Experimental Analysis of Blended Pavement Quality Concrete on Cold joints of Rigid Pavement

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ABSTRACT

One-time construction of entire reinforced concrete pavement is not possible as there is a delay in the concreting process or some site limitations. Due to delays in a sequence of the fresh and old concrete cold joints are formed in pavement panels, the Cold joint creates unfavourable conditions on reinforced concrete pavements and produces an adverse effect on the compressive strength of concrete and bond strength of concrete between joints. To control the formation of cold joints selfing and crossing theory is implemented to improve the pavement quality concrete (PQC). To check the effect of the cold joint on concrete, cube, cylinder, and beams are cast for various time lags keeping blend ratio is one as constant. The specimens are tested for Compressive strength, Split Tensile strength, and Flexural strength of the concrete. Results obtained from selfing and crossing are compared with conventional methods of concrete. In a conventional method, the strength of concrete starts decreasing when time lag starts increasing from 0 minutes. In the selfing and crossing method, the strength of concrete increases as time lag increases from 0 to 90 minutes but after that, strength starts decreasing. It has been observed that the strength of concrete joints prepares by the conventional method is less compared to the same concrete joints prepared at different time lags using the selfing and crossing technique. It can be concluded that strength at joint increases using the selfing and crossing technique as compared to the conventional technique.

Keywords
Cold joint, Crossing, Selfing, PQC, Time lag, Blend ratio

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Introduction

The selfing is a term assigned to the blending of two different individual mixes of the same concrete grade mix but different blend ration (r) and time lag (t) value into a single composite mass. which henceforth is called as the selfed mass, and the corresponding strength of which be termed as selfed strength. On the other hand, the crossing 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 (1). The conventional curing method adaptation is possible only on laboratory casted specimen, it is not possible to adapt to actual site work. Hence the strength also effects of improper curing, the effects of different improper curing sequences on the strength of blended pre-stiffened mixes have been studied (2) The pre-stiffened mixes in the composite mass under observation have different mix proportions, water-cement ratio, and time lags as variables. The corresponding theoretical strength values have been predicted using selfing theory and crossing theory, and are compared with the actual values obtained by experiments. The site application of this concept has been further widened to include the effect of cumulative curing for the blended pre-stiffened mixes for the finding out strength then an effective strength and its design chart has been proposed as an aid to design proper blend ratio for a composite mix. The chart can also be used as a strength improvement chart (3).

Significance of Remix Concrete Concept

It is very difficult to cast the concrete structures monolithically on-site, the number of construction joints is formed at the time of casting of building elements, rigid pavements section in road construction. These construction joints are playing a significant role in the expansion and contraction of concrete. Concrete is a mixture of various ingredients like cement, aggregates, water, and admixtures, each ingredient showing an important role in the concrete mix design. When water adding into to dry mass of cement and aggregates, this mixture will start gaining strength instantly at a time (t = 0 min). Thus Concrete prepared at t = 0 minute but due to transportation time, delay in placing of concrete, or some other site constraints it placed into the mould or actual site at a time lag t min. These time lags produced adversely affect the strength of concrete (4).

In actual concreting work, since some amount of time has to be provided right from the preparation of a mix to the casting in the mould. A time lag up to t = ti (initial setting time) is neglected as compressive and split tensile strength, as well as its workability, do not change so much from those of the 0-hr concrete (5). Concrete in the range of time lag beyond ti cease to be green and fully plastic, since part of which has suffered a good deal of setting due to delay in casting, and so the t-hr concrete (THC) in this range of time lag is identified as partially set concrete. The various studies disclose the strength of concrete under considering the various time lag like 30min, 60min..etc. is goes on decreasing gradually in nature. The observations were made on evolving compressive strength, and split tensile strength by considering two grades of concrete mix i.e. M40 & M 50 with water to cement ratios of 0.4 and 0.35 and cured for 28 days. Initial studies on the strength aspect of preset mixes were carried out by (6). On the effect of presetting of cement on the mortar strength, their studies revealed that the reduction in mortar strength occurs in case cement mortar is moulded after the cement has undergone an initial setting. This study describes that there is a significant improvement in the strength of mortar or concrete if the preset mortar or concrete is mixed with fresh one concrete of the same or higher grade in suitable proportions. A large number of studies have been carried out on hardened and fresh concrete mixes by providing a suitable blend ratio covering the study of compressive strength, tensile strength, and elastic modulus by using the concept of selfing. The ratio of old concrete quantity to fresh concrete quantity is called a blend ratio (7).

Materials Used and Part Analysis

Cement, Sand & Aggregate is used to prepare the concrete.

Table 1 Properties of Aggregate.

Sr. No.	Properties	Normal Aggregate
1	Specific Gravity	2.78(CA) & 2.63(FA)
2	Bulk Density	1.487 kg/lit (CA)
3	Impact Value	17.64 % (CA)
4	Fineness Modulus	6.97(CA)
5	Water Absorption	1.2 % (CA)
6	Moisture Content	37 %

Shape and Size Matter: The properties of fresh concrete and old concrete mixtures are depending on Particle shape and surface texture. Elongated shape rough-textured and angular particles require more water to produce workable concrete. Therefore, the quantity of cement should be more to keep the optimum water-cement ratio

Fineness modulus = 5.505.

