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Investigate the Mechanical Properties of Cement Mortar Contain Waste Materials Exposed to Harmful Solution

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Abstract: ***Scientists from all over the world have focused heavily on environmental degradation and the comparatively high cost of trash disposal, which has prompted researchers to develop a way to repurpose waste materials in various applications. Iraqi citizens use hundreds of tons of PVC annually, creating a sizable amount of garbage. Without any benefit or recycling, these vast quantities end up in landfills. In addition, one of the main problems the Iraqi government is currently dealing with is landfills. So, the purpose of this study is to recycle PVC waste. Also, it is known that Reinforced Concrete industrial structures are liable to the effects of crude oil products, which may have a disadvantageous influence on their exploitation and safety. therefore, this paper study, the influence of crude oil products (Gasoline) on the physico - mechanical properties of cement mortar. Therefore, experiments were conducted using cement mortar mixes containing five levels of PVC (0%, 2%, 4%, and 6% by weight of CEMENT). Compressive and flexural strength tests were used to demonstrate how PVC and gasoline influenced the mechanical properties of cement mortar.***

Keywords: cement mortar, compressive strength, modulus of rupture, gasoline, waste, PVC

1. Introduction

Each year, the globe produces millions of tons of waste, the majority of which cannot be recycled. Recycling garbage also uses energy and pollutes the environment. Additionally, the ecology is greatly endangered by rubbish disposal and accumulation in the suburbs. The removal of trash and the addition of beneficial characteristics to concrete can both be accomplished by using waste materials in concrete manufacturing. Given the growth of the green concrete market, it is essential to assess waste - contained concrete on all fronts in order to gauge its potential. [1]

Plastics have taken over many aspects of our daily lives in all their forms. Due to the buildup of plastic - related garbage, the recent increase in plastic demand has resulted in serious environmental problems. Due to this condition, researchers now have a new area of study in which to examine the characteristics and potential applications of recycled plastics as a new generation of building materials. [2]

PVC can currently be processed into a variety of long - lasting products like pipes, window frames, cable insulation, floor coverings, and roof covers, as well as short - lived products like PVC and other materials used in food packaging, detergents, textiles, and medical equipment. [3]

In recent years, plastic usage has increased significantly over the globe, which has resulted in enormous amounts of garbage related to plastic. Due to its benefits to the environment and economy, recycling plastic trash to create new materials like concrete or mortar seems to be one of the finest ways to dispose of plastic garbage. A number of studies have been carried out or are currently being conducted to assess the qualities of cement - composites that incorporate different kinds of plastic waste as aggregate, filler, or fiber. [4]

Due to the significant volume of waste produced and the limited space at dump sites, recycling of plastics has garnered increasing attention in recent years. High - consumption plastics like PVC are particularly affected by this problem. [5] [6]

Concrete tanks have been used to store crude oil and its products since the beginning of the twentieth century. Concrete was increasingly used to create oil tanks due to the severe scarcity and high cost of steel during the Second World War. However, this field saw a breakthrough in the early 1970s when massive concrete rostrums were constructed in the North Sea for the purpose of extracting crude oil and temporarily storing vast amounts of crude oil in submerged concrete tanks. [7]

2. Research Significance

One of the primary motivations for this research, in addition to examining the effects of these wastes on the characteristics of the materials used in building projects and their combined behavior, is the urgent need to collect and develop methodological knowledge about recycle waste materials and helps reduce energy use, reduce the use of new raw materials, reduce water and air pollution, and reduce greenhouse gas emissions.

On the other hand this paper is an attempt to provide some information about effect gasoline on some properties of cement mortar which can be used as storage tanks for petroleum products.

3. Source of Recycled Wastes

The factories that make doors, windows, and some types of home furniture are the sources of these waste materials. These factories are widely distributed in Baghdad, the capital, and the waste materials were collected from these factories, cleaned, and sieved to remove foreign objects and

unwanted materials before being used in the production of concrete.

