FROM POUR TO PERFECT:

9 Steps to Concrete Exterior Flatwork Success

Version: 06-2023

RA Crete-Scape Ltd. | Whitby, ON

CONCRETE ONTARIO

Good Roads

Cement Association of Canada

HERE ARE THE 9 CRITICAL STEPS:

1 CERTIFICATION.

Certification is the cornerstone for ensuring exceptional concrete quality.

From the concrete supplier to the labourers and finishers of the contractor and inspectors, personnel involved in the project must be qualified by an accredited certification program in the province. Ensuring that all parties involved have the knowledge, proficiency and are certified will allow for more consistent product quality, delivery, and an overall longer-lasting product.

More specifically:

Concrete Producer

- Current valid R1025 Certificate of Ready Mixed Concrete Production Facilities or
- Current valid R1026 Certificate of Mobile Mix Concrete Production Facilities

Contractor

- Concrete Ontario Municipal Exterior Flatwork Certification or
- ACI Concrete Flatwork Associate/Finisher Certification

2 SCHEDULING.

Concrete is a highly versatile material suitable for year-round applications and it requires planning and consideration of weather and environmental conditions.

During summer months, scheduling concrete pours early in the morning and late in the afternoon will minimize moisture loss and will allow for more ideal placing conditions. Placement of concrete for exterior flatwork late in the fall and early winter should be avoided, if possible, as concrete needs adequate time to air dry and time to develop the strength and durability necessary to withstand de-icing salts.

3 CONCRETE.

Environmental exposures determine the applicable concrete designed for optimal performance and durability.

For all exterior unreinforced concrete flatwork, a 28-day compressive strength of 32 MPa is required to withstand life-cycle loads, a maximum water/cementitious materials ratio (w/cm) of 0.45 is needed for durability and a 5-8% plastic air content (20 mm aggregate size) for freeze-thaw resistance. (Class C-2 as per CSA A23.1) Having addressed the performance criteria of the concrete, placeability must be considered through the slump. The slump requirements of modern concrete must be identified and reviewed by the contractor and concrete supplier prior to construction.

FROM POUR TO PERFECT

4 GRADING.

The preparation of the grade lays the foundation for success for the remainder of the project.

The base must be properly graded and compacted in order to provide uniform support to the concrete slab and avoid settlement which may lead to uncontrolled cracking and tripping hazards to the public. In hot weather, the base material should be dampened before concrete is placed, being careful to avoid puddles. Likewise, concrete should not be placed on snow, ice or frozen granular base material.

5 EQUIPMENT.

The quality of the final product is only as good as the tools used to place and finish it.

All equipment used must be consistent with the product being placed, avoiding segregation, impact on air void structure and overall surface durability.

What to use: come-alongs, square-ended shovels, magnesium and aluminum floats (Keeping floats as flat as possible)

What to avoid: garden rakes, fresnos, trowels and rollerbugs

6 FINISHING.

When it comes to concrete surface work, simplicity is key.

Minimal finishing is recommended and helps to preserve the durability characteristics in the all-important top portion of the concrete. The surface work must be completed immediately after screeding, and care must be taken to prevent the addition of any water to the surface of the concrete as a finishing aid or due to adverse weather conditions. After the concrete is placed and consolidated, the general procedure is followed by bullfloating and a final surface finish, most commonly a light broom finish. Over finishing using hand tools may compromise the surface durability and should be avoided.

7 CURING.

Lasting concrete quality depends on proper protection.

The fundamental concept of concrete curing relies on maintaining an adequate moisture content and temperature in concrete for a period of time immediately following placing and finishing operations. Such conditions allow the development of desired properties in concrete, such as strength, durability and chloride resistance. Contractors, at the beginning of any project, must coordinate crew and resources to provide curing for a minimum of 7 days, maintaining the concrete temperature above 10°C, according to CSA A23.1. Surface protection must be carried out according to OPSS.MUNI 904 and includes burlap and water, vapour barriers, or curing compounds. Curing of concrete provides the greatest benefit for the smallest investment.

8 JOINTING.

The natural dimensional changes of concrete must be accommodated.

Concrete's inherent nature to crack due to shrinkage; and to expand due to thermal fluctuations creates a need for proper jointing. To manage and control concrete shrinkage and random cracking, transverse contraction joints must be formed or saw cut to at least one-quarter (1/4) of the slab thickness at planned locations. In addition, to prevent potential mid panel cracking, the transverse joint spacing should be no more than 1.5 times the width of the sidewalk. Timing of the contraction joint installation using saw-cuts is highly dependent on the mix design as well as the concrete and ambient temperatures. To accommodate the thermal expansion, full-depth expansion joints using 12 mm thick joint filler must be installed. Improper joints may lead to random cracking or tenting of panels causing a tripping hazard.

9 SALTING.

Winter public safety takes precedence above all else.

