Preparation and Diagnosis of Polyethylene terephthalate (PET) And Studying of Its Effect as Additives on the Concrete Properties

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Abstract: Polyethylene terephthalate (PET) was prepared from (PET) flakes and 25% of NaOH solution were added to in tri-neck flask, the reaction run for six hours at temperature (100-130) ^{o}C and the precipitate was reacted with ethylene glycol at temperature (130-160) ^{o}C. IR spectrophotometer was used for the diagnoses of (PET). Differential scanning calorimeter (DSC) is used to indicate glass transition temperature T_g, the melting temperature T_m and the heat absorbed. Part hundred ratios (phr's) of (PET) rather than dosage of PET in gms. To concrete cubes were added to study its effect on concrete properties. Additives of (phr,s) impart performance such as increased cement dispersion, and enhance the performance of concrete which was appeared in maintaining a lengthening or slow the setting time that meets product and job needs. Maximum and minimum compressive strength is 43.7 MPa and 30.0 MPa at 0.3 gm. and 0.1 gm. respectively.

Keywords: PET; IR spectroscopy; functional groups; adhesives; concrete; bond, compressive strength.

تحضير و تشخيص البولي إثلين ترفثاليت ودراسة تأثيره كمضاف على خصائص الكونكريت

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الخلاصة: تم تحضير البولي إثلين ترفثاليت من رقائق قناني الماء البلاستيكية المستخدمة للشرب وإضافة ٢٥% من محلول هيدروكسيد الصوديوم بالماء المقطر في دورق ذو ثلاثة أعناق وتم التفاعل بعد مرور ست ساعات في درجة حرارة (١٠٠-١٣٠) ^{o}م وتم معاملة الراشح مع الاثلين كلايكول في درجة حرارة (١٣٠-١٦٠) ^{o}م .تم استخدام جهاز قياس طيف الأشعة تحت الحمراء لتشخيص البولي اثلين ترفثاليت. إن درجة حرارة الانتقال الزجاجي، درجة حرارة الانصهار وكمية الحرارة الممتصة من قبل النموذج تم دراستها باستخدام جهاز المسعر الحراري التفاضلي. تم إضافة نسب جزء مئات من البولي اثلين ترفثاليت و فضلا عن مضافات وزنيه لعمل المكعبات الكونكريتية. لدراسة تأثيرها على خصائص الكونكريت. إن عمل هذه الإضافات هو تحسين أداء خصائص الاسمنت كزيادة التشتت، العمل على تحسين اداء الكونكريت والتي تظهر من حيث إطالة أو إبطاء زمن التصلب التي تواجه المنتج واحتياجات العمل. ان أعلى وأوطأ مقاوميه انضغاطية ٤٣,٤ ميكاباسكال و ٣٠,٠ ميكاباسكال عند ٠,٧ غم و ٠,١ غم على التوالي.

الكلمات المرشدة: البولي أثلين ترفثاليت، طيف الأشعة تحت الحمراء، ، المجاميع الدالة، قوى التلاصق، كونكريت، مادة رابطة، مقاوميه الأنضغاطية.

Introduction:

For the past few decades, active researches has taken place in polymer-modified concrete and the effect of different polymers on the structural and mechanical properties of concrete. Besides, a series of test without modification was also carried out. Water soluble polymer, one of 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 relative large cement grains (up till 80 μm) by the polymers. Some polymer materials may provide good adhesion to other materials as well as resistance to physical damage (abrasion, erosion, and impact). The choice of polymer mainly depends on the application. The combination of Portland cement with polymers can result in extremely durable, tough and strong building-material composites those are economical and kind to the environment[1]. Polymer additives can improve the properties such as desire strength and water permeability than the conventional concrete. These additives are dispersed in water or redispersible powders. The polymers are added to hydraulic cement, with or with out aggregate or admixtures, depending on the desired results. The addition of a convenient amount of a polymer to a concrete mix can significantly enhance the properties of the resulting mixture. These additives known as admixture can be in the form of polymer particles or liquids[2].

Researches concerning the use of by-products to argument the properties of concrete have been going on for many years. In the recent decades, the efforts have been made to use industry by-products such as fly ash, silica fume, ground granulated blast furnace of industry (GGBS), glassy cullet, etc., in civil construction. The potential applications of industry by-product in concrete are as partial aggregate replacement or as partial cement replacement depending on their chemical composition and grain size. The use of these materials in concrete comes from the environmental constraints in the safe disposal of these products. Big attention is being focused on the environment and safeguarding of natural resources and recycling of waste materials. Many industries are producing a significant number of products which incorporate scrap (residues) in last 20 years, a lot of works concerning the use of several kinds of urban wastes in building material industrials process have been published. One of the new waste materials used in concrete industry is recycled plastic. For solving the disposal of large amount of recycled plastic material, reuse of plastic in concrete industry is considered as the most

feasible application. Recycled plastic can be used as coarse aggregate in concrete[3].

Fly ash based geopolymer concrete were also investigated, geopolymers are formed when alumina silicates, such as fly ash, dissolve in a strong alkaline solution, reorganize and precipitate in a hardened state. The economical and sustainable production of geopolymer cement for structural uses hinges on minimizing the quantity of high energy materials, like NaOH, required to activate fly ash. The concretes were produced with addition of NaOH at the rate of 10%, 13% and 16% of the fly ash mass[4].

