

fore, the subgrade, should be sloped for proper drainage. In winter, remove snow and ice prior to placing concrete, and do not place concrete on a frozen subgrade. Smooth, level subgrades help prevent cracking. All formwork must be constructed and braced, so that it can withstand the pressure of the concrete without movement. Vapor retarders directly under a concrete slab increase bleeding and the potential for cracking, especially with high-slump concrete. When a vapor retarder is used, cover it with 3 to 4 inches of a compactible granular fill, such as a crusher-run material to reduce bleeding. Prior to concrete placement, lightly dampen the subgrade, formwork, and the reinforcement if severe drying conditions exist.

- b. *Concrete.* In general, use concrete with a moderate slump (not over 5 inches [125 mm]). Avoid retempering concrete to increase slump prior to placement. Higher slump (up to 6 or 7 inches [150 to 175 mm]) can be used, provided the mixture is designed to produce the required strength, without excessive bleeding and/or segregation. This is, generally accomplished by using water-reducing admixtures. Specify air-entrained concrete for outdoor slabs subjected to freezing weather. (See CIP 2)
- c. *Finishing.* Initial screeding must be promptly followed by bull floating. DO NOT perform finishing operations with water present on the surface or before the concrete has completed bleeding. Don't overwork or over-finish the surface. For better traction on exterior surfaces use a broom finish. When ambient conditions are conducive to a high evaporation rate, use means to avoid rapid drying and associated plastic shrinkage cracking by using wind breaks, fog sprays, and covering the concrete with wet burlap or polyethylene sheets between finishing operations.
- d. *Curing.* Curing is an important step to ensure durable crack-resistant concrete. Start curing as soon as possible. Spray the surface with liquid membrane

curing compound or cover it with damp burlap and keep it moist for at least 3 days. A second application of curing compound the next day is a good quality assurance step.

- e. *Joints.* Anticipated volumetric changes due to temperature and/or moisture should be accommodated by the construction of contraction joints by sawing, forming or tooling a groove about $\frac{1}{4}$ to $\frac{1}{3}$ the thickness of the slab, with a spacing between 24 to 36 times the thickness. Tooled and saw-cut joints should be run at the proper time (CIP 6). A maximum 15 feet spacing for contraction joints is often recommended. Panels between joints should be square and the length should not exceed about 1.5 times the width. Isolation joints should be provided whenever restriction to freedom of either vertical or horizontal movement is anticipated—such as where floors meet walls, columns, or footings. These are full-depth joints and are constructed by inserting a barrier of some type to prevent bond between the slab and the other elements.
- f. *Cover Over Reinforcement.* Providing sufficient concrete cover (at least 2 inches [50 mm]) to keep salt and moisture from contacting the steel should prevent cracks in reinforced concrete caused by expansion of rust on reinforcing steel.

References

- 1. *Control of Cracking in Concrete Structures*, ACI 224R, American Concrete Institute, Farmington Hills, MI.
 - 2. *Guide for Concrete Floor and Slab Construction*, ACI 302.1R, American Concrete Institute, Farmington Hills, MI.
 - 3. *Concrete Slab Surface Defects: Causes, Prevention, Repair*, IS177, Portland Cement Association, Skokie, IL.
 - 4. Grant T. Halvorson, *Troubleshooting Concrete Cracking During Construction*, Concrete Construction, October 1993.
 - 5. *Cracks in Concrete: Causes, Prevention, Repair*, A collection of articles from Concrete Construction Magazine, June 1973.
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Follow These Rules to Minimize Cracking

- 1. Design the members to handle all anticipated loads.
- 2. Provide proper contraction and isolation joints.
- 3. In slab on grade work, prepare a stable subgrade.
- 4. Place and finish according to recommended and established practices.
- 5. Protect and cure the concrete properly.