Methodology

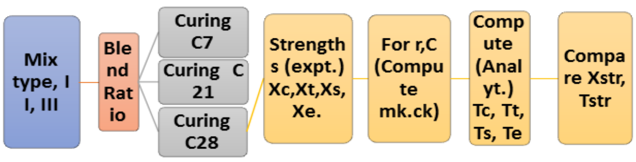


Fig. 1. Flow chart for methodology

Xc = Compressive strength (Experimental)
Xt = Tensile strength (Experimental)
Xs = Shear strength (Experimental)
Xe = Modulus of elasticity (Experimental)

Phase –I

Calculation of strength of composite mixed concrete.
Testing of materials (Cement, Aggregate, etc.)
Design the concrete of M40 & M 50 grade

Phase –II

Considering the lag times for various blended ratios and calculations of the strength of composite mass. The casting of the cube, cylinder, and beam, and slab joint specimens of various grades of concrete and different time intervals. To verify experimentally and analytically strength of remix concrete mixes of different proportions in a certain blend ratio for general Selfing and general Crossing of all the mix types including improper curing combination.

Methodology adapted and experimental setup

In this study Firstly Control mix proportion for M40 & 50-grade concrete was obtained shown in Table 2. The Mix design in this study was designed along the guidelines of the standard IS 10262:2009. A Total of two different concrete mixes were considered and remixed for different time lag and blend ratio.

Experimental Results

The objective of this study was to determine the Compressive strength, Split Tensile strength, Flexural strength, transverse strength, the effect of stress and strain on the pavement under the different time lags like 30Min, 60Min, 90Min,120min .., etc.
For this purpose different test on hardening, concrete was conducted at the age of 7 and 28 days. 161 Numbers of the specimen were prepared to carry out this research, details of specimens given in Table 3.

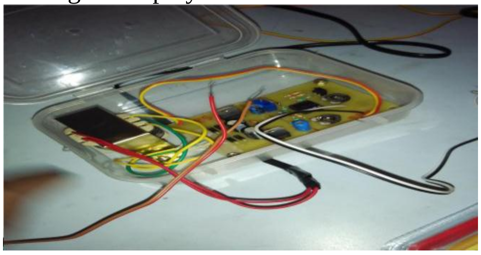
Table 2 Mix Proportion of concrete (IS 10262 & IS 456).

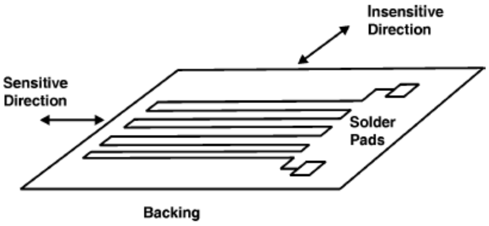
Trial Mix Ratio				
Grade	W/C	Cement	Fine Aggregate	Coarse Aggregate
M 40	0.40	1	1.82	3.09
M 50	0.35	1	1.43	2.42

Strain Gauge

A strain gauge is a device used to measure strain on an object (Fig.3). Invented by Edward E. Simmons and Arthur C. Ruge in 1938, the most common type of strain gauge consists of a flexible insulating backing which supports a metallic foil pattern. The gauge is attached to the object by a suitable adhesive, such as cyanoacrylate (8). As the object is deformed, the foil is deformed, causing its electrical resistance to change. This resistance change, usually measured using a Wheatstone bridge, is related to the strain by the quantity known as the gauge factor.
The following observations and parameters are measured from strain gauge,
i. Input supply to the load cell is given through a dc voltage regulator & is10 volt Dc & 0.04 A.
ii. The load cell is checked for accuracy. The calibration constraint is when input is 410 U then output is 350 U.
iii. Input supply to the strain gauge is also given by a DC voltage regulator & is 5 volt DC & 0.04.
A Strain gauge circuit - Strain gauge is connected in a Wheatstone bridge circuit (Fig. 2) and forms the R4 side of the bridge. Any change in the strain gauge resistance due to the application of load will unbalance the bridge and produces a non-zero output voltage. The Digital strain indicator is used to measure the strain in the static condition. It incorporates basic bridge balancing networks, internal dummy arms, an amplifier, and a digital display to indicate strain value. In resistance type strain gauge when the wire is stretched elastically its length and diameter get altered. This results in an overall change of resistance due to change in

both dimensions. The method is to measure the change in resistance, which occurs as a result of the change in the applied load. Strain can be calculated analytically in the section by using Hook's law. Distrain indicator is used to measure extreme fiber in a particular section. It incorporates basic bridge balancing network, internal dummy arms, amplifier & digital display to indicate strain value.





The methodology adopted for concrete Mix

Firstly Control mix proportion for M40 & 50-grade concrete was obtained for two groups of concrete in which the first group consists.

Crossing: Blending of two different types of concrete mixes (i.e., M40 old+ M50 new), one of which is a partial set one and the other is a relatively fresher one, and are blended in a certain weight ratio.

Selfing: Blending of two concrete mixes (i.e., M40old +M40 new), which are identical in all respect, one of which is a partial set one, and the other is a relatively fresher one, and are blended in a certain weight ratio (7). Mix design was carried out manually conforming to IS 10262:2009. The casting of Cube, Cylinder, & Beam specimens of M-40& M50 grades of concretes at different time laps intervals. The number of specimens shown in table 3.2, Find out compressive, transverse & flexural strength of the cube, cylinder & pavement slab specimen (9).

