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Effect of Cement and Rigid Polyvinyl Chloride Waste on Consistency Limits and Compaction Characteristics of Soil

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Abstract

The plastic wastes of all kinds are the one species polluting the environment and which also have negative effects on public health, where they accumulate in huge quantities in landfills up to millions of tons per year, and to disposal of it depends on technique incineration, landfill and recycling, however, each technique has advantages and disadvantages, as well as raised effects on the environment. Plastic waste is the raw materials can be used in various engineering applications, including many wastes of rigid polyvinyl vinyl chloride (PVC) and plasticized which that contains additives by a large margin.

So this study aimed to get rid of the waste (PVC) and selection used in paving roads by mixing with the soil and cement, which is used granules waste (PVC) in a mixture of soil and cement as a partial substitute for soil, and study the effect of the ratio by mass of granules (PVC) in the mixture on some physical and engineering properties of the soil. The ratio of the granules (PVC) was changed from 0% to 1.25% by the weight of the reality the natural soil in the mixture. The results showed that the addition of granules (PVC) only to the soil may impact significantly on the value of limit of liquidity as the average increase between the ratios in the value of the extent of liquidity was 21.12% compared to the native soil 19.4%, while for a fairly plasticity results showed all it is non plastic at all the ratios (PVC).

It was also study the effect of addition of cement and plastic waste together into the soil and separates on the properties of compaction, it stated results that they decreases the value of the maximum dry density, while the impact on water content optimization differs between them, when add cement only raised while when you add the plastic decreased. Through the results of this study illustrated the possibility to exploit the remnants (PVC) mixing with the soil and used in several applications from the fields of civil engineering, such as paving roads, car parking floors, side waking and other auto plants. The cost of using it is probably less than the cost of disposing of it by traditional methods in addition to the environmental benefits of good at least.

Keywords: *Chemically Soil Stabilization; Ordinary Portland Cement (OPC); Rigid Polyvinyl Chloride (PVC); Compaction Test; Consistency Limits.*

1. Introduction

Environmental pollution is represented a problem of the largest and most serious problems of this age, since ancient times in which lived human was facing different environmental problems, but the environmental problems faced by the people of this century quite different from those of the problems faced by the human during the past thousands years.

Solid waste are those solids or semi-solid which varies components by gravity and the source, where disposed of by dumping in the environment [1], and can be classified into solid waste bio-degradable and non-biodegradable in the environment, solid waste consider more serious than that liquid waste and gaseous pollution, where they cause in all the different elements of the environment, for example: when burned caused air pollution and when dumped in landfills cause contamination of soil and ground water.

The studies of World Health Organization (WHO) have referred that the rate of production of solid waste in the various countries of the world ranging from 0.4 kg / person per day in poor countries and 2.5 kg / person per day in rich countries [2]. The growing problem of solid waste disposal and identify the sources and quantities and their physical and chemical properties led to the search for ways how to manage environmental and good healthy, and because increasing the quantity and multiplicity of sources. The solid waste it has become a pose significant environmental problem and these residues have a direct impact and an indirect negative impact on human health and the environment. The most important pollutants are rigid plastic waste of various types, which have much damage to health and safety of human and also the environment, because to be used widespread in various industrial, commercial activities, agricultural, fill, save and food packaging.

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Chemists have known plastic for more than 150 years ago, where making styrene compound was in 1838, in 1843 were manufactured of acrylic, and polyester in 1847. In 1907 discovered (Lubakaland) phenol plastic, which was the first composite material produced in large quantities, and has since discovered many types and modern plastic material. As making chemical Alexander Parkes in 1862 the first form of the plastic material of cellulose nitrate [3].

2. World Production of Plastic

Plastic production increased from 7 million tons in 1950 to bigger than 150 million tons in 2005, as the value of the annual production of plastic products about 130 billion dollars [4]. Global production reached of the polyvinyl chloride is about 17 million tons in the year 1985. And more than 40 million tons in 2006 [4], saluting expected to reach the amount of polyvinyl chloride waste in year 2020 to about 7.2 million tons per year [5]. Reached the amount of waste polyvinyl chloride in Western Europe in the year 1994 in about 1487 kilotons [6], and reached global consumption of material (PVC) in 1990 to about 17281 kilo tons [7], which refers to the size of the environmental problem, because the accumulation of products (PVC) in the environment. And increasing global consumption of material (PVC) in various industries from the year 1966 until the year 2005, the consumption was hailed in the U.S.A and Japan in the year 2005 only about 5182 kilotons and 2967 kilotons respectively [7,8].

