Can HVFAC technology be adopted for site-mixed concrete?

By An Analyst

It was in the year 2000 that I first came to know about the technology of high-volume fly ash (HVFA) concrete. Two papers gave a general idea about the technology[1,2]. However, I believed that the technology was in the nascent stage and had not gone beyond the realm of laboratory investigations, until I heard about some demonstration projects being conducted in India. Being quite enthusiastic to know more about this technology and the latest developments in this field, I seized the opportunity of attending the one-day seminar on the subject, organised jointly by the Confederation Indian Industry (CII), India and CANMET, Canada, in the second week of October 2004.

It was quite an informative and thought-provoking seminar. However, after carefully listening to the presentations of various distinguished speakers including Dr V. M. Malhotra, as also the panel discussion, I was left wondering as to what extent this new technology would be suitable for application in the typical Indian conditions, dominated by the preponderance of site-mixed concrete, most of which is volume batched. I have spent more than 35 years on various construction sites and based on my long experience I would like to share my views on the subject.

At the outset, I would like to make it clear that I whole-heartedly support the technology of HVFA concrete. I fully agree that emissions of green house gases (GHGs) such as CO_2 and NO_x are rising alarmingly and that if these are not controlled, would threaten the very survival of the mankind. I also subscribe to the argument that construction industries in various countries, including India, need to use more and more supplementary cementitious materials such as fly ash, blast-furnace slag, etc so that non-renewable resources are used sparingly and the emissions of GHGs are reduced. In this context, Dr V.M. Malhotra and his colleagues in CANMET, Canada, need to be complimented for developing the technology of HVFA concrete and trying to promote the same in countries like India.

However, one cannot forget the ground realities which exist currently in the Indian construction industry. Although this is the second largest industry in India, next only to agriculture — producing goods and services valued at Rs 210 billion, and contributing 5 percent to the GDP of the country — it also happens to be the second largest employment generating industry in the country, employing over 30 million persons in 1999-2000, that is, around 16 percent of the nation's working population. As against this, the percentage of workforce employed in construction in many developed countries is around 6-8 percent.

Traditionally, concrete construction has been a labour-intensive activity in India. Even today, an overwhelming majority of concrete produced in the country is site-mixed, and most of it is volume-batched. Although, weigh batching and use of a mechanical device for mixing (usually a 200-*l* (10/7) mixer)

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are now insisted upon on many small and medium-sized construction projects, the labour component in the production of concrete is still very high. The situation is gradually changing, and a change in favour of mechanisation in construction is slowly catching up; however, this is restricted to urban and semi-urban areas only.

Ready-mixed concrete (RMC) arrived in India in the mid 1990s and has spread and gained acceptance in major metropolis (Mumbai, Bangalore, Delhi, Chennai, Kolkata) and other big cities (Hyderabad, Pune, Coimbatore, etc). However, even in these cities, the use of RMC has mainly been confined to large-volume construction, where speed of construction is a key factor. As a result, cement consumption of the currently operational 80-odd RMC plants put together may not even exceed 5 percent of the total cement produced in the country.

This indicates that site-mixed concrete is still overwhelmingly used on numerous medium and small concrete construction sites in India. It is for this category that the use of HVFA concrete may pose a number of problems.

Efficiency of mixing

In HVFA concrete, the proportion of fly ash in the total cementitious materials is kept in the range of 50-60 percent. Mixing of two powdery materials – cement and fly ash – with almost equal proportions in a low-efficiency mixer having a capacity of 200-*l* or 280-*l* is bound to pose difficulties. It is quite likely that fly ash may not get dispersed evenly in the concrete mix. Further, the mixer operator in a typical site-mixed concrete job is always in a great hurry, and as far as my experience goes, the standard mixing time recommended in codes or specifications is hardly followed. HVFA concrete will certainly need more mixing time, and it will be difficult to exercise control on this on a typical construction site in India.

Controlling mixing water content

Further, HVFA concrete requires that the water-binder (w/b) ratio be maintained between 0.32 to 0.38 and this is going to be the toughest challenge in site-mixed concrete production. All of us are well aware of the fact that site-mixed concrete work is usually carried out by a team of illiterate or semi-literate labourers, who are unable to appreciate the importance of ensuring low levels of water in the concrete mix. Throughout my long experience in construction, I have tried to introduce a simple flush tank-like attachment to the 10/7 mixer to allow measured quantity of mixing water in the mixer. I was successful to a certain extent in this regard; however, this is yet to become a common practice in the country. The water content in the HVFA concrete needs to be kept around 120-135 l/m^3 and if one is not able to control it then it is obvious that the desired properties of strength and durability would not be achieved.

