Trakia Journal of Sciences, Vol. 7, Suppl. 2, pp 15-19, 2009

Available online at:
http://www.uni-sz.bg
ISSN 1313-7050 (print)
ISSN 1313-3551 (online)

Original Contribution

THE INVESTIGATION OF THE EFFECT OF THE REINFORCEMENT'S KIND ON THE TENSILE STRENGTH IN THE FIBER REINFORCED COMPOSITE MATERIALS

Nilgün Becenen[1], Bülent Eker[2]

[1*] Trakya University, Edirne Vocational College of Technical Sciences, Edirne, Turkey

[2] Namık Kemal University, Faculty of agriculture, Tekirdağ, Turkey.

ABSTRACT

Fiber-glass reinforced plastics are the polymer composite materials which have a widespread using field today. Basically, they are obtained from continuous or transient fiber-glass dispersed in the resin that works as a matrix. The fiber-glass which is the reinforcement material determines the mechanical properties of the composite material. The resin preserves the reinforcement components and keeps them together. In this work, the composite materials are produced by combining the sheared fiber-glass in the form of woven and felt with thermoset plastic matrix, and then the effect of the reinforcement's kind on the tensile strength of the composite materials is investigated.

Key Words: Fiber reinforced composites, tensile strength of composite materials.

INTRODUCTION

Today the technology of the composite materials makes progress rapidly and the new products are served to the market. The composites which their cost decreases with the increasing demand and production are the candidates for being the material of the future in many fields since they have physical and chemical advantages according to classical industrial materials [1] [1].

The material that is obtained by bringing two or more materials -which are not appropriate alone for the asked aim- together physically in a macro structure in specific conditions and rates ensuring the asked properties is called as composite material [2].

The fibers in the matrix material are the basic resistance elements of the composite structure. The most important reinforcement materials used in the composite structures today are the continuous fibers. The short or long continuous fiber forms of aramide, carbon and fiber-glass is important for making modern composites [3]. Turhan [4] explains in his work that the mechanical properties of fiber-glass and its rate in matrix in glass reinforced plastic materials determine the mechanical properties of composite materials. Demircioğlu [5] emphasizes that tensile and bending strength of composite materials increase with increasing fiber height.

In this paper, the effect of reinforcement's kind on the tensile strength of mechanical properties in composite materials with plastic matrix is considered. For this aim, the tensile strengths of the composite materials obtained by combining sheared, woven and felt formed fiber-glass with thermoset plastic matrix are tested.

MATERIAL AND METHOD

In this work, ortoftalic polyester resin of common using aim as matrix and also sheared, woven and felt formed fiber-glass is used as reinforcement in production of the composite material. Also, chemicals for solidification and accelerating, normal drying oven, electronic scale device and tensile test devices are used.

*** Correspondence to**: *Nilgün Becenen, Trakya University, Edirne Vocational College of Technical Sciences, Edirne, Turkey; e-mail: nbecenen@yahoo.com*

Material

Matrix material

Ortoftalic polyester resin of common using aim is used in the work. It is liquid.

Reinforcement materials

Three types of fiber-glass are used. Fiber/resin ratio is taken constant as 1/2 for every sample. These reinforcement materials:

a) Sheared bunches: It is produced by cutting E-type fiber-glass bunches whose TEKS number is 2400g/1000m. It is a product of fiber-glass industry.

b) Glass woven: Woven type which is produced in a form of straight rush mat by glass wicks is used. It is a biaxial woven. It is a product of glass industry.

c) Glass felt: It is product of glass industry that has a wide using field. Glass felt has properties like well weight distribution, getting wet quickly and easily, processing easily. Its unit field weight is 300 (±%5) g/m^2.

The composite materials are produced on the glass molds by hand lay-up method. The amount which will be processed is mixed by adding cobalt naftalat and metil etil keton peroxit solutions in specific rates into the resin. Some of this prepared resin is put on the glass molds. Weighed fiber-glass clippings and any part of woven which is weighed and cut according to the mold are placed on the resin as reinforcement.

