International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

Stabilization of Soil using Mixture of Acrylic and Polycarbonate Polymer

Jasfeeda Mushtaq[1], Gunjan Bhalla[2]

[1]*M.Tech Scholar, Dept. of Civil Engineering, CT University, Punjab, India*
[2]*Assistant Professor, Dept. of Civil Engineering, CT University, Punjab, India*

Abstract - *From ages we are facing a lot of problems due to expansive soils like failures or damage of structures. This problem is due to high shrinkage and low strength of expansive soils especially clays. The properties of shrinkage and swelling vary at different water contents. Due this high range in variation, our structures undergo failure or damage. In order to cope this damage, we had done many experiments and research but still we are lacking and lagging. Either there is availability or economic issues or sometimes results obtained were not futile enough. That is why we are still researching and experimenting. Thus there is a need to provide an economical material to strengthen soil. This paper aims to evaluate the use of mixture of acrylic and polycarbonate in Geotechnical applications and the effect of waste Acrylic and polycarbonate on engineering properties of expansive soils. Twelve different samples were prepared. Four samples were those containing 0 to 6 percent of acrylic polymer, four were those which were having only polycarbonate ranging from 0 to 6 percent and the rest were having mixture of acrylic and polycarbonate. All the samples were tested for unconfined compressive strength determination after 3, 7 and 14 days of curing period. It was concluded that the addition of acrylic and polycarbonate polymers into expansive clayey soil can significantly improve the engineering characteristics like optimum moisture contents, maximum dry density, Atterberg's limits and unconfined compressive strength of expansive soil.*

Key Words: **Atterberg's limits, Acrylic Polymer, Polycarbonate, Compaction characteristics, Unconfined Compressive Strength, Soil Stabilization**.

1. INTRODUCTION

Soil stabilization is the manmade process introduced many years ago and its main aim is at modifying the properties of soil [1]. Soil Stabilization is that process in which various materials either naturally occurring man-made are injected into the soil and leads to enhancement of various properties of soil like shear strength, bearing capacity etc. It controls the swell-shrink properties. This process has been proved very helpful in case of expansive soils [2]

Previously many materials have been used for stabilization. Many researchers have used either manufactured, natural or by product materials [3][4][4] like fly ash, lime, tile, waste tires, chips, granules, acrylic polymers etc. Since expansive soils are highly swelling and have high shrinkage power making it unsuitable for construction purposes .As they undergo high volume change on absorbing water [5][6]. So far lime has been in much use as it is regarded as the most suitable for enhancing expansive soils having fine fractions in excess of 25 percent. The chemical reaction occurring between soil and lime is responsible for strength improvement in soil. By adding egg shell powder the Atterberg's limits showed much degradation in its values and after reaching the amount of 20 percent the Atterberg's limits were almost found to be constant. In order to avoid such problems polymers can be used as an additive for soil stabilization as the former are not easily available everywhere and not much economical instead polymers are easily available and are economical. Polymers can be recycled and reused and are found in those things which are used in day to day life. In this research we are using a mixture of acrylic and polycarbonate polymers which are easily available in waste products like plastic bottles, hard discs, polyethene bags etc. Since these wastes are increasing day by day so using them for such a relevant process, we can have a waste free environment. As acrylic polymer has been previously used for soil stabilization of expansive soils [7] but if on mixing it with polycarbonate we can have better results and better enhancement in soil properties.

2. MATERIALS

2.1 Soil

The principal component used in almost all construction works is soil. Soil plays an important role while we are determining engineering properties of materials used in construction work. So, it is our main concern to look after the soil its type and various properties. The soil which we are using in our study is expansive soil. It has been taken from different parts of Punjab which are almost 5 kms away from the CT University Ludhiana. The soil was then pulverized for testing. Atterberg's limits, compaction and unconfined compressive strength tests. The results are given below

Table -1: Engineering Properties of untreated soil

Engineering properties	Values
Liquid limit	54%
Plastic limit	26%
Plasticity index	27%
Percent passing sieve no.200	100%
Unconfined compressive	136%
Optimum moisture content	33%
Maximum dry density	13.4%

2.2 Acrylic Polymer

Acrylic polymers are produced during the manufacturing of plastic products. Acrylics are found in world at a very large scale and are in high demand. The acrylic polymer used in this study was collected from the Garg Acrylics manufacturing unit Ludhiana.

