The Daily Star
DHAKA MONDAY APRIL 27, 2020, BAISHAKH 14, 1427 BS
INFRASTRUCTURE

The usefulness of ready-mix concrete in building infrastructures

DR MD TAREK UDDIN

Md Tarek Uddin

Ready-mix concrete (RMC) is produced at batching plants as per specifications of concrete and then transferred to the project sites. Wet mix plants are more popular than dry mix plants. In wet mix plants, all ingredients of concrete including water are mixed in a central mixer and then transferred to the project sites by agitator trucks. During transit, the trucks continuously revolve at 2~5 rpm to avoid setting as well as segregation of concrete. The whole operation of the plant is controlled from a control room. The ingredients of concrete are loaded in the mixer as per the mix design. The mix design of concrete is a recipe for production of one cubic metre of concrete. The mix design is to be changed with the variation of specific gravities of cement, coarse aggregate, and fine aggregate; moisture states of aggregates, etc. For example, if specific gravity of coarse aggregate is increased, the weight of coarse aggregate is to be increased accordingly. If aggregate contains extra amount of water over saturated surface dry conditions, the amount of mixing water is to be reduced accordingly. At the RMC plant, the Quality Control Engineer should make a check-list to ensure quality of the product.

RMC has many advantages over on-site mixing. RMC (i) allows for quick construction, (ii) reduces cost associated with labour and supervision, (iii) has superior quality control through accurate and computerised control of ingredients of concrete, (iv) helps in minimising cement wastage, (v) is relatively pollution free, (vi) helps early completion of the project, (vii) ensures durability of concrete, (viii) helps in saving natural resources, and (ix) is an effective option for construction in a limited space.

On the other hand, RMC has some limitations also: (i) the transit time from the plant to the project site is a critical issue as concrete sets with time and cannot be used if concrete sets before pouring at site, (ii) agitator trucks generate additional road traffic, and (iii) the roads may become damaged due to the heavier load carried by the trucks. If a truck carries 9 cubic metres of concrete, the total weight of the truck would be about 30 tonnes. However, there are ways to minimise these problems. By using a chemical admixture, the setting time of cement can be prolonged. The roads can be designed considering the weight of agitator trucks. RMC can also be transferred by smaller trucks having carrying capacities of one to seven cubic metres of concrete. Considering the advantages of RMC over on-site mixing, RMC is popular worldwide. It can be noted that almost half of the total volume of concrete consumed globally is produced at RMC plants.

Discharging RMC through a chute

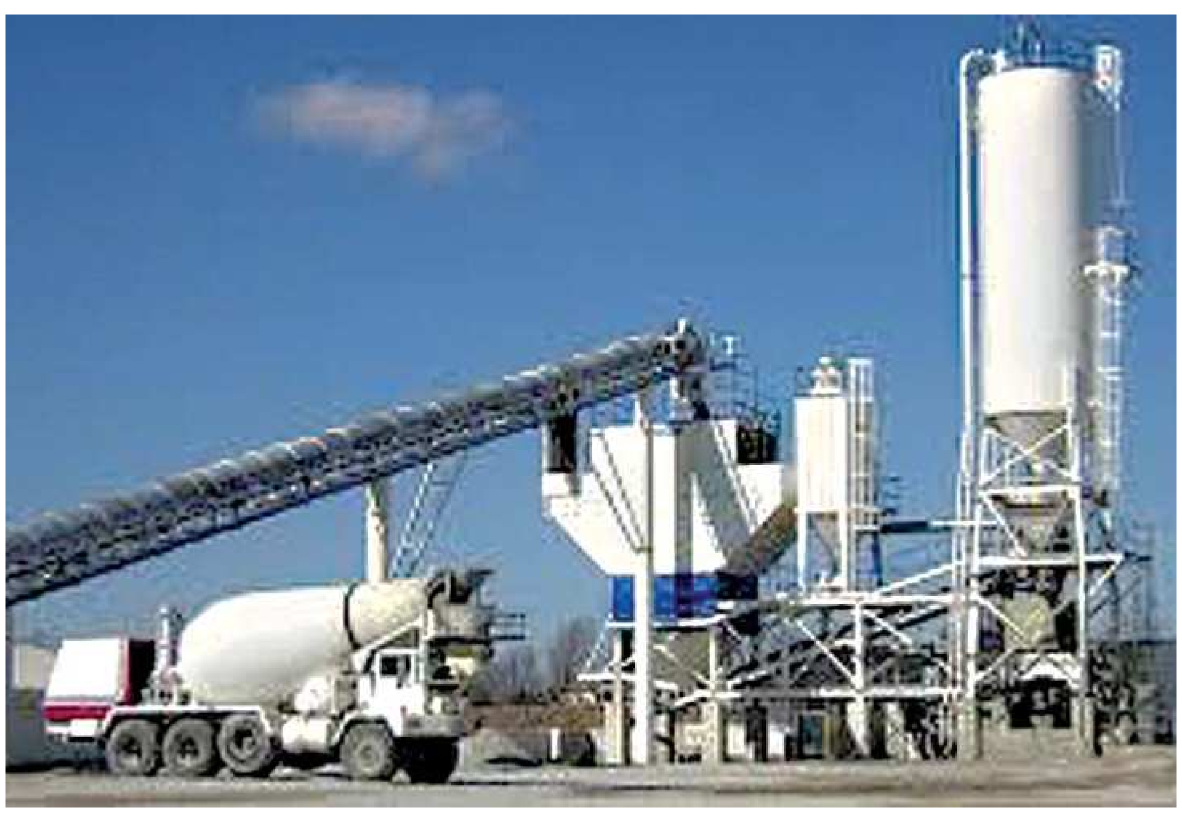
The ingredients of RMC are cement, coarse aggregate, fine aggregate, water, and chemical admixture. Under our cement standards, 27 kinds of cement are specified. CEM Type I is a purely clinker-based cement. In other types, a part of clinker is replaced by a mineral admixture, such as fly ash, slag, etc. Due to the slow rate of chemical reaction with water, the mineral based cements are better compared to the purely clinker cement. Mineral based cement delays setting and keeps concrete workable for a prolonged time. It also reduces heat accumulation in concrete due to slow reaction with water.

