Influence of reinforced plasticized PVC by steel and brass wire meshes on the creep & recovery behavior

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Abstract

In this research was to reach an experimental way to improve the properties of creep and recovery of plasticized polyvinyl chloride, have been prepared samples by injection granules polyvinyl chloride in the machine injection of plastic materials under temperature of 170° and then the preparation of samples of other reinforced by using wire meshes of iron diameters (0.25, 1) mm, and a wire mesh diameter (1 mm) of brass. The study of the properties of creep and recovery conducted at room temperature of 35^0 by using creep machine (SM1006) located in the laboratory of metals in the Department of Materials at the Faculty of Engineering University of Basrah .the results showed that there is a clear improvement in reducing the creep of the material plasticized polyvinyl chloride. The amount of emotion creep of the sample unreinforced specimens (0.653) .while it was (0.0175) for samples with iron wire mesh (1mm) diameter then it was (0.048) for samples with iron wire mesh diameter (0.25 mm) diameter. But it was (0.028) for the samples reinforced by brass wire mesh of (1mm) diameter.

الخلاصة

في هذا البحث تم التوصل إلى طريقة عملية لتحسين خواص الزحف والاسترجاع للبولي فينيل كلورايد اللدن , تم تحضير العينات بواسطة حقن حبيبات البولي فينيل كلورا يد في ماكنة حقن المواد البلاستيكية تحت درجة حرارة 170 مئوية ومن ثم تحضير عينات أخرى مسلحة بواسطة استخدام مشبكات من الحديد بأقطار mm (0.25,1) ومشبك من البراص بقطر(1mm) . إن دراسة خواص الزحف والاسترجاع اجريت في جهاز الزحف والإرجاع (SM1006) الموجود في مختبر المعادن في قسم المواد في كلية الهندسة جامعة البصرة بدرجة حرارة الغرفة $35\ ^0C$ و أظهرت النتائج أن هناك تحسن واضح في تقليل الزحف لمادة البولي فينيل كلورايد اللدن حيث كان مقدار انفعال الزحف للعينة غير المسلحة (0.653) بينما كانت قيمته (0.0175) للعينات المسلحة بالمشبك الحديدي ذو قطر (1mm) وكانت قيمته (0.048) للعينات المسلحة بالمشبك الحديدي ذو قطر (0.25 mm) لكن قيمته (0.028). للعينات المسلحة بالمشبك البراص ذو قطر (1mm).

1.1 Introduction

Composite material is usually defined as a combination of two or more materials with significantly different properties. Such materials are made for improving structural, thermal, or other characteristics of a single material. A typical composite contains one or more discontinuous phases called (reinforcement).They are usually stronger than the continuous phase (matrix). Some examples of composite materials are used as concrete, filled plastics, armors, aerospace, automotive, sports, and unidirectional continuous or chopped fiber reinforced composites. Multidirectional reinforced composites, such as laminates and fabric or three dimensionally reinforced materials which, are widely used .Mechanical, physical, or other properties of composite depend on those of the constituents and their distribution. Some of the properties are strong functions of the arrangement of the constituents, e.g., orientation of fibers, shape, size, size distribution, etc. Concentration is usually measured in terms of volume or weight fraction of the constituents and its distribution is measures of homogeneity of composite .There are three common types of composite materials:

1- Fibrous composite: consists of fibers (long or short) in matrix.

2- Laminated composite: consists of layers of various materials.

3- Particulate composite: composed of particles in matrix. [1]

1.2Aim of this work

The main aim of this research is to find a way to strengthen PVC even through in strengthening pipeline and also can manufacture cars clashes from these materials.

2.Literature Review:

Victor Iliev Rizov (2006). deals with low velocity impact behavior of two densities of ductile polyvinylchloride (PVC) foam manufactured by Divinicell. Low velocity impact tests are carried out on foam beam and panel specimens. A drop weight rig is used to carry-out the impact tests. The test rig is equipped with a load cell connected to a data acquisition PC computer, which allows the most important dynamic and kinetic parameters, such as the contact force, load–time response, impactor velocity and energy to be measured. Post-impact creep response of the foam is also investigated. Finite element analyzes are also conducted to study the dynamic response of foam specimens subjected to a low velocity impact. The present paper contributes towards the development of a damage tolerance design approach for structural foams [2].

