# Comparative Study on Durability of Self-Compacting Concrete with Marble Waste by Using RCPT Method

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**Abstract—**Self-compacting concrete (SCC) possesses enhanced qualities and working conditions due to the elimination of compaction. SCC generally has higher powder content and thus it is necessary to replace some of the cement by additions to achieve an economical and durable concrete. The durability of concrete is another important factor in a structure, so Rapid Chloride Penetration Test (RCPT) as per ASTM C 1202 was conducted to find the durability of self-compacting concrete. The paper deals with the comparative durability study with the replacement of 10 % of cement with and without the marble waste in SCC.

**IndexTerms—**Self compacting concrete- SCC, RCPT, Marble waste, Super plasticizers, Viscous modifying agent, Fly ash,

## 1. INTRODUCTION

Self-Compacting Concrete (SCC), which flows under its own weight and does not require any external vibration for compaction, has revolutionized concrete placement. SCC, was first introduced in the late 1980's by Japanese researchers, is highly workable concrete that can flow under its own weight through restricted sections without segregation and bleeding.

Normal concrete casting relies on compaction to ensure adequate strength and durability. Insufficientcompaction leads to voids, which reduces strength, strongly influences the natural physical and chemical properties in concrete.

For SCC, it is generally necessary to use super plasticizers in order to obtain high mobility. Adding a large volume of powdered material or viscosity modifying admixture can eliminate segregation. SCC was introduced in India in the Nineties.

The advancement of concrete technology can reduce the consumption of natural resources and energy sources which in turn further lessen the burden of pollutants on the environment. Presently, large amount of marble dust are generated in natural stone processing plants with an important impact on the environment and humans.

Hence, the reuse of marble waste material has been emphasized and annual output of more than 68 million tons of processed product is utilized.

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## 2. MATERIALS USED

**2.1 Cement** Ordinary Portland cement (Grade 53) was used and its properties are

- Specific gravity of Cement – 3.15
- Initial setting time of cement – 45 min
- Final setting time of cement – 360 min
- Consistency – 36 %

**2.2Fine aggregate River** sand (maximum size 4.75mm) was used and properties are

- Specific gravity of FA – 2.58
- Water absorption – 1.3%

**2.3Coarse aggregate** Natural crushed stone (size- 12.5mm) was used and its properties are

- Specific gravity of CA – 2.73
- Water absorption – 0.4%

Both fine aggregate and coarse aggregate are conformed to Indian Standard Specifications IS: 383-1970.

**2.4Fly ash** Class C Fly ash was used and specific gravity is 2.15.

**2.5 SuperplasticizerMasterGlenium SKY 8233** is an admixture of a new generation based on modified polycarboxylic ether super plasticizer was used as per code EN 934-2

**2.6Viscosity modifying agent is** about 1% is an added along with super plasticizer.

**2.7Marble Dust**

The Marble Dust chosen for these experiments was white coloured. It is directly obtained from deposits of marble factories during shaping. Hence Marble Dust was sieved using 0.25mm sieve.The Specific gravity of the marble dust was found to be 2.3.

**2.8Mix design for M60 grade of SCC**TheMix design done as per code IS 10262:2009 and given in Table 1.

## 3 TEST METHOD

### 3.1 Rapid Chloride Penetration Test (RCPT)

This test method was originally developed by the Portland Cement Association, under a research program paid for by the Federal Highway Administration (FHWA). The original test method may be found in FHWA/RD-81/119, Rapid Determination of the Chloride Permeability of Concrete." Since the test method was developed, it has been modified and adapted by various agencies and standard's organizations

• AASHTO T277, "Standard Method of Test for Rapid Determination of the Chloride Permeability of Concrete" • ASTM C1202, "Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration"

The test procedure developed by the researcher as per AASHTO T277 and ASTM C1202 is described below. Test method involves obtaining a 100 mm (4 in.) diameter core or cylinder from the concrete being tested. A 50 mm (2 in.) specimen is cut from the sample. The side of the cylindrical specimen sample is coated with epoxy, and after the epoxy is dried, it is put in a vacuum chamber for 3 hours. The specimen is vacuum saturated for 1 hour and allowed to soak for 18 hours. It is then placed in the test device. The left-hand side (–) of the test cell is filled with a 3% NaCl solution. The right-hand side (+) of the test cell is filled with 0.3N NaOH solution. The system is then connected and a 60-volt potential is applied for 6 hours. Readings are taken every 30 minutes. At the end of 6 hours the sample is removed from the cell and the amount of coulombs passed through the specimen is calculated.

