EXPERIMENTAL INVESTIGATION ON EFFECT OF SELF-CURING AGENTS ON MECHANICAL PROPERTIESOF HIGH PERFORMANCE CONCRETE

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ABSTRACT:- The Conventional curing may experience a decrease in quality because of Self-drying up in cement. The Self-curing is one of the most ideal approaches to enhance the quality and strength of the Concrete. In this paper the self-curing cement was thrown for M20 evaluation of cement with Poly ethylene glycol (PEG) as a curing operator. The test program comprises of determination of mass misfortune and quality crumbling against weakened Hydrochloric corrosive (HCl), fast chloride infiltration test on the example of 28 days, 1 year and 2 years of curing. From the studies lessening because of hydrochloric corrosive assault of completely drenched example, Sprinkler cured example and self-cured example were analyzed and the example cured by completely inundation into HCl for 28 days, 1 year and 2 years demonstrates the better result.

KEYWORDS: Poly ethyl glycol (PEG), Self cured solid, Durability, Chloride assault

1. INTRODUCTION:-

It is a standout amongst the most sturdy building materials as it gives prevalent imperviousness to fire, contrasted and wooden development and can pick up quality after some time. Structures made of cement can have a long administration life. Reinforced bond is a composite material in which concrete's for the most part low versatility and pliability are killed by the fuse of backing having higher unbending nature and in addition adaptability. Strength relates to its impenetrability to disintegrating coming to fruition as a result of external causes furthermore inward cases. . Sturdiness of concrete is its impenetrability to going into disrepair workplaces to which the strong may be revealed in the midst of its organization life.

The diminishment of porosity and vulnerability surmises the adjustment in compound strike and disintegration resistance. . Curing of bond is keeping up agreeable clamminess content in concrete in the midst of its underlying stages with a particular final objective to develop the desired properties. However awesome curing is not for the most part practical generally speaking. A couple of inspectors offered the conversation starters whether there will act normally curing concrete. . The idea of self- curing specialist is to diminish the water vanishing from cement, and consequently build the water maintenance limit of the solid contrasted with routine cement. Past examination has demonstrated that both curing time and curing temperature altogether impact the compressive quality of geopolymer cement. A few scientists, have examined the impact of curing time and curing temperature on the properties of geopolymer cement. Palomo et al. , in their study on fly fiery remains based geopolymers have reported that the curing temperature and curing time fundamentally influenced the mechanical quality of fly powder based geopolymers. They reasoned that higher curing temperature and more curing time demonstrated to bring about higher compressive quality. In higher w/c cements the water can be, and frequently is supplied by outer curing in low w/c cements, the porousness of the solid rapidly turns out to be too low the successful exchange of water from the outside surface to the solid interior.

For a solid, bendable and strong development the support needs the accompanying properties:

- High relative quality
- High toleration of elastic strain
- Good bond to the solid, independent of pH, dampness, and comparable components
- Thermal similarity, not bringing on unsuitable hassles in light of evolving temperatures.
- Durability in the solid environment, regardless of consumption or supported anxiety for instance.

Hence this paper investigates the durability properties against Chloride attack and it was compared with the conventionally cured and self-cured specimens. The proportions were studied and discussed in terms of strength deterioration factor.

Objective of the Investigation

1. To examine the properties such as workability of self- compacting self-curing concrete with various dosage of curing agents such as PEG, SAP, LWA, with fixed percentage of self-compacting agent.
2. To determine the strength of SCSCC and to compare it with conventionally cured concrete which involves immersion curing and sprinkler curing.
3. To explore the optimized percentage of SCSCC from various test combinations

2. EXPERIMENTAL STUDY

Portland Pozzolana bond of 43 evaluations fitting in with Indian Standard is utilized for making concrete all through the examination. Particular gravity is one of the critical parameter in solid blend plan which can be discovered utilizing Pycnometer. The Specific gravity of concrete is 3.15.The Chemical Properties of bond is given in Table 1.

Table 1 Chemical Property

Material	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	LOI
Cement	23.5	5.1	3.4	63.4	1.6	1.4

Locally accessible waterway sand, with a particular gravity of 2.54 and fineness modulus of 2.54 was utilized as fine total. Hand broken rock stones from neighborhood quarries were utilized as coarse total as a part of this examination. Most extreme size of coarse total was restricted to 20mm. The Specific gravity of coarse total utilized was 2.6. Self-curing concoction viz poly ethyl glycol was utilized and its properties are appeared in Table 1. The solid blend was composed according to Indian standard to accomplish a compressive quality of 20Mpa. A Mix extent utilized for the study was 1:1.425:3.10. A consistent water concrete proportion of 0.5 was utilized as a part of all the blends.

