EXPERIMENAL STUDY ON THE PARAMETERS AFFECTING THE BENDING BEHAVIOR OF COMPOSITE PLATES.

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ABSTRACT

In this paper the bending behavior of composite plates manufactured from polyester reinforced with fiberglass, jute fiber and eggshell powder is studied .The moisture effect on the plate bending behavior is investigated by immersing the specimens in salt water and distilled water for 7 days. Also the effect of type of edges fixture on the central displacement of the plate is investigated. The results showed that for the fiberglass composite plates the central displacement for the moist specimens is 3-4 times as that for dry specimens. For the eggshell powder composite plates, it is found that the stiffness of the dry specimens is greater than that of moist specimens by about three times. The moisture absorption shows no significant effect on the stiffness of the jute composite plate.

Key words composite plates, bending, and moisture absorption.

دراسة عمليه للعوامل المؤثرة على سلوك الانحناء لصفائح مركبة

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الخلاصة:-

في هذا البحث تم دراسة سلوك الأنحناء لصفائح مصنعة من البولستر المدعم بالياف الزجاج والياف الجوت ومسحوق قشور البيض.تأثير امتصاص الرطوبة على سلوك الأنحناء تم اختباره وذلك بغمر العينات بالماء المالح والماء المقطر لمدة 7 ايام.كما تم دراسة تاثير نوع التثبيت لحافة الصفيحة على الأزاحة المركزية للصفيحة.بينت النتائج في حالة صفائح الألياف الزجاجية ان الأزاحة لمركز الصفيحة للعينات الرطبة كان اكبر بمقدار 3-4 مرات مما في حالة العينات الجافة. في حالة صفائح مسحوق قشور البيض فقد وجد ان صلابة العينات الجافة اكبر بحوالي ثلاث مرات من العينات الرطبة.الرطوبة الممتصة لم تظهر تاثير مهم في حالة صفائح الياف الجوت.

INTRODUCTION:

Composite materials are extensively used in naval industry airframe structures, storage tanks, petroleum pipes, cars, and high- tech designs, because of their high strength to weight ratios. So it is very useful to predict their degradation service loads and environment [Robert. Jones 1990].

In addition to temperature change and water, composites are often exposed to other environmental in fluencies' such as ultra – violet light, solvents, vapors, acids and alkalis. The resistance of the matrix is clearly crucial in protecting the fiber- matrix interface and the fibers it selves. Both epoxy and polyester resins more readily absorb organic solvents than aqueous solutions. Traditional glass fiber reinforced polyester (ARP) can show a catastrophic reduction in strength when exposed to acidic solutions, especially if the composite is under load principally this is due to the E- glass fibers cracking when attacked by the acid [F.L, Matthews 1994].

A Study of the creep behavior at room temperature of E- glass, epoxy aging in water for different periods showed that the main causes for damage development in polymeric materials are water absorption or (moisture) from the environment[G- C papanicolaou 2008]. An investigation of the mechanical properties of glass fiber reinforced polymer matrix under tensile compressive and in plane shear strength at room temperature and hot wet conditions, showed that the mechanical properties are reduced by presence of moisture, the strength reduction varied from a bout 11% to 18% depending on the type of property[M. Ragharedre 2004].An experimental investigation on the fracture toughness of woven carbon fiber reinforced composite after being exposed to water, saline water, acidic water, organic fuel, ice temperature and hot air of 60 °C, showed that the fracture toughness decreases continuously with increased duration of environmental exposure [P K Dash, A K Chatterjee 2004].

In another study of the effect of environment on the performance of vinyl ester and epoxy based glass fiber reinforced thermoset composite pipes intended for use in oil and seawater transportation, the pipes were subjected to both static and cyclic loads. The effects of wide range of accelerated and the natural environments on the tensile and fatigue behavior were explored [Mohammed Shaffeq 2006] .In study of the chemical and physical changes in vinyl ester and isophthalic polyester following exposure to water, alkaline and saline environments at ambient and elevated temperatures for extended periods of time. Changes in the glass transition temperatures and tensile strength of the polymer were observed after prolonged exposure at elevated temperature,

particularly in the case of the ophthalmic polyester. The immersion in salt water and alkaline solution showed no ionic penetration into bulk [Joannie W.chin 1998].

Study the effects of changing hydrothermal conditioning cycles on moisture gain loss kinetics and on interlinear shear strength of varied weight fraction glass fiber reinforced epoxy and polyester matrices composites, showed that the absorption/adsorption kinetic depended on the nature of hydrothermal shock cycle and on weight fraction of fiber reinforcement [B. C. RAY].