For mass concrete, mineral-based cement can be used. For high-strength concrete, a large quantity of cement is necessary and control of heat of this concrete is a great challenge. Mineral-based cement is effective for this case also. Mineral-based cement has many other advantages, such as long-term strength development, reduction in environmental pollution, long-term durability, and sustainability of construction materials. Some particular mineral admixture based cements, such as slag cement, have proven records in terms of strength development as well as long-term durability of concrete in harsh seawater environment. In harsh environments, it is also necessary to reduce permeability of concrete by limiting the amount of water in concrete.

Fine and coarse aggregates occupy 75 percent of the volume of concrete. Fine aggregate is locally available with different coarseness. Coarse sand reduces the demand of water due to the reduction of total surface area and eventually gives more strength. The fineness modulus (FM) of sand should be within the range 2.3 to 3.1. The grading and other properties of fine and coarse aggregate should satisfy ASTM C33. The aggregates should not contain over 5 percent clay and silt, should be free from salt, and should be inert. In general, 20 mm downgraded coarse aggregates are used in Bangladesh. If the quantity of smaller sized aggregates (below 12 mm) is low in aggregate, they are to be added separately to control proper grading. At least 30 percent of the total aggregate should be below 12 mm. The aggregate should be strong and should not contain a large quantity of flaky or elongated particles.

Our RMC plants import coarse aggregate from other countries. A problem related to reaction of coarse aggregate with cement was found in many countries (known as alkali-silica reaction (ASR)). Therefore, the possibility of ASR of aggregate is to be checked. Water that does not have unusual taste, odor, colour or turbidity and that is suitable for drinking can be used. Impurities in water may affect setting time, strength, and durability of concrete and also cause discoloration. The amount of chlorides, alkali carbonate and bicarbonate, and sulfates should be within the specified limits. The pH of water should be within six to eight.

As concrete is to be delivered from the plant to the project site, a chemical admixture having both water-reducing and retarding properties is to be used to keep concrete soft for a prolonged time. In a research study in Bangladesh, it was found that sulfonated naphthalene polymer-based chemical admixture and polycarboxylic ether-based chemical admixture have better performance compared to the other admixtures. The dosage of chemical admixture should not cross the specified maximum limit. The admixture should not cross the expiry date. The admixture should be agitated properly when it is added in the mixture plant. The solid portion of the admixture may settle at the bottom of the storage tank and if admixture is pumped from the top of the tank, the admixture will not work properly. Before RMC production, trial mixes are to be prepared to verify the strength requirement as well as slump retention. For proper quality control, it is necessary to record a Quality Control Data Sheet (QCDS) for each agitator truck covering mix design parameters, material properties, travel time, site location, workability at site and plant, strength of concrete, etc. Based on this data, statistical analysis can be carried out to set the target strength of the future RMC production against the design strength of concrete as per ACI 318. It will also build confidence of the team members of the RMC plant and will be a very useful document that can be used as reference, if there is a conflict with the client. RMC suppliers should discuss possible technical concerns and measures with the clients for successful completion of a project using RMC.



RMC Plant

Dr Md Tarek Uddin, PEng, *is Professor, Department of Civil and Environmental Engineering (CEE), Islamic University of Technology (IUT).*