



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 9, September 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569



Experimental Investigation on Aramid Fiber Reinforced Concrete with Partial Replacement of Fine Aggregate by Copper Slag and Coarse Aggregate by Recycled Aggregate

Muhammed Mannan¹, Ramya B V²

P.G. Student, Department of Civil Engineering, Bapuji Institute of Technology and Engineering College, Davanagere, Karnataka, India¹

Assistant Professor, Department of Civil Engineering, Bapuji Institute of Technology and Engineering College, Davanagere, Karnataka, India²

ABSTRACT: Cement, fine aggregate and coarse aggregate are the main constituent of the concrete. The properties of concrete depend on the properties of constituents. The use of ingredients may increase the cost of concrete. The industries produced the waste which cause pollution. Sometime production of cement cause emission of carbon dioxide which will leads to pollution. Therefore waste products obtained from the industries can be used as replacement materials in the concrete instead of dumping and causing environment pollution. Copper slag has similar characteristics of fine aggregates and it is used as replacement material in concrete. The copper slag replacement percentage is 0%, 10%, 20%, 30% and 40% to the weight of fine aggregate. The recycled aggregates has similar properties of coarse aggregate therefore it is used as replacement material in concrete. The recycled aggregate replacement percentage is 0%, 20%, 40%, 60% and 80% to the weight of coarse aggregate. The specimens with the replacement materials at different percentage were prepared and compared with conventional specimen. The test results of compressive strength, split tensile strength and flexural strength indicates the strength of concrete.

KEYWORDS: Cement, Fine aggregates, Coarse aggregate, Recycled aggregates, Copper slag, and Aramid fiber

I. INTRODUCTION

Concrete is the foundational construction engineering ingredient which is utmost acquainted in the construction engineering. Numerous ingredients are utilize for making the concrete. The main primitives of concrete are cement, fine aggregate, coarse aggregate, admixture and water. Concrete strength is mainly depend on the characteristics of ingredients. The some of ingredients are naturally obtained the natural ingredients available may varies decades to decade due to higher usage in such alternative material can be used to reduce the consumption of naturally available ingredients. Some of industrial waste products can be utilizes as a substitution material for variety of applications. Industrialization improve living standards of the people with various industries gives employment to the people. In another way industries produced waste products. The waste products are dumping over the useful land which sometime cause unhealthy environment. Instead of damping some solids wastes can be reused in various applications. This can be used as alternative material for various application the day to day life. Some by products obtained from the industry which is also used as construction material. By the use of that product in construction reduced cost of construction also improve certain strength. Therefore in this study used copper slag, recycled aggregates used as partial replacement ingredients.

1.1 Copper Slag

Copper slag is manufacturing derivate ingredient obtained by the smelt and purify process of copper. At the time of smelting process impurities form slag which is floats as a molten metal. Slag can be extinguish in water which form angular grains which is treat as a waste product. It is used in various construction application. It is considered as replacement ingredient to the river sand due to similar physical properties of sand. It is granular in texture and specific gravity is high. It is utilized as a fine aggregate due to partial size are of the order of sand.



Fig 1.1: Copper slag

1.2 Recycled Aggregate

Concrete is the world's largest consuming material behind water and its wide spread on use of urban development basis. Recycle aggregate is obtained from demolition construction waste. It is another method to improve concrete sustainability to replace natural aggregate with replaced components. The predicated total capacity of construction waste is 7.8 million tons out of 7.8 million tons construction work is produced 7.6 million tons concrete waste. Strength of concrete is simulated by the nature of aggregate hence use of recycle aggregate is limited reliable in the use of concrete.

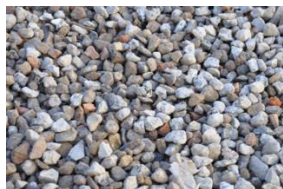


Fig 1.2: Recycled aggregates

1.3 Aramid Fiber

Aramid fiber is a synthetic fiber. It is available in fiber, chopped fiber, pulp and powder form. Aramid fiber is available in various size and colour. It is made from small molecules of synthesized polymers. The molecules are oriented to axis of fiber. Due to high chemical bond proportion fiber has more strength than other synthetic fiber. The compound used in the manufacture of aramid fiber is petroleum based chemicals or petrochemicals.