The focus of this paper is to use the eggshell powder as low-cost natural material as a replacement for synthetic material. No study has been found in the literature dealing with the mechanical behavior of this material. . This study is aimed to investigate the effect of moisture content as compared to other types of composites on the bending behavior of eggshell composite plates .

MATERIALS AND EXPERIMENTAL PROCEDURE

The maximum deflection of composite plates was measured for the following cases

1- Different types of reinforcement (fiberglass, jute and eggshell powder) with polyester as the matrix. The volume fraction is 30% for all types.

2- Different types of boundary conditions such as clamped and simply supported plate (free sides).

3- Investigate the effect of moisture on the maximum deflection of the plates by immersing the specimens in a distilled water and salt water for one week.

EXPERIMENTAL APPARATUS

The equipment used in the experimental measurements is shown in **Fig .a.**

A steel plate is used to represent the distributed load. The plate is mounted on the stand of the equipment and the distributed load is applied by using a sand layer from which the value of load is calculated.

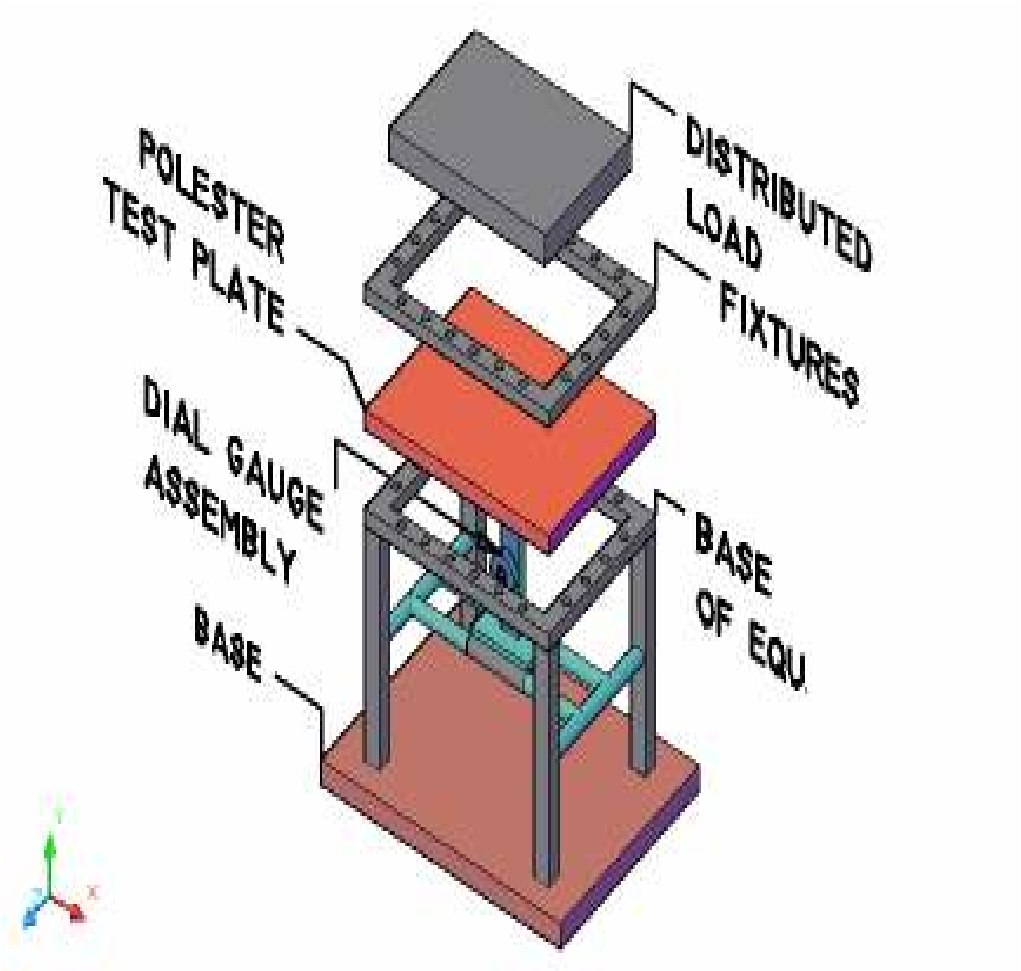

Fig. a . The test apparatus

SPECIMENS PREPARATION

The block diagram shown in **Fig .b.** shows the different steps used in manufacturing of composite plate