4. Experimental Work

4.1 Materials

4.1.1 Cement

Ordinary Portland cement, Type I, produced by United Cement Company (TASLUJA - BAZIAN) in Al - Sulaymaniyah / Iraqis used through this study. It is stored in air - tight plastic containers to avoid exposure to atmospheric conditions like humidity. Tables (1) show the chemical composition of the cement used throughout this study. Results indicate that the adopted cement conforms to the Iraqi Specification No.5/1984. [8]

Table 1: Chemical Composition of Cement

Oxide Composition	Abbreviation	Content (%)	Limit of Iraqi Specification NO.5/1984
Lime	CaO	62.33	-
Silica	SiO_2	22.01	-
Alumina	Al_2O_3	5.49	-
Iron Oxide	Fe_2O_3	3.93	-
Magnesia	MgO	0.86	≤5.0%
Sulfate	SO_3	2.04	≤2.5%
Loss on ignition	L. O. I	1.07	4
Insoluble residue	I. R	0.68	1.5
Lime saturation factor	L. S. F	0.83	0.66 - 1.02

4.1.2Fine Aggregate

Al - Ekhaider natural sand of 4.75mm maximum size, was used as fine aggregate. The grading of original fine aggregate is shown in Table (2). Results indicate that fine aggregate grading is within the requirements of the Iraqi Specification No.45/1984. [9]

Table 2: Sieve analysis of FineAggregate Compared with the Requirements of Iraqi Specification No.45/1984

Sieve size (mm)	Cumulative Passing%	Limits of Iraqi specification No.45/1984, zone 3
10	100	100
4.75	96	90 - 100
2.36	89	85 - 100
1.18	81	75 - 100
0.600	67	60 - 79
0.300	27	12 - 40
0.150	3	0 - 10

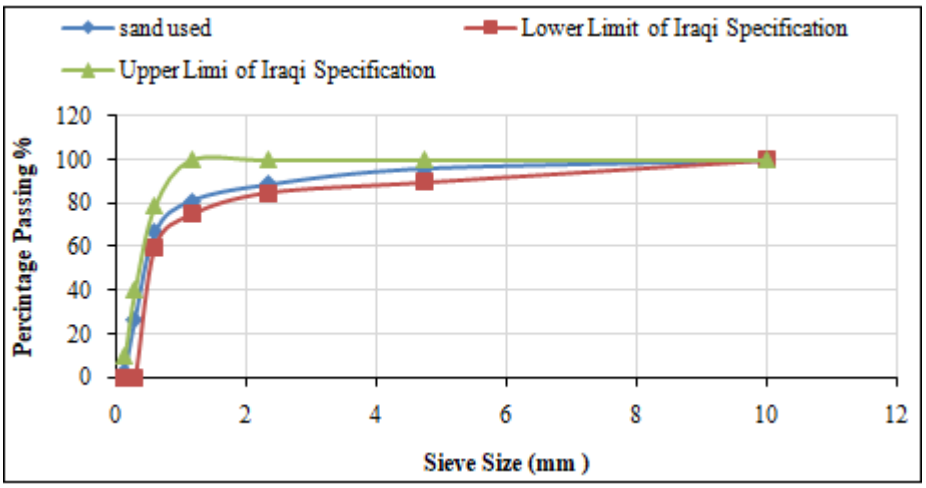

Figure 1: Sieve analysis for the sand used

4.1.2 P. V. C (waste materials)

PVC (waste materials) used in this study as shown in Figure (2)

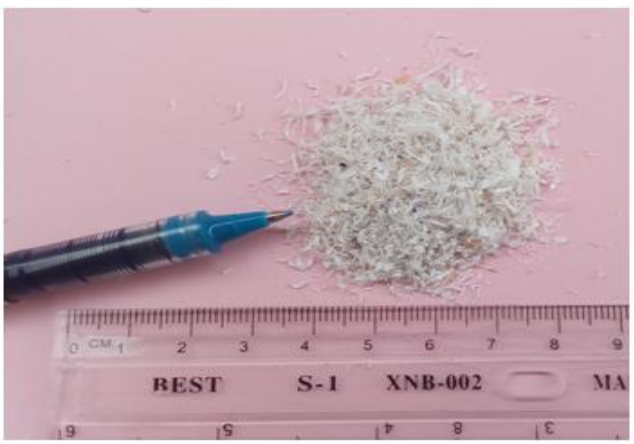

Figure 2: PVC used in this study

5. Water

Ordinary Tap water is used for casting and curing all the specimens for (28) days in this research.

6. Harmful Solution

Gasoline is a transparent, petroleum - derived flammable liquid that is used primarily as a fuel, it consists mostly of organic compounds obtained by the fractional distillation of petroleum, enhanced with a variety of additives.

Many reports indicate that over the long - term, oil does damage concrete. Petroleum products contain sulfur, and when that seeps into concrete it combines with other molecules in the foundation to create acids. These acids destabilize the concrete matrix. Food oils also cause damage to concrete. [10]

7. Testing Program

Specimens divided into two groups each of group contain four mixes In this research, the 50 mm cubic specimens were tested the compressive strength, and prisms (50 x 50 x 150 mm) specimens of modulus of rapture and (50*50*150) specimens mm for modulus of rupture tests according to Iraqi Standard Specification IQS 27 - 1985, [6] for four mixes of each groups.

