International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 5, August 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Accelerate the Strength Gaining Properties of Concrete by using Different Cementtitious Materials, Non- Chlorides Hardning Acceleraters and Water Curing in Rigid Pavement

Rakesh Kumar[1], Er. Anil Kumar[2]

[1]M.Tech Scholar, [2]Assistant Professor
[1,2]Department of Civil Engineering Prannath Parnami Institutes of Technology & Management, Choudharywas, Hisar, Haryana, India

How to cite this paper: Rakesh Kumar | Er. Anil Kumar "Accelerate the Strength Gaining Properties of Concrete by using Different Cementtitious Materials, Non-Chlorides Hardning Acceleraters and Water Curing in Rigid Pavement" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.844-848, **https://doi.org/10.31142/ijtsrd26525**

IJTSRD26525

ABSTRACT
The present study work was carried out to determine the effect of Non Chlorides Hardening Accelerators with different cementations' materials i.e. OPC & PPC. On concrete mixtures when Non-Chlorides Accelerators used in OPC mixtures with water curing, keeping the ascending dose of non chlorides hardening accelerators i.e. 0%, 0.58%, 0.73%, 0.87%.The two strength properties of concrete determined in experimental work namely compressive strength and flexural strength at 7 and 28 days. The effect of accelerators enhancing the flexural strength was found to be fading at later age of concrete which was also observed in case of compressive strength. The maximum percentage gains at 7 and 28 days were 27.18 & 20.48 respectively recorded at maximum dosage of accelerators. In case of PPC mixtures, Non chlorides hardening accelerators rage kept – 0%, 0.57%, 0.72%, and 0.85%. In PPC mixtures also moderate to high increase in the flexural and compressive strength was observed at early age with increasing the dosage of accelerators Hence through the result conclusion high early strength concrete mixtures can be obtained by using Non chlorides hardened accelerators and two types of cementations materials i.e. OPC & PPC. With different curing methods namely water curing and curing with membrane forming curing compounds.

KEYWORDS: *OPC, PPC, Non chloride hardening accelerator, compressive strength*

I. INTRODUCTION

Distresses in the in the rigid pavements are of many types and repair rehabilitation is distress-specific. It is always advisable to identify the cause of the distress before initiating any repair work. Of many distresses that a concrete road undergoes, the distresses that require partial depth and full depth repair are of greater significance, as in such cases the scale and magnitude of repair work is larger and may even involve replacement of slab. Traditional methods of repair and rehabilitation of concrete pavements are time consuming as the concrete attains the required strength by the hydration of cement which is a slow process. Appropriate low-cost and timely measures are required to extend the life of the pavements. It is practically and economically not advisable to close the roads for repairs, in heavy-traffic areas, particularly in case of the dual two-lane carriageway national highways which are built on Public-Private Partnership model. Accelerated rehabilitation which is popularly known as fast-track construction and rehabilitation is the only solution for this problem. Fast-track construction is not a new technology, as it is being successfully adopted in the developed countries since last two decades, though its application is limited in India, particularly in the rehabilitation of concrete pavements.

II. Review of literature

Kovler Konstantin and Roussel Nicolas, (2014) Workability and fundamental rheological properties, reversible and non-reversible evolution, thixotropy, slump loss, setting time, bleeding, segregation and practical issues related to formworkfilling and pressure, are addressed among the properties of fresh concrete. Among hardened concrete properties compressive strength and other mechanical and physical properties of hardened concrete, such as tensile strength ,elastic properties ,shrinkage ,creep, cracking resistance, electrical, thermal, transport and other properties are covered. Testing, interpretation, modeling and prediction of properties are addressed, as well as correlation with properties of fresh concrete and durability, effects of special binders, recycled and natural aggregates, fiber reinforcement, mineral and chemical admixtures. Special attention is given to the properties of hardened lightweight and self-compacting concrete.

Ghafoori N. and Tays M. W.,(2010) The selected fast-track Type I Portland cement concretes were studied for resistance to wear at both opening and maturity (28 days) times.Depth of wear and rate of deterioration as functions of matrix proportions and constituents, opening-time categories, and testing duration were determined. The influence of variables such as cement content, curing age, and accelerating admixture on compressive strength and abrasion resistance of the selected matrices were studied. The coefficient of variation and abrasion index for the abrasion test of the trials concrete were also examined. Lastly,the relationship between the abrasion resistance (depth of wear) and compressive strength at both opening and maturity ages were investigated.

Gupta Vedprakash (2009) This report examines the repair and restoration of concrete pavements systematically by distress classification and the underlining objectives of each concrete repair and restoration technique. It also covers the composition and characteristics of a broad range of repair materials for cracks, spalling, potholes, rough patches and sunken slab. The review covers techniques used in routine maintenance of concrete pavements but excludes slab replacement. Emphasis will be given to road pavements but they are also applicable to other concrete pavements.