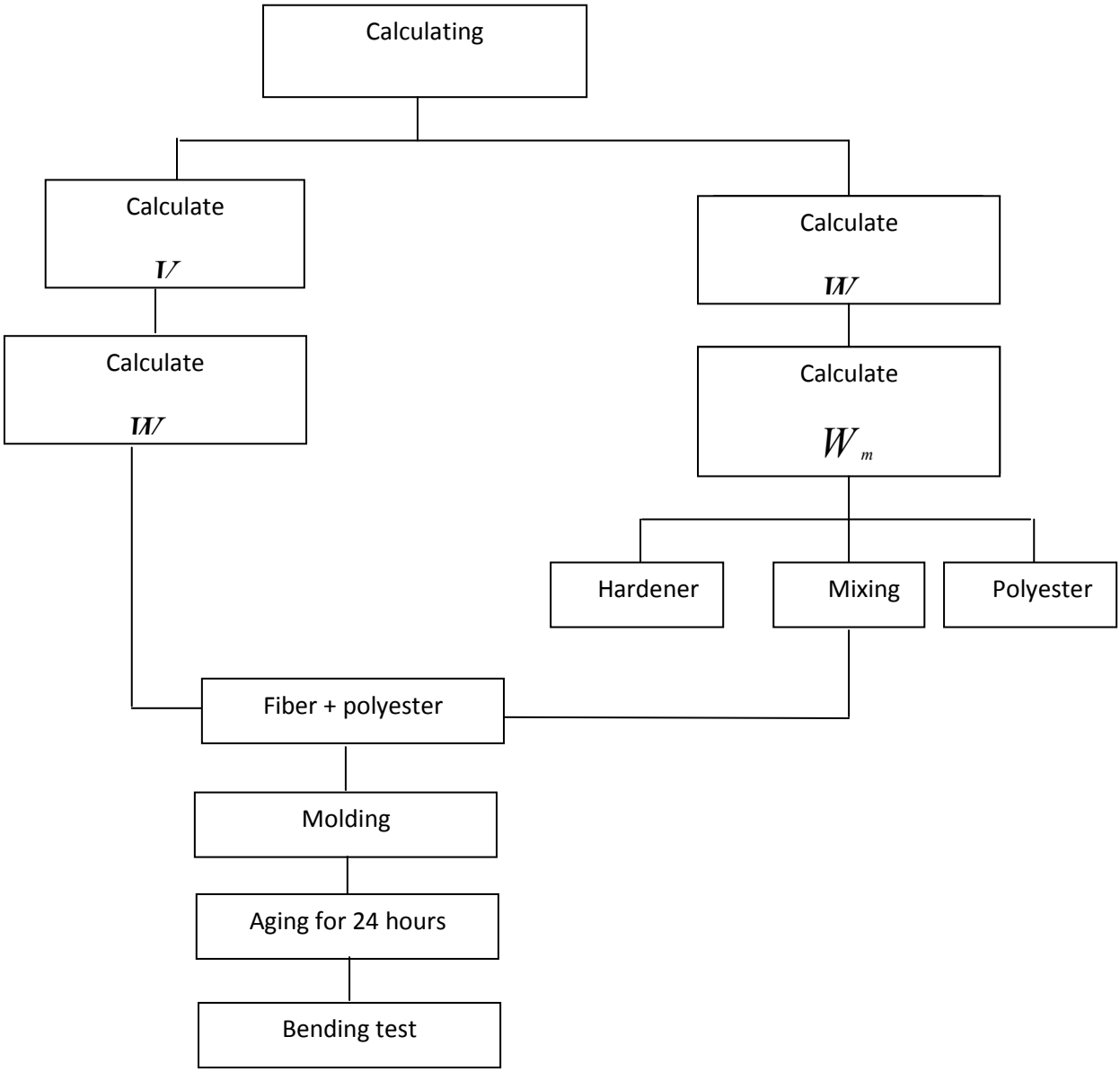

Fig .b .The different steps used in the manufacturing of composite plate

RESULTS AND DISCUSSION

Bending of composite plates under uniform distributed load is investigated. The following cases are considered:

1- Different types of materials.

- Fiber glass –polyester as synthetic fibers.
- Jute –polyester as natural fibers.
- Egg shell powder –polyester.

2- Different types of fixtures.

