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**RESEARCH ARTICLE**

# Efficient Use of Aluminum Industry Waste (Red Mud) for High Quality Self Compacting Concrete

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## *Abstract*

Now- a- days in developing countries like India Cost reduction in the building is the primary objective of the researchers. This can achieved by making some low cost martial like concrete by utilization of waste and by products particularly from mining and mineral industries. Hence this research work aims to find out the effect of addition of red mud, which is a waste product from the aluminium industries, on the properties of self compacting concrete containing admixtures. In this way the waste of aluminium industry will be reused in a productive way for increasing the strength of concrete and make it economically for people. This work includes experimentation and combinations of admixtures. The different percentages of red mud used in experimentation are 1%, 2%, & 3%.Wich provides different strength amount to the concrete. The percentage increase in the compressive strength at 2% addition of red mud is 9.11% which is maximum then it goes on decreasing.



## INTRODUCTION

The material science is progressing speedily because of development in recent technology. In last few decades, a lot of research was carried out all over the world to improve the quality and reliability of concrete in terms of strength and durability. Consequently concrete has no longer remained a construction material consisting only of cement, aggregate, and water. Over that, concrete has became an engineered custom modified material with a number of new constituents to meet the distinct requirements of construction industry. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, good structural performance and adequate durability.

Concrete is a composite material composed of aggregate mixed together with a fluid cement which hardens over time. Self-consolidating concrete or self-compacting concrete (SCC) is categorized by a low yield stress, high deformability, and moderate viscosity essential to ensure uniform suspension of solid particles during transportation, assignment (without external compaction), and thereafter until the concrete sets. Such concrete can be used for casting profoundly reinforced sections, places where there can be no access to vibrators for compaction and in complex shapes of formwork which may otherwise be impossible to cast, giving a far better-quality surface than conventional concrete. Prof. Okamura at Ouchi University, Japan first time conceptualized SCC in the year 1986.

### History of the related research work

A proposed research work by (Celik Ozyildirim, 2003 ) aims to build up a framework for mixture proportions of various number of materials used for self compacting concrete. In particular the author reviewed two main phases as laboratory phase and plant phase which gives complete idea about how to define different mixes, batches and materials. An investigations proposed by (Masahiro Ouchi, 2015 ) is based on self compacting concrete and testing

method which has to be adopted in laboratory for testing of self compacting concrete. It also elaborated different applications of SCC regard with construction sector.
Research reported presented by (Kiran K. Shetty *et.al,* 2014.) has given a total information regarding the use of red mud, its percentage and mix proportions of SCC. In addition to this it presents different methods about the replacement of iron tailings in self compacting concrete. It concludes various test results such as compressive test, flexural test & tensile strength test results, which helped us in defining mixes and proportioning of red mud. Researcher (Manjur A.Shendure, 2015) has also carried out studies on the effect of concrete mixer variation on properties of self compacting concrete using red mud. And also proposed method how to perform J-ring test, V-funnel test, U-box test, L- box test, J-Ring test. Also the strength properties of self-compacting concrete using red mud like compressive strength and these properties are compared with regular concrete strength and normal self compacting concrete and effort has been made to study the effect of replacement of cement with Neutralized Red Mud and performance of concrete using it.

## Test Methods

To check the change in strength of concrete according to the proportional change in the concrete contents number of test have to be conducted. Here in this research work the test included are slump flow test, L box test, Compressive Strength Test, Flexural Strength Test.

**1. Slump Flow Test.**
This is simple and rapid test procedure, even if two people are required to measure the T50 time. It can be used on site, despite the fact that the size of the base plate is somewhat unwieldy and level ground is essential. It is most commonly used test, and gives a good assessment of filling ability.

**2. L box test method**
This is extensively is used test, suitable for laboratory, and perhaps site use. It assesses filling and transient ability of SCC, and serious deficient in the stability (segregation) can be detected visually. Segregation may also be detected by subsequently inspecting sections of the concrete in the horizontal section.

**3. Compressive Strength Test**
Compressive strength of concrete is defined as the load, which causes the failure of a standard specimen divided by the area of cross section in uni-axial compression under a given rate of loading. The test of compressive strength should be made on 150mm size cubes.

**4. Flexural Strength Test**
Flexural strength which is also known as modulus of rupture, bend strength, or fracture strength is a material property and can be defined as the stress in a material just before it yields in a flexure test. The transverse bending test is most commonly employed, in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three point flexural test technique. The flexural strength represents the highest stress experienced inside the material at its moment of rupture. It is measured in terms of stress, here given the symbol $\sigma$.

**5. Split Tensile Strength Test**
Split Tensile Strength Test is a test in which a cylindrical specimen is loaded to failure in diametric compression applied along the entire length. It can also be defined as a method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter, which is also known as Brazilian Test and Dimetral Compression Test.

