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Research Article

Effect of blended concrete and intermittent curing sequences on rigid pavement

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Abstract*:* Concrete is a carefully controlled mixture of cement, fine aggregate, coarse aggregate and water. It starts gaining strength from the instant of time since water is added to the dry mass of the ingredients. Concrete thus prepared at t (time)=0 hour but placed into the mould at a time lag t is bound to be, adversely affected in strength, (henceforth it is used to denote, compressive strength, tensile strength, bond strength, shear strength, elastic modulus, modulus of rupture. Concrete thus achieved by laying a "fresh" concrete mass over relatively "older" preset mass of concrete (be of the same or of different mix types) at a certain delayed time of casting is often observed at construction work may be termed as layered concretes or "Spread Concretes". Selfing and Crossing of concrete provides a wide scope in preventing the wastage of concrete materials which is partially set, which is not suitable for good quality of construction. After applying selfing technique to such partially set concrete at different delayed times , it is seen that there is an increase in strength as compared to old concrete mixes which is most of the time acceptable. It is seen that the strength of concrete prepared at t = 15 minutes is less as compared to the same concrete at t = 15 minutes selfed with a fresh concrete of same grade. Curing method applied with four sequences Air_0 $Water_{28}$, Air_{28} $Water_0$, Air_7 $Water_{21}$, and Air_{21} $Water_7$. It is observed that the strength of concrete which undergoes intermittent curing is less than that of strength due to cumulative curing after 28 days of curing

Keyword: Selfing, crossing, cold joint, intermittent curing, blend ratio, Time lag.

1. INTRODUCTION

Cement is a high-priced factor in concrete so its wastage is to be prevented and try and reuse of wastage concrete, sure it's miles beneficial to analyze up to what significance the old concrete be made durable on producing it correctly in place of fully rejected. In the selfing and crossing method, we used the development of preset concrete blended through including higher grade or same grade of newly prepared concrete considering time lag (t). In selfing and crossing approach blending of two grades of concrete mixes, one is surprisingly old concrete (Co) than the fresh concrete of equal grade or higher grade mix concrete (Cf).

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Selfing is a time period attributed to the mixing of two same grade of concrete having time lag (t) & blend ratio (r) in to a composite mass. Blend ratio is ratio of prestiffened concrete to fresh concrete (Co) / (Cf) (Bairagi, N. K., Goyal, A. S., Joshi 1989).
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. The improper curing sequences effected the the strength of blended pre-stiffened mixes (Pujar and Prakash 2014). The pre-stiffened mixes within the composite mass under observation have extraordinary mix proportions, water-cement ratios, and time lags as variables (Ramezanianpour, A. A., & Malhotra 1995). The corresponding theoretical compressive strength values had been expected the use of selfing idea and its generalized version, crossing theory, and are as compared with the real values received through experiments (Bairagi, N. K. 2009). The application of selfing & crossing theory has been further widened to considering intermittenet curing effect on pavement quality concrete.To Finding out compressive strength, modulus of elasticity, deflection, stress , strain and subgrade reaction effect and its internal relationship design chart has been proposed as an aid to design proper blend ratio for a composite mix.

1.1. Consequence of Remix Concrete Concept

In regular practice it is very difficult to cast the whole stretch of rigid pavement monolithically. The cold joints are formed during the construction. The cold joint effect considered in temperature correction and warping stress calculation of rigid pavement surface. Concrete is the mixture of cement, sand, coarse aggregate, water and admixture. At the time of placing of concreting work, Initial setting time provided to the preparation of mix, transportation purpose. The concrete is start gaining the strength instantly when adding the water. The placing of concrete is done before initial setting time ($t=t_i$ in hr.) but due to various site cobstraint not possible to placed the concrete within time (K.L. Bidkar and Dr.P.D.Jadhao 2019). This time lag in placing (i.e. time t = t in hr.) is adversely effect the characteristic like, workability, compressice strength, split tensile strength and modulus of elasticity of pavement quality concrete (PQC). Concrete lap their intial setting time t_i in between mixing to placing, Time lag (t) beyond time t_i give up to green and completely plastic.The reduction in concrete strength occurs in case cement is moulded after cement has undergone initial setting (Bairagi, N. K. 1970; Bairagi 1977). The time lag and improper intermittenet curing sequences is also affect the strength of PQC. To maintain the strength the blending of two preset concrete mix is work out on site same grade or adding higher grade (Bairagi, N. K., Goyal, A. S., Ramachandra Rao 1990). In curing method hydration reaction is work out and help to developed strength in PQC. The hydration method is carefully associated with concrete microstructure development, proper curing measures are vital to preserve satisfactory moisture and temperature condition (Ge, Wang, and Gao 2009; Safiuddin, M., Raman, S. N., & Zain 2007) . Normally 28 days fully submerged or non stop curing on the laboratory offers a quality result to reached the required strength of pavement concrete, but in regular site practices, that continuous curing is not possible, hence they used gunny bag curing methods. This curing methods is not adequate to get final strength of PQC (RenJuan Sun, Hoonill Won 2011). Adequate curing is vital with the right approach of its application for a newly placed concrete to gain the enviable characteristics and well-known durability of the hardened concrete (ilhanTohumcu 2013; N. R. El-Sakhawy, H. S. El-Dien, M. E. Ahmed 1999). Curing is most importanat in early aage of concrete. Though the exact lab curing exercise is not feasible on the site. Up to a certain limit is it possible to achived the proper curing sequence to improve the quality of PQC. Curing may be applied in several ways and the most appropriate means of curing may be dictated by the site or the construction method. The curing condition i.e. natural curing , standard curing, sealed curing and water curing on the capillary absorption of ordinary concrete has an important effect on at the compressive strength, modulus of elasticity and porosity of concrete (Ge et al. 2009; RenJuan Sun, Hoonill Won 2011).

2. **Effect of intermittent curing on pavement quality concrete (PQC**).