The 3D shapes of 150mm size were thrown to perform corrosive assault under weakened hydrochloric corrosive. The chamber example of 100 mm breadth and 50mm tallness was utilized to perform fast chloride infiltration test. Research facility sort blender machine was utilized to blend the elements of cement. To deliver great workable self-curing concrete the accompanying strategy was followed in throwing. In the first place totals and concrete were permitted to blend for one moment and some measure of water was included inside two minutes. At long last the self-curing compound PEG was included with the remaining water and the solid was permitted to blend for three minutes. Every one of the examples was all around compacted utilizing table vibrator. The examples were demoulded following a day and after that set in curing tank for 28 days of curing. The self-curing examples were set independently without inundating in water. Since the workability is an exceptionally touchy parameter in self-curing concrete both droop and compaction component tests were directed to quantify the workability of blend. The cast examples were subjected to various natural presentations and tried for mechanical quality properties. The bond content and the w/c proportion significantly affect the inward impact on the inside relative mugginess of the solid whether self-curing or routine blends, this affirms with the discoveries already finish up for traditional cement blends.

3. TEST STRATEGIES

The assessment of ternary blended concrete in acidic environment was made considering the execution from visual evaluation, mass mishap and quality disintegrating variable.

3.1 Visual assessment

Round and empty case of 45 mm broadness and 90 mm long were tossed for visual examination and the prepared cases were cured in water for 28 days and after which they were doused in 5% HCl game plans. The tube formed illustrations were arranged so all sides were in contact with the courses of action. The pH5 of the two game plans were reliably checked and adjusted to keep relentless by supplanting the ate up courses of action by new game plans. The visual impression of destructive attack was made by execution scale indicated in Table 2 took after by Al- Tamimi.

Table 2 Scale of visual deterioration level of concrete specimens immersed in acidic solutions

Scale	Deterioration level
0	No attack
1	Very slight attack
2	Slight attack
3	Moderate attack
4	Severe attack
5	Very severe attack
6	Partial disintegration

3.2 Acid assault

Chloride assault is the term used to depict the arrangement of concoction responses between chloride particles and the segments of solidified cement chiefly bond glue, brought on by introduction of cement to dampness. 3D square example of 150mm size was thrown for ordinary and self-curing concrete. All the solid examples were inundated in chloride answer for 2years. Every one of the examples was situated so that all the sides were in contact with the arrangements. A non-permeable compartment is chosen and chloride arrangement has been set up by including 5% of cemented hydrochloric corrosive of 50 liters of refined water. The pH of the arrangement was consistently checked and changed in accordance with keep them steady. The execution of cement was made in light of the visual evaluation, mass setback and quality rot variable. Quality rot component is described as the extent of advancement in compressive quality to beginning compressive quality. The test for compressive quality was done at the room temperature and as indicated by the Indian benchmarks. The test was finished in a PC controlled weight testing machine.

3.3 Rapid Chloride Penetration test

Rapid Chloride Penetration test (RCPT) was executed according to ASTM C 1202 to decide the electrical conductance of self cured and routine cement blends at 28 years old days curing and to give a quick sign of its imperviousness to the infiltration of chloride particles. The test technique comprise of observing the measure of electric current went through 50mm thick cuts of 100mm ostensible distance across of barrel shaped examples for span of six hours. The test setup for RCPT is appeared in Fig.1.

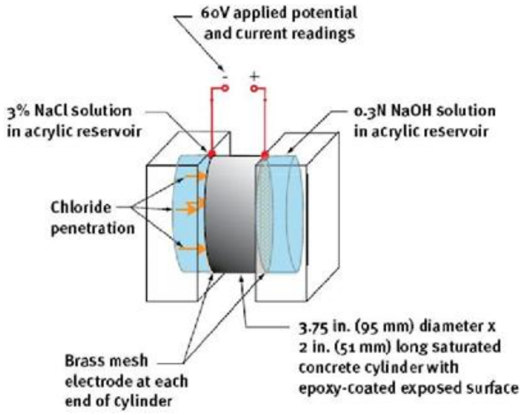

Fig 1. RCPT Test representation

The RCPT contraption comprises of two supplies. The example was altered between two stores utilizing an epoxy holding specialist to make the test set up watertight. One supply (associated with the Positive terminal of DC source) was loaded with 0.3 N Sodium hydroxide arrangements and the other repository (associated with the Negative terminal of DC source) was loaded with 3 N Sodium chloride arrangements. A DC of 60 V was connected over the example utilizing two stainless steel terminals (networks) and the current over the example was recorded at 30 minutes interim for length of six hours. The aggregate charge went amid this period was figured as far as coulombs utilizing the trapezoidal guideline (ASTM C 1202).