Polyethylene terephthalate (PET) is one of the most important raw materials used in make fibers. Depending on its processing and thermal history, it may exist both as an amorphous (transparent) and as a semi-crystalline (opaque and white) material. It can be prepare by a transeterification reaction between ethylene glycol and dimethyl terephthalate. It uses as the main virtue of PET it is fully recyclable, unlike other plastics, it polymer chain can be recovered for additional use[5].

These polymers can be transparent when in its amorphous state; or translucent when crystalline state with excellent barrier(CO_2 permeation). Due to the hydrophilic nature of PET, compounds remain its favorite coloration rout color is used in very large in entities for applications such as PET beverage bottles[6]. Amorphous plastics are transparent and brittle, or glasslike, because of restricted molecular motion. This motion of polymer backbone in the glassy state is limited to band distortions at molecular vibrations in contrast, a wiggling type segmental movement occurs in the polymer chain of elastomers[7].

The diagnosis of the prepared polyethylene terephalate was done by infrared spectrophotometer technique. The characteristics of polymer by infrared spectroscopy (IR) represent one specific applications, although, at large and important one, of the group frequency concept. To a first approximation the spectrum of single units in homopolymer is identical with that of along sequence of such units and where differences do occur they are capable of providing valuable information on microstructure, such as a stereogularity and on the way in which the chains back spatially with copolymers the spectrum may not be the precise sum of the component bands, may provide useful information such as the diagnosis of random or block copolymers. The success of infrared spectroscopy in the characterization of the organic compounds is the result of

the almost general validity and applicability of the concept of group frequencies. In a comparatively complex molecule individual functional groups such as carbonyl, hydroxyl, amine and olefin are vibrationally independent of the rest of the molecule and give readily recognizable characteristics vibration frequencies[8]. Concrete additives has been used, recently, used chemical admixture, which are materials in form of powder or fluids to enhance concrete performance, projects specified rarely limits on concrete setting time. Concrete producers some time address setting time requirements and because of the large impact time has on the over- all construction schedule[9]. The use of the prepared superplasticiezers to enhance concrete performance such as durability, reinforcement that is used as an ingredient of a cementitious mixture to modify its freshly mixed, setting or hardening properties and that is added to the batch before or during mixing [10].

In this investigation the use of the prepared PET is to enhance concrete performance.

Methods:

Preparation of PET:

25g of PET flakes, which obtained from cutting local water drinking bottles, emplaced in 500 ml of tri-neck round flask, which is fixed by stand on Isomental heater. 25% NaOH, Klaus Englart (EMC Laboratory, Germany) solution PH14 was dropped on the (PET) flakes under consideration. A stirrer HeDolf made in Germany, was inserted into the vertical neck B24 (mm diameter), a thermometer in the side neck B19 (mm diameter) and the condenser at the other side neck B19 (mm diameter), which was connected to a path of cold water with pump gw 220 v 50 HZ and 0.6A to ensure efficient condensation, while the reaction was carried out at (100-130) ^{o}C. Fig.(1) shows the setup used for PET

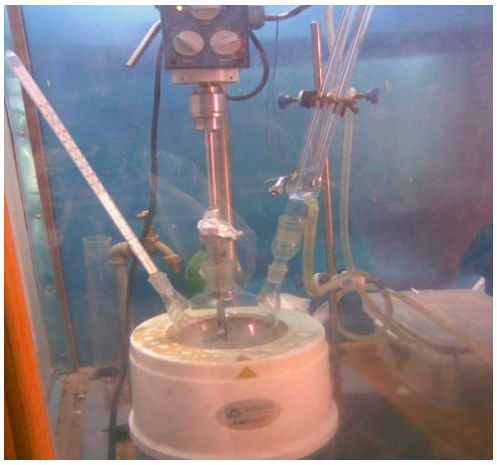

Fig.(1). The setup instruments for PET preparation.

And mixing for six hours, until PET completely reacted with NaOH. A precipitation at the bottom of the flask was filtered at 100^{o}C by using Whitman filter paper chart 15.0 cm, and Left precipitation to dry over night, while the

solution was collected into flask; PET was etched from the filter paper into a Petri dish then into the round flask where reacted with 25 ml. of ethylene glycol at (130-160) ^{o}C (Gianland Chemical Company, U.K.). for 6 hours. The product was filtered at 100^{o}C by using Whitman filter paper 15.0 cm. And left over night to dry. A product of white oil-powder soluble substance of PET was obtained with PH9 by the detection with indicator paper. And PH7 when was dissolved in water overlook the amount which was dissolved. The product of PET was collected into Petri dish while the solution was collected into flask, and the of product PET cured at 60^{o}C. The prepared product of PET was collected into plastic container.

The diagnosis:

PET flakes and the prepared PET in the reaction with NaOH only (dry powder) were examined by IR spectrophotometer, Buck scientific, Model 500; the latter was examined with KBr. The PET bottles flakes give an explanation that most of the ester groups encountered in polymers give rise to characteristics bands at 1150-1200 cm^{-1}. as in Fig.(2) which shows also a typical example, with particularly strong peak at 1050-1060 cm-1 which are a specific for terephthalate group. Coupled with band at 730 cm-1 this lead to the clear identification of poly(ethylene terephthalate). The Chemical structure of PET is shown in Fig.(3)[11]. In Fig.[4], the IR spectroscopy of the prepared PET, the functional group (carbonyl group) in which the second of these peaks is the C=O stretching mode of a carbonyl compound and it is precise position at 1680 cm^{-1} suggest a saturated ester. The success of infrared (IR) spectroscopy in the characterization of organic compounds is the results of the almost general validity and applicability of concept group frequencies, such as carbonyl group. Aromatic absorption occurs at 1600 cm^{-1}. Conformation is also occurs with PET by Infrared spectroscopy both Trans and gauche conformation and to the O-H end group of the molecules, a method is proposed that can discriminate otherwise similar the PET fibers. The absorbencies at 1200 and 860 cm^{-1} relative, respectively, to the gauche and trans conformers[8]. The carboxylic acid can be indicated at 1700-1725 cm^{-1} and end group content was evaluated at the absorbencies 3440 and 824 cm^{-1}[12] as shown in Fig.(5).

