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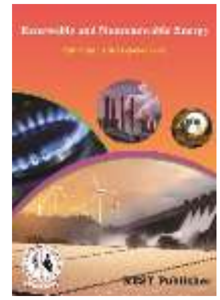

Design Validation and Simulation of Jaw Crusher Plates in a Digital Environment

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Abstract: *Jaw crushers are machines used to crush or compress the raw materials using the metallic plates in mining,cement industries etc. And the chronic problem is high maintenance cost and life time in jaw crusher. In this paper this problem is to solve by improving the jaw plates is designed in different types of teeth profiles such as buttress, square, Acme, with worth and has been designed in CATIAV5 and analysis by using different materials like marten sitesteel, epoxy carbon,E glass epoxy, ceramic coating (MgZro3) and compared in ANSYS. The developments achieved by these techniques lead to increase in customer satisfaction and best productivity.*

1. INTRODUCTION

The mining and preparation of ore for extraction of the minerals and production of a commercial end production of such minerals is called material processing or ore dressing. Apart to reduce the regular size of the ore it is process of using the machines for crushing purpose are jaw crusher. The first mechanical stage in material processing is commination which involves liberation of valuable minerals or ores. These are carried out in two or three stages. The large lumps of the run mines are reduced i the primary stage. It can be reduced the lumps of 1.5m to 10-20cm using the jaw crusher. These primary crushers are commonly designed to operate 75% of the available time, and these are caused by the insufficient crusher feed and mechanical delays in the crusher. And the secondary plant consists of appropriate crushers and screen. In this the crusher reduces to the ore in finer graduations. A jaw or toggle crushers consists of a set of vertical jaws. One jaw being fixed and the other being moved back and forth relatives to it by cam or pitman mechanisms. The jaws are attached apart at the top and then at the bottom as it formed as a tapered chute so that the materials is crushed into smaller size as it comes down after compression of the plates. And it escapes out from the bottom opening. The movement of the jaw can be quite smaller since complete crushing is not performed in one stroke. The inertia required to crush the material is provided.

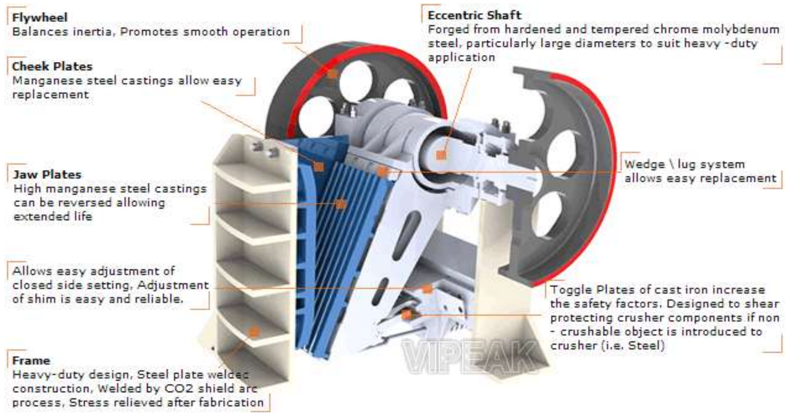

FIGURE 1.

By a weighted fly wheel to moves shaft creating an eccentric motion that causes the closing of the gap. Jaw crusher functions has been shown in the fig

2. LITERATURE SURVEY

A Review on study of Jaw Plates of jaw crusher, Ramakrishna s.More,Sunil j.Rajpal states crushers are major size reduction equipment used in mechanical, metallurgical and allied industries which crushes different types of soft and hard materials. Swing jaw plates are takes direct part into this operation. Hence the design and analysis are very important. This paper focuses on review of a work carried out by research on analysis of swing jaw plate i.e. kinematic and dynamitic analysis of the jaw crusher are improved, thoughthere were so many researchers work done on analysis, but still, there is so many areas of scope to develop the analysis of swing jaw plate. A design & analysis of swing jaw plates of jaw crusher, Ramakrishna S.More observed a jaw crusher break minerals, ore of high strength. The stiffness of swing plate has not been varied with changes in rock strength. Thus, stiffness of swing plate is enough to crush taconite with an unconfined compressive strength (QU) of up to 308MPa, may be over signed for softer fragmental. Hence the weight of the swing plate is necessary to reduced. In this paper work can be done with help of point - load deformation failure (PDF) relationship along with interactive failure of rock particles. Design of plates is carried by using CATIA. And finite element analysis will carry out by using ANSYS. The different comparisons of a corrugated swing jaw plates behaviour calculated with the traditional and new FEA. Failure models with stiffeners. Computer aided parameter design of tooth shape in jaw crusher. Sher,Zhiyu qin,Shuo rong analyses a new computer aided parameter design (CAPD) method by which a visual and three-dimensional entity model of crusher has been achievedbased on a Pro/E’s function of entity model creating. Relevant explanation has particularly been present relevant explanation have particularly been present for screening of specified parameter and performing procedures of creating an entity model required by parametricdesign of crushing jaw plate and tooth-shape in jaw crusher. This kind of design method can lay a foundation of computer aided and appropriate crushing jaw plate and tooth shape in a jaw crusher.

3. OBJECTIVE OF THE PROJECT

Problems in the existed in jaw crusher plate in are as follows:

- To increases the crushing efficiency.
- These are designed to reduce the wear life.
- Less power consumption.

4. DESIGN OF THE TEETH PROFILES IN DIFFERENT PROFILES

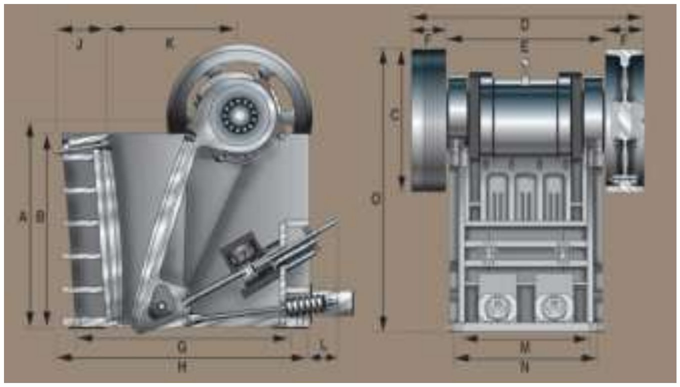

FIGURE 2.

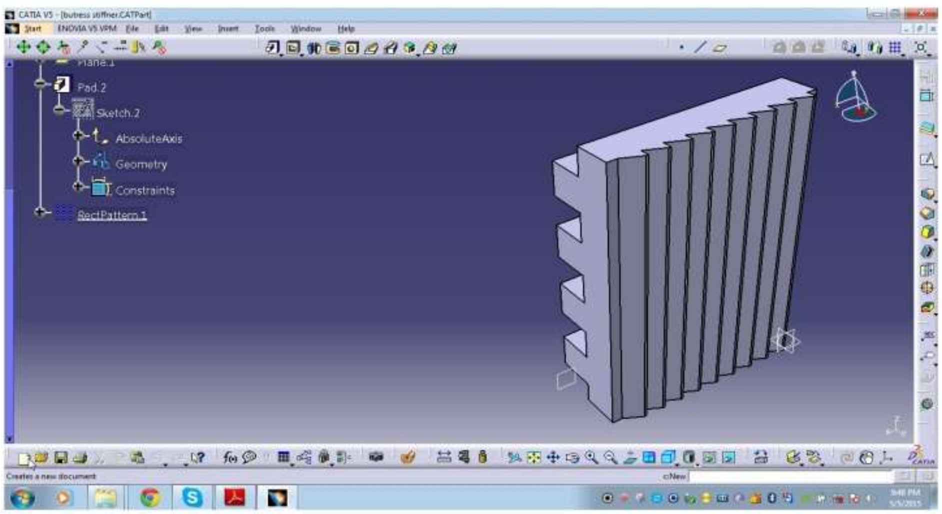

FIGURE 3. Butters teeth profile has been designed by using the CATIA as per the design

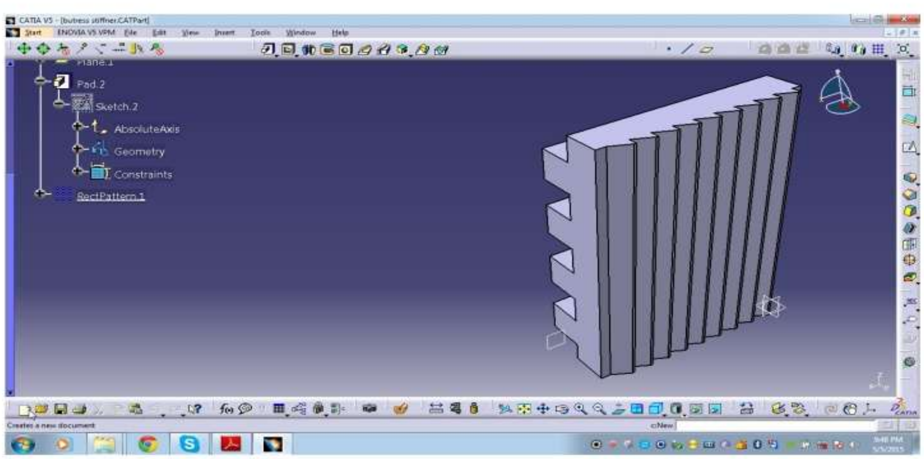

FIGURE 4. Knuckle teeth profile has been designed by using the CATIA as per the design

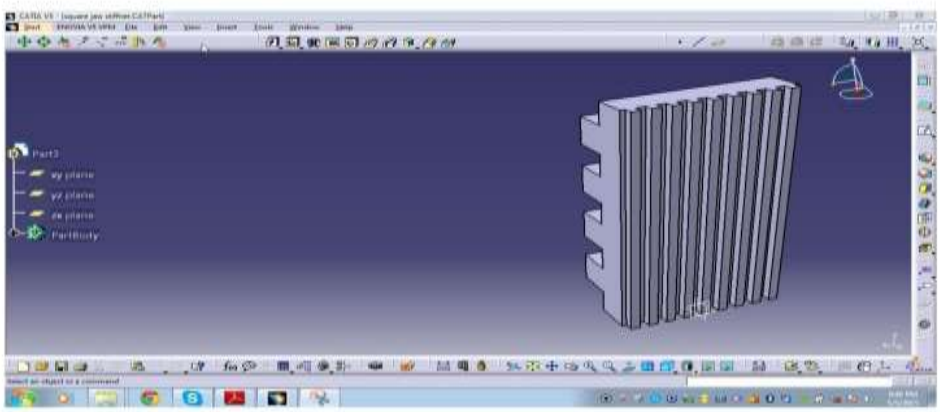

FIGURE 5. Square teeth profile has been designed by using the CATIA as per the design

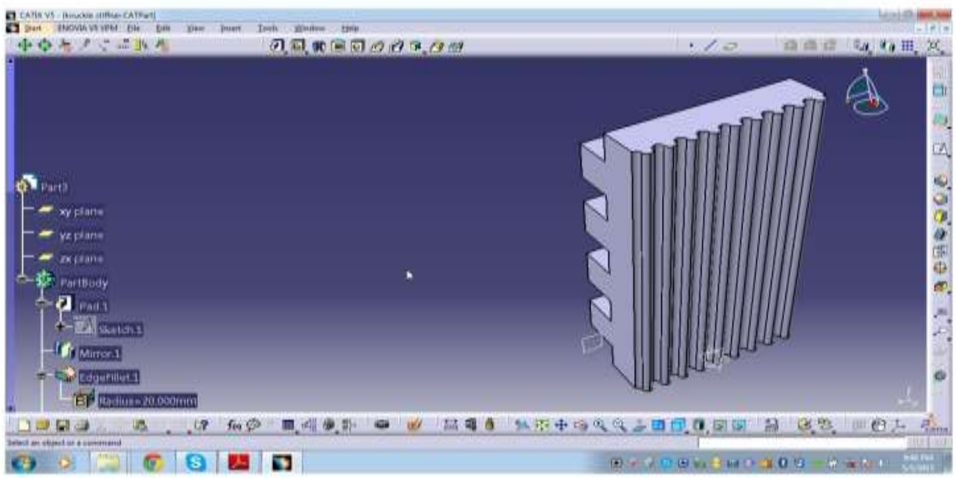

FIGURE 6. With worth teeth profile has been designed by using the CATIA as per the design

5. MATERIAL PROPERTIES OF THE MATERIALS USED IN ANALYSIS

[1] Martensite Steel: Austenitic Manganese Steel is only when the manganese content exceeds about 0.08% that the steelmay be classed as an alloy steel. When manganese content exceeds about 10%, the steel will be austenitic after slow cooling. One particular type of steel, known as Hadfield manganese steel, usually contains 12% manganese. Austenitic Manganese Steel-Standard and Specifications (ASTM 128 A/ 128M) .This specification covers Hadfield austenitic manganese steel castings and alloy modifications.The wear resistant cast steel is generally, referred to as Hadfield manganese steel. Although the above mentioned ten grades of austenitic steels have chemical composition to the Hadfield's original composition, its primary reason for existence is the assurance it provides the user from unexpected failure in demanding applications

[2] Eopxy Carbon: The polymer matrix composite materials constituted by continuous carbon fibers embedded in a thermosetting epoxy resins were first developed to satisfy high stand required in hard material design. It has high specification stiffness and mechanical strength are basic requirements that have to be fulfilled by carbon-epoxy laminated. It can consider all the loads modes with the experience during service conditions such as tension,bending, fatigue, and impact notwithstanding the relatively low impact resistance of carbon-epoxy composites. It has higher cure temperature and pressure improved the perfect of woven fabric laminated. Those can be directly related to reduce porosity content.

