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EFFECT OF XANTHAN GUM ON COMPACTION CHARACTERISTICS OF CLAYEY SOIL

Durga S[1], Ms. Jaseena A Rasheed[2]

[1]PG Student, Dept. of Civil Engineering, Sarabhai Institute of Science and Technology
[2]Assistant Professor, Dept. of Civil Engineering, Sarabhai Institute of Science and Technology

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Abstract - *Materials such as cementatious binders have been utilized in engineering since the beginning of human civilization. Since cement is responsible for heavy green house gases alternative such as biopolymers are being actively studied. So it is necessary for the soil treatment process to be cost efficient, eco-friendly and yield optimum results. The present study is treatment of clayey soil using xanthan gum. Xanthan gum is a microbial biopolymer which is an environmental friendly polysaccharide. It forms a hydrogel on interaction with soil which improves the soil characteristics. In the present work, tests such as Standard Proctor Compaction test will be done with varying percentage of Xanthan gum (1%, 2 and 3%) and the optimum results will be obtained. From the tests conducted it was observed that with the increase in percentage of Xanthan gum OMC values increased and MDD value decreased. Due to viscosity the soil particles are dispersed randomly resulting in overall reduction in density and increased absorption of water increased OMC. The strength showed an increase in percentage of about 65%.*

Key Words: Clayey soil, Xanthan gum, polysaccharide, hydrogel, Standard proctor compaction, UCS.

1. INTRODUCTION

Among the various methods and agents used for the process of stabilization, Cement and petrochemical materials are currently considered the most popular soil improvement materials. Although petroleum-based polymers show great success in the field of geotechnical engineering as soil improvement materials, biopolymers show superiority over petroleum-based polymer in some environmental aspects such as fossil energy requirements, gross water use, and contribution to global climate change. Actually, the contribution of global climate change for Nylon 66 or Nylon 6 is approximately 7 to 8 kg of CO_2 equivalent per kilogram of polymer; however, it is approximately 2 kg of CO_2 equivalent per kilogram of biopolymer. This means that biopolymers can not only be used as a product but also as a component of greenhouse gas reduction strategies. However, cement industries are responsible for 5 % of global carbon dioxide emission, as the production of 1 ton of cement is accompanied by the emission of 1 ton of carbondioxide. Therefore, the development of renewable soil improvement materials with friendly environmental impact is needed. Biopolymers are sustainable, carbon neutral, and always renewable material because they are made from ever-available agricultural nonfood crops.

1.1 Xanthan Gum

This anionic polysaccharide is produced by the bacteria Xanthomonas campestris. Xanthan gum's negative charge comes from its carboxylic acid (-COOH) groups, since hydrogen atoms easily dissociate from these carboxylic acid groups to form carboxylate (-COO−) anions. Xanthan gum can also form hydrogen bonds with its numerous hydroxyl (-OH) groups. Small amounts of xanthan gum significantly increase an aqueous system's viscosity, which makes it a commonly used commercial substance. However, since the xanthan gum solution is pseudoplastic, its viscosity decreases with an increased shear rate. Xanthan gum also forms a viscous hydrocolloid when mixed with water, so it can also be considered dissolved in water. Xanthan gum hydrates immediately in cold water and is extremely stable to pH (from 2.5 to 11), heat and shear. Figure shows Xanthan gum used.

Fig-1: Xanthan gum

1.2 Clayey Soil

Clay is collected from a place called 'Mangattkadavu' in Thiruvanathapuram district. It appears to be brown in colour. The test were done as per IS code. For the soil natural water content was obtained as 49.48%. The soil was classified as high plastic clay and the percentage of clay and percentage of silt was obtained as 71% and 29% respectively. The liquid limit obtained is 64.7% and plasticity index is 32.9%.Then according to IS specification, the soil belongs category CH.

2. COMPACTION CHARACTERISTICS

The process of compaction is used for enhancing the surface soil layer. Compaction test [IS: 2720-part 7(1983)] were carried out by using different percentages of Xanthan gum mixed with clay. Light compaction test was carried out on

clayey soil to determine optimum moisture content (OMC) and maximum dry density (MDD).OMC was determined as 20% and dry density was 17.85 kN/m3 for clayey soil. The compaction behavior of clay soil was studied with respect to different concentrations of biopolymer.

Table -1: variation in OMC and MDD

Percentage of Xanthan gum	MDD (kN/m³)	OMC (%)
0 %	17.85	20
1 %	15.6	25
2 %	14.85	28.57
3 %	13.98	31.9

It was observed that when the concentration of xanthan gum biopolymer was increased from the value of maximum dry density reduced. This could be because of the physical categorization of the biopolymer solution, particularly its viscosity, and partial weight of soil. Due to viscosity, the soil particles are dispersed randomly because of their lightweight, resulting in the overall reduction in soil density.

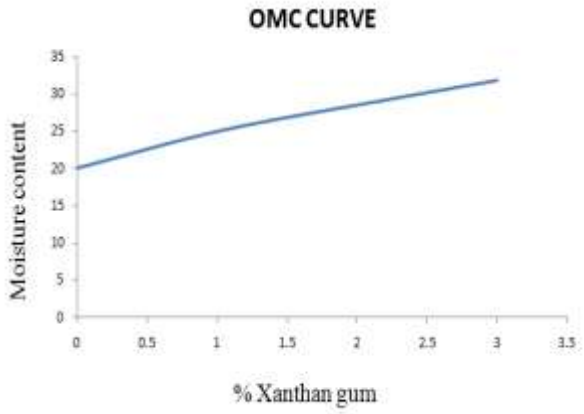

Fig-2: variation of OMC with Xanthan gum

Moreover, this viscosity is increased with increase in the concentration of the solution, resulting in a further reduction in the soil density. Increasing concentration of solution also increased the optimum moisture content due to the increased absorption of water used in dissolving the biopolymer (source : Joga J R and Varaprasad B.J.S ,2019)

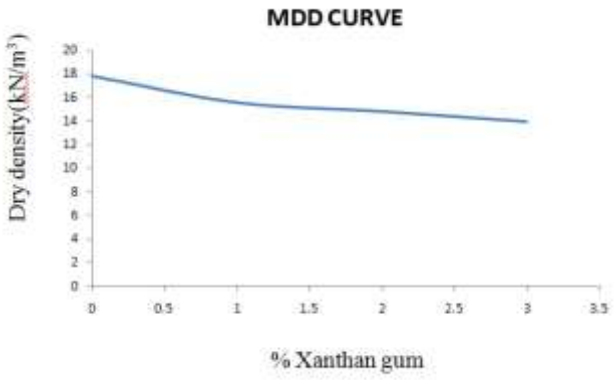

Fig -3: variation of MDD with Xanthan gum

3. CONCLUSION

In stabilization of expansive soil using biopolymer it is observed that, Xanthan gum is shown to have a significant strengthening effect on the treated soil. This strengthening is achieved by increasing the inter-particle relations within the soil and, thereby, increasing the cohesive forces within the soil. The majority of the strength of Xanthan treated fine grained soils originates from hydrogen or electrostatic bonding From the standard proctor compaction test, it is observed that the OMC value increased with the increase in percentage of Xanthan gum used. The MDD value decreased with the increase in percentage of Xanthan gum used. The strength characteristics showed increase with the increase in percentage of Xanthan gum used till 2% and then showed decrease.

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AUTHOR

Author 1: Durga s from Trivandrum, Kerela D/o Rajendran and Sindhu D S