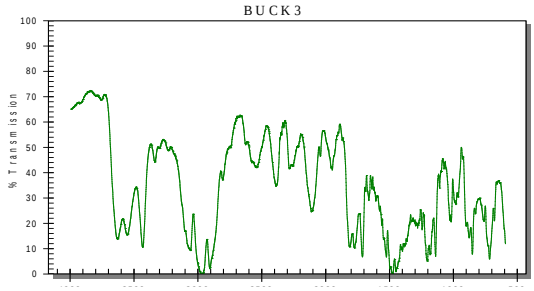

Fig. (2).IR spectroscopy of PET flakes of water drinking bottles

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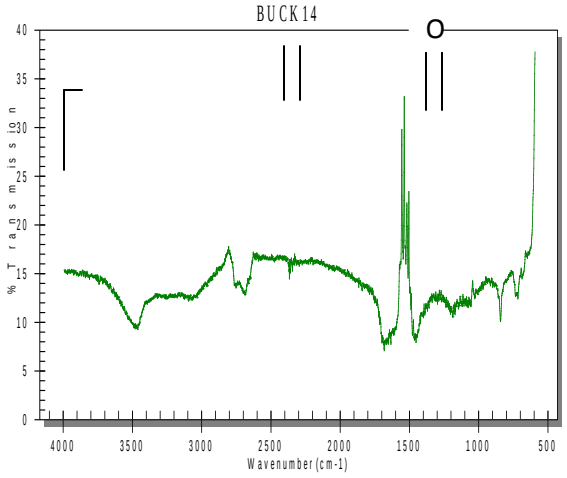

Fig.(3). The chemical structure of PET.

DSC Measurements':

Differential scanning calorimeter, DSC-60, DELL, SHIMADZU, was used to measure the heat absorbed of the sample raised at heat rate 20°C/min, the results are shown in the endothermic process of Fig.(5), f

Fig.[4]. The IR spectroscopy of PET

Fig.(4) The IR spectroscopy of PET reacted with NaOH.

T_m 284.45°C, heat capacity is -413.67 mJ (-41.37 J/g). The T_m in the endothermic process of Fig.(6), for prepared PET in the reaction with NaOH only (dry powder) was 116.36 °C, which is the same as T_g in Fig.(5), the heat capacity is -1.30 J (130.4KJ)[13].

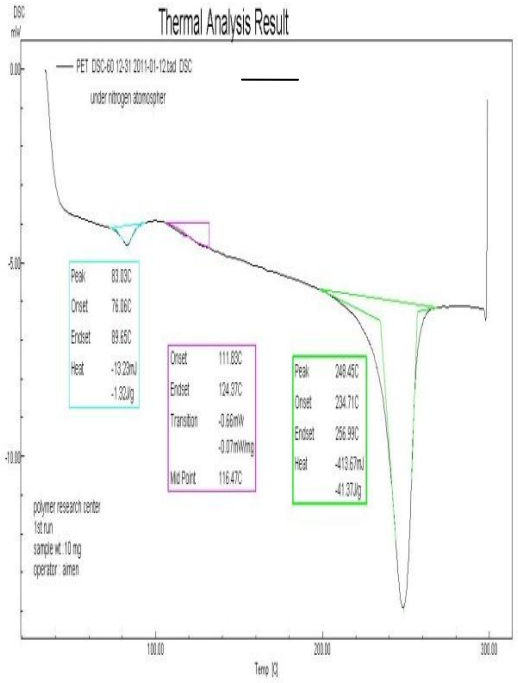

Fig.(5). DSC of PET flakes.

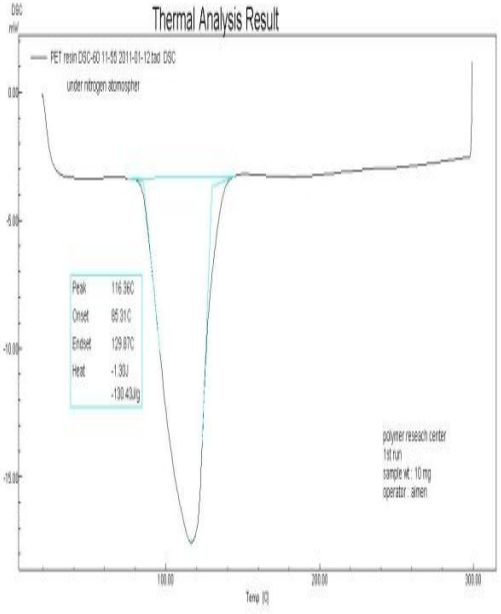

Fig.(6). DSC of PET resin.

The Standard (w/c):

The vicat instrument which is shown in Fig.(7). was adjusted and filled the cylinder of the instrument with cement paste and drop the pour 10 mm^3 on the cement paste, the penetration was measured and repeated for different (w/c) ratios, as shown in Table-1-, then graph of w/c versus penetration was sketched as shown in Fig.(8). To determine the standard w/c. the standard (w/c) was measured equal to 0.28. From Table-3- graph of penetration versus time for cement at the standard w/c ratio 0.28 was measured at (25) mm. penetration, was sketched as shown in Fig.(9).