Appropriate curing is most crucial in mass concreting to provide required strength & stability of pavement quality concrete. In mass concreting usually concentrate on the hydration process of cement, for that managed water-cement ratio as well as hold proper moisture & temperature condition (Wang, Kejin, James K. Cable 2006). Recently concrete internally cured and applied on field directly known as Intrenally cured concrete (ICC) pavement. The ICC pavement achieved 28 days compressive strength within 7 days and increased the ultimate strength (Bentz and Weiss 2011; Bergin 2016).For durability of concrete point of view Temperature, moisture, hydration process are important, for maintining this supplementary cementious material (SCMs) are used in the pavement concrete, to improved concrete properties such as ultimate strength, durability, workability of concrete, and impermeability. Due to some site constraint like,time lag in placing of concrete, handling of concrete, improper site management, breakdown of work due to various reasons etc.,not possible to achieved quality of PQC. To overcome this problem the process of remixing concrete method used also if necessary addition of small quantity of extra water known as retempering of concrete .

3. **Materials Used and Part Analysis**

Cement: A cement is a binder, a substance that sets and hardens and can bind other materials together.

Table 1: Physical Properties of OPC

Physical Properties		**BIS-1489:1991**	**Test Result**
Setting time	Initial	30 min	36 min
	Final	600 min	400 min
Specific Gravity			3.15

Aggregate: Aggregates are ,aterial such as sand, gravel, or crushed stone that, along with water and portland cement, are an essential ingredient in concrete.

Sand: Sand is either crushed rock or as naturally seen on the sea shore, in river beds, or in deserts, or it is artificially produced.Its classification may be as per shape of its particles, which differs depending on where the sand came from originally.

Table 2: Aggregate properties

Sr. No.	**Properties**	**Normal Aggregate**
1.	**Specific Gravity**	**2.72(CA) & 2.65(FA)**
2.	**Bulk Density**	**1.496 kg/lit (CA)**
3.	**Impact Value**	**17.32 % (CA)**
4.	**Fineness Modulus**	**6.92(CA)**
5.	**Water Absorption**	**1.15 % (CA)**
6.	**Moisture Content**	**23 % (FA)**

Shape and Size Matter : Particle shape and surface texture affect mainly, the properties of freshly mixed concrete. Elongated shape rough-textured and angular particles require more water to produce workable concrete.

3.1. Laboratory Investigation

To study the effects of intermittent curing on strength of rigid pavement , selected M40 & M50 two concrete mix grades shown in table 3 are selected to cast the pavement speimens in conventional, selfing and crossing techniques . For compressive strength, cubes of dimension 150 x 150 x150 mm were cast and tested as per IS 516: 1959. & foe tensile strength Cylinder of dimension 150 mm diameter & 300mm height were cast & tested details of specimen shown in table 4 & 5

Concrete cubes & cylinder cast by providing different blend ratio, time lag and cured under different curing conditions. Considered the curing conditions are, A00W28, $A_{07}W_{21}$, $W_{14}A_{14}$, $A_{21}W_{07}$, $A_{28}W_{00}$, for various blend ratio viz., $r = \infty$, 3.00, 1.00 and 0 as well as time lag t (minute) 0.00. 30.00, 60.00, 90.00, 120.00 and 150.00 min is used for the test.All the specimens were demolded the next day and put to curing for 'the specified periods in water as per the various planned, improper curing sequences as mentioned above. The specimens to be cured for the specified partial water curing were taken out of water and stored outside in air for the designated period. The 28-day water cured specimens were, however, tested soon after taking out from water after or on swapping the water. Completely air-cured and partially water-cured specimens were, however, tested in dry condition. The cube and cylinder specimens were tested on 100 ton and 200 -ton- capacity machine after suitable calibration in each case. The cubes and cylinder specimens were tested for compressive strength and modulus of elasticity as per the method specified in IS: 516-1959 (Methods of test for strength of concrete and the cylinder specimens were tested for split tensile strength in accordance with the prescribed procedure in IS:5816-1970 (Methods of test for split tensile strength of concrete cylinders). The average value of the compressive strength and modulus of elasticity have been calculated by testing 3 cubes and 3 cylinder specimens respectively.To verify experimently and analytically strength of remix concrete mixes of different proportion in a certain blend ratio for general Selfing and general Crossing of all the mix types including improper curing combination

Table 3. 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

Table 4 Specimen schedule

Sr. No	Method of concrete mixing	Grade of remixing	Blend ratio (r)	Time Lag (t in hr)
1	Conventional	M40(old)+M40Fresh) M40(old)+M50(Fresh)	0	0.5
2	Selfing	M40(old)+M40Fresh)	0.33	0.5
3	Crossing	M40(old)+M50(Fresh)	0.33	0.5
4	Conventional	M40(old)+M40Fresh) M40(old)+M50(Fr	0	1.5

		esh)		
5	Selfing	M40(old)+M40Fresh)	1	1.5
6	Crossing	M40(old)+M50(Fresh)	0	1.5
7	Conventional	M40(old)+M40Fresh) M40(old)+M50(Fresh)	3	2
8	Selfing	M40(old)+M40Fresh)	3	2
9	Crossing	M40(old)+M50(Fresh)	3	2

The exerimenatl program shown in fig 1 to develop simple technique of producing high strength concrete from available materials used for producing normal grade concrete.

