12. CORROSION MITIGATION MEASURES

The following section provides some useful information regarding corrosion mitigation measures for structural elements. As previously mentioned, Department guidelines such as the ***California Amendments (to the AASHTO LRFD Bridge Design Specifications - Eighth Edition)***, **Bridge** ***Memo to Designers***, ***Standard Specifications***, ***Special Provisions***, and the ***Highway Design Manual*** have been developed to cover these topics. The purpose of the information provided in this section is to provide additional background information regarding corrosion mitigation in addition to the listed Department guidelines.

12.1 Corrosion Mitigation Measures for Reinforced Concrete

Uncontaminated, high quality concrete normally provides excellent corrosion protection for reinforcing steel. The high pH environment, greater than 12.5, of the concrete keeps the reinforcing steel in a non-active corrosion state. Intrusion of chlorides into the concrete through contact with chloride-contaminated soil, water, or marine atmosphere, however, may lead to corrosion of the embedded reinforcing steel.

Contact of the concrete with soil or water containing sulfates can, over time, cause deterioration, increased porosity, and decreased pH of the concrete. In addition to the obvious loss of integrity of the concrete, this degradation may also lead to accelerated corrosion of the reinforcing steel.

Corrosion protection of reinforced concrete is required in accordance with ***Section 5 Concrete Structures*** of ***California Amendments (to the AASHTO LRFD Bridge Design Specifications)*** most current edition (see References). ***Table 5.10.1-1 Minimum Concrete Cover to Reinforcement (in.) for 75-year Design Life*** specifies the use of increased clear concrete cover over the reinforcing steel, corrosion resistant concrete mix designs, reduced water to binder ratio as well as reinforcement coatings (***Authorized Material Lists***) and stainless steel for corrosion protection of reinforced concrete exposed to chloride environments. This document also provides mitigation measures to protect against corrosion due to acids or sulfates.

Section 90-1.02H Concrete in Corrosive Environments of the ***Standard Specifications*** provides specification language for corrosion resistant concrete mix designs that address corrosive conditions specified in ***Section 5 Concrete Structures California Amendments*** above.

Concrete mixes used by the Department to mitigate chlorides are based on the diffusion rate of chlorides using Fick's Second Law of Diffusion. Dense concrete mixes that are less permeable slow the diffusion of chlorides through concrete. Therefore, the time for chlorides in the soil or water to reach the reinforcing steel

is increased. It is desirable to slow the rate of chloride diffusion in reinforced concrete because high chloride contents at the level of the reinforcing steel will cause the reinforcing steel to corrode.

The use of supplementary cementitious materials (such as fly ash, granulated blast-furnace slag (GGBS), silica fume, metakaolin, etc.), reduced water content and increased cementitious material content result in high-density, durable concrete. Additional thickness of clear cover over the reinforcing steel also increases the time it takes for chlorides to reach the level of the reinforcement. ***Bridge Memo to Designers 3-1*** and ***10-5*** (see References) provides additional guidance regarding protection against corrosion for reinforced concrete due to chlorides, sulfates, and acids.

12.2 Dampproofing and Waterproofing

When a coating is required to minimize exposure of concrete, reinforced concrete, or metal surfaces to moisture, dampproofing or waterproofing should be considered. ***Standard Specification 54 Waterproofing*** describes both methods in detail. Dampproofing and waterproofing may be considered for a concrete surface or for a column retrofit when a steel shell is used. Generally, corrosion can occur where the soil is in contact with the surface to be protected; therefore, it may only be necessary to treat those surfaces in contact with soil. Dampproofing and waterproofing may also be considered for protecting concrete surfaces exposed to highly acidic soil and/or water. These treatments may also be used as mitigation measures to protect RCP from stray current by coating the inside and outside of the pipe.

Dampproofing requires the concrete surface to be cleaned and coated with a primer, then mopped with two coats of waterproofing asphalt. Waterproofing is similar to dampproofing, but provides even more corrosion protection. In addition to cleaning and treating with a primer, two layers of saturated glass fabric membrane and three mop applications of waterproofing asphalt are required for concrete structures.

Because of air quality restrictions in some geographical regions solvent-based primer specified in ASTM D41/41M Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing, may not be allowed. When the ASTM D41/41M primer cannot be used, slow curing emulsion alternatives SS1h or CSS1h, specified in Section 94 of the ***Standard Specifications***, may be used (verify Volatile Organic Content (VOC) with approval of the local air quality pollution control board.