After the resin below is absorbed into the fiber-glass with a roll, the rest of the resin is absorbed into the reinforcement with brush blows and a roll. It is taken pains to make resin-fiber dispersion homogeneous in these processes. While preparing the composite material with two and four layers, it is waited for the resin to reach pre-hardness for almost half an hour in order to eliminate the probability of air presence after carrying out the first layer. The second layer is laid by using the same method. For the composites with four layers, after carrying out three layers continually, the composite is waited for an hour. Because the polymerization reaction is an ecsotermic reaction and also the split and fire can occur in the product owing to the exit of heat in many layers. After waiting, the fourth layer is laid by the same method, two units of every kind of sample are prepared and it is waited for the polymerization to be completed in the room temperature. After a day, post cure process is applied to one units of samples at the same time at 50, 80 ve 110 ^{0}C for an hour. The tensile tests are carried out after fifteen days since preparing the samples.

Method

Tensile test: the tensile strengths of the prepared composite materials are determined by the tensile tests. The prepared samples are tested with the universal device of Shimadzu AGS10KNG with a tensile velocity of 1mm/min. The calculations are performed by the software in a computer that controls the tensile device. The elastic module, max-load, tensile strength, stretch in max-load, breaking off load, stretch in breaking off are given by the same software. By taking the average of results of experiments for every composite material group, the tensile strengths are determined.

RESULTS

Tensile strength tests are applied to the composite materials which are made from ortoftalic matrix prepared in laboratory conditions and sheared fiber, felt and 90^0 woven reinforcement materials in four recurrences in all. The values of elastic module, max-load, tensile strength, max-stretch, breaking off load, and stretch in breaking off which are obtained by the tensile tests are shown in tables 3.1-3.3 and in figures 3.1-3.3. The tensile test values of the composite material without cure and consists of ortoftalic resin and sheared fiber reinforcement are given in table 3.1. The average tensile strength is found as 61.34722 MPa. The tensile test graph of the same sample is shown in figure 3.1. Two flow points are seen in the graph. This situation occurs since the small atoms or sheared fibers obstruct the slipping by forming groups and increase the flowing point while the material changes its shape.

In some points in the sample, because one region transforms more than other regions and a large regional shrinking happens in cross section field, transformations weren't uniform.

Table 3.1. *The values of the tensile experiment for the ortoftalic resin and sheared fiber reinforced composite material without cure.*

Sample no	Elastic module [MPa]	Max-load [kgf]	Tensile strength [MPa]	Stretch in max-load [%]	Breaking off load [kgf]	Stretch in breaking off [%]	Sample length [mm]	Thickness [mm]
1	2025.89	140.211	65.1658	2.84522	140.211	2.85044	10.5500	2.00000
2	1923.85	138.342	64.2006	2.48783	78.0082	2.50522	10.5500	2.40000
3	1872.43	133.342	58.4447	1.94652	59.1435	3.00087	10.7000	2.40000
4	1783.91	128.229	57.5778	2.91478	123.6402	2.91739	10.4000	2.10000
Average	**1901.52**	**135.031**	**61.34722**	**2.548588**	**100.2507**	**2.81848**	**10.5500**	**2.225**

