Preparation and Testing of Local Polyester Composites Based on Unsaturated Polyesters as Binder

MICHAEL H. NOSSEIR, N. L. DOSS, And S. Y. TOUFIK, *Laboratory of Polymer And Pigment, National Research Centre, Dokki, Cairo, Egypt*

Synopsis

A series of polymeric composites were prepared with sand/polyester ratio 92:8%. The sand used was local one. The polymeric composites were tested for their compressive strength, exterior volume, porosity, water uptake, specific gravity, volume of open pores and bulk density. The mechanical properties of these polymeric composites were within the range required for building bricks. No significant differences were observed between the polymeric composites made of glass sand and those from untreated sand except in exterior volume and compressive strength. Medium untreated sand was found to give better results in the mechanical properties.

INTRODUCTION

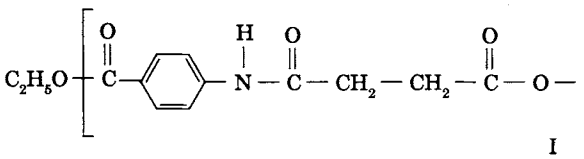
Recent advances in techniques of building were based on the increased use of plastics. There are some basic advantages inherent in plastics[1] such as lightness and strength, nonconductivity, long life, malleability, and uniform color. The use of plastics has often enabled builders and home buyers to realize savings in construction energy and maintenance costs. Local sand was chosen as an inorganic filler for its low cost, natural occurence in Egypt, and hardness and high resistance to friction and chemicals. In this work trials were made to use some of the polyesters prepared in producing a polyester composite from totally local materials. Our aim was to use these composite materials as building bricks.

EXPERIMENTAL

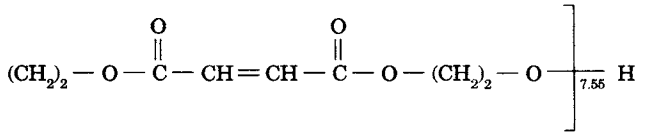
Materials

The following materials were used:

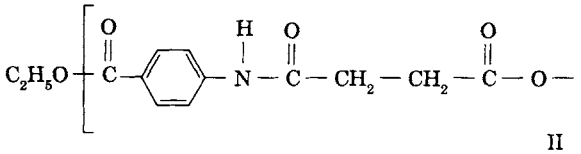
Polyesters Nos. I, II, III and IV[2]



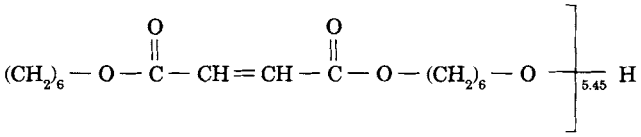
I

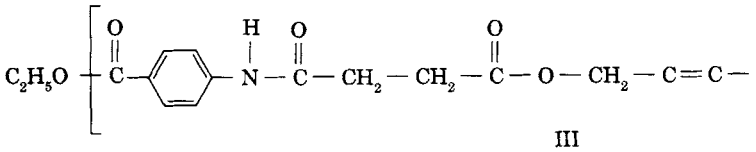


Journal of Applied Polymer Science, Vol. 31, 2705–2710 (1986)
© 1986 John Wiley & Sons, Inc.
CCC 0021-8995/86/082705-06$04.00

