Chapter 2
Overlay Design Process

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Abstract Bonded concrete overlays have been used for nearly 100 year to extend the life of pavements, concrete slabs, bridge decks or other structural slabs. First, this chapter describes material selection, for slabs on grade and pavements; joints; and construction procedures including steel placement, environmental effects, and curing. Secondly, the bonded concrete overlay (BCO) process is described: the steps required in project selection; design of the BCO; construction, and quality assurance with flow charts included to provide a graphical overview.

2.1 Purpose of Overlays

Bonded concrete overlays (BCOs) have been used since 1909. The primary purpose of overlays is to extend the life of a concrete slab or pavement, bridge deck or other structural slab. It has been shown [1, 2] that as the remaining life of a pavement decreases due to distress, e.g. cracking, spalling or punchouts, the life can be extended significantly by the use of a bonded concrete overlay. For a slab or pavement in good condition, a 25% increase in thickness can nearly double the stiffness, resulting in nearly a 50% reduction in flexural stress.

Other reasons foroverlaying concrete pavements or slabs include:

- provide an improved frictional surface for pavements or bridges;
- provide a smooth surface for industrial floors or buildings;
- increase the elevation of the top surface to match an adjacent slab;
- provide a more durable wearing surface;

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• repair corrosion-damaged slabs or bridge decks with sound, durable concrete; and
• provide architectural features such as color or texture.

2.2 Materials Selection

2.2.1 Slabs on Grade/Pavements

2.2.1.1 Concrete

The cement content of the BCO concrete must be high enough to ensure that the available paste is sufficient to achieve bond at the interface, which eliminates the need for a bonding agent, and to meet strength and permeability requirements. Reduced paste requirements may be met by using well-graded aggregates. Some specifications mandate minimum cement content, e.g. 390 kg/m³ for normal overlay concrete and 490 kg/m³ for dense overlay concrete. Lower levels of cement are desirable to reduce cost, reduce heat of hydration and reduce shrinkage. Reduced cost and reduced heat of hydration may also be accomplished by using fly ash as cement replacement; the addition of fly ash also has the advantages of improving durability and, in many cases, ultimate strength.

The water-cement ratio is determined by strength and durability (permeability) requirements. Generally, a water-cement ratio of 0.40 will provide good durability and strength. One specification requires a water-cement ratio of 0.40 for normal overlay concrete and 0.32 for dense overlay concrete.

Aggregates should be selected for workability; aggregates should also have adequate durability for the intended application. The paste requirement may be reduced by improving overall aggregate gradation as suggested by Shilstone [3, 4] and Crouch [5]. Shilstone suggests incorporating an intermediate aggregate, and this may be particularly helpful when using steel fibers.

Admixtures will often include air entraining agent, which will help workability and improve freezing and thawing resistance. The use of fly ash may require greater dosages of air entraining agent to achieve the same percentage of entrained air. High range water reducers are often specified, and the amount should be based on trial batches. The addition or retarders in hot weather helps to preserve workability until the concrete can be placed and finished without affecting strength development.

2.2.1.2 Reinforcement

Steel reinforcing and steel and synthetic fibers have been used as reinforcement. Steel reinforcing has been used in the form of tied bars and welded mats.