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Possibility Of Concrete Demolition Waste & Rubber Tyre Waste In Stone Column To Improve Bearing Capacity Of Clayey Soil

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Abstract**—***Bearing capacity is a very important parameter of the soil. As the construction of the superstructure mainly depend upon foundations of that structure, whole structure has been erected on the soil of suitable bearing capacity. But if that value of bearing capacity is on lower side then improvement of soil can be done. The manner of improvement may be use of piles, piers, cassions and stone columns. Material to be used in stone column are aggregates up to size 100mm. Waste materials generated such as Rubber and Concrete demolition waste can be used as replacement of aggregates.*

In this present study clayey of medium plasticity (CI) used was collected from village lohatbaddi,distt Ludhiana (PB). Concrete demolition waste (CDW) was collected from waste of cubes tested in concrete laboratory. Rubber tyre waste (RTW) in crumbed powder form was collected from Speedways Tyre industry, Transport Nagar, Ludhiana. In this study an attempt was made to use CDW and RTW in improving bearing capacity of the soil. The percentage of RTW: CDW (0:100, 20:80, 40:60, 60:40, 80:20, 100:0) was used in this present study. After the optimization of RTW: CDW (20:80) for single column of L/D ratio 6 [1]. Then this percentage was used for L/D ratios 3, 6 & 10 for the number of columns 1,2,3,4&5 [2].The allowable bearing capacity for L/D = 6 is more than for 3 & 10 [8] and it was maximum for five number of columns. The allowable bearing capacity with five stone columns was 2-3 times the bearing capacity of soil without stone columns.

Keywords— (Bearing capacity,stone column, CDW,RTW,MDD)

I. INTRODUCTION

A. Clay

In soft weak clayey soils, the problems are always there which are due to poor strength, high compressibility and permeability of the soil. These sort of soft clays are extensively found in many parts of India and many other countries of world. In these cases where the clayey soil extends up to large depths, it is better and economical to go for stone columns for the stability of soil. Stone column technique is mostly used in recent times for ground improvement of clayey deposits in most of the world. Main function or say purpose of stone column technique is to increase the load carrying capacity of the clayey soil and to stiffen the soft deposits up to the 10 to 15 meters [4]. To support the structures with flexible base, stone columns can be formed in performed bores. The technique is generally used when the large post construction settlement are allowed. However if the settlements are not allowed in recent times, Vibro flotation technique is used to install stone columns.

The stone columns achieve its axial capacity from the passive earth pressure developed due to the bulging of the column and increased resistance to lateral deformation under superimposed surcharged load. The length of stone column is significantly less then length of piles , it is not necessary to rest stone column on very firm bearing stratum as in case of piles.

B. Rubber Tyre Waste (RTW)

Rubber tires are a ductile, non-biodegradable material which will have existence for long period of time without any decay or degradation. Mostly open burning and using as a fuel in some countries in solution of disposal of rubber which is very serious hazard. Tyres can't undergo any bio-degradation even after landfill treatment, material and energy recoveries to alternate to disposal of this, solid waste. Tyre disposal remains problematic issue in the industrialized countries of the world. Globally 1.2 billons of waste tyre rubber was produced every year. It is estimated that 11% of post consumer tyres are exported and 27% are sent to landfill or dumped illegally and only 4% rubber in used for civil engineering projects. About 1000 million tyres end their useful life every year. From total 65% of rubber consumed by the tyres and tubes in the market. Per capita consumption of rubber was 0.8 kg against 14 kg in the developing countries.

