

Theoretical Evaluation to Tensile Strength of Composite Material by Using Ansys Program

Ali I. Al-Mosawi

Technical Institute - Babylon

Email:aliibrahim76@yahoo.com

Abstract

In this research the tensile strength of vinyl ester resin reinforced with different weight percentage (20%,40%,60%) from Woven roving glass fibers (E) type (0° - 45°) has been studied theoretically by using Ansys program version (11) to estimation the effect of different reinforcing under variation loading. The standard specification (ISO-R-527) was used to fabricant the test specimens in Ansys program. The theoretical results shows that high tensile strength value for vinyl ester resin after reinforcing with glass fibers due to high elastic modulus for these fibers and this strength will increase with increasing percentage of fibers and this agree with the experimental results obtained from tensile test .

Keywords: Tensile strength , Vinyl ester resin, Composite Material .

الخلاصة

في هذا البحث تم دراسة مقاومة الشد لراتنج الفينيل أستر المقوى بنسب وزنية مختلفة (20%,40%,60%) من ألياف الزجاج نوع (E) بشكل حصيرة (0° - 45°) نظرياً باستخدام برنامج (Ansys Version 11) لتقييم تأثير التقوية المختلفة تحت الأحمال المتنوعة. أُعتمدت المواصفة القياسية (ISO-R-527) في تصنيع نماذج الإختبار ببرنامج (Ansys). لقد بينت النتائج النظرية التي تم الحصول عليها إرتفاع قيمة مقاومة الشد لراتنج الفينيل أستر بعد تقويته بألياف الزجاج نتيجة لإرتفاع معامل مرونة هذه الألياف وتزداد هذه المقاومة مع زيادة نسبة التقوية بالألياف وهو يتفق مع النتائج العملية التي تم الحصول عليها من إختبار الشد .

الكلمات المفتاحية: مقاومة الشد ، راتنج الفينيل أستر ، مادة مركبة.

Introduction .

A composite is commonly defined as a structural material that consists of two or more combined 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 reinforcing phase material may be in the form of fibers, particles, or flakes. The matrix phase materials are generally continuous. Examples of composite systems include concrete reinforced with steel and epoxy reinforced with graphite fibers, etc [Mallic,2007]. 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 .

Analysis of these properties shows that they depend on (1) the properties of the individual components;(2) the relative amount of components;(3) the size, shape, and distribution of the discontinuous components;(4) the degree of bonding between components; and (5) the orientation of the various components [DeGarmo,2008] .

Vinyl ester, is a resin produced by the esterification of an epoxy resin with an unsaturated monocarboxylic acid. The reaction product is then dissolved in a reactive solvent, such as styrene, to a 35 - 45 percent content by weight. It can be used as an alternative to polyester and epoxy materials in matrix or composite materials, where its characteristics, strengths, and bulk cost intermediate between polyester and epoxy[Michel,2007].

G. Morom, E. Drukkler, A. Weinberg ,and J. Banbaji studied the effect of hybrid fibers (Carbon/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] . Abbas , Ali, and Sajed 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] .

Tensile Strength .

Tensile properties indicate how the material will react to forces being applied in tension. A tensile test is a fundamental mechanical test where a carefully prepared specimen is loaded in a very controlled manner while measuring the applied load and the elongation of the specimen over some distance. Tensile strength or ultimate strength is defined as the maximum load that results during the tensile test, divided by the cross-sectional area of the test specimen. Therefore, tensile strength, like yield strength, is expressed in Mpa. Tensile tests are used to determine the modulus of elasticity, elastic limit, elongation, proportional limit, reduction in area, tensile strength, yield point, yield strength and other tensile properties [Daniel,2003]. Tensile strength can be obtain from the following formula :

$$\sigma = \frac{P}{A}$$

where :

σ = tensile strength (N/m²)

P = test load (N)

A = cross section area of specimen (m²)

Work Procedure .

In this research, Ansys program version (11) was used to calculate tensile strength value for vinyl ester resin before and after reinforced with different weight percentage from woven roving glass fibers (20%,40%,60%) . specific Properties for both resin and fibers was input in database of Ansys program , as well as standard shape of specimens , and applied different amount of loads to make a theoretical emulation to experimental tensile test , and then draw the obtained data after applied the loads . Table (1) show the specifications used to draw test specimens , and table (2) show the experimental results obtained from tensile test . Table (3) show the theoretical results obtained from Ansys program .

