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Strength Variation of Blended Mix by Selfing and Crossing Theory

A.P Nikam[1], U.S. Ansari [2]

Research Scholar, Department of Civil Engineering, SND COE & Research Center, Yeola Nasik, India[1]

Professor, Department of Civil Engineering, SND COE & Research Center, Yeola Nasik, India[2]

Abstract: Concrete is one of the most widely used construction material having ingredients as cement, fine aggregate, coarse aggregate and water. It develops strength in the presence of water when added to the dry mixture of the ingredients. The development of strength in the said mass starts instant of the time when the water is just added to it up to a certain time preferably the initial setting time and the prepared mass remains plastic and can be moulded easily, after which the hardening process proceeds faster towards the final setting time and the mass becomes hard and solid which cannot be moulded at all. Delays in concreting are leading to partial setting of concrete which has suffered a long period of exposure in the open before actual casting in the mould. This concrete should not be utilized for strength purpose in practice, and is to be discarded, but still it contains a good portion of the active part of the reactive cement in that mass. These situations may affect the strength of final product. The strength also depends on the plane at the concrete joint made while casting. If blending of such partially set concrete with richer mix to attain the target strength, can achieve economy and there will be no wastage of material. Much building waste is made up of materials such as concrete and mortar damaged or unused fur various masons during construction. Observational research has shown that this can be as high as 5 to 10% of the materials that go into a building a much higher percentage than the 2.5-5% usually assumed by quantity surveyors and the construction industry. Since considerable variability exists between construction sites, there is much opportunity for reducing this waste and by reusing the material natural resources and the environmental balance can be maintained and economy will be gained. The study aims for identifying such a time lag after that the required target strength may be achieved even after delay in casting. To identify the meeting planes of two interface layers which has lesser effect on compressive strength. Use of Bonding Agent (SBR Latex) for improves time lag and strength of concrete. Study of Blended of concrete (Selfing and Crossing).

Keywords: Selfing, Crossing, Blended Mix Concrete, Stryine Butdine rubber, Ultimate Load.

I. INTRODUCTION

Delays in concreting can result in cold joints. To avoid cold joints, placing of concrete should be resumed substantially before the time of initial set. For unusually long delays during concreting, the concrete should be kept alive by periodically revibrating it. However, concrete should not be over vibrated to the point of causing segregation. As in practice casting cannot be completed in one go or there is a time lapse between mixing and placing, the strength of the final product is affected. The strength could also depend on the plane where casting at two different points meet. Therefore the concrete which is not cast immediately after mixing, but is cast after some time can be called as partially set concrete.

Need of Joints in Construction :-

Joints are necessary in concrete structures for a variety reasons. Not all concrete in a given structure can be placed continuously, so there are construction joints that allow for work to be resumed after a period of time. Since concrete undergoes volume changes, principally related to shrinkage and temperature changes, it can be desirable to provide joints and thus relieve tensile or compressive stresses that would be induced in the structure. Alternately, the effect of volume changes can be considered just as other load effects are considered in building design. Various concrete structural elements are supported differently and independently, yet meet and match for functional and architectural reasons. In this case, compatibility of deformation is important, and joints may be required to isolate various members.

Construction joints:-

For many structures, it is impractical to place concrete in a continuous operation. Construction joints are needed to accommodate the construction sequence for placing the concrete. The amount of concrete that can be placed at one time is governed by batching and mixing capacity, crew size, and the amount time available. Correctly located and properly executed construction joints provide limits for successive concrete placements, without adversely affecting the structure. For monolithic concrete, a good construction joint might be a bonded interface that provides a watertight surface, and allows for and shear continuity through the interface. Without this continuity, a weakened region results that may serve as a contraction or expansion joint. A contraction joint is formed by creating a plane of weakness. Some, or all, of the reinforcement may be terminated on either side of the plane. Some

