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MODELLING AND ANALYSIS OF CRANKSHAFT FOR FOUR STROKE DIESEL ENGINE BY USING COMPOSITE MATERIALS

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Abstract:The 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 V5software. Static structural analysis is performed to obtain the stress magnitude at critic allocations of crankshaft in. The static analysis is done using Software ANSYS 2021R1 which resulted in the stresses, deformation and elastic strain. Boundary conditions are applied at bearings**.** Crankshafts find many applications in various branches of engineering. They are used whenever there is the need to translate reciprocating linear motion into rotation or vice-versa. In their more varied configurations, crankshafts are usually used in internal combustion engines but also in piston steam engines. It lays on the former the vaster and varied range of applications of crankshafts. The internal combustion engines cover various fields of uses, from small scale model planes to large maritime engines.

Keywords: Crankshaft, Composite Materials,Al7075,SiC,Catia,Ansys

I. INTRODUCTION

Crankshaft is an extensive segment with a perplexing (complex) geometry in the engine, which changes over the reciprocating displacement of the piston into a rotating movement with a four-link mechanism. In a reciprocating engine, it translates reciprocating motion of the piston into rotational motion, whereas in reciprocating, it converts the rotational motion into reciprocating motion. In order to do the conversion between two motions, the crankshaft has "crank throws" or "crankpins", additional bearing surfaces whose axis is offset from that of the crank, to which the "big ends" of the connecting rods from each cylinder attach. It is typically connected to a flywheel to reduce the pulsation characteristic of the four-stroke cycle, and sometimes a torsion or vibration damper at the opposite end, to reduce the tensional vibrations often caused along the length of the crankshaft by the cylinder’s farthest from the output end acting on the tensional elasticity of the metal. Crankshafts find many applications in various branches of engineering. They are used whenever there is the need to translate reciprocating linear motion into rotation or vice-versa. In their more varied configurations, crankshafts are usually used in internal combustion engines but also in piston steam engines. It lays on the former the vaster and varied range of applications of crankshafts. The internal combustion engines cover various fields of uses, from small scale model planes to large maritime engines. So, crankshafts produced by the various methods apply to: e.g., engines for road, rail and maritime transport, portable machinery, electrical generators, agricultural and industrial machinery. Crankshafts are also used in driven machinery such as air compressors and reciprocating pumps. The industrial potential for a new crankshaft manufacturing process is huge, as the existing and common methods, forging; casting and machining are very costly. The former two demand high volume production to be cost effective, as the investment in tools and machinery is huge. Translator motion of the pistons which is changed into rotational motion. In the combustion of the fuel-air mixture, power is produced. This power is transformed into rotary movement of the crankshaft. The linear motion of the pistons is converted via the connecting rod into torque. It is then passed to the flywheel. Crankshafts also function as load bearing as some load is withstand during the process. One of the loads is the severe bending and torsional stress.

2.PROBLEM STATEMENT

In this paper static analysis is carried out on crankshaft made up different composite materials Al7075+2%SiC and Al7075+5%SiC

3. LITERTURE SURVEY

Solanki and Dodia et al [1] in their research, performed the numerical analysis of the crankshaft. They observed the stresses occurring in critical cross-sections of thecrankshafts. The obtained stress values were compared with the previously analytically calculated values. By comparing the results, they found that the numerical results were very close to analytical and can be used as such for calculations, considering the numerical method requires a much shorter time.**ZissimosP.Mourelatos et al[2]** A system model for analyzing the dynamic behaviour of an internal combustion engine crankshaft is described. The model couples the crankshaft structural dynamics, the main bearing hydrodynamic lubrication and the engine block stiffness using a system approach. A two-level dynamic sub structuring technique is used to predict the crankshaft dynamic response based on the finite-element method. The dynamic sub structuring uses a set of load dependent Ritz vectors. The main bearing lubrication analysis is based on the solution of the Reynolds's equation. Comparison with experimental results demonstrates the accuracy of the model. Numerical results also show the capabilities and significance of the model in engine crankshaft design. **M.Fonte, P. Duarte, V. Annes, M. Freitas, L. Reis et al [3]** The fatigue strength and its correct assessment play an important role in design and maintenance of marine crankshafts to obtain operational safety and reliability. Crankshafts are under alternating bending on crank pins and rotating bending combined with torsion on main journals, which mostly are responsible for fatigue failure. The commercial management success substantially depends on the main engine in service and of its design crankshaft, in particular. The crankshaft design strictly follows the rules of classification societies. The present study provides an overview on the assessment of fatigue life of marine engine crankshafts and its maintenance taking into account the design improving in the last decades, considering that accurate estimation of fatigue life is very important to ensure safety of components and its liability. An example of semi-built crankshaft failure is also presented and the probable root case of damage ,and at the end some final remarks are presented **Farzin H Montazersadgh et al[4**] proposed dynamic analysis and were investigated the effect of torsional load and the variation of stress magnitude at critical location by using the finite element analysis techniques**. Amarjeet Singh et.al.[5]**Analyzed and optimized strength, the main intention of this method was conducted static analysis on four cylinder engine crankshaft. In this method after getting out the stress results, the critical points identified were the knuckle of crank arm and extreme left bearing.

