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Research Paper

A STUDY ON CBR BEHAVIOR OF WASTE PLASTIC (PET) ON STABILIZED RED MUD AND FLY ASH

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An experimental study was carried out to investigate the dry density and CBR behavior of waste plastic (PET) content on stabilized red mud, fly ash and red mud fly ash mix. In the present work pieces of waste plastic (PET) bottle size less than 20 mm and bigger than 4.75 mm was taken and mixed in different proportions of 0.5, 1, 2, 3, and 4% by dry weight of red mud, fly ash and red mud fly ash mix and the geotechnical properties were evaluated. The study reveals that addition of waste plastic (PET) content in red mud, fly ash and red mud fly ash mix resulted in an appreciable increase in the dry density and CBR values. The benefit of adding waste plastic content beyond 2% does not improve the dry density and CBR values appreciably. The material can be used in base courses in constructing rural roads. There by leading to safe disposal of these waste materials in an environmentally friendly manner.

Keywords: Waste Plastic (PET), Red mud, Fly ash, Stabilization, Dry Density and CBR

INTRODUCTION

The water bottle is the greatest rising beverage industry in the world. According to the International Bottled Water Association (IBWA) sales of bottled water have increased by 500% over the last decade and 1.5 million tons of plastic are used to bottle water every year. The general survey shows that 1500 bottles are dumped as garbage every second. PET is reported as one of the most abundant plastics in solid urban waste (de Mello *et al*., 2009). Waste Recovery Program, WRAP (2005) indicates that the reduction of waste benefits the natural environment with indubitable economical advantages, since waste represents a large loss of resources and raw materials that could be recovered, recycled or considered for other uses. In 2007, it is reported a world's annual consumption of PET bottles is approximately 10 million tons and this number grows about up to 15% every year. On the other hand, the number of recycled or returned bottles is very low (ECO PET, 2007). On an average, an Indian uses 1 kg of plastics per year and the world annual average is an alarming 18 kg. As per data available on

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Municipal Solid Waste MSW (2009), approximately, 4000-5000 ton per day post-consumer plastics waste are generated. On other hand, red mud and fly ash also present very typical problem for Aluminum Industries. Due to presence of caustic soda the red mud has very high pH value greater than 11. Its disposal is problematic and it is hazardous to environment. Fly ash is a waste by- product from thermal power plants which use coal as fuel. It is estimated that about 100 million tons of fly ash is being produced from different thermal power plants in India consuming several thousand hectares of valuable land for its disposal causing severe health and environmental hazards.

The main purpose of this investigation is utilization of these wastes in civil engineering purposes in road construction or any other requirements.

MATERIALS

Red Mud

The red mud used in this study was procured from Hindalco Industries Ltd. Renukoot, Uttar Pradesh, India. It contained a sand fraction of about 28%, and silt and clay content of about 72%. It had a specific gravity of 2.85 and liquid limit of 40%. The maximum dry density and optimum water content obtained from a light compaction test for the red mud were 1.53 g/cc and 31%, respectively. The value of cohesion and angle of internal friction were 0.125 kg/cm^2 and 26.0 respectively. The unsoaked and soaked CBR values of the red mud were 2.92 and 1.24%. There was no found swelling index and swelling pressure in case of red mud.

Figure 1: Waste Plastic (PET) Pieces

Fly Ash

The fly ash used in this study was procured from Hindalco Industries Ltd. Renukoot, Uttar Pradesh, India. It contained a sand fraction of about 19%, and silt content of about 81%. It had a specific gravity of 2.24 and liquid limit of 43%. The maximum dry density and optimum water content obtained from a light compaction test for the fly ash were 1.21 g/cc and 31%, respectively. The unsoaked and soaked CBR values of the red mud were 8.03 and 1.97%. There was no found swelling index and swelling pressure in case of fly ash.