Table (1) : The specifications used to draw test specimens

Model	Type of Element	No of Element	No of Nodes
Linear	Solid 185 Geometry , 8 Nods ,3-D Modeling	3922	1961

Table (2) : The experimental results obtained from tensile test

Reinforcing Percentage	0	20 %	40 %	60 %
Value	64	125	220	312

Table (3) : The theoretical results obtained from Ansys program

Reinforcing Percentage	0	20 %	40 %	60 %
Value	67.282	131.41	231.281	327.999

Following a short description to materials used :

- 1- Vinyl Ester Resin type Deraken 510-a40 with (1.21g/cm³) density .
- 2- Woven roving glass fibers E-type (0°-45°) with (2.6g/cm³) density .
- 3- Test specimens: standard specification (ISO-R-527)was used to fabricant the test specimens with rectangular section .

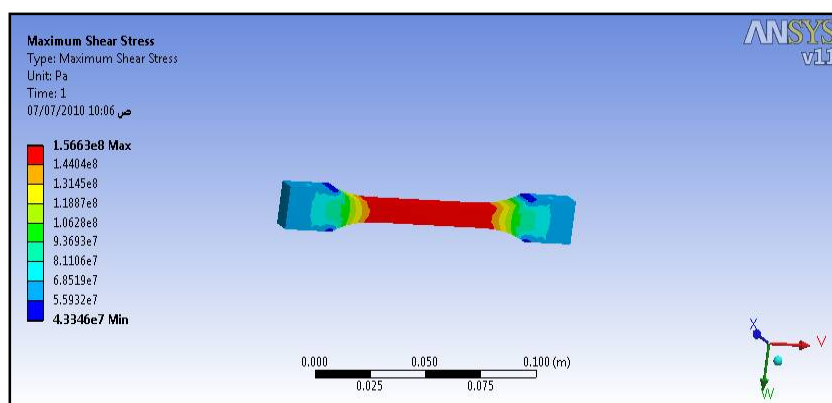
Results & Discussion .

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 tensile test done on the vinyl ester resin reinforced woven roving glass fibers we get the results shown in the diagrams which represent the value of tensile strength :

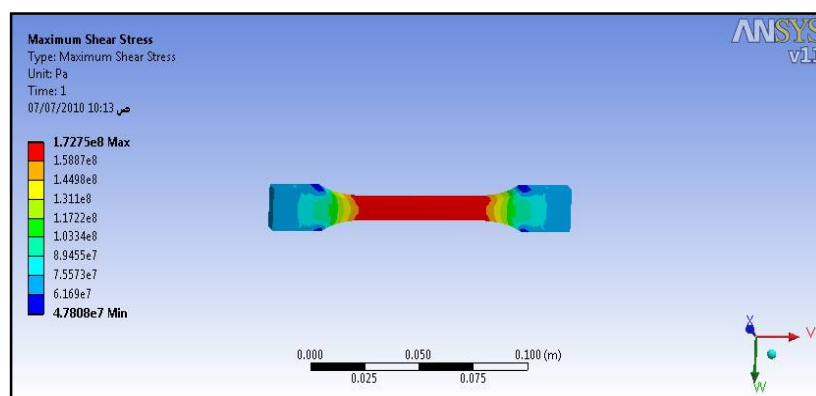
Fig(1) represent the tensile strength to vinyl ester resin before reinforcement , where we observed that , low tensile strength for this resin when exposed to loads ,because of in general the resins considered a brittle materials , which accepted with experimental results obtained by [Ali,2009].

After reinforcing by fibers this property will be improved greatly as shown in **Fig(2)** which represent the tensile strength to vinyl ester resin after reinforcing with (20%) glass fibers , where the strength of resin will increased due to the fibers will withstand the maximum part of loads and by consequence will raise the strength of composite material and this also accepted with experimental results obtained by [Abbas, Ali,Sajed,2009].

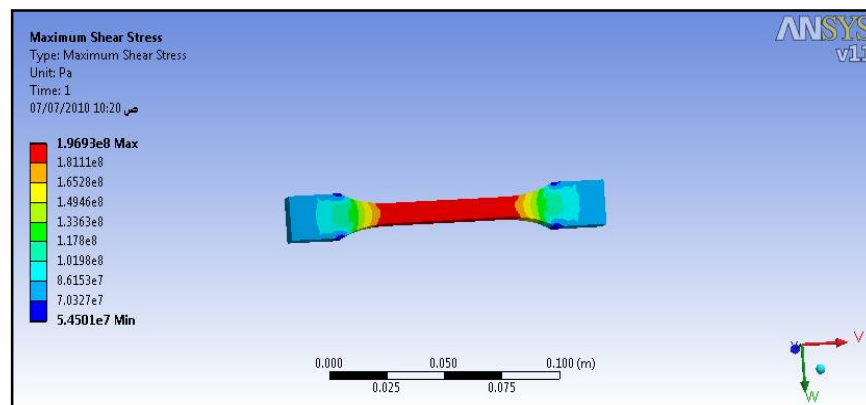
The tensile strength will be increased as the fibers percentage addition increased as illustrated in **Fig(3)** and **Fig(4)** which represent tensile strength to vinyl ester resin after reinforcing with (40%) and (60%) from glass fibers respectively . These fibers will be distributed on large area in the resin which will be improved tensile strength greatly [Kiichi,2009].



