Technical Circular T-03/26
Date August 20, 2026

**To:** All Engineering Directors
All Regional Directors
All HQ Directors: Operations, Planning and Major Projects
All Directors and Managers, Provincial Field Services
All Managers and Supervisors, Structural Construction Services

**Subject: Testing of Chloride and Sulphate Exposure for New Concrete Elements in Highway Construction Projects**

## 1.0 Purpose

The long-term durability and performance of concrete elements may be reduced where they are in direct contact with in situ soil, imported aggregate, groundwater, or surface water containing sulphates and chlorides for which the concrete mix design is not compatible.

This Technical Circular establishes procedures and requirements for testing a project site for potential exposure of new concrete elements (e.g., footings, culverts, retaining walls, bridge substructures) to sulphate and chloride. The procedure includes identification of the class/degree of sulphate exposure for the overall project site, and testing of imported aggregates to ensure they do not exceed the site's class/degree of sulphate exposure. The sulphate class/degree of exposure for the site is used to inform the design of the concrete mix. The design shall also consider the severity of chloride test results.

## 2.0 Characterizing Degree of Sulphate Exposure and Roles and Responsibilities

The sulphate content test results shall be used to determine the degree of sulphate exposure as defined in CSA A23.1 Table 3 titled, "Additional requirements for concrete subjected to sulphate attack". The degrees/classes defined by CSA are Very Severe (S-1), Severe (S-2), and Moderate (S-3). The Ministry uses an additional degree of exposure of "Less than Moderate" for sulphate contents that fall below the Moderate (S-3) degree of exposure. The sulphate content of each exposure class/degree is specified in the table below.

**Classes/Degrees of Sulphate Exposure used in CSA A23.1 Table 3**

| Class of exposure | Degree of exposure | Water-soluble sulphate ($SO_4$) in soil sample[1] | Sulphate ($SO_4$) in surface and groundwater samples[2] | Water soluble sulphate ($SO_4$) in recycled aggregate sample[3] |
|---|---|---|---|---|
| S-1 | Very Severe | >2.0% | >10,000 mg/L | >2.0% |
| S-2 | Severe | 0.20-2.0% | 1,500 – 10,000 mg/L | 0.60 – 2.0% |
| S-3 | Moderate | 0.10-0.20% | 150 – 1,500 mg/L | 0.20-0.60% |
| | Less than Moderate | <0.10% | <150 mg/L | <0.20% |

Notes
1. Testing for in-situ or imported soil/aggregate samples shall be in accordance with CSA A23.2-3B or alternatively in accordance with procedures described in MoTT Technical Circular T-04/13 on evaluating the potential for acid rock drainage and metal leachate.
2. Testing of water samples shall be in accordance with CSA A23.2-2B
3. Recycled Concrete Aggregate Material shall be tested in accordance with CSA A23.2-8B.

Sulphate and chloride sampling and testing are the responsibility of the project Geotechnical Engineer and shall be included in any subsurface investigation program carried out for all projects with new concrete infrastructure. The class/degree of sulphate exposure for the overall project site shall be included in the project geotechnical report.

The class/degree of sulphate exposure stated in the geotechnical report shall be written into the construction contract special provisions and the concrete designer shall develop a mix design appropriate for the class/degree of sulphate exposure stated in accordance with the requirements in the special provisions. The contract special provisions shall also state that the contractor tests and provides only imported soils and aggregates that do not exceed the pre-existing class/degree of sulphate exposure for the project site.

Chloride testing is to be carried out in compliance with Canadian Highway Bridge Design Code. The Code also states that the structural design shall consider the severity of the test results. Chloride testing shall be carried out in accordance with AASHTO T291, ASTM D512, ASTM C1218[1], CSA A23.2-4B[1], ion chromatography, or equivalent. Chloride testing may be waived when resistivity is greater than 5000 ohm-cm.

## 3.0 Sampling Procedure - Geotechnical Investigation Program

This sampling and testing procedure is mandatory for subsurface elements of bridge substructures, retaining walls, shotcrete walls with anchor or soil nail tiebacks and for project subsurface investigation programs for other concrete elements.

Boreholes/test pits:

- At least one borehole or test pit for collecting samples should be located as close as possible to each concrete element. If the location of concrete element(s) is unknown at time of geotechnical investigation(s), then use available information to interpret the location as best as possible.
- If multiple concrete elements are located within close proximity (< 100 m), a single borehole for testing would be adequate coverage.
- Borehole depth shall extend several meters below the proposed concrete foundation element depth to account for seasonal groundwater fluctuation.

