Reinforcing by Palms-Kevlar Hybrid Fibers and Effected on Mechanical Properties of Polymeric Composite Material

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Abstract

The mechanical properties of araldite(AY103) matrix composites reinforced with hybrid palms - kevlar fibers were evaluated . There are indications that the incorporation of both fibers into a single matrix which is araldite resin will stabilize mechanical properties and lowering manufacturing costs . In this research the impact strength , tensile strength ,flexural strength ,and hardness were studied for composite material reinforced with hybrid fibers for palms and kevlar as a woven roving (0°-45°) with surface density (285g/cm^2) . These fibers were mixed with araldite resin in different reinforcement percentage (20%,40%,60%) and the effect on the above mechanical properties were studied . It has shown an improvement in these mechanical properties after reinforcement by fibers The value of mechanical properties will increase with increasing percentage of reinforcement .

Keywords : Hybrid Fibers , Composite Material , Mechanical Properties .

الخلاصة .

إن الهدف من هذه الدراسة هو التعرف على الخواص الميكانيكية للمادة المتراكبة ذات أساس من الإرلدايت(AY103) المدعم بألياف النخيل الطبيعية وألياف كيفلار الهجينة . حيث هنالك مؤشرات على إن دمج هذين النوعين من الألياف في أرضية واحدة يحافظ على الخواص الميكانيكية ويخفض تكاليف التصنيع . في هذا البحث تم دراسة مقاومة الصدمة ، مقاومة الشد ، مقاومة الإنثناء ، والصلادة للمادة المتراكبة المدعمة بألياف هجينة من ألياف النخيل الطبيعية وألياف كيفلار بشكل حصيرة ثنائية (°0−°45) وبكثافة سطحية (285g/cm^2). حيث تم مزج هذه الألياف في أرضية من راتنج الإرلدايت وبنسب تدعيم مختلفة (60%,40%,20%) ودراسة أثر ذلك على الخواص الميكانيكية ، أظهرت النتائج تحسن هذه الخواص بعد التدعيم بالألياف إضافة إلى زيادة قيمة هذه الخواص مع زيادة نسبة التدعيم .

الكلمات الدالة : الألياف الهجينة ، مادة متراكبة ، الخواص الميكانيكية .

Introduction .

A composite is a structural material that consists of two or more constituents that are combined at a macroscopic level and are not soluble in each other . One constituent is called the reinforcing phase and the one in which it is embedded is called the matrix [Auter,2006] . The composite material however , generally possesses characteristic properties , such as stiffness ,strength ,weight ,high-temperature performance ,corrosion resistance ,hardness , and conductivity that are not possible with the individual components by themselves [DeGarmo,2008] . There are many types of composite materials and several methods of classifying them , one such method is bases on geometry and consists of three distinct families [Liyong,2002]:

1- Laminar Composites : laminar composites are those having distinct lagers of materials bonded together in some manner.
2- Particular Composites : particular composites consists of discrete particles of one material surrounded by a matrix of another material .
3- Fiber-Reinforced Composites :the most popular type of composite material is the fiber-reinforced composite geometry .

G.Morom ,etal studied the effect of hybrid fibers (Palms / Kevlar) on the impact strength of epoxy resin [Morom,1986] . also Ali investigated the effect of changing the reinforcement percentage by fibers on Mechanical properties, for composite material consists of conbextra epoxy (EP-10) resin reinforced by biaxial woven roving kevlar fibers [Ali,2009] . Azhdar studied the impact fracture toughness of fiber reinforced epoxy resin[Azhdar,1992] .Al-Jeebory etal studied effect the change of reinforcement percentage of fibers on the thermal conductivity for polymeric composite material consist of conbextra epoxy (EP-10) resin reinforced by biaxial woven roving S–type glass fibers [Abbas & Ali,2009] .

Hybrid Composites .

