Evaluations of Some Physical Properties of Cement with PVA/Polyol as Binder Material to produce insulating board

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Abstract:

The composition of polymer blend (PVA/Polyol) by percentage 3:1, which is mixed with different a percentage (10%-90%) with different percentages of cement (10%-90%), where investigated. The optimal percentage of polymer blend and cement is 10% and 90% respectively. Physical properties of the mixture such as density, water absorption and compressive strength were determined; mixture of 10% cement was used as a binder to study the physical properties with different percentages of polymer blend and sand. This will prove a resistance to water absorption and can be used in ready construction panels.

Keywords: Cement, PVA/Polyol, Binder, water absorption, compressive strength.

Introduction:

The development of new composite materials possessing increased strength and durability when compared with conventional types. This is a major requirement of applications in repairing and in the improvement of infrastructure materials that used in the civil construction industry. Polymer concrete (P.C) is an example of a relatively new material with such high performance. It's excellent mechanical strength and durability reduce the need for maintenance and frequent repairs required by conventional concrete. An additional advantage of (P.C) is its fast curing time, which is an asset in the production of precasts as parts can be demolded a few hours after the concrete placement. Composite material in applications with coatings and repairs.[J. T. Dikeon, A.O. Kaeding and U.S. (1992)], [K.S. Rebez, D.W. Fowler, (1996)]. Polymer concrete is a composite material, it is not a hydraulic cement concrete but is a graded mixture of coarse and fine aggregates (including special micro-fine fillers) bound together by an appropriate organic resin system. Polymer concrete is a highly-filled material with filler loadings ranging from 85%-90% by weight, for most dielectric applications. [M.Gunsan Karan (1995)].

The study will also report the modification of sandy blends. The performances of different percentage systems as sand stabilizers were estimated through measurements of compressive strength in the polymer of polymer content [Abdulah. Al-Khubash and Shihab W. Abdalla (2006)]. Although polymer concrete (P.C) has been eylecimented for more than 30 years and studies in many countries, structural polymer concretes still remain a relatively new class of composite building materials. The properties of these materials are still being explored, and new composition of more perfect and promising polymer-concrete, including those for special purpose are being developed. The experience in industrial production of articles and structures is being accumulated, and the results of analyzing behavior of these materials in various operating conditions are being generalized. It is known that the polymer-concrete differs from the natural concrete manufactured on the basic cement according to the difference between the initial in each of their strengths, chemical resistance to various corrosive media, rather than adhesion to metal, wood, cement, concrete and other materials. In addition many investigators report on the increased deformability of some polymer-concrete (shrinkages, creep, and high coefficient of thermal expansion)[R.D. Maksimov, L. Jirgens, J. Jansons and E. Plume, (1999)].

The chief properties of concern in sand stabilization are mechanical properties, volume stability, permeability and durability. Soil improvement techniques can be classified in various ways for example in mechanical, chemical, and physical stabilization. In mechanical stabilization the density of polymer blend (polyvinyl acetate (PVA)/Polyol) and sand increased by the application of mechanical forces as in the case of surface layer compaction. Chemical stabilization includes incorporation of additives such as natural soil [M. Golestanch, G. Amini, G. D Nalafpour and M.A. Beggi, (2010)]. Physical stabilization is to obtain low humidity of the sample with enhance soil physical performance as the result obtained with increasing the polymer content.

The use of the systems were an advantage due to the increased life span of the material. In addition to this it is mixed and applied in the same manner as ordinary cementatious materials, hence utilizing common skills and equipment. The impervious nature of these polymer-aggregates matrices, mean they are less susceptible to corrosion by chloride, acids, and carbonation as a result of exposure to carbon dioxide[Michelle Miller (2005)].

Polymer-concrete is a modified concrete in which percent (10% to 15% by weight) of the cement binder is replaced by synthetic organic polymer. It is produced by either incorporating a monomer, prepolymer-monomer mixture or a dispersed polymer (latex) into the cement concrete mix. To effect the polymerization of the monomer or prepolymer-monomer catalyst is added to the mixture. The process of the technology used is very similar to that conventional concrete. Therefore, polymer-cement concrete can be cast in place in the field applications [A. Blaga, J. Beandom (1985)]. For the past few decades, active research has taken place in polymer modified concrete, polymer concentration and polymer-impregnated concrete. Currently the same is used in popular construction materials because of comparative high performance, multifunctional and sustainability compared to conventional cement concrete. Concrete-polymer composite is environment-conscious and conform to concerns of saving of natural resources, the longevity of infrastructures and environmental protection [Ali Zadehnozaria Mehdi, (2011)].