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contraction joints, termed "partial contraction joints" allow a portion of the steel to pass through the joint. These joints, however, are used primarily in water retaining structures. An expansion joint is formed by leaving a gap in the structure of sufficient width to remain open under extreme high temperature condition. If possible, construction joints should coincide with contraction, isolation, or expansion joints. To achieve a well-bonded water tight interface, a few conditions should be met before the placement of fresh concrete. The hardened concrete is usually specified to be clean and free of laitance. If only a few hours elapse between successive placements, a visual check is needed to be sure that loose particles, dirt and laitance are removed. The new concrete will be adequately bonded to the hardened fresh concrete, provided that the new concrete is vibrated thoroughly. Older joints need additional surface preparation. Cleaning by an air-water jet or wire brooming can be done when the concrete is still soft enough that laitance can be removed, but hard enough to prevent aggregate from loosening. Concrete that has set should be prepared using a wet sand blast or ultra- high pressure water jet. ACI 318 slates that existing concrete should be moistened thoroughly before placement of fresh concrete. Concrete that has been placed recently will not require additional water, but concrete that has dried out may require saturation for a day or more. Pools of water should not be left standing on the wetted surface at the time of placement; the surface should just be damp. Free surface water will increase the water-cement ratio of new concrete at the interface and weaken the bond strength.

Location of Joints: Careful consideration should be given to selecting the location of the construction joint. Construction joints should be located where they will least affect the structural integrity of the element under consideration, and be compatible with the building's appearance. Placement of joints varies, depending on the type of element under construction and construction capacity. For this reason, beam and slabs will be addressed separately from columns and walls. When shrinkage compensating concrete is used, joint location allows for adequate expansion to take place. Desirable locations for joints placed perpendicular to the main reinforcement are at points of minimum shear or points of contra flexure.

Horizontal construction joints in beams girders are usually not recommended. Common practice is to place beams and girders monolithically with the slab. In column and walls, although placements with a depth of 10 meter have been made with conventional formwork, it is general practice to limit concrete placements to a height of one story. Construction joints in columns and bearing walls should be located at the undersides of floor slabs and beams. Construction joints are provided at the top of floor slabs for columns continuing to the next floor. The concrete in the columns and walls should be allowed to stand for at least two hours before placement of subsequent floors. If concrete placement is stopped for longer than the initial setting time, the joint should he treated as a construction joint. The discontinuity occurs between the layers due to the inability of freshly poured, wet concrete to intermix with and bind properly to the hardened concrete. Such a discontinuity is the result of logistical issues such contractors work schedule or unexpected material shortage.

Concept of Delayed Casting and Partially Set Concrete: Development of strength of concrete is in the presence of water added to the dry mixture of the ingredients. The process of gaining of strength starts at the instant of time when the water is just added to the dry mix. This time t=0 is identified as Fig.

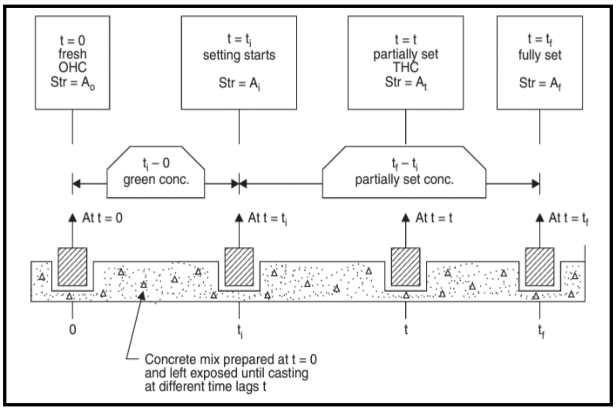

Fig.1. concept of delayed concrete

0-hr, and at this stage the concrete possess full workability, and attains normally maximum strength when cast. Therefore it will be better if the prepared mass of fresh concrete having t=0 be moulded without any delay to get maximum strength.Now generally in concreting works it is experienced that due to some onsite circumstances like, settlement of formwork, mechanical failure of machineries, failure of power supply, unforeseen accidents, delay in transport in case of TM, shortage of material etc., the concrete mass undergoes certain setting before being placed in the mould.

