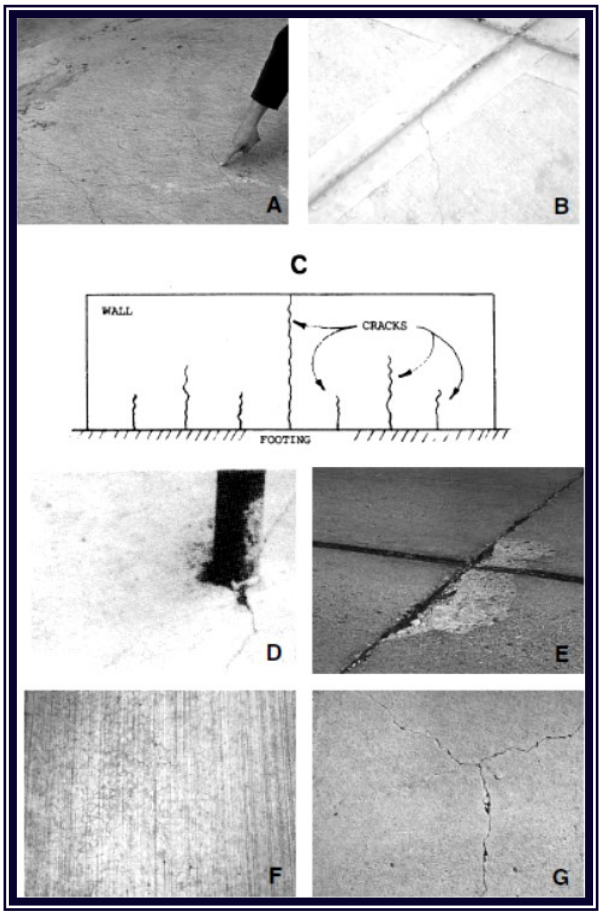
Concrete Tech Tip # 4

Cracking Concrete Surfaces

1. WHAT is Cracking?

Concrete, like other construction materials, contracts and expands with changes in moisture content and temperature and deflects depending on load and support conditions. When provisions for these movements are not made in design and construction, cracks can occur. Some forms of common cracks are:

Figure A - Plastic Shrinkage Cracking (See CTT-5)
Figure B - Cracks Due to Improper Jointing (See CTT-6)
Figure C - Cracks Due to Continuous External Restraint
(e.g.: - Cast in place wall restrained along bottom edge of footing)
Figure D - Basement Floor Cracks (See CTT-6)
Figure E - D-Cracks from Freezing and Thawing
Figure F - Craze Cracks (See CTT-3)
Figure G - Settlement Cracks



Cracks rarely affect structural integrity. Most random individual cracks look bad and, although they permit entrance of water, they do not lead to progressive deterioration. They are simply unsightly. Closely spaced pattern cracks or D-cracks due to freezing and thawing are an exception and may lead to ultimate deterioration.

2. WHY Do Concrete Surfaces Crack?

The majority of concrete cracks usually occur due to improper design and construction practices, such as:

A) Omission of isolation and control joints and improper jointing practices.
B) Improper subgrade preparation.
C) The use of high slump concrete or addition of water on the job.
D) Improper finishing.
E) Inadequate or no curing.

3. HOW to Prevent or Minimize Cracking?

All concrete has a tendency to crack and it is not possible to consistently produce completely crack-free concrete. However, cracking can be reduced and controlled if the following basic safeguards are observed

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References

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Reviewed & Revised 2016

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A) **Subgrade and Formwork**. All top soil and soft spots should be removed. Regardless of its type, the soil beneath the slab should be well compacted by rolling, vibrating or tamping. The slab and, therefore the subgrade, should be sloped for proper drainage. Smooth, level sub grades help prevent cracking. All formwork must be constructed and braced so that it can withstand the pressure of the concrete without movement. Polyethylene vapor barriers can increase bleeding and greatly increase cracking of high slump concrete. In these circumstances, when possible, reduce the water content of the mix to reduce bleeding. In the absence of vapour barriers or retarders, immediately prior to concrete placement, dampen the subgrade, formwork, and the reinforcement.

B) **Concrete**. In general, use concrete with a moderate slump (not over 100 mm). Avoid retempering. If a higher slump is to be used, proportions will have to be changed and special mixtures developed to avoid excessive bleeding, segregation and low strength. Specify air-entrained concrete for outdoor slabs subjected to freezing weather. (See CTT-2)

C) **Finishing**. DO NOT perform finishing operations with water present on the surface. Initial screeding must be promptly followed by bull floating. For better traction on exterior surfaces, use a broom finish.

If evaporation is excessive, reduce it by an appropriate means to avoid plastic shrinkage cracking. Cover the concrete with wet burlap or polyethylene sheets or use a monomolecular film in between finishing operations, if conditions are severe.

D) **Curing.** Start curing as soon as possible. Spray the surface with liquid membrane curing compound or if moist curing, cover it with a non-woven geotextile and polyethylene sheets and keep it moist for at least 3 days at a minimum temperature of 10^{o}C. Follow the manufacturer's recommendations for application rate of curing compounds.

E) **Joints.** Provisions for contraction or expansion movements, due to temperature and/or moisture change, should be provided with construction of contraction joints by sawing, forming or tooling a groove about ¼ to ⅓ the thickness of the slab, no further apart than 25 times the thickness. Often closer spacing of control joints will be necessary to avoid long thin areas. The length of an area 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**. Cracks in reinforced concrete caused by expansion of rust on reinforcing steel should be prevented by providing sufficient concrete cover (at least 50mm) to keep salt and moisture from contacting the steel.

Follow These Rules to Minimize Cracking

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

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