C. Concrete Demolition Waste (CDW)

From estimation around about 10-12 million tons of construction waste was generated annually in India. About 55000million cu.m are required for the housing sector and 750million cu.m are required for the road sector. To reduce the demand supply gap, recycling of construction and demolition waste aggregates can be done. 1.3 billion ton of solid waste is generated by the cities across the globe. This number is likely to be increase in 2025 to 2.2 billion ton. According to 2012 World Bank report the building

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accounts the half the solid waste generated and half the total solid material used. According to CSE (Centre of Science and Environment) 5.75 billion sq.m of additional floor space has been newly built in India since, 2005. According to TIFAC's (Technology Information Forecasting and Assessment Council's) thumb rule 40-60 kg of CDW/ sq.m is been generated due to new construction in India. From 2005-2013 India produced about 287 million ton of CDW and in 2013 about 50 million from total. As quantity vise CDW is from dams, roads and other projects etc is more than any other solid waste.

II. Objectives

Followings are the objectives of this study:-

A. To improve the bearing capacity of clayey soil with use of stone columns[4].

B. To make efficient use of Concrete Demolition Waste and Rubber Tyre waste.

C. To justify better pattern and Length to Diameter (L/D) ratio of columns.

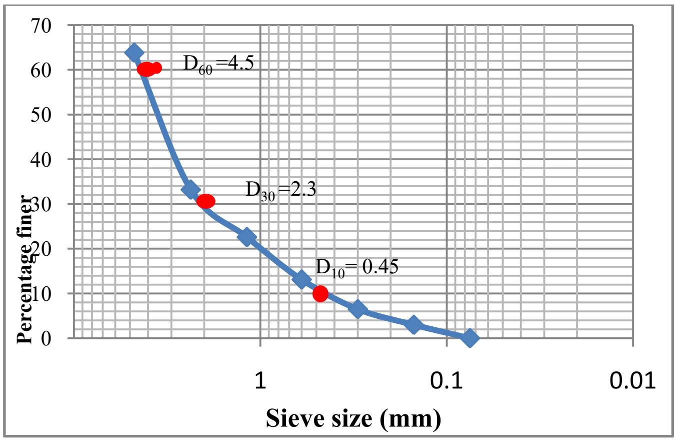
III. Materials Required

A. Clayey Soil

Clayey soil collected and transported from village lohatbaddi & distt Ludhiana (Punjab) was processed in sufficient quantity in the beginning of entire testing program. Soil collected were allowed to dry in the air at room temperature and then hand mixed in dry state by pulverizing it manually to break the lumps with wooden hammer. The soil was dried in oven for 24 hour at 100+ 5 c before use. Then it was allowed to cool at room temperature then the required quantity of soil was taken for various tests to be performed.

B. Concrete Demolition Waste

Concrete Demolition waste sample is collected from concrete laboratory of Civil Engineering Department of the College. The sample that sieved through 5.6 mm sieve and retained at 75 micron sieve is used for the testing procedure. The values of Coefficient of curvature (Cc) and Coefficient of uniformity (Cu) were worked out.



Sieve analysis of Concrete Demolition Waste
Cc= 2.3 and Cu = 10 (Uniformly well graded demolition waste)

C. Rubber Tyre Waste (RTW)[11]

Rubber tyre Waste sample was collected from the Speedways Tyre Industry, Transport Nagar, Ludhiana(Punjab).Rubber tyre waste in the form of powder that is extracted from waste tyres.
The values of Coefficient of curvature (Cc) and Coefficient of uniformity (Cu) were

- *Cc = 1.53 and Cu = 1.05*

IV. Methods of Operation

A. Material Processing

Clayey soil collected and transported from village lohatbaddi & distt Ludhiana (Punjab) was processed in sufficient quantity in the beginning of entire testing program. Soil collected were allowed to dry in the air at room temperature and then hand mixed in dry state by pulverizing it manually to break the lumps with wooden hammer. The soil was dried in oven for 24 hour at 100+ 5 c before use. Then it was allowed to cool at room temperature then the required quantity of soil was taken for various tests to be performed.

B. Laboratory tests conducted

On the processed dry soil the following laboratory tests were conducted carefully with the apparatus with precision accuracy.

