Design And Analysis Of Gear Box Base Plate Using Computer Aided Engineering.

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Abstract: The existing gear control box is made up of sheet metal. It is having assembly of shifting rod connected with a wire, which is connected with gear shifting shaft. This component is basically used for controlling or changing the gears of an Automobile. This system is located beside the driver seat, in a four wheeler car. Box cover & shifting rod is only visible from outside. During operation Driver pulls the shifting rod & internal assembly allows the gear to shift. Here, in this project the attempt is made to replace the metallic Gear Box Base Plate with the composite material. The robostic tools of designs i.e. ProE, Ansys, Hypermesh, Moldflow are used to analyze the strength, vibrations and thermal check over the composite Gear Box Base plate. This trial is attempted for possible replacement of metallic component to control the inertia of the vehicle without affecting the performance.

Keywords: **Ansys, FEA, Moldflow, ProE.**

I. INTRODUCTION

Today, world requires speed in each and every field. Hence, rapidness and quick working is most important. Now a days for achieving rapidness, various machines and the equipment are being manufactured. In such a modern era of liberation, small-scale industries are contributing in a big way to the growth of our country. New machines and techniques are being developed continuously to manufacture various products at cheaper rates and high quality. Automobile transmission can be performed by means of automatic transmission or manual transmission. The transmission system in a car helps in transmitting mechanical power from the engine to the wheels. In the competitive world in the global market, automotive industries are striving to produce product at high quality at shorter time and at low cost.

Fig. 01 Original base plate with assembly

This can be achieved by well plan design activities and by considering various modern information technology tools like Finite Element Analysis & Computer Aided Design. Fig. 1shows the actual system considered but the bottom plate called base plate is considered for analysis.

II. LITERATURE SURVEY AND ANALYSIS

- B & M Shifters USA:

Race shifters of aluminum alloy is replaced by carbon fiber reinforced composite material. By 'B & M' Shifters USA. This new shifter from B & M destined to be one of the most handsome race shifters on the market today! B & M has taken the legendary performance of the pro stick and added the lightweight strength of carbon fiber and the cutting edge style of the magnum and has produced an instant classic! The carbon fiber pro stick shifter includes all of the standard pro stick features with new magnum grip handle CNC machined from billet aluminum. Compact, strong and functional, what more could you ask for in a shifter for a drag race car!

- Mitsubishi Pajero Gear Lever:

Replacement gear lever pivot ball housing manufactured in die cast aluminum. Full kit comes with self-lubricating nylon pivot ball, gaskets and rubber boot tie. Available in New Zealand from Mitsubishi Dealers, the Gearbox shop and selected automotive parts suppliers.

A. Material Selection:

As, the converted composite part needs to withstand a number of requirements. So the following properties are considered while selecting the plastic polymer.

- High impact resistance.
- High temperature.
- High vibration.
- Chemical resistance.
- Stiffness.
- Wear resistance etc.

B. Introduction to Nylon:

Whilst by far the bulk of polyamide materials are used in fibers, they have also become important as special thermoplastics of particular use in engineering applications. The fiber-forming polyamides and their immediate chemical derivatives and copolymers are often referred to as nylons. There are also polyamides available of more complex composition which are not fiber-forming and are structurally quite different. These are not normally considered as nylons.

Polyamides the latter part of the periods polyamides became available which might be classified as thermoplastic rubber. There thus exists a very wide range of materials-fibers, crystalline plastics, amorphous plastics, adhesives and rubbers-which are classified as polyamides. They have the common feature that the amide (-CONH-) group occurs repeatedly in the polymer. Such an amide group can increase resistance to swelling and dissolution in hydrocarbons, increase inner chain attraction and hence stiffness and heat deformation resistance, reduce electrical insulation resistance, particularly at high frequencies, and increase water absorption.

C. Properties of Nylon 66:

- ✓ 100% elastic under 8% of extension
- ✓ Specific gravity of 1.14
- ✓ Melting point of 263°C
- ✓ Extremely chemically stable
- ✓ No mildew or bacterial effects
- ✓ 4 - 4.5% of moisture regains

D. Properties of n- 66 with 20% glass fiber:

- ✓ Melting point = 252-265° c
- ✓ Max. service temperature = 227-254° c
- ✓ Coefficient thermal expansion (at 20°c)
- ✓ Thermal conductivity (k) = 0.42 W/mK
- ✓ Density = 1.25 g/cc
- ✓ Modulus of elasticity = 4.5-7.2 GPa
- ✓ Ultimate strength =120 MPa
- ✓ Yield strength = 130 MPa
- ✓ Impact strength, Izod Notched =.83 J/cm
- ✓ Poisson's ratio =0.33
- ✓ Hardness = R 110
- ✓ Shrinkage value = .0052 cm/cm

E. Additives Used:

The major nylon molding materials are each available in a number of grades. These may differ in molecular weight but they may also differ in the nature of additives which may be present.