Time Lag: The moment water is added in a dry mixture of coarse aggregates (CA) + fine aggregates (FA) + cement (C), the mixture starts gaining strength [call it: at t = 0]. It is advisable to cast the mass immediately into the required mould, otherwise, any delay in placing the green mass into the mould, is reflected adversely in the strength of the mix. This is because, in the green mass, the process of setting has started from the instant t = 0.

The time lag of casting = time lag = time.

Concretes at Various Time Lag Range

The maximum strength of a mix is obtained at t = 0. As time lag goes on increasing, certainly, strength goes on decreasing. Let us tolerate time lag t at best up to the initial setting time ti, assuming that, both the workability as well as the strength do not differ much from those at t = 0. Concrete in the range of t between t = 0 and ti, is the fresh concrete, or green concrete, or 0 -hr concrete. But, as t crosses the range of initial setting time ti and proceeds towards the final setting time t_f, a larger portion of the mass is under the grip of vigorous setting, resulting in lower and lower strength than that of the fresh mix (at t = 0).The concrete mass for time lag t, well beyond initial setting time, and approaching the final setting time, (in which though still a portion remains reactive to impart strength), the workability as well as strength progressively become too low to be considered for usage in practice.

Testing and Results

a) Characteristic Compressive Strength Test

A compressive strength test was performed on cube samples using a compression testing machine. Six samples reading are taken off each time lag and average strength values reported. Keeping in mind the gap in the research area, the objective of this study was to determine the strength of concrete under various selfing and crossing time lag parameters. For this different purpose test on hardening, concrete was conducted at the age of 7 and 28 days. The Ultimate compressive strength of the cube specimen for M40 grade of the concrete cast by the conventional method is shown in figure 4 and cast by the selfing method shown in figure 5.

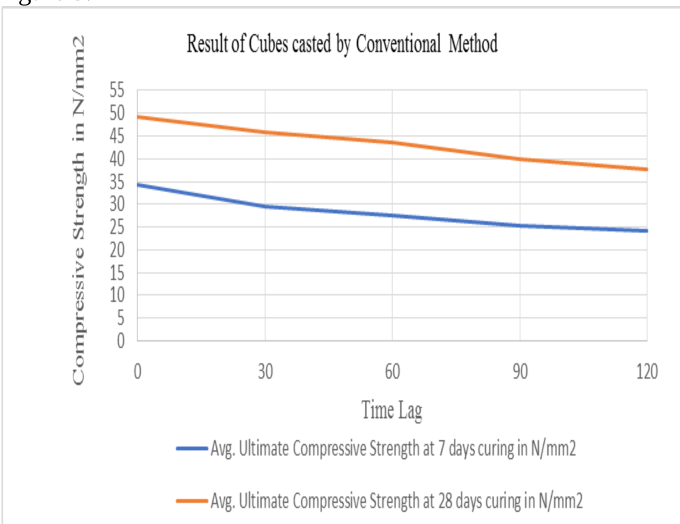


Fig. 4. Ultimate compressive strength (Conventional method).

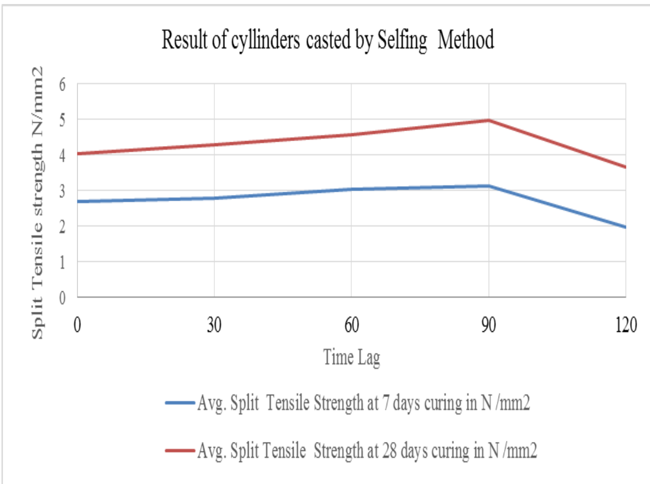


Fig. 5. Ultimate compressive strength (Selfing method).

b) Splitting Tensile Strength

Splitting tensile strength tests were performed on the cylindrical specimen. Six samples per time lag (i.e., 0min, 30min, 60min, 90min, and 120min) were tested with the average strength values reported. The Ultimate splitting tensile strength of cylinder specimen for M40 grade of the concrete cast by the conventional method is shown in Figure 6 and cast by the selfing method shown in figure 7.

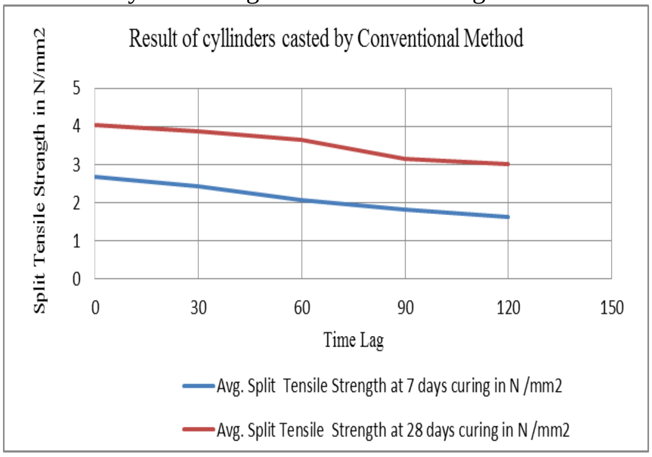


Fig. 6. Split tensile strength (conventional method).