Hybrid composites involve two or more types of fibers set in a common matrix .The particular combination of fibers is usually selected to balance strength and stiffness , provide dimensional stability ,reduce cost ,reduce weight ,or improve fatigue and fracture resistance . Types of hybrid composites include (1)interply(alternating layers of fibers); (2) interply(mixed strands in the same layer) ;(3) interply-intarply ;(4) selected placement(where the more costly material is used only where needed) ;and (5) interply knitting(where plys of one fiber are stitched together with fibers of another type) [DeGarmo,2008] .

Kevlar Fibers .

Kevlar fibers is an organic aramid fiber with (3100 *MPa*) tensile strength, and (131,000 *MPa*) elastic modulus. A density approximately one-half of aluminum, good toughness, and negative thermal expansion coefficient .In addition , it is flame retardant and transparent to radio signals ,making it attractive for a number of military and aerospace applications where the service temperature is not excessive [Morom,1986] . **Table(1)** shows some characteristic of Kevlar fibers . **Figure (1)** shows the chemical structure of kevlar fibers.

Table(1) : Some characteristic of Kevlar fibers[Mallick,2007]

Property	Specific strength ($10^6 m$)	Specific stiffness ($10^6 m$)	Density(Kg/m^3)
Value	0.254	8.8138	0.1439×10^4

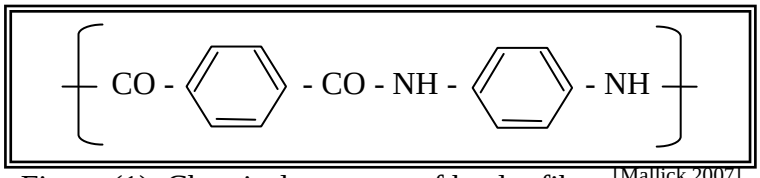


Figure (1): Chemical structure of kevlar fibers[Mallick,2007]

Araldite Resin (AY103).

Araldite resin (AY103) belongs to epoxy group which have excellent thermal and physical properties ,and usually used in composite materials for different application ,where it distinct by excellent adhesive capability especially to fibers ,also it retain constant dimension after dryness [Dorey,1978] . **Figure (2)** shows the chemical structure of this resin.

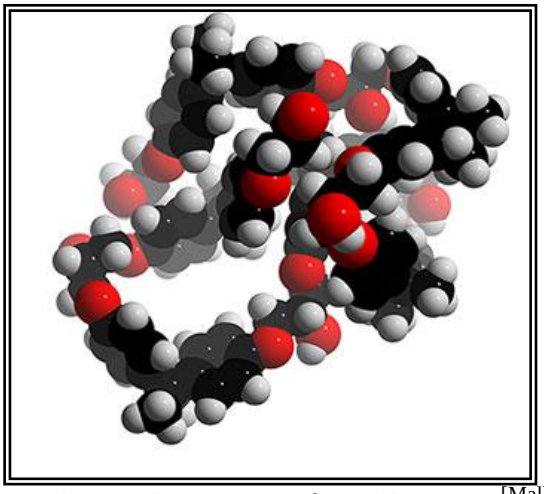


Figure (2): Chemical structure of Araldite resin[Mallick,2007]

Experimental Work .

The experimental work includes the following points :

1- Materials: There are three types of materials employed in this study:

a- Matrix material, Araldite resin (AY103) which mixed with (HY956) as a hardener .

b- Reinforcing fibers: Two types of fibers used here :

1- Palms fibers: which belongs to cellulose fibers .

2- Kevlar fibers : a woven roving fibers(0 º - 45 º) with surface density of (285 g/m^2).

These types of fibers used as consecutive layers in same matrix with 50% palms fibers and 50% Kevlar fibers .

2- Test Specimens: Four types of specimens were manufactured as follows :

a- Impact Specimens : impact specimens fabricated according to the (ASTM-E23) standard suitable to Charpy Impact Instrument .Notch depth is (0.5*mm*) and notch base radius is (0.25*mm*).

b- Tensile Strength Specimens :these specimens manufactured according to the (ISO-R-527) standard .

c- Hardness Specimens : hardness specimens are a disc shape with (25*mm*) diameter and (10*mm*) thickness .

d- Flexural Strength Specimens :these specimens fabricated according to (ASTM-D790) standard as a rectangular shape(10*mm*×135*mm*) .