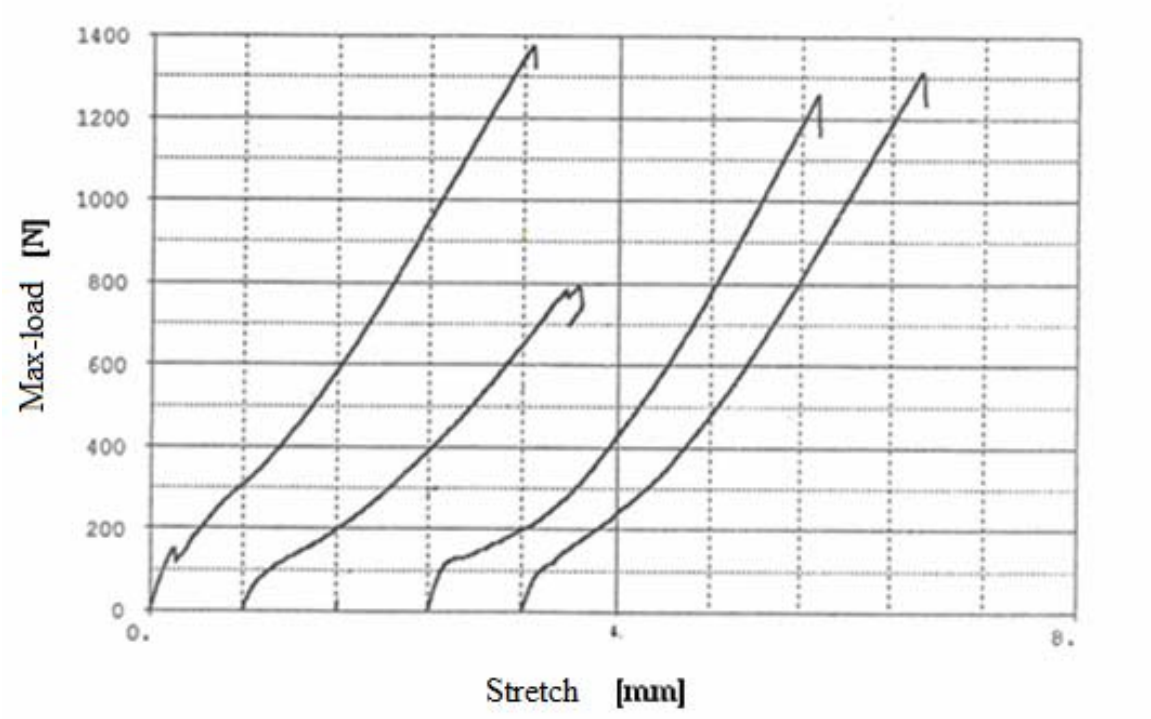

Figure 3.1*. The tensile experiment graph for the ortoftalic resin and sheared fiber reinforced composite material without cure.*

The tensile values for the composite material without cure and which has 4 layers, ortoftalic resin and 90^o woven glass reinforcements are given in table 3.2. It has showed much more strength than other samples. The average tensile strength is obtained as 184.2915 MPa. The tensile graph for the same sample is shown is figure 3.2. Since a well fiber matrix interface is formed, equal stretch-transformation is seen.

Table 3.2. *The tensile values for the 4 layers ortoftalic resin and 90^o woven glass reinforced composite material without cure.*

Sample no	Elastic module [MPa]	Max-load [kgf]	Tensile strength [MPa]	Stretch in max-load [%]	Breaking off load [kgf]	Stretch in breaking off [%]	Sample length [mm]	Thickness [mm]
1	2325.15	480.796	155.919	4.21304	466.775	4.22000	10.8000	2.80000
2	3447.47	550.391	203.679	3.96130	534.586	3.98522	10.6000	2.50000
3	3205.84	494.052	188.155	3.86609	476.972	3.88261	10.3000	2.50000
4	2319.93	517.251	189.413	4.31304	507.308	4.32870	10.3000	2.60000
Average	**2824.598**	**510.6225**	**184.2915**	**4.088368**	**496.4103**	**4.104133**	**10.5000**	**2.60000**