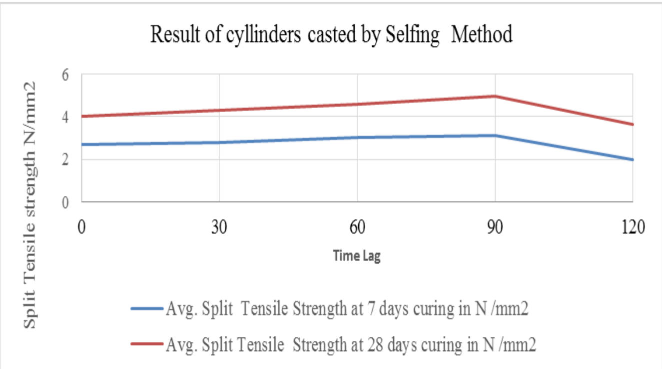


Fig. 7. Split tensile strength (Selfing method).

Table 3 Details of Specimen

Sr. No.	Specimen size in mm	Blend Ratio (r) (old concrete /New concrete)	Time Lag (in Minute)	Conventional Method Specimen (Numbers)	Selfing Method (Numbers)	Crossing Method (Numbers)	Total No. of specimens
1	Cube(150 x150)	1	0, 30, 60, 90, & 120	30	24	--	54
2	Cylinder (150 dia.)			30	24	--	54
3	Beam (100 x 100 x 500)			20	24	--	44
4	RCC beam (150 x 180) singly R/F			3	3	3	9

c) Flexural Strength on Plain Cement Concrete Beam

Flexural strength tests were performed on a flexural testing machine having 100KN capacity using beam specimen (10). Six samples per batch were tested with the average strength values reported. Flexural strength of beam specimen (100 mm x 100 mm x 500mm) for M40 grade of the concrete cast by the conventional method is shown in figure 8 and cast by the selfing method shown in figure 9

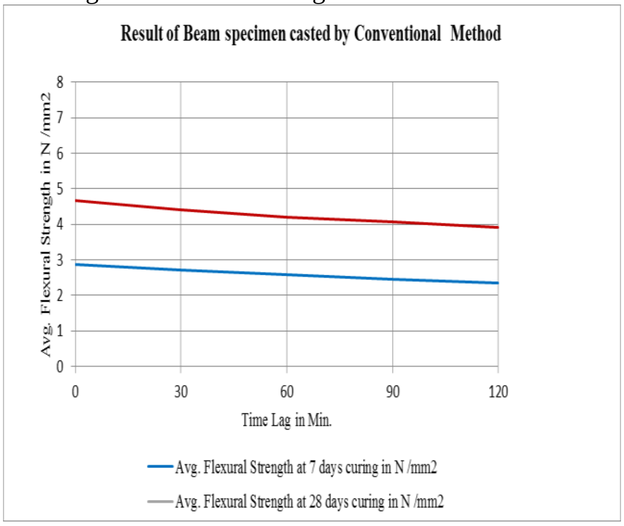


Fig. 8. Flexural strength of the conventional method

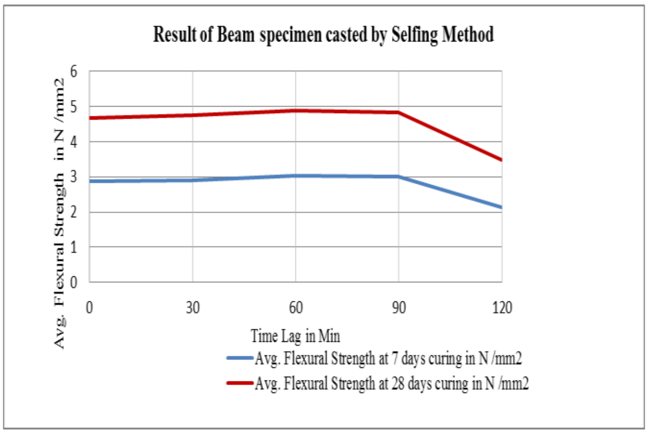


Fig. 9. Flexural strength by Selfing Method

d) Find out uploading strain & stress of RCC Beams specimens (B-1 To B-9) using strain gauges and UTM

RCC beam section of size 150mm x 180mm x 1000mm cast as per rigid pavement joint section requirement, providing distribution steel of 10mm dia. Tor steel (Fe500) at spacing 90mm c/c on both sides at the base with clear cover 40mm and the top provided 25mm dia. dowel bars of length 150mm and spacing 140mm c/c with clear cover 40mm from top, also provide 8mm Ø of stirrups are used with all side 30 mm clear cover. (Ramsamooj 1999) By applying Uniformly distributed loan using universal testing machines, tested the specimen & find out the effect of transverse strength, transverse shear stresses & strain of rigid pavements (11)

