MODELING AND ANALYSIS OF CRANKSHAFT

T.Kiran kumar[1], A. Harsha Vardhan[2], K. Eshwar Santhosh[3] , R.Sai Kumar[4], M. Blessy Raisa[5]

[1,2,3,4]Students, Department of Mechanical Engineering, NRI Institute of technology,Pothavarappadu, Agiripalli, Eluru District, Andhra Pradesh, India-521212

[5]Assistant Professor, Department of Mechanical Engineering, NRI Institute of Technology, ,Pothavarappadu, Agiripalli, Eluru District, Andhra Pradesh, India-521212.

---***---

Abstract - The internal combustion (I.C) engine crankshaft is a high volume production component with a complex shape. This changes the piston's reciprocating displacement into the crank's rotating motion. One of the crucial parts for the internal combustion engine's efficient and accurate operation is the crankshaft. CATIA-V5 software is used to construct the crankshaft modelling. Using the ANSYS software and boundary conditions, finite element analysis (FEA) is carried out to determine the change of stress at crucial crank shaft points. It can also be expanded to include other materials, static analysis, and crank shaft optimization. In this project, structural steel, grey cast iron, kevlar, and graphene were employed as materials. To determine the change in stress magnitude at crucial crankshaft positions, finite element analysis (FEA) is used. The engine specification chart serves as the source of simulation inputs.

Key Words: Ansys, FEA, CATIA V-5, I.C. Engine, Kevlar, Graphene.

1.INTRODUCTION

The engine's crankshaft is a large segment with a puzzling (complicated) design that converts the piston's reciprocating motion into a rotating movement using a four-link mechanism. It occurs in a reciprocating engine turns the piston's reciprocating action into rotational motion, and when the piston is rotating, it does the opposite. The "large ends" of the connecting rods from each cylinder are attached to the "crank throws" or "crankpins" on the crankshaft, which are additional bearing surfaces whose axis is offset from that of the crank.It is typically connected to a flywheel to lessen the four-stroke cycle's pulsation, and occasionally to a torsion or vibration damper at the other end to lessen the tensional vibrations that are frequently caused along the crankshaft's length by the cylinder furthest from the output end acting on the tensional elasticity of the metal. In many different areas of engineering, crankshafts are used. They are employed whenever reciprocating linear motion needs to be converted to rotation or the opposite. Crankshafts are typically employed in internal combustion engines but they can also be found in piston steam engines in more complex arrangements.The former supports the wider and more diverse variety of crankshaft applications. Small size model aeroplanes to massive maritime engines are just a few of the applications for internal combustion engines. Therefore, crankshafts made using different techniques are applicable to, among other things, portable machinery, electrical generators, agricultural and industrial machinery, and engines for land, air, and sea transportation. Additionally, powered machinery like reciprocating pumps and air compressors employ crankshafts.Since the currently used and typical procedures, forging, casting, and machining, are relatively expensive, there is enormous industrial potential for a new crankshaft manufacturing process. Due to the substantial investment in tools and equipment, the first two require high volume production to be economically viable. The pistons' translator motion is converted to rotational motion. Power is generated during the combustion of the fuel-air mixture. The crankshaft begins to rotate as a result of this power. The connecting rod transforms the pistons' linear motion into torque. After then, it is given to the flywheel. Because some load must be borne during the process, crankshafts also serve as load bearers. The heavy bending and torsional stress is one of the loads.

1.1 Functions of crankshaft in IC Engine

The crankshaft, connecting rod, and piston constitute a four bar slider-crank Mechanism, which converts the sliding motion of the piston (slider in the mechanism) to a rotary motion. Since the rotation output is more practical and applicable for input to other devices, the concept design of an engine is that the output would be rotation. In addition, the linear displacement of an engine is not smooth, as the displacement is caused by the combustion of gas in the combustion chamber. Therefore, the displacement has sudden shocks and using this input for another device may cause damage to it. The concept of using crankshaft is to change these sudden displacements to a smooth rotary output, which is the input to many devices such as generators, pumps, and compressors. It should also be mentioned that the use of a flywheel helps in smoothing the shocks.

1.2 Materials and Manufacturing Processes

The material of crankshaft should be tough and fatigue resistant. Generally carbon steel, special steel and special cast iron are used. In industrial engines, commonly made from carbon steel such as 40C8, 55C8 and 60C4 etc.In transport engines, manganese steel such as 20Mn2, 27Mn2 and 37Mn2.

Manufacturing of crankshaft is done by two methods:

1) Forging

2) Sand Casting

2.LITERATURE REVIEW

This study says about earlier researchers, analysis and studies on crankshaft, its construction, design, methodology and working done by different people. We studied some of those papers and those papers are mentioned as follows.

Chinmay.et.ak [1] In this study a static simulation of the crankshaft of a 4-stroke, single-cylinder gasoline engine is carried out and reported.Using the CATIA programme, a crankshaft three-dimensional model is produced. From the FEA analysis, deformation and Von Mises stress were determined. It uses the same crankshaft for topological optimization. The optimised design's mass is 12% less than the baseline design's mass.For the applicable loading conditions, the optimised design technique offers a workable design, and it stands out as an effective design, especially at higher loads.

L.Kaethick et.al. [2] The goal of the current study is to use Solid Works and ANSYS to create and analyse a 3D model of a two-wheeler crankshaft. The performance of the chosen crankshaft materials, EN8 and Forged steel, is assessed. The fluctuation in stress on the surface of the crankshaft was calculated using finite element analysis. The FE model in ANSYS is subjected to the load and boundary conditions. Additionally. The findings demonstrate that the stresses in the crankshaft are well within the factor of safety limit, and numerous debates have resulted in the finding that EN8 has better structural behaviour than forged steel. Since the EN8 crankshaft can withstand a static load and has a higher tensile strength than the Forged Steel crankshaft.

Aatish Chaudhary et.al[3] This article does a dynamic simulatio on a crankshaft from a single-cylinder, four-stroke gasoline engine. Using SOLID WORKS software, a three-dimensional model of the crankshaft of a gasoline engine is produced. To determine the change in stress magnitude at crucial crankshaft regions, finite element analysis is used. ANSYS is used to perform the dynamic analysis. We can infer from the findings that the composite material's maximum values are lower than those of forged steel. Given that the 3.8 kg of forged steel weighs more than the 2.16 kg of composite material.

Dr. K. Satyanarayana, et.al.[4] A single-cylinder, four-stroke diesel engine's crankshaft is used for the static simulation. Using CATIA V5 software, The software ANSYS 2021R1 is used to do the static analysis. Comparing the structural steel and Al7075+2%SiC based on the aforementioned data, it can be seen that the latter exhibits less deformation and similar von-Miss stress and strain. Three distinct materials are used to create the crankshaft, and it has been determined from these three designs that Al7075+5%Sic is significantly more useful than Al7075+2%Sic and structural steel. The corresponding stress for Al7075+5%Sic and Al7075+2%Sic is better.Comparing Al7075+5%Sic to structural steel and Al7075+2%Sic, the Al7075+5%Sic has displayed less deformation and elastic strain. Therefore, the best and most practical composite to employ is Al7075+5%Sic.

Amrutham Sandeep et.al.[5] Aim of the task to format and production of crankshaft to a four-cylinder IC engine with the aid of the manner of using theoretical calculations in format vicinity for Aluminum alloys 6061 and business enterprise grade. A 3-D version is created inside the three-D modeling software utility software program. In present project, as per the digital simulation done on crank shaft with two different material aluminum alloy 7475 and 6061. This result showed aluminum alloy 7475 is better than 6061 alloy and thermal gradient value is higher where equal heat dissipation is achieved resulting stable temperature through the crank shaft body.

R.K. Patel et.al. [6] An attempt is made in this paper on a four-cylinder engine crankshaft.The 3-D modelling of the crankshaft is done in CATIA V5 and the stress, fatigue and modal analysis is done by using ANSYS 15.0. Main purpose of this work is to investigate the fatigue life of crankshaft under complex loading conditions. The maximum stress point, maximum deformation and dangerous areas are found by the static analysis of the crankshaft. First to six order natural frequencies were achieved by using the crankshaft modal analysis. Bending deformation under the lower frequency is the main deformation of crankshaft. From the natural frequencies result values, it is clear that the chances of crankshaft being resonant are very low. The resonance of vibration system can be avoided effectively using appropriate structural design.

