Electrical Properties And Compressive Strength of Concrete With SCMs and COIRS

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Abstract - The cement industry is the third largest carbon dioxide emitter after housing and transport. It is so popular and abundant in use.The easiest way to reduce CO2 emission is to replace cement in the concrete mix with supplementary cementitious materials like fly ash, Rice Husk Ash. However this will reduce the early strength and might hamper productivity. This paper presents concrete fiber composites like coirs, steel fibres. This paper is an experimental study of resistivity of different mix proportions of concrete and their strength. Analysis by electrical resistivity method is discussed. Interest of electrical resistivity measurement (totally non destructive) is studied, elaborated with destructive tests on concrete

Keywords—Strength, electrical resistivity, Fly ash, Rice husk ash, coirs.

I. INTRODUCTION

As structural materials, cement paste, mortar, concrete composites have received much attention in terms of their mechanical properties, but relatively little attention in terms of their electrical conduction properties. Nevertheless, the electrical properties are relevant to the use of the structural materials for Non-destructive testing (NDT) . The ability to provide non-structural functions allows a structural material to be multifunctional, thus saving cost and enhancing durability. Furthermore, the electrical properties shed light on the structure of the materials, particularly concerning the interfaces in the composite materials. Therefore, for both technological and fundamental reasons, the electrical properties of cement-matrix composites are of interest and constitute the subject of this review. This review addresses the resistivity of concrete.

II. MATERIALS AND EQUIPMENTS OF USE

Objectives of Study

This study is conducted for objectives:

1. To compare resistivity and strength of OPC concrete.
2. To calibrate the electrical properties of OPC concrete.
3. To explore new Non destructive test.

III. EQUIPMENTS

The following are the main equipment used for determining the resistivity of mortar and concrete.

1. Dimmerstat Range (0 -240 V)
2. Two metal plates 8cm Thick 17 cm x 17 cm
3. Multimeters showing micro Ampere
4. Crocodile pins
5. Connectors

Resistivity measurement

Resistivity is the characteristic of the material of which the conductor is made. It is the electrical property of the material due to which , it impends or resists the flow of electricity through it.

Compressive strength measurement

The most common test performed on concrete is for compressive strength.

Resistivity & compressive strength

Electrical resistivity of M20, M25 and M 30 OPC concrete blocks measured. Resistivity measurements were conducted on cubes prepared on 3, 7, 14, 28 days.

Effects of SCMs, Coirs, steel fibres

Because of the pozzolanic effect and physical properties SCMs create a finer pore size distribution and lower ionic concentration which leads to higher resistivity than in normal Portland cement concrete.

Effect of steel fibres on resistivity

Short steel fibres used as an admixture in cement paste also decreases the resistivity . The contact electrical resistivity between stainless steel fibre and cement paste is around 6 x 10 2 ohm.cm. The interface between steel fibres and cement matrix behaves similarly as steel reinforcing bar.

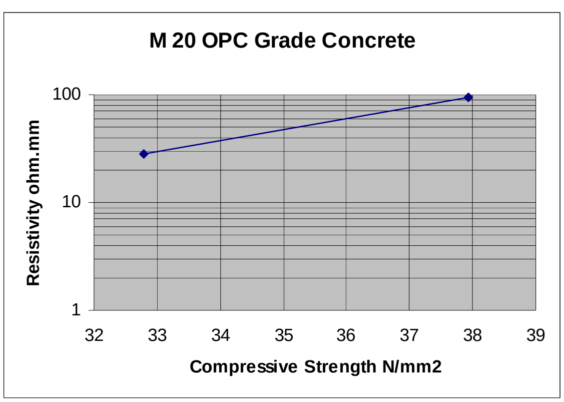
Fibres dispersion in concrete accounts for percolation. It refers to the situation in which there is continous electrical conduction path formed by the fibres due to the contact between adjacent fibres in the composite.

The fibres are so much electrically conductive than the cement matrix. The presence of fibres introduces interface between fibres and matrix that will increase resistivity of the concrete.

M 20 OPC Grade with Rice Husk Ash (RHA)

Voltage v	Current mA	Resistivity Ω mm	Age Days	Compressive strength N/mm2	Grade
80	1.8	66.67 x10^7	Day 28	32.78	M 20 (15 % RHA)
100	2.7	55.56 x10^7			
120	3.6	50 x10^7			
180	6	45 x10^7			
220	8.7	37.93 x10^7			
230	9.5	36.31 x10^7			
80	0.9	133 x10^9	Day 28	28.44	M 20 (20 % RHA)
100	1.2	125 x10^9			
120	1.5	120 x10^9			
180	2.4	112 x10^9			
220	3.5	94.28 x10^9			
230	4.5	76.67 x10^9			

GRAPH 1:

