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EFFECT OF DIFFERENT PACKING FACTORS, WATER CEMENT RATIO ON SELF COMPACTING CONCRETE OF M-40 GRADE WITH PARTIAL REPLACEMENT OF CEMENT BY FLY ASH AND METAKAOLIN

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ABSTRACT-- ***Mineral admixtures like fly ash and metakaolin are pozzolanic and cimentitious materials which do not allow carbon dioxide emission. The effect of these by-products on strength and workability was investigated. The experimental work focused on 30% replacement of cement with fly Ash, and the other with 20% replacement of cement with fly ash and 10% of MetaKaolin. By different water-cement ratio (0.32, 0.34, 0.36, 0.38) and variable packing factors (1.12, 1.14, 1.16) For M-40 grade of self compacting concrete. The mix Proportions are based on modified Nan-su Mix Design .The test results such as slump flow, V-funnel and L-Box were carried to obtain fresh and harden properties. The experimental Work showed that the better work ability and compressive strength for packing factor value 1.12. The good workability were obtained for binder content of 531Kg/m³***

Key Words: Self Compacting Concrete, admixture, fly ash, and MetaKaolin, packing factor vi, Compression Strength, Workability, VMA, Super Plasticizer.

INTRODUCTION

In the late 1980s self-compacting concrete (SCC) an advanced construction material was first developed in Japan mainly used for highly congested reinforced structures in seismic regions. SCC has occupied a unique position among modern construction materials because of its lower overall costs, faster construction times and reduction of on-site repairs, eliminating the need of vibration, reduction in the noise pollution improving durability and has better surface finish, filling capacity of highly congested structural members and also safe working environment [1,2].SCC concrete requires a high slump that can easily be achieved by super plasticizer addition to a concrete mixture. Special attention has to be paid to mix proportionately to remain cohesive during handling operations. A simple approach consists of increasing the sand content by 4 to 5% to avoid segregation on superplasticizer addition [3,4] . Cement production coupled with major co_2 emissions, therefore partial replacement of cement by pozzolanic and cimentititous by-products such as mineral Admixtures [5,6]Partial replacement of Cement by Fly Ash and meta kolin will allow relevant carbon-di oxide emissions reductions. Investigations about the pozzolanic properties of fly ash calcined clays and calcined agriculture wastes were already carried out [7, 8].

Using pozzolanic admixtures not only reduce carbon dioxide emissions but also allows structures with longer service life, thus lowering their environmental impact [9]. The usage of mineral admixtures in the production of SCC not only provides economical benefits but also reduces heat of hydration. Incorporating high volumes of mineral admixtures such as fly ash, Metakaolin can make it cost effective. However such SCC durability has to be proven [10]. Use of mineral admixture such as fly ash and metakaolin improves rheological properties and reduces cracking of concrete due to the heat of hydration of the cement [11]. The present study investigates the effect of different packing factors and different water cement ratio with partial replacement of cement as fly ash and metakaolin for workability and compressive strength.

MATERIALS USED IN EXPERIMENT:

Cement: The type of cement will be selected depend on the properties like strength, durability and over all requirements for the concrete. In this experimental study, ordinary Portland cement 53 grade conformation to IS: 8112-1989.

PROPERTIES OF CEMENT

PHYSICAL PROPERTIES	RESULTS
Finesses (retained on 90- μm) sieve)	7.91%
Normal consistency	28.2%
Vicat initial setting time (minutes)	76

Vicat final setting time (minutes)	215
Specific gravity	3.15
Compressive strength at 7-days	20.5 MPa
Compressive strength at 28-days	51.1 MPa

Coarse and Fine Aggregates:
Consistency of grading is of vital importance. The normal adopted size is ranged from 10 to 20,,. All types of aggregates are suitable. 4.75mm maximum size locally available natural sand was used as fine aggregate, having specific gravity, fitness modulus and unit weight and crushed stone with 10mm maximum size having specific gravity, fineness modulus and unit weight was used as coarse aggregate.

PHYSICAL PROPERTIES OF COARSE AND FINE AGGREGATES

PROPERTY	FINE AGGREGATE	COARSE AGGREGATE
Specific Gravity	2.57	2.6
Fitness Modulus	3.2	7.7
Surface Texture	smooth	-
Particle Shape	Rounded	angular
Crushing Value	-	17.5
Impact Value	-	12.3

Fly Ash: The combustion of powder coal in thermal power plant produces a very grey powder called fly ash. Fly ash is obtained from National Thermal power station, Ramagundam, Karimnagar Dist, Telangana, India for this work.

