Key Factors For Concrete Durability

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Hoover Dam outlets, built before WWII, are still in perfect condition, demonstrating the importance of sound site practice for concrete durability.

The two main reasons why concrete is the most abundantly used construction material are its durability and competitive pricing compared to other construction materials. Concrete's durability also leads to significant reductions in maintenance costs over its service life, says John Roxburgh, senior lecturer at Cement & Concrete SA's School of Concrete Technology.
"But there is still alarming ignorance about the fact that increased durability of concrete – and lower life-cycle costs - can often be achieved by following some simple rules," Roxburgh advises.

Although most concrete is inherently very durable, it can nevertheless be susceptible to chemical or mechanical attack or degradation. The mechanical and physical processes of deterioration could include abrasion, erosion, cavitation, and freezing. "The more common chemical processes that can cause deterioration in concrete are soft or pure water attack, acid attack, carbonation (along with the associated corrosion of steel reinforcement), sulfate attack, alkali-silica reaction, and the ingress of crystal-forming or corrosive salts. However, the corrosion of steel, and subsequent cracking and spalling of concrete caused by it, is the most common durability problem."

But Roxburgh feels these concrete deterioration issues can be prevented, or at least significantly reduced, by following three simple principles:

Firstly, the concrete mix should be designed for the specific environment in which the concrete will be used. For example, if the concrete is going to be placed in sulfate-bearing soil, the concrete mix design should be one that will mitigate sulfate attacks. Another precaution would be using heavily extended cement in the mix to reduce the risk of alkali-silica reaction.

Secondly, good on-site practice will optimize the durability of concrete. Good site practice in transporting, placing, compacting, curing correctly, and using concrete with suitable plastic properties will reduce the formation of cracks and voids and enhance the concrete strength, finish, and durability. Good site practice also involves the correct depth of concrete cover to protect the steel re-bars.

The final and probably most crucial principle to making concrete durable is to make it waterproof. Almost all durability problems associated with chemical deterioration of the concrete or steel, as well as mechanical damage such as freeze-thaw and salt-crystal jacking, can be prevented - or considerably slowed down - by making the concrete impervious to water, and a lesser extent, gas. "Water both transports chemicals into the concrete and facilitates chemical reactions in the concrete. By stopping or minimizing water ingress, potential deterioration is either stopped or reduced. Gases can contain chemicals with adverse effects. Of course, the first two of the above principles are intrinsically linked to making concrete waterproof," Roxburgh adds.

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Adhering to all the rules of good site practice is essential to ensure concrete durability, says CCSA.