Table 2: Mix design for the PVC prepared with cement

No. of Group	Name of sample	W/C (%)	PVC (%)
Group 1	0PVC	48.5	0
	2PVC		2
	4PVC		4
	6PVC		6
Group 2	0PVC	48.5	0
	2PVC		2
	4PVC		4
	6PVC		6

8. Mixing Procedure

All mixtures were manufactured in weighted quantities (cement, sand, PVC, and water). Initially PVC. It is added to the cement and sand mixed dry, then the specified amount of water added to the mixture, re - mixed manually for a period of (about 30 seconds), and then poured into the molds. The mold vibrate for approximately 10 seconds. After 24 hours, cubic (5 x 5 x 5 cm) and prisms (5 x 5 x 15 cm) specimens were taken from the mold. Then, the specimens were cured in water for 28 days after that allspecimens were exposed to outdoor conditions for about 2 days at a temperature of about 38°C.

Then the first group exposedto natural conditions in the laboratory, but the second group was placed in the pool contains harmful solution (crude oil products (Gasoline)), and after 28 days the specimens were taken out from the pool, were exposed to outdoor conditions for about 2 days at a temperature It is about 38 °C.

9. Results and Discussion

9.1. Compressive Strength

The data in Figures (3) to Figure (7) and Table (3) to Table (5) show the increase in PVC content from 0 to 2 %, 4 % and 6 % leads to Diminished in compressive strength values 22.75%, 27.78% and 28.94% respectively for Group 1 and Diminished to 20.07%, 26.08% and 26.78% respectively for Group 2 for the specimens which tested in the same age.

The outcomes in this study demonstrated that the ratio of addition PVC particles to the cement mortar should be at the suitable level to obtain rational compressive strength in component could use in some construction applications in spite of exposed to harmful solution.

Table 3: The average compressive strength outcomes of cement mortar with different ratios of PVC

Name of sample	W/C (%)	PVC (%)	Compressive strength (Mpa)	Compressive strength (Mpa)
			Group 1	Group 2
0PVC	48.5	0	26.43	25.31
2PVC		2	20.4167	20.23
4PVC		4	19.0867	18.71
6PVC		6	18.78	18.54

Table 4: Effect of PVC content on average compressive strength for Group 1

Name of sample	W/C (%)	PVC (%)	Compressive strength (Mpa)	Diminished in compressive strength %
			Group 1	
0PVC	48.5	0	26.43	
2PVC		2	20.4167	-22.75
4PVC		4	19.0867	-27.78
6PVC		6	18.78	-28.94

Table 5: Effect of PVC content on average compressive strength for Group 1

Name of sample	W/C (%)	PVC (%)	Compressive strength (Mpa)	Diminished in compressive strength %
			Group 2	
0PVC	48.5	0	25.31	
2PVC		2	20.23	20.07
4PVC		4	18.71	26.08
6PVC		6	18.54	26.75

