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Study of the Mechanical Properties for Reed -Reinforced Epoxy Composites and Reed-Sisal Hybrid Epoxy Composites

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Abstract

In this investigation, the mechanical properties such as : elongation, tensile strength, flexural strength and impact properties were studied for epoxy composites reinforced with reed in weight percentages of (0,15,25 and 35)% and epoxy composites reinforced with reed-sisal in weight percentages (5,10 and 15)%.Hand-lay up was used to prepare the composites ,sisal fibers and reed fibers were treated with NaOH .The results showed that the tensile strength , flexural strength and impact increase with the increase in weight percentages of reed and decrease in elongation with increase of the loading, the hybrid composites showed an increase in tensile and impact properties with increase in weight percentages of fibers and decrease in elongation with increase in the reed loading and increase in flexural strength with increase in sisal fibers loading.

Keywords: epoxy resin , sisal fibers ,reed fibers , hybrid composites , mechanical properties.

الخلاصة

في هذا البحث تم دراسة الخواص الميكانيكية مثل قوة الشد وقوة الصدمة وقوة الانحناء والاستطالة لمتراكبات الايبوكسي المسلح بالقصب بنسب مئوية وزنية %(٣٥ and ٢٥ ، ١٥، ٠) وكذلك تم دراسة هذه الخواص لمتراكبات الايبوكسي المسلح بالألياف الهجينة من ألياف السيزال و القصب بنسب مئوية وزنية %(١٥ and ١٠، ٥ ، ٠) .وقد تم معاملة الألياف كيميائيا بهيدروكسيد الصوديوم واستخدمت الطريقة اليدوية لتحضير العينات .لقد أظهرت النتائج ان قوة الشد وقوة الصدمة وقوة الانحناء تزداد والاستطالة تقل مع زيادة النسب المئوية الوزنية للقصب في متراكبات الايبوكسي أما في المتراكبات الهجينة فقد أظهرت النتائج أن قوة الشد وقوة الصدمة تزداد والاستطالة تقل مع زيادة النسب المئوية الوزنية للقصب في المتراكبات بينما قوة الانحناء تزداد مع زيادة النسب المئوية الوزنية لألياف السيزال .

1-Introduction:

Now a days fibers reinforced composites are in use in a variety of structures ranging from space craft and aircraft to building and bridges, this wide use of composites has been facilitated by introduction of new materials (1).Epoxy resins are one of the most important classes of thermosetting polymers which are widely used as materials for fiber – reinforced composite materials and as structural adhesives (2,3,4). Fiber – reinforced polymer composites are considered as an important class of engineering materials since they have many properties such as: offer outstanding mechanical properties, unque flexibility in design capability and ease of fabrication, they have additional advantages include: light weight, corrosion and impact resistance and excellent fatique strength (5,6). Fibers can be categorized as being synthetic and natural, natural fibers also being subcategorized as being plant, animal, mineral fibers (7,8,9). The natural fibers such as sisal, bananas, flax, bagasse and hemp, have advantages to be used instead of synthetic fibers in composites (10). These advantages include:

1-lighter weight 2-low abrasion 3-reduction in energy consumption 4- better vibration dampening capabilities 5-better in sulation and sound absorption properties 6-better degradation when service-life is exhausted 7-reduction in the dependence on petroleum based production (11,12,13).

Various works on the application of natural fillers and fibers in composites likes pin apple, sisal, coconut coir ,jute palm ,cotton, rice husk, bamboo and wood as a reinforced composites have been reported in literatures (14) :

Mechanical properties of epoxy/coconut shell filler particle composites were studied, the results showed that tensile and flexural properties of composites increased with the increase of the filler particles content (14). Mechanical properties study of pseudo- stem banana fiber reinforced epoxy composites indicated that the tensile strength of composite is increased by 90%

compared to virgin epoxy ,the flexural strength increase and the impact strength properties is improved when banana woven fabric reinforced used with epoxy material (15). Impact properties of jute/epoxy and hemp/epoxy laminates showed quantifying the superiority of hemp/epoxy on jute/epoxy laminates under falling impact loading (16). Study of flexural properties of arenga pinnata fiber reinforced epoxy composites indicated that the woven roving arenga pinnata fibere reinforced has a better bonding between its fibers and material compare to long random chopped random .17)Thermo mechanical properties of jute /bagasse hybrid fiber reinforced epoxy thermoset composites were studied(18).