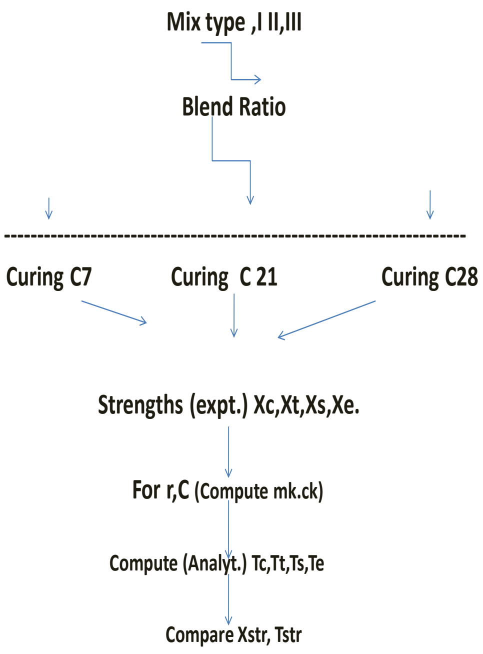

Fig 1. Flow Chart

X_c = Compressive strength (Experimental)
X_t = Tensile strength (Experimental)
X_s = Shear strength (Experimental)
X_e = Modulus of elasticity (Experimental)
C_7,C_{14},C_{21} & C_{28} Intermittenet Curing period

3.2. Materials and Test Specimens

Ordinary Portland cement conforming to Indian Standard .IS: 269 -1976 has been used for all the mixes. River-sand and crushed granite coarse aggregate in Metal have been used. For normal concrete mixes, the grading of fine and coarse aggregates conformed to the grading requirements specified in IS: 383-1910 (Specification for coarse and fine aggregates from natural sources _for concrete). For high strength concrete, a type grading curve has been used. The type grading curve was arrived at by carrying out a series of pilot tests in which the proportions of coarse to fine aggregates. Metal 1 and Metal 2, A/C ratios and W/C ratios were varied. The results obtained from the Pilot tests conducted are given in

Table IV & Table V. The specific gravities and bulk densities of the fine and coarse aggregates used were determined as per 2386 (Part III) - 1963 (Methods of Test for Aggregate for Concrete) and found to be 2.62 and 2.63 and 1615 kg/m3 and 1587 kg/m3 respectively. The aggregates used were in a saturated surface dry condition. The control test specimens comprised of 150 mm standard cubes and 150 mm 300 mm cylinders for the determination of the compressive strength, split tensile strength And modulus of elasticity of all the concrete types cured under the following insufficient curing (cumulative curing) sequences. A0W28, A7W21, A21W7, A28W00 W28A00 shown in table 6.

Table 5. Specimens details

Specimens	Conventional (BL_0)	Selfing & Crossing ($BL_{0.33}$)	Selfing & Crossing (BL_1)	Selfing & Crossing (BL_3)
Cube in Nos.	36	72	72	72
Cyllinder in Nos.	36	72	72	72

4. RESULTS AND DISCUSSIONS

The individual types considered within the scope of the present investigation are concreting of normal as well as higher grades each of these mix types again cured under various cumulative improper curing sequences. The computation for the prediction of the strengths analytically following various steps of calculation using proper analytical. procedure for any two appropriate combinations of the preset mix cases in blending by using repetitively the selfing equation is really an impossible task if intended to be carried out manually.

Table 6. Details of work for Cubes (Curing Sequences)

Sr.no	Blend ratio (r)	Time lag (t) Minute	Curing Sequences
1	0	0	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
1	0.33	30	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		60	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		90	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		120	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
2	1	30	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		60	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		90	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		120	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
4	3	30	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		60	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		90	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$
		120	$A_{00}W_{28}$, $A_{07}W_{21}$, A_{14} $W_{14,}$ $A_{21}W_{07}$, $A_{28}W_{00}$

Table 7. Comparison between the analytical and experimental values of Selfed strength of Mix M40 for different time lag parameters (Type of Curing $A_{28}W_{00}$).

Type of Curing	Blend Ratio (r)	Time Lag (t) in Minute	Compressive strength (N/mm^2)			Tensile strength(N/mm^2)			Modulus of Elasticity in Gpa)		
			XC(t)	AC(t)	% Error	XT(t)	AT(t)	% Error	XE(t)	AE(t)	% Error
	0	0	43.25	43.25	0	4.60	4.60	0	32.88	32.88	0
	0	30	40.25	41.29	2.52	4.44	4.50	1.27	31.72	32.13	1.27
	0	60	37.65	37.98	0.87	4.30	4.31	0.44	30.68	30.81	0.44
	0	90	34.65	35.21	1.59	4.12	4.15	0.80	29.43	29.67	0.80
	0	120	32.15	33.02	2.63	3.97	4.02	1.33	28.35	28.73	1.33
	0.33	0	44.25	44.25	0.00	4.66	4.66	0.00	33.26	33.26	0.00
	0.33	30	46.58	46.98	0.85	4.78	4.80	0.43	34.12	34.27	0.43
	0.33	60	45.25	45.39	0.31	4.71	4.72	0.15	33.63	33.69	0.15
A_{28} W_{00}	0.33	90	42.65	42.35	-0.71	4.57	4.56	-0.35	32.65	32.54	-0.35
	0.33	120	40.35	40.95	1.47	4.45	4.48	0.74	31.76	32.00	0.74
	1	0	44.56	44.56	0.00	4.67	4.67	0.00	33.38	33.38	0.00
	1	30	43.25	43.29	0.09	4.60	4.61	0.05	32.88	32.90	0.05
	1	60	42.35	42.65	0.70	4.56	4.57	0.35	32.54	32.65	0.35
	1	90	40.05	40.65	1.48	4.43	4.46	0.74	31.64	31.88	0.74
	1	120	39.65	39	-1.67	4.41	4.37	-0.83	31.48	31.22	-0.83
	3	0	44.25	44.25	0.00	4.66	4.66	0.00	33.26	33.26	0.00
	3	30	43.25	44.05	1.82	4.60	4.65	0.91	32.88	33.19	0.91
	3	60	41.25	42	1.79	4.50	4.54	0.90	32.11	32.40	0.90
	3	90	40.87	41.35	1.16	4.48	4.50	0.58	31.96	32.15	0.58
	3	120	37.39	37.6	0.69	4.28	4.30	0.35	30.57	30.68	0.35

Table 8. Comparison between the analytical and experimental values of Selfed strength of Mix M40 for different time lag parameters (Type of Curing $A_{21}W_{07}$).