T. Pulngern and etal (2011). displacement per sustained load and fraction deflection was found to reduce significantly presents the flexural and creep performances of the strengthened wood/poly(vinyl chloride) (WPVC) composite members by using various types of flat bar strips adhered to the tension side. The WPVC composite member used was produced by an industrialscale twin-screw extruder using the weight ratio of the wood to PVC compound of 1:1. High carbon steel (HCS) flat bar was selected a suitable material for the strengthening of WPVC composite members because of its high tensile stress, thin and light weight. For tension failure control, the flexural properties of strengthened WPVC composite member were improved with thickness and

number of HCS strip used. By using one strip of HCS with 0.5 mm thickness adhered in tension side of WPVC composite member, the ultimate loads increased significantly up to 64% and 101% under flat-wise and edge-wise loading directions, respectively. Moreover, the strengthening of WPVC by using the HCS flat bar could reduce significantly the creep behavior, especially in edge-wise direction. Due to the same sustained load, the creep displacements of the strengthening WPVC composite members reduced significantly for 48% under flat-wise direction, and 11% under edge-wise loading direction. The creep by the HCS strengthening method [3].

Yanjun Xu and etal (2009). studied The creep behavior of bagasse-based composites with virgin and recycled polyvinyl chloride (B/PVC) and high density polyethylene (B/HDPE) as well as a commercial wood and HDPE composite decking material was investigated. The instantaneous deformation and creep rate of all composites at the same loading level increased at higher temperatures. At a constant load level, B/PVC composites had better creep resistance than B/HDPE systems at low temperatures. However, B/PVC composites showed greater temperature-dependence. Several creep models (i.e., Burgers model, Findley's power law model, and a simpler two-parameter power law model) were used to fit the measured creep data. Time–temperature superposition (TTS) was attempted for long-term creep prediction. The four-element Burgers model and the two parameter power law model fitted creep curves of the composites well. The TTS principle more accurately predicted the creep response of the PVC composites compared to the HDPE composites [4].

3.Experimental Work

In this part, the main necessary materials in this work and it`s properties was prepared. Then method of preparation was defined as well as the mold that was made for forming of required specimens, geometric forms and standard dimensions. The tests performed on these specimens like tensile and creep tests defined.

2.1 Matrix Material

Grains of plasticized polyvinylchloride (PVC) was used as a matrix material in this work because it represents one of thermoplastic polymers that is used widely in different applications , as it known this material is produced in the general petrochemical industrial company in Basrah . This material was supplied from local market. And because easy manufacturing and cheap production costs of this material, it is considered as one of more important plastic materials of wide world currency.

Table (1) mechanical properties of flexible PVC

Density [g/cm3]	1.1–1.35
Thermal conductivity [W/(m·K)]	0.14–0.17
Yield strength [psi]	1450 - 3600
Young's modulus [psi]	350000
Flexural strength (yield) [psi]	11000
Resistivity [Ω m]	10^{12}–10^{15}
Surface resistivity [Ω]	10^{11}–10^{12}

