International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.8, pp 739-749, 2017

Experimental Research on Concrete by using Red Mud, Foundry Sand, Conplast SP430 -as a Partial Replacement of Fine Aggregates

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Abstract: Improved compaction around congested reinforcement. Potential to enhance durability through improved compaction of cover concrete. Improved build ability (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 aluminum industries, and foundry waste sand, which is a waste product from foundry, on the properties of self-compacting concrete containing two admixtures.

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 foundry waste and red mud sand. After 2% addition of foundry waste sand and red mud, the compressive strength starts decreasing, i.e. the compressive strength of self compacting concrete produced with (SP+VMA) is maximum when 2% foundry wasted red mud a sand is added. The percentage increase in the compressive strength at 2% addition of foundry waste sand and red mud. 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) and red mud.

Keywords: Concrete, Red Mud, Foundry Sand, Conplast SP430 -as a Partial Replacement of Fine Aggregates.

1.0 Introduction

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 by using foundry sand and red mud. Concrete technology has under gone from macro to micro level study in the enhancement of strength and durability properties. 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. Thus SCC eliminates the needs of vibration either external or internal for the compaction of the concrete without compromising its engineering properties. 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. Therefore 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, flow ability 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, and reinforcement density and construction conditions`[1,2]. 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.

2.0 Charecteristics of SCC

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.

2.1 Objectives:

Improved compaction around congested reinforcement. Potential to enhance durability through improved compaction of cover concrete. Improved build ability (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 aluminum industries, and foundry waste sand, which is a waste product from foundry, on the properties of self-compacting concrete containing two admixtures.

3.0 Scope of Study

1. The effect of addition of red mud/foundry waste sand on the durability characteristics of self-compacting concrete containing more than three admixtures.
2. The effect of high temperature on the properties of self compacting concrete containing more than three admixtures with red mud/foundry waste sand.
3. 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.

4.0 Materials Used

4.1 Red Mud

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

In spite of the fact that the aluminum 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 anywhere in nearby vicinity of the plant. In the last decade, the production of aluminium in spite 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 [4]. The degree of damage inflicted to ground water & air during the single production stages from bauxite to aluminium depends on a couple of tact's of which those connected with the alumina winning & red mud disposal.

4.2. Foundry Sand

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 [5,6]. 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.

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). Typically, about 1 ton of foundry sand is required for each ton of iron or steel casting produced.

5.0 Chemicals Used:

5.1 Glenium Stream-2

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 colorless free flowing liquid and manufactured by BASF Construction Chemicals (India) Pvt. Ltd., Pune.

