International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 9, Issue 12 (February 2014), PP. 26-29

Flexural Strength of Roller Compacted Concrete using Mineral Admixtures

Ch.Chennakesava[1], A.M.N.Kashyap[2], S.K.V.S.T.Lavakumar[3], G.Sasikala[4]
[1]*PG Student,S.R.K.R.College of Engineering , Bhimavaram.*
[2]*D.M.S.S.V.H College of Engineering, Machilipatnam*
[3]*Assistant Professor, S.R.K.R.College of Engineering, Bhimavaram.*
[4]*Assistant Professor, S.R.K.R.College of Engineering, Bhimavaram.*

Abstract:- The purpose of the study is to investigate the effects of silica fume and Fly Ash additives on the Flexural Strength of concrete. An attempt is also made to attain a more durable and higher strength concrete by a suitable combination of Ordinary Portland Cement (OPC), SF and FA. SF and FA are used as cement replacement in proportions of 0, 5, 10, 15% by weight respectively. Flexural strength is tested after 7, 28 days of the lime saturated water curing period. The experimental results indicate that using FA only decreases while SF only slightly increases 28-days flexural strength. On the other hand, using SF and FA together shows relatively more strength gain.

Keywords:- Roller Compacted Concrete, Silica Fume, Fly Ash, Flexural Strength

I. INTRODUCTION

Portland cement concrete pavements (PCCP) usually have design life from 20 to 60 years. A concrete pavement is to carry the traffic loads and resist the environmental conditions in this long service life. To ensure this, the concrete used the pavement should have adequate strength and durability. The use of mineral admixtures such as Ground Granulated Blast Furnace Slag (GGBFS), Silica Fume (SF) or Condensed Silica Fume (CSF) and Fly Ash (FA) and these are by-products of other industries, has recently increased to enhance the strength and durability properties of concrete. The durability of the concrete with or without puzzolanic materials in the marine environment is very important.

II. LITERATURE REVIEW

Alexander and Mackechnie (2004) have studied the concrete mixes for durable marine structures. Du Prezz and Alexander (2004) have also studied durability indexes for concrete in marine conditions. They reported that three blended binders (GGBS, FA and CSF) were used to cast a series of wall and slab elements. The elements were cured using practical site methods currently employed in the industry. Cores were extracted at early (28-day) and delayed (120- day) ages and used to determine the durability index properties. The results indicated that it is possible to manufacture, place and cure site concrete to achieve acceptable durability properties using GGBS, FA and CSF. This type of pozzolanic materials convert Calcium Hydroxide (CH) (a product of cement hydration) to Calcium Silicate Hydrate (C-S-H). This improves strength, yet removes the potential for the soluble CH to leach (increasing porosity) or Carbonate decreasing pH and increasing delayed ettringite formation potential). There is also a physical effect of SF: Extremely fine SF particles fill the pores in aggregate-cement paste interface, which cause a denser interface. Thus, SF increases the adherence between the aggregates and cement paste. Sabir (1997) points out that for low levels of SF (5-10%) and at low concrete strength levels (up to 40MPa compressive strength), the SF is more efficient in acting as a filler than as a pozzolan.

In general, SF incorporation results in the improvement of tensile strength. Bhanja and Sengupta (2005) showed that, while other mix design parameters remaining constant, SF incorporation in concrete results in significant improvement in the tensile and compressive strengths of concrete. The optimum SF replacement by percentage for tensile strength has been found to be a function of water-cementitious material (w/cm) ratio of the mix. The optimum 28-day split tensile strength has been obtained in the range of 5-10% SF replacement level, whereas the same for flexural strength ranged from 15% to 25%. Both the split and flexural tensile strengths at 28 days follow almost the same trend as the 28-day compressive strength. Increase in split tensile strength beyond 15% SF replacement is almost insignificant, whereas sizeable gains in flexural tensile strength have occurred even up to 25% replacements. For the purpose of pavement thickness design, pavement concrete is characterized by its flexural strength (AASHTO, 1993; FAA, 1995). Also flexural strength at early days is important as it is an indication of the pavement’s ability to withstand traffic loads before opening the road.

Therefore, the flexural strengths at early, moderate and late days of with FA and SF modified concrete are investigated in this study.

III. MATERIALS AND METHODS

2.1.1. Cementitious materials

ASTM Type I 42,5# ordinary Portland cement is used as main cementitious material throughout this study. FA and SF are used as pozzolanic mineral additives.