- Simply supported plate (free sides).
- Plate with two sides clamped.
- Plate with three sides clamped.
- Plate with four sides clamped.

3- Immersion the specimens in distilled and salt water for 7 days.

EFFECT OF FIXTURE TYPE

Figures.1,2,3.show the effect of the plate edge type on the central deflection for the fiber glass , jute and egg shell powder composite respectively(without treatment). From these figures it can be clearly seen that the egg shell composite sustain higher load with small deflection while the jute fiber composite sustain lower load with moderate deflection. This means that the egg shell powder which contains ($CaCO_3$) is stiffer than jute-fiber. Also it can be seen that the minimum central deflection occurs when the four sides of the plate are fixed for all cases as expected.

EFFECT OF MOISTURE ABSORPTION

Figures.4, 5, 6.shows the effect of immersion of the specimens in salt water for (7) days on the load –deflection relation for the fiber glass, jute and egg shell powder composite respectively. It can be clearly seen that the central deflection increases by 14% and 3% for eggshell powder and fiberglass composite plates compared with dry condition. This means that salt water has a significant effect on the eggshell composite, due to chemical reaction. For the fiberglass and jute fiber, the salt water effect on the central deflection may be caused by reduction in mechanical and physical properties (i.e. stiffness, strength and hardness) due to degradation of fiber-matrix interface resulting in loss of adhesion and interfacial bond strength.

Figures.7,8,9.shows the effect of moisture absorption due to immersing of the specimens in distilled water for (7) days on the load –deflection relation for the fiber glass, jute and egg shell powder composite respectively. It can be shown that immersing in distilled water leads to increasing the central deflection by 8% and 4% for eggshell powder and fiber glass plates respectively .Also it can be seen that immersing the jute composite plates in salt and distilled water for short periods has no significant effect.

CONCLUSION

From the present study the following main conclusions can be made:-

1-The eggshell powder composite sustains maximum load in the dry condition.

2-Under the same load the jute fiber composite sustain larger deflection, compared with the fiberglass and eggshell powder composites.

3-The salt water has a significant effect on the eggshell powder composite deflection. The distilled water has lower effects.

4-The distilled water has more effect than salt water on the fiberglass composite deflection.

5-The salt water and distilled water have the same effect on the deflection of the jute fiber composite.