[3] E Glass Epoxy Carbon: Basically the glass epoxy composite itself is a brittle material and further addition of TiO2 as filler made the material still harder and hence the bending strength increased with addition of filler content. Also it can be observed that there is a sharp yield in case of TiO2 filled composite. The addition of ZnS leads to increase in the bending strength compared to normal GFRP composites. As observed from the graph, there is no sharp yield in the case of ZnS filled composites. Since ZnS is a ductile material, the addition of filler had enhanced the bending strength of composites and there is proportional deformation with respect to load

[4] Ceramic Coating: Ceramics that are predominantly ionic in nature having crystal structure comprised of charge of ions. Ceramics that are predominantly Ceramic coating is provided on the metal to improve its wear resistance. These are many ceramic materials are available and seems not easy to choose the best. Its subtract properties and the interlayer properties will influence much on the selection of top coating. By this the wear resistance can also be improved through various post processing of the ceramic coating. Indentation, rolling contact, fatigue, sliding wear etc can be good to characterize these coatings. It has extreme hardness that can reduce wear caused by friction, high wear resistance and corrosion resistances. It has high strength at elevated temperature.

TABLE 1.

material	Young's modulus	Poisson's ratio	density
Martensite steel	210 GPa	0.3	7838Kg/m3
Epoxy carbon	134GPa	0.3	1600kg/m3
Eglass epoxy	50GPa	0.3	2000Kg/m3
Ceramic coating	46GPa	0.2	5600kg/m3

6. ANALYSIS IN THE ANSYS

[1]Butterss teeth profile has been designed by using the CATIA as per the design
[a]Butterss teeth profile in martensite steel

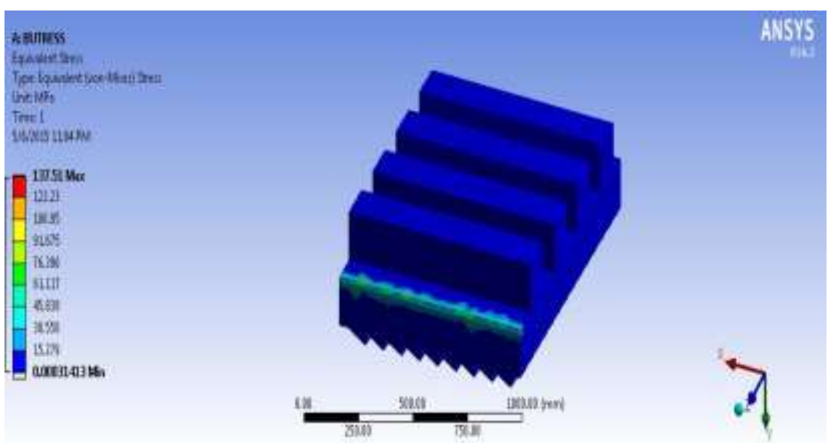

FIGURE 7.
137.51MPa Maximum Vonmises stress and 0.00031minimum vonmises stress has been occured when the load is applied at the butterss teeth profile by using the martensite steel.

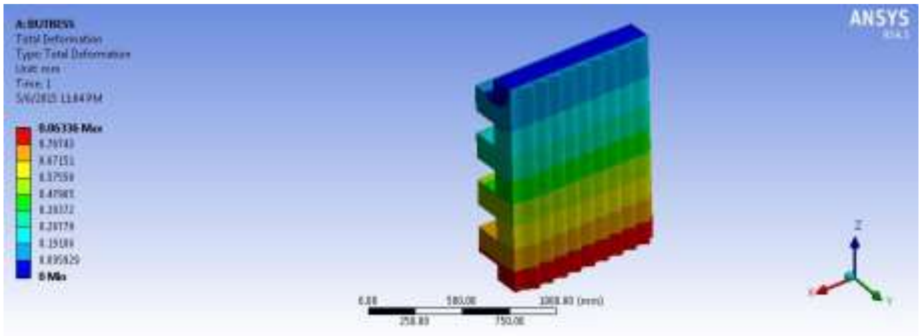

FIGURE 8.

0.86mm Maximum total deformation and 0minimim has been occured when the load is applied at the butterss teeth profile by using the martensite steel.

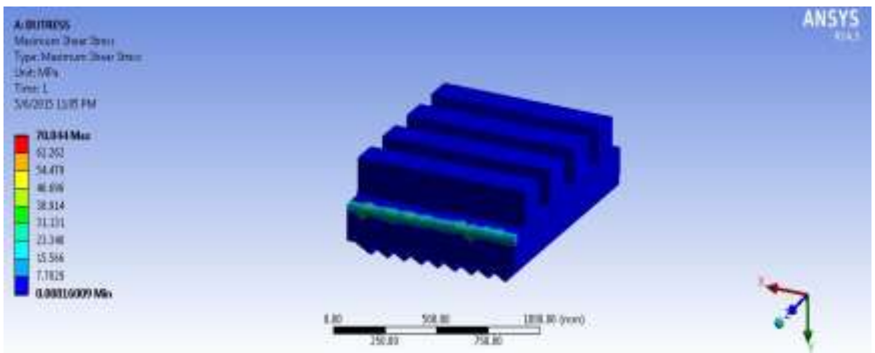

FIGURE 9.

70.04 Max total deformation and 0.0001.min has been occured when the load is applied at the butterss teeth profile by using the martensite steel.

[b]Butterss teeth profile coated byepoxy carbon

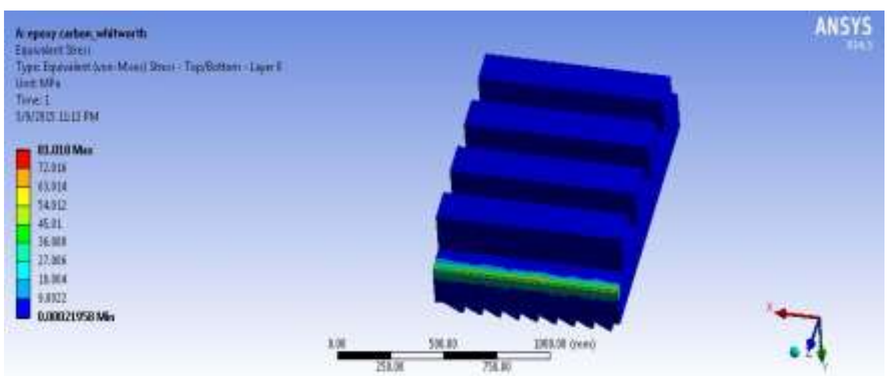

FIGURE 10.

81.01 Max vonmises stress and 0.0002.min has been occured when the load is applied at the butterss teeth profile by using the epoxy carbon.

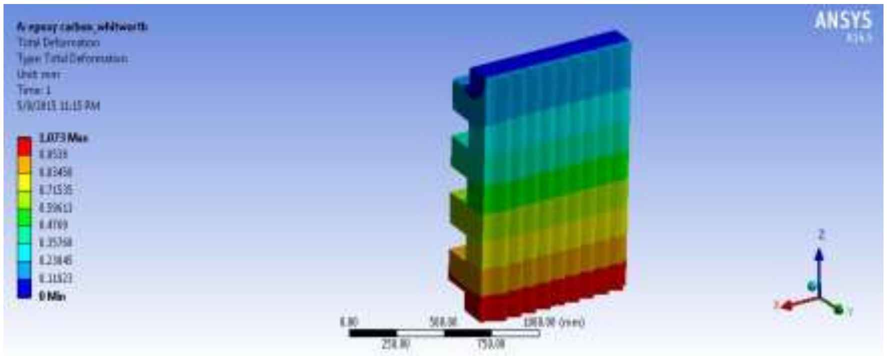

FIGURE 11.

1.073mm Maxtotal deformation and 0.min has been occured when the load is applied at the butterss teeth profile by using the epoxy carbon.

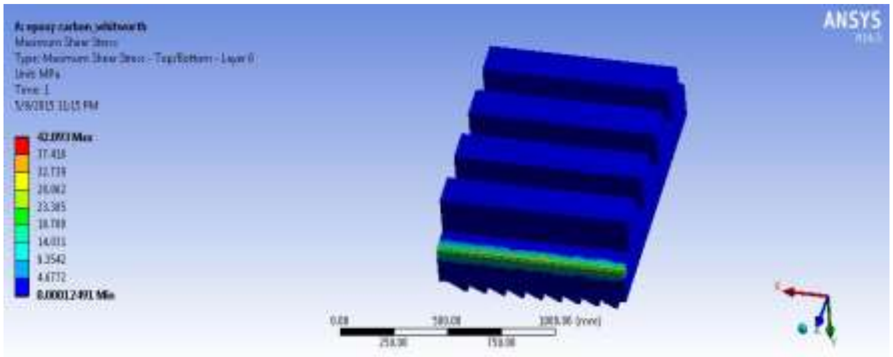

FIGURE 12.

42.09 Max in maximum shear stress and 0.0001.min has been occured when the load is applied at the butterss teeth profile by using the epoxy carbon.

[c]Butterss teeth profile coated by E Glass Epoxy

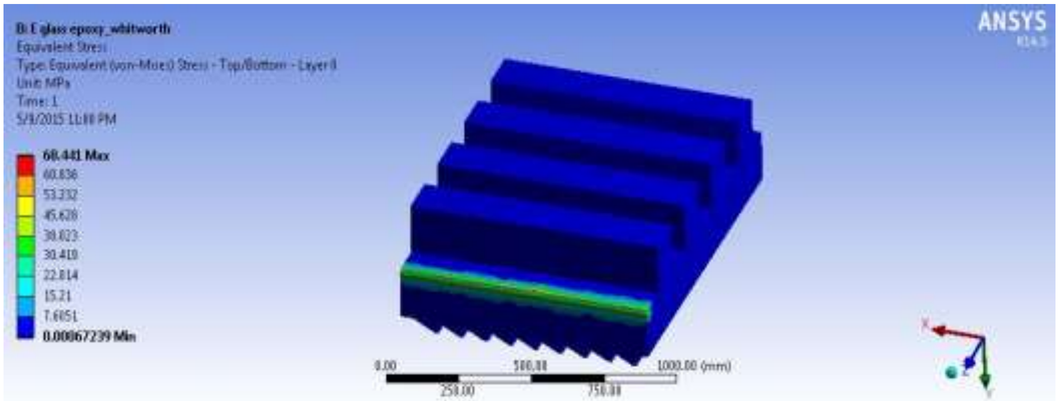

FIGURE 13.

