Preservation of Capex Towards Industrial Cooling Towers

Awareness of capex preservation is increasing amongst asset owners. By using the latest developments in Protective Coating technologies, they are avoiding expensive Repair & Rehabilitation expenses, and thereby reducing the Life Cycle Cost of massive assets such as the Industrial Cooling Towers.

Anupam Shil, Head – SBU (Protective Coating), STP Limited

Industrial Cooling Towers are used to remove heat through evaporation of water in a moving air stream being carried from various sources such as a machinery or some heated process material. Their main use is to remove the heat absorbed in the circulating cooling water used in large processing units, such as power plants, refineries, petrochemical plants, steel plants, fertilizer and chemicals plants, etc. They serve to dissipate the heat into the atmosphere and air diffusion distributes the heat over a much larger area as compared to what hot water can distribute heat in a larger body of water.

Few coal-fired and nuclear power plants located in coastal areas make use of once-through sea water for cooling. In such a set-up, the discharge water outlet system requires very careful design to avoid environmental problems by causing disturbance in the aquatic life.

Based on the method adopted to circulate the air, cooling towers can be classified as:

1) Natural Draft Cooling Tower (mostly used in large power plants).

2) Induced Draft Cooling Tower, which can further be sub-divided into a variety of modified designs based on their intended utility.

The circulation rate of cooling water in a 700 MW coal-based power plant is typically about 71,600 cubic meters an hour and the circulating water requires a supply water make-up rate of approximately 5 percent (i.e., 3,600 cubic meters an hour). Most petroleum refineries also have very large cooling tower systems. A refinery processing 40,000 metric tons of crude oil per day (i.e., 3,00,000 barrels or 48,000 m^3 per day) circulates about 80,000 cubic meters of water per hour through its cooling tower system.

In fact, the world's tallest cooling tower 'Kalisindh Super Thermal Power Project' (KATPP) is at Jhalawar, Rajasthan. It is a 600 MW x 2 capacity unit encompassing two 202 meters (663 ft) tall cooling towers.

Such massive water handling requires equally expansive water containing concrete structures. A sizable capital expenditure budget is allocated towards these, as they are an inevitable part of the processing system. As prudent investors, it is important that preservation of these valuable assets is contemplated and effectively planned.

In the last few decades, accelerating consumerism and its demands on the construction sector has posed serious questions in terms of availability of high-quality raw materials, which are essential for a structure to have a long and dependable life. The limited natural resources cannot suffice for this rate of growth versus the rate of depreciation that has surfaced due to several nations growing together at a fast pace. Most of the construction materials that are being used today and consumed in enormous quantities, after completion of their service life do not remain by nature, recyclable; the finest example being Concrete. The speed at which depletion of these resources are taking place demands serious attention towards finding ways and techniques to mitigate this threat by implementing proactive solutions that can keep structures healthy and longer-lasting.

While at the time of construction, water is an essential element to initiate the process of hydration, once the construction is over, ingress of water into concrete results in these chemical changes within a structure that eventually results in its ageing.

1) *ASR (Alkali Silica Reaction)* – One of the most important chemical reactions that take place in an alkaline environment within the concrete with its fine or coarse aggregates is ASR. This results in conversion of the available amorphous silica to a gel form, which not only creates internal stresses within the structure due to volumetric expansion, but also acts as reservoirs due to its inherent tendency to absorb water.

