

BEST PRACTICE GUIDELINES FOR SELECTING CONCRETE BRIDGE DECK SEALERS

GENERAL

Penetrating sealers are used on highway Portland Cement Concrete bridge decks to reduce the rate of chloride attack on the reinforcing steel corrosion thereby extending service life and reducing life-cycle structure costs of the bridge deck (preventative maintenance).

By applying penetrating sealers to existing concrete surfaces, the permeability of the concrete is reduced by up to one order of magnitude. The permeability of the concrete is one of the most important factors which will effect the rate of deterioration of rebar corrosion, alkali-aggregate reaction, carbonation, and the effects of freeze-thaw cycles of which all could occur at the same time.

HISTORY

Concrete sealing has a long history in Alberta; in the 1960's boiled linseed oil was used for maintenance of existing bridge curbs. Epoxies and other types of sealers were also tried in the 60's. The first epoxy-wearing surface in Alberta was in 1963 at Morley. Dehydratine, a black tarry substance, was routinely used on abutments, since the late 1960's. Epoxy and acrylic sealers were routinely used on standard precast girders starting in the middle of 1970's. Penetrating Silane sealers were first used in Alberta on concrete bridge decks in 1986.

CONCRETE PROPERTIES

- Concrete is a conglomerate of sand and rock glued together by cement paste (hydrated cement – cement reacted with water to form calcium silicate chemical bonds).
- Concrete is a synergistic material; the whole has greater structural properties than the sum of the individual parts.
 - Cement – raw materials
 - limestone
 - iron ore
 - sand
 - clay or shale

- Composition of Concrete
 - aggregates (coarse and fine)
 - cement
 - water
 - voids (connected and isolated)
 - supplementary cementing materials (fly ash and silica fume)
 - admixtures (air entraining, water reducers, superplasticizers, retarders, etc.)

- Why Concrete Deteriorates
 - permeability to moisture, chlorides, gases
 - lack of properly entrained air
 - exposure conditions

- Durability of Concrete
 - cement content
 - quality of aggregates
 - exposure conditions
 - surface finish
 - rebar cover depth
 - weather conditions at time of placement
 - mix design
 - mixing equipment and procedure

- Deterioration of Concrete
 - freeze-thaw damage (internal)
 - alkali aggregate reaction AAR (internal)
 - salt scaling (surface)
 - aggregate popouts
 - abrasion damage (surface)
 - spalling (potholes)
 - rebar corrosion

INTRODUCTION TO SEALERS

The department generally seals bridges on a 4-year cycle (this cycle could vary from region to region). In the 1960's boiled linseed oils mixed with 50% kerosene were used to seal decks and curbs which offered minimal protection to the concrete. We now use penetrating sealers and coatings, which offer better protection against the ingress of de-icing salts.

Sealers are applied on concrete bridge decks:

- To reduce the permeability of the concrete, preventing moisture and road salts from being absorbed into the concrete slab.
- To prevent water leakage into the space below through cracks or joints.

For sealers to be effective they require the following performance properties:

- ability to seal previously sealed surfaces
- waterproofing ability
- breathability
- chemical resistance
- resistance to ultra-violet rays
- penetration
- skid resistance
- low toxicity
- volatility
- freeze-thaw/salt scaling resistance

TYPES OF SEALERS

Concrete sealers work in two ways. First they prevent the absorption of chloride ions. Depending upon the exposure condition of the unprotected deck, the average internal moisture is about 50 to 80 percent of the saturation level. Secondly, they allow the progressive internal drying of concrete to a 30 to 40 percent level by reducing the rate of moisture gain from the environment. The most important property the sealer must have is that it must protect the concrete and at the same time it must be breathable.

Types of concrete surface sealing products:

- Penetrating Sealers

Penetrating sealers are products that are absorbed into the surface of the concrete and react with the concrete to form a hydrophobic (or water repelling) surface. No film is formed; therefore pores in the concrete are not blocked.

- Coatings

Coatings (coloured or clear) are products that bond to the surface of the concrete and form a film. The waterproofing properties of the coating are generally independent of the concrete properties, although the coating must remain adhered to the concrete for the coating to function.

ALBERTA TRANSPORTATION'S SEALER CLASSIFICATION AND PERFORMANCE REQUIREMENTS

There are three types of sealers on the Alberta Transportation approval list and each type of sealer has a specific application and use.