68.44 Max vonmises stress and 0.0006 min has been occured when the load is applied at the butterss teeth profile by using the E glass epoxy .

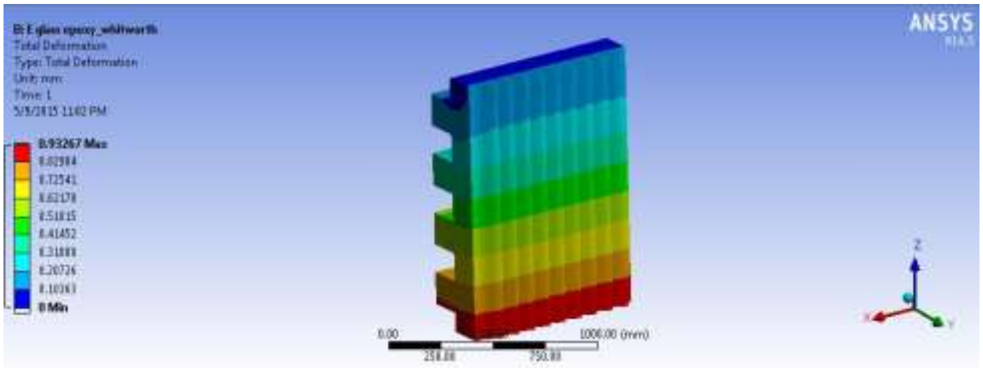

FIGURE 14.

0.93mm Max total deformation and 0.min has been occured when the load is applied at the butterss teeth profile by using the E Glass epoxy .

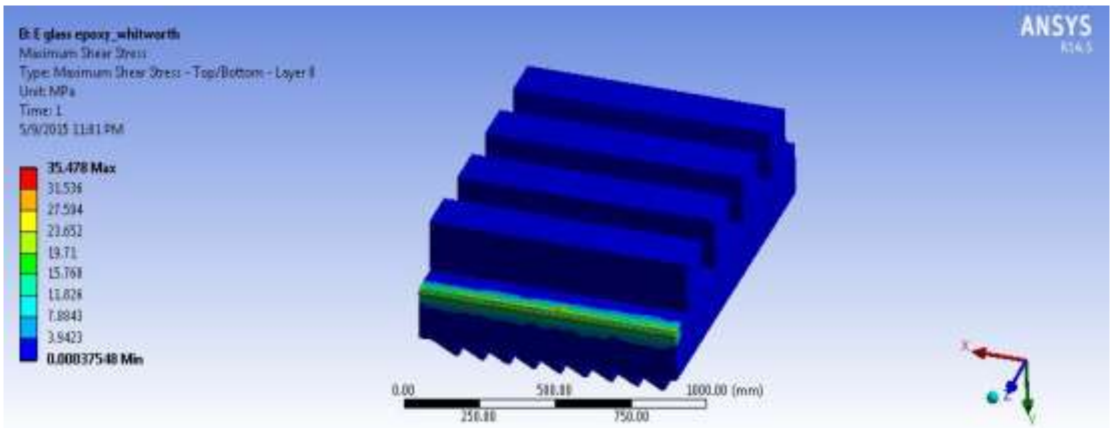

FIGURE 15.

35047 Max total deformation and 0.0003.min has been occured when the load is applied at the butterss teeth profile by using theE Glass epoxy .

[d]Ceramic coating

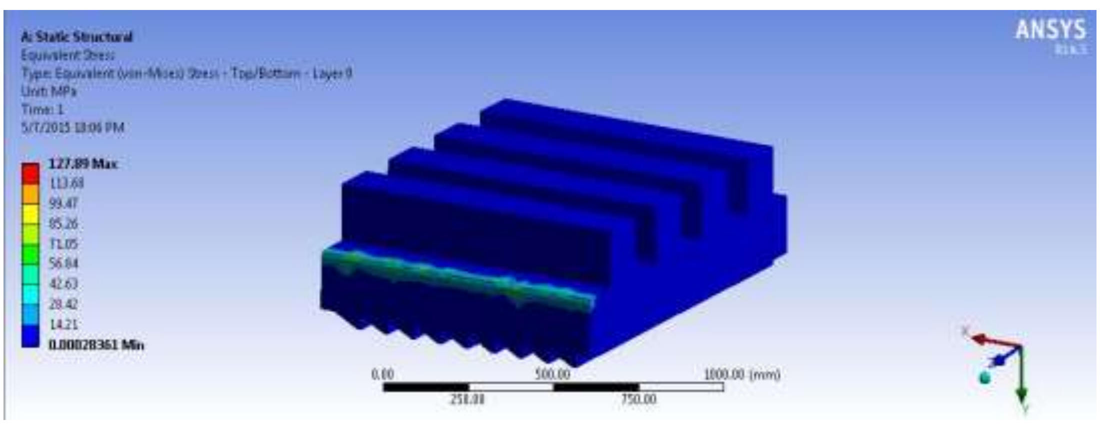

FIGURE 16.

127.89 Max vonmises stress and 0.0002 .min has been occured when the load is applied at the butterss teeth profile by using the ceramic coating.

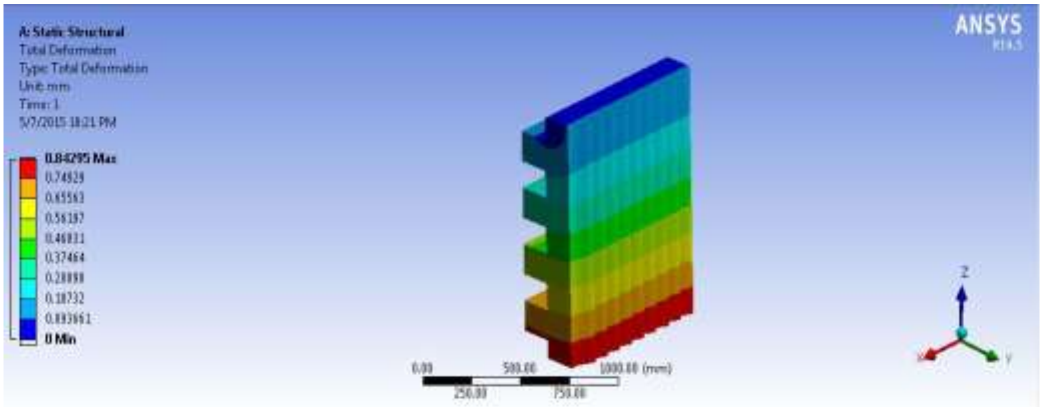

FIGURE 17.

0.84mmMax total deformation and 0.min has been occured when the load is applied at the butterss teeth profile by using the ceramic coating.

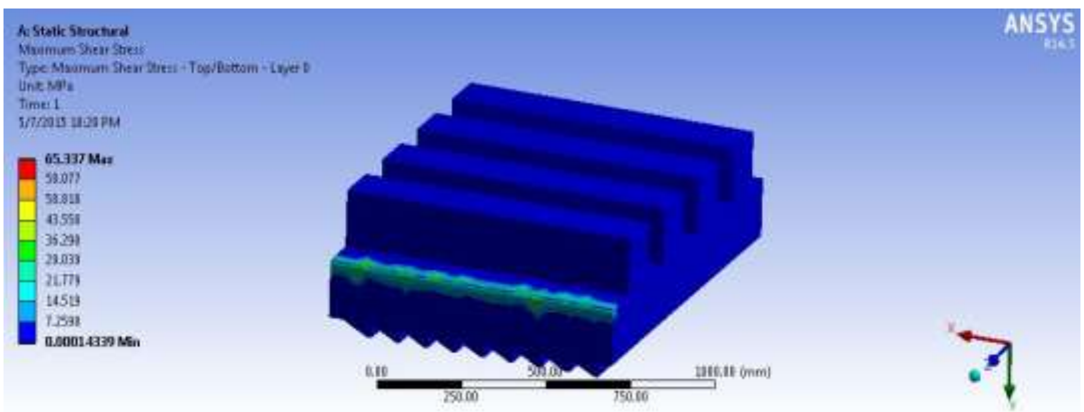

FIGURE 18.

65.33MPa Max total deformation and 0.0001.min has been occured when the load is applied at the butterss teeth profile by using the ceramic coating.
[2] Knuckle profile designed in Catia model designed and analysed by
[a] by using the marten site steel

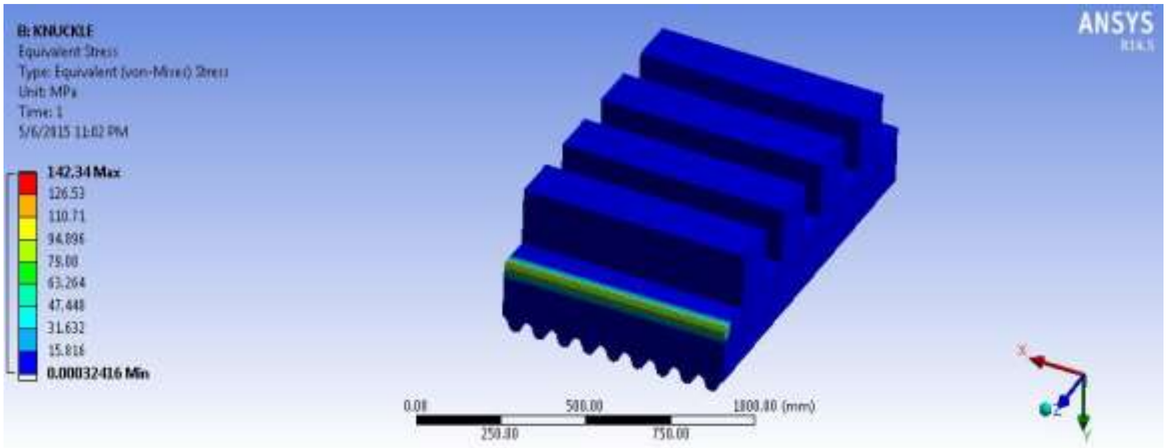

FIGURE 19.

142.34 MPa Max vonmises stress and 0.0003.min has been occured when the load is applied at the knuckle teeth profile by using the martensite steel.

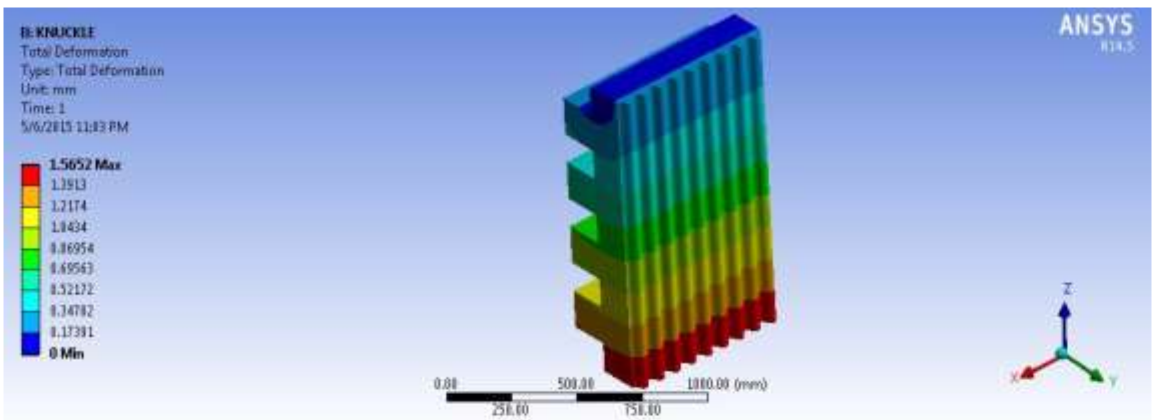

FIGURE 20.

1.56Max total deformations and 0.min has been occured when the load is applied at the knuckle teeth profile by using the martensite steel.