3. Wastes of Polyvinyl Chloride (PVC)

Polyvinyl chloride is the one of plastic materials which used in a widely rang, where are contain different percentages of additives depend on the quality and nature of the application, where classified to rigid PVC which the proportion of additives is relatively small about 2% to 25%, while the PVC plasticizer additives percentage is from 25% to about 65% [4]. The rigid polyvinyl chloride uses in many various applications, including water pipes, sewage pipes and water cannons, as uses in the constructions of building such as doors, windows, insulators and plastic panels, and also uses in the manufacturing of building materials extensions health. Using plasticized of polyvinyl chloride in various industries, including manufacturing medical supplies such as pipes, bags of blood and other also used in food packaging and filling.

4. Damage Plastic and Its Impact on the Environment

Seriousness of plastic is varying from type to another, but the most dangerous types it is PVC, known as (Poly vinyl Chloride), this most common types of plastic a health hazard, as it proved several research that it has led and lead to numerous health problems including various cancers and damage to the immune system, and this type of plastic release toxic substances are many and varied know as chlorinated components, which seep into the water, air and food and is considered responsible for the dissemination of toxic substances on the planet. The industry PVC need to chlorine, one of the industry's most consuming it, and chlorine responsible for the problems of many poisoning, the CFC compound containing chlorine is responsible for the damage to the ozone layer, which has given us by God to protect us from ultraviolet radiation (UV) in sunlight that cause cancers skin. Dioxin compound is the most powerful toxic chemicals and kicks off from the plastic during its production and use or burn, it showed from studies conducted in the United States that the high rate of dioxin in children and adults and this ratio is sufficient to induce health problems for them [9,28].

5. Methods to Dispose of Plastic Wastes

As a result of the growing demand and the urgent need to use polyvinyl chloride (PVC) of plastic products in various sizes led to increased accumulation of waste until it became a burden on the environment and the disposal of the highlights of the environmental problems facing the world. This problem led to increase awareness and the emergence of international attention to need searches for solutions to reduce the negative effects of the accumulation of plastic waste, but the scientists, engineers and researchers starting to think about getting rid of it and it uses in many construction works without detriment to the environment. There are several methods used to dispose of plastic waste, namely:

5.1 Incineration

Which is the most widely used today to get rid of waste plastics, despite the fact this method greatly harm the environment and human and cause many health problems, the burning of plastic to get rid of it leads to the emission of several toxic gases, so it is the most dangerous gases emitted from the burning remnants of polyvinyl chloride as hydrogen chloride gas (HCl), dioxins components (Dioxin), carbon dioxide (CO2), carbon monoxide (CO) and the ash resulting from the incineration process contain heavy elements were added in the form of salts membership during manufacturing processes [9], which resulted in higher temperatures during the burning process (more than 1000^{o} C) can evaporate and spread into the atmosphere.

So as a result of the above, the process of burning PVC is not typical solution to get rid of the waste permanently harm the environment and in terms of public health and thus lead to double gravity [1].

5.2 Landfill

This presses means buried solid waste underground , including plastic waste, and have demonstrated the process of land filling of waste plastic to be ineffective and cause many dangers and large environmental pollution, this waste is composed of material oil chemicals degrade in the heart of the landfill to produce toxic substances causing contamination of soil and groundwater where one ton of waste pollutes about 500 cubic meters of underground water and this water will cause various cancer diseases to human which drink it [10].

5.3 Recycling

It is the process of recycling and use of waste whether home or commercial so as to minimize the impact of this waste accumulation on the environment, and has been confirmed by practical experience in this area as if it were taking recycling programs outlet grandpa can help in reducing the costs of raw material and operating, as well as the usefulness of environmental by reducing environmental pollution, and here the product of plastic recycled usually of lower quality than the basic product used for the first time, and it is not used in the same purposes as the basic product, and in spite of this , the cost of manufacturing more expensive than the cost of manufacturing the basic product in terms of raw materials, which makes the process of recycling is uneconomically logical, but a waste of energy, and still the recycling process for waste PVC is used, as previous studies indicated that rates of recycling ranging from 1% to 3% and the rest is disposed of by incineration and landfill [11]. Recycle of PVC waste is the less recycling rates comparing to other types of plastic wastes, where 6% of PVC only were recycled in west Europe [12]. The study of research referred that only 4300 tons of PVC was recycling from total weight 4,300,000 tons of in USA year 1995, and this quantity represented 0.1% from total quantity of generation in USA, While in Austria the rate of recycling of PVC was 0.25% only in year 1994 [13].

