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TO: All Bridge Designers

FROM: A. J. Siccardi

SUBJECT: Technical Memorandum #1
Concrete Properties Related General Information

The following information is provided as data for your information and use as needed in a given situation. It is not intended to be a thorough or complete treatise; rather, merely "back to basics" knowledge which may be of value in the understanding of problems that are encountered in the design and construction of concrete bridges.

Concrete Durability is defined by ACI as that property which provides resistance to weathering action, chemical attack, and abrasion resistance. It is often deemed equivalent to concrete strength; however, such an equivalency is not necessarily certain.

1. Weathering Action: Primarily relates to the durability of the concrete to resist freeze - thaw cycles. In a qualitative sense, for a given water/cement ratio air-entrained concrete will provide greater durability than will non-air entrained concrete. As a general statement and in all instances, fly ash mixtures have a greater freeze/thaw resistance at equivalent strengths.

2. Chemical Attack: Primarily relates to the durability of the concrete to resist:

   (a) Sulfate Severity - The cement chemistry is very important especially the C3A and C4AF elements. The porosity of the concrete is also important, of course, and again the lower the water/cement ratio, the more dense and less porous is the concrete.

(b) Alkali-Aggregate Reaction - Where reactive aggregate is known to be present replacement of cement with fly-ash in amounts up to 20% have proven useful in reducing the percent expansion of the concrete and thus the alkali-aggregate reaction. Based on 4 year samples studied by the Bureau of Reclamation, a 20% replacement has been shown to reduce the expected percent expansion by as much as 400%.

(c) Corrosion - This action is an indirect deleterious effect of chemical attack. Each of you is intimately aware of the effects of corrosion on bridge decks. Good quality control procedures is probably the most effective countermeasure to corrosion. This means a minimum cover of 1-1/2". To assure this cover, statistical evaluation of actual in-place construction, suggests a nominal cover of at least 1-3/4" is necessary from the top of deck to the nearest reinforcement. It is important to make every attempt to minimize cracking in the concrete which is done by minimizing the water/cement ratio, avoiding over finishing during the construction process, and using good curing practices.

(d) Abrasion Resistance - The Bureau of Reclamation suggests the two most important factors are the use of a low water/cement ratio and the use of the largest aggregate possible in the environment. Abrasion resistance, measured by the depth of wear of the concrete surface, increases as the concrete strength increases. As an example, for a concrete strength at the time of testing of 5000 psi, wear of 0.1 inches can be expected whereas 3000 psi concrete of the same consistency will wear about twice as much or about 0.2".

Concrete Sealing may have merit for certain uses. In general, sealers are of two basic types,

(a) Penetrating Sealers - Silanes or siloxanes which can provide nominal resistance to moisture penetration into the concrete. Whenever a sealer is deemed necessary, it shall be this type.

(b) Surface Sealers - Urethanes, epoxies, and other polymer materials. These types of sealers are very short-lived and are not considered to have any short range or lasting resistance to moisture penetration.