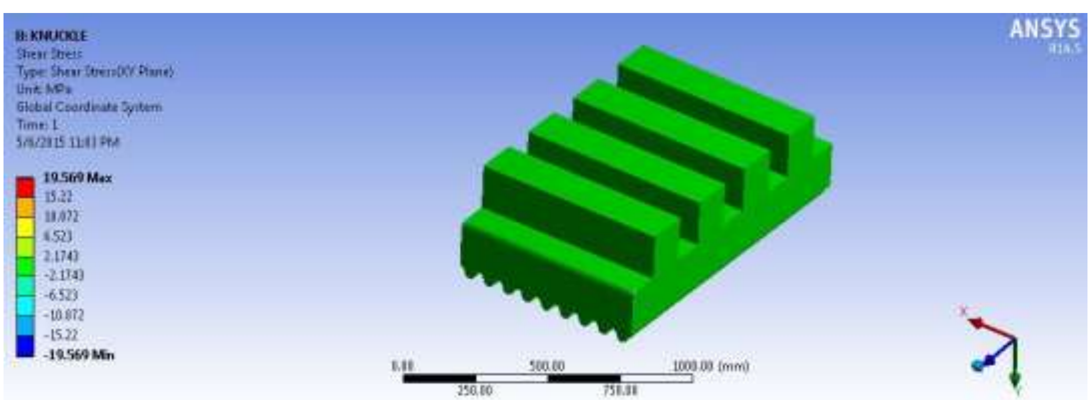

FIGURE 21.

19.5Mpa Max occured in maximun shear stress -19.56 Min has been occured when the load is applied at the knuckle teeth profile by using the martensite steel.

[b]Epoxy carbon

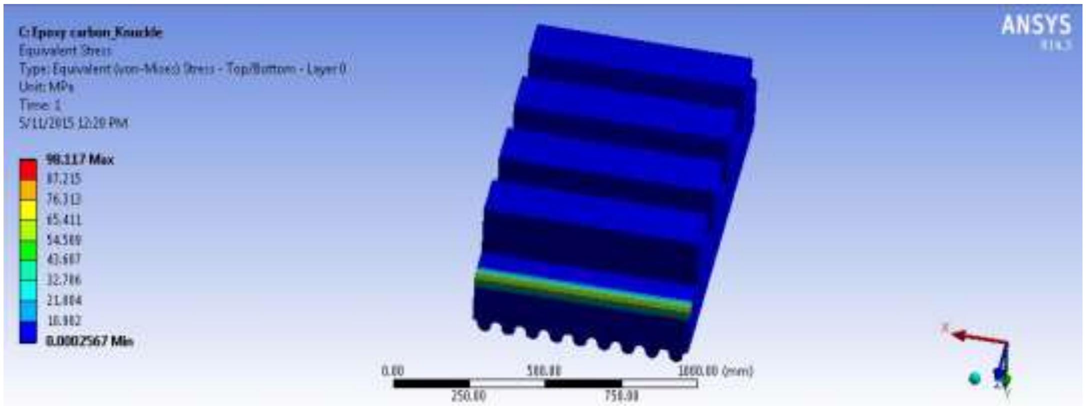

FIGURE 22.

98.11MPa Max vonmises stress and 0.0002.min has been occured when the load is applied at the knuckle teeth profile by using theEpoxy carbon.

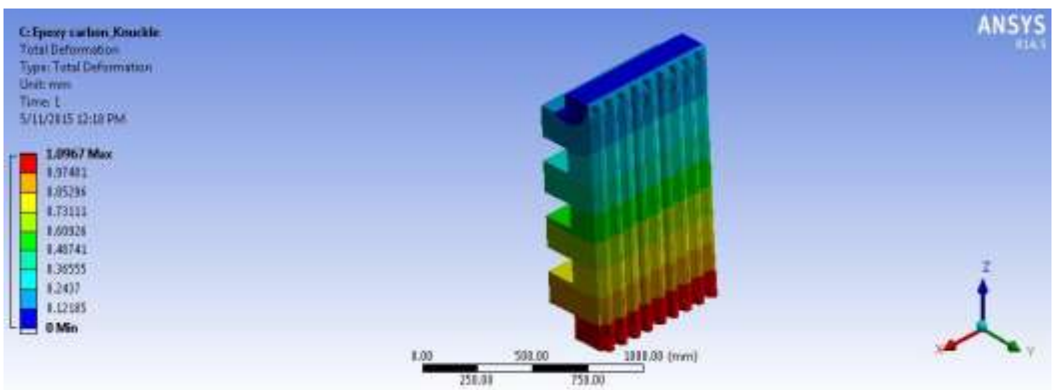

FIGURE 23.

1.0967mm Max total deformation and 0.0001.min has been occured when the load is applied at the butterss teeth profile by using theEpoxy carbon.

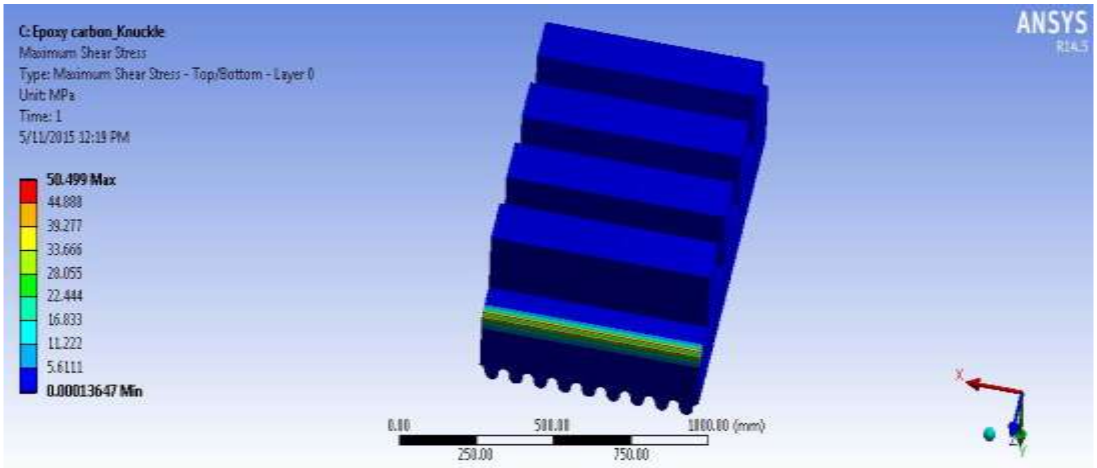

FIGURE 24.

50.499 Max and 0.0001.minMax maximiun shear stress has been occured when the load is applied at the butterss teeth profile by using Epoxy carbon

[c]E glass epoxy

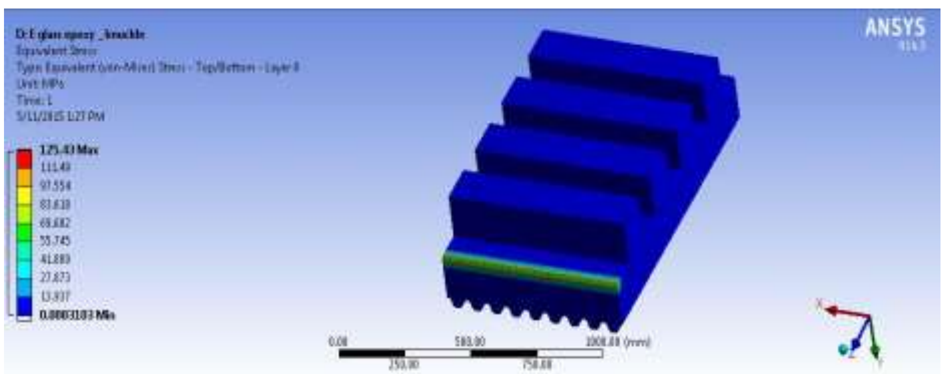

FIGURE 25.

125.43MPa Max vonmises stress and 0.0003.min has been occured when the load is applied at the knuckle teeth profile by using the glass carbon

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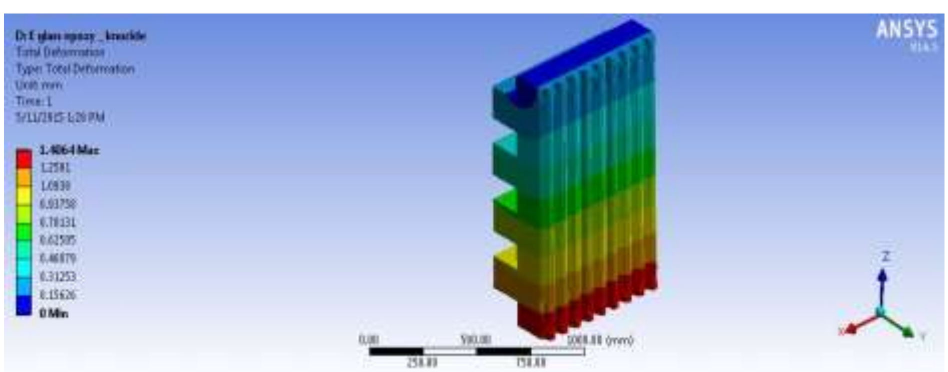

FIGURE 26.

1.4064mm Max total deformation and 0.min has been occured when the load is applied at the knucle teeth profile by using theE glass carbon.

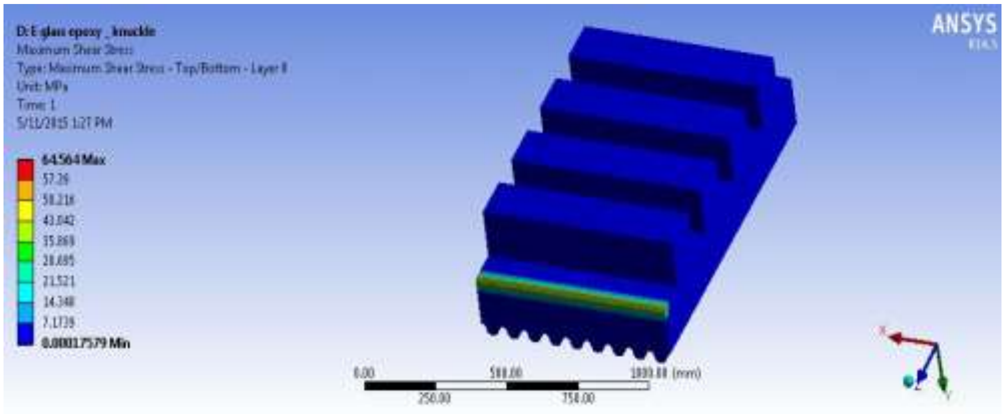

FIGURE 27.

64.564MPa Max occured in a maximum shear stress and 0.00017.min has been occured when the load is applied at the knucle teeth profile by using the E glass carbon martensite steel.
[d]Ceramic coating

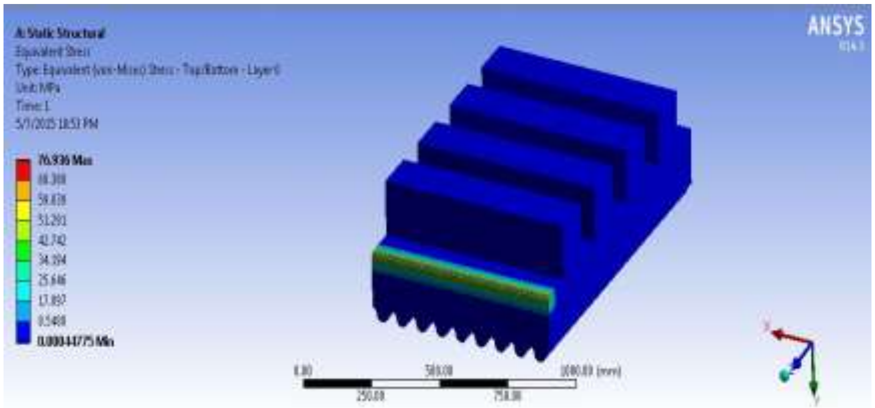

FIGURE 28.

76.9Max vomisies stress and 0.0004.min has been occured when the load is applied at the kunckle teeth profile by using the ceramic coating.