Red Mud and Fly Ash Mix

50% red mud and 50% fly ash were mixed and evaluated geotechnical properties. It contained a sand fraction of about 23%, and silt and clay content of about 77%. It had a specific gravity of 2.46 and liquid limit of 41%. The maximum dry density and optimum water content obtained from a light compaction test for the red mud were 1.38 g/cc and 31%, respectively. The unsoaked and soaked CBR values of the red mud were 7.60 and 1.62%. There was no found swelling index and swelling pressure.

Waste Plastic

Waste Plastic bottle (PET) was taken from recylicling plastic plant Kanpur Uttar Pradesh. Figure 3 shows the waste plastic (PET). The sizes of waste plastic pieces passing from 20 mm sieve and retained on 4.75 mm sieve.

RESULTS AND DISCUSSION

OMC and MDD of Red Mud, Fly Ash and Red Mud Fly Ash Mix with Different Percentages Waste Plastic (PET) Content

This investigation shows that from light compaction MDD values of the red mud, fly ash and red mud fly ash mix increases as the waste plastic (PET) increases till 2%, further Increment in waste plastic (PET) reduces the MDD values. So the optimum value of waste plastic content is 2% for the MDD. The OMC values are found to be approximately constant in each case. In the above context, Figure 2 to 4 shows the graphical representation.

Laboratory CBR Values of Red Mud and Waste Plastic Content

California Bearing Ratio test was conducted for evaluating the suitability of the sub-grade and material used in sub-base and base of the flexible pavement. Figure 5 and 6 shows the load penetration curve for red mud and red mud with different percentage of waste plastic content (0.5, 1.0, 2.0, 3.0 and 4.0) in unsoaked and soaked condition.

Figure 7 and 8 shows the load penetration curve for fly ash and fly ash with different percentage of waste plastic content (0.5, 1.0, 2.0, 3.0 and 4.0) in unsoaked and soaked condition.

Figure 9 and 10 shows the load penetration curve for red mud fly ash mix and red mud fly ash mix with different percentage of waste plastic content (0.5, 1.0, 2.0, 3.0 and 4.0) in unsoaked and soaked condition.

The CBR values for unsoaked and soaked condition of red mud, fly ash and red mud fly ash mix with different percentage of waste plastic are shown in Figures 11 and 12. The CBR values in unsoaked and soaked condition are shown in Table 1.

Figure 2: Moisture Density Relationships of Red mud and Red mud with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content

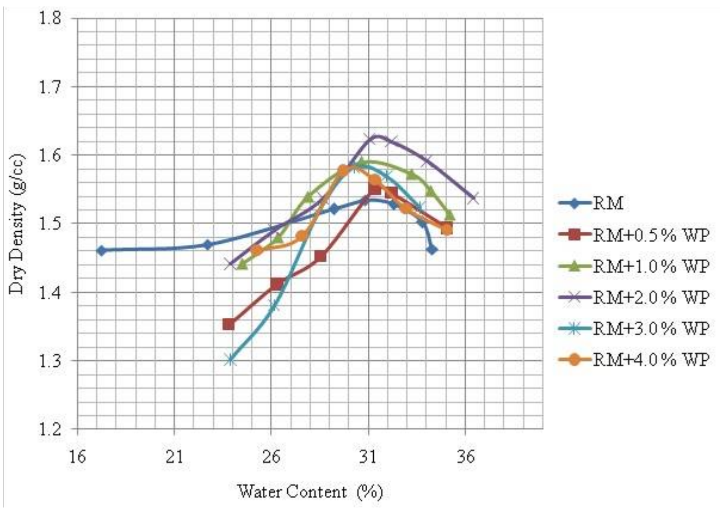

Figure 3: Moisture Density Relationships of Fly ash and Fly ash with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content

