DEVELOPMENT OF EFFICIENT SELF COMPACTING CONCRETE BY USING MINERAL ADMIXTURE

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Abstract:- Self-compacting concrete is a concrete that exhibits high flow ability. The study was carried out to develop self-compacting concrete using mineral admixtures and industrial wastes. The wastes such as fly ash were used as a partial replacement of cement to produce concrete, thus minimizing the amount of cement used and reducing the cost.Critical investigation have been done to study the effect of mineral admixture such as metakolin, micro silica on compressive strength and workability of self-compacting concrete. The cement was replaced with fly ash by 20% to 35 %. The 35% replacement of cement by fly ash was considered as datum. The metakolin were added in different percentages varied from 4% to 12%. The workability tests such as slump flow, V-funnel, U-box, L-box and compressive strength were carried out to study the effect of metakolin in SSC. Similarly micro silica were also added in different percentages varied from 4% to 8%. The various tests such as slump flow, V-funnel, U-box, L-box and compressive strength were carried out to study the effect of micro silica in SSC.The admixtures ac-stailbocrete and ac-viscocrete were also added about 0.2% and 0.5% of total cementitious content in every mix . Experimental results obtained have been extensively analyzed to find out the optimum effect of ingredients on the compressive strength and workability. The results obtained are presented and discussed in this paper.

Keywords: Self compacting concrete, Slump, Fly ash, Micro silica, Metakolin.

I. INTRODUCTION

Self-Compacting Concrete is a special type of concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction even in the presence of congested reinforcement. It is a mixture of cement, coarse aggregate, fine aggregate, water and admixtures.

With the advent of new construction technologies the need for improvement of material science is increasing. In last three decades, a lot of research was carried out through globe to improve the performance of concrete in terms of strength and durability qualities. Consequently the scope of conventional concrete has become limited. Concrete today is customized as per the requirements .The growing use of concrete in special architectural configuration and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, good structural performance and adequate durability.

This concrete was first developed in Japan in late 80s to combat the deterioration of concrete quality due to lack of skilled labours, along with problems of homogeneity and compaction of casting concrete mainly within structures so as to improve the durability of concrete and structures. After the development of SCC in Japan in 1988, whole Europe started working on this unique noise free revolution in the field of construction industries. The last half of decade 1991-2000 has remind very active in the field of research in SCC in Europe ,that is why Europe has gone ahead of USA in publishing specification and guidelines for self compacting concrete. Now all over the world a lots of research is going on, so as to optimize the fluidity of concrete with its strength and durability properties without a drastically increase in the cost. A very limited work is reported from India, where the future for concrete is very bright due to scarcity of skilled man power, on-mechanization of construction industry, abundant availability of construction materials available at very low cost .therefore ,it can be said that SCC is still quite unknown to many researchers ,builders ,ready mix concrete production.

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II. EXPERIMENTAL PROGRAMME

2.1 Material used.

The materials used for this experimental work are OPCcement-53 Grade, sand, water, aggregates, micro silica, metakolin, fly ash, ac-stabilocrete.

2.1.1 Cement

Ordinary Portland cement of 53grade was used in this experimentation conforming to IS-22612.

2.1.2 Aggregate

The maximum size of aggregate is limited to 20mm.Aggregate of size 10mm is desirable for structures having congested reinforcement. The moisture content or absorption characteristics must be closely monitored as quality of SCC will be sensitive to such changes.

2.1.2 Water

Potable water was used for experimentation.

2.1.3 Micro Silica

Micro silica having fineness by residue on 45 micron sieve = 0.8 %, specific gravity = 2.2, Moisture Content =0.7% was used. The chemical analysis of silica fume has indicated (Grade 920-D): silicon dioxide = 89.2%, LOI at 975[degrees] C = 1.7% and carbon = 0.92%, they are conforming to ASTM C1240-1999 standards.

2.1.4 Metakolin

Metakolin is a de-hydroxylated form of the clay mineral kaolinite.Rocks that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain.