**Formula:**

The following formula is used for calculating the average reading-

900*(i1+2*i2+2*i3+2*i4+2……i11+2*i12+i13)/1000

The test results are compared to the values in the TABLE 1. This chart was originally referenced in FHWA/RD-81/119 and is also used in AASHTO T277-83 and ASTM C1202 specifications. Table 1 Standard as per ASTM C 1202

TABLE 1

| Charge passed coulombs | Chloride ion penetrability |
|---|---|
| > 4000 | High |
| 2000 – 4000 | Moderate |
| 1000 – 2000 | Low |
| 100 – 1000 | Very low |
| < 100 | Negligible |

## 4 DURABILITY TEST METHODS FOR HARDENED SCC

4.1 **Experimental Work** Design mix comprises of cement replacement by 10 percentage by mass with marble waste in self-compacting concrete. For design mix the samples for RCPT measuring100mm diameter and 5omm thickness were casted as per ASTM 1202 specification.

TABLE 2

| Mix design for M60 grade of SCC | |
|---|---|
| W/C | 0.28 |
| Cement | 500 Kg/m$^3$ |
| Fly ash | 140 Kg/m$^3$ |
| Fine aggregate | 738.45 Kg/m$^3$ |
| Coarse aggregate (12.5mm) | 846.50 Kg/m$^3$ |
| Super plasticizer (PCE) | 4.48 Kg/m$^3$ |
| Viscosity modifying agent | 0.64 Kg/m$^3$ |
| Water | 192.98 Kg/m$^3$ |

## 5 RESULT AND DISCUSSION

The RCPT method is the fastest method and is often used for specification and quality control purposes. The procedure of this test method is used for measuring the resistance of concrete to chloride ion penetration has no bias because the value of this resistance can be defined only in terms of a test method. The method relies on the results from a test in which electrical current passes through a concrete sample during a six-hour exposure period. The interpretation is that the larger the Coulomb number, or the charge transferred during the test, the greater the permeability of the sample. The more permeable the concrete, the higher the coulombs; the less permeable the concrete, the lower the coulombs. The results is tabulated in Table 3 and Table 4.

TABLE 3

| SCC | | | |
|---|---|---|---|
| RCPT TEST RESULTS | | | |
| TIME(min) | SAMPLE 1 | SAMPLE 2 | SAMPLE 3 |
| 0 | 81 | 80 | 85 |
| 30 | 94 | 89 | 96 |
| 60 | 96 | 92 | 100 |
| 90 | 101 | 96 | 103 |

| | | | |
|---|---|---|---|
| 120 | 104 | 97 | 103 |
| 150 | 104 | 99 | 103 |
| 180 | 104 | 99 | 103 |
| 210 | 104 | 100 | 104 |
| 240 | 106 | 102 | 104 |
| 270 | 108 | 103 | 106 |
| 300 | 109 | 105 | 106 |
| 330 | 109 | 105 | 108 |
| 360 | 109 | 106 | 108 |
| TOTAL | 2219.4 | 2122.2 | 2220.3 |
| AVG | 2187 | | |

TABLE 4

| SCC + MARBLE WASTE | | | |
|---|---|---|---|
| RCPT TEST RESULTS | | | |
| TIME(min) | SAMPLE 1 | SAMPLE 2 | SAMPLE 3 |
| 0 | 60 | 60 | 42 |
| 30 | 66 | 65 | 48 |
| 60 | 68 | 66 | 48 |
| 90 | 69 | 68 | 48 |
| 120 | 72 | 69 | 49 |
| 150 | 72 | 70 | 50 |
| 180 | 74 | 71 | 52 |
| 210 | 74 | 71 | 52 |
| 240 | 75 | 72 | 53 |
| 270 | 74 | 72 | 53 |
| 300 | 74 | 72 | 54 |
| 330 | 75 | 72 | 54 |
| 360 | 76 | 72 | 54 |
| Columbs | 1547.10 | 1499.40 | 1094.40 |
| AVG | 1523.25 | | |

## 6 CONCLUSION

SCC technology is now being adopted in many countries throughout the world, it is necessary to examine the durability of concrete.

In SCC, RCPT test results were found as specified in ASTM C 1202 the current passed was measured at an interval of 30min for six hours for each sample and readings in Columbs were to be satisfactorywhen compared with normal SCC and SCC with marble wastewere tabulated as shown in Table 3 and Table 4.The comparative study for Self-compacting concrete with and without marble waste is tested and results found to be satisfied for SCC with marble waste with which cement is replaced about 10 % of marble waste.

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