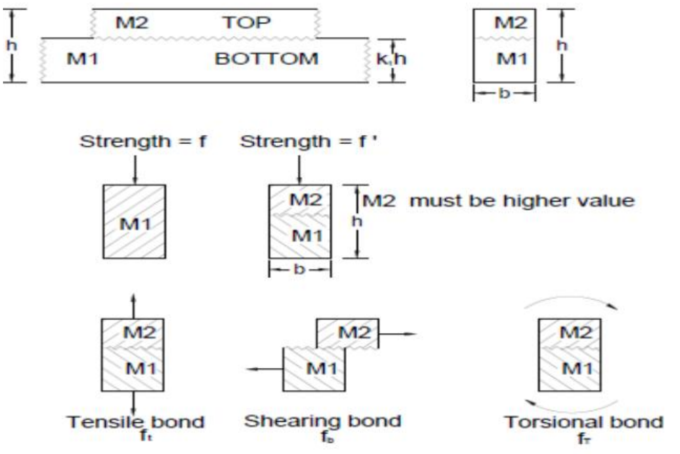


Fig. 10. Concept of Selfing and Crossing

Fig. 11. Beam secion Testing Set Up

Specimen: B-1

Table 4 Uploading strain & stressusing strain gauges.(Cast by Conventional Method**)**

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	134	0.000893	22.333
2	5	138	0.000920	23.000
3	10	147	0.000980	24.500
4	20	152	0.001013	25.333
5	30	173	0.001153	28.833
6	40	187	0.001247	31.167
7	50	198	0.001320	33.000
8	70	202	0.001347	33.667
9	85	215	0.001433	35.833
10	95	228	0.001520	38.000
11	115	234	0.001560	39.000
12	125	249	0.001660	41.500
13	128	272	0.001813	45.333
14	129	288	0.001920	48.000

Sample calculation:

a) The output of Wheatstone bridge circuit is

Vo = Vex/4 x (Gauge Factor) x ($\Delta L/L$)

Where Vo = Output Voltage of bridge

Vex = Input voltage of bridge.

($\Delta L/L$) = ε = Strain

Assume Gauge Factor for strain gauge = 4

Using the above Equation

$129*10^{-4} = 12/4x5x\ (\varepsilon)$

Strain (ε)= 0.001920

This is the experimental value.

b) Now, by Using Hooke's law

Stress = Strain xYoung's Modulus of elasticity

Stress = 0.001920 x25x10^3

Stress = 48 Mpa

This is the experimental value of bending stress.

Specimen: B-2

Table 5 Uploading strain & stressusing strain gauges.(Cast by Conventional Method**)**

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	133	0.000887	22.167
2	5	147	0.000980	24.500
3	10	152	0.001013	25.333
4	20	155	0.001033	25.833
5	30	169	0.001127	28.167
6	40	182	0.001213	30.333
7	50	195	0.001300	32.500
8	70	201	0.001340	33.500
9	95	225	0.001500	37.500
10	110	235	0.001567	39.167
11	120	242	0.001613	40.333
12	122	251	0.001673	41.833
13	124	269	0.001793	44.833
14	127	283	0.001887	47.167

Specimen: B-3

Table 6 Uploading strain & stress using strain gauges.(Cast by Conventional Method)

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	128	0.000853	21.333
2	5	128	0.000853	21.333
3	10	129	0.000860	21.500
4	20	130	0.000867	21.667
5	30	142	0.000947	23.667
6	40	164	0.001093	27.333
7	60	179	0.001193	29.833
8	70	188	0.001253	31.333
9	95	198	0.001320	33.000
10	115	204	0.001360	34.000

11	125	215	0.001433	35.833
12	128	239	0.001593	39.833
13	129	278	0.001853	46.333
14	130	298	0.001987	49.667

Table 7 Average uploading stress & strain of RCC Beam specimen B-1 toB-3,(Cast by Conventional Method)

SpecimenB-1		Specimen B-2		Specimen B-3		Average	
Strain	Stress	Strain	Stress	Strain	Stress	strain	stress
0.000893	22.333	0.000887	22.167	0.00085	21.333	0.00088	21.94433
0.00092	23	0.000980	24.500	0.00085	21.333	0.00092	22.94433
0.00098	24.5	0.001013	25.333	0.00086	21.5	0.00095	23.77767
0.001013	25.333	0.001033	25.833	0.00087	21.667	0.00097	24.27767
0.001153	28.833	0.001127	28.167	0.00095	23.667	0.00108	26.889
0.001247	31.167	0.001213	30.333	0.00109	27.333	0.00118	29.611
0.00132	33	0.001300	32.500	0.00119	29.833	0.00127	31.77767
0.001347	33.667	0.001340	33.500	0.00125	31.333	0.00131	32.83333
0.001433	35.833	0.001500	37.500	0.00132	33	0.00142	35.44433
0.00152	38	0.001567	39.167	0.00136	34	0.00148	37.05567
0.00156	39	0.001613	40.333	0.00143	35.833	0.00154	38.38867
0.00166	41.5	0.001673	41.833	0.00159	39.833	0.00164	41.05533
0.001813	45.333	0.001793	44.833	0.00185	46.333	0.00182	45.49967
0.00192	48	0.001887	47.167	0.00199	49.667	0.00193	48.278

