FATIGUE ANALYSIS OF CRANKSHAFT

The crankshaft is one of the most important components of an I.C engine. It converts the reciprocating displacement of the piston into a rotary motion of the crank. The main purpose of this work is to investigate the fatigue life of crankshaft under complex loading conditions. The crankshaft experiences both bending and torsion resulting from action of engine attributing to cyclic changes in centrifugal inertia forces, gas pressure and reciprocating inertia forces. Accurate prediction of fatigue life is really significant to check safety of components and its reliability.

CAD model:

The model of the cranskshaft is designed in Solidworks. The material used is Structural Steel.

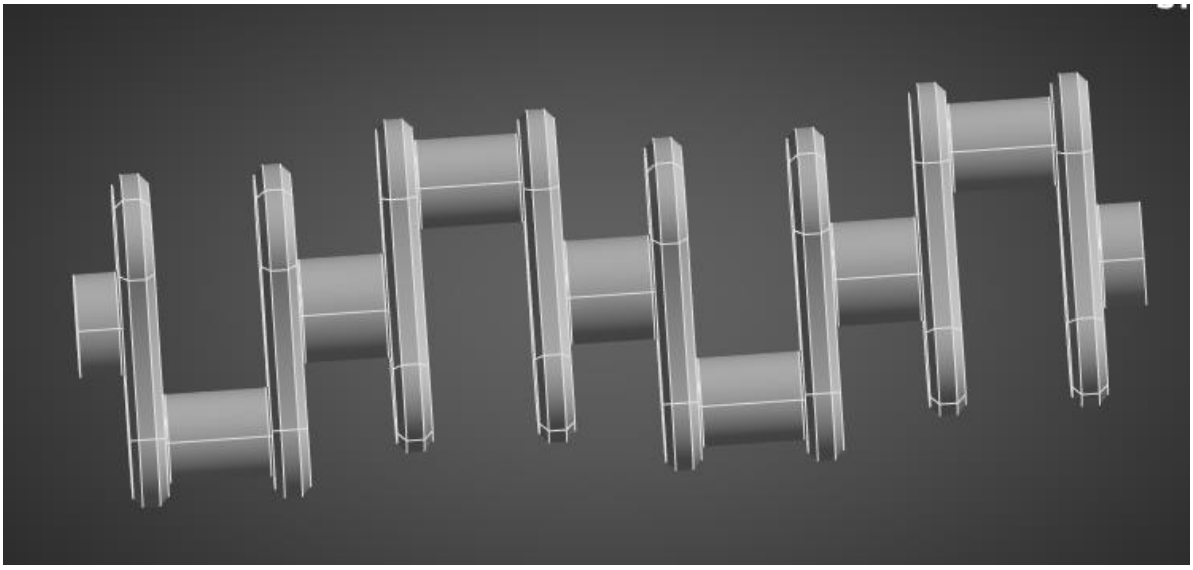

Figure 1: CAD Model of crank shaft

Material Properties	Values	Unit
Structural Steel		
Elastic Modulus	200	GPa
Density	7850	kg/m^3
Poisson's ratio	0.3	
Yield strength	250	MPa
Behaviour	Isotropic	

Static Structural Analysis:

Performed Static Structural analysis of the crankshaft in ANSYS 2024 to determine the Von Mises stress and the critical spots of the crankshaft where max stresses are developed. FEA analysis was done on the crankshaft for better life, and durability of engine mounting condition. The mesh type used is tetrahedron and convergence of the mesh is observed at 6mm element size. After meshing the number of elements found was 29291 and number of nodes was 49312.