Himanshu Bist et.al. [7] In this paper, we performed the structural analysis of a single-cylinder crankshaft using ANSYS for 4 different materials to see which is the most suitable for it. We used Solid works for creating the 3-d model of the crankshaft. For all 4 materials used, it was observed that the maximum deformation is taking place at the center of the crankpin in the crankshaft. The minimum value of deformation was observed for the Structural steel, whereas the minimum value of equivalent and shear stress was observed for Titanium alloy. As a result of the 4, structural steel is the best for the crankpin region, where the most deformation occurs, and titanium alloy is best for crankshaft journals and crank cheeks.

Saurabh Patil et.al. [8] This paper deals with the static analysis of a composite crankshaft of a single cylinder 4-stroke petrol Engine. For a reference crankshaft of Royal Enfield Bullet 350 CC is considered, which is made from medium carbon steel. Carbon fiber/Epoxy is used as an alternative material for medium carbon steel. In this paper crankshaft is modeled by using CATIA-V5 software. Structural analysis has been done by using ANSYS workbench 18.2. The validation of crankshaft is compared with the theoretical and FEA results of von-misses stress and strain are in the limits. The maximum deformation occurs at the center of the crankpin neck surface. Carbon-Epoxy composite has the low values of total deformation, stress and strain. And also, weight of the crank shaft is reduced by 79.03%. The value of von-mises stress of FEA analysis for carbon fiber/epoxy crankshaft is less than the material yield stress.

Timur Choban Khidir et.al.[9] This study aims to carry out study static Von mises stress, deformation and strain by modelling crankshaft in SOLIDWORKS program, to compare between tow materials alloy steel and malleable cast iron (Von mises), deformation and fatigue failure analysis of two designs existing model and modified model by applying resultant bearing load equal to 16066.5 N to the small end of connecting rode, this load results of (1089 N) tangential force and (3539 N) as radial force. The results show that there are no severe changes in the studied parameters and that both materials bear the applied load without failure. The results show that there are not severe changes in the parameter values, so both materials bear the applied load and works in the safe region.

R.Suganthini Rekha et.al.[10] This work is about evaluating and comparing the load and fatigue performance of two vying production techniques for crankshaft viz. forged steel and Ti-6Al-4V+12%TiC used in automobiles. Three-dimensional model of crankshaft shaft is created using ProEngineer. Comparisons for the properties such as equivalent stress, strain and total deformation of crankshafts made up of forged steel and Ti-6Al-4V+12%TiC were determined, and the results were compared. Model theoretical calculations are performed for clear analysis.The analysis of crank shaft was found that the Ti-6Al-4V+12TiC material have a good physical property and it has an appreciable deformation under the moment than forged material steel. The stress, strain, and deformation of the Ti-6Al-4V+12%TiC is also low as compared to the forged steel material. Crank shaft is usually made of forged steel, but the performance of the crankshaft is less than what is projected. So, Ti-6Al-4V+12% TiC came into consideration.

M.Srihari et.al.[11] This study is about selection of best material by comparing the Static analysis on a crankshaft from a multi cylinder (4-cylinder) 4- stroke I.C Engine. The modeling of the crankshaft is created using CATIA-V5 Software. Finite element analysis is performed on the crank shaft using the ANSYS. The Theoretical results are obtained vonmisses stress is 19.6Mpa, shear stress is 9.28Mpa. The validation of model is compared with the Theoretical and FEA results of Von-misses stress and shear stress are within the limits. Above Results Shows that the maximum deformation appears at the center of crankpin neck surface. The maximum stress appears at the fillets between the crankshaft journal and crank cheeks and near the central point Journal. The edge of main journal is high stress area. The Value of Von-Misses Stresses that comes out from the analysis is far less than material yield stress so our design is safe, and we should go for optimization to reduce the material and cost.

Mr. Mathapati N. C. et.al. [12] This work in doing for optimization of a crankshaft in crank-pin web fillet region with fatigue life as well as to study a relation between fillet radius/diameter of crankpin to fatigue life. The modelling of crankshaft is created by Creo-parametric. Finite element analysis is performed to obtain the variation of stress at critical locations and fatigue life of the crank shaft using the ANSYS software. Radius of fillet is changes in model of crankshaft to improvement in fatigue life. The maximum stress and deformation appear at the center of crankpin fillet between the crankshaft journal and crank cheeks, and near the central point journal. The edge of main journal is maximum stress area in the crankshaft. The use of numerical method such as Finite Element Method now a days commonly used to give detail information about various components. The r/d ratio is increases than Von misses stress are decreases as well as number of cycles to failure in increases.

Saeed Asiri [13] This paper is able to show the effect of materials of the crankshaft on those two elements. research discusses the shafts of three different types of materials: homogeneous, composite, and functionally graded materials (FGM).It has been shown that the performance of crankshaft was improved in case of FGM. Based on the results of the modal and harmonic analysis, it is concluded that FGM crankshaft would offer the best durability and show optimum performance when compared with the other two material crankshafts investigated in this study. Finite element model of the crankshaft was created using ANSYS to perform modal and harmonic analysis to visualize how the system behaves in real-world conditions.Based on the results of the modal and harmonic analysis, it is concluded that FGM crankshaft would offer the best durability and show optimum performance when compared with the other two material crankshafts investigated in this study.

Priyanka M. Chavan et.al.[14] The present study focuses on the design, performance analysis of a four-stroke single cylinder diesel engine crankshaft. Design calculations are carried out theoretically using CREO 3.0 . Finite element analysis is run to validate the design by using ANSYS software. Maximum total deformation occurs at crank web location. Von Mises stress & Maximum principal stress under the combustion gas load are within the yield strength limit and ultimate strength limit of the material respectively. Maximum stress concentration observed at crank pin fillet location. Deformation and stresses are important input to fatigue analysis and optimization of the crankshaft, Crankshaft with EN19 material is safe for 75 bar peak cylinder pressure operation without any failure.

Ashwin Kumar Devaraj et.al.[15] This study describes the stress distribution of a forged steel crankshaft used in a single cylinder 4 stroke vertical engine by using software ANSYS.The stress analysis results are significant to improve the component design at the early developing stage. Modal analysis was used to determine the natural frequencies of the crankshaft and the mode shapes were examined. The maximum load occurs at the crank angle of 355 degrees. At this angle only bending load is applied to the crankshaft. Knowing the natural frequencies of the crankshaft the resonance problems can be avoided by keeping the excitation frequencies far away from the natural frequencies thus avoiding dynamic failure. Critical stress locations on the crankshaft geometry are the regions corresponding to the interface between the shaft and the web and web and the pin which result in high stress concentration factors.

P.Thejasree, G.Dileep Kumar et.al. [16] In this paper, first the 3D model of the engine parts are built in the software 'CATIA V5' and are then transferred to 'ANSYS'. In the present analysis the effect of gas forces was analyzed at crankpin and main journals of the crankshaft. The maximum load acting on the crankpin was found to be 22163 N for the bench mark model whereas for the developed concepts 1, 2 and 3, it was found to be 22624 N, 22066 N and 22303 N respectively. The maximum stress for the bench mark model was found to be 67 MPa and whereas for the developed concepts 1, 2 and 3, it was found to be 80MPa, 71 MPa and 79 MPa respectively. Structural static analysis shows that the stress concentration regions are located at the fillets of crank pin and main journals. Dynamic stress and strain analysis has been carried to determine the stress and deformation of the crankshaft in a working cycle. The weight of the crankshaft for concept-2 has been reduced by 1.6 kg which is a 12.8% reduction in weight without much increase in the stress.

Ramesh Ganugapenta et.al.[17] In this project Static and Modal Analysis was done on crankshafts of single cylinder four stroke engines by using Steel En36 and Cast iron Alloy. Static element analysis was performed on Crankshaft to obtain the Deformation and Stress at critical locations. Modal Analysis was done on the Crankshaft to obtain Mode Shapes and Natural Frequency of the crankshaft. Finally Fatigue Analysis is done for best material to estimate life time of crankshaft. From the results it is observed that Steel En36 is safer than cast iron Alloy . But both materials are within the elastic limits. From the Modal Analysis results we observe that Steel En36 is Stable than cast iron Alloy .