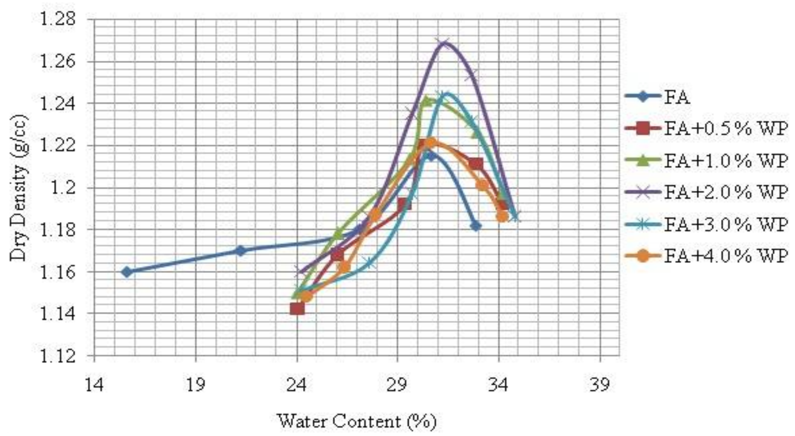

Figure 4: Moisture Density Relationships of Red mud Fly ash mix and Red mud Fly ash mix with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content

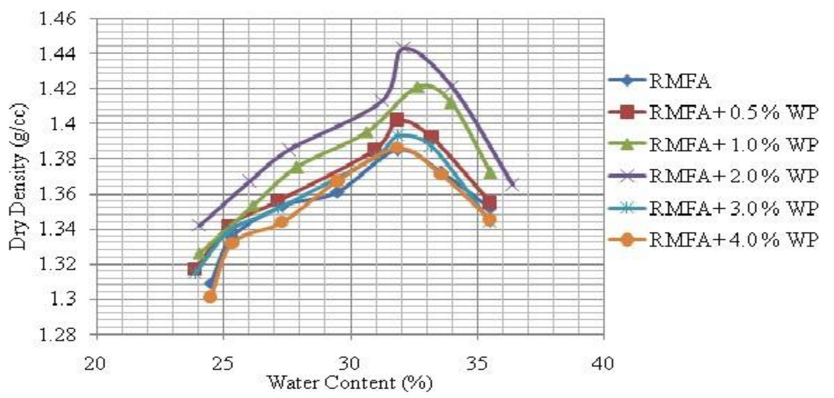

Figure 5: Relationship Between Load Vs. Penetration of Red Mud and Red Mud with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content (CBR Unsoaked Test)

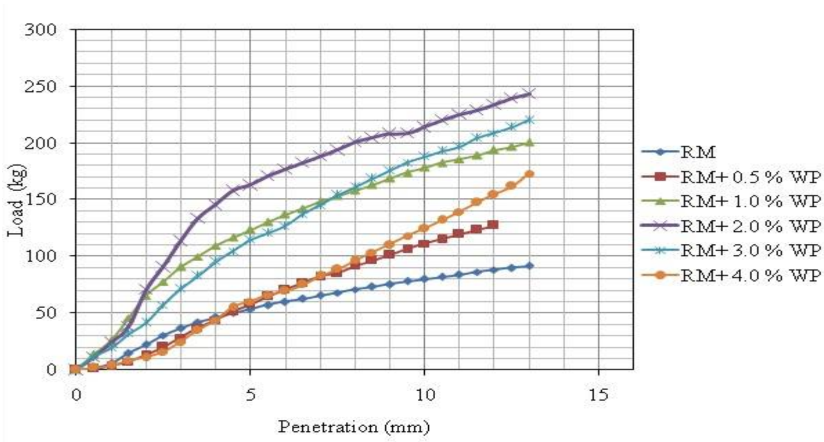

Figure 6: Relationship Between Load Vs. Penetration of Red mud and Red mud with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content (CBR Soaked Test)

