J. Integr. Sci. Technol. 2022, 10(3), 185-188 Article

Journal of Integrated
SCIENCE & TECHNOLOGY

# An empirical research on modified concrete using demolition construction waste as partial substitutes of fine aggregates

Sachin Sharma,[1]* Priyanka Pandey,[1] Abhay M. Shende,[2] Rakesh Bhandari[3]

*[1]Department of Civil Engineering, Sangam University, Bhilwara, India. [2]Priyadarshini J. L. College of Engineering, Nagpur, India. [3]Department of Research, Sangam University, Bhilwara, India*

Received on: 26-January-2022, Accepted and Published on: 30-Aug-2022

## ABSTRACT

Nowadays, Demolition construction waste is in very high demand in the market and is also useful to improve the higher strength of designed ecofriendly concrete compared to Conventional Concrete. Natural sand and fine aggregate supplies are diminishing in the market as a result of large major building and the desire to minimize the cost of concrete production by using demolition construction waste as a substitute of fine aggregates in the modified green concrete. The utilization of demolition construction wastes as fine aggregate in concrete would also be beneficial in economic impact and also maintain the environment. The durability and mechanical properties of modified concrete are improved. Various Grade of mix design of concrete as per (IS 10262:2009) can give better results with demolition construction waste as replacement of fine aggregates at age of 28 days curing periods. From the various literature review, here various results obtained it is suggested that demolition construction waste with a replacement level of up to 20% can be used as a fine aggregate for improvement of modified concrete.

*Keywords: Concrete, Demolition Construction Waste, Fine Aggregates, Compressive Strength*

## INTRODUCTION

Demolition Construction waste is created from any development and construction activity such as building, roads, flyovers, bridges, subways, Reconstruction of Building, etc. It comprises generally inactive and non-biodegradable materials like cement paver blocks, concrete structures, plaster, bricks, metals, woods, plastics, etc. Construction Wastes such as various categories of coatings, blunder, dust soil, Steel iron, hardware, plastics, woods, or other materials are among the wastes obtained by structures.

Corresponding Author: Sachin Sharma, Research Scholar, Department of Civil Engineering, Sangam University, Bhilwara
Tel: +91- 7976851995
Email: sachin2410s@gmail.com

Cite as: *J. Integr. Sci. Technol., 2022, 10(3), 185-188*

ISSN: 2321-4635 http://pubs.iscience.in/jist

It is possible to carry out the practice of removing impurities and crushing rubble into a suitable and required aggregate particle size. Using appropriate mechanical equipment such as jaw and impact crushers, swing hammer crushers, and other similar devices. The three methods for processing demolition waste are (i) Wet (ii) dry, and (iii) thermal, which can be employed separately or in combination [1].

Wastes of Paints, adhesives, wall coverings, and dirt fasteners are commonly found. Fine aggregates, concrete, wood, paper, metal, and glass make up a heterogeneous blend of building components. These sorts of demolition waste are produced by the selective and total removal/demolishing of existing structures, which can be caused by man-made structures or natural calamities such as earthquakes, floods, landslides, and hurricanes, among other things. DC Waste is created during the construction, and demolition of building structures materials, highways, and other forms of constructive construction. In DC wastes, concrete, asphalt, woods, gypsum, metals, plastics, and recovered construction components are all common materials. Demolition of Construction Waste is a difficult task to do because it is enormous, cumbrous, and inert, as well as a mixture of numerous materials with distinct qualities. With the introduction of sustainable methods in the various construction industries, DC waste generation and management challenges have become a focal point for achieving long-term sustainability goals. The recycling, reduction, and reuse attitude is extremely beneficial when dealing with Demolition Construction Waste. Concrete that contains natural sand and coarse recycled aggregate use 6% more water than concrete that contains natural sand and fine recycled aggregate. Concrete might be manufactured successfully with recycled aggregates derived from demolition construction waste. The ever-increasing demand for natural fine aggregates in emerging countries such as India is the cause of a scarcity of excellent grade fine aggregates. Due to fast urbanization in towns and surrounding cities, demolition waste of ancient constructive structures for the adoption of new and modern advanced construction technology to meet growing economic needs increases demolition construction wastes [2]. The high industrial expansion has resulted in the emergence of important global concerns, such as a reduction in the number of natural aggregates and a massive amount of garbage generated by demolition and construction activities [3].

