GROUND IMPROVEMENT

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***Abstract*: Soil fabrics (geotextiles) are a permeable textile structural composition, and are mainly use in civil engineering applications associated with soil, rocks, or water. The American specifications (ASTM-D1316) indicated in the definition of this type of fabrics that they are used in some installations for civil and structural engineering, as the traffic increases day by day, many road related problems happen. Due to the heavy volume and heavy traffic the roads were damage very early, to avoid such a situation, we can use the geotextile.**

Geotextiles can be roughly in to two-type woven and nonwoven, in this research, non-woven (geotextile-50 pressed) was use in the work. The effect of geotextile sheets on improving the load-settlement characters of three-layered soil (three-layer clay, two-layer recycle concrete aggregate); moreover, the use of geotextiles has been study to reduce the required thickness of the sub-base layer of the road.

Geotextile also worked to separate or (isolate) two materials that are not alike, such as two soil layers with different properties, such as separating the subgrade layer from the subbase layer.

The way toward changing the internal properties of soil to improve the bearing capability and strength property of weak soil is known as Stabilization of that weak soil. Road paths or structure situated on weak soil needs adjustment. Adjustment of soil is primarily accomplished for altering designing properties of that feeble soil to improve the bearing capacity and durability property of that soil.

The purpose of the assessment is to assess the materials to evaluate these material with an audit on the modification of clayey soil utilizing crushed concrete aggregates. This proposal presents the outcomes of an assessment that explored the utilization of crushed aggregate in the adjustment of extensive clayey soil.

Index Terms: Soil, Pavement, Aggregate, Maximum Load Test, Geotextile

I. INTRODUCTION

Many geotechnical structures are constructed on weak and loose soil deposits. Thus for safe design this formation needs improvement before construction starts. A popular technique to improve such soil condition is to use aggregate and geotextile in the soil.

In a broad sense, stabilization incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance (Bowles, 1998). Stabilization of soil means improving of soil strength under applied load. The soil properties will be increased reasonably with or without the help of admixtures so that base/sub-base soil is capable of supporting the traffic load in all-weather condition (Buddhu, 2000).

The design of different structures such as road, buildings, dams, bridges etc. requires knowing the geotechnical properties of the foundation soil, therefor, laboratory tests are performed to investigate the geotechnical properties of soil. Soils should have adequate bearing capacities to support heavy structures and reduce the compressibility under the applied loads. Therefore, it is important to improve the bearing capacity of weak and soft soils using sustainable materials such as wastes. The results of permanent deformation characteristics of recycled asphalt pavement, crushed aggregate, and aggregates of dense grading under triaxial cyclic loads showed that crushed aggregate has the lowest permanent deformation among the three materials. In the recent year the stabilization of soil with suitable admixture such as lime, cement, calcium chloride, fly ash, bituminous material etc. has been successfully used on increasing scale for the construction of road foundation in Bangladesh, India, United Kingdom, and U.S.A etc. (Bardet, 1997). In this research work two admixtures such as aggregate and geotextile are considered. Some admixture improves poor soils and then capable of supporting greater loads but they are not economical (Leonards, 1962). If volume of earth involves under a pavement or under a foundation is huge, that result the quantity of stabilization prohibitive. The high pressure exerted on the pavement and base course generally preludes using the stabilized soil for bases (Cernica, 1995). Therefore, stabilization, except for secondary roads is centered on use in sub-grade and sub-bases. For secondary roads, a stabilized material (particularly a mechanically stabilized soil) can be used as the principal component of the pavement (Carraro, 2008). Secondary road construction includes gravel surfaces of types, soil cement and oiled earth surfaces. The choice of the proper admixtures, which should be used, depends upon the use for which it is independent (Craig, 1997).

In this study the subgrade improvement was done by mixing aggregates. The aggregates can be used in different proportions on subgrade. The intention is mainly for improving the highway subgrade as per specifications. The literatures suggest various method with these materials on soil. In some studies it's mentioned that mixing the materials and when used in layers also improve the maximum load test value.

II. MATERIALS AND METHODS

a) Materials

The material used in the present research work are:-

- **Soil: -** The soil samples were obtained from a depth of 1.5 to 2 m below the ground level. Shelby tubes were used to obtain undisturbed soil samples. After the excavation, the Shelby tubes with a sharp bottom edge were pushed vertically into the soil under hydraulic pressure and extracted after removing the surrounding soil by hand drilling. Also, the soil sample of Shelby tubes is used to calculate the field moisture content (16.5%) and density of the soil (1.715 g/cm3). Disturbed soil samples are obtained by hand drilling from the test pit.
- **Geo Textile: -** Geotextile is known as a fibrous material that is used with soil environment and contains non-woven and woven materials with polymers, natural products like jute, fabricated with the use of textile process. Polypropylene: When you polymerize the monomers of propylene with specific catalysts, it gives birth to thermoplastic polypropylene in a crystalline environment. Geotextile was directly purchase from the market according to the required specification.
- **Aggregate:-** The aggregates used for the study is collected from the Panipat. The size of the aggregates used in this study varies from 10-12mm.

