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EFFECT OF STABILIZING AGENT ON STRENGTH CHARACTERISTICS OF RECYCLED AND NON-RECYCLED MUNICIPAL SOLID WASTE

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Abstract - *The prime objective of this research is to convert MSW into suitable engineering material with the help of conventional soil treatment method called soil stabilization. The Pirana, Ahmedabad, Gujarat MSW which is now a major headache for some municipal authority in terms of big heaps (15 m) and for dumping tons of waste on daily basis. The objective is to treat this MSW with conventional stabilizing agents with cement, and lime, and fly ash with different proportion. Stabilizing agents are added in proportion of 1:1:3 with 1 part of cement 1 part of lime and 3 part of fly ash. Geotechnical tests like grain size analysis test, standard proctor test and unconfined compressive strength test will be performed on both treated and untreated samples. The comparison of results will be made with respect to variation in stabilizing agents and most optimum percent mix will be determined on the basis of UCS results.*

Key Words*: *Municipal solid waste, soil stabilization, Unconfined compressive strength test

1. INTRODUCTION

Municipal solid waste management is emerging out to be one of the most serious environmental problems for local municipalities in developing countries due to continuous expansion in the urban population. Municipal soil waste has shown poor geotechnical properties comparing to good soil. So enhancement it requires before using it. Here we Have selected soil stabilization technique to improve the engineering properties of municipal solid waste. Soil stabilization is the process of alteration of soil properties by physical or chemical means to improve the engineering properties of the soil. Soil stabilization using cement and lime is one of the most trending methods of stabilization of clayey soils. The main objectives of the soil stabilization is to improve the compressive strength of municipal solid waste.

2. BACKGROUND

Service road has been constructed using cement stabilised municipal solid waste at the karadiyana open dumpsite , shri lanka by U. P. Nawagamuwa and P. D. A. Muthukumarana 2018. CBR value of the original MSW soil samples ranged from 4% to 9%. CBR value of soil stabilized with cement increases when the cement content is increased from 0 to 10%. It was revealed that a cement percentage of 5% would be sufficient to comply with the requirement specified by ICTAD [15] on CBR values. GGGB has been used to improve geotechnical properties of municipal solid waste by karthik G 2018. Permeability (k) of contaminated soil is 3.84×10^{-4} cm/s where as that for uncontaminated soil was found to be 2.48×10^{-4}cm/s. This indicates the contamination of soil has been lead to increase in porosity which in turn increased permeability of soil. UCS of uncontaminated soil was found to be 8.11 kN/m^2 and that of contaminated soil is 6.78 kN/m^2. At 15% of GGBS UCS value is 8.35 kN/m^2. Quick lime and fly ash has been used as stabiliser in proportion of 1:3 by Behnam Fatahi & Hadi Khabbaz 2013. MDD is increase from 1243 kg/m^3 to 1295 kg/m^3 (4.0% increase). Compression index decrease from 0.325 to 0.225. Secondary compression index decrease from 0.052 to 0.033.

3. MATERIAL USED AND EXPERIMENTAL PROCEDURE

3.1 Cement

Cement which is to be used as mixture material with municipal solid waste for increasing stability is of PPC 53 Grade.

3.2 Lime

Lime used for stabilizing municipal solid waste is quick lime.

3.3 Fly ash

Fly ash which is to be used as mixture material with municipal solid waste for increase stability was procured from power plant in Ahmedabad.

3.4 Municipal solid waste

Municipal solid waste is collected from pirana site Ahmedabad.

3.5 Mix proportion

Various sample is prepared with proportion of 1:1:3 (cement : lime : fly ash).

Mix	Cement	Lime	fly ash	UCS	SPT	GSA
Mix–1	0.00%	0.00%	0.00%	6	6	6
Mix–2	1.67%	1.67%	5.00%	15	6	6
Mix–3	3.33%	3.33%	10.00%	15	6	6
Mix–4	5.00%	5.00%	15.00%	15	6	6
Mix–5	6.67%	6.67%	20.00%	15	6	6
Total				66	30	30

Table 1 Mix proportion

3.6 Test performed

Grain size analysis test, standard proctor test and unconfined compressive strength test were performed as per their respective IS codes.

4. RESULT AND ANALYSIS

4.1 Grain size analysis on Recycled and Non-recycled MSW

Grain size analysis test is performed on raw municipal solid waste as well as on municipal solid waste with stabilizing agents. For various mix contain results for Recycled MSW are as shown in the table below.