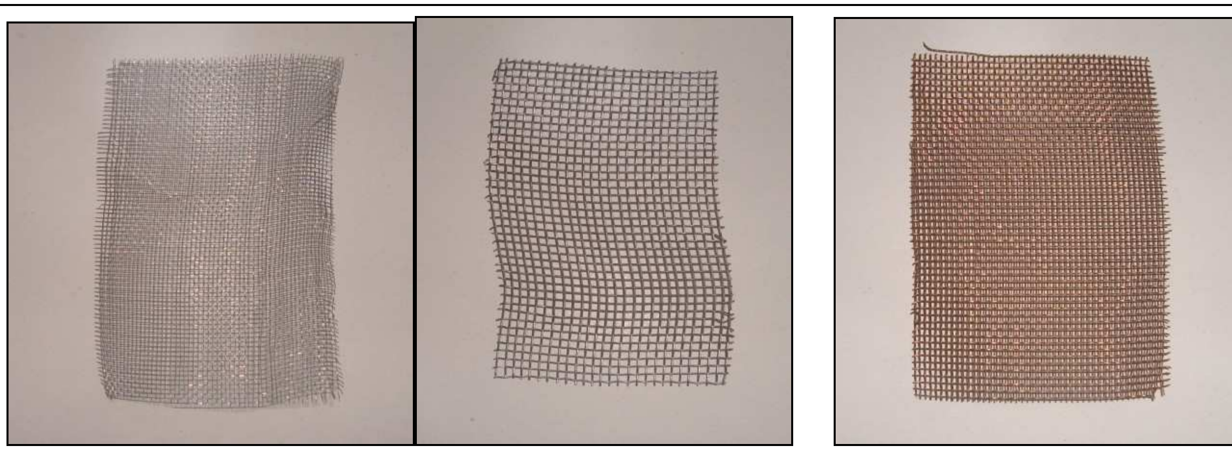
2.2 Reinforcement Materials

Woven wires mesh (0- 90) was used as reinforcement material, as shown Figure (1*)* and has been supplied from local market in three types:-

i- Galvanized steel wire mesh with (1mm) diameter.

ii- galvanized steel wire mesh with(0.25mm) diameter .

iii – galvanized brass wire mesh with(1mm) diameter



a b c

Figure (1) Types of used wire mesh: (a) galvanized Brass wire mesh with 1mm diameter. (b) Galvanized Steel wire mesh with 1mm diameter. (c) Galvanized steel wire mesh with 0.25mm diameter

2.3 Mould Preparations

The iron mould as shown in the Fig (2) was made in the local work shop.

Figure (2) iron mould

2. 5 Specimens Injection Process

In this process, plastic material injection machine as shown in the Fig (3) was used whereas, this type of machine distinct by it ability to inject several types of granular plastics like (PVC, PE, LDPE, PP...etc) in wide range of temperature . An amount of (plasticized PVC) was put in the hopper, and then the machine was heated to (170C^{0}) the mould was fixed between the two platern where the part that contains the injection effluent is fixed in the stationary part of machine and the other part is fixed in the moving platern.

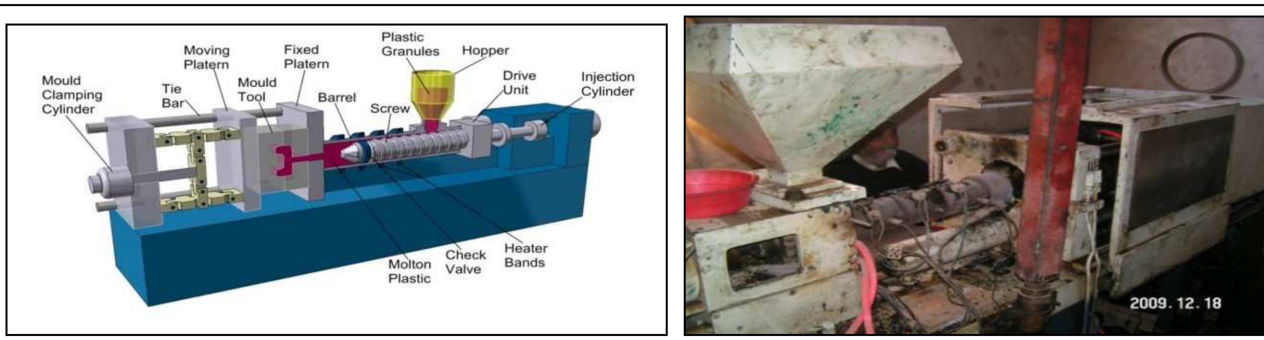


Figure (3) plastics Injection machine

2.6 Creep Specimens Preparation:

Creep specimens was prepared by cutting the mould specimens in form of creep specimens according to ASTM D2990 and standard quoted dimensions from the creep device guide(SM1006) as shown in the Fig. (4).[20]