4.MODELLING AND ANALYSIS OF CRANKSHAFT

4.1 Modelling of crankshaft using catiaV5

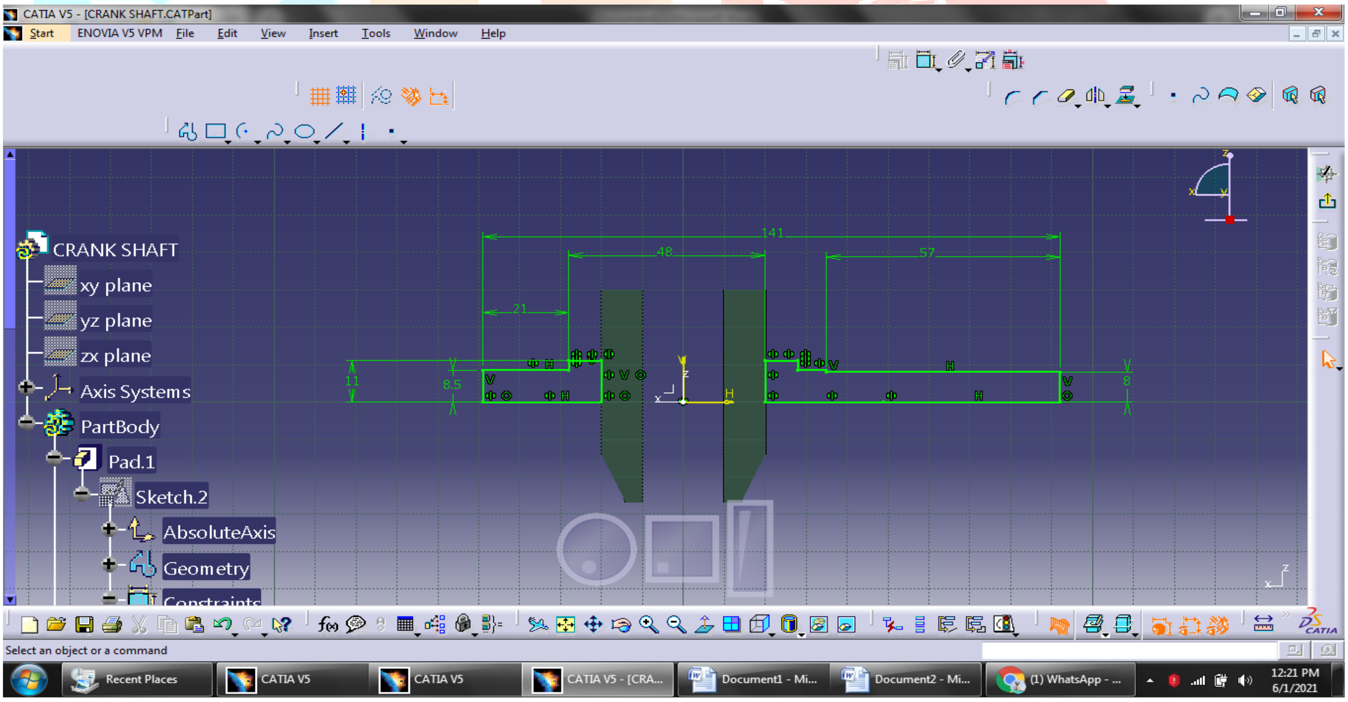

Fig.4.1Design of the Crank shaft in CATIA

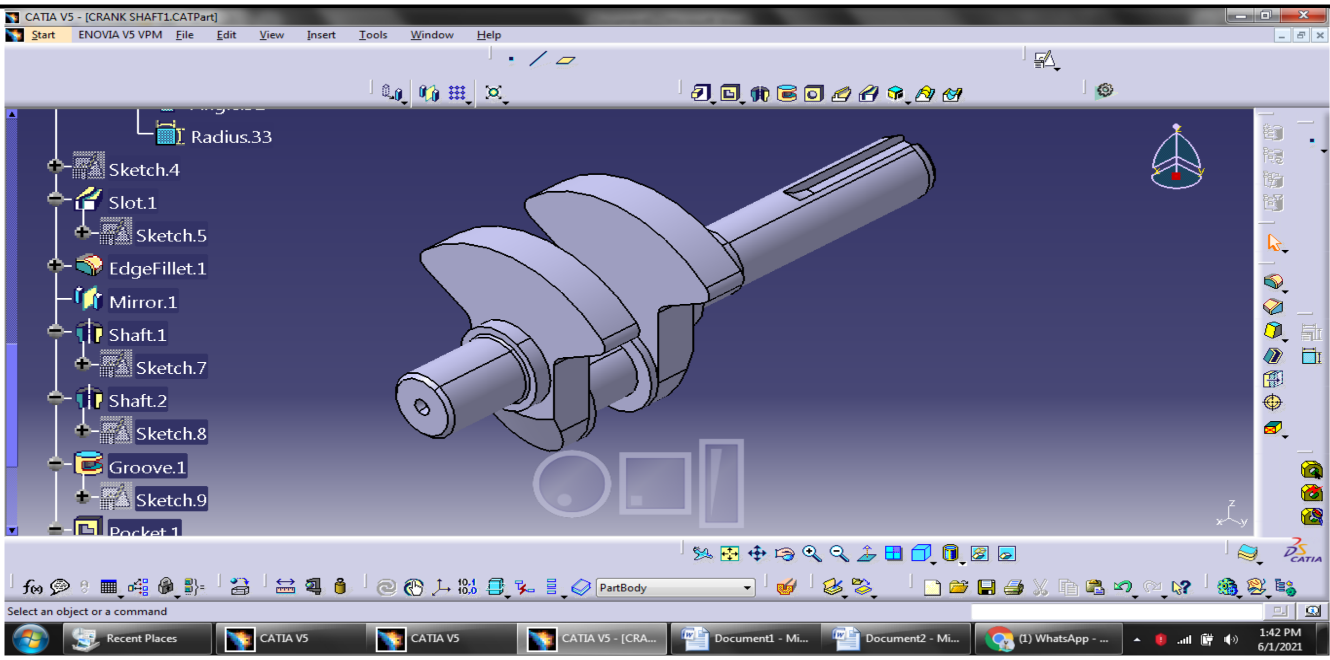

Fig.4.2Design of the Crank shaft in CATIA

4.2ANALYSIS OF CRANKSHAFT

Structural static analysis: A static analysis is used to calculate the effects of steady loading conditions ignoring the effects of inertia and damping. In static analysis loading and response conditions doesn't vary with time. The input loading conditions that can be given in static analysis are moment, applied force and pressure and the output can by displacement,forces in a structure, stress and strain. If the values obtained in static analysis crosses the allowable values it will result in the failure of structure. The static structural analysis is carried out on the recent Ansys 2021R1 version.

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.
Define the boundaries: Define the boundaries for the imported model in the ANSYS using the option of 'create named selection'.
Generate Mesh: Now the model must be broken into finite number of pieces which are called as elements. This process is known as meshing. At boundaries to get the accurate results we do inflation. Inflation is the process of producing the finer elements.
Apply the conditions: Now the boundary conditions are applied at the bearing on both the sides of crankshaft.
Obtain solution and plot results: Use the method six DOF to obtain the results, the results obtained are tabulated in the table.

