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EXPERIMENTAL INVESTIGATION OF EFFECT OF SHRINKAGE REDUCING ADMIXTURE ON SHRINKAGE CRACKING OF CONCRETE

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ABSTRACT

One of the main factors that contribute to the cracks in concrete is shrinkage. One of the causes that result in the early deterioration of reinforced concrete involves volume changes in concrete due to autogenous shrinkage and moisture loss. As concrete cures and dries, tensile stresses are created due to hydration and loss of moisture. When a concrete's tensile strength is exceeded by an applied stress, a crack forms in the concrete. Concrete has a relatively low tensile strength compared to its compressive strength and experiences a variety of volumetric changes depending on environmental conditions, curing conditions, and applied stresses. Practically speaking it is difficult to make concrete which does not shrink and crack. It is only the question of magnitude. Now the question is how to reduce the shrinkage and shrinkage cracks in concrete structures. As shrinkage is an inherent property of the concrete, it demands greater understanding of the various properties of concrete, which influence its shrinkage characteristics.

In this dissertation an attempt is made to study the shrinkage characteristics and of concrete, containing admixture Shrinkage Reducing admixture. The shrinkage characteristics of concrete like length, width, total number and total area of cracks etc. are measured on concrete panels.

Keywords: Cracking in concrete, Concrete, Shrinkage, Shrinkage reducing admixture.

I. INTRODUCTION

As shrinkage is an inherent property of the concrete, it demands greater understanding of the various properties of concrete, which influence its shrinkage characteristics. In general, the "gel" structure of the cementitious paste in concrete undergoes swelling when it is wetted and shrinkage when it is dried. Such cracking adversely affects durability of the concrete, integrity and aesthetics of the structure. It is only when the mechanism of all kinds of shrinkage and the factors affecting the shrinkage are understood, an engineer will be in a better position to control and limit the shrinkage in the body of concrete.

The volume instability results in response to moisture, chemical, and thermal effects. In addition, various deleterious chemical reactions involving the constituents of concrete or embedded materials can play significant roles causing localized internal expansions. The impact of cracking on durability, especially corrosion, is detrimental to many transportation structures. In particular, cyclic or tidal exposures initiate dry-wet cycles and

provide a constant source of salts to enter the cracks, significantly exacerbating deterioration. Similarly, cracked concrete in contact with sulphate rich soil can lead to accelerated sulphate attack. The complex relationships between cracking and accelerated deterioration are unique to each situation and are not well understood. Thus considerable attention is needed from the research community to fully understand the principles involved and transfer them to the practicing engineering community for improved durability.

Following are the some causes to occur shrinkage cracks in concrete.

1. Excessive surface moisture evaporation in hot and dry atmosphere:-Due to excessive surface moisture evaporation in hot and dry atmosphere water loss in concrete occurs which finally results in to shrinkage cracks.

2. Adverse condition like wind blowing causes also reduction of surface moisture of early placed concrete result in shrinkage cracks.

3. Accelerate the setting time of concrete produces heat in concrete which result to occurs shrinkage cracks.

4. Excessive temperature of the concrete also produces shrinkage cracks in initial set and final set concrete

5. Over mixing of the concrete result in heterogeneous mixing which results in shrinkage cracks.

6. Time between placing and starts to curing concrete influences shrinkage cracks in concrete.

II. EXPERIMENTATION WORK

Concrete is a composite material, which is a widely used for various construction activities around the world. The main drawback of concrete is its low tensile strength. Another drawback of concrete is its volume change due to many reasons like alkali aggregate reaction, acid attack, temperature effect, freezing and thawing, effect of fire, alternate wetting and drying, corrosion, shrinkage and creep. The volume change in concrete leads to cracking of the concrete. Shrinkage of concrete is one of the major problems with respect to durability of concrete. This volume change is considered to be the most detrimental property of concrete, which affects its long term strength and durability. To the practical engineer, the aspect of volume change in concrete is important from the point of view that it causes unsightly cracks in concrete.

The shrinkage cracks lead the atmospheric agencies to the embedded steel. Hence deterioration of steel starts thus affecting the strength and durability of structures. Deformation and cracking owing to shrinkage significantly affect the durability, serviceability, structural integrity, aesthetic and construction cost of structure. Shrinkage causes the shortening of tall structure, loss of pre-stressed element and if differentially restrained, may lead to increased deflection in beams or long term settlement of slab. The term shrinkage is more commonly related to plastic shrinkage and drying shrinkage. Since the autogenous shrinkage and carbonation shrinkage are of very less magnitude, they are not accounted for usually. When concrete is subjected to the atmospheric temperature it undergoes shrinkage effect. This effect is starting from casting of concrete and it gives an influence up to final setting of concrete. This effect is changing due to addition of various admixtures in concrete.

