CHARACTERIZATION OF WASTE BUILDING DERIVED MATERIALS AS AN ALTERNATIVE MATERIAL FOR REPLACING SOIL IN CIVIL ENGINEERING.

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Abstract

Generation of Construction and Demolition Wastes and their disposal is a critical issue at present. The amount of waste generated during demolition activities is much greater than the waste generated during construction activities. Our country generates an estimated 150 million tons of C&D waste every year. But India recycles just one per cent of its construction and demolition (C&D) waste. So, on the contrary of just leaving the landfills, we are utilizing this building waste as an alternative of soil by replacing the soil via varying the composition. The primary component of Building Derived Materials (BDM) is predominantly composed of concrete and bricks. In our Project, we have used Light weight concrete, Crushed Tiles, Crushed Normal Portland cement concrete and Crushed Bricks. We have done various Engineering properties tests on the combined form of soil and Building Derived Materials. Based on the results obtained, a comparison of various Building Derived Materials specimens is done and presented in tabular formand can be applied in various Geotechnical applications. The reuse of construction demolition materials like concrete,bricks, etc., is an attempt to reduce the cost of using new materials and reduces the consumption of natural resources.Since there are no existing ASTM standards for the practical use of such materials, the outcomes of this study can also be used to formulate standard code of practice to use BDM for ground improvement purposes.

Keywords: Construction and Demolition Wastes, Building Derived Materials (BDM), Light weight concrete, Crushed Tiles, Crushed Normal Portland cement concrete and Crushed Bricks.

Introduction

India is the second largest populated country in the world, the construction industry in India is one of the major economic sectors after agriculture, generating a huge amount of construction and demolition waste. The Construction Industry has been identified as responsible for the consumption of around 50% of natural resources and 50% of the total waste produced by construction, reconstruction, conservation, demolition or downfall of structures and infrastructures, being produced in huge quantities. Rapid urbanization and growth of infrastructure in the present days has resulted in dramatically increased demand for land space. This necessitated the construction industry to improve the soil grounds or otherwise are unsuitable for construction activities.

The preservation of the environment, specifically of the natural resources is of utmost importance for current and future generations. Construction creates an estimated third of the world's overall waste, and at least 40% of the world's carbon dioxide emissions. Construction and related demolition activities generate a large amount of solid waste, generally termed as construction and demolition wastes (CDW). The Building Derived Materials (BDM) gives rise to huge amount of solid wastes which leads to negative impacts on the environment. This generation of CDW leads to pollution and has a very serious effect on the environment. Managing and properly disposing these wastes are becoming a major problem in today's society.

Construction and Demolition Waste is one of the leading problems in India. Our country produces 150 million tons of waste every year. Recycling of waste and other building materials is difficult and uneconomical. And India tries to recycle only 1% of demolition waste produced. Construction Demolished waste is generally dumped in the disposal area. On the contrary to this, here we are using this as an alternative to the soil. It reduces the demand for new resources, cuts down the cost and effort of transport and production, use waste which would otherwise be lost to landfill sites.

Our Project aims at characterizing the Building Derived Materials along with the soil and it promotes the use for ground improvement techniques. The use of BDM in geotechnical applications such as improving soil properties under foundation willreduce the consumption of natural resources by replacing soil and use of BDM divert them from landfills, thus encouraging green and sustainable development. The huge generated amounts of construction and demolition (C&D) waste around the world, which amounts up to more than 25% of the total generated waste, has become a serious environmentalchallenge that needs to be addressed. Our Project studies sheds light on the concern for different adverse environmental impacts and proposes the reuse of BDM as an alternative along with the soil. The reuse of construction demolition materials like concrete, bricks, etc., is an attempt to reduce the cost of using new materials and reduces the consumption of natural resources.

- Minimizes the negative impacts on the Environment and utilize the demolition waste.
- Reuse of materials which leads to Sustainability by knowing their properties.
- Our Project Study can be used as the basis for the various applications in Civil Engineering such as Ground fills, Highways, Embankment filling, Earthen dams.

Objectives

1. To minimize the negative impacts on the Environment and utilize the demolition waste.
2. To Reuse the materials which leads to Sustainability by knowing their Engineering properties.