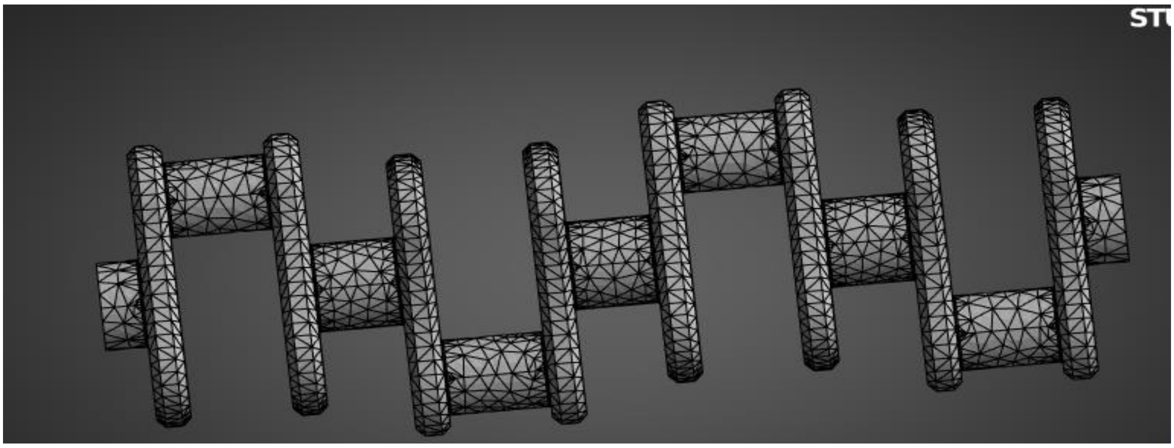

Figure 2: Mesh

Boundary Conditions:

This study is primarily concerned with load acting on the crankshaft which makes uphold because of gas pressure force internal of the cylinder; inertial force is acting because rotation of the crankshaft and the some other response forces act on the connecting rod inflicted on its working. In this paper investigation as indicated by the engine parameter and dynamic computation add up to the most extreme power of 24000N connected to check quality of crankshaft amongst static examination.

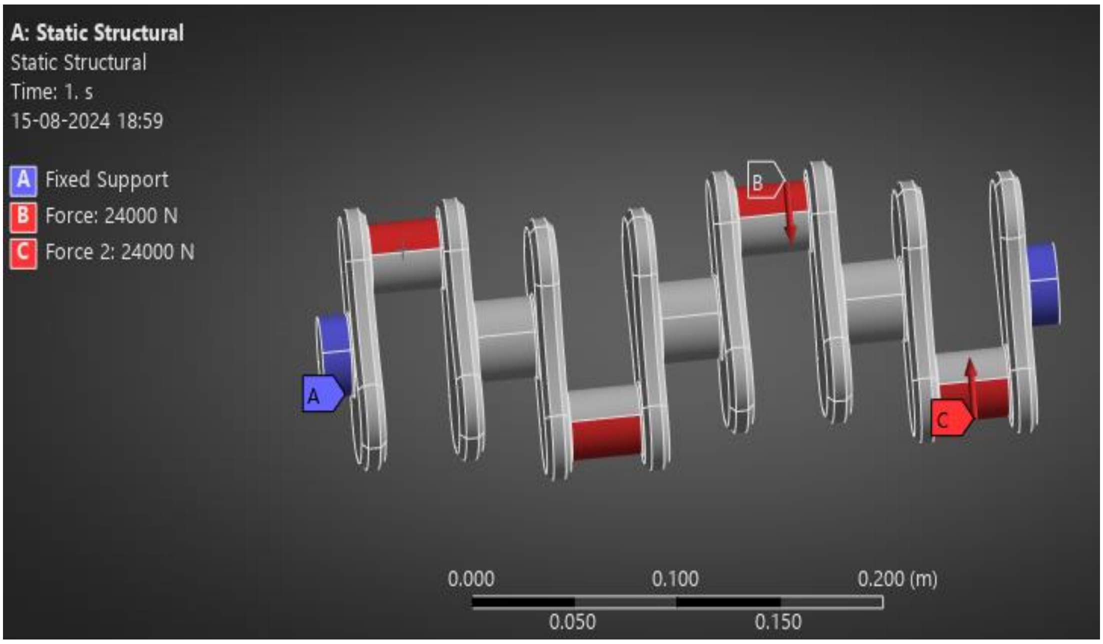

Figure 3: Boundary and loading conditions

- Maximum deformation is 0.03 mm and it occurs at the link between main bearing journal and crankpin and crank arm. The weakest area was found near the knuckle of crank portion and the extreme left bearing supported end of the crankshaft.
- The maximum value of stress at this critical point is 283.35 MPa

