A

PROJECT REPORT

ON

"APPLICATION OF INDUSTRIAL WASTE- IN THE MANUFACTURING OF SELF COMPACTING CONCRETE"

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARD OF B. E. CIVIL, DEGREE OF SHIVAJI UNIVERSITY, KOLHAPUR

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"Application of Industrial Waste in Self Compacting Concrete"

This work is being submitted for the award of degree of BACHELOR OF ENGINEERING in CIVIL ENGINEERING as a partial fulfillment of the requirement of the prescribed syllabus of Shivaji University, Kolhapur.

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SYNOPSIS

Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

Due to industrialization there is huge amount of red mud and foundry waste sand created. Aluminum is now consume during manufacture red mud which is used Red Mud and Foundry waste Sand are industrial waste and causing threat to environment so the reduce the cost of the construction also to make structure more durable, reduce problem of this material the project has been undertaken so that it can be used for construction fashion following points attempted.

1] To study the properties of foundry waste sand.

2) To blend to mix or to replace cement by different % by foundry waste sand.
3) To study properties of Red mud
4) To prepare the concrete by blending or by replacing the cement by Red mud
5) To study the comparativeness.

Facing lot more problem of foundry waste.

Very close to the kolhapur there is project of steel industry, sand used for the formation of mould when the molds are opened the waste sand is dumped for the filling the low lying areas while doing this the agriculture areas is converted into barren area Because there is no. space for the waste other than the land filling similar case is in case of Aluminum industry where red mud is concluded to be waste. Which contains lot amount of bauxite and that is why red mud is also dump in the nearby areas here it is causing big threat for the society and it is disturbing the eco system of the environment.

So it is the dire need to use this particular otherwise waste material for the constructive in such fashion in the case of concrete so that concrete which became cost effective as well as ecofriendly. And hence this project is attempted.

CHAPTER 1

INTRODUCTION TO SELF COMPACTING CONCRETE

The development of new technology in the material science is progressing rapidly. In last three decades, a lot of research was carried out throughout globe to improve the performance of concrete in terms of strength and durability qualities. Consequently concrete has no longer remained a construction material consisting of cement, aggregate, and water only, but has becomes an engineered custom tailored material with several new constituents to meet the specific needs 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. In recent years, a lot of research was carried out throughout the world to improve the performance of concrete in terms of its most important properties, i.e.

strength and durability. Concrete technology has under gone from macro to micro level study in the enhancement of strength and durability properties from 1980's onwards. Till 1980 the research study was focused only to flow ability of concrete, so as to enhance the strength however durability did not draw lot of attention of the concrete technologists. This type of study has resulted in the development of self compacting concrete (SCC), a much needed revolution in concrete industry. Self compacting concrete is highly engineered concrete with much higher fluidity without segregation and is capable of filling every corner of form work under its self weight only (Okamura 1997). Thus SCC eliminates the needs of vibration either external or internal for the compaction of the concrete without compromising its engineering properties.

This concrete was first developed in Japan in late 80's to combat the deterioration of concrete quality due to lack of skilled labours, along with problems at the corners regarding the homogeneity and compaction of cast in place concrete mainly with intricate structures so as to improve the durability of concrete and structures. After the development of SCC in Japan 1988, whole Europe started working on this unique noise free revolution in the field of construction industry. The last half of decade 1991-2000 has remained very active in the field of research in SCC in Europe. That is why, Europe has gone ahead of USA in publishing specifications and guidelines for self compacting concrete (EFNARC 2002). Now, all over the world, a lot of research is going on, so as to optimize the fluidity of concrete with its strength and durability properties without a drastical increase in the cost. The first North American conference on design and use of self-consolidation concrete was organized in November 2002. At present many researchers are working in numerous universities and government R&D organizations due to benefits of the use of this concrete. A very limited work is reported from India, where the future for concrete is very bright due to scarcity of skilled man power, non-mechanization of construction industry, abundant availability of construction materials available at very low cost. Therefore, it can be said that SCC is still quite unknown to many researchers, builders, ready mix concrete producers, academia etc.

Self compacting concrete is basically a concrete which is capable of flowing in to the formwork, without segregation, to fill uniformly and completely every corner of it by its own weight without any application of vibration or other energy during placing. There is no standard self-compacting concrete. There fore each self-compacting concrete has to be designed for the particular structure to be constructed. However working on the parameters which affect the basic properties of self-compacting concrete such as plastic viscosity, deformability, flowability and resistance to segregation, self-compacting concrete may be proportioned for almost any type of concrete structure.

To establish an appropriate mixture proportion for a self-compacting concrete the performance requirements must be defined taking into account the structural conditions such as shape, dimensions, reinforcement density and construction conditions. The construction conditions include methods of transporting, placing, finishing and curing. The specific requirement of self-compacting concrete is its capacity for self-compaction, without vibration, in the fresh state. Other performances such as strength and durability should be established as for normal concrete.

To meet the concrete performance requirements the following three types of self-compacting concretes are available.

a) **Powder type of self-compacting concrete:** This is proportioned to give the required self-compactability by reducing the water-powder (material<0.1mm) ratio and provide adequate segregation resistance. Super plasticizer and air entraining admixtures give the required deformability.

b) **Viscosity agent type self-compacting concrete:** This type is proportioned to provide self-compaction by the use of viscosity modifying admixture to provide segregation resistance. Super plasticizers and air entraining admixtures are used for obtaining the desired deformability.

c) **Combination type self-compacting concrete:** This type is proportioned so as to obtain self-compactability mainly by reducing the water powder ratio, as in the powder type, and a viscosity modifying admixture is added to reduce the quality fluctuations of the fresh concrete due to the variation of the surface moisture content of the aggregates and their gradations during the production. This facilitates the production control of the concrete.

CHAPTER 2

NEED FOR SCC

Now having a look over history of SCC, question arises that what is needed to go for SCC? So, here are some of the important aspects to go with SCC:

Foundry sand and red mud has pozzolanic properties hence increasing the binding properties and gives the better strength at the same time it reduces the cost problems. And also reduces the following problems.

1. Foundry waste dumping
2. Red mud dumping.

In dumping land become useless. It starts polluting the groundwater.

So it should be used in some constructive fashion. Which is going to cater in two ways Help in getting better quality of concrete.

For several years, the problem of the durability of concrete structures has been a major problem posed to engineers. To make durable concrete structures, sufficient compaction is required. Compaction for conventional concrete is done by vibrating.

Over vibration can easily cause segregation. In conventional concrete, it is difficult to ensure uniform material quality and good density in heavily reinforced locations.

If steel is not properly surrounded by concrete it leads to durability problems. This is the problem mainly with heavily reinforced sections where a very high congestion of reinforcement is seen. In this case, it becomes extremely difficult to compact the concrete. Then what can be done to avoid honeycombing?

The answer to the problem may be a type of concrete which can get compacted into every corner of form work and gap between steel, purely by means of its own weight and without the need for compaction. The SCC concept was required to overcome these difficulties.

The SCC concept can be stated as the concrete that meets special performance and uniformity requirements that cannot always be obtained by using conventional ingredients, normal mixing procedure and curing practices.The SCC is an engineered material consisting of cement, aggregates, water and admixtures with several new constituents like colloidal silica, pozzolanic materials, chemical admixtures to take care of specific requirements, such as, high-flowability, compressive strength, high workability, enhanced resistances to chemical or mechanical stresses, lower permeability, durability, resistance against segregation, and possibility under dense reinforcement conditions.

The properties, such as, fluidity and high resistance to segregation enables the placement of concrete without vibrations and with reduced labour, noise and much less wear and tear of equipment.

Use of SCC overcomes the problem of concrete placement in heavily reinforced sections and it helps to shorten construction period.

Self-compacting concrete is growing rapidly, especially in the pre-cast market where its advantages are rapidly understood and utilized.

Super plasticizer enhances deformability and with the reduction of water/powder segregation resistance is increased.

High deformability and high segregation resistance is obtained by limiting the amount of coarse aggregate.

However, the high dosage of super-plasticizer used for reduction of the liquid limit and for better workability, the high powder content as 'lubricant' for the coarse aggregates, as well as the use of viscosity-agents to , as well as the use of viscosity-agents to increase the viscosity of the concrete have to be taken into account.

Now in our project we are(have) used replacement of(done replacement of/replaced) cement by volume by red mud and foundry waste. Because of red mud and foundry waste are solid waste.

Also conventional method of waste red mud in ponds has often adverse environmental impact and during monsoon waste may be carried by runoff to the surface water course and a result of leaching may cause contamination of ground water, for further disposal of large quantities of red mud dumped, produces problem's of storage occupying of a lot of space at present about 60 million tones of red mud is generated annually worldwide which is not being recycled satisfactorily. The use of red mud due to higher compressive strength. To make light weight strong concrete. Typical red mud contains Cao, Sio_2, and Fe_2O_3

Foundry waste basically contents (contains) uniformly sized, and which having one or more organic binder.

If some new sand and binder is typically added to maintain the quality of casting and make up sand lost during operation.

Also it is used for purposes as substitute constituents in aggregate and as kiln feed in the manufacture of Portland cement. It having low absorption and non plastic nature. It mobiles leachable fraction, angle of shear resistance be in the range of 33 to 40 degree as compared to conventional sand.

Besides above following are the advantages of SCC:

1. **Improved Concrete Quality:**

- SCC yields homogeneous concrete in situations where the castings are difficult due to congested reinforcement, difficult access etc.
- SCC shows a good filling ability especially around reinforcement
- SCC is very well suited for special and technically demanding structures such as tunnel linings, as the possibility to compact the concrete is limited in the closed space between formwork and rock.
- Shows narrow variation in properties on site.
- Most suitable for concrete filled tubes (CFT) technology construction for high rise buildings.
- It ensures better quality of in-situ pile foundation.

2. **Environmental & Human Health Protection:**

- Reduces noise at sites, the pre cast factory, and neighborhood, hence, it is a silent concrete.
- Eliminates problems with blood circulation leading to "white fingers" caused by compacting equipment, hence called a healthy concrete.

- SCC gives noise protection in precast industry, by introducing no restrictive measures like ear protection, marked areas, safety instructions are necessary.
- Shortens the construction time by accelerating construction process, especially in pre cast industry.

3. **Economy & Time Reducing:**

- Its ease of placement improves the productivity and the cost saving through reduced equipment and labor equipment.
- Reduction in wear and tear of forms, therefore, it extends the service life of forms.
- Reduction in the number of worker. Normally one cum requires 1.5 man-hours; with SCC this is reduced to 0.35 man-hours.
- It reduces the consumption of resources and cost, even considering a higher price per cubic meter for the concrete. Okamura has reported that it is possible to reduce the overall bridge cost by 5-15%.
- Because of its high fluidity, this concrete does not need any vibrations so that it allows to save energy and ensure suitable cost in place.
- Reduction of expenses and manpower needed for patching finished precast elements.
- It can enable the concrete supplier to provide better consistency in delivering concrete, which reduces the interventions at the plants or job sites.

4. Construction with SCC is not affected by the skill of the workers, and shape and arrangement of reinforcing bars of the structures.
5. SCC use at construction sites reduces the chance of accident by reducing number of cables needed for the operation of compacting equipment, hence, reduces the workers compensation premiums.

6. It gives wide opportunity for the use of high-volumes of by products materials[15-18]
Such as fly ash, lime stone powder, quarry dust etc., (Yahia et al. 1999, Bouzoubaa, and Lachemi 2001, Persson 2002, Naik and Kumar 2003) since a higher volume of powder material is required for enhancing the cohesiveness and reducing the amount of superplasticizer and viscosity modifying agents.