2.3 Polycarbonate

Polycarbonates are used in the manufacturing of electrical and glass goods. Either we can melt any scrap glass product made from polycarbonate or we can generally use the polycarbonate sheets. In this study polycarbonate sheets have been used. Polycarbonate sheets have been collected from the Fiber world- fiber sheets, polycarbonate sheets manufacturers unit in Mohali Punjab.

3. PREPARATION OF TEST SAMPLES AND TESTING PROCEDURE

3.1 Unconfined compressive strength

IS: 2720 (Part10) -1991 and IS: 4332 (Part V) -1970 was used for sample preparation of unconfined compressive strength testing. In order to determine the testing soil acrylic mix, soil polycarbonate mix and soil acrylic polycarbonate mix. 4 samples of each were mixed and chloroform, the chloroform was evaporated later on. Samples were put under oven drying condition at a temperature of 40 degree Celsius for desired curing period. The treated samples were tested after 3, 7, 14 days of curing period.

4. RESULT AND DISCUSSION

Fig.1 shows the variation in maximum dry density with the addition of acrylic, polycarbonate and then their mixture. It was found that MDD increases with the increase in concentration of acrylic content and it shows the maximum increase when 6 percent acrylic was added. For samples containing polycarbonate MDD was found to increase with increase in polycarbonate content but showed maximum increase at 4 percent of polycarbonate content then MDD was found to decrease beyond 4 percent. For samples containing mixture of acrylic of acrylic and polycarbonate MDD increases with increasing content up to 4 percent and then decreases on reaching 6 percent of content.

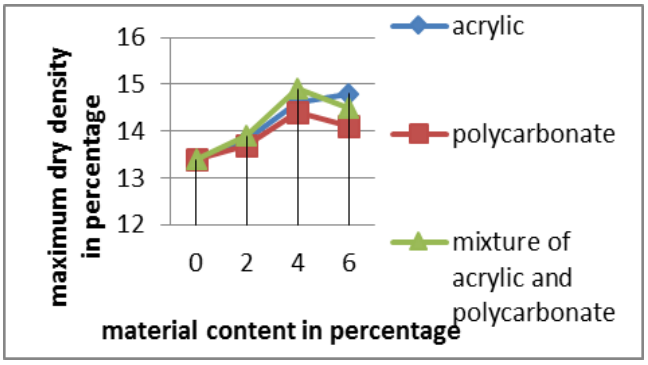

Fig -1: Variation in maximum dry density with different percentages of acrylic, polycarbonate and their mixture

Fig.2 shows the effect of acrylic, polycarbonate and their mixture on the OMC. It was found that for the samples containing only acrylic polymer the OMC decreases on increasing acrylic content upto 6 percent same happened for the samples containing polycarbonate only but the decrease on OMC was found maximum at 4 percent of polycarbonate content and after 4 percent OMC was found to increase. For samples containing mixture of acrylic and polycarbonate the OMC decreases with increase in content of mix and the maximum decrease was found at 2 percent of acrylic and polycarbonate mixture. Beyond 2 percent OMC starts increasing with increase in content. The increase in OMC is due to the absorbent properties of both acrylic and polycarbonate and due to the water trapped with the flocculants expansive soil structure.

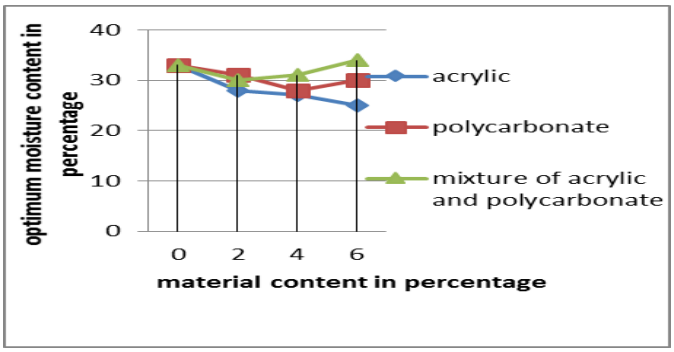

Fig-2 Variation in optimum moisture content with different percentages of acrylic, polycarbonate and their mixture

Fig.3 shows the variation of liquid limit with the addition of acrylic, polycarbonate and then their mixture. It was found that liquid limit decreases in all the three cases on increasing the content. But the decrease in liquid limit was found to be maximum in case of mixture of acrylic and polycarbonate at 4 percent. The decrease in liquid limit occurs due to the hydrophilic nature of acrylic and polycarbonate and also due to the properties of the acrylic and polycarbonate like molecular weight, density, ion properties of expansive soil are changed.