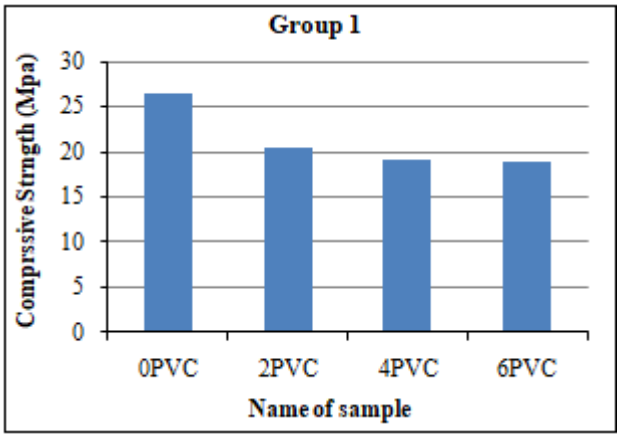

Figure 3: Effect of PVC content on compressive strength for Group 1

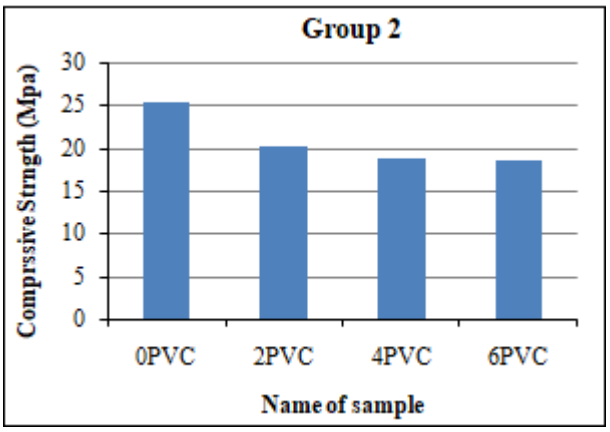

Figure 4: Effect of PVC content on compressive strength for Group 1

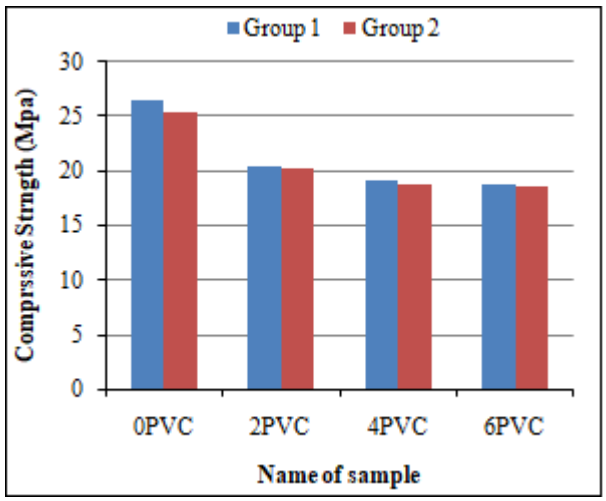

Figure 5: Effect of PVC content on compressive strength

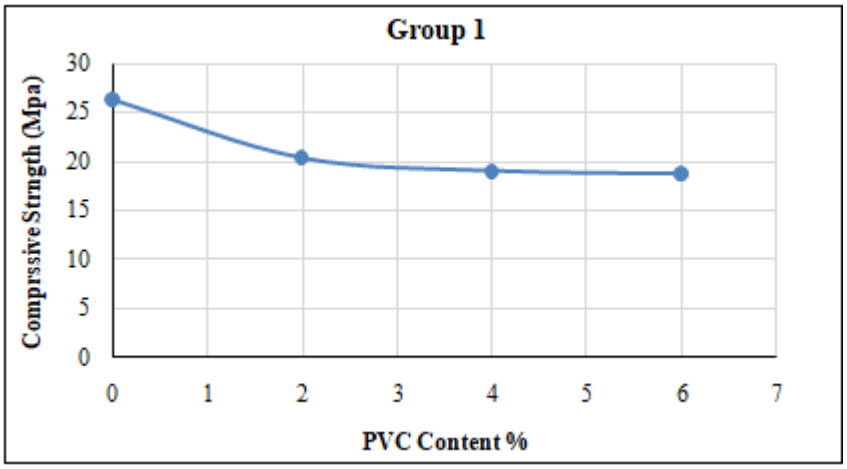

Figure 6: Effect of PVC content on compressive strength

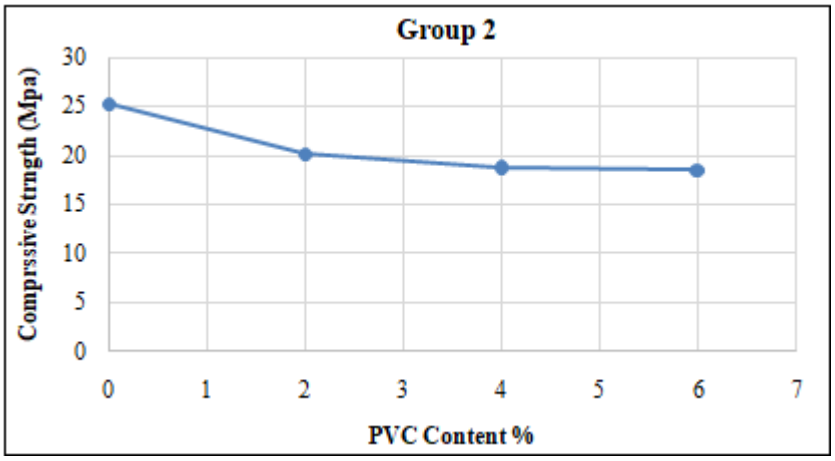

Figure 7: Effect of PVC content on compressive strength

9.2. Modulus of rupture

The data in Figures (8) to Figure (12) and Table (6) to Table (8) show the increase in PVC content from 0 to 2 %, 4 % and 6 % leads to Diminished in Modulus of Rupture values 8.02%, 12.02 % and 13.65% respectively for Group 1 and Diminished to 8.54%, 12.62% and 14.37% respectively for Group 2 for the specimens which tested in the same age.

