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GEO AND BIO POLYMERS IN STABALIZING EXPANSIVE AND DISPERSIVE SOILS

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Abstract
As adjustment of soil enhances its building properties, concoction and mechanical adjustment procedures are being used. In the present review two troublesome soils; expansive soil and dispersive soil are settled with geopolymer and biopolymer. Sodium based antacid activators and fly ash as an added substance is utilized as geopolymer and Xanthan gum and Guar gum are utilized as biopolymers. The viability of geopolymer is examined as far as unconfined compressive strength (UCS), differential free swelling (DFS), swelling pressure (SP), sturdiness and scattering tests. The swelling pressure got lessened by 97.14% at long last with expansion of 40% fly ash and 15% bentonite. The scattering test indicated bentonite to be a to a great degree dispersive soil, whose dispersiveness is controlled by expansion of salt enacted fly ash. From UCS and toughness test it is watched that bentonite included with 40% fly ash and 10% arrangement gave better outcomes. The adequacy of biopolymer is concentrated in view of UCS tests on dispersive soil and pond ash at their dampness content. For dispersive soil, sturdiness, scattering and DFS tests are additionally done. It is watched that dispersive soil and lake ash blended with different rates of Xanthan gum and Guar gum are not dispersive and are more solid than standard base ash and dispersive soil tests. Guar gum is found to grants higher bound compressive strength and toughness than Xanthan gum.

Key Words: Geo polymer, Bio polymer, Xanthan gum, Guar gum, Bentonite.

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1. INTRODUCTION

1.1 INTRODUCTION

Soil adjustment in a wide sense incorporates different techniques utilized for changing the properties of soil to improve its building execution. By adjustment the real properties of soil, i.e., volume steadiness, strength, compressibility, penetrability, solidness and tidy control is enhanced, which makes the dirt appropriate for utilize. There are distinctive techniques for adjustment, which incorporate physical, synthetic and polymer strategies for adjustment. Physical strategies include physical procedures to enhance soil properties. This incorporates compaction techniques and seepage. Waste is a productive approach to expel extreme water from soil by methods for pumps, pipes and channel with a plan to keep soil from swelling because of immersion with water. Compaction forms prompt increment in water resistance limit of soil. Waste is less basic because of for the most part poor association between strategy viability and cost. Be that as it may, compaction is extremely basic strategy. Despite the fact that, it makes soil more impervious to water, this resistance will lessen after some time. Substance soil adjustment utilizes chemicals and emulsions as compaction helps, water anti-agents and covers. The best compound soil adjustment is one which brings about non-water-solvent and hard soil grid. Polymer techniques for adjustment have various critical favorable circumstances over physical and concoction strategies. These polymers are less expensive and are more compelling and essentially less hazardous for nature when contrasted with numerous substance arrangements. In the present review two troublesome soils, sweeping soil and dispersive soil are considered for adequacy of geopolymer and biopolymer adjustment.

2 LITURATURE REVIEW

Srivastava *et al*. (1999) have also described the results of experiments carried out to studythe consolidation and swelling behaviour of expansive soil stabilized with lime sludge and fly ash and the best stabilizing effect was obtained with 16% of fly ash and 16% of lime sludge.

Cokca (2001) used upto 25% of Class-C fly ash (18.98 % of CaO) and the treated specimenswere cured for 7 days and 28 days. The swelling pressure was found to reduced by 75% after 7 days curing and 79% after 28 days curing at 20% addition of fly ash.

Pandian*et al*. (2001) had made an effort to stabilize expansive soil with a Class–F Fly ashand found that the fly ash could be an effective additive (about 20%) to improve the CBR of black cotton soil(about 200%)significantly.

Turker and Cokca (2004) used Class C and Class F type fly ash along with sand forstabilization of expansive soil. As expected, Class C fly ash was found to bemoreeffective and the free swell decreased with curing period. The best performance was observed with soil, Class C fly ash and sand as 75%, 15% and 10%, respectively after 28 days of curing.

3. MATERIALS AND METHODOLOGY

3.1 Materials Used

Details of materials adopted for the present study have been presented below.

3.1.1 Bentonite

The commercial available bentonite is used in the present study, which are from Kutch mining area, Bhuj district, Gujarat, India. A small amount (20 gm) of the sample was sealed in polythene bag for determining its natural moisture content. The soil was air dried and pulverized as required for laboratory test.