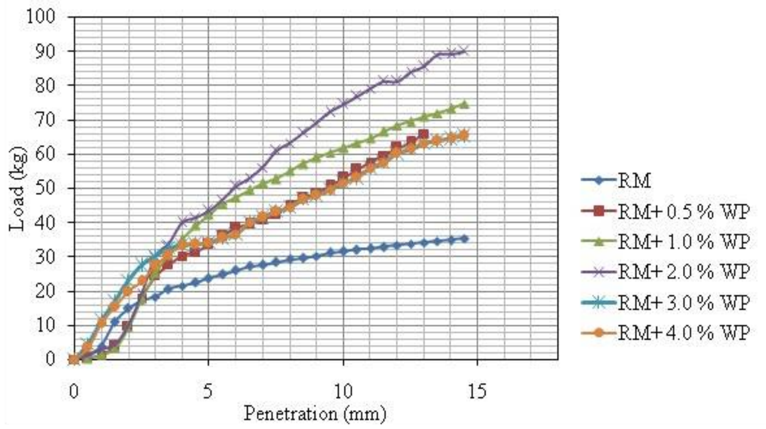

Figure 7: Relationship Between Load Vs. Penetration of Fly Ash and Fly Ash with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content (CBR Unsoaked Test)

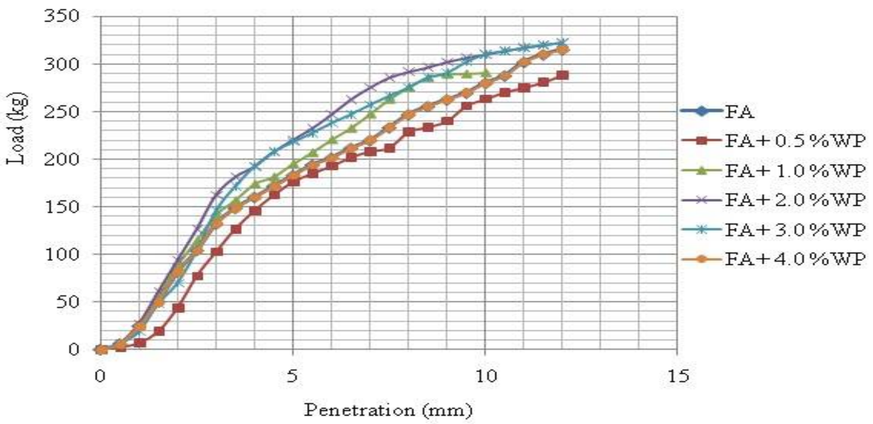

Figure 8: Relationship Between Load Vs. Penetration of Fly Ash and Fly Ash with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content (CBR Soaked Test)

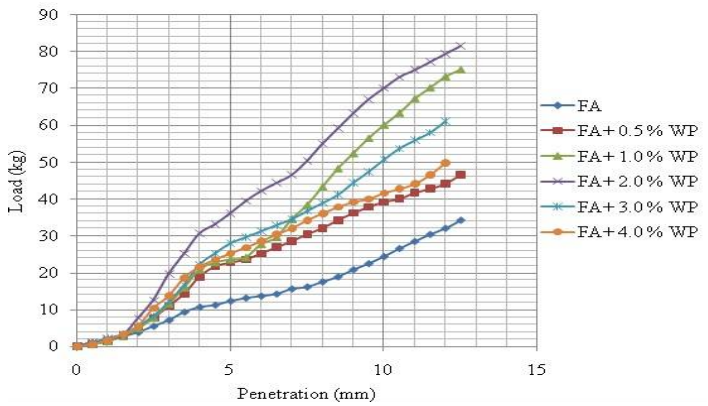

Figure 9: Relationship Between Load Vs. Penetration of Red mud Fly ash mix and Red mud Fly ash mix with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content (CBR Unsoaked Test)

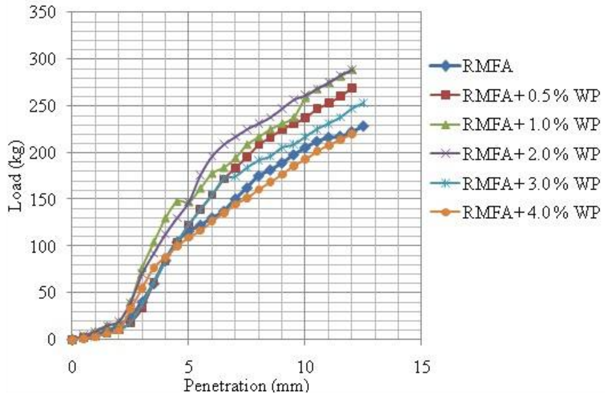

Figure 10: Relationship Between Load Vs. Penetration of Red Mud Fly Ash Mix and Red mud Fiy Ash Mix with 0.5, 1.0, 2.0, 3.0 and 4.0% Waste Plastic Content (CBR Soaked Test)