Recycled MSW				
stabilizing agent			Grain size analysis	
Cement	Lime	fly ash	Cu	Cc
0.00%	0.00%	0.00%	6.0042	0.588341
1.67%	1.67%	5.00%	9.5323	0.952463
3.33%	3.33%	10.00%	16.6161	1.097291
5.00%	5.00%	15.00%	8.6718	1.595062
6.67%	6.67%	20.00%	9.5723	1.376074

Table 2 Grain size analysis result of recycled MSW

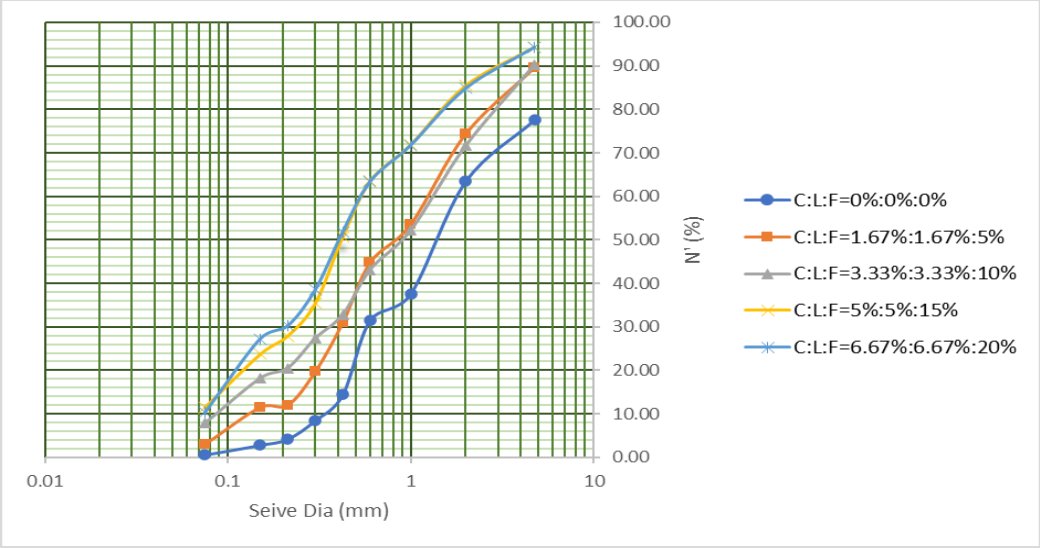

Figure 1 Graph of particle size distribution curve at various mix for recycled MSW

Recycled municipal solid waste is in range of poorly graded soil due scarcity of finer particles but after addition of stabilizing agents it comes under well graded soil.
For various mix contain results for Non-recycled MSW are as shown in the table below.

Non Recycled MSW				
stabilizing agent			Grain size analysis	
Cement	lime	fly ash	Cu	Cc
0.00%	0.00%	0.00%	4.6793	0.763195
1.67%	1.67%	5.00%	7.6005	1.212143
3.33%	3.33%	10.00%	11.4784	1.349638
5.00%	5.00%	15.00%	12.5241	1.31012
6.67%	6.67%	20.00%	11.4522	0.789892

Table 3 Grain size analysis result of recycled MSW

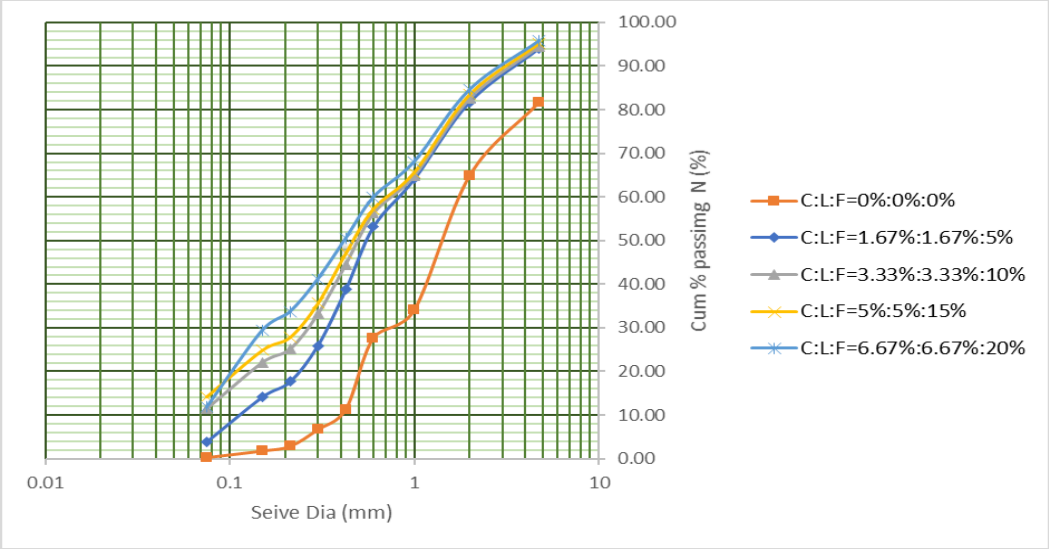

Figure 2 Graph of particle size distribution curve at various mix for recycled MSW

It is same as for Recycled municipal solid waste. Non-recycled municipal solid waste comes under range of poorly graded soil due scarcity of finer particles but after addition of stabilizing agents it comes under well graded soil.

