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STUDIES ON INFLUENCE OF COPPER SLAG AND QUARRY DUST AS FINE AGGREGATE REPLACEMENT IN CONCRETE

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ABSTRACT

In order to avoid using natural river sand, analternative materialsis proposed to predict the strength of the concrete by replacing fine aggregate partially by waste materials like copper slag and quarry dust which is an environmental waste , and millions of tonnes are dumped as a wastage and to make use of those materials without sacrificing strength and durability of the concrete structures. The strength is measured by the use of non destructive and destructive techniques. Non destructive techniques like four probe electrical resistivity metre, can incorrosion testing metre, ultra sonic pulse velocity. Destructive techniques used to determine compressive strength, split tensile strength. The permeability parameter such as water absorption test is carried out and it is determined . In this paper M30 grade of concrete has been used for the entire study . The replacement of both the material is done individually and the target strength has been obtained. Replacement of copper slag and quarry dust is done individually as 10%, 20%, 30%, 40%, 50%. therefore it is recommended that up to10-40% (by weight of sand) of copper slag can be used as a replacement for fine aggregate. 10-20%(by weight of sand) of quarry dust can be used as a replacement of fine aggregate.in order to obtain a concrete with good strength and durability requirements.

Keywords: environmental waste,copper slag, quarry dust, electrical resistivity, ultrasonic pulse velocity, corrosion resistivity, water absorption.

1. INTRODUCTION

Copper slag is a composite material and it has excellent physical and mechanical properties and it is a by product obtained during the matte smelting and refiningcopper. the reuse of copper slag is environmentally friendly as well as economically viable, which can not only save the land fill space for storage of copper slag but satisfy the rising consumption of natural fine aggregates in construction industry.new by products and waste materials are being generated by various industries,Dumping or disposal of these material causes environmental and health problems. It has been estimated that approximately 24.6 million tons of copper slag are generated from the world copper industry.thereforerecycling of waste materials has a great potential in concrete industry.

Quarry dust which is made while in processing of the granite stone into aggregates, this is formed as fine dust in crushers that process the coarse aggregates, which is majorly used for earth work filling material in the road formations. Therefore here the dust partially replaced the use of fine aggregate in concrete. For past two years escalation in cost of sand due toAdministrative restrictions in india and sand cost is comparatively two or three times greater that of crusher waste (quarry dust) even in places where river is available near by . the function of fine aggregate is to assit in producing workability and uniformity in mixture, now a days the natural river sand has become scarce and very costly. Hence we are forced to think of alternative material such as quarry dust and copper slag.The optimum concrete mix for both replacement has been suggested without sacrificing strength and workability of concrete.

2. EXPERIMENTAL PROGRAM

Materials Used: The various material used in the preparation of concrete are sand, cement coarse aggregates, copper slag , quarry dust and water.

Cement: Portland pozzolona cement (PPC) –The brand name zuari which is available in market is used.

Fine Aggregate: The natural river sand available in local market is used.

Coarse Aggregate: Crushed granite conforming to IS 383 – 1987 was used in this study. Coarse aggregate passing through 20mm and retained on 16 mm sieve was used.

Copper slag and quarry dust: Copper slag is obtained from tuticorinsterlite industry and quarry dust is obtained from near by crushers.

Water: Water is an important ingredient of concrete as it actively participated in chemical reaction with cement, clean portable water which is available in our college campus is used.

Mix Proportion: The mixture proportion for the controlled concrete of M30 grade was arrived from the trial mixes as per IS code method.

Test specimens: The ingredient of the concrete mixtures were mixed and cast into moulds. After 24 h, the samples were demoulded and cured in water.For compressive strength and ultra sonic pulse velocity 10cm size moulds were used. for split tensile strength 100×200 mm size moulds were used . for corrosion testing 100×200mm size moulds in which 10 mm bars are inserted.

Test methods

Compressive strength: Compression test conducted on hardened concrete using a compression testing machine of 2000 KN capacity available in structures lab. The compressive strength of result at the age of 7 and 28 days.

Split tensile strength: It is carried out using 100×200mm cylinders .the split tensile strength results at the age of 28 days and 56 days.