Table-1-The Standard w/c at t=22±1 ^{o}C.

w/c	penetration m.m.	Weight of water (gm)
0.22	5	80
0.25	11	90
0.26	15	94
0.28	25	101
0.29	35	105
0.30	38	110
0.31	40	112

Setting Time Measurements:

Setting time was measured by using Vicat instrument sort HUMBOLDT MFG. CO. NORRIDGE, as shown in Fig.[7]. For different weight of prepared product of PET, this was reacted with NaOH and ethylene glycol (0.1, 0.15, 0.18, 0.22, 0.25, 0.3, and 0.32) gm. by using sartorius sensitive electric balance. The cement used is from Basrah Cement Plant (The General South State Company of Cement) which is an ordinary Portland Cement, Table-2- shows the usual composition limits of Portland cement[14]. The cement paste was prepare with (w/c) = 0.28 and which was emplaced in the cylinder of vicat instrument to measure setting time, which were repeated for the different weights of the prepared PET as in Table-3-

Table-2- Usual Composition Limits of Portland Cement.

Oxide	cement, percent
CaO	60-67
SiO_2	17-25
Al_2O_3	3-8
Fe_2O_3	0.5-0.6
MgO	0.5-0.4

Alkalis(asNa_2O)	**0.3-1.2**
SO_3	**2.0-3.5**

Table-3-. The setting time against penetration for several phr's of PET

set.time min.	**cement t=20° C. penet. mm.**	**0.02 phr t=28° C penet. mm.**	**0.04 phr t=28° C penet. mm.**	**0.05 phr t=29° C penet. mm.**
15	**40**	**40**	**40**	**40**
20	**39**	**40**	**40**	**40**
25	**39**	**40**	**40**	**40**
30	**38**	**40**	**40**	**40**
35	**37**	**40**	**39**	**39**
40	**37**	**40**	**40**	**38**
45	**39**	**38**	**40**	**39**
50	**38**	**40**	**40**	**40**
55	**36**	**40**	**40**	**40**
60	**37**	**40**	**40**	**39**
65	**37**	**40**	**40**	**38**
70	**36**	**40**	**39**	**38**
75	**37**	**39**	**37**	**40**
80	**37**	**39**	**40**	**38**
85	**37**	**36**	**38**	**38**
90	**35**	**35**	**37**	**38**
95	**36**	**37**	**38**	**38**
100	**34**	**38**	**38**	**38**
105	**36**	**37**	**38**	**38**
110	**35**	**39**	**38**	**38**
115	**36**	**34**	**38**	**38**
120	**34**	**31**	**36**	**38**
125	**35**	**30**	**38**	**37**
130	**35**	**28**	**37**	**37**
135	**35**	**21**	**38**	**37**
140	**35**	**19**	**35**	**39**
145	**35**	**22**	**37**	**31**
150	**33**	**15**	**36**	**35**
155	**33**	**12**	**33**	**34**
160	**32**	**21**	**37**	**23**
165	**32**	**11**	**34**	**19**

170	30	5	38	11
175	28	3	30	12
180	26	2	34	3
185	26	4	26	2
190	16	1	30	1
195	14	1	20	1
200	26	1	12	1
205	12	0	11	0
210	8		9	
215	4		10	
220	4		7	
225	0		8	
230			3	
235			2	
240			2	
245			1	
250			0	
255				
260				
265				
270				
275				
setti .time	0.06 phr t=28°	0.07 phr t=28°	0.08 phr t=28°	0.09 phr t=30°

min.	C penet. mm.	C penet. mm.	C penetr. mm.	C penet. mm.
15	37	40	39	40
20	39	40	39	40
25	37	40	40	39
30	37	40	40	40
35	38	40	39	40
40	38	39	40	39
45	36	40	40	40
50	36	40	40	40
55	36	40	39	39
60	37	40	39	39
65	36	38	39	40
70	36	38	39	40
75	35	40	39	39
80	38	40	39	40
85	36	38	39	40
90	38	38	39	39
95	38	39	36	37
100	37	38	40	40
105	36	39	40	39
110	36	39	39	37
115	36	39	39	39

120	**35**	**39**	**38**	**39**
125	**35**	**39**	**38**	**38**
130	**35**	**37**	**37**	**35**
135	**35**	**23**	**38**	**40**
140	**36**	**17**	**37**	**38**
145	**35**	**14**	**38**	**38**
150	**35**	**7**	**38**	**27**
155	**35**	**4**	**37**	**14**
160	**36**	**7**	**24**	**4**
165	**33**	**5**	**35**	**3**
170	**26**	**2**	**20**	**2**
175	**29**	**1**	**7**	**1**
180	**18**	**2**	**7**	**1**
185	**14**	**1**	**4**	**2**
190	**10**	**0**	**3**	**0**
195	**5**		**3**	
200	**9**		**2**	
205	**5**		**1**	
210	**2**		**4**	
215	**2**		**1**	
220	**3**		**1**	
225	**4**		**1**	
230	**8**		**1**	
235	**1**		**0**	

240	**1**			
245	**1**			
250	**2**			
255	**2**			
260	**1**			
265	**2**			
270	**1**			
275	**0**			

