World Journal of Engineering Research and Technology
WJERT
www.wjert.org
SJIF Impact Factor: 5.924

ENHANCEMENT MECHANICAL PROPERTIES OF POLYMERS REINFORCING BY HYBRID COMPOUND SUCH AS RUBBER CRUMBS AND NANO GRAPHENE

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Article Received on 09/08/2022 **Article Revised on 29/08/2022** **Article Accepted on 26/09/2022**

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ABSTRACT

Polymeric composite materials consist of a matrix and fibers, and the properties of these compounds can be improved by adding hybrid compound such as rubber crumbs and nano-graphene. Where we worked in this research to add glass fibers to the epoxy once and twice, i.e. in different proportions, where one layer was equivalent to 10% by weight of the weight of the polymeric material, and two layers consisted of 20% by weight of the polymeric material, then a hybrid compound consisting of 1% nanographene with 20% rubber particles were added. The results showed that when this hybrid compound was added to the polymeric compound, it significantly improved the mechanical properties, where the percentage of improvement in maximum stress reached 36% and the percentage of increase in impact strength to 235%.

KEYWORD: composite polymer, Hybrid Compound, Graphene, Rubber crumbs.

INTRODUCTION

There are many factors affecting the manufacture of industrial, medical and military applications, and the materials manufactured for them may be the basis for this.[1] Therefore, many researchers were interested in manufacturing materials that have new and useful properties more than metals and improving those properties by using many chemical additives or by adding nano materials.[2] As it happens now in most applications. Graphene is an important material that improves the mechanical properties, which will be discussed and

researched and its effect on the properties. Rubber is called a natural sulfur gum, and natural rubber is found in the form of droplets in the sap of the rubber tree that is grown in tropical countries, which is used in the manufacture of car tires, is the most common type of rubber ; Due to its cheap price and high mechanical properties.[3]

Numerical analysis can be applied using simulation programs of materials that are manufactured experimentally and a number of collision accelerators can be applied to a mechanical application (hood) to study the mechanical properties of that application.

MATERIALS AND METHODS

Experimental procedures were carried out using polymeric materials like epoxy and the preparation of mechanical samples to study their laboratory properties after adding glass fibers to the epoxy once and twice, i.e. in different proportions, where one layer was equivalent to 10% by weight of the weight of the polymeric material, and two layers consisted of 20% by weight of the polymeric material.[4]

Then a hybrid compound consisting of (1% nanographene with 20% rubber particles) was added. Where epoxy was utilized, Renksan Ltd. manufacturer in Turkey developed epoxy clear coat (Ren floor HT 2000), which had a specific density of 1.1 kg/L and a curing agent for HT2000 with a mixing ratio of (2:1) as indicated in Fig. 1. According to Fig. 2 and 3, the type of fiber used is E-glass (E6-CR), and Figure 3 shows the nanomaterial utilized.[5] nanographene, which was obtained from Skyspring nanomaterials Products 0541DX , Fig. 4 Crumb rubber is from the recycling of the tires of the local industry in Iraq.[6]

Fig. 1 epoxy Ren floor HT 2000

Fig. 2 E-glass (E6-CR)

Fig. 3 nano graphene

Fig. 4 Crumb rubber

Sample molds were manufactured according to (ASTM) specifications and prepared for the purpose of manufacturing samples from the previously mentioned material.

Tensile test The tensile test samples were manufactured according to the specifications of ASTM (D638-14) as Fig. 5 show the mold Where 4 types of samples were manufactured (note Table 1) .