Additives used in nylon can be grouped as follows:

- ✓ Heat stabilizers.
- ✓ Light stabilizers.
- ✓ Plasticizers.
- ✓ Lubricants.
- ✓ Reinforcing fillers.
- ✓ Fungicides.

- ✓ Nucleating agents
- ✓ Impact modifiers.

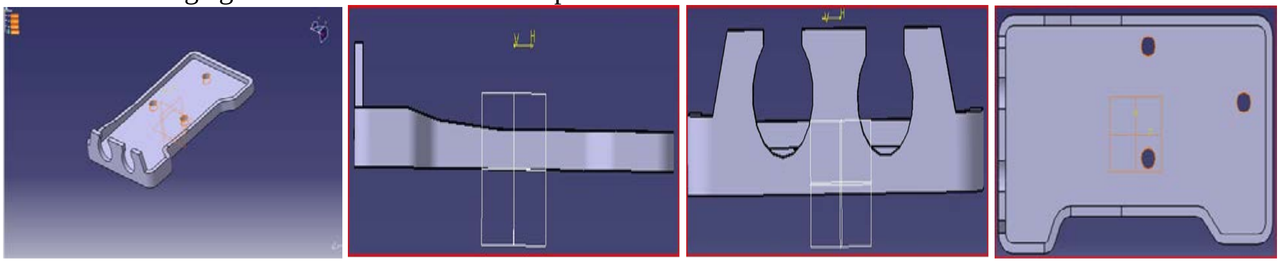

Fig. 02 Isometric, Front, Side, Top View of the original component respectively.

A. Drafting of Original Component:

Following diagram is drafted by using the measured dimensions of the Gear Box Base Ulate using Pro Engineering ProE.

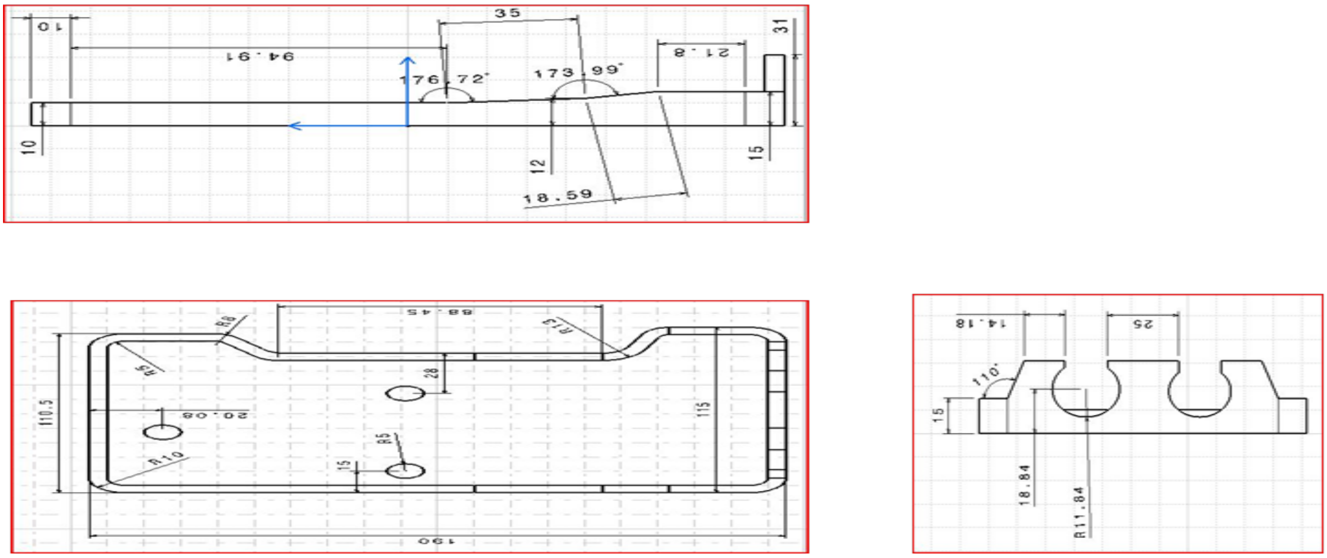

Fig. 03 Drafting of Original Part.

B. Modelling of the Modified Part:

Design of the proposed plastic part is done with a lot of care, because it is a composite part. Many considerations like wall thickness, ribs, hole, radius, fillet has been taken for designing of modified component.