2.1.5 Fly ash

The finally divided residue that results from the combustion of ground or powdered coal and that is transported by flue gases are known as fly ash.

2.1.6 AC-STABILOCRETE

AC-STABLOCRETE is a bio-polymer specially developed for providing concrete with enhanced viscosity and controlled rheological properties.AC-STABLOCRETE imparts concrete with superior stability, thus increasing resistance to segregation and facilitating placement.

2.1.7 AC-VISCOCRETE-P

AC-VISCOCRETE-P is brown colour free flowing liquid and its relative density is 1.22 + 0.02 @270 ^{o}c and its PH is 7to8.

2.2 Experimental methodology

Effect of Fly Ash

TRIALS OF SCC USING FLYASH									
TRIALS	Cement (Kg/ cum)	Fly ash (Kg/ cum)	Coarse aggregate (Kg/cum) 51% of total agg.		Fine agg. (Kg/cum) 49% of Total agg.	W/P ratio	Water (Kg/cum)	Additive 1 (Kg/cum)	Additive 2 (Kg/cum)
			20mm 60% of C.A.	10mm 40% of C.A.					
REF. Trial	512	128 (20% of p.c.)	522.36	345.81	761.48	0.25	179.52	3.20	1.28
1.	472.5	157.5 (25%)	518.59	343.31	755.98	0.26	183.18	3.15	1.26
2.	441	189 (30%)	515.08	340.99	750.87	0.26	183.04	3.15	1.26
3.	409.5	220.5 (35%)	511.58	338.67	745.76	0.26	182.91	3.15	1.26

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TEST RESULTS OF SCC USING FLYASH								
Percentage of fly ash	20%		25%		30%		35%	
Slump flow	5 min 685mm	30 min 675mm	5 min 695mm	30 min 685mm	5 min 715mm	30 min 695mm	5 min 690mm	30 min 665mm
V-funnel	T0 12sec.	T5 14sec.	T0 10sec.	T5 12sec.	T0 12sec.	T5 13sec.	T0 12sec.	T5 13sec.
T500	3.96		3.58		3.48		4.02	
U-Box	25mm		29mm		15mm		15mm	
L-Box	0.8		0.9		0.7		0.7	
7 days Compressive strength	27.8 N/mm2		23.62 N/mm2		19.74 N/mm2		19.45 N/mm2	
28 day Compressive strength	40.46 N/mm2		38.35 N/mm2		35.39 N/mm2		35 N/mm2	

Effect of Micro Silica

TRIALS OF SCC USING MICROSILICA										
TRIALS	Cement (Kg/ cum)	Fly ash (Kg/ cum)	Micro silica (Kg/cum)	Coarse aggregate (Kg/cum) 51% of total agg.		Fine agg. (Kg/cum)	W/P ratio	Water (Kg/cum)	Additive 1 (Kg/cum)	Additive 2 (Kg/cum)
				20mm	10mm					
1.	384.3	220.5 (35%)	25.2 (4%)	509.25	337.13	742.36	0.26	182.83	3.78	1.26
2.	371.7	220.5 (35%)	37.8 (6%)	508.34	336.52	741.03	0.26	182.79	3.78	1.26
3.	359.1	220.5 (35%)	50.4 (8%)	507.42	335.92	739.71	0.26	182.76	3.78	1.26

Result of SCC Using micro silica and 35% fly ash

Percentage of micro silica	4%		6%		8%	
Slump flow	5 min 745mm	30 min 710mm	5 min 725mm	30 min 685mm	5 min 705mm	30 min 655mm
V-funnel	T0 10sec.	T5 1sec.	T0 11sec.	T5 14sec.	T0 10sec.	T5 12sec.
T500	3.88		4.10		5.10	
U-Box	22mm		18mm		15mm	
L-Box	0.9		0.8		0.9	
7 days Compressive strength	23.58 N/mm2		28 N/mm2		32.46 N/mm2	
28 day Compressive strength	38.86 N/mm2		42.9 N/mm2		47.93 N/mm2	

