

DEVELOPMENT OF A NEW NATIONAL STANDARD FOR PRECAST CONCRETE PAVERS IN CANADA

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SUMMARY

This paper highlights the changes to the third edition of CSA (Canadian Standards Association) Standard A231.2, *Precast Concrete Pavers*, published in 2006. It supersedes the second, published in 1995 and reaffirmed in 2005. It is written in SI (metric) units. A number of modifications have been made to this Standard. First, the definition of a concrete paver has been changed to include larger size pavers 300 x 300 x 80 mm (or greater in height) and a definition for architectural finishes has been added. A distinction between production sampling and field sampling has been added and performance, sampling and conditioning of specimens is different for each sampling criteria. Enhancements have been made to the de-icing salt freeze-thaw durability test procedure, particularly to the cooling requirements, to better define the test method and to improve the consistency of test results among laboratories. An appendix on installation has been added to assist designers with their specifications. This Standard was prepared by the CSA Technical Committee on Precast Concrete Paving Elements under the jurisdiction of the Strategic Steering Committee on Concrete and Related Products, and was formally approved by the CSA A231.2 Technical Committee. Final balloting for this standard occurred in June 2006 and the standard is expected to be available in August 2006.

1. INTRODUCTION

Development of the third edition of CSA (Canadian Standards Association) Standard A231.2, *Precast Concrete Pavers*, began in 2005. The new standard supersedes the second, published in 1995 and reaffirmed in 2005. It is written in SI (metric) units. The Standard was prepared by the CSA Technical Committee (TC) on Precast Concrete Paving Elements under the jurisdiction of the Strategic Steering Committee on Concrete and Related Products, and was formally approved by the TC. The TC consists of a matrix of five (5) "General Interest", seven (7) "Producer Interest" and five (5) "User Interest" category members. The CSA matrix requirements for this standard include a minimum of four (4) and maximum of eight (8) members per category. Final balloting for this standard occurred in June 2006 and the standard is expected to be available in August 2006. Several significant additions and changes to the standard have been incorporated in the latest edition. This paper will review these changes.

2. OVERVIEW OF THE STANDARD

The scope of the standard is unchanged from previous editions and is stated as "Specifying the requirements for concrete pavers manufactured from hydraulic cement concrete to be used in the construction of pedestrian and vehicular traffic areas" (CSA, 2006). The new CSA Standard A231.2,

Precast Concrete Pavers, is divided into 7 mandatory clauses and two informational (non mandatory) annexes as follows:

Clause 1 Scope
Clause 2 Reference Publications
Clause 3 Definitions
Clause 4 Materials
Clause 5 Sampling and Testing
Clause 6 Requirements and Basis for Acceptance
Clause 7 Test Methods
Annex A Efflorescence
Annex B Installation

3. ENHANCEMENTS AND MODIFICATIONS TO THE NEW STANDARD

Several new enhancement and modifications have been made to the new standard. First, the definition of a concrete paver has been changed in Clause 3 to include larger size pavers 300 x 300 x 80 mm (or greater in height) and also includes a definition for architectural finishes. Clause 5 now includes a distinction between production sampling and field sampling. A new acceptance criterion for field sampling is defined in Clause 6 and 7 related to performance, sampling and conditioning of specimens. Enhancements have also been made to the de-icing salt freeze-thaw durability test procedure in Clause 7, particularly to the cooling requirements, to better define the test method and to improve the consistency of test results among laboratories. Finally, an appendix on installation has been added to assist designers with their specifications.

3.1 Clause 3 - Definitions

In previous editions of the standard, a paver was defined as having a face areas less than or equal to 0.065 m², an aspect ratio (length divided by thickness) less than or equal to four, and a minimum nominal thickness of 60 mm. Over the past 10 years (since the previous edition of the standard was first adopted) there has been a change in the perception and use of segmental paving units in the Canadian market place. Larger units, greater than 0.065 m² but still meeting the minimum 4:1 aspect ratio, are being used in the same applications as the traditional smaller units. For example, it is now common in many Canadian markets to see 300 x 300 x 80 mm units installed in pedestrian applications and 300 x 300 x 100 mm units installed in vehicular applications along side their smaller 100 x 200 mm “cousins”. Figure 1 shows 300 x 300 x 100 mm pavers in a vehicular application in Montreal, QC.