Some polymers are soluble in water and their low solubility causes difficulties in respect to the application concrete modifier. For water soluble polymers, one of the major advantages is the absence of surfactants to keep the polymers in solution. The polymer molecules are supplied on molecular scale, improving the approach of the relatively large cement grains (up to 80μm) by the polymers [Sivakumar M. V. N, (2011)].

The aim of this study is to investigate the bond strength of polymer blend with cement and sand, in which different percentage by weight where taken, from PVA/Polyol with cement and PVA/Polyol with Sand. Restoration of specimen in mortar cubes using self adhesive resin under different percentage conditions, the procedure by using mortar cubes of such work restoration has requires several sequential steps and the use of adhesive systems associated with resin based mortar cubes agent is very common. In addition to etch-and-rinse adhesive, self-etching systems are used with purpose of eliminating the rinsing drying steps and facilitating the bonding procedure [Guilherm B. Guardia, Luuciano S. Conclaves; Americo B. Corer; Rafael R. Moraes; Mario A. C Sinhoreti; Lourenco Correr-SobRinho, (2010)].

2-Experiment

2-1- Preparation of polymer blend :

The procedure including the mixing of the PVA:Polyol (polymer blend) by weight such that the percentage of (3:1).

2-2- Mixing Process: The polymer blend is mixed with the cement by different percentage (10, 20, 30, 40, 50, 60, 70, 80, 90)% , in which the water: cement (w/c) ratio is 0.4 as shown in table (1).

2-3- Pour Models:

From step (2), the mixtures then poured into molds were put in mortar cubes (5x5x5) cm for 24 hours.

The measurement of the physical and mechanical properties of the samples prepared, were found that the best percent of cement used in the mixture was 10% as shown in table (1).

2-4- Preparation of binder mixing with sand:

The mixing of polymer blend (PVA/Polyol) with sand and the cement percent in the binder was (10%).Where different sand percentage of (50, 60, 70, 80, 90)% and polymer blend (10, 20, 30, 40, 50)% have been selected [M. S. Morsy, S. H. Alsyed and M. Aqel, (2011)], and we have reduced the sand and the polymer blend mixture by 10% by weight before adding the binder, and the w/c ratio is 0.4, as in table (2).

2-5- The physical and mechanical examination of the prepared samples:

A- Density of the sample:

the samples were dried at room temperature and weights of the samples were measured by using sensitive electronic scale, and the dimensions of the samples were measured by using vernier Caliper to calculate the size of the samples; the density was calculated using the following equation [Jan F. Radek (1983)]:

$\rho = m/v$ where m is the mass of the samples in Kg.

V is the size of the samples in m^3. as in tables (1, 2).

B-Water absorption: the water absorption was calculated by using the following equation [E. Condren and S. Pavia (2007)]: water absorption=$(W_1–W_2/W1)x100\%$ where W_1: final weight of the sample after absorption for 24 hours in gm.

W_2: Initial dry weight of the samples in gm. As in tables (1, 2).

C-Measurements of compressive strength: the compressive strength was calculated by test mark Industries HUMBOLDT Machine, U.S.A. and applying the following equation [Mohd Amirul Mukmini Bin Alias(2011)]:

P=F/A, where P is the compressive strength, F is the force in Newton applied by the machine and A is the area of the samples in mm^2. The Compressive strength test of two sets of specimens cured for 7 days in an environmental chamber was carried out. One set consisted of cement with different percentage by weight of Polymer blend as indicted in table-1-, and the other set of sand with different percentages of Polymer blend as indicted in table-2-. The results of the compressive strength as in tables (1, 2).

Table-1-. Percentage of sample preparation of polymer concrete.