## Results

**Test Results Of Self Compacting Concrete Containing Red Mud & The Combination Of Admixtures (SP+VMA)**
The following tables give the test results of effect of addition of red mud in various percentages on the properties of self compacting concrete containing an admixture combination (SP+VMA)

Compressive Strength Test results of self compacting concrete containing the combination of admixtures (SP+VMA) with various percentages of red mud

**Table No. 1:** Compressive strength of SCC with **2% red mud** and with combination of admixtures (SP+VMA)

| Specimen Identification | Weight of specimen (N) | Density (N/cum) | Average density (N/cum) | Failure Load (KN) | Compressive strength(MPa) | Average compressive strength(MPa) |
|---|---|---|---|---|---|---|
| C1 | 82.2 | 24355.5 | 24177.7 | 1020 | 45.33 | 44.29 |
| C2 | 83.8 | 24829.6 | | 990 | 44.00 | |
| C3 | 78.8 | 23348.1 | | 980 | 43.55 | |

**Table No. 2**: Compressive strength of SCC with **3% red mud** and with combination of admixtures (SP+VMA)

| Specimen Identification | Weight of specimen (N) | Density (N/cum) | Average density (N/cum) | Failure Load (KN) | Compressive Strength(MPa) | Average compressive strength(MPa) |
|---|---|---|---|---|---|---|
| D1 | 84.0 | 24888.8 | 24533.0 | 970 | 43.11 | 42.66 |
| D2 | 81.2 | 24059.O | | 930 | 41.33 | |
| D3 | 83.4 | 24711.1 | | 980 | 43.55 | |

**Overall Results Of Compressive Strength**

The following table gives the overall results of compressive strength of self compacting concrete containing the combination of admixtures (SP+VMA) for various percentage addition of red mud

**Table No. 3**: Overall Result of Compressive Strength

| Percentage addition of red mud | Compressive strength (MPa) | Percentage increase or decrease of Compressive strength w.r.t. ref mix |
|---|---|---|
| 0(Ref.) | 40.59 | - |
| 1 | 41.18 | +1.45 |
| 2 | 44.29 | +9.11 |
| 3 | 42.66 | +5.10 |

The variation of compressive strength can be depicted in the form of graph as shown in **Figure No .1**

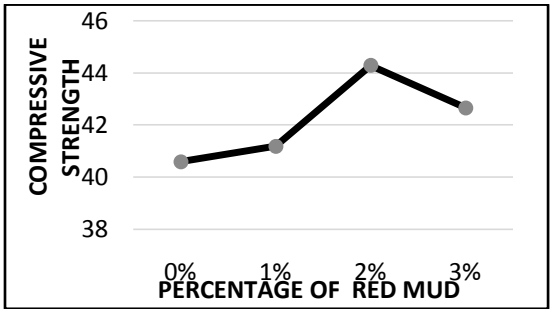


**FIG. No. 1:** The variation of compressive strength of SCC containing red mud.

**Tensile Strength Test Results Of Self Compacting Concrete Containing The Combination Of Admixtures (SP+VMA) With Various Percentages Of Red Mud**

**Table No4.** Tesile strength of SCC with**2% red mud** and with combination of admixture(SP+VMA)

| Specimen identification | Failure Load (KN) | Tensile strength F=2P/ $\pi dl$ (MPa) | Average tensile Strength (MPa) |
|---|---|---|---|
| C1 | 350 | 4.95 | 4.62 |
| C2 | 300 | 4.24 | |
| C3 | 330 | 4.67 | |

**Table No.5:** Tensile strength of SCC with **3% red mud** and with combination of admixtures (SP+VMA)

| Specimen identification | Failure Load (KN) | Tensile strength F=2P/ $\pi dl$ (MPa) | Average tensile Strength (MPa) |
|---|---|---|---|
| D1 | 230 | 3.25 | 3.34 |
| D2 | 240 | 3.39 | |
| D3 | 240 | 3.39 | |

**Overall Results Of Tensile Strength**

The following table gives the overall results of tensile strength of self compacting concrete containing the combination of admixtures (SP+VMA) for various percentage addition of red mud

**Table No. 6:** Overall Result of tensile Strength

| Percentage addition of red mud | Tensile strength (MPa) | Percentage increase or decrease of tensile strength w.r.t. ref mix |
|---|---|---|
| 0(Ref.) | 3.34 | - |
| 1 | 4.00 | +19.76 |
| 2 | 4.62 | +38.32 |
| 3 | 3.34 | 0 |