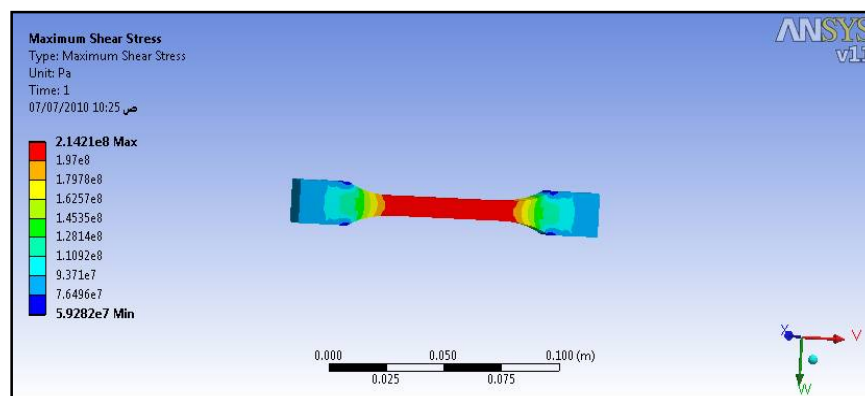
Fig(1) : Tensile strength to vinyl ester resin before



Fig(2) : Tensile strength to vinyl ester resin after reinforcing



Fig(3) : Tensile strength to vinyl ester resin after reinforcing with



Fig(4) : Tensile strength to vinyl ester resin after reinforcing with

Conclusions .

From the obtained results we get :

- 1- Low tensile strength of vinyl ester resin .
- 2- Improvement of mechanical properties after reinforcement by glass fibers .
- 3- Increased tensile strength with increasing fibers percentage .

References .

- Abbas A. Al-Jeebory, Ali I. Al-Mosawi, Sajed A. Abdul Allah, 2009 “Effect of percentage of Fibers Reinforcement on Thermal and Mechanical Properties for Polymeric Composite Material ”, The Iraqi Journal for mechanical and materials Engineering , Special Issue ,1st Conference of Engineering College . pp70-82.
- Ali I. Al-Mosawi, 2009 “Study of Some Mechanical Properties for Polymeric Composite Material Reinforced by Fibers ”, Al-Qadessiyah Journal For Engineering Science , Vol 2 , No 1. pp.14 – 24 .
- Auter K.Kaw , 2006 “ Mechanics of Composite Materials” ,2nd Edition ,Taylor and Francis Group ,LLC.
- B.A.Azhdar ,1992 “Impact Fracture Toughness of Fiber Reinforced Epoxy Resin”, M.SC Thesis ,U.O.T.
- Daniel Gay , Suong V. Hoa , Stephen W. Tsai , 2003. “Composite Materials Design and Applications”, CRC Press LLC .
- E. P. DeGarmo, J.T. Black, and R.A. kohser, 2008 “ Materials and processes in Manufacturing ” , 10th Edition , John Wiley & Sons.
- G. Morom , E. Drukkler ,A. Weinberg ,and J. Banbaji ,1986 “Impact behavior of Carbon / Kevlar Hybrid Composites” , Composites ,Vol 17 ,No 2,pp,150-153.

- Kiichi Hasegawa, Hiroshi Hirano, Joji Kadota, Masahiro ABE, Satoshi Matsuda, Hajime Kishi and Atsushi Murakami ,2009. “*Properties of GFRP Using Matrix Resin of Epoxy/ Acrylate Interpenetrating Polymer Network*” , Journal of the Society of Materials Science, Japan Vol.54 No.4 . pp.447 – 452 .
- Mallick ,P.K. ,2007 “*Fiber-Reinforced Composites: Materials, Manufacturing, and Design*” ; 3rd Edition , CRC Press, Nov.
- Michel Biron , 2007 “ *Thermoplastics and Thermoplastic Composites* ” , 1st Edition, Elsevier.