PHYSICAL PROPERTIES OF FLY ASH

PHYSICAL PROPERTIES	TEST RESULTS
Colour	Grey
Specific Gravity	2.14
Fineness	17

CHEMICAL PROPERTIES OF FLY ASH

Constituents	**Percent by weight**
Loss on ignition	4.15
Silica (siO2)	58.50
Iron oxide (Fe 2 O3)	3.45
Alumina (Al 2 O3)	28.10
Calcium oxide (Ca O)	2.22
Magnesium Oxide (MgO)	0.33
Total Sulphur (SO3)	0.069

PHYSICAL PROPERTIES OF METAKAOLIN

S.NO	PHYSICAL PROPERTIES	UNITS	RESULT
1	Color		Close to STD
2	Appearance		Off white powder
3	Loose bulk density	Gm/litre	356
4	Oil absorption	gm/litre	58.7
5	Moisture	%	0.22
6	pH		6.22
7	Residue on 325 mesh	%	0.13
8	PSD-D(50)-50% particles	µ	1.68
9	Specific Gravity		2.63

CHEMICAL COMPOSITION OF METAKAOLIN

S.NO	CHEMICAL	PERCENTAGE
1	SiO_2	52.4
2	Fe_2O_3	4.3
3	Al_2O_3	36.1
4	CaO	0.1
5	MgO	0.84
6	K_2O	1.38
7	LOI	3.37

CHEMICAL PROPERTIES OF METAKAOLIN

S.No	Characteristics	Requirements as per IS 12089	Test Result
1	SiO2	-	32.51%
2	Al2O3	-	21.76%
3	Fe2O3	-	1.1%
4	CaO	-	35.68%
5	MgO	17 max	7.6%
6	Loss on ignition	-	0.35
7	IR	5.0 max	0.455
8	Manganese content	5.5 max	0.15
9	Sulphide sulphur	2.0 max	0.47
10	Glass content	85 min	92
11	Moisture content	-	5.2
12	Particles passing 50mm	95%	100%
13	Chemical moduli (CaO+MgO+Al2O3)	>1.0	2

Test Method for Fresh SCC:

The main characteristics of SCC are the properties in the fresh state. SCC mix design is focused on the ability on the ability to flow under its own weight without vibration, the ability to obtain homogeneity without segregation of aggregation and the ability to flow through heavily congested reinforcement under its own weight.

Sever test methods are available to evaluate these main characteristics of SCC for evaluating the compacting characteristics of fresh SCC more common tests are used which are described below

1. L Box – Type Tests
2. V-Funnel Test
3. The Slump Flow Test

Mix proportioning and results

The quantities of the products materials for 30% replacement with cement with Fly Ash

PACKING FACTOR 1.12

MIX	CEMENT	FLY ASH	FINE AGGREGATE	COARSE AGGREGATE	W/C
Mix-1	277	254	891	738	0.38
Mix-2	277	254	891	738	0.36
Mix-3	277	254	891	738	0.34
Mix-4	277	254	891	738	0.32
Mix-5	277	254	891	738	0.3

PACKING FACTOR 1.14

MIX	CEMENT	FLY ASH	FINE AGGREGATE	COARSE AGGREGATE	W/C
Mix-1	277	237	908	752	0.38
Mix-2	277	237	908	752	0.36
Mix-3	277	237	908	752	0.34
Mix-4	277	237	908	752	0.32

PACKING FACTOR 1.16

MIX	CEMENT	FLY ASH	FINE AGGREGATE	COARSE AGGREGATE	W/C
Mix-1	277	223	923	765	0.38
Mix-2	277	223	923	765	0.36
Mix-3	277	223	923	765	0.34
Mix-4	277	223	923	765	0.32

The quantities of materials for 20% replacement of cement with Fly Ash and 10% replacement of Meta kaolin

PACKING FACTOR 1.12

MIX	CEMENT	FLY ASH	META KAOLIN	FINE AGGREGATE	COARSE AGGREGATE	W/C
Mix-1	277	228	26	891	738	0.38
Mix-2	277	228	26	891	738	0.36
Mix-3	277	228	26	891	738	0.34
Mix-4	277	228	26	891	738	0.32

