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Comparing Study between The Effect of Wet and Dry Carbon Fibers on Hardness and Impact of Polystyrene Carbon Fiber Sheets Composite

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Abstract:

This research tends to study the effect of the two types of carbon fiber; wet and dry; on hardness, and impact strength of polystyrene (PS) matrix composite. Specimen were prepared as laminate containing (2) layers of (PS) and (2,4,6,8,10) layers of wet and dry carbon fibers separately. Brinell hardness, and Charpy impact has been measured for the specimen, it has been found that (PS) reinforced with dry carbon fiber is much lighter and harder, and more resistance to impact.

Key words:- Laminate composite, Carbon Fibers, Polymer matrix composite.

Introduction:

Composite materials are engineered or naturally occurring materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct within the finished structure. Most composites have strong, stiff fibres in a matrix which is weaker and less stiff. The objective is usually to make a component which is strong and stiff, often with a low density[1-4]. Fibre-reinforced polymer (FRP), is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, or aramid, although other fibres such as paper or wood or asbestos have been sometimes used. The polymer is usually an epoxy, vinylester or polyester thermosetting plastic. FRPs are commonly used in the aerospace, automotive, marine, and construction industries [5-7]. Carbon fiber is most notably used to reinforce composite materials , particularly the class of materials known as fiber reinforced polymers, carbon fibres are created when polyacrylonitrile fibres (PAN), Pitch resins, or Rayon are carbonized (through oxidation and thermal pyrolysis) at high temperatures. Through further processes of graphitizing or stretching the fibres strength or elasticity can be enhanced respectively [8]. There are two types of carbon fibers wet, and dry fibers [9]. Dry Carbon Fiber Fabric that has been reinforced and pre-impregnated with resin, the resin system is epoxy and includes proper curing agent, while wet

carbon fiber has a glossy finish, where in this type the epoxy is painted on to the woven carbon fiber structure and cured through external heating. The result can be varied consistency throughout the product. Alternatively, through high amounts of pressure and a vacuum the epoxy can be applied to the surface and pushed through the fibers[10]. Aim of this research was to study the effect of carbon fiber type on RockwBrinell hardness, and impact of a laminates made of two layers of poly styrene (PS) and wet, and dry carbon fiber sheets separately.

Experimental Part:

1- Materials:

Polystyrene (PS) sheets from (BOAC company UK), wet and dry sheets of carbon fiber from (Hyfil carbon-fiber Ltd, UK), and EF80 resin and hardener from (Alna International USA) was used as an adhesive.

2- Method of Preparation:

Between two external layers of (PS) sheets (2,4,6,8,10) layers of wet, and dry carbon fiber mat were laminate respectively. EF80 resin and hardener adhesive was used to combined the layers together, specimen were left under (20 kgf) force for (24 hr) to complete the solidification of adhesive, after that the specimen were cutting by an electrical saw to form the standard specimen test for Brinell hardness which is a cylindrical shjape with (10*10) mm dimension according to (ASTM C730-98), and Charpy impact test which is a ruler with (5*150) mm according to the (ASTM C623-92) .

3- Testing:

Brinell device type (AKHEU, USA) supplied with a digital reading unit type (ABX-651) was used to measure hardness of the specimen.Charpy imact test device type (Universal Equipment, USA) with a digital reading unit type (Sony CDM, UK) was used to record the results.

Results and Discussion:

Figure (1) illustrates the hardness of poly styrene (PS) laminates strengthened with wet and dry carbon sheets. From this figure we may see that both wet and dry carbon sheets lead to a huge enhance in hardness number of poly styrene matrix, where hardness number increase from (125 up to 531) Mpa when wet carbon sheets ranges from (2 to 10) sheets, while with the same range of dry carbon sheets hardness increased from (140 up to 614) Mpa. Although there is some closeness in hardness value through figure (1), but yet dry carbon sheets is much better when we consider their lower weight comparing with the wet carbon sheets as can be seen from figure (2) which illustrates weight difference between the poly styrene laminates reinforced with wet and dry carbon sheets respectively. Figures (3,4) Shows the relation between weight and hardness of PS/wet, and dry carbon sheets laminates respectively, from these two figures it is very clear that dry carbon sheets has the lower weight which is (2.102 kg) but the higher hardness number which is (614 Mpa).