K.Durga Prasad et.al. [18] In this paper a static simulation is conducted on a crankshaft from a single cylinder 4- stroke diesel engine. A three-dimension model of diesel engine crankshaft is created using CATIA V5. The static analysis is done using HYPERMESH.which resulted in the load spectrum applied to crank pin bearing. This load is applied to the FEA model in HYPERMESH. Above Results Shows that FEA Results Conformal matches with the theoretical calculation so we can say that FEA is a good tool to reduce time consuming theoretical Work. The maximum deformation appears at the center of crankpin neck surface. The maximum stress appears at the fillets between the crankshaft journal and crank cheeks and near the central point Journal. The edge of main journal is high stress area. The Value of Von-Misses Stresses that comes out from the analysis is less than material yield stress. So our design is safe and we should go for optimization to reduce the material and cost.

Randhavan B M et.al.[19] This paper is related to design and finite element analysis of crankshaft of 4-cylinder diesel engine of heavy vehicle like truck.Engine has capacity of 3785.1cc. The finite element analysis in ANSYS software by using five materials based on their composition viz. FG260, FG300, EN8, EN24 and Aluminum Alloy material. The parameter like von misses stress, deformation; maximum principal stress were obtained from analysis software. The results of Finite element indicate that the Aluminum alloy material can be best suitable material among all. From the Analysis Software we can say that the maximum deformation at the centre of crankpin of crankshaft. FEA results shows comparative readings for FG260, FG300, EN8, EN24 and Aluminum Alloy within 5-7% difference. Hence, we can conclude aluminum-based alloy material can be suitable for crank shaft.

Shubham M. Bhosale et.al. [20] The main objective of this study is to investigate weight and cost reduction opportunities for a crankshaft of a four-cylinder diesel engine crankshaft of TATA Indica Vista car. It identifies and solves the problem by using the modelling and simulation techniques.The modelling of the crankshaft is created by using SOLID WORKS/CATIA software. Finite element analysis is performed to obtain the variation of stress of the crankshaft by using ANSYS software. In the crankshaft, the crack grows faster on the free surface while the central part of the crack front becomes straighter. Comparative study needs to be applied for the selection of material and manufacturing process to have cost effectiveness and shape with fewer defects respectively. Accurate stresses are critical input to fatigue analysis and optimization of the crankshaft. Residual imbalances along the length of the crankshafts are crucial to performance. Utilizing crankcase deflection analysis to improve engine performance.

2.1 Summary

By using these literature surveys an Finite Element FE model of a Crankshaft was introduced and tested on a physical crankshaft against actual calculated values. Mechanical responses to forces, moments, and displacements can be modelled using the model. It also proved to be a valuable instrument for evaluating the crankshaft practical characteristics. In addition, as changes are applied in contrast to the initial configuration, the model may be used to mimic the device's reaction. Our aims to build solution for this problem that Understand the fundamental load limitations, pressure peaks of interaction. Then, create a 3D model of crankshaft. The model is imported into ANSYS to complete structural analysis. Investigate the compatibility of various materials (composite) in crankshaft with material properties available in ansys, Further materials are varied to observe the structural behavior of crankshafts.

3.MODELLING AND ANALYSIS OF CRANKSHAFT

3.1 Modelling of crankshaft using catiaV5

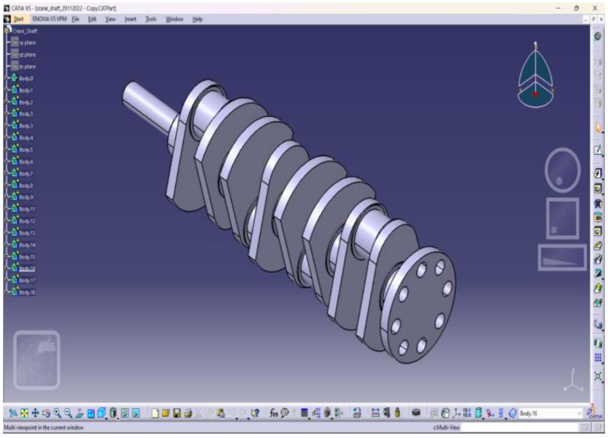

Fig.1 Isometric view of crankshaft

3.2ANALYSIS OF CRANKSHAFT

Structural static analysis: Static analysis ignores the effects of inertia and damping to calculate the impacts of steady loading situations. In static analysis, the conditions for loading and responding don't change over time. Moment, applied force, and pressure are examples of possible input loading circumstances for static analysis, and displacement, forces acting on a structure, stress, and strain are examples of possible output loading conditions. Structural failure will occur if the values from the static analysis exceed the permissible range. The most recent Ansys 2021R1 version is used to perform the static structural analysis.

Engineering Data: The materials to be used in this analysis is selected in the engineering data where there are different libraries available consists of different types of materials and the materials which are not available are made by creating a new labrarary and a new material is created by giving their respective mechanical properties.The properties of the materials used in this analysis are given in fig 2,3,4,5.

Insert Geometry: Import the 3D model which was earlier done in CATIA which will be in '.CATpart' format. Convert it into the '.igs' format to import it to the ANSYS and do the analysis of crankshaft. The CAT part is shown in fig.1.

Define the boundaries: In ANSYS, select the 'create named selection' option to define the bounds for the imported model.

generate Mesh: The model must now be divided into a limited number of components, known as elements. We call this procedure meshing. We perform inflation at boundaries to obtain precise results. The process of creating the finer parts is inflation.The meshed model is shown in fig 6.

Apply the boundary conditions: At the bearing on both the sides of the crankshaft, boundary conditions are currently being imposed.

Obtain solution and plot results: Utilize the six DOF approach to generate the findings, which are then tabulated in the table.

Properties of Outline Row 3: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Density	7850	kg m^-3
3	Isotropic Secant Coefficient of Thermal Expansion		
5	Isotropic Elasticity		
6	Derive from	Young's Modulus and Poisson's...	
7	Young's Modulus	2E+11	Pa
8	Poisson's Ratio	0.3	
9	Bulk Modulus	1.6667E+11	Pa
10	Shear Modulus	7.6923E+10	Pa
11	Strain-Life Parameters		
19	S-N Curve	Tabular	
23	Tensile Yield Strength	2.5E+08	Pa
24	Compressive Yield Strength	2.5E+08	Pa
25	Tensile Ultimate Strength	4.6E+08	Pa
26	Compressive Ultimate Strength	0	Pa

Fig.2 Structural Steel Properties

Properties of Outline Row 5: KEVLAR 149

	A	B	C
1	Property	Value	Unit
2	Density	1470	kg m^-3
3	Isotropic Elasticity		
4	Derive from	Young's M...	
5	Young's Modulus	1.79E+11	Pa
6	Poisson's Ratio	0.36	
7	Bulk Modulus	2.131E+11	Pa
8	Shear Modulus	6.5809E+10	Pa
9	Tensile Ultimate Strength	3.45E+09	Pa

Fig.3 properties of Grey cast iron

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7200	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modulus and Poisson...	
8	Young's Modulus	1.1E+11	Pa
9	Poisson's Ratio	0.28	
10	Bulk Modulus	8.3333E+10	Pa
11	Shear Modulus	4.2969E+10	Pa
12	Tensile Yield Strength	0	Pa
13	Compressive Yield Strength	0	Pa
14	Tensile Ultimate Strength	2.4E+08	Pa
15	Compressive Ultimate Strength	8.2E+08	Pa

Fig.4 Properties of Kevlar149

Properties of Outline Row 4: GRAPHENE

	A	B	C
1	Property	Value	Unit
2	Density	2267	kg m^-3
3	Isotropic Elasticity		
4	Derive from	Young's M...	
5	Young's Modulus	2.4E+12	Pa
6	Poisson's Ratio	0	
7	Bulk Modulus	8E+11	Pa
8	Shear Modulus	1.2E+12	Pa
9	Tensile Ultimate Strength	1.3E+11	Pa

