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SOME STUDIES ON LOCAL SAND COMPOSITES WITH UNSATURATED POLYESTER RESINS

دراسة على متركبات رملية مع بعض البولى امترات الغير مشبعة

N.L. DOSS
Laboratory of Polymers and Pigments
National Research Centre
Dokki, Cairo, Egypt

S.Y. TOUFIK
Laboratory of Polymers and Pigments
National Research Centre
Dokki, Cairo, Egypt

الخلاصة - تم تحضير ثلاثة أنواع من البولى امترات الغير مشبعة وتم تحويلها بواسطة مونمر الستيرين الى التركيب الشكى الغير قابل للذوبان فى المذيبات العضوية المختلفة ثم عولجت هذه البولى امترات بنوعين مختلفين من الرمل المحلى وهذا الرمل الزجاجى مأخوذ من منطقة أم تميم والرمل الغير معالج من ضاحية مدينة نصر وذلك لتكوين متراكبات رملية . ثم درست الخواص الطبيعية والميكانيكية لهذه المتراكبات وذلك باستخدام نسب مختلفة من البولى امترات المحضرة الى الرمل . كما درس أيضا تأثير نوع البولى امتر ، نسبة البولى امتر الى الرمل وكذلك حجم حبيبات الرمل على الصفات الميكانيكية للمتراكبات المتكونة .

ABSTRACT - Three unsaturated polyester resins were prepared and cross-linked with styrene monomer in presense of two different types of local sand, namely, glass sand from the Om Temin area and untreated sand from Nasr City suburb [Egyptian Desert], to produce sand composites. The mechanical properties of the formed composites using different ratios of polyester to sand were measured. The effect of the polyester type, polyester/sand ratio and the mesh size of sand grains on the mechanical properties was also investigated.

INTRODUCTION

Many variations of the mechanical and physical properties of unsaturated polyester resins can be developed through appropriate compounding of the latter with fillers or extenders such as calcium carbonate, various clays or sand.[1] The use of local sand as inorganic filler has the advantage of low cost, natural occurance in Egypt, hardness and high resistance to friction and chemicals. In our previous work [2], four unsaturated polyesters were prepared and used with styrene and local sand to form polymeric composites. The physical and mechanical properties of these composites were studied.

The work is now extended to investigate the effect of the polyester type, polyester to sand ratio, sand type and mesh size of sand grains, on the mechanical properties of the formed composites.

We hoped to obtain sand composites with improved mechanical properties that can be used as building materials.

EXPERIMENTAL

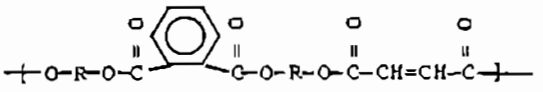
Three unsaturated polyester resins based on the reaction of phthalic anhydride & maleic anhydride with each of ethlene glycol, prolylene glycol and 1,6 hexane diol were prepared.[3] The molcular weight ofthe prepared resins were determined by end group analysis [4] For each polyester resin a prepolymer mixture was prepared by mixing the resin with styrene in the ratio of 70:30 and crosslinking was com-

menced by adding BZ_2O_2 as an initator in 1% wt of the prepolymer. Sand composites were prepared by mixing different ratios of local sand with the above formed prepolymers. The mixture was poured into stainless steel molds [3x3x3 cm] and the material was manually pressed to eliminate voids and minimize pores. The molds were heated for three hours at each of the following temperatures 60,80,100,120,150°c respectively.

Standard test method for compressive-strength, apparent porosity, water absorption, apparent specific gravity, exterior volume, volume of open pores and bulk density were carried out according to the American Society for Testing Materials. (5)

RESULTS AND DISCUSSION

Unsaturated polyester resins based on poly [proplyene-maleate-phthalate] (I), poly [ethylene-maleate phthalate], (II), and poly [hexane-maleate phthalate] (III) were prepared.



(I-III)

I R = $-CH_2-\underset{\displaystyle CH_3}{CH}-$

II R = $-CH_2-CH_2-$

III R = $(CH_2)_6$

The prepared resins were characterized by molecular weight determination which were found to be 1677,1936,2253, for polyesters I,II and III respectively.

1- Effect of prepolymer/sand ratio on the mechanical properties of sand composites.

Table (1) shows the mechanical properties of polymeric composites made of untreated sand and different ratios of prepolymer II. Results indicate that increasing the polyester ratio from (4% to 8%) did not significantly affect the exterior volume, volume of open pores, apparent porosity, water absorption, apparent specific gravity of bulk density. On the other hand, the compressive strength increased regulary with increasing the polyester ratio and optimum results were obtained with a sand composite formed of 8% prepolymer II and 92% untreated sand. It is worthy to notice that all of the above values for mechanical properties are in the range required for building materials.(6) The ratio of (8%:92%) polyester to sand was therefore held constant throughout the preparation of all polymeric composites used for the following studies.