$$Q = 900(I_0 + 2I_{30} + 2I + \ldots + 2I_{330} + 2I_{360}) \ldots 1$$

Where Q, charges went in coulombs and I_0 current in amperes instantly after voltage is connected. The solid quality (level of Chloride particle vulnerability) can be evaluated taking into account the breaking points are as given in ASTM C 1202.

3.4. Mass loss

The solid 3D squares of 150 mm size were thrown for finding the mass loss because of the corrosive assault [1,8,10]. The readied 3D squares were cured in water for 28 days 1 year and 2 years, after which they were drenched in 5% HCl arrangements. The underlying mass and the mass of solid examples after the submersion time of 30 days, 1 year and 2 years were measured for finding the mass misfortune because of the crumbling of solid examples. The normal estimation of three examples was considered for evaluation.

3.5. Quality weakening variable (SDF)

The crumbling of solid shape examples were researched by measuring the quality disintegration element communicated in rate and it was figured by utilizing the equation.

$$SDF = [(f_{cw} - f_{ca})/f_{cw}] \times 100$$

Where, f_{cw} is the normal compressive quality of solid 3D squares cured in water and f_{ca} is the normal compressive quality of shapes drenched in corrosive arrangements. The compressive quality test was done for every example following 1 month, 1 year and 2 year of drenching period. In every test period, the normal estimation of five examples were tried and reported.

4. RESULTS AND DISCUSSIONS

4.1 Visual assessment

Table 3 shows the summery of the visual assessment of the cylindrical specimens after 30 days, 1 and 2 years of immersion of specimen in 5% HCl solutions. The edges and surfaces of all the specimens were maintained without any disintegration while immersed in water after the observation period of 30 days, 1 and 2 years. From the table 3, it was observed that the Sprinkler cured specimen suffered a greater degree of acid attack than the other in acid solutions. Because of the extensive responses, the examples were crumble and transformed into a white thick mass notwithstanding peeling . The corrosive diffuses into solid structure wrecks the bond gel folio and framing delicate and dissolvable gypsum (calcium sulfate hydrate), which responds with C3A to shape ettringite. The arrangement of auxiliary ettringite results in a generous extension of ordinary examples and prompts expand the level of corrosive assault. The lessening of $Ca(OH)_2$ in mixed cement decreases the development of auxiliary ettringite and diminishes the extension of solid examples. This is because of the improvement of thick solid mass by decreasing the small scale pores and its sizes.

Table 3 Visual assessment test

Grade of concrete	Amount of Acid added	Days of curing	Charge passed		
			Fully immersed	Sprinkler	Self cured
M 20	5% of HCl with 50*l* of water	30 days	2-3	3	2
		1 year	3-4	4	3-4
		2 year	4	5	5

4.2 Rapid Chloride Penetration test

Table 5 shows the result of Rapid Chloride Penetration Test. Chloride Permeability based on Charge Passed is given in table 4. The mass loss in percentage gives an indication about the amount of chloride penetration into the concrete. Mass loss obtained in conventional curing is 10% also the charges passed in fully immersed concrete specimen is 1771.2°C and for sprinkler cured, Self cured Specimen are 2536.2°C, 1196.32°C respectively. From which it is to be concluded that chloride permeability is low for the fully immersed and self cured Specimens whereas the sprinkled cured specimen has moderate permeability of chloride. The test results are compared to the values in the table below (Table 4). This table was originally referenced in FHWA/RD-81/119 and is also used in AASHTO T277-83 and ASTM C1202 specifications.