Effect of Metakolin

TRIALS OF SCC USING METAKOLIN										
TRIALS	Cement (Kg/cum)	Fly ash (Kg/cum)	Metakolin (Kg/cum)	Coarse aggregate (Kg/cum) 51% of total agg.		Fine agg. (Kg/cum)	W/P ratio	Water (Kg/cum)	Additive 1 (Kg/cum)	Additive 2 (Kg/cum)
				20mm	10mm.					
1.	384.3	220.5 (35%)	25.2 (4%)	509.25	337.13	742.36	0.26	182.83	3.78	1.26
2.	359.1	220.5 (35%)	50.4 (8%)	507.42	335.92	739.71	0.26	182.76	3.78	1.26
3.	333.9	220.5 (35%)	75.6 (12%)	505.60	334.72	737.05	0.26	182.69	3.78	1.26

Results of SCC using metakolin and 35% fly ash

Percentage of Metakolin	4%		8%		12%	
Slump flow	5 min 740mm	30 min 700mm	5 min 715mm	30 min 680mm	5 min 700mm	30 min 680mm
V-funnel	T0 11sec.	T5 13sec.	T0 9sec.	T5 11sec.	T0 10sec.	T5 13sec.
T500	4.63		4.25		3.98	
U-Box	20mm		14mm		21mm	
L-Box	0.8		0.8		0.9	
7 days Compressive strength	22.86 N/mm2		23.67 N/mm2		27.05 N/mm2	
28 day Compressive strength	38.38 N/mm2		41.62 N/mm2		44.92 N/mm2	