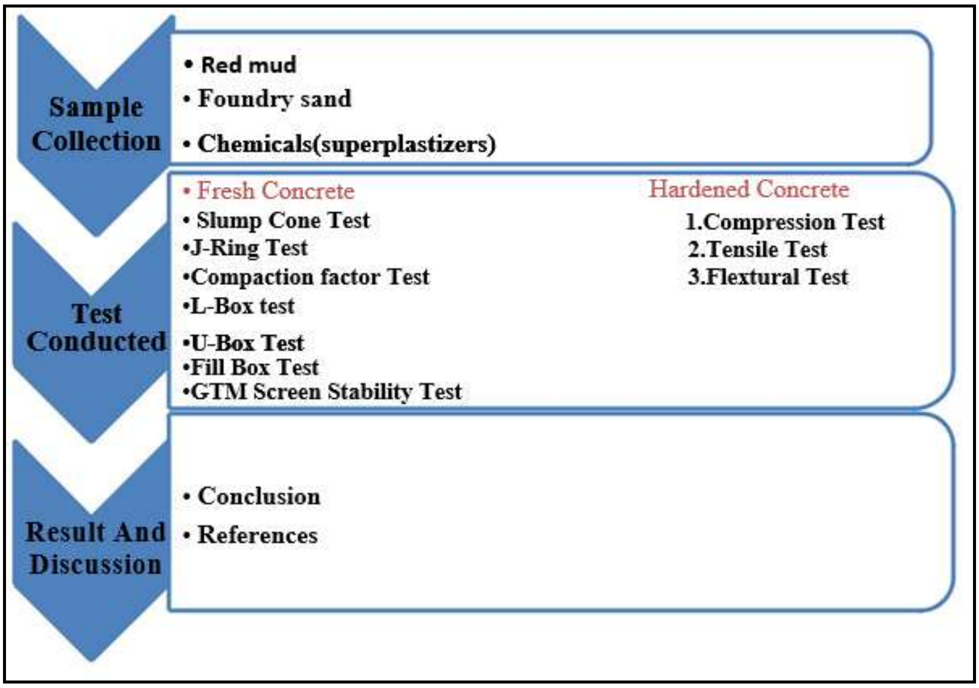
5.2 Conplast SP 430

A high performance concrete super plasticizer based on modified polycarboxylic ether was used in the experimentation. The trade name of the super plasticizer is Conplast SP 430. It greatly improves the cement dispersion. It is manufactured by BASF Construction Chemicals (India) Pvt. Ltd., Pune. Optimum dosage of Conplast SP 430 should be determined in trial mixes. As a guide a dosage range of 300ml to 1200ml per 100kg of cementitious material is normally recommended.

5.3 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, SiO2 and Fe2O3 in the range around 5 to 10 percent, 2 to 10 percent and 40 to 50 percent, respectively[7]. 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 was reported to increase strength & affect settling time. Greater additions decrease the strength.

6.0 Methodology:



7.0 Result and Discussion:

Table 1: Standard value of acceptance for different test methods of SCC

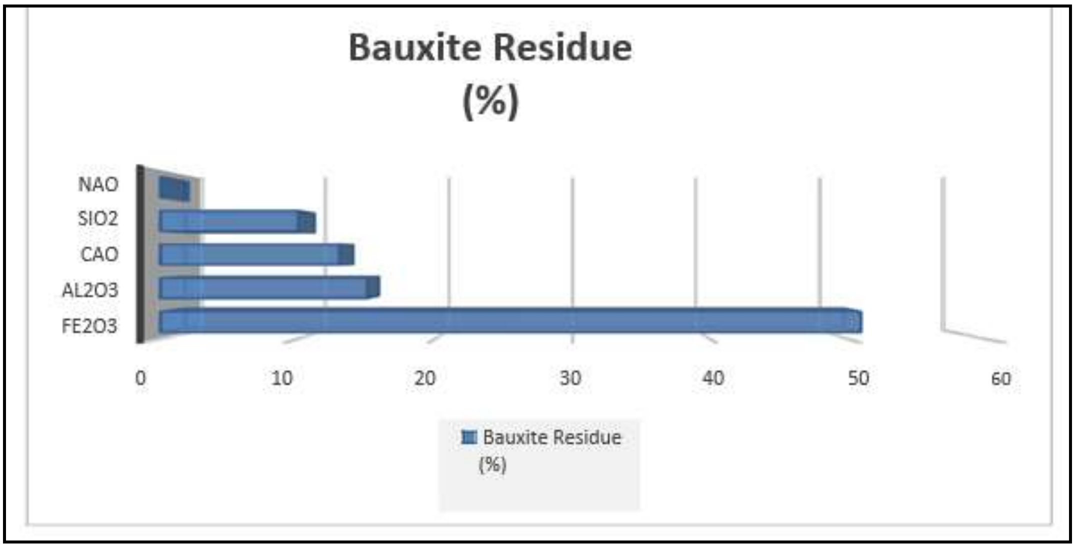
S.No.	Methods	Unit	Typical Range Of Values	
			minimum	maximum
1	Slump Flow	Mm	600	800
2	J-Ring	Mm	0	10
3	V-Funnel	Sec	6	12
4	L-Box	(h_2/h_1)	0.8	1.0
5	U-Box	h2-h1	0	30
6	Fill Box	%	90	100
7	GTM Screen Stability Test	%	0	15

7.1 Red Mud:

Red mud is one of the major solid wastes coming from Bayer process of alumina production.