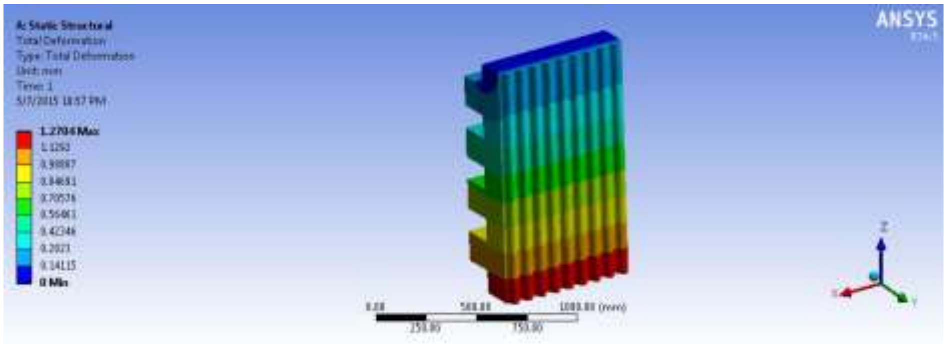

FIGURE 29.

1.27MPa Max total deformation and 0.min has been occured when the load is applied at the kunkle teeth profile by using the ceramic coating.

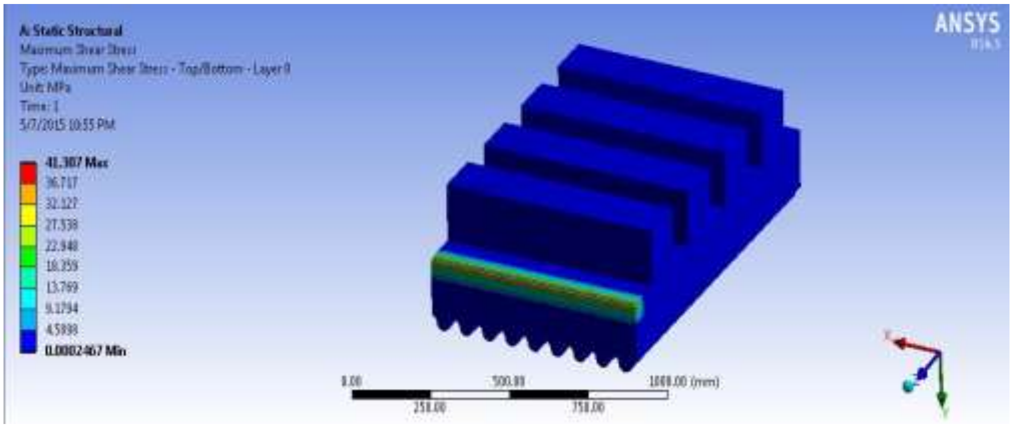

FIGURE 30.

41.307MPa Max occured maximun shear stress and 0.0002min has been occured when the load is applied at the kunkle teeth profile by using the ceramic coating.

[3] Square profile designed in Catia model designed and analysed

[a]by using themartensite steel

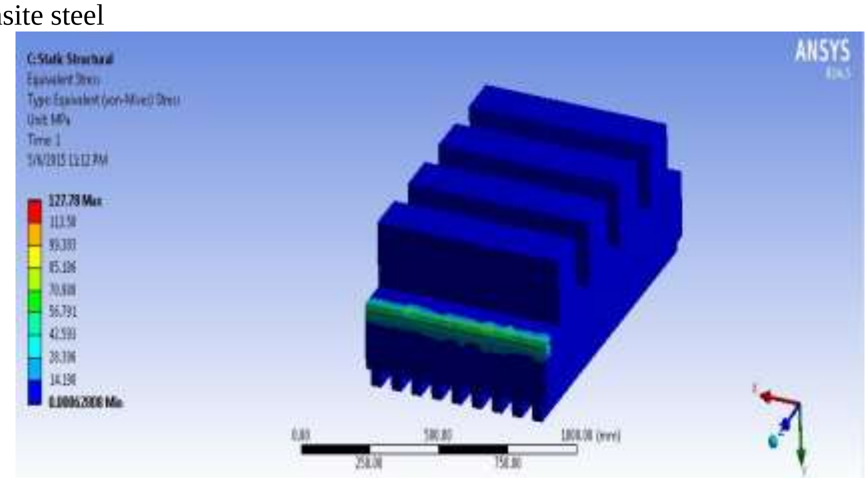

FIGURE 31.

127.78MPa Max total deformation and 0.0006.min has been occured when the load is applied at the square teeth profile by using themartensite steel.

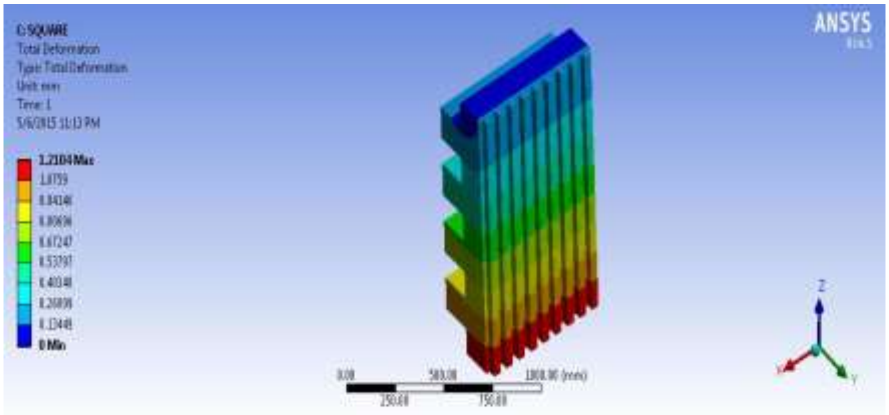

FIGURE 32.

1.21mm Max total deformation and 0.min has been occured when the load is applied at the square teeth profile by using the martensite steel.

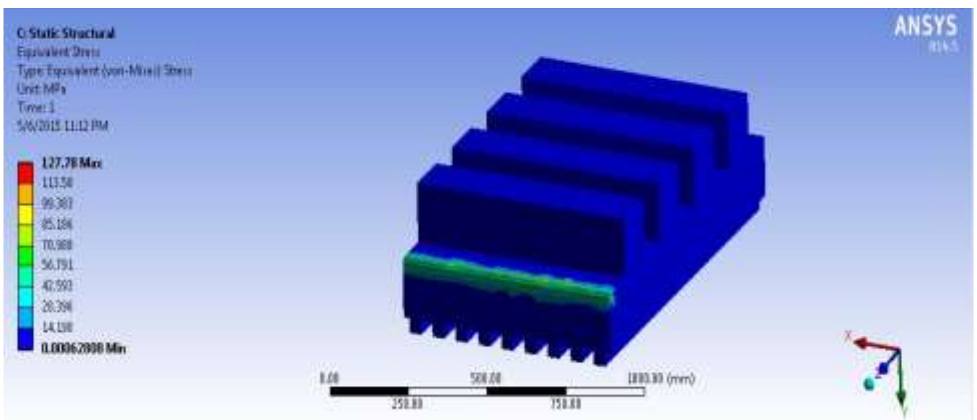

FIGURE 33.

64.24Max vonmises stress and 0.0009.min has been occured when the load is applied at the square teeth profile by using the martensite steel.

[b]Epoxy carbon

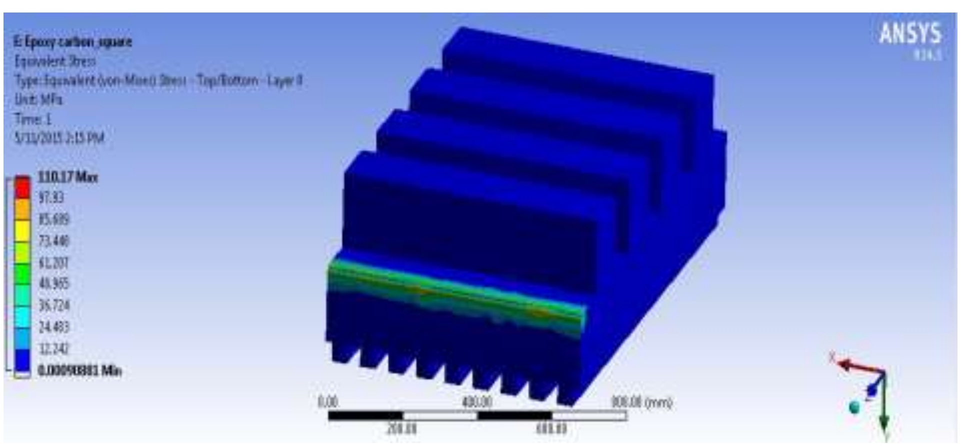

FIGURE 34.

110.17MPa vonmises stress Max and 0.0001.min has been occured when the load is applied at the butterss teeth profile by using the martensite steel.

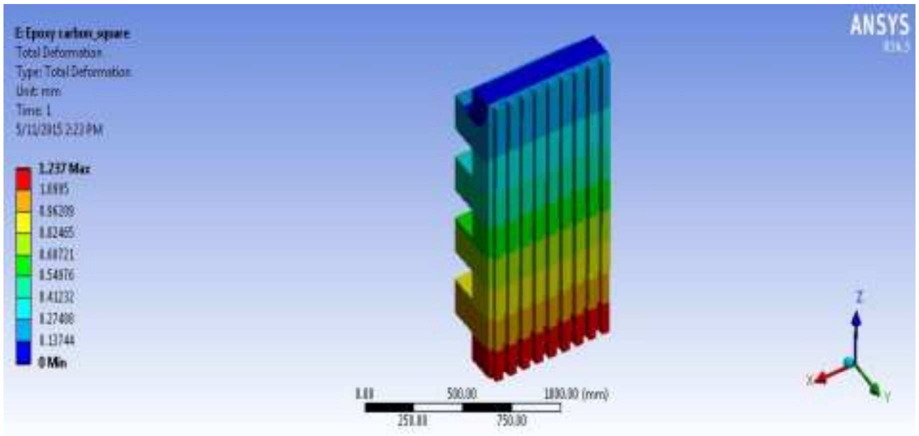

FIGURE 35.

1.27mm Max total deformation and 0 .min has been occured when the load is applied at the square teeth profile by using the epoxy carbon.

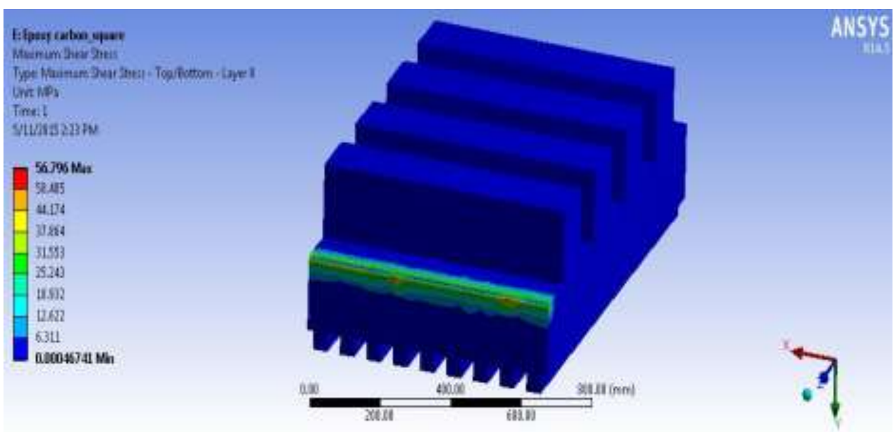

FIGURE 36.