Type of Curing	**Blend Ratio (r)**	**Time Lag (t) in Minute**	**Compressive strength (N/mm^2)**			**Tensile strength(N/mm^2)**			**Modulus of Elasticity in Gpa)**		
			XC(t)	**AC(t)**	**% Error**	**XT(t)**	**AT(t)**	**% Error**	**XE(t)**	**AE(t)**	**% Error**
	0	0	42.22	42.22	0	4.55	4.55	0	32.49	32.49	0
	0	30	39.18	40.22	2.57	4.38	4.44	1.29	31.30	31.71	1.29
	0	60	36.63	37.66	2.75	4.24	4.30	1.38	30.26	30.69	1.38
	0	90	33.62	34.64	2.96	4.06	4.12	1.49	28.99	29.43	1.49
	0	120	31.12	30.10	-3.40	3.91	3.84	-1.69	27.89	27.43	-1.69
	0.33	0	43.22	43.22	-0.01	4.60	4.60	0.00	32.87	32.87	0.00
	0.33	30	45.55	44.53	-2.29	4.72	4.67	-1.14	33.75	33.37	-1.14
	0.33	60	44.22	45.26	2.29	4.66	4.71	1.15	33.25	33.64	1.15
$A_{21}W_{07}$	0.33	90	41.61	42.65	2.42	4.52	4.57	1.22	32.25	32.65	1.22
	0.33	120	39.32	40.34	2.53	4.39	4.45	1.27	31.35	31.76	1.27
	1	0	43.53	43.53	-0.01	4.62	4.62	0.00	32.99	32.99	0.00
	1	30	42.22	43.24	2.37	4.55	4.60	1.19	32.49	32.88	1.19
	1	60	41.32	40.30	-2.54	4.50	4.44	-1.26	32.14	31.74	-1.26
	1	90	39.02	40.03	2.51	4.37	4.43	1.26	31.23	31.63	1.26
	1	120	38.63	39.65	2.58	4.35	4.41	1.30	31.08	31.49	1.30
	3	0	43.22	43.22	-0.01	4.60	4.60	0.00	32.87	32.87	0.00
	3	30	42.22	41.19	-2.51	4.55	4.49	-1.25	32.49	32.09	-1.25
	3	60	40.22	41.25	2.50	4.44	4.50	1.26	31.71	32.11	1.26

	3	90	39.85	40.88	3.99	4.42	4.48	1.27	31.56	31.97	1.27
	3	120	36.35	35.32	3.91	4.22	4.16	-1.45	30.15	29.72	-1.45

Table 9. Comparison between the analytical and experimental values of Selfed strength of Mix M40 for different time lag parameters (Type of Curing $A_{14}W_{14}$).

Type of Curing	**Blend Ratio (r)**	**Time Lag (t) in Minute**	**Compressive strength (N/mm2)**			**Tensile strength(N/mm2)**			**Modulus of Elasticity in Gpa)**		
			XC(t)	**AC(t)**	**% Error**	**XT(t)**	**AT(t)**	**% Error**	**XE(t)**	**AE(t)**	**% Error**
	0	0	41.20	41.19	0.00	4.49	4.49	0.00	32.09	32.09	0.00
	0	30	38.12	39.15	2.64	4.32	4.38	1.33	30.87	31.29	1.33
	0	60	35.61	34.57	-3.00	4.18	4.12	-1.49	29.84	29.40	-1.49
	0	90	32.58	33.61	3.05	4.00	4.06	1.54	28.54	28.99	1.54
	0	120	30.10	31.12	3.29	3.84	3.91	1.66	27.43	27.89	1.66
	0.33	0	42.20	42.19	-0.02	4.55	4.55	-0.01	32.48	32.48	-0.01
	0.33	30	44.53	45.55	2.24	4.67	4.72	1.13	33.36	33.74	1.13
	0.33	60	43.20	44.23	2.34	4.60	4.66	1.18	32.86	33.25	1.18
	0.33	90	40.58	39.55	-2.61	4.46	4.40	-1.30	31.85	31.44	-1.30
	0.33	120	38.30	39.32	2.60	4.33	4.39	1.31	30.94	31.35	1.31
A_{14} W_{14}	1	0	42.51	42.50	-0.02	4.56	4.56	-0.01	32.60	32.60	-0.01
	1	30	41.19	42.21	2.43	4.49	4.55	1.22	32.09	32.48	1.22
	1	60	40.30	41.32	2.48	4.44	4.50	1.25	31.74	32.14	1.25
	1	90	38.00	39.00	2.57	4.31	4.37	1.29	30.82	31.23	1.29
	1	120	37.60	38.63	2.65	4.29	4.35	1.34	30.66	31.08	1.34
	3	0	42.20	42.19	-0.02	4.55	4.55	-0.01	32.48	32.48	-0.01
	3	30	41.20	40.16	-2.57	4.49	4.44	-1.28	32.09	31.69	-1.28
	3	60	39.18	40.22	2.57	4.38	4.44	1.29	31.30	31.71	1.29
	3	90	38.83	37.79	3.99	4.36	4.30	-1.36	31.16	30.74	-1.36
	3	120	35.32	34.29	3.91	4.16	4.10	-1.49	29.71	29.28	-1.49

Table 10. Comparison between the analytical and experimental values of Selfed strength of Mix M40 for different time lag parameters (Type of Curing $A_{07}W_{21}$).

