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Experimental Investigation on Strength Characteristics of Concrete by Utilization of Demolition Waste and Fly Ash

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ABSTRACT—

In this research work, at first, 3 batches of concrete were prepared by making use of TSMA. First batch was of conventional concrete made by using conventional NA. The second batch was made by making 50% NA replacement by RCA and the third batch was made by making 70% replacement of NA by RCA. A total of 27 samples were made in each batch, out of which, 9 were cubes, 9 were beams and the rest 9 were cylinders. These 3 batches were tested on their workability, compressive strength, flexural strength and split tensile strength. Thus, fourth concrete batch was prepared which had 70% aggregate replacement and 15% fly ash (FA). Fly ash here, was not used as replacement of any ingredient, rather it was used as an additive, along with regular cement. For this mix also, 27 samples were made and these samples were tested on same parameters.

Keywords: Concrete, Natural aggregates, Recycled aggregates, Normal mixing approach, Compressive strength, Flexural strength, Split tensile strength

1. INTRODUCTION

Construction and demolition (C & D) waste forms a major portion of total solid waste production in the world. C & D waste is generated whenever any sort of construction/demolition activity takes place, like as building, roads, bridges, flyover, subway, remodeling etc. These wastes are heavy, having high density, often bulky and occupy decent storage space either on the road or dumping grounds. It is not uncommon to see huge stocks of this waste, which is heavy as well, stacked on roads especially in large projects, resulting in traffic congestion and several other related problems. Hence an appropriate step towards management of this waste is required. With a huge increase in the quantity of disposable materials on one hand and a continuous shortage of dumping sites on the other hand, the waste disposal problems are growing alarmingly.

Preservation of the environment and conservation of the rapidly depleting natural resources is very important for sustainable development. Continuous industrial development is showcasing serious problems of construction and demolition waste disposal, while on the other hand, there is critical shortage of natural aggregate for production of new concrete. Thus, recycling of aggregate materials from construction and demolition waste may help in reducing the demand and fulfill the supply gap in both these sectors. Although, recycling and reusing of concrete and masonry wastes for making aggregates have already started but the scale of recycling is almost negligible as compared to the need or demand of new aggregates for construction. Also, these recycled aggregates are merely used for inferior type of works as of now. The current scenario demands the use of recycled materials not only in low quality construction, but atleast in other usual, day to day construction, if not in high grade construction.

2. MATERIAL USED

2.1 Cement:

Cement used for this experimental program is Ultratech Cement (OPC, Grade 53). Whatever may be the cement used, it is required to conform to BIS specification IS: 12269- 1987 with a designed strength for 28 days being a minimum of 53 MPa.

2.2 Sand:

Sand is a very important building material. It occurs abundantly in nature and is formed by the decomposition of rocks. It should be well graded (all particles that have the almost same size) and clean. Fine aggregates should be free from gritty particles and injurious particles like dust, kankar, soft and flaky particles of shale and also, it should be durable enough. Fine aggregates should also be free from salts & alkalis. Sand particles consist of small grains of silica. Sand has particles ranging in size from 0.06 mm to 2 mm. Particles which are smaller than 0.0625 mm but larger than 0.0078125 mm are termed as silt.

2.3 Natural aggregate:

Natural aggregates used, were obtained from igneous rocks. Hard, dry, angular and rough surfaced aggregates smaller than 20mm size were preferably used.

2.4 Fly Ash:

Fly ash, in this research work, is not used as a replacement or alternative of cement, rather, it is used as an additive along with the same amount of cement. Fly ash used in this research work is Class F Fly ash, satisfying IS 3812-2003 (Part-1).

2.5 Recycled Concrete Aggregates:

Recycled concrete aggregates used are derived from crushing old concrete demolition waste. The crushed waste was then segregated to obtain coarse aggregates, which formed the base for recycled aggregate concrete. These recycled aggregates were then sorted for the desired shape and size.

