Research Paper Engineering

Impact Strength of Ternary Blended Steel fiber Reinforced concrete

*Samir M. Gami. ** D.A.Sinha

*Student M.E. Structural Engineering B.V.M Engineering College, Vallabhvidhyanagar

**Professor M.E. Structural Engineering B.V.M Engineering College, Vallabhvidhyanagar

ABSTRACT

Recent trend in engineering, especially in concrete structure is to develop economical, eco environmental and durable concrete with decreasing or reducing the use of natural material and increasing the use of industrial waste or by products from industries without affecting the higher strength of concrete. To achieve this higher impact strength, OPC as a cementitious material is not sufficient, so in this paper industrial waste like fly ash (class F), and Metakaolin , Silica fume and Blast furnace slag are used as supplementary cementitious materials in various proportions. It gives ternary mix and by using this mineral admixtures with OPC cement, different nine types of cement are prepared and same used to find impact strength of concrete at 28 days.

Keywords : Metakaolin, Silica fume, G.G. B.S,Impact strength

Introduction

Concrete has played important role in infrastructure development. Concrete has many advantages over other construction material including low cost, applicability under many conditions, adaptability, use and production of cement and concrete has increasing rapidly become a major causes of global ecological problems with special reference to the over exploitation of non- renewable natural resources due to high temperature. production processes, fossil fuels combustion and extraction of raw material. Concrete is made up of cement, coarse aggregate, fine aggregate and water. When water is added in to cement, chemical reaction takes place and due to this hydration lime is generated. Out of that 25% of lime remains intact on surface and overtime it would be susceptible to the effect of weathering and loss of strength and durability.

To overcome this effect, pozzolanic material i.e. siliceous material that develops any hydraulic cementitious properties in the presence of lime is added into OPC cement which reacts with free lime and convert in to calcium silicate hydrate (C-SH) which gives higher strength to concrete and also make it durable.

Ternary concrete mixtures include three different cementitious materials. In this paper we discussed about combinations of portland cement, fly ash, and a third cementitious material. ASTM C595 blended cement used in combination with a three cementitious materials. It is considered a ternary mixture. Other materials in combination with portland cement such as Metakaolin or Rice husk ash, Silica fume and Blast furnace slag are not currently in common usage.

The low strains associated with concrete failure place it in the category of brittle materials. This implies that the statically determined properties of concrete in the laboratory may not be used to predict the behavior of concrete subjected to high stress rates, those associated with impact, blast , or earthquake.

WHAT ARE THE BENEFITS OF TERNARY BLENDED CEMENTS?

Ternary blended cements can be produced to provide the benefits in performance that are also available when slag cement is used as a separate component of the concrete mix. By varying the proportions of the ternary blend, attributes such as sulfate resistance and resistance to alkali silica reaction can be attained with blended cement. A blend designed for a specific project requirement can also be produced. For concrete producers, blended cement may allow them to take advantage of the benefits of slag cement despite storage constraints.

Methodology:-

IMPACT TEST (Drop weight method)

Impact strength of a concrete is a measure of its ability to absorb shock load or sudden impact due to external load.Impact strength can be expressed in terms of energy required to cause crack and measured in terms of N-m. For the impact strength test the specimens of dimensions 150mm diameter and 63mm height are cast.

Drop weight test is adopted for testing impact specimens . the specimens are kept in the Schrudder's impact testing machine and the hammer weighing 4.54 Kg(45.4 N) is dropped from a height of 457mm (0.457m)

No. of blows required to cause first crack and final failure are noted down. The final failure is defined as the opening of cracks in the specimen sufficiently so that pieces of concrete are touching at least 3 out of 4 positions lugs on the base plate. The impact energy is calculated as follows.

Impact energy = w x h x n

Where, w= weight of hammer = 45.4 KN

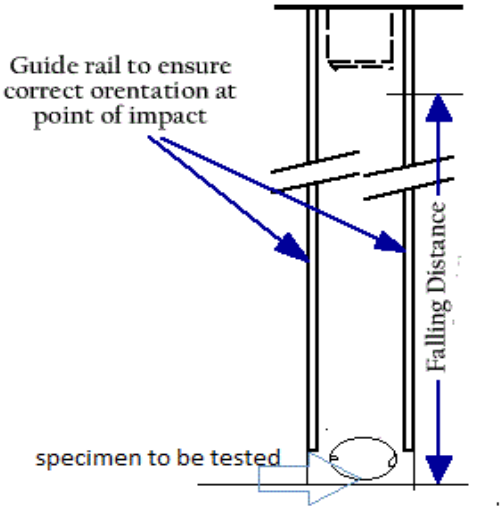
h= height of fall =457mm =0.457m

n= number of blows required to cause first crack and final failure.

Experimental work:-

For the impact strength test, the specimens of dimensions 150mm diameter and 63mm height are cast.Here In this mix design of M-30 is 0.45 : 1 : 1.86 : 2.41. with this steel fiber is added 1% by volume fraction and super plasticizer Conplast

SP430 is used by 0.78% vol. of cement.



