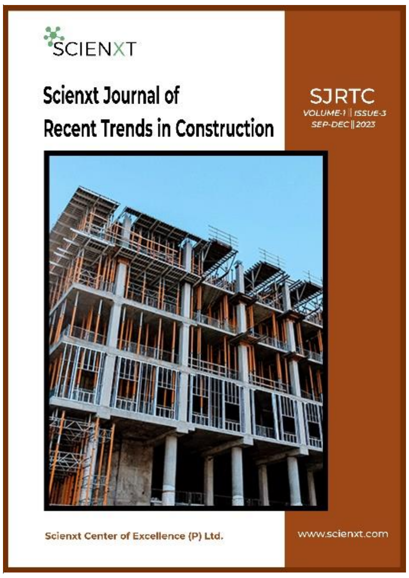


Scienxt Journal of Recent Trends in Construction
Volume-1 || Issue-3 || Sept-Dec || Year-2023 || pp. 1-13

Use of building derived material as an alternative material forreplacing soil in geotechnical enginerring

Yellavula Sreeya Reddy[1]
Somireddy Shiva Prasad Reddy[2]
Dr. P. Raja Sekhar [*3]
Dr K.Shanker[4]
A.Madhavilatha[5]

[1,]Final year B.E students, Department of Civil Engineering, Matrusri Engineering College.
[1,2]Associate Professor, Department of Civil Engineering, Matrusri Engineering College.
[3]Professor and Principal , K I T S , Huzurabad.
[4]Associate Professor, Malla Reddy Engineering College(A). Hyderabad

**Corresponding Author: Dr. P. Raja Sekhar*
Email: prsraj40@gmail.com

Abstract:

This study investigates the potential of BDM in its virgin state for enhancing the geotechnical and mechanical properties of soft soil with low shear strength. A series of material and geotechnical tests carried out on soil replaced with different percentages of BDM include specific gravity, water absorption, standard Proctor's test, permeability test, and Triaxial shear box test. The results indicated that an optimum of 16–24% of BDM by weight can be added to soil to improve its mechanical and geotechnical properties such as shear strength and compaction. It is observed that the strength of BDM decreases. The results of AIV and LA abrasion test on BDM exposed to chemicals show that the performance of the BDM deteriorates in the presence of heat. The results obtained from the proposed study can be used to promote the practical use of BDM in geotechnical applications. However, necessary precautions must be adopted for their practical application in ground improvement based on soil conditions.

Keywords:

Building Derived Materials (BDM), Triaxial shear test, Shear strength, Geotechnical Applications.

1. Introduction:

The growing interest in utilizing waste materials in civil engineering applications has opened up the possibility of constructing reinforced soil structures with unconventional backfills. According to World Bank reports (2012), generation of Construction and Demolition Waste (CDW) will reach 5 billion tons by 2025 globally, out of which major generators are Asia-pacific and North America regions. Improper handling and disposal of this inert waste create environmental hazards and also occupy land space. Recycling and reuse of CDW may help to attain a sustainable ecosystem. CDW comprises wood, concrete, and brick, glass, tiles, out of which concrete and brick forms a major part and is termed as Building Derived Materials (BDM). A series of triaxial tests are conducted to investigate the stress–strain relationship and strength of BDM and a mixture of sand and BDM. The laboratory test results are used to establish the parameters required for the hyperbolic modeling of these materials. Hyperbolic parameters are varying with an increase in confining pressures and with percentage addition of BDM. Plastic properties of sand–BDM are computed with this model and well matching with experimental data. The analysis indicates that the performance of sand–BDM mixture, being both lightweight and reasonably strong, compared well with that of sandy gravel, as a backfill material.

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 will reduce 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 environmental challenge that needs to be addressed.

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, and earthen dams.

1.1. Objectives:

- Characterization of available local soils and (BDM), separately and in conjunction, to identify theirmaterial as well as geotechnical properties.
- Experimental assessment of shear strengthbehavior a of BDM-soil mixture, using shear test.
- Determination of the optimum proportion of BDM

2. 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, namelycrushed 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.