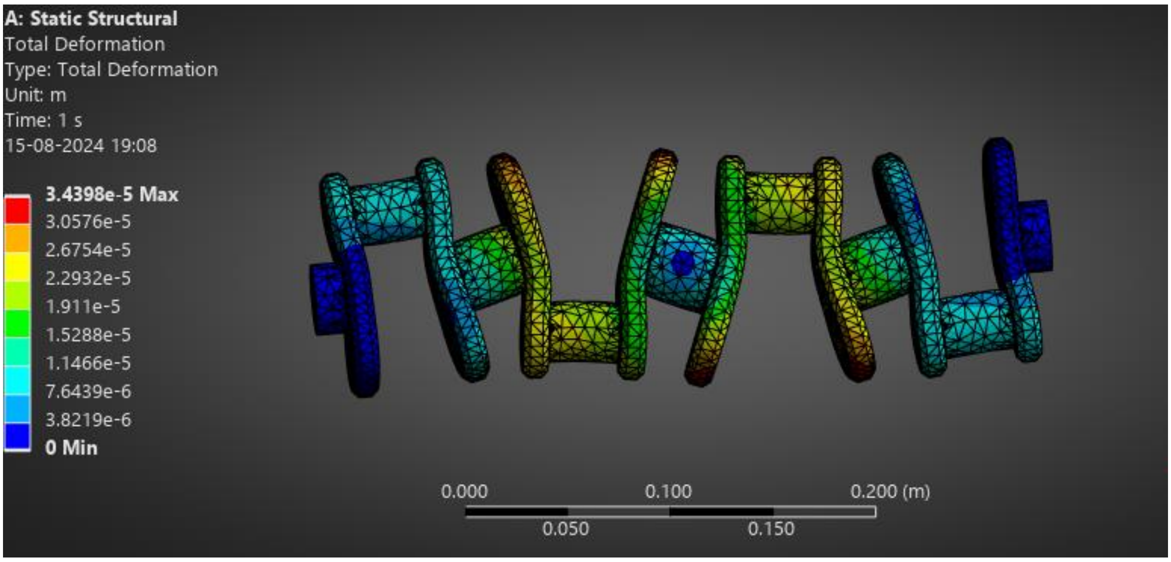

Figure 3: Total Deformation

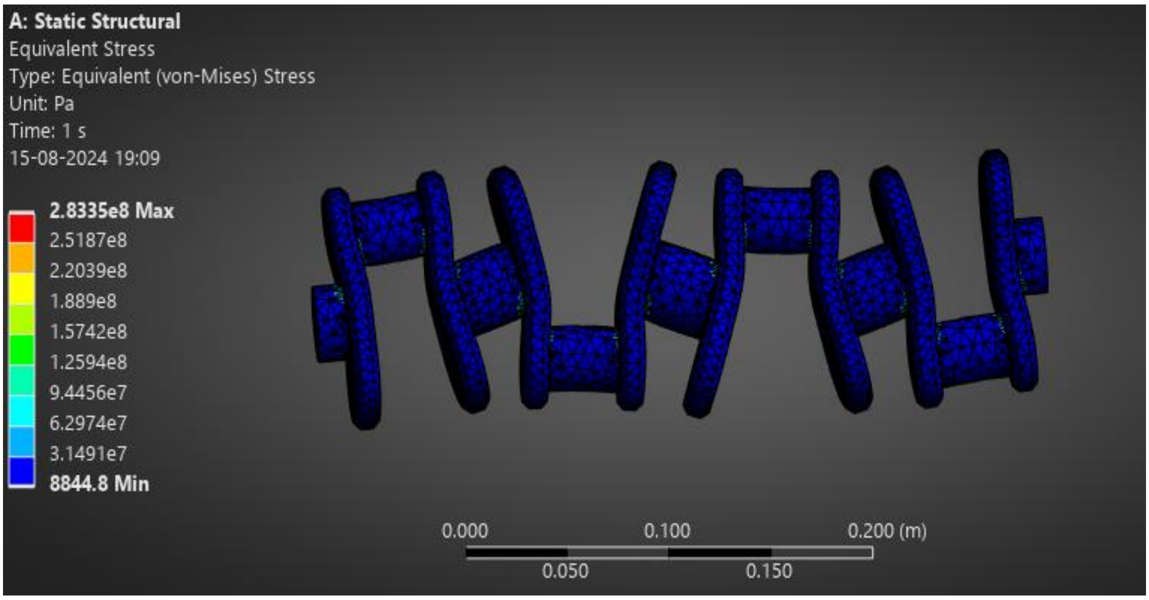

Figure 4: von-Mises Stress

Modal Analysis:

Vibration characteristic found from the modal analysis of crankshaft. Crankshaft stabilizer is moving in circles, so it can just in part make up for all that shaking. Only the low frequency will be the greater source of the engine which vibrates, implying that bring down request regular frequency of the crankshaft has a larger influence on the framework reaction.