Figure 1. Prince-Arthur Street at the corner of Hôtel-de-Ville Street in Montreal, QC. This section, exposed to traffic, was built in 1996 with 300 x 300 x 100 mm thick pavers (Source: City of Montreal)

This use of larger size pavers in the same applications as the traditionally defined smaller units is common in municipal applications and has created some confusion among designers and specifiers in Canada. When considered along side each other, the units are installed with the same construction techniques and are subjected to the same load and environmental conditions. It is therefore important that designers are given proper guidance on the required dimensional properties. Considering the long history of these larger paving units in the Canadian marketplace, the TC recommended a change to Clause 3 such that the face area is increased from 0.065 m^2 and is now defined as being less than or equal to 0.090 m^2 . The definition, however, retains the maximum aspect ratio of 4:1 and minimum nominal thickness of 60 mm. In addition, Clause 3 was expanded to note that a paver must have a maximum aspect ratio of 3:1 for vehicular applications. With this definition, 300 x 300 x 80 mm units are now defined as pavers and are acceptable in pedestrian applications, and 300 x 300 x 100 mm units are acceptable as pavers for vehicular applications. It is also worth noting that in the previous standard, neither of these units fit into a CSA paver or slab definition, since slabs are defined to have an aspect ratio greater than 5:1 in Canada. 300 x 300 x 60 mm units, under the new definition, will remain in the slab definition according to CSA A231.2-06 *Precast Concrete Paving Slabs*. In addition to offering clarity on larger segmental unit sizes, by including a definition of aspect ratio for vehicular applications, this is the first time that the CSA standard has defined a concrete paver in mandatory language based on application. This represents a significant move forward to improve specifications in Canada and a first for a North American segmental paving standard.

The other change to the definitions is the addition of a definition on architectural finishes. These are defined as finishes where the surface is modified by mechanical means such as blasting, hammering, polishing or tumbling. In later related notes to clauses, architecturally finished units are recommended to meet dimensional and freeze-thaw mass loss requirements prior to the application of the finishes. Since the methods used to apply architectural finishes vary in application and timing, the TC determined that this would be the most appropriate recommendation for the current standard.

3.2 Clause 5 - Sampling and Testing

Clause 5.2 of the standard references production sampling, with a non-mandatory note that recommends sampling as follows; every 40,000 m² of production or every two months (whichever comes first), or at any time there is a change in manufacturing process, mix design or material. This clause remains unchanged in the new standard, but a new clause, Clause 5.3 *Field Sampling*, has been added. The intent of Clause 5.3 is to protect the owner and contractor from installing pavers that are produced less than 28 days before installation, and may have not reached a maturity level acceptable to performance in the harsh Canadian climate. Maturity is defined by compressive strength at the time of delivery rather than the standard requirement for compressive strength after 28 days of laboratory conditioning. This new clause states that, at the purchaser's option, field sampling may be taken at a minimum frequency of 3000 m² on the job site to confirm the minimum compressive strength requirements at the time of installation. The performance requirements are further defined in Clause 6.1.1.

3.3 Clause 6 - Requirements and Basis for Acceptance

Clause 6.1.1, Compressive Strength, describes the compressive strength requirements for production samples and field samples ("at the time of installation"). The production sample requirements are unchanged in the new standard, with a requirement of five saw cut cubes or cored cylinders to have a minimum average compressive strength of 50 Mpa after 28 days with no individual test less than 45 Mpa. The requirement for field samples that has been added to this clause in relation to the new clause 5.3 requires a minimum average compressive strength of 40 Mpa. The test method is defined in Clause 7.2.2.2, *Compressive Strength for Field Samples at Installation*.