Sample No.	Prcent of cement	Percent of polymer blend.	w/c	Water absorption	ρ Kg/m3	Force (N)	Compressive strength MPa.
A1	90%	10%	0.4	17.73%	1619	23375	9.35
A2	80%	20%	0.4	20%	1335.4	11500	4.60
A3	70%	30%	0.4	24.50%	1265	10725	4.29
A4	60%	40%	0.4	29.71%	1150.3	7000	2.8
A5	50%	50%	0.4	14.1%	1122	13250	5.3
A6	40%	60%	0.4	5.44%	998.2	19100	7.64
A7	30%	70%	0.4	3.64%	982	21000	8.4
A8	20%	80%	0.4	3.44%	860	25450	10.18
A9	10%	90%	0.4	2.275%	690	30375	12.15

Table-2-. Percentage of sample preparation and calculation of water absorption, density and compressive strength.

Sample No.	Percent of sand.	Percent of Polymer blend.	w/c	Water absorption	ρ Kg/m3	Force (N)	Compressive strength MPa
B1	90%	10%	0.4	1.9%	1728.6	7000	2.80
B2	80%	20%	0.4	2.5%	1690	8000	3.2
B3	70%	30%	0.4	3.6%	1580.4	9000	3.6
B4	60%	40%	0.4	11.2%	1508.9	11750	4.7
B5	50%	50%	0.4	16.48%	1443.2	14500	5.89

Results and Discussions:

A feature of polymer-concrete (P.C) as composite materials is a high degree of filling by cement and sand aggregate attaining at different percentages of Polymer blend compared with cement from 10-90% by weight which depending on their application. Thus (P.C) are composite with high degree of filling and accordingly with a large total surface of filler particles. The properties of such different multicomponent system to great extent depend on the interaction effects at the polymeric binder/cement aggregate interface. Reactivity of filler surface affects the adsorption interaction of filler with a polymeric binder and as a result considerably influences the physical-mechanical characteristics of P.C. on the whole, at the same time, the chemical composition of the sand aggregates exhibit differences as the case of cement [Allied (2009)]. Fig.(1) shows the variation of non-linear relation of compressive strength relative to the percent of Polymer blend with maximum value of (12.15 MPa) indicated at 90% polymer, which was reduced to a minimum value (2.8 MPa) at 40% Polymer blend, as in fig.(4) where the compressive strength of sand which indicates maximum value (5.89 MPa) at 50%polymer blend and minimum value (2.802 MPa) at 10%polymer blend which in contrast to fig.(1), Fig.(2), shows the percent of Polymer blend verses the density for cement, shows inverse linear relation as the percent of Polymer blend increase the density decrease, Fig.(6), shows different non-linear relation for sand. For light concrete or foamed concrete we have reached a density of (487.2 Kg/m^3) which are suitable for both percast and cast-in-place applications. Some of highly isolative cementitious foams at densities 48 Kg/m^3 (3pcf) to 645 Kg/m^3 (40pcf) or higher can be used as block fills, light weight proof deck and void-fill materials [5]. Fig.(3), describes the effect of water absorption on Polymer blend percents for cement, which is reduced at percents 50-80% as further increase return the increase in water absorption with a 10%polymer blend. For sand samples as indicated in fig.(5), in which the effect of water absorption on Polymer blend as increasing Polymer blend the water absorption decrease at 10%polymer blend.

Described herein is a composition including a substantially hydraulic cementitious material and at least one Polymer blend compound having a cyclic Polyhydroxy backbone chain comprising four or five adjacent carbon atoms. Wherein a hydroxyl group attached to each carbon backbone chain and where the composition includes an effective amount of at least one calcium silicate or calcium aluminates material in the crystalline phase [Catalan Lionel Kinrade, D. Stephan (2011)]. Further aim of this investigation to provide a measure of adjusting the adhesion provided by PVA/Polymer blend percentage with cement and sand. While it is desirable for creeping, adhesive to show strong adhesion in order to develop good sheet properties, the adhesion provide by PVA/Polymer blend with cement and sand is strong which might be used for coating compositions compromise of compatible materials, which form uniform films. A Typical practice in this industry today, involves the use of adhesive polymer in combination with release oil. These materials are not compatible and do not form uniform films. The most preferred polymer is one that is formed by reacting at a temperature at least of 25 ^{o}C and as high as 50 or 100 ^{o}C. The water soluble Polymer blend used in combination with PVA adhesive may-be selected from a wide number of water soluble Polymer blend. They are generally simple Polymer blends which contain not more than six hydroxyl groups. Also they are of relatively low molecular weight e.g. below 3,000 and usually below about 2,000. The results demonstrate the ability to alter adhesion by introduction of plasticizers. They also demonstrate the ability to maintain high adhesion properties when significant physical changes to the polymer film have taken place [Gray S. Furaman. Jr. (1993)].The choice of Polymer blend, depends especially on the size and flexibility of its molecular weight structure and its functionality. Result of this study demonstrate that the polymer binder can alter significantly the performance of the cement based material compared to the conventional casting polymeric material can produce a product with better bond between fibers and cement matrix [Yixin Shao and Jun Qiu (2002)].