In spite of above all, following are the some of the disadvantages of SCC:

DISADVANTAGES OF SCC

- The production of SCC places more stringent requirements on the selection of materials in comparison with conventional concrete.
- An uncontrolled variation of even 1% moisture content in the fine aggregate will have a much bigger impact on the rheology of SCC at very low W/C (~0.3) ratio. Proper stock pilling of aggregate, uniformity of moisture in the batching process, and good sampling practice are essential for SCC mixture,
- A change in the characteristics of a SCC mixture could be a warning sign for quality control and while a subjective judgment, may some times be more important than the quantitative parameters.
- The development of a SCC requires a large number of a trial batches. In addition to the laboratory trial batches, field size trial batches should be used to simulate the typical production conditions. Once a promising mixture has been established, further laboratory trial batches are required to quantify the characteristics of the mixture.

- SCC is costlier than conventional concrete initially based on concrete materials cost due to higher dosage of chemical admixtures, i.e. high range water reducer and viscosity enhancing admixture (VEA). Increase in material cost can be easily offset with improvement in productivity, reductions in vibration cost and maintenance and proper uses of mineral admixtures.

CHAPTER 3

3.1 INGRADIENTS OF SCC

SCC is something different than the conventional concrete or modification of conventional concrete it has similar ingredients such as Aggregate binder, however there blending is changed so as to get the advantage of self compactness:

3.1.1 Cement:- Generally Portland cement is used for SCC.

3.1.2Aggregates:- The maximum size of aggregate is generally limited to 20mm . Aggregate of size 10 mm is desirable for structures having congested reinforcement. Wherever possible size of aggregate higher than 20 mm could also be used. Well graded cubical or rounded aggregate are desirable. Aggregates should be of uniform quality with respect to shape and grading.

Fine aggregate can be natural or manufactured. The grading must be uniform throughout the work. The moisture content or absorption characteristics must be closely monitored as quality of SCC will be sensitive to such changes.

Particles smaller than 0.125mm i.e. 125 micron size are considered as FINES which contribute to the powder content.

3.1.3 Mixing water: - Ordinary potable water of normally pH 7 is used for mixing and curing the concrete specimen.

3.1.4 Admixtures for SCC:-An admixture is a material other than water, aggregates and cement and is added to the batch immediately before or during its mixing. Admixtures are used to improve or give special properties to concrete. The use of admixture should offer an improvement not economically attainable by adjusting the proportions of cement and aggregates and should not adversely affect any properties of the concrete.

The admixture consist chiefly of those which accelerate and those which retard hydration or setting of the cement, finely divided materials which improves workability, waterproofers, pigments, wetting, dispersing and air-entraining agents and pozzolanas.

Admixtures ranging from additions of chemicals to waste materials have been used to improve certain properties of concrete. The admixture is generally added in a relatively minute quantity. The degree of control must be higher to ensure that over dosages are unlikely to occur. Excess quantity of admixture may be detrimental to the properties of concrete. It may be mentioned here that concrete of poor quantity will not be converted to the good quality concrete by adding admixture.

As mentioned briefly before basic properties of self-compacting concrete are plastic viscosity, deformability, flowability and resistance to segregation. Several components of concrete are used provide and control these properties. It is important to have a stable equilibrium between the plastic viscosity and the yield stress in the self-compacting concrete. If this equilibrium is upset then we may have several problems such as, insufficient flow which will affect the filling ability leading to incomplete filling of the forms or, too low a plastic viscosity which may cause segregation. Fig.1 shows in qualitative way, the influence on the yield stress and plastic viscosity of the individual components of concrete.

The effect of each component may be summarized as follows:

- Variations in the powder content affect mainly the yield stress and some extent the plastic viscosity.
- Air content affects mainly the plastic viscosity.
- Water affects the yield stress and the plastic viscosity.
- Superplasticizer dosage affects mainly the yield stress and marginally the plastic viscosity.
- Viscosity modifying admixtures affect mainly the plastic viscosity.

The proposed viscosity modifying admixture is high molecular weight polyelectrolytes with high affinity to water. It imparts structure to the liquid phase of the mix by interaction of ionic functional groups with water and its own molecules. By binding the water to itself, the viscosity of the pore water is increased and, in addition, a three dimensional network is formed. The combination of both affects contribute to the effective control of the viscosity of the mix and prevent bleeding and segregation

The ionic interaction of the viscosity modifying admixture molecules are flexible and can be partially or completely broken down when a reactive low force (shear) is applied. The yield stress is slightly increased. At normal mixing or placing conditions (moderate shear), the interactions of the viscosity modifier mentioned above, guarantee the homogeneity of the mix and prevent the segregation. The balance between the yield stress and the plastic viscosity is the key to the appropriate self-compacting concrete rheology.

3.1.4.1 Chemical Admixtures:-

Superplasticizer

Glenium™ SKY 784 is used because it is essential component of SCC to provide necessary workability.

Viscosity Modifying Agent (VMA)

Other types may be incorporated as necessary, such as Glenium Sky is used for stability to improve freeze-thaw resistance, and retarders for Control of Setting.

3.1.4.2 Mineral Admixtures:

Fly Ash: - Fly ash in appropriate quantity may be added to improve the quality and durability of SCC.

Red Mud: - Red mud which is residual product of aluminum from bauxite can be used in appropriate quantity to improve the quality and durability of SCC.

Foundry waste sand: - Like Red mud, Foundry waste sand is also another substitute to cement in concrete. It when used in appropriate quantity help to improve the quality and durability of SCC.

CHAPTER 4

PROPERTIES OF SCC

4.1 Fresh SCC Properties

The 3 main properties of SCC in plastic state are

1. Filling ability (excellent deformability)
2. Passing ability (ability to pass reinforcement without blocking)
3. High resistance to segregation.

1. Filling ability

Self compacting concrete must be able to flow into all the spaces within the formwork under its own weight. This is related to workability, as measured by slump flow or Orimet test.

The filling ability or flowability is the property that characterizes the ability of the SCC of flowing into formwork and filling all space under its own weight, guaranteeing total covering of the reinforcement. The mechanisms that govern this property are high fluidity and cohesion of the mixture.

2. Passing ability

Self compacting concrete must flow through tight openings such as spaces between steel reinforcing bars under its own weight. The mix must not 'block' during placement.

The passing ability is the property that characterizes the ability of the SCC to pass between obstacles- gaps between reinforcement, holes, and narrow sections, without blocking. The mechanisms that govern this property are moderate viscosity of the paste and mortar, and the properties of the aggregates, principally, maximum size of the coarse aggregate. Stability or resistance to the segregation is the property that characterizes the ability of the SCC to avoid the segregation of its components, such as the coarse aggregates. Such a property provides uniformity of the mixture during transport, placement and consolidation.

The mechanisms that govern this property are the viscosity and cohesion of the mixture.

3. High Resistance to Segregation

Self compacting concrete must meet the requirements of 1 and 2 while its original composition remains uniform. The key properties must be maintained at adequate levels for the required period of time (e.g.20 min) after completion of mixing. It is property 2 the passing ability and property 3 resistance to segregation that constitute the major advance, form a merely super plasticized fresh mix which may be more fluid than self compacting concrete mix.

Latest developments in accordance with the objectives of the European SCC project aim to limit the admixtures used for general purpose SCC s to only one by using new types and combinations of polymers. Experience has shown that such an admixture may have to add to generate and maintain compacting concrete using less liable materials.

CHAPTER 5

SCC AND MEASUREMENT OF IT'S FLOW PROPERTIES

5.1. GENERAL

It is important to appreciate that none of the test methods for SCC has yet been standardized and the tests described are not yet perfected or standardized. The methods presented here are descriptions rather than fully detailed procedures. They are mainly ad-hoc methods, which have devised specifically for SCC. Hence for the validation of concrete these tests have not been considered.

In considering these tests, there are number of points which should be taken into account:

- One principal difficulty in devising such tests is that they have to assess three distinct, though related, properties of fresh SCC – its filling ability (flowability), its passing ability (free from blocking at reinforcement), and its resistance to segregation (stability). No single test is so far derived which can measure all the three properties.
- There is no clear relation between test results and performance on site.
- There is little precise data, therefore no clear guidance on compliance limits.
- Repetition of the tests is advised.
- The test methods and values are stated for maximum aggregate size upto 20 mm; different test values and/or different equipment dimensions will be appropriate for other aggregate sizes.

- Different test values may be appropriate for concrete being placed in vertical and horizontal elements.
- Similarly, different test values may be appropriate for different reinforcement densities.

5.2. TEST METHODS

5.2.1 SLUMP FLOW TEST.

Introduction:

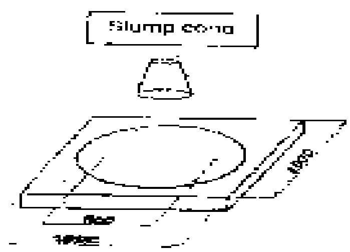
The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. It was first developed in Japan for use in assessment of underwater concrete. The test method is based on the test method for determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete.

Assessment of test:

This is simple, rapid test procedure, though two people are needed if the T50 time is to be measured. It can be used on site, though 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. It gives no indication of the ability of the concrete to pass between reinforcement without blocking, but may give some indication of resistance to segregation. It can be argued that the completely free flow, unrestrained by any boundaries, is not representative of what happens in practice in concrete construction, but the test can be profitably be used to assess the consistency of supply of ready-mixed concrete to a site from load to load.

Equipment.

The apparatus is shown in figure.



Mould in the shape of a truncated cone with the internal dimensions 200mm at the base, 100mm diameter at the top and a height of 300mm, confirming to EN12350-2

Base plate of a stiff non-absorbing material, at least 700mm square, marked with a circle marking the central location for the slump cone, and a further concentric circle of 500mm diameter. The apparatus usually required for this test are as under-

Trowel.

Scoop.

Ruler.

Stopwatch

Procedure:

- About 6 liter of concrete is needed to perform the test, sampled normally.
- Moisten the base plate and inside of slump cone.
- Place base plate on level stable ground and the slump cone centrally on the base plate and hold down firmly.
- Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with trowel.
- Remove any surplus concrete from around the base of the cone.
- Raise the cone vertically and allow the concrete to flow out freely.

- Simultaneously, start the stopwatch and record the time taken for the concrete to reach the 500mm spread circle. (This is T50 time).
- Measure the final diameter of the concrete in two perpendicular directions.
- Calculate the average of the two measured diameters. (This is slump flow in mm).

5.2.2 U box test method

Introduction

The test was developed by the Technology Research Centre of the Taisei Corporation in Japan. Sometimes the apparatus is called a "box shaped" test. The test is used to measure the filling ability of self-compacting concrete. The apparatus consists of a vessel divided by a middle wall into two compartments, shown by R1 and R2 in Fig.

An operating with a sliding gate is fitted between the two sections. Reinforcing bars with nominal diameters of 13mm are installed at the gate with center-to-centre spacing of 50mm.This creates a clear spacing of 35mm between the bars. The left hand section is filled with about 20 liter of concrete then the gate lifted and concrete flows upward into the other section. The height of the concrete in both sections is measured.

Assessment of test.

This is a simple test to conduct, but the equipment may be difficult to construct. It provides a good direct assessment of filling ability-this is literally what the concrete has to do-modified by an unmeasured requirement for passing ability. The 35 mm gap between the sections of reinforcement may be considered too close. The question remains open of what filling height less than 30 cm. is still acceptable

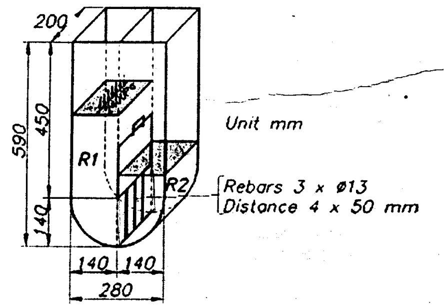


Fig. 5.2 – Box Test

Equipment.