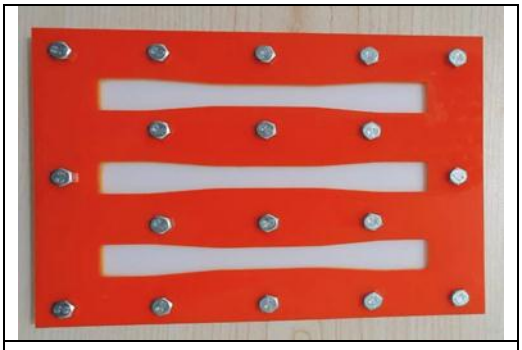

Fig. 5 Tensile Specimens

Then they were examined in the laboratories of Al-Qadisiyah University - College of Engineering - Republic of Iraq **,** Where the samples were examined in the laboratories of the Mechanical Engineering Department in a tensile testing device Fig. 6.[7]

Impact test molds are manufactured of impact Resistant Test to standard specifications ASTM (D256-04), Where Fig. 7 show the shape of the mold. After that, the examination was also conducted in the same college above in the laboratory of the Engineering Materials Department in the device shown in the Fig. 8,[8] by using the charpy method in an electronic way, as the device gives a digital reading, where the dimensions of the sample were entered, and then giving the command to apply force after leaving the raised arm in the device automatically at the moment of giving the command.

Fig. 6 Tensile test device

Fig. 7 Impact test Specimens

Hardness test was checked in the same previous section of Al-Qadisiyah Engineering using the Shore D type hardness tester indicated in the fig 9, where the device works manually with results given by the digital reader located at the top of the device.[9]

Fig. 8 Impact test device

Fig. 9 (shore D) test device

Numerical Analysis

To solve many engineering problems and with the development of technology, several engineering programs have been designed that deal with engineering solutions in an analytical way, such as the ANSYS program and the Abaqus program, where these programs deal with Finite Element Analysis (FEA) and this method is used to predict the mechanical properties or other properties of any sample or material And once this sample will reach a state of failure than others.

Element types In each type of application, a specific element is used in the Analyses program**,** In this research we took the hood as an application , is similar to the type of shell of three-dimensional model, Shell 281 was chosen as the type of element used in this work, note Fig. 10.[10]

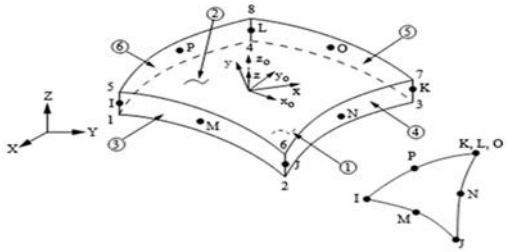

Fig. 10 Shell 281 element type

Drawing app (Bonnet) after determining the type of the element, the required model was created by selecting the key points and then converting these points into lines by instructing lines in creating models and then converting them into a three-dimensional drawing. Note the two Figures 11,12.

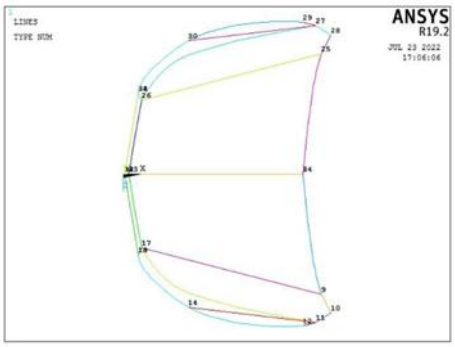

Fig. 11 Lines of structure

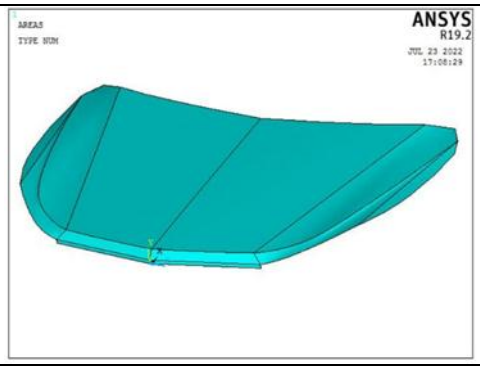

Fig. 12 Model in Ansys

Mesh of structure where a numerical analysis was done by determining the type of element and the required number of elements in the mesh in ansys , then the model was exported to the Abacus program , Fig. 13 show the shape of the mesh in the Abaqus program.