Type 1 Sealer, Penetrating

- Type 1a
Penetrating silane sealers are used in sheltered areas, and where the relative humidity of the concrete is less than 55%. The solids content typical range for Type 1a sealer is 14% to 32%. These sealers are applied on concrete surfaces that are 28 days or older.
- Type 1b
Penetrating silane sealers used in traffic bearing areas are for outdoor use. The relative humidity of the concrete is 75% or less. The application rate is usually higher than the Type 1a for the same brand of sealer. These sealers are generally called 40% silane sealer, which has a solids content range of 25% to 33%. These sealers are used on concrete decks that are cured for 28 days or older.
- Type 1c
Penetrating sealer that is considered a 100% silane sealer. The solids content of this sealer range from 65% to 72%. The relative humidity of the concrete is 85% or less. This type of sealer is used on precast concrete that is steam cured for 1 to 5 days (28-day preferable) before application.

Type 2 Sealer, Clear Coating

- Type 2a
Is a one component clear coating type sealer that is used on curbs. Depending upon the type of sealer that was first applied, using a different product of the sealer type may not be compatible and may react and debond. These sealers are used on concrete that are cured for 28 days or older.
- Type 2b
Is a two component clear coating type sealer (epoxy) that is also used on curbs. These sealers are generally mixed at a ratio of 1 to 1, any miss batching will result in the sealer not setting up. If the pot life of these sealers is exceeded, the sealer will become stringy. In special cases of badly scaled decks, we seal these decks with a Type 1b sealer followed by a Type 2b sealer for optimum protection. Check for compatibility of the products used. These sealers are used on concrete that are cured for 28 days or older.

Type 3 Sealer, Pigmented Coating

- Type 3
These are pigmented sealers used for coating areas that are exposed to the public, covers graffiti and offers good esthetics. These sealers are used on concrete that are cured for 28 days or older.

APPLICATION OF SEALERS

Prior to sealing the concrete deck, the Contractor shall:

- Have the deck cleaned by washing, power sweeping and whatever method the contractor chooses to remove all dirt, sand, clay and other debris from the deck. The department's Best Practice is to clean the deck one week in advance of sealer application, thereby reducing the need for further cleaning as a result of tracked on dirt and contaminants. To meet environmental constraints, schedule the deck washing program in conjunction with the deck sealing program. Shotblasting and or sandblasting are not required.
- Before the sealer is applied, the deck must be allowed to dry and this may take 1 to 3 days depending upon weather conditions, air temperature, sunshine, last rainfall, type of concrete surface, porosity of the concrete and relative humidity in the air. In order to obtain maximum waterproofing in the concrete, the deck has to be very dry before application of sealer.
- Contractor should be experienced and able to recognize conditions that do not warrant application. Common sense must be used.
- The coverage rate of the sealer needs to be calculated depending on the type of sealer used. The Approved Products List indicates the minimum application rate for each product under ideal conditions. For best results the application rate as indicated on the sealer product should be increased by 30% to allow for variable concrete condition.
- Check for compatibility of the products on previously sealed concrete surfaces.
- The method of application could be by garden sprayer or airless sprayers.
- Silane sealer should be kept in airtight drums and should be stirred to mix the active ingredient prior to use. Product to be used within the manufacturer's specified shelf life.

TESTING SEALERS (QUALITY CONTROL)

- Prior to application, the Contractor shall sample the sealers to be used and submit the samples to a lab for testing. The tests should include solids content, infrared spectrographic analysis and gas chromatography analysis. Compare the results to the sealer attributes as originally approved. Only use products that are identical to those approved.

- To determine the effectiveness of the sealed concrete, in-situ waterproofing performance of the sealed concrete surface can be measured when tested in accordance with test method BT005 – Alberta Test Procedure for Measuring the Waterproofing Performance of Core Samples taken from Sealed Concrete Surfaces.
- All sealer products must meet the latest requirements of the Specification for the Supply of Concrete Sealers (B388).
- Quality assurance samples should be taken for each lot of material applied. Quality assurance samples should then be submitted to the owner's representative for testing as specified in Specification B388.

APPROVED SEALER PRODUCTS

An up-to-date Bridge Concrete Sealer Approved Products List for sealers named below is available at

<http://www.transportation.alberta.ca/Content/docType253/Production/BRSEALERS.pdf>

Type 1a
Type 1b
Type 1c
Type 2a
Type 2b
Type 3

The Best Practice Guidelines for Bridge Coatings is only intended as a guide for selecting sealer type. The department assumes no responsibility for errors or omissions, and will not accept liability of any nature whatsoever that may be suffered by others using this information.

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