(1) Liquid limit and plastic limit
(2)Standard proctor test
(3)Plate load test

To determine the liquid limit of this soil under investigation standard Casagrande's apparatus was used and the test was done as pre standard procedure prescribed in IS.2720 (part-1) –2970. Similarly Plastic Limit

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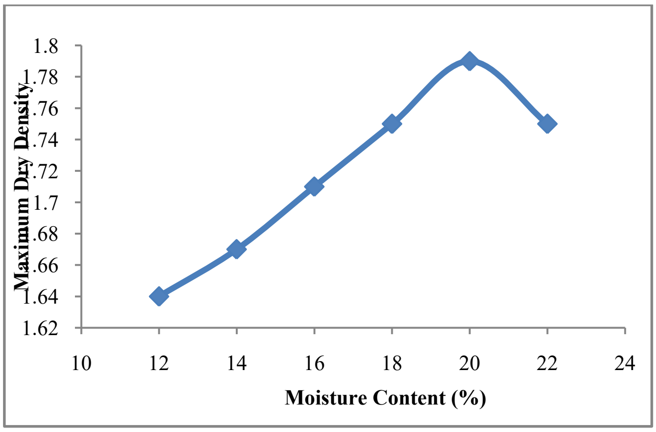
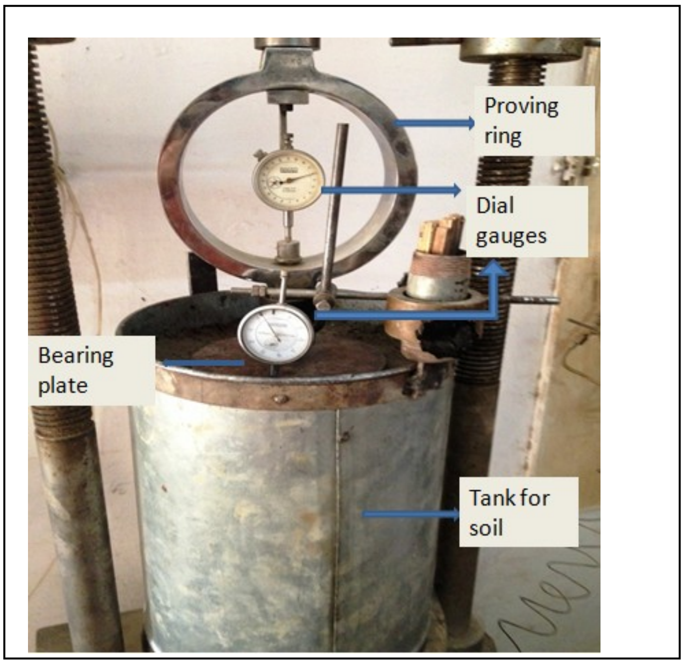
was determined as per standard test method of I.S2720(part-1)-1970: 2008 took soil about 30 gm and then sieved through 425u I.S sieve and meticulously mixed soil. It was approximately mixed with 10% of water in evaporating dish. It is mixed with fingers thoroughly to make it plastic enough to shape into a small and allowed for some time for maturing. About 10 gm of plastic soil prepared above and ball is rolled with fingers on a glass plate to form the thread. The water content was increased till the thread because smaller than 3mm without crumbling. The percentage of water was noted each time