2.3 Graphical presentation of test results

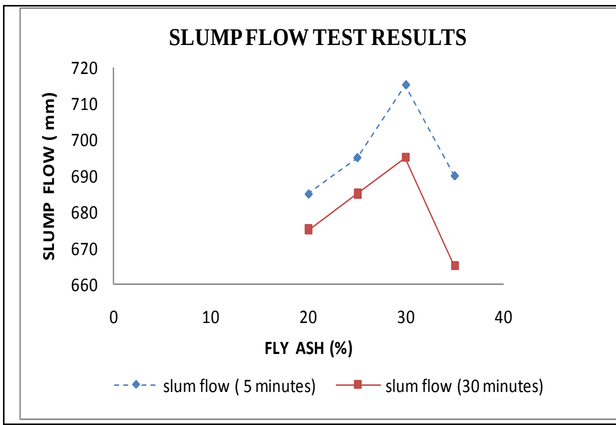

Fig.1: Fly Ash Percentage Vs Slum flow

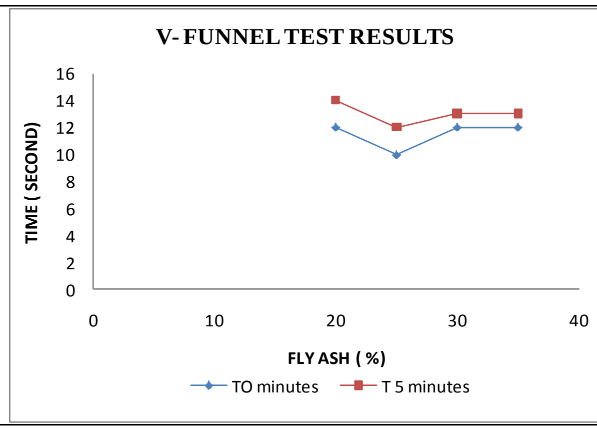

Fig.2: Fly Ash Percentage Vs Flow Time

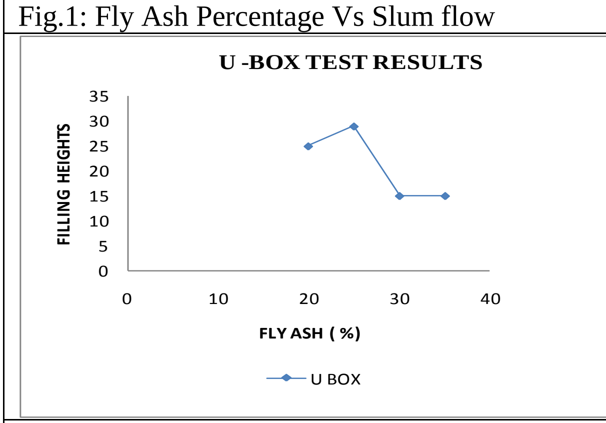

Fig.3: Fly Ash Percentage Vs Filling Heights

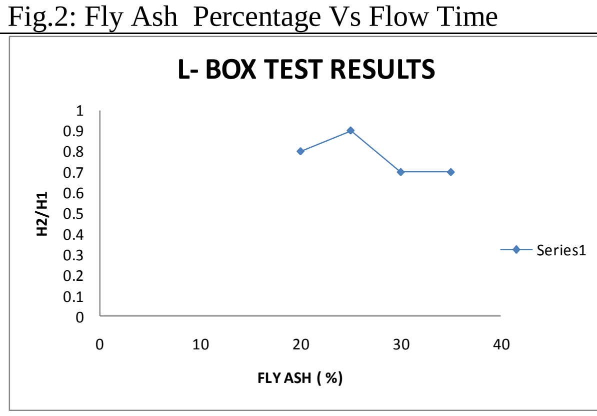