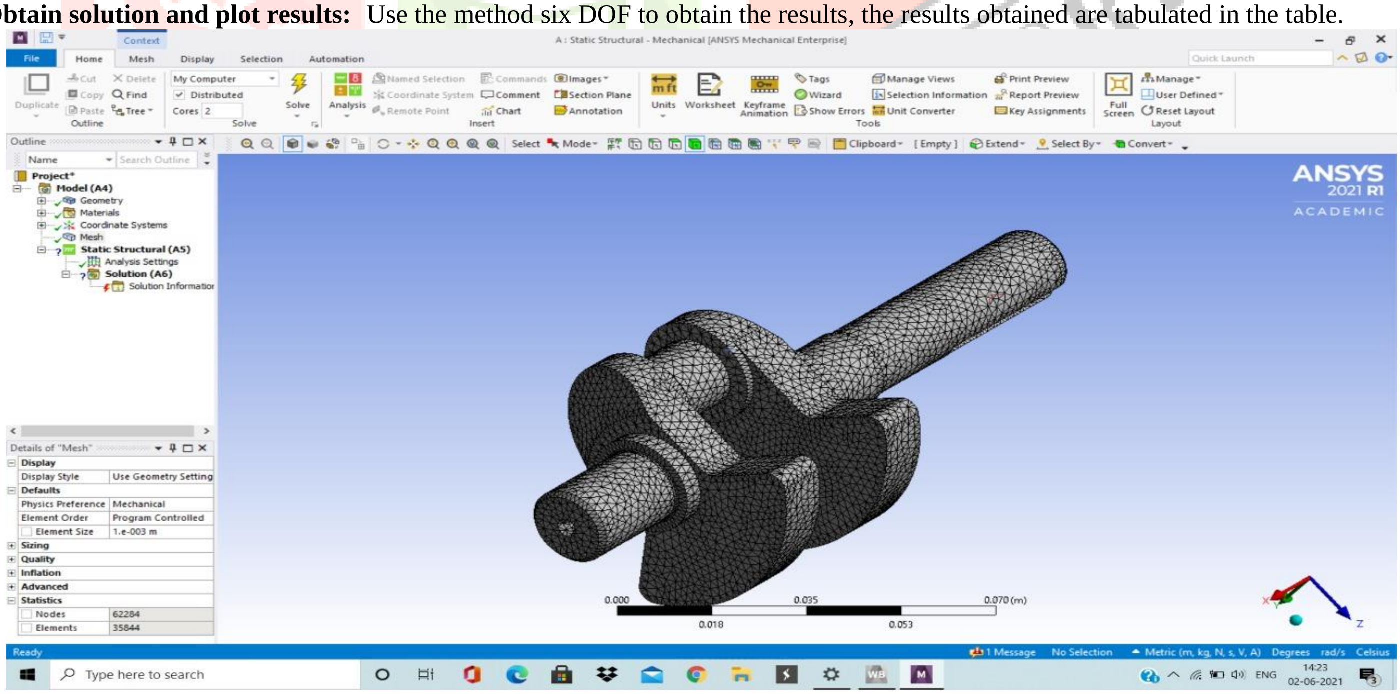

Fig.4.3 Meshed model of crank shaft

5.RESULTS & DISCUSSION

Materials Used For Crankshaft:

- Structural Steel
- Al7075+2%SiC
- Al7075+5%SiC

The structural static analysis is conducted on crankshaft by using these different materials. First the analysis is carried out by structural steel then the Parameters like von-misses stresses, deformation, equivalent elastic strain is found . Later the analysis is performed on crankshaft by Al7075+2%SiC and Al7075+5%SiCand above parameters are calculated.

