BLISTERING
Small bumps in the surface of flatwork that appear in the finishing operation.

CAUSES
- Blisters are caused by air and/or water trapped under the surface concrete.
- Premature or improper finishing is the leading cause of blisters.
- The action of troweling tends to move water and air bubbles trapped under a sealed surface together.
- Dry and windy conditions will cause the surface to dry out and crust over.

PREVENTION
- Avoid premature closing of the surface of the concrete, use wood or magnesium floats on the first pass.
- Avoid overworking the surface with bullfloats, jitterbugs, and screeds.
- Use proper vibration and compaction techniques.
- Beware of concrete placed directly over plastic film, place a sand layer above the film.
- Fog sprays or evaporation-retardant films will facilitate finishing in dry and windy conditions.
- Refloating with a wood float can reduce blisters from concrete that was prematurely closed.
- Avoid concrete with excessive air contents and fines for hard troweled finishes.

SCALING
When the surface of a hardened concrete breaks away to a depth of 1.5 mm to 5 mm. This generally occurs within the first year of placement.

CAUSES
- Freezing and thawing of the water in porous, non-air-entrained concrete.
- De-icing salts, especially those containing ammonium sulfate or nitrate.
- Faulty workmanship.
- Excessive and early drying out of the mortar.

PREVENTION
- Use air-entrained concrete; cure properly.
- Avoid the use of de-icing salts in the first winter.
- Delay finishing operations until all free water has evaporated or been removed. Never use dry cement as a "mop coat."
- Avoid overworking the surface; a broom finish is recommended on exterior work.
- Allow a minimum of 30 days for the concrete to cure before it is exposed to freezing.
- Use caution when applying curing compounds and sealers late in the season.
- Continuous wet curing of concrete is best (7 days minimum).
- Specify and proper mix design for exterior flat work per ACI recommendations.

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CONCRETE SURFACE DEFECTS

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DUSTING
The presence of a powdery material at the surface of a hardened concrete slab.

CAUSES
- **Premature Finishing** – This brings excess water, cement, and fines to the surface, which weakens the paste.
- **Carbonation** – Open salamander heaters or engines give off carbon dioxide, inhibiting the normal hydration process.
- **Condensation** – This can occur when the temperature of concrete on an inside floor made with cool materials rises slower than surrounding, more humid air—common in spring and fall.
- **Inadequate Curing** – "Dryout" will occur where there is not sufficient moisture to continue the hydration process of the Portland cement paste, producing a soft, weakened material.

PREVENTION
- Do not begin finishing operation until all free water has evaporated or been removed from the surface, so that the concrete will support the weight of finisher.
- Vent exhaust and/or fumes to the outside; provide adequate ventilation.
- When high humidity is anticipated, use heated concrete. Open windows for ventilation and use blower-type heaters or fans to increase air circulation.
- PLAN AHEAD – Provisions should be made by the contractor prior to the placing of concrete to assure adequate time for proper placing, finishing, and curing based on the existing conditions at the job site.

CRACKS
Breaks that occur in areas other than those placed intentionally.

CAUSES
- Shrinkage after hardening (drying shrinkage).
- Poor subgrade preparation and drainage.
- Uneven settlement.
- Hydrostatic pressure or structural loads (premature back-filling).
- Thermal cracking (in thick sections).

PREVENTION
- Place or cut control joints at recommended distances.
- Put control joints where concrete meets other sections or slabs, over grade beams, and other recommended locations.
- If existing material cannot be properly compacted and drained, add 8 cm to 15 cm of sound granular fill.
- Prepare subgrade properly and build construction joints where required.
- Provide adequate drainage.
- Lower the water-to-cement ratio.
- Use the largest aggregate size allowed.

POPOUTS
A conical fragment that breaks out of the surface of the concrete. Usually a fractured aggregate particle will be found at the base of the hole.

CAUSES
- Porous aggregate pieces with high rates of absorption which fail in freezing conditions.
- Deleterious aggregates, like: chert, coal, soft limestone, weak shales, hard burned dolomite, and pyrite.
- Aggregates that swell with moisture.
- Chemical reactions between reactive aggregates and the alkalis in the cement.

PREVENTION
- Use durable aggregates.
- Use concretes with low water-to-cement ratios.
- Use proper curing methods.
- Slope exterior work for proper drainage.
- Popouts can be repaired by drilling out the spalled particle and patching the hole.

DISCOLORATION
Changes in color from pour to pour, spots, mottled light or dark patches. These can be caused by a number of factors.

CAUSES
- Variations in any placing or finishing operations.
- Delayed finishing or early finishing can affect color.
- Finishing in bleed water will lighten and weaken the surface.
- Delayed finishing/hard troweling almost always darkens the surface.
- Job-site-added calcium chloride flakes are very difficult to dissolve in cold concrete and can result in dark spots.
- Calcium chloride retards the ferrite phase of the cement. The ferrite phase tends to remain dark in the presence of calcium chloride. Cold weather increases this effect.
- Plastic sheeting will cause light and dark spots in areas of contact and non-contact (greenhouse effect).

PREVENTION
- Avoid the use of field-added flaked or pellet calcium chloride.
- Maintain constant subgrade, placing, finishing, and curing conditions.
- Finishing time is controlled by the concrete set time, not bleed water. Surface water is controlled by wind speed, humidity, mix design, subgrade, admixtures, and temperature.
- Products are available to treat minor discoloration and stain removal.
- Use wet burlap instead of plastic sheeting to prevent discoloration and maintain curing.

PLASTIC SHRINKAGE
Small cracks in the surface of concrete. These can combine with drying shrinkage cracks.

CAUSES
- High rate of evaporation of water from the concrete surface, affected by:
  - Ambient temperature.
  - Relative humidity.
  - Wind velocity.
  - Temperature of concrete.

PREVENTION
- Dampen subgrade and forms.
- Erect windbreaks to reduce wind velocity.
- Minimize placing and finishing time.
- Begin curing as soon as possible after finishing, using membrane curing compound, curing paper, wet burlap, sand, or other acceptable methods.
- Use monomolecular films (evaporation retardants) or a fog spray immediately after the screeding to maintain the water-to-cement ratio at the surface.

CRAZING
A large number of interconnected small cracks just in the surface of the concrete. They are nonstructural, and most visible on a nearly dry surface.

CAUSES
- Rapid drying of the concrete surface due to high evaporation rates, such as temperature, low humidity and high winds.
- Overuse of placing tools, such as the jitterbug vibrator, darby, or bull float, will bring excess mortar to the surface.
- Premature finishing with a float and trowel will bring excess moisture and paste to the surface. Rapid loss of this moisture may cause crazing.
- Use of a dry cement or cement and sand mix as a mop coat to absorb excess water.

PREVENTION
- Use monomolecular films (evaporation retardants) or a fog spray immediately after the screeding to maintain the water-to-cement ratio at the surface.
- Use a fog spray or cover with wet burlap or canvas as soon as possible after strike off and darbying. Maintain spray or keep covers in place until surface is nearly ready for finishing.
- Begin curing immediately. Where possible, continue mist curing to lower temperature by evaporation.
- Use placing tools only to bring the surface to its proper plane, in preparation for finishing. Do not overwork surface paste.
- Do not begin finishing operations until all free water has been evaporated or removed and the slab can support the finisher with only slight indentation.
- Use low-slump, air-entrained concrete and finish at the proper time.