b) Methods

- **Sampling: -** Samples of soil, geosynthetic material and crushed aggregate was collected from the different sampling station.
- **Preparation of sample: -** After the collection of samples it was prepared for analysis. It was firstly cleaned and left over night for air dry. Then it was sieve from 4.75 mm sieve as to maintain uniformity in the particle of sample.
- **Characterization of Crushed aggregate: -** The physical properties of aggregate was examine.
- **Geotechnical analysis of Soil: -** Geotechnical property of the fly ash was analyzed in the Geotechnical Laboratory by performing geotechnical test.
- **Characterization of geotextile: -** the characterization of collected geotextile was done as to analyze the compatibility of it geotextile for reinforcement.
- **Preparation of Stone Column: -** After the Analysis of characteristics the Stone Column was prepared. Three types of Stone Column sample were prepared. One sample in which single layer of geotextile was used. Second sample in which double layer of geotextile was used and in third sample four layers of geotextile was used
Stone Column made was left overnight in order to get air dry in the reinforcement and then it was subjected to analysis.
- **Analysis of Stone Column: -** After the making of Stone Column all these Stone Column were subjected to analysis of stability for the use of Stone Column which include Maximum Load Test.

III. RESULTS

RESULT FOR ANALYSIS OF SOIL

Properties of the sample	Value	Remarks
Soil	Sand	-
Classification of Soil	SP	-
Angle of Friction (ϕ)	20°	IS 2720 – 13 (BIS 1986 (a))
Cohesion (c)	1.96 kN/m²	
Specific Gravity	2.65	Pycnometer Method Clause 8.3 BS 1377 : Part 2 (1990)
Water Content	3.44%	-
Optimum Moisture Content	8.40%	BS 1377 : Part 4 (1990)
Dry Density	0.0016 kg/cm³	
Bulk Unit Weight ($\gamma_{unsat.}$)	19.66 kN/m³	
Saturated Unit Weight ($\gamma_{sat.}$)	21.75 kN/m³	
Poisson's ratio	0.30	IS 9221-1979
Modulus of elasticity	20,000 kN/m²	

RESULT FOR ANALYSIS OF CRUSHED AGGREGATE

Parameter	Aggregates	Remarks
Classification	GW	-
Friction angle (ϕ)	42°	IS 2720 – 13 (BIS 1986 (a))
Cohesion (c)	0.10 kN/m²	
Bulk Unit Weight ($\gamma_{unsat.}$)	22.78kN/m³	BS 1377 : Part 4 (1990)
Saturated Unit Weight ($\gamma_{sat.}$)	23.25 kN/m³	
Poisson's ratio	0.30	IS 9221-1979
Modulus of Elasticity	55,000kN/m²	

CHARACTERISATION OF GEOTEXTILE

S. No.	Property	Value
1	Tensile Strength	5 KN/m
2	Grab Tensile Strength	5 KN
3	Roll Width	5 m
4	A.O.S	65 m
5	Trapezoidal Tear Strength	165 N
6	CBR Strength	750

RESULT FOR STONE COLUMN ANALYSIS

Type of Reinforcement	Experimental Results			Average Value (kN)	Final Settlement (mm)
	End Load (kN) (First Trial)	End Load (kN) (Second Trial)	End Load (kN) (Third Trial)		
Single un-reinforced column	7	7.20	7.10	7.10	30.00
Single vertically encased column	14	14.70	14.20	14.30	30 .00
Single horizontally reinforced column	14.5	15.5	15	15.00	30.00
Group of 3 unreinforced columns	17.00	16.90	17.70	17.20	30.00
Group of 3 vertically encased columns	21.80	22.10	22.70	22.20	30.00
Group of 3 horizontally reinforced columns	22.40	22.50	22.60	22.50	30.00
Group of 4 unreinforced columns	20.50	20	20.70	20.40	30.00
Group of 4 vertically encased columns	24.70	24.40	24.10	24.40	30.00
Group of 4 horizontally reinforced columns	24.90	24.80	25	24.90	30.00

IV. CONCLUSION

Based on the testing done and results obtained the followings conclusions were made

- Vertically enclosed stone columns increased bearing capacity by providing a 47.33% boost, while horizontal reinforcement gave a 49.65% rise.
- Vertically-increased 3-stone columns increased bearing capacity by 76.44% while horizontal reinforcement increased bearing capacity by 77.47%
- The findings from the model testing showed that although unreinforced 3-stone columns had a bearing capacity, the test model's bearing capacity was more than that of 3 unreinforced stone columns.
- Vertically encased 4 stone columns increased bearing capacity by 81.92 percent, compared to the horizontal reinforcement, which provided an additional 83.60 percent capacity increase in the bearing. The results from the modelling experiment comparing Unreinforced 3 stone columns to Vertical Reinforcement 4 stone columns can be observed in the figure.
- Adding lateral confinement to stone columns is done using geosynthetic encasement, which mobilizes hoop pressures. In contrast, friction horizontal reinforcement keeps columns from bulging. Horizontal soil reinforcement proved to be better at carrying loads than enclosed columns.
- Geotextile reinforcement requires the use of hoop stresses and increased load bearing strength, all of which are attained at the same time, as opposed to unreinforced stone columns. Additional results: Additionally, horizontal reinforcement improves aggregate shearing tolerance, which causes a greater load-carrying capacity for the aggregate-geotextile-aggregate composite than a vertically enclosed floating column.

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