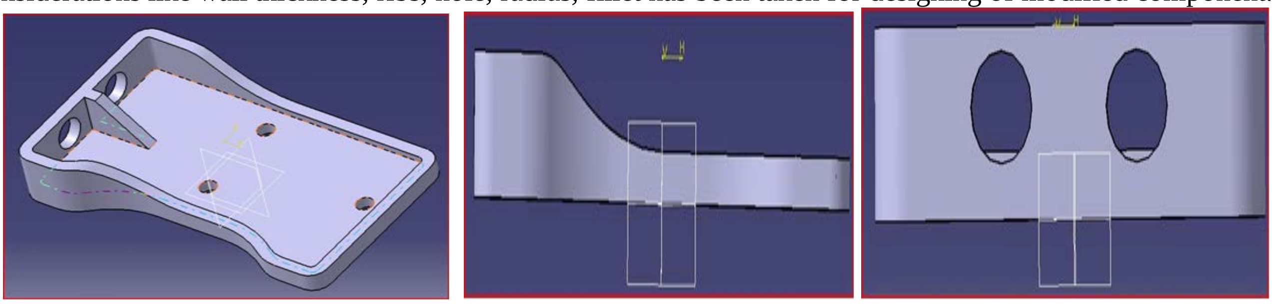

Fig. 04 Isometric, Side and Front view of Modified Part Respectively.

C. Drafting Of Modified Cad Part:

Basic Features of the Modifications:

- ✓ Radius: As it is seen the total part does not contain any sharp corner and edge. Because any sharp corner or sharp edge leads the part which is made up of plastics to destruction. As the stress concentration is high on the sharp locations. Another reason of keeping radius throughout the part is easily molding and faultless molding.

- ✓ Rib: In this part ribs and stiffness is much required, because one part of the body is attached to the car body, where as another part carries the engine partially. As it is proposed to be molded in single part, therefore, the occurrence of the high stress is almost certain on the body. So, if any part of the body is not supported, then the apex and the part will fail.
- ✓ Wall Thickness: Here, it can be seen that, the wall thickness is maintained throughout the body. If the wall thickness is not maintained, then part shrinkage because of inefficient cooling or non-uniform cooling or non-uniform cooling will lead to part failure.

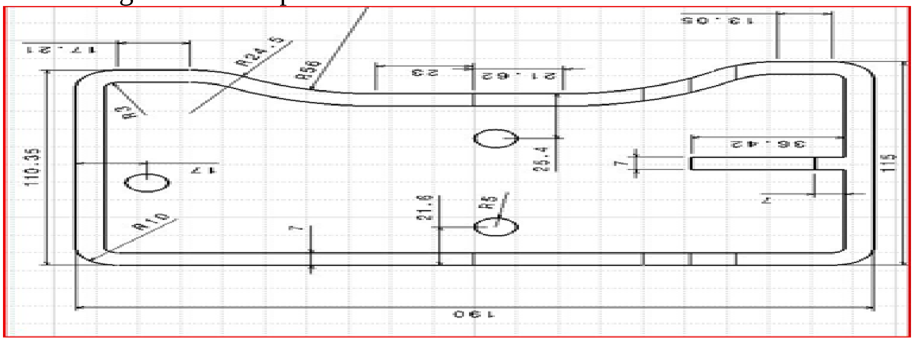

Fig. 05 Drafting Of Modified Part.

D. Meshing:

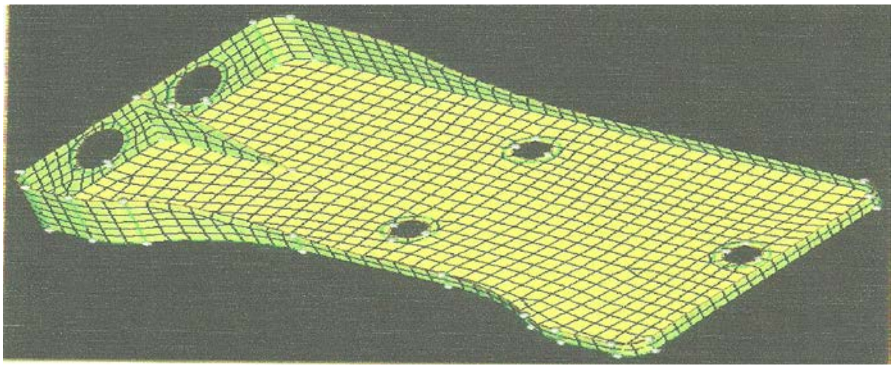

Fig. 06 Meshing of modified part

Mesh details:

- ✓ Hypermesh 8.0 platform is used for meshing.
- ✓ FE model generated on mid surface Mixed elements (Quad & tria) are used for meshing.
- ✓ 2D shell elements are used
- ✓ Average 4.0 mm & min 2.0 mm element size.
- ✓ Washer is created near holes.
- ✓ Dense meshing near hole areas.