3. EXPERIMENTAL WORK AND TEST

3.1 Casting of cubes:

It is stated in IS 516-1959 that test specimen for determining compressive strength of concrete should be a cube of size 150mm x150mm x 150mm. Thus in this research work, molds with the size mentioned earlier is used for casting cubical specimens. In this research, concrete of grade M20 was taken as reference and all the batches were compared keeping in view this reference strength, which is 20 N/mm². Now for M20 mix, the material proportion adopted is 1:1.5:3, that is for 1 part of cement, 1.5 part of sand and 3 parts of aggregate is required. Initially, 3 different type of batches were made for different material proportions. 9 cubes were made for every batch and thus, a total of 27 cube specimens were formed.

3.2 Casting of Beam:

It is stated in IS 516-1959 that test specimen for determining flexural strength of concrete should be a cuboid of size 150mm x150mm x 700mm. Thus in this research work, moulds with the size mentioned earlier is used for casting beam specimens. In this research, concrete of grade M20 was taken as reference and all the batches were compared keeping in view this reference strength, which is 20 N/mm². Now for M20 mix, the material proportion adopted is 1:1.5:3, that is for 1 part of cement, 1.5 part of sand and 3 parts of aggregate is required. Three different type of batches were made for different material proportions. 9 beams were made for every batch and thus, a total of 27 beam specimens were formed.

3.3 Casting of Cylinder:

It is stated in IS 5816-1970 that test specimen for determining split tensile strength of concrete should be a cylinder of 150mm diameter and 300mm height. Thus in this research work, moulds with the size mentioned earlier is used for casting cylindrical specimens. In this research, concrete of grade M20 was taken as reference and all the batches were compared keeping in view this reference strength, which is 20 N/mm². Now for M20 mix, the material proportion adopted is 1:1.5:3, that is for 1 part of cement, 1.5 part of sand and 3 parts of aggregate is required. Three different type of batches were made for different material proportions. 9 cylinders were made for every batch and thus, a total of 27 cylinder specimens were formed.

4. TEST RESULTS

4.1 Compressive Strength:

Compressive strength test was performed on 3 cubes of each batch mix. There were 4 batch mixes and each one having 3 cubes, thus making a total of 12 cubes. Out of these 12cubes, 4 cubes were tested for 7 days, 14 days & 28 days each. An average value of 3 test result values was considered as final result value.

The results obtained, for cubes cured for 7,14 & 28 days, are mentioned in the following table

Table 4.1: Compressive Strength Result

Sr. No.	**MIX**	7 days Avg. Compressive Strength	14 days Avg. Compressive Strength	28 days Avg. Compressive Strength
01	Nominal Mix (Batch 1)	17.98	24.81	27.53
02	Batch 2 (50% RCA Replacement	17.76	24.20	26.86