Fig.4: Fly Ash Percentage Vs Blocking Heights

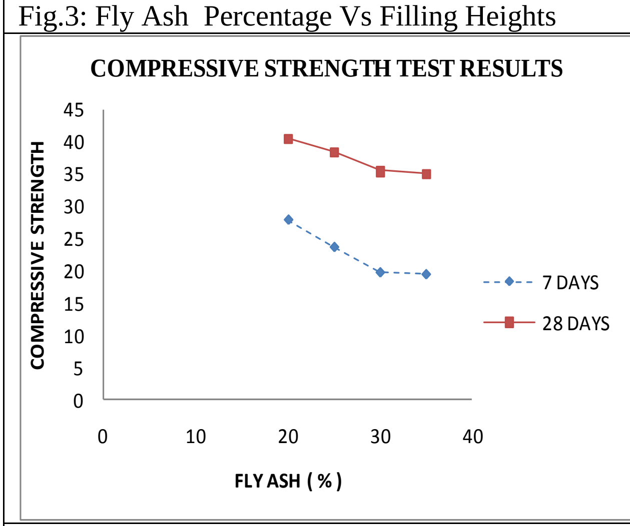

Fig.4: Fly Ash Percentage Vs Compressive Strength

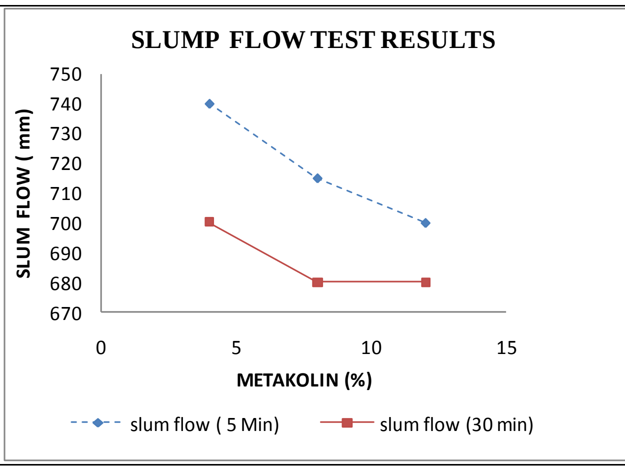

Fig.6: Metakolin Percentage Vs Slum flow

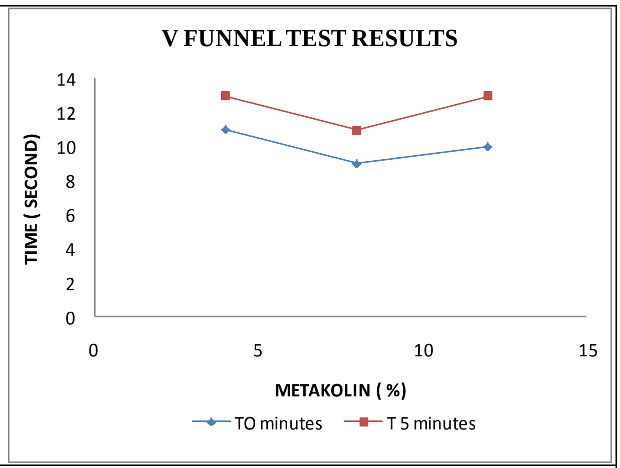

Fig.7: Metakolin Percentage Vs Flow Time

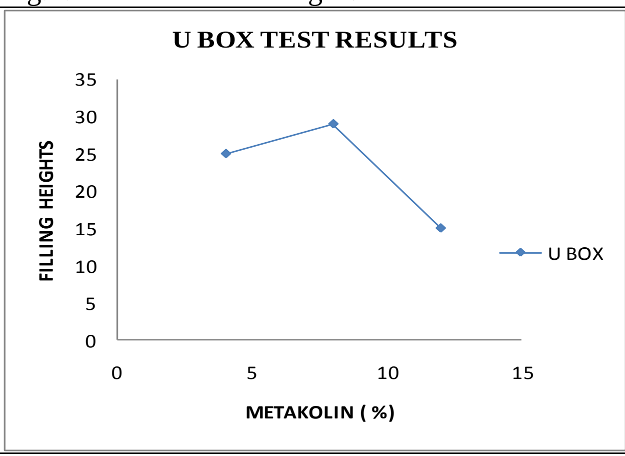