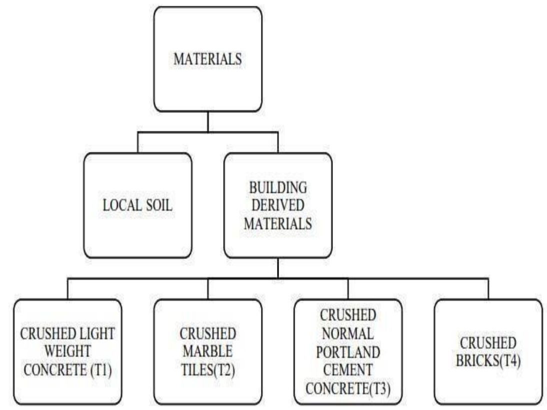


Figure 1. Materials

METHODOLOGY

We have collected locally available soil and also the building derived materials from Meerpet, Hyderabad. And then we have separated the BDM specimens. In the present project study, four types of BDM, namely crushed lightweight concrete (T1), crushed tiles (T2), crushed normal Portland cement concrete (T3), and crushed bricks (T4) are characterized to assess their compatibility when used in conjunction with soil.

The tests which give the index properties are performed on the virgin soil and the tests which gives us the engineering properties are performed on both soil and BDM. The tests like compaction, permeability, CBR test has done on the combined form of soil and BDM by varying their composition. For every specimen, i.e., T1, T2, T3, T4 the test results are compared and this can be used to promote the practical use for ground improvement techniques.

Figure 2. Showing Samples

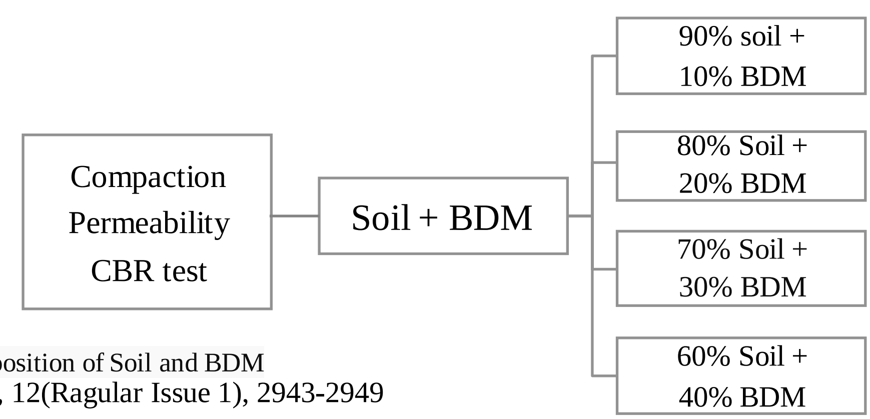


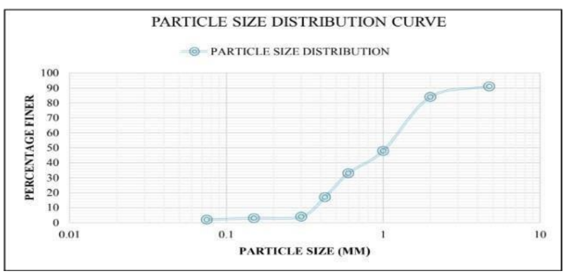
Figure 3. Composition of Soil and BDM

Material Characterization

Particle-size distribution of soil and C&DW was performed according to Indian standardIS:2720—IV and materials were classified as per IS:1498. The specific gravity of materials was ascertained based on the pycnometer method, following the guidelines laid by IS: 2720—III. Standard Proctor tests were performed on the samples with different mix proportions of soil andC&DW to determine the compaction parameters in accordance with IS:2720—VII. The results of the compaction test are used to determine the optimum quantity of C&DW to replace the soil without compromising the strength and to achieve improved backfill properties.

Properties of Soil

The particle-size distribution curve for the soil was obtained by the process laid in IS:2720—IV. The Liquid limit and plastic limit of soil is determined in accordance with IS: 2720—VI. The index properties include the parameters like specific gravity, percentage fines and consistency limits are listed in Table 2.



Graph 1. % of fines

Table 1. Properties of soil

Properties	Obtained Value
Specific gravity	2.5
Water content	18.61%
Coefficient of Uniformity	6
Curvature Coefficient	1.2
Liquid limit	56.58%
Plastic limit	13.58
OMC (optimum moisture content)	16%
MDD (maximum dry density)	1.99 g/cm3

Properties of Soil and BDM

Mix proportions

Table 2. Showing the composition of Soil and BDM

Sample	BDM %	SOIL %
1	10 %	90 %
2	20%	80%
3	30%	70%
4	40%	60%

Below in the table we can see the various composition of the soil and BDM used for testing.