Fig.5 Properties of Graphene

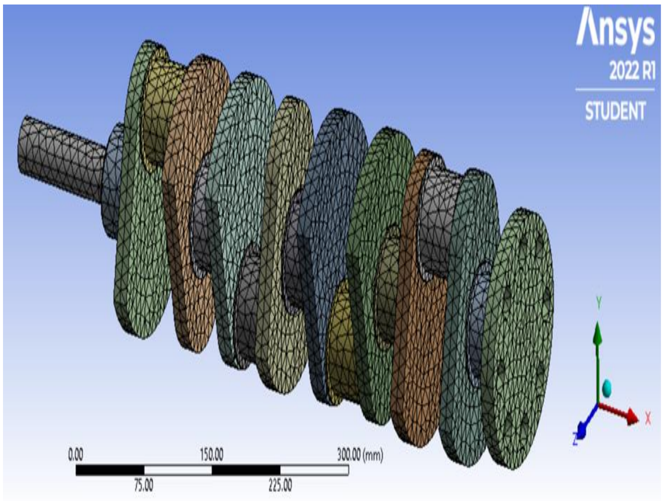

Fig.6 Meshed model of crankshaft

4.RESULTS & DISCUSSION

Materials Used For Crankshaft:

- stuctural steel
- Grey cast iron
- Kevlar
- Graphene

These various materials are used to conduct the structural static study on the crankshaft. The structural steel is analysed first, followed by the determination of parameters such as equivalent stresses, total deformation, and equivalent elastic strain. Later, the crankshaft is analysed using grey cast iron, kevkar, and graphene, and the parameters mentioned above are computed.

4.1 Stainless Steel

Analysis of Structural steel : Total deformation,Equivalent elastic strain, Equivalent stress, X deformation, Y deformation, and Z deformation is represented in fig 7, 8, 9, 10, 11 and 12.