U box of a stiff non absorbing material.

Trowel

Scoop

Stop watch.

Procedure

- About 20 liter of concrete is needed to perform the test, sampled normally.
- Set the apparatus level on firm ground, ensure that the sliding gate can open freely and then close it.
- Moisten the inside surfaces of the apparatus, remove any surplus water.
- Fill the one compartment of the apparatus with the concrete sample.
- Leave it to stand for 1 minute,
- Lift the sliding gate and allow the concrete to flow out into the other compartment.
- After the concrete has come to rest, measure the height of the concrete in the compartment has been filled, in two places and calculate the mean (H1). Measure also the height in the other compartment (H2)

- Calculate H1-H2, the filling height.
- The whole test has to perform within 5 minutes.

5.2.3 L box test method

Introduction

This test, based on a Japanese design for underwater concrete, has been described by Peterson. The test assesses the flow of the concrete, and also the extent to which it is subjected to blocking by reinforcement. The apparatus is shown in figure.

The apparatus consists of a rectangular section box in the shape of an 'L', with a vertical and horizontal section, separated by a moveable gate, in front of which vertical lengths of reinforcement bars are fitted.

The vertical section is filled with concrete, and then the gate lifted to let the concrete flow into the horizontal section. When the flow has stopped, the height of the concrete at the end of the horizontal section is expressed as a proportion of that remaining in the vertical section (H2/H1 in the diagram). It indicates the slope of the concrete when at rest. This is an indication passing ability, or the degree to which the passage of concrete through the bars is restricted.

The horizontal section of the box can be marked at 200 mm and 400 mm from the gate and the times taken to reach these points measured. These are known as T20 andT40 times and are an indication for the filling ability.

The sections of bar can be of different diameters and spaced at different intervals: in accordance with normal reinforcement considerations, 3x the maximum aggregate size might be appropriate.

The bars can principally be set at any spacing to impose a more or less sever test of the passing ability of the concrete.

Assessment of test.

This is widely is used test, suitable for laboratory, and perhaps site use. It assesses filling and passing ability of SCC, and serious lack of stability (segregation) can be detected visually. Segregation may also be detected by subsequently sawing and inspecting sections of the concrete in the horizontal section. Unfortunately there is no agreement on materials, dimensions, or reinforcing bar arrangement, so it is difficult to compare test results. There is no evidence of what effect the wall of the apparatus and the consequent 'wall effect' might have on concrete flow, but this arrangement does, to some extent, replicate what happens to concrete on site when it is confined within formwork.

Two operators are required if times are measured, and a degree of operator error is inevitable.

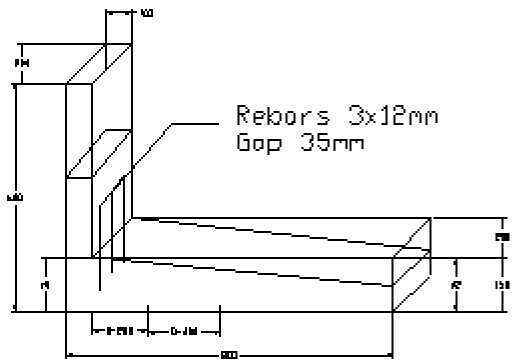
Equipment.

L box of a stiff non absorbing material

Trowel

Scoop

Stop watch



Procedure

- About 14 liter of concrete is needed to perform the test, sampled normally.
- Set the apparatus level on firm ground, ensure that the sliding gate can open freely and close it.
- Moisten the inside surfaces of the apparatus, remove any surplus water
- Fill the vertical section of the apparatus with the concrete sample.
- Leave it to stand for 1 minute.
- Lift the sliding gate and allow the concrete to flow out into the horizontal section.
- Simultaneously, start the stopwatch and record the times taken for the concrete to reach the 200 and 400 mm marks.
- When the concrete stops flowing, the distance "H1" and "H2" are measured.
- Calculate H2/H1, the **Blocking Ratio**.
- The whole test has to be performed within 5 minutes.

5.2.4 Orimet Test

Introduction

The Orimet was developed at the University of Paisley as a method for assessment of highly workable, flowing fresh concrete mixes on construction sites. The equipment is shown in figure.

The test is based on the principle of an orifice rheometer. The Orimet consists of a vertical casting pipe fitted with a changeable inverted cone shaped orifice at its lower, discharge, end, with a quick – release trap door to close the orifice. Usually the orifice has an 80 mm internal diameter which is appropriate for assessment of concrete mixes of aggregate size not exceeding 20 mm. Orifices of other sizes, usually from 70 mm to 90 mm in diameter, can be fitted instead.

Operation consists simply of filling the Orimet with concrete then opening the trap door and measuring the time taken for light to appear at the bottom of the pipe(when viewed from above).

Assessment of test.

This test is able to simulate the flow of fresh concrete during actual placing on sites. It is rapid test, and the equipment is simple and easily maintained. The test has the useful characteristic of being capable of differentiation between highly workable, flowing mixes, and might therefore useful for compliance testing of successive loads on site. The timing procedure, however, may be subjected to error, and ideally requires two people.

Equipment.

Orimet device of a stiff non-absorbing material

Bucket (+/- 10 liter)

Trowel

Scoop

Stopwatch

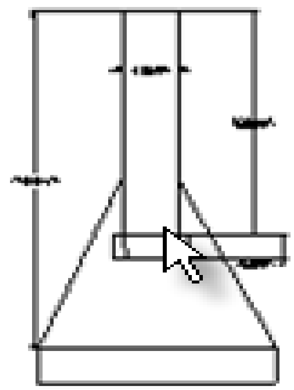


Fig.5.4 Orimet Test

Procedure

- About 8 liter of concrete is needed to perform the test, sampled normally.
- Set the Orimet on firm ground.
- Moisten the inside surfaces of the casting pipe and the orifice.
- Keep the trap door open to allow any surplus water to drain.
- Close the trap door and place a bucket underneath.
- Fill the apparatus completely with concrete without compacting or tapping, simply strike off the concrete level with the top with the trowel.
- Open the trap door within 10 seconds after filling and allow the concrete to flow out under gravity.
- Start the stopwatch when the trap door is opened, and record the time for the discharge to complete9the flow time). This is taken to be when light is seen from above through the orifice section.
- The whole test has to be performed within 5 minutes.

5.2.5 V Funnel Test and V Funnel test at T5 minutes

Introduction

The test was developed in Japan and used Ozawa et al. The equipment consists of a V-shaped tunnel, shown in fig. An alternative type of V-funnel, the O funnel, with a circular section is also used in Japan.

The described V-funnel test is used to determine the filling ability (flow ability) of the concrete with a maximum aggregate size of 20mm.The funnel is filled with about 12 liter of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow time will increase significantly.

Assessment of test

Though the test is designed to measure flow ability, the result is affected by concrete properties other than flow. The inverted cone shape will cause any liability of the concrete to block to be reflected in the result – if, for example there is too much coarse aggregate. High flow time can also be associated with low deformability due to high paste viscosity, and with high inter-particle friction.

While the apparatus is simple, the effect of the angle of the funnel and the wall effect on the flow of concrete are not clear.

Equipment.

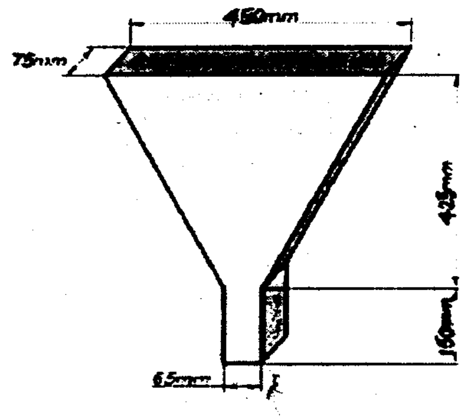
V-funnel

Bucket (+/- 12 liter)

Trowel

Scoop

Stopwatch



Procedure of flow time

- About 12 liter of concrete is needed to perform the test, sampled normally.
- Set the V-funnel on firm ground
- Moisten the inside surfaces of the funnel.
- Keep the trap door open to allow any surplus water to drain.
- Close the trap door and place a bucket underneath.
- Fill the apparatus completely with concrete without compacting or tamping; simply strike off the concrete level with the top with the trowel.
- Open within 10 sec after filling the trap door and allow the concrete to flow out under gravity.
- Start the stopwatch when the trap door is opened, and record the time for the discharge to complete (the flow time). This is taken to be when light is seen from above through the funnel.
- The whole test has to be performed within 5 minutes.

Procedure of flow time at T5 minutes

- Do not clean or moisten the inside surfaces of the funnel again.

- Close the trap door and refill the v-funnel immediately after measuring the flow time.
- Place a bucket underneath.
- Fill the apparatus completely with concrete without compacting or tapping, simply strike off the concrete level with the top with the trowel.
- Open the trap door 5 minutes after the second fill of the funnel and allow the concrete to flow out under gravity.
- Simultaneously start the stopwatch when the trap door is opened, and record the time for the discharge to complete (the flow time T 5minutes).
- This is taken to be when light is seen from above through the funnel.

5.2.6. J-RING TEST

Introduction:

The principle of J Ring test may be Japanese, but no references are known. The J Ring test itself has been developed at the University of Paisley. The test is used to determine the passing ability of the concrete. The equipment consists of a rectangular section (30mmx25mm) open steel ring, drilled vertically with holes to accept threaded sections of reinforcement bar. These sections of bar can be of different diameters and spaced at different intervals in accordance with normal reinforcement consideration, 3x the maximum aggregate size might be appropriate. The diameter of the ring of vertical bars is 300mm, and the height 100mm.

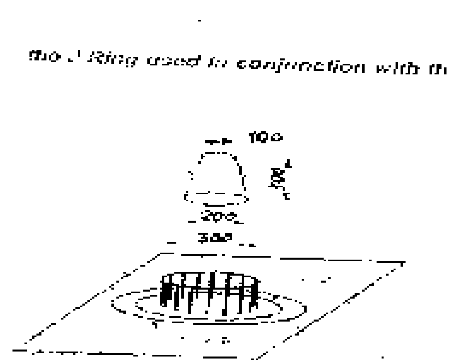
The J Ring can be used in conjunction with the slump flow, the Orimet test or even with the V-funnel. These combinations test the flowing ability and (the contribution of J ring) the passing ability of the concrete. The Orimet time and/or slump flow spread are measured are usual to assess flow characteristics. The J ring bars can principally be set at any spacing to impose a more or less severe test of the passing ability of the concrete. After the test, the difference in height between the concrete inside and that just outside the J ring is measured. This is an indication of passing ability, or the degree to which the passage of concrete through the bars is restricted.

Assessment of test:

These combinations of tests are considered to have great potential, though there is no general view on exactly how results should be interpreted. There are number of options- for instance it may be instructive to compare the slump-flow/J Ring spread with the unrestricted slump flow: to what extent is it reduced?

Like the slump flow test, these combinations have the disadvantage of being unconfined, and therefore do not reflect the way concrete is placed and moves in practice. The Orimet option has the advantage of being dynamic test, also reflecting placement in practice, though it suffers from requiring two operators.

Equipment:



Mould, without foot pieces, in the shape of a truncated cone with the internal dimensions 200mm diameter at the base, 100mm diameter at the top and a height of 300mm.

Base plate of a stiff none absorbing material, at least 700mm square, marked with a circle showing the central location for the slump cone, and a further concentric circle of 500mm diameter.

Trowel.

Scoop.

Ruler.