3.1.2 Fly ash

Safe disposal and management of fly ash are the two major issues concerned with the production of fly ash. At present, the generation of fly ash is far in excess of its utilization. Similarly, another pond ash was collected. Here, pond ash is used for comparison with dispersive soil (white soil). XRD analysis of fly ash, which indicated that the major minerals present in the fly ash are quartz, mullite and hematite.

3.1.3 Alkali Activated Fly ash (geopolymer)

The alkali activation of waste materials has become an important area of research in many laboratories because it is possible to use these materials to synthesize inexpensive and ecologically sound cement like construction materials. Alkali activated fly ash also known as geopolymer, is the cement for the future.

3.1.4 Dispersive soil

It was collected from hostel area, NIT Campus Rourkela. A small amount (20 gm) of the sample was sealed in polythene bag for determining its natural moisture content. More soil was collected air dried, pulverized and sieved with 425 μm Indian standard as required for laboratory tests.

3.1.5 Xanthan gum

Xanthan gum is a microbial exopolysaccharide produced by the gram-negative bacterium *Xanthitalics Campestris* by fermenting glucose, sucrose, or other carbohydrate sources. This biopolymer is applied in the food, cosmetic, pharmaceutical and petrochemical industries and in other sectors as a thickening agent, stabilizer, or emulsifier and combined with other gums it can act as a gelling agent (Chen *et al.* 2013).This was added with dispersive soil and pond ash in different percentage (1%, 2% and 3%).

3.1.6 Guar gum

The Guar or cluster bean (CyamopsisTetragonoloba) is an annual legume and the source of Guar gum. It is also known as Gavar, Guwar or Guvar bean. Few agriculturists in semi-arid regions use guar as a source to replenish the soil with essential fertilizers and nitrogen fixation, before the next crop. Guar as a plant has a multitude of different functions for human and animal nutrition but its gelling agent containing seeds (Guar gum) are today the most important use.

3.2 Methodology Adopted

In the present study, methodology of stabilizing soil using geopolymer and biopolymer is explained as follows.

3.2.1 Stabilization using geopolymer

In the present study, the alkali was prepared by taking sodium silicate and sodium hydroxide keeping in view, the ratio of sodium silicate to sodium hydroxide in their dry mass as 2. The prepared alkali (S) was added in varying percentages (5%, 10%and 15%) with fly ash (FA) in different percentages (20%, 30% and 40%) by dry weight of total solids to bentonite. The alkali, taken in 10% with fly ash 40% by dry weight of total solids was also added with dispersive soil. Then, optimum moisture content (OMC), maximum dry density (MDD), unconfined compressive strength (UCS), and durability of different samples were experimentally investigated and compared with only bentonite and dispersive soil samples. Differential free swelling (DFS) with (3, 7 and 14 days) and without curing, swelling pressure and dispersion tests were also done for treated bentonite samples and compared with only bentonite samples.Evaluation of UCS of treated soil samples were done on an interval of 0, 3, 7 and 14 days and compared with only bentonite samples.DFS of treated soil samples were done on an interval of 0, 3, 7 and 14 days. The samples which were tested after 3, 7 and 14 days were wrapped in cling film and left at ambient temperature of 32-35º C and humidity conditions (50–60 % RH). Following Table 3.1 shows the details of the alkali activated fly ash mixed in various percentages with bentonite.

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Table 3.1 Details of the alkaline activator mixed soil specimens

S.NO.	Name of the mix	Particulars of the mix
1	Bentonite + FA (20%) + S (5%)	Soil+20%fly ash by weight of total solids+5% alkali by weight of total solids
2	Bentonite + FA (30%) + S (5%)	Soil+30%fly ash by weight of total solids+5% alkali by weight of total solids
3	Bentonite + FA (40%) + S (5%)	Soil+40%fly ash by weight of total solids+5% alkali by weight of total solids
4	Bentonite + FA (20%) + S (10%)	Soil+20%fly ash by weight of total solids+10% alkali by weight of total solids
5	Bentonite + FA (30%) + S (10%)	Soil+30%fly ash by weight of total solids+10%alkali by weight of total solids
6	Bentonite + FA (40%) + S (10%)	Soil+40%fly ash by weight of total solids+10%alkali by weight of total solids
7	Bentonite + FA (20%) + S (15%)	Soil+20%fly ash by weight of total solids+15%alkali by weight of total solids
8	Bentonite + FA (30%) + S (15%)	Soil+30%fly ash by weight of total solids+15%alkali by weight of total solids
9	Bentonite + FA (40%) + S (15%)	Soil+40%fly ash by weight of total solids+15%alkali by weight of total solids
10	WS + FA (40%) + S (10%)	Soil+40%fly ash by weight of total solids+10%alkali by weight of total solids