During the winter months, the application of salts to the surface of the concrete is a critical element for the safety of the public. Salt type, concentration and timeline of application may impact the expected service life of exterior flatwork. Following all the procedures previously outlined, a strong, durable concrete surface can be anticipated to resist loading, abrasion, and chemical attack. However, the premature application of salts may result in reduced surface durability and ultimately service life as the concrete has not had the opportunity to fully develop its necessary characteristics. Manufacturer recommendations including salt dosages must always be followed to minimize the deleterious impacts of de-icing salts on the quality of the concrete and to preserve long-lasting infrastructure.

References:

1. CSA A23.1-19 – Concrete Materials and Methods of Concrete Construction, Canadian Standards Association (CSA Group)
2. OPSS.MUNI 1350 (Nov '19) Concrete - Materials and Production
3. OPSS.MUNI 351 (Nov '21) Construction Specification for Concrete Sidewalk
4. OPSS.MUNI 353 (Nov '21) Concrete Curb and Gutter Systems
5. OPSS.MUNI 904 (Nov '12) Concrete Structures
6. Guide for Concrete Pavement Distress Assessments and Solutions: Identification, Cause, Prevention & Repair, National Concrete Pavement Technology Center, October 2018
7. Concrete Information – Concrete Slab Surface Defects: Cause, Prevention, Repair, Portland Cement Association, IS177, 2001

COMMON EXTERIOR FLATWORK DEFECTS

To avoid these common defects, contractors and concrete suppliers must work together to provide a final product that Municipalities and Owners can be proud of.

SCALING

MUNICIPAL CONCRETE DEFECT

Local flaking or peeling away of the top portion of hardened concrete.

CAUSES

- Insufficient air entrainment especially near the surface or non-air entrained concrete is used.
- Overfinishing of the concrete surface is conducted.
- Concrete is placed during extreme temperatures.
- Improper curing methods are employed.
- Application of excessive amount of de-icing chemicals, especially on newly installed concrete which is saturated and of lower strength.

AVOIDANCE

- Ensure concrete meets Class C-2 requirements.
- Follow all proper curing regimes including time of application.
- Minimize overworking the surface as excessive finishing reduces entrained air near the surface.
- While considering public safety, allow the maximum amount of time possible before salt application.

MORTAR FLAKING

MUNICIPAL CONCRETE DEFECT

Dislodging of small mortar sections directly above coarse aggregate. Distinct from popouts. (See below).

CAUSES

- Concrete is placed during periods of rapid surface drying without protection. This includes high wind speeds, warm temperatures, and low relative humidity.
- Improper curing methods are employed.

AVOIDANCE

- Follow all proper curing regimes.
- Curing must start as soon as possible which, for exterior textured surfaces, means as soon as the broom finish has been applied.
- During rapid surface evaporation periods, consider the use of fog spraying systems.
- Consider scheduling the placement of concrete during early mornings or late afternoons.

FROM CONCRETE TO PERFECT

COMMON EXTERIOR FLATWORK DEFECTS

DRYING SHRINKAGE CRACKING

MUNICIPAL CONCRETE DEFECT

The reduction in concrete volume which occurs as moisture evaporates during curing leading to premature cracking.

CAUSES

- Improper subgrade or subbase compaction and inspection.
- High moisture absorption rates of the subgrade or subbase.
- Improper curing methods are employed.
- Inadequate jointing system design and/or layout is used.
- Control joints are not installed in a timely manner.

AVOIDANCE

- Subgrade or subbase is adequately graded and compacted to the specified minimum % of the maximum dry density.
- Dampening of the subgrade or subbase without leaving standing water.
- Follow all proper curing regimes.
- Ensure proper and timely use of concrete jointing (Contraction, isolation, construction and expansion joints).

POPOUTS

MUNICIPAL CONCRETE DEFECT

Conical fractures from the expansion of porous coarse aggregates just below the concrete surface.

CAUSES

- Concrete is in a fully saturated condition during freezing temperatures and aggregate sources contain soft, porous material.

AVOIDANCE

- Consider the use of alternative aggregate sources.
- Proper curing followed by air-dry time to maximize the surface durability.

FROM POUR TO PERFECT

COMMON EXTERIOR FLATWORK DEFECTS

HEAVING

MUNICIPAL CONCRETE DEFECT

Uplift and/or settlement of the concrete slabs.

CAUSES

- Frost susceptible soils.
- Inadequate uniform support of the subgrade or subbase.
- Thermal expansion of improperly jointed concrete slabs.

AVOIDANCE

- Minimize the impact of frost susceptible soils by using a subbase.
- Subgrade or subbase is adequately graded and compacted to the specified minimum % of the maximum dry density.
- Full-depth usage of expansion and isolation joints.

STRUCTURAL CRACKING

MUNICIPAL CONCRETE DEFECT

Complete failure of the concrete slab.

CAUSES

- Frost susceptible soils.
- Inadequate uniform support of the subgrade or subbase.
- Excessive loading and insufficient slab thickness.

AVOIDANCE

- Minimize the impact of frost susceptible soils by using a subbase.
- Subgrade or subbase is adequately graded and compacted to the specified minimum % of the maximum dry density.
- Ensure concrete thickness is appropriate for anticipated loading.

