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Strength and Acid Resistance of M50 Grade Self-Compacting Concrete

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ABSTRACT

Self-compacting concrete have very high strength and durability and is a fluid mixture of high performance, which is applicable in placing at difficult condition and without any vibrator in the structures with congested reinforcement. Sufficient powder along with a super plasticizer is used to make Self compacting concrete in order to flow it while the coarse aggregate are kept in a vicious suspension.M50 grade self-compactingconcrete is developed using fly ash and rice husk ash which are industrial by products. The flow and strength properties of SCC incomparison with conventional concrete are investigated. Concreteis susceptibility to acid (such as nitric acid, hydrochloric acid andacetic acid) attacks because of its alkaline nature. Acid DurabilityLoss Factor is used to study the loss of strength, stability and weight of SCC in the influence of acid. This factor gives the performance of both strength and durability.

Keywords: *Acid Resistance, Durability, SSC-Self compacting concrete, CC-Conventional Concrete, M50 grade.*

1. INTRODUCTION

SCC can be produced by designing an appropriate mix proportion and then concrete properties are obtained. SCC actually in its fresh state in practice has very high fluidity. So the ability and good properties of segregation resistance of self-compacting concrete contributes in reducingthe risk of honey combing of concrete. In addition SCC also shows good compressive strength. It has low yield value which ensures high deformability and moderate viscosity withsolid particles in uniform suspension. The greater material cost of SCC in comparison with conventional concrete of similar mechanical properties is dueto relatively high demand of cementitious material and Highrange water reducing (HRWRS) and viscosity enhancingadmixtures (VEAs) and other chemical admixtures.

2. LITERATURE REVIEW

JRMCA (1998) had proposed a standardized method ofmixed design to produce SCC which is a simplified version of Okamura and Ozawa (1995) where powder material andwater binder is used with a large amount of ratio < 0.30.RELEM report 23 from technical committee 174 (skarendalh2001) states deformability, flow ability and resistance tosegregation are main functional requirements of a fresh SCC.

- Gibbs (1999) actuates that SCC can be designed and constructed using a broad range of normal concreting material.
- In the Brite-euram project, Peterson (1999) states that bothnatural and crushed aggregate can be successfully used in SCC as long as the attention is given to amount of paste necessary to avoid blocking of the aggregates.
- Takada (1998) ,Sugamata (1999) suggests that class C andclass F may be used successfully in SCC.
- Tviksta (2000) found that addition of super plasticizer at later stage of mixing leads to better flow ability.
- T.Cerulli, C.Pistolesi, C.Maltese, D.Salvoni(2003) have studied blast furnace slag based plaster and its durability with respect to traditional plasters.
- Erntroy and Shacklock have suggested empirical graph forhigh strength concrete which relates arbitrary reference number to the compressive strength.

PROPERTIES OF MATERIALS

- Cement: Ordinary Portland cement confirming to IS – 12269 having specific gravity 3.15
- Fine Aggregate: Natural river sand confirming to IS-385 zone II having specific gravity 2.63(by pycnometer)
- Course Aggregate: Crushed at granite angular aggregate ofsize 12.5mm specific gravity 2.675 confirming IS3812-1981 and Rice Husk Aggregates (RHA)
- Chemical admixture/Super Plasticizer (SP): Glenium B233
- Fly ash obtained from Vijayawada thermal power station inAP, of specific surface 4750 cm^2/bm by Blaine's apparatus.
- RHA of specific gravity 2.3, loss of ignition 3.6% and fineness Blains =16000 cm^2/gm

MIX PROPORTIONING

The major work in producing SCC is designing as appropriatemix proportion and then the properties of the concrete are evaluated and calculated. SCC shows high fluidity in its fresh state along with its abilityin self-compacting and resistance in segregation, these all contribute in reducing honey combing risk of concrete. Cement, coarse aggregate, fine aggregate, water, mineral andchemical admixture are the usual ingredients of SCC but no standard or all encapsulating method currently exist for SCC for the mixture proportions determinations.