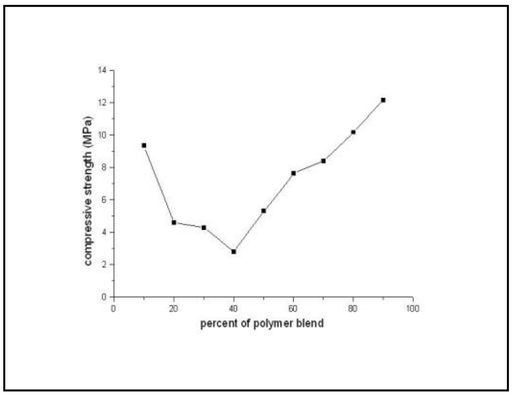

Fig.(1). Compressive strength variations of cement with Polymer blend percentage .

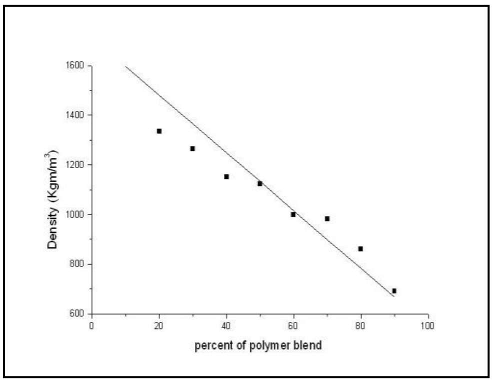

Fig.(2). The effect of Polymer blends on the density.

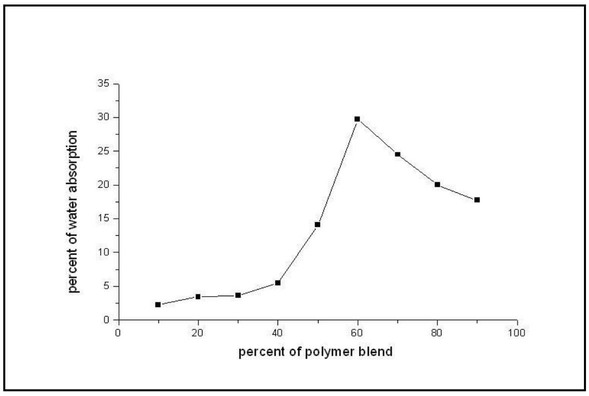

Fig.(3). Percent of polymer blend affected by water absorption on percent.

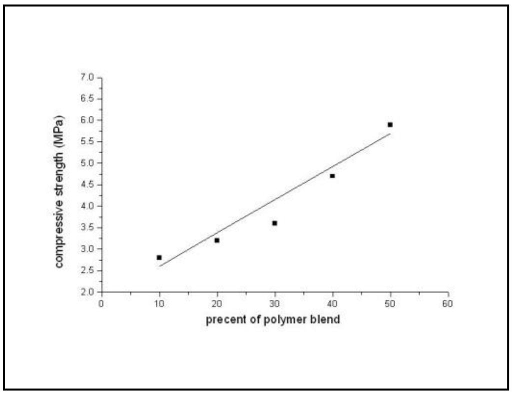

Fig.(4). Percent of polymer blend with compressive strength of sand.

