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Lightweight Concrete from Flyash

Béton léger avec des cendres volantes

Leichtbeton aus Flugasche

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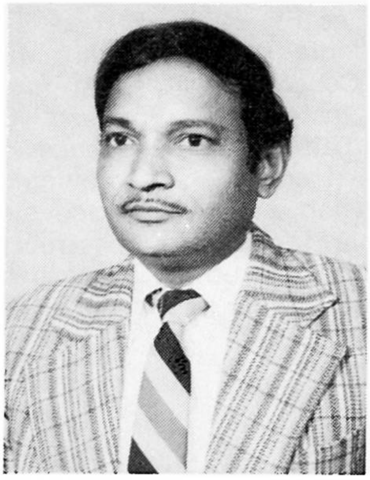

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SUMMARY
Lightweight Concrete of suitable strength can be produced from flyash and lime on addition of certain chemicals, and by autoclaving. Production costs of lime flyash. 'Foam Concrete' and 'Pressed Concrete' were found to be cheaper than for conventional lightweight concrete. These foam concrete blocks can be used in non-load bearing walls and partitions. Pressed Blocks can be used even in load bearing structures.

RÉSUMÉ
Du béton léger de résistance suffisante peut être produit à l'aide de cendres volantes et de chaux, en ajoutant certaines substances chimiques, et à l'aide d'un durcissement sous pression. Les coûts de production de "béton mousse" ou de "béton pressé" sont inférieurs à ceux d'un béton léger ordinaire. Les briques en béton mousse sont utilisées pour des murs non porteurs ou des séparations. Les briques en béton pressé peuvent également être utilisées pour des murs porteurs.

ZUSAMMENFASSUNG
Leichtbeton von annehmbarer Festigkeit kann hergestellt werden aus Flugasche und Kalk, unter Beigabe gewisser chemischer Substanzen, und mittels Dampferhärtung. Die Produktionskosten von Schaumbeton und Pressbeton aus Flugasche und Kalk sind günstiger als diejenigen von normalem Leichtbeton. Die Würfel aus Schaumbeton werden verwendet für nichttragende Wände und Abtrennungen. Die Würfel aus Pressbeton können auch für tragende Bauteile eingesetzt werden.

1. INTRODUCTION

Flyash is a by-product of pulverised coal fired thermal power station. It is being treated as a waste and its disposal is causing a serious problem of space and atmospheric pollution. As per an estimate a thermal power station of 1000 MW capacity produce about 0.10 to 0.12 million tons of flyash annually. Simple open space storage of this waste product may require about 1250 Cubic Meter of space.

Pulverised Fuel ash discharged by a thermal power station is generally of two type. Main part is about 70-75 percent consisting of very fine ash mostly finer than 76 micron, 15 to 20 percent of the total discharge gets collected at the bottom of boiler and is known as bottom ash. This study deals with the finer part which is generally known as Fly Ash. Efforts were made at the U.P., P.W.D. Research Institute, Lucknow, India to utilize this waste product in manufacturing Foam Concrete and Pressed Concrete. Keeping in view the cost considerations, lime was used as binder instead of Portland Cement. Inherent pozzotanic property of the flyash was utilised in the process. Some chemical accelerators were added to achieve early strength. Autoclaving (Steam curing under pressure) was resorted to so as to further expedite the development of strength. Products achieved were found acceptable for use in construction industry. Foam Concrete blocks were found to have as cube crushing stength of about 60 to 100 Kg/Square Cum, and Pressed concrete Blocks were found to have a crushing strength of about 100 to 250 Kg/Sq.Cum.

2. MATERIALS

Following materials were used in the study.

