CONCRETE SASK

**TECH TIP #3**

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# CRACKING CONCRETE SURFACES

## WHAT are some forms of cracks?

Concrete, like other construction materials contracts and expands with changes in moisture content and temperature and deflects depending on load and support conditions. Cracks can occur when provisions for these movements are not made in design and construction.

Some forms of common cracks are:

- Plastic Shrinkage Cracking Cracks Due to Improper Jointing
- Cracks Due to Continuous External Restraint (e.g.: Cast in place wall restrained along bottom edge of footing)
- Basement Floor Cracks
- D-Cracks from Freezing and Thawing
- Craze Cracks
- Settlement Cracks

Most random cracks that appear at an early age, although unsightly, rarely affect structural integrity or the service life of concrete. 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.

Two exceptions are:

- D-cracks, which occur due to freeze-than deterioration of some types of porous aggregates in concrete. These cracks initiate at joints at the bottom of exterior slabs and typically appear at later ages.

- Cracking due to alkali-aggregate reactions (AAR) will lead to long term structural damage.

## WHY does concrete crack?

Most concrete cracking usually occurs due to improper design and construction practices, such as:

- Omission of isolation and control joints and improper jointing practices.
- Improper subgrade preparation.
- The use of high slump concrete or excessive addition of water on the job.
- Improper finishing.
- Rapid loss of moisture from newly placed concrete in dry conditions
- Inadequate or no curing.

## HOW to prevent or minimize cracking?

All concrete tends to crack and is not possible to produce completely crack-free concrete. However, cracking can be reduced and controlled if the following basic concrete practices are followed:

- **Subgrade**: All topsoil and soft spots should be removed. Regardless of its type, the subgrade soil and granular base beneath the slab should be well compacted by rolling, vibrating or tamping. The slab, and therefore, the subgrade and granular base, should be sloped for proper drainage. Smooth, level subgrades and granular base help prevent cracking. Vapour barriers under a concrete slab increase bleeding and greatly increase the potential for cracking, especially with high slump concrete. When it is required to place concrete directly on a polyethylene vapour barrier, take special care to ensure that finishing operations are performed after all bleed water has dissipated from the surface. In dry conditions, lightly dampen the subgrade or granular base, formwork and reinforcement immediately prior to concrete placement. In winter, remove all snow and ice before placing concrete. Do not place concrete on frozen ground. Proper, heated enclosures are required for any winter concrete.
- **Formwork**: All formworks must be constructed and braced so that it can withstand the pressure of the concrete without movement. Polyethylene vapour barriers increase bleeding and greatly increase cracking of high slump concrete. Cover the vapour barrier with 25 to 50mm of damp sand to reduce bleeding.
- **Concrete**: In general, use concrete with a moderate slump not exceeding 125mm. Higher slumps can be used provided is designed to produce the required strength without excessive bleeding and/or segregation. This is generally accomplished using slump modifying admixtures. Use air-entrained concrete for exterior slabs exposed to freezing weather. Concrete mixtures can be designed for reduced shrinkage to minimize cracking.
- **Finishing**: Initial screeding must be promptly followed by bull floating. **DO NOT** perform subsequent finishing operations with water present on the surface or before the concrete has completed bleeding. Do not 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.
- **Curing**: Curing is an important step to ensure durable crack-resistant concrete. Start curing as soon as possible. Cover the concrete with wet burlap or curing blankets and keep moist most for at least 3 days. Liquid membrane curing compounds can also be used. A second application of curing compound the following day is a good quality assurance step. Use of any curing compound should follow the manufacturer's instructions.
- **Joints**: Anticipated volume changes due to temperature and/or moisture should be accommodated by contraction joints saw-cut or tooled at the proper time to a depth of approximately ¼ to ⅓ the thickness of the slab, and with a spacing of 24 to 36 times the slab thickness. A maximum spacing of 4.6m (15') for

contraction joints is often recommended. Panels between joints should be square and the length should not exceed 1.5 times the width. Isolations joints to the full thickness of the slab should be provided whenever restriction to freedom of either vertical or horizontal movement is anticipated such as where floors meet walls, columns or footings.

- **Reinforcement:** Wire mesh and reinforcement in slabs cannot prevent cracking. Reinforcement can reduce crack width when placed at the proper location. Providing sufficient concrete cover (at least 50mm) to keep salts and moisture from contacting the steel should prevent cracks in reinforced concrete caused by expansion of rust on reinforcing steel.

## Follow these rules to minimize cracking

- Design the members to handle all anticipated loads.
- Provide proper contraction and isolation joints.
- Slab-on-grade work requires a properly prepared, stable, uniformly compacted subgrade and granular base.
- Place and finish according to recommended and established practices.
- Protect and cure the concrete properly.

References:

*1. Guide for Concrete Floor and Slab Construction, ACI 302.1R, American Concrete Institute, Farmington Hills, MI.*
*2. Concrete Slab Surface Defects: Causes, Prevention, Repair, IS 177T, Portland Cement Association, Skokie, IL*
*3. Control of Cracking in Concrete Structures, ACI 224R, American Concrete Institute, Farmington Hills, MI.*
*4. Grant T. Halvorsen, Troubleshooting Concrete Cracking During Construction, October 1993.*
*5. CIP 4: Cracking Concrete Surfaces, National Ready-Mixed Concrete Association*
*6. CAN CSA A23.1-24/A23.2-24*