Results and Discussion :--

NORMAL	100% OPC without steel fibre
C+0+0	100% OPC + 1% Steel fibre
C+30+0	70% OPC + 30% Fly Ash+ 1% Steel fibre
C+25+5	70% OPC + 25% Fly Ash+ 05% M/SF/BF+ 1% Steel fibre
	M=Metakaoline SF=Silica fume,BF= Blast furnace
C+20+10	70% OPC + 20% Fly Ash+ 10% M/SF/BF + 1% Steel fibre
C+15+15	70% OPC + 15% Fly Ash+ 15% M/SF/BF + 1% Steel fibre
C+10+20	70% OPC + 10% Fly Ash+ 20% M/SF/BF + 1% Steel fibre
C+5+25	70% OPC + 5% Fly Ash+ 25% M/SF/BF + 1% Steel fibre
C+0+30	70% OPC + 0% Fly Ash+ 30% M/SF/BF + 1% Steel fibre

Impact test reading after 28 days curing.

MIX	METAKAOLIN					
	SPC 1 (N)		SPC 2(N)		SPC 3(N)	
	VCN	FCN	VCN	FCN	VCN	FCN
NORMAL	29	33	27	30	29	32
C+0+0	32	37	35	38	33	37
C+30+0	34	37	36	40	33	39
C+25+5	33	36	35	38	36	40
C+20+10	37	42	39	43	40	43
C+15+15	42	46	41	47	44	49
C+10+20	43	47	40	45	39	44
C+5+25	36	40	38	41	35	38
C+0+30	34	37	31	35	33	36
MIX	SILICA FUME					
NORMAL	29	33	27	30	29	32
C+0+0	32	37	35	38	33	37
C+30+0	34	37	36	40	33	39
C+25+5	34	38	37	42	36	38
C+20+10	38	42	39	44	41	47
C+15+15	42	50	46	54	45	52
C+10+20	41	46	40	44	43	48
C+5+25	37	41	39	44	40	45
C+0+30	36	40	34	36	37	39
MIX	G.G.B.S.					
C+25+5	35	37	37	39	34	38
C+20+10	38	42	40	43	41	45
C+15+15	40	44	38	43	37	40
C+10+20	44	51	47	54	46	57
C+5+25	41	46	37	42	40	47
C+0+30	35	41	38	41	32	36

VCN = No. of blows for first visible crack

FCN= No. of blows ultimate failure crack

MIX	***METAKAOLIN IMPACT ENERGY***					
	SPEIMEN 1		SPECIMEN 2		SPECIMEN 3	
	V.C.	F.C.	V.C.	F.C.	V.C.	F.C.
NORMAL	60.2	68.5	56	62.24	60.2	66.39
C+0+0	66.4	76.8	72.6	78.84	68.5	76.77
C+30+0	70.5	76.8	74.7	82.99	68.5	80.92
C+25+5	68.5	74.7	72.6	78.84	74.7	82.99
C+20+10	76.8	87.1	80.9	89.22	83	89.22
C+15+15	87.1	95.4	85.1	97.51	91.3	101.7
C+10+20	89.2	97.5	83	93.37	80.9	91.29
C+5+25	74.7	83	78.8	*85.07*	*72.6*	*78.84*
C+0+30	*70.5*	*76.8*	*64.3*	*72.62*	*68.5*	*74.69*
MIX	***SILICA FUME IMPACT ENERGY***					
NORMAL	*60.2*	*68.5*	56	62.24	60.2	66.39
C+0+0	66.4	76.8	72.6	78.84	68.5	76.77
C+30+0	70.5	76.8	74.7	82.99	68.5	80.92
C+25+5	70.5	78.8	76.8	87.14	74.7	78.84
C+20+10	78.8	87.1	80.9	91.29	85.1	97.51
C+15+15	87.1	104	95.4	112	93.4	107.9
C+10+20	85.1	95.4	83	91.29	89.2	99.59
C+5+25	*76.8*	*85.1*	*80.9*	*91.29*	*83*	*93.37*
C+0+30	*74.7*	*83*	*70.5*	*74.69*	*76.8*	*80.92*
MIX	***BLAST FURNACE IMPACT ENERGY***					
NORMAL	60.2	68.5	56	62.24	60.2	66.39
C+0+0	66.4	76.8	72.6	78.84	68.5	76.77
C+30+0	70.5	76.8	74.7	82.99	68.5	80.92
C+25+5	72.6	76.8	76.8	80.92	70.5	78.84
C+20+10	78.8	87.1	83	89.22	85.1	93.37
C+15+15	83	91.3	78.8	89.22	76.8	82.99
C+10+20	91.3	106	97.5	112	95.4	118.3
C+5+25	85.1	95.4	76.8	87.14	83	97.51
C+0+30	72.6	85.1	78.8	85.07	66.4	74.69