The main aim of this experimentation is to study the effect of the shrinkage characteristics concrete containing Shrinkage reducing admixture. The shrinkage parameters like length of crack, width of crack, total number of cracks and total area of cracks are found for the concrete specimens containing Shrinkage reducing admixtures.

III. METHODOLOGY OF WORK

3.1 GENERAL.

The main aim of the project is to find out the shrinkage characteristics concrete containing Shrinkage reducing admixtures. The shrinkage parameters like length of crack, width of crack, total number of cracks and total area of cracks are found for the concrete specimens.

3.2 EXPERIMENTAL INVESTIGATION.

The experimental work includes the casting, curing and testing of specimens (slabs). A concrete mix M20 grade was designed. The locally available materials were used.

3.2.1. PROPERTIES OF MATERIALS.

Cement:-Portland cement of 43 grade is used. The specific gravity of cement is 3.15.

Coarse Aggregate-The coarse aggregate of 12 mm size was used. The specific gravity was found to be 2.67

Fine Aggregate:-The fine aggregate i.e. sand obtained from river & conforming to Zone II is used. Grading of sand was done strictly as per IS 383-1970. The specific gravity of sand was found to be 2.86 and fineness Modulus was 3.336.

Water: - Clean potable water was used for mixing.

Admixtures:-Shrinkage Reducing Admixtures (SRA):-

Shrinkage Reducing Admixtures is obtained from Degussa construction chemicals manufacturing company. Its market name is Flow Cable. It is in the golden yellow powder form .It is used with a proportion of 0.2%, 0.4%, 0.6%, 0.8%, 1.0% and 1.2% with respect to weight of cement.

Mix proportion:-

M20 mix is used. The Mix proportion is 1: 1.30: 2.50. The water cement ratio was 0.42.

Then the mix proportion becomes

Cement	Water	Sand	Coarse Aggregate
469.52	197.2	592.23	1026.78
1	0.42	1.27	2.51

Actual quantities required for per bag of cement:-.

The mix proportion is 0.42: 1: 1.27: 2.51 for 50 kg of cement, the quantity of materials are worked out as bellow:

a) Cement = 50 kg

b) Fine aggregate = 63.5 kg

c) Coarse aggregate = 125.5 kg

d) Water:-

1) For w/c ratio 0.42, quantity = 21 kg

2) Extra quantity water to be added for absorption in case of CA at 0.7% per mass.=0.88 lit

3) Quantity of water to be deducted for moisture present in sand, at 2% mass.= 1.27lit

4) Actual quantity of water required to be added = 21.0+0.88-1.27= 20.61 lit

5) Actual quantity of fine aggregate.

= 63.5+1.27

= 64.77 Kg

6) Actual quantity of coarse aggregate.

= 125.5 – (0.5/100) x 125.5

= 124.87 Kg

Actual mix proportion becomes for 1 bag cement:-

Cement	Water	Sand	Coarse Aggregate
50	20.61	64.77	124.87
1	0.41	1.30	2.50

IV. CASTING AND TESTING PROCEDURE

The plate moulds used for the experimentation were of dimension 510×305×55 mm. The ingredients of concrete were weighed according to proportion 1: 1.30: 2.50. With water cement ratio 0.42 which corresponds to M20 concrete.

A steel mesh of opening 50×50 mm of diameter 3.0 mm was kept at the base of plate mould which acts as a restraint to induce shrinkage. This dry mix, sand and aggregates were added and again thoroughly mixed. Now the calculated quantity of water to added to this mix. Now the varying dosage of SRA (0.2%, 0.4%, 0.6%, 0.8%, 1.0% and 1.2%) respect to weight of cement added in concrete.

Now the mix was again agitated to get a homogeneous mix in mixer. This mix was poured in plate mould, which was kept on the table vibrator.The slab specimen was finished smooth after giving sufficient compaction both through table vibrator and hand compaction. Immediately after casting, the slab specimens were kept in an open atmosphere along with the mould.The moment all the specimens were transferred to the open atmosphere the time was reckoned. For plastic shrinkage 6 hrs observations were made. In all the experiments the average temperature of the atmosphere was ranging from 34°C to 41°C.

As the almost plastic shrinkage cracks occurs in the initial 6-8hrs after concreting so after 6 hrs from the time of transferring the specimens to open atmosphere the plastic shrinkage parameters such as length of crack, width of crack and total number of cracks were noted down on a plastic sheet. For this purpose, a transparent plastic sheet was placed on a glass plate which in turn was kept on the surface of the concrete specimens and all the possible visible cracks were drawn on the sheet. The minor cracks were drawn with the help of a magnifying lens. The widths of cracks were measured with the help of a hand microscope.