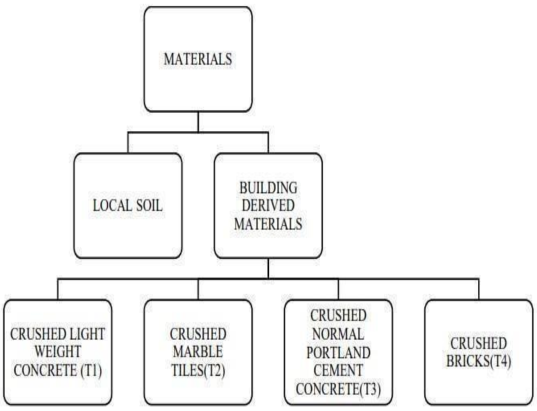


Figure. 1: Materials

Figure. 2: Showing samples

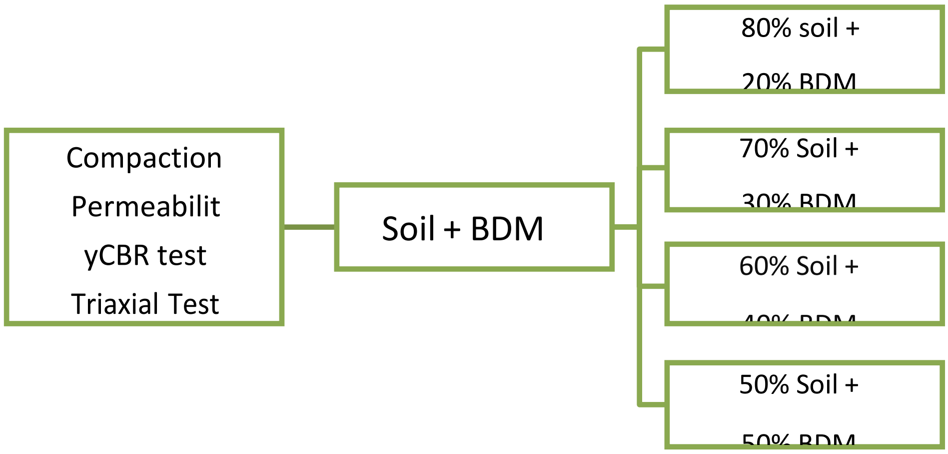


Figure. 3: Composition of soil and BDM

2. 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.

2.1. 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 specificgravity, percentage fines and consistency limits arelisted in Table. 2.

Graph. 1: % of fines

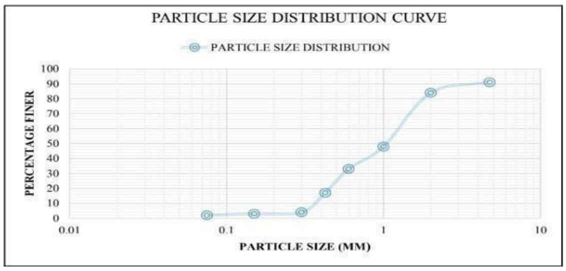


Table.1: Properties of soil

Properties	Obtained Value
Specific gravity	2.6
Water content	18.8%
Coefficient of Uniformity	6.5
Curvature Coefficient	1.3
Liquid limit	56.0%
Plastic limit	15.%
OMC (optimum moisture content)	16%
MDD (maximum drydensity)	1.99 g/cm3

2.2. Properties of soil and BDM:

2.2.1. Mix proportions:

Table. 2: Showing the composition of soil and BDM

Sample	BDM %	Soil %
1	20%	80%
2	30%	70%
3	40%	60%

4	50%	50%

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

3. 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.

3.1. 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, and T4 along with the soil.

Table. 3: Comparing the Test values of T1

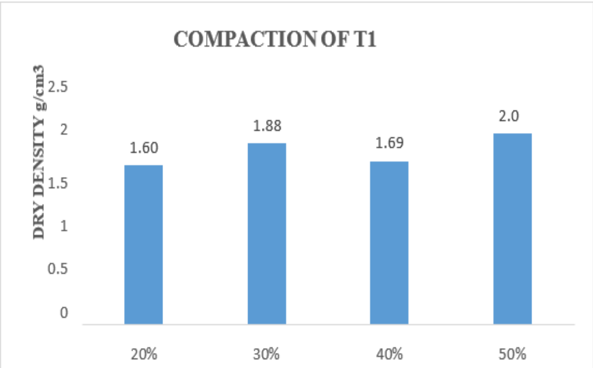
composition	compaction	Permeability	CBR
20%	OMC = 15% MDD = 1.60 g/cm3	Avg = 3.69x 10^-3 cm/sec	CBR @ 2.5mm = 6.18% CBR @ 5mm = 5.58%
30%	OMC = 17 % MDD = 1.88 g/cm3	Avg = 1.19 x 10^-3 cm/sec	CBR @ 2.5mm = 6.2% CBR @ 5mm = 6.49%

