International Journal of Technical Research and Applications e-ISSN: 2320-8163,
www.ijtra.com Volume 3, Issue 1 (Jan-Feb 2015), PP. 23-24

COMPARISON OF THE COMPRESSIVE STRENGTH OF SCC AND NVC AT ELEVATED TEMPERATURE

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Abstract-The effect of temperature on Self- compacting concrete (SCC) is investigated in this paper. SCC is a high-performance concrete that flows under its self-weight with adequately filling all the voids without any segregation or bleeding. It is a revolutionary development in the area of concrete admixtures. In this paper effort has been made to present the effect of temperature on compressive strength of self-compacting concrete produced by replacing ordinary Portland cement with 15% fly ash and then treated water quenched. Compressive strength of concrete is the major property which identifies the quality of concrete produced. Generally the compressive strength test is performed on concrete samples at room temperature to determine the developed strength of concrete. In order to study the effects of high temperatures on compressive strength of SCC, cubical specimens (100x100x100 mm) were heated at high temperatures (150˚C, 200˚C, 250˚C and 300˚C) for varying exposure duration ($1^1/_2$, 2, $2^1/_2$ and 3 hours) . The results obtained were compared with the corresponding properties of NVC (Normally Vibrated Concrete).

Index Terms: Self Compacting concrete, fly ash, compressive strength, fresh properties.

I. INTRODUCTION

In the field of construction technology, every possible effort is being made to develop concrete which is more durable, eco-friendly and economical. SCC has contributed majorly to the field of concrete technology such that it holds many advantages in comparison to conventional concrete. It is a peculiar type of concrete which has attribute to flow under its self-weight even through impenetrable reinforcement thus extinguishing the need of external vibration. As the concrete used for specific purpose, the risk of exposing it to higher temperature also increases. In case of unexpected fire, the concrete properties are changed. Hence, it is important to understand the change in property due to elevated temperature.

This paper reports the effect of high temperature on SCC with fly ash (15% replacement of OPC) for water-powder (fly ash & cement) ratio as 1.28 by volume. Experiments were conducted to assess the properties of water powder ratio and mortar (cement-45%, fly ash- 15%, sand-40%) required for producing SCC meeting the flow criteria. Moreover, to achieve the required flow of SCC, chemical admixture Conplast SP430 has been used.

II. EXPERIMENTAL STUDY

A. Materials

Ordinary Portland cement of grade 43 was used in the present study. The fine aggregate used was natural sand with specific gravity 2.60 and fineness modulus 2.42. Locally available crushed stone having the maximum size of 12.5 mm was used as coarse aggregate with fineness modulus 6.71332. Class F fly ash obtained from Century pulp and paper mill, Lalkuan (Uttarakhand) was used. Conplast SP430-SRV was the superplasticizer obtained from Fosroc chemicals (I) ltd, conforming to IS: 9103-1999.

B. Mixture Design

The SCC mixture was made by replacing 15% of cement with class F fly ash.

Table I. Mix design for 1000 litre concrete

Mixes design	Mortar %	Aggregate %	Mortar			Aggregates	Water/ binder ratio
			Cement (Kg)	*Fly-ash (Kg)*	*Sand (Kg)*	*Coarse aggregates (Kg)*	
SCC	60	40	528.92	62.424	783.174	603.680	1.28
Superplasticizer = 2 ml per 100 kg of paste							

A. Experimental Procedure

Cubes of size 100mmx100mmx100mm were prepared and cured for a time period of 28 days. After which they were heated at varying temperatures (150ºC, 200ºC, 250ºC and 300ºC) for different time period. The specimens were cooled by the method of quenching thereby its compressive strength was tested. Triplicate samples were used in the present study. Also NVC of the same grade was prepared and after 28 days of curing they were heated and cooled using quenching thereafter were tested for compressive strength. The results of SCC and NVC were compared.