E. *Mold Flow:*

Mold flow analysis enables us to simulate the plastic injection molding process, and thus ensure the quality and efficiency of an injection molding process and product molded. The simulation is usually conducted during the product the product design stage or the early stages of the tool design, and helps to reduce and eliminate many problems associated with commissioning an injection mold, before construction and major investment in the mold has even begun. The processing characteristics of the plastic injection molded part is studied during the course of the mold flow simulation allowing optimization of the part is studied during the course of mold flow simulation allowing optimization of the part and mold design by adjusting areas such as gate positions, wall thickness and cooling parameters to be economical by saving time, energy and money.

Mold Flow Plastics Insight:

Mold flow plastics Insight is an in-depth simulation software package that determines the optimal combination of part geometry, material, mold design and processing parameters for your part or mold design. Plastics Insight products provide information on plastics flow, mold cooling, warpage of the part and orientation of reinforcing fibers, part stiffness and shrinkage, gas flow for gas injection molding as well as thermo set flow.

- ✓ Simulation
- ✓ Warpage Analysis
- ✓ Stress Analysis
- ✓ Fiber Orientation Analysis
- ✓ Molding Process Optimization
- ✓ Gas Injection Molding Process

F. Fill Time –Result:

The fill time result shows the position of the flow front at regular intervals as the cavity fills. Each color contour represents the parts of the mold. Which were being filled at the same time. At the start of infection, the result is dark blue, and the last places to fill are red. If the part is a short shot, the section, which did not fill, has no color.

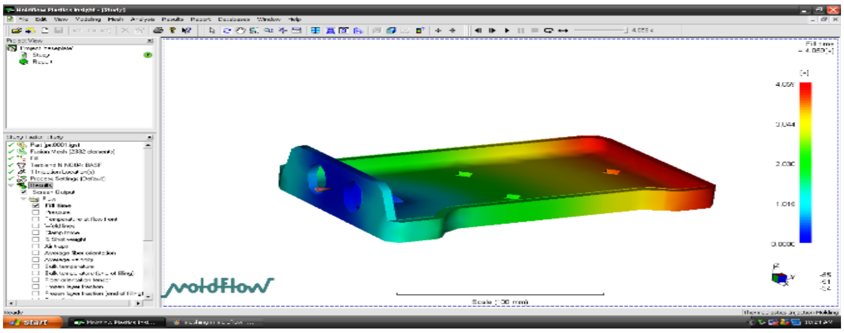

Fig. 07 Fill time

A. Weldeline –Results:

The weld lines result is generated at the end of a filling analysis. This analysis shows where weld lines are likely to occur on your model along with the angle at which the flow front converges to form the weld line. Weld lines occur where two or more flow fronts converge. The presence of weld lines may indicate a structural weakness and/or a surface blemish.

Fig. 08 weld lines

A. Air Trapes:

The air trapes result is generated at the end of a mid- plane or fusion flow analysis, and also shows a black line wherever an air trap is likely to occur. This may be where the melt stops at a convergence of at least two flow fronts, or at the ends of flow paths.

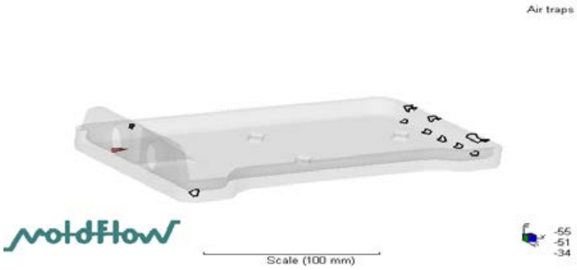

Fig. 09 Air traps

A. Temperature at Flow Front-Result:

Temperature at flow front is a mid-stream nodal result generated from a Mid-plane, Fusion and 3D flow analysis, and shows the temperature of the polymer when the flow front reached a specified node. This can be at the end of the analysis, or at specified time during the analysis.

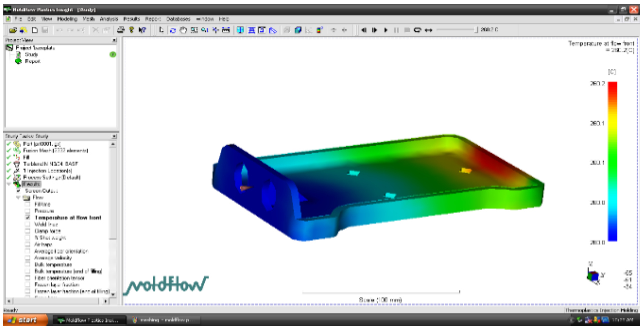

Fig. 10 Temp at Flow Front

B. Time to Freeze:

The time to freeze, part result shows the amount of time taken of all of the elements in the part to freeze to ejection temperature. The part is initially assumed to fill with material at the melt temperature at time zero.