India is also benefitted from the construction boom, as are many other developing countries. With India's fast-growing construction industry, it's only natural to relate the production of demolition and construction waste to the industry's growth and challenges [4].

Sand and gravel are mined all over the world and together account for the most solid material extracted and the rawest material used on the planet after water (materials are mined around 70-80 percent of the 50 billion tonnes per year). A massive volume of D&C waste has become available, posing a tremendous threat to the environment and civilization. Recycling concrete waste has been identified on large scale as the most convenient method to alleviate the increase the problem of disposal waste through landfills [5]. The world is experiencing a construction boom as a result of more rapid urbanization, which causes primary resources to be overstressed in response to changing market conditions. For example, over 100 percent of demolition construction waste in the case of cement and bricks, 40–60 percent steel, 85 percent paint, and 70 percent glass generated in India is used in the construction industry [6]. In several areas around the world, the evaluation of the utilization of DCW in the building industry has been stimulated, and many comparative studies have been developed to gain a better understanding of the role of these wastes in the development of new structures [7].

The earning society, along with the innovative transformation, has prompted the most monstrous creation of waste in humankind's whole history. This issue has prompted most nations to look for solutions to decline contamination rates in the world [11]. The development of the construction industry is as yet one of the biggest waste generators today [12-13]. The government authority prerequisite to relieve the ecological effect of the different development projects through the legitimate administration of the DCW potentiates their reincorporation into the development creation chain through reusing. Nonetheless, to involve this loss in new undertakings, it is important to assess the physical, compound, mechanical, and solidness qualities of the DCW [14-17]. Cakir et. al. [18] showed that the durability of concrete can be expanded up to 60% by utilizing recycled aggregates and a streamlined ball factory strategy. The review included compared of several aggregates, for example, natural aggregates, recycled aggregates, silica fume, basalt fiber, and recycled aggregates total and streamlined ball factory method. Diosa [19] carried out a test investigation of mechanical properties of high-strength concrete from reused aggregates sources, getting huge enhancements concerning mechanical resistance and durability. Hurtado [20] experimented on the impact of partial substitution of Portland cement by Ash from the paper business in the manufacture of mortar specimens; results showed that it is feasible to get better mortar workability however less mechanical resistance.

In summary, the popularity of concrete, the natural aggregates for its manufacture, and the age of development and destruction waste the advancement of studies where some waste is utilized and fused into the manufactured materials such as concrete [21,22]. Cement is one of the ingredients of concrete which is high cost and with the production of cement more amount of $CO_2$ is released during its manufacturing [24-29]. Concrete provides the best serviceability, durability, and availability compared to other components of building materials [30-32].

## Materials & Methodology

The crushed concrete was sieved on an Indian Standard sieve to separate the fine aggregates, coarse aggregates, and cement powder. IS sieves of 80 millimeters, 40 millimeters, 20 millimeters, 10 millimeters, 4.75 millimeters, 2.36 millimeters, 1.18 millimeters, 600μ, 300μ, and 150μ were used. The fractions which pass through a 20 millimeters sieve and thus are retained on 4.75 millimeter IS sieves be utilized as coarse aggregates in the modified green concrete as a replacement level. The different proportion ratio of concrete is Cement: F.A.: C.A. by weight as 1:1.67:3.33 with a 0.50 w/c ratio. The characteristics target compressive strength was found at 31.6 MPa. This experiment used 100 mm cubes, which were evaluated at 7 and 28 days after the curing time with potable water [1].