Table1: SCC Proportions of Materials and its Limitation

	High Fines	VMA	Combination
Cementations, lb/yd3(kg/m3)	750-1000 (450-600)	650-750 (385-450)	650-750 (385-450)
Water/cementations material	0.28-0.45	0.28-0.45	0.28 – 0.45
Fine aggregate/mortar %	35-40	40	40
Fine aggregate/total aggregate %	50-58	-	-
Coarse aggregate/total mix %	28-48	45-48	28-48

EFNARC-Proposals

- In designing the mix the relative proportions of the keycomponents by volume is useful rather than by mass.
- Water/powder ratio by volume 0.8-1.10
- Total powder content-160 to 240 (400-600kg) per cubicmeter
- Coarse aggregate content normally 280 to 35% by volume ofthe mix
- Water cement ratio is selected based on requirements in EN206.
- Typically water content does not exceed200lt/m3
- The sand content balances the volume of other constituents. Generally design should be done conservatively so that thecapability of the concrete despite variation in raw materials inmaintaining its specified fresh properties is ensured.

Design of M50 grade concrete (trial mix)

- Specified 28 days cube strength: 50Mpa
- Degree of control: very good
- Control Fa: 0.8
- Degree of Workability: very low
- Type of cement: ordinary Portland cement
- Type of C.A.: crushed granite
- Type of F.A: natural sand
- Specific gravity of Cement: 3.15
- Specific gravity of F.A: 2.63
- Specific gravity of C.A:2.675
- Target mean strength (fck): σ/control factor50/0.85=58.85N/mm^2
- From chart for the required strength reference no is 15.
- From chart for obtained reference no and for very highworkability the w/c ratio is 0.34

The aggregates are obtained by analytical and graphical method. So that 30% of the material passes through 4.75mmIS sieve.

- Ratio of fine to total aggregate =35%
- Cement: FA: CA: water =1:0.98:35/100x28:65/100x2.8:0.34
- Weight of cement required for 1m^3 of concrete =C+0.98C+1.82C+0.34C=1000
- Or, 1.706C=1000kg/m3 C=585.13 Kg/m^3
- W=198.9 Kg/m^3 FA=573.4 Kg/m^3 CA=1064.9 Kg/m^3

Let the cement quantity is fixed to 600 Kg/m^3

The modified quantities are:

- Water = 190 Kg/m^3
- Cement=600 kg/m^3
- Water = 190 kg/m^3
- FA=840 kg/m^3
- CA =800Kg/m^3

The final mix proportion is 0.34:1:1.4:1.33.

OPTIMIZATION OF MIX PROPORTION

To arrive at suitable mix proportion for conventional concrete(CC) & SCC, extensive trials are conducted at laboratories.

Designation	Cement (Kg/m^3)	Water (Kg/m^3)	F.A (Kg/m^3)	C.A (Kg/m^3)

RC1	425	144.5	604.5	1125.6
RC2	450	160	604.5	1125.6
RC3	510	177	604.5	1125.6
RC4	550	185	604.5	1125.6
RC5	660	190	604.5	1125.6

Table2: Trial mix to optimize water content

Table3: Trial mix with RHA

Designation	Cement (Kg/m^3)	SP (Bwp)	Water (Kg/m^3)	F.A (Kg/m^3)	C.A (Kg/m^3)
RC1	425	1%	144.5	604.5	1125.6
RC2	450	3%	160	604.5	1125.6
RC3	510	5%	177	604.5	1125.6
RC4	550	7%	185	604.5	1125.6
RC5	660	10%	190	604.5	1125.6

Designation	Cement (Kg/m^3)	SP (Bwp)	Water (Kg/m^3)	F.A (Kg/m^3)	C.A (Kg/m^3)
RC1	480	0.25%	177	604.5	1125.6
RC2	480	0.5%	177	604.5	1125.6
RC3	480	0.75%	177	604.5	1125.6
RC4	480	1.0%	177	604.5	1125.6
RC5	480	1.25%	177	604.5	1125.6

Table4: Trial Mix with SP

Grade	Ce men t (Kg/m^3)	RHA (Kg/m^3)	Water (Kg/m^3)	SP (Bwp)	F.A (Kg/m^3)	C.A (Kg/m^3)
M50	**480**	**24**	**16.5**	**0.5 %**	**604.5**	**1125.6**

Table5: Quantities of materials for M50 grade ofconventional concrete

Table6: Quantities of materials for M50 grade of self-compacting concrete (SCC)

Grade	Ce men t (Kg/m^3)	Fly Ash (Kg/m^3)	RHA (Kg/m^3)	Wat er (Kg/m^3)	SP (Bwp)	F.A (Kg/m^3)	C.A (Kg/m^3)
M50	**480**	**62.4**	**41.6**	**178.16**	**1.75%**	**865.2**	**865.2**

Table7: Mix proportions for M50 grade of conventional concrete and SCC

Grade	**Conventional Concrete by ES Method**	**SCC by ES Method**
M50	**0.34:1.0:1.2:2.2**	**0.34:1.0:1.71:1.71**

TESTING

Test on Fresh Concrete: To find the Filling ability, passing ability and segregation resistance on fresh SCC, we performed Slump test, V-Funnel and L-Box tests. As per theEFNARC specifications, the prescribed limits of the tests areas follows.