Type of	**Blend**	**Time**	**Compressive strength (N/mm2)**	**Tensile strength(N/mm2)**	**Modulus of Elasticity in Gpa)**

Curing	Ratio (r)	Lag (t) in Minute	XC(t)	AC(t)	% Error	XT(t)	AT(t)	% Error	XE(t)	AE(t)	% Error
$A_{07}W_{21}$	0	0	40.17	40.17	0.00	4.44	4.44	0.00	31.69	31.69	0.00
	0	30	37.05	38.09	2.71	4.26	4.32	1.36	30.44	30.86	1.36
	0	60	34.58	33.55	-3.09	4.12	4.05	-1.53	29.40	28.96	-1.53
	0	90	31.55	32.58	3.14	3.93	4.00	1.58	28.09	28.54	1.58
	0	120	29.07	30.10	3.40	3.77	3.84	1.72	26.96	27.43	1.72
	0.33	0	41.17	41.17	0.00	4.49	4.49	0.00	32.08	32.08	0.00
	0.33	30	43.50	44.52	2.29	4.62	4.67	1.15	32.98	33.36	1.15
	0.33	60	42.17	43.21	2.40	4.55	4.60	1.21	32.47	32.87	1.21
	0.33	90	39.54	38.51	-2.68	4.40	4.34	-1.33	31.44	31.03	-1.33
	0.33	120	37.27	38.29	2.67	4.27	4.33	1.34	30.52	30.94	1.34
	1	0	41.48	41.48	0.00	4.51	4.51	0.00	32.20	32.20	0.00
	1	30	40.15	41.18	2.49	4.44	4.49	1.25	31.68	32.09	1.25
	1	60	39.27	40.30	2.54	4.39	4.44	1.28	31.33	31.74	1.28
	1	90	36.97	37.97	2.64	4.26	4.31	1.33	30.40	30.81	1.33
	1	120	36.58	37.61	2.73	4.23	4.29	1.37	30.24	30.66	1.37
	3	0	41.17	41.17	0.00	4.49	4.49	0.00	32.08	32.08	0.00
	3	30	40.17	39.14	-2.64	4.44	4.38	-1.31	31.69	31.28	-1.31
	3	60	38.15	39.19	2.64	4.32	4.38	1.33	30.88	31.30	1.33
	3	90	37.81	36.77	3.99	4.30	4.24	-1.39	30.74	30.32	-1.39
	3	120	34.28	33.25	3.91	4.10	4.04	-1.54	29.28	28.83	-1.54

Table 11. Comparison between the analytical and experimental values of Selfed strength of Mix M40 for different time lag parameters (Type of Curing $A_{00}W_{28}$).

Type of Curing	Blend Ratio (r)	Time Lag (t) in Minute	Compressive strength (N/mm2)			Tensile strength(N/mm2)			Modulus of Elasticity in Gpa)		
			XC(t)	AC(t)	% Error	XT(t)	AT(t)	% Error	XE(t)	AE(t)	% Error
$A_{00}W_{28}$	0	0	44.17	44.17	0.00	4.65	4.65	0.00	33.23	33.23	0.00
	0	30	41.05	42.09	2.45	4.49	4.54	1.23	32.04	32.44	1.23
	0	60	38.58	37.55	-2.76	4.35	4.29	-1.37	31.06	30.64	-1.37
	0	90	35.55	36.58	2.80	4.17	4.23	1.41	29.81	30.24	1.41
	0	120	33.07	34.10	3.00	4.03	4.09	1.51	28.75	29.20	1.51
	0.33	0	45.17	45.17	0.00	4.70	4.70	0.00	33.60	33.60	0.00
	0.33	30	47.50	48.52	2.11	4.82	4.88	1.06	34.46	34.83	1.06
	0.33	60	46.17	47.21	2.19	4.76	4.81	1.10	33.97	34.35	1.10
	0.33	90	43.54	42.51	-2.43	4.62	4.56	-1.21	32.99	32.60	-1.21
	0.33	120	41.27	42.29	2.42	4.50	4.55	1.21	32.12	32.52	1.21
	1	0	45.48	45.48	0.00	4.72	4.72	0.00	33.72	33.72	0.00

	1	30	44.15	45.18	2.27	4.65	4.71	1.14	33.22	33.61	1.14
	1	60	43.27	44.30	2.31	4.60	4.66	1.16	32.89	33.28	1.16
	1	90	40.97	41.97	2.39	4.48	4.54	1.20	32.00	32.39	1.20
	1	120	40.58	41.61	2.46	4.46	4.52	1.24	31.85	32.25	1.24
	3	0	45.17	45.17	0.00	4.70	4.70	0.00	33.60	33.60	0.00
	3	30	44.17	43.14	-2.39	4.65	4.60	-1.19	33.23	32.84	-1.19
	3	60	42.15	43.19	2.39	4.54	4.60	1.20	32.46	32.86	1.20
	3	90	41.81	40.77	3.99	4.53	4.47	-1.26	32.33	31.93	-1.26
	3	120	38.28	37.25	3.91	4.33	4.27	-1.38	30.94	30.52	-1.38

Table 12. Comparison between the analytical and experimental values of Selfed strength of Mix **M50** for different time lag parameters (Type of Curing $A_{28}W_{00}$).

Type of Curing	Blend Ratio (r)	Time Lag (t) in Minute	Compressive strength (N/mm2)			Tensile strength(N/mm2)			Modulus of Elasticity in Gpa)		
			XC(t)	AC(t)	% Error	XT(t)	AT(t)	% Error	XE(t)	AE(t)	% Error
	0	0	52.17	52.17	0.00	5.06	5.06	0.00	36.11	36.11	0.00
	0	30	49.05	50.09	2.06	4.90	4.95	1.04	35.02	35.39	1.04
	0	60	46.58	45.55	-2.27	4.78	4.72	-1.13	34.13	33.74	-1.13
	0	90	43.55	44.58	2.30	4.62	4.67	1.16	33.00	33.38	1.16
	0	120	41.07	42.10	2.43	4.49	4.54	1.22	32.04	32.44	1.22
	0.33	0	53.17	53.17	0.00	5.10	5.10	0.00	36.46	36.46	0.00
	0.33	30	55.50	56.52	1.81	5.21	5.26	0.91	37.25	37.59	0.91
	0.33	60	54.17	55.21	1.88	5.15	5.20	0.94	36.80	37.15	0.94
	0.33	90	51.54	50.51	-2.04	5.03	4.97	-1.02	35.90	35.54	-1.02
	0.33	120	49.27	50.29	2.03	4.91	4.96	1.02	35.10	35.46	1.02
$A_{28}W_{00}$	1	0	53.48	53.48	0.00	5.12	5.12	0.00	36.57	36.57	0.00
	1	30	52.15	53.18	1.93	5.06	5.10	0.97	36.11	36.46	0.97
	1	60	51.27	52.30	1.96	5.01	5.06	0.98	35.80	36.16	0.98
	1	90	48.97	49.97	2.01	4.90	4.95	1.01	34.99	35.35	1.01
	1	120	48.58	49.61	2.07	4.88	4.93	1.04	34.85	35.22	1.04
	3	0	53.17	53.17	0.00	5.10	5.10	0.00	36.46	36.46	0.00
	3	30	52.17	51.14	-2.02	5.06	5.01	-1.00	36.11	35.76	-1.00
	3	60	50.15	51.19	2.02	4.96	5.01	1.01	35.41	35.77	1.01
	3	90	49.81	48.77	3.99	4.94	4.89	-1.05	35.29	34.92	-1.05
	3	120	46.28	45.25	3.91	4.76	4.71	-1.13	34.02	33.63	-1.13