HVFA concrete should only be produced in an RMC facility or on projects having batching-mixing plant wherein sufficiently high level of quality control measures are exercised

Superplasticiser

HVFA concrete necessarily includes a superplasticiser. The slump of this concrete is increased not by adding more water but by the addition of a superplasticiser. In India, the use of a plasticisers and superplasticisers has gained acceptance only in recent years and the utilisation of these chemicals is certainly on the rise, thanks mainly to the RMC and infrastructure projects. Unfortunately, in site-mixed concrete, the use of chemical admixtures has not gained acceptance. The use of these materials need some level of quality control measures at site to ensure that proper quality chemicals are used in correct dosages. The IS code on chemical admixtures, namely, IS 9103, was revised in 1999 to include the conformity and uniformity tests. However, the awareness on the topic is lacking even amongst engineers working on big projects. How can then one expect the masons and supervisors handling site-mixed concrete to be knowledgeable about the admixtures in general and superplasticisers in particular? Are they capable of dealing with the problem of cement-superplasticiser-fly ash compatibility? Further, how can they introduce an exact amount of superplasticiser when proper dosing arrangements are just not available on a site-mixed concrete work?

Fly ash

The quality of fly ash is a big question. The IS 3812, which was revised in 2003, specifies certain physical requirements like Blaine's fineness, lime reactivity, particles retained on 45 micron sieve, compressive strength, soundness, etc for ensuring that only the desired quality of fly ash is used in concrete. The code has also introduced certain uniformity requirements. However, the quality control exercised on a typical site-mixed concrete job site in India is just not equipped to exercise proper controls on the quality of fly ash that would be incorporated in concrete. Under such circumstances, there is a possibility that improper quality fly ash — even bottom ash — get introduced in concrete. The resulting consequences are fraught with danger. To my knowledge, currently there is only one agency in our part of the country, claiming to be supplying a reliable quality fly ash.

Supervision and quality control

As mentioned earlier, proper supervision and quality control are generally lacking in typical site-mixed concrete jobs. There is a total dependence on the *mukadam* and his team of labourers, who are not knowledgeable enough to understand the importance of keeping the w/b ratio at lower level, ensuring adequate mixing of fly ash and incorporating adequate dosage of a good-quality superplasticiser in the mix. Further, on most of these jobs, the contractor/builder/developer is not in a position to afford the "luxury" of having qualified personnel for construction. Further, HVFA concrete also needs sufficient curing, which is usually an ignored area in site-mixed concrete.

Of course, this is not to deny the fact that there are certain enlightened contractors/builders and consultants in

the country, who are fully aware of the implications of good quality concrete and are exercising good controls on many of their construction sites using site-mixed concrete. Unfortunately, their number is abysmally low.

Fly ash-based blended cement

For most of the site-mixed concrete jobs, fly ash-based blended cement, that is, portland pozzolana cement (PPC), seems to be most suitable. Already, the use of PPC has picked up in the country in recent years and it is replacing ordinary portland cement (OPC) in many applications, including the reinforced concrete structures. The current trend also shows that the level of absorption of fly ash in PPC is steadily increasing. From a level of around 15 percent in the 1990s, the fly ash absorption level in PPC has today reached a level of around 25 percent or so. Some of the cement producers are able to incorporate even up to 30 percent fly ash. In my opinion, this type of cement is well suited for use in site-mixed concrete.

Conclusion

In conclusion, I would like to again reiterate that HVFA concrete technology is certainly a welcome advancement in the field of concrete technology. However, this new technology needs to be used with caution and care. To begin with, it is my humble suggestion that HVFA concrete should only be produced in an RMC facility or on projects having batching-mixing plant wherein sufficiently high level of quality control measures are exercised. Considering that in most of the site-mixed concrete jobs in the country quality control measures are inadequately exercised or totally absent, these sites may not be permitted to adopt HVFA concrete. If this is not done then it is quite likely that the HVFA technology will be misused. It is indeed frightening to imagine in the consequences of leaving this technology in the hands of masons and semi-literate labourers. As Dr V M Malhotra himself pointed out in the concluding panel discussions during the seminar, HVFA concrete technology would get a bad name if it were left in the hands of masons! The difference between ordinary concrete and HVFA concrete is the know-how, which is very vital and this must be clearly understood by the engineering fraternity in the country.

HVFA concrete technology would get a bad name if it were left in the hands of untrained masons!

References

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