The re-use of waste plastics, especially PVC to get rid of them the best alternative route for the benefit of the environment. The requirements of the civil engineering applications of concrete works in large quantities in various business as well as the production of cement mortar in the manufacture of cement bricks, soil stabilization (for road pavement, slop stability ant etc), tiles, sidewalks of roads, stations, car parking and footpaths, it possible to use the waste of PVC as a partial substitute for the aggregate in the concrete, and has conducted several research in this area to take advantage of waste PVC to replace the rubble, whether fine or coarse in the concrete mixture [14], [15]. Also conducted several separate research to benefit from the wastes of polyethylene and polycarbonate and melamine in concrete admixtures [16, 17]. Kao and his aides have studied the use of PVC waste in concrete admixtures to replace the rubble, sand river partially [18]. As the researcher Kinda Hannawi and his aides have studied the physical and mechanical properties of the cement mortar that contains the type of plastic waste PET, PC as aggregate in the mixture [19]. Choi and others studied the effect of waste PET bottles aggregate on the properties of concrete [20]. The influence of curing conditions on the durability-related performance was studied by Silva and Brito [21]. A. Najjar and E. A. Basha studied the use of rigid PVC wastes for partial replacement of natural coarse aggregate in concrete mixture [22]. E. A. Basha., and A. J. Dabdab were used the PVC of waste as a partial substitute for the fine aggregate for production cement bricks [23]. PardisParto and BehzadKalantari were investigated in two researches carry out the effect of polypropylene fibers on the California bearing ratio and compressive strength of stabilized wind-blown sand [24, 25]. Also the effects of waste plastic fibers on compaction and consolidation behavior of reinforced soil were investigated by Arpan Lascar and Sujit Kumar Pat [26]. Mona Malekzed and HuriyeBilsel studied the effect of polypropylene fiber on physical and hydro mechanical behavior of expansive soils [27].

6. Advantages of PVC as the Industrial Soil

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The waste of PVC especially (UPVC) is characterized properties of high mechanical compared with the rest of the plastic waste , where the waste UPVC non- annealed and characterized a degree of hardness being able to exploit it to improve the soil, although the PVC material is hydrophilic, do not interact with water and do not interfere in the reaction hydrogenation (hydration reaction) during the period curing of the soil, but some applications of soil stabilization do not need soil to resist the high pressure, which can be used in this type of waste in the soil structure, so can be use the waste of PVC as non-industrial or industrial soil, where the PVC granules characterized advantages can be summarized as follows:

- **i.** Have a high resistance to chemicals, particularly alkaline ones.
- **ii.** Low density compared with natural sandy soil, which gives lightness in weight.
- **iii.** Have resistance acceptable for loads.
- **iv.** Used as the industrial soil or industrial sand does not require additional energy to run.
- **v.** Have a high melting point (TM) supports use in improving the soil.
- **vi.** Have high degree glass transition (Glass transition temperature) make it bonds unable to move at high temperatures relatively even (80^o C).

During cracking waste PVC to granules, they are not given a regular geometric shape (circular) and therefore they are holding within the structure of the soil and contribute to the resistance loads, in addition to that cannot be separated from the soil structure.

The uses of PVC waste in the soil stabilization has many benefits in terms of contributing to the reduction of accumulation in the landfill and get rid of it due to its use in improving the soil, and use it in other works, such as the work of ordinary concrete and cement mortar. The aim of this study is to choose rigid waste PVC in use as improved engineering properties and the physical properties of the soil. Where then test the limits of its influence on Atterberg limits and the maximum dry density (MDD) and optimum moisture content (OMC) of compaction test.

7. Materials and Tests Used

7.1 Materials used

7.1.1 Soil

Used a soil obtained from the area of the Almamora adjacent to Azzahra city in Libya, where it was taken a sample of soil from a depth of half a meter below the surface of the earth in order to overcome roots of plants surface and have been purified completely from organic materials and all the stones with a diameter larger than half of centimeter, then dried in the oven for 24 hours at a temperature of 110 C^o and left to cool for two hours at least, then conducted by the laboratory experiments necessary for the purpose of classification and find the engineering and physical properties, and through the results obtained and in accordance to AASHTO classification system concluded that the type of soil fine sand (A3) and specific weight is 2.68 . Table (1) shows the results of soil sieve analysis and Figure (1) shown grain size distribution.