In the design concrete, 20 beams and 30 cubes for a nominal mix of design concrete of M25 grade were cast with variable amounts of raw construction for various proportion ratios of 1:1.25:2.5 and 1:1.5:3 using a w/c ratio of 0.46. [9]. Sizes of various concrete specimens as cube 100 mm3 were prepared for the investigation of the compressive strength of design concrete. All cubes were ready as per the following bureau of Indian Standard (IS: 516-1959). The size of the concrete specimen as Beam molds (100 millimeters x 100 millimeters x 150 millimeters) was prepared for obtaining the flexure strength of the concrete specimens, as per IS 516:1959 specifications [8]. Each batch of fresh design concrete must undergo a slump test, which has a measurement of the consistency of different batches for the workability of modified design concrete. According to IS 1199 – 1959 norms, the slump value (Workability) is measured [2, 23].

M20 grade of Concrete is ready for the plain concrete. Concrete specimens were made in various proportions of mix design according to IS 10262 – 2009. The concrete cube specimens were evaluated at three different times during the curing process: 28 days, 7 days, and 3 days [9]. The blocks had a dimension of (25 millimeters x 13.5 millimeters x 6 millimeters) and were prepared to acquire a good idea. To replace fine aggregates were used in various proportions ranging between 0.20, 0.40, 0.60, and 0.80. Various five different design mixes were produced with sand replaced by DC wastes at the various proportion of 0, 20, 40, 60, and 80 percent [4]. IS 10262:2009 is used to design concrete mixes for the M30 grade [10]. With a w/c level of 0.45, a mix design of M20 grade was used for concrete mixing [5]. Concrete of the M30 grade was used. A total of 36 examples were determined with varied replacement levels of coarse aggregates & fine aggregates with DCW of various replacement levels of 0%, 20%, 30%, 40%, 50%, and 60%. The compressive strength of all of the following specimens was tested for 7 days and 28 days [7].

## Result & Discussion

The characteristics compressive strength of recycled design concrete ready with 10% various partial replacement levels of cement by destroyed waste powder is comparatively with conventional concrete in this investigation, however, the strength declines significantly beyond these varied replacement levels. When the waste powder is used to replace cement up to varied replacement levels of 20%, the M-25 grade of concrete is nearly attained. [1]. Compressive strength test done with three cubes specimens and also two-beam specimens were cast for the test of flexure strength after 28 days with 0%, 20% ceramic waste +0% demolition waste, 20% ceramic waste +10% demolition waste, 20% ceramic waste + 15% demolition waste and 20% of ceramic and demolition waste with different replacement of fine aggregate used for design mix ratios of concrete was 1:1.25:2.5 and 1:1:5:3 [2]. Whenever the replacement level of fine aggregate by C & D wastes was improved from the different percentage of 40 to 60, higher compressive strength of modified green concrete was desired [4].

Figure 3. Shows variation of the Impact of fly ash & aggregates blast furnace slag have a combined influence on the characteristics compressive strength of modified design concrete. It shows that replacing FA with Blast Furnace Slag increases the replacement level of Blast Furnace Slag produced and also Fine aggregates replaced Ordinary Portland Cement was a lower impact on curing 28 days. Increasing compressive strength of design concrete with duration of 60 days. (Recycled Aggregates + 90% Fly Ash + 10% Blast Furnace Slag + 90% Ordinary Portland Cement + 10% Fly Ash) has a curing period of 28 days. The 20.06 MPa compressive strength of which is almost same of TSN-1 (Recycled Aggregates + sand + Ordinary Portland Cement) but TSN-12 (Recycled aggregates + 85% FA + 15% Blast Furnace Slag + 85% Ordinary Portland Cement +15% Flyash) was slightly increased compressive strength than TSN-1, in 28 day curing period [5].