Other changes to Clause 6 include a change to Clause 6.1.2 to allow freeze-thaw durability to be tested at 28 and 49 days respectively. This change, from the previous 25 and 50 day requirement, accommodates laboratory schedules so that the testing matches up with regular laboratory operating hours. Accordingly, the maximum allowable loss requirement has been adjusted mathematically for the 25 day requirement, and is now 225 g/m² at this threshold.

3.4 Clause 7 - Test Methods

Clause 7.2.2.2 Compressive Strength for Field Samples at Installation is a new clause noting that the test specimens for field testing shall be tested within 24 hours of sampling and shall be unconditioned. This requirement differs from production samples that are conditioned in a moist curing chamber 14 days and air dried for 14 days prior to testing.

Another significant change is to Clause 7.3.5 *Freezing-thaw Cycles* which replaces Clause 7.3.4 from the previous edition of the standard. The revised clause is stated below, with changes underlined:

One freeze-thaw cycle shall be completed every 24h. Each cycle shall consist of 16 ± 1 h of cooling followed by 8 ± 1 h of heating. The specimens shall be subjected to freeze-thaw cycling, which should preferably be continuous. If, for reasons beyond the operator's control, a freezing period cannot commence at the specific time, the specimens shall remain in a thawed condition until conditions are suitable for resumption of the test. The specimen temperature shall conform to -15 ± 3 °C for the last 7 h of the cooling cycle and a minimum of 5 °C for the last 1h of the heating cycle. The time during which the temperature is -15 ± 3 °C, shall not be longer than 12 h. The temperature shall be recorded at least every 15 min

with a temperature probe insulated from cabinet air, resting against, below, or inside the specimen.

The purposes of these changes are:

1. To avoid using the word *freezing* to designate a segment of the cycle during which the temperature is not necessarily under 0°C . The word *cooling* was deemed to be more appropriate by the Technical Committee,
2. To avoid using the word *thawing* to designate a segment of the cycle during which the temperature is not necessarily above 0°C . The word *heating* was also deemed to be more appropriate by the Technical Committee, and
3. Most importantly, narrowing the envelope defining the standard freeze-thaw cycle. With the proposed changes, the clause becomes more restrictive concerning the allowable effective cooling rates since cooling rate is a key parameter in controlling the freeze-thaw durability of concrete. This proposal was inspired by the last modifications made to clause B.2.1 of BNQ 2621-900 (a standard similar to ASTM C 672 on scaling resistance on concrete). Figures 2 to 4 describe the effects of the changes on the heating and cooling cycles of the previous clause 7.3.4.

Clause 7.3.4 of the old standard was fairly unrestrictive concerning the cooling cycle. The only requirements were that the length of the cooling cycle must be 16 ± 1 h and that the temperature of the sample must be $-15 \pm 3^{\circ}\text{C}$ during the last 2 h of the cycle (Figure 2). This allows the use of cooling cycles having significantly different cooling rates. Two extreme cases are shown in Figure 2.