7.1.2 Rigid Polyvinyl Chloride (PVC)

Used of PVC in this search out of production for Libyan factory Abekemash west of Tripoli city about 100 km, were obtained from the company's complex national industry to production pipes, Janzour city in west of Tripoli city about 25 km, which is a granular soft were milling waste of PVC prior to use with sizes ranging from 1 mm to 2 mm were used in this study, and the density is 1.35 g/cm3.

7.1.3 Ordinary Portland Cement (OPC)

Cement used in this study was obtained from the local market and factory plant of Souk Alkhamies, the market kind of Ordinary Portland Cement (OPC), the specific weight is 3.20 and seeded on the strength of 42.5 N.

7.1.4 Water

It has been preparing specimens before every testing by mixtures of soil and water with additives and stored for a week.

7.2 Tests Used

It has been preparing specimens before every testing by mixtures of soil and water with additives and stored for a week.

7.2.1 Sieve analysis

This test was performed on samples received from the sites, according to the specifications of the USA (1966- ASTM-D 422), and that for the classification of soil and granulated plastic wastes from an engineering stand point and determine its compliance with the specifications, noting that drying the soil has been in the oven at a temperature of 110 Co for 24 hours and cooling before use.

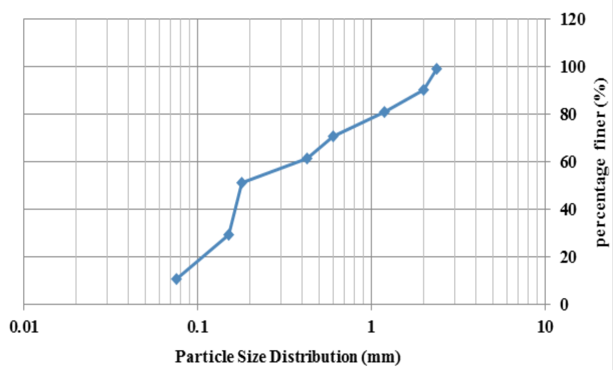


Figure 1: grain size distribution for soil used

7.2.2 Specific weight

This test was conducted for the soil and the plastic waste used in accordance with the specifications of the USA (ASTM-D854-1958), and the results showed that the specific weight of the soil 2.68 and plastic waste (PVC) 1.35 g/cm3.

7.2.3 Consistency limit

It has been testing separately plasticity and liquidity, according to the USA standard (ASTM 4318) and (AASHTO T89 and T90). Soil used in this test passing 0.425 mm sieve. The tests were conducted on soil with different ratios of cement and polyvinyl chloride (PVC).

7.2.4 Compaction test

The standard Proctor test were used, accordance to the USA standard (ASTM D698-1970 and D1557) and (AASHTO T99 (standard)) so as to find the maximum dry density (MDD) and optimum moisture content (OMC) of the soil.

8. Test Program

In order the effect of the variables on the geotechnical properties, the ratio of all the additives in the soil were varied as described in the following table (1). The properties studies were liquid limit, plastic limit and compaction.

Table: 1 program of laboratory tests, see Appendix 1

8.1 Samples preparation

The fine sand sample was dried in an oven for 24 hrs at 110o C. Before use all proportions of the additive were prepared by weight of dry soil. Six samples of mixture were prepared for every proportion of additives, five for compaction test to find OMC and MDD and one for finding Atterberg limits.

8.2 Mixing and curing procedures

For the results, cement should be uniformly distributed and mixed throughout the material. The addition of water helps the cement to adhere particles of the soil and prevents segregation. The manual method were used for mixing the soil with additives, the amount of cement were 2%, 4%, 6%, 8%, and 12%, and PVC were 0.25%, 0.50%, 0.75%, 1.0%, and 1.25%, by weight of dry soil were employed. Every proportion was added to the soil and the dry-mixed by manual mixture into uniform mixture.

The OMC of pure soil for standard proctor maximum density was then used into the mixture until it appeared that the water had been evenly distributed. About 3% of water was added to each soil cement mixtures to ensure adequate water for cement hydration. The additive-soil mixture was the cured in the plastic bag to prevent moisture loss for 7 days. The soil mixture was dried in an oven for24 hrs. At 110o C. after that, the mixture was cooled in the air and the liquid limit, plastic limit and compaction were performed.

9. Results and Discussion

9.1 Effect of cement and plastic waste on the soil consistency

9.1.1 Effect of cement and plastic waste on the liquidity

The effect of cement and plastic waste (PVC) on both of plasticity and liquidity of the soil are illustrated in the table (2).