Standard Proctor Test

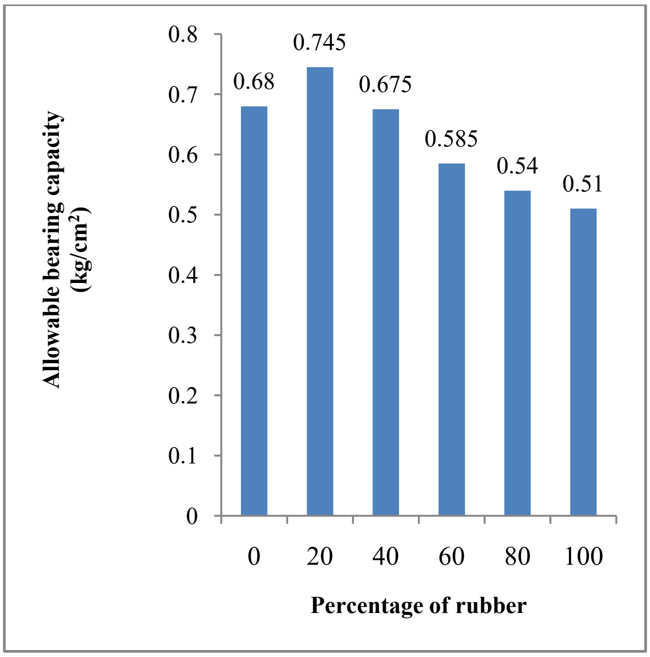


Pate load test setup and results[6] **:-** The model tests were carried out in a circular test tank of 400 mm length and 300 mm diameter having 24 gauge sheet (5mm thick). Two plates of size 30mm wide and 60 mm long are welded and turned at 90 degree so that tank can be lifted and placed on bearing plate with ease. Bearing plate of 10 mm thickness and 340 mm diameter is placed below the tank. This plate is placed for equal pressure distributions on the bottom face of the tank. Different sizes of plates are used between proving ring and soil in tank. Steel ball is used to transfer the equal pressure on circular plate. Stone column is made with pipe of external 20 mm diameter and length of stone column can we taken by erection of pipe in tank till the marking on pipe touches the soil surface, soil around the pipe was compacted gently.

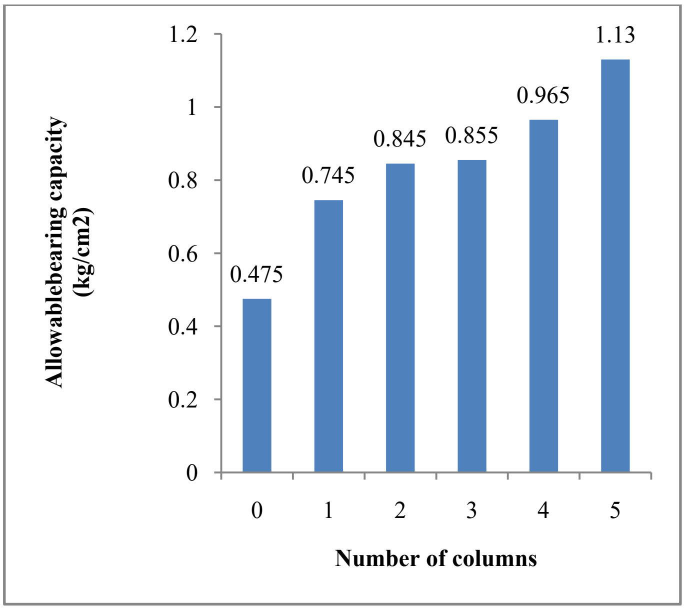


S. No	Number of columns	RTW + CDW (%)	Depth of column (mm)	L/D Ratio	Column Area (cm^2)	Load (kg)	Loaded Area (cm^2)	Ratio of Column Area/Loaded Area)	Allowable Bearing Capacity (kg/cm^2)
1.	None	0 + 0	Nil	Nil	Nil	121	254.34	Nil	0.475
2.	One	0 + 100	120	6	3.14	173	254.34	1.2	0.68
3.	One	20 + 80	120	6	3.14	189.5	254.34	1.2	0.745
4.	One	40 +60	120	6	3.14	160.1	254.34	1.2	0.675
5.	One	60 + 40	120	6	3.14	149	254.34	1.2	0.585
6.	One	80 + 20	120	6	3.14	138.5	254.34	1.2	0.54
7.	One	100 + 0	120	6	3.14	130	254.34	1.2	0.51
8.	One	20 + 80	60	3	3.14	174	254.34	1.2	0.68
9.	One	20 + 80	200	10	3.14	180.5	254.34	1.2	0.705
10.	Two	20 + 80	60	3	6.28	192.7	254.34	2.46	0.755
11.	Two	20 + 80	120	6	6.28	215.3	254.34	2.46	0.845
12.	Two	20 + 80	200	10	6.28	195.4	254.34	2.46	0.765
13.	Three	20 + 80	60	3	9.42	208.5	254.34	3.7	0.82
14.	Three	20 + 80	120	6	9.42	225.8	254.34	3.7	0.885
15.	Three	20 + 80	200	10	9.42	210	254.34	3.7	0.825
16.	Four	20 + 80	60	3	12.56	215.1	256	4.9	0.84
17.	Four	20 + 80	120	6	12.56	247.5	256	4.9	0.965
18.	Four	20 +80	200	10	12.56	202.5	256	4.9	0.79
19.	Five	20 + 80	60	3	15.7	230	254.34	6.2	0.90
20	Five	20 + 80	120	6	15.7	289	254.34	6.2	1.135
21.	Five	20 + 80	200	10	15.7	254	254.34	6.2	1