Figure (5) illustrates the effect of sheet numbers of both wet and dry carbon fibers on impact strength of PS matrix laminates. From this figure it is

clear that impact increases with increasing in sheet numbers, Values of impact strength is very close at sheet numbers (2, and 4) for both types of carbon fibers sheets, then dry carbon fiber sheet laminates become higher in impact strength. Maximum value for impact of wet carbon fiber sheet is (618J), while for dry carbon sheet it was (737J).

Figures (6,7) illustrate the relation between weight of PS/wet, and dry carbon fiber sheets laminates and impact strength respectively. In both figures impact strength increases with weight increment, but in wet carbon fiber sheets the relation is more linear than dry carbon fiber sheets, means the last is better, as can we see when we comparing between the two figures, where we find that dry carbon fiber sheets give higher impact strength (737 J) at lower weight (2.102 kg) than wet carbon fiber sheets which give (618 J) at (2.800 kg).

Conclusions:

Comparing between hardness, and impact of PS/wet, and dry carbon fiber sheets laminates show that:-

Laminates reinforced with dry carbon fiber sheets is lighter than that reinforced with wet carbon fiber.

Laminates reinforced with dry carbon fibers are more impact strength, and harder than the laminates reinforced with wet carbon fiber sheets.

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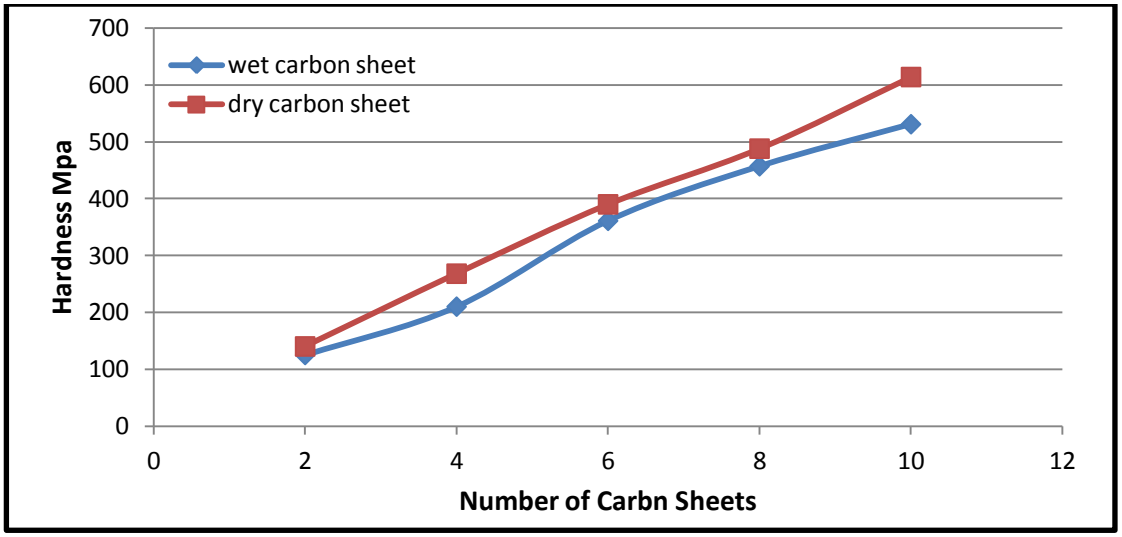