Three specimens Were manufactured for each test which different by the resin and reinforcement percentage as shown in **Table(2)** . Hand molding was used to manufacture the specimens . some resin spread in the mould and the fiber layer put on it and this process repeated to obtain the desired thickness .

Table(2) :Structure of specimens

Specimens number	1	2	3
Resin(weight %)	80	60	40
Fibers(weight %)	20	40	60

3- Mechanical Tests :in this study four types of mechanical tests were used to determined the properties of composite material ,and these tests are :

a- Impact Test : Charpy Impact Instrument was used to determine the impact resistance of composite material .

b- Tensile Test :this test was used to calculate the tensile strength of composite material under uniaxial load .The universal test instrument manufactured by (ZheJinang TuGong Instrument Co., Ltd) used to measure this property with a (20*KN*) load .

c- Hardness Test : In this test the "Brinell method" was used to measure hardness , this test made with a steel ball (5*mm*) diameter and (10*kg*) exposition load, loaded into specimens for (15*sec*) , and the hardness number represents the diameter of impression after the load removal, which left on surface by the ball. universal test instrument manufactured by (Uali Test Company) used for this test .

d- Flexural Strength Test : Flexural strength can be measured by three point test by using universal hydraulic press (ZheJinang TuGong Instrument Co., Ltd) to calculate the maximum load exposed on middle of the specimen .

Results & Discussion .

The mechanical properties of composite materials have a great important in the field of using these materials ,where the values of these properties should be high and acceptable so it can done its duty successfully .From the mechanical tests done on the araldite resin reinforced with hybrid palms and kevlar fibers . The results represent the values of impact strength , tensile strength , hardness, and flexural strength with the fiber reinforcement percentage :

1- Impact Strength : **figure(3)** shows the value of impact strength with fibers reinforcing percentage .Generally ,the impact resistance considered low to the resins due to brittleness of these materials ,but after reinforcing it by fibers the impact resistance will be increased because the fibers will carry the maximum part of the impact energy which exposition on the composite material .All this will raise and improved this resistance .The impact resistance will continue to increase with increased of the fibers reinforcing percentage [Ali,2009].

2- Tensile Strength :the resin considered as brittle materials where its tensile strength is very low as shown in **figure(4)** ,but after reinforcing by fibers this property will be improved greatly ,where the fibers will withstand the maximum part of loads and by consequence will raise the strength of composite material .The tensile strength will be increased as the fibers percentage addition increased , where these fibers will be distributed on large area in the resin [Abbas&Ali,2009].

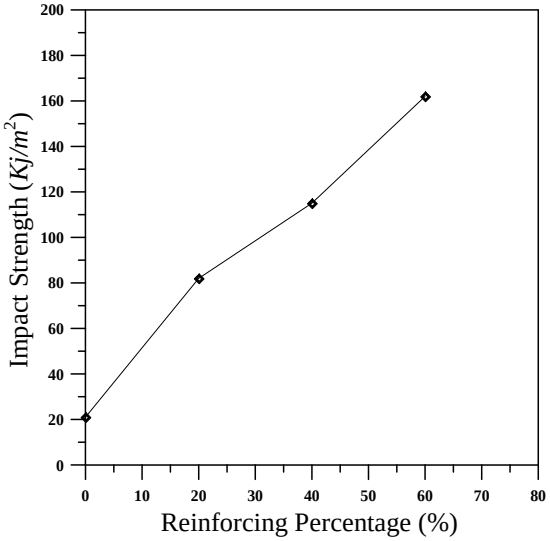
3- Flexural Strength :as mentioned above ,the resin is brittle ,therefore its flexural strength will be low before reinforcement as shown in **figure(5)** .But after added the fibers to this resin the flexural strength will be raised to the producing material because the high modulus of elasticity of these fibers will helps to carry a large amount of loads and raise this strength [Sergio,2005].