III. TEST RESULT

FRESH CONCRETE

All the mixtures were tested by Slump test, to assess the workability. Tables give the workability values of OPC and PPC mixtures for various dosages of accelerator.

Table -Workability of OPC mixtures

Mixture	OPC0	OPC1	OPC2	OPC3
Accelerator Dosage (%)	0	0.58	0.73	0.87
Slump (mm)	10	10	10	5

Table Workability of PPC mixtures

Mixture	PPC0	PPC1	PPC2	PPC3
Accelerator dosage (%)	0	0.57	0.72	0.85
Slump (mm)	10	10	10	10

HARDENED CONCRETE – STRENGTH

The results and discussions on the hardened properties of the concrete mixtures at early age and at full maturity are reported in this section. Compressive and flexural strengths of the mixtures cured with water and alternatively with curing compound, for various dosages of accelerator and at different curing ages are presented. Percentage gains in compressive and flexural strengths of all the mixtures (OPC, PPC) cured with water and alternatively with curing compound, for different accelerator dosages and at different curing ages, measured with reference to that of respective control mixtures were assessed, so as to investigate the influence of accelerator on the hardened properties at early and later age of concrete mixtures. Average efficiency of the curing compound for the compressive and flexural strengths of all the mixtures at different curing ages was also assessed. The efficiency of the curing compound for a given mixture, at a given period of curing and for a known dosage of accelerator was defined as the ratio of strength of the mixture cured with curing compound to the strength of the same mixture cured with water, expressed as percentage. Average efficiency of the curing compound at a given curing age was calculated as the average of the efficiencies at the corresponding age for different dosages of accelerator. The ratio of the flexural and compressive strengths is always part of discussions in the experimental reports on concrete, particularly on pavement concrete. The flexural strength results are affected by moisture conditions and it is practically proven that variability of the modulus of rupture is higher.

OPC Mixtures

This section reports the results and discussions on the compressive and flexural strengths of OPC mixtures at early age and at full maturity.

Compressive strength of water-cured OPC mixtures

Compressive strengths of OPC mixtures cured with water for various dosages of accelerator and at different curing ages are reported in tables.

Table Compressive strength of water-cured OPC mixtures at 7 days

Mix	Specimen Id	Accelerator, %	Failure load, kN	Comp. strength, Mpa	Average Value, MPa
	OPCW01	0	833.85	37.06	
OPC0	OPCW02	0	824.07	36.62	37.20
	OPCW03	0	853.47	37.93	
	OPCW11	0.58	860.83	38.26	
OPC1	OPCW12	0.58	863.28	38.37	38.19
	OPCW13	0.58	853.47	37.93	
	OPCW21	0.73	863.28	38.37	
OPC2	OPCW22	0.73	853.47	37.94	38.37
	OPCW23	0.73	873.09	38.80	
	OPCW31	0.87	887.80	39.46	
OPC3	OPCW32	0.87	882.90	39.24	39.16
	OPCW33	0.87	873.09	38.80	

Table Compressive strength of water-cured OPC mixtures at 28 days

Mix	Specimen Id	Accelerator, %	Failure load, kN	Comp. strength, Mpa	Average value, MPa
	OPCW01	0	1125.69	50.03	
OPC0	OPCW02	0	1118.34	49.70	49.96
	OPCW03	0	1128.15	50.14	

	OPCW11	0.58	1128.15	50.14	
OPC1	OPCW12	0.58	1137.96	50.58	50.46
	OPCW13	0.58	1140.41	50.68	
	OPCW21	0.73	1157.58	51.45	
OPC2	OPCW22	0.73	1167.39	51.88	51.85
	OPCW23	0.73	1174.75	52.21	
	OPCW31	0.87	1177.20	52.32	
OPC3	OPCW32	0.87	1167.39	51.89	52.29
	OPCW33	0.87	1184.56	52.65	

Discussion

All the mixtures attained the stipulated design strength at 28 days of curing. Accelerator was moderately effective in increasing the compressive strength of concrete mixtures at early age.. The accelerator had negligible effect at 28 days in all the mixtures, which shows its waning effect in the later age of concrete.