Table8: Fresh Properties of SCC

Grade	Slump Flow		L-Box			V-Funnel	
	Slump (mm)	T50 (sec)	T20 (sec)	T40 (sec)	H2/H1	T0 (sec)	T5 (sec)
M50	700	3.9	3.0	7.7	0.9	7.3	13.6

Test on SCC & CC in Hardened State: 100mm size cubes are taken to carry out Compressive strength tests on compression testing machine of 1000KN capacity as per IS 516:1959. 150mm diameter and 300mm height cylinderswere taken on a compression testing machine of 1000KN capacity as per IS 516:1959 to carry out Split tensile strengthtests. Prisms of size 100x100x500mm were taken to carry outFlexural strength tests on flexural testing machine of capacity100KN as per IS 516:1959.

Table 9: M50 Grade Hardened Concrete strength properties Comparison.

Property	**Strength at 3 days**			**Strength at 7 days**			**Strength at 28days**		
	CC	SCC	% Incr easedecr ease	CC	SCC	%Increase decrease	CC	SCC	% Increase decrease
Comp.Strength (N/mm^2)	30.82	29.00	-5.67	37.57	36.34	-3.3	54.82	56.76	3.53
Split Tensile Strength (N/mm^2)							5.48	5.64	+ 2.8
Flexural Strength (N/mm^2)							5.72	5.91	+3.2

CHEMICAL ANALYSIS

Sample Calculation: Volume of Sulphuric acid and HCL required for complete immersion of cubes in the tray =75 Lts.

- **A Preparation of 2% H_2SO_4**

Sulphuric acid (Merck sample, GR grade) specific gravity1.84is used to prepare 1 liter of 2% H_2SO_4 20 ml of conc. H_2SO_4 is to be dissolved in 980 ml of distilled water. Proportionately to prepare 75 lit of 2% H_2SO_4, 1.5 lit of con H_2SO_4 is dissolved in 73.5 lit of distilled water.

V_0 = Volume in liters of concentrated H_2SO_4 present in 7.5 litof solution =1.5lit

- **B Preparation of 5% H_2SO_4**

The same sulphuric acid described above, is used to prepared 1litre of 5% H_2SO_4 is to be dissolved in 950ml of distilled water. Proportionately, to prepare 45 litre of 5% H_2SO_4 , 2.25 lit of conc. H_2SO_4 is dissolved in 42.75 lit of distilled water.

- **C Preparation of 2% HCL**

HCL of (Qualigens AR grade),sp, gr. 1.18 is used toprepare 1lit of 2% HCL 20ml of conc. **HCL** is to be dissolvedin 980ml of distilled water. Proportionately to get 75 liters of2% HCL, 1.5 lit of conc.HCL is dissolved in 73.5 lit of distilled water.

V_0 = Volume in liters of concentrated HCL present in 7.5 liters of solution is 1.5liters.

- **D Preparation of 2% HCL**

HCL described above is used to prepare 1lit of 5% HCL 50ml of conc. **HCL** is to be dissolved in 950ml of distilled water. Proportionately to get 75 liters of 5% HCL, 3.75 lit ofconc.HCL is dissolved in 71.25 lit of distilled water.

V_0 = 3.75liters.

- **E. Preparation of sodium hydroxide (NaOH) solution:**

Sodium Hydroxide (fine chemicals) of L.R grade is used. 3gm of the sample is weighed out in a beaker and it is dissolvedin 100mlof distilled water. The solution is thoroughly shakenwith a glass rod to get uniform solution.