56.796MPa Max maximum shear stress and 0.0004.min has been occured when the load is applied at the square teeth profile by using the epoxy carbon

[c]E glass epoxy

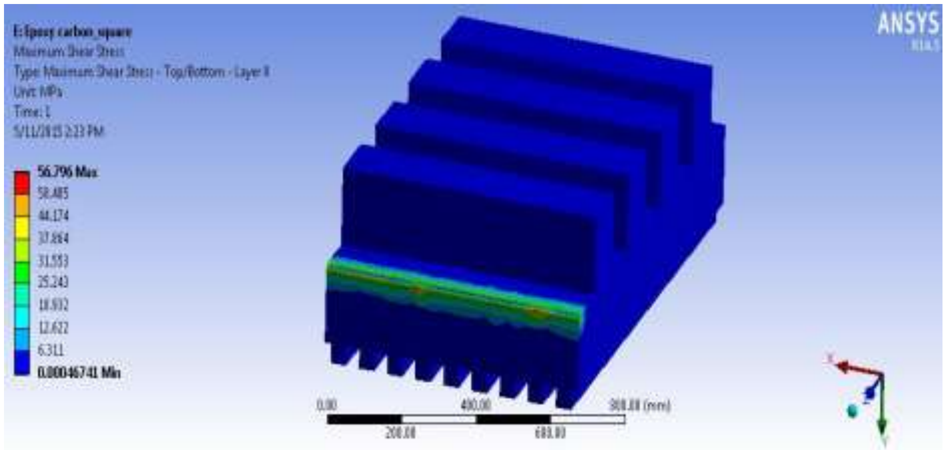

FIGURE 37.

110MPa Max vonmises stress and 0MPa .min has been occured when the load is applied at the square teeth profile by usingE glass epoxy

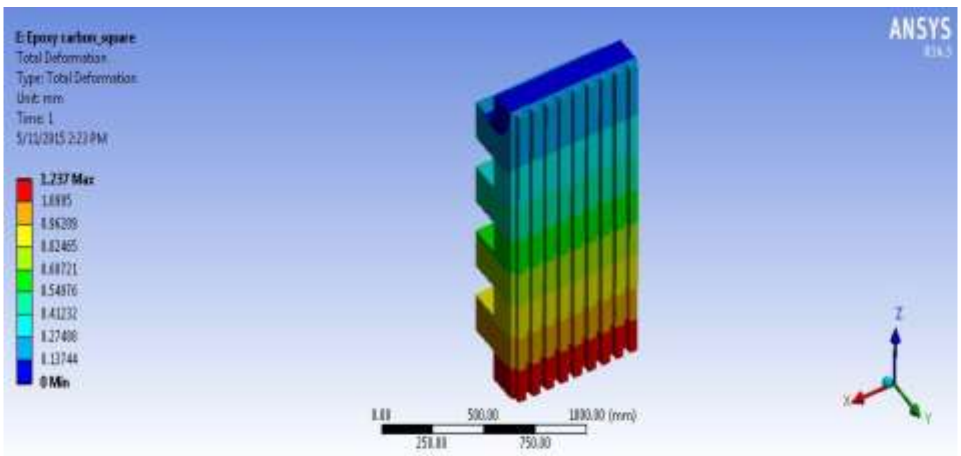

FIGURE 38.

1.2407mmMax total deformation and 0.min has been occured when the load is applied at the square teeth profile by using the eglass epoxy carbon.

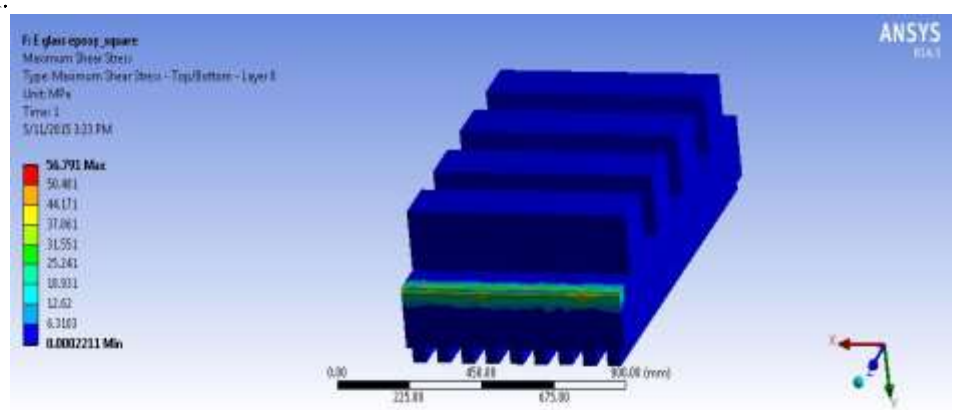

FIGURE 39.

56.791MPa Max maximin shear stress and 0.0004.min has been occured when the load is applied at the square teeth profile by using theeglass epoxy carbon.

[d]Ceramic coating

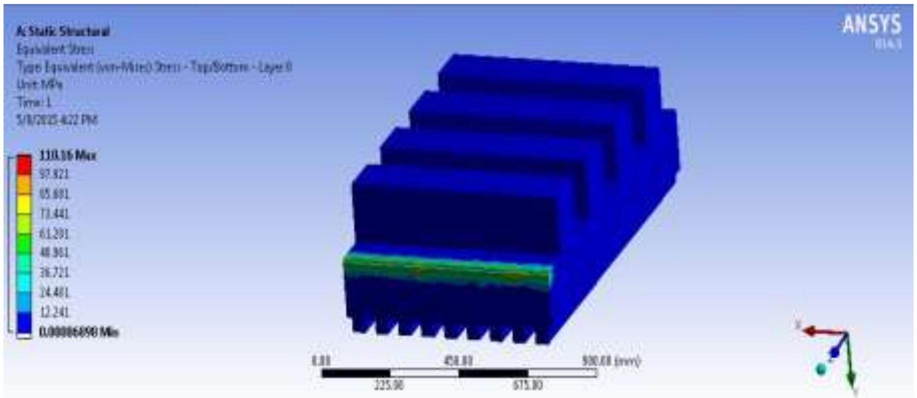

FIGURE 40.

110.6MPa Max vonmises stress and 0.0008.min has been occured when the load is applied at the square teeth profile by using theceramic coating

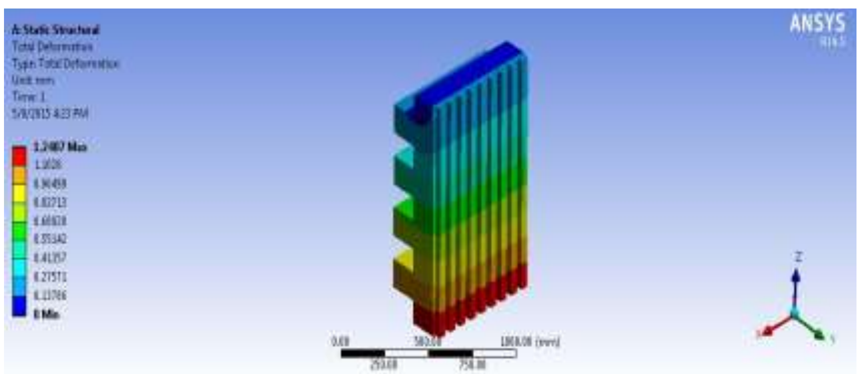

FIGURE 41.

70.04 Max total deformation and 0.0001.min has been occured when the load is applied at the butterss teeth profile by using the ceramic coating.

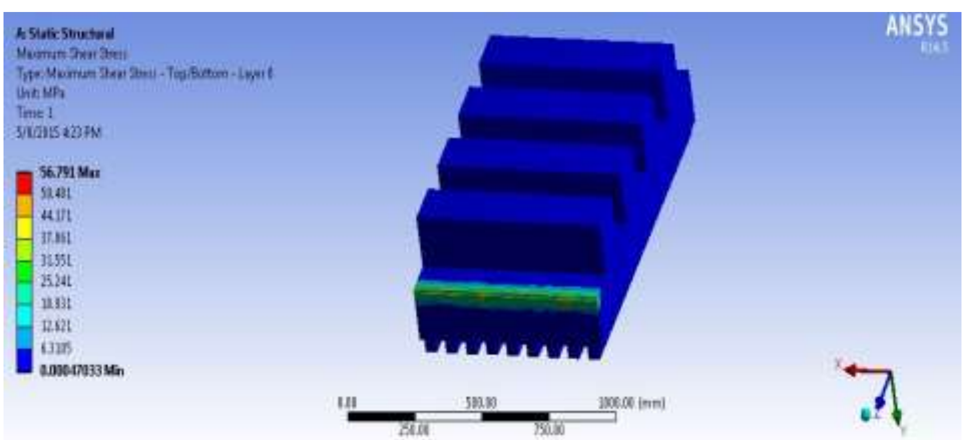

FIGURE 42.

70.04MPa Max total deformation and 0.0001.min has been occured when the load is applied at the butterss teeth profile by using the ceramic coating. Catia model of with worth

[a]By using Martensite steel

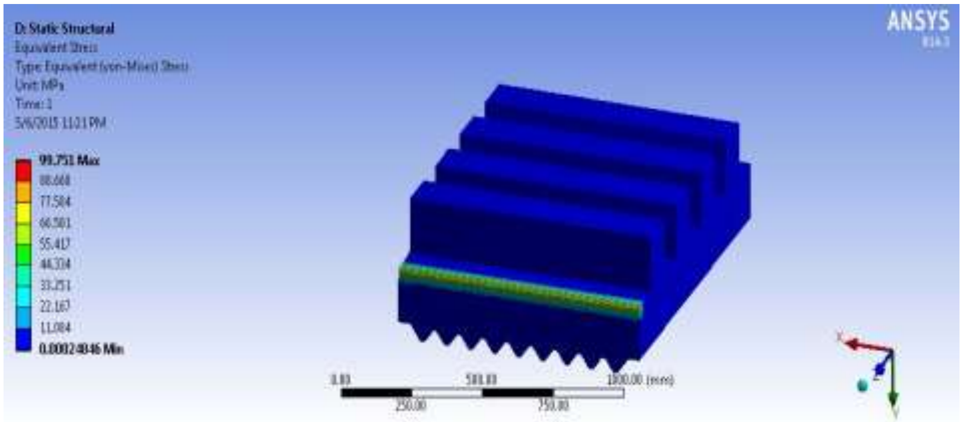

FIGURE 43.

99.751MPa Max vonmisis stress and 0.0002min has been occured when the load is applied at the butterss teeth profile by using the martensite steel.

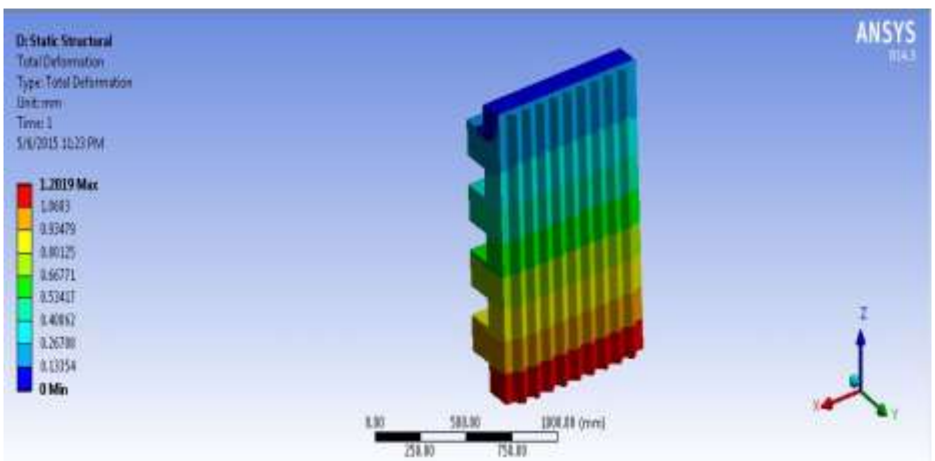

FIGURE 44.

1.2mmMax total deformation and 0.min has been occured when the load is applied at the butterss teeth profile by using the martensite steel.