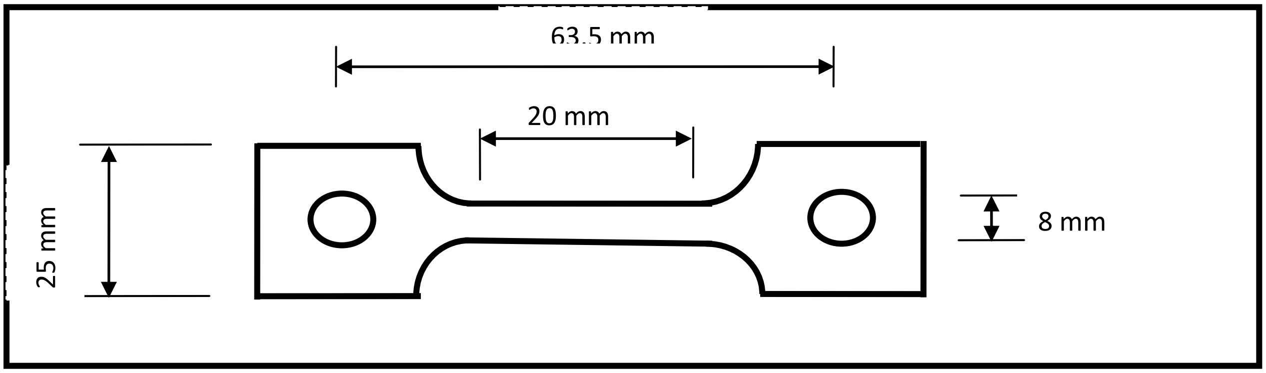


Fig. (4) Geometry and dimensions of the creep specimen used in the study

3. Creep and Recovery Test

The creep and recovery tests have been done by creep machine(SM 1006) at room temperature 35 C^0 in metals lab of material engineering department in engineering collage of Basrah University as shown in the Fig (5). In the creep test the main load of creep is the weight of (arm + pin+ handle pin) .the creep and recovery experimentally test data is abstracted in the table (2):

Fig (5) creep test machine

Table 3 shows results of creep and recovery tests for reinforced and non reinforced specimen

Table (3) Creep Reinforcement and Non Reinforcement

Type of specimen	Creep stress (0.878976 MPa)				Total time (sec)
	Creep time (sec)	Strain	Recovery time (sec)	Strain	
non-reinforcement	1570	0.653	2030	0.421	3600
reinforced by steel wire meshes (0.25mm)	2000	0.048	1600	0.03	3600
reinforced by steel wire meshes (1mm)	1701	0.0175	1899	0.012	3600
reinforced by brass wire meshes (1mm)	1920	0.028	1680	0.017	3600

5-Results and Discuss

Fig (6) shows the creep and recovery curve for the non reinforced creep specimen. The creep and recovery test is done through one hour included (1570 sec) for creep test while (2030 sec) for recovery test. The maximum creep strain in this test is (0.653) but it recovery value is (0.421) after (2030 sec).This rate of creep as a result of strain that used PVC is kind of plasticizer, which is characterized high ductility up to 300% before fracture.

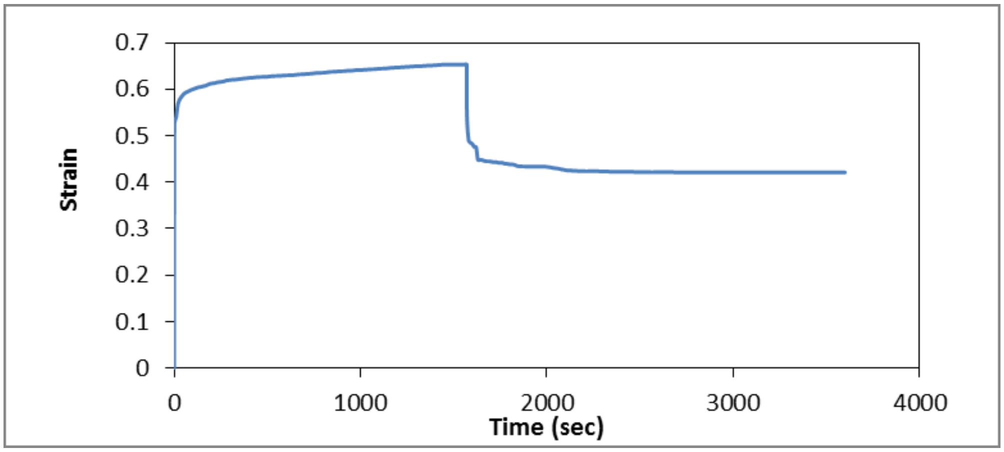


Fig (6) creep and recovery test for non reinforced specimen

Fig (7) shows the creep and recovery curve for the reinforced specimen with (0.25mm) diameter of galvanized wire mesh steel. The creep and recovery test is done through one hour included (2000sec) for creep test while (1600 sec) for recovery test. The maximum creep strain in this test is (0.048) but its recovery value is (0.03) . Note there is an improvement in the creep strain of samples Reinforcement by 0.25 mm diameter of steel wire mesh . this improvement reach to 92% compared with non reinforcement speicemen .