BLEDZKI et al studied mechanical properties of abaca fiber reinforced pp composite and comparison with jute and flax fiber pp composites, they found that the tensile, flexural and falling weight impact properties increase in between 30 to 80% for different fibers loading.(19). MERIES IDICALA et al studied mechanical properties of randomly orient, short banana and sisal hybrid fiber reinforced polyester composites, they found that appositive hybrid effect is observed in the flexural strength, flexural modulus and tensile strength (20). Cansuger fibers treated chemically with sodium hydroxide has higher values of flexural strength and impact strength from chopped carbon fibers in chopped fibers/cansuger fibers hybrid –epoxy composite (21). NOORANISA et al studied tensile, flexural and chemical resistance properties for sisal/carbon fiber reinforced hybrid composites, they found an increase in tensile and flexural properties with increase in the carbon fibers loading significant improvement in tensile properties and flexural properties of sisal/carbon hybrid composites has been observed by alkali treatment (22). Effect of layering pattern on the dynamic mechanical properties and thermal degradation of oil palm- jute fibers reinforced epoxy hybrid composites ,the results showed that hybridization with jute fibers enhanced the dynamic mechanical and thermal properties (23).Impact properties of empty fruit bunch fibers and Jute fibers tri-layers hybrid reinforced epoxy composites showed that the notched izod impact strength of most hybrids increased with respect to the virgin matrix and the laminates coupled with (HEA) showed better impact properties than the one without coupling agent (24). flexural properties and modulus of all wild cane grass fiber-reinforced polyester composites increase with increase in fiber loading and the tensile modulus of wild cane grass fibers relatively more than those of sisal and banana fibers and much higher than that of coir fibers (25)

2-Experemental Part:

Materials:

Epoxy resin 105(it has low viscosity and density is 1.04g/cm2 ,supplied from industrial chemical and resin Jordan /the Jordian swiss) was used as a matrix material ,sisal fibers (in length 2-2.5 cm ,supplied from bras corda ,s.a. brazil) and reed (in length 15 cm , width 3mm and depth 1mm,supplied from a local source) were used as a reinforced materials .

Chemical Treatment:

The sisal fibers and reed fibers are washed and soaked in the solution prepared from NaOH and distilled water for three hours , 2% of NaOH is used ,the fibers were taken out of the solution and left for three day to dray at room temperature .Chemical treatment with NaOH eliminates moisture from the fibers and enhances the flexural rigidity ,the chemical treatment remove the impurities and stabilizes the molecular orientation (26,27).

Preparation of Composites:

A glass cast mould was used to manufactured the composites by using hand lay-up technique ,the composites from epoxy resin reinforced were prepared indimensions(150×150)mm.fiber–reinforced composites were cut using a circular iron saw to get the dimensions of specimens for mechanical testing as shown in figures (2-1),(2-2) and (2-3).

Figure (2-1) tensile specimen shape

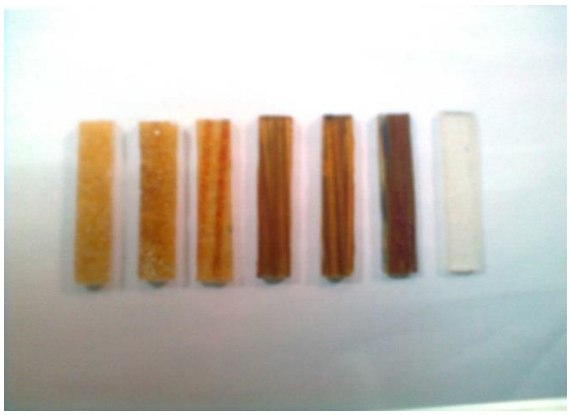


Figure (2-2) Impact specimen shape

Figure (2-3) flexural specimen shape

Methods of Test:

Tensile properties such as tensile strength and elongation at break were determined according to ASTM D638 procedure in dimensions, gage length and cross-head speed (28).