The comparison showed that the different characteristics and behaviors of all soil mixtures. Note, through results that the addition of both cement and PVC into the soil, resulting in a continuous increase in the liquidity limit, in spite of the difference between cement and PVC in the degree of unity rally, where noted that the degree of elevation of add cement only larger than in the case of adding PVC only to the soil, where it was the highest value reached at cement 40.38%, while the highest value at the PVC was 24.80%. Overall, the increases in the case of added cement may be for two reasons; first: need cement to finish the interaction, and the second: is the increase in the size of the voids between the particles, and that occurred during the storage period because of contiguity between the grains.

In the case of PVC increases is properly to have occurred for two reasons:

1. Namely the increase in the surface area of the particles after the addition of plastic.

2. The increase in the size of the blanks or voids because the size of the plastic granules smaller than the size of the soil particles, which led to the re-arrangement of the distribution of the size of the granuloma of the sample. In addition, the plastic does not react with water, where it is scientifically known that plastic hydrophobic material.

Table 2: The results of liquid limit of soil + additives

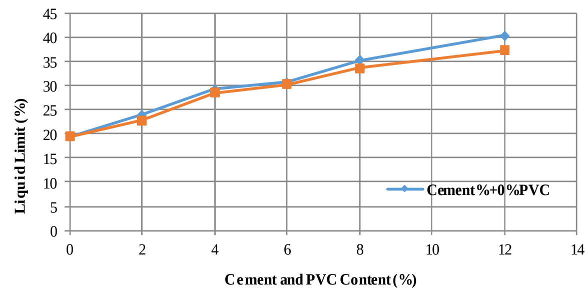
C%	0	2	4	6	8	12
LL%	19.40	24.00	29.24	30.70	35.20	40.38

PVC%	0	0.25	0.50	0.75	1.0	1.25
LL%	19.40	19.70	21.00	19.80	24.80	20.70
C% + PVC%	0 + 0	2 + 1.25	4 + 1.25	6 + 1.25	8 + 1.25	12 + 1.25
LL%	19.40	22.85	28.58	30.30	33.62	32.33

PVC% + C%	0 + 0	0.25 + 6	0.05 + 6	0.75 + 6	1.0 + 6	1.25 + 6
LL%	19.40	24.80	26.30	27.60	29.45	30.30

From figure (2) notice of the curve representing add 1.25% PVC as a constant with changing cement ratios to the soil, the liquidity limit rises constantly and follows the same behavior curve of add cement only to the soil, but the values of the results difference as that in the case of cement added only, where to be slightly higher values. And can deduce from this that the PVC may impact in reducing the liquidity limit when adding cement.

In the case of fixed add cement ratio 6% to changing plastic ratio in the soil, noted through the curve in figure (3) that the liquidity began to rise even higher value has reached 30.30%, but the values of the results reduced compared to all the results of the previous cases, whether add cement only, or in the case of plastic fixed with change cement, or in the case of plastic only. In general, note that the highest value of liquidity in the order, observed when adding cement only, been followed when fixing plastic proportion with cement variable, then when fixing cement ratio with changing plastic ratios, while the latter case when adding plastic only where does not get any development mentioned, can see results in table (2).



Figur 2: Variations LL of soil with additives cement and PVC

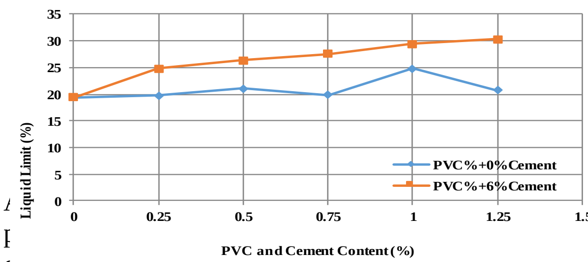


Figure 3: Variations LL of soil with additives PVC and Cement

the plastic and hardened cement granules after interaction property.

9.2 Effect of cement and PVC on the soil compaction characteristics

9.2.1 Effect of cement and PVC waste on the dry density of the soil

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Table (3) shows the values of maximum dry density (MDD) for all the different proportions of cement and PVC in the soil. Figures (4) and (5) represent the relationship between the additives and maximum dry density; it is through curves behaviors observed the effect of these additives on the maximum dry density very clear, except when adding PVC only to the soil. It is through these paths curves shown that the more cement and plastic ratio increased to soil the value of dry density decreases, although the decline is almost a gradual and slow. Also note that the densities are lower when adding cement comparing at add the plastic waste to soil. In fact, that the reason of the low density, probably attributed to the poor size distribution of soil, caused to the difficulty of cement to link between soil particles after interaction with water, and the intransigence creating large voids between the particles. As in the case of plastic waste, the causes of the low density is attributable to the value of the density of plastic smaller than the density of soil, in addition to the specific weight where is smaller too. When fixed proportion of plastic 1.25% with a change in the cement ratios in the soil, noted that density reduced at all points, and there are no significant differences in the results when compared at add cement only to the soil, and this is evident through the results shown in table (3), and the conduct of the curve behavior similar to a large extent, as is evident in figure (4).