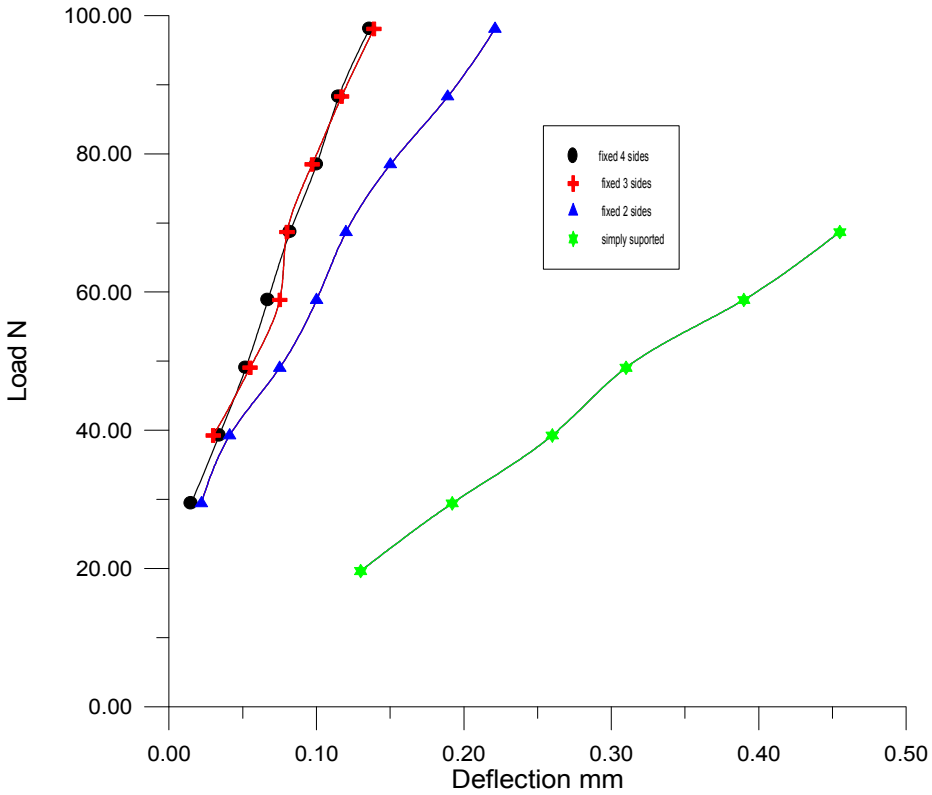

Fig.1. The effect of fixture type on the load-deflection

For fiber-glass- composite without treatment

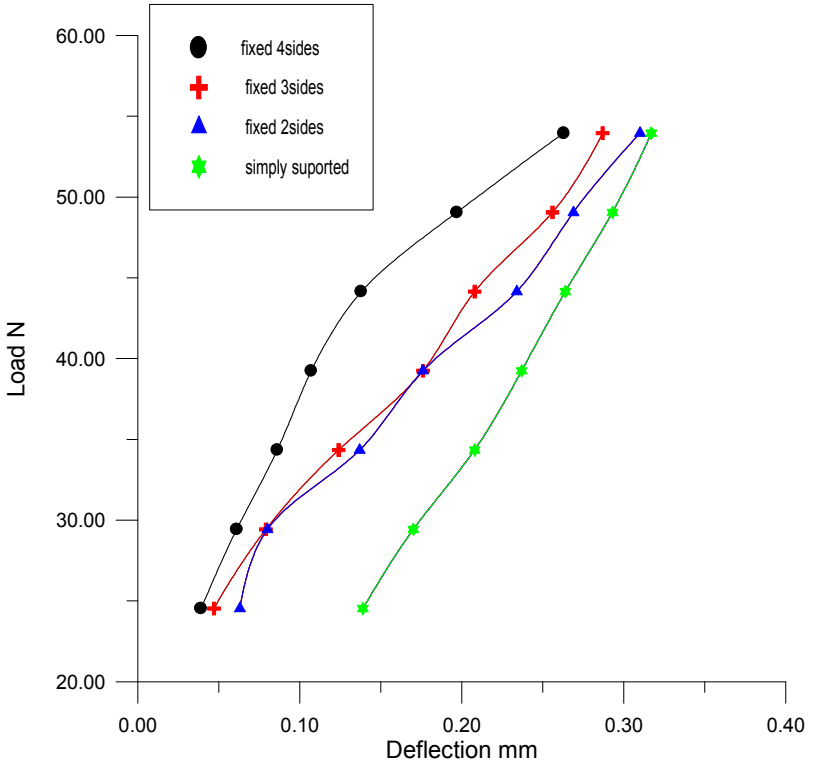

Fig .2. The effect of fixture type on the load-deflection for the jute fiber-poly ester composite without treatment

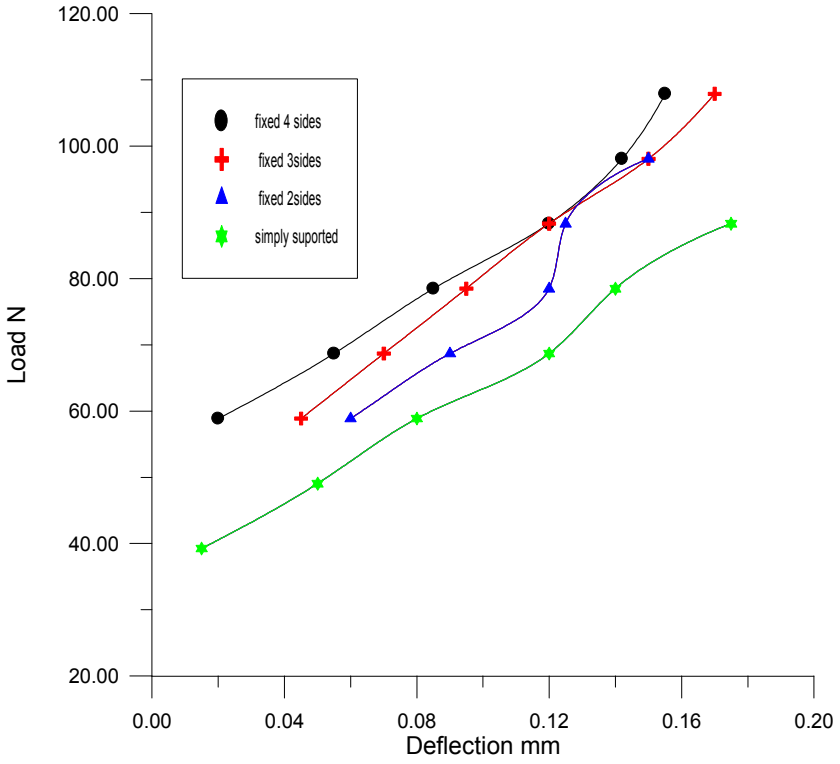

Fig .3 .The effect of fixture type on the load-deflection for Eggshell powder- polyesters composite without treatment