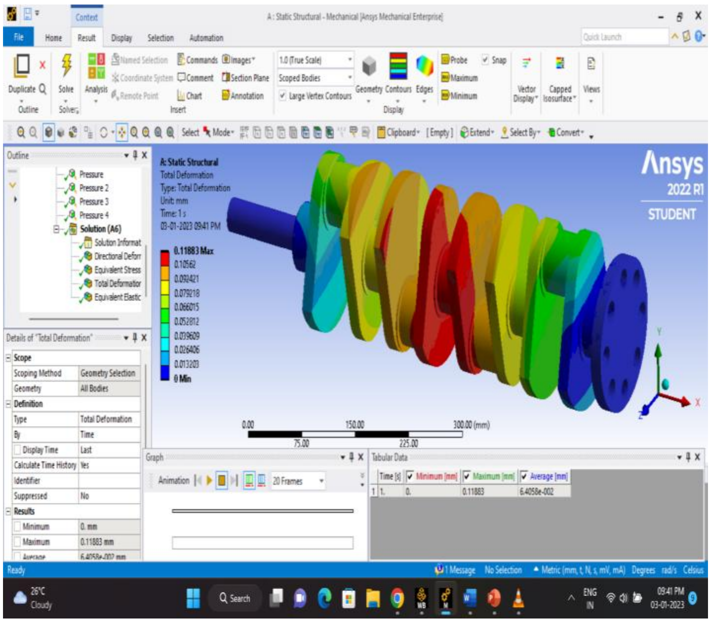

Fig 7: Total deformation

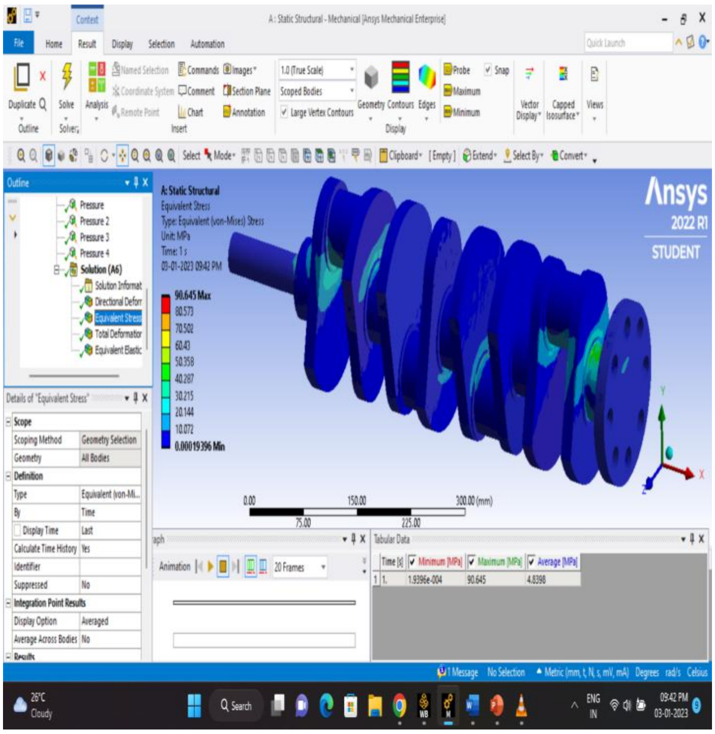

Fig 8: Equivalent Stress

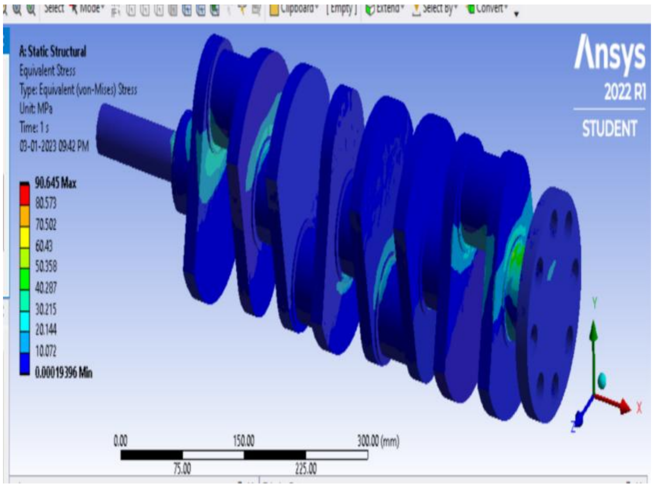

Fig 9: Equivalent Elastic Strain

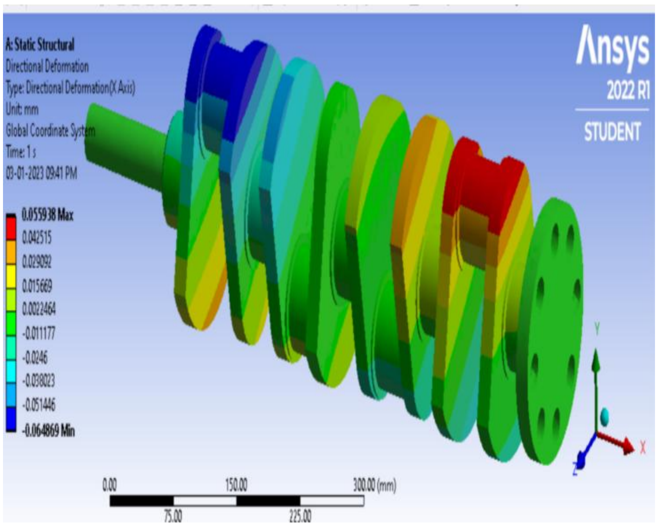

Fig 10: X deformation

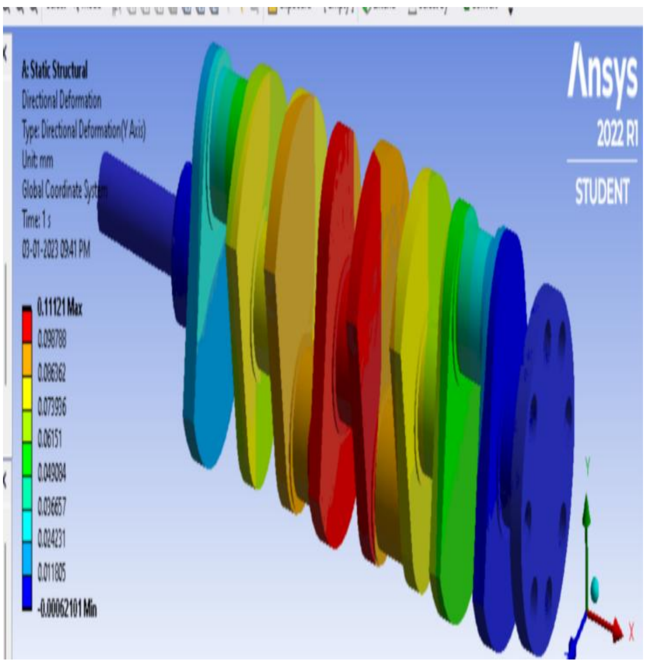

Fig 11 Y deformatioin

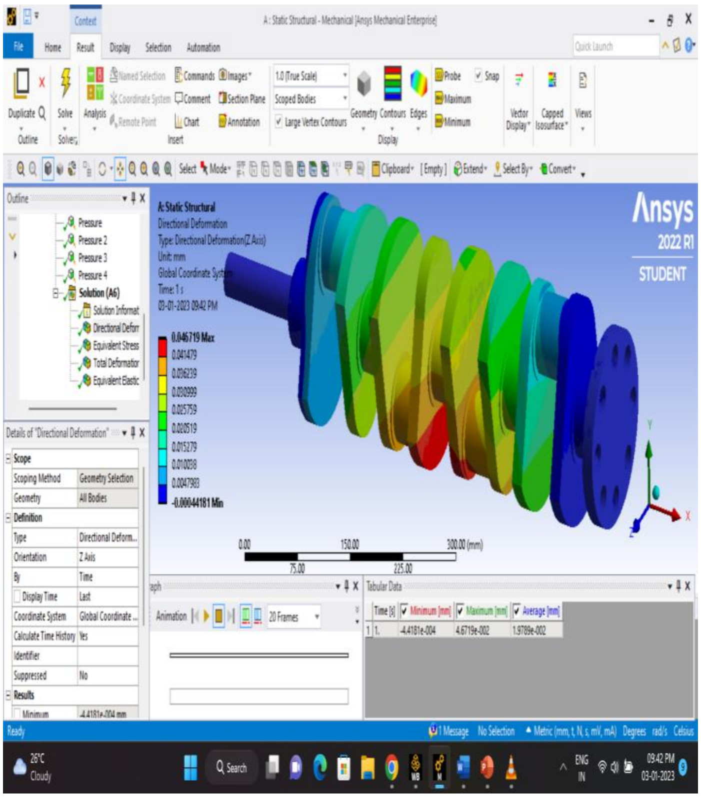

Fig 12: Z deformation

5.2 Grey cast iron

Analysis of grey cast iron: Total deformation,Equivalent elastic strain, Equivalent stress, X deformation, Y deformation, and Z deformation is represented in fig 13, 14, 15, 16, 17 and 18.

