obtained from the F.E.A with contact Analysis

S. NO.	valve gear mechanism	Ansys workbench value	
		existing material	composite material
1	Gap	0.00080414	-0.0008051
2	pressure	5.74E+08	2.22E+08
3	penetration	6.47E-08	6.43E-05

In the contact analysis, we observed that gap and penetration between the rocker arm and valve and rocker arm and cam is very very low. It is concluded that our design is under safety condition.

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