Fig 1.3: Aramid fiber

II. RELATED WORK

Velumani and Maheswari (2016) [1] This investigation narrates the mechanical as well as durability characteristics of reinforced concrete beam by substituting sand as copper slag in concrete. Copper residue has alike properties of fine aggregates. Because of indistinguishable properties residue utilized as alternative ingredient for fine aggregate. Copper slag has high strength properties and low water absorption capacity therefore replacement shows increase in the self-weight of concrete at maximum range of 20%. **Patil et.al. (2016)[2]** This experimental work describes the accomplishment of copper slag as a substitution ingredient for sand in M30 mix concrete. M30 mix concrete with different percentage from 0% - 100% various specimen are prepared and conduct strength tests. The test results show higher the workability if percentage of copper slag is higher. Compressive strength is increase maximum of 34% at 20% replacement of copper slag. The concrete attains high strength than conventional concrete strength. The flexural strength increase maximum of 14% at 30% replacement of copper slag. **Jitendera kumar tanaji mohite et.al. (2015)[3]** The experimental work carried out tests on natural aggregate, recycled aggregate and blended aggregate and compare the results which indicates that strength of recycled aggregate is slightly less than natural aggregate concrete at same condition. The reduction amount depends on parameter like w/c ratio, blending and quality of recycled aggregate. **Jitender sharma et.al. (2014)[4]** This research work brief about initiation and production of recycle coarse aggregates and describe the application of re-cycled coarse aggregate in construction. The experimental



work is conducted by substituting natural coarse grains with recyclable coarse aggregates. The results indicates that water cement ratio is lower, higher the tensile strength and elastic modulus.

2.1 Objectives of the work

The main aim of exploratory work is done to bring out experimental work to enhanced the performance of concrete with fine aggregate and recycled coarse aggregate.

Based on literature review the following objectives are derived

- To understand the characteristics of copper slag and recycled aggregates and prepared mix design for M30 grade concrete.
- To review harden concrete strength by substituting copper slag (0%, 10%, 20%, 30%, 40%, 50% 60%) and recycled aggregates (0%, 20%, 40%, 60%, 80%) in different percentage.
- To review the consequence of copper slag by sand and recycle aggregate by coarse aggregate on concrete strength parameters.
- To utilize the construction demolition waste and industrial waste effectively in concrete.
- To ascertain the optimal substitution proportion of copper slag and recycle aggregate in concert mix.

III. MATERIALS AND METHODOLOGY

3.1 Material Used

The characteristics of the materials is used for preparing concrete mix. To know the performance and appearance of the material various tests are carried out as per Indian standard procedure and to provide concrete mix design for required strength.

The ingredients are used in the work are the following;

3.1.1 Cement

Ordinary Portland cement of ultra tech 43 grade is used. The characteristics were determined as per IS standards IS: 8112-1989 and IS: 4031- part4 1988 are describe in below.

Table 3.1.1: Physical properties of cement

Sl No	Property	Results	IS Standards
1	Relative density	3.148	3.1-3.15
2	Fineness	4.24%	<10%
3	Initial setting time	42min	Not less than 30min
4	Final setting time	241min	Not more than 600min
5	Standard consistency	32%	30-35%

3.1.2 Fine Aggregates

The manufacture sand is use in this experimental investigation. The physical characteristics were determine by various tests as per IS Standards which is describe in the below.

Table 3.1.2: Physical properties of fine aggregate

Sl No	Property	Results	IS Standards
1	Relative density	2.68	IS:2386-1963
2	Finesse modulus	3.08	IS:2386-1963
3	Bulk density	1.49g/cm ³	IS:2386-1963
4	zone	II	IS:383-1970
5	Water absorption	0.5%	IS 2386-1963

3.1.3 Coarse Aggregates

The size of 20mm of locally available coarse aggregates are used in this experimental work. The characteristics were determined by the various tests as per IS standards which is described in the below.

Table-3.1.3: Physical properties of coarse aggregates

SI No	Property	Results	IS standards
1	Relative density	2.85	IS:2386-1963
2	Fineness modulus	6.15	IS:383-1970
3	Bulk density	1.58g/cm ³	IS:383-1970
4	Water absorption	0.42%	IS 2386-1963

3.1.4 Copper Slag

Copper slag is commercial factory derivative ingredient. It is used as sand in this study. The properties were determined by the various tests as per IS standards which is described in the below.

Table 3.1.4: Properties of copper slag

SI No	Property	Results
1	Relative density	3.2
2	Bulk density	1.70g/cm ³
3	Fineness modulus	3.47
4	Water absorption	0.38%
5	Zone	II

3.1.5 Recycled Aggregates

A demolished building crushed aggregates of size 20mm use as coarse aggregates in this experimental work. The properties were determined by various tests as per IS standards which is described in the below.