03	Batch 3 (70% RCA Replacement	16.87	23.31	25.75
04	Batch 4 (70% RCA Replacement + 15% FA Addition)	17.53	24.15	26.86

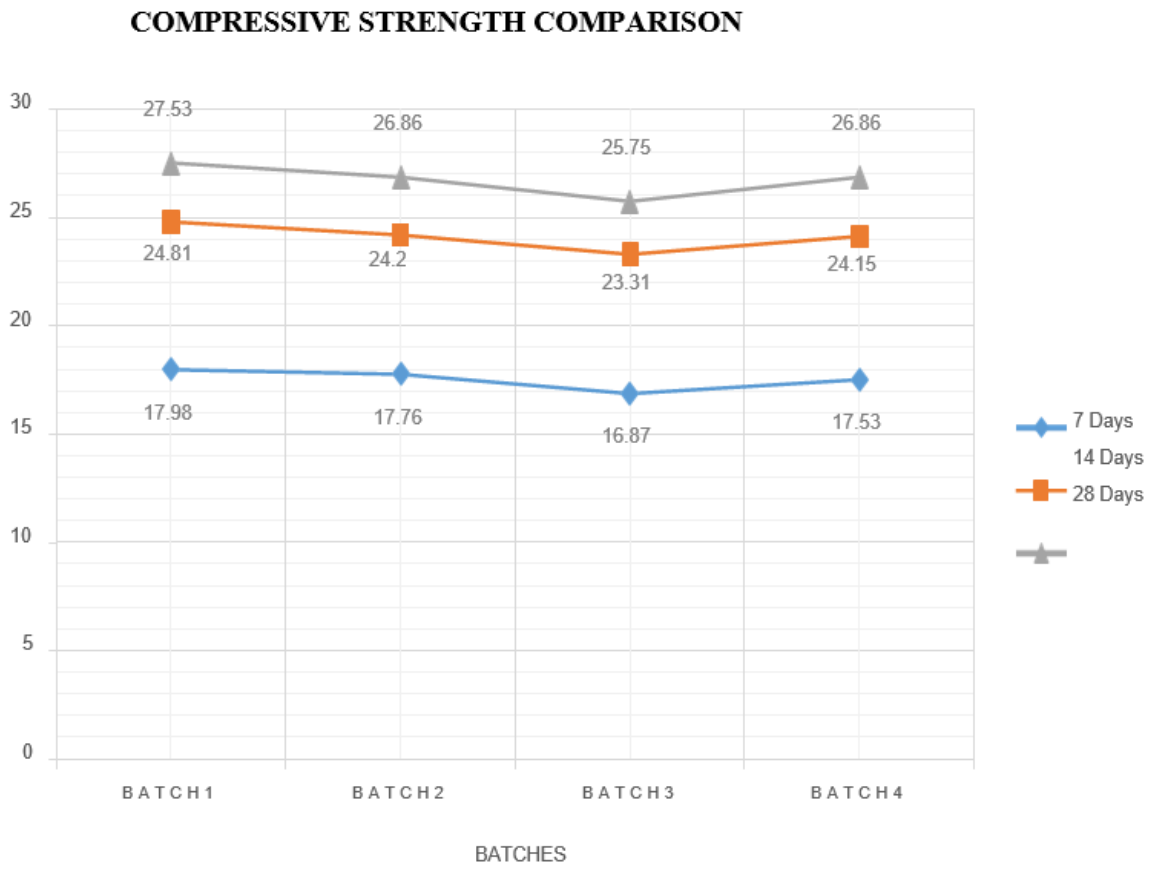


Figure 1: Graph showing variation of Compressive strength of different mixes specimen

Discussion: It is quite clear from the graph above, the 7 day compressive strength of batch 4 mix (the mix with 70% RCA + 15% FA) was found to be reduced by 2.50% as compared to conventional concrete, the 14 day compressive strength of batch 4 mix was found to be reduced by 2.66% as compared to conventional concrete and the 28 day compressive strength of batch 4 mix was found to be reduced by 2.43% as compared to conventional concrete. Although the 28 day strength reduced as compared to nominal mix, but this strength was more than the required mean target strength. Thus, this mix is acceptable.

4.2 Flexural Strength :

Flexural strength test was performed on 3 beams of each batch mix. There were 4 batch mixes and each one having 3 beams, thus making a total of 12 beams. Of these 12beams, 4 beams were tested for 7 days, 14 days & 28 days each. An average value of 3 test result values was considered as final result value. The results obtained, for beams cured for 7 days, are mentioned in the following table:

Table 4.2: Flexural Strength Result

Sr. No.	**MIX**	7 days Avg. Flexural Strength	14 days Avg. Flexural Strength	28 days Avg. Flexural Strength
01	Nominal Mix (Batch 1)	3.63	4.14	4.82
02	Batch 2 (50% RCA Replacement	3.61	4.08	4.76
03	Batch 3 (70% RCA Replacement	3.37	3.90	4.44