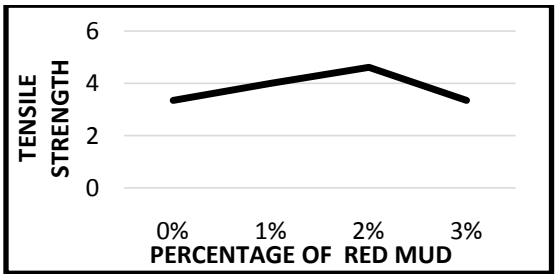


**FIG. No. 2:** The variation of tensile strength of SCC containing red mud

The variation of tensile strength can be depicted in the form of graph as shown in Figure No. 2

**Flexural Strength test results of self compacting concrete containing the combination of admixtures (SP+VMA) with various percentages of red mud**

**Table No.7:** Flexural strength of SCC with **2% red mud** and with combination of admixtures (SP+VMA)

| Specimen Identification | Failure Load (KN) | Flexural strength $F=PL/BD^2$ | Average tensile strength (MPa) |
|---|---|---|---|
| C1 | 11.4 | 5.70 | 5.53 |
| C2 | 10.8 | 5.40 | |
| C3 | 11 | 5.50 | |

**Table No.8:** Flexural strength of SCC with **3% red mud** and with combination of admixtures (SP+VMA)

| Specimen Identification | Failure Load (KN) | Flexural strength $F=PL/BD^2$ | Average tensile strength (MPa) |
|---|---|---|---|
| D1 | 11 | 5.50 | 5.50 |
| D2 | 11.2 | 5.60 | |
| D3 | 10.8 | 5.40 | |

**Overall Results Of Flexural Strength**

The following gives the overall results of flexural strength of self compacting concrete containing the combination of admixtures (SP+VMA) for various percentage addition of red mud

**Table No. 9:** Overall Result of tensile Strength

| Percentage addition of red mud | Flexure strength (MPa) | Percentage increase or decrease of tensile strength w.r.t. ref. mix |
|---|---|---|
| 0(Ref.) | 5.12 | - |
| 1 | 5.36 | +4.69 |
| 2 | 5.53 | +8.01 |
| 3 | 5.50 | +7.12 |

The variation of flexural strength can be depicted in the form of graph as shown in Figure No.3

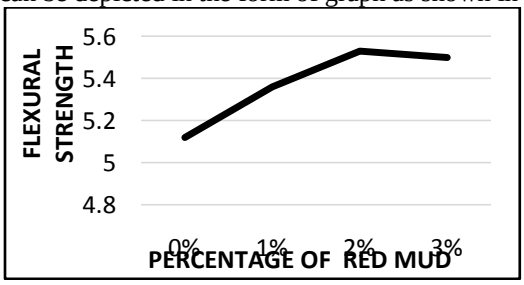


**FIG. No. 3:** The variation of flexural strength of SCC containing red mud

**Slump Flow Test**

The higher the slump flow value, the greater its ability to fill formwork under its own weight. A value of at least 650 mm is required for SCC. There is no specific all over accepted advice on what are rational tolerances about a specified value, through ±50mm, as with the relative flow able test might be appropriate.

The T50 time is a secondary indication of flow. A lesser time indicates larger flow ability. In case of severe segregation most coarse aggregate will stay in the centre of the pool of concrete and mortar and cement paste at the concrete periphery. In case of minor segregation border segregation a border of mortar without coarse aggregate can occur at the edge of the pool of concrete. If none of these phenomena appear it is no assurance that segregation will not occur since this is a time related aspect that can occur after a longer period.

**L Box Test**

If the concrete flows as freely as water, at the rest it will be horizontal, so H2/H1=1.Therefore the nearer this test value, the "blocking ratio" is to unity, the better the flow of concrete. Obvious blocking of course aggregate behind the reinforcing bars can be detected visually.

## Conclusion

In present development status of India there is a greater need for self-compacting concrete to improve durability of the structure. There is huge amount of Red mud is produced every day and dumped on the ground it is a threat for environment. This waste is used for dumping or filling the low lying areas causing the environment in deterioration in long run, so this mix should be used for the construction activity it will reduce the problem of environmental pollution at the same time it reduces the cost of the construction and add it makes the concrete high performing from the durability point of view. The amount of cement is reduced which is replaced by RED MUD up to some extent.

It has been experimentally observed that the compressive strength of the self compacting concrete produced with the combination of admixtures such as (SP+VMA) used here which goes on increasing up to 2% addition of red mud. After adding of 2% red mud, the compressive strength starts decreasing, i.e. the compressive strength of self compacting concrete produced with (SP+VMA) is maximum if added 2% of red mud. The percentage increase in the compressive strength on adding 2% of red mud is 9.11%. Thus, according to the research work done it can be concluded that the maximum compressive strength of the self compacting concrete with the combination of admixtures (SP+VMA) may be obtained by adding 2% of red mud which is a waste material from aluminum industry.

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