ABSTRACT

Self-compacting concrete (SCC) offers several benefits over the normal vibrated concrete (NVC), mainly the ease in placement and lack of vibration. It also proves to be efficient in densely arranged bars and in areas where it is more difficult to use vibrators.

SCC is achieved by reducing the volume ratio of aggregate to cementitious materials, increasing the paste volume and using various viscosity enhancing admixtures and superplasticizers. It is observed that the behaviour of the design concrete mix is significantly affected by variation in humidity and temperature both in fresh and hardened state. Curing techniques and curing duration significantly affects “curing efficiency”. Techniques used in concrete curing are mainly divided into two groups namely, Water adding techniques and Water-retraining techniques.

In the current study, the effect of few selected curing techniques on the mechanical properties of self compacting concrete (SCC) of grade M30 and M50 have been studied.

In the first phase, various trials are performed with 0.01 m³ of concrete with the use of locally available materials and checked the fresh property tests (Slump flow, J-ring flow, V-funnel, L-box and U-box) according to the standards of European Guidelines and finalized the mix proportion of M30 and M50 grade of SCC, considered as a reference SCC mix.

In the second phase, the mechanical properties including compressive, tensile, flexural and shear strengths affected by various curing techniques such as, normal water immersion, hot water, ice, sea water, wet covering, polyethylene film, external curing compound, dry curing and internal curing admixture are checked. In addition, self curing is also attempted using chemical agents.

In the final phase, the design mix of M30 grade of Normal Vibrated Concrete (NVC) is finalized and compared the effect of curing techniques on the mechanical properties of similar grade of SCC. The microstructure of both the concretes (SCC & NVC) has been studied using SEM (Scanning Electron Microscope) and related to strength and
durability aspects. The cost of casting concrete with selected curing techniques is calculated and compared for economic aspect.

From the experimental results, it is observed that the various mechanical properties are being affected by different curing techniques while water immersion curing technique gives the maximum strength. The self curing method is working well and achieves about 90-95% strength than the strength with immersion method at 28 days.

For compressive strength, the test results revealed that the strength is affected by the method of curing. For M30SCC, 28 days water immersion method gives the maximum compressive strength 34.9 N/mm² while with dry curing the compressive strength reduced to about 72%. However, hot water, sea water, polyethylene film and self curing self compacting concrete give very good results to the tune of 95% of the water immersion strength.

For M50SCC at 28 days, again the maximum compressive strength is achieved through immersion curing while with dry curing it is only 52%. Sea water curing achieves about 94% of compressive strength compared to immersion method. Ice curing, Polyethylene film, Wet covering, External curing compound and Self curing techniques achieve strength between 88-90% of immersion strength.

At 28 days for M30NVC, water immersion method achieves maximum strength while second highest strength is with Hot water curing technique (about 96%). Self curing techniques give about 93% compressive strength than that of immersion method. Ice water curing gains minimum compressive strength 25.6 N/mm² about 68% of immersion compressive strength while dry curing gives 26.2 N/mm². Sea water, Polyethylene film & Wet covering achieve compressive strength in the range of 91% to 94%.

It was observed that with prolonged period of 90 days curing the self curing method in all the three types of concrete is able to achieve design compressive strength. Thus self curing self compacting concrete (SCSCC) can be a good alternative of curing in the areas with water scarcity or where quality of water is not satisfactory. The results of microstructure support this finding.
It is also observed that both the grades of SCC have shown good compressive strength in sea water and hot water curing while the strength under ice curing is not satisfactory.

Splitting tensile strength for M30SCC is highest with immersion curing while hot water gives about 95% at 28 days. The lowest splitting tensile strength is with dry curing and self curing achieves about 94%. The splitting tensile strength of M30SCC is better than M30NVC for all the curing techniques. Splitting tensile strength of M50SCC with different curing techniques ranges between 6.5 to 8% of their compressive strength while for M30SCC it ranges between 7.5 to 9.26% of compressive strength.

For flexural strength, M30SCC achieves better results than M50SCC. The values of flexural strength, for M30SCC, range between 11.1% to 14.7% of compressive strength with different curing techniques and between 8.5% to 10.7% for M50SCC. For M30NVC, the values of flexural strength range between 8.5% to 11.4% of their respective compressive strength. Thus SCC proves to be better than NVC for flexural strength.

For shear strength, M30SCC achieves better results than M50SCC. The values of shear strength range between 10.3% to 14.5% of compressive strength with different curing techniques for M30SCC and between 9.3% to 10.2% for M50SCC. For M30NVC, the values of shear strength range between 8.5% to 12.9% of their respective compressive strength. Thus SCC proves to be better than NVC for shear strength. The highest strength is achieved with immersion curing for M30SCC, for M50SCC it is through curing compound and for M30NVC it is with immersion curing.

In analytical phase/modeling, the empirical models for compressive strength for SCC and NVC were derived from the experimental results and verified with past research work.

Thus SCC is proved be a superior concrete than NVC and SCSCC can be utilized as tool of casting sustainable concrete in the areas of water scarcity or with little compromise in the cost.