PACKING FACTOR 1.14

MIX	CEMENT	FLY ASH	META KAOLIN	FINE AGGREGATE	COARSE AGGREGATE	W/C
Mix-1	277	213	24	908	752	0.38
Mix-2	277	213	24	908	752	0.36
Mix-3	277	213	24	908	752	0.34
Mix-4	277	213	24	908	752	0.32

PACKING FACTOR 1.16

MIX	CEMENT	FLY ASH	META KAOLIN	FINE AGGREGATE	COARSE AGGREGATE	W/C
Mix-1	277	200	23	923	765	0.38
Mix-2	277	200	23	923	765	0.36
Mix-3	277	200	23	923	765	0.34
Mix-4	277	200	23	923	765	0.32

The following Results of workability and compressive strength for 30% replacement of cement with Fly Ash for different packing factors

PACKING FACTOR 1.12

MIX	W/C	7 DAYS COMPRESSIVE STRENGTH	28 DAYS COMPRESSIVE STRENGTH	SLUMP FLOW DIA	T500 SEC	V FUNNEL AT 0 MIN (SEC)	V FUNNEL 5 MIN (SEC)
M1	0.38	33	47	740X740	2.7	6.4	11
M2	0.36	34	50	730X730	2.95	6.48	11.5
M3	0.34	38	55	720X720	3.15	6.72	12.1
M4	0.32	40	57	660X660	3.2	7.0	12.3

PACKING FACTOR 1.14

MIX	W/C	7 DAYS COMPRESSIVE STRENGTH	28 DAYS COMPRESSIVE STRENGTH	SLUMP FLOW DIA	T500 SEC	V FUNNEL AT 0 MIN (SEC)	V FUNNEL 5 MIN (SEC)
M1	0.38	31	45	730X730	2.8	6.8	13.7
M2	0.36	34	49.6	720X720	2.9	7	14.6
M3	0.34	37	54	710X710	3.15	7.5	15
M4	0.32	39	56	660X660	3.2	7.8	15

PACKING FACTOR=1.16

MIX	W/C	7 DAYS COMPRESSIVE STRENGTH	28 DAYS COMPRESSIVE STRENGTH	SLUMP FLOW DIA	T500 SEC	V FUNNEL AT 0 MIN (SEC)	V FUNNEL 5 MIN (SEC)
M1	0.38	30.5	43	720X720	3	7	13.8

M2	0.36	33	49	710X710	3	7.2	14.7
M3	0.34	37	52	690X690	3	7.4	14.5
M4	0.32	38.5	53	650X650	3	7.6	14.5

The following results of workability and compressive strength for 20% replacement of cement with flash and 10% with meta kaolin

PACKING FACTOR 1.12

MIX	W/C	7 DAYS COMPRESSIVE STRENGTH	28 DAYS COMPRESSIVE STRENGTH	SLUMP FLOW DIA	T500 SEC	V FUNNEL AT 0 MIN (SEC)	V FUNNEL 5 MIN (SEC)
M1	0.38	29	43	730X730	2.5	6.5	9.9
M2	0.36	31	49	721X721	3.0	6.7	10.7
M3	0.34	35	51	710X710	3.2	6.9	11.4
M4	0.32	37	52.0	630X630	3.6	7.2	12.1

PACKING FACTOR 1.14

MIX	W/C	7 DAYS COMPRESSIVE STRENGTH	28 DAYS COMPRESSIVE STRENGTH	SLUMP FLOW DIA	T500 SEC	V FUNNEL AT 0 MIN (SEC)	V FUNNEL 5 MIN (SEC)
M1	0.38	28	42	720X720	2.7	7	11.8
M2	0.36	32	47	710X710	3.2	7.2	12.8
M3	0.34	34	49	650X650	3.6	7.6	13
M4	0.32	36	51	630X630	3.8	7.9	14