Chemical composition of red mud

	Bauxite Residue (%)	Typical Values Worldwide (%)
Fe_2O_3	51	30-60
Al_2O_3	15	10-20
CaO	13	2-8
SiO_2	10	3-50
NaO	0.20	2-10



7.2 Foundry sand:

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

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

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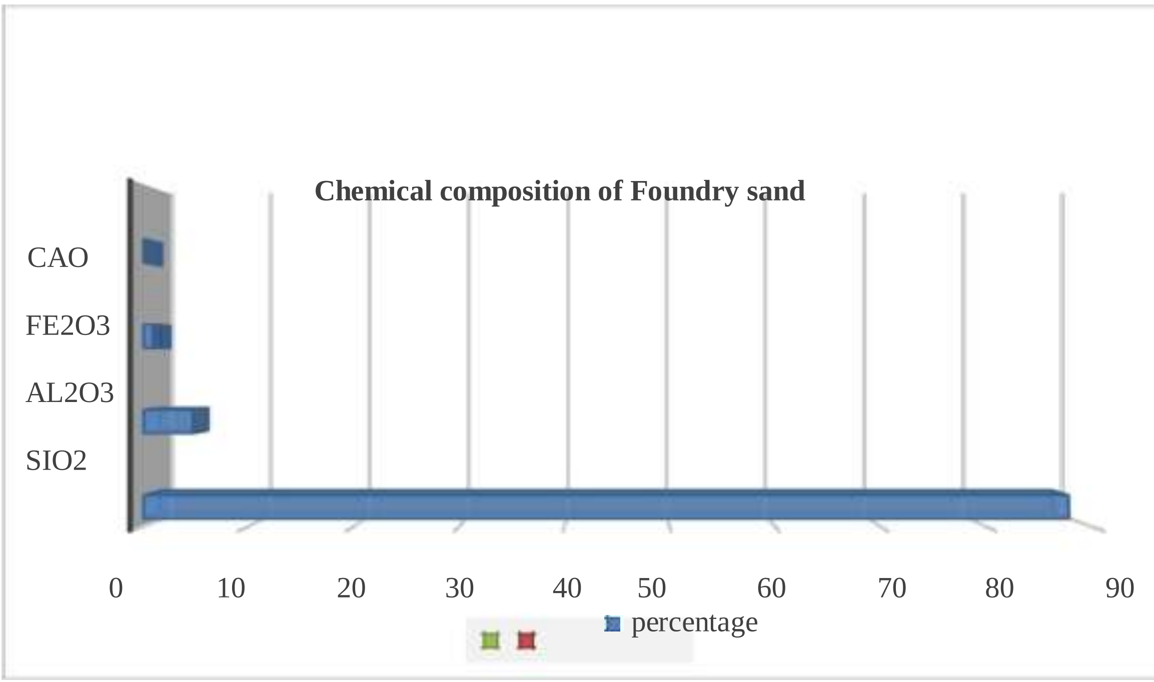


7.3 Fly ash:

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

Table: Chemical composition of fly ash.

Oxides	Percentages
SiO2+Al2O3+ Fe2O2	70 min
SiO2	35 min
Reactive silica	20 min
MgO	05 max
SO3	03 max
Na2O	1.5 max

7.4 Coarse Aggregate:

Coarse aggregate of nominal size of 20mm or below is chosen for the study.

Table: Coarse Aggregate

S.No	Property	Result
1	Specific Gravity	2.8
2	Fitness Modules	6.4
3	Particle Shape	Angular

7.5 Fine Aggregate:

Locally available river sand confined grading zone II of IS: 383-1970 is used. Generally fines are classified based on size, i.e.; below 4.75mm is regarded as fine aggregate

Table: Fine Aggregate

S.No	Property	Result
1	Specific Gravity	2.68
2	Surface Texture	Smooth
3	Fineness Modulus	4.3

8.0 Mix Design:

The mix design is done as per the IS mix design method for self compacting concrete for M30 grade concrete. The mix proportion adopted in the experimentation was 1:1:0.5 with a water/binder ratio 0.31. The fly ash/cement ratio used was 1:3.5.