Electrical Resistivity and Canin corrosion resistivity: The electrical resistivity of the concrete specimens was performed using a four-point Werner electrode according to published recommendations and internal laboratory test procedure. Measurements where performed on 100×200mm cylinders where 10 mm steel rod is inserted. All tests were performed at different ages like 7, 14,28,56 and 98 days.

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Table 1: physical properties of PPCcement

s.no	Property	Test results
1	Specific gravity	3.15
2	Standard consistency	27%
3	Initial setting time	95min
4	Final setting time	210 min

Table 2 : fine aggregate replacement ratio for copper slag specimen

s.no	Mix id	Copper slag %	Fine aggregate %
1	C	0	100
2	C1	10	90
3	C2	20	80
4	C3	30	70
5	C4	40	60
6	C5	50	50

Table 3 : fine aggregate replacement ratio for quarry dust specimens

S.NO	MIX ID	QUARRY DUST%	FINE AGGREGATE%
1	C	0	100
2	Q1	10	90
3	Q2	20	80
4	Q3	30	70
5	Q4	40	60
6	Q5	50	50

Mix Proportions

Cement = 425.73Kg/m^3
Water = 191.58 lt/m^3
Coarse aggregate = 1152.57 Kg/m^3
Fine aggregate = 6657.82 Kg/m^3

Mix Ratio

Water cement ratio 0.45
Mix Ratio for M30 grade of concrete by IS 10262:2009
1 : 1.56 : 2.78

3. RESULTS AND DISCUSSIONSCOMPRESSIVE STRNGTH

Compressive strength of concrete mixes made with and without copper slag and quarry dust was determined at 7, 28days. The compressive strength by different types of concrete mix with respect to their compressive strength at the age of 7,and 28days varies. The compressive strength of concrete gains maximum strength at early age was observed for all copper slag and quarry dust specimen based concrete mixes when compared with concrete mixes (control concrete).

Table 4: shows obtained compressive strength of copper slag mixes

Mix id	7 days N/mm²	28days N/mm²
C	25.7	36.02
C1	26.65	35.24
C2	23.15	34.65
C3	22.8	34.2
C4	23.3	32.5
C5	22.5	30

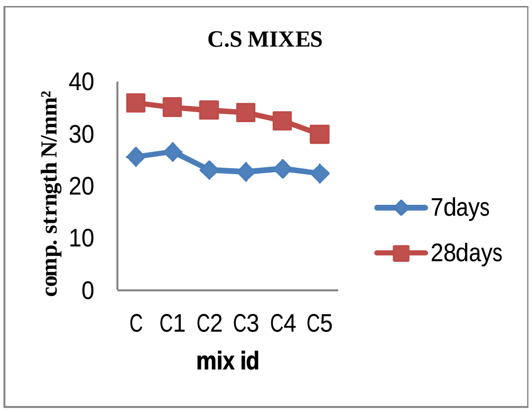

Figure. 1 Shows the compressive strength of copper slag mixes at ages of 7 days and 28 days

The compressive strength is found to be high at C1 mix when it is compared to that of conventional mix in 7 days and 28days and slight decrease is found in other mixes

Table 5 : shows obtained compressive strength of quarry dust mixes

Mix id	7days N\mm²	28days N/mm²
C	25.7	36.02
Q1	26.15	37.5
Q2	24.9	36.2
Q3	20.45	34.25
Q4	17.5	33.31
Q5	17.25	32.28

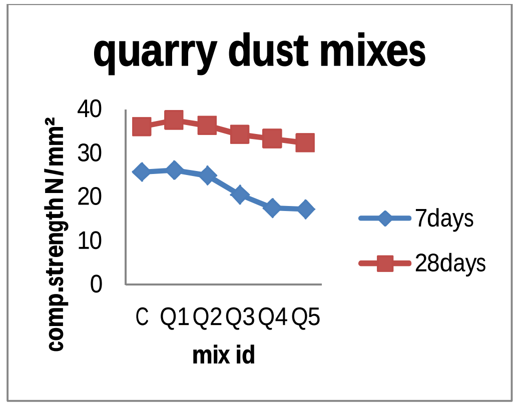

Figure. 2: shows the compressive strength of quarry dust mixes at the age of 7days and 28 days.

The compressive strength is found to be high at Q1 Mix when compared to that of other mixes.

4. SPLIT TENSILE STRENGTH

For split tensile strength, mixes made with and without copper slag an quarry dust and it is determined at the age of 28 days and 56 days.