C. Shear Stress at Wall- Result:

The shear stress at wall result is generated from a Mid-plane and fusion flow analysis, and shows the shear stress at the plastic frozen/molten interface at the time the result was written. While the shear stress is not the actual residual stress in a part, it is related to it. It is the measure of the factors affecting the degree of orientation of the melt next to frozen layer.

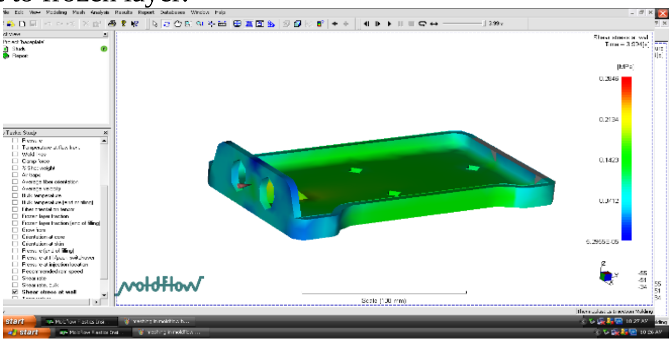

Fig. 11 shear stress at wall

G. Linear Static Analysis:

Analysis has been carried out on hyper works 8.0 by glass reinforced epoxy for different amount of loads such as 1 N,2 N,3 N,4 N,5 N & 10 N analysis is interpreted. Displacement of the component and von mises-stress is found out for different amount of loads. Analysis has been carried out for thickness of 7mm of load.

H. *Boundary Condition for Modified Component:*

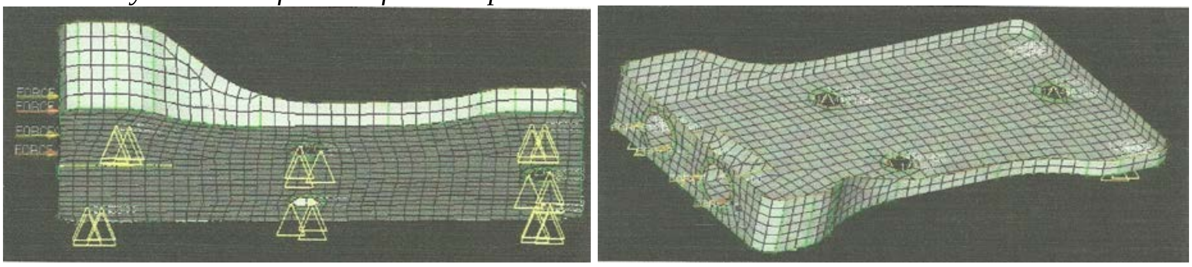

Fig.12 boundary condition, Isometric view for BC's respectively

Analysis for Load of 1N:

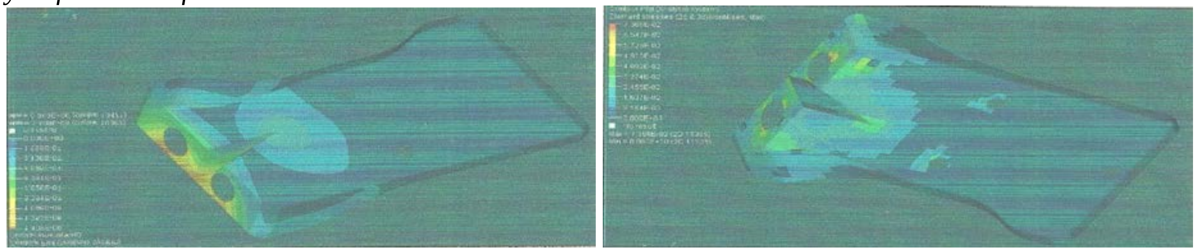

Fig: 13 Analysis for 1N

Analysis for 2N of Load:

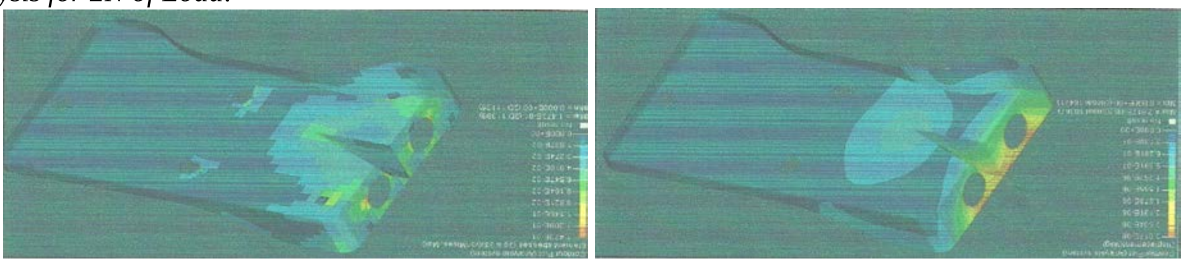

Fig: 15 Analysis for 2N

Analysis for 3N of Load:

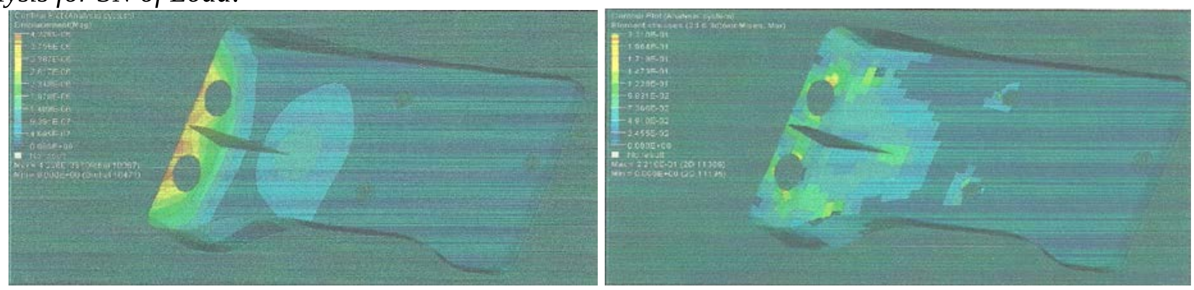

Fig: 16 Analysis for 3N

Analysis for 4N of Load:

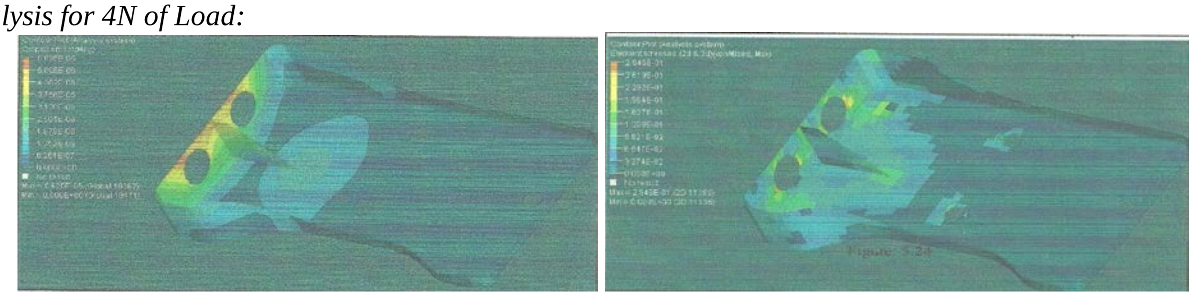

Fig 17 Analysis for 4N

Analysis for 5N of Load:

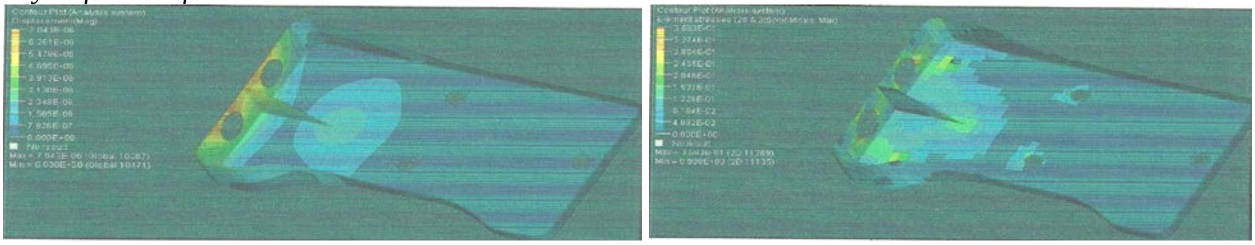

Fig 18 Analysis for 5N

Analysis for 10N of Load:

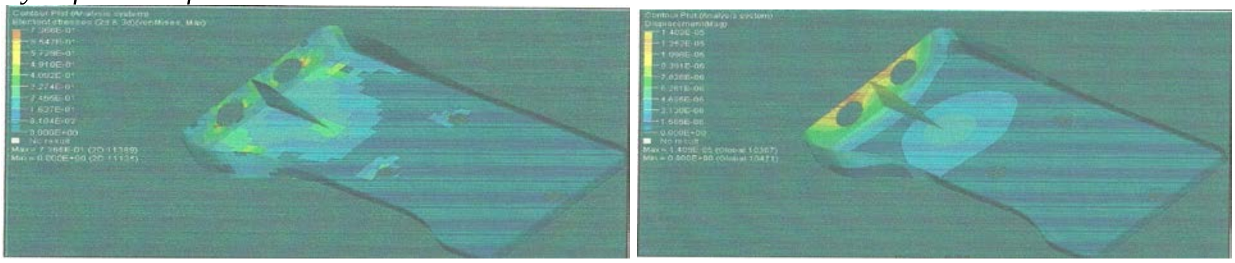

Fig 19 Analysis for 10N

I. *Thermal Stress Analysis:*

Thermal analysis is performed in optistruct 8.0. Two types of loading conditions were created.

