Project Name:	B-11-01: Study of permeability to chloride ions and durability with various pozzolanic additions and	**Start Date:**	2020-01-01
Project Number:	2022	**Completion Date:**	2020-05-31

Project Details:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
chlorine penetration (coulombs)	3500	2500	Yes
compression resistance (x)	(not set)	(not set)	No
spalling (x)	(not set)	(not set)	No
freeze thaw stability (x)	(not set)	(not set)	No
air bubble distribution (x)	(not set)	(not set)	No

[233] In 2009-2010, the MTQ and the Canadian Standards Association (“CSA”) added a new requirement to the standards applicable to concrete , namely a permeability threshold for chlorine ions (maximum conductivity from 1000 coulombs to 56 days). This standard has been implemented since the chlorine ions passing through the concrete can cause the steel reinforcements of the concrete structures to rust, which we seek to avoid. Mr. Bertrand testified that in order to meet concrete standards, twenty-two tests must be performed, to which is now added the new test for permeability to chlorine ions.

[234] A grace period of a few months was granted to the companies to allow them time to do the tests necessary to demonstrate that their concrete mixes complied with the new standard.

[235] According to Mr. Bertrand, the new standard caught everyone in the industry off guard. BMQ did not measure the penetration rate of chlorine ions in its mixtures before the standards were changed, since this was not required. However, a standardized test existed in the industry to do this.

resistance to compression, spalling and the freeze / thaw cycle and to check the stability of the distribution of the network of air bubbles had to be carried out.

Field of Science/Technology:

Civil Engineering (2.01.01)

Project Details:

Intended Results: Improve existing processes
Work locations: Lab
Key Employees: Jacques Bertrand (Civil - PEng. (1970) / President)
Evidence types:

Scientific or Technological Advancement:

Uncertainty #1: Technological uncertainty

[236] This project began on February 8, 2010 and ended on December 21, 2010. BMQ therefore undertook to verify whether its concrete mixes met the new standard. The objective of the project was to reformulate and optimize the concrete mixes according to the new standard. Mixtures with five different types of cement have been tested. According to Mr. Bertrand, the information available on each type of cement - for example, their technical data sheets - did not allow the permeability to chlorine ions to be determined in advance. For example, GU concrete (common concrete) had a chlorine ion permeability of 3500 coulombs, which exceeded the new standard.

[237] BMQ's assumptions included whether the different cements met the standard, whether BMQ blends were able to meet the standard, and, if the new standard was not met, what changes were to be made be made to the mixtures. According to Mr. Bertrand, the uncertainty was that BMQ did not know if the concrete mixes would comply with the new standard.

CRA ARGUED:
[243] According to the respondent [CRA], the activities carried out by BMQ in the context of this project are only an attempt to validate existing products with regard to applicable industry standards, and therefore, these activities cannot be qualified as activities of SR&ED. According to Mr. Mimoune, existing mixtures containing known ingredients were tested. The

techniques used by BMQ to adapt the mixes also fall under standard engineering techniques. The scientific method would also not have been respected since there are no links between the mixtures tested, that is to say that they do not fit into a logical sequence and that we have simply abandoned some when they did not meet the standard, instead of trying to understand the causes of failure.

The most significant underlying key variables are:

adding pozzolan (unresolved), modify mixing method (unresolved), effects of latex (unresolved)

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

Benchmark Method/Source	Measurement	Explanatory notes
Internet searches	1 Articles	Only quoted new government standards

Activity #1-1: Activity 1 (Fiscal Year 2020)

Methods of experimentation:

Method	Experimentation Performed
Trials:	15 runs / samples

[238] BMQ carried out tests on fifteen mixtures. Five mixtures were subjected to more than one test. According to Mr. Bertrand, when a mixture did not meet expectations, it was either left out or reformulated. In addition, when a mixture was modified to reach the new standard, it then became necessary to check whether the other standards were still respected. Thus, tests to check the resistance to compression, spalling and the freeze / thaw cycle and to check the stability of the distribution of the network of air bubbles had to be carried out.

[239] After a first series of tests which led to the conclusion that no mixture complied with the new standard, BMQ modified the quantity of cement and modified the mixing sequence and the method of introducing the adjuvants; this second series of tests was successful for certain mixtures. Subsequently, BMQ decided to substitute pozzolanic mineral additions for a certain amount of cement in order to improve the compression results.

THE JUDGE NOTED:

[244] BMQ made an inventory of its products, checked which ones met the standards, changed the mixing sequence and how to introduce the adjuvants, balanced the content of cement and minerals like pozzolan in order to reformulate products and, after receiving the results of laboratory tests , selected the mixtures which complied with the standards. BMQ did not investigate the reasons why some of these mixtures did not meet the standards.

[247] BMQ first tried to characterize its various existing mixtures of concrete made with different types of cement. The timesheets produced in evidence describe validation activities of mixtures in relation to the various tests making it possible to determine whether the concretes met the standards. The timesheets do not show any time spent reformulating mixtures, but there are many hours spent discussing and analyzing results, as well as hours validating mixtures. I also note that the mixtures have been tested directly, without having been reformulated in any way. This therefore demonstrates that the activities consisted of normal data collection carried out within the framework of the BMQ business in order to validate the mixtures against the standards, so that these were not SR&ED activities.

[248] BMQ also carried out tests to verify the effect of pozzolan on cements as well as the effect of modifying the mixing method. According to Mr. Mimoune, pozzolan is a known material and its effects on porosity have also been well known and documented in the scientific literature for many years. In the response to the examination report, BMQ admitted that adding pozzolan and modifying the mixing method are techniques known in the industry, specifying however, the use of a mobile concrete mixer makes the results unpredictable.

Results:

- chlorine penetration: 2800 coulombs (70% of goal) -- Average on 15 mixtures. 6 of 15 met the 2,500 goal.

[239] For six mixtures, these modifications made it possible to comply with the new standard and all the applicable standards.

[240] Mr. Bertrand also indicated that the addition of latex to a mixture containing a general purpose cement had increased the permeability to chlorine ions.

Conclusion:

RULING & RATIONALE: THE JUDGE CONCLUDED;

[248] BMQ however did not convince me that the use of a mobile concrete mixer brings a degree of scientific uncertainty that would justify that the activities be qualified as SR&ED activities.

[249] Although I accept that the standard for permeability to chlorine ions has been received with surprise by people in the industry, I do not see how the MTQ could have set up such a standard knowing that the companies subject to this standard could not meet it. This therefore also demonstrates an absence of scientific or technological uncertainty in this regard.

[250] Also, BMQ has not convinced me that it followed the scientific method for this project. Indeed, although tests have been made scientifically by an independent laboratory, a certain amount of trial and error is noticeable given the passage from one mixture to another without a specially detailed analysis of the reasons why a mixture respects the standards or does not meet them.

[251] Finally, with regard to the existence of a detailed report, the tests carried out by BMQ can be partially reconstructed using the documentation produced at the hearing and the testimony of representatives of BMQ.

[252] Thus, for these reasons, the activities carried out by BMQ in the context of this project cannot be qualified as SR&ED activities since they consist of normal product characterization tests that have not created scientific uncertainty.

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