Table 3.1.5: Physical properties of recycled aggregate

SI No	Property	Results
1	Relative density	2.45
2	Bulk weight	1.71g/cm ³
3	Fineness modulus	5.95
4	Water absorption	0.58%

3.1.6 Aramid Fiber

A yellow colour para aramid fibers are used in this experimental work. A constant of 0.25% of fiber used for a volume of concrete throughout the experimental work. The properties of aramid fiber given by the manufactured firm is described below.

Table-3.1.6: Properties of aramid fiber

Sl No	Property	Results
1	Colour	Yellow
2	Specific gravity	1.46
3	Highly fabricated short (size)	0.5-1mm
4	Bulk density	3-11lb/ft ³
5	Surface area	7-11 m ²
6	Temperature	-200 to 350°C

3.1.7 Superplasticizer

A conplast SP430 superplasticizer conforming to IS: 1903:99 used in the experimental work. It is used for reduction of water up to 25% in the concrete which provides good quality and less permeable of concrete. Dosage of 1% used in the work to achieve good workability.

3.1.8 Water

Water is prime constituent concrete which forms reaction with cement. As per IS: 456:2000 water is clean and free from hazardous particles. The potable water used in this work. The water of PH 6 to 8 used in this experimental work.

3.2 Methodology

The methodology of this experimental work is represented in below.

- Collection of materials
- conducting preliminary tests on materials
- Mix design for M30 grade of concrete as per IS 10262:2019
- Calculating quantity of materials for cubes, cylinders, beams
- Casting a specimens and placing for curing at 7days and 28days
- Testing of specimens
- Results
- Conclusions

Table-3.2: Mix design details

MIX DESIGN FOR M30 GRADE OF CONCRETE AS PER IS 10262-2019 MIX PROPERTION(1:1.74:3.1)					
Cement kg/m ³	Water kg/m ³	Fine aggregate kg/m ³	Coarse aggregate kg/m ³	Chemical admixture kg/m ³	W/C ratio
380	175	664	1178	3.8	0.44

IV. EXPERIMENTAL RESULTS**4.1 COMPRESSIVE STRENGTH TEST RESULTS****Table 4.1.1**Copper slag compressive strength test results

Percentag e (%)	7days (N/mm ²)	28days (N/mm ²)
0	22.79	37.60
10	24.10	40.01
20	26.00	43.63
30	23.40	38.80
40	21.53	36.23

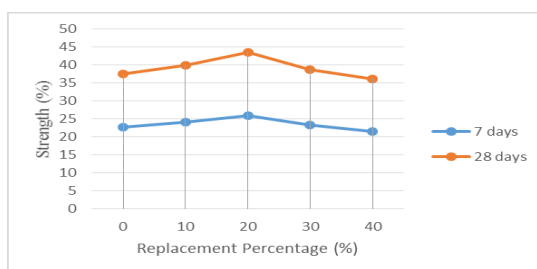


Fig 4.1.1: Copper slag compressive strength test results

Table 4.1.2 Recycled aggregate compressive strength test results

Percentage (%)	7days (N/mm ²)	28days (N/mm ²)
0	22.79	37.60
20	23.12	39.01
40	25.08	39.96
60	22.84	35.46
80	21.00	31.02

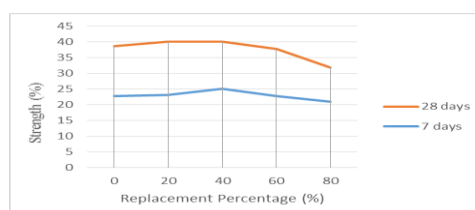


Fig 4.1.2: Recycled coarse aggregates compressive strength test results

4.2 Split tensile strength test results

Table 4.2.1: Copper slag split tensile strength testResults

Percentage (%)	7days (N/mm ²)	28days (N/mm ²)
0	2.45	3.23
10	2.63	3.31
20	2.68	3.40
30	2.32	3.33
40	1.99	2.97

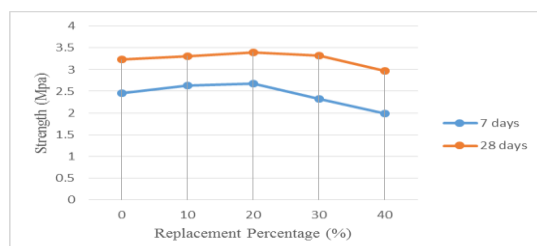
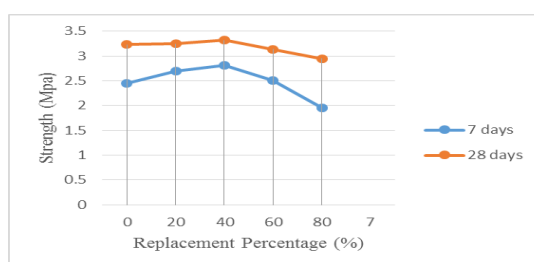