Table 6: shows the obtained split tensile strength of copper slag mixes.

Mix id	28days N/mm²	56 days N/mm²
C	3.55	4.32
C1	3.42	4.20
C2	3.32	3.74
C3	3.38	3.82
C4	2.29	2.90
C5	2.28	2.72

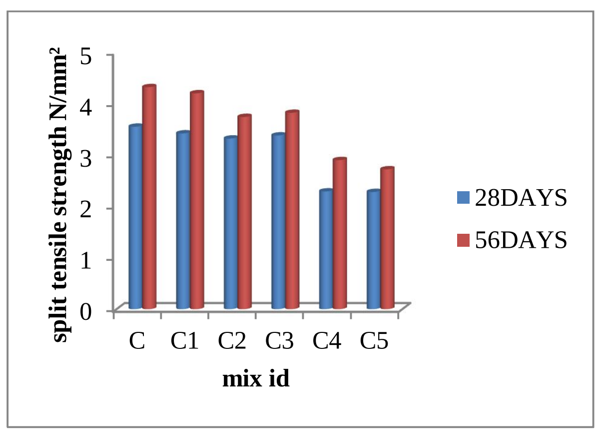

Figure.:3 shows the obtained split tensile strength ofcopper slag mixes at the age of 28 days and 56 days

Table 6 : shows the split tensile strength of quarry mixes

Mix id	28days N/mm²	56 days N/mm²
C	3.55	4.32
Q1	3.62	4.38
Q2	3.43	4.16
Q3	3.22	3.8
Q4	2.89	2.92
Q5	2.46	2.64

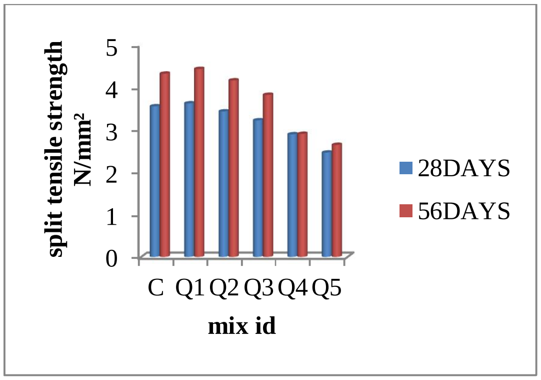

Figure. 4: Shows obtained split tensile strength for quarry dust mixes at the age of 28 days and 56 days.

Q1 mix is found to be higher than that of all other mixes.

5. ELECTRICAL RESISTIVITY TEST

It is used to measure the corrosion in concrete by using Werner four probe electrical resistvitymetre

Table 7: shows the electrical resistivity of copper slag mixes

Mix id	7days ρ(kΩm)	14days ρ (kΩm)	28days P (kΩm)	56days ρ (kΩm)	98days ρ(kΩm)
C	6.2	7.51	38.5	48	64.3
C1	5.91	7.64	32	40	62.4
C2	4.71	7.76	21	38	59
C3	13.1	8.6	26	41	55.2
C4	7.24	9.9	32.5	40	54.8
C5	5.91	6.21	20	28	42.4

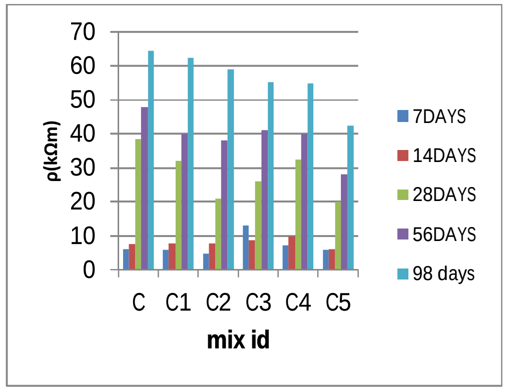

Figure. 5: shows obtained electrical resistivity of copper slag mixes.

The graph shows copper slag specimens has low electrical values compared to that of conventional concrete. Where as electrical resistivity of concrete increases with age of concrete.

Table 8: shows electrical resistivity of quarry dust mixes.