2.1.2. Aggregate

A growing number of transportation-related agencies are experimenting with increased control of aggregate gradation in their specifications for the production of Portland cement concrete. The justification is that modest controls in gradation that do not require an inordinate amount of increased effort or cost can yield significant benefits in workability, strength, durability, and reliable mix design. MDOT (1996) provides an optional incentive if the mix aggregate gradation meets the following requirements: "The combined aggregates shall be well graded from the coarsest to the finest with no more than 18 percent nor less than 8 percent of the combined aggregate retained on any individual sieve with the exceptions that the No. 50 sieve may have less than 8 percent retained, and the coarsest sieve may have less than 8 percent retained" (MDOT, 1996; Cramer and Carpenter, 1999). Therefore, three coarse and one fine crushed basalt aggregate batches with different size ranges are combined at the designated ratios to satisfy the 8-18 band requirement for aggregategradation and used in this study. Maximum aggregate size is 25mm.

2.1.3. *Superplasticiser*

A naphthalene sulfonate basis superplasticizer is used. The workability of pavement concretes is limited to 15-50mm slump range . Thus, superplasticizer is incorporated in all mixes and the content is adjusted slightly for some mixes to maintain the same degree of workability (20-30mm slump). The workability and consistency of the fresh concrete mixes are measured using the slump cone test (ASTM C 143M-97). The superplasticizer contents and the slump results are shown in Table 2. After the slump test, the fresh concrete samples are filled into the moulds in three layers, each approximately one-third volume of the mold. Each layer is alsomrodded with 25 strokes for consolidation, and sample surface is then levelled with a trowel.

2.1.4. *Mixture proportioning*

ASTM Type I 42.5 OPC is used as the basic cementitious material. FA and SF are added as a partial replacement of the cement by proportions of 0%, 5%, 10%, 15% and 0%, 5%, 10% by weight of the total cementitious materials, respectively. The water/cementitious material (w/cm) ratio is constant at 0.45 for all mixes. The dosage of cement is 350 kg/m3. Table 2 gives the details of the mixes employed in the present work. The amounts of all ingredients are based on one cubic meter of total mix.

Table 2: Mix Proportions

Mixtures	**M1[*]**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**	**M12**
PC(%)	100	95	90	95	90	80	90	85	80	85	80	75
FA(%)	0	0	0	5	5	5	10	10	10	15	15	15
SF(%)	0	5	10	0	5	10	0	5	10	0	5	10
W/Cm	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Water(kg/m^3)	167.1	167.1	167.1	167.1	167.1	167.1	167.1	167.1	167.1	167.1	167.1	167.1
Cement(kg/m^3)	350	332.5	315	332.5	315	297.5	315	297.5	280	297.5	280	262.5
FA(kg/m^3)	-	-	-	17.5	17.5	17.5	35	35	35	52.5	52.5	52.5
SF(kg/m^3)	-	17.5	35	-	17.5	35	-	17.5	35	-	17.5	35
Aggregate	1769	1769	1769	1769	1769	1769	1769	1769	1769	1769	1769	1769
SP(%) [**]	2	2	2	1.5	1.5	2	1.25	1.5	1.5	1.25	1.25	1.25
Slump (mm)	25	25	25	25	20	30	20	30	30	25	25	30

M1[*] - Control Mixture

**** - Percentage by weight of cementitious material**

IV. TESTING

In this study, third point flexural strength test in accordance with ASTM C78 was carried out to evaluate strength properties of the concrete samples. Three 100x100x 400mm beams were cast for each mix. The beams were demoulded after 24 hours and stored in a lime saturated water tank at 20 ± 1 °C until test time. The flexural strength of each beam was determined at 7, 28 days.

V. TEST RESULTS & DISCUSSIONS

The Flexural Strengths for 7 days and 28 days are shown in the following table.