Impact properties of material represent is ability to absorb and dissipate energy during plastic deformation (25). Impact strength was determined by following (ISO 179) After standard specimens were prepared a ccording to a requirement dimensions .The specimens were tested by using a notch milling machine .The energy loss was obtained from reading at scale plate, the impact strength can be calculated by using the following equation (29):

IS= energy of fracture (J)/cross-section area for the specimen (A)

Flexural properties were determined according to ASTM D790 this standard test method was used to measure flexural properties of unreinforced and reinforced plastic including high-modulus composites and electrical insulating materials in this method ,the maximum stress (flexural stress) can be calculated on the load –deflection curve by the following equation (30):

$S= 3PL/ 2b^2$

Where : S= flexural strength (N/m^2)

L= span load (N)

b= width of specimen (m)

d= depth of specimen (m)

3-Results And Discussion:

A) Tensile strength and elongation :

In general, mechanical properties of composites depend on : type of matrix , level of fibers , type of loading , applied stress and adhesion between matrix and fibers (31).According to the results shown in table (3-1) and figures (3-1) and (3-2) which appear the variation of elongation and content of reed in the reed – epoxy composites and the variation between the tensile strength and content of reed in the composites ,it is noted that the elongation at break decreases with increase of the fibers contents since ,the materials have become harden with the increase in fiber contents. Tensile strength increase with increasing in weight percentages of reed in composites. Results of testing for composites that containing reed fibers and sisal fibers were listed in table (3-2) and shown in figures (3-3),(3-4), It is showed that the elongation at break decrease with increase in reed contents due to the tensile applied in direction of longitudinal-axis of reed where the reed fibers long and were put in parallel in the composite while the sisal fibers are short and in random direction and the tensile strength increase with increase of weight percentages of fibers (21).The tensile strength of these hybrid composites has been found to be higher that of the matrix and the elongation at break has been found to be lower .The chemical treatment for fibers with NaOH increase the interfacial adhesion or compatibility between the fibers and the matrix thereby improving mechanical properties of the composites ,this result lead to improve the tensile strength (32). Comparing figure (3-1) with figure (3-3) showed that the elongation lowered with increase content of reed fibers in the composites.

Table (3-1) tensile strength and elongation for epoxy reinforced with reed

Sample	Elongation (mm)	Tensile strength (Mpa)
Pure epoxy	13.440	14.749
Epoxy + 15% reed	10.185	21.447
Epoxy + 25% reed	5.991	45.238
Epoxy + 35% reed	4.430	82.660

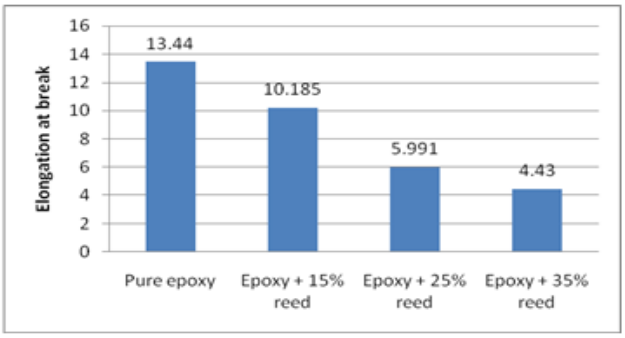
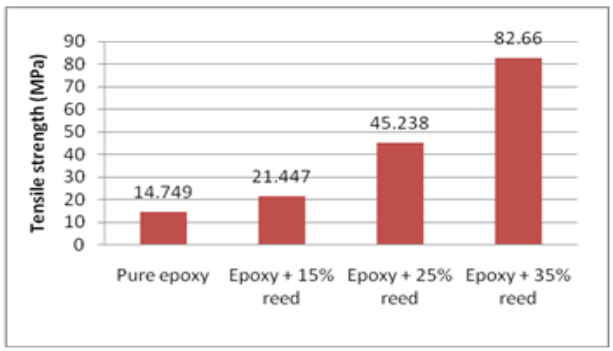


Figure (3-1) Elongation at break for pure epoxy and reed - reinforced epoxy composites



Figure(3-2)Tensile strength of pure epoxy and reed – reinforced epoxy composites

Table(3-٢)tensile strength and elongation for epoxy reinforced with sisal/ reed hybrid

Sample	Elongation (mm)	Tensile strength (Mpa)
Epoxy + 15% sisal + 0% reed	9.015	17.44
Epoxy + 10% sisal +5% reed	8.111	21.025
Epoxy + 5% sisal + 10% reed	7.351	46.150
Epoxy + 0% sisal + 15% reed	7.185	21.447