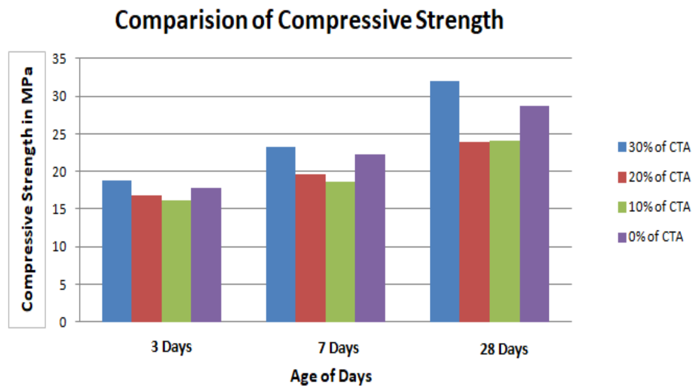


**Figure 1**. M20 Concrete ratio with CTA replacement ranging from 0% to 30% and their targeted Compressive Strength at duration between 3 days, 7 days, & 28 days [3]

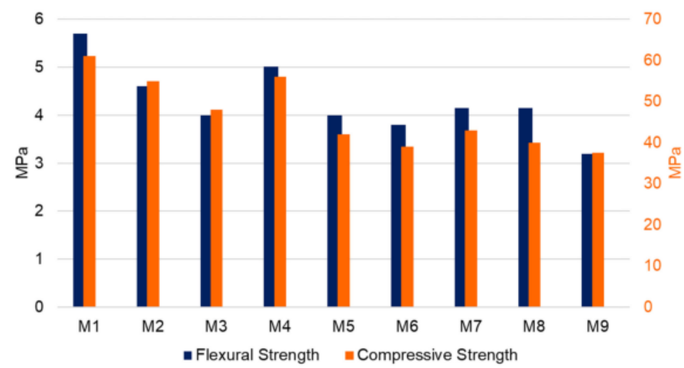


**Figure 2.** Mechanical properties of concrete mixtures: flexural strength, compressive strength

According to the results of the various test experiments, construction and demolition waste with a replacement distance of up to 30% could be used effectively as a fine aggregate in modified design concrete production without affecting concrete characteristics [6].

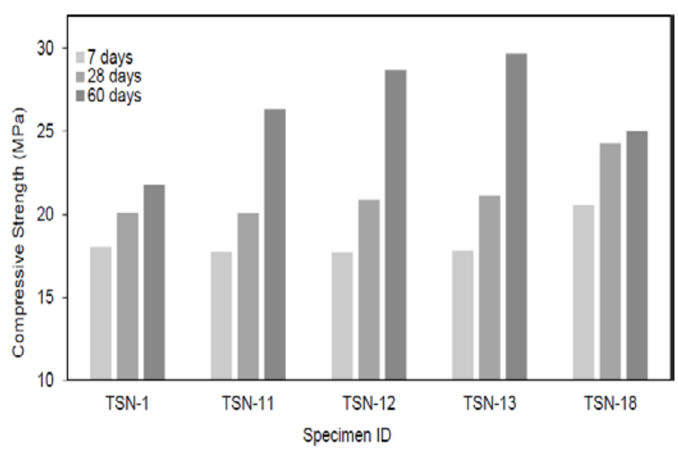


**Figure 3.** Impact behavior of Fly Ash and Blast Furnace Slag on Compressive Strength of Concrete [5]

With 20% substitution of fine aggregates by C&D waste, various test results of concrete's compressive strength were produced [7].

## Conclusion

All Partially replacement fine aggregates with demolition construction waste could improve the mechanical and durability properties of concrete by up to 20%. M-25 grade of recycled concrete waste was prepared by replacing 10% level of cement through demolished waste powder, replacement level up to 20% of fine aggregates (Sand) with DCW, and enhancing the coarse aggregate replacement level to 30% with demolition construction waste for compressive strength. Also, Voids, Porosity, and Water absorption decrease with the addition of DC waste compared to conventional concrete. Reduces fine aggregates (Sand) mining by use of Demolition Construction Waste.

## Conflict of interest

Authors declared no conflict of interest for publication of this work.