Concretes cast at various stages of time lag Therefore, the interval of time t between the preparation of dry mix including the water addition i.e. t=0 and casting of the same concrete into the mould at some elapsed time t called as time lag. This time lag t parameter plays important role in the point of development of strength for the said mix. The concrete cast after certain time lag t is said to be partially set concrete or time lag concrete or t-hr concrete. Thus, the workability of such time lag concrete or partially set concrete is affected adversely on comparing with the fresh concrete i.e. 0-hr concrete. Thus, for a certain mix type A, the strength of 0-hr and t-hr is given by Ao and at, respectively. And those for t=ti i.e. initial setting time and t=tf for final setting time are given as Ai and Af respectively. Now, for the time lag between 0 and tithe said concrete can be used safely and will attain the required target strength with proper workability. But if this time lag exceed the and progresses towards the tf, the

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exposed concrete mass becomes unworkable and less serviceable and this mass is not advised to be used at all and declared as waste.

Fresh, Old and Blended Mix: The concrete which is generally cast immediately after mixing at the time t=0 i.e. 0-hr concrete is called as fresh concrete and possess highest strength. If the concrete is kept exposed to the open air for certain time lag t and becomes partially set called as t-hr concrete or simply old concrete. This concrete is unserviceable and does not achieve the target strength therefore should be discarded.

Now if the partially set concrete i.e. t-hr concrete is mixed with the freshly prepared concrete i.e. t=0. and this composite mass thus, produced may be reused for attaining the target strength or strength relatively lesser to target strength such concrete is termed as blended composite mix.

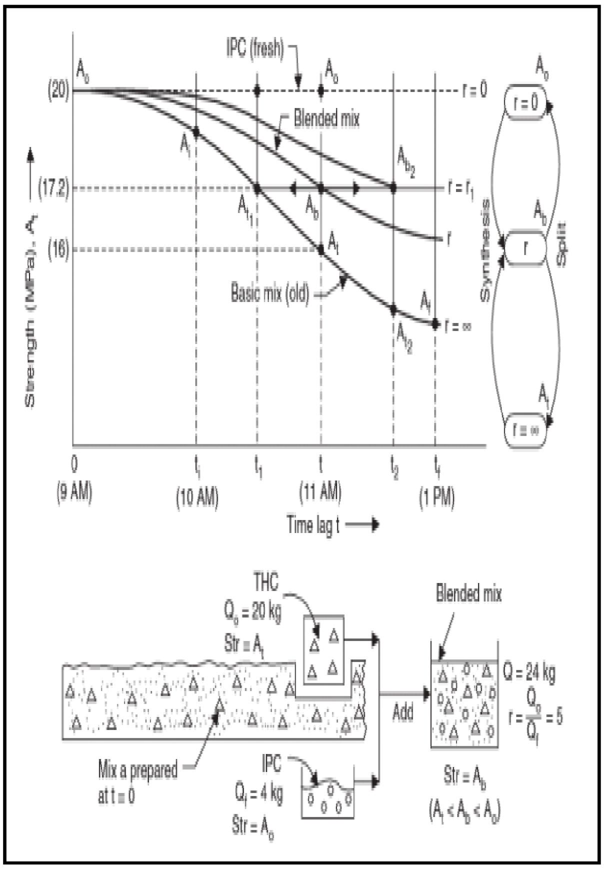

Fig.no.2 Ideal strength-time variation of blended concretes

The variation of strength against time lag is generally dropping in nature and the improvement in this dropping strength depends upon the blend ratio r. The blend ratio is expressed as r = (Qo / 0); where Qo and Qf are the weights of old quantity concrete to fresh quantity concrete respectively. Here if r = 0 i.e. Qo= 0, the mix is termed as either single mass of concrete and does not contain any old mix at all. And if r = ∞ i.e. Qf = 0, it represent the mass of only old concrete without any fresh mix.