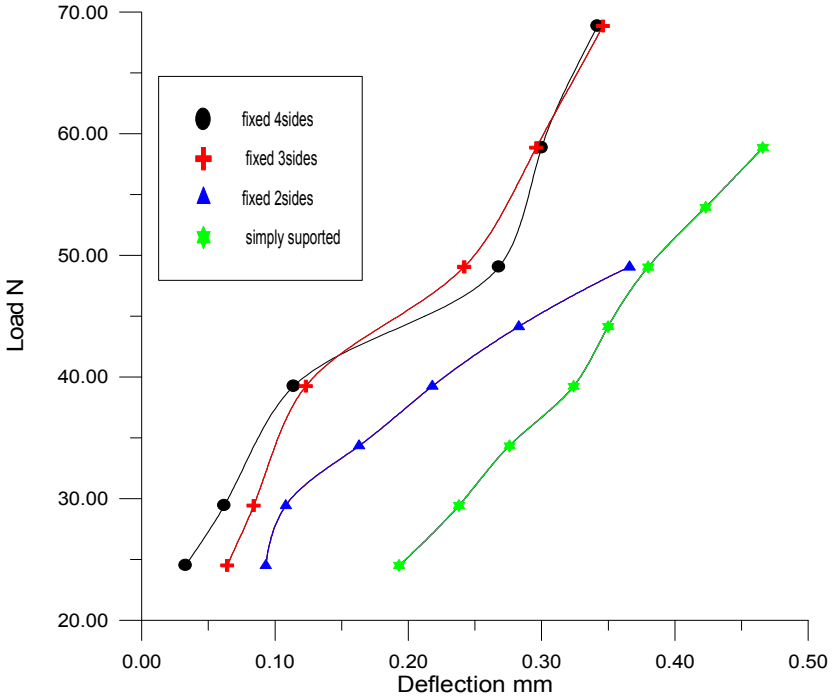

Fig .4. The effect of fixture type on the load-deflection for fiberglass-Polyester composite immersed in salt water for 7 days

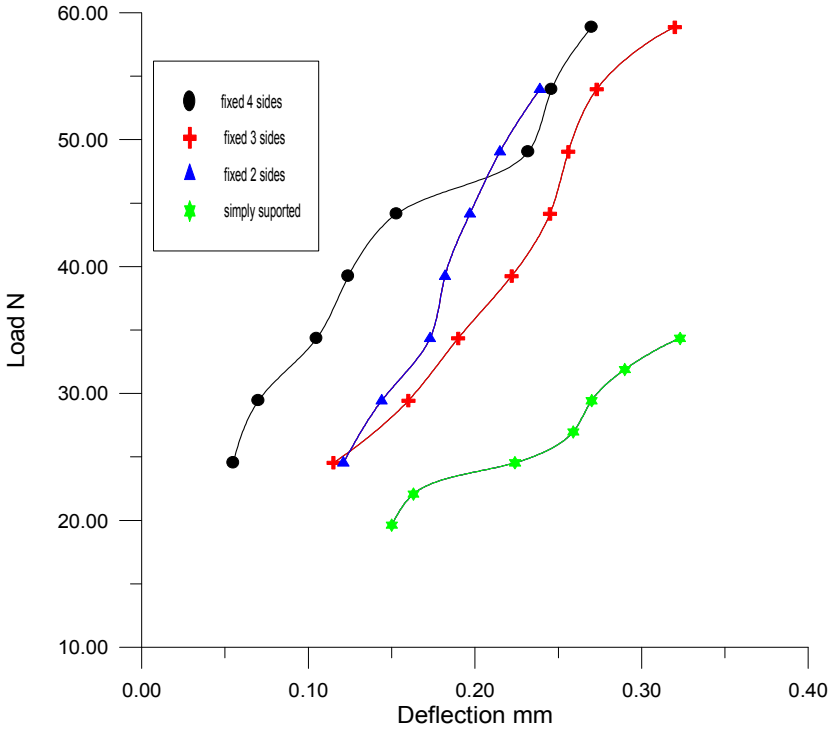

Fig.5. The effect of fixture type on the load-deflection for jute- Polyester composite immersed in salt water for 7days