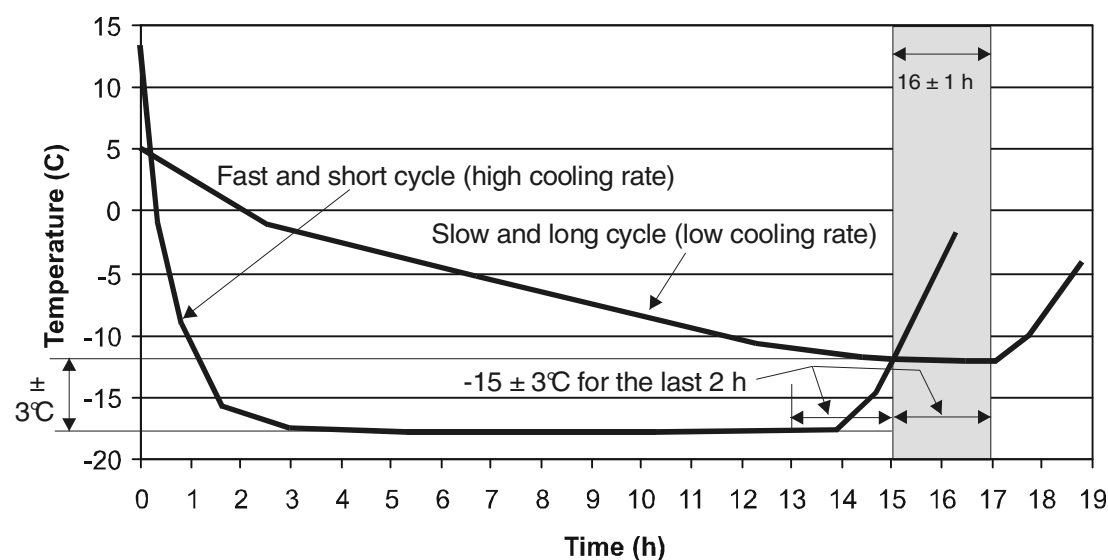


Figure 2. Examples of cooling cycles complying with the previous standard clause 7.3.4 (Source Canadian Standards Association)

The modified version in the new clause 7.3.5 clause is more restrictive. Although still imposing that the minimum temperature of the cooling cycle must be $-15 \pm 3^{\circ}\text{C}$, this temperature must now be maintained during at least 7 h at the end of the cycle, without exceeding 12h (See Figure 3). This

approach decreases the risk of allowing the use of highly different cooling rates. Two extreme cycles are shown in Figure 3. The curves show that extreme cases are more limited with the new requirement.

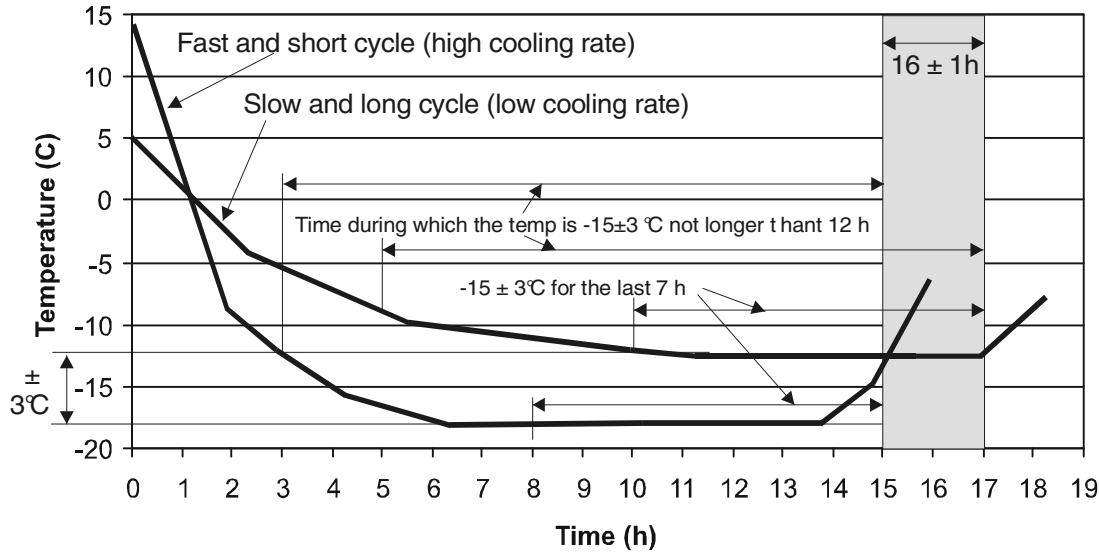


Figure 3. Examples of cooling cycles complying with the new clause 7.3.5. (Source Canadian Standards Association)

The heating cycle is not modified by the proposed change. Figure 4 shows two extreme cases of acceptable heating cycles: a fast and short cycle with a maximum temperature far above the minimum value of 5 °C, and, a slow and longer cycle with a maximum temperature just above the minimum value of 5 °C. The heating rates of these two cycles are significantly different but it was determined that the rate of heating is not a key parameter controlling the scaling resistance of concrete.