J ring a rectangular section (30mmx25mm) open steel ring, drilled with holes. In the holes can be screwed threaded sections of reinforcement bar (length 100mm, diameter 10mm, and spacing 48 +/- 2mm)

Procedure

- About 6 liter of concrete is needed to perform the test, sampled normally.
- Moisten the base plate and inside of slump cone,
- Place base-plate on level stable ground.
- Place the J ring centrally on the base plate and the slump-cone centrally inside it and hold down firmly.
- Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with the trowel.
- Remove any surplus concrete from around the base of the cone.
- Raise the cone vertically and allow the concrete to flow out freely.
- Measure the final diameter of the concrete in two perpendicular directions.
- Calculate the average of the two measured diameters (in mm).
- Measure the difference in height between the concrete just inside the bars and that just outside the bars.

- Calculate the average of the difference in height at four locations (in mm).
- Note any border of mortar or cement paste without coarse aggregate at the edge of the pool of concrete.

Tests to be fulfilled to qualify as SCC:

Though there are many test methods to confirm the qualification to SCC, as mentioned above, no single method or combination of methods have obtained universal acceptance.

One cannot declare a mix of SCC by only looking at the slump flow. For example, a mix with slump of even 650mm or more may not be an SCC, as it may, some times be susceptible to blocking and segregation as well. For example [6], in japan, the slump flow test, V-funnel test, and the box shaped test (or U-box test) are used for the purpose of SCC acceptance. In Sweden slump flow and L-box test are used.

So any mix aimed to be SCC must be tested for at least three workability tests. These can be a combination of any of the following, in addition to slump flow test, V-funnel test, L-box blocking ratio test etc.

Table 5.1: Suggested value of acceptance for different test methods of SCC

Sl No.	Methods	Unit	Typical range of values	
			Minimum	Maximum
1	Slump flow by Abrams cone	mm	600	800
2	T_{50cm} slump flow	sec	2	5
3	J-ring	mm	0	10

4	V-funnel	sec	6	12
5	Time increase, V-funnel at $T_{5minutes}$	sec	0	+3
6	L-box	(h_2/h_1)	0.8	1.0
7	U-box	h_2-h_1	0	30
8	Fill-box	%	90	100
9	GTM screen stability test	%	0	15

CHAPTER 6

RED MUD

Red mud is one of the major solid wastes coming from Bayer process of alumina production. At present about 3 million tones of red mud is generated annually, which is not being disposed or recycled satisfactorily.

The conventional method of disposal of red mud in ponds has often adverse environmental impact and during monsoon, the wastes may be carried by runoff to the surface waters course and a result of leaching may cause contamination of ground water; further disposal of large quantities of red mud dumped, poses increasing problems of storage occupying a lot of space.

Inspite of the fact that the aluminium production plant produces a great quantity of red mud, such plants are producing aluminium at an increasing rate of 1% per annum since last decade.

Red mud is predominantly, a finely powdered mud. It adversely effects the air, land & water environment of surrounding area. With this reference it is desired and greatly needed to utilize the red mud in some way, or recycled, which otherwise is dumped in huge amounts any where in nearby vicinity of the plant.

WHAT IS RED MUD?

Red mud is the iron rich residue from the digestion of bauxite. It is one of the major solid waste coming from Bayer process of alumina production. In general, about 2-4 tones of bauxite is required for production of each tone of alumina (Al_2O_3) & about one tone red mud is generated. Since the red mud is generated in bulk it has to be stored in large confined & impervious ponds, therefore the bauxite refining is gradually encircled by the" storage ponds. At present about 60 million tones of red mud is generated annually world wide which is not being disposed or recycled satisfactorily.

In the most common method of dumping that is the impoundment on land in a diked impervious area called ponds. The mud slurry is pumped to the ponds situated close to the bauxite refinery .The mud accumulates

& settles in the pond in due course of time. In order to reduce alkali pollution through red mud a number of methods using drainage decantation & special technique such as dry disposal have been developed. Dry disposal is expensive & not yet installed any where in India. However the dry disposal can only conserve the land to a considerable extent, but the conservation of minerals remains unattempted.

EFFECT OF RED MUD ON ENVIRONMENT

In the last decade, the production of aluminium inspite of some stragnancy and even set back periods, has shown a steady rise of about 1%.

The ecological consequences of aluminium production are well known; land devastation by bauxite exploitation usurpation of big land areas by erection of disposal sites for red mud, threatening of surface & underground water & air pollution by waste gases from aluminum electrolysis plant & rolling mills. The degree of damage inflicted to ground water & air during the single production stages from bauxite to aluminium depends on a couple of tacts of which those connected with the alumina winning & red mud disposal.

POSSIBLE IMPACT ON ENVIRONMENT

The impact of red mud impoundment can be manifest in several ways, the biggest danger is water pollution. Ground usurpation especially in case of cultivable soil or densly populated regions disturbance of landscape harmany can sometimes assume trouble-some relations. There is some danger, too by air pollution by dust spreading from dry parts of impoundment. In order to prevent possible damages depending on the peculiarities of each disposal site already in the planning stage & then during the exploitation & after its end it is necessary to make efforts for avoiding of damages or reducing them to least amount.

GROUND WATER POLLUTION.

After rinsing & compacting, the red mud is transported to the impoundment usually with a content of 3.5 to 5% even upto 7% Na-oxide. It was found that the water with such content some times rises the alkalinity of the underground water so that pH index can become larger than 11.5 what was registered by piezometer located around the sedimentation basins at Podgorical. In the wells from which water is supplied to the surrounding population the pH of water is 10.5.

ENVIRONMENTAL RISK OF STORING RED MUD

Storage of red mud has a few inherent problems. Water stored in raised up dyke System may over flow or cause change breach of the dykes during heavy rains and high gales. Such breaches of the dykes have been found to occur in red mud ponds causing surface pollution and pollution of the nearby river, despite close vigil on the dykes. With water stored at unnatural high level compared to the surroundings there has been induction of caustic seepage to nearby unused wells, confirming possible pollution of subsoil water system by seepage. In the red mud pond classification of red mud particles takes place during settling. The finer particles being on top consequently the pond with exposed surface of dry mud becomes source of dust nuisance to the adjoining locality during dry seasons. The people of the locality near the pond have to bear the nuisance of dust which also carries fine particles of soda & other residual Bayer chemicals.

UTILIZATION OF RED MUD

In order to protect the complete ecosystem, which is exposed to the impact of the discharged red mud, it is indispensable to utilize in mass quantity.

Red mud has been used for different commercial purposes. Some of the commercial uses of red mud in different fields are as follows:-

CONSTRUCTION INDUSTRY

Cement, building blocks, or bricks to a lesser extent lightweight aggregates and rubble are potential large volume applications where red mud might be used. It is expected that a minimum pretreatment (dewatering) would be required for use of red mud in bricks
and- lightweight aggregates. For use in cement and as a rubber filler, acid washing would be required & complete drying and powdering would be necessary for filler application. Cement and brick manufacturing plants are fairly, widely distributed throughout the United States, with light weight aggregate plants being less numerous. There is potential for such plants being located near the source of red mud which is considered necessary to minimize transportation costs.

Other application for red mud, such as application in exothermic mixes as a scouring or polishing medium or as a drilling mud, are considered of low potential for either technical, economic or low-volume reasons.

RED MUD AS CONCRETE MATERIAL

Red mud has been used to produce synthetic dense aggregate in U.S.A & Japan (U.K. patent 1976) by pelletizing firing at temperature of 1200-1316 °C. The compressive, tensile and bending strengths of concrete made with red mud aggregate have been found to be considerably higher than those of concrete made with river gravel.

Light weight aggregates have been manufactured from mixture of red mud and various other materials like fly ash, blast furnace slag etc. Lightweight aggregate is used with cement to make a lightweight strong concrete.

BRICKS FROM RED MUD

Bricks made with addition of 40 to 50 % red mud to the alluvial soils on firing at 1000 to 1020 °C gives compressee strength of 20.0 to 25.0 kg/cm^2. These bricks are golden yellow in colour and are better suited as facing bricks. The bricks so produced do not show any efflorescence & water absorption.

- Pleasing colour & colour shades depending on content.
- Improved dry strength for handling before firing.
- Lower firing temperature & thus fuel or energy savings.

PLASTIC & RESIN FILLERS

Though numerous material can be used as fillers it was considered significant that red mud as a filler in rubber gave a rupture strength higher than all other fillers excepting carbon black. It should thus be a suitable substitute for carbon black in some applications. Thus use as a filler requires that the red mud slurry be acid washed, dried & powdered.

RED MUD PLASTIC

The recent development of a new material; red mud plastic (RMP) made by combining polymer (PVC) and red mud waste, aims at overcoming the negative qualities of PVC, while preserving & enhancing its advantage.

CEMENT

Oxides of calcium, aluminium, silicon & to a minor extent iron make up the major portion of the cement. A typical red mud contains CaO, SiO_2 and Fe_2O_3 in the range around 5 to 10 percent, 2 to 10 percent and 40 to 50 percent, respectively. Thus, its potential use as a raw material for cement manufacture has been of interest. However, the amount of red mud that might be incorporated directly as a raw material would be low because it contains a relatively high iron oxide.
Addition of 15 percent of treated red mud to portland cement were reported to increase strength & affect settling time. Greater additions decreases the strength.

METALLURGICAL

Literature references on metal recovery total 140 articles. It is seen that approximately half the reference pertain to recovery of iron.

Recovery of titania and additional alumina is also proposed. The higher value metals such as niobium, gallium and vanadium have received attention but are present in such low concentration that their commercial recovery has not been tried.

Several processes have been developed to recover iron from the red mud residues. One method is the carbon lime soda sinter process which can be applied either to ore or to the red mud. In this process the iron is reduced & recovered by magnetic separation from the waste residues after alumina leaching. A U.S. patent has been issued describing the application of fluidized bed to produce sponge granted for a process to treat high iron content bauxite ores involving reductive roasting with magnetic separation of iron form the leach residues.

Direct electric arc smelting of the red mud has been proposed for recovery of iron from high-iron content bauxites. In this case, pig iron can be produced with upto 98 percent recovery of iron value in the bauxite. The slag from the smelting operation can also be further treated to recover up to 84 percent of the alumina lost by the Bayer process. This particular process was recently advocated by the McDowell Wellmen Engineering Company as being both technically & economically feasible and they have developed the process through a pilot scale stage. The economics assume thai the pig iron or steel would be produced near the bauxite refining plant to take advantage of low cost iron units in the red mud.

ALUMINA & TITANIA RECOVERY

Alumina & titania recovery from the red mud are only of secondary interest .However, if the mud is smelted from iron recovery, the slag from the smelting operation can be leached with sodium carbonate solution to recover most of the alumina values. Titania can be recovered by leaching the residue of carbonate leach with sulfuric acid. The recovery of titanium from the red nuid is technically feasible but the complicated processing is too costly to compare with the recovery from natural titanuim ores such as ilmenite and rutile.

OTHER METALS

Various other rare metals such as gallium, vanadium & scandium can be recovered from the red mud residues or at various stages in the Bayer process. It has been reported that gallium recovery is economical by direct electrolysis of caustic aluminate liquors. Several studies have also been conducted on vanadium recovery. In one method a vanadium slag is separated from the pig iron mud. In another method, liquid-liquid extraction by amines is used on the leach liquor from the Bayer process to recover vanadium.

FOUNDRY WASTE SAND

ORIGIN

Foundry sand consists primarily of clean, uniformly sized, high-quality silica sand or lake sand that is bonded to form molds for ferrous (iron and steel) and nonferrous (copper, aluminum, brass) metal castings. Although these sands are clean prior to use, after casting they may contain Ferrous (iron and steel) industries account for approximately 95 percent of foundry sand used for castings. The automotive industry and its parts suppliers are the major generators of foundry sand.