Table 13. Comparison between the analytical and experimental values of Selfed strength of Mix **M50** for different time lag parameters (Type of Curing $A_{21}W_{07}$).

Type of Curing	Blend Ratio (r)	Time Lag (t) in Minute	Compressive strength (N/mm2)			Tensile strength(N/mm2)			Modulus of Elasticity in Gpa)		
			XC(t)	AC(t)	% Error	XT(t)	AT(t)	% Error	XE(t)	AE(t)	% Error

$A_{21}W_{07}$	0	0	51.14	51.14	0.00	5.01	5.01	0.00	35.76	35.76	0.00
	0	30	47.99	49.02	2.11	4.85	4.90	1.06	34.64	35.01	1.06
	0	60	45.56	44.52	-2.33	4.72	4.67	-1.16	33.75	33.36	-1.16
	0	90	42.52	43.54	2.35	4.56	4.62	1.18	32.60	32.99	1.18
	0	120	40.05	41.07	2.49	4.43	4.49	1.25	31.64	32.04	1.25
	0.33	0	52.14	52.14	0.00	5.05	5.05	0.00	36.11	36.11	0.00
	0.33	30	54.47	55.50	1.84	5.17	5.21	0.92	36.90	37.25	0.92
	0.33	60	53.14	54.18	1.91	5.10	5.15	0.96	36.45	36.80	0.96
	0.33	90	50.51	49.48	-2.09	4.97	4.92	-1.04	35.53	35.17	-1.04
	0.33	120	48.24	49.27	2.07	4.86	4.91	1.04	34.73	35.09	1.04
	1	0	52.45	52.45	0.00	5.07	5.07	0.00	36.21	36.21	0.00
	1	30	51.12	52.15	1.97	5.00	5.05	0.99	35.75	36.11	0.99
	1	60	50.24	51.27	2.00	4.96	5.01	1.00	35.44	35.80	1.00
	1	90	49.65	48.95	-1.44	4.93	4.90	-0.72	35.23	34.98	-0.72
	1	120	48.98	48.58	-0.81	4.90	4.88	-0.41	34.99	34.85	-0.41
	3	0	52.14	52.14	0.00	5.05	5.05	0.00	36.11	36.11	0.00
	3	30	51.14	50.11	-2.06	5.01	4.96	-1.02	35.76	35.39	-1.02
	3	60	49.12	50.15	2.06	4.91	4.96	1.03	35.04	35.41	1.03
	3	90	48.78	47.75	3.99	4.89	4.84	-1.08	34.92	34.55	-1.08
	3	120	45.25	44.22	3.91	4.71	4.65	-1.16	33.63	33.25	-1.16

Table 14. Comparison between the analytical and experimental values of Selfed strength of Mix **M50** for different time lag parameters (Type of Curing $A_{14}W_{14}$).

Type of Curing	Blend Ratio (r)	Time Lag (t) in Minute	Compressive strength (N/mm2)			Tensile strength(N/mm2)			Modulus of Elasticity in Gpa)		
			XC(t)	AC(t)	% Error	XT(t)	AT(t)	% Error	XE(t)	AE(t)	% Error
$A_{14}W_{14}$	0	0	51.15	51.15	0.00	5.01	5.01	0.00	35.76	35.76	0.00
	0	30	47.99	49.02	2.11	4.85	4.90	1.06	34.64	35.01	1.06
	0	60	45.56	44.53	-2.33	4.73	4.67	-1.16	33.75	33.36	-1.16
	0	90	42.52	43.55	2.35	4.56	4.62	1.18	32.60	32.99	1.18
	0	120	40.05	41.07	2.49	4.43	4.49	1.25	31.64	32.04	1.25
	0.33	0	52.15	52.15	0.00	5.05	5.05	0.00	36.11	36.11	0.00
	0.33	30	54.48	55.50	1.84	5.17	5.21	0.92	36.90	37.25	0.92
	0.33	60	53.15	54.18	1.91	5.10	5.15	0.96	36.45	36.80	0.96
	0.33	90	50.53	49.50	-2.09	4.98	4.92	-1.04	35.54	35.18	-1.04
	0.33	120	48.27	49.29	2.07	4.86	4.91	1.04	34.74	35.10	1.04
	1	0	52.48	52.48	0.00	5.07	5.07	0.00	36.22	36.22	0.00
	1	30	51.14	52.17	1.97	5.01	5.06	0.99	35.76	36.11	0.99
	1	60	50.27	51.29	2.00	4.96	5.01	1.00	35.45	35.81	1.00
	1	90	49.67	50.68	1.98	4.93	4.98	0.99	35.24	35.59	0.99
	1	120	49.00	50.03	2.05	4.90	4.95	1.03	35.00	35.37	1.03
	3	0	52.17	52.17	0.00	5.06	5.06	0.00	36.11	36.11	0.00
	3	30	51.17	50.13	-2.06	5.01	4.96	-1.02	35.77	35.40	-1.02
	3	60	49.14	50.18	2.06	4.91	4.96	1.03	35.05	35.42	1.03

	3	90	48.81	47.78	3.99	4.89	4.84	-1.07	34.93	34.56	-1.07
	3	120	45.27	44.24	3.91	4.71	4.66	-1.16	33.64	33.26	-1.16

Table 15. Comparison between the analytical and experimental values of Selfed strength of Mix **M50** for different time lag parameters (Type of Curing $A_{07}W_{21}$).