Fig.8: Metakolin Percentage Vs Filling Heights

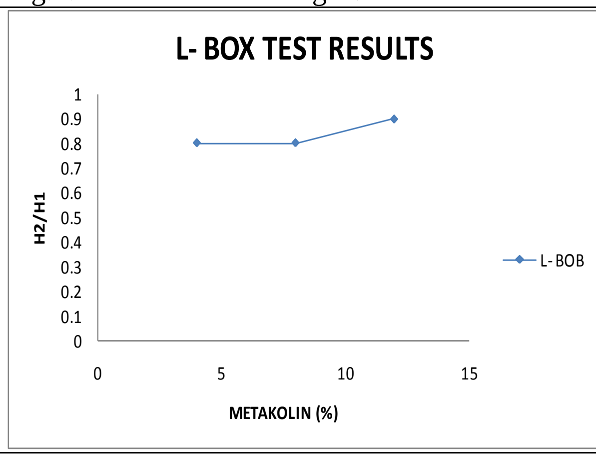

Fig.9: Metakolin Percentage Vs Blocking Heights

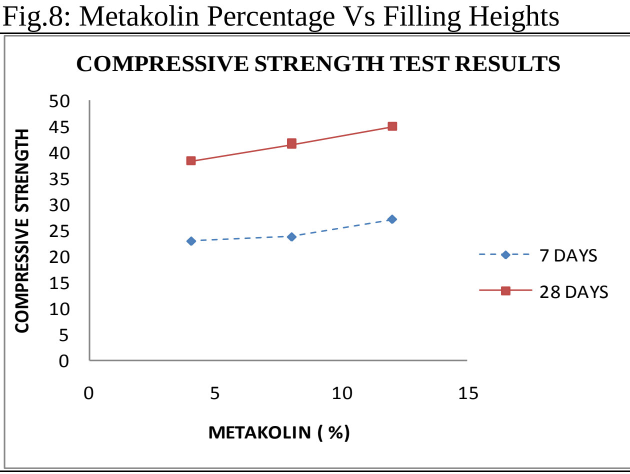

Fig.10: Metakolin Percentage Vs Compressive Strength

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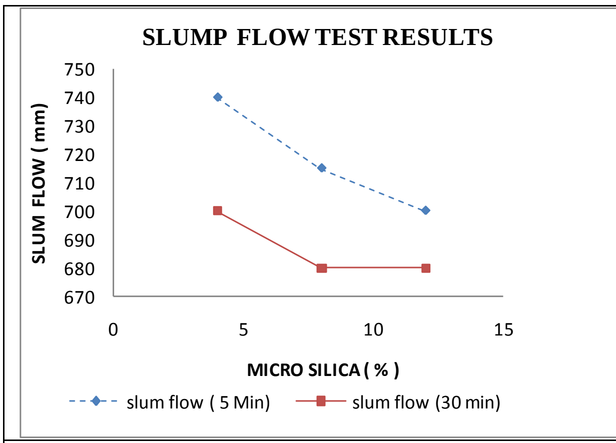