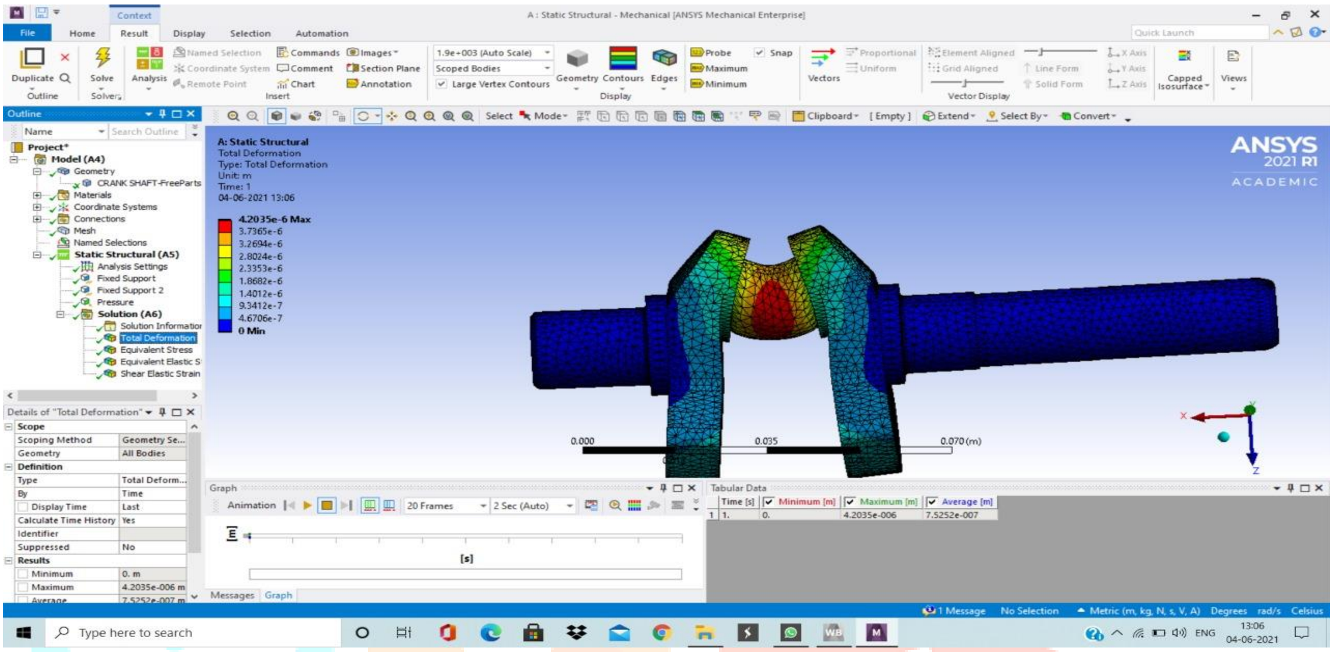

Fig. 5.1 Total Deformation of crank shaft(Al7075+5%SiC)