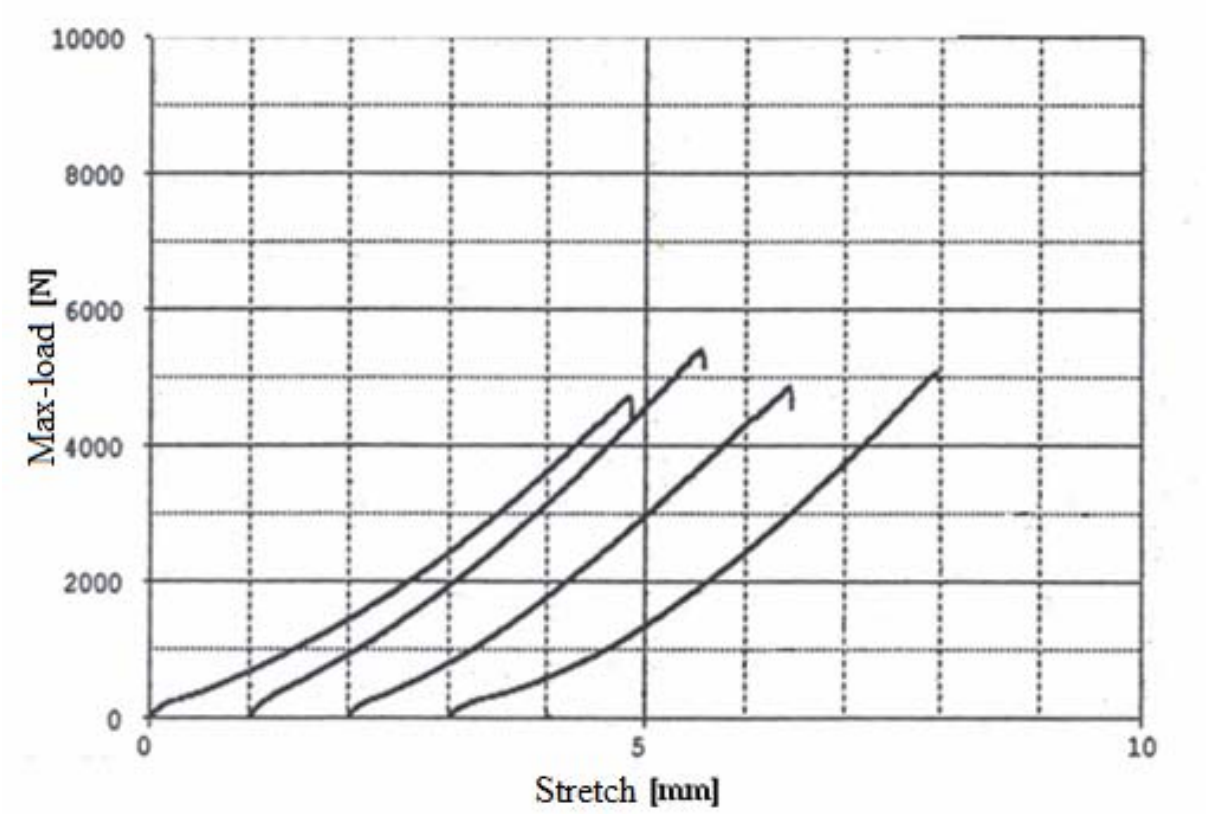

Figure 3.2*. The tensile graph for the 4 layers ortoftalic resin and 90^o woven glass reinforced composite material without cure.*

In table 3.3, the values of tensile experiment for the composite material without cure, and which has 4 layers, ortoftalic resin and glass felt reinforcements. Although it has four layers, its tensile strength is lower than 90^0 woven fiber-glass reinforcement. The average tensile strength is found as 86.04875 MPa. The tensile graph for the same sample is shown in figure 3.3.

Table 3.3. *The values of the tensile experiment for the four layers ortoftalic resin and glass felt reinforced composite material without cure.*

Sample no	Elastic module [MPa]	Max-load [kgf]	Tensile strength [MPa]	Stretch in max-load [%]	Breaking off load [kgf]	Stretch in breaking off [%]	Sample length [mm]	Thickness [mm]
1	2083.85	341.859	81.6090	2.99435	338.035	3.01565	10.4000	3.95000
2	2877.66	369.137	85.3371	2.86522	365.823	2.89130	10.1000	4.20000
3	5718.39	408.396	93.0443	2.37870	404.062	2.40696	10.2000	4.22000
4	2019.85	344.919	84.2046	3.28870	342.624	3.30000	10.3000	3.90000
Average	**3174.938**	**366.0778**	**86.04875**	**2.881743**	**362.636**	**2.903478**	**10.25**	**4.06750**

