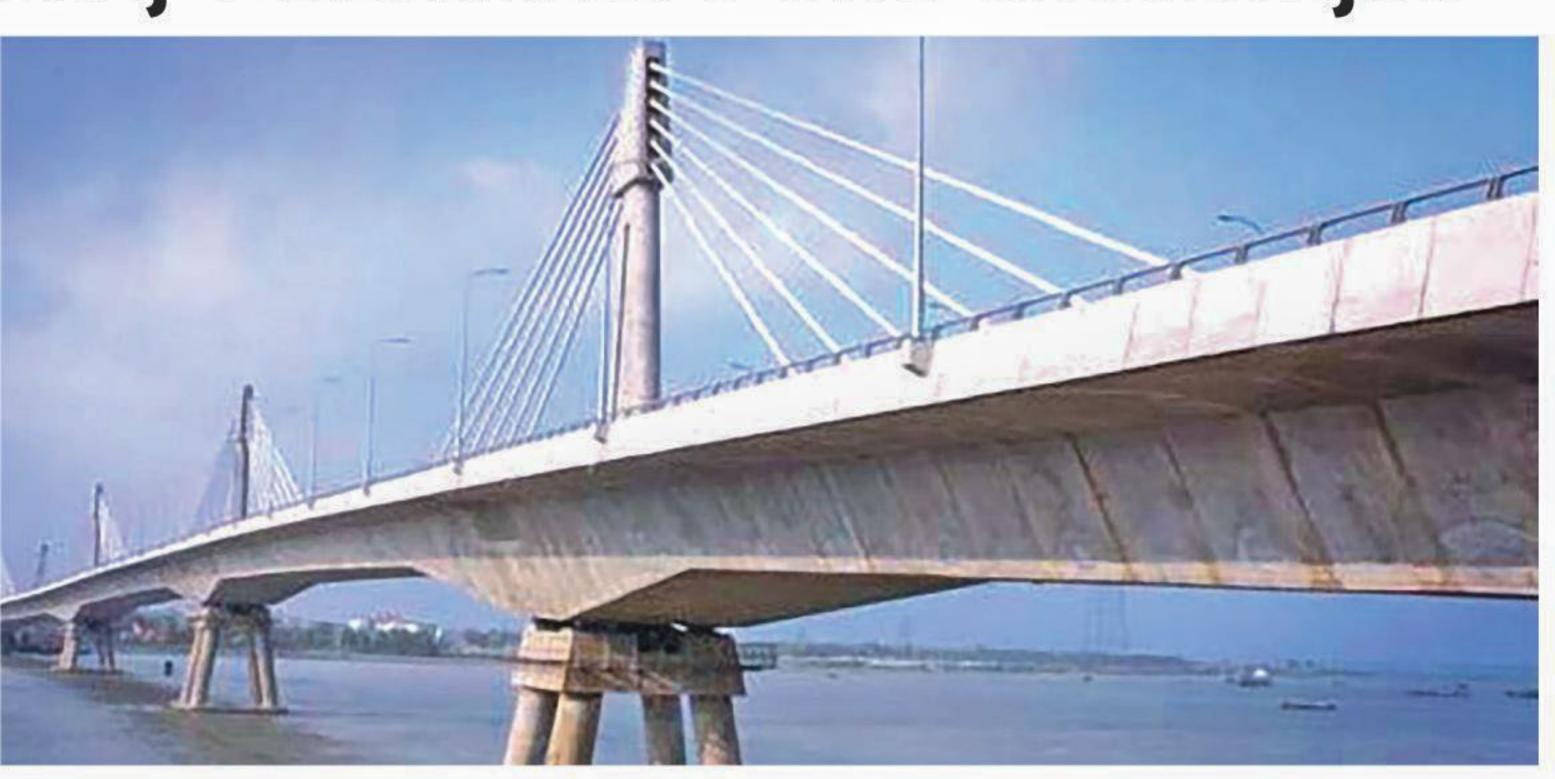
High-Strength Concrete: Key Parameters and Challenges



Shah Amanat Bridge: Concrete strength of the superstructure is 10,000 pounds per square inch (psi).