4- Hardness :generally the plastic materials have low hardness ,where we observed in **figure(6)** the lowest value for araldite resin before reinforcement .But this hardness value will greatly increased when the resin reinforced by hybrid fibers ,due to distribution the test load on fibers which decrease the penetration of test ball to the surface of composite material and by consequence raise the hardness of this material .The hardness will be increased with increasing the percentage of fibers reinforcement [Ali,2009].

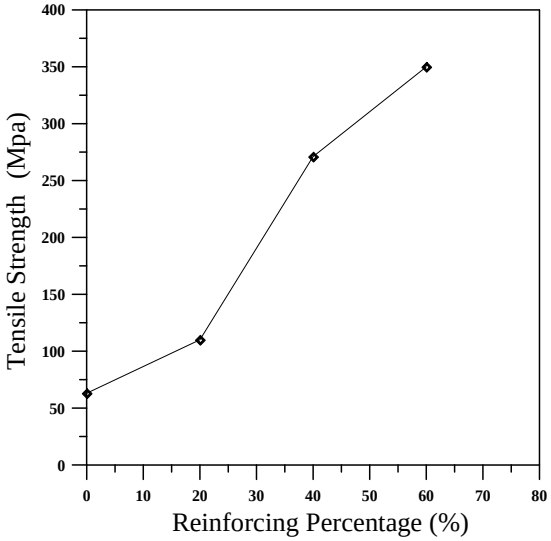
Conclusions .

From the obtained results we get :

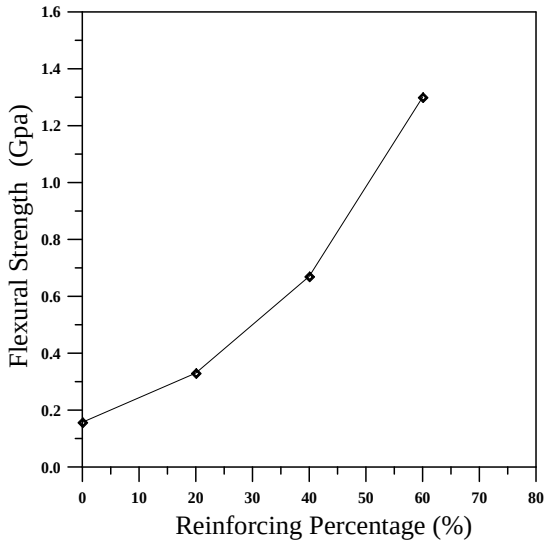
1- Low mechanical properties (Impact, Tensile, Flexural Strength, and hardness) of the araldite resin .
2- Improvement of mechanical properties after reinforcement by palms and kevlar fibers .



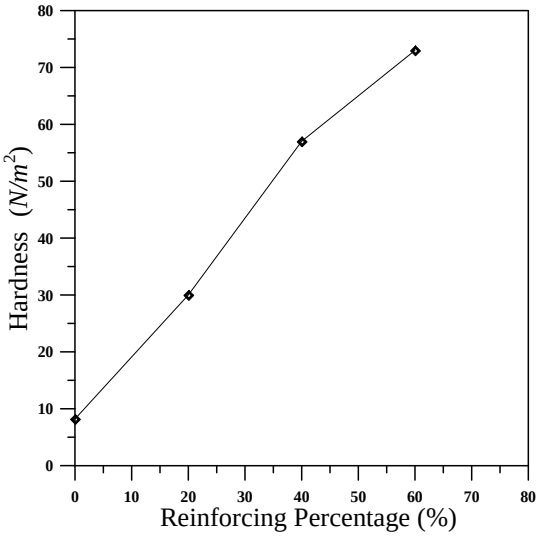
Fig(3): Impact Strength



Fig(4): Tensile Strength



Fig(5): Flexural Strength



Fig(6): Hardness

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