Concept of Selfing and Crossing:
Selfing is a term attributed to the blending of two different individual mixes of the same mix type but of different r and t values into a single composite mass, which henceforth be called as the selfed mass, and the corresponding strength of which be termed as selfed strength. Crossing, on the other hand, is the generalized version of selfing, where the two mixes in blending are of different types, and the corresponding terms are crossed mass and crossed strength.Selfing is a term attributed to the blending of two mixes, one being relatively old and the other being relatively fresh, of known strengths, each at their corresponding time lags, in certain proportion. If the two mixes in blending are of the same mix type, they are in Selfing, Otherwise, they are in Crossing. The blending of two different mixes of the same mix type but of different r and t values into a single composite mass which is called as selfed mass and the corresponding strength of which be termed as selfed strength. When the blending, of two mixes are of different types and the corresponding terms are crossed mass and crossed strength.

Absolute Setting -It is the blending of two partially set mixes of the same mix type, at a certain blend ratio done at a certain time lag when each of the constituters fixes in turn is blended composite mix with certain identical blend ratio. Absolute Crossing- Mix A and mix B are different but the corresponding blend ratio and time lag of each mix in blending are identical. Pure Selfing- It is the blending of two partially set mixes of the same mix type, at a certain blend ratio, done at certain time lag, in which one of the constituent mixes is really a blended composite mix with a certain blend ratio, done at a certain time lag, while the other one is the instantaneously prepared mix at that time lag. Pure Crossing- It is similar to pure selfing case but the two partially set mixes in blending are different. One of the mix A (old) is with (r1,t1), while the other mix B (IPC) is with(O,t2) which is synonymous with the B (IPC) with (0,t), and also with B(OHC) with (0,0).

Concrete Consumption:
Much building waste is made up of materials such as concrete and mortar damaged or unused fur various masons during construction. Observational research has shown that this can be as high as 5 to 10% of the materials that go into a building a much higher percentage than the 2.5-5% usually assumed by quantity surveyors and the construction industry. Since considerable variability exists between construction sites, there is much opportunity for reducing this waste and by reusing the material natural resources and the environmental balance can be maintained and economy will be gained.

II. EXPERIMENTALPROGRAM

The entire investigation and experimental work was carried out form identification of problems up to the result and discussion for problem. The following chart

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gives the detail work carried out with the sequence of the activities from starting to the end of investigation.

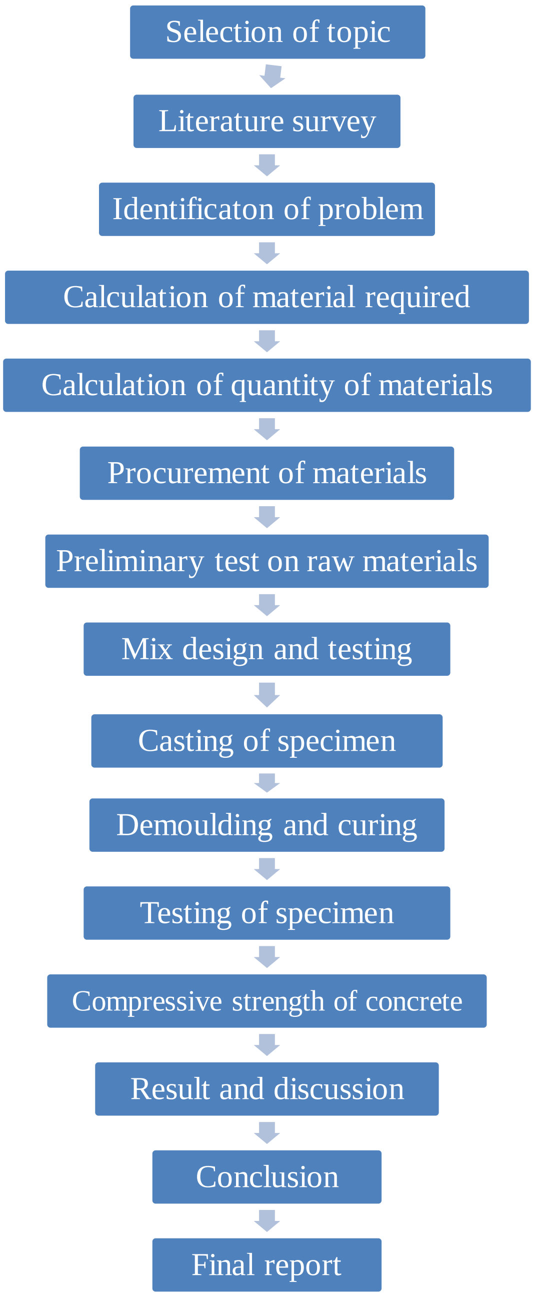

Fig. no.3 Flow chart of investigation

Experimental Investigation:- Preliminary Test on Materials: The preliminary tests on the raw material used for the investigation was done firstly. The raw material selected, tested and used for the investigation was confirming as the revalent and respective IS codes and IS specifications.