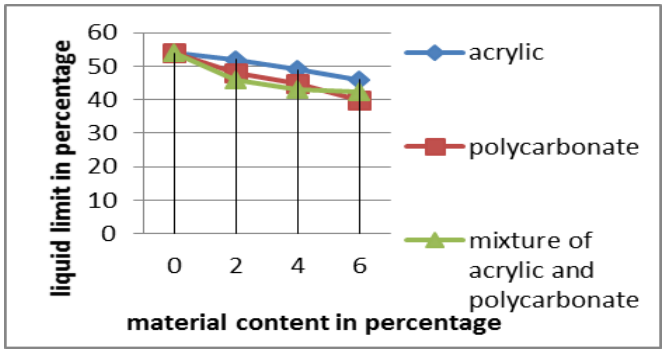

Fig-3 Variation in liquid limit with different percentages of acrylic, polycarbonate and their mixture

Fig.4 shows the variation of plastic limit with the addition of acrylic, polycarbonate and then their mixture. It was found that the plastic limit increases with increasing percentage of acrylic, polycarbonate and their mixture. The maximum increase was found in those samples in which acrylic and polycarbonate were used as a mixture.

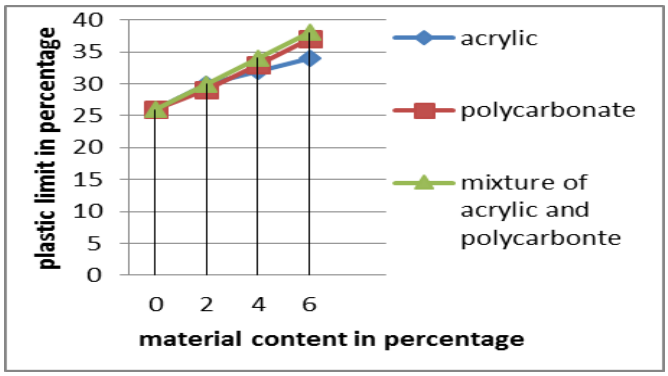

Fig-4 Variation in plastic limit with different percentages of acrylic, polycarbonate and their mixture.

Fig.5 shows the variation of plasticity index with the addition of acrylic, polycarbonate and then their mixture. It was found that plasticity index decreases with increasing percentage of acrylic, polycarbonate and their mixture. The maximum decrease was found in those samples where we have used the mixture of acrylic and polycarbonate.

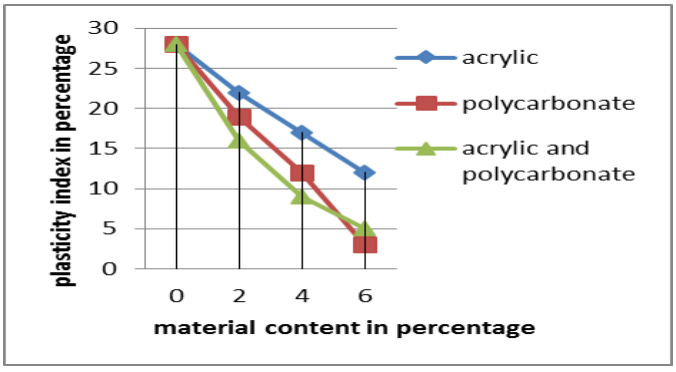

Fig-5 Variation in plasticity index with different percentages of Acrylic, polycarbonate and their mixture

Fig.6, fig.7 and fig.8 show the variation in unconfined compressive strength after 3, 7 and 14 days of curing period with the addition of acrylic, polycarbonate and then their mixture. It was found that UCS value increased by 58%, 48% and 49% after 3, 7 and 14 days of curing respectively while as when only polycarbonate was used it got increased by 59%, 48% and 52% after 3, 7 and 14 days of curing and on using mixture of acrylic and polycarbonate the value of UCS was increased by 56%, 50% and 53 % after 3, 7 and 14 days of curing. In all the three cases at 6 percent of dosage the increase in UCS was found to be maximum. This is due to the toughness nature of both acrylic and polycarbonate.