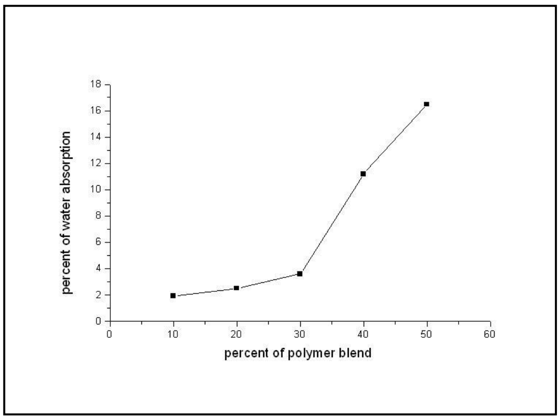

Fig.(5).Percent of polymer blends affected by percent of water absorption.

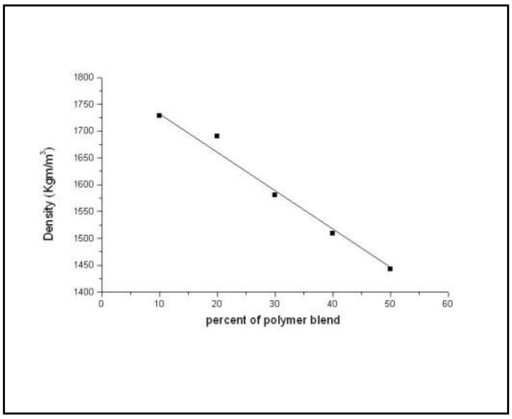

Fig.(6). Variation of percent of polymer blends with density

Conclusions:

The methodology used here, which consist of first checking the effects of organic matter on cement or sand hydration while planning to handle mixtures of cement presumed to contain a certain amount of Polymer blend turned out to be efficient in guiding the investigation. It was less time consuming, less energy intensive and more economical since a small quantity of water was needed to check the effect and was also investigated for organic matter and fiber presumed to contain amount of Polymer blend. The binding action of polymer mentioned above should have favored the specimen's strength increase resulting from an increase of untreated fibers; Polymers with different kinds of fillers are used as constructions materials. They have good binding properties and good adhesion levels with aggregates. They have long chain structure, which helps in developing long and short range structures of bonding. In contrast, cement materials usually provide superior compressive, tensile and flexural strengths to the concrete-compound and Portland cement. Some polymer materials by selectively provide higher tensile and flexural strength to the structure compared to compressive strength. In addition, they provide good adhesion to other materials as well as resistance to physical damage (abrasion, corrosion and impact) and chemical attack.

More over the investigation provides different possibilities for the use of polymer blend in onstructions such as:

1- The use of polymer blend (PVA/plyol) to be resistant to water absorption compared with the use of (PVA) alone which will disintegrate.

2- The use of the binder in this study improved the properties of the materials used, which worked to raise the compressive strength to (12.15 MPa).

3- It is possible to use the binder to improve the physical and mechanical properties of polymer concrete.

4- Possible use of the binder to produce light weight concrete panels.

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دراسة الخواص الفيزيائية لمزيج البوليمر البولي فاينيل اسيتيت/البولي اول المخلوط مع الاسمنت

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****قسم الفيزياء- كلية التربية للعلوم الصرفة- جامعة البصرة***

الملخص:

تكوين مزيج من خلط البولي فينيل اسيتيت/البولي اول بنسبة 1:3الذي تم دراسته بنسب مختلفة (10-90)% مع نسب مختلفة من الاسمنت (10-90)%. كانت النسبة المثلى من خلط مزيج البوليمر و الاسمنت 10% و90% على التوالي. تم تعيين الخواص الفيزيائية للخليط، مثل الكثافة، امتصاص الماء و مقاومية الانضغاطية. كذلك دراسة الخواص الفيزيائية بأستخدام خليط بنسبة 10% اسمنت كرابط مع نسب مختلفة من مزيج البوليمر والرمل. هذا الخليط سوف يبرهن على مقاوميته لأمتصاص الماء وأمكانية أستخدامه في ألواح البناء الجاهز.

الكلمات المفتاحية: الأسمنت، متعدد خلات الفينايل/البولي اول، مادة رابطة، الأمتصاصية، قوة الأنضغاطية.