Results and Discussion

The study is carried out to study, perform, and compare the experimental data for varying combinations of C&DW and soil to determine the optimum quantity of C&DW to be employed as reinforcing material in the backfill soil. The index and engineering tests like sieve analysis, liquid limit, specific gravity, compaction tests were carried out.

Comparison of the tests

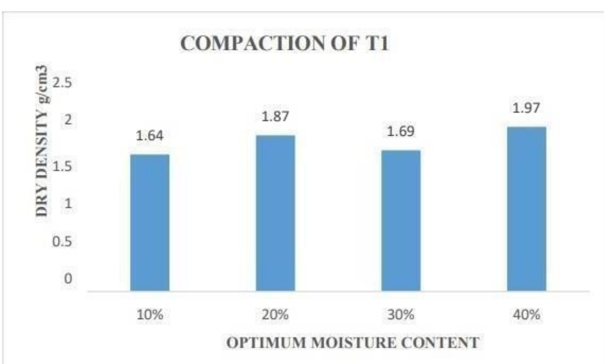
The various tests done on the BDM specimens are compared and the comparison graph is plotted. We can compare compaction, permeability and CBR test values of T1, T2, T3, T4 along with the soil.

Table 3. Comparing the Test values of T1

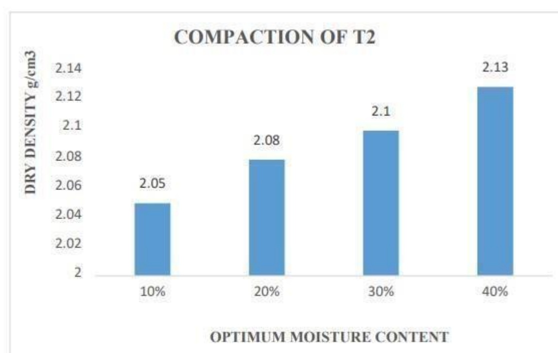
composition	compaction	Permeability	CBR
10%	OMC = 16% MDD = 1.64 g/cm3	Avg = 3.79x 10^-3 cm/sec	CBR @ 2.5mm = 6.08% CBR @ 5mm = 5.48%
20%	OMC = 16 % MDD = 1.87 g/cm3	Avg = 1.18 x 10^-3 cm/sec	CBR @ 2.5mm = 6.1% CBR @ 5mm = 6.48%
30%	OMC = 20 % MDD = 1.69 g/cm3	Avg = 1.14 x 10^-3 cm/sec	CBR @ 2.5mm = 5.77% CBR @ 5mm = 5.93%
40%	OMC = 20 % MDD = 1.97 g/cm3	Avg = 4.47 x 10^-3 cm/sec	CBR @ 2.5mm = 5.6% CBR @ 5mm = 6.704%

Table 4. Comparing the Test values of T2

composition	compaction	permeability	CBR
10 %	OMC =12 % MDD=2.05 g/cm3	Avg = 1.69 x 10^-4 cm/sec	CBR @ 2.5mm = 3.61 % CBR @ 5mm = 3.95%
20%	OMC = 16% MDD = 2.08 g/cm3	Avg = 2.16 x 10^-3 cm/sec	CBR @ 2.5mm= 3.78% CBR @ 5mm = 4.28%
30%	OMC = 16 % MDD = 2.1 g/cm3	Avg = 2.24 x 10^-3 cm/sec	CBR @ 2.5mm = 3.94 % CBR @ 5mm = 4.72%
40%	OMC = 16 % MDD = 2.13 g/cm3	Avg = 2.59 x 10^-3 cm/sec	CBR @ 2.5mm = 4.28% CBR @ 5mm = 4.94%