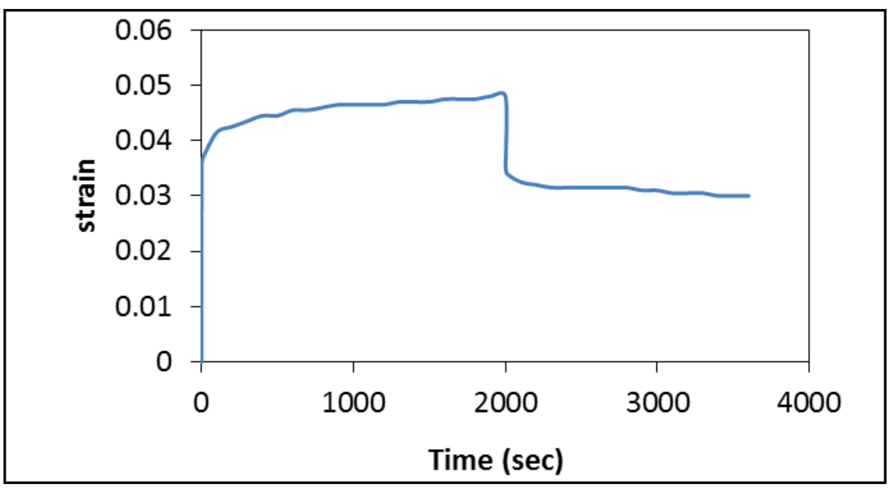


Fig (7) creep and recovery tests for reinforced specimen with (0.25mm) diameter of galvanized wire mesh steel

Fig (8) shows the creep and recovery curve for the reinforced creep specimen with (1mm) diameter of galvanized wire mesh steel. The creep and recovery test is done through (3500 sec) included (1701sec) for creep test while (1899 sec) for recovery test . The maximum creep strain in this test is (0.0174) but it recovery value is (0.012) Through the below diagram that concluded that in the case of reinforcing by 1 mm steel wire mesh. Note getting the biggest improvement in the creep reach to 97% compared with non reinforcement sample because of the use of steel fibers in reinforcing.

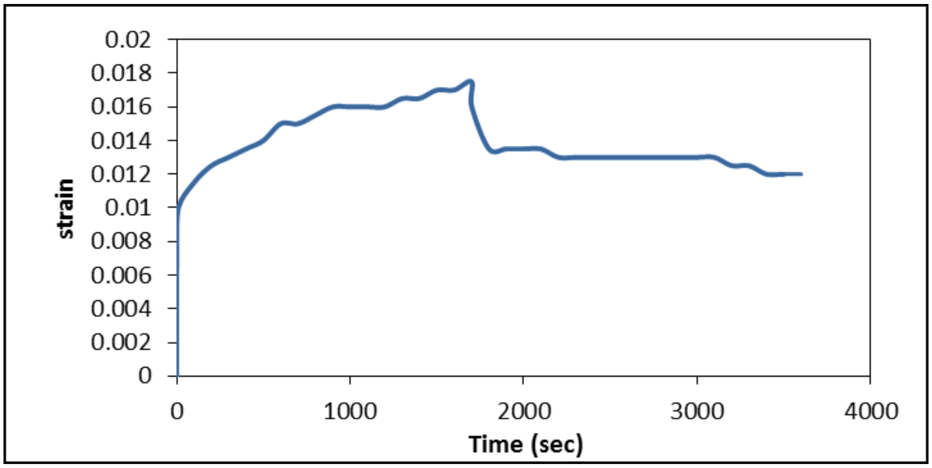


Fig (8) creep and recovery tests for reinforcement specimen by the (1mm) diameter of galvanized wire mesh steel

Fig (9) shows the creep and recovery curve for the reinforcement creep specimen by the (1mm) diameter of galvanized wire mesh brass. The creep and recovery test is done through one hour included (1920sec) for creep test while (1680 sec) for recovery test. The maximum creep strain in this test is (0.028) but it recovery value is (0.017).This show that improvement in creep as 95% compared with non reinforcement specimen.

