



# REMOVAL OF OPTIONAL ALKALI LIMIT IN STANDARD SPECIFICATIONS FOR PORTLAND CEMENT

## Introduction

Alkali-silica reactivity (ASR) is a potentially deleterious expansive reaction between alkalis in the pore solution of concrete and certain reactive aggregates. When ASR was first identified as a distress mechanism in the 1940s, cements with equivalent alkali contents below 0.60 percent by mass were shown to reduce the risk of this reaction. Subsequent research has shown that limiting the cement alkali content to 0.60 percent is not always sufficient to control deleterious ASR with every aggregate nor in all concrete mixtures. It is now well accepted that the reactivity of the aggregate and the amount of alkalis available in the concrete are more important in predicting deleterious ASR than cement alkali content alone.

## Question

Why was the optional alkali limit removed from U.S. portland cement standards [