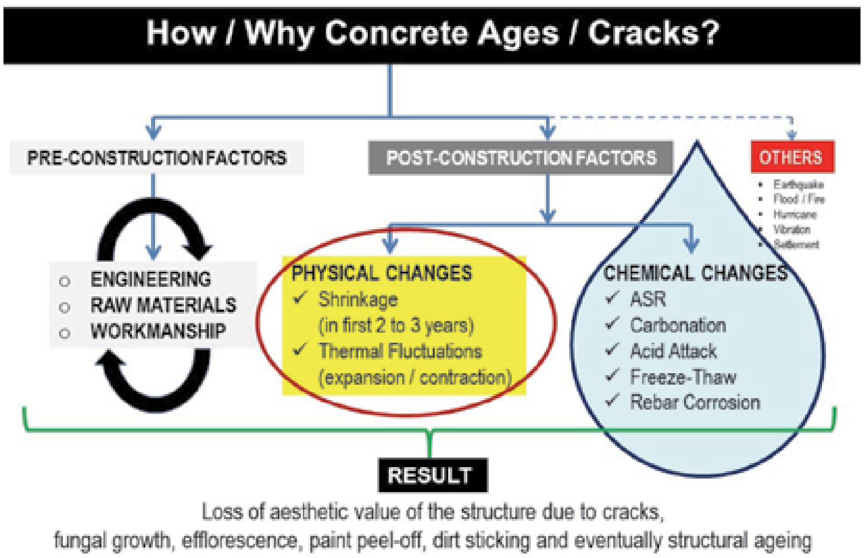
2) *Carbonation* – Sometimes also referred to as the corrosion of concrete, it is a chemical reaction occurring between calcium hydroxide present inside the cement (post hydration) with Carbonic acid (formed by reaction of atmospheric carbon with moisture/water). This results in formation of Calcium Carbonate (Chalk) and free water. Even though this transformation forms a compound that has significant compressive strength, it reduces the pH environment (state of passivity) within concrete, making the rebar more corrosion prone, while also transforming the crystalline structure of Ca $(OH)_2$ to amorphous $CaCO_3$.

3) *Acid Attack* – Increasing industrial emissions into the atmosphere contains a large reserve of SOx and NOx pollutants. These combine with atmospheric moisture (clouds) to form various acids like Sulphuric/Sulfurous acids, Nitric/ Nitrous acids, etc. During rains, these mild acids come down to start acid-alkali reactions within a cementitious body, thus resulting in breakdown of the crystalline lime within a concrete.

4) *Freeze-Thaw* – In colder regions, due to atmospheric temperature dropping to sub-zero levels, water trapped inside concrete expands while it freezes. This causes internal stresses and such repeated cycles cause cracking and eventually spalling of concrete chunks, thus, disintegrating the structure.

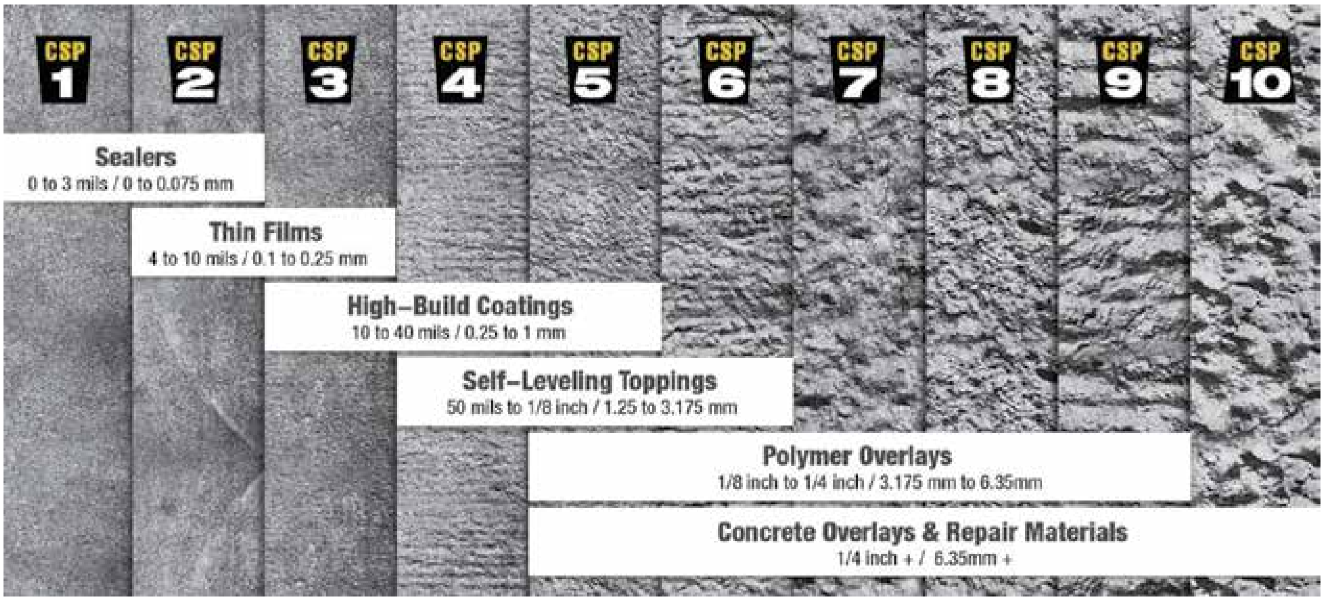
5) *Rebar Corrosion* – Water ingress into concrete acts as an electrolyte resulting in ionic exchange between Iron rebar and oxygen. This results in corrosion of the rebar, causing reduction in its tensile strength and at the same time generates internal stress due to swelling of the rebar.