2- Effect of polyester type on the mechanical properties of sand composites

Table (2) includes data for the mechanical properties of polymeric

composites formed from 8% by weight of each of polyester I,II or III with 92% by weight of untreated sand. Close investigation of the data illustrates that changing the type of polyester did not significantly change most of the mechanical properties (except the apparent porosity which increased in the order of PE<I<II<III). On the other hand the compressive strength of the formed composites regularly increased in the order of PEI<II<III and this may be related to increase in molecular weight of the polyester used (1677,1936, and 2253 for polyesters I,II and III respectively). So it may be concluded that the mechanical properties of sand composites formed from untreated sand and different types of polyesters, are strongly affected by the type of polyester and also by the degree of unsaturation of the polyester used. Values are still within the range required by the ASTM for building materials.

3- Effect of type of sand used on the formation and mechanical properties of sand composites.

Two types of local sand, namely glass sand from the Om Temim area and untreated sand from Nasr City suburb (Egyptian Desert) were used. The chemical analysis of the two types was shown in our previous publication [2]. Polymeric composites were formed from 8% by weight of each of PE I,II and III and 92% by weight of each of untreated sand and glass sand respectively. The data for the mechanical properties of the formed composites are depicted in table (3).

It was found that while untreated sand gave rise to composites with any of the three polyesters I,II or III, glass sand failed to give compact composites with PE II. Glass sand, however, formed compact composites with PE I and III. In general, it may be noticed that improved mechanical properties and higher values for compressive strength are reached when sand compistes are formed from PE I,II,III and untreated sand rather than from glass sand. This clearly indicates that the type of sand has a pronounced effect on the formation and properties of sand composites.

4- Effect of mesh size of untreated sand on the compressive strength of sand composites.

The compressive strength of polymeric composites formed from PE I and III and different mesh size of untreated sand (92%) are given in table (4). Data show that using different mesh sizes of untreated sand [(coarse ¼-1 μ), (medium ⅛-¼ μ), (fine 1/16-⅛ μ)] with PE I, resulted in sand composites, having the same value for compressive strength but this value is always higher than that obtained with untreated sand and PE I (cf. Table 3). On the other hand, different mesh sizes of untreated sand formed sand composites with polyester III, having compressive strength which has almost the same value, but always lower that that obtained with PE III and untreated sand without sizing. Strangely enough, polyester (II), failed to from compact composites with either coarse, medium or fine untreated sand (Table 4).

CONCLUSION

It may be concluded from the above results that polyester type, molecular weight of polyester chain, polyester/sand ratios, type of sand and mesh size of sand grains, are all factors which have a pronounced effect on the mechanical properties of the formed composites

especially on the compressive strength. Improved mechanical properties are obtained when 8% by weight of either of the three polyesters used and 92% of local sand are used in forming the composites. The above results show that polymeric composites obtained using PE II and III and either untreated or glass sand, can be used in building constructions.

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T A B L E (1)

EFFECT OF POLYESTER /SAND RATIO ON THE MECHANICAL PROPERTIES OF SAND COMPOSITES (UNTREATED SAND)

PROPERTY \ % PE *	4	5	6	7	8
Exterior Volume ; cm^3	18.03	17.32	17.51	18.94	20.19
Volume of open pores ; cm^3	5.27	5.12	3.49	5.73	5.17
Apparent porosity ; %	29.23	29.56	19.93	30.25	25.61
Water absoption ; %	18.94	17.80	12.68	19.53	16.27
Apparent specific gravity; %	2.18	2.36	1.96	2.22	2.12
Bulk density ; gr/cm^3	1.54	1.66	1.57	1.56	1.57
Compressive Strength; kg/cm^2	12	16	20.8	40	44

* PE = Polyester

T A B L E (2)

EFFECT OF POLYESTER TYPE ON THE MECHANICAL PROPERTIES OF SAND COMPOSITES (UNTREATED SAND)

PROPERTY \ PE TYPE	I	II	III
Exterior volume, cm^3	12.88	20.19	15.93
Volume of open pores, cm^3	1.09	5.17	2.44
Apparent porosity, %	8.46	25.61	15.41
Water absorption, %	3.79	16.27	8.72
Apparent Specific gravity	2.44	2.12	2.09
Bulk density, gr/cm^3	2.23	1.57	1.77
Compressive strength, kg/cm^2	40.4	44	58.13

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T A B L E (3)

EFFECT OF TYPE OF SAND ON THE FORMATION AND MECHANICAL

PROPERTIES OF SAND COMPOSITES

PROPERTY	PE I		PE II	PE III	
	untreated sand	glass sand	untreated sand	untreated sand	glass sand
Exterior volume; cm^3	12.88	11.72	20.19	15.83	7.77
Volume of open pores; cm^3	1.09	1.37	5.17	2.44	2.74
Apparent porosity ; %	8.46	11.69	25.61	15.41	35.26
Water absorption ; %	3.79	4.76	16.27	8.72	13.99
Apparent specific gravity	2.44	2.79	2.12	2.09	3.89
Bulk density; gr/cm^3	2.23	2.46	1.57	1.77	2.52
Compressive strength; kg/cm^2	40.4	24.8	44	58.13	48

T A B L E (4)

EFFECT OF MESH SIZE OF UNTREATED SAND GRAINS ON THE COMPRESSIVE STRENGTH OF SAND COMPOSITES

GRAIN SIZE	COMPRESSIVE STRENGTH kg/cm²	
	PE I	PE III
Coarse	77.6	24.8
Medium	77.12	24.8
Fine	73.08	24.0

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