Table 4 Chloride Permeability based on Charge Passed

Charge Passed (Coulombs)	Chloride Permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low

Table 5 RCPT Test results

S. No.	Time in Hrs	Current in I (A)		
		Fully immersed	Sprinkler	Self cured
1	0	0	0	0
2	0.5	0.01020	0.01040	0.01017
3	1	0.02082	0.02109	0.02067
4	2	0.02318	0.02340	0.02303
5	3	0.02875	0.02900	0.02844
6	4	0.03348	0.03389	0.03315
7	5	0.04448	0.04491	0.04424
8	6	0.05143	0.05178	0.05123

4.3. Mass loss

Fig 1 display the results of mass loss of control fully cured, sprinkler cured and self cured concrete due to acid attack and the mass loss is consider as a function of time. The resistance of cement based materials to chemical attack is mainly due to permeability and alkalinity of concrete mass. The PCC mix suffered the most deterioration in terms of mass loss when immersed in 5% HCL solutions. The mass loss of 30, 1 year and 2 year curing M20 grade OPC specimens were 6.4%, 9% and 11.7% respectively. The mass losses of the OPC specimens were reduced when the cement content increases (increasing the concrete grades) per m3 of concrete. Mass losses in fully immersed concrete specimen in 30 days of immersion obtained were 6.4%. This value was further increased as 9% and 11.7% for one and two year respectively. While the sprinkler curing is considered the mass loss is 8.3% for 30 days and 12%, 16.2% for one and two years respectively. Higher the mass loss was obtained in sprinkler curing. The mass loss in self curing is 7%, 10% and 13.2% respectively for 30 days, 1 and 2 years. It is evident from the result that specimen which is fully immersed has lower weight loss.

Comparing the mass loss of fully self cured specimen with immersed specimen is about 9% in 30 days, about 10% mass loss in 1 year and 11.36% in 2 years. Comparing the mass loss of fully self cured specimen with sprinkler curing specimen is about 18.57% in 30 days, about 20% mass loss in 1 year and 22% in 2 years.

4.4 Strength deterioration factor (SDF)

The reduction of compressive strength due to acid attack was expressed in the form of strength deterioration factor (SDF). Figures 2 shows the SDF of 30 days 1 and 2 years cured specimens of M20, grade concrete immersed in 5% HCL. Strength loss in fully immersed concrete specimen in 30 days of immersion was obtained as 7.8%. This value was further increased as 14.5% and 20% for one and two year respectively. While the sprinkler curing is considered the mass loss is 10.4% for 30 days and 20%, 29% for one and two years respectively. Higher the strength loss was obtained in sprinkler curing, comparing with self-cured specimen. The strength loss in self-curing is 9.2%, 17.5% and 24.9% respectively for 30 days, 1 and 2 years. It is evident from the result that specimen which is fully immersed has lower strength loss.

Fig 2 Strength deterioration Test Setup

Comparing the strength loss of fully self cured specimen with immersed specimen is about 13% in 30 days, about 14.28% mass loss in 1 year and16.46% in 2 years. Comparing the mass loss of fully self cured specimen with sprinkler curing specimen is about 15% in 30 days, about 17.14% mass loss in 1 year and 19.6% in 2 years.

The sprinkler curing specimens are severely affected by the acid attack and hence the SDF values of such specimens were more than 10%. The rate of change SDF for Sprinkler cured specimen was observed as rapid change. SDF of fully immersed specimens were comparatively lesser than the self cured specimens. The maximum SDF value of 19.6% was observed in 2 years cured M20 grade concrete. Meantime the minimum SDF value of 13% was observed in 30 days cured M20 grade concrete.