Mix id	7days ρ(kΩm)	14days ρ(kΩm)	28days ρ(kΩm)	56days ρ(kΩm)	98days ρ(kΩm)
C	6.2	7.51	38.5	48	59.5
Q1	5.42	7.8	36	48	59
Q2	5.81	8.71	21.5	32	46
Q3	6.34	7.33	30.3	50	54
Q4	7.73	8.25	27	38	47
Q5	6.92	7.4	25.5	32	41

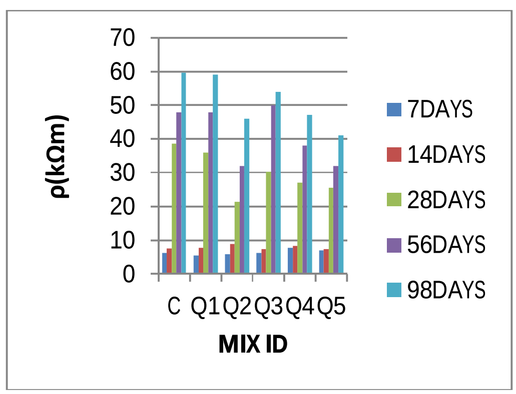

Figure 6; shows electrical resistivity of quarry dust mixes.

The percentage improvement of electrical resistivity is seen in C and Q1 mix. More over electrical resistivity is same for all specimens.

Canin corrosion resistivity

It is used to measure the magnitude of potential currents and generally it guides the corrosion condition.

Table 9: shows cannin corrosion resistivity values for copper slag mixes

Mix id	28 days (mv)	56days (mv)	98days (mv)
C	489.8	532	592.5
C1	450.33	494.5	548
C2	300.33	392.5	452
C3	561.8	580	624.8
C4	366.6	405.5	484.5
C5	529.6	548.5	581

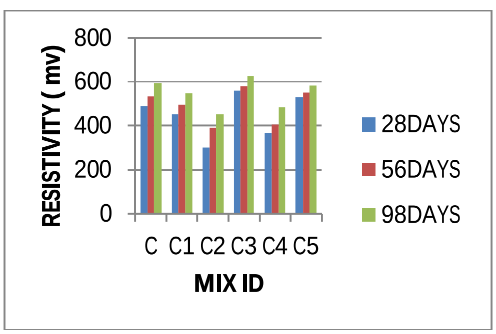

Figure. 7: shows corrosion resistance for copper slag mixes.

The corrosion is high for C3 and C5 when compared to all other mixes.

Table 10: shows canin electrical resitivity values for quarry dust specimens

Mix id	28days (mv)	56days (mv)	98days (mv)
C	489.8	532	592.5
Q1	501	566	598.3
Q2	635.2	624	654.8
Q3	484.8	502.5	552.3
Q4	614.16	633	667
Q5	371.6	568.5	591.5

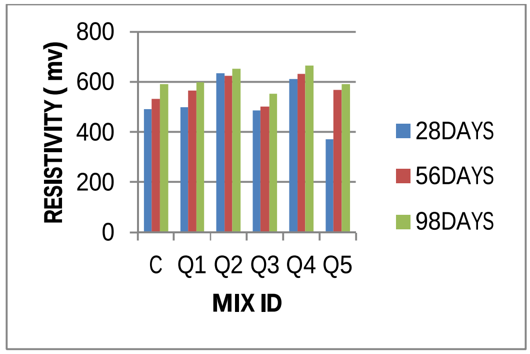

Figure.8: Shows corrosion resistance for quarry dust specimens.

Thecorrosion is high for Q2 and Q4 mix compared to that of other mixes.

6. CONCLUSION

- The compressive strength of the concrete is seen high in C1 and C2 mix when compared to that conventional mix in 7 days and 28 days of copper slag replacement ratio of 10-30% .and for quarry dust 10-20% replacement ratio is suggested to obtained strength.
- The split tensile strength of the concrete is seen high in 10 -30% replacement ratio in both copper slag and quarry dust concrete mixes.
- The percentage improvement of electrical resistivity is seen high in lower replacent ratio in bothcoppersalg and quarry dust concrete mixes.
- The canin corrosion resistivity results more corrosion occurs at higher replcament.
- More over the target strength has been obtained from (10-30%) replacement ratio and a only graduall decrease is seen in higher replacement . hence both copper slag and quarry can be partially replace the use of natural sand without sacrificing strength and durability.

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