Standardization of NaOH

Ox, Acid to NaOH or, N1V1 = N2V2

Or, 1.5 x 1 = N2 x 2.15, N2 = 1.5 x ½.15 = 0.6977N

Concentration of NaOH = 0.6977 N

Tray No. with 2% **HCl**	NaOH consumed for ml of acid in thetray	Acid = NaOH N1V1= N2V2 N1=N2V2/V1	Co Moles/Lit.
1	0.20 ml	0.6977x0.2/1	0.13954
5	0.25 ml	0.6977x0.25/1	0.1744
9	0.20 ml	0.6977x0.2/1	0.13954
12	0.25 ml	0.6977x0.25/1	0.1744
15	0.25 ml	0.6977x0.25/1	0.1744

Tray No. with 5% **HCl**	NaOH consumed forml of acid in the tray	Acid = NaOH N1V1= N2V2 N1=N2V2/V1	Co Moles/Lit.
2	0.50 ml	0.6977x0.5/1	0.34885
6	0.55 ml	0.6977x0.55/1	0.38373
10	0.65 ml	0.6977x0.65/1	0.45351
13	0.75 ml	0.6977x0.75/1	0.52327
16	0.65 ml	0.6977x0.65/1	0.45351

Tray No. with 5% **HCl**	NaOH consumed forml of acid in the tray	Acid = NaOH N1V1= N2V2 N1=N2V2/V1	Co Moles/Lit.
3	1.20 ml	0.6977x1.20/1	0.41862
7	1.15 ml	0.6977x1.15/1	0.401175

11	1.15 ml	0.6977x1.15/1	0.401175
14	1.10 ml	0.6977x1.10/1	0.383735
17	1.05 ml	0.6977x1.05/1	0.366295

Tray No. with 5% **HCl**	NaOH consumed forml of acid in the tray	Acid = NaOH N1V1= N2V2 N1=N2V2/V1	Co Moles/Lit.
4	2.80 ml	0.697x 2.80/1	0.97678
8	2.80 ml	0.6977x 2.80/1	0.97678
18	2.85 ml	0.6977x 2.85/1	0.994225

Standardization of NaOH

N1=N2V2/V1 = 1.5 x 1/2.25 = 0.6667N

Concentration of NaOH = 0.6667 N

Tray No. With 2%HCl	NaOH consumed for ml of acid in the tray	Acid = NaOH N1V1= N2V2 N1=N2V2/V1	C15 Moles/Lit.
1	0.05 ml	0.6977x0.05/1	0.03333
5	0.05 ml	0.6977x0.05/1	0.03333
9	0.05 ml	0.6977x0.05/1	0.03333
12	0.05 ml	0.6977x0.05/1	0.03333
15	0.05 ml	0.6977x0.05/1	0.03333

Tray No. With 5%HCl	NaOH consumed for ml of acid in the tray	Acid =NaOH N1V1=N2V2 N1=N2V2/V1	C15 Moles/Lit.
2	0.15 ml	0.6977x0.10/1	0.0.6667
6	0.10 ml	0.6977x0.10/1	0.0.6667
10	0.10 ml	0.6977x0.10/1	0.0.6667
13	0.10 ml	0.6977x0.10/1	0.0.6667
16	0.10 ml	0.6977x0.10/1	0.0.6667

Tray No. with 2%H2SO4	NaOH consumed for ml of acid in the tray	Acid = NaOH N1V1= N2V2 N1=N2V2/V1	C15 Moles/Lit.
3	0.30 ml	0.6977x0.30/1	0.100005
7	0.30 ml	0.6977x 0.30/1	0.1

11	0.25 ml	0.6977x0.25/1	0.08333
14	0.35 ml	0.6977x0.35/1	0.11667
17	0.30 ml	0.6977x0.30/1	0.1

Tray No. with 5%H2SO4	NaOH consumed for ml of acid in the tray	Acid = NaOH N1V1= N2V2 N1=N2V2/V1	C15 Moles/Lit.
4	0.65 ml	0.6977x0.65/1	0.216675
8	0.65 ml	0.6977x0.65/1	0.216675
18	0.65 ml	0.6977x0.65/1	0.216675

For 2%HCL Acid Replacement on 15Th Day,

2% HCL acid is used in each tray – 12 lit

= 0.24 lit HCl + 11.76 lit water = Vo =0.24 lit.

Tray No.	Co Moles/Litre	C15 Moles/litre	Acid Consumed (C0-C15)V0/C0
1	0.13954	0.03333	182.67
5	0.17440	0.03333	194.13
9	0.13954	0.03333	182.67
12	0.17440	0.03333	194.13
15	0.17440	0.03333	194.13

For 5%HCL Acid Replacement on 15^{Th} Day,

5% HCL acid is used in each tray – 12 lit

= 0.6 lit HCl + 11.76 lit water = Vo =0.6 lit.