Fig.(7). Vicat instrument

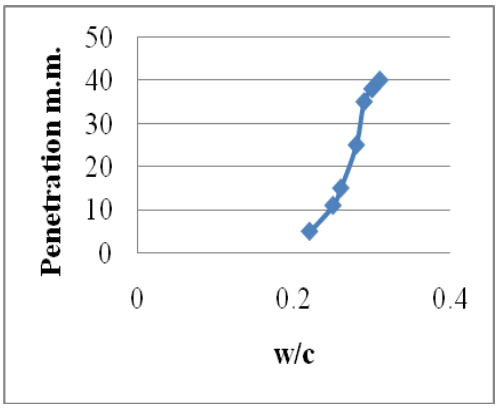

Fig.(8). The standard w/c. versus penetration

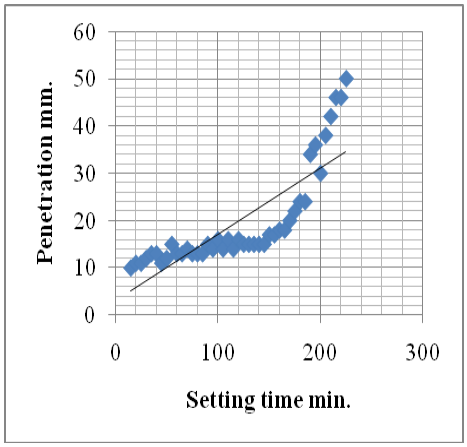

Fig.(9). Penetration setting time dependant of pure cement

Table flow cone test:

Different weights (0.03, 0.05, 0.08, 0.1, 0.15, 0.18 and 0.2) gm. From the preparation products of PET, were fixed. The system was set with glass cone fixed by stainless steel stand vertically on glass plate, which were rest on a table, equal amount of cement paste (w/c= 0.4) was emplaced to full the cone, while the finger was closed the lower end of the cone 1.07 cm in diameter until the upper top of the cone 5.25 cm inner diameter was filled and leveled the top, the finger was lifted to let the cement paste flow on the glass plate and the diameter of the dropped cement was measured after it was dried. The steps with each of the above mentioned weights were repeated with PET, which was prepared at PH7 at different time intervals as in Table-4-.

Table-4- examination results of concrete, t=29°C.

Time min.	Phr 0 dia. mm	Phr 0.01 dia. mm	Phr 0.02 dia mm	Phr 0.03 dia. mm
0	76.2	53	37	41.7
10	43.2	60.2	53.4	72.2
20	42.5	55.3	70	74.2
30	35	52.7	75	66
40	36.4	45.5	51.3	60.7
50	23.2	43	47.2	55.2
60	30	22.3	47	59.1
70	24	18.2	21.6	30.5
80		13.3	21.6	
90		22		
100		22.1		
110		28		
Time min.	Phr 0.04dia.mm	Phr 0.06 dia.mm	Phr 0.07 dia.mm	Phr 0.08 dia. mm
0	58.4	43	73.5	28.5
10	37.8	51	67.9	21.3
20	42.3	54.5	71	38.2
30	40.5	53.7	65.8	30.9
40	35.6	49.1	62.2	42.9

50	**38.4**	**46.3**	**30**	**32.2**
60	**30.3**	**33.5**	**34.5**	**30.2**
70	**34.3**	**29**	**35.9**	**29.3**
80	**30.5**	**17**	**19**	**27.3**
90	**32**			**22.9**
100	**22.5**			
110	**11.4**			

Preparation of concrete cubes for compressive strength test:

Steel cubes (150*150*150) which were used for preparation of concrete cubes[15]. The concrete paste was prepared at (W/C=0.5) as follows:

a- One part of cement to 1.5 part of sand and 3 parts of gravels were weighted. .

b- (0.02, 0.03, 0.04, 0.4, 0.06, 0.08, 0.1, 0.3, 0.5, 0.6 and 0.7) gm. From the preparation products of PET, were weighted.

c- Whole mixing water with required amount of PET was prepared into flask with PH7 for each of the above weights in (b) and was emplaced into a bowl.

d- One part of cement was added to the mixed water into the bowl and gloves were worn, mixing by hand was done for one minute until the whole cement was dissolved.

e- 1.5 part of sand was added to the mixture in step (d) and continue mixing by hands was done for 2 minutes.

f- 3 parts of gravels was added to the mixture in step (e), and continue mixing by hands was done, until concrete paste was ready to fill the stainless steel cubes in steps:

1- A layer of the concrete past was emplaced half the depth for all of the stainless steel cubes.

2- 17 strokes were done at different parts of the cube by using steel rod 60 centimeters in length and 16 mm diameter in narrow end.

3- The cube was filled with concrete paste and continues 35 strokes were completed.

4- Laterally and longitudinally pressing by hands on trowel mold cubes was done. A plane surface with the top of the mold was cut off by drawing the straight edge of the trowel, held perpendicular to the molds with sawing motion over the length of the mold.

5- The specimens were emplaced in a moist room for (24) hours and kept in their cubes for the initial period. The specimen were taken off from their cubes after (24) hours which were immersed in saturated water curing tank, for (28) days including the (24) hours[16].

Compressive strength measurements were done by using MATEST machine. Table-5- shows the compressive strength for the different weights of prepared PET.

Table-5- The compressive strength of concrete cubes.