## References and notes


1. Vikas Srivastava, Mohd Monish, Raushan Ranjan, and P. K. Mehta, "Demolition Waste in Concrete". Bloomsbury Publishing India Pvt Ltd 2015 V. Matsagar (ed.), *Materials, Design and Testing* ISBN 978-93-84898-71-7, pp – 4234-4242. **2015**
2. Saswat Hota, Vikas Srivastava, "Partial Replacement of Fine Aggregate with Ceramic and Demolition Waste in Rigid Pavement". *International Journal of Innovative Research in Science, Engineering, and Technology*. Vol. 5, Issue 8, pp – 15141 – 15151, **2016**
3. Prof. Shruthi. H. G, Prof. Gowtham Prasad M. E., Samreen Taj, Syed Ruman Pasha, "Reuse of Ceramic Waste as Aggregate in Concrete". *International Research Journal of Engineering and Technology (IRJET)*. Vol. 3, No 7. pp – 115-119, **2016**
4. Mahesh Tapas, Krutika Patil, Priyanka Nair, Aditya Palhade, Vinay Agarwal, Rahul Chaudhari, "Use of Construction and Demolition Waste as Partial Replacement of Fine Aggregate for Development of Paving Block". *Journal of Advances and Scholarly Researches in Allied Education*. Vol. 15, No. 2, pp – 21-24, **2018**
5. Md. Omar Ali Mondal, Md. All Mokadim, Abu Zakir Morshed, "Use of Supplementary Cementitious Materials in Recycled Brick Aggregate Concrete". *Proceedings of the 4th International Conference on Civil Engineering for Sustainable Development* (ICCESD2018), 9~11 February, KUET, Khulna, Bangladesh (ISBN-978-984-34-3502-6), **2018**
6. A. Naveen Arasu, M. Muhammed Rafsal, O. R. Surya Kumar, "Experimental Investigation of High-Performance Concrete by Partial Replacement of Fine Aggregate by Construction Demolition Waste". *International Journal of Scientific & Engineering Research*. Vol. 9, No. 3, pp – 46-52. **2018**
7. Fernando A. N. Silva, João M. P. Q. Delgado, António C. Azevedo, António G. B. Lima and Castorina S. Vieira, "Preliminary Analysis of the Use of Construction Waste to Replace Conventional Aggregates in Concrete". *Building Journals, MDPI*. pp 1-13.
8. IS: 516-1959, Methods of Tests for the strength of concrete, Bureau of Indian Standard, New Delhi
9. IS 456-2000: Plain and Reinforced concrete, Bureau of Indian Standards, (BIS), New Delhi.
10. IS 10262-2009: Recommended guidelines for concrete mix design, Bureau of Indian Standards (BIS), New Delhi.
11. Yang, D.; Liu, M.; Ma, Z. Properties of the foam concrete containing waste brick powder derived from construction and demolition waste. *Journal of Building Engineering*, 32, 101509, **2020**.
12. Francisco, J.T.M.; De Souza, A.E.; Teixeira, S.R. Construction and demolition waste in concrete: *Property of pre-molded parts for paving. Cerâmica*, 65, 22–26, **2019**.
14. Whittaker, M.J.; Grigoriadis, K.; Soutsos, M.; Sha, W.; Klinge, A.; Paganoni, S.; Casado, M.; Brander, L.; Mousavi, M.; Scullin, M.; et al. Novel construction and demolition waste (CDW) treatment and uses to maximize reuse and recycling. *Adv. Build. Energy Res.*, 1–18, **2019**
15. Cantero, B.; Bravo, M.; de Brito, J.; del Bosque, I.S.; Medina, C. Mechanical behavior of structural concrete with ground recycled concrete cement and mixed recycled aggregate. *Journal of Cleaner Production*, 275, 122913, **2020**.
16. Chen, A.; Han, X.; Chen, M.; Wang, X.; Wang, Z.; Guo, T. Mechanical and stress-strain behavior of basalt fiber reinforced rubberized recycled coarse aggregate concrete. *Construction Building Matererials*, 260, 119888, **2020**.