All the specimens were now demoulded and transferred to the curing tank after 24 hrs. From 6 hrs. to 24 hrs. Occurs plastic as well as drying shrinkage. So at 24 hrs. Specimens were again observed for the shrinkage parameters like length of crack, width of crack and total number of cracks on the plastic sheet.

These specimens were now transferred to the curing tank wherein they were allowed to cure for 28 days. After 28 days, these specimens were kept in atmosphere for two days. Almost drying shrinkage cracks occurs after 28 days so these specimens were again observed for the shrinkage parameters like length of crack, width of crack and total number of cracks on the plastic sheet.

Sr. No.	Different Admixture Combination		Shrinkage Parameters					
			Max. length of crack in mm			Max. width of crack in mm		
			6Hrs	24 Hrs	28 Days	6 Hrs	24 Hrs	28 Days
1	Ref. concrete without		161	56	61	0.3	0.25	0.35
2	DIFF. % OF S.R.A	0.2%	130	45	49	0.25	0.2	0.3
		0.4%	116	39	41	0.2	0.15	0.25
		0.6%	60	31	36	0.2	0.1	0.15
		0.8%	44	51	42	0.25	0.15	0.25
		1.0%	142	51	62	0.3	0.2	0.25
		1.2%	196	69	83	0.4	0.35	0.3

Table 1 Test results of concrete specimens:-

Overall Test Results Shrinkage Parameters concrete containing various % of SRA admixture.

The following give the test results of Shrinkage Parameters concrete containing various % of SRA admixtures.

Table 2:- Overall results Shrinkage Parameters containing various % of SRA admixtures

Sr. No.	Different Admixture Combination		Shrinkage Parameters					
			Total number of cracks			Total area of cracks in mm2		
			6 Hrs	6 Hrs	6 Hrs	6 Hrs	6 Hrs	6 Hrs
1	Ref. concrete without		123	43	29	355	103.20	97.05
2	DIFF. % OF S.R.A	0.2%	40	40	27	251.63	72.79	73.40
		0.4%	48	58	19	204.95	59.05	43.25
		0.6%	16	16	15	162	22.20	25.80
		0.8%	13	13	16	32.55	21.85	38.35
		1.0%	70	70	31	485.20	133.24	109.83
		1.2%	84	84	36	646	212.90	161.804

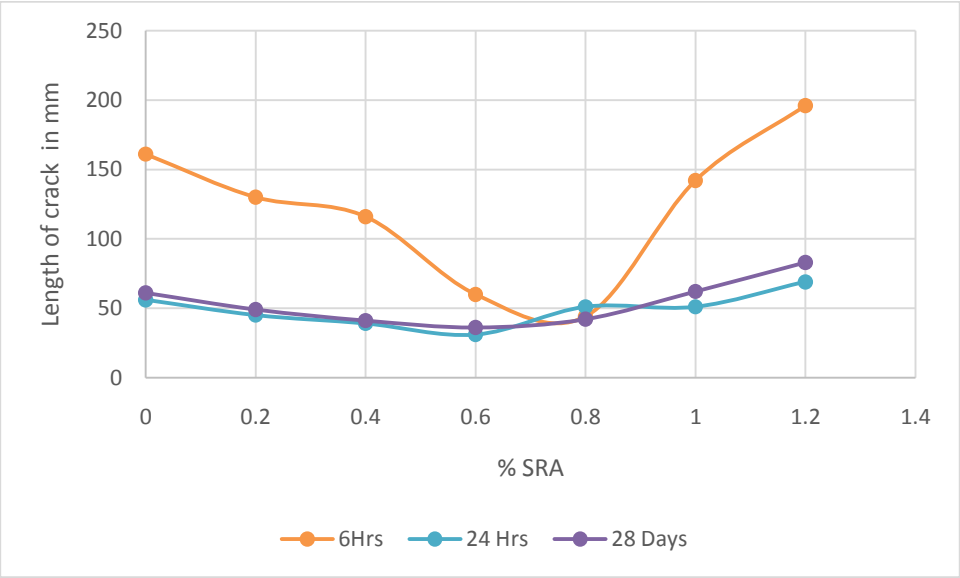
Table 3: Percentage Increase or Decline of Parameters containing varying dosage SRA admixtures w.r.t Ref. concrete without admixtures