Fig.11: Micro Silica Percentage Vs Slum flow

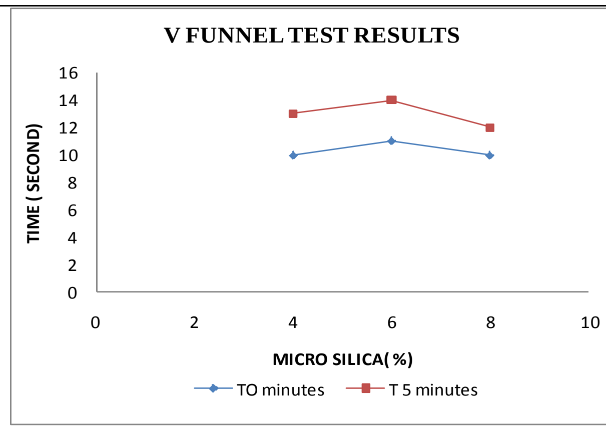

Fig.12: Micro Silica Percentage Vs Flow Time

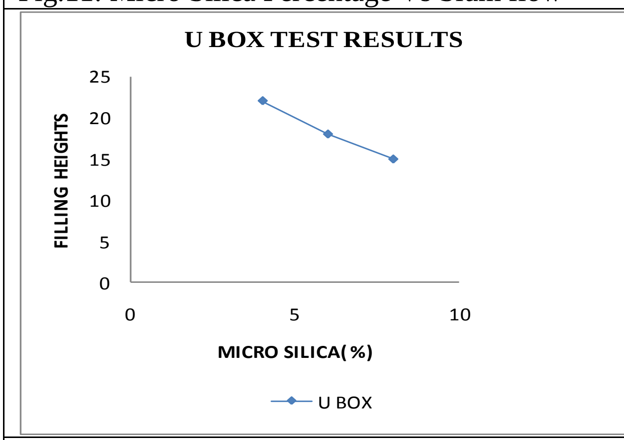

Fig.13: Micro Silica Percentage Vs Filling Heights

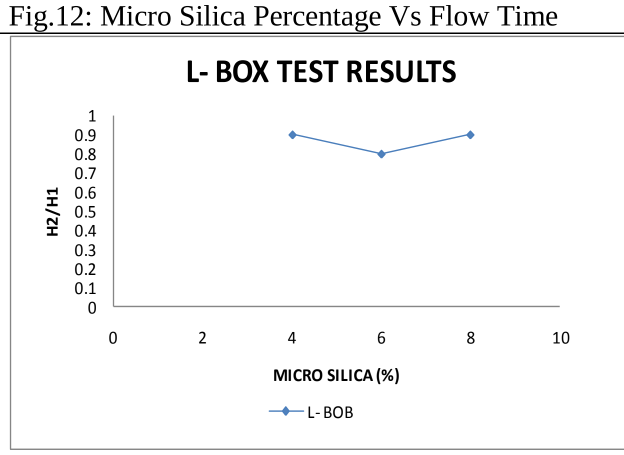

Fig.14: Micro Silica Percentage Vs Blocking Heights

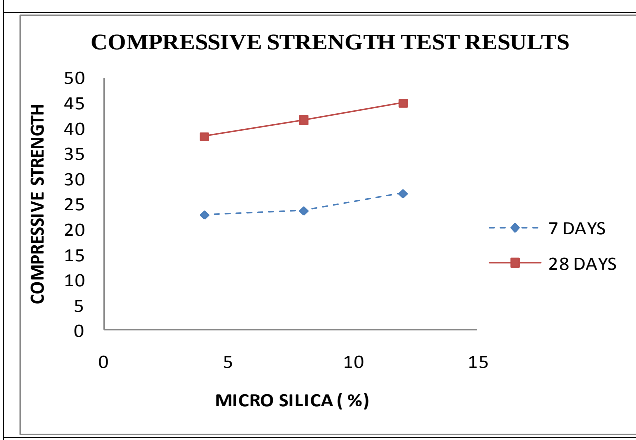

Fig.15: Micro Silica Percentage Vs Compressive Strength

III. DISCUSSIONS

3.1Discussion

1. Addition of increased percentage of fly ash results in decrease of compressive strength gradually but Workability parameters are within limits. By adding 20%, 25%, 30% and 35% fly ash we have observed that the slump flow obtained at 30 minute was 675mm,685mm,695mm and 665mm.All the results were within the recommended limits are 650-800mm.

2. The results obtained from the v-funnel test were quite good. With 20%,25%,30%,35% fly ash T0 time were 12 sec,10sec,12sec,12sec and T5 time was 14sec,12sec,13sec,13sec.The recommended value are 8-12 seconds for T0 and 11-15 sec for T5.

3. The time required to flow 500mm for 20%, 25%, 30% and 35% fly ash were 3.9 sec, 3.58 sec, 3.48 sec and 4.02 sec respectively which were well within the specified limit of 2-5sec.

4. The U-Box test results showed that the filling height for 20%, 25%, 30%and 35% fly ash were 25mm29mm, 15mm and 15mm respectively. The recommended limit was 0-30mm.

5. The L-Box test results addressed that blocking ratio for 20%, 25%, 30% and 35% fly ash were 0.8, 0.9, 0.7 And 0.7 respectively. The recommended limit was 0.8-1.0.

6. The addition of micro silica was done at 4%, 6% and 8% by taking 35% fly ash as base. The slump flow for 4%, 6% and 8% micro silica was found to be 710 mm, 690mm and 655mm respectively. This implies that it increased by 8% on average and hence better flow ability.

7. The U-Box test results addressed that filling height for 4%, 6% and 8% micro silica were 22mm, 18mm and 15mm respectively. The results were within recommended limits.

8. The L-Box test showed that blocking ratio for 4%, 6% and 8% micro silica were 0.9, 0.8 and 0.9 Which were between the ranges of 0.8-1.0 as per recommended value.

9. All the above test was again carried out by adding metakolin over 35% fly ash as base. The slump Flow obtained for 4%, 8% and 12% metakolin were 700mm, 680mm, 680mm respectively.The slump now obtained was on higher side implying better flow ability.

10.The U-Box test results showed that filling height for 4%,8% and 12%metakolin were 20mm,14mm and 21mm.Out of these the filling height for 8% metakolin was closer to zero showing better filling ability which was for more better than 25mm as obtained for 20% fly ash mix.

IV. CONCLUSIONS

Following conclusions are drawn from the investigations carried out

1. With Increase in percentage of Micro Silica compressive strength decreases.
2. Increase in percentage of micro silica gives better flow ability.
3. Admixture used imparts concrete with superior stability thus increasing resistance to segregation and facilitating placement.
4. Slump flow for 30% fly ash was observed to be maximum, which gives greater ability to fill the form work under its own weight.
5. With Increase in percentage of Metakolin compressive strength of concrete also increases giving efficient SCC.
6. With Increase percentage in fly ash, the compressive strength decreases.

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