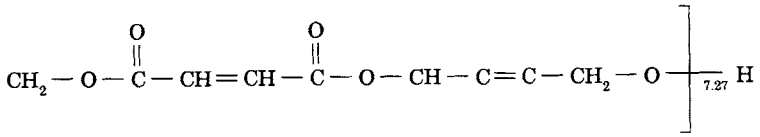


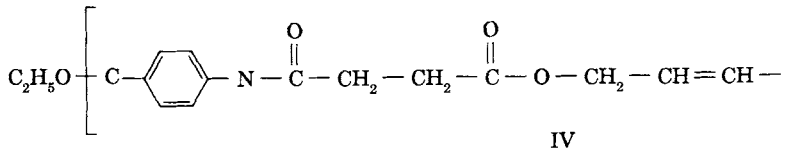
II



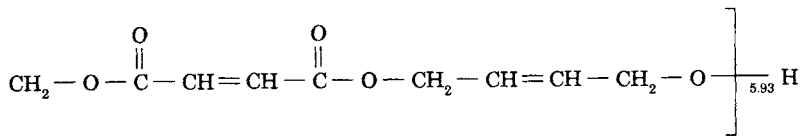


III





IV



Two Different Types of Local Sand were used, namely, glass sand from the Om Temim area (Egyptian desert) and untreated sand from a Nasr city suburb. The chemical analyses of the two types of sand used throughout this work are shown in Table I.

Benzoyl Peroxide The purified product was obtained from a commercial source by dissolving in chloroform and precipitating by addition of excess methyl alcohol, mp 103–106°C.

Styrene Monomer A commercial styrene product was used. The initiator was removed by shaking three times with 10% sodium hydroxide solution followed by washing several times with distilled water until the washing gave a negative test to phenolphthalein. It was dried for 24 h over anhydrous sodium sulfate, filtered, and distilled at 60°C. The purified product was directly used.

Dioxane The pure grade was used.

TABLE I
The Chemical Analysis of Sand

Ingredient	Glass sand	Untreated sand
SiO_2	99.40	93.13
Al_2O_3	0.20	3.86
Fe_2O_3	0.10	0.11
MgO	0.01	0.25
CaO	0.01	0.19
Na_2O	0.08	0.05
K_2O	Trace	0.20
H_2O^+	0.04	1.23
H_2O^-	0.01	0.43

METHODS

The ingredients used for the preparation of the composite material were polyester, styrene, benzoyl peroxide, dioxane, and sand. The ratio between the polyester and styrene was 70:30 by weight. At the same time, the polyester and the sand weights conform to the proportion 8:92. An amount of benzoyl peroxide equivalent to 1% of the total weight of the polyester and styrene was used as an initiator while a few milliliters of dioxane were used as a mutual solvent.

The polyester was first dissolved in dioxane, followed by the addition of benzoyl peroxide and the sand which were mixed well by stirring the mixture, at room temperature, for 5 min. The styrene was then added, and all the ingredients were mixed thoroughly by stirring till the mixture was homogenized. This final composite mixture was poured in stainless cubic steel molds with dimensions $3 \times 3 \times 3$ cm, and the material was manually pressed to eliminate voids and also to minimize the pores. When the molds were filled, the excess material was removed, and the material was levelled with the top of the mold by a trawel. Finally, the molds were placed in a vacuum oven and heated according to the following heating schedule. After the completion of the heating time, they were left to cool at room temperature (see Table II).

Standard methods of testing for compressive strength, apparent porosity, water absorption, apparent specific gravity, exterior volume, volume of open pores, and bulk density were according to the *Book of the American Society for Testing Materials*.[3] After preparing a series of polymeric composites and changing the sand/polyester ratio, it was found that the optimum was 8% polyester. Therefore, this ratio was maintained constant throughout

TABLE II
Heating schedule

Time elapsed from start of heating (h)	Temp (°C)
3 h	40
3 h	40–60
3 h	60–80
3 h	80–100
3 h	100–120
3 h	120–140

TABLE III
Mechanical Properties of Polymeric Composites Formulation Based on 8% Polyester Resin: 92% Glass Sand