The outcomes in this study demonstrated that the ratio of addition PVC particles to the cement mortar should be at the suitable level to obtain rational Modulus of Rupture in component could use in some construction applications in spite of exposed to harmful solution.

Table 6: The Modulus of Rupture outcomes of cement mortar with different ratios of PVC

Name of sample	W/C (%)	PVC (%)	Modulus of Rupture (Mpa) Group 1	Modulus of Rupture (Mpa) Group 2
0PVC	48.5	0	5.24	5.15
2PVC		2	4.82	4.71
4PVC		4	4.61	4.50
6PVC		6	4.52	4.41

Table 7: The Modulus of Rupture outcomes of cement mortar with different ratios of PVC

Name of sample	W/C (%)	PVC (%)	Modulus of Rupture (Mpa) Group 1	Diminished in Modulus of Rupture %
0PVC	48.5	0	5.24	
2PVC		2	4.82	8.02
4PVC		4	4.61	12.02
6PVC		6	4.52	13.65

Table 8: The Modulus of Rupture outcomes of cement mortar with different ratios of PVC

Name of sample	W/C (%)	PVC (%)	Modulus of Rupture (Mpa) Group 2	Diminished in Modulus of Rupture %
0PVC	48.5	0	5.15	
2PVC		2	4.71	8.54
4PVC		4	4.50	12.62
6PVC		6	4.41	14.37