2.1 Fly ash

Laboratory analysis of the Flyash used is given in Table a(A) and 1(B) below:-

Table - 1(A)

PHYSICAL CHARACTERISTICS OF FLY ASH USED

Sl. No.	Name of Test	Value obtained with fly ash: Panki Distt. Kanpur	Obra Distt. Mirza-pur	River side Kanpur	Hardwaganj Distt. Aligarh (Old plant)	Value as per I.A. 3819 (Part-1)	Remarks
1	2	3	4	5	6	7	8
1.	Lime resctivity in Kg/cm^2	76.55	56.08	24.71	25.95	40	(Minimum)
2.	Compressive strength of 1:4:15 fly ash: Cement : Standard sand mortar as compared to 20 days strength of plain 1:3 cement : Standard sand mortar percent						
	29 days	81.3	82.0	-	76.6	80	(Minimum)

1	2	3	4	5	6	7	8
	90 days	100.1	100.9	-	92.0	100 (Minimum)	
3.	Fineness by B.S. 170 sieve percent retained	40	4.0	35.0	30.0	-	
4.	Fineness by Blain's air Permeability appertatus Cm^2/gm	3768	4308	2260	2683	3200(Minimum)	

* FLY ASH from Panki Kanpur was chosen for use.

TABLE - 1 (B)

CHEMICAL ANALYSIS OF FLY ASH USED

(a)	Loss on Ignition	6.0	%
(b)	Soluble Silica	2.784	%
(c)	Insoluble Silica	58.530	%
(d)	Calcium Oxide	1.153	%
(e)	Mg. Oxide	0.204	%
(f)	R_2O_3	2.290	%
(g)	Insoluble Matter	29.039	%

2.2 Ordinary white lime - class C

2.3 Accelerators:-

2.3.1 Sodium Silicate of Commercial quality.

2.3.2 Calcium Chloride of Commercial quality.

2.4 Foaming Agent - Aluminium Powder of Commercial quality.

3. PROCESURE

3.1 Foam concrete

3.1.1 Flyash passing through 200 mesh was taken and mixed thoroughly with lime in a ratio 3 Flyash to 1 lime.

3.1.2 Sodium Silicate and Calcium Chloride in equal quantities were dissolved into water. Quantity of Sodium silicate and Calcium Chloride was 4.25 percent each of the mix.

3.1.3 The slurry (with about 60% water) of Flyash, lime and accelerators was added with foaming agent (Aluminium Powder) at the rate of 0.025 percent by weight. The entire mass was thoroughly mixed to ensure proper spread of minute quantities of additives.

3.1.4 The mix was poured into moulds and the moulds were stored in a room. Moulds were opened next day (after about 18 Hours) and left in the open air under a shed.

3.1.5 After 48 Hrs of moulding the cubes were subjected to Autoclaving with steam pressure of 14 Kg. per Sq. Cm for eighteen hours.

3.1.6 The cubes were taken out of the chamber after 18 Hrs and were allowed to dry for about 12 Hrs.

3.1.7 The compressive strength was then determined by Universal Testing Machine. The results obtained in one of series of experiment are given in Table No. 2 below:

3.1.8 The Table No. 2 also contains the density in Kg/Cubic Metre. It may be observed that the blocks obtained were of light weight.

TABLE No. 2

LABORATORY TEST RESULTS OF FOAM CONCRETE

SL No.	MOULD NUMBER	MIX.	Strength in Kg. Per Sq cm.	Weight in gms	Density Kg. Per cum
1	2	3	4	5	6
1.	IV/A_1	Fly-ash = 700 gm Lime = 233 gm Na_2 Sio_3, $Cacl_2$ Al. Powder	102.24	298	868.8
2.	IV/A_2	-do-	80.8	101	808.0
3.	V/A_1	Fly-ash = 300 gm Line = 100 gm Na_2 Sio_3, $Cacl_2$ Al. Powder	92.54	103	824.0
4.	V/D_1	Fly-ash = 300 gm Lime C = 100 gm Na_2 Sio_3, $Cacl_2$ Al. Powder	86.35	100.2	801.60
5.	C/D_2	-do-	89.89	100.0	800.00
6.	IV/C_1	Fly-ash = 700 gm Lime C = 210 gm Na_2 Sio_3, $Cacl_2$ Al. Powder	86.73	29.0	845.00
7.	IV/C_2	-do-			
8.	VII/F	Fly-ash = 300 gm Lime C = 100 gm Na_2, Sio_3, Ca Cl_2 Al. Powder	92.55	101	808.0
9.	VII/G_1	Fly-ash = 300 gm Lime C = 100 gm Na_2, Sio_3, Ca Cl_2 Al. Powder	94.82	102	816.0
10.	VII/G_2	-do-	94.37	100.2	801.6