Fig 3.1: Conducting UCS test for geo polymers & Biopolymer

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3.2.2 Stabilization using biopolymer

The experimental investigations were made on soil and stabilized soil using biopolymer as per Indian standards. It was observed that Guar gum (GG) is more viscous compared to Xanthan gum (XG). Hence, Xanthan gum solutions with percentages of 1, 2 and 3% and Guar gum solutions with percentages of 0.5, 1 and 2% were added with dispersive soil (WS) and pond ash (PA)toinvestigate the effect of biopolymers on compaction characteristics, unconfined compressive strength. Durability and dispersion tests were also done for biopolymer modified dispersive soil and compared to only dispersive soil sample. Evaluation of UCS of biopolymer modified dispersive soil samples were done on an interval of 0, 3 and 7days and also done for sample kept for sundried (1 day) and compared with only dispersive soil samples. The samples which were tested after 3 and 7 days were wrapped in cling film and left at ambient temperature of 32-35ºC and humidity conditions (50–60 % RH). Table 3.2 show details of the dispersive soil specimens and pond ash specimens mixed in different percentages with Xanthan gum (XG) and Guar gum (GG), respectively.

Table3.9 Details of the biopolymer modified dispersive soil specimens

S.NO.	Name of the mix	Particulars of the mix
1	WS+1% XG	Dispersive soil added with 1% Xanthan gum
2	WS+2% XG	Dispersive soil added with 2% Xanthan gum
3	WS+3% XG	Dispersive soil added with 3% Xanthan gum
4	WS+0.5% GG	Dispersive soil added with 0.5% Guar gum
5	WS+1% GG	Dispersive soil added with 1% Guar gum
6	WS+2% GG	Dispersive soil added with 2% Guar gum

Table3.10 Details of the biopolymer modified pond ash specimens

S.NO.	Name of the mix	Particulars of the mix
1	PA+1% XG	Pond ash added with 1% Xanthan gum
2	PA +2% XG	Pond ash added with 2% Xanthan gum
3	PA +3% XG	Pond as added with 3% Xanthan gum
4	PA +0.5% GG	Pond ash added with 0.5% guar gum

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5	PA +1% GG	Pond ash added with 1% guar gum
6	PA +2% GG	Pond ash added with 2% guar gum

4. RESULT:

This section describes the comparison of experimental results of expansive soil (bentonite) with and without stabilization.

The comprehensive results of OMC and MDD for all the above cases are presented in the Table 4.1. It can be seen that the variation in MDD marginal with change in fly ash content and percentage of alkali solution.

Table 4.1OMC and MDD of bentoniteandalkali activated fly ash added withbentonite

Sample Name	OMC (%)	MDD (KN/m^3)
Bentonite	23.01	12.60
Bentonite + FA (20%) + S (5%)	29.81	12.84
Bentonite + FA (40%) + S (5%)	28.48	12.76
Ben tonite + FA (20%) + S (10%)	31.12	13.33
Bentonite + FA (30%) + S (10%)	28.38	13.49
Bentonite + FA (40%) + S (10%)	27.23	13.31
Bentonite + FA (20%) + S (15%)	26.99	13.30
Bentonite + FA (30%) + S (15%)	29.66	13.08
Bentonite + FA (40%) + S (15%)	25.60	13.57

Table 4.2 shows comparison of UCS of bentonite and bentonite added with fly ash (20%, 30% and 40%) and alkali solution (5%) for without (0 day)and with curing period of 3, 7 and 14 days. It can be seen that at 0 day the UCS value of the stabilized bentonite is less than that of only bentonite, which may be due to high apparent cohesion value of only bentonite. With increase in moisture content the apparent cohesion values decreased. There is increase in UCS value with increase in fly ash contents, but, again there is decrease with increase in alkali solution (15%) and the UCS values observed with 40% fly ash and 10% alkali solution is maximum for 3, 7 and 14 days of curing period. This may be due to inappropriate proportion of fly ash and alkali solution.