Overall Test Results of Self Compacting Concrete Containing

The Combination of Admixtures With Addition of Red Mud And

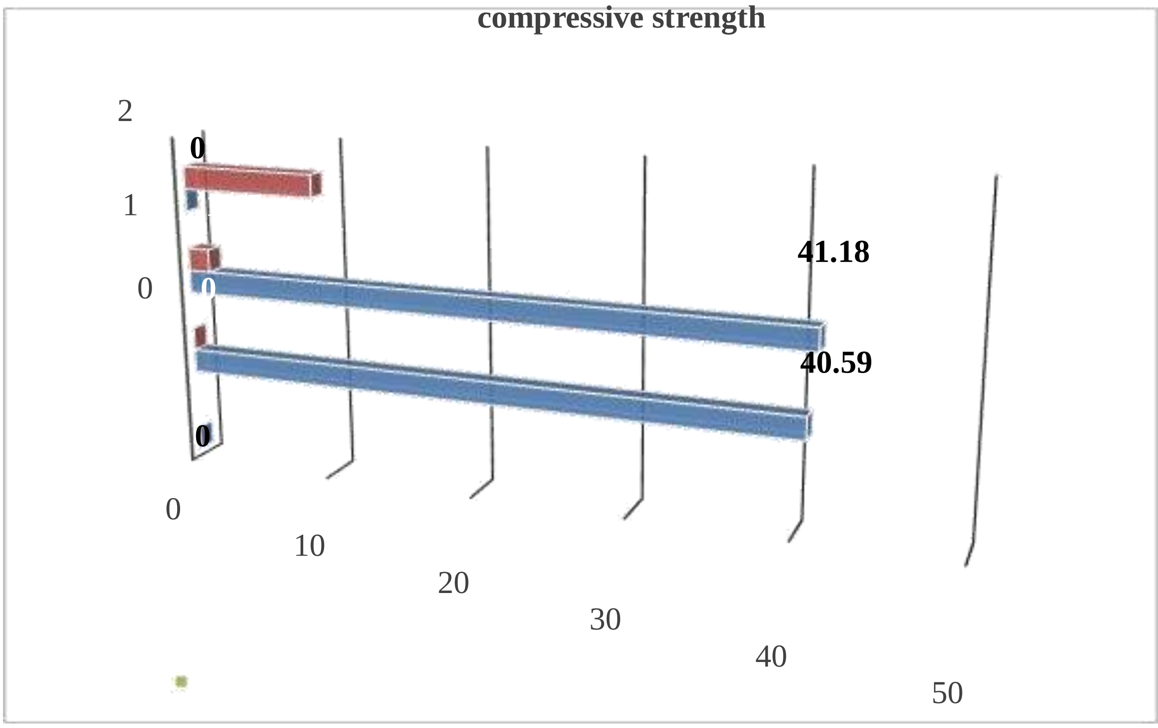
Foundry Sand

The following tables give the test results of effect of addition of red mud and foundry sand in various percentages on the properties of self compacting concrete containing an admixture combination

Compressive strength of overall test results of self compacting concrete containing the combination of admixtures (SP+VMA) with various percentages of red mud and foundry sand.

Table Overall Result of Compressive Strength

Percentage of addition of red mud and foundry sand	Compressive strength (Mpa)	Percentage increasing or decreasing of Compressive strength w.r.t ref. mix
0	40.59	-
1	41.18	+1.45
2	44..29	+9.11
3	42.66	+5.10
4	40.29	-0.74

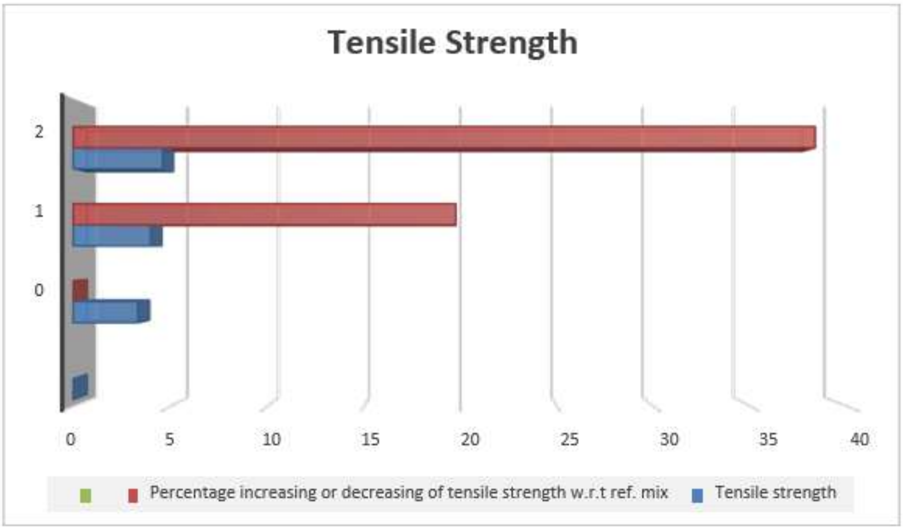


Percentage increasing or decreasing of Compressive strength w.r.t ref. mix

Tensile strength of overall test results of self compacting concrete containing the combination of admixtures (SP+VMA) with various percentages of red mud and foundry sand.