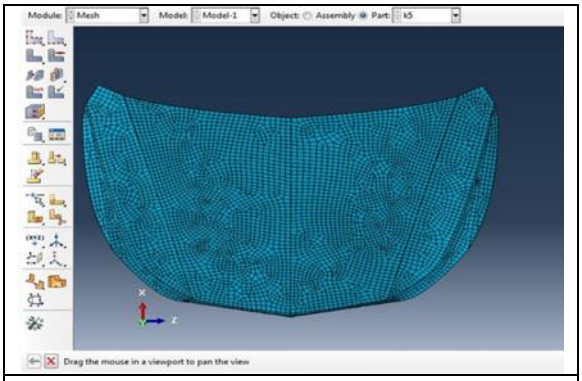

Fig. 13 Mesh in Abaqus

RESULTS AND DISCUSSION

Initially the mechanical properties were examined for two main types of materials (epoxy with one layer of fiberglass equivalent to 10% and then epoxy with two layers of fiberglass with percentage of 20% relative to the epoxy matrix) , Then a hybrid compound consisting of (1% nanographene with 20% rubber particles) was added to the two cases of added glass fibers**.**

Tensile test, Table 2 shows the mechanical properties after tensile testing that were reached in the laboratory after examining the basic samples, which are epoxy plus a fiber layer and epoxy with two layers of fiber glass, after that, the improvement was done by adding the Hyb, Table 3 represents the results of the stresses obtained on the two cases of fiberglass.

The improvement that occurred in the epoxy samples with fiberglass can be observed from what is the literal epoxy. Fig. 14 , Fig 15 which shows the stress-strain curve for those samples.

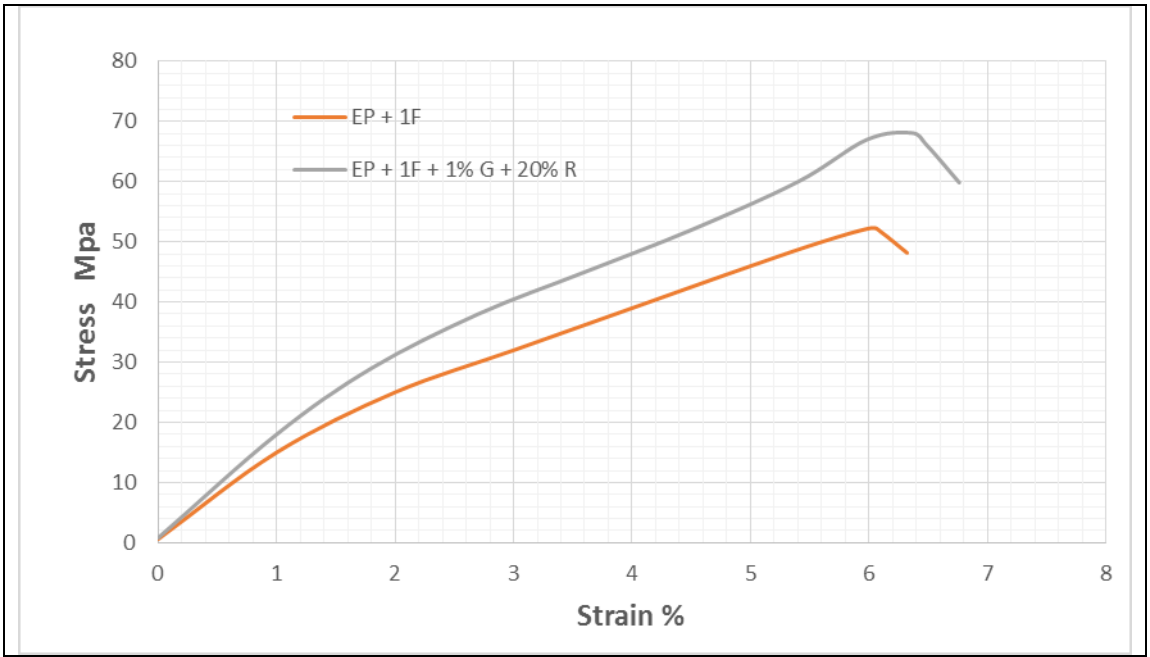

Fig. 14 stress - strain curve for (EP + 1F , EP + 1F + Hyb)