Mechanical properties	V	VI	VII	VIII
Exterior volume (cm^3)	3.36	4.15	24.75	7.58
Volume of open pores (cm^3)	0.42	1.18	2.75	0.85
Apparent porosity (%)	12.49	28.01	11.10	11.16
Water absorption (%)	10.98	28.96	11.26	10.73
Apparent specific gravity	1.30	1.34	1.10	1.17
Bulk density (g/cm^3)	1.14	0.97	0.99	1.04
Compressive strength (kg/cm^3)	93.89	45.60	167.20	125.11

the preparation of the polymeric composites (V, VI, VII, VIII, IX, X, XI, and XII) that were formulated from polyesters (I–IV). Polymeric composite (V) was obtained from polyester resin (I); (VI) from polyester resin (II); (VII) from polyester resin (III); and (VIII) from polyester resin (IV), all with glass sand. Polymeric composite (IX) was obtained from polyester (III) with Nasr city sand and (X), (XI), and (XII) from polyester resin (III) with different mesh sizes (fine, medium, and coarse) of untreated Nasr city sand.

The polymeric composites prepared by the procedure previously mentioned were tested for their compressive strength, exterior volume, porosity, water uptake, specific gravity, volume of open pores, and bulk density. The results are shown in Tables III–V, respectively.

Although the mechanical properties of all polymeric composites prepared were within the range required for building bricks as reported by the ASTM,[3] the most favorable polymeric composite was that formulated from polyester (III) and glass sand.

The differences in mechanical properties between the polymeric composite (VII) made of glass sand with the chosen polyester resin (III) and the polymeric composite (IX) made from untreated sand with the polyester resin (III) are shown in Table IV.

From this table, it is obvious that there is no significant differences between the polymeric composite made of glass sand and that made from untreated sand except in exterior volume and the compressive strength,

TABLE IV
Difference in Mechanical Properties between Polymeric Composite Formulation Based on 8% polyester resin: 92% Glass Sand and 8% Polyester Resin: 92% Untreated Sand

Ingredients	VIII	IX
Exterior volume (cm^3)	24.75	7.45
Volume of open pores (cm^3)	2.75	0.78
Apparent porosity (%)	11.10	10.45
Water absorption (%)	11.26	8.87
Apparent specific gravity	1.10	1.32
Bulk density (g/cm^3)	0.99	1.18
Compressive strength (kg/cm^3)	167.20	108.08

TABLE V
Differences in Mechanical Properties between Polymeric Composites (IX), (X), (XI), and (XII)

	IX 8% polyester:92% untreated sand	X 8% polyester:92% fine untreated sand	XI medium sand	XII coarse sand
Exterior volume (cm^3)	7.46	3.25	7.28	4.90
Volume of open pores (cm^3)	0.78	0.66	0.85	2.44
Apparent porosity (%)	10.45	11.17	20.15	51.76
Water absorption (%)	8.87	10.73	18.84	28.75
Apparent specific gravity	1.32	1.17	1.27	3.73
Bulk density (g/cm^3)	1.18	0.93	1.04	1.80
Compressive strength (kg/cm^3)	108.08	126.12	168.42	88.23

but is still in the range required for building bricks. Table V showed the differences between polymeric composite (IX) made from polyester resin (III) and untreated sand and polymeric composite (X, XI, and XII) made from different mesh sizes; fine, medium, and coarse untreated sand, respectively.

From Table V, we conclude that better results in the mechanical properties were obtained using medium sand especially in the exterior volume and compressive strength.

All the polymeric composites can be used as plastics in building construction, but we recommend the use of polyester (III) with untreated sand in the ratio 8% polyester resin:92% sand in the presence of benzoyl peroxide as initiator.

References

1. *Plastics in Building Construction*, Technomeric, 851 New Holland Ave, 1983, Vol. VI, No. 7, pp. 11–12.

2. M. H. Nosseir, N. L. Doss, and S. Y. Toufik, *J. Appl. Polym. Sci.*, to appear.

3. *Book of American Society for Testing Materials, 1946, Part II, Nonmetallic Materials Constructional, Library Institute of Paper Chemistry*, American Society for Testing Materials, Philadelphia, 1946 , pp. 218–220, 320–322.

Received April 19, 1985
Accepted June 28, 1985