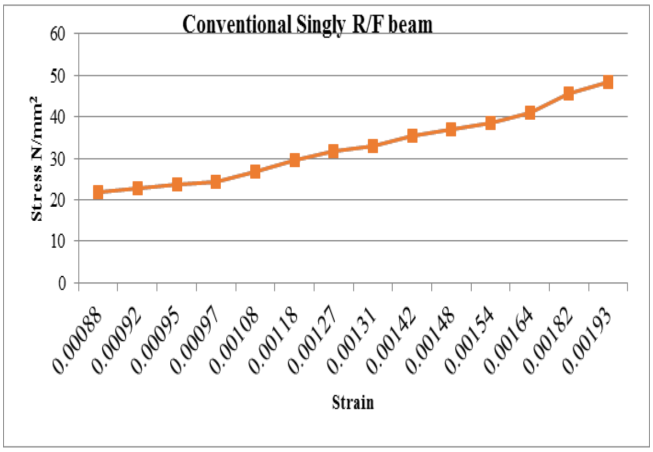


Fig. 12. Average Stress and Strain for singly R/F Beam Specimens cast by Conventional Method

Specimen: B-4

Table 8 Uploading strain & stress using strain gauges (Cast by Crossing Method)

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	125	0.000833	20.833
2	5	134	0.000893	22.333
3	15	144	0.000960	24.000
4	20	150	0.001000	25.000
5	35	166	0.001107	27.667
6	45	184	0.001227	30.667
7	55	194	0.001293	32.333
8	65	200	0.001333	33.333
9	85	209	0.001393	34.833
10	95	219	0.001460	36.500
11	115	231	0.001540	38.500
12	125	254	0.001693	42.333
13	134	268	0.001787	44.667
14	140	281	0.001873	46.833

Specimen: B-5

Table 9 Uploading strain & stress using strain gauges (Cast by Crossing Method)

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	133	0.000887	22.167
2	5	147	0.000980	24.500
3	10	152	0.001013	25.333
4	20	155	0.001033	25.833
5	30	169	0.001127	28.167
6	40	182	0.001213	30.333
7	50	195	0.001300	32.500
8	70	201	0.001340	33.500
9	95	225	0.001500	37.500
10	110	235	0.001567	39.167
11	120	242	0.001613	40.333
12	135	251	0.001673	41.833
13	140	269	0.001793	44.833
14	145	283	0.001887	47.167

Specimen: B-6

Table 10 Uploading strain & stress using strain gauges, Cast by Crossing Method)

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	118	0.000787	19.667
2	5	118	0.000787	19.667
3	10	122	0.000813	20.333
4	25	128	0.000853	21.333
5	35	134	0.000893	22.333
6	40	162	0.001080	27.000
7	60	175	0.001167	29.167
8	75	184	0.001227	30.667
9	85	195	0.001300	32.500
10	90	225	0.001500	37.500
11	110	230	0.001533	38.333
12	115	245	0.001633	40.833
13	125	275	0.001833	45.833
14	135	285	0.001900	47.500

Table 11 Average uploading stress & strain of RCC Beam B-4 to B-6(Cast by Crossing Method)

Specimen 4		Specimen 5		Specimen 6		Average	
Strain	Stress	Strain	Stress	Strain	Stress	Strain	Stress
0.00083	20.833	0.00089	22.167	0.00079	19.667	0.000836	20.8890
0.00089	22.333	0.00098	24.5	0.00079	19.667	0.000887	22.1666
0.00096	24	0.00101	25.333	0.00081	20.333	0.000929	23.2220
0.001	25	0.00103	25.833	0.00085	21.333	0.000962	24.0553
0.00111	27.667	0.00113	28.167	0.00089	22.333	0.001042	26.0557
0.00123	30.667	0.00121	30.333	0.00108	27	0.001173	29.3333
0.00129	32.333	0.0013	32.5	0.00117	29.167	0.001253	31.3333
0.00133	33.333	0.00134	33.5	0.00123	30.667	0.001300	32.5000
0.00139	34.833	0.0015	37.5	0.0013	32.5	0.001398	34.9443
0.00146	36.5	0.00157	39.167	0.0015	37.5	0.001509	37.7223
0.00154	38.5	0.00161	40.333	0.00153	38.333	0.001562	39.0553
0.00169	42.333	0.00167	41.833	0.00163	40.833	0.001666	41.6663
0.00179	44.667	0.00179	44.833	0.00183	45.833	0.001804	45.1110
0.001873	46.833	0.001887	47.167	0.0019	47.5	0.001887	47.1667

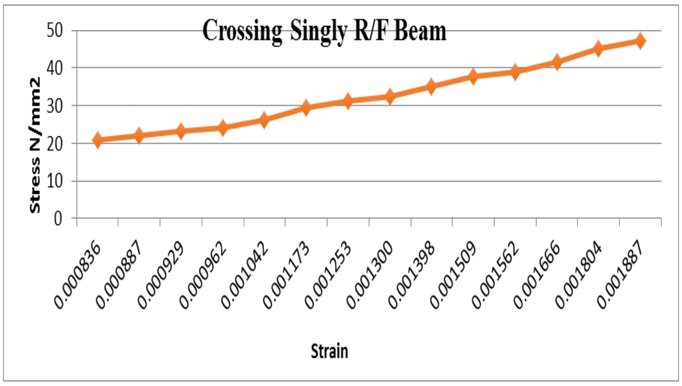


Fig. 13. Average Stress and Strain of R/F Beam Specimens Cast by Crossing Method

Specimen: B-7

Table 12 Uploading stress & strain using strain gauges, (Cast by Selfing Method)