17. De Andrade, G.P.; Polisseni, G.D.C.; Pepe, M.; Filho, R.D.T. Design of structural concrete mixtures containing fine recycled concrete aggregate using packing model. *Construction Building Matererials*, 252, 119091, **2020**.
18. Cakır, Ö.; Dilbas, H. Durability properties of treated recycled aggregate concrete: Effect of optimized ball mill method. *Construction Building Matererials*, 268, 121776, **2021**
19. Diosa, J.S. Experimental Analysis of the Mechanical Properties of High-Strength Concrete Made with Recycled Concrete Aggregates; Pontificia Universidad Javeriana Cali: Cali, Colombia, **2020**
20. Hurtado, I. Evaluation of the Effect of the Partial Replacement of Portland Cement by Ash from the Paper Industry in Mortars and Walls; Pontificia Universidad Javeriana Cali: Cali, Colombia, **2019**
21. Zhang, C.; Hu, M.; Yang, X.; Miranda-Xicotencatl, B.; Sprecher, B.; Di Maio, F.; Zhong, X.; Tukker, A. Upgrading construction and demolition waste management from downcycling to recycling in the Netherlands. *Journal of Cleaner Production*, 266, 121718, **2020**
22. Wagih, A.M.; El-Karmoty, H.Z.; Ebid, M.; Okba, S.H. Recycled construction and demolition concrete waste as aggregate for structural concrete. HBRC J., 9, 193–200, **2013**
23. IS 1199-1959: Methods of sampling and analysis of concrete, Bureau of Indian Standards, (Bis), New Delhi.
24. J. Alex, J. Dhanalakshmi, B. Ambedkar, "Experimental investigation on rice husk ash as cement replacement on concrete production", *Construction and Building Materials*, Vol. 127, pp. 353–362, **2016**
25. E. Aprianti, P. Shafgh, S. Bahri, J. Nodeh, "Supplementary cementitious materials origin from agricultural wastes—a review", *Construction and Building Materials*, Vol. 74, pp. 176–187, **2015**
26. R. Khan, A. Jabbar, I. Ahmad, W. Khan, A. N. Khan, J. Mirza, "Reduction in environmental problems using rice-husk ash in concrete", *Construction and Building Materials*, Vol. 30, pp. 360–365, **2012**
27. O. A. U. Uche, M. Adamu, M. A. Bahuddeen, "Influence of Millet Husk Ash on The Properties of Plain Concrete", Epistemics in Science, Engineering and Technology, Vol. 2, No. 2, pp. 68–73, **2012**
28. N. Bheel, S. L. Meghwar, S. Sohu, A. R. Khoso, A. Kumar, Z. H. Shaikh, "Experimental Study on Recycled Concrete Aggregates with Rice Husk Ash as Partial Cement Replacement", *Civil Engineering Journal*, Vol. 4, No. 10, pp. 2476-3055, **2018**
29. Naraindas Bheel, Abdul Wahab Abro, Irfan Ali Shar, Ali Aizaz Dayo, Sultan Shaikh, Zubair Hussain Shaikh, "Use of Rice Husk Ash as Cementitious Material in Concrete", *Engineering, Technology & Applied Science Research* Vol. 9, No. 3, 4209-4212, **2019**
30. E. Aprianti, "A huge number of artificial waste material can be supplementary cementitious material (SCM) for concrete production -a review part II", *Journal of Cleaner Production*, Vol. 142, No. 4, pp. 4178-4194, **2017**
31. Z. Li, "Introduction to Concrete" in Advanced Concrete Technology, *John Wiley and Sons*, **2011**
32. Abdul Razzaque Sandhu, Muhammad Tahir Lakhiar, Ashfaque Ahmed Jhatial, Hemu Karira, Qadir Bakhsh Jamali, "Effect of River Indus Sand and Recycled Concrete Aggregates as Fine and Coarse Replacement on Properties of Concrete", *Engineering, Technology & Applied Science Research*, Vol. 9, No. 1, 3832-3835, **2019**