Table 3: show the results of MDD of soil + additives

(C%) MDD	0 1.90	2 1.61	4 1.59	6 1.46	8 1.48	12 1.44
(PVC%) MDD	0 1.90	0.25 1.87	0.50 1.86	0.75 1.84	1.00 1.84	1.25 1.82

(C% + PVC%) MDD	0 + 0 1.90	2 + 1.25 1.75	4 + 1.25 1.66	6 + 1.25 1.46	8 + 1.25 1.42	12 + 1.25 1.39
(PVC% + C%) MDD	0 + 0 1.90	0.25 + 6 1.66	0.50 + 6 1.66	0.75 + 6 1.65	1.00 + 6 1.67	1.25 + 6 1.55

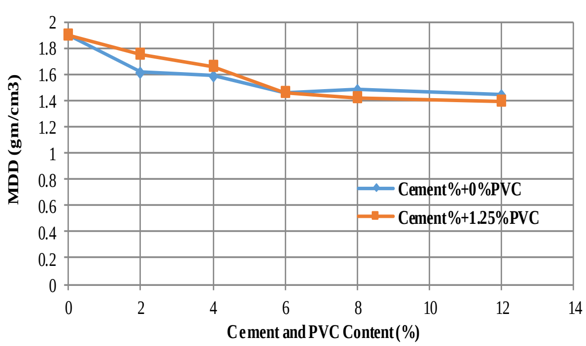

Figure 4: variations MDD of soil with additives cement and PVC

Through figure (5), which represents the relationship between the maximum dry density and adding plastic waste (PVC) only to the soil, as well as when you add and fixed cement ratio of 6% to variable plastic proportions to the soil, noted of during the course of the curves behavior that effect add cement with plastic together to the soil are greater than the effect of adding plastic only to the soil, and also obvious by the results shown in table (3), where found that the smaller value of the density in the case of adding plastic only is 1.820 g/cm3, while in the other case the value is 1.549 g/cm3.

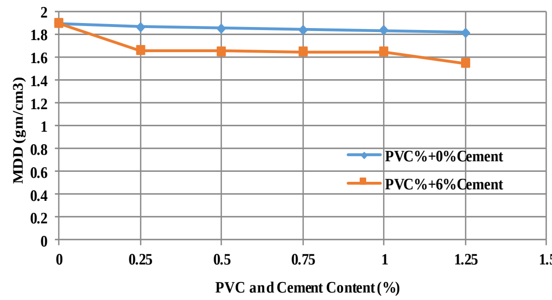

Figure 5: Variations MDD of soil with additives PVC and Cement

In fact, note that through the shapes and the results of tables, it is clear and obvious that the effect of adding cement only to the soil and the addition of plastic as fixed ratio to cement as a variable to soil, or add cement as a fixed ratio to plastic as a variable ratio to the soil on maximum dry density of soil. While when adding plastic only to the soil was very small. The speculate in the interpretation of these cases are as follows: First, in the case of adding plastic just may be caused by the size of the plastic granules have improved gradation of the soil since it is a poor gradient, in addition, the plastic granules have facilitated the sliding soil particles and densiting by layout of air from voids, so because of the softer plastic granules allowing this flexibility, which is characterized by plastic physically overlap and densiting for coarse grains of soil and convergence over each other.

Second: and for the rest of the other cases shall be the reason for falling density is in two important reasons are the contiguity and assembly, which happened to granular soil in large fragments, because the cement interaction with water which create large spaces between these fragments, resulting in lower density, and another reason is the small plastic density compared to the soil and cement.