Cement: Ordinary Portland cement (OPC) of 53 Grade confirming IS: 122691987 was used throughout the experimentation. During experimental work the cement was stored in a suitably weather-tight and dry area to protect it from dampness. The properties of cement used are shown in below Table.

Table.no.1 Properties of OPC

Sr. No.	Test	Observation
1	Normal consistency	34%
2	Initial setting time	49 minutes
3	Final setting time	310 minutes
4	Specific gravity	3.15
	Compressive strength of cement, N/mm^2	–
	On 7 days curing	15
	on 28 days curing	23.5
6	Fineness of cement	4%

Fine aggregate: The river sand was used as fine aggregate conforming to the requirement of IS 383:1970. The river sand was washed and screened, to eliminate unwanted deleterious materials and over size particles. The tests for determination of specific gravity, absorption /moisture content and bulk density of the aggregates was carried out. The surface dry aggregates were used for tests. These properties of aggregates are necessary to decide proportions of the concrete mix. The properties are given below in Table. Sieve analysis for fine aggregate.

Table.no.2 Specific gravity, bulk density, voids ratio and absorption of aggregates

IS Sieve analysis	% Retained	Cumulative% Retained	% passing
4.75mm	61.33	-	-
2.36mm	18.03	79.36	20.64
1.18mm	15.56	94.92	5.08
600micron	2.34	97.26	2.75
300micron	1.52	98.78	1.22
150micron	0.78	99.56	0.44
<150micron	0.44	100	0

Coarse aggregates: The coarse aggregate of 20mm from crushed basalt rock, conforming to IS 383:1970 were used. The aggregates were free from adherent coating, injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. Care was taken that the aggregates do not contain high concentrations of flaky, elongated shapes and organic impurities which might affect the strength or durability of the concrete. Table is specifying the properties of coarse aggregate

Table.no.3 results of sieve analysis

IS Sieve analysis	% Retained	Cumulative% Retained	% passing
20mm	0	0	100
10mm	53.75	53.75	46.25
4.75mm	45.55	99.3	0.7
<4.75mm	0.7	100	0

Mix proportion and mix details: Design of the concrete mixes involves determination of the proportions of the ingredients that are water, cement, fine and coarse aggregates, which would produce concrete having specified properties both at the fresh and hardened states with the maximum economy. Workability is specified as the important property of concrete in the fresh state and for the hardened state it is compressive strength. The mix design is therefore generally carried out for a particular compressive strength and adequate workability so that the fresh concrete can be properly placed, moulded and compacted. Concrete proportioning often involves the selection of materials as well as their relative proportions. One of the major objectives of the mix designing of concrete is to minimize the aggregate voids, which in turn minimizes the amount of

Curing Condition: Curing in generally considered as a creation of favourable environment during the early period for uninterrupted hydration. In this process concrete is kept moist and warm enough so that the hydration of cement can continue. It is given a place of increasing importance as the demand 'for high quality concrete is increasing and it has also showed that quality of concrete shows all round improvement with sufficient uninterrupted curing. The test specimens were stored in a water tank which was free from vibration, at temperature of about 27°±2°C. The specimens were stored with the water at such a level which was at least 15cm above the top most cubes i.e. every cube was completely immersed into water. The tank was closed from top with a polythene sheet cover for minimizing evaporation of water from tank. The specimens were stored for continuous complete curing of 28 days, and on 29thday they were removed from the tank and kept for drying of 24 hours and were tested the next day. A paste required to fill these voids, maintaining workability and strength.