Graph 2. Comparison of the Compaction tests of T1 & Soil



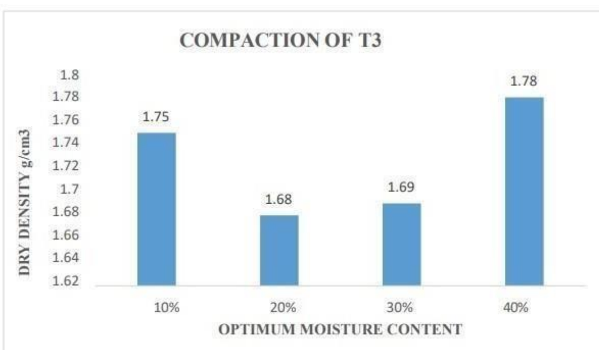
Graph 3. Comparison of the Compaction tests of T1 & Soil

Table 5. Comparing the Test values of T3

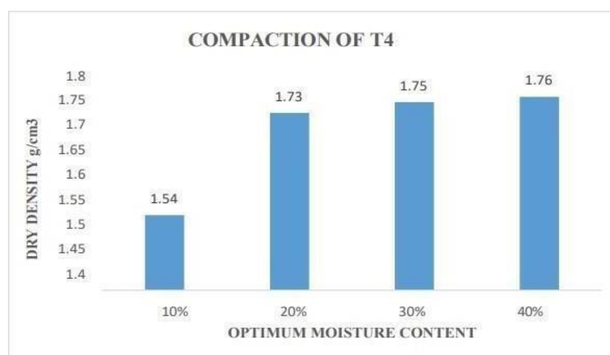
composition	compaction	permeability	CBR
10 %	OMC = 12 % MDD = 1.75 g/cm3	Avg = 4.03 x 10^-3 cm/sec	CBR @ 2.5mm = 5.44% CBR @ 5mm = 5.05%
20%	OMC =16 % MDD = 1.68 g/cm3	Avg = 1.39 x 10^-3 cm/sec	CBR @ 2.5mm = 5.6% CBR @ 5mm = 5.61%
30%	OMC = 20 % MDD = 1.69 g/cm3	Avg = 1.59 x 10 ^-3 cm/sec	CBR @ 2.5mm = 5.92% CBR @ 5mm = 5.93%
40%	OMC = 20 % MDD = 1.78 g/cm3	Avg = 2.07 x 10^-3 cm/sec	CBR @ 2.5mm = 6.27% CBR @ 5mm = 6.81%

Table 6. Comparing the Test values of T4

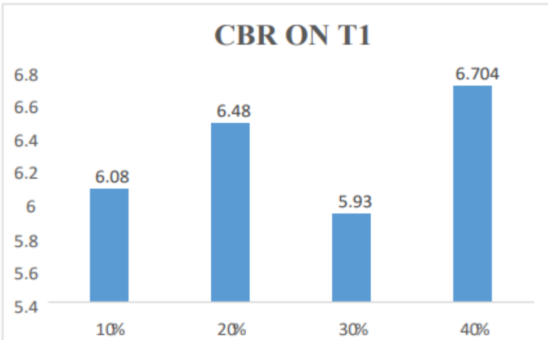
composition	compaction	permeability	CBR
10 %	OMC = 16 % MDD = 1.54 g/cm3	Avg = 13.5 x 10^-3 cm/sec	CBR @ 2.5mm = 4.29% CBR @ 5mm = 3.84%
20%	OMC = 16 % MDD = 1.73 g/cm3	Avg = 8.23 x 10^-3 cm/sec	CBR @ 2.5mm = 5.6% CBR @ 5mm = 7.36%
30%	OMC = 16 % MDD = 1.75 g/cm3	Avg = 9.62 x 10 ^-3 cm/sec	CBR @ 2.5mm = 7.41% CBR @ 5mm = 9.11%
40%	OMC = 20% MDD = 1.76 g/cm3	Avg = 6.847 x 10 ^-3 cm/sec	CBR @ 2.5mm= 7.58% CBR @ 5mm = 9.67%



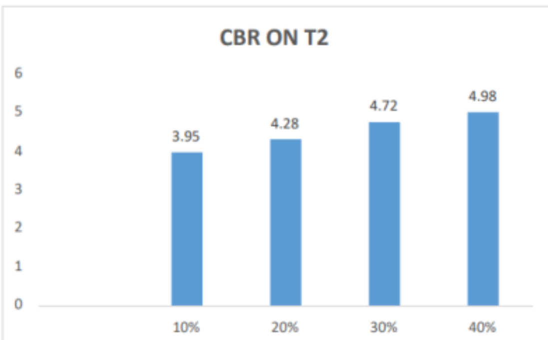
Graph 4. Comparison of Compaction tests of T3 & soil