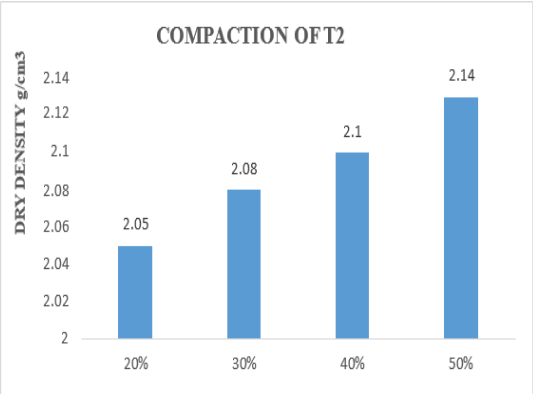
40%	OMC = 21 % MDD = 1.69 g/cm3	Avg = 1.16 x 10^-3 cm/sec	CBR @ 2.5mm = 5.79% CBR @ 5mm = 5.95%
50%	OMC = 22 % MDD = 2.0 g/cm3	Avg = 4.5 x 10^-3 cm/sec	CBR @ 2.5mm = 5.7% CBR @ 5mm = 6.8%

Table. 4: Comparing the test values of T2

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

50%	OMC = 17 % MDD = 2.14 g/cm3	Avg = 2.6 x 10^-3 cm/sec	CBR @ 2.5mm = 4.3% CBR @ 5mm = 5.1%





Graph. 2: Comparison of the compaction tests *Graph. 3: Comparison of the compaction testsof T1 & Soil*

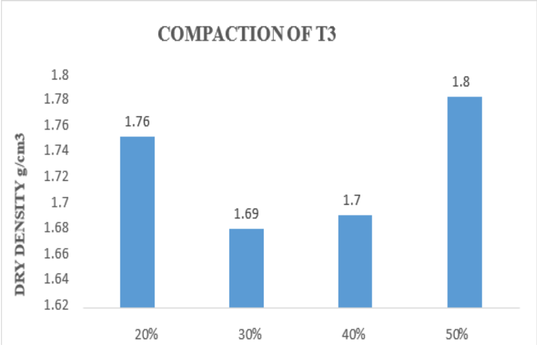
Table. 5: Comparing the test values of T3

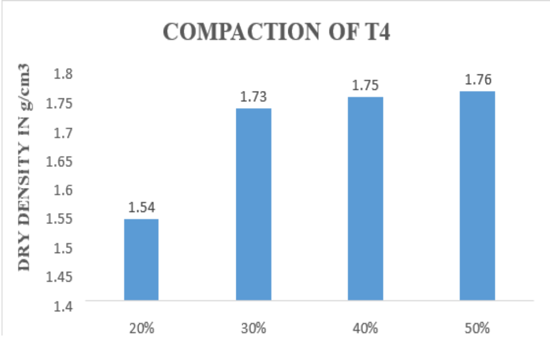
composition	compaction	permeability	CBR
20 %	OMC = 13 % MDD = 1.76 g/cm3	Avg = 4.2 x 10^-3cm/sec	CBR @ 2.5mm = 5.47% CBR @ 5mm = 5.05%
30%	OMC =17 % MDD = 1.69 g/cm3	Avg = 1.5 x 10^-3cm/sec	CBR @ 2.5mm = 5.8% CBR @ 5mm = 5.61%
40%	OMC = 21 % MDD = 1.7 g/cm3	Avg = 1.6 x 10 ^-3cm/sec	CBR @ 2.5mm = 5.92% CBR @

			5mm = 5.93%
50%	OMC = 21 % MDD = 1.8 g/cm3	Avg = 2.1 x 10^-3cm/sec	CBR @ 2.5mm = 6.27% CBR @ 5mm = 6.81%