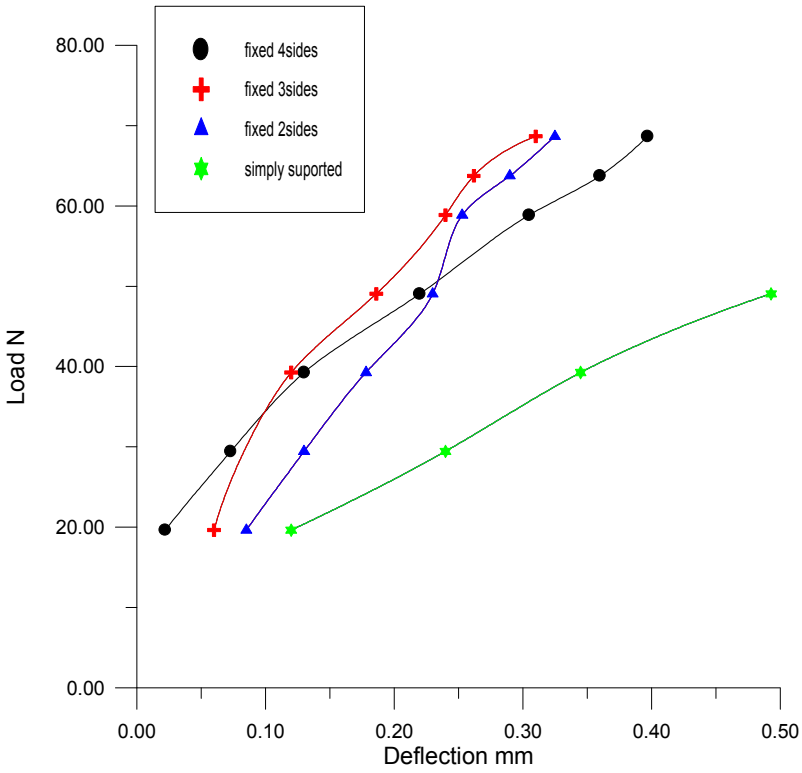

Fig.6. The effect of fixture type on the load-deflection for eggshell powder-polyesters composite immersed in salt water for 7days

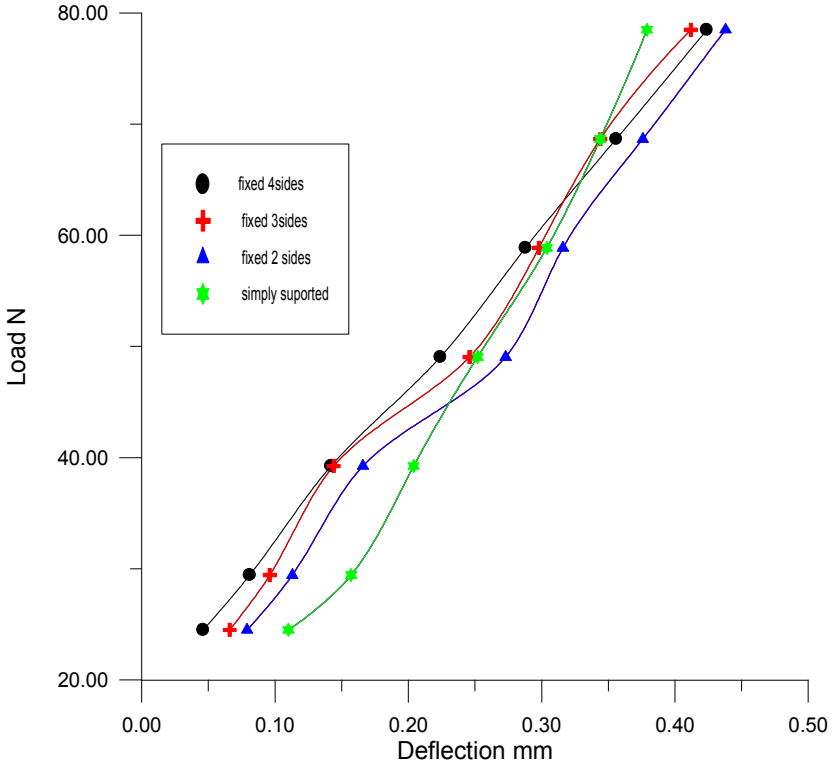

Fig.7. The effect of fixture type on the load-deflection for fiberglass- composite immersed in distilled water for 7 days