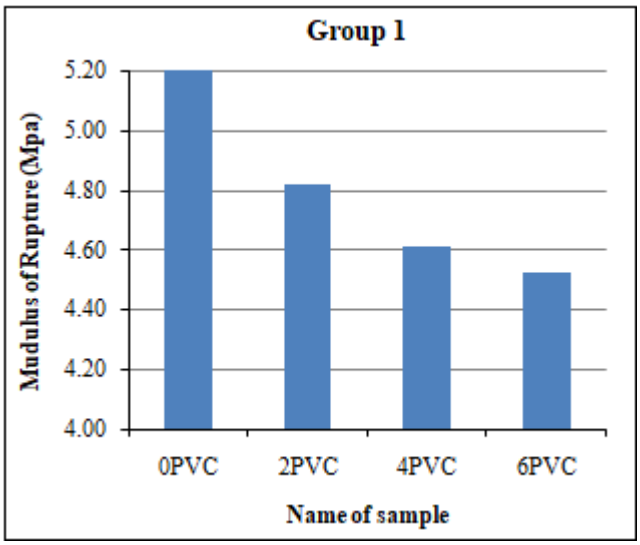

Figure 8: Effect of PVC content on modulus of rupture

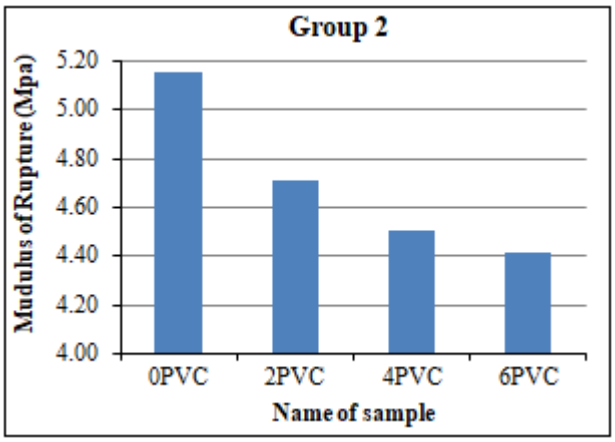

Figure 9: Effect of PVC content on modulus of rupture

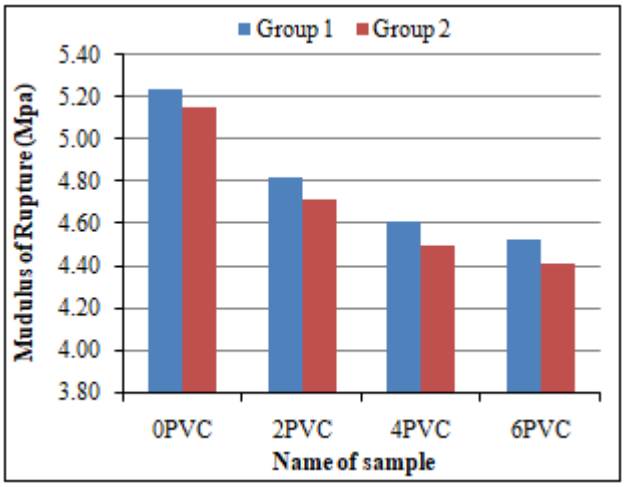

Figure 10: Effect of PVC content on modulus of rupture

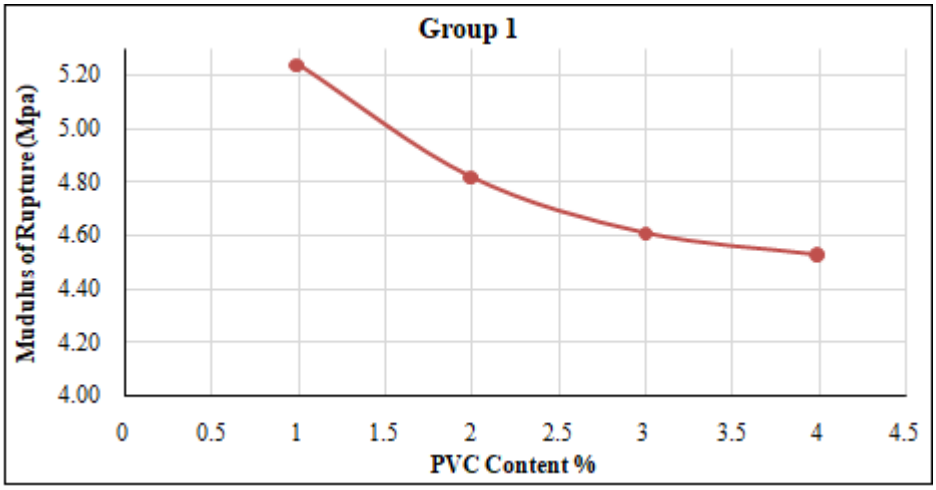

Figure 11: Effect of PVC content on modulus of rupture

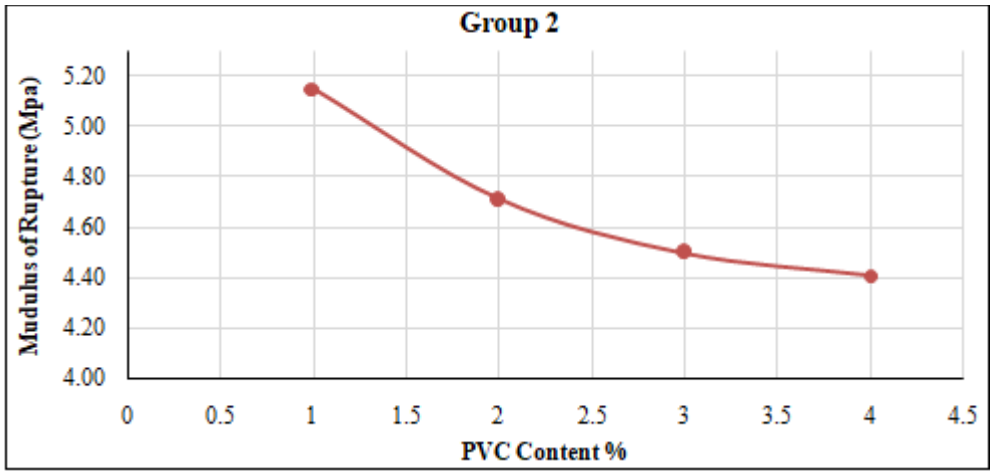

Figure 12: Effect of PVC content on modulus of rupture

10. Conclusions

All of these recycling efforts help to conserve natural resources, one of the primary goal s of resource recovery, This paper investigated the suitability of using PVC derived from The factories that make doors, windows, and some types of home furniture in the production of mortars and influence of crude oil products (Gasoline) on cement mortar.

According to the experimental data previously discussed, Groups 1 and Group 2 cement mortars made with Portland cement and PVC can be used in construction work, especially in nonstructural members, despite exposing the cement mortar to harmful solution. However, the loss in Compressive strength and Modulus of Rupture is appropriate if it compares with the huge benefit of release the environmental from the waste in spite of exposed the cement mortar to harmful solution in addition the PVC cannot effected by crude oil products (Gasoline) because the reaction between two materials is not founded.

Therefore, the authors advised that now is the time to start using residual PVC for construction works in order to maintain our resource and reduce the Global Warming to save Our Planet.

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