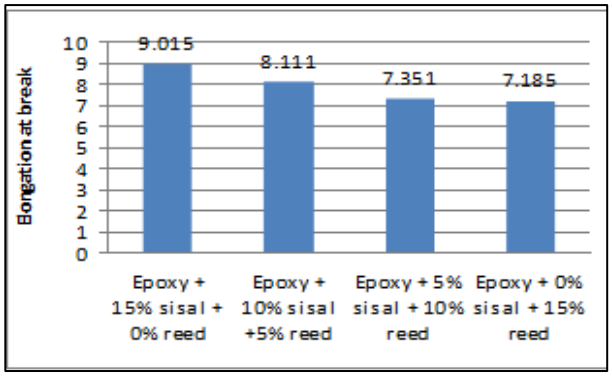


Figure (3-3) Elongation at break for hybrid

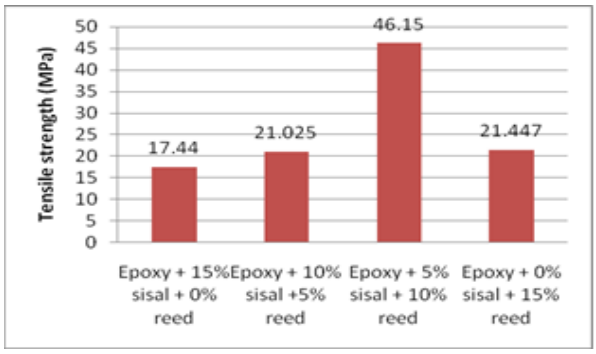


Figure (3-4)Tensile strength for hybrid composites

B)Impact strength:

Results of impact test for epoxy reinforced with reed were shown in table (3-3) and illustrated in figure (3-5), the results were indicated that the impact strength increase with increasing of weight percentages of reed in composites. Table (3-4) and figure(3-6) show results of impact test for epoxy reinforced with hybrid reed/sisal fibers , from these results ,it was showed that the reed –composites have higher impact strength than of chopped sisal composites because the longer fibers increase the impact strength (21). The composite has higher reed has higher impact strength when epoxy reinforced with hybrid .It is noted that the composite with 5% sisal and 10% reed has higher impact strength than that of 15% reed or 15% sisal.

PRASAD et al have studied the behavior of untreated and alkali fibers for coir- polyester composites and concluded that flexural strength, modulus and impact strength of composites containing alkali-treated fibers were higher than the same volume fractions of untreated fibers (33).

Table (3-3) Impact strength for epoxy reinforced with reed

Sample	Impact (KJ/m²)
Pure epoxy	5.454
Epoxy + 15% reed	17.272
Epoxy + 25% reed	23.636
Epoxy + 35% reed	72.727

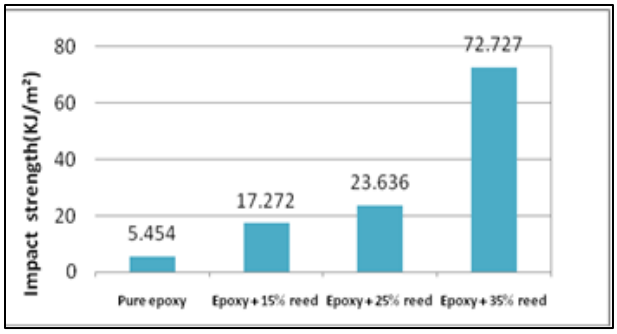


Figure (3-5) Impact strength for reed - reinforced epoxy composites

Table (3-4) Impact strength for epoxy reinforced with sisal / reed hybrid

Sample	Impact (KJ/m²)
Epoxy + 15% sisal + 0% reed	7.363
Epoxy + 10% sisal +5% reed	9.45
Epoxy + 5% sisal + 10% reed	42.727
Epoxy + 0% sisal + 15% reed	17.272