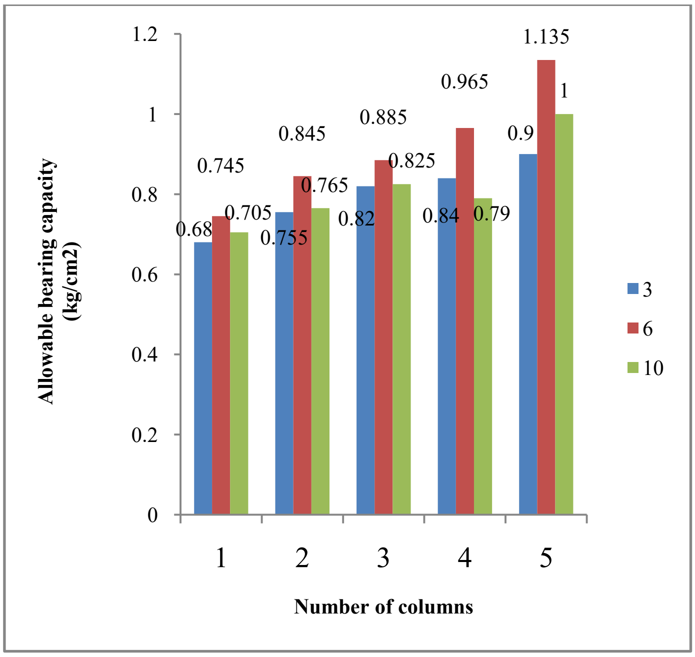
Result and Discussions



Allowable Bearing capacity v/s % of rubber used in stone column



Allowable Bearing capacity For (L/d =6) v/s Number of columns



Comparison of Allowable bearing capacity for L/D ratios and number of columns

Conclusion

The value of allowable bearing capacity for single column with different Percentage of rubber and Concrete demolition waste was maximum at (20% rubber + 80% demolition waste) having value 0.745 kg/cm2 with L/D = 6 whereas value of bearing carrying capacity of soil without column was 0.475 Kg/cm2. Allowable bearing capacity decreases with increase in percentage of rubber, this decrease was due to decrease in adhesion of rubber with soil particles and due to compressibility of rubber.

The value of allowable bearing capacity for two columns with L/D ratio 3 is equal to 0.755 kg/cm2 it increases to 0.845 kg/cm2 for L/D equal to 6 and then decreases to 0.765 kg/cm2 at L/D equal to 10. Decrease in allowable bearing capacity after L/D = 6, was due to buckling of stone columns. The value of allowable bearing capacity for three columns with L/D ratio 3 is equal to 0.82 kg/cm2 it also increases to 0.885 kg/cm2 for L/D ratio 6 and it also decreases to 0.825 kg/cm2 for L/D ratio 10. Similar observation were made in case of Four and five number of columns.

In case of five columns the value of Allowable Bearing Capacity of almost 2.5 times the allowable bearing capacity of virgin soil and about 2 times the allowable bearing capacity of soil with stone column of demolition waste only.

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