Table : 3 Test Results of Flexural Strength

Mixtures	M1*	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
7 days	2.65	2.81	2.61	2.91	3.12	3.03	3.13	3.02	2.83	3.26	2.96	3.07
28 days	4.08	4.31	4.15	3.72	4.08	4.35	3.61	4.20	4.53	4.05	4.48	4.43

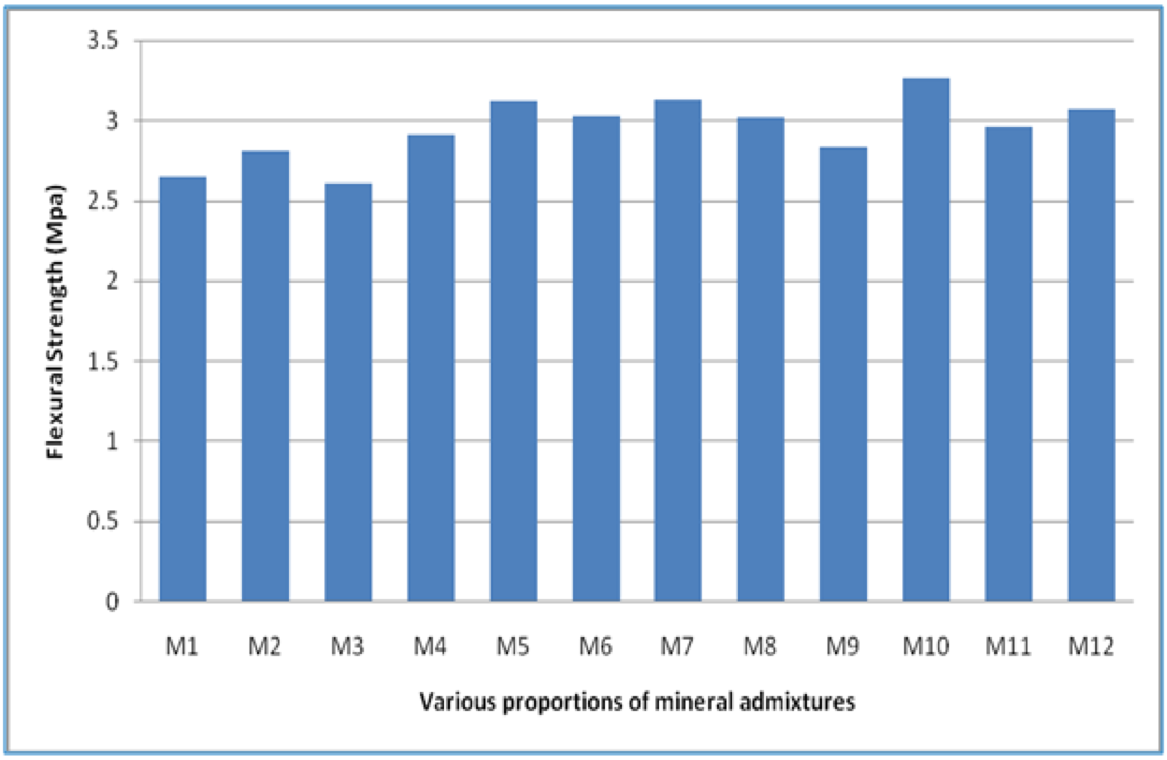

Fig 1.Graph showing 7 days Flexural Strength

VI. DISCUSSION

i. The effect of FA on flexural strength of binary mixtures with OPC and FA

As it is clearly seen from Figure 1, seven days flexural strength increased with increasing FA replacement in the binary mixtures. As minimum 7 days flexural strength was obtained at control mix, maximum 7 days flexural strength which is 3.26 Mpa is reached at the type M10 mix containing 15% FA.The results showed that the increases in flexural strength after 28 days for the binary mixes containing FA are higher than that of the control mix. High long-term strength development of the FA mixtures can be attributed to pozzolanic reactions.

ii. Joint effects of SF and FA on flexural strength

The flexural strength results of the ternary mixtures with OPC, FA and SF as cementitious material were shown in Figure 2. When FA and SF were used together, 7, 28 days. flexural strengths increased compared to the control mixture. Among all the mixes, maximum 28 days flexural strength was obtained as 4.53 MPa in mix proportions of 85% OPC + 10% FA and 5% SF (M8).