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	150	0.001000	25.000
2	10	120	0.000800	20.000
3	20	128	0.000853	21.333
4	25	124	0.000827	20.667
5	40	126	0.000840	21.000
6	50	120	0.000800	20.000
7	60	124	0.000827	20.667
8	80	131	0.000873	21.833
9	90	133	0.000887	22.167
10	105	134	0.000893	22.333
11	110	159	0.001060	26.500
12	125	178	0.001187	29.667
13	135	187	0.001247	31.167
14	155	205	0.001367	34.167

Specimen: B-8

Table 13 Uploading stress & strain using strain gauges. (Cast by Selfing Method)

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	124	0.000827	20.667
2	10	124	0.000827	20.667
3	20	128	0.000853	21.333
4	25	137	0.000913	22.833
5	40	139	0.000927	23.167
6	50	148	0.000987	24.667
7	60	169	0.001127	28.167
8	80	172	0.001147	28.667
9	100	177	0.001180	29.500

10	115	182	0.001213	30.333
11	120	184	0.001227	30.667
12	134	187	0.001247	31.167
13	146	199	0.001327	33.167
14	152	200	0.001333	33.333

Specimen: B-9

Table 14 Uploading stress & strain using strain gauges, (Cast by Selfing Method).

Sr. No.	Load KN	Uploading Deflection mV	Strain	Stress
1	0	122	0.000813	20.333
2	10	123	0.000820	20.500
3	20	128	0.000853	21.333
4	25	131	0.000873	21.833
5	40	148	0.000987	24.667
6	50	152	0.001013	25.333
7	75	158	0.001053	26.333
8	85	157	0.001047	26.167
9	95	165	0.001100	27.500
10	100	175	0.001167	29.167
11	110	179	0.001193	29.833
12	120	189	0.001260	31.500
13	132	215	0.001433	35.833
14	156	228	0.001520	38.000

Table 15 Uploading stress & strain of RCC Beam B-7 to B-9(Cast by Selfing Method) using strain gauges.

Specimen7		Specimen 8		Specimen 9		Avg.Value	
Strain	Stress	Strain	Stress	Strain	Stress	Strain	Stress
0.001	25	0.00083	20.667	0.00081	20.333	22	0.00088
0.0008	20	0.00083	20.667	0.00082	20.5	20.389	0.00082
0.00085	21.333	0.00085	21.333	0.00085	21.333	21.333	0.00085
0.00083	20.667	0.00091	22.833	0.00087	21.833	21.77767	0.00087
0.00084	21	0.00093	23.167	0.00099	24.667	22.94467	0.00092
0.0008	20	0.00099	24.667	0.00101	25.333	23.33333	0.00093
0.00083	20.667	0.00113	28.167	0.00105	26.333	25.05567	0.00100
0.00087	21.833	0.00115	28.667	0.00105	26.167	25.55567	0.00102
0.00089	22.167	0.00118	29.5	0.0011	27.5	26.389	0.00106
0.00089	22.333	0.00121	30.333	0.00117	29.167	27.27767	0.00109
0.00106	26.5	0.00123	30.667	0.00119	29.833	29	0.00116
0.00119	29.667	0.00125	31.167	0.00126	31.5	30.778	0.00123
0.00125	31.167	0.00133	33.167	0.00143	35.833	33.389	0.00134
0.00137	34.167	0.00133	33.333	0.00152	38	35.16667	0.00141

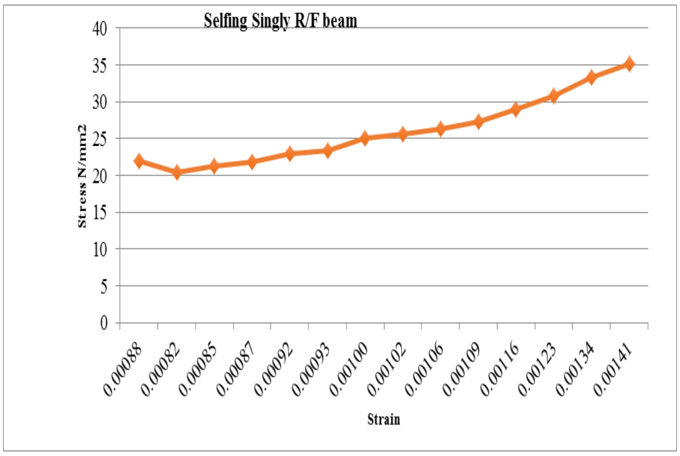


Fig.14. Average Stress vs. Strain for Selfing singly R/F beam Specimens Cast by Selfing Method

Table 16 Analysis of Stress vs. Load of Conventional, Crossing and Selfing Methods.