Mode	Frequency(Hz)
1	276.47
2	363.06
3	679.12
4	925.98
5	1012.8
6	1326.5

- The lowest frequency was found to be 276.47Hz from the finite elements analysis results and the different vibration mode shapes.

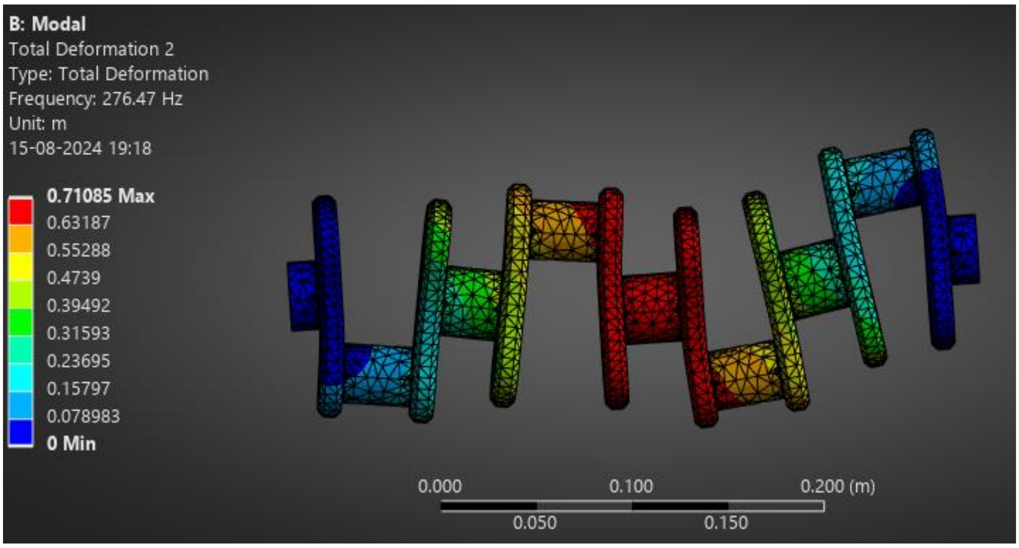

Figure 5: First mode shape

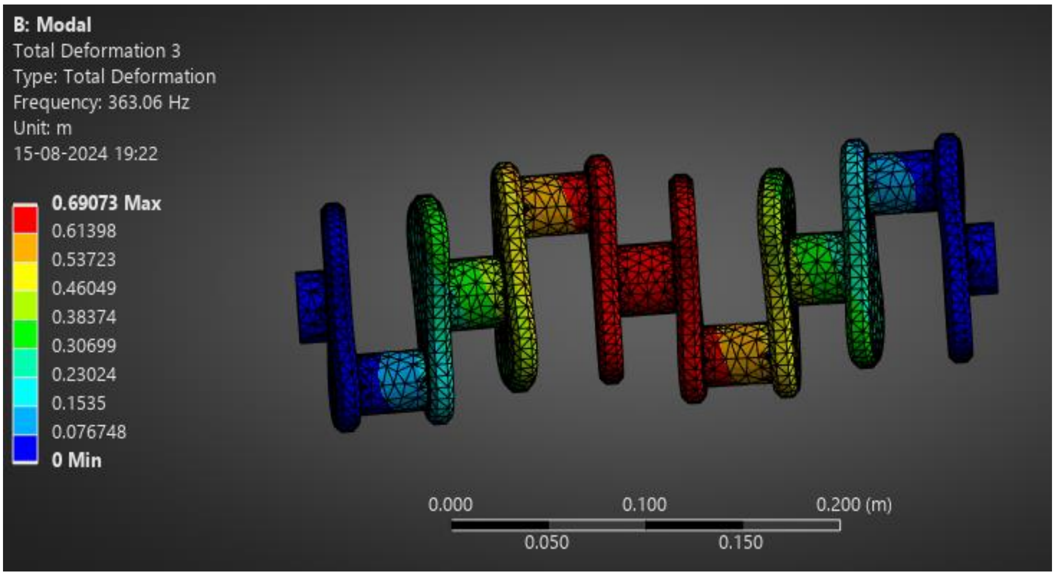

Figure 6: Second mode shape

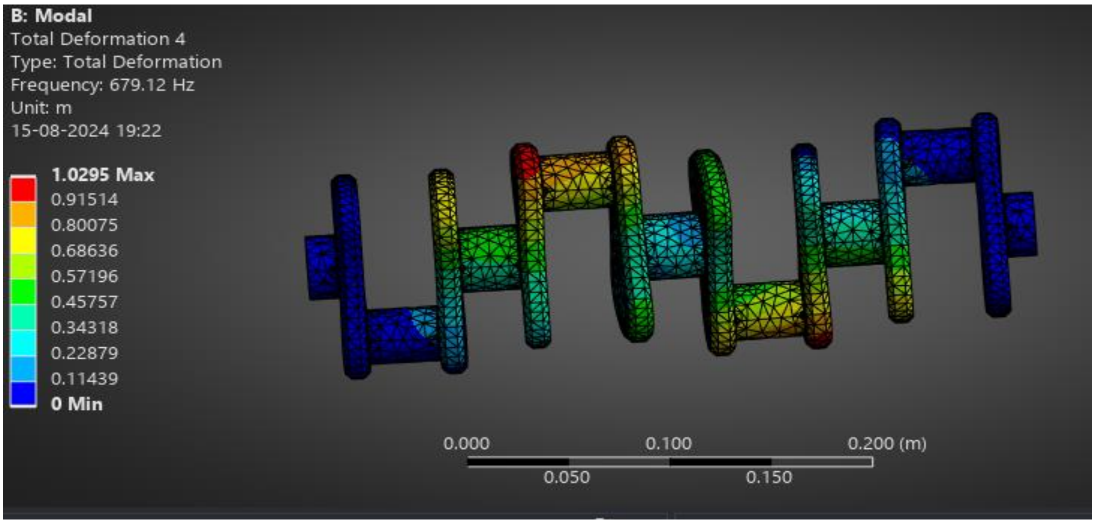