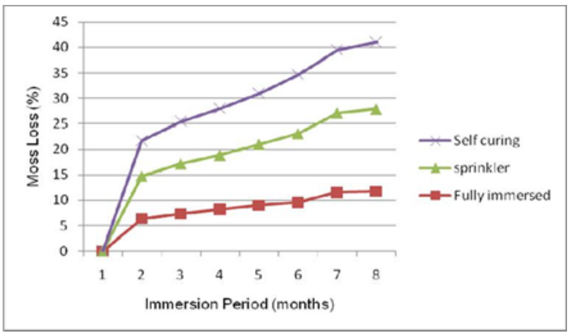

Figure 3 Mass loss of M20 grade concrete due to immersion in 5% HCl solution

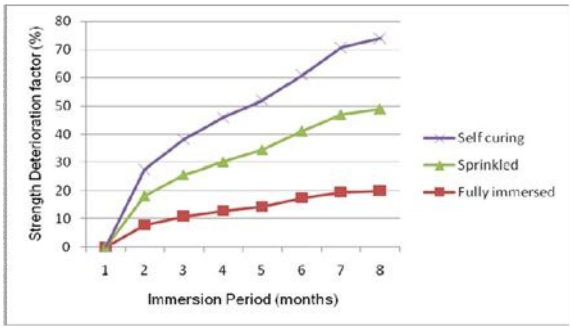

Figure 4 SDF of M20 grade concrete due to immersion in 5% HCl solution

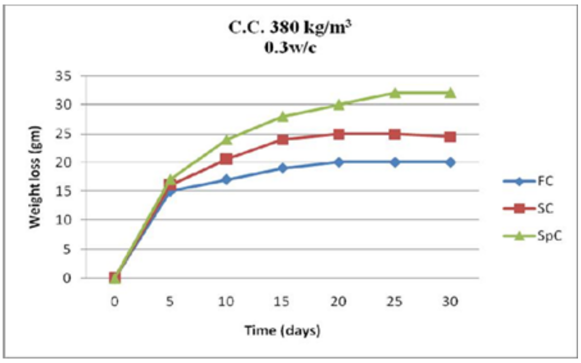

Figure 5 Weight Loss for CC 380 kg/m3

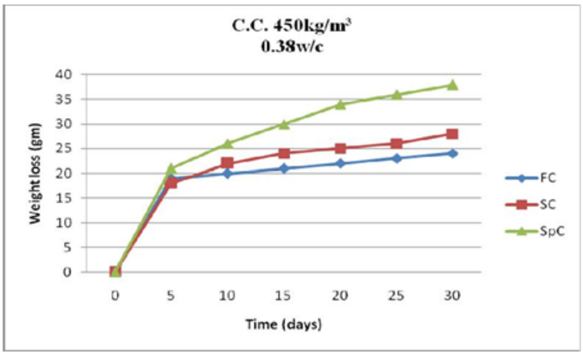

Figure 6 Weight Loss for CC 450 kg/m3

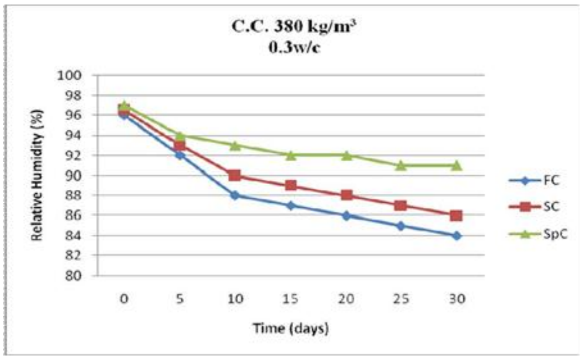

Figure 7 Internal relative Humidity for CC 380 kg/m3

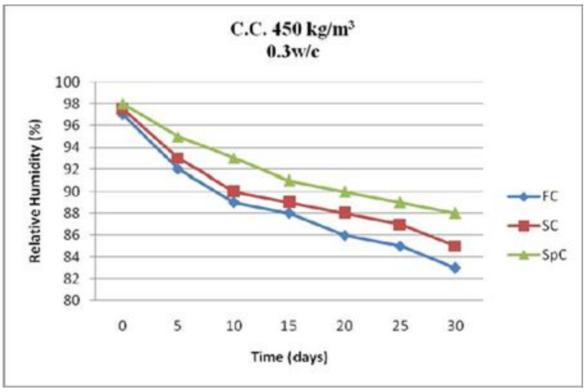

Figure 8 Internal relative Humidity for CC 450 kg/m3

5. CONCLUSIONS

The accompanying conclusions are drawn from the after-effects of the examinations:

- The Sprinkler cured examples of the whole M20 grade cement were extremely weakened after the submersion of 5%HCl arrangements up to 30 days 1 and 2 years.
- Comparing the mass loss of completely self cured example with submerged example is around 9% in 30 days, around 10% mass misfortune in 1 year and 11.36% in 2 years.
- Comparing the mass loss of completely self cured example with sprinkler curing example is around 18.57% in 30 days, around 20% mass misfortune in 1 year and 22% in 2 years.
- Comparing the quality loss of completely self cured example with drenched example is around 13% in 30 days, around 14.28% mass misfortune in 1 year and 16.46% in 2 years.
- Comparing the mass loss of completely self cured example with sprinkler curing example is around 15% in 30 days, around 17.14% mass misfortune in 1 year and 19.6% in 2 years.
- In RCPT test chloride porousness is low for the completely submerged and self cured Specimens while the sprinkled cured example has moderate penetrability of chloride.
- This is because of the improvement of thick solid mass by diminishing the smaller scale pores and its sizes.
- It is recommended to utilize completely inundation and self curing techniques for curing for the better toughness and quality.
- This is due to the development of dense concrete mass by reducing the micro pores and its sizes.
- It is suggested to use fully immersion and self curing methods of curing for the better durability and strength.