Tray No.	Co Moles/Litre	C15 Moles/litre	Acid Consumed (C0-C15)V0/C0
2	0.34885	0.06667	485.3
6	0.38373	0.06667	498.72
10	0.45351	0.06667	511.79
13	0.52327	0.06667	523.55
16	0.45351	0.06667	511.79

For 2% H_2SO_4, V0 = 0.24 lit H_2SO_4 + 11.76 lit water

Tray	Co Moles/Litre	C15	Acid Consumed

No.		Moles/litre	$(C_0-C_{15})V_0/C_0$
3	0.41862	0.1	182.67
7	0.401175	0.1	180.18
11	0.401175	0.08333	190.15
14	0.383735	0.11667	167.03
17	0.366295	0.1	174.47

For 5% H_2SO_4, V0 = 0.60 lit H_2SO_4 + 11.40 lit water

Tray No.	C_0 Moles/Litre	C_{15} Moles/litre	Acid Consumed $(C_0-C_{15})V_0/C_0$
4	0.97678	0.216675	466.9
8	0.97678	0.216675	466.9
18	0.994225	0.216675	469.24

Weight Loss Calculation

Percentage weight loss = (Initial Weight – Final Weight) X100 / Initial weight

Weight Loss Calculation

Percentage strength loss = (Initial Strength – FinalStrength) X100 / Initial weight.

Calculation of Acid durability Factor (ADF) = Sr N/MCalculation of Acid Attack Factor (AAF)

For each of the two cubes the extent of deterioration in terms of acid diagonals (in mm) at each corner of the struck face and the opposite face is measured and acid attack factor(AAF) per face is calculated.

AAF = (Loss in mm on eight corners of each of 2 cubes)/4

3. EXPERIMENTAL RESULT

Table10: Weight loss and compressive strength loss forM50 – Conventional concrete

Acid %	**%Wt. and % CSLoss**	**Days**					
		15	**30**	**45**	**60**	**75**	**90**
2 % H_2SO_4	% Wt.Loss	2.26	5.20	6.48	8.28	10.28	19.20
	% CS Loss	0.85	1.12	2.53	3.12	4.72	6.78
5 % H_2SO_4	% Wt.Loss	3.45	6.79	9.28	11.28	13.20	15.57
	% CS Loss	0.96	1.54	3.12	4.85	5.91	7.72
2 % HCL	% Wt.Loss	1.39	3.21	5.49	7.78	10.79	14.72
	% CS Loss	0.36	1.34	2.79	5.24	6.4	7.59
5 % HCL	% Wt.Loss	1.38	3.45	5.56	7.76	11.79	13.72
	% CS Loss	0.89	1.49	3.23	4.32	5.25	7.72

Table11: Weight loss of M50 – SCC and its compressivestrength loss

Acid %	%Wt. and % CSLoss	Days					
		15	**30**	**45**	**60**	**75**	**90**
2 % H_2SO_4	% Wt.Loss	0.56	1.28	1.76	2.38	4.84	7.68
	% CS Loss	0.74	1.00	2.36	2.79	3.56	4.67
5 % H_2SO_4	% Wt.Loss	0.64	1.36	3.49	5.72	6.01	7.73
	% CS Loss	0.81	1.23	2.83	3.73	4.89	6.75
2 % HCL	% Wt.Loss	0.28	0.96	1.97	2.98	4.77	6.72
	% CS Loss	0.3	1.12	2.12	4.36	5.92	6.42
5 % HCL	% Wt.Loss	0.3	1.20	1.98	4.28	5.46	7.36
	% CS Loss	0.66	1.32	2.56	3.42	4.39	6.39

Table12: Acid Durability Factors and Acid AttackFactors

Age	Factors	M-50 CC		M-50 SCC	
		2% H_2SO_4	5% H_2SO_4	2% HCL	5% HCL
15	Sr	98.15	99.04	99.26	99.19
	ADF	14.02	14.15	14.18	14.17
	AAF	0.12	0.20	0.10	0.15
30	Sr	97.88	98.45	99.0	98.77
	ADF	27.96	28.13	28.28	28.22
	AAF	0.25	0.29	0.16	0.21
45	Sr	96.47	96.88	97.64	97.17
	ADF	41.34	41.52	41.84	41.64
	AAF	0.42	0.53	0.24	0.36
60	Sr	96.88	95.15	97.26	96.27
	ADF	55.36	54.37	55.57	55.01
	AAF	0.78	0.89	0.41	0.72
75	Sr	95.28	94.09	96.44	95.11
	ADF	68.05	67.20	68.88	67.93
	AAF	1.41	1.20	0.60	0.80
90	Sr	93.22	92.28	95.33	93.25
	ADF	79.90	79.09	81.71	79.92
	AAF	1.18	1.38	0.78	1.12

4. DISCUSSION OF RESULTS

Table 8 gives the properties such as filling ability, passing ability etc. of the SCC mixes in the fresh state. EFNARC specifications indicates that this values in the mix possess theself-compacting characteristics.