Figure 7: Third mode shape

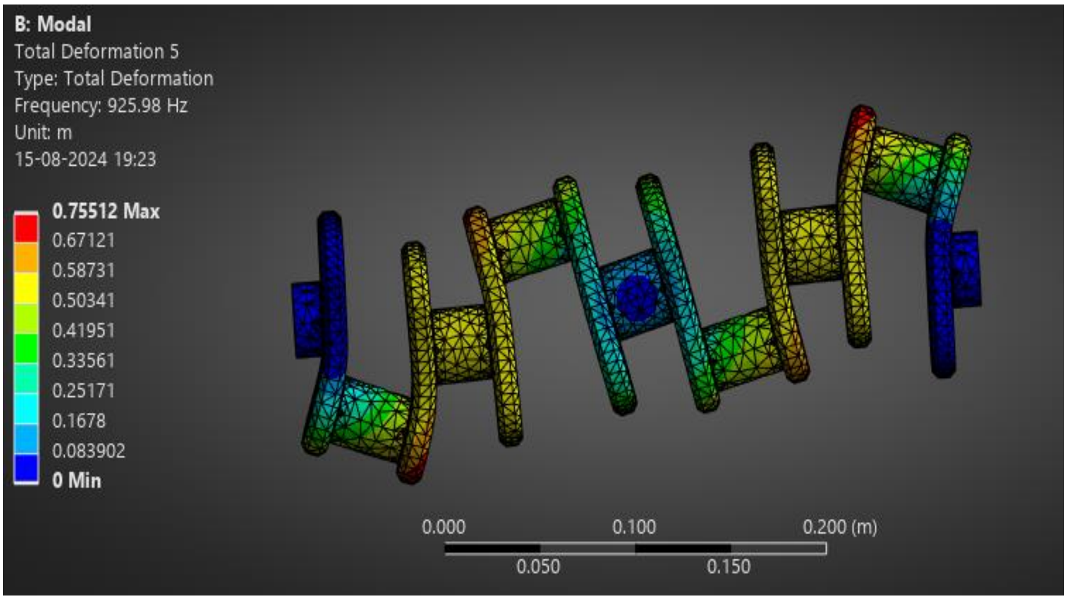

Figure 8: Fourth mode shape

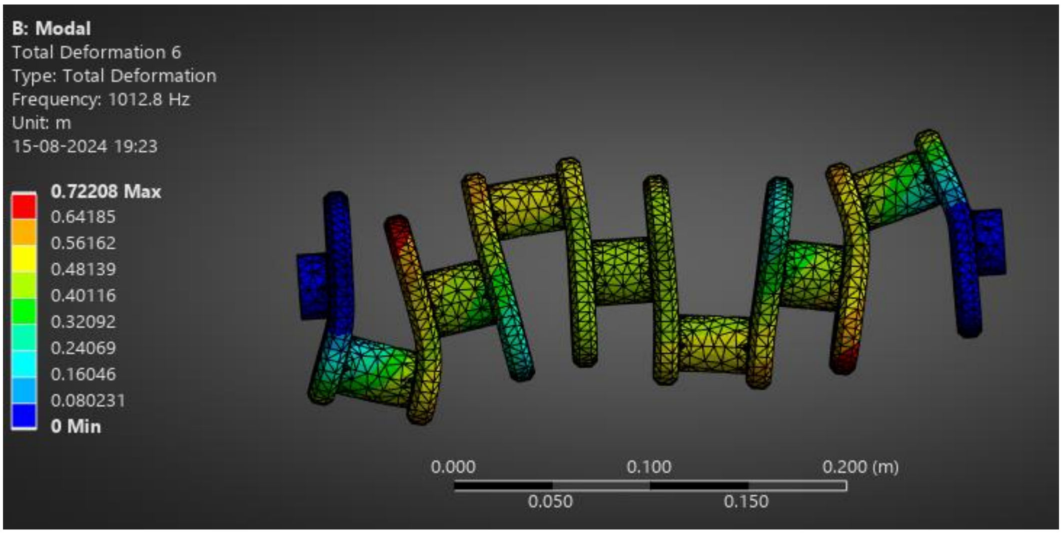

Figure 9: Fifth mode shape

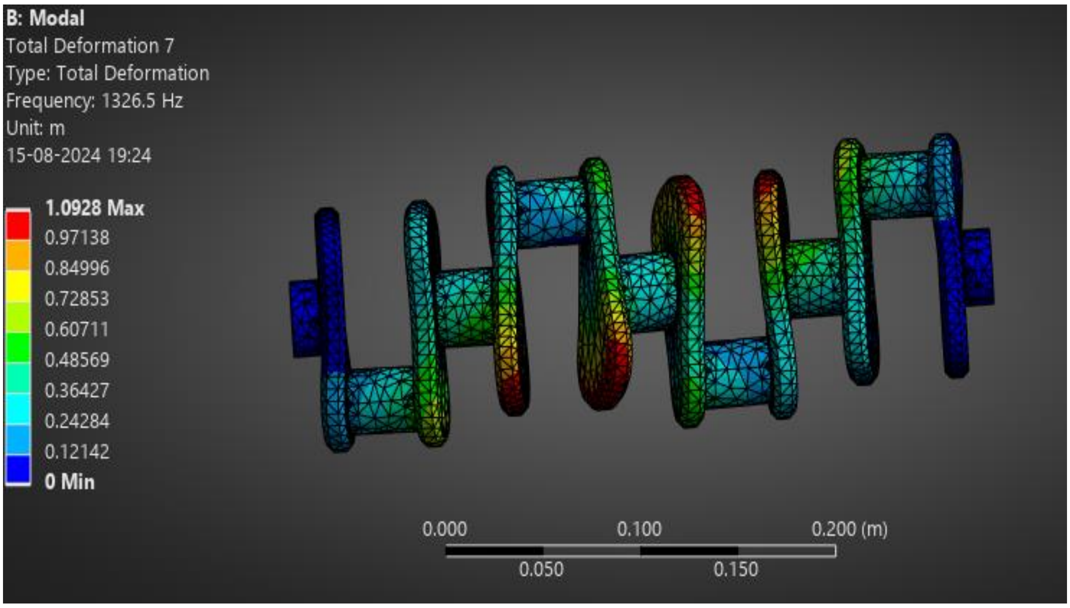

Figure 10: Sixth mode shape

Fatigue Analysis:

Determined the life, damage, biaxiality indication, safety factor of the crankshaft by performing harmonic analysis of the model. Maximum stress is found near the hole portion and it is shown in biaxiality indication figure. The results provide a valuable theoretical basis to optimize the crankshaft design consequently its fatigue life for multi-cylinder engines. Fatigue life of the crankshaft is one of the most important factor for optimization of crankshaft and increasing the fatigue life.