REFERENCES

- Al-Tamimi AK, Sonebi M. Assessment of self-compacting Concrete Immersed in Acidic Solutions, Journal of Materials in Civil Engineering, No. 4, 15(2003)354-7.
- A. Palomo, M.W. Grutzeck, M.T. Blanco, " Alkali-activated fly ashes-A cement of the future ", cement and Concrete Research, 29 (8) : 1999, pp. 1323 -1329.
- ASTM C1202-09, Standard test method for electrical indication of concrete's ability to resist chloride ion penetration, ASTM international, west Conshohocken, PA, (2003), DOI: 10.1520/C0033-03.
- Bai J, Wild S, Sabir BB. Chloride ingress and strength loss in concrete with different PC-PFA-MK binder compositions exposed to synthetic sea water, Cement and Concrete Research, No. 3, 33(2003)353-62
- Barker AP, Hobbs DW. Performance of Portland limestone cements in mortar prism immersed in sulphate solutions at 50C, Cement and Concrete Composites, 21(1999) 129-37.
- Bentz, D.P., and Snyder, K.A., " Protected Paste volume in Concrete-Extension to Internal Curing Using Saturate Light weight Fine aggregate," Cement and Concrete Research, V. 29, 1999, pp. 1863-1867.
- Bentz DP, LuraP, Roberts JW. Mixture proportioning for internal curing concr Int.No. 2, 27 (2005)
- Chatveera B, Lertwattanaruk P, Makul N. Effect of sludge water from ready mixed concrete plant on properties and durability of concrete, Cement and Concrete Composites, 28(2006)441-50.
- D. Hardjito, S. E. Wallah, D. M. J. Sumajouw, and B.V. Rangan, "Fly ash-based geopolymer concrete", Australian Journal of Structural Engineering, Vol 6, No.1, 2005, pp. 1-9.
- Dakshina Murthy NR, Raaseshu D, Seshagiri Rao MV. Studies on fly ash concrete under sulphate attack in ordinary, standard and higher grades at earlier ages, Asian Journal of Civil Engineering and Housing, No. 2, 8(2007)203-14.
- Han-Young Moon, Seung-Tae Lee, Seong-Soo Kim, Sulphate resistant of silica fume blended mortars exposed to various sulphate solutions, Canadian Journal of Civil Engineering, No. 4, 30 (2003)625-36.
- J. G. S. van Jaarsveld, J. S. J. van Deventer, and G. C. Lukey, "The Effect of Composition and Temperature on the Properties of Fly Ash and Kaolinite-based Geopolymers", Chemical Engineering Journal, 89 (1- 3): 2002, pp. 63-73.
- Mather B. Self curing concrete, why not? Conc Int No 1, 23: 2001.
- McGrath PF, Internal Self-desiccation of silica fume concrete. MASc thesis, Civil Engineering Department, Universty of Toronto 1989
- Mjornell K. Self-Desiccation in concrete. Chalmers University of Technology 1994; 2(556):94
- Mullick AK. Performance of concrete with binary and ternary cement blends, The Indian Concrete Journal, January 2007, pp.15-22.
- Murthi P and Sivakumar V., (2008) Asian J Civil Engg (Building and Hoousing)., 9:473
- P. Rovnanik, "Effect of curing temperature on the development of hard structure of metakaolin-based geopolymer", Construction and Building Materials, 24 (2010), pp. 1176-1183.
- Ramakrishna G and Sundararajan T(2005) Cem concr comp., 27:547
- Tiwari AK, Bandyopadhyay P, Concrete properties affecting corrosion of embedded rebars, The Indian Concrete Journal, 2004, pp. 157-63.
- Wang J, Dhi R K, Levitt M. Membrane Curing of concrete , Cement Concr res No 8, 24: 1994
- Zhu W, Bartos PJM . Permeation properties of self-compacting concrete, cement Concr res 2003:33(6):921-6