Figure (1) Hardness of PS Laminates with Wet, and Dry Carbon Sheets

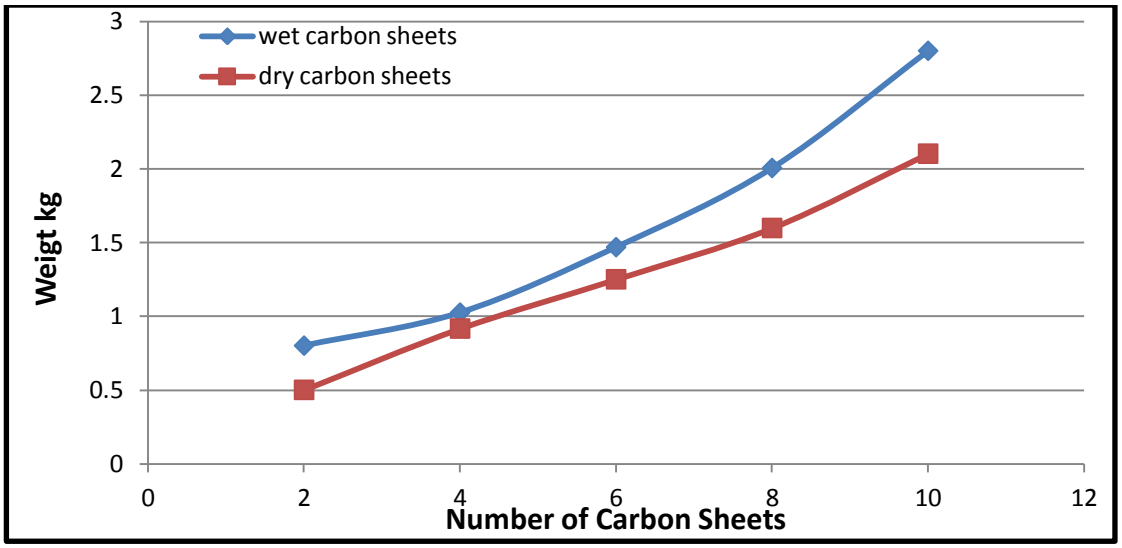

Figure (2) Weight of PS Wet , and Dry Laminates

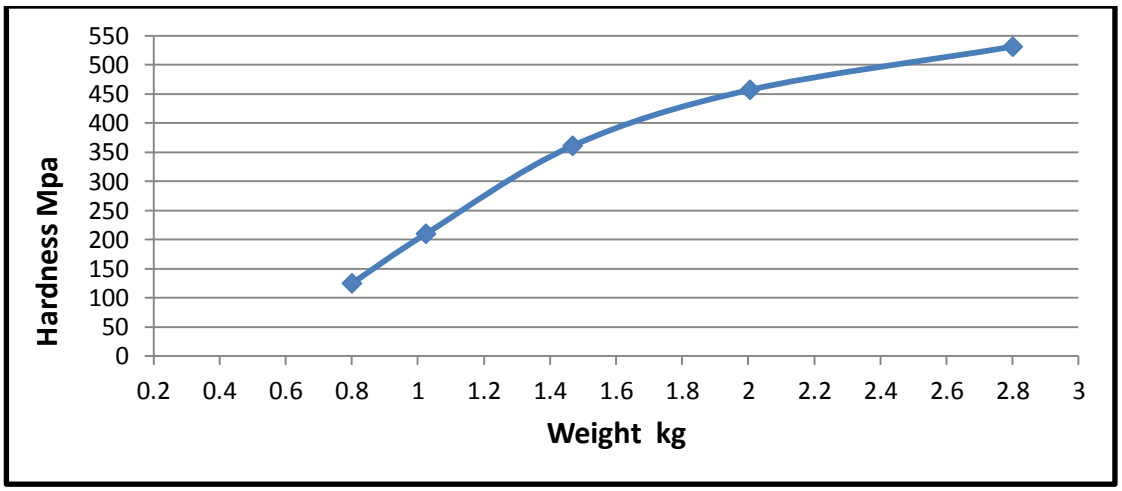

Figure (3) Relation Between Weight of PS/Wet carbon Laminates and Hardness Number