Material	Specific gravity	Bulk density (kg/m^3)	Void ratio	Absorption (%)
Coarse agg. 20mm	2.61	1618.4	0.43	0.5
Fine agg.	2.67	1812.7	0.33	1.0

a) Mix Design for M-20

Material	Proportion by weight	Weight in kg/m^3
Cement	1	372
F.A.	1.53	570
C.A.	3.3	1212
Water	0.5	186

b) Mix Design for M-30

Material	Proportion by weight	Weight in kg/m^3
Cement	1	465
F.A.	1.2	561
C.A.	2.45	1139
Water	0.4	186

The moulds of size 15cm X15cm X15cm used in the study. Plywood partition of standard size was kept in the cube in order to check the effect of bonding between interface layers at different time lags.

Fig. no.4: Vertical and Diagonals joints of interface layer in plan

Fig. no.5 Testing of Specimen

Test results and discussions: The following observation was made for different parameters namely Type-1, 2, 3 and 4 of stained concrete, for compressive strength and graphs are plotted for compressive strength against time lag in minutes.

Table.no.6 Selfed concrete consisting M20 (old) +M20 (fresh) grade concrete.

Parameter name		20	20	20	20
Time lag		50	120	180	240
Plane	Spcm. No.				
	1	41.21	50.65	19.82	12.43
	2	39.99	22.14	26.20	14.84
	3	39.35	24.09	20.80	16.89
	AVG	40.18	32.56	22.27	14.72

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Partially set concrete of grade M20: Table shows the result of compressive strength of partially set concrete of grade M20 with time lag of 50,120,180,240 minutes. The average value of compressive strength is also calculated accordingly.

Table shows the result of compressive strength of selfed concrete consisting M20 (old)+M20 (fresh) grade concrete with addition of new freshly prepared concrete at the various time lag of 50,120,180,240 minutes. And thus average value of compressive strength is also calculated accordingly.

Table.no.5 Crossed concrete consisting M20 (old)+M30 (fresh) grade concrete:

Parameter Name		20+20	20+20	20+20	20+20
Time Lag		50	120	180	240
Plane	Spcm. No.				
	1	43.58	35.96	27.28	8.31
	2	45.37	38.33	28.97	15.65
	3	40.22	34.24	29.48	17.23
	AVG	43.06	36.18	28.76	13.69

Table shows the result of compressive strength of crossing concrete consisting M20 (old)+M30 (fresh) grade concrete with addition of new freshly prepared concrete at the various time lag of 50,120,180,240 minutes. And thus average value of compressive strength is also calculated accordingly.

Table.no.7 Crossed concrete consisting M20 (old) +M30 (fresh) grade concrete.

Parameter Name		**20+30**	**20+30**	**20+30**	**20+30**
Time Lag		**50**	**120**	**180**	**240**
Plane	**Spcm. No.**				
	1	44.48	35.16	30.81	14.33
	2	45.17	37.42	32.33	14.36
	3	45.80	39.97	31.88	16.32
	AVG	45.15	38.07	31.67	15.00

Selfing of concrete with the use of bonding agent SBR Latex:

Table shows the result of compressive strength of selfed concrete with use of SBR Latex as bonding agent with time lag of 12, 16 hours which was applied in the various plane of concrete which consisted of three planes horizontal, vertical and diagonal plane.

The average value of compressive strength is also calculated accordingly in the table.