The most common casting process used in the foundry industry is the sand cast system. Virtually all sand cast molds for ferrous castings are of the green sand type. Green sand consists of high-quality silica sand, about 10 percent bentonite clay (as the binder), 2 to 5 percent water and about 5 percent sea coal (a carbonaceous mold additive to improve casting finish). The type of metal being cast determines which additives and what gradation of sand is used. The green sand used in the process constitutes upwards of 90 percent of the molding materials used.(1)

In addition to green sand molds, chemically bonded sand cast systems are also used. These systems involve the use of one or more organic binders (usually proprietary) in conjunction with catalysts and different hardening/setting procedures. Foundry sand makes up about 97 percent of this mixture. Chemically bonded systems are most often used for "cores" (used to produce cavities that are not practical to produce by normal molding operations) and for molds for nonferrous castings.

The annual generation of foundry waste (including dust and spent foundry sand) in the United States is believed to range from 9 to 13.6 million metric tons (10 to 15 million tons).(2) Typically, about 1 ton of foundry sand is required for each ton of iron or steel casting produced.

CURRENT MANAGEMENT OPTIONS

Recycling

In typical foundry processes, sand from collapsed molds or cores can be reclaimed and reused. A simplified diagram depicting the flow of sand in a typical green sand molding system is presented in Figure 6.1. Some new sand and binder is typically added to maintain the quality of the casting and to make up for sand lost during normal operations.(3)

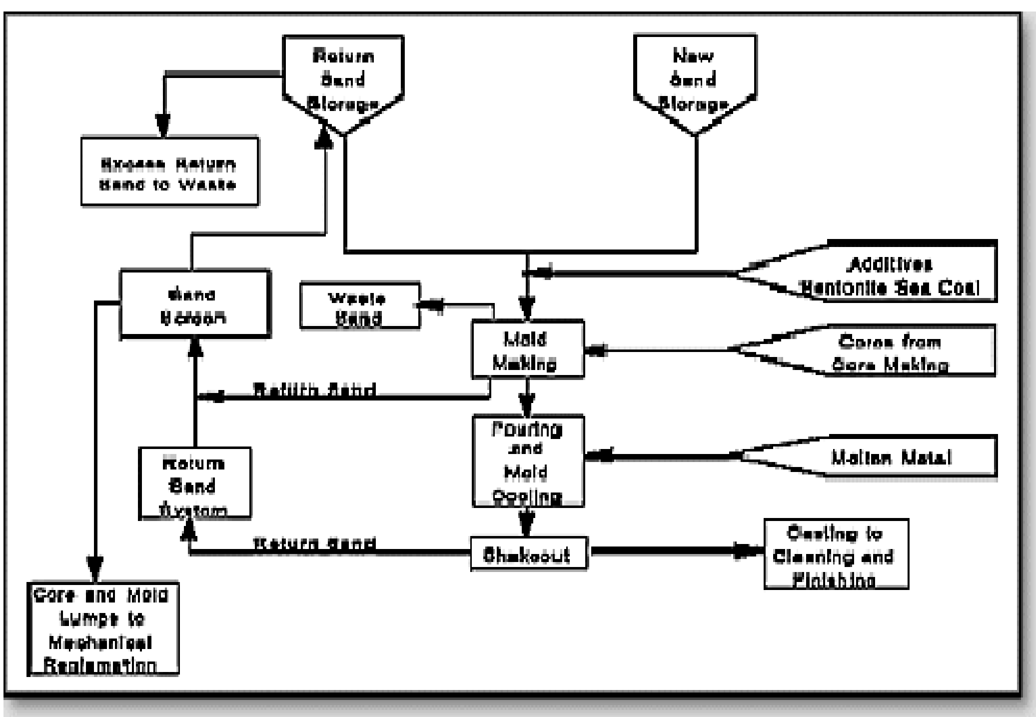


Figure 6-1. Simplified schematic of green sand mold system.

Little information is available regarding the amount of foundry sand that is used for purposes other than in-plant reclamation, but spent foundry sand has been used as a fine aggregate substitute in construction applications and as kiln feed in the manufacture of Portland cement.

Disposal

Most of the spent foundry sand from green sand operations is landfilled, sometimes being used as a supplemental cover material at landfill sites.

MATERIAL PROPERTIES

Chemical Properties

Spent foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder (bentonite, sea coal, resins) and dust. Table 7-2 lists the chemical composition of a typical sample of spent foundry sand as determined by x-ray fluorescence.

Silica sand is hydrophilic and consequently attracts water to its surface. This property could lead to moisture-accelerated damage and associated stripping problems in an asphalt pavement. Antistripping additives may be required to counteract such problems.

Depending on the binder and type of metal cast, the pH of spent foundry sand can vary from approximately 4 to 8.(7) It has been reported that some spent foundry sands can be corrosive to metals.(5)

Because of the presence of phenols in foundry sand, there is some concern that precipitation percolating through stockpiles could mobilize leachable fractions, resulting in phenol discharges into surface or ground water supplies. Foundry sand sources and stockpiles must be monitored to assess the need to establish controls for potential phenol discharges.(4,6,7)

Table 6.1 Foundry sand sample chemical oxide composition, %. (1)

Constituent	Value (%)
SiO_2	87.91
Al_2O_3	4.70
Fe_2O_3	0.94
CaO	0.14
MgO	0.30
Na_2O	0.19
K_2O	0.25

CHAPTER 7

AIM OF EXPERIMENTATION

Self compacting concrete is a high performance concrete that can flow under its own weight to completely fill the formwork without segregation and self consolidate without any mechanical vibrations, even in the presence of congested reinforcements. Such concrete can accelerate placement and reduce labour required for consolidation and finishing.

In other words, "Self compacting concrete is a highly flowable, yet stable concrete that can spread readily into place and fill the formwork without any consolidation and without undergoing any significance separation".

Self compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The fluidity and segregation resistance of self compacting concrete ensures a high level of homogeneity, minimum concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure.

In addition following are some more points, which makes self compacting concrete more reliable in concreting works-

- Improved compaction around congested reinforcement.
- Potential to enhance durability through improved compaction of cover concrete.
- Improved buildability (e.g.: concreting deep elements in single lifts).

- Elimination of vibration leading to environmental, health and safety benefits.
- Quicker and easier concrete placement.

The field of concrete technology has seen miraculous changes due to the invention of various admixtures. The admixtures modify the properties of fresh concrete and offer many advantages to the user.

The main aim of this experimentation is to find out the effect of addition of red mud, which is a waste product from the aluminium industries, and foundry waste sand, which is a waste product from foundry, on the properties of self compacting concrete containing two admixtures. In this experimentation combinations of admixtures which is taken-.

Super plasticizer + VMA.

The flow characteristics and strength characteristics of self compacting concrete produced from different waste material and different percentages of that material are found. The different percentages of red mud used in experimentation are 0%, 1%, 2%, 3%, 4%, 5%, 6%, 7% and 8% and The different percentages foundry waste used in experimentation are 2%, 4%, 6%, 8%.

CHAPTER 8

EXPERIMENTAL PROCEDURE AND TEST RESULTS

8.1. GENERAL:

The main aim of this experimentation is to find out the effect of addition of red mud, which is a waste product from the aluminium industries, and foundry waste sand, which is a waste product from foundry, on the properties of self compacting concrete containing three admixtures. In this experimentation combinations of admixtures which is taken-.

Super plasticizer + VMA.

The flow characteristics and strength characteristics of self compacting concrete produced from different waste material and different percentages of that material are found. The different percentages of red mud used in experimentation are 0%, 1%, 2%, 3%, 4%, 5%, 6%, 7% and 8% and The different percentages foundry waste used in experimentation are 2%, 4%, 6%, 8%, 10%.

8.2. MATERIALS USED:

In the experimentation PPC was used. Locally available sand and coarse aggregates were used. The specific gravity of sand was found to be 2.55 and was Zone II sand. The specific gravity of coarse aggregates used was found to be 2.61. The coarse aggregates were 12mm and down size. The mix proportion adopted in the experimentation was 1:1:0.5 with a water/binder ratio 0.31. The flyash/cement ratio used was 1:3.5.

The flyash used in the experimentation is pozzocrete 60 was obtained from DIRK INDIA PRIVATE LTD. The chemical composition of flyash is shown in the table 8.2a.

Table 8.2a: Chemical composition of flyash.

Oxides	Percentages
SiO_2+Al_2O_3+ Fe_2O_2	70 min
SiO_2	35 min
Reactive silica	20 min
MgO	05 max
SO_3	03 max
Na_2O	1.5 max
Total chlorides	0.05 max

The red mud used in the experimentation was obtained from HINDALCO, Belgaum. The fineness of red mud was found to be 35 m^2/gm with particle size of 75 microns and its density is found to be 3gm/cc. The chemical composition of red mud is shown in table 8.2b.

Table 8.2b: Chemical composition of red mud

Chemical composition	Bauxite residue (%)	Typical values worldwide (%)
Fe_2O_3	51	30-60
Al_2O_3	15	10-20
C_aO	13	2-8
SiO_2	10	3-50
Na_2O	0.20	2-10

The foundry waste sand used in this experimentation was obtained from KOL

Table 8.2c. Chemical composition of Foundry sand

Constituent	Percentage (%)
SiO_2	87.91
Al_2O_3	4.70
Fe_2O_3	0.94
CaO	0.14
MgO	0.30
Na_2O	0.19
K_2O	0.25

A viscosity modifying admixture called GLENIUM STREAM2 was used to induce the flow without segregation. GLENIUM STREAM 2 is dosed at the rate of 50 to 500ml/100Kg of cementitious material. Other dosages may be recommended in special cases according to specific job site conditions. GLENIUM STREAM 2 consists of a mixture of water soluble polymers which is absorbed on to the surface of cement granules thereby changing the viscosity of water and influencing the rheological properties of the mix. It also resist the segregation due aggregation of the polymer chains when the concrete is not moving. GLENIUM STREAM 2 is a chloride free admixture. It should be added to the concrete after all the other components of the mix. This is particularly important in order to obtain maximum efficiency. It is a colourless free flowing liquid and manufactured by BASF Construction Chemicals (India) Pvt. Ltd., Pune.

A high performance concrete superplasticizer based on modified polycarboxylic ether was used in the experimentation. The trade name of the superplasticizer is GLENIUM™ SKY 784. It greatly improves the cement dispersion. It is manufactured by BASF Construction Chemicals (India) Pvt. Ltd., Pune. Optimum dosage of GLENIUM™ SKY 784 should be determined in trial mixes. As a guide a dosage range of 300ml to 1200ml per 100kg of cementitious material is normally recommended.

8.3. EXPERIMENTAL PROCEDURE

The cement, sand and coarse aggregates were weighed according to the mix proportion 1:1:0.5. The flyash and cement proportion used in the experimentation was 1:3.5. To this dry mix the required quantity of red mud (0%,1%, 2%, 3%, 4%, 5%, 6%, 7% and 8%) was added and homogenously mixed. To this dry mix the required quantity of water was added and thoroughly mixed. To this the superplasticizer was added at the rate of 700ml/100Kg of cementitious material and mixed intimately. Now the viscosity modifying agent (VMA) was added at the rate of 100ml/100Kg of cementitious material. The entire mix was thoroughly mixed once again. At this stage, almost the concrete was in a flowable state. Now, the flow characteristic experiments for self compacting concrete like slump flow test, orimet test, V-funnel test, L-box test and U- box test were conducted.

After conducting the flow characteristic experiments the concrete mix was poured in the moulds required for the strength assessment. After pouring the concrete into the moulds, no compaction was given either through vibrated or through hand compaction. Even the concrete did not require any finishing operation. After 24 hours of casting, the specimens were demoulded and were transferred to the curing tank wherein they were allowed to cure for 28 days.

For compressive strength assessment, cubes of size 150mmX150mmX150mm were prepared. For tensile strength assessment, cylinders of diameter 150mm and length 300mm were prepared. Indirect tension test (Brazilian test or split tensile test), was carried on these cylindrical specimens. For flexural strength assessment, the beams of size 100mmX100mmX500mm were prepared and two point loading on an effective span of 400mm was adopted

After 28 days of curing the specimens were tested for their respectively strengths.