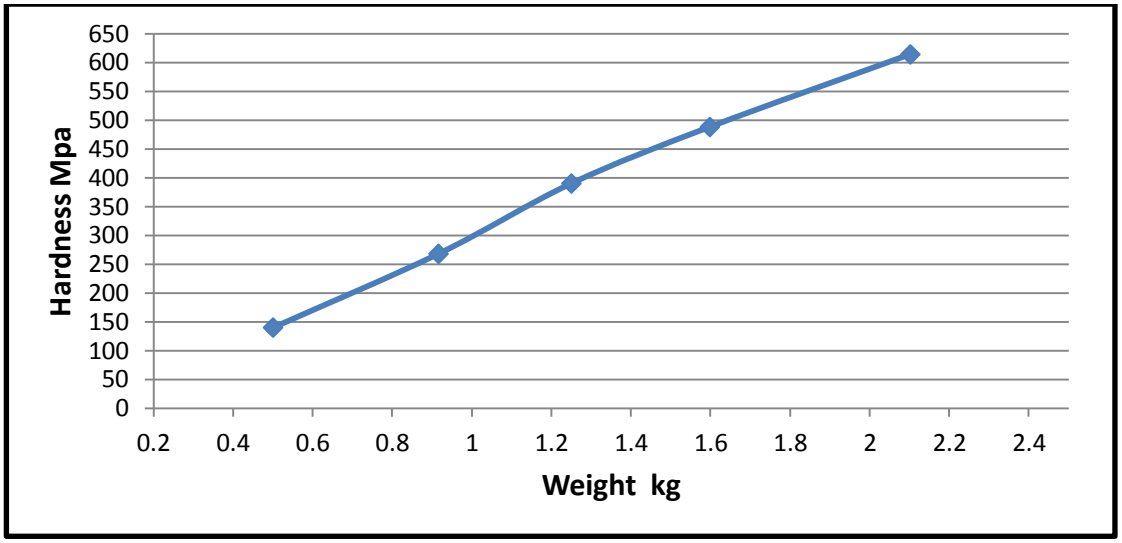

Figure (4) Relation Between Weight of PS/Dry carbon Laminates and Hardness Number