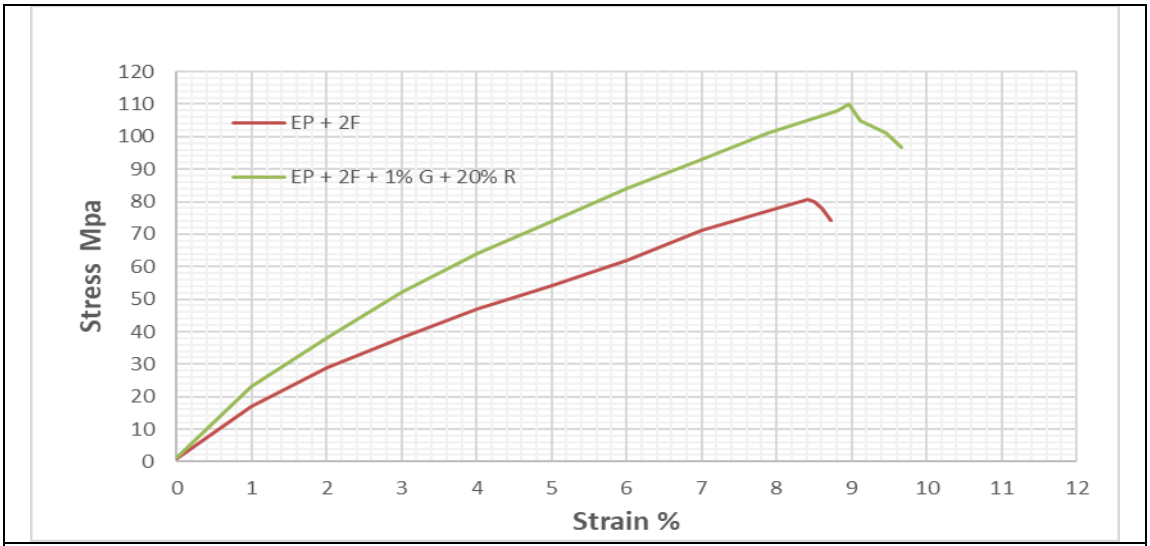

Fig. 15 stress - strain curve for (EP + 2F , EP + 2F + Hyb)

Impact test after conducting this examination in advance, the results mentioned in the two tables Table 4, Table 5 were reached, as they show the readings reached by the test device in terms of the values of absorbed energy and impact resistance.

Hardness test Where we tested all sampling models and each model examined 5 different places of the sample and took an average of them, as Table 6 shows the results that were reached.

Table 1 Composites Samples.

No	Samples	Abbreviation
1	Epoxy + One layer fiber glass	E + 1F
2	Epoxy + Two layer fiber glass	E + 2F
3	Epoxy + One layer fiber glass + 1% Nano Graphene + 20% Rubber	E + 1F + Hyb
4	Epoxy + two layer fiber glass + 1% Nano Graphene + 20% Rubber	E + 2F + Hyb

Table 2: Tensile test properties with out Hyb.

Property	EP + 1F	EP + 2F
Ultimate stress (MPa)	52.32	80.77
Fracture stress (MPa)	48.18	74.12
Strain at Fracture (%)	6.32	8.72
Young modulus (MPa)	870	961

Table 3: Stresses after add the Hyb.

samples	EP + 1F	EP + 1F + Hyb
Hyb	52.32	68.12
	EP + 2F	EP + 2F + Hyb
	80.77	109.98

Table 4: Impact strength (KJ \ m^2).

EP + 1F	EP +1F + 1% G + 20% R
16.66	27
EP + 2F	EP +2F + 1% G + 20% R
29.5	98.6

Table 5: Abs Energy (KJ)

EP + 1F	EP +1F + 1% G + 20% R
0.5	0.81
EP + 2F	EP +2F + 1% G + 20% R
0.887	2.96

Table 6: Shore D.