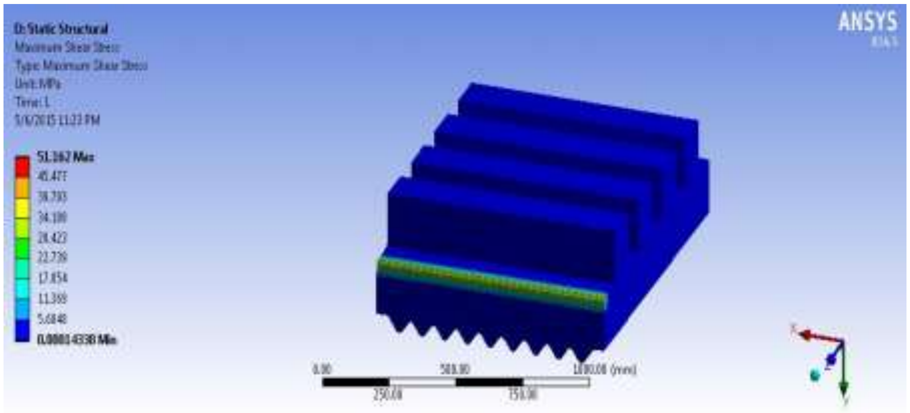

FIGURE 45.

51.6MPA Max maximum shear stess and 0.0001.min has been occured when the load is applied at the withworth teeth profile by using the martensite steel.

[b]Epoxy carbon

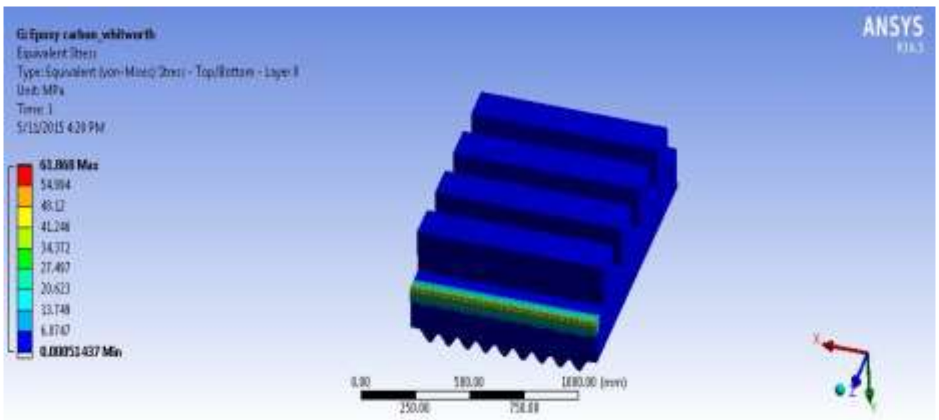

FIGURE 46.

61.868MPa Max and 0.0001.min has been occured when the load is applied at the butterss teeth profile by using the epoxy carbon.

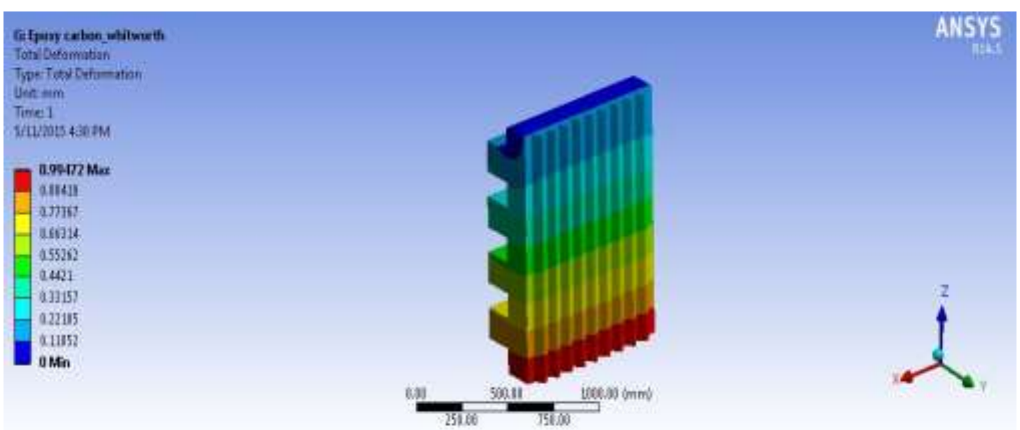

FIGURE 47.

0.99mm Max total deformation and 0.0001.min has been occured when the load is applied at the withworth teeth profile by using the epoxy carbon.

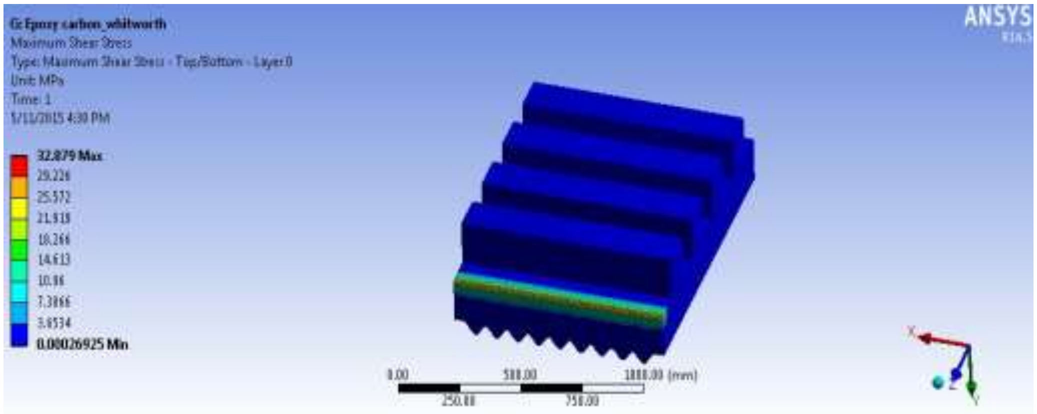

FIGURE 48.

32.879MPa Max and 0.0001.min has been occured when the load is applied at the withworth teeth profile by using the epoxy carbon

[c]E glass epoxy

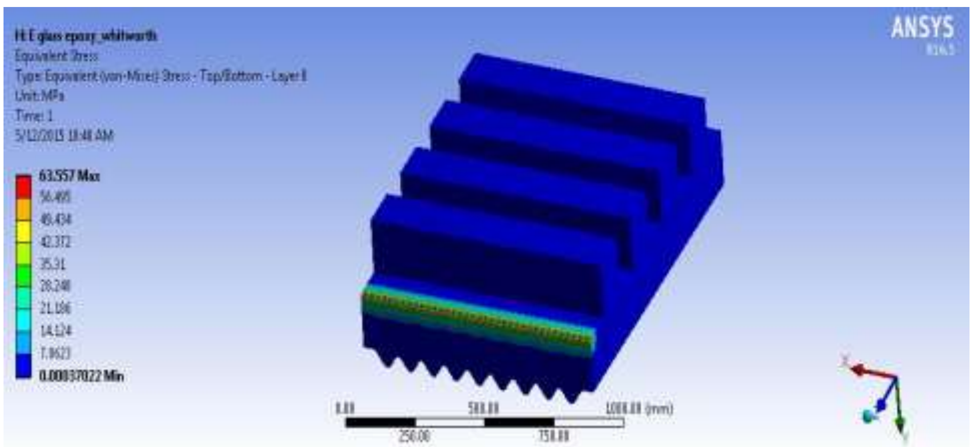

FIGURE 49.

63.55MPa Max vonmises stress and 0.0003.min has been occured when the load is applied at the withworth teeth profile by using theE glass epoxy

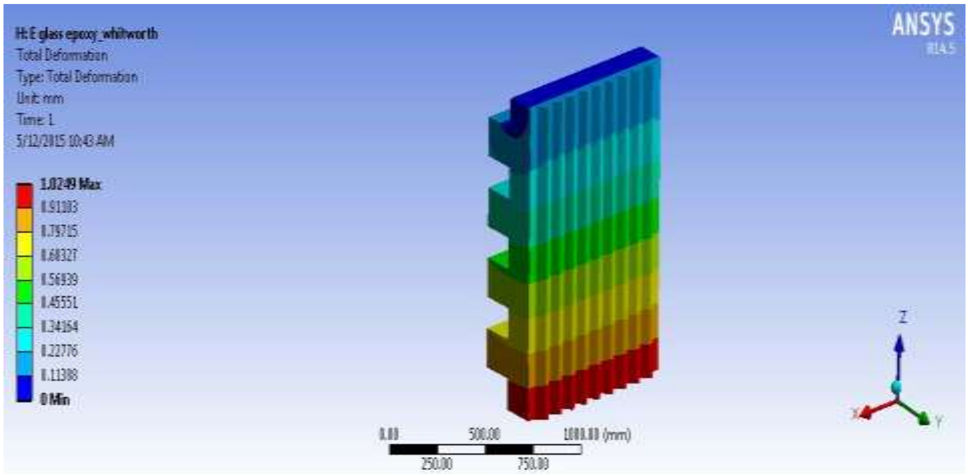

FIGURE 50.

1.02mm Max total deformation and 0.min has been occured when the load is applied at the withworth teeth profile by using theE glass epoxy.

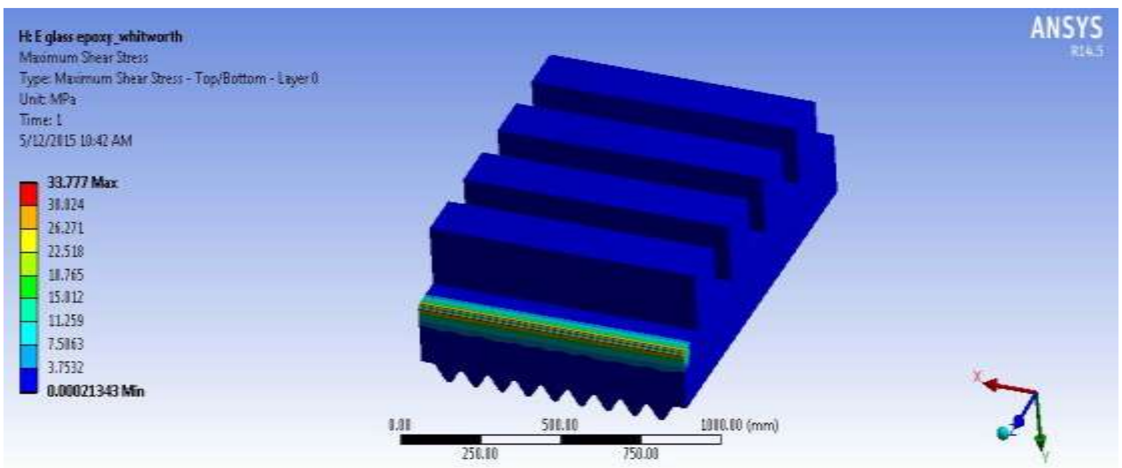

FIGURE 51.

33.7MPaMax maximum shear stress and 0.0002.min has been occured when the load is applied at the withworth teeth profile by using theE glass epoxy.

[d]Ceramic coating

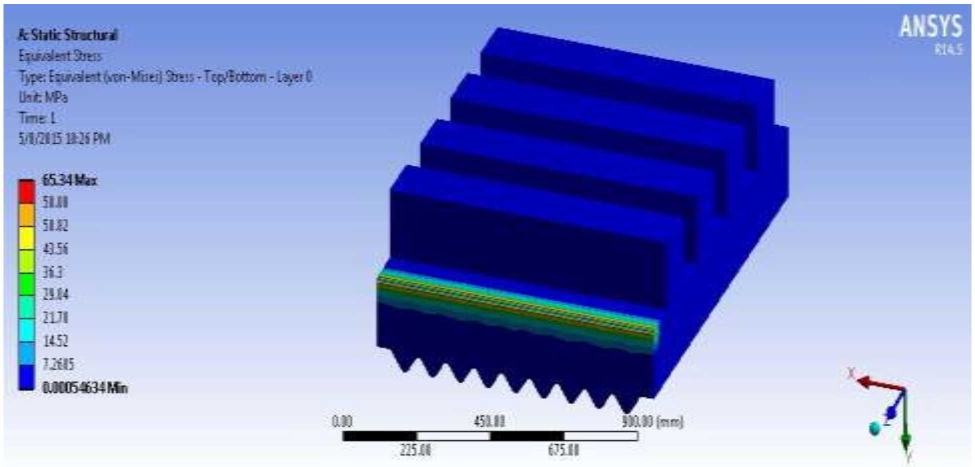

FIGURE 52.