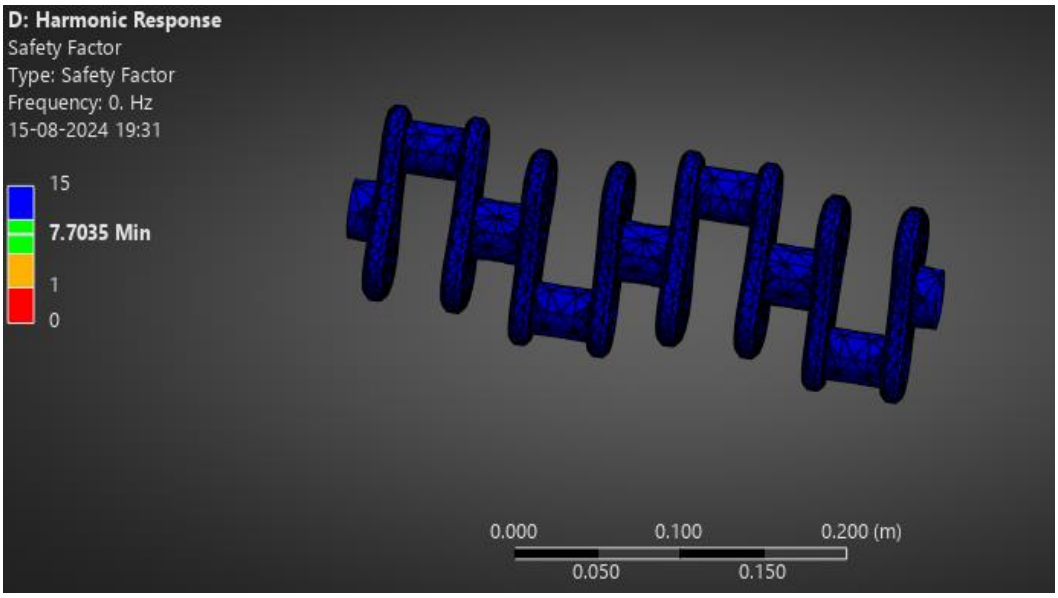

Figure 11: Life

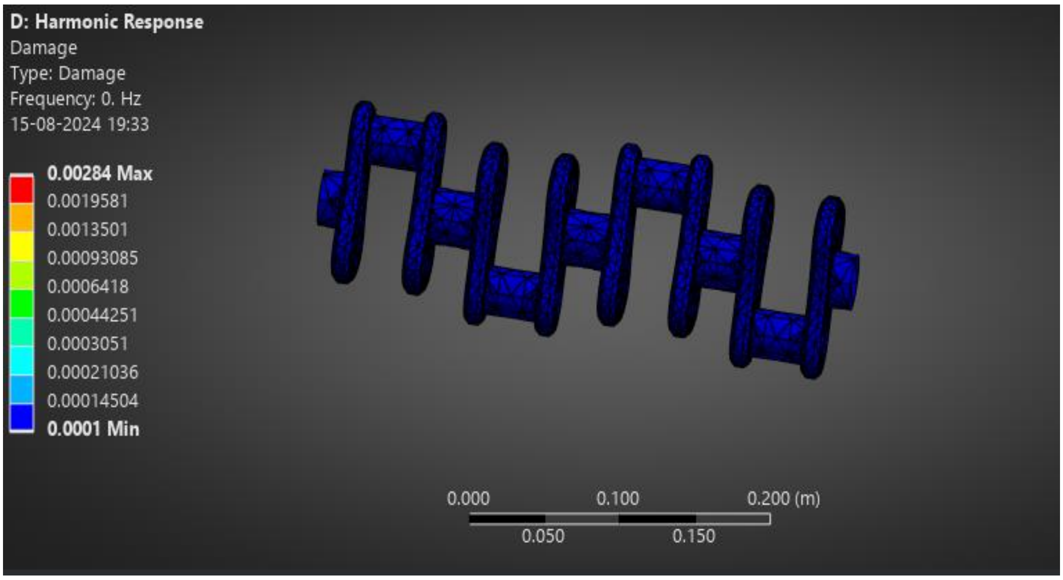

Figure 12: Damage