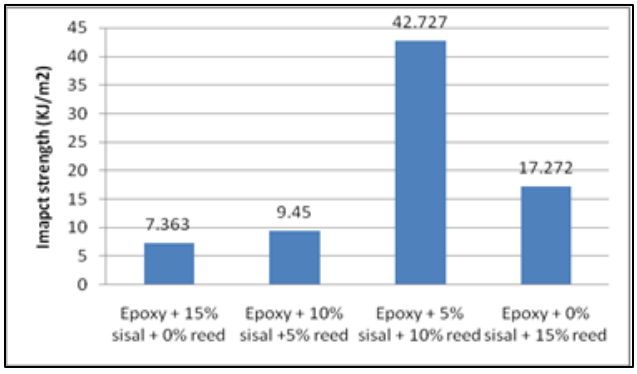


Figure (3 – 6)Impact strength for hybrid composites

C) Flexural strength :

Table(3-5) shows the flexural properties for reed fiber composites and pure epoxy ,Table (3-6) shows the flexural properties for sisal/ reed hybrid composites. According to table(3-5) reed epoxy composites indicated an increase in flexural strength with increasing fibers content in composites as shown in figure(3-7),according to table(3-6) and from figure(3-8), it can be seen that the flexural strength increased with the increasing in sisal fibers content in hybrid composites, since, the sisal fibers were used in composites as the skin material and the reed fibers were used as the core material . It is noted that the hybrid composites with 10% sisal and 5% reed showed higher flexural strength than that of 15% reed and less than 15% sisal.

Table (3-5) flexural strength for epoxy reinforced with reed

Sample	Flexural strength (N/mm²)
Pure epoxy	192
Epoxy + 15% reed	240
Epoxy + 25% reed	298
Epoxy + 35% reed	384

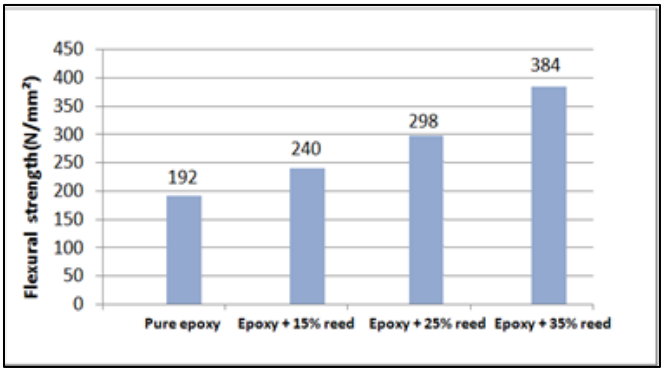


Figure (3-7) flexural strength for reed – reinforced epoxy composites

Table (3-6) flexural strength for epoxy reinforced with sisal / reed hybrid

Sample	Flexural strength (N/mm²)
Epoxy + 15% sisal + 0% reed	344
Epoxy + 10% sisal +5% reed	288
Epoxy + 5% sisal + 10% reed	264
Epoxy + 0% sisal + 15% reed	240

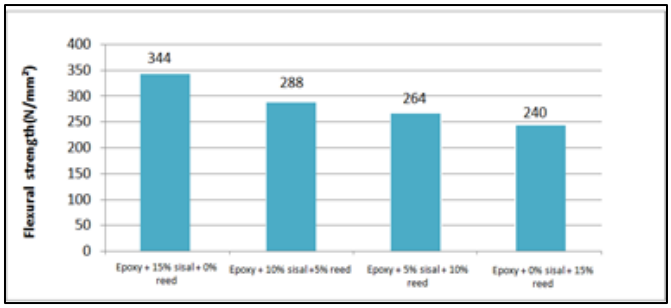


Figure (٣-8) flexural strength for hybrid composites

4-Conclusions :

The following conclusions can be drawn from the present study :

1- The tensile properties of reed -epoxy composites increase with increasing the fibers where affected by the amount of fibers in the composites, the more fibers content , the higher the strength .

2- Impact and flexural strength increase with increase content of fibers in reed -epoxy composites.

3- The hybrid composites showed an increase in tensile and impact properties with increase in fibers loading .

4- The hybrid composites showed higher tensile and impact strength at weight percentages 5% sisal + 10% reed.

5- A positive hybrid effect is observed in flexural of the hybrid composites .

6- Reed –epoxy composites and sisal / reed hybrid composites showed decrease in elongation with increasing fibers content in composites .

7- In hybrid composites, the elongation decrease with increase of reed in the composites.

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