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9.2.2 Effect of cement and PVC waste on moisture content of the soil

From the results in table (4) and through figure (6) noted from the curve at add cement only to the soil that the water content began to rise even to the rate of 8%, After that the curve dropped when the ratio of cement was increased up to 12%. The interpretation of this event to the increase in water content at add the three first ratios of cement, the reason may attributed to this quantity of cement is insufficient to fill the voids and collect soil particles with each other due to the gradient poor soil. In addition the greater the amount of cement increased need more water for completion of the reaction, and when started to reach sufficient cement ratio, began decreasing voids and increased the effectiveness of cement interaction for combining soil particles, then decreased water content and began to decline. When add 1.25% plastic as a fixed ratio to the all cement ratios in the soil, noted that the water content increased at adding first four ratios up to 8% cement + 1.25% plastic, then dropped at the rest of the other ratios, illustrated by this behavior, the greater cement ratio increased water content, because the cement needed water for to complete the reaction. In fact, note through figure (6) that the curves behavior are similar when adding cement only to soil or when add plastic to cement in the soil, but the difference only is in the values of the results. And also noted that the water content values when adding cement only to the soil is higher than when adding plastic waste with cement to the soil, and this is due to the hydrophobic plastic material where does not interact with water, while the cement always needs to be an increase water proportion for to process interaction.

Table 4: show the results of OMC of soil + additives

(C%) OMC	0 10.30	2 16.20	4 16.95	6 22.34	8 13.10	12 18.00
(PVC%) OMC	0 10.30	0.25 12.49	0.50 12.62	0.75 11.60	1.00 11.32	1.25 11.25

(C% + PVC%) OMC	0 + 0 10.30	2 + 1.25 15.15	4 + 1.25 15.95	6 + 1.25 16.32	8 + 1.25 14.79	12 + 1.25 14.14
(PVC% + C%) OMC	0 + 0 10.30	0.25 + 6 17.95	0.50 + 6 18.22	0.75 + 6 16.60	1.00 + 6 14.94	1.25 + 6 14.41

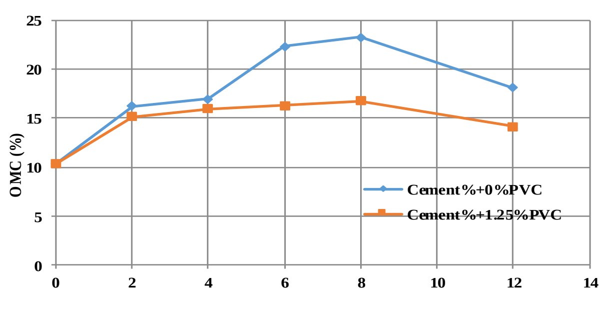

Figure 6: Variation OMC of soil with additives cement and PVC

Through results in table (4) and figure (7) it is clear when adding 6% cement to the changing plastic ratios in the soil, and when compared to the curve which represents add plastic only, It is found that the behavior of curves decline are similar and the difference only in the values of the results, where noted that the water content in the case of adding plastic only higher than when add cement and plastic together into the soil, from this behavior it is noted that the effect of adding cement to plastic in the soil reduced water content due to the interaction of cement. But when continue to increase the plastic ratios the water content is began reducing gradually until the last ratio was used, the reason may be due to that the higher increase percentage of plastic are caused to fill the voids and then improves gradation and thus water content dropped. In addition it is known that plastic material is hydrophobic where it does not absorb water, therefore when the plastic ratio increased in the soil the water content decreased.

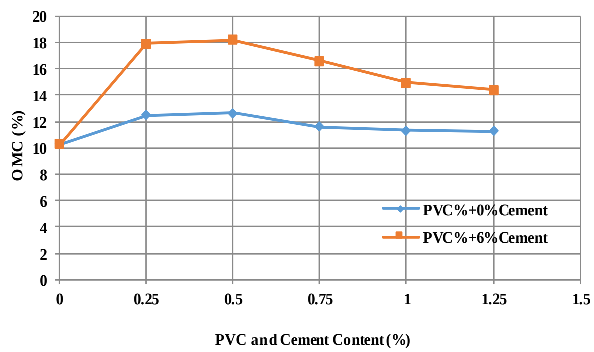

Figure 7: Variations OMC of soil with additives PVC and cement

rate used in this research, it is due to the disposal of the highest possible amount of this dangerous material for the benefit of the environment, including cleanliness. And the selection of 6% cement added to the changing proportions of plastic in the soil, is due to the economic terms as the price of cement is quite high compared to other construction materials.

The addition of plastic waste to the local soil for the construction of road pavements and the other constructions, are one way to get rid of this waste, and at the same time its investment to improve the strength of soil resistance, and it is not only limited to that but also follows includes:

1. The advantage of this mixture lightly weight because the plastic waste density is much lower than the density of soil.