Table 4.2 UCS of bentonite and bentonite with fly ash (20%, 30% and 40%) and alkali solution (5%, 10% and 15%) without curing and with curing (3 days, 7 days and 14 days)

Sample Name	UCS (kPa) 0 day	UCS (kPa) 3 days	UCS (kPa) 7 days	UCS (kPa) 14 days
Bentonite	504.43	363.97	324.02	282.21
Bentonite + FA (20%) + S (5%)	181.06	339.44	451.75	951.80
Bentonite + FA (30%) + S (5%)	255.38	718.10	992.79	1189.76
Bentonite + FA (40%) + S (5%)	130.32	532.43	828.89	972.31
Bentonite + FA (20%) + S (10%)	157.76	296.07	643.27	1053.88
Bentonite + FA (30%) + S (10%)	184.49	623.61	1108.70	1469.20
Bentonite + FA (40%) + S (10%)	328.67	857.92	1386.74	1632.25
Bentonite + FA (20%) + S (15%)	180.09	137.21	163.99	114.30
Bentonite +FA (30%) + S (15%)	118.96	261.44	314.13	324.10
Bentonite +FA (40%) + S (15%)	117.18	294.37	299.17	294.19

Fig. 4.25 (a)

Fig. 4.25 (b)

Fig. 4.25 (c)

Fig. 4.25 (d)

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Fig. 4.25 (e)

Fig. 4.25 (f)

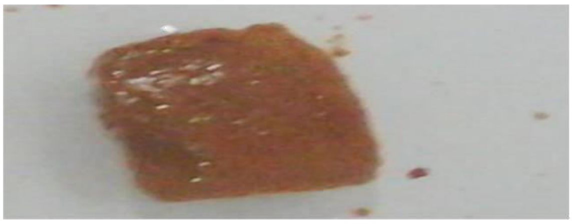

Fig. 4.25 (g)

Fig. 4.25 (h)

Fig. 4.25 (i)

Fig. 4.25 (j)

Fig. 4.25 (a) Cubes of bentonite in water after five to seven minutes, Fig. 4.25(b), (c), (d), (e), (f), (g), (h), (i) and (j) Cubes of Bentonite added with fly ash (20%, 30% and 40%) and alkali activator (5%, 10% and 15%), respectively in water after five to seven minutes.

5. CONCLUSION

Based on the obtained results and discussion there of following conclusions can be drawn.

- The greatest ideal dampness substance was for bentonite included with geopolymer with fly ash (20%) and soluble base arrangement (10%) and MDD was most extreme for bentonite included with fly ash (40%) and antacid arrangement (15%).

- The UCS estimation of the geopolymer balanced out bentonite found to shift with rate of fly ash and antacid arrangement, and greatest UCS esteem was gotten with 40% fly ash and 10% salt arrangement.
- Based on toughness test, the imperviousness to misfortune in strength (RLS) was most extreme for bentonite with 40% fly ash and 10% salt arrangement and it got decreased with expansion of 15% arrangement.
- Based on differential free swell test, it was watched that with expanded rate of antacid actuated fly ash, the swelling rate diminished impressively. Following 3 days of curing for bentonite + FA (20%) + S (10%), and bentonite + fly ash (20%, 30% and 40%) + S (15%), the swelling rate wound up plainly immaterial and the treated soil moved toward becoming non-swelling. Comparative perceptions were made for bentonite + fly ash (20%, 30% and 40%) + S (5%, 10% and 15%) following 7 days and bentonite + fly ash (20%, 30% and 40%) + S (5%, 10% and 15%) after 14 daysof curing.
- Based on scrap test and twofold hydrometer test it was watched that bentonite was to a great degree dispersive (84.87%). In any case, it progressed toward becoming non-dispersive with expansion of more than 5 % of geopolymer.
- It was watched that with expansion of biopolymer, OMC expanded and MDD diminished for dispersive soil. Be that as it may, The UCS esteem expanded with expansion of biopolymer.

- With same rate of gum, it was watched that dispersive soil balanced out with guar gum has better strength contrasted with that of Xanthan gum.
- Based on solidness test the RLS was greatest for Xanthan gum (1%) and guar gum (1%). The RLS diminished with expanded rate of Xanthan gum be that as it may, for guar gum RLS got was ideal at 1%.
- Based on morsel test and twofold hydrometer test it was seen that white soil was to a great degree dispersive (89.57%) and progressed toward becoming non-dispersive with expansion of biopolymer.
- It was watched that with expansion of biopolymer, OMC expanded and MDD diminished for lake ash. In any case, The UCS esteem expanded with expansion of biopolymer.
- With same rate of gum, it was watched that lake ash balanced out with Guar gum would be advised to strength contrasted with that of Xanthan gum.

- It was watched that sundried specimen has preferable UCS esteem over example put away inside covered with film/wax.

The present review demonstrated that biopolymer and geopolymer can be adequately utilized as settling specialists for far reaching and dispersive soil. IT was likewise watched that geopolymer is more compelling than biopolymer as far as adjustment.

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