Table Overall Result of Tensile Strength

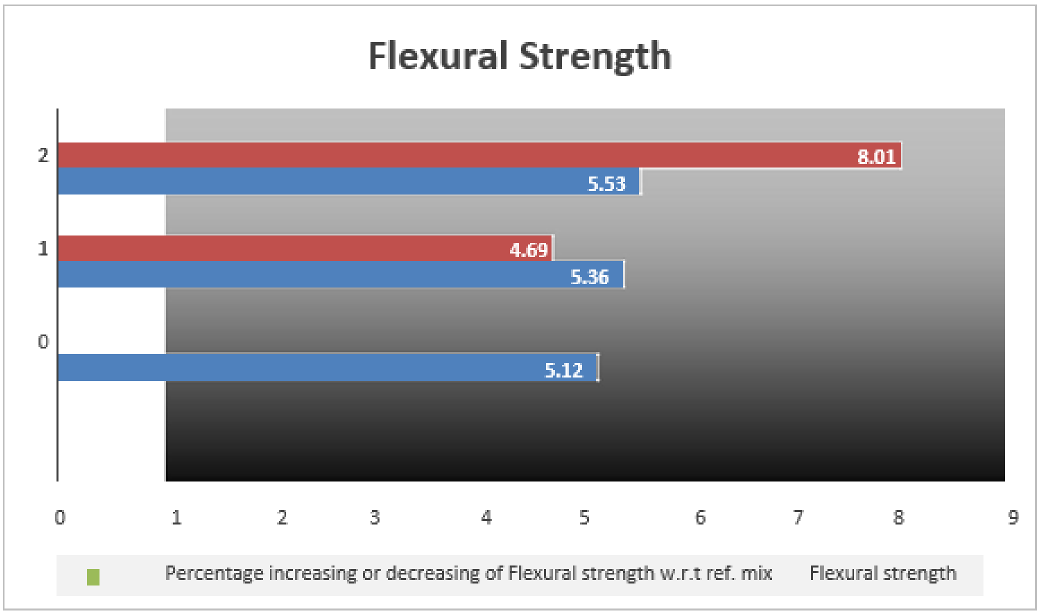
Percentage of addition of red mud and foundry sand	Tensile strength (Mpa)	Percentage increasing or decreasing of tensile strength w.r.t ref. mix
0	3.34	-
1	4.00	+19.76
2	4.62	+38.32
3	3.34	0
4	3.25	-2.69



Flexural strength of overall test results of self compacting concrete containing the combination of admixtures (SP+VMA) with various percentages of red mud and foundry sand.

Table Overall Result of Flexural Strength

Percentage of addition of red mud and foundry sand	Flexural strength (Mpa)	Percentage increasing or decreasing of Flexural strength w.r.t ref. mix
0	5.12	-
1	5.36	+4.69
2	5.53	+8.01
3	5.50	+7.12
4	5.26	+2.73



Overall Results of flow properties:

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

Table Overall Test Results

Percentage of red mud and foundry sand	Slum flow (mm)	Slum test (sec)	V-funnel flow time (sec)	U-box filling height H_1-H_2 (mm)	L-box		
					Blocking ratio H_1/H_2	T20 (sec)	T40 (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

Cost Analysis

Particular	Rates(Rs.)
Rate of Cement per bag	280/-
Crushed Sand: Rate/ Cum	700/-
12mm aggregate/ Cum	500/-
Rate of Super plasticizer/kg	150/-
Rate of VMA/ kg	80/-
Red Mud/Ton	300/-
Other	350/-

9.0 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 industrialization there is greater increase in the foundry activity in at around Coimbatore district, mainly in case of kondampatti area. Similarly there is big project on foundry sand.

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.

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 foundry waste and red mud sand. After 2% addition of foundry waste sand and red mud, the compressive strength starts decreasing, i.e. the compressive strength of self compacting concrete produced with (SP+VMA) is maximum when 2% foundry wasted red mud a sand is added. The percentage increase in the compressive strength at 2% addition of foundry waste sand and red mud. 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) and red mud.

10.0 References:

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