AVERAGE METAKAOLIN IMPACT ENERGY				
MIX	AVG VCN	VISIBLE % INC. or DEC.	AVG FCN	FAILURE % INC. OR DEC.
NORMAL	58.79	-15	65.701	-15.178571
C+0+0	69.16	0	77.458	0
C+30+0	71.23	3	80.225	3.5714286
C+25+5	71.93	4	78.842	1.7857143
C+20+10	80.22	16	88.524	14.285714
C+15+15	87.83	27	98.206	26.785714
C+10+20	84.37	22	94.057	21.428571
C+5+25	75.38	9	82.3	6.25
C+0+30	67.78	-2	74.692	-3.5714

AVERAGE SILICA FUME IMPACT ENERGY				
MIX	VCN	% INC. or DEC.	FCN	% INC. OR DEC
NORMAL	58.79	-15	65.701	-15.178571
C+0+0	69.16	0	77.458	0
C+30+0	71.23	3	80.225	3.5714286
C+25+5	74	7	81.608	5.3571429
C+20+10	81.61	18	91.982	18.75
C+15+15	91.98	33	107.89	39.285714
C+10+20	85.76	24	95.44	23.214286
C+5+25	80.22	16	89.907	16.071429
C+0+30	74	7	79.533	2.6785714

AVERAGE G.G.B.S. IMPACT ENERGY				
MIX	VCN	% INC. or DEC.	FCN	% INC. or DEC.
NORMAL	58.79	-15	65.701	-15.178571
C+0+0	69.16	0	77.458	0
C+30+0	71.23	3	80.225	3.5714286

C+25+5	73.31	6	78.842	1.7857143
C+20+10	82.3	19	89.907	16.071429
C+15+15	79.53	15	87.832	13.392857
C+10+20	94.75	37	112.04	44.642857
C+5+25	81.61	18	93.365	20.535714
C+0+30	72.62	5	81.608	5.3571429

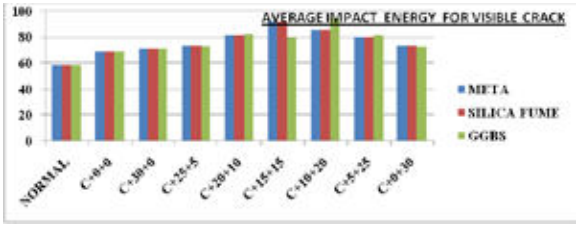
Discussion :-

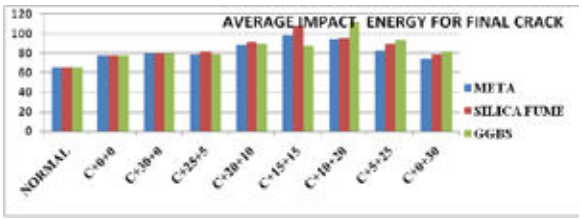
Here in this paper a research has been carried out to find the optimum percentage for ternary blended concrete. As per literature review it has been found that flyash can be replaced upto 30 to 35 %.

As per the above result it has been seen that different pozolanic material have different impact energy in varying percentage of ternary blended concrete.

For this impact test result Metakaoline optimum mix C+15+15 has 27% impact energy increased for first visible crack and 26.78 % impact energy increased for ultimate failure crack with reference mix C+0+0 .

For this impact test result Silica Fume optimum mix C+15+15 has 33% impact energy increased for first visible crack and 39.28 % impact energy increased for ultimate failure crack with reference mix C+0+0 . Same for For this impact test result G.G.B.S. optimum mix C+10+20 has 37% impact energy increased for first visible crack and 44.64 % impact energy increased for ultimate failure crack with reference mix C+0+0 .Here in this result by comparing impact strength of Normal mix to ternary optimum mix is largly varying from 0 to maximum 45%. E.g. from the table for the Normal mix for GGBS impact strength is about average 77.45 N/mm2 while for optimum mix it is about more than 112 N/mm 2 which is higher of 45%.





Conclusion:-

From the above experimental work it is concluded the results as under :-

1. For Metakaoline ternary mix C+15+15 gives higher impact strength. It shows that in ternary mix when fly ash and Meatakaoline are replaces by 15% equally with cement then a mix give higher impact strength and increase in percentage upto 27.

2. For Silica Fume ternary mix C+15+15 gives higher impact strength. It shows that in ternary mix when fly ash and Silica Fume are replaces by 15% equally with cement then a mix give higher impact strength and increase in percentage upto 39.

3. For Ground Granulated Blast Furnace Slag ternary mix C+10+20 gives higher impact strength. It shows that in ternary mix when fly ash and G.G.B.S.are replaces by 10% and 20% with cement then a mix give higher impact strength and increase in percentage upto 44.

Thus it indicated economical and environment friendly ternary blended concrete with 1% of steel fiber which we have to use in usual practice.

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