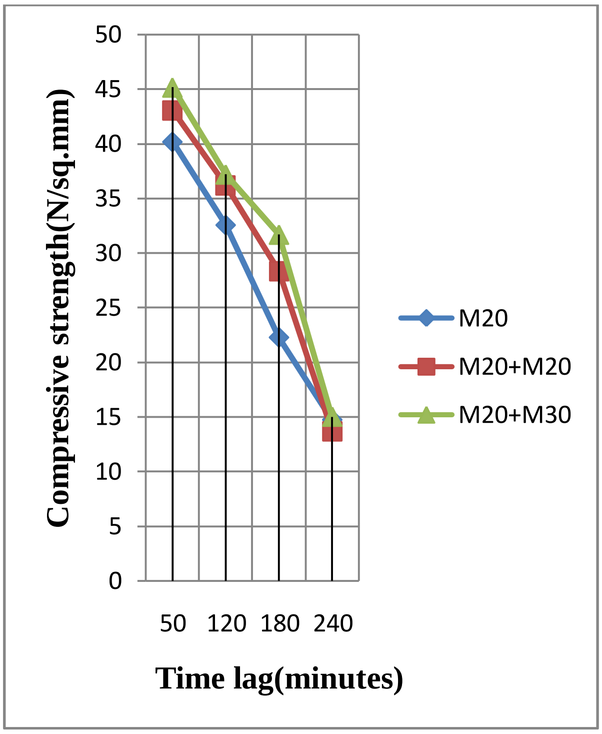

Fig. no.6 Graph for Strength variation of partially set, selfed, crossed concrete

Table.no.8 Result of compressive strength of selfed concrete with use of SBR Latex as bonding agent

Time Lag(Hrs)		12	16
Plane	Specimen No.		
Horizontal	1	20.70	21.30
	2	21.65	22.10
	3	20.15	20.15
	Average	20.83	21.18
Vertical	1	18.20	19.21
	2	19.30	20.15
	3	19.65	20.50
	Average	19.05	19.95
Diagonal	1	24.65	26.02
	2	24.10	25.10
	3	25.65	26.10
	AVERAGE	24.8	25.8

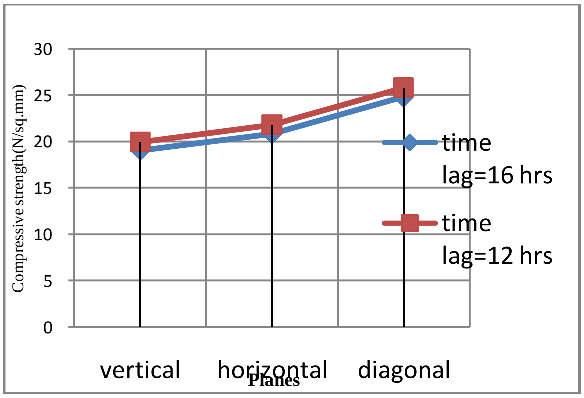

Fig. no.7 Graph Strength variation of different bonds

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III. CONCLUSIONS

(1) The compressive strength of partially set concrete goes on reducing as the time lag exceeds towards final setting time.
(2) The effect of reduction of compressive strength of partial set concrete can be overcome by blending with same grade or higher grade of concrete, i.e selfed it with M20 or crossed it with M30 grade.
(3) Selfing of old mix with fresh mix should the strength improvement of 10.60 % increment.
(4) In case of crossing old mix with fresh M30 concrete it improved the strength by 22.95 % with partially set concrete and by 12.5 % increment in strength with respect to selfed concrete.
(5) Improvement in compressive strength of selfed and crossed concrete is due to improvement in fresh properties of blended concrete i.e. workability and compaction.
(6) Target strength of concrete as per design is achieved by crossing with higher grade of concrete, inorder to save material as delayed concrete is discarded as waste.
(7) Though the concrete is to be cast upto initial setting time for attaining target strength. It can also be attained upto delay of 180 min by blending with same or different mix.
(8) Use of bonding agent SBR latex should strength improvemet up todelay of 12 hrs to 16 hrs.
(9) Out of the planes adopted for casting of interface layers, diagonal plane should maximum compressive strength of 25.8 MPa. On comparing with other planes due to wedge action theory.
(10) When concrete is delayed for casting up to 16 hours, target compressive strength can be gained by using proper bonding agent in proportion with cement i.e. 1:1 (kg : liters).

FUTURE SCOPE OF WORK

(1) The present study can be conducted using different concrete grade or using high performance concrete.
(2) Mathematical formulations can be done using equation developed by Bairagi N.K. and validation of result can be done.
(3) Bonding agent can be mix with proportion of cement instead by applying a coat on joint/ interface layer and strength can be checked accordingly.
(4) SBR latex can be used as a plasticizer and mixed in ingredients in order to improve workability of concrete ultimately increasing the strength of it.

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