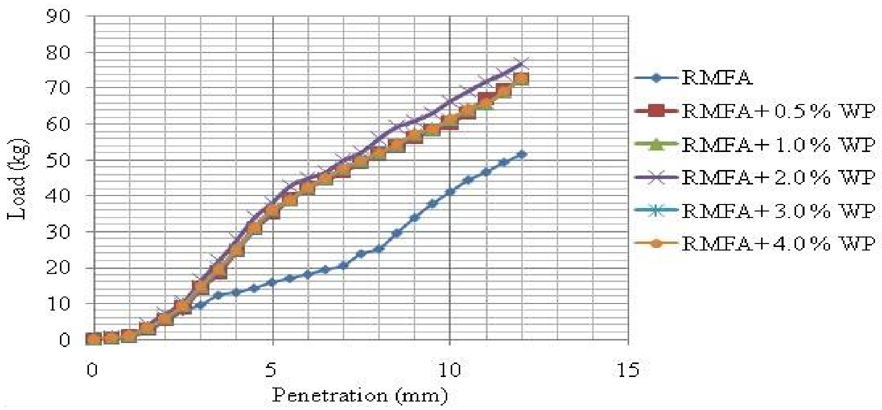

Figure 11: Relationship Between CBR Values Vs. % of Waste Plastic Content in Unsoaked Condition

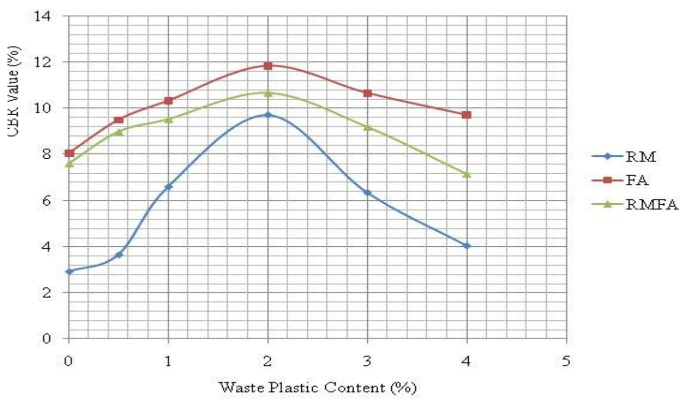

Figure 12: Relationship Between CBR Values Vs. % of Waste Plastic Content in Soaked Condition

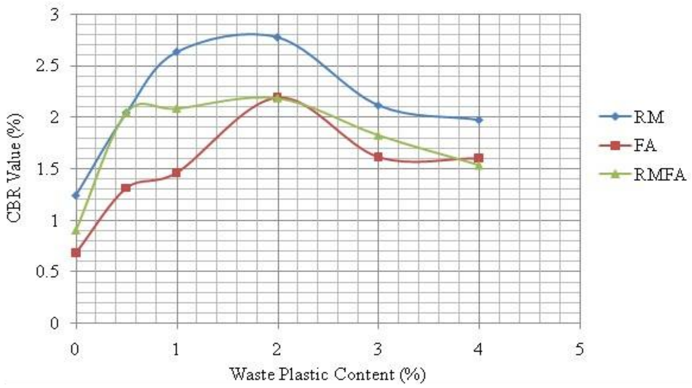

Table 1: CBR Values of Red mud, Fly ash and Red mud Fly ash mix in Different Unsoaked and Soaked Condition