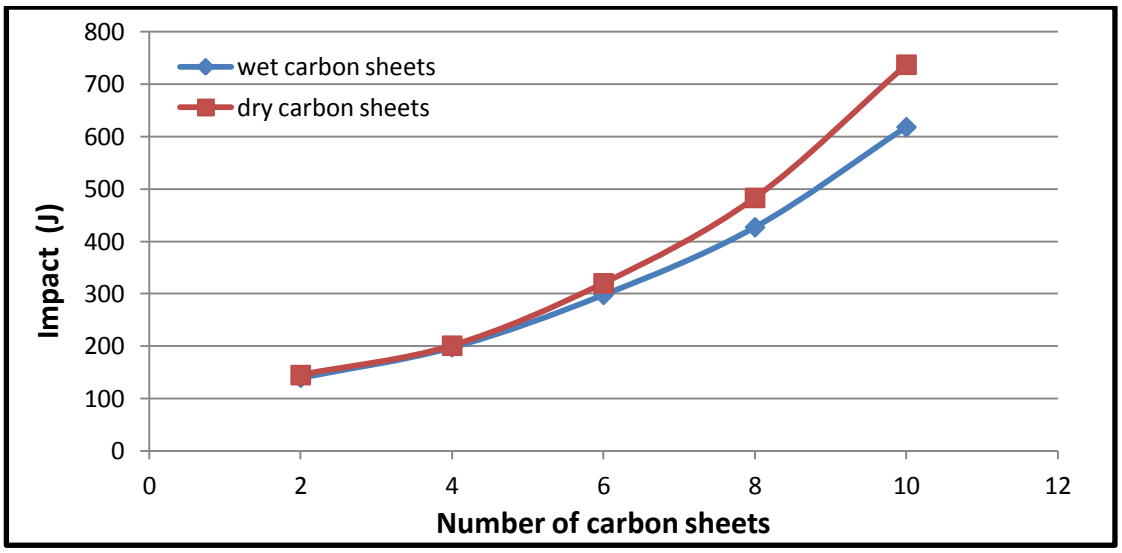

Figure (5) Impact of PS Laminates with Wet, and Dry Carbon Sheets

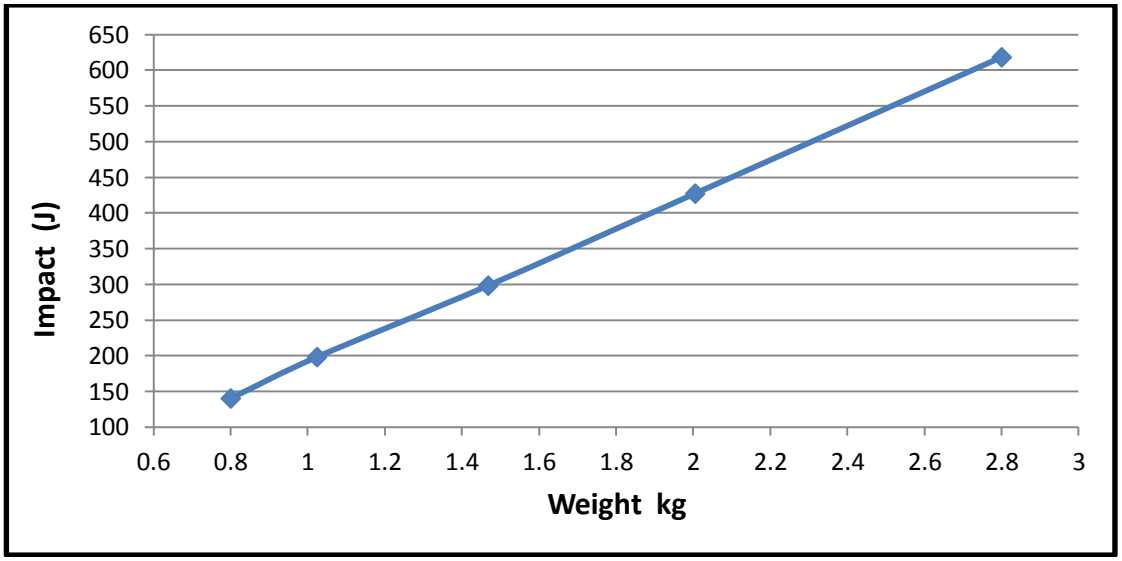

Figure (6) Relation Between Weight of PS/Wet carbon Laminates and Impact Strength

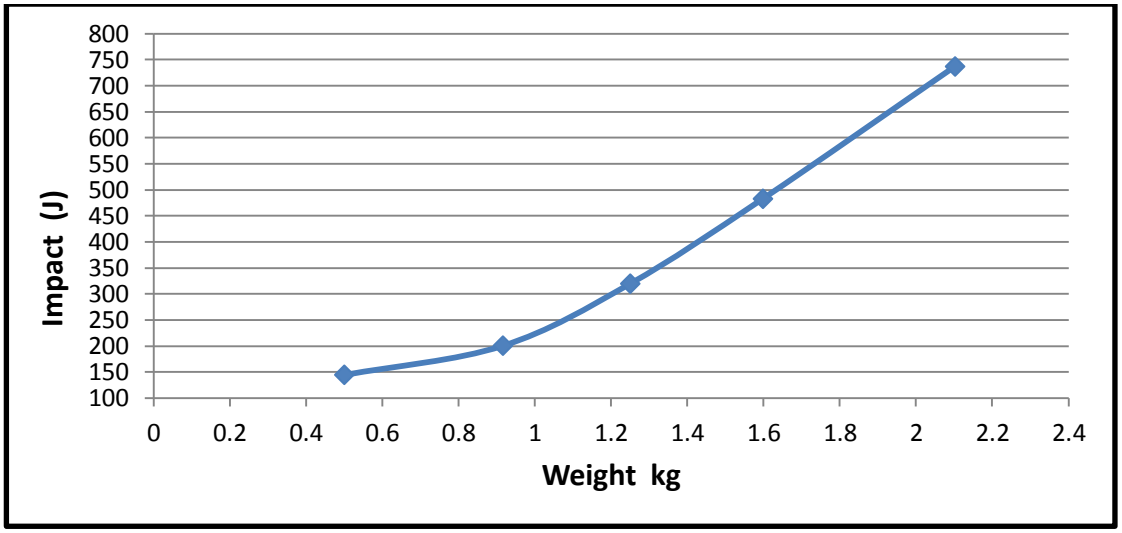

Figure (7) Relation Between Weight of PS/Dry carbon Laminates and Impact Strength

دراسة مقارنة بين تأثير ألياف الكاربون الرطبة والجافة على الصلادة ومقاومة الصدمة لمادة مركبة من البولي ستايرين المدعم بطبقات من ألياف الكاربون

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الخلاصة:

يهدف هذا البحث الى دراسة تأثير نوعين من ألياف الكاربون وهي الرطبة والجافة على صلادة ومتانة الصدمة لمتراكبات ذات اساس من البولي ستايرين (PS). تم تحضير العينات على شكل طبقات تتكون من (2) طبقة من البولي ستايرين و (10,8,6,4,2) طبقة من الياف الكاربون الرطبة والجافة بشكل منفصل. تم قياس صلادة برنل للعينات وقد وجد بأن ألياف الكاربون الجافة أخف وزنا بكثير وأصلد واعلى مقاومة للصدمة.

مفاتيح البحث: المواد المركبة ذات الطبقات، ألياف الكاربون، المواد المركبة ذات الاساس البوليمري.