Wt. of PET gm.	Wt. of load Kg.	age days	F kN	Comp str. MPa
0	**69200.2**	**28**	**692.2**	**30.8**
0.02	**79826.2**	**28**	**798.3**	**35.5**
0.03	**83042.0**	**28**	**830.4**	**36.4**
0.04	**85663.8**	**28**	**856.6**	**38.1**
0.06	**88336.0**	**28**	**883.36**	**39.3**
0.08	**70007.8**	**28**	**700.1**	**32.1**
0.1	**66289.4**	**28**	**662.9**	**30.0**
0.3	**98340.9**	**28**	**983.4**	**43.7**
0.5	**92857.8**	**28**	**928.6**	**41.2**
0.6	**79707.8**	**28**	**797.1**	**35.4**
0.7	**97580.5**	**28**	**975.8**	**43.4**

Results and Discussion:

The setting time-penetration of pure concrete in Fig.[9], (phr=0) shows that initial setting time was obtained after two hours and the final setting time at (220) min. While the result of penetration with setting time in which part hundred ratio (phr) of the prepared PET is 0.02, the curve at the beginning was acted as a retarder, the lengthening of set times as the concrete performance was proceeded, the initial setting time was obtained at 125 minutes and the hardened (final setting time) was occurs at 205 minutes as shown in Fig.(10). The polymers impart performance properties such as increase cement particles dispersion, enabling drastically reduce water requirements while maintaining "mixes" slump life[17]. Fig.(11). at Phr=0.04 of PET, shows the initial setting time of the concrete was obtained at 135 minutes. And begins to hardening at 195 minutes.

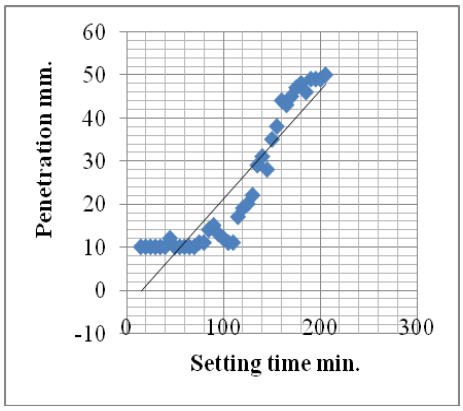

Fig.(10). Penetration setting time dependant at phr. =0.02.

and completed at 250 minutes, water-reducing admixtures improve concrete's plasticit (wet) and hardening properties, while set controlling admixtures are used in concrete being placed and finished in other than optimum temperatures[18]. An esterification group is the basic substance of PET[19]. In Fig.(12) at phr=0.05, shows the quick hardening after the initial setting time which occurs at 135 min. and the final setting time was

205 min. In Fig.(13) at phr=0.06 of PET, shows the curve is a retarder, the effort of slump retention is through re-dosing the PET resin to the concrete mixture which is a measure to adjust the set.

The initial setting time was occurred at 165 min. and the final setting has completed at 275 minutes. Excessive addition of retarder will drastically reduce the strength, there by impairing the integrity of the finish work and excessive amount may produce "dry out" the inability of plasticit to set before the water necessary for chemical reaction evaporated[20]. The lengthening of hardening is the result of increasing additive of the prepared PET, which reach the initial setting time at 165 minutes and the final setting time which is take longer to occur at 275. Water-soluble substance, have its effect that many adhesive layers are superplasticizer blend of the admixture and can also have various unsaturated carboxylic acid, carboxylic acid anhydrides, or other acid derivatives grafted onto, or polymerized into the polymer[21]. In Fig.(14), at phr = 0.07 shows initial setting was occurred at 115 min. and final setting time was 190 min. there was a discrepancy between the initial setting time and the final setting time, because hardening became more quickly after the initial setting time which was hardened in 75 minutes. In Fig.(15), at phr=0.08 shows the initial setting time was occurred at 160 min. and the final setting time at 235 min. the setting time is run properly as dry out for (3) hours and hardening at 235 minutes. In this case unsaturated carboxylic acid and their anhydrides wherein was said adhesive layer[21].

In Fig.[16]. At phr=0.09 further increase of PET cause dry out more quick, there was a discrepancy between the penetration of the initial setting time which was occurred at 150 min. and the penetration of the final setting time at 190 min.[22]. Concrete of good performance has advantages in that it permits easy and quick placement. A reasonably workable concrete can be obtained by using high cement content while maintaining the normal water: cement ratio or by increasing the water content while maintaining the same cement content. Both methods, however, lead to segregation, excessive shrinkage, undesirable heat development and long-term detrimental effects. It remains cohesive and does not have undesirable bleeding, segregation or strength loss characteristics[23].

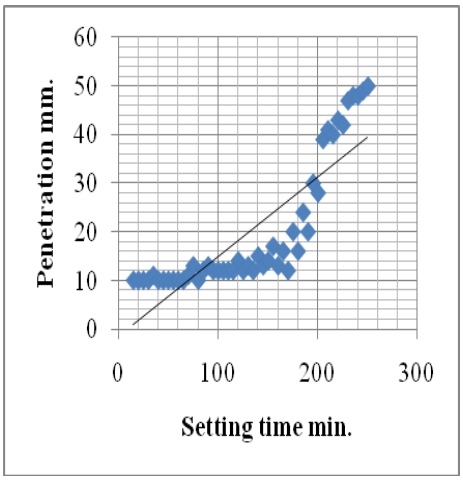

Fig.(11). Penetration setting time dependant at phr=0.04.