PROF. DR. MD. TAREK UDDIN

High-strength concrete (HSC) is a type of concrete with high compressive strength compared to normal-strength concrete (NSC). Although there is no exact limit of compressive strength which could distinguish HSC from NSC, the American Concrete Institute defines HSC with compressive strength of more than 6,000 psi. The main advantages of HSC are: (1) it reduces cross-section of structural elements and therefore increases available space, (ii) it improves aesthetics due to slimmer cross-section, (iii) it reduces self-weight of the structure, (iv) it increases modulus of elasticity of concrete and reduces creep (deformation under continuous loading) that controls short-term and longterm deflections, and (v) it improves long-term durability of structures which is a key concern toward sustainable use of construction materials. HSC is a useful material for high-rise buildings, long-span bridges, heavy-duty industrial floors, pre-stressed concrete, etc.

Concrete is a mixture of cement, water, coarse and fine aggregates with or without chemical and mineral admixtures. As aggregate covers 75 percent of the volume of concrete, for HSC, high-strength well-graded aggregate is essential. The presence of different sizes of aggregate (well-graded) in appropriate

proportions is important to reduce void. The maximum size of aggregate is also another important factor. Due to the internal bleeding of water in concrete, the bonding can be poor for large-sized aggregate. 20 mm downgraded aggregate can be used for making concrete of strength of 6,000 psi or higher. However, it can be reduced to 12 mm if strength requirement is 10,000 psi or more. The bonding with cement paste around aggregate is improved for smaller-sized coarse aggregate. For HSC, the amount of cement is to be increased compared to NSC. The amount of cement in HSC varies from 420 to 650 kg per cubic metre based on the strength requirement. As the amount of cement is increased, the size of the fine aggregate is also to be increased compared to NSC. Increase in the sizes of fine aggregate will create adequate free space among aggregates for cement hydration products generated from a larger amount of cement compared to the NSC. Due to the use of more cement, heat of hydration and plastic shrinkage of fresh concrete will be increased, but can be controlled with the utilisation of mineral admixtures with clinker, such as fly ash, slag, etc. A part of cement (5 to 8 percent) can also be replaced by silica fume. As silica fume particles are very fine (less than one-hundredth of cement particles), they fill nano-scale voids in concrete. It can also convert calcium hydroxide generated in the hydration process of clinker to new strength giving material, CSH gel.

Another important parameter of HSC is water to cement ratio (W/C). The W/C for HSC can be fixed within the range from 0.25 to 0.40 based on the strength requirement. For complete hydration of cement, 23 percent of water is required. The extra water will create void in concrete and will eventually reduce strength. By lowering W/C, the amount of void in concrete is reduced, which is a mandatory requirement of HSC. With the reduction of

W/C, workability (flow ability) of concrete will be reduced. However, the flow ability of concrete can be improved significantly by using

water-reducing chemical admixture. Based on a laboratory investigation, it has been found that to produce strength over 5,000 psi, it is necessary to use stone chips as coarse aggregate. A further study has been conducted for production of HSC using Maddhapara hard rock mine of Dinajpur. The stone chips produced at this quarry site are very strong (abrasion loss is less than 23 percent), and therefore can be utilised for making HSC. A mixture of concrete using Maddhapara hard rock with W/C of 0.30, CEM Type I cement of 460 kg per cubic metre, and silica fume of 40 kg per cubic metre produced compressive strength of 11,000 psi. The strength can be improved further by reducing maximum size of coarse aggregate and increasing cement

content. For production of HSC, it is recommended to make trial mixes before construction. Pre-construction meeting with the contractor is also important. During construction extra care is necessary to prevent plastic shrinkage and thermal cracking. Extra care is also necessary for quality control of materials, mixing, transportation, placing, compaction, and curing. As we are investing a huge amount for construction of several mega projects and the private sector has also come forward to invest in the construction of high-rise buildings, our civil engineers need to familiarise themselves with the parameters and challenges for making HSC. HSC is a durable concrete and, therefore, all construction works in marine exposure can be planned with HSC.

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Major realtors widen footprint

STAFF CORRESPONDENT

Real estate companies, which are known for catering to customers in Dhaka city, are also developing housing projects in many parts of the country, on the back of rising demand, rapid urbanisation and improved communications.

