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Effect of Xanthan Gum on Unconfined Compressive Strength of Clayey Soil

Durga S[1], Ms. Jaseena A Rasheed[2]
[1]*PG Student,* [2]*Assistant Professor, Dept. of Civil Engineering, Sarabhai Institute Of Science and Technology*

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 Unconfined Compression 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 increased the strength till 2% and then showed decreased. The strength showed an increase in percentage of about 65%.***
Keywords: ***Clayey soil, Xanthan gum, polysaccharide, hydrogel, UCS.***

I. 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.

A. 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.

Figure 1: Xanthan gum

B. 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.

II. COMPRESSIVE STRENGTH TEST

Unconfined compressive strength test (IS: 2720-part 10 (1973)) were carried out on clayey soil by adding Xanthan gum. Unconfined compressive test was carried out on clayey soil to determine unconfined compressive strength. Compressive strength of clayey soil was 40 kN/m². The unconfined strength of soil sample was studied and after the addition of biopolymer Xanthan gum. The table shows the values obtained from Unconfined Compressive Strength test.

Table 1 Variation in UCS with varying percentage of Xanthan gum

PERCENTAGE OF XANTHAN GUM	UCS VALUE (KN/M^2)
0%	40
1%	52
2%	66
3%	60

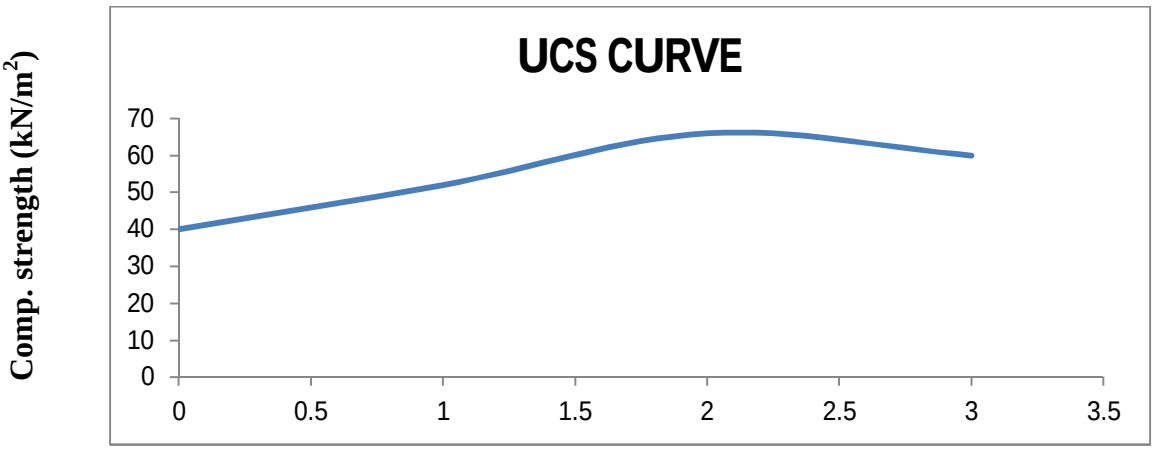

Figure 2 Variation in UCS with varying percentage of Xanthan gum

III. CONCLUSION

The optimum value for UCS is obtained as 2%.The strength increased from 40 kN/m^2 to 66 kN/m^2 and the percentage increase is in strength of soil is 65%. The increase in strength till 2 % is because of the formation of hydrogel when Xanthan gum mixed with soil. After 2% clay particles will not be available for reaction with Xanthan gum and hence leading to a decrease in strength of soil. Figure 4.3 shows the UCS curve obtained (source : Nair L. P and Kannan K , 2019).

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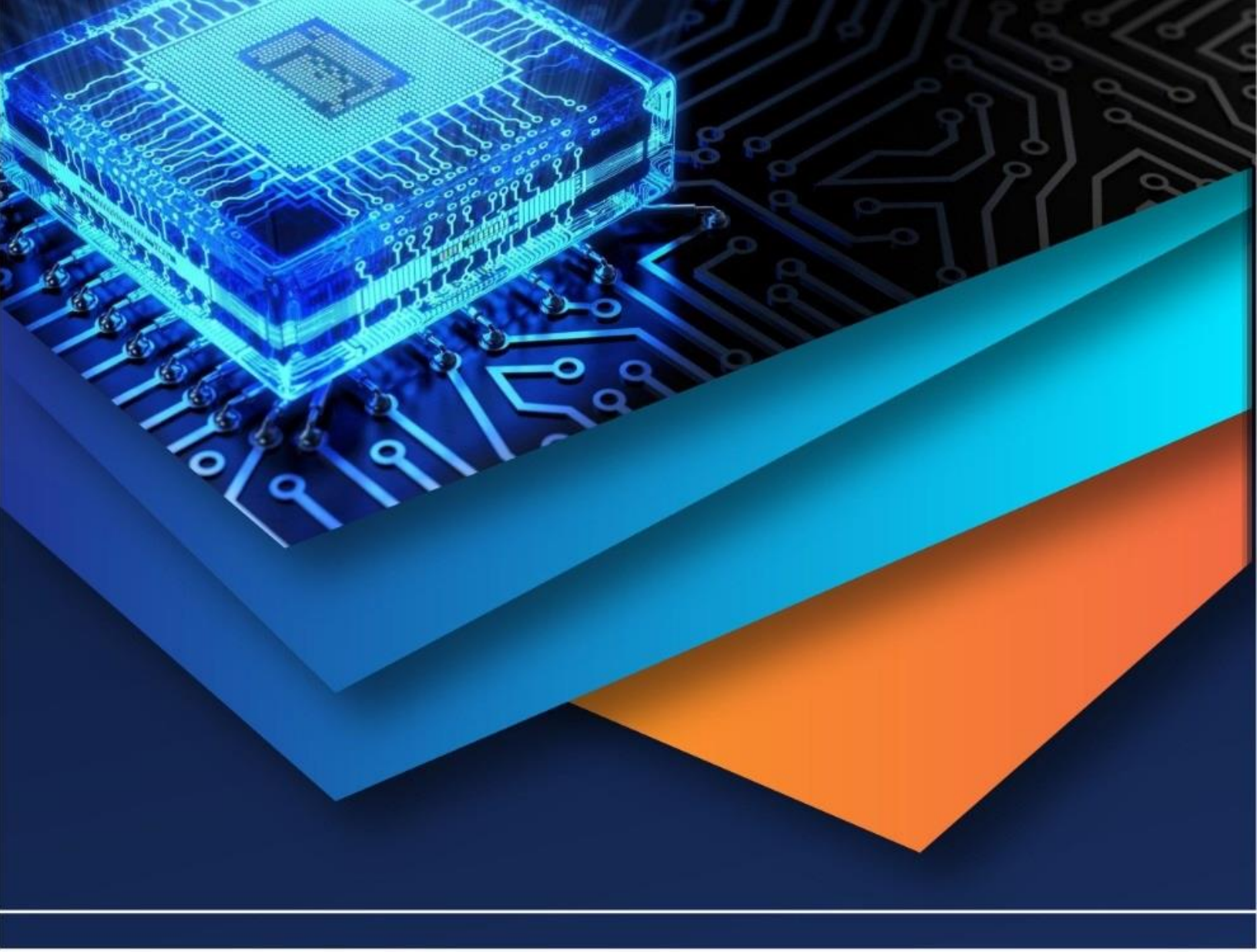

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