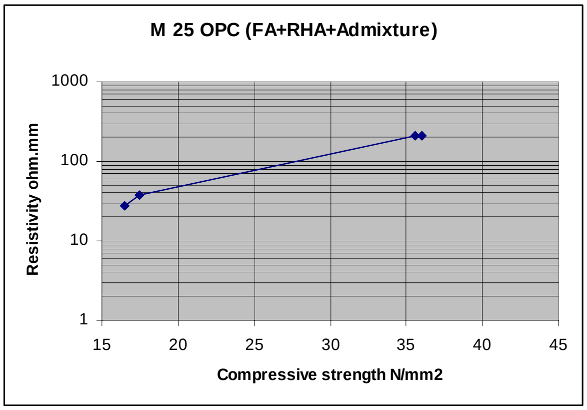


M 20 OPC with Rice husk Ash + Coconut Fibres (RHA + CF)

Voltage v	Current mA	Resistivity Ω mm	Age Days	Compressive strength N/mm2	Grade
80	1.2	100 x10^7	Day 7	17.78	M 20 (20% RHA+ 1 % CF)
100	1.5	110 x10^7			
120	2.6	69.23 x10^7			
180	3.3	81.81 x10^7			
220	5.5	60 x10^7			
230	5.6	61.6 x10^7			
80	1	120 x10^7	Day 7	16.44	M 20 (20% RHA+ 2 % CF)
100	1.4	107 x10^7			
120	2	90 x10^7			
180	3.8	71 x10^7			
220	6.2	53.22 x10^7			
230	7.2	47.91 x10^7			
220	5.73	57.5 x10^7	Day 7	19	M 20 (20% RHA+ 3 % CF)
230	5.92	58.2 x10^7			
220	5.1	64.7 x10^7	Day 7	21.33	M 20 (20% RHA+ 4 % CF)
230	6.4	63.88 x10^7			

M 25 OPC with Fly Ash+ Rice Husk Ash+Admixture (FA+RHA + Admixture)

Voltage v	Current mA	Resistivity Ω mm	Age Days	Compressive strength N/mm2	Grade
220	32	103.12 x 10^6	Day 28	30.66	M 25 (10% FA+ RHA 20 %+3 % Admix)
230	36.9	93.49 x 10^6			
220	16.04	187.03 x 10^6	Day 28	29.77	M 25 (12% FA+ RHA 18 %+3 % Admix)
230	20.4	161.76 x 10^6			
220	14.5	206.89 x 10^6	Day 28	35.55	M 25 (13% FA+ RHA 17 %+3 % Admix)
230	14.84	222.37 x 10^6			
220	12.06	248.75 x 10^6	Day 28	34.22	M 25 (15% FA+ RHA 15 %+3 % Admix)
230	13.12	251.52 x 10^6			
220	14.22	210.97 x 10^6	Day 28	36	M 25 (16% FA+ RHA 14 %+3 % Admix)
230	16.18	203.95 x 10^6			
220	5.32	37.5 x 10^6	Day 7	17.5	M 25 (24% FA+ RHA 6 %+3 % Admix)
230	6.48	25.4 x 10^6			
220	6.42	31.15 x 10^6	Day 7	27.5	M 25 (25% FA+ RHA 5 %+3 % Admix)
230	7.52	29.25 x 10^6			
220	7.36	27.17 x 10^6	Day 7	16.5	M 25 (26% FA+ RHA 4 %+3 % Admix)
230	7.34	29.97 x 10^6			



M 30 OPC with Rice Husk Ash + Steel fibres (RHA + Steel Fibres)

Voltage v	Current mA	Resistivity Ω mm	Age Days	Comp. strength N/mm2	Grade
220	19.9	165.82×10^3	Day 28	25.33	M 30 (17 % RHA)
230	20.0	172.5×10^3			
220	13.1	251.90×10^3	Day 28	27.02	M 30 (20% RHA)
230	13.9	248.20×10^3			
220	9.11	365.32×10^3	Day 28	35.55	M 30 (10.5 % RHA +0.25 % Steel Fibres)
230	9.03	378.40×10^3			
220	19.81	151.43×10^3	Day 14	28.88	M 30 (17.5 % RHA)
230	21.26	155.22×10^3			
220	0.058	251.35×10^3	Day 14	30.22	M 30 (12.5 % RHA +0.75 % Steel Fibres)
230	0.062	255.45×10^3			
220	0.05	181.5×10^3	Day 14	18.66	M 30 (15 % RHA +0.25 % Steel Fibres)

IV. CONCLUSION

- For calibration of compressive strength , resistivity measurement can be an effective method for Non Destructive Testing .
- Use of supplementary cementing materials (also known as mineral admixtures) such as fly ash, Rice husk Ash can help to increase electrical resistivity of concrete
- The parameters which have a significant influence on electrical resistivity of Concrete. It include
  - Time of moist curing
  - Use of SCMs Supplementary Cementitious Materials)
  - Coirs, Steel Fibres.
- Relation between Resistivity and Compressive strength is linear one.
- No Relation can be established in case of steel fibres reinforced concrete.

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