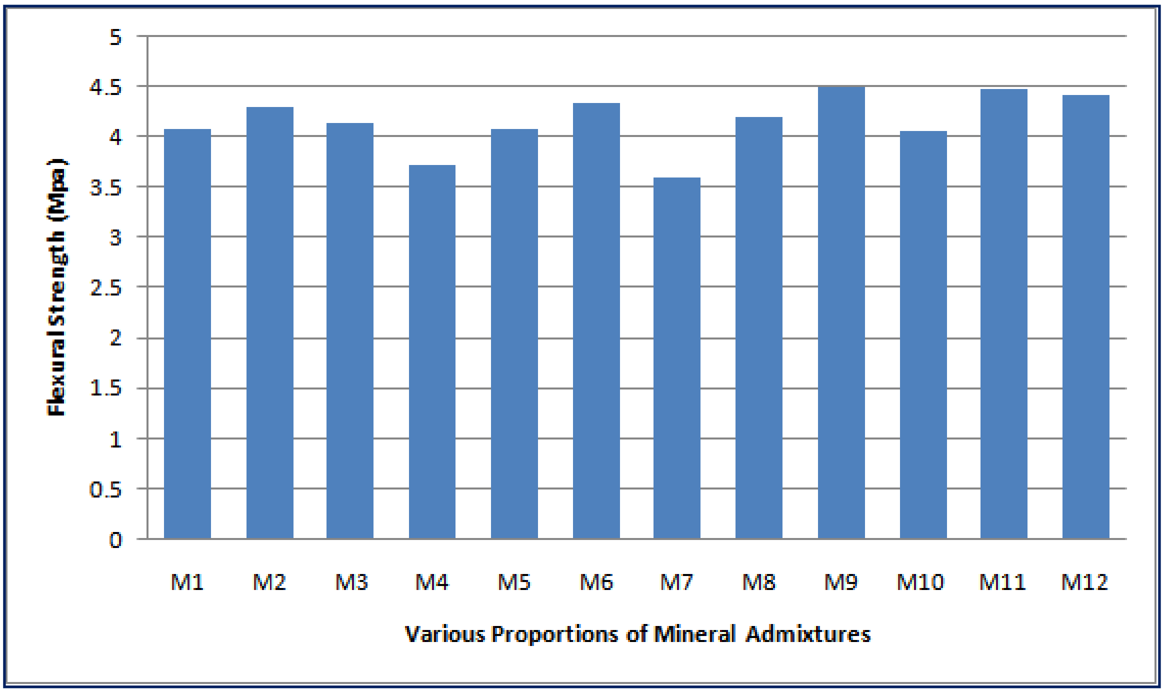

Fig. 2 Graph showing 28 days Flexural Strength

The experimental results indicated that using only FA as cement replacement decreased 28-days flexural strength as SF slightly increased. Using FA and SF together in the mixtures showed better strength performance at 28 days. This can be attributed to the synergetic pozzolanic and microfiller effect of SF and FA. In such a way that, since the FA particles are smaller than the cement particles and they fit between them, resulting in a dense cement matrix. Much smaller SF particles then fit between FA particles and further densify the matrix resultingly an improvement in interfacial zone and mortar.

VI. CONCLUSION

This study has demonstrated that more durable and stronger pavement concrete can be obtained with a suitable combination of OPC, FA and SF. The experimental results in the current test conditions have indicated that using FA only decreases while SF only slightly increases 28 days flexural strength. On the other hand, using SF and FA together shows relatively more strength gain. Among all those tested, maximum 28 days flexural strength of 4.53 MPa is obtained for the mix proportions of 85% OPC + 10% FA and 5% SF.

REFERENCES

[1]. American Association of State Highway and Transportation Officials (AASHTO), 1993.Guide for design of pavement structures, Washington, D.C, US.

[2]. Alexander M.G. and Mackechnie J.R., "Concrete mixes for durable marine structures", *Journal of the South African Institution of Civil Engineering*, Vol. 45, No. 2, 2003, p. 20- 25. Discussion on paper: *Journal of the South African Institution of Civil Engineering*, Vol. 46, No. 1, 2004, p. 15-16.

[3]. Bhanja S. and Sengupta B., "Influence of silica fume on the tensile strength of concrete",*Cem. Concr. Res.*, 35, 2005, p. 743-747.

[4]. Carette G. and Malhotra V.M., "Early - age strength development of concrete incorporating fly ash and condensed silica fume", Fly Ash, Silica Fume, Slag, and Other Minerals By- Products in Concrete, V.M. Malhotra (Ed.), SP 79, ACI, Detroit, 1983, p. 765-784.

[5]. Atis C.D., Sevim U.K., Ozcan F., Bilim C., Karahan O., Tanrikulu A.H., Eksi A., "Strength properties of roller compacted concrete containing a non-standard high calcium fly ash", Materials Letters, Vol. 58, 2004, p. 1446-1450