Fig 4.2.1: Copper slag split tensile strength test results

Table 4.2.2: Recycled aggregate split tensile strength test results

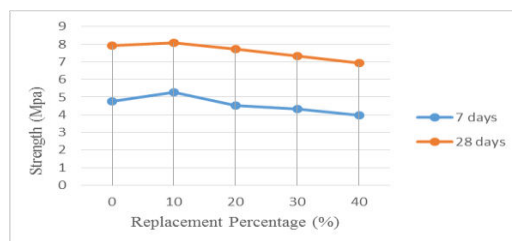
Percentage (%)	7days (N/mm ²)	28days (N/mm ²)
0	2.45	3.23
20	2.70	3.25
40	2.82	3.32
60	2.51	3.14
80	1.96	2.95

**Fig 4.2.2:** Recycled coarse aggregate split tensile strength results

4.3 Flexural strength test results

Table 4.3.1: Copper slag flexural strength test results

Percentage (%)	7days (N/mm ²)	28days (N/mm ²)
0	4.76	7.97
10	5.29	8.08
20	4.54	7.74
30	4.32	7.35
40	3.98	6.92

**Fig 4.3.1:** Copper slag flexural strength test results**Table 4.3.2:** Recycled aggregate flexural strength test results

Percentage (%)	7days (N/mm ²)	28days (N/mm ²)
0	4.76	7.97
20	4.92	8.12
40	5.06	8.24
60	4.53	7.78
80	3.89	6.95

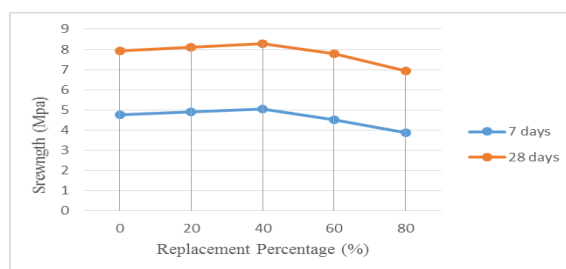


Fig 4.3.2: Recycled coarse aggregate flexural strength test results

V. CONCLUSION

After the experimental investigation the above results are obtained. From the above results following conclusion are derived which is listed below.

1. The substitution of fine aggregate by copper slag increase the concrete strength at certain proportion.
2. When copper slag is 20% and sand is 80% and other ingredients are constant maximum harden strength is achieved.
3. At 20% replacement maximal increment in the 28th days harden concrete strength were found to be 16.03%, 5.98% and 3.98% correspondingly.
4. The substitution of fine aggregate with copper slag reduce the cost of concrete.
5. When recycled coarse aggregate is 40% and coarse aggregate is 60% and other ingredients are constant maximum compressive and split tensile strength is achieved.
6. When recycled coarse aggregate is 20% and coarse aggregate is 80% and other ingredients are constant maximum flexural strength is achieved.
7. At 40% replacement the maximal increment in the 28th day compression, split strength were found to be 6.20%, 3.02% and correspondingly.
8. Used of recycled aggregate as replacement material reduced cost of concrete.
9. The industrial by products can be used as replacement materials in the concrete effectively without any hazardous.

REFERENCES

- [1] K. Sathishkumar and K. Anitha (2017) "experimental investigation on partial replacement of cement by dolomite powder and fine aggregate by copper slag" IJPAM, volume116, ISSN: 1314-3395.
- [2] Velumani and maheswari (2016) "mechanical and durability properties of Rc beam using copper slag as affine aggregate in concrete" IRJET, volume 3(3), pp332-337.
- [3] Patil M.V (2016) "performance of copper slag as sand replacement in concrete" IJAER, volume 11(16), pp4349-4353.
- [4] Jitender Sharma and Sandeep Singla (2014) "study of recycle concrete aggregates" volume13, pp123-125.
- [5] Parekha D N, Dr modhera C.D (2011) " assessment of recycled concrete aggregate" volume1, issuen1, pp1-9.
- [6] Patil M.V (2016) "performance of copper slag as sand replacement in concrete" IJAER, volume 11(16), pp4349-4353.
- [7] M.S Shetty (2012) "concrete technology" New Delhi S Chand and Company Ltd.
- [8] IS 10262-2019, recommended guide lines for concrete mix, bureau of Indian standard, New Delhi.



**Impact Factor:
7.569**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details