Same procedure is adopted for foundry waste sand. Instead of red mud, required quantity of (2%, 4%, 6%, 8%, 10%) foundry waste sand is used.

8.4. TEST RESULTS

RED MUD

TEST RESULTS OF SELF COMPACTING CONCRETE CONTAINING 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 8.1 Compressive strength of SCC with 0% 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)

A1	82.4	24414.8	24079.0	900	40.00	40.59
A2	81.8	24237.0		930	41.33	
A3	79.6	23585.2		910	40.44	

Table 8.2 Compressive strength of SCC with 1% 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)
B1	86.0	25481.5	24651.8	960	42.67	41.18
B2	80.0	23703.7		920	40.88	
B3	83.6	24770.4		900	40.00	

Table 8.3 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 8.4 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	24059.0		930	41.33	
D3	83.4	24711.1		980	43.55	

Table 8.5 Compressive strength of SCC with 4% red mud and with combination of admixtures (SP+VMA)

Specimen	Weight of	Density	Average	Failure	Compressive	Average

identification	specimen (N)	(N/cum)	density (N/cum)	Load (KN)	strength (MPa)	compressive strength (MPa)
E1	84.0	24888.8	24256.7	930	41.33	40.29
E2	79.6	23585.1		900	40.00	
E3	82.0	24296.3		890	39.55	

Table 8.6 Compressive strength of SCC with 5% 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)
F1	84.00	24888.8	24355.7	850	37.78	37.62
F2	82.60	24474.0		870	38.66	
F3	79.80	23644.4		820	36.44	

Table 8.7 Compressive strength of SCC with 6% 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)
G1	85.60	25362.9	24059.2	790	35.11	35.11
G2	77.60	22992.6		810	36.00	
G3	80.40	23822.2		770	34.22	

Table 8.8 Compressive strength of SCC with 7% 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)
H1	83.20	24651.8	24592.5	800	35.55	34.51
H2	84.00	24888.8		780	34.66	
H3	81.80	24237.0		750	33.33	

Table8.9 Compressive strength of SCC with 8% 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)
I1	86.00	25481.5	24335.8	760	33.77	33.62
I2	79.40	23525.9		770	34.22	
I3	81.00	24000.0		740	32.88	

OVERALL RESULTS OF COMPRESSIVE STRENGTH

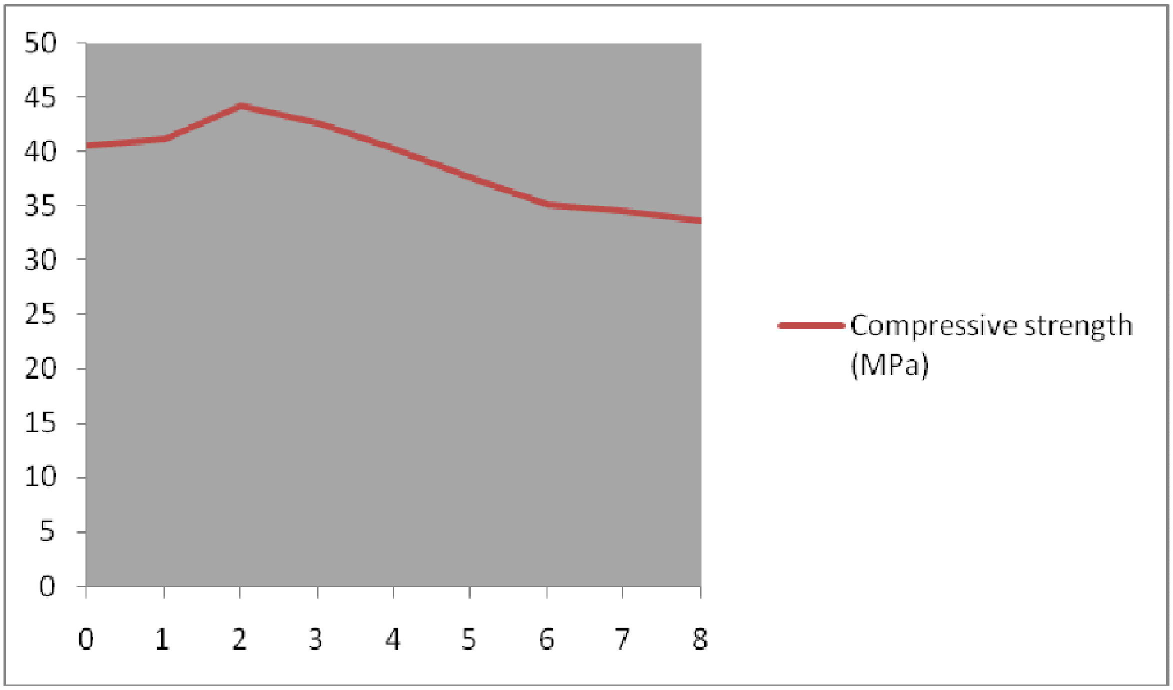
The following table no.8.10 gives the overall results of compressive strength of self compacting concrete containing the combination of admixtures (SP+VMA) for various percentage addition of red mud

Table 8.10 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
4	40.29	-0.74
5	37.62	-7.32
6	35.11	-13.50
7	34.51	-14.98
8	33.62	-17.17

The variation of compressive strength can be depicted in the form of graph as shown in figure.



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 8.11 Tensile strength of SCC with 0% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
A1	250	3.53	3.34
A2	240	3.39	
A3	220	3.11	

Table 8.12 Tensile strength of SCC with 1% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
B1	320	4.52	4.00
B2	280	3.96	
B3	250	3.53	

Table8.13 Tensile strength of SCC with 2% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
C1	350	4.95	4.62
C2	300	4.24	
C3	330	4.67	

Table 8.14 Tensile strength of SCC with 3% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
D1	230	3.25	3.34
D2	240	3.39	
D3	240	3.39	

Table 8.15 Tensile strength of SCC with 4% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
E1	220	3.11	3.25
E2	240	3.39	
E3	230	3.25	

Table8.16 Tensile strength of SCC with 5% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
F1	220	3.11	3.10
F2	240	3.39	
F3	200	2.82	

Table8.17 Tensile strength of SCC with 6% red mud and with combination of admixtures (SP+VMA)

Specimen	Failure load	Tensile strength	Average tensile

identification	(KN)	f=2P/πDL (MPa)	strength (MPa)
G1	210	2.97	2.87
G2	200	2.82	
G3	200	2.82	

Table 8.18 Tensile strength of SCC with 7% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
H1	160	2.26	2.50
H2	200	2.82	
H3	170	2.41	

Table 8.19 Tensile strength of SCC with 8% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
I1	160	2.26	2.16
I2	170	2.40	
I3	130	1.83	

OVERALL RESULTS OF TENSILE STRENGTH

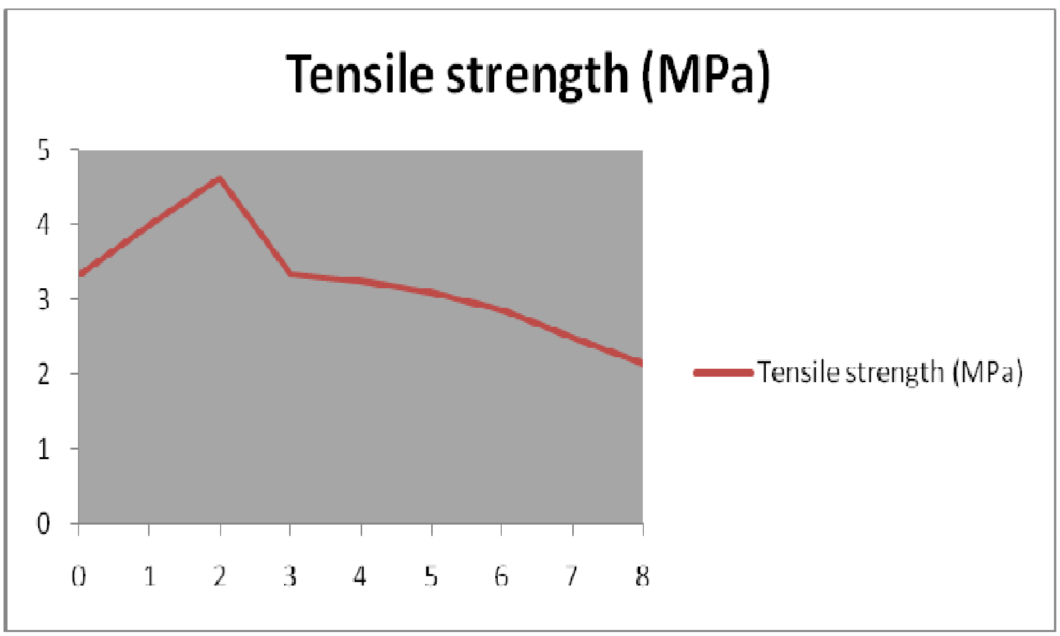
The following table no. 8.20 gives the overall results of tensile strength of self compacting concrete containing the combination of admixtures(SP+VMA) for various percentage addition of red mud

Table 8.20 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
4	3.25	-2.69
5	3.10	-7.19
6	2.87	-14.07
7	2.50	-25.15
8	2.16	-35.33

The variation of tensile strength can be depicted in the form of graph as shown in figure.



The variation of tensile strength of SCC containing red mud

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

Table 8.21 Flexural strength of SCC with 0% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
A1	10.0	5.00	5.12
A2	10.5	5.25	
A3	10.2	5.10	

Table 8.22 Flexural strength of SCC with 1% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
B1	11.0	5.50	5.36
B2	10.6	5.30	

B3	10.6	5.30	

Table 8.23 Flexural strength of SCC with 2% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
C1	11.4	5.70	5.53
C2	10.8	5.40	
C3	11.0	5.50	

Table 8.24 Flexural strength of SCC with 3% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
D1	11.0	5.50	5.50
D2	11.2	5.60	
D3	10.8	5.40	

Table 8.25 Flexural strength of SCC with 4% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
E1	10.9	5.45	5.26
E2	10.5	5.25	
E3	10.2	5.10	

Table 8.26 Flexural strength of SCC with 5% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
F1	10.2	5.10	5.15
F2	10.4	5.20	
F3	10.3	5.15	

Table 8.27 Flexural strength of SCC with 6% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
G1	10.1	5.05	4.92
G2	9.8	4.90	
G3	9.0	4.80	

Table 8.28 Flexural strength of SCC with 7% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
H1	9.9	4.95	4.83
H2	9.4	4.70	
H3	9.8	4.90	

Table 8.29 Flexural strength of SCC with 8% red mud and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
I1	9.4	4.70	4.40
I2	8.8	4.40	
I3	8.2	4.10	

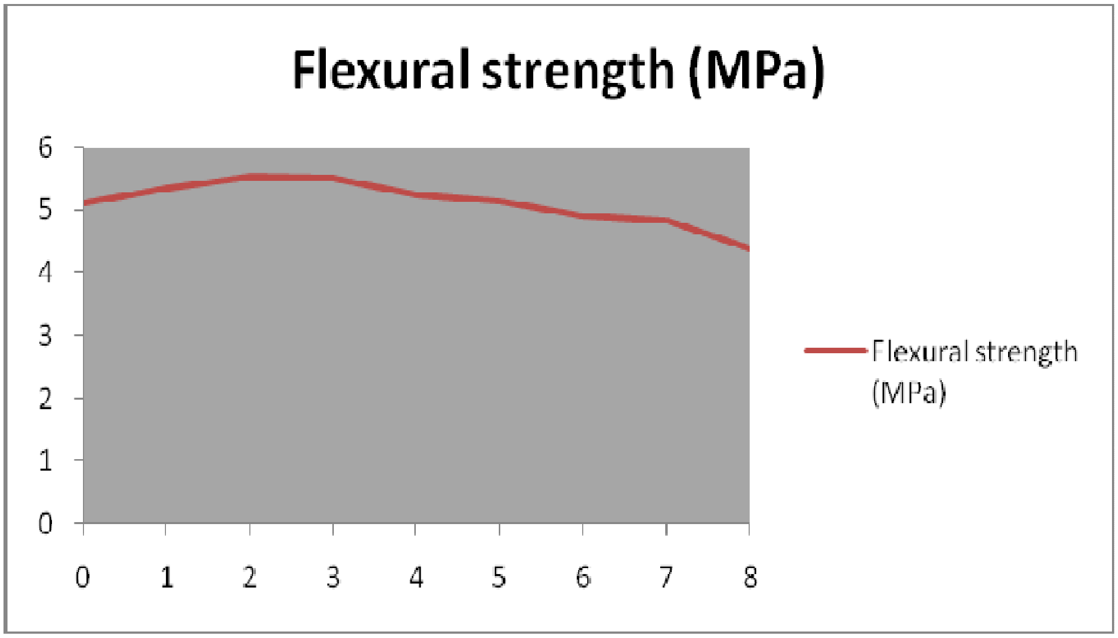
OVERALL RESULTS OF FLEXURAL STRENGTH

The following table no.8.30 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 8.30 Overall Result of flexural Strength

Percentage addition of red mud	Flexural 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
4	5.26	+2.73
5	5.15	+0.59
6	4.92	-3.91
7	4.83	-5.66
8	4.40	-14.06

The variation of flexural strength can be depicted in the form of graph as shown in figure.