Sr. No.	Different Admixture Combination		Shrinkage Parameters								
			Total no. of cracks in %			Total area of cracks in %			Total length of cracks in %		
			6 Hrs	24Hrs	28Day	6 Hrs	24Hrs	28Days	6 Hrs	24 Hrs	28Day
1.	Ref. concrete without admixtures		123	43	29	355.00	103.20	97.05	161	56	61
2.	DIFF. % OF S.R.A	0.2%	-20.32	-6.98	-6.89	-29.46	-29.46	-24.367	-19.25	-19.63	-19.67
		0.4%	-30.08	+11.63	-34.48	-42.27	-42.78	-55.43	-27.95	-30.56	+32.78
		0.6%	-52.85	-62.79	-48.28	-54.37	-78.49	-73.42	-62.73	+44.64	-40.98
		0.8%	-80.49	-69.76	-44.83	-90.89	-78.83	-60.48	-72.67	-8.93	-31.15
		1.0%	-26.01	+62.79	+6.896	+36.69	+25.91	+13.14	-11.80	-8.93	-1.64
		1.2%	+7.32	+95.34	+24.14	+81.97	+103.9	+66.72	+21.74	+23.21	+36.065

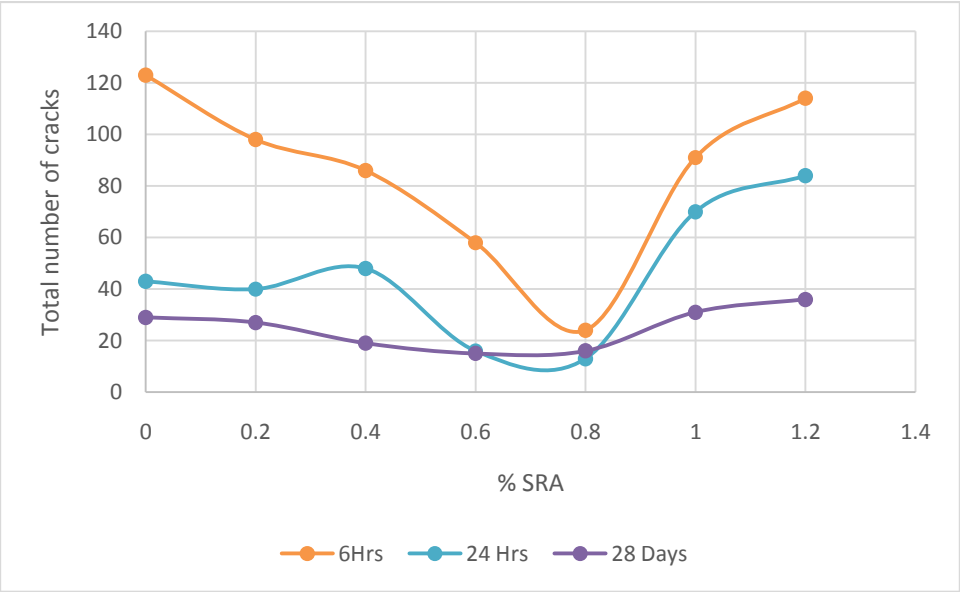
Table 3 gives Percentage Increase or Decrease of Total No., Area of cracks, Length of cracks and no of cracks concrete containing varying dosage SRA admixtures w.r.t Ref. concrete without admixtures

NOTE:- 1) Positive sign(+) indicates increase in parameter w.r.t. ref. concrete mix.

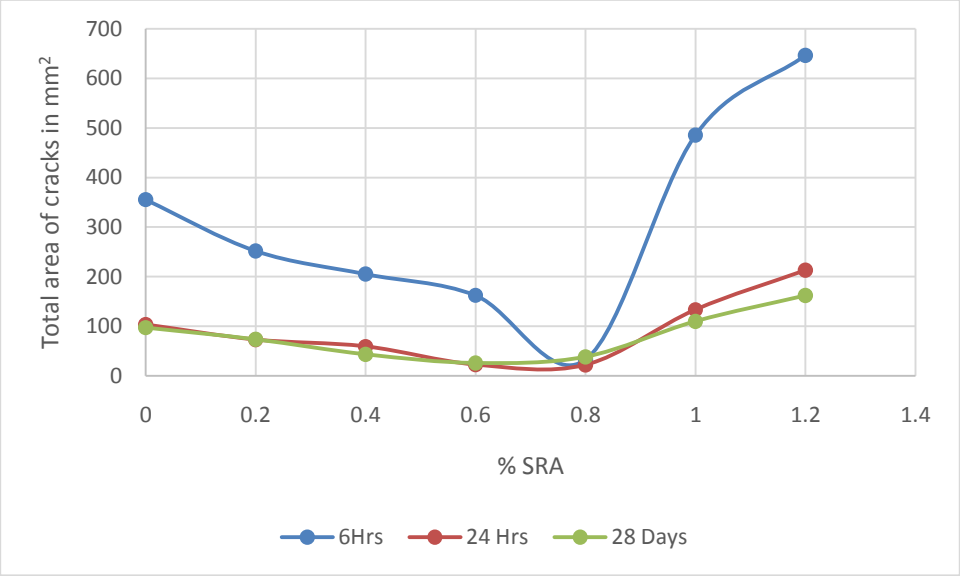
2) Negative sign(-) indicates decrease in parameter w.r.t. ref. concrete mix.