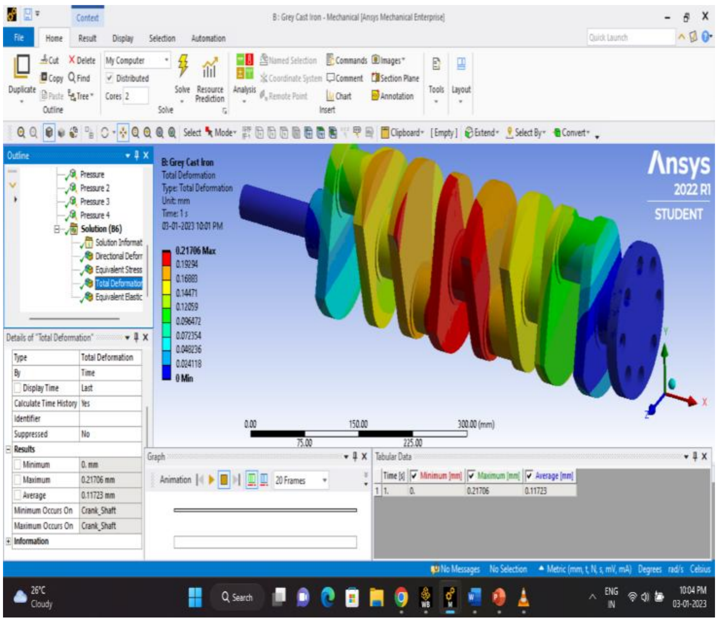

Fig 13: Total deformation

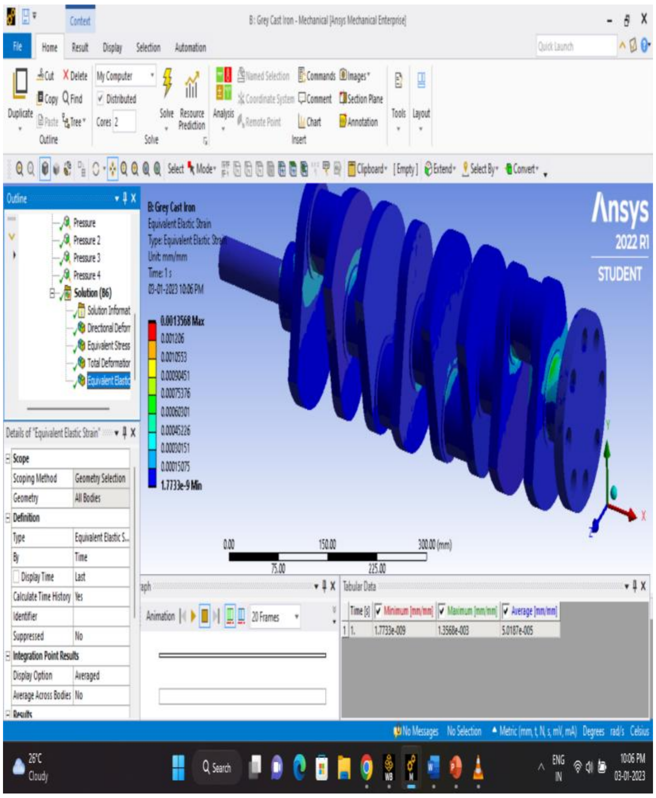

Fig 14: Equivalent elastic strain

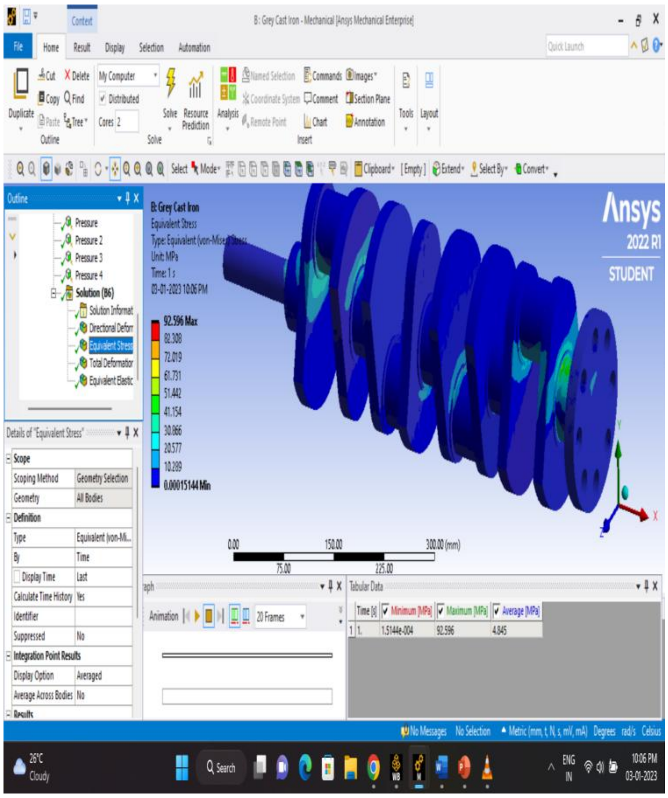

Fig 15: Equivalent stress

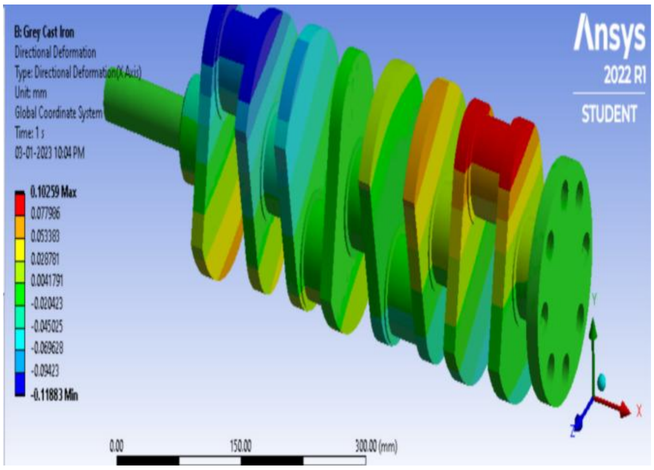

Fig 16: X deformation

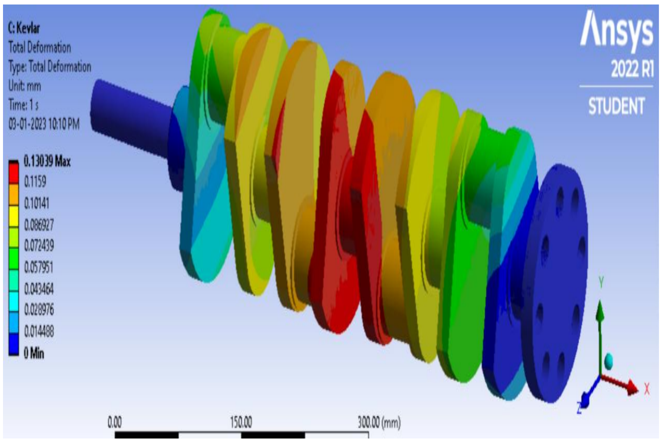

Fig 17: Y deformation

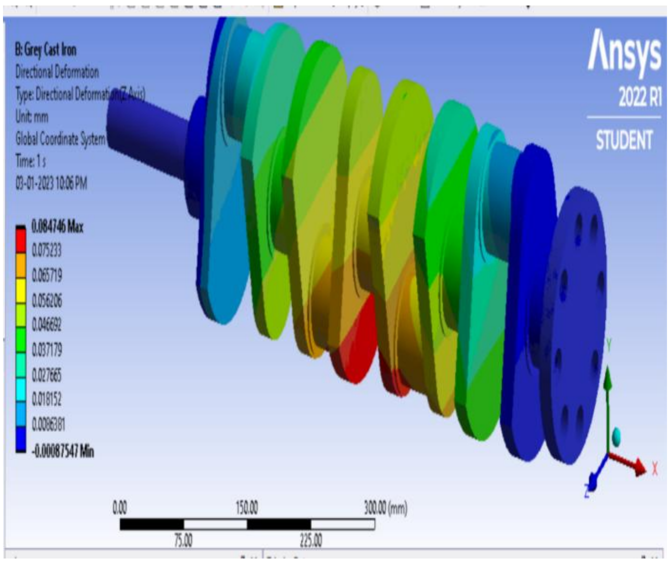

Fig 18: Z deformation

4.3 Kevlar:

Analysis of Kevlar: Total deformation, Equivalent elastic strain, Equivalent stress, X deformation, Y deformation, and Z deformation is represented in fig 19, 20, 21, 22, 23 and 24