Soil Sampling:

- A representative sample of 800g or more shall be obtained for each test
- As a minimum, one soil sample shall be taken between a depth of 0.3 m to 1.2 m and one at the groundwater table or within 1.5 m below the lowest seasonal groundwater elevation.
- Soil Samples below 1.2 m shall be taken for each significant change in subsurface material or at representative intervals to the end of the borehole unless groundwater is encountered.
- If the same soil layer is continuous across the site, it is not necessary to obtain samples of the same soil unit from all boreholes.
- Combining samples from different soil layers to create composite or bulk samples is not permitted.

[1] Typically used for hardened grout, mortar or concrete but can be adapted for aggregates

- Sampling for retaining walls should consider length as well as depth. As a minimum one sample should occur for each 100 m of wall length.
- Sampling of soil through permanent free-standing bodies of water is not required.
- The collected samples shall be representative of the site conditions within the project limits.

Water Sampling:

Water samples shall be collected and tested from groundwater, local runoff water, proximate water bodies or watercourses, and when applicable, drainage system discharge as stated in the Canadian Highway Bridge Design code.

- Each water sample should be at least 125 ml in volume and should only be stored in a container provided by the analytical laboratory responsible for performing the test. The samples do not have to be refrigerated. Well waterlines shall be purged by opening the faucet for 2 to 3 minutes prior to sampling.

## 4.0 Exemptions for Non-Structural, Temporary, or Low Risk Concrete Elements

Sulphate and chloride testing of in-situ soil is not required for non-structural, temporary, or low risk concrete elements such as.

- Non-structural replaceable concrete elements with a service life under 20 years.
- Temporary concrete elements with a service life of under 5 years; examples include temporary shoring walls, temporary concrete pads, etc.
- Low strength control density fill (flowable fill); examples include trench and abandoned culvert backfill.

## 5.0 Possible Alternative Assessment and Testing Process

An alternative two step sampling and testing method may be followed to determine the exposure class/degree if requirements 1 and 2 described below are met. This alternative method involves surface sampling instead of borehole sampling and replaces lab testing with experienced based observations combined with a review of existing site records if available.

**Requirement 1** - The concrete element(s) must be of low risk as defined below

- gravity or MSE walls comprised of modular blocks described in SS942 (low risk decided on a case-by-case basis by Structural Professional of Record),
- concrete culvert headwalls (decided on a case-by-case basis by applicable POR),
- concrete elements built on imported backfill with subsurface/surface drainage that prevents groundwater or surface water interaction. The backfill would be tested to ensure an appropriate sulphate exposure class/degree.
- Bridge rehabilitation projects where the past performance of concrete is known and/or documented

**Requirement 2** - The location of concrete element(s) must

- not be within the embankment bridge interface zone as defined in CSA S6:19.
- not be on a numbered highway with the exception of bridge rehabilitation projects as defined in requirement 2 above,

- not be in an area where failure would result in the loss of more than one lane of access, and
- not be in an area where failure would impact other infrastructure upslope or downslope of the element under consideration.

If both requirements above have been met, then the alternate sampling and testing methodology would follow the two-step process described below:

**Step 1: Initial Soil Sampling**

- Collect one or more samples of native soil near the surface or at depth using a shovel or hand auger. Test the samples following the procedures outlined in CSA A23.2-3B.
- If the test results indicate a Severe or Very Severe degree of sulphate exposure, then this classification will be reported as the project site exposure class/degree.
- If the results show a Moderate or less than Moderate degree of sulphate exposure, proceed to Step 2 for further assessment.

**Step 2: Site Assessment**

- Investigate the surrounding area for potential sources of sulfate, including nearby peat deposits, marshy terrain, gypsum deposits, upstream agricultural land, or sulfide-rich bedrock.
- Conduct a visual inspection of existing concrete structures within approximately 100 meters of the proposed structure. Look for signs of sulfate-related degradation such as cracking patterns, spalling, soft cement paste (testable by scratching with a knife), efflorescence, or disintegration.
- Review maintenance records of nearby concrete structures to identify any previous repair work that may mask signs of sulfate damage.

If any of the three bullets above fail to identify sulphate indicators, then the reported exposure class/degree will either be Moderate (S-3) or less than Moderate as determined from Step 1.

If any of the above three bullets above identify sulphate indicators, then subsurface investigation must be carried out to obtain and test soil and water samples as described in sections 2.0 and 3.0 above.

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