Canadian Standards on Alkali-Aggregate reactions

Benoit Fournier
Laval University, Quebec City, Canada

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CSA A 23.1 & A23.2 on AAR

- Documents last published in 2009 (five-year cycle)
- CSA A23.1 → Concrete materials and methods of concrete construction
- CSA A23.2 → Test methods and standard practices for concrete
CSA A 23.1 & A23.2 on AAR

- AAR-related specifications
- CSA A23.1 requires that aggregates be non-reactive or that preventive measures be taken
- CSA A23.2 Three test methods and two standard practices to detect and prevent AAR
- 15% of CSA standards A23.1 & A23.2 deal with AAR
CSA A 23.1 – Appendix B
Informative

- **General**
- **Types of alkali-aggregate reactions**
- **Methods for evaluating potential reactivity of aggregates (current and other methods)**
- **Distribution of potentially-reactive aggregates across Canada**
- **Measures to prevent AAR in concrete incorporating potentially reactive aggregates**
- **Reactivity of reclaimed concrete for use as recycled aggregate**
- **Summary**
Testing for AAR


1) determining potential alkali-reactivity of aggregates, and

2) selecting preventive measures against ASR using a risk analysis approach.
Standard Practice CSA A23.2-27A
Evaluating of potential alkali-reactivity of concrete aggregates

- Field performance survey
- Laboratory test program
  - Petrographic examination: ACR & ASR
    (ASTM C 295)
  - Chemical Method: ACR
    (CSA A23.2-26A)
  - Accelerated Mortar Bar Method: RAS
    (CSA A23.2-25A)
  - Concrete Prism Test: RAC & RAS
    (CSA A23.2-14A)
Field Performance Survey of AAR
Figure 1
Process for determining the potential alkali-aggregate reactivity of concrete aggregate and use of preventive measures
Laboratory investigations

Petrographic Examination

Aggregates other than quarried carbonate rocks
Option: no testing; the aggregate is considered highly reactive

Quarried carbonate rocks
Chemical Method for ACR
Not PR
PR
Expansion > limit
Expansion < limit
Select preventive measure

Other rock types
Accelerated Mortar bar test
Expansion < limit
Expansion > limit
Accept

Concrete Prism Test
Expansion > limit
Expansion < limit
Petrographic Examination

- Essential step:
  - Nature of aggregate (ACR, ASR)
  - Select best test to perform

- Risky to accept/reject aggregates based on petrographic examination only.
Laboratory investigations

Petrographic Examination

Aggregates other than quarried carbonate rocks
Option: no testing; the aggregate is considered highly reactive

Quarried carbonate rocks

Chemical Method for ACR

Not PR

Other rock types

Accelerated Mortar bar test

Expansion > limit

Expansion < limit

Concrete Prism Test

Steel Slag

Reject

Expansion < limit

Accept

PR

Expansion > limit

Expansion < limit

Select preventive measure

Not PR
Chemical Method for ACR

- Screen test for quarried carbonate rocks *
- Chemical analysis for Al₂O₃, MgO and CaO
- Zones for aggregates considered potentially expansives or non-expansives (ACR)
- Next step → Concrete Prism Test
Chemical Method for ACR

- Screen test for quarried carbonate rocks
- Chemical analysis for $\text{Al}_2\text{O}_3$, $\text{MgO}$ and $\text{CaO}$
- Zones for aggregates considered potentially expansives or non-expansives (ACR)
- Next step → Concrete Prism Test
Laboratory investigations

Petrographic Examination

- Aggregates other than quarried carbonate rocks
  - Option: no testing; the aggregate is considered highly reactive
  - Select preventive measure

- Quarried carbonate rocks
  - Chemical Method for ACR
    - Not PR
      - Expansion > limit
    - PR
      - Expansion > limit

- Other rock types
  - Accelerated Mortar bar test
  - Expansion < limit
    - Accept
  - Expansion > limit

Steel Slag

Reject
Accelerated Mortar Bar Test (AMBT)

Bars immersed in 1N NaOH solution at 80°C for 14 days

1 Scope
This Test Method allows detection within 16 d of the potential for deleterious expansion of concrete aggregate due to alkali-aggregate reaction, by means of mortar bars subjected to accelerated test conditions.