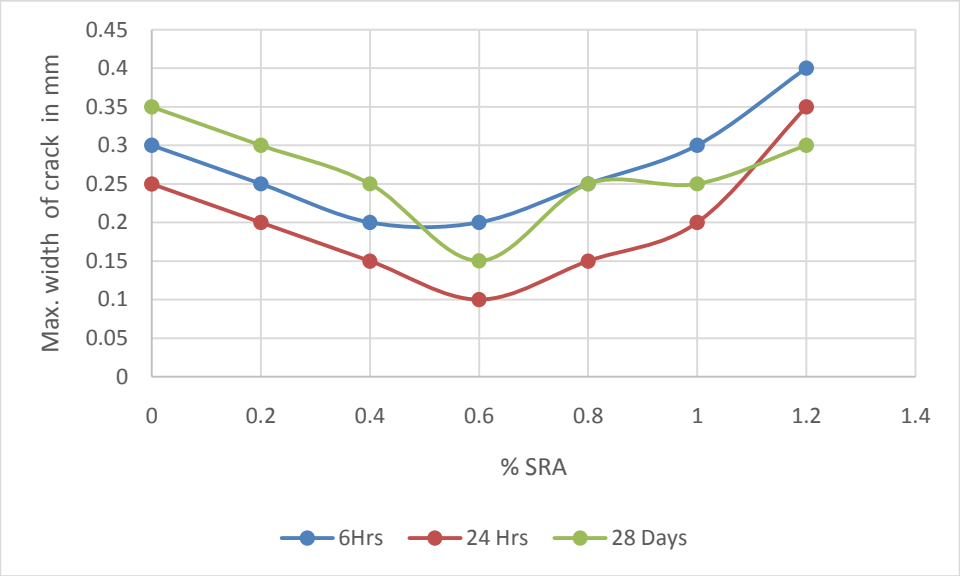
Graph No1. Results of Shrinkage Parameters (length of cracks) of concrete containing admixture (0% to 1.2%)



Graph No. 2. Results of Shrinkage Parameters (no of cracks) of concrete containing admixture (0% to 1.2%)



Graph no3. Results of Shrinkage Parameters (Area cracks) of concrete containing admixture (0% to 1.2%)



Graph no4. Results of Shrinkage Parameters (Max. width of crack in mm) of concrete containing admixture (0% to 1.2%)

V.CONCLUSION

Based on the results obtained in this study the following conclusions are drawn.

1. As % of SRA dosages increases shrinkage cracks of the concrete reduces.

2. For SRA the optimum dosage of 0.8% gives minimum shrinkage parameters like, maximum length, maximum width, total no of cracks and area of cracks are less as compare to other dosage applied to concrete.

3. Shrinkage produces permanent cracks in concrete leads to permeable concrete. Hence it is necessary to use optimum dosage for design.

REFERENCES

[1.] Antoine E.Naaman, Thanasakwongtanakitcharoen,et al "Influences of diffrene fibres on plastic shrinkage of concrete " ACI material journal title no 102-M07 (Jan-Feb 2005),pp 49-57.

[2.] Peter H. Morris and F dux, "A review of ACI recommendations for preventation of plastic cracking" ACI material journal title no 102-M35 (sept-oct 2005),pp 307-314.

[3.] Min-hongzhang,lianli,andp.paramasivam "shrinkage of high- strength lightweight aggregate concrete exposed to dry environment " ACI material journal title no 102-M10 (march-april 2005)pp.86-92.

[4.] Calvin Mccall, Michel E. King "Effect of aggregate gradingh on drying shrinkage of florida concrete" concrete international march2005.

[5.] Dale P.Bentz "Curing with shrinkage reducing admixture" concrete international oct.2005.

[6.] Luis Fernandez luco, Roberto Pombo and Robert torent "shrinkage compensating concrete in argentina" concrete international may 2003.

[7.] Shetty M. S., "Concrete Technology", S. Chand & Company Ltd, 2006.