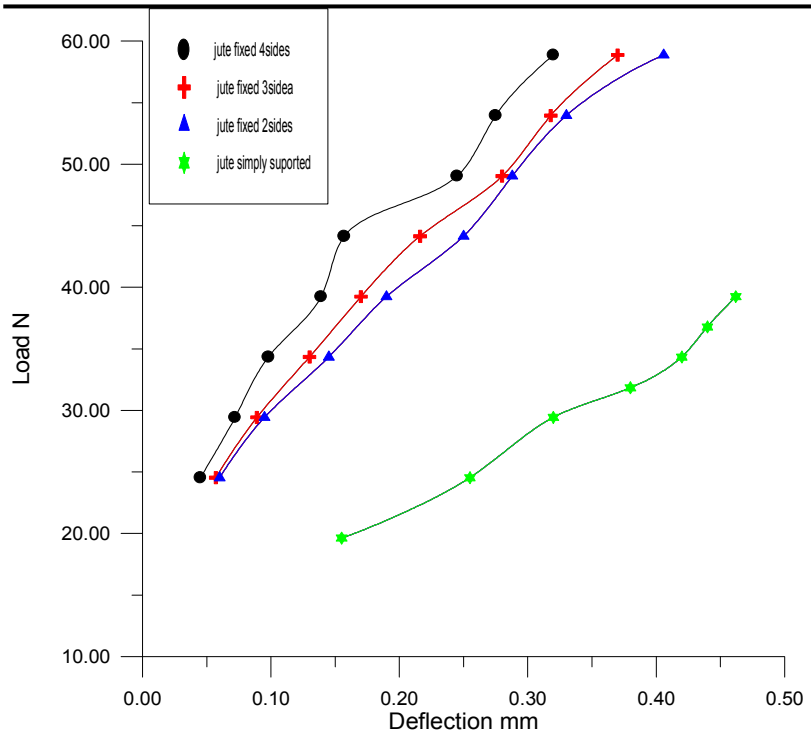

Fig.8. The effect of fixture type on the load-deflection for jute fiber-polyesters composite immersed in distilled water for 7days

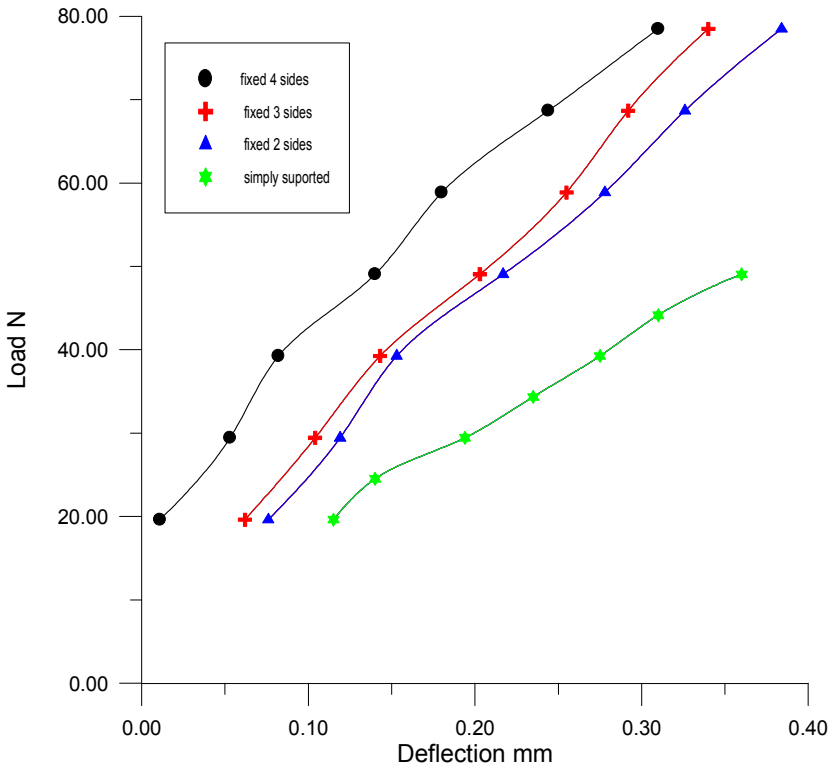

Fig.9. The effect of fixture type on the load-deflection for eggshell powder-polyesters composite immersed in distilled water for 7days

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