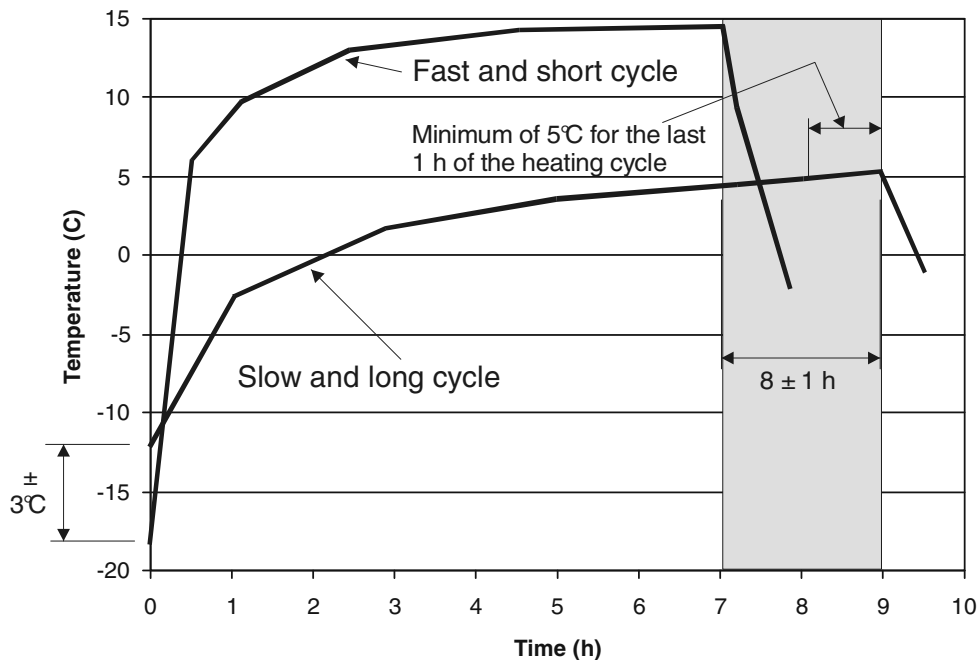


Figure 4. Examples of heating cycles complying with the previous clause 7.3.4 and the current clause 7.3.5 (Source Canadian Standards Association)

3.5 Annex B - Installation

Annex B represents an important addition to this standard, providing a convenient source of information to design professionals on construction guidelines for interlocking concrete pavements. The Annex includes the following sections:

- B.1 Purpose
- B.2 Job Planning
- B.3 Layout
- B.4 Excavating and compacting the soil subgrade
- B.5 Applying geotextiles (optional)
- B.6 Spreading and compacting the sub-base and/or base aggregates
- B.7 Constructing edge restraints
- B.8 Placing and screeding the bedding sand
- B.9 Placing the concrete pavers

The annex also includes a comprehensive photo gallery highlighting some of the latest installation technologies including mechanical joint sweeping and saw cutting dust collector systems.

4. CONCLUSION

A summary of the significant changes included in the current edition of the CSA standard on Precast Concrete Pavers, CSA A231.2-06 has been provided. The revised standard represents a change in thinking for the standard with the major changes and additions being the optional field sampling, larger allowable surface areas for pavers, and the addition of a definition (and installation annex) outlining the requirement for vehicular applications. CSA A231.2-06 is expected to be published in the autumn of 2006 as a compendium standard with CSA A231.1-06 *Precast Concrete Paving Slabs*.

5. REFERENCES

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