Type of Curing	**Blend Ratio (r)**	**Time Lag (t) in Minute**	**Compressive strength (N/mm2)**			**Tensile strength(N/mm2)**			**Modulus of Elasticity in Gpa)**		
			XC(t)	**AC(t)**	**% Error**	**XT(t)**	**AT(t)**	**% Error**	**XE(t)**	**AE(t)**	**% Error**
$A_{07}W_{21}$	0	0	51.15	51.15	0.00	5.01	5.01	0.00	35.76	35.76	0.00
	0	30	47.99	49.03	2.11	4.85	4.90	1.06	34.64	35.01	1.06
	0	60	45.57	44.53	-2.33	4.73	4.67	-1.16	33.75	33.37	-1.16
	0	90	42.52	43.55	2.35	4.56	4.62	1.18	32.61	33.00	1.18
	0	120	40.05	41.08	2.49	4.43	4.49	1.25	31.64	32.05	1.25
	0.33	0	52.15	52.15	0.00	5.05	5.05	0.00	36.11	36.11	0.00
	0.33	30	54.48	55.50	1.84	5.17	5.21	0.92	36.90	37.25	0.92
	0.33	60	53.15	54.18	1.91	5.10	5.15	0.96	36.45	36.81	0.96
	0.33	90	50.55	49.52	-2.08	4.98	4.93	-1.04	35.55	35.19	-1.04
	0.33	120	48.29	49.31	2.07	4.86	4.92	1.04	34.75	35.11	1.04
	1	0	52.50	52.50	0.00	5.07	5.07	0.00	36.23	36.23	0.00
	1	30	51.17	52.19	1.96	5.01	5.06	0.99	35.77	36.12	0.99
	1	60	50.29	51.32	2.00	4.96	5.01	1.00	35.46	35.82	1.00
	1	90	49.70	50.70	1.98	4.93	4.98	0.99	35.25	35.60	0.99
	1	120	49.03	50.05	2.05	4.90	4.95	1.03	35.01	35.37	1.03
	3	0	52.19	52.19	0.00	5.06	5.06	0.00	36.12	36.12	0.00
	3	30	51.19	50.16	-2.06	5.01	4.96	-1.02	35.77	35.41	-1.02
	3	60	49.17	50.20	2.06	4.91	4.96	1.03	35.06	35.43	1.03
	3	90	48.83	47.80	3.99	4.89	4.84	-1.07	34.94	34.57	-1.07
	3	120	45.29	44.26	3.91	4.71	4.66	-1.16	33.65	33.26	-1.16

Table 16. Comparison between the analytical and experimental values of Selfed strength of Mix **M50** for different time lag parameters (Type of Curing $A_{00}W_{28}$).

Type of Curing	**Blend Ratio (r)**	**Time Lag (Min.) t**	**Compressive strength (N/mm2)**			**Tensile strength(N/mm2)**			**Modulus of Elasticity in Gpa)**		
			XC(t)	**AC(t)**	**% Error**	**XT(t)**	**AT(t)**	**% Error**	**XE(t)**	**AE(t)**	**% Error**
$A_{00}W_{28}$	0	0	51.15	52.18	0.00	5.01	5.06	0.00	35.76	36.12	0.00
	0	30	48.00	49.03	2.10	4.85	4.90	1.06	34.64	35.01	1.06
	0	60	45.57	44.53	-2.33	4.73	4.67	-1.16	33.75	33.37	-1.16

0	90	42.53	43.55	2.35	4.56	4.62	1.18	32.61	33.00	1.18
0	120	40.06	41.08	2.49	4.43	4.49	1.25	31.64	32.05	1.25
0.33	0	52.15	53.15	1.89	5.06	5.10	0.95	36.11	36.45	0.95
0.33	30	54.48	55.50	1.84	5.17	5.22	0.92	36.91	37.25	0.92
0.33	60	53.15	54.19	1.91	5.10	5.15	0.96	36.45	36.81	0.96
0.33	90	50.58	49.55	-2.08	4.98	4.93	-1.04	35.56	35.19	-1.04
0.33	120	48.31	49.33	2.07	4.87	4.92	1.04	34.75	35.12	1.04
1	0	52.52	51.50	-1.98	5.07	5.02	-0.99	36.24	35.88	-0.99
1	30	51.19	52.22	1.96	5.01	5.06	0.99	35.77	36.13	0.99
1	60	50.31	51.34	2.00	4.97	5.02	1.00	35.47	35.83	1.00
1	90	49.72	50.72	1.98	4.94	4.99	0.99	35.26	35.61	0.99
1	120	49.05	50.07	2.05	4.90	4.95	1.03	35.02	35.38	1.03
3	0	52.21	51.19	-2.00	5.06	5.01	-0.99	36.13	35.77	-0.99
3	30	51.21	50.18	-2.06	5.01	4.96	-1.02	35.78	35.42	-1.02
3	60	49.19	50.22	2.06	4.91	4.96	1.03	35.07	35.43	1.03
3	90	48.85	47.82	3.99	4.89	4.84	-1.07	34.95	34.58	-1.07
3	120	45.32	44.29	3.91	4.71	4.66	-1.16	33.66	33.27	-1.16

Table 17. Intermittent curing effect (Grade M40 remixing at r=0,0.33, 1 & 3)