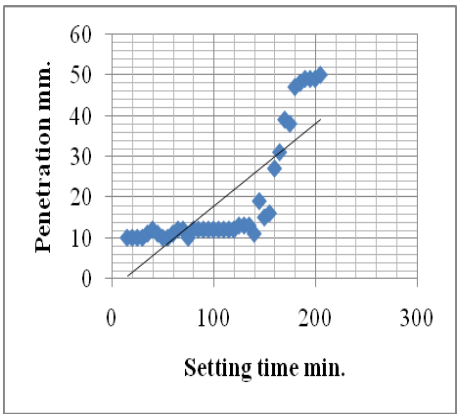

Fig.(12). Penetration setting time dependant at phr.=0.05.

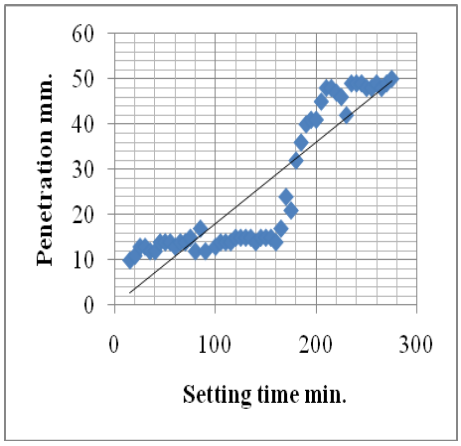

Fig.(13). Penetration setting time dependant at phr=0.06.

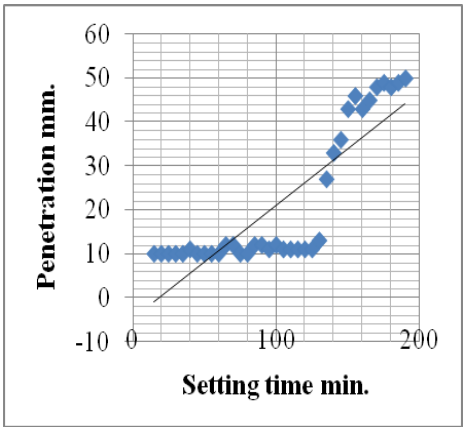

Fig.(14). Penetration setting time dependant at phr=0.07.

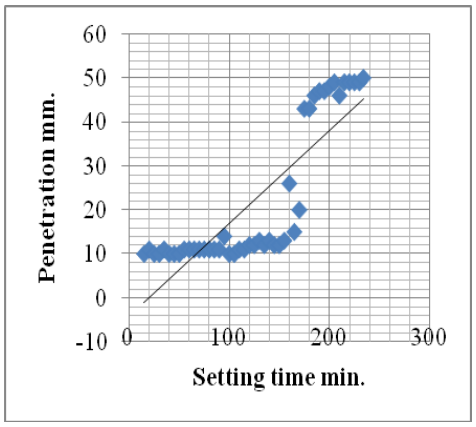

Fig.(15). Penetration setting time dependant at phr.=0.08.

The addition 0.32gm. of PET indicates that accelerators typically increase early strength. However, later-age strengths may be reduced relative to the same concrete without the accelerator. They also tend to increase early-age shrinkage and creep rates, but test have shown that ultimate values seem to be unaffected[18].

In case of concrete, flowing concrete permits placement in congested reinforcement and in relatively in accessible areas. Easy and quick placement characteristics and the need for only nominal vibration make it suitable for placement in bay areas, floor, foundation slabs, bridge, pavements, roof desk, etc. Pumping of concrete is very much improved by incorporating admixture, which have also been found successful in concrete placed by tremie, particularly under water[23]. The measurement of initial and final setting times were (145 ± 15) and (220 ± 50) min. respectively[24], initial slump have been reached of about 40 mm. with dosage from (0.1-0.32) gm.

The process requires a close control due to competing poly-condensation and degradation reactions, for which reaction by-products and overall moisture content must be minimized. With this in view, the most appropriate molecules would promote addition reactions while avoiding by-products such as water, which include degradation at high conversions. The modified structure and size must be taken into account to ensure solubility required with PET for efficient reactivity, since PET was performed at 100-160 ^{o}C[7].

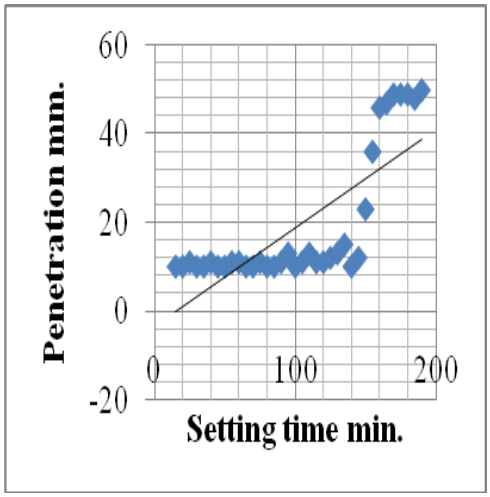

Fig.(16). Penetration setting time dependant at phr=0.09.