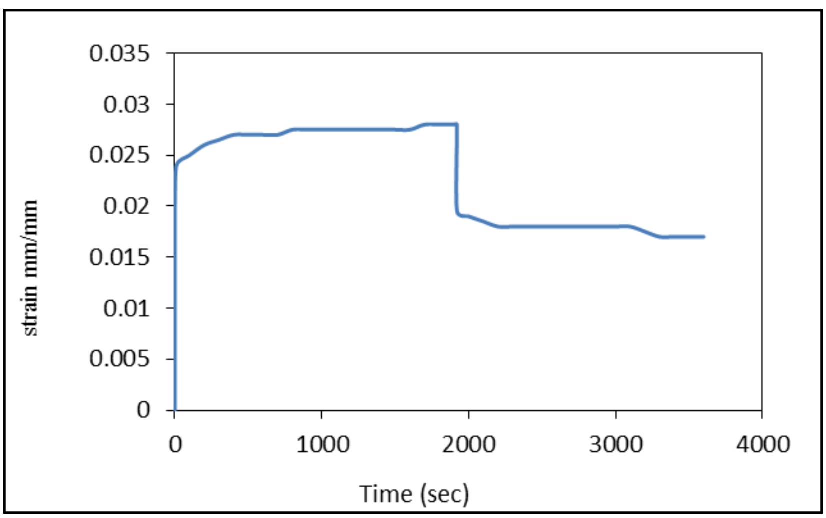


Fig (9) creep and recovery tests for reinforcement specimen by the (1mm) diameter of galvanized wire mesh brass

Fig (10) show the Comparison between the experimental creep and recovery Results for Reinforced and non reinforced specimens. The improvement of creep is shown in the following table (4).

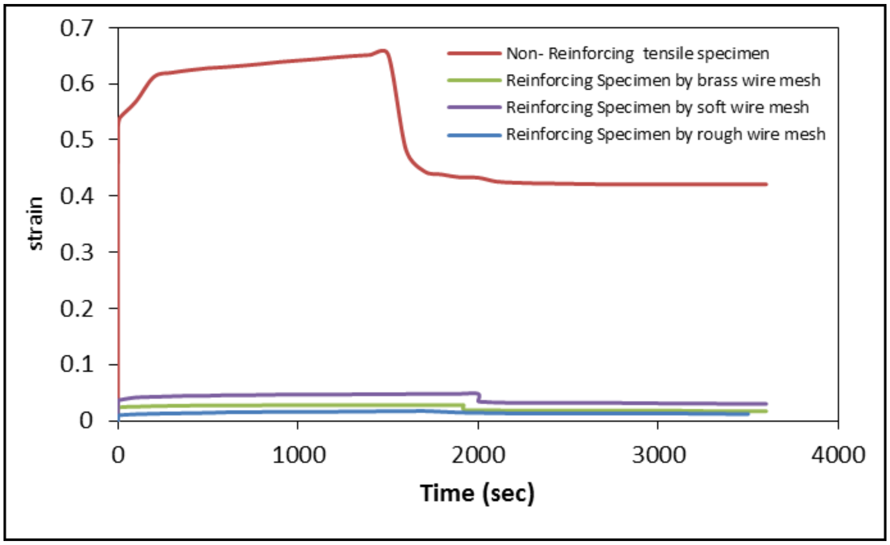


Fig (10) comparing between reinforcing and non reinforced creep and recovery specimens

Note that a large improvement in creep and recovery by reinforcement wire mesh because the using wire mesh is steel &brass on the other hand the creep and recovery tests are done under elastic region . the improvement in creep and recovery for all types of wire mesh are equal approximately as shown in table (4) .

Table(4) improvement in creep and recovery behavior

Material type	Maximum creep strain	Maximum recovery strain
Non reinforced specimen	0.653	0.421
reinforced specimen by (1mm) galvanized steel wire mesh	0.0174	0.012
reinforced specimen by (0.25mm) galvanized steel wire mesh	0.048	0.03
reinforced specimen by (1mm) galvanized brass wire mesh	0.028	0.017

6- Conclusions

Through previous results, it can be observed that creep resistance significantly improved after reinforcing by steel wire meshes with diameters (0.25 , 1) mm and brass wire meshes with 1 mm diameter than could be said that the creep and recovery properties were improved due to using wire meshes it young modulus of elasticity higher than of PVC. Also by using wire meshes with different diameters of the same material as a reinforcement is leads to high resistance of creep is better comparing with non reinforced specimen .

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