1	2	3	4	5	6
11.	VIII/G_3	Fly-ash = 300 gm Lime C = 100 gm Na_2, Sio_3, Ca Cl_2 Al. Powder	78.2	105.0	840.0
12.	X/8	Fly-ash = 758 gm Lime C = 233 gm Na_2, Sio_3, Ca Cl_2 Al. Powder	93.87	100.0	808.0
13.	X/D_1	Fly-ash = 700 gm Lime C = 233 gm Na_2 Sio_3, Ca Cl_2 Al. Powder	88.0	106.0	848.0
14.	X/D_2	Fly-ash = 700 gm Lime C = 233 gm Na_2 Sio_3, Ca Cl_2 Al. Powder	78.0	107.0	856.00
15.	X/D_3	-do-	79.8	106.0	848.00

3.2 Pressed Concrete Blocks

3.2.1 The process was the same as given in para 3.1 except that no foaming agent was added to it. The moulding was done under manual pressure. The consistency of the mix was kept such that it did not flow under its own weight but required nominal presure to get properly moulded.

3.2.2 The results of cube strength are given in table No.3 for one of the series of tests. It may be seen that mix ratios tried were 1:3 and 1:4 i.e. one part lime and three/four parts flyash.

3.2.3 The fall in cube strength due to decrease in the percentage of lime is not very significatn but the economy so achieved in quite significant.

TABLE No. 3

LABORATORY TEST RESULTS REGARDING FOAM CONCRETE

Sl No.	Mould	MIX	Strength in Kg. Per Sq.cm.
1	2	3	4
1.	X/G_1	Fly-ash = 700 gms Lime C = 233 gms Na_2 Sio_3, Ca Cl_2	240.0
2.	X/C_2	Fly-ash = 700 gms Lime C = 233 gms Na_2 Sio_3, Ca Cl_2	236.73
3.	X/G_3	Fly-ash = 700 gms Lime C = 233 gms Na_2 Sio_3, Ca Cl_2	248.0
4.	XI/D_1	Fly-ash = 700 gms Lime C = 175 gms Na_2 Sio_3, Ca Cl_2	228.3
5.	XI/D_2	-do-	232.36

4. PROBABLE REACTIONS

4.1 Strength of lime mortars is attributed mainly to the process of carbonation. But the process of carbonation, when carbon dioxide is solely taken from atmosphere, is confined to the outer layer only. Under such a situation the pozzolanic material present in the lime mortar does not, by and large, participate in the strength development.

4.2 When lime flyash concrete blocks are subjected to steam preassure in an outoclave the fine silica present in the flyash (Pozzolanic material) reacts with lime. This hydrothermal reaction between silica and lime yields various Calcium Silicate Hydrates - One of them being Tobermorite.

4.3 Quartz (Silica) available in normal way in the flyash-lime mixture reacts extremely slowly due to slow dissolution in water. Consequently strength development is not only very slow but incomplete also. To overcome this problem moderately reactive silica in the form of gels were supposed to be helpful. sodium Silicate and Calcium Chloride were added to the lime-flyash paste. This addition enhenced the quantity of calcium silicate in the paste, and also introduced silica gel into it.

4.4 Autoclaving with high stream pressure and with these additives imparted reasonable strength to the lime flyash blocks to make them suitable for structural use.

4.5 It is not considered fit to give much of the chemistry and reactions involved in the process due to space limitations. But these are available in various research works specially those of G.E. Bessey, H.F.W. Taylor, R. Kondo and others.

5. ACKNOWLEDGEMENT

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