EP + 1F	EP +1F + 1% G + 20% R
70.5	73
EP + 2F	EP +2F + 1% G + 20% R
72	74

Result of numerical analysis in this part, the numerical analytical section is discussed and the analytical results that have been reached are discussed after the work of a network in the Abacus program, several mechanical factors were implemented with a number of different variables , where in this analysis the most important mechanical characteristic that can be dealt with clearly for this application is the effect and to know the variables of influence in terms of form and their inter-distribution , in order to demonstrate some of the mechanical properties, we did experiment of collision case for speed at 120 Km/h . Where at this speed we can observe their effect on the mechanical properties at the shock through distribution and how different the normalization areas are in terms of stresses, emotions and shear stress as shown in Fig. 16, Fig. 17, Fig. 18, and through this we can notice that the yellow and red areas are more dangerous than others while the blue areas are the safest.

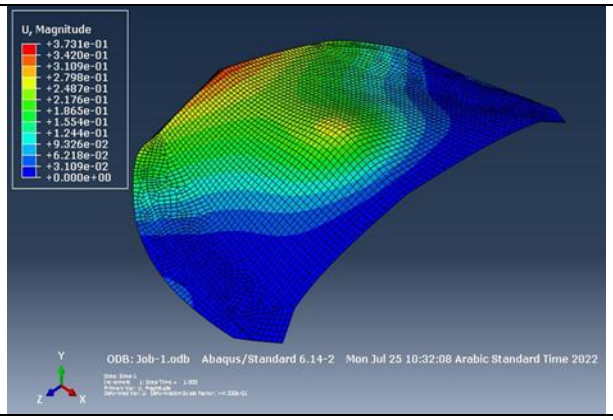

Fig. 16 Contour of displacement distribution

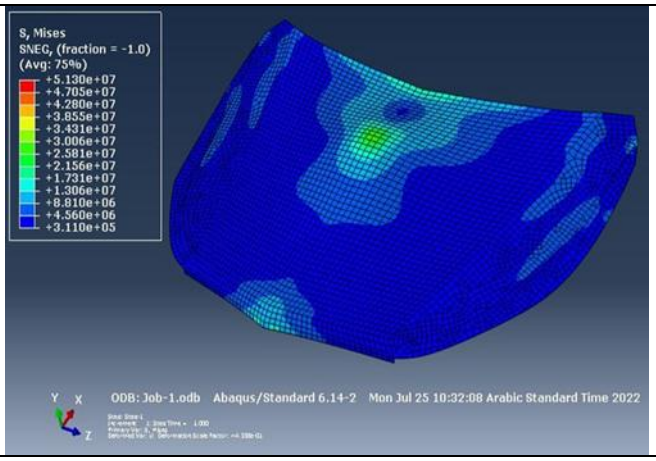

Fig. 17 Contour of Von Misses stress distribution

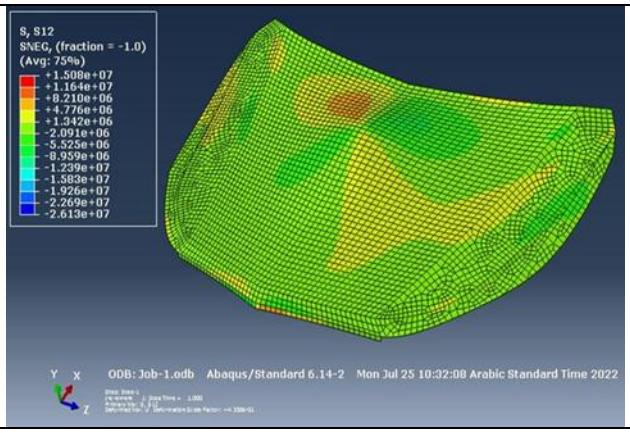

Fig. 18 Contour of shear stress distribution

CONCLUSIONS

Through this research, many conclusions can be drawn, including that:

1. Composite materials are light in weight, cheap in cost, easy to manufacture, transparent and with good properties compared to metals.
2. The mechanical properties (stress, impact, hardness,) of the epoxy/glass fibers compound were improved after adding nanographene particles and rubber crumbs.
3. When applying the numerical analysis using simulation programs for the same composite materials that were made experimentally and applying a number of collision accelerations to a mechanical application (hood), it was found that the failure parameters in the distribution characteristics were not clear except at a speed of 120 km / h.

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