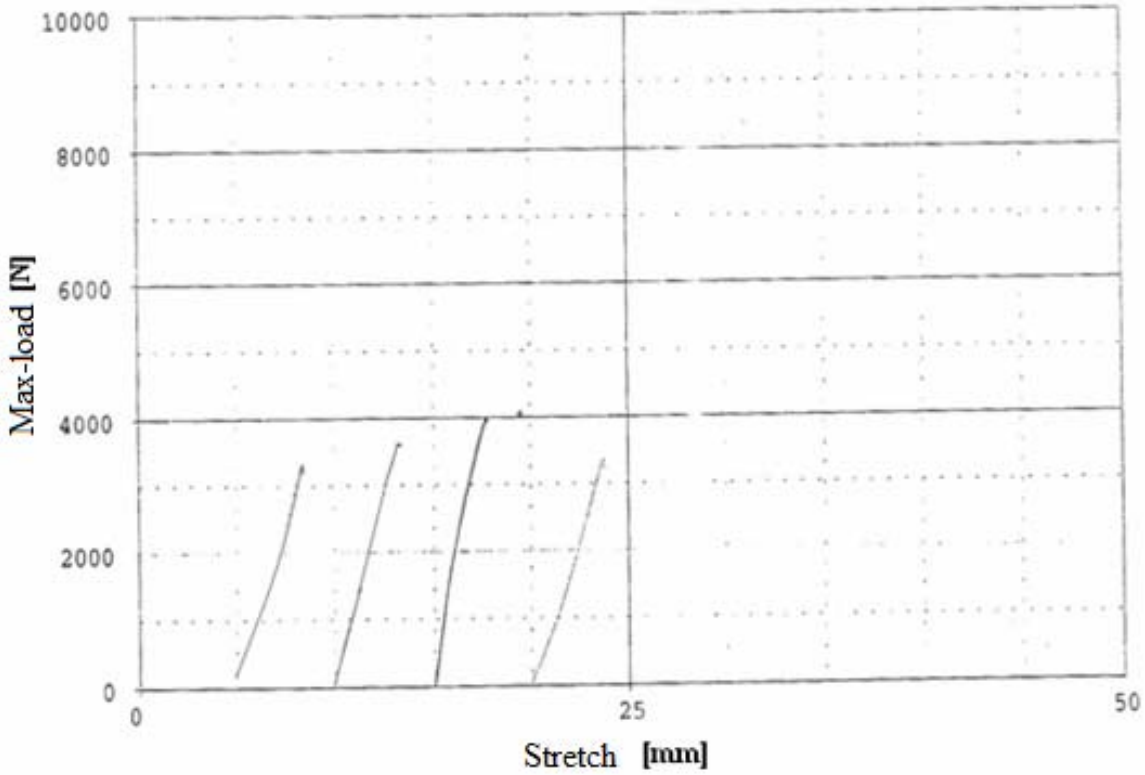

Figure 3.3. *The tensile graph for the four layers ortoftalic resin and glass felt reinforced composite material without cure.*

CONCLUSION

The tensile strength, elastic modules and the % stretch values in breaking off for the composite materials which are reinforced with sheared fiber-glass are smallest in comparison with woven, felt reinforcements. The tensile strength is 61.3472 MPa for the ortoftalic matrix and sheared fiber reinforced composite material. The highest tensile strength is found in four layers 90^{o} glass woven reinforced composite samples. This value is 184.2914MPa for the ortoftalic matrix. The obtained results show that the tensile strengths of the composite materials increase with increasing fiber length.

REFERENCES

1. W. F. Smith. "Material science and engineering", Translation: N.G.Kınıkoğlu, Literature, İstanbul (2001).
2. O. Ünal. "Lectures on structure materials". Kocatepe University (2007).
3. M. Mısıroğlu. "The effect of fiber-glass reinforcement on the mechanical properties", Master thesis, Sakarya University, Sakarya (1996).
4. M. Turhan. "The investigation of fiber volume rates on the mechanical properties of CTPs", Master thesis, Sakarya University, Sakarya (2007).
5. G. Demircioğlu. "The effect of the fiber dimension in short glass reinforced epoxy composite materials.Master thesis, Gazi University, Ankara (2006).