This figure is a concise depiction of various forces which results in disintegration of a concrete structure with time.



A closer look will reveal that all the above five causes are mainly due to ingress of water/moisture through surface cracks and the labyrinth of micro pores and nano-capillaries within a concrete structure. Water, while it sustains life, also acts as the most destructive element that has the power to disintegrate a compound back to its elemental form. Due to this fact, application of Protective Coatings ensure that a civil structure remains waterproofed, has emerged over the years as a proven solution to enhance its useful service life. Thus, more dependable coating technologies are being adopted to protect concrete structures, starting from foundation to the rooftop.

We know that the presence of an electrolyte and potential difference between two connected zones through a metallic pathway causes loss of material at the anodic



location, and results in corrosion of metal. Similarly, ingress of water/moisture in cured concrete brings about several chemical changes causing its gradual disintegration. However, when it comes to protection of metals, much more extensive guidelines are being accepted and adopted globally like the ISO:12944 which provides painting system guidelines for corrosion protection of steel structures. Concrete, on the other hand, has been covered with surface preparation standards (by International Concrete Repair Institute); however, the industry yet awaits a universally accepted global standard, providing guidelines for surface coating of concrete structures.

Coating technologies have travelled from age-old bitumen to coal-tar to epoxies to polyurethanes. Coal tar mastic initially superseded in terms of performance against bitumen due to its resistance against soil bacteria and root infiltration, especially for underground applications. Eventually, the hybrid formulations, where coal tar base was used as epoxy resin filler in combination with phenalkamine hardeners, delivered high performance coaltar epoxy coatings at a much affordable price.

Then the chemistry of solvent-free formulations gave a new dimension to the protective coating technology by delivering coatings with extremely low micro-porosity. Thin aliphatic polyurethanes augmented well to all grades of epoxies by providing them good UV protection. And with the advent of 100% Solids, High-build, UV resistant PU coatings, preservation of critical concrete structures for decades has been conceptualized.

Last year, a thermal power plant in its expansion project at Tamil Nadu approved to protect the NDCT slanted raker columns with ShaliUrethane PC (2K Zero VOC UV Resistant Polyurethane Protective Tough Coating).

A gas-based power plant in Maharashtra approved to protect its more than a decade-old IDCT basin with ShaliUrethane PC (2K Zero VOC UV Resistant Polyurethane Protective Tough Coating); its concrete structures exposed to moisture and sunlight protected with ShaliPoxy HB (2K Protective Flexible Epoxy Coating); followed by a UV-resistant top coat of ShaliUrethane PU TC 2K (2K Aliphatic Polyurethane UV Resistant Top Coat).

Structural repairs of damaged concrete in such Repair & Rehabilitation projects are carried out using either ShaliFix EM (3K Epoxy Mortar) or ShaliFix FRM (Polymer Modified Fiber Reinforced Mortar) after applying compatible bonding primers like ShaliBond Concrete or ShaliSBRLatex. In case of spalled concrete exposing rebar sections, adequate treatment of rebars with ShaliPrime Zn R (2K Anti-Corrosive Zinc Rich Primer), after neutralizing with ShaliPrime RC (1K Water Based Rust Convertor), and refurbishment of spalled section with ShaliFix MC (High Performance Cementitious Repair Micro Concrete) is carried out.