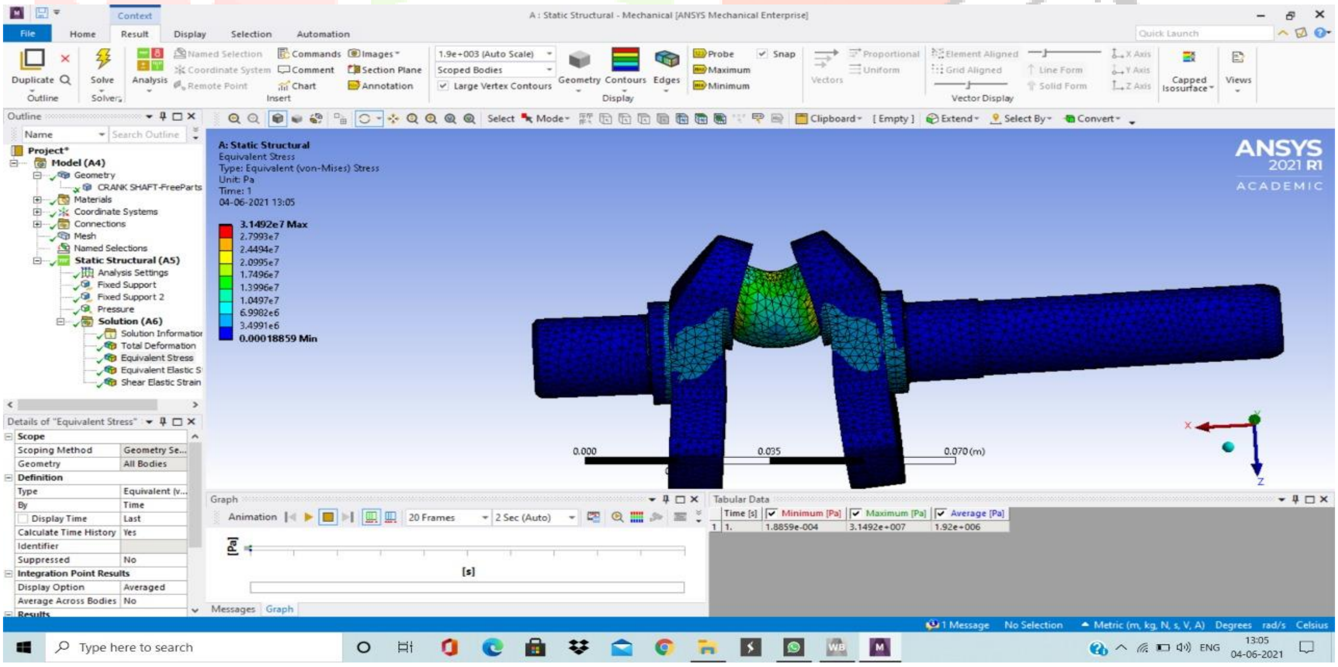

Fig. 5.2 Equivalent Von-Misses Stress of crank shaft(Al7075+5%SiC)

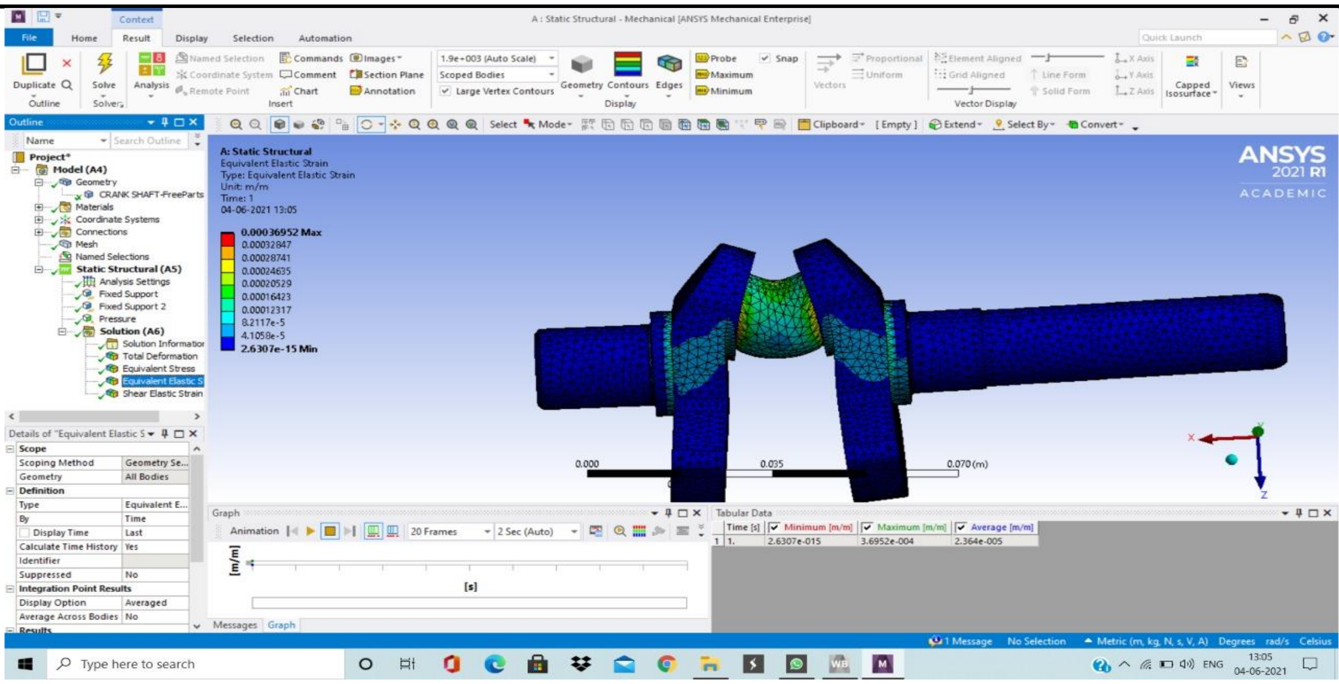

Fig. 5.3 Equivalent Elastic Strain of crank shaft (Al7075+5%SiC)