The variation of flexural strength of SCC containing red mud

FLOW TEST RESULTS

The following tables give the flow test results of effect of addition of red mud in various percentages on the properties of self compacting concrete containing an admixtures combination of (SP+VMA)

Table 8.31 Slump Flow Test Results

Percentage of red mud	Slump flow (mm)	Time in sec T_{50}
0	680	4.9
1	700	4.7
2	720	4.3
3	710	4.6
4	680	5.3
5	650	5.8
6	630	8.6
7	590	12.4
8	560	13.2

Table 8.32 V - Funnel Test Results

Percentage of red mud	Flow time sec
0	33.10
1	24.61
2	18.70
3	32.80
4	34.60
5	36.80
6	42.00
7	52.80
8	66.54

Table 8.33 U - Box Test Results

Percentage of red mud	Height of conc. In 1st compartment H_1 (mm)	Height of conc. In 2st compartment H_2 (mm)	Filling height H_1-H_2 (mm)
0	290	290	0
1	290	290	0
2	290	290	0
3	290	285	5
4	290	285	5
5	290	280	10
6	290	280	10
7	290	275	15
8	290	270	20

Table 8.34 L - Box Test Results

Percentage of red mud	Height H_1	Height H_2	Blocking ratio H_2 /H_1	Time taken for conc. To reach a distance of 200 mm (T_{20}) sec	Time taken for conc. To reach a distance of 400 mm (T_{40}) sec
0	80	65	0.812	9.24	15.8
1	75	66	0.88	6.30	10.2
2	80	76.8	0.96	3.80	6.5
3	70	60	0.85	4.60	8.8
4	72	60	0.83	5.20	9.2
5	70	55	0.78	5.50	11.2
6	80	48	0.60	6.30	13.4
7	82	32	0.39	7.20	15.6
8	95	15.2	0.16	9.40	25.2

OVERALL RESULTS OF FLOW PROPERTIES

Overall flow test results of effect of addition of red mud in various percentages on the properties of self compacting concrete containing an admixtures combination of (SP+VMA)

Table 8.35 Overall Test Results

Percentage of red mud	Slump flow (mm)	Slump test (sec)	V – funnel flow time sec	U – box Filling height H_1-H_2 (mm)	L –box		
					Blocking ratio H_2 /H_1	(T_{20}) sec	(T_{40}) sec
0	680	4.9	33.10	0	0.812	9.24	15.8
1	700	4.7	24.61	0	0.88	6.30	10.2
2	720	4.3	18.70	0	0.96	3.80	6.5
3	710	4.6	32.80	5	0.85	4.60	8.8
4	680	5.3	34.60	5	0.83	5.20	9.2
5	650	5.8	36.80	10	0.78	5.50	11.2
6	630	8.6	42.00	10	0.60	6.30	13.4
7	590	12.4	52.80	15	0.39	7.20	15.6
8	560	13.2	66.54	20	0.16	9.40	25.2

FOUNDRY WASTE SAND

TEST RESULTS OF SELF COMPACTING CONCRETE CONTAINING THE COMBINATION OF ADMIXTURES (SP+VMA)

The following tables give the test results of effect of addition of foundry waste sand 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 foundry waste sand-

Table 8.36 Compressive strength of SCC with 0% foundry waste sand 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)
A1	82.4	24414.8	24079.0	900	40.00	40.59
A2	81.8	24237.0		930	41.33	
A3	79.6	23585.2		910	40.44	

Table 8.37 Compressive strength of SCC with 2% foundry waste sand 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)
J1	84.4	25007.4	25146.6	970	42.03	42.03
J2	81.4	24118.5		990	42.90	
J3	88.8	26311.1		950	41.17	

Table 8.38 Compressive strength of SCC with 4% foundry waste sand 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)
K1	81.6	24117.6	25046.6	930	40.30	40.15
K2	84.0	24888.8		910	39.43	
K3	88.2	26133.3		940	40.73	

Table 8.39 Compressive strength of SCC with 6% foundry waste sand 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)
L1	82.4	24114.8	24077.8	850	36.83	37.70
L2	81.8	24237.0		900	39.00	
L3	80.6	23881.5		860	37.27	

Table 8.40 Compressive strength of SCC with 8% foundry waste sand 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)
M1	88.6	26251.8	25560.4	800	34.67	35.68
M2	87.2	25837.0		820	35.53	
M3	83.0	24592.3		850	36.83	

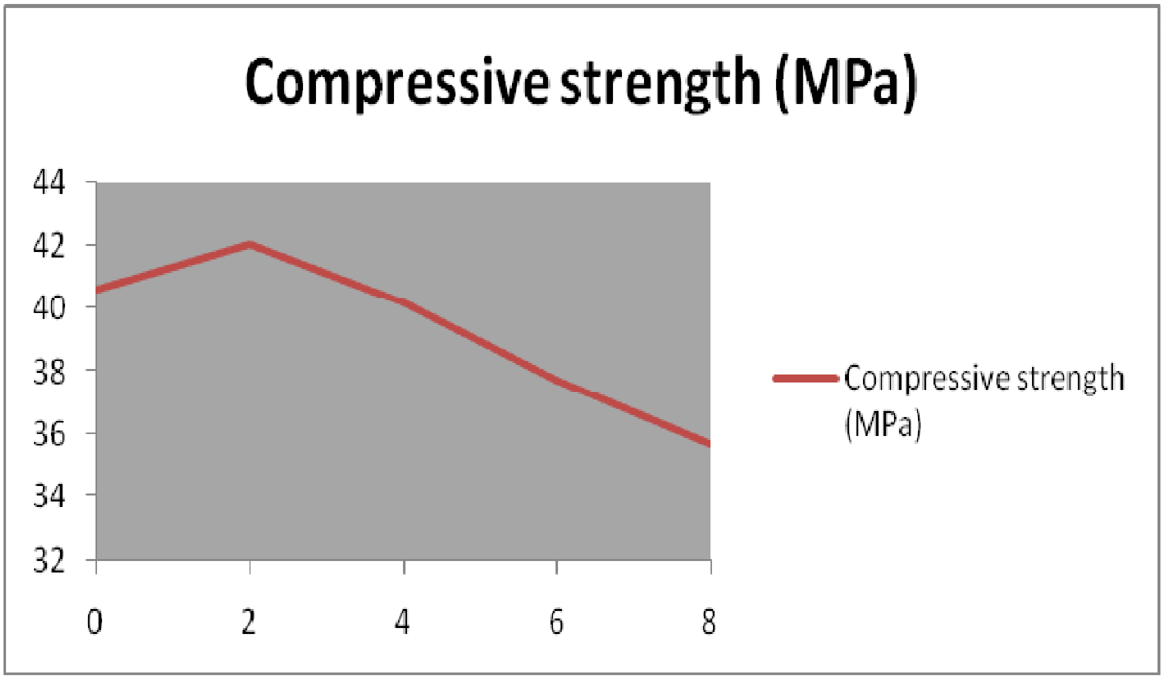
OVERALL RESULTS OF COMPRESSIVE STRENGTH

The following table no. 8.41 gives the overall results of compressive strength of self compacting concrete containing the combination of admixtures(SP+VMA) for various percentage addition of foundry waste sand

Table 8.41 Overall Result of Compressive Strength

Percentage addition of foundry waste sand	Compressive strength (MPa)	Percentage increase or decrease of compressive strength w.r.t. ref mix
0(Ref)	40.59	-
2	42.03	+3.55
4	40.15	-1.08
6	37.70	-7.12
8	35.68	-12.10

The variation of compressive strength can be depicted in the form of graph as shown in figure.



The variation of compressive strength of SCC containing foundry waste sand

Tensile strength test results of self compacting concrete containing the combination of admixtures (SP+VMA) with various percentages of foundry waste sand -

Table 8.42 Tensile strength of SCC with 0% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
A1	250	3.53	3.34
A2	240	3.39	
A3	220	3.11	

Table 8.43 Tensile strength of SCC with 2% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
J1	290	4.10	3.86
J2	280	3.96	
J3	250	3.54	

Table 8.44 Tensile strength of SCC with 4% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
K1	240	3.39	3.25
K2	210	2.97	
K3	240	3.39	

Table 8.45 Tensile strength of SCC with 6% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
L1	210	2.97	2.73
L2	180	2.54	
L3	190	2.68	

Table 8.46 Tensile strength of SCC with 8% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Tensile strength f=2P/πDL (MPa)	Average tensile strength (MPa)
M1	150	2.12	1.93
M2	140	1.98	
M3	120	1.70	

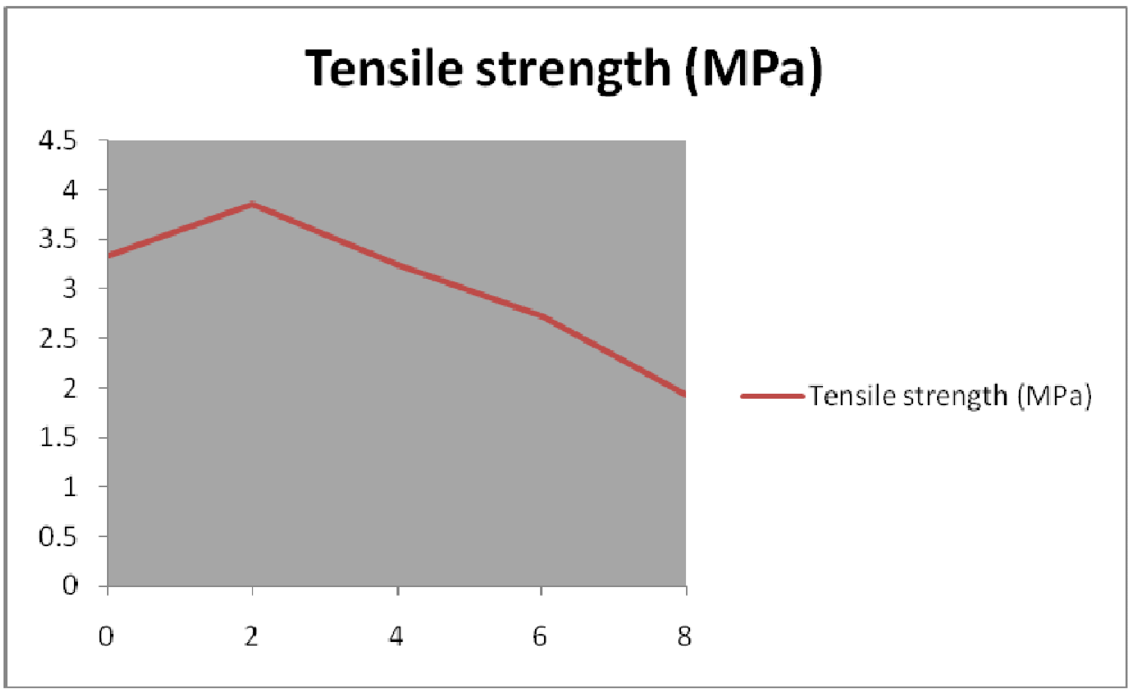
OVERALL RESULTS OF TENSILE STRENGTH

The following table no.8.47 gives the overall results of tensile strength of self compacting concrete containing the combination of admixtures(SP+VMA) for various percentage addition of foundry waste sand

Table 8.47 Overall Result of tensile Strength

Percentage addition of foundry waste sand	Tensile strength (MPa)	Percentage increase or decrease of tensile strength w.r.t. ref mix
0(Ref)	3.34	-
2	3.86	+4.66
4	3.25	-2.69
6	2.73	-18.26
8	1.93	-42.22

The variation of tensile strength can be depicted in the form of graph as shown in figure.