	Unsoaked Condition			Soaked Condition		
Waste Plastic Content (%)	RM	FA	RMFA	RM	FA	RMFA
0	2.92	8.03	7.6	1.24	0.68	0.9
0.5	3.65	9.49	8.98	2.04	1.31	2.04
1.0	6.6	10.32	9.52	2.63	1.46	2.08
2.0	9.72	11.84	10.66	2.77	2.19	2.18
3.0	6.35	10.66	9.19	2.11	1.61	1.82
4.0	4.04	9.71	7.15	1.97	1.6	1.53

CONCLUSION

In this work, light compaction test and California Bearing Ratio test were conducted and the results of the tests have been presented and discussed in the above. Conclusion drawn on the basis of these results and discussion has been summarized below:

1. The MDD values are increases after inclusion of waste plastic content till 2% and decreases after 2% of waste plastic contents in each case. It indicates that 2% is the optimum dose, and OMC values are approximately constant in each case.
2. A marked increase in the california bearing ratio values was observed due to the addition of 0.5, 1.0 and 2.0% of waste plastic (PET) and was found to be decrease after inclusion of 3.0 and 4.0%, So increase of CBR value indicates that the thickness of pavement can be reduced by inclusion of waste plastic content up to 2%.

In the present study main aim is utilization of red mud, fly ash and waste plastic as a stabilizing material in civil engineering work. This material can be used as rural road construction where the red mud and fly ash are easily available means near the aluminum industries.

NOMENCLATURE

RM: Red Mud

FA: Fly Ash

RMFA: 50 % red mud + 50 % fly ash

WP: Waste Plastic

REFERENCES

1. Choudhary A K, Jha J N and Gill K S (2010), "A Study on CBR Behavior of Waste Plastic Strip Reinforced Soil", *Emirates Journal for Engineering Research*, Vol. 15, pp. 51-57.
2. Consoli N C, Montardo J P, Prietto P D M and Pasa G S (2002), "Engineering behavior of a sand reinforced with plastic waste", *Journal of Geotechnical and Geoenvironmental Engineering,* ASCE 128, Vol. 6, pp. 462–472.
3. De Mello D, Pezzin S H and Amico S C (2009), "The effect of post-consumer PET particles on the performance of flexible polyurethane foams", *Journal of Royal Society of chemistry,* Vol .28, pp. 702–708.
4. Dutta R K and Sarda V K (2006), "CBR Behavior of Waste Plastic Strip-Reinforced Stone Dust/Fly ash Overlying Saturated Clay", *Turkish Journal of Engineering and Environmental Science,* Vol. 31, pp. 171-182.
5. ECO PET, (2007), <http://www.ecopet.eu/Domino_english/ecopet.htm>, accessed on 13th September 2012.
6. IS: 2720-Part-3-1980, "Determination of Specific Gravity".
7. IS: 2720-Part-4, "Grain Size Analysis".
8. IS: 2720-Part-7-1980, "Determination of Water Content-Dry Density Relation Using Light Compaction".
9. IS: 2720-part-11-1993, "Determinaton of The Shear Strength Parameters of a Specimen Tested in Unconsolidated Undrained Triaxial Compression without The Measurement of Pore Water Pressure".
10. IS: 2720-Part-16-1979, "Laboratory Determination of California Bearing Ratio".
11. Plastic ID codes "American chemistry council." Sheet No. 1-3, Detail available at Plastic code website <http://*www.plasticbottles.com/topic/recyclelogy*.htm>.
12. Prasad D S V and Raju G V R (2008), "Utilization of Industrial Waste in Flexible Pavement Construction", *Electronic Journal of Geotechnical Engineering*, Vol. 13, pp. 50 -57.
13. Rao Hanumanth C H V, Naidu P and Satyanayarana P V V (2012), "Characterization of Lime Stabilized Red mud Mix for Feasibility in Road Construction", *International Journal of Engineering Research*, Vol. 3, pp. 20-26.
14. Sivakumar Babu G L and Chouksey S K

(2011), “Stress-Strain Response of Plastic Waste Mixed Soil”, *Waste Management*, Vol. 31, pp. 481-488.

15. Waste Recovery Program, WARP (2010). <http://www.wasteereduction. org.> (accessed on 13th September 2012.