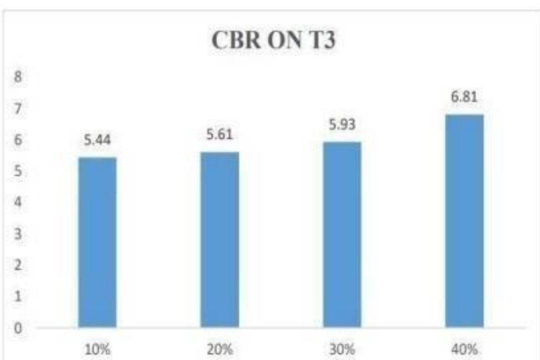
Graph 5. Comparison of Compaction tests of T4 & soil



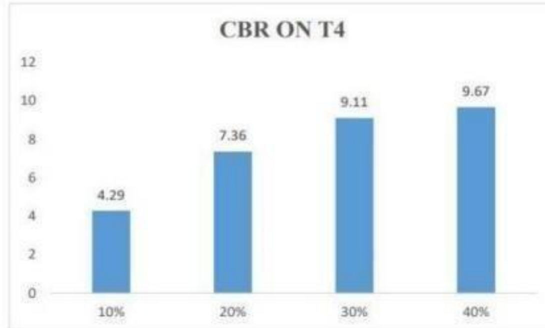
Graph 6.CBR Test on T1



Graph 7.CBR Test on T2



Graph 8.CBR Test on T3



Graph 9.CBR Test on T4

Conclusions

1. From the Grain Size Analysis, we can conclude that the soil has different particle sizes. Hence, it is Well-Graded Soil.
2. The Liquid Limit of the soil is 56.5%.
3. Plastic limit of the soil sample is 13.58%
i.e., plasticity index IP= Liquid limit – Plastic limit = 42.92
IP > 17., The soil is High Plastic soil
4. The OMC of soil = 16 %, MDD of soil = 1.99g/cm3
5. The soil when replaced with 40% T2 has dry density = 2.13 g/cm3 i.e., comparing to virgin soil the water content increased and dry density increased by 7.03%.
6. The soil when replaced with 40% T3, the CBR value is 6.81%, has increased by value 4.37 % and when replaced with 30% T4 the CBR value is 9.11% has increased by 6.64% when compared to the virgin soil.
7. The permeability of soil is 6.66x10^-3cm/sec, when replaced with 30% T1, the permeability is 1.14x10^-3 cm/sec.

References

[1] Indian Standard Code IS:2720 Part – 1, Part -2, Part – 3, Part – 4, Part – 5, Part – 6, Part – 9, Part – 16, Part – 17.

[2] Apurvkumar Prajapati and Hasan Rangwala, (2022)- "Utilization of Recycled Construction and Demolition Waste in Backfill Soil", International Journal of Geosynthetics and Ground Engineering, Volume 8 Issue 5, Article 67, 10 October 2022.

[3] Castorina S. Vieira and Paulo M. Pereira, (2022)- "Influence of the Geosynthetic Type and Compaction Conditions on the Pullout Behavior of Geosynthetics Embedded in Recycled Construction and Demolition Materials", Sustainability, Volume 14, Issue 3, 21 January 2022.

[4] Nuno Cristelo, Castorina Silva Vieira and Maria de Lurdes Lopes, (2016)- "Geotechnical and Environmental Assessment of Recycled Construction and Demolition Waste for Road Embankments", Procedia Engineering, Advances in Transportation Geotechnics, Volume 143, pages 51-58, 7.06.2016.

[5] Soil Mechanics And Foundation Engineering – Geotechnical Engineering: K.R. Arora

[6] Principles and Practices of Soil Mechanics and Foundation Engineering, V. N. S. Murthy.

[7] Moataz A. Al- Obaydi, Orhan A. Atasoy (2022) – Improvement in Field CBR values of subgrade soil using Construction – Demolition Materials.

[8] Junhui Zhang, Fan Gu (2019) – Use of building related construction and demolition wastes in highway embankment; Laboratory and Field Evaluations.

[9] Arul Arulrajah, Suksun Horpibulsuk (2014) – Physical properties and shear strength responses of recycled construction materials in unbound pavement base/ subbase applications.