Realtors have long been developing housing projects outside of the capital, said Liakat Ali Bhuiyan, first vice-president of the Real Estate & Housing Association of Bangladesh (REHAB).

He attributed improved communications and availability of electricity for Dhakabased real estate companies making a foray into divisional cities such as Chattogram, Sylhet and major districts such as Cumilla.

"A lot of real estate projects are going on in Cumilla. There are real estate projects in Khulna, Sylhet, Mymensingh and even in Jamalpur," he said.

"If civic facilities become increasingly available in other cities and major district towns, people will start living in their hometowns and will only commute to Dhaka for jobs and businesses."

Scarcity of land in the capital city is another reason for the realtors to start developing real estate projects in other cities to remain in the business as well as keep growing. People's increased purchasing power and availability of bank loans are also moving realtors outside of Dhaka, according to Bhuiyan.

"There was a time when people only wanted to own property in Dhaka. That mindset has changed. Now they are building homes and apartments in their hometowns. This is providing housing solutions to lower and middle-income groups."

Structural Engineers Ltd (SEL), a reputed real estate company in Bangladesh, was one of the few such organisations that seriously explored opportunities beyond Dhaka. In 2006, it undertook a project in Cumilla to see whether there is any demand for apartments in the district.

"Nobody could believe that the project would be completed. But SEL completed the project very fast and handed it over to its owner only in three years, successfully introducing the concept of apartments in the district town," said Mohammad Abdul Awal, managing director of SEL. A number of local developers have sprung up seeing the success of SEL.

SEL has already handed over a number of projects. It completed two projects in Khulna. It is currently developing housing projects in Cumilla.

Awal said there are opportunities outside Dhaka. "Dhaka-centric housing is not a solution. Cities around Dhaka have to be developed."

He said the success of a housing project would depend on the house rent of an area. If the house rent is high, there would be demand for apartments.

However, the quality of housing projects outside Dhaka can face a number of questions because engineers are not involved in most of the projects. The construction materials that are being used should be looked into.

There is also a lack of knowledge among the local realtors, Awal said. The market is still small outside of Dhaka. Awal said users have to be cautious so that construction materials are used in proper quantity and quality.

Building Technology & Ideas Ltd (bti) is another major company which has been exploring opportunities outside of the capital city.

It went to Chattogram, the second biggest city, in 2000 and since then it has delivered 22 projects. Another 20 projects are underway, said FR Khan, managing director of the company.

"We went to Chattogram because there was demand," he said, adding the response has been good.

The company has handed over three projects in Cumilla and as many projects in Khulna.

Some more major companies such as Rangs Properties, Navana, Concord, ABC, Rupayan Group, and ANZ Properties have operations in Chattogram, according to Mahbubur Rahman, executive director of Sanmar Properties, which started its operations in the port city in 1999.

Rupayan Group expanded its operations outside of the capital in 2007 with a view to creating new markets for the real estate company. It is now developing projects in Chattogram, Cumilla and Sylhet.

Cumilla and Sylhet are rapidly urbanising,' said Mehedi Hasan, head of media of the group. He said of late Chattogram and Sylhet

"There is demand as Chattogram,

have emerged as major markets for real estate companies. The company has bought land in Kuakata and Cox's Bazar for real estate projects.

Hasan said there are local developers in the cities and major districts, but not all of them can take up large projects like major realtors.

Companies that have not set foot outside of Dhaka also understand the importance of exploring opportunities in other parts of the country.

Companies would have to explore opportunities outside of the capital city because land scarcity is becoming acute in Dhaka day by day, according to Sarwar N Chowdhury, senior assistant vice-president for business development and customer care at Bay Developments Ltd, which is focused on Gulshan, Baridhara and Banani areas