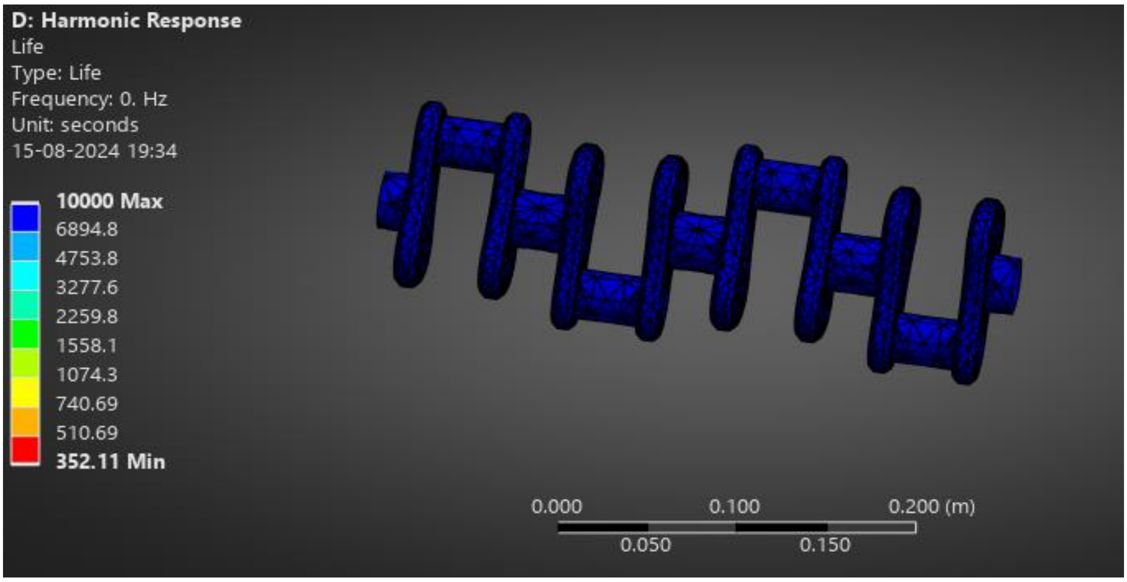

Figure 13: Life

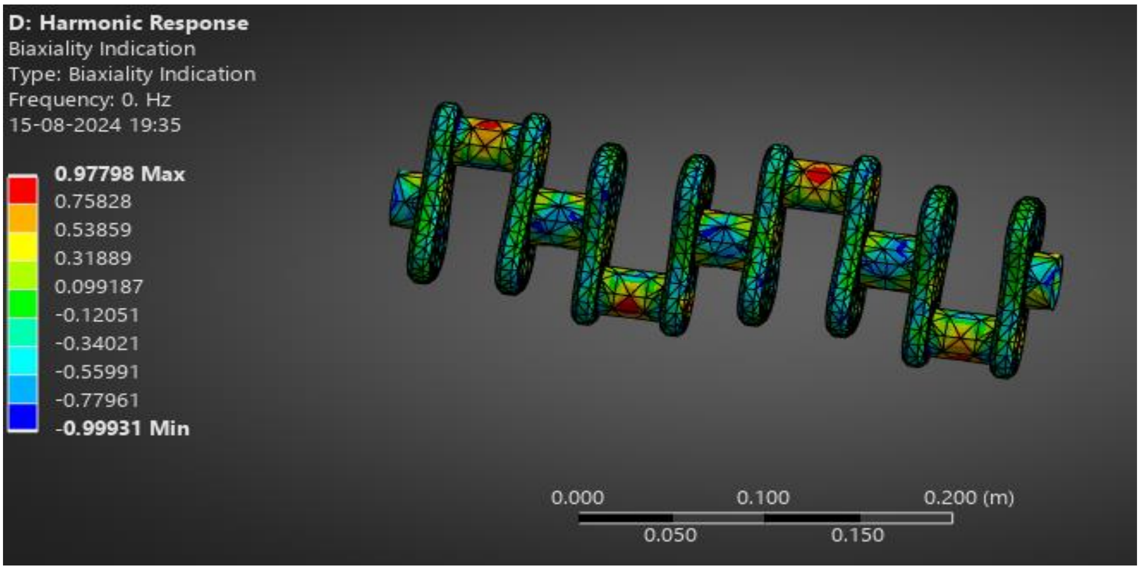

Figure 14: Biaxiality Indication