Flexural strength of water-cured OPC mixtures

Flexural strengths (modules of rupture) of OPC mixtures cured with water for various accelerator dosages and at different curing ages are shown in table

Table Flexural strength of water-cured OPC mixtures at 7 days

Mix	Specimen Id	Accelerator, %	Failure load, kN	Modulus of rupture, MPa	Average Value, MPa
	OPCW01	0	12.5	5.00	
OPC0	OPCW02	0	12.5	5.00	4.93
	OPCW03	0	12.0	4.8	
	OPCW11	0.58	12.5	5.00	
OPC1	OPCW12	0.58	13.0	5.20	5.13
	OPCW13	0.58	13.0	5.20	
	OPCW21	0.73	13.0	5.20	
OPC2	OPCW22	0.73	14.0	5.60	5.47
	OPCW23	0.73	14.0	5.60	
	OPCW31	0.87	14.5	5.80	
OPC3	OPCW32	0.87	15.0	6.00	5.87
	OPCW33	0.87	14.5	5.80	

Table Flexural strength of water-cured OPC mixtures at 28 days

Mix	Specimen Id	Accelerator, %	Failure load, kN	Modulus of rupture, MPa	Average value, MPa
	OPCW01	0	15.5	6.20	
OPC0	OPCW02	0	15.5	6.20	6.20
	OPCW03	0	15.5	6.20	
	OPCW11	0.58	16.0	6.40	
OPC1	OPCW12	0.58	16.0	6.40	6.27
	OPCW13	0.58	15.0	6.00	
	OPCW21	0.73	16.0	6.40	
OPC2	OPCW22	0.73	16.5	6.60	6.33
	OPCW23	0.73	15.0	6.00	
	OPCW31	0.87	17.0	6.80	
OPC3	OPCW32	0.87	17.0	6.80	6.93
	OPCW33	0.87	18.0	7.20	

All the beam specimens of water-cured OPC mixtures developed cracks in their pure bending zones while failing under flexure. The response of the mixtures to the addition of accelerator in the development of higher flexural strength was better than that seen in the development of compressive strength. The effect of accelerator in enhancing the flexural strength was found to be fading at later age of concrete, which was also observed in the case of compressive strength. The maximum percentage gains at 7 and 28 days were 27.18 and 20.48 respectively, recorded at the maximum dosage of the accelerator.

PPC Mixtures

The results and discussions on the compressive and flexural strengths of PPC mixtures at early age and at full maturity are reported in this section. Accelerator dosage though varied from 2 litres to 5 litres per cubic metre of concrete following the guidelines of the manufacturer, the dosages in PPC mixtures when expressed in terms of percentage of cement mass slightly differed from that in OPC mixtures due to variation in mix proportioning.

Compressive strength of water-cured PPC mixtures

The compressive strengths of the mixtures at different curing ages and for various dosages of accelerator, measured with reference to that of the control mixture at the corresponding curing ages are shown in table.

Table Compressive strength of water-cured PPC mixtures at 7 days

Mix	Specimen Id	Accelerator, %	Failure load, kN	Comp. strength, Mpa	Average value, MPa
	PPCW01	0	755.37	33.57	
PPC0	PPCW02	0	755.37	33.57	33.57
	PPCW03	0	755.37	33.57	
	PPCW11	0.57	774.99	34.44	
PPC1	PPCW12	0.57	765.18	34.08	34.46
	PPCW13	0.57	784.80	34.88	
	PPCW21	0.72	784.80	34.88	
PPC2	PPCW22	0.72	794.61	35.32	35.28
	PPCW23	0.72	801.97	35.64	
	PPCW31	0.85	814.23	36.19	
PPC3	PPCW32	0.85	804.42	35.75	36.12
	PPCW33	0.85	819.13	36.41	

Table Compressive strength of water-cured PPC mixtures at 28 days

Mix	Specimen Id	Accelerator, %	Failure load, kN	Comp. strength, Mpa	Average value, MPa
	PPCW01	0	1088.91	48.39	
PPC0	PPCW02	0	1098.72	48.83	48.65
	PPCW03	0	1096.27	48.72	
	PPCW11	0.57	1098.72	48.83	
PPC1	PPCW12	0.57	1096.27	48.72	48.65
	PPCW13	0.57	1088.91	48.39	
	PPCW21	0.72	1108.53	49.26	
PPC2	PPCW22	0.72	1108.53	49.26	49.29
	PPCW23	0.72	1110.98	49.37	
	PPCW31	0.85	1147.77	51.01	
PPC3	PPCW32	0.85	1147.77	51.01	51.01
	PPCW33	0.85	1147.77	51.01	

Discussion

Performance of accelerator at early age in PPC mixtures cured with curing compound was observed to be moderate but was inferior to its performance in the same mixtures when cured with water. The compressive strength of all the mixtures cured with curing compound for a given curing age and for a given dosage of accelerator was found to be lesser than that of the mixtures cured with water. None of the mixtures could attain the stipulated design strength at 28 days of curing.

Flexural strength of water-cured PPC mixtures

The flexural strengths for different accelerator dosages and for different curing ages, measured with reference to that of control mixture at the corresponding curing ages are shown in table.