Sr.no.	Blend ratio [r =(Co) / (Cf)]	Curing pattern	Air28 Water0	Air21 Water7	Air7 Water21	Air0 Water28
1	0	CB_0T_0	29.55	32.4	42.01	46.9
2	0.33	$CB_{0.33}T_{0.5}$	31.12	31.64	42.95	44.59
3		$CB_{0.33}T_1$	28.89	29.45	41.84	43.95
4		$CB_{0.33}T_{1.5}$	26.24	28.24	39.15	41.69
5		$CB_{0.33}T_2$	21.54	24.1	34.87	38.97
6	1	$CB_1T_{0.5}$	28.01	31.02	38.94	42.32
7		CB_1T_1	26.04	29.58	36.97	41.97
8		$CB_1T_{1.5}$	25.04	27.12	35.98	40.69
9		CB_1T_2	20.98	26.24	34.87	37.94
10	3	$CB_3T_{0.5}$	30.12	31.02	40.18	42.18
11		CB_3T_1	28.64	30.15	39.01	39.57
12		$CB_3T_{1.5}$	24.15	27.15	36.47	37.98
13		CB_3T_2	23.05	28.45	33.54	34.97

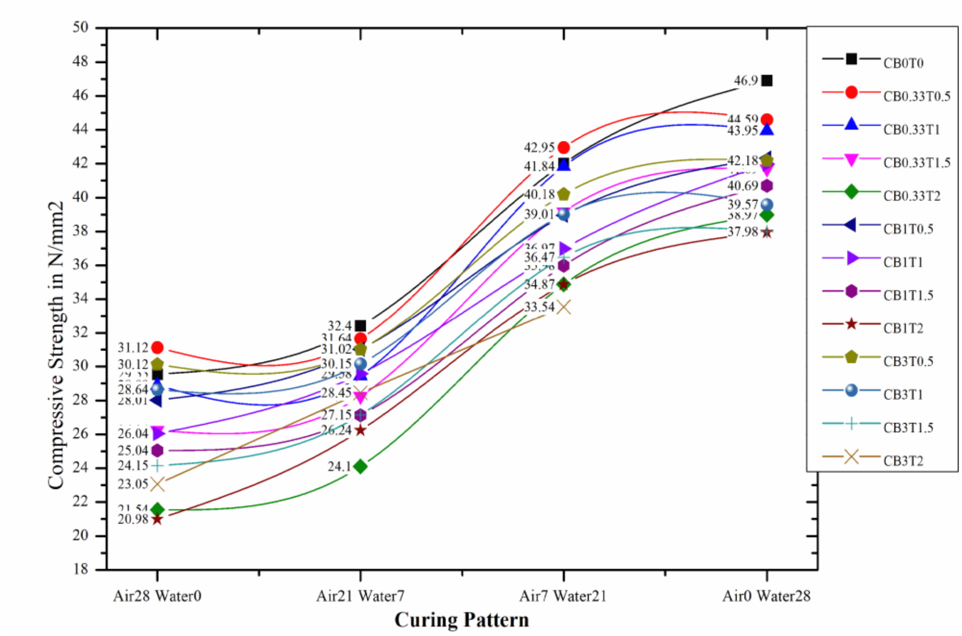

Fig.4 Compressive strength of pavement quality concrete vs Intermittent Curing Condition

Notation:

CB_1T_0 : CB_1 = Casting of Cubes for blend ratio r =1, & T_0= Time lag is 0 Minute

CB_1T_1 : CB_1 = Casting of Cubes for blend ratio r =1, & T_1= Time lag is 30 Minute

CB_1T_2 : CB_1 = Casting of Cubes for blend ratio r =1, & T_2= Time lag is 60 Minute

CB_1T_3 : CB_1 = Casting of Cubes for blend ratio r =1, & T_3= Time lag is 90 Minute

CB_1T_4 : CB_1 = Casting of Cubes for blend ratio r =1, & T_4= Time lag is 120 Minute

Similarly

CB_3T_1 : CB_3 = Casting of Cubes for blend ratio r =3, & T_1= Time lag is 30 Minute

The compressive strength of cube , split tensile strength of cylinder and modulus of elasticity for the conventional as well as pure selfed mixes of grade M40 & M50 for the various blend ratios, viz., r =0, 0.33, 1 and 3 and time lag t= 0min, 30min, 60min, and 120min
calculated from the experimental observations and the effect of improper curing sequences are presented in table no.7, 8,9,10,& 11 for M40 grade and table no. 12,13,14,15 & 16 for M50 grade. The fig 4 represnted that after applying remixing technique to the existing partially set concrete at various time lag (t) , there is an increment in compressive strength with respect to curing pattern Air_{28} $Water_0$ to Air_0 $Water_{28}$. The comcpressive strength increases in Air_0 $Water_{28}$ Curing pattern is around 35% than Air28 Water0 curing sequences.The calculation of strength of concrete done by Bairagi's mathematical equation and actual laboratory strength value not much differ.

5. CONCLUSION

The strength of concrete which undergoes intermittent curing is less than that of strength due to cumulative curing after 28 days of curing. The maximum compressive strength of concrete achieved by using $A_{00}W_{28}$ Curing Condition.The strength of blended concrete gives better result up to r = 0, 1, & in-between 1 & 3. This strength gives satisfactory results up to time lag 90 minutes.Blend Concrete with r = 3 and infinity gives poor strength so in practice old concrete was not suitable for reuse. As time lag is increased after initial setting time (IST), the concrete becomes dry and set, hence it is preferred to use the concrete before final setting the time. After applying selfing technique (M40 Old + M40 Fresh Mix) to the existing partially set concrete at various time lags (t) and at blend ratio r = 0.33, r = 1 it has been observed that there is an small increment in properites of pavement quality concrete i.e compressive stremgth, split tensile strength, workability and elastic modulus. By adding a higher grade of fresh concrete i.e. (M50 Grade) to the old partially set concrete (M40 Old) i. e crossing technique quality of concrete improved, strength & workalbily increases as compared to addition of same grade of fresh concrete (New M40) to the old partially set concrete.

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