III. RESULTS AND DISCUSSION

A. Fresh Properties

In order to study the self compactability parameters various tests (V-funnel test, J-ring test, L-box test,etc.) were conducted on SCC. Any SCC should fulfill three properties i.e. passing ability, filling ability and resistance to segregation. These were confirmed by performing the above mentioned tests on the mixture. Table 2 shows the fresh properties of SCC.

B. Hardened Properties

After the preparation of the moulds and heating them at required temperature for the desired duration with quenching they were tested for their compressive strength. Compression load was applied at a pace rate of 3 kN/s on UTM of capacity 1000kN. Test results and graphs indicate that exposure of concrete to temperature in the range of 150˚C to 200˚C for the duration of $1^1/_2$ to 2 hours, increase in the average compressive strength. This increase was observed 2.52% at150˚C and 6.94% at 200˚C. This regain in strength is

generally attributed to greater Vander Waals forces as a result of cement gel layers moving closer to each other during heating. Furthermore, during cooling, concrete gets further damaged. For higher temperature and longer duration, the average compressive strength of concrete decreases to 5.98% at 250˚C and 10.25% at 300˚C. This decrease in strength is due to the degradation of material at high temperature. Figure I and figure II shows the results for compressive strength of SCC and NVC respectively.

Mix	Slump Flow(mm)	T_{50} (sec)	V- funnel (t_f sec)	V- funnel ($t_{5\ min}$) (sec)	J- Ring height difference (mm)	L- Box (H_2/H_1) ratio	rimet (se	Result
Limiting values as per EFNARC(2005)	***650-800***	***0-5***	***6-12***	***6-12***	***0-10***	***0.8-1***	***0-5***	
SCC1	560	-	-	-	-	-	-	Failed
SCC2	630	-	-	-	-	-	-	Failed
SCC3	642	-	-	-	-	-	-	Failed
SCC4	675	7	10	8.5	-	-	3	Failed
SCC5	**710**	**3.0**	**8**	**10**	**2**	**0.95**	**3.5**	**Passed**

Table II. Properties of Fresh SCC with fly ash

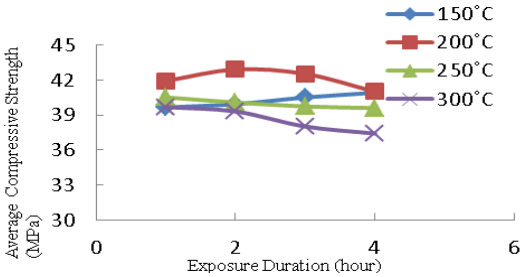

Fig I Average cube compressive strength of SCC after 28 days (quenching)

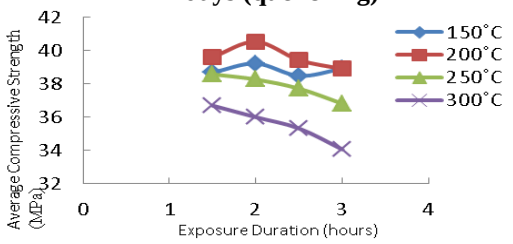

Fig. II Average cube compressive strength of NVC after 28 days (quenching)

IV. CONCLUSIONS

- The compressive strength of SCC specimens after heating are higher than those of conventional ones for the whole studied range of temperature in the study in spite of the fact that the SCC has lower original strength value.
- The formulated SCC was highly flow able and segregation resistant.
- Upto200˚C temperature, cube compressive strength of NVC and SCC increases as the temperature duration increases after water quenched treatment.
- For 2 hours 200˚C temperature maximum percentage gain has been observed. In case of higher exposure duration, the percentage of strength gain is more as compared to room temperature. However, this increase in the rate of strength decreases with increase in the time duration.
- The maximum cube compressive strength of SCC is higher than its original value by 9.20%, while that of conventional concrete is higher than its original one by 6.94%.
- The loss in strengths resulting from exposure to higher temperature in SCC is smaller than the conventional concrete in all the tested temperature levels.

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