The variation of tensile strength of SCC containing foundry waste sand

Flexural strength test results of self compacting concrete containing the combination of admixtures (SP+VMA) with various percentages of foundry waste sand –

Table 8.48 Flexural strength of SCC with 0% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
A1	10.0	5.00	5.12
A2	10.5	5.25	
A3	10.2	5.10	

Table 8.49 Flexural strength of SCC with 2% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
J1	10.4	5.20	5.27
J2	10.5	5.25	
J3	10.7	5.35	

Table 8.50 Flexural strength of SCC with 4% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
K1	10.2	5.10	5.01
K2	9.8	4.90	

K3	10.1	5.05	

Table 8.51 Flexural strength of SCC with 6% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
L1	9.0	4.50	4.63
L2	9.5	4.75	
L3	9.3	4.65	

Table 8.52 Flexural strength of SCC with 8% foundry waste sand and with combination of admixtures (SP+VMA)

Specimen identification	Failure load (KN)	Flexural strength $f=PL/BD^2$ (MPa)	Average flexural strength (MPa)
M1	9.0	4.50	4.48
M2	9.1	4.55	
M3	8.8	4.40	

OVERALL RESULTS OF FLEXURAL STRENGTH

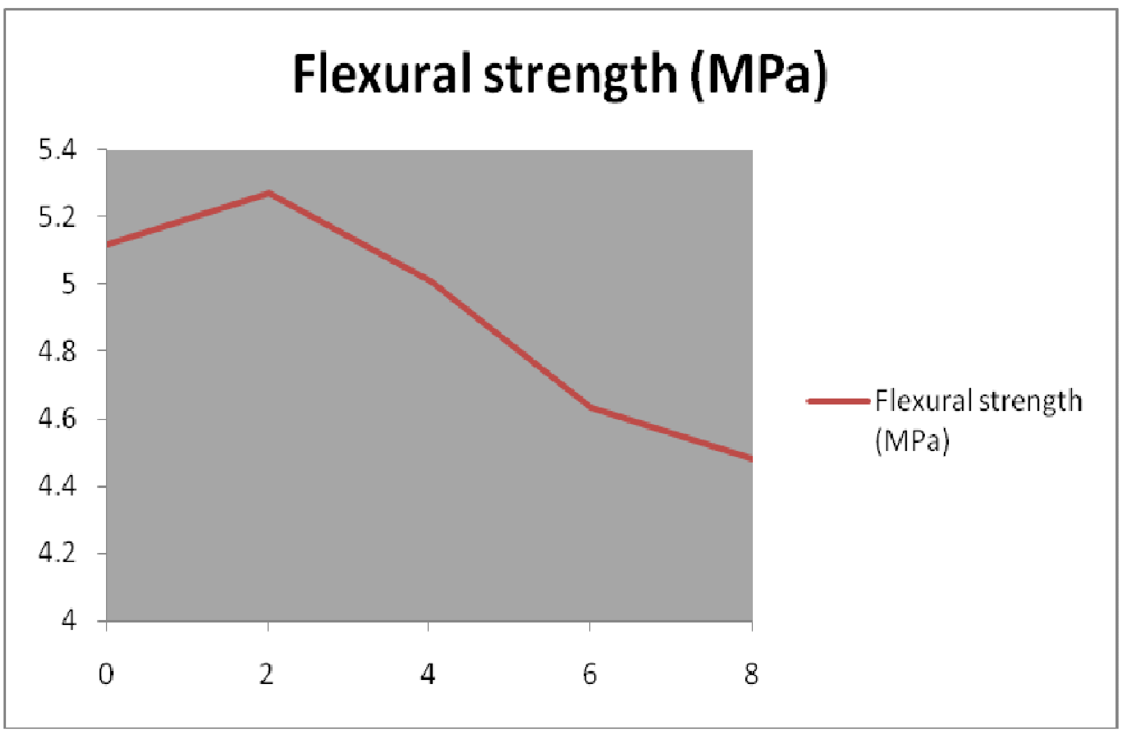
The following table no. 8.53 gives the overall results of flexural strength of self compacting concrete containing the combination of admixtures (SP+VMA) for various percentage addition of foundry waste sand

Table 8.53 Overall Result of flexural Strength

Percentage addition of foundry waste sand	Flexural strength (MPa)	Percentage increase or decrease of tensile strength w.r.t. ref mix
0(Ref)	5.12	-
2	5.27	+2.92

4	5.01	-2.15
6	4.63	-9.57
8	4.48	-12.5

The variation of flexural strength can be depicted in the form of graph as shown in figure.



The variation of flexural strength of SCC containing red mud

FLOW TEST RESULTS

The following tables give the flow test results of effect of addition of red mud in various percentages on the properties of self compacting concrete containing an admixtures combination of (SP+VMA)

Table 8.54 Slump Flow Test Results

Percentage of foundry waste sand	Slump flow (mm)	Time in sec T_{50}
0	680	4.9
2	730	4.1
4	680	5.3
6	610	9.7
8	530	14.1

Table 8.55 V - Funnel Test Results

Percentage of foundry waste sand	Flow time sec
0	33.10
2	18.10
4	33.00
6	45.30
8	79.80

Table 8.56 U - Box Test Results

Percentage of foundry waste sand	Height of conc. In 1st compartment H_1 (mm)	Height of conc. In 2st compartment H_2 (mm)	Filling height H_1-H_2 (mm)
0	290	290	0
2	290	290	0
4	290	280	10
6	290	275	15
8	290	270	20

Table 8.57 L - Box Test Results

Percentage of foundry waste sand	Height H_1	Height H_2	Blocking ratio H_2 /H_1	Time taken for conc. To reach a distance of 200 mm (T_{20}) sec	Time taken for conc. To reach a distance of 400 mm (T_{40}) sec
0	80	65	0.812	9.24	15.8
2	70	65	0.92	3.98	7.68
4	65	60	0.92	5.32	9.98
6	70	60	0.85	5.80	11.68
8	70	30	0.43	8.98	17.92

OVERALL RESULTS OF FLOW PROPERTIES

Overall flow test results of effect of addition of red mud in various percentages on the properties of self compacting concrete containing an admixtures combination of (SP+VMA)

Table 8.58 Overall Test Results

Percentage of foundry waste sand	Slump flow (mm)	Slump test (sec)	V – funnel flow time sec	U – box Filling height H_1-H_2 (mm)	L –box		
					Blocking ratio H_2 /H_1	(T_{20}) sec	(T_{40}) sec
0	680	4.9	33.10	0	0.812	9.24	15.8
2	730	4.1	18.10	0	0.92	3.98	7.68
4	680	5.3	33.00	10	0.92	5.32	9.98
6	610	9.7	45.30	15	0.85	5.80	11.68
8	530	14.1	79.80	20	0.43	8.98	17.92

CHAPTER 9

COST COMPARISON

Cost comparison between SCC and SCC after blending of cement:

From the above results and graph plotted which will give

the optimum percentage for the foundry waste sand 2% and red mud 2%.

Cost analysis:

Particulars	Rates(Rs.)
Rate of Cement per bag	280/-
Crushed Sand: Rate/ Cum	700/-
12mm aggregate/ Cum	500/-
Rate of Superplasticizer/kg	150/-
Rate of VMA/ kg	80/-
Red Mud/Ton	300/-
FWS/Ton	200/-
other	350/-

- It observed from the cost analysis the cost of conventional concrete is Rs.4090/cum and cost of concrete with blending by optimum percentages of foundry waste and red mud are Rs.4040/cum. and Rs.4045/cum. respectively.
- Because of these results we conclude that, the SCC with blending by red mud and foundry waste sand which are industrial wastages causing hazards to the ecosystem enhance the strength and reduces the cost than the normal SCC.

CHAPTER 10

CONCLUSIONS

In present scenario there is a greater need for self compacting concrete due to sickness of member and architectural requirement, also to improve durability of the structure.

Now the world is going to facing greater need of high performance concrete, durability point of view and SCC where the conventional way of compacting may not be always useful under different site condition. So instead of going for the conventional concrete let us mix the concrete compacting on its own which is called as self compacting concrete.

Now due to industrialisation there is greater increase in the foundry activity in at around Satara district, mainly in case of Kolhapur area. Similarly there is big project near Kolhapur of foundry sand. Hidalgo there is huge amount of Red mud is produced every day and dumped on the ground it is threat environment.

This waste is used for dumping for 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. So from these three points the project is under taken.

Based on the experimentation conducted, the following observations were made and hence some conclusions.

It has been observed that the compressive strength of self compacting concrete produced with the combination of admixtures such as (SP+VMA) goes on increasing up to 2% addition of red mud. After 2% addition of red mud, the compressive strength starts decreasing, i.e. the compressive strength of self compacting concrete produced with (SP+VMA) is maximum when 2% red mud is added. The percentage increase in the compressive strength at 2% addition of red mud is +9.11

Thus, it can be concluded that maximum compressive strength of self compacting concrete with the combination of admixtures (SP+VMA) may be obtained by adding 2% red mud which is a waste material from aluminum industry.

It has been observed that the compressive strength of self compacting concrete produced with the combination of admixtures such as (SP+VMA) goes on increasing upto 2% addition of foundry waste sand. After 2% addition of foundry waste sand, the compressive strength starts decreasing, i.e. the compressive strength of self compacting concrete produced with (SP+VMA) is maximum when 2% foundry waste sand is added. The percentage increase in the compressive strength at 2% addition of foundry waste sand.

Thus, it can be concluded that maximum compressive strength of self compacting concrete with the combination of admixtures (SP+VMA) may be obtained by adding 2% foundry waste sand which is a waste material of ferrous industry (foundry).

CHAPTER 11

SCOPE FOR FURTHER STUDY

The following experimental studies can be conducted in future with respect to self compacting concrete-

- The effect of addition of red mud/foundry waste sand on the durability characteristics of self compacting concrete containing more than three admixtures.
- The effect of high temperature on the properties of self compacting concrete containing more than three admixtures with red mud/foundry waste sand.
- The effect of addition of red mud/foundry waste sand on the shrinkage and the creep properties of self compacting concrete containing more than two admixtures.

- Similarly there are lot more mineral admixtures which are the wastage of the industry. The other type of ingredients wastages used for manufacturer of concrete to reduce the problems of environmental attack.

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