In this investigation an important admixture has determined the most important progress in the field of concrete structures in terms of higher strength, longer durability and safer

placement. More recently poly-functional PET have been developed which are able to completely keep the initial slump for at least two hours, moreover multi-purpose and poly-functional thermoplastic are able to reduce drying shrinkage[25]. Fig.(17). Shows flow table test of concrete as in Table-4-., the variations of diameter with time of series1at phr= (0) to series4 at phr= 0.03, there are differences in diameter of concrete, with notes that the time of end flow at 70 min. of phr (0.0) and (0.03), indicated in series1 and 4. The increase in flow time related to the high performance of the concrete as in series2. In series3 the flow was nearly equal to the time allowed for flow which is 10 min. at the period 30 min. which indicate high performance have done at this period. In Fig.(18). Series1 at phr= 0.04 to series (4) at phr= 0.08, in which the behavior of series are in same behavior to all other series indicated in Fig.(17) and (18). Accept the in series4 there were some differences especially at the beginning of the test and high flow was indicated at the period 40 min. The increase in flow time in series1 was related to high performance of concrete. In series2 and series3 the ends flow at 80 min. The high performance in series3 has started from the period 20 min. to the period 40 min. The properties of higher performance concrete, mainly in the fresh state are governed by the flow behavior of the paste, which is controlled by the dispersion of cement particles by the superplasticizer, a procedures have been done for evaluating the flow behavior of cement paste with different dosages of PET are studied. It is

observed the cone flow time, mini slump spread and the rheological parameters show the same trend with change in dosages of PET. Also the rheological parameters increase with time and the rate of increase is more significant at dosage less than the saturation dosage, as determined from the flow table test[26].

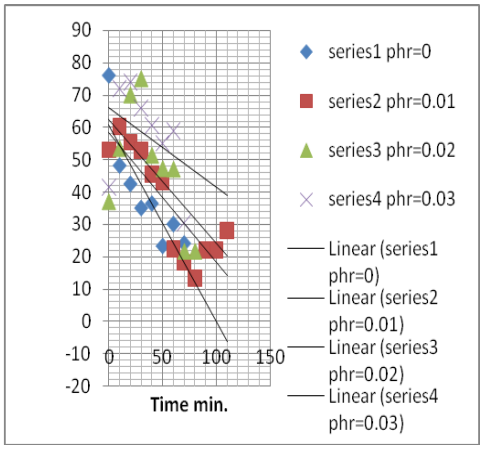

Fig.(17).Diameter variations with time for concrete at different phr's.

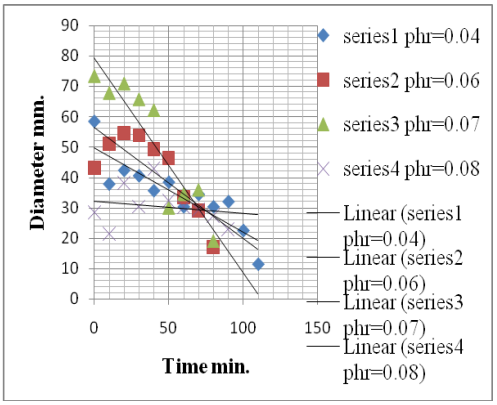

Fig.(18).Diameter variations with time for concrete at different phr's.

From Table-5-, the compressive strength of concrete with no additives was 30.76 MPa, and with PET additives by weight, the maximum compressive strength was (43.7) MPa at dosage at 0.3 gm., which is high compressive strength[27] and minimum compressive strength is (30.0) MPa at dosage 0.1 gm. Another value for high compressive strength were 41.2 at dosage 0.5 and 43.4 at dosage 0.7 gm. With notes that at dosage 0.06 gm. the compressive strength was 39.3 MPa. At dosage 0.03 gm. And for completely failure when subjected again for reloaded extra value was measured 20 MPa. in which the factors accountable to the compatibility between PET and C_3A, C_4AF of cement content. Reactivity of calcium sulfate content C_3A, final from calcium sulfate in ground cement (Hemihydrite, dihydrite, or anhydrite gypsum), which are the fiber position of the end group in the chain, the counter-ion type (sodium or calcium), is the presence of residual sulfate which affects the de-flocculation properties[14].

Conclusion:

In normal cement paste large irregular agglomerates of cement particles predominate. The addition of PET causes them to disperse. Available data suggest that the admixture is absorbed by the cement particles and causes them to repeal each other, resulting in better workability. As shown in figures we have slump range from 40 to 35 mm. at different setting time range from (15-155±15) min. at phr's =0.02-0.09. The main purpose of using the PET is to produce flowing concrete with very high slump to use in heavily reinforced structures and in placements where adequate consideration by vibration cannot be readily achieved. The Tricalcium aluminate C_3A ($3CaO.SiO_2$)

present in most cement is comparatively small but its behavior and structural relationship with other phases in cement make it of interest. And its hydrate forms a prismatic dark interstitial material, possibly with other substances in solid solution. The Dicalcium Silicate C_2S ($2Cao.Sio_2$) present in (25) percent by weight. The Tricalcium aluminoferrite C_4AF ($4CaO.Al_2O_3.Fe_2O_3$) is a solid solution ranging from C_2F to C_6A_2F. Gypsum $CaSO_4.H_2o$ constituents is 3.5 percent by weight. The actual proportions of the various compounds vary considerably from cement to cement, and the fact that different types of cement are obtained by suitable proportioning of the raw materials. Not only the properties of cement but the w/c also affects the rate of gain of strength of concrete. Mixes with low w/c gain strength, expressed as a percentage of long-term strength more rapid than mixes with higher w/c. Preparation assorted PET water bottles which have been cut into flaks and treated into a recovered PET, in this study PET have been used as new product to enhance the performance of concrete cubes.

Superplasticizer can be used in the same three ways as a conventional plasticize:

1-To impart extreme workability (beyond that obtainable with a conventional plasticizers).

2-To permit a large water reduction to be made beyond the limits of normal plasticizing admixture.

3-To achieve economical environmental benefits (e.g. reduction of the cement content whilst maintaining performance.

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