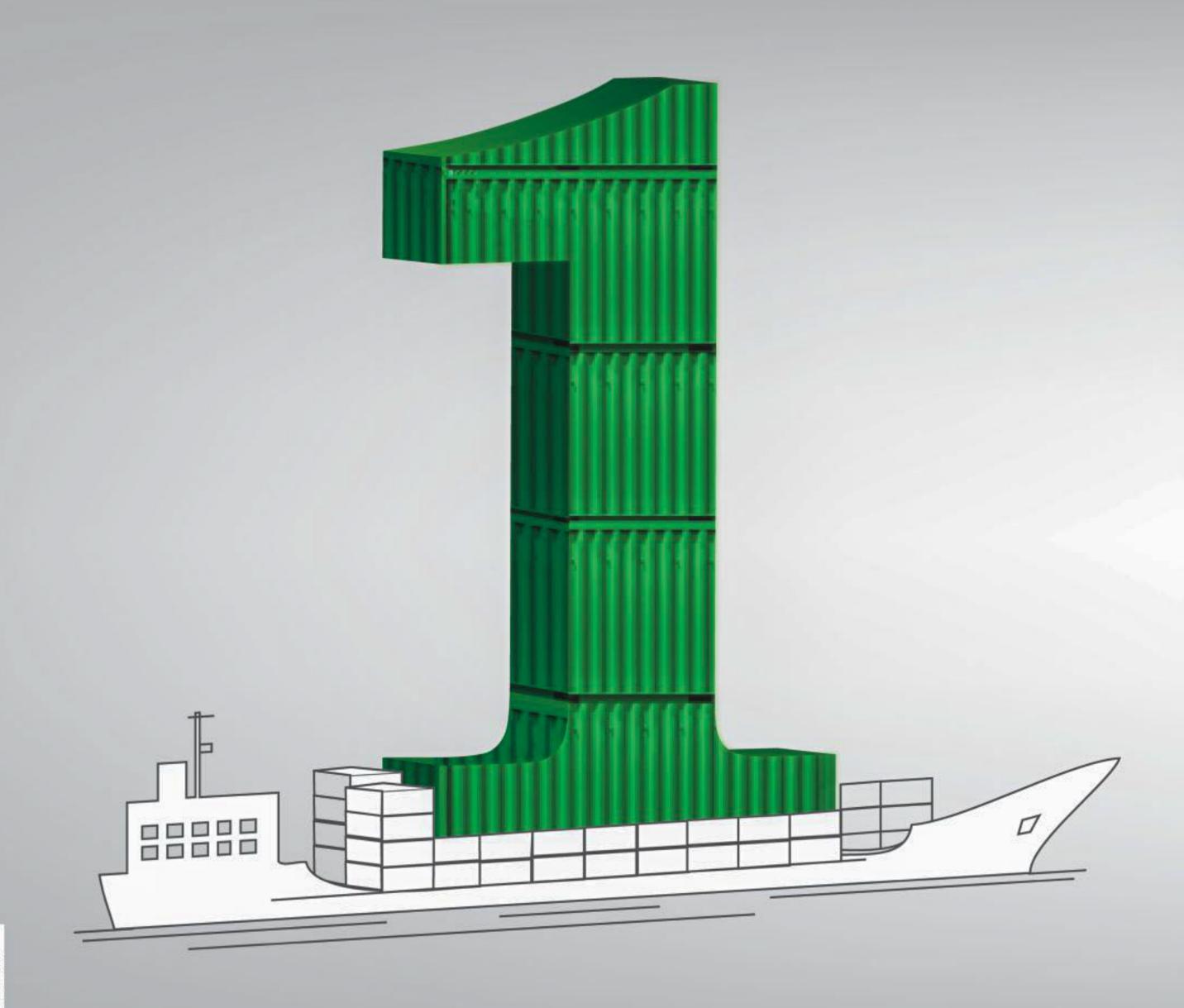
Rupayan Group's Hasan said monitoring

becomes difficult for companies which are based in Dhaka. Project officials, engineers and owners can regularly visit a project site in Dhaka but it becomes tough if the projects are away from the capital city. The company has set up offices in Chattogram and Sylhet.

Md Abu Sadeque, executive director of the Centre for Housing and Building Research, said retailers should store the construction materials properly.

Cement gets hardened after a certain period if it is not stored properly, he said. "So, there should be a standard cement warehouse at the project site."

The standards for storing cement have to be followed as the quality and strength of cement falter gradually as time passes said Sadeque, also a former director of the Housing and Building Research Institute.



THE EXPORT LEADER

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