04	Batch 4 (70% RCA Replacement + 15% FA Addition)	3.49	4.02	4.70

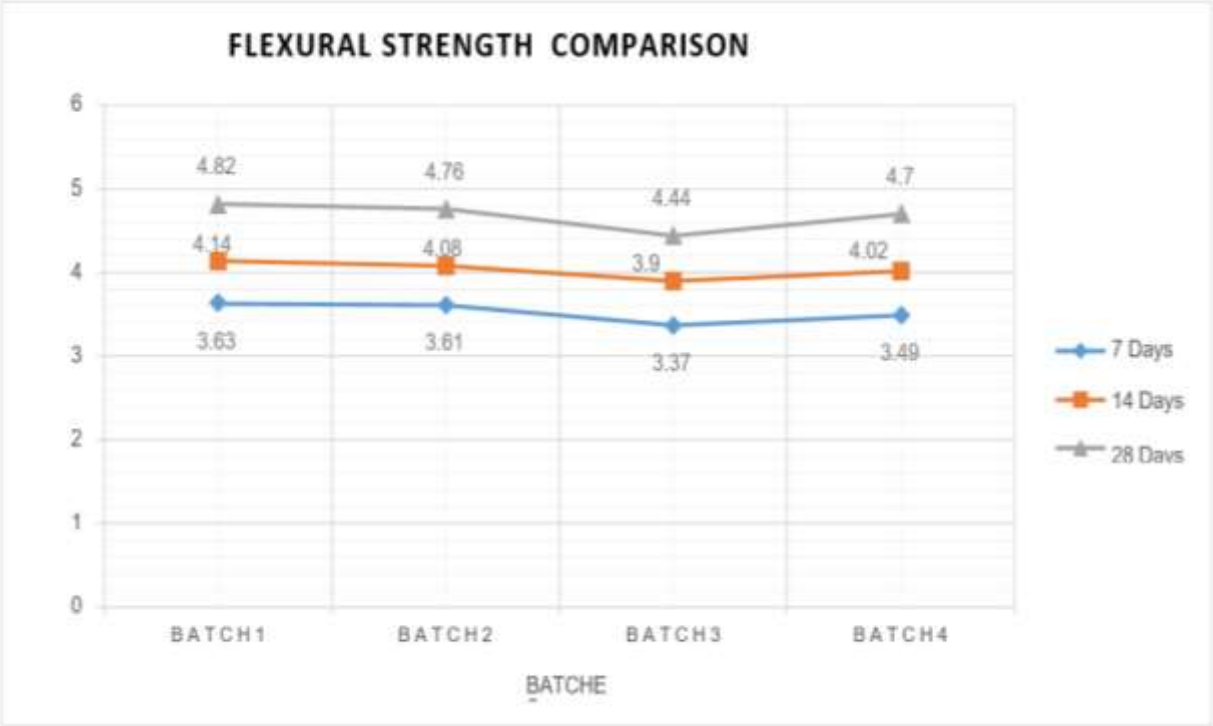


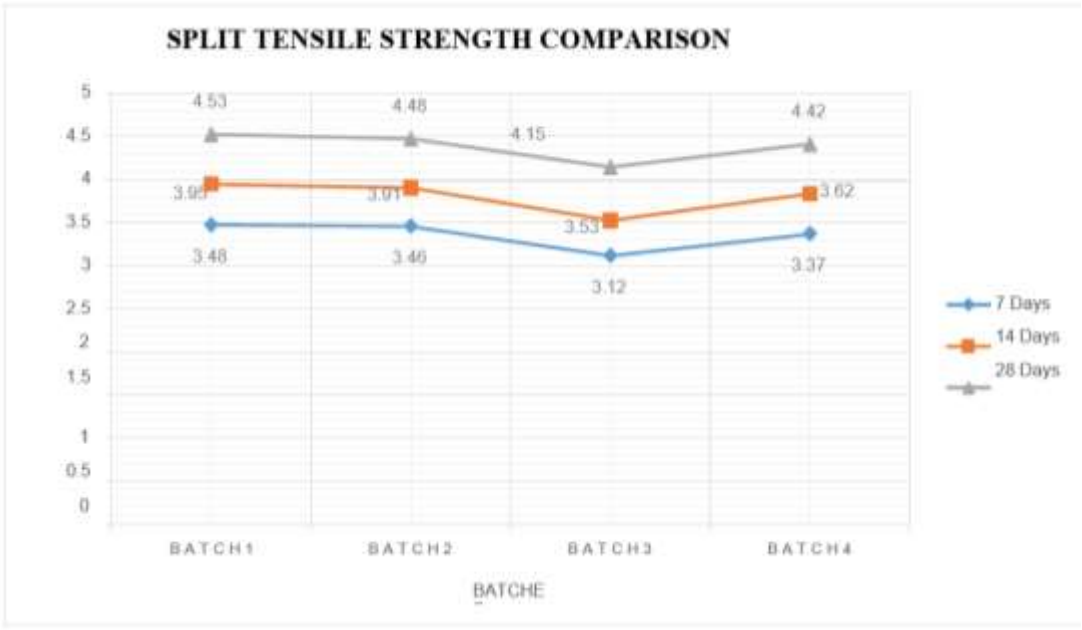
Figure 3 Graph showing variation of flexural strength of different mixes specimen

Discussion: It is pretty clear from the graph above, the 7 day flexural strength of batch 4 mix (the mix with 70% RCA + 15% FA) was found to be reduced by 3.85% as compared to conventional concrete, the 14 day flexural strength of batch 4 mix was found to be reduced by 2.90% as compared to conventional concrete and the 28 day flexural strength of batch 4 mix was found to be reduced by 2.49% as compared to conventional concrete

4.2 Split Tensile Strength:

Split tensile strength test was performed on 3 cylinders of each batch mix. There were 4 batch mixes and each one having 3 cylinders, thus making a total of 12 cylinders. Out of these 12cylinders, 4 cylinders were tested for 7 days, 14 days & 28 days each. An average value of 3 test result values was considered as final result value.

Sr. No.	**MIX**	7 days Avg. Tensile Strength	14 days Avg. Tensile Strength	28 days Avg. Tensile Strength
01	Nominal Mix (Batch 1)	3.48	3.95	4.53
02	Batch 2 (50% RCA Replacement	3.46	3.91	4.48
03	Batch 3 (70% RCA Replacement	3.12	3.53	4.15
04	Batch 4 (70% RCA Replacement + 15% FA Addition)	3.37	3.84	4.42



Graph 3: Comparison of Split tensile strengths of beams of different batches cured for 7, 14 and 28 days

Discussion: It is quite evident from the graph above, the 7 day split tensile strength of batch 4 mix (the mix with 70% RCA + 15% FA) was found to be reduced by 3.16% as compared to conventional concrete, the 14 day split tensile strength of batch 4 mix was found to be reduced by 8.35% as compared to conventional concrete and the 28 day split tensile strength of batch 4 mix was found to be reduced by 2.42% as compared to conventional concrete.

5. CONCLUSIONS

From the results of the tests which were conducted on the recycled aggregate concrete, it is quite evident that reusing of concrete could prove very useful, not only from cost perspective but also from environment point of view. From the obtained results, it was observed that:

1. The slump value for batch 2 and batch 3 was found to decrease as compared to the slump of batch 1, clearly indicating that there was a decrease in workability of the concrete. But the slump value of batch 4 was found to be almost equivalent to the slump of batch 1, showing that the workability was increased.
2. The 7 day, 14 day and 28 day compressive strength of the concrete of batch 4, that is, the concrete with 70% RCA and 15% fly ash, was found to be less than that of conventional concrete. The decrease in compressive strength for 7 day, 14 day and 28 day was 2.50%, 2.66% and 2.43% respectively. Although, the strength decreased as compared to the strength of nominal concrete mix, but even then, it was not less than the target mean strength, which was 26.6 MPa.
3. The 7 day, 14 day and 28 day flexural strength of the concrete of batch 4, that is, the concrete with 70% RCA and 15% fly ash, was found to be less than that of conventional concrete. The decrease in flexural strength for 7 day, 14 day and 28 day was 3.85%, 2.90% and 2.49% respectively.
4. The 7 day, 14 day and 28 day split tensile strength of the concrete of batch 4, that is, the concrete with 70% RCA and 15% fly ash, was found to be less than that of conventional concrete. The decrease in split tensile strength for 7 day, 14 day and 28 day was 3.16%, 8.35% and 2.42% respectively.

REFERENCES

{1} Rayachoti Narayana1 and Suchitra Kumari Panda2: Experimental Investigation On Concrete with Different Waste Stone Aggregate As A Replacement Of Coarse Aggregate International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072.

{2} Krishan Pareek Effect of Recycled Aggregate on Mechanical and Durability Properties of Concrete International Journal of Structural and Civil Engineering Research Vol. 8, No. 2, May 2019

{3} Shamsher Singh1 Pankaj Rathore 2 Sanjeev Verma: Influence of recycled concrete aggregates on strength properties of concrete *i*Journals: International Journal of Software & Hardware Research in Engineering ISSN-2347-4890 Volume 6 Issue 10 October, 2018

{4} Shamsher Singh1 Pankaj Rathore 2 Sanjeev Verma: Experimental Investigation of Green Concrete in Construction Industry by Using Recycled Aggregate (Demolished Waste) iJournals: International Journal of Software & Hardware Research in Engineering ISSN-2347-4890 Volume 6 Issue 10 October, 2018.

{6} Manik Goyal Harish Kumar; Green Concrete: A Literature Review International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published by, www.ijert.org RTCEC - 2018 Conference Proceedings.

{7} 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 Volume 9, Issue 3, March-2018 ISSN 2229-5518.

{8} Vardhan Nagarkar: Experimental study on Green Concrete. Article · April 2017 DOI: 10.22214/ijraset.2017.4126

{9} Wenchao Liu, Wanlin Cao , Jianwei Zhang, Ruwei Wang and Lele Ren (2017) "Mechanical Behavior of Recycled Aggregate Concrete-Filled Steel Tubular Columns before and after Fire" Materials 2017, 10, 274; doi:10.3390/ma10030274.

{10} Jozef Junak and Alena Sicakova (2017) "Effect of Surface Modifications of Recycled Concrete Aggregate on Concrete Properties" Buildings 2018, 8, 2; doi:10.3390/buildings8010002.

{11} Aref M al-Swaidani, Tamer al-Hajeh (2017), " Production of greener recycled aggregate concretes using local supplementary cementing materials" MOJ Civil Eng. 2017;2(1):12–18

{12} Bhushan Rasik Kothari Abhay Shelar: Experimental Investigation of Recycle Concrete Aggregate IJIRST –International Journal for Innovative Research in Science & Technology| Volume 3 | Issue 02 | July 2016 ISSN (online): 2349-6010

{13} Ms. Manjushree G. Shinde*, Prof. M. R. Vyawahare, Prof. P. O. Modani***: Effect of Physical Properties of Recycled Aggregate On The Strength Of Concrete International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 4, April – 2013 ISSN: 2278-0181.

{14} Kumutha, R. & Vijai, K. (2010), "Strength of Concrete Incorporating Aggregates Recycled from Demolished Waste," ARPN Journal of Engineering and Applied Sciences, vol.5, No.5, pp.64-71.

{15} Abdelfatah A., Tabsh S. W., and Yehia S., "Alternative ways of making concrete with recycled coarse aggregate," in Proceedings of the 4th International Conference on Applications of Traditional and High Performance Materials in Harsh Environments, Institute of Materials Systems, Sharjah, UAE, March2010