Table 5.1 The obtained parameters are tabulated in the below table:

S.NO	MATERIAL	TOTAL DEFORMATION (m)	EQUIVALENT (VON-MISES) STRESS (Pa)	EQUIVALENT ELASTIC STRAIN
1	Steel	5.1669×10^-6	3.1852×10^8	0.0017021
2	Al7075+2%SiC	4.7206×10^-6	3.1492×10^7	0.0004149
3	Al7075+5%SiC	4.2035×10^-6	3.1492×10^7	0.0003695

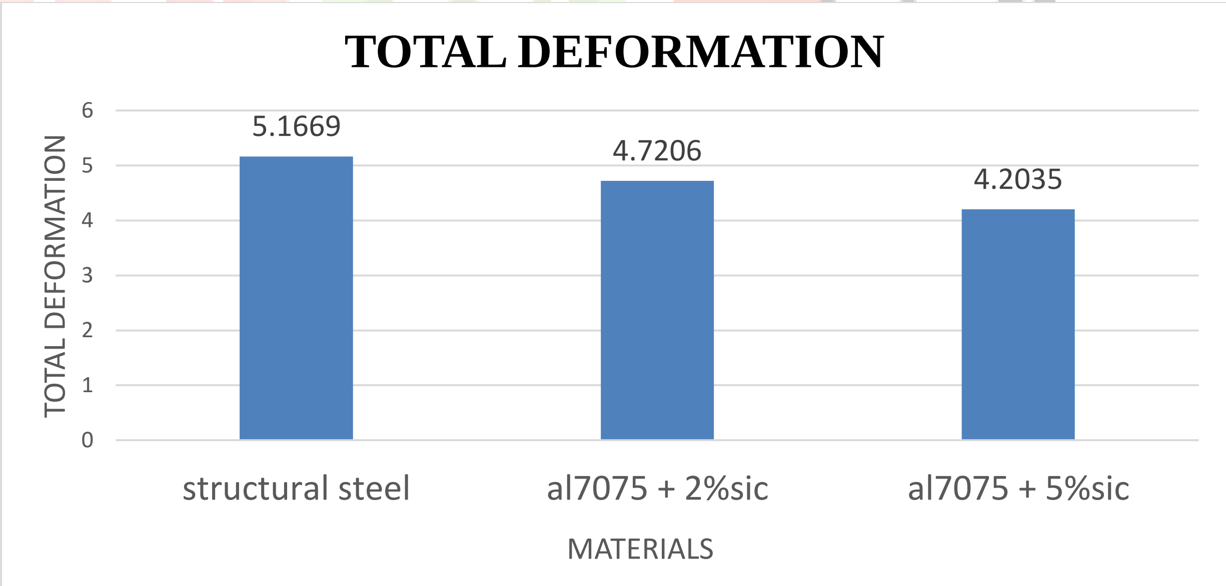

Fig. 5.4 Total Deformation Graph

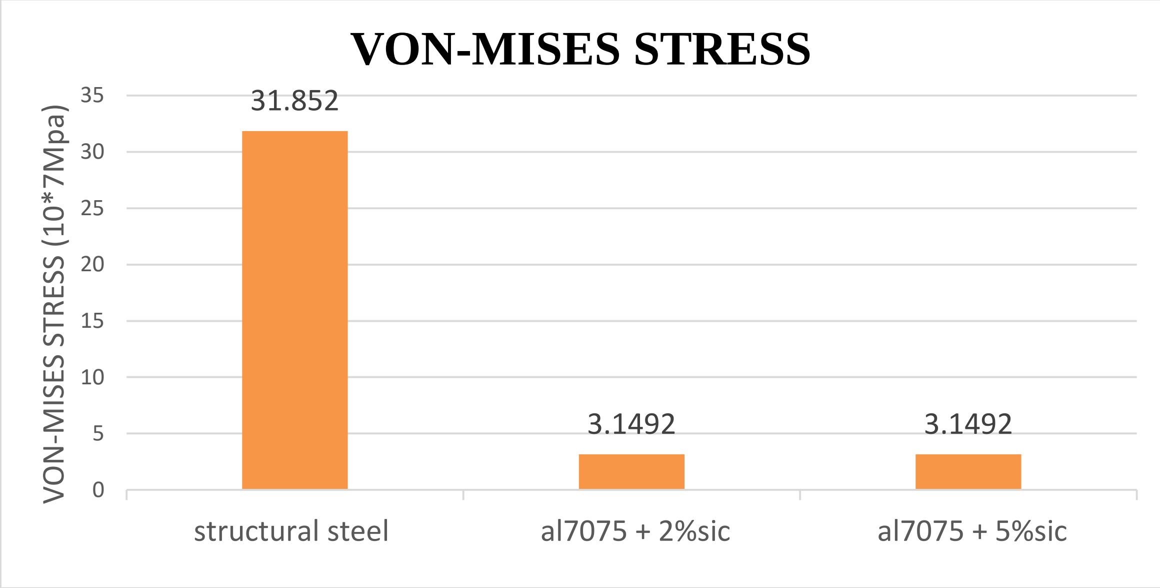

Fig. 5.5Von-Misesstress Graph

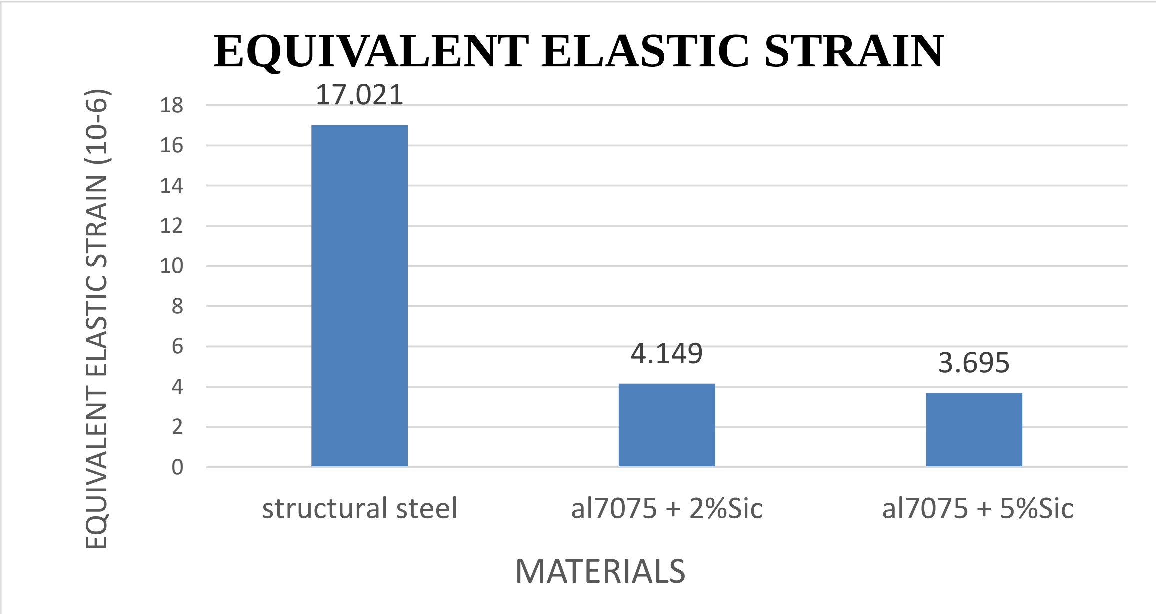

Fig. 5.6Equivalent Elastic Strain Graph

By comparing the structural steel and Al7075+2%SiC from the above results it is obtained that the l7075+2%SiC shows the less deformation, equivalent von-misses stress and strain while comparing to the structural steel.
Then after by increasing the content of percentage composition of Sic i.e.; Al7075+5%SiC
Then it shows less deformation and less strain but same stress while comparing to the Al7075+2%SiC

6. CONCLUSION:

1.Crankshaft is designed with three different materials from those three different designs it is concluded that it is very much useful to use Al7075+5%Sic rather thanAl7075+2%Sic and structural steel.
2. Al7075+5%Sic and Al7075+2%Sic has got better equivalent stress.
3. The Al7075+5%Sic has shown less deformation and elastic strain when compared with structural steel and Al7075+2%Sic.
4. This Al7075+5%Sic has got less equivalent stress than structural steel.
5. So Al7075+5%Sic is best and convenient composite to be used.

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