2 Reference publications
C3A (Canadian Standards Association)
A23.1-09
Concrete materials and methods of concrete construction
A23.2-1A-09
Sampling aggregates for use in concrete
A23.2-1A-09
Potential expansivity of aggregates (procedure for length change due to alkali-aggregate reaction in concrete prisms at 38 °C)
A23.2-1A-09
Petrographic examination of aggregates
A23.2-2A-09
Standard practice to identify degree of alkali-reactivity of aggregates and to identify measures to avoid deleterious expansion in concrete
A23.2-2A-09
Standard practice for laboratory testing to demonstrate the effectiveness of supplementary cementing materials and lithium-based admixtures to prevent alkali-aggregate reaction in concrete
A3001-08
Cementitious materials for use in concrete
ASTM International (American Society for Testing and Materials)
C 109/C 109M-08
Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)
C 151/C 151M-09
Standard Test Method for Autoclave Expansion of Hydraulic Cement
C 305-06
Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars for Plastic Consistency
Laboratory investigations

Petrographic Examination

Aggregates other than quarried carbonate rocks
Option: no testing; the aggregate is considered highly reactive

Quarried carbonate rocks

Chemical Method for ACR

Other rock types

Accelerated Mortar bar test

Steel Slag

Reject

Expansion < limit

Concrete Prism Test

Expansion > limit

Accept

Expansion < limit

Expansion > limit

Not PR

PR

Select preventive measure
Concrete Prism Test

A23.2-14A
Potential expansivity of aggregates (procedure for length change due to alkali-aggregate reaction in concrete prisms at 38 °C)

1 Scope

1.1 This Test Method provides requirements for the measurement of the length change of concrete prisms, due to alkali-aggregate reaction, stored under moist conditions at a temperature of 38 °C, for a minimum of 365 d.

1.2 This Test Method is intended for the evaluation of the potential expansivity (related to alkali-aggregate reaction) of coarse or fine aggregates, or a combination of fine and coarse aggregates.

1.3 This Test Method can be used to demonstrate the effectiveness of supplementary cementing materials and lithium-based admixtures to prevent alkali-silica reaction in concrete in accordance with CSA A23.2-28A.

2 Reference publications

CSA (Canadian Standards Association)
A23.1-09
Concrete materials and methods of concrete construction
A23.2-20A-09
Test method for detection of alkali-reactive aggregate by accelerated expansion of mortar bars
A23.2-27A-09
Standard practice to identify degree of alkali-reactivity of aggregates and to identify measures to avoid deleterious expansion in concrete
A23.2-28A-09
Standard practice for laboratory testing to demonstrate the effectiveness of supplementary cementing materials and lithium-based admixtures to prevent alkali-silica reaction in concrete
A23.2-SC-09
Making concrete mixes in the laboratory
A301-09
Cementitious materials for use in concrete

ASTM International (American Society for Testing and Materials)
C 455/C 455M-08
Standard Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar and Concrete

July 2009
Concrete Prism Test (CPT)

- Expansion limit of 0.04% at one year
- Testing potential ASR and ACR of coarse or fine aggregates
- Best test method available but often considered too long (one year)
Testing for AAR


2) selecting preventive measures against ASR using a risk analysis approach based on:

- Degree of reactivity of the aggregate
- Size of element and environmental conditions
- Expected service life of the structure
Testing for AAR

- CSA Standard Practice A23.2-28A: Laboratory testing to demonstrate the effectiveness of SCMs and chemical admixtures (LiNO₃) to prevent ASR in concrete
  - Concrete Prism Test
  - Accelerated mortart Bar Test