4.2 Standard proctor test on Recycled and Non-recycled MSW

Standard proctor test is performed on raw municipal solid waste as well as on municipal solid waste with stabilizing agents. For various mix contain results for Recycled MSW are as shown in the table below.

Recycled MSW				
stabilizing agent			proctor test	
Cement	Lime	fly ash	MDD (gm/cc)	OMC
0.00%	0.00%	0.00%	1.5031	21.67%
1.67%	1.67%	5.00%	1.5388	19.94%
3.33%	3.33%	10.00%	1.5428	18.83%
5.00%	5.00%	15.00%	1.5685	17.96%
6.67%	6.67%	20.00%	1.5780	16.51%

Table 4 Standard proctor test result of Recycled MSW

Recycled municipal solid waste has shown MDD of 1.5031 gm/cc and OMC of 21.67%. after addition of stabilizing agent MDD has shown trend of increasing order and OMC has Shown trend of Decreasing order as shown in table 4.

For various mix contain results for Non-recycled MSW are as shown in the table below.

Non-recycled MSW				
stabilizing agent			proctor test	
Cement	lime	fly ash	MDD (gm/cc)	OMC
0.00%	0.00%	0.00%	1.5410	20.99%
1.67%	1.67%	5.00%	1.5526	19.89%
3.33%	3.33%	10.00%	1.5735	19.04%
5.00%	5.00%	15.00%	1.5856	18.52%
6.67%	6.67%	20.00%	1.5986	17.84%

Table 5 Standard proctor test result of Non-recycled MSW

Non-recycled municipal solid waste has shown MDD of 1.5410 gm/cc and OMC of 20.99%. after addition of stabilizing agent MDD has shown trend of increasing order and OMC HAS Shown trend of Decreasing order as shown in table 5.

Non-recycled MSW has shown higher MDD comparing to recycled MSW. However incremental rate is higher in recycled MSW comparing Non-recycled MSW with increment of stabilizing agent by 72.48%.

4.3 Unconfined compression test on Recycled and Non-recycled MSW

Unconfined compression test is performed on raw municipal solid waste as well as on municipal solid waste with stabilizing agents. For various mix contain results for Recycled MSW are as shown in the table below.

Recycled					
stabilizing agent			UCS test (KN/m2)		
Cement	lime	fly ash	3 days	7 days	Increase
0.00%	0.00%	0.00%	14.5758	14.5758	0.00%
1.67%	1.67%	5.00%	27.4819	40.2978	46.63%

3.33%	3.33%	10.00%	36.7826	55.0583	49.69%
5.00%	5.00%	15.00%	65.5472	90.6949	38.37%
6.67%	6.67%	20.00%	82.3361	115.6635	40.48%

Table 6 Unconfined compression test result of Recycled MSW

UCS value for recycled municipal solid waste is 14.5758 KN/m2. After addition of stabilizing agent enormous increment in UCS value has shown as in table 6. UCS test were performed after 3 days and 7 days after preparation of UCS sample with stabilizing agent added. 7 days UCS value is approximately 40% higher comparing to 3 days UCS value. So here Municipal solid waste with stabilizing agent has shown same strength gaining characteristics as of concrete.

For various mix contain results for Non-recycled MSW are as shown in the table below.

Non-recycled MSW					
stabilizing agent			UCS test (KN/m²)		
Cement	Lime	fly ash	3 days	7 days	Increase
0.00%	0.00%	0.00%	15.9126	15.9126	0.00%
1.67%	1.67%	5.00%	40.9095	57.7215	41.10%
3.33%	3.33%	10.00%	63.7036	87.4935	37.34%
5.00%	5.00%	15.00%	89.0940	121.9474	36.87%
6.67%	6.67%	20.00%	104.9871	146.5639	39.60%

Table 7 Unconfined compression test result of Non-recycled MSW

Non-recycled MSW has shown UCS value of 15.9126 KN/m² which is higher than Recycled MSW. Here strength gaining characteristic is also same as of concrete.

5. CONCLUSIONS

5.1 Grain size analysis test

Recycled and Non recycled MSW are in range of poorly graded soil after addition of stabilising agent they are converted in range of well graded soil.

5.2 Standard proctor test

In recycled MSW MDD is increasing at rate of 0.1918% and in non recycled MSW MDD is increasing at rate of 0.1112% per one percent of stabilizing agent added.

In recycled MSW OMC is decreasing at rate of 0.7897% and in non recycled MSW OMC is decreasing at rate of 0.5790% per one percent of stabilizing agent added.

5.3 Unconfined compression test

In Recycled MSW 7- days UCS value is 43.79% higher than 3- days UCS value & for Non – recycled MSW it is 38.73%. So it shows same strength gaining characteristics as in concrete.

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