2. Features characteristic mixture plasticity compared to regular soil because of plasticity of plastic is characterized it, and this in turn contributes to the absorption of loads that pass over it.

3. The addition of plastic waste leads to a reduction of voids and thus reduces the porosity of the soil, thereby reducing to water absorption.

4. The properties of plastics that material hydrophobic, that mean unabsorbed and does not interact with water, and this property leads to decrease in water absorption, and therefore the soil resistant to corrosion and decomposition because of salts and sulfates and acids dissolved in the water, as well as the resistance to fragmentation due to exposure to the phenomenon of freezing and expansion and contraction.

10. Conclusions

Through the results obtained from the reality of laboratory experiments and after use add cement and waste plastic of PVC into the soil conclude the following:

1. The addition of cement only to the soil has increased the liquidity for all ratios. As for the plasticity the results showed that all mixtures of different ratios of cement additive in addition to the natural soil it is non plastic.

2. The results showed that the addition of plastic only to the soil increased liquidity for all proportions added, and for plasticity the experiments showed that all the samples of soil mixture is non plastic.

3. At add 1.25% plastic as a constant to all the changing proportions of cement in the soil the values of liquidity rose at all proportions added, but when fixed cement ratio of 6% to plastic additive variable in the soil concluded that liquid limit was not affected in general, compared to the original soil.

4. The addition of cement and plastic separated into the soil reduced the values of dry density, it is noted that the increasing the cement or plastic proportions decreased dry density, but the effect of cement on the density was greater, either when add cement and plastic together in both cases to the soil reducing the values of density at all points.

5. Conclude that the water content raises as the higher proportion of cement until reach the ratio to 8%, after this rate begins to reduction. While when add plastic can be note that the water content has increased at the first and second ratios added (0.25%, 0.50%), and then begin a steady reducing in the rest of the other ratios. But when adding cement and plastic together into the soil in both cases, conclude that the water content rises in the first points after that were reduced in the rest of the points, also can be conclude that the water content values at fixing plastic ratio with changing cement ratios add was biggest than the second case when fixing cement ratios with changing in the plastic ratio.

Appendix 1

Table: 1 program of laboratory tests

Series	Test No	Type of Soil	Sample Preparation	Curing Time	Type of Curing	Test Used
1	A1	FS	Natural Soil			LL.PL.SCT
2		FS	Soil + Cement			
	B1		Soil +2% C	7 days	Pb	LL.PL.SCT
	B2		Soil + 4% C	7days	Pb	LL.PL.SCT
	B3		Soil + 6% C	7 days	Pb	LL.PL.SCT
	B4		Soil + 8% C	7 days	Pb	LL.PL.SCT
	B5		Soil + 12% C	7 days	Pb	LL.PL.SCT
3		FS	Soil + PVC%			
	C1		Soil + 0.25% PVC	7 days	Pb	LL.PL.SCT
	C2		Soil + 0.5% PVC	7 days	Pb	LL.PL.SCT
	C3		Soil + 0.75% PVC	7 days	Pb	LL.PL.SCT
	C4		Soil + 1.00% PVC	7 days	Pb	LL.PL.SCT
	C5		Soil + 1.25% PVC	7 days	Pb	LL.PL.SCT
4		FS	Soil + C% + PVC%			
	D1		Soil + 2% C + 1.25% PVC	7 days	Pb	LL.PL.SCT
	D2		Soil + 4% C + 1.25% PVC	7 days	Pb	LL.PL.SCT
	D3		Soil + 6% C + 1.25% PVC	7 days	Pb	LL.PL.SCT
	D4		Soil + 8% C + 1.25% PVC	7 days	Pb	LL.PL.SCT
	D5		Soil + 12% C + 1.02%PVC	7 days	Pb	LL.PL.SCT

			Soil + PVC% + C%			
5	E1	FS	Soil + 0.25% PVC+6% C	7 days	Pb	LL.PL.SCT
	E2		Soil + 0.5%+6% C	7 days	Pb	LL.PL.SCT
	E3		Soil + 0.75% PVC+6% C	7 days	Pb	LL.PL.SCT
	E4		Soil + 1.0% PVC+6% C	7 days	Pb	LL.PL.SCT
	E5		Soil + 1.25% PVC+ 6% C	7 days	Pb	LL.PL.SCT

FS : Fine Sand , Pb : Plastic bag , C : Cement , PVC : Ploy Vinyl Chloral , LL : Liquid limit , PL : Plastic Limit , SCT : standard compaction test , SA : sieve analysis , GS : Specific gravity

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