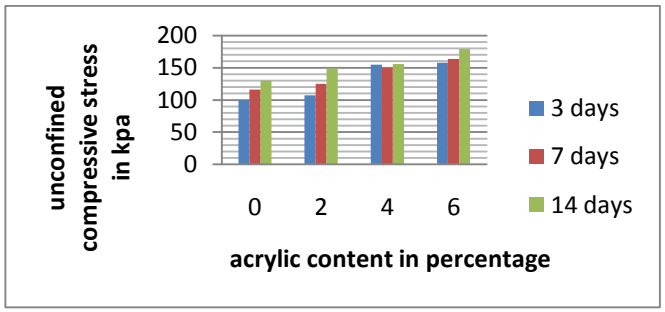

Fig -6 Variation of UCS with different percentages acrylic of polymer

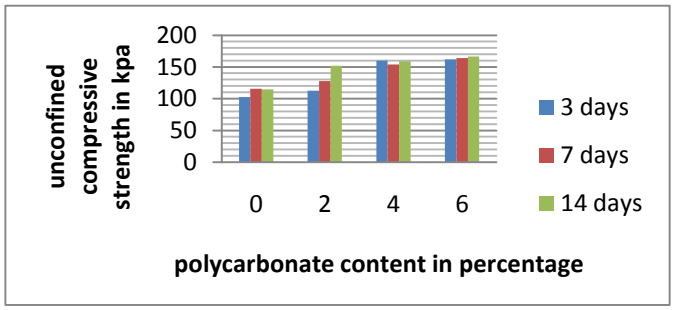

Fig-7 Variation of UCS with different percentages of polycarbonate

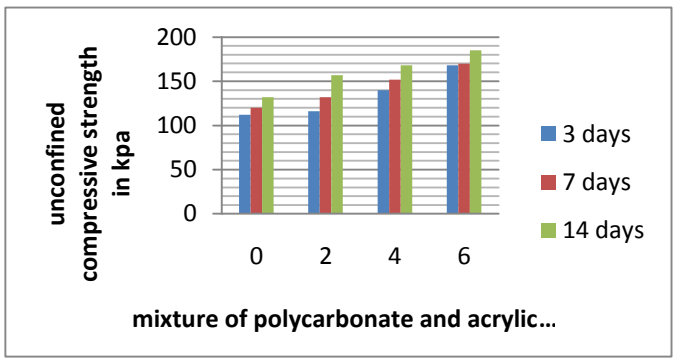

Fig. 8 Variation of UCS with different percentages of mixture of Acrylic and Polycarbonate.

5. CONCLUSIONS

- Based on the current investigation, the following conclusions were made
- The liquid limit was found to decrease with increase in content or dosage of acrylic, polycarbonate and their mixture because decrease in liquid limit occurs due to the hydrophilic nature of acrylic and polycarbonate and also due to the properties of the acrylic and polycarbonate like molecular weight, density, ions properties of expansive soil are changed.
- The plastic limit was found to increase on adding the dosage of acrylic, polycarbonate and their mixture individually because the increase in value is due to the water loving nature of both polycarbonate and acrylic which on combination gives much increase to the hydrophilic nature.
- The compaction characteristics of expansive soil vary significantly. The optimum moisture content was found to increase while the maximum dry density decreases with increase in dosage in all the three cases.
- The unconfined compressive strength also increases with increase in dosage and curing period. The maximum increase in UCS value is at 6 percent content of acrylic, polycarbonate and their mixture individually at 14 days curing.

6. ACKNOWLEDGEMENT

The authors would like to thank all the persons who helped them during the project.

7. REFERENCES

1. Shashikant verma, Dharmchandra poddar, Zaim lari [2018] soil stabilization by using fly ash, rice husk and lime, IJREAM, ISSN: 2454-9150 Vol-03, Issue-11.
2. Yulvi zaika, Agoes Socharjono [2016], Bagasse Ash and additive materials treated expansive soil, EJGE, Vol. 21, pp 7085-7094.
3. MelikBekhiti, Habib Trouzine, Mohamed Rabehi [2019] influence of waste tire rubber on swelling behavior, unconfined compressive strength and ductility of cement stabilized bentonite clay soil. Elsevier, construction and building materials 208(2019) 304-313.
4. E kalkan, utilization of red mud as a stabilization material for preparation of clay, liners. Eng Geol.87 [3, 4] [2006] 220-229.
5. N.M. Al-Akhras, M.F Attom, K.M. Al Akhras, A.I.H Malkawi [2008], influence of fibers on swelling properties of clayey soil. Geosynthetics International, 15, No. 4, 304-309.
6. Assadi, A., Shahaboddin, S., [2009]. A micro mechanical approach to swelling behavior of unsaturated expansive clays under controlled drainage conditions. Applied clay science 45, 1-2, 8-19
7. Avsar, E., Ulusay, R., Sonmez, H., [2009]. Assessments of swelling anisotropy of Ankara clay. Engineering geology 105, 1-2, and 24-31.
8. GP Makusa [2013], soil stabilization methods and materials in engineering. Mining and Geotechnical engineering, p. 35,