Table Flexural strength of water-cured PPC mixtures at 7 days

Mix	Specimen Id	Accelerator, %	Failure load, kN	Modulus of rupture, MPa	Average Value, MPa
	PPCW01	0	13.00	5.20	
PPC0	PPCW02	0	12.00	4.80	4.80
	PPCW03	0	11.00	4.40	
	PPCW11	0.57	12.00	4.80	
PPC1	PPCW12	0.57	13.00	5.20	4.93
	PPCW13	0.57	12.00	4.80	
	PPCW21	0.72	12.50	5.00	
PPC2	PPCW22	0.72	12.00	4.80	5.13
	PPCW23	0.72	14.00	5.60	
	PPCW31	0.85	13.00	5.20	
PPC3	PPCW32	0.85	13.00	5.20	5.20
	PPCW33	0.85	13.00	5.20	

Table Flexural strength of water-cured PPC mixtures at 28 days

Mix	Specimen Id	Accelerator, %	Failure load, kN	Modulus of rupture, MPa	Average Value, MPa
	PPCW01	0	17.00	6.80	
PPC0	PPCW02	0	16.00	6.40	6.60
	PPCW03	0	16.50	6.60	
	PPCW11	0.57	17.00	6.80	
PPC1	PPCW12	0.57	17.00	6.80	6.67
	PPCW13	0.57	16.00	6.40	

	PPCW21	0.72	17.00	6.80	
PPC2	PPCW22	0.72	15.00	6.00	6.67
	PPCW23	0.72	18.00	7.20	
	PPCW31	0.85	15.00	6.00	
PPC3	PPCW32	0.85	18.00	7.20	6.80
	PPCW33	0.85	18.00	7.20	

Discussion

Pure flexure failure was observed in all the beam specimens of water-cured PPC mixtures. Moderate to high increase in the flexural strength was observed at early age with increase in the dosage of accelerator. The response of the accelerator was found to be poor at 7 and 28 days in increasing the flexural strength. The maximum flexural strength at a given curing age was mostly observed when the accelerator dosage was maximum.

IV. Conclusion

1. Workability of all the mixtures (OPC, PPC) was found to be low. Mixtures were insensitive to slump test. Increase in accelerator dosage resulted in further reduction in the workability,. Workability of the PPC mixture for a given dosage of accelerator was lower than that of OPC mixture.
2. Accelerator was effective at early age of concrete mixtures. Strength of the mixtures at full maturity was the least affected due to the addition of accelerator. All the water-cured mixtures attained stipulated design strength at 28 days.
3. The compressive strength response of the water-cured OPC mixtures to accelerator was moderate
4. There was excellent compressive strength response of water-cured PPC mixtures to accelerator
5. The optimum performance of accelerator was high and was consistent in case of flexural strength

V. REFERENCES

[1] Kovler Konstantin and Roussel Nicolas, “Properties of Fresh and Hardened Concrete”, Cement and Concrete Research, Vol. 41, No. 7, 2014, pp 775-792.

[2] Ghafoori N. and Tays M. W., “Resistance to Wear of Fast-track Portland Cement Concrete”, Construction and Building, Vol. 24, No. 8, 2010, pp 1424-1431.

[3] Gupta VedPrakash, “Repair and Improvement of Damaged Cement Concrete Pavement”, Indian Highways, Vol. 37, No. 9, 2009, pp 47-50.

[4] Dao Vinh T. N., Dux Peter F. and Morris Peter H., “Tensile Properties of Early-Age Concrete”, ACI Materials Journal, Vol. 106, No. 6, 2009, pp 483-492.

[5] Kapila K. K., “Case Study of Cracking of a Newly Built Road”, Indian Highways, Vol. 37, No. 6, 2009, pp 71-74.

[6] Bissonnette Benoit, Attiogbe Emmanuel K., Miltenberger Matthew A. and Fortin Carl, “Drying Shrinkage, Curling, and Joint Opening of Slabs-on-Ground”, ACI Materials Journal, Vol. 104, No. 3, 2007, pp 259-267.

[7] Sikdar P. K., “Pavement Preservation-A Better Understanding”, Indian Highways, Vol. 34, No. 11, 2006, pp 47-50.

[8] Lee H., Cody R. D., Cody A. M. and Spry P. G., “The Formation and Role of Ettringite in Iowa Highway Concrete Deterioration”, Cement and Concrete Research, Vol. 35, No. 2, 2005, pp 332-343.

[9] Collepardi M., “A State-of-the-art Review on Delayed Ettringite Attack on Concrete”, Cement & Concrete Composites, Vol. 25, No. 4-5, 2003, pp 401-407.

[10] Bouzoubaa Nabil, Fournier Benoit, Malhotra V. Mohan and Golden Dean M.,“Mechanical Properties and Durability of Concrete Made with High-Volume Fly Ash Blended Cement Produced in Cement Plant”, ACI Materials Journal, Vol. 99, No. 6, 2002, pp 560-567.