- ✓ Fixed.
- ✓ Temperature.

Loading Condition for Thermal Analysis:

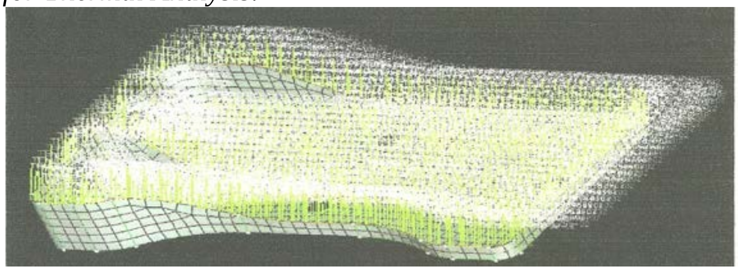

Fig: 20 Temperature loading

Analysis for 100°C Temperature:

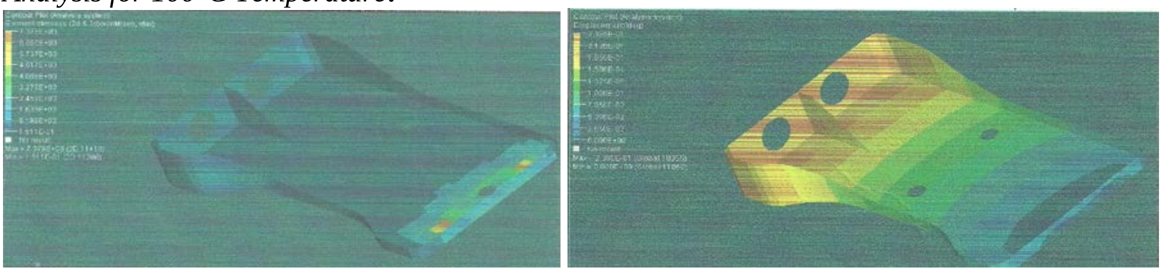

Fig 21 Analysis for 100*c

Analysis for 125°C of Temperature:

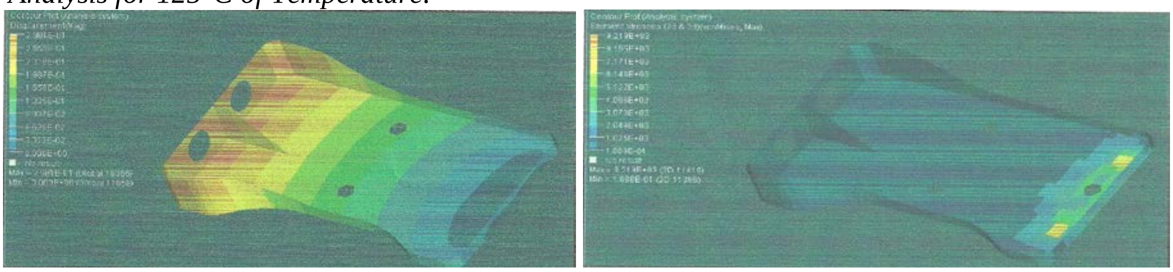

Fig: 22 Analysis for 125*c

Analysis for 135°C Temperature:

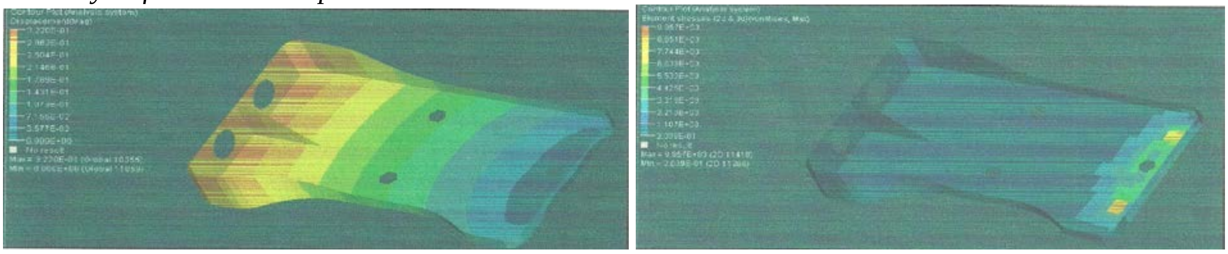

Fig: 23 Analysis for 135*c

Analysis for 150°C of Temperature:

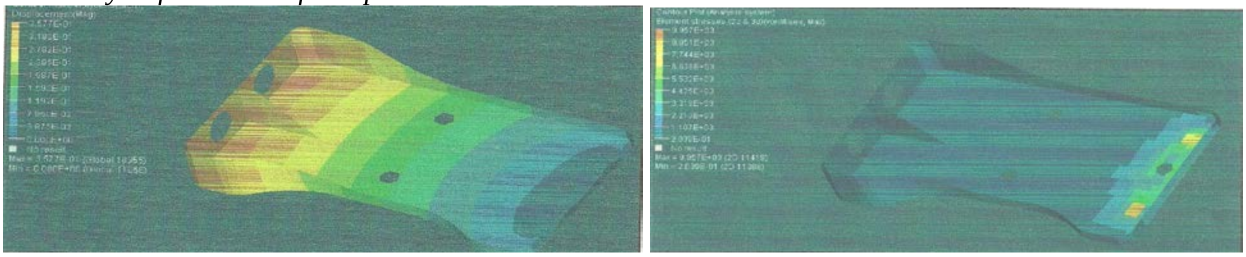

Fig: 24 Analysis for 150*c

Analysis for 175°C Temperature:

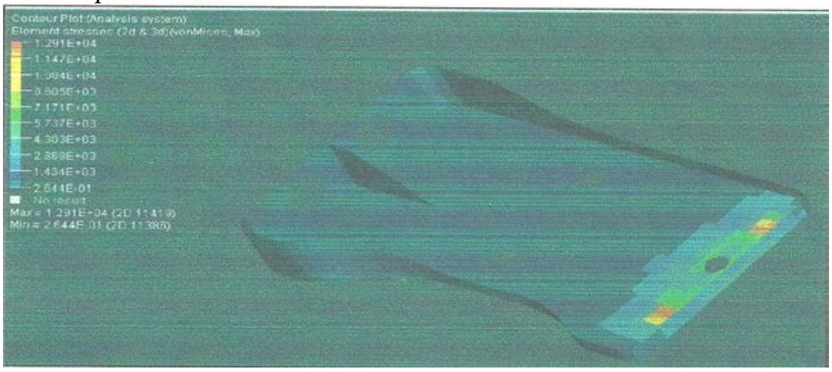

Fig: 25 Analysis for 175*c

III. RESULT

Thus from the above result and their compositions it can be concluded that through nylon 20% material can be replaced with aluminum, then the comparison of the cost with aluminum is calculated.

Cost (in Rs) of the materials are found as:

- Al casting alloy = 135/kg
- Nylon 66 with 20% glass fiber = 180/kg

But, it is Rs45 higher than that of Al casting alloy. But other important factor of the material which relates the volume is density and it is considered further as.

- Al casting alloy = (2.68gm/cc)
- Nylon 66 with 20% glass fiber = 1.35gm/cc

It is almost twice that of Al which as a result will reduce the material cost. Also one can observe in the comparison of results that Nylon 66 exhibits better service properties with higher value of factor of safety than the other two materials. Thus, it can be concluded that Nylon 66 with 20% glass fiber is most suitable to replace Al casting alloy. Regarding processing cost, it is expected to be lower in case of injection molding than die casting of Aluminum for mass production, thus reducing the product cost.

IV. CONCLUSION

The entire project on product development of "Gear Box Base Plate" in the sense of metal to plastic conversion has been completed with all the possible modeling and analysis. Thus after completion of the experiment, it can be concluded that, by a slight modification of the design and by proper process design the material of the Gear Box Base Plate can be converted into Nylon 66 with 20% glass fiber successfully with a reduced cost for the same or better performance.

Due to lack of time and availability of some resources, the Topology and Topography optimization can not be done. But this project has left so much scope to go forward with the product development of Inlet manifold for manufacturing purpose with the chosen material in the view of both cost reduction and better performance. By this, development benefits which were a part of the on-going drive to make vehicles lighter and more efficient polymer parts are made by replacing metal parts.

IV. FUTURE WORK:

In modern world there are so many new inventions and research going on which use plastic polymer in many appliances. These plastic polymer parts are made by replacing metal parts so as to reduce weight, increase corrosion resistance, to reduce cost of production & ultimately increase life of part. By using plastic polymer in vehicle body parts they can be more attractive than before and too versatile for manufacturing of automobile. It can increase strength, reduce cost, increase life etc. so that vehicles become affordable for any person. Now a days modeling & analysis have become easier using various softwares like Pro-E, Hypermesh, Moldflow Analysis etc.

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