Compressive Strength: It is observed that the compressive strength of SCC (M50) decreases by 5.67% and 3.3% than the conventional concrete for 3 and 7 days respectively. Additionof fly ash has given this reduction. The compressive strengthof SCC increases by 3.53% than conventional concrete after 28 days as in table 9.

Tensile strength: It is observed that by conducting split tensile test of mixes on standard cylindrical specimen and alsothree point load test on standard prism,the results are tabulated in table 9, where Tensile strength of SCC (M50) increases by 2.8% than conventional concrete.

Flexural strength are obtained by conducting three point load test on standard prism of mixes and is expressed as modulus of rupture which is higher by 15-20% than the values obtained by relationship $f_b = 0.7f_{ck}$ for normal concrete of similar strength.

Acid Attack: The SCC specimens in sulfuric acid for 15 weeks show moderate attack, while the CC specimens show deterioration ranging from very severe attack to total disintegration. The specimens in addition turn into a white pulpy mass to peeling. These reactions in the concrete binderresulted from expansive reactions. In addition sulphates reactwith hydrated calcium silicate phase, there by forming gypsum (Ca_2SO_4) present in all Portland cement which reactswith C_3A to form ettringite and monosulphoaluminate.Thus a substantial expansion and peeling from the resulting reactions take place which after cleaning and removing the deteriorated layers with a steel wire brush, lead to an increasein mass loss each week. The chlorides react with hydrated calcium silicate (in Portland cement) phase a slightly greater with the SCC mix than CC mix, thereby forming CaCL2 which reacts with C3A to form ettringite and chloroaluminate. The SCC and CC specimens' mixes shows moderate attack, but overall degree of attack in sulphuric solution tended to be more severe than the degree of attack in hydrochloric solution.

Mass Loss: The mass loss of SCC and CC mixes in water at15 weeks' time is Zero. The CC mix in terms of mass loss suffered the most deterioration when immersed in 2% and 5% H2SO4solutions.The mass loss was 15.50% and 20% respectively. The time for 10% mass loss due to acid attack was mentioned in table 10 & table11.The weight loss of CC specimen reaches 10%level within 75 days of immersion in 2% H_2SO_4 and 45 days of immersion in 5% H_2SO_4. CC specimen reaches 10% mass loss within 75 days of immersionin 2% HCL and 60 days of immersion in 5% HCL. The SCC mix shows very good resistance to acid attack. Onlyless than 9.5% mass loss is observed in SCC mix immersed inboth H2SO4 and HCL solution.

Acid Durability Factor and Acid Attack Factors

Table12 show the ADF and AAF of CC and SCC immersed in 2% and 5% of H_2SO_4 and HCL solutions. The relative strength and durability factors were increased in SCC mix immersed in both the solutions. The ADF decreases when immersed period increases for SCC as compared to CC in boththe solutions

5. CONCLUSION

SCC is less affected than that of CC immersed in H2SO4 and HCL solution. The presence of RHA and FA offered the resistance against permeability and prevents the entry of acidic solutions.

In SSC the flow properties developed is satisfying, within recommended values.

The resistance against segregation of SCC is also good.

The optimum dosage was found 1.75% by weight of powder of the super plasticizer

Durability studies through acid attack test done by the investigation show that SCC in terms of acid durability factor as compared to conventional concrete of same grade is more durable. Acid consumption is also less.

In SCC the Percentage weight loss and percentage strength loss is less as compared to conventional concrete of same grade. The percentage weight loss and strength loss of CC and SCC mixes increases corresponding to time after immersing in 2% and 5% H2SO4 and HCL solutions. The mass loss with SCC was obtained nearly 10% in sulfuric solution at 15 weeks while CC mix at 8 weeks. In hydrochloric solution at 15 weeks the same loss with SCC was obtained. After 15 weeks, in SCC the mass loss is 40% less than CC.

The investigation indicates better acid resistance of the ternary blended concrete (SCC) performance than binary blended

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