65.34MPa Max vonmises stress and 0.0005.min has been occured when the load is applied at the butterss teeth profile by using theCeramic coating

.

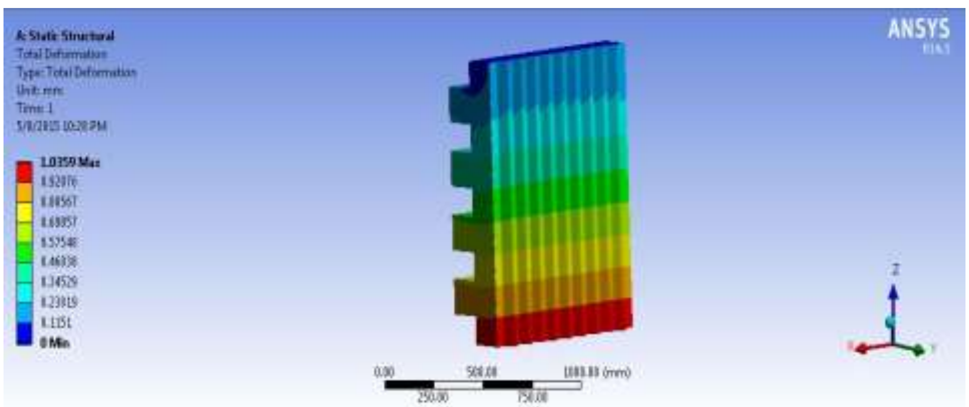

FIGURE 53.

1.03mmMax total deformation and 0.min has been occured when the load is applied at the withworth teeth profile by using theCeramic coating

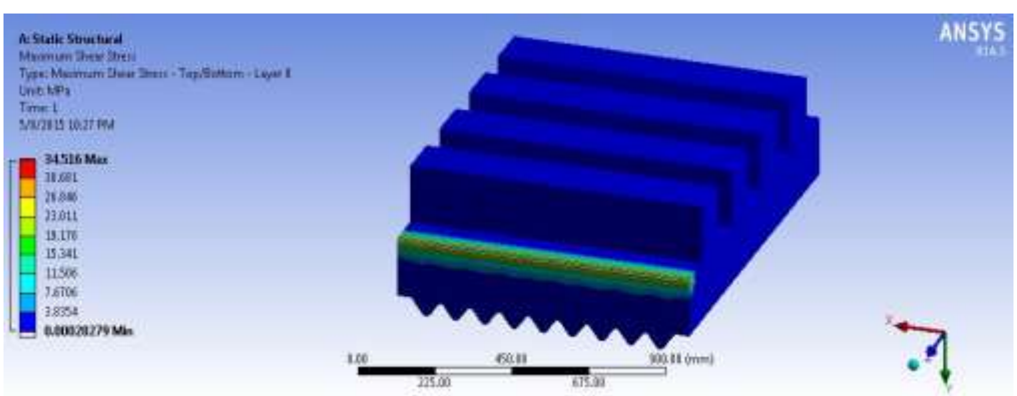

FIGURE 54.

34.5MPa Max maximum shear stress and 0.0002.min has been occured when the load is applied at the withworth teeth profile by using theCeramic coating

7. RESULTS AND DISCUSIION

Effect of composite material on buttress profiled jaw plate

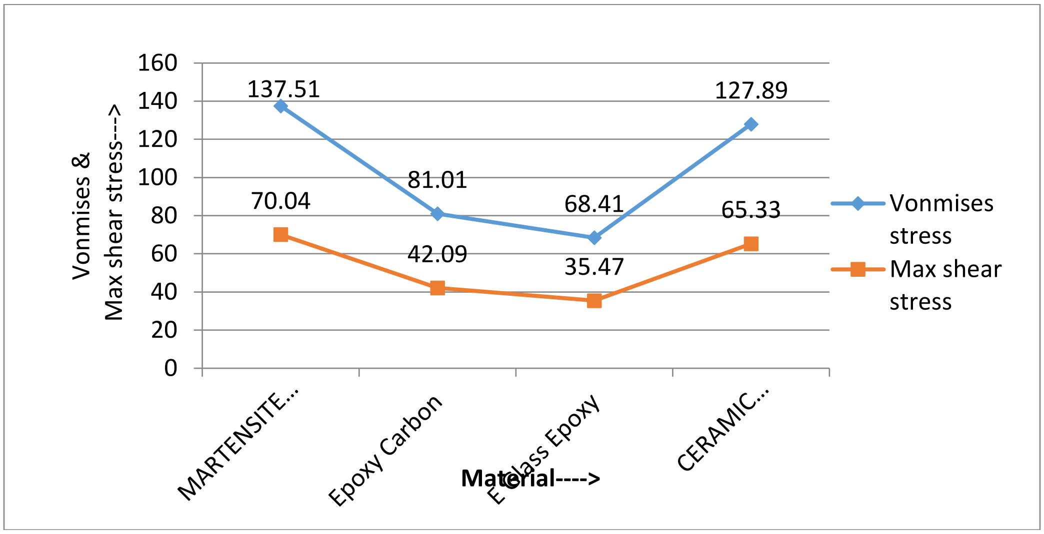

FIGURE 55.

Effect of composite material on knukle profile jaw plate

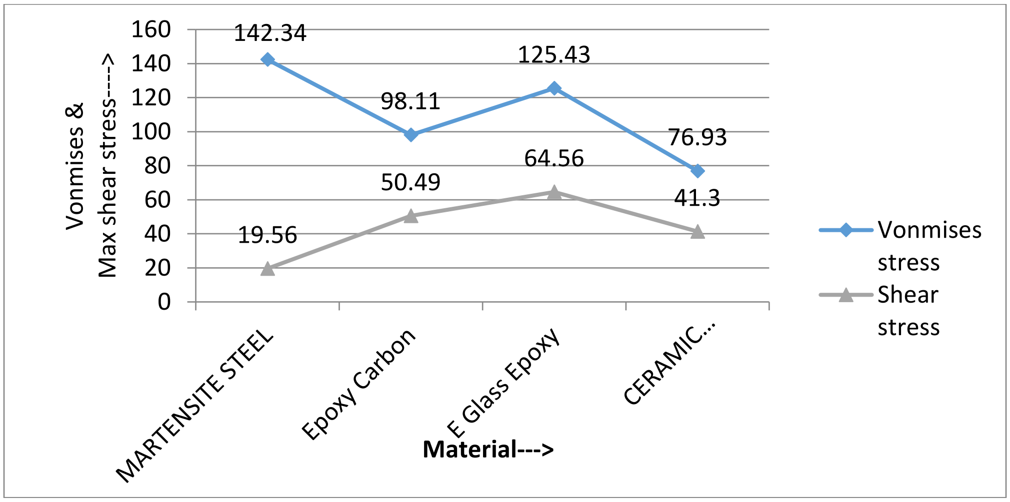

FIGURE 56.

Effect of composite material on square profile jaw plate

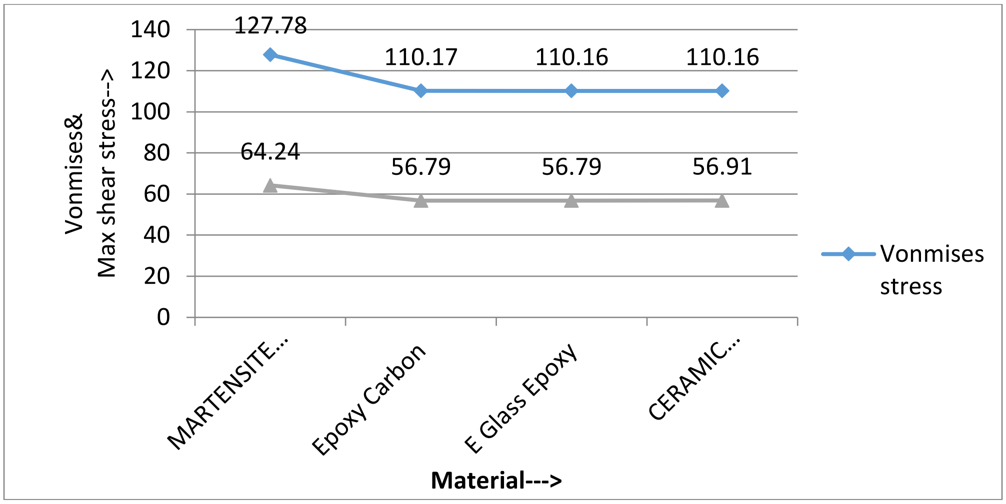

FIGURE 57.

Effect of composite material on withworth profile jaw plate

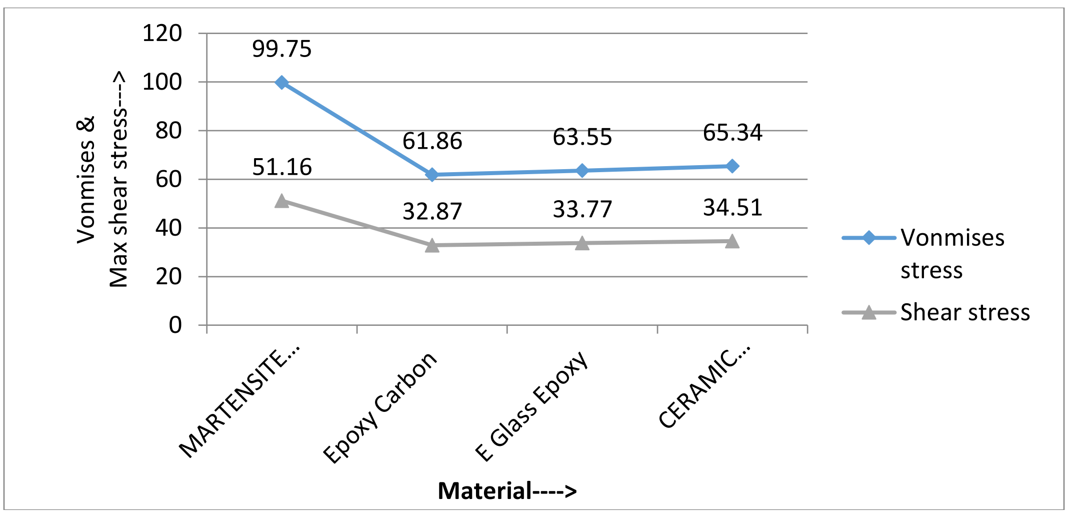

FIGURE 58.

8. CONCLUSION

In this project swing jaw plate models were created by using CATIA V5R20 then it is converted into IGS format for doing structural analysis.

- Finite element analysis of swing jaw plates is carried out on different profiles of jaw plates, using ANSYS 14.5 software to predict the behaviour when it is subjected to point loading under simply supported boundary conditions. The structural analysis of different profiled jaw plates as shown in figures.
- The minimum stresses (61.86MPa) developed on whit worth profiled jaw plate with composite material Epoxy carbon compared to martensite steel as shown in above.
- From the table 4, we can observe the total deformation and max shear stresses for martensite steel and different composite materials.
- The minimum shear stress (32.87 MPa) developed for Whitworth profiled jaw plate with composite material Epoxy carbon compared to other profiles and materials as shown in Graph 1, 2, 3 and 4.

- The maximum deformation developed at the end of the jaw plate, least deformation (0.93mm) obtained in buttress profiled jaw plate with composite material E glass epoxy as shown

Future Scope: Further work is needed to apply the basic, non-simultaneous failure and rock-machine interaction theory with the following modifications and extensions.

- Varying packing arrangements from the simplified row assumption to random distributions found in actual operation can be applied to get more accurate results.
- All the Rock names are given on the based on the composition and texture, not strength or deformability. Thus limestone, as shown by the comparison of fragmental and dolomitic limestone, can have widely varying strengths. Therefore, crushers cannot be selectively designed with low factors of safety without testing the exact rock to be crushed.
- Rock strength will vary even within a specific quarry. Other work has shown that coefficients of variation of rock strength can be as much as 20 - 50% of the mean for are stricted sampling region.
- Line loading also produces deformation hardening behavior. Such loading conditions may be applicable for modeling the behavior of slabby material when loaded with ridged

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