Loads	Conventional Stress	Conventional Strain	Selfing Stress	Selfing Strain	Crossing Stress	Crossing Strain
0	21.9443	0.000878	20.889	0.00088	22	0.00088
5	22.9443	0.000918	22.16667	0.00082	20.389	0.00081567
15	23.7777	0.000951	23.222	0.00085	21.333	0.000853
20	24.2777	0.000971	24.05533	0.00087	21.7777	0.000871
35	26.889	0.001076	26.05567	0.00092	22.9447	0.000918
45	29.611	0.001184	29.33333	0.00093	23.3333	0.00093333
55	31.7777	0.001271	31.33333	0.00100	25.0557	0.00100233
65	32.8333	0.001313	32.5	0.00102	25.5557	0.00102233
85	35.4443	0.001418	34.94433	0.00106	26.389	0.00105567
100	37.0557	0.001482	37.72233	0.00109	27.2777	0.001091
110	38.3887	0.001535	39.05533	0.00116	29	0.00116
130	41.0553	0.001642	41.66633	0.00123	30.778	0.00123133
135	45.4997	0.00182	45.111	0.00134	33.389	0.00133567
140	48.278	0.001931	47.16667	0.00141	35.1667	0.00140667

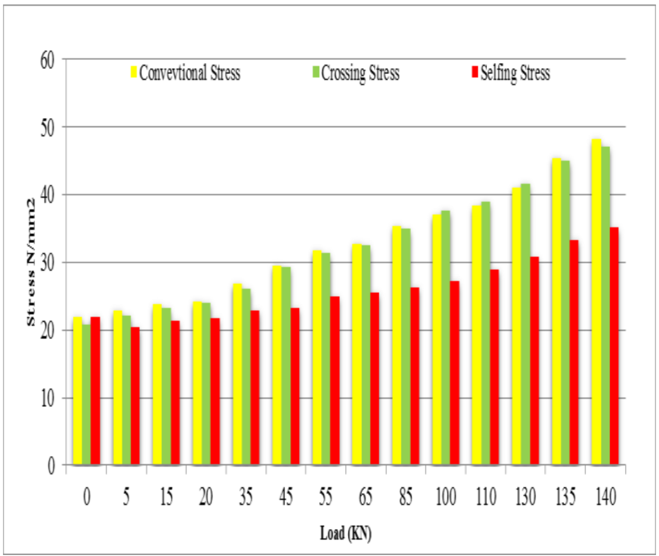


Fig. 15. Stress vs. Load of Conventional, Crossing and Selfing Comparison

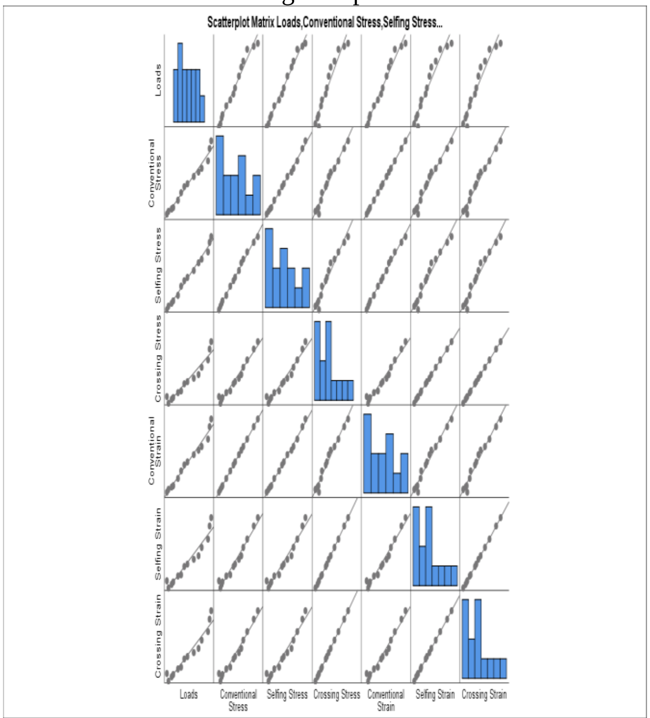


Fig. 16. Relationship between Load, Conventional, Selfing, Crossing stress and Conventional, Selfing, Crossing strain

Result and discussion

After applying the selfing technique to the existing partially set concrete at various time lags, it has been observed that there is an increment in the Compressive strength, Split Tensile strength, and Flexural strength of fresh concrete as compared to old concrete shown in Fig. 4,5,6,7,8 & 9.Also, it is observed that the strength of concrete prepared before 30 minutes is less as compared to the concrete which is prepared using selfing theory for the same time lag.
During the experimental work, the strength of concrete increases as time lag increases up to 90 minutes in the crossing and selfing methods comparing with a conventional method showing in Fig.12,13,&14 Whereas, in the conventional method, the characteristic strength of concrete decreases as time lag increases. The addition of fresh concrete with higher grade to the partially set old concrete (M40 old+M50 new) is called a crossing technique. It shows that in R.C.C. beam flexural strength is increased by the use of crossing technique keeping constant blend ratio r = 1. The combination of old and fresh concrete with different grade increases the flexure strength of concrete. The tensile strength, stress, and strain of the specimen of lower grade pavement quality concrete benefits by remixing more than those with higher-grade concrete shown in Fig.15 & 16

Conclusion

Based on experimentation work, it is concluded that the effect of reduction of concrete strength and efficiency of cold joint strength due to new and partial set concrete can be minimized by using the selfing and crossing technique of concrete providing blending of the same grade or adding higher grade of concrete, overlaying it. The concrete tested for blend ratio r=1 and maximum time lag considered 120 minutes gives better strength up to 90 min lag as compared to r and t having more values than these. A suggested value for concreting is for 40 % to 60 % first layer filling followed by the remaining percentage overlay for the next delayed second layer filling. The optimum result is achieved at 50% first layer filling, followed by an overlay of the next 50 % delayed second layer filling..3

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