FROM BOOM TO PERFECT

COMMON EXTERIOR FLATWORK DEFECTS

PLASTIC SHRINKAGE CRACKING

MUNICIPAL CONCRETE DEFECT

Shallow cracks that are caused by rapid loss of moisture from the surface of concrete before it has fully set.

CAUSES

- Wind, low humidity, and high temperatures leading to high evaporation rates of the surface.

AVOIDANCE

- During rapid surface evaporation periods, consider the use of fog spraying systems.
- Commence proper curing regimes as soon as possible.

DISCOLOURATION

MUNICIPAL CONCRETE DEFECT

Distinct colour changes in large areas of concrete.

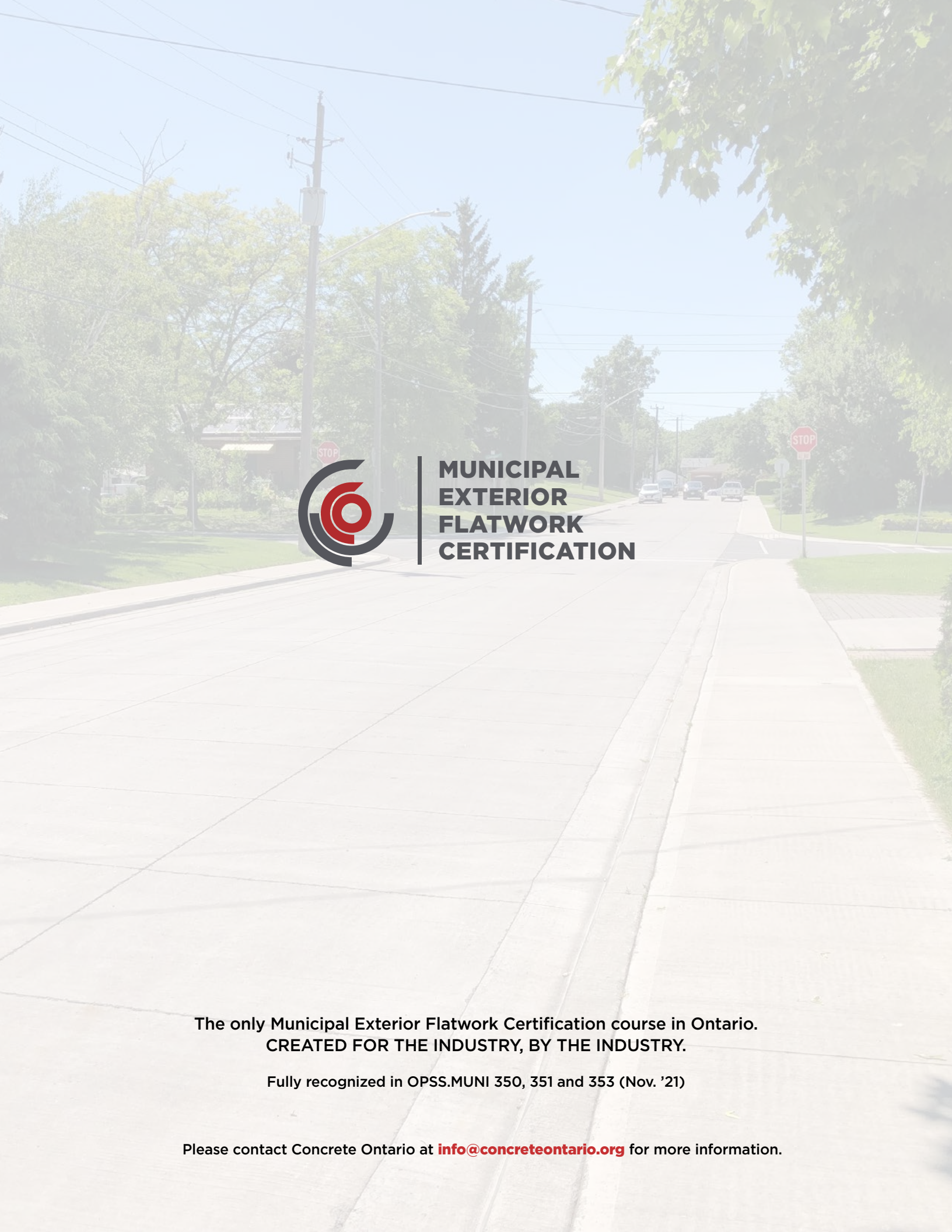
CAUSES

- Excessive on-site water addition.
- Improper usage of curing regimes, primarily vapour barriers and wet burlap.

AVOIDANCE

- Minimize water addition on-site.
- Follow all proper curing regimes.
    - More specifically, the precise application of vapour barriers and wet burlap by keeping them as flat as possible.

FROM CONCRETE TO PERFECT



MUNICIPAL EXTERIOR FLATWORK CERTIFICATION

The only Municipal Exterior Flatwork Certification course in Ontario.
CREATED FOR THE INDUSTRY, BY THE INDUSTRY.

Fully recognized in OPSS.MUNI 350, 351 and 353 (Nov. '21)

Please contact Concrete Ontario at **info@concreteontario.org** for more information.