Concrete Bridge Maintenance

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The durability of structural concrete bridges has become a serious problem, costing billions of dollars to various national economies, besides influencing the productivity, international competitiveness, and quality of life in those countries. India, for example, the Indian Railway network has 120,000 bridges as old as 140 years. Although these bridges are old, proper repair, rehabilitation and protection can extend their service lives for several years more.

Performance requirements for the system

Independent of the bridge deck waterproofing system choice, certain performance criteria have to be met in order to avoid potential concerns regarding leakage, poor bonding, and embitterment or softening of the membrane in service, such as:

- Impermeability to water under all conditions
- Good adhesion to deck and surfacing
- Capability of bridging shrinkage cracks in concrete
- Highly mechanical properties to handle traffic loads including shear forces in curves and during braking and accelerating
- Tolerant of deck texture and details
- Tough enough to withstand site damage and operations
- Safe to apply
- Ability to withstand elevated surface temperatures
- Can be applied over a wide range of ambient conditions
- Non-degradable

How to protect Bridges

There are several methods that can be used to rehabilitate reinforced concrete. When unprotected external reinforced concrete is placed in the environment, deterioration begins immediately. The main environmental factors which contribute to the deterioration of concrete are oxygen, water, carbon dioxide and chloride ion (salt). The damage to concrete may include:

- Carbonation of the concrete causing corrosion of the reinforcing steel
- Spalling due to corrosion of reinforcing steel
- Cracking caused by wetting and drying
- Rust Stains and other stains
- Salt penetration from marine rain causing salt erosion and spalling

Exclusion of The Factors of Corrosion from Concrete

The aim of repairing a bridge is to extend its life. Inappropriate repair action may actually reduce the life expectancy of the bridge. It is also possible that money spent on extensive and costly repair will not extend the life of the bridge significantly and would be better put towards a new bridge. In concrete structures, defects such as corrosion of reinforcement may not be apparent at the present time, but the effects may show up in the form of concrete cracking and spalling at a future date. It may not be appropriate to spend money on repairing some localized defects if much more extensive defects are likely to show up in the near future. Investigation by specialists into the complete structure may be warranted prior to undertaking costly repairs of concrete. It is possible using the science of building protection to effectively exclude water, chloride ion and carbon dioxide from new or old concrete so that deterioration does not proceed.

Impregnation

It is the process of applying a silane based compound on the concrete surface which penetrates into the substrate and polymerizes forming a permanent hydrophobic layer, for resisting penetration of water, chloride ions and other pollutants.

Anti-Carbonation

Carbon dioxide and carbonation can be specifically excluded by the practice of coating with an Anti-Carbonation Coating. This is a special coating produced to stop carbon dioxide diffusion through the coating into the concrete while allowing water vapour to pass through easily. This then stops carbonation of the concrete so the concrete remains alkaline enough around the steel to keep the steel protected from corrosion. For superior state of the art concrete protection, concrete structures should be impregnated to exclude water and chloride ion from the structure followed by the application of an anticarbonation coating to exclude carbon dioxide. This gives double protection against concrete corrosion.

Protective Coatings

Surface coatings are used on concrete structures to provide additional protection against ingress of water, water soluble salts and atmospheric gases. In addition they enhance the aesthetic appearance and help in hiding the patchy appearance of concrete that has been repaired in different places.

Basically there are two types of protective coatings:

- Film forming – relying on adhesion over concrete.
- Non-film forming – penetrate into concrete surface.

Generally, film-forming coatings are highly efficient against ingress of moisture, water-soluble salts (chlorides), gases and vapours (carbon dioxide). However build up of water vapour pressure behind them, especially if water is able to get into the concrete from another face, can cause the coating to blister and peel off unless the adhesion of the film to concrete is very good. Also, if the film lacks elasticity and fails to bridge over active cracks or subsequently formed shrinkage cracks, pollutants will find easy ingress into the concrete at the site of cracked coating and will eventually cause deterioration in concrete.