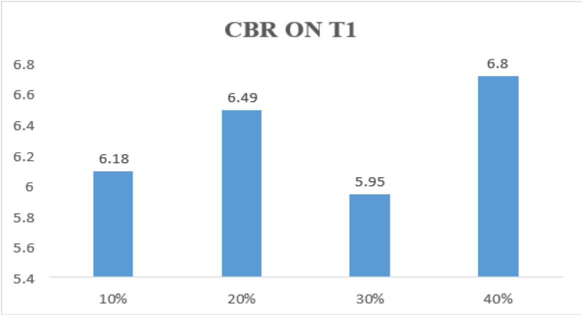
Table. 6: Comparing the test values of T4

composition	compaction	permeability	CBR
20 %	OMC = 16 % MDD = 1.54 g/cm3	Avg = 13.5 x 10^-3cm/sec	CBR @ 2.5mm =4.29% CBR @ 5mm = 3.84%
30%	OMC = 16 % MDD = 1.73 g/cm3	Avg = 8.23 x 10^-3cm/sec	CBR @ 2.5mm = 5.6% CBR @ 5mm = 7.36%
40%	OMC = 16 % MDD = 1.75 g/cm3	Avg = 9.62 x 10 ^-3 cm/sec	CBR @ 2.5mm =7.41% CBR @ 5mm = 9.11%
50%	OMC = 20% MDD = 1.76 g/cm3	Avg = 6.847 x 10 ^-3 cm/sec	CBR @ 2.5mm= 7.58% CBR @ 5mm = 9.67%

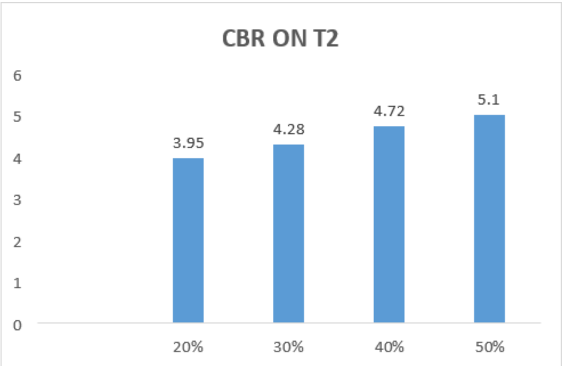




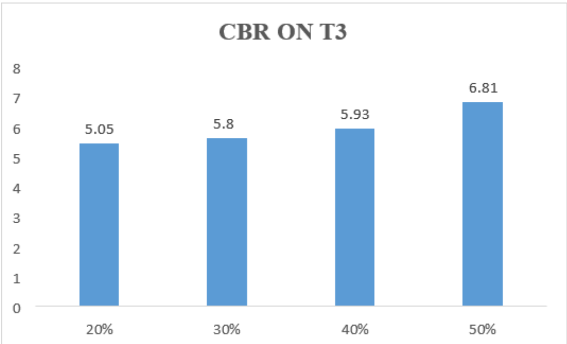
Graph. 4: Comparison of compaction tests of T3 & soil *Graph. 5: Comparison of compaction tests of T4 & soil*



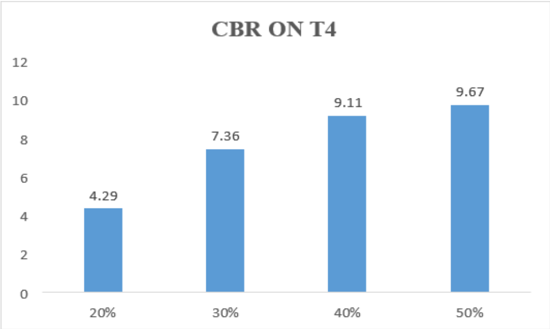
Graph. 6: CBR Test on T1



Graph. 7: CBR test on T2



Graph. 8: CBR test on T3



Graph. 9: CBR test on T4

4. Conclusions:

1. The soil found to be Well- Graded Soil.
2. The Liquid Limit of the soil is 58.50%.
3. Plastic limit of the soil sample is 15.50% i.e., plasticity index IP= Liquid limit – Plastic limit = 43%. IP > 17. The soil is High Plastic soil
4. The OMC of soil = 15 %, MDD of soil = 2.1g/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 valueis 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^-3cm/sec.

5. 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 deLurdes Lopes, (2016)- "Geotechnical andEnvironmental 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 highwayembankment; 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.