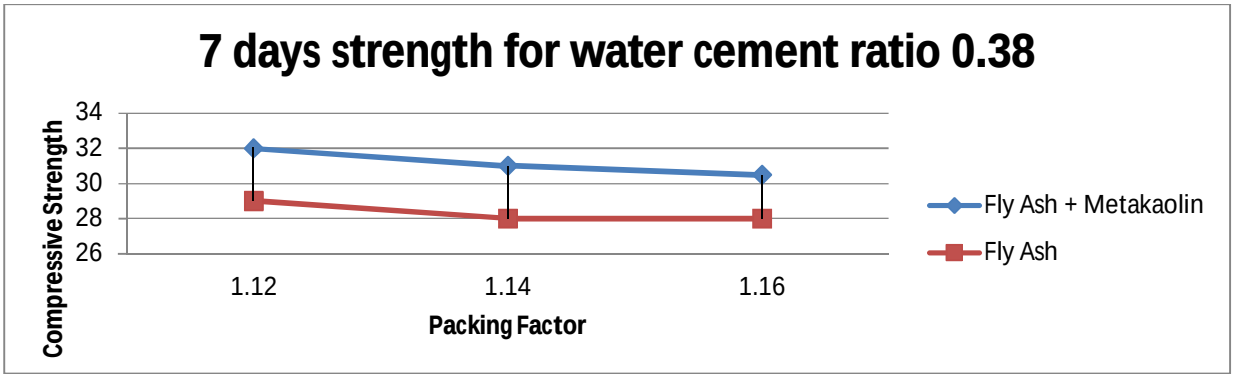
PACKING FACTOR 1.16

MIX	W/C	7 DAYS COMPRESSIVE STRENGTH	28 DAYS COMPRESSIVE STRENGTH	SLUMP FLOW DIA	T500 SEC	V FUNNEL AT 0 MIN (SEC)	V FUNNEL 5 MIN (SEC)
M1	0.38	28	41	680X680	3.2	7.2	12.1
M2	0.36	30	45	670X670	3.4	7.6	13.6
M3	0.34	33	48	650X650	3.8	7.8	13.2
M4	0.32	35	5	630X630	4	8.0	14.0

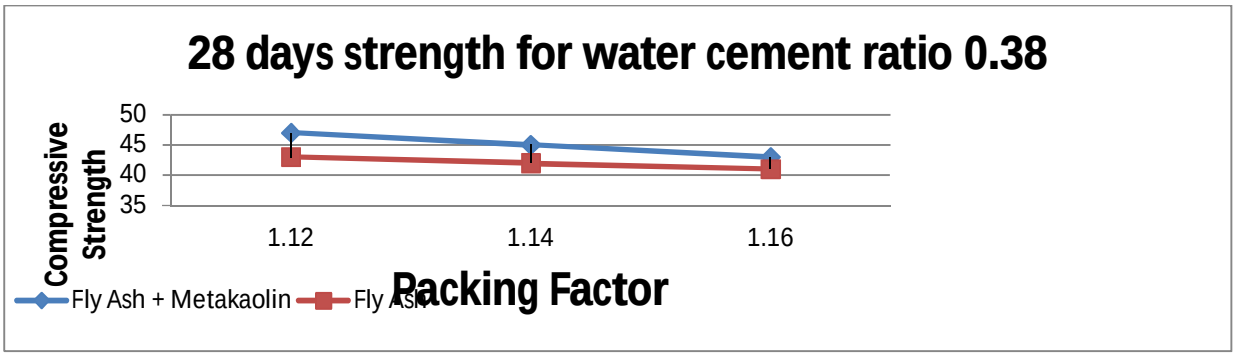
GRAPHICAL REPRESENTATIONS:

The following graphs represent comparative study of properties of self compacting concrete with 30% replacement of cement with Fly Ash, other with 20% replacement of cement with fly Ash and 10% with MetaKaolin

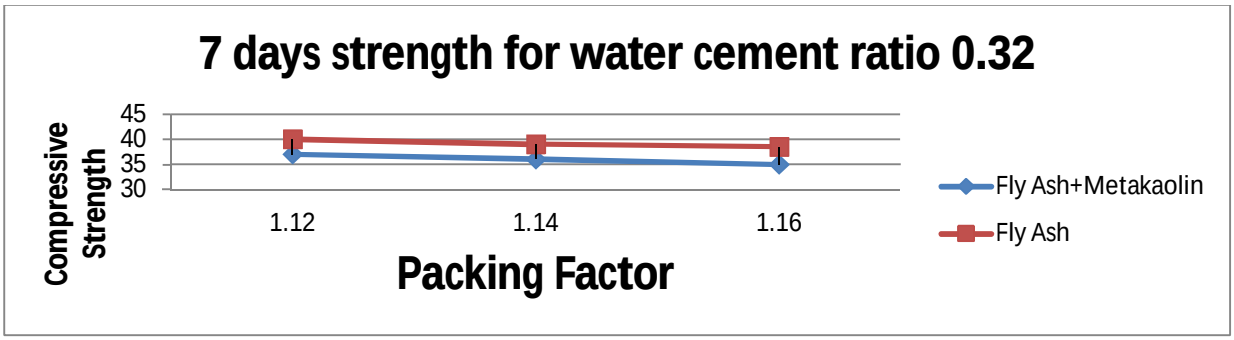
Graph 1:



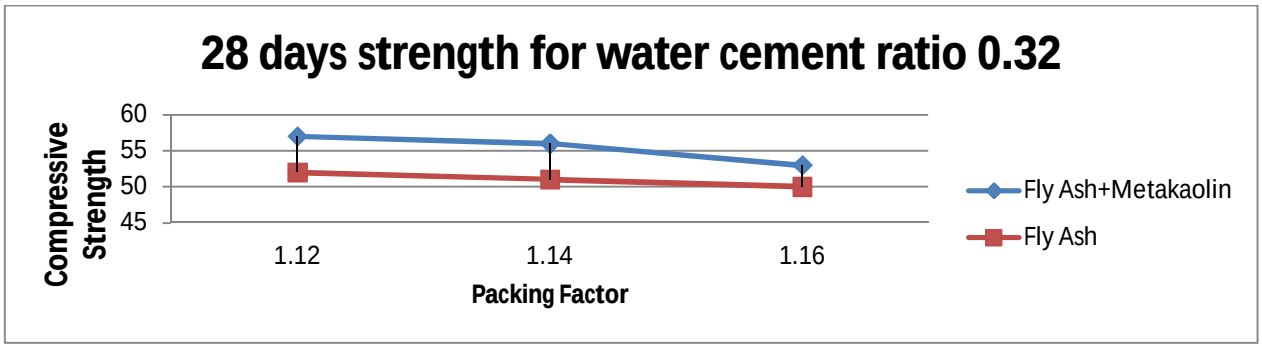
Graph 2:



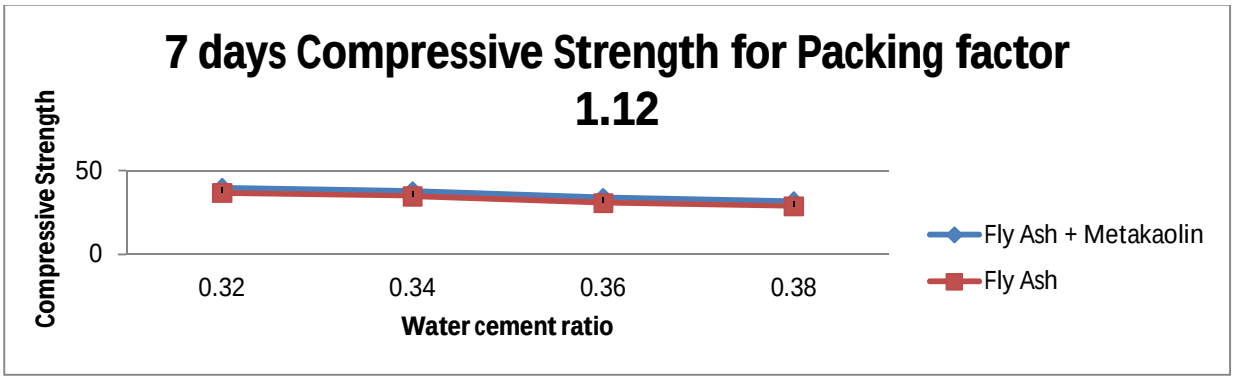
Graph 3:



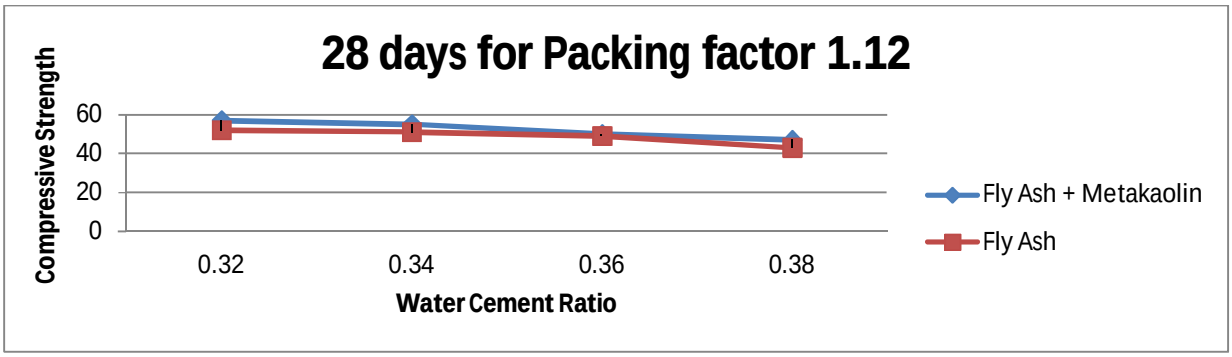
Graph 4:



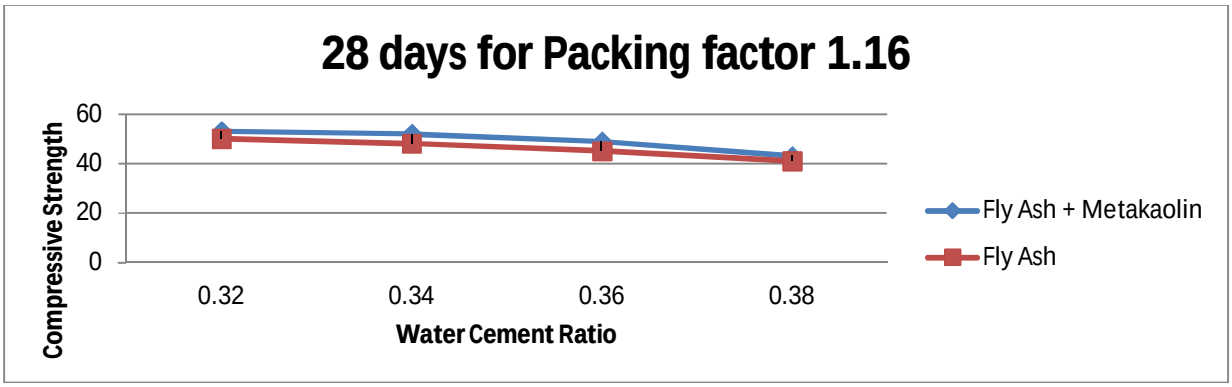
Graph 5:



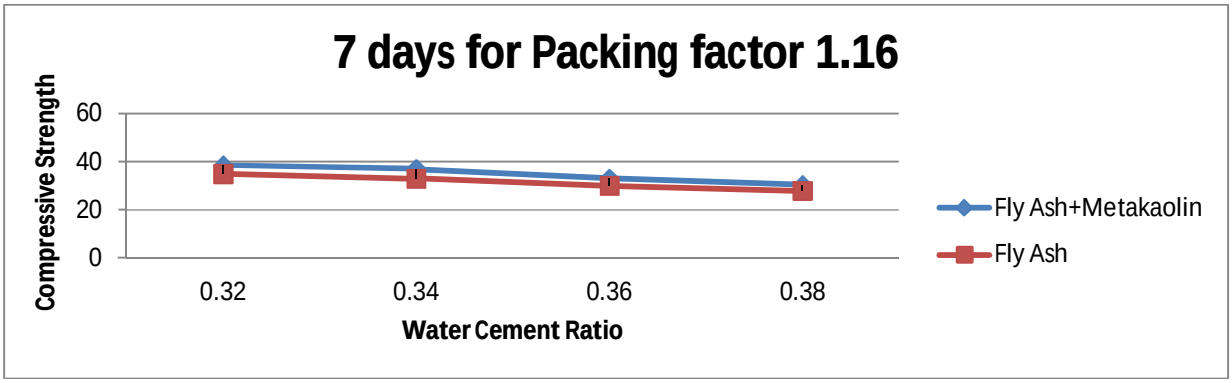
Graph 6:



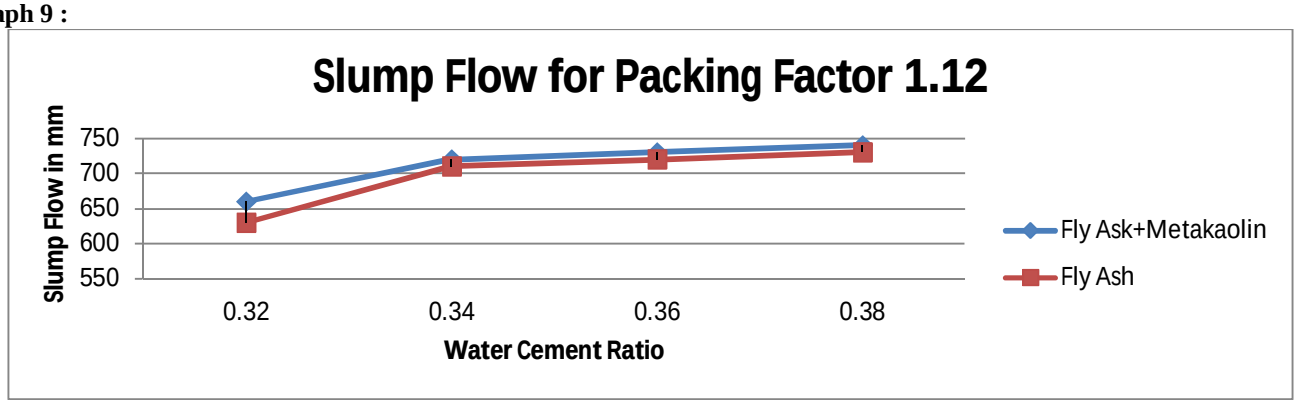
Graph: 7



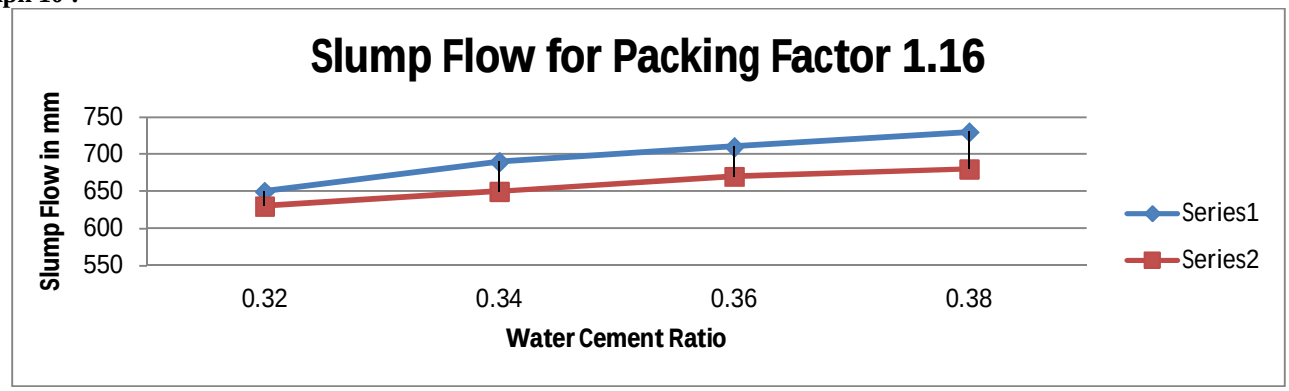
Graph 8 :



Graph 9 :



Graph 10 :



CONCLUSIONS:

1. STRENGTH:- The graph 1 and 2 shows the relation between packing factor and compressive strength for (fly ash and metakoalin) 7 days w/c ratio equal to 0.38 . When the packing factor increases, compressive strength is decreased by 9.4 percent for 7 days; whereas it is 8.52% for 28 days. The graph 3 and 4 shows the relation between packing factor and compressive strength for 7 days for w/c relation equal to 0.32. The compressive strength is decreased by 7.5% for 7 days and 8.78 % for 28 days.
2.EFFECTOF W/C ON COMPRESSIVE STRENGTH:- The graph 5 and 8 shows that when water cement ratio decreases compressive strength is increasing by 25 % for PF 1.12 , 1.16 for 7 days .similarly graph 6 and 7 compressive strength increase by 8.51 % for PF 1.12 , 1.16 for 28 days .
3. EFFECT OF PF AND W/C RATIO ON SLUMP FLOW: - The graph 8 and 9 shows that when w/c increases the slump flow diameter increases for PF of 1.12, similarly for PF of 1.16. When PF changes from 1.12 to 1.16, the slump value changes from 730 mm to 680mm.
4. The replacement of 10% cement with metakaolin and 20% with fly Ash increases self compact ability characteristic like filling ability, passing ability, flowing ability and segregation resistance.
5. It has been reported that economically competitive SCC can be produced by replacing up to 30% Fly Ash.

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