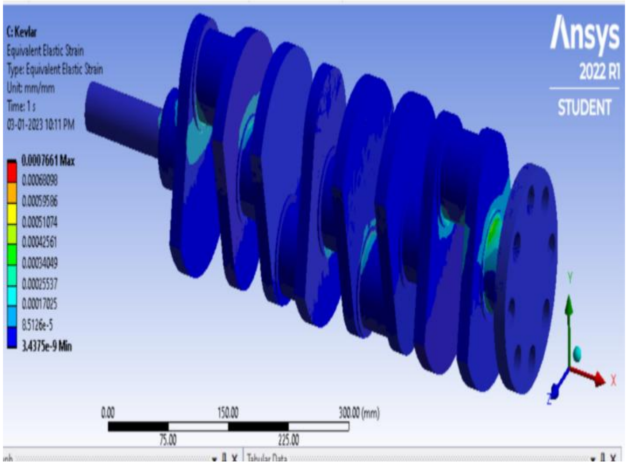

Fig 19: Total deformation

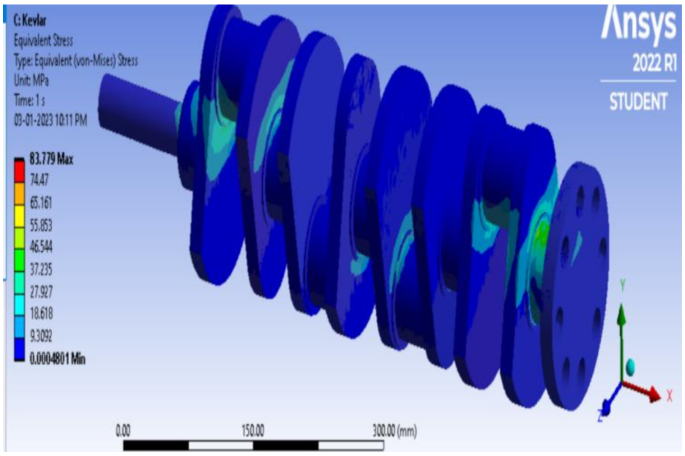

Fig 20: Equivalent elastic strain

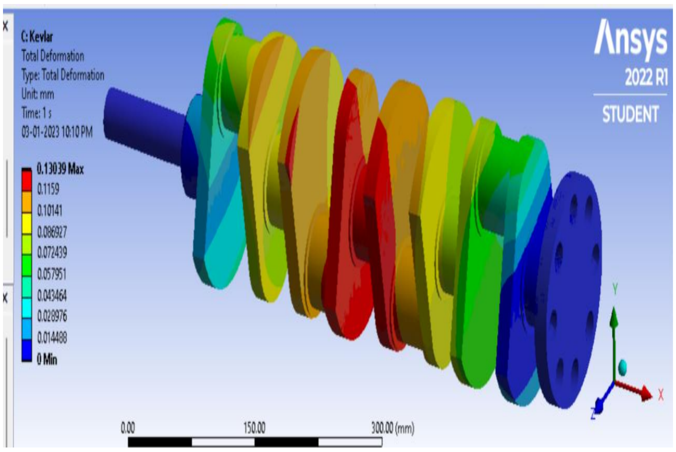

Fig 21: Equivalent stress

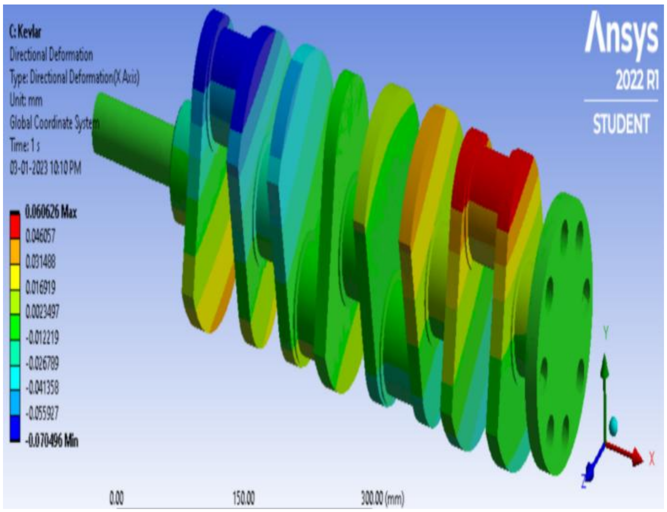

Fig 22: X deformation

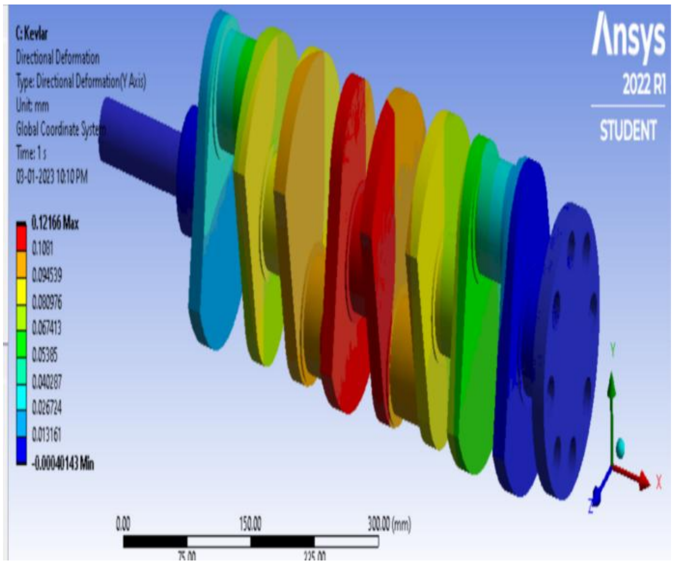

Fig 23: Y deformation

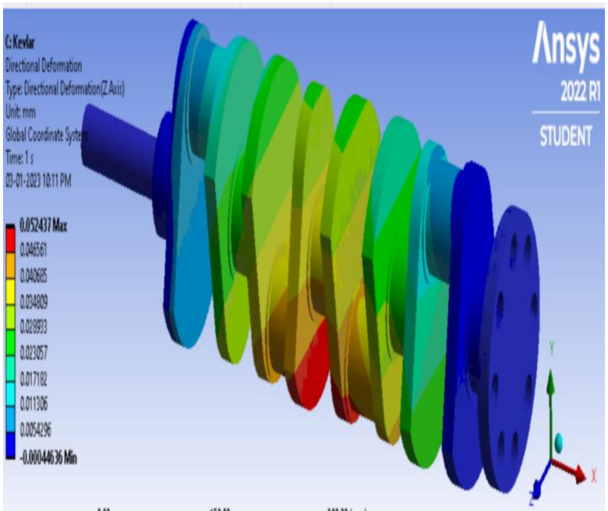

Fig 24: Z deformation

4.4 Graphene:

Analysis of Graphene: Total deformation,Equivalent elastic strain, Equivavalent stress, X deformation, Y deformation, and Z deformation is represented in fig 25, 26, 27, 28, 29 and 30

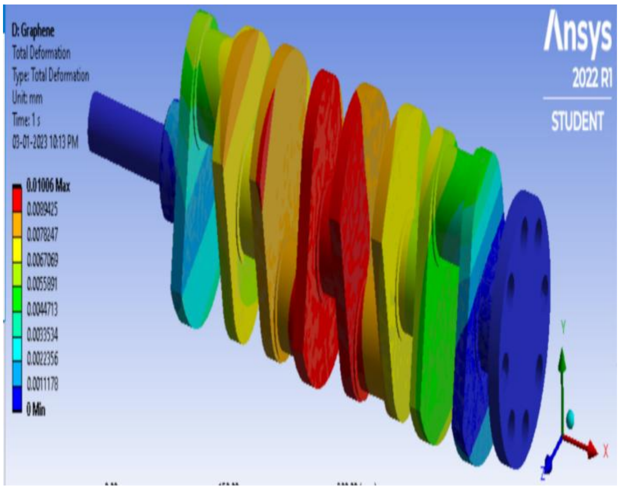

Fig 25: Total deformation

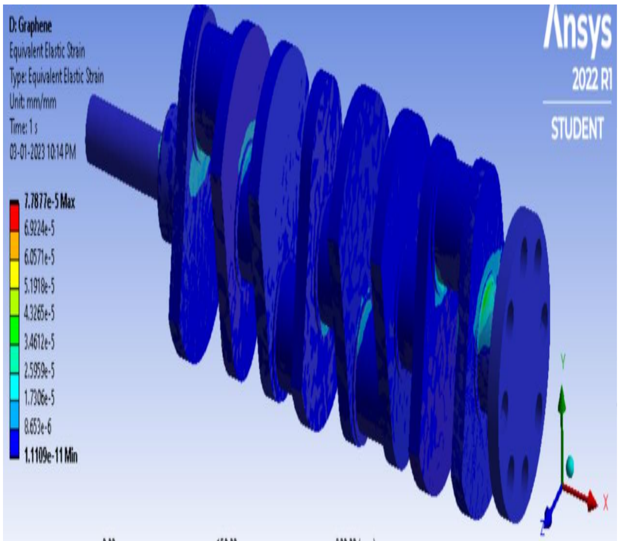

Fig 26: Equivalent elastic strain

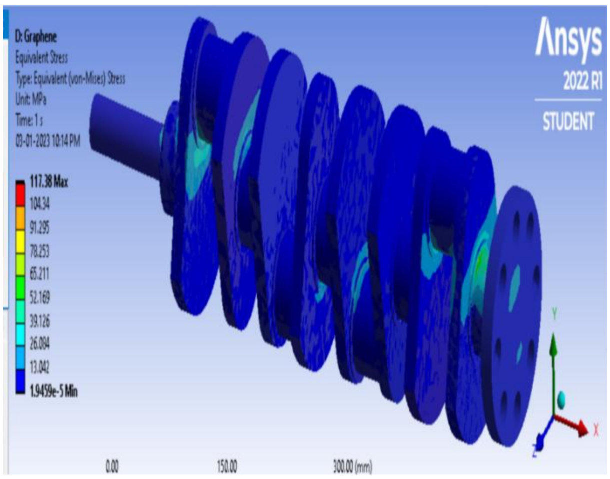

Fig 27: Equivalent stress

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 01 | January - 2023 Impact Factor: 7.185 ISSN: 2582-3930

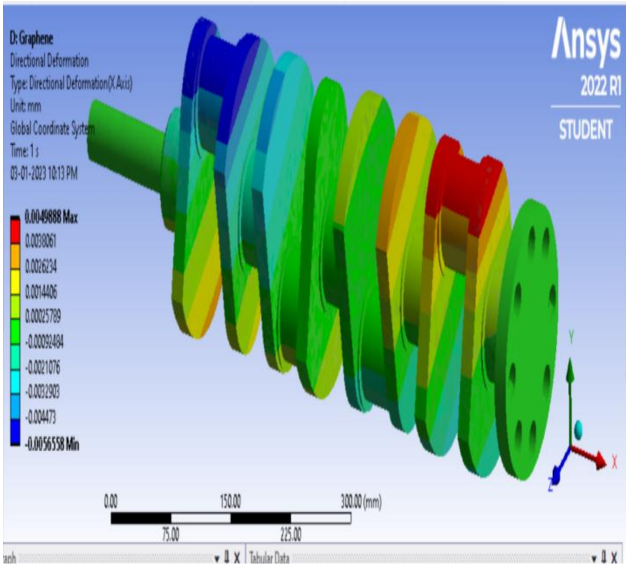

Fig 28: X deformation

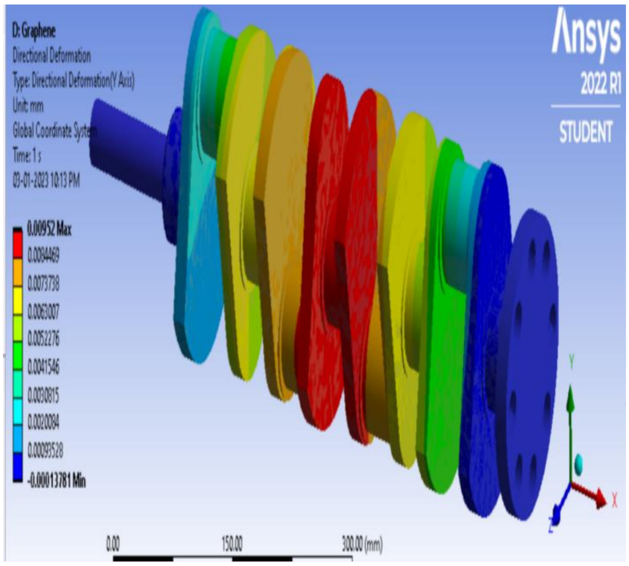

Fig 29: Y deformation

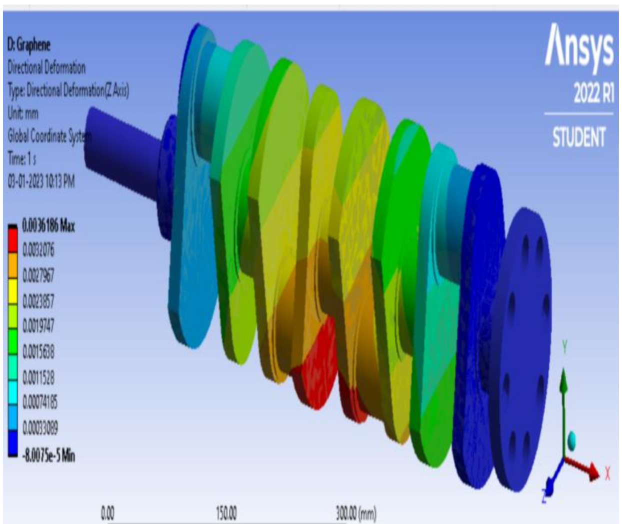

Fig 30: Z deformation

To design a Crankshaft, a stress analysis was performed using the finite element method which was done in the Ansys software. Modelling was done for crankshaft. Also, analysis is carried out for Crankshaft with Structural steel, Grey castiron, Kevlar, Graphene. It is observed that the crankshaft made of graphene is lighter and stronger than the conventional steel with similar design specifications. The Total deformation, maximum strain and stresses are compared in following table-1 and 2. The results table is based on the previous images which are the results of crankshaft obtained from the static structural analysis by using Ansys.

Table .1 Final results of Structural steel and Grey cast iron

Results	**Materials**	
	Structural Steel	**Grey Cast Iron**
Total deformation	0.118 Max	0.217 Max
Equivalent elastic strain	90.645 Max	92.596 Max
Equivalent stress	0.000731 Max	0.00135 Max
X deformation	0.055938 Max	0.10259 Max
Y deformation	0.11121 Max	0.20335 Max
Z deformation	0.046719 Max	0.084746 Max

Table .2 Final results of Kevlar and Graphene

Results	**Materials**	
	Kevlar	**Graphene**
Total deformation	0.130 Max	0.0100 Max
Equivalent elastic strain	83.779 Max	117.38 Max
Equivalent stress	0.000766 Max	0.0000778 Max
X deformation	0.060626 Max	0.0049888 Max
Y deformation	0.12166 Max	0.00952 Max
Z deformation	0.052437 Max	0.0036186 Max

5.CONCLUSION

1. Using a variety of materials and our project, we were able to model and analyse a crankshaft in three dimensions.

2. In this project, four different materials were employed, and they were then contrasted. In terms of overall deformation and elastic strain, graphene performs better than all other materials.

3. In addition, when developing the essential parts, the properties of one particular material, steel, were taken into account. When designing the important elements, considerations of materials other than those in this dissertation may also be made.

4. The crankshaft's weight can be reduced. Graphene is six times more lightweight than steel. Losing weight reduces the fuel consumption of the car. Under various loading conditions, it is found that crankshafts made of graphene distort and strain less than conventional crankshafts.

5. Compared to other materials, graphene is less dense and has a lower Young's modulus. Internal combustion engines

perform better because graphene crankshafts can absorb more energy because they are 200 times stronger than steel.

REFERENCES

1. L.Karthick, NareshMallireddy, J.Yogaraja, S.Sivakumar, A.Sasikumar, '"Modelling and Analysis of an EN8 crankshaft material in comparison with Forged steel crankshaft" ,Elsvier, Volume47,Part17,https://doi.org/10.1016/j.matpr.2021.05.079, Pages 6168-6172, 2021.

2. Chinmay Dube, Neeraj Mohite, Bhushan Pawar, Mukund Kharde "Review Paper on Static Structural Analysis of Crankshaft of Single Cylinder Petrol Engine", Social Scienece Research Network, ISSN 1556-5068, 2021.

3. Aatish Chaudhary, Abhishek Mishra , Devendra Raj Pandey , Jiyaul Mustafa, "Design & Analysis of Crankshaft by ForgedSteel & Composite Material", International Journal for Research in Applied Science & Engineering Technology , Volume 8 Issue V,ISSN: 2321-9653,pages 1107-1112 2020.

4. Dr. K.Satyanarayana, Annamreddi Venkata Vinay, Madathingala,Dr B.Nagaraju, "modelling and analysis of crankshaft for four stroke diesel engine by using composite materials", International Journal of Creative Research Thoughts,Volume 9, Issue 6, ISSN: 2320-2882,pages g354-g360,2021

5. Amrutham Sandeep , Mengu Vijay John, S.P. Jani, "Theoretical modelling and analysis of a four-wheeler crank shaft by different aluminumalloys",Elsvier,Volume45,Part2,https://doi.org/10.1016/j.matpr.2020.08.560, Pages 1679-1683,2021.

6. .R. K. Patel ,G. K. Ghosh , S. R. Pradhan, "Fatigue and modal analysis of Crankshaft using ANSYS software",The International Society for Microbial Ecology,ISSN 2730-6151, ISME, 2019

7. Himanshu Bist, Himanshu Bhatt, "Modeling and Analysis of Crankshaft (Using ANSYS)", International Journal of Recent Engineering Science, Volume 8 Issue 2, 1-9, ISSN: 2349 – 7157, doi:10.14445/23497157/IJRES-V8I2P101, 2021

8. Saurabh Patil, 2S. R. Pawar, "static analysis of composite crankshaft of single cylinder petrol engine using ansys software",Journal of Emerging Technologies and Innovative Research, Volume 5, Issue 6, ISSN-2349-5162, 2018.

9. Timur Choban Khidir, Mohammed Qasim, Abbas Mohammed Ismael, "Modelling and Assessment of Crankshaft through SOLIDWORK Program",research gate,,ISSN:2329-4150,pages 162-165,2021

10. R.Suganthini Rekha , Dr. S.Nallusamy, R .Vijayakumar, S.Saravanan, "shaft with metal matrix composites",International Journal of Applied Engineering Research, vol 10 no. 62, , ISSN 0973-4562, Pages- 133-137, 2015

11. M. Srihari, Shaik Himam Saheb & S. Vijaya Nirmala, "design and analysis of crankshaft for 4- stroke deisel engine",International Journal of Scientific Research and Modern Education , Volume I, Issue II, ISSN (Online): 2455 – 5630, Pages 90-95, 2016

12. Mr. Mathapati N. C., Dr. Dhamejani C. L, "fea of a crankshaft in crank-pin web fillet region for improving fatigue life",INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY, volume 2, issue 6, issn: 2394-3696,2015

13. Saeed Asiri, "Modeling and Analysis of Automotive Engine Crankshaft Made of Composite and Functionally Graded Materials", Hindawi, Volume 20, https://doi.org/10.1155/2022/4005368, 2022

14. Priyanka M. Chavan, Prof. R. H. Shinde, "Design & Analysis of Crankshaft for Single Cylinder Diesel Engine",International Research Journal of Engineering and Technology, Volume: 08 Issue: 09, e-ISSN: 2395-0056,Pages 1311-1319, 2022

15. Ashwin Kumar Devaraj, "Finite Element Analysis of Crankshaft", Research gate,ISSN:2329-4150,2011.

16. Thejasree , G.Dileep Kumar , S.Leela Prasanna Lakshmi, "Modelling and Analysis of Crankshaft for passenger car using ANSYS",Elsvier,ISSN 0346-2512 , Pages 11292-11299, 2017

17. Ramesh Ganugapenta, M. Dora Babu, B.R. Satheesh Raja, M. Kumar, "Design, Static and Modal Analysis Of Crankshaft", International Journal of Creative Research Thoughts, Volume 6, Issue 1, ISSN: 2320-2882, Pages 254-261,2018

18. K. Durga Prasad, K. V. J. P. Narayana, N. Kiranmaye, "Design and Stress Analysis of Crankshaft for Single Cylinder 4 Stroke Diesel Engine",International Journal of Engineering Research & Technology , Vol. 7 Issue 11, ISSN: 2278-0181, Pages 154-159, 2018.

19. Randhavan B M, Prof Galhe D S, "Design and Analysis of Crankshaft of Four Cylinder1 Diesel Engine for Heavy Vehicle",International Journal of Scientific Research in Science, Engineering and Technology, Volume 3, Issue 5, ISSN : 2394-4099, Pages 131-138, 2017

20. Shubham M. Bhosale, Prasad K. Chunekar, Prasad P. Gharat, Saurabh S. Sirsikar, "a review of optimization and analysis of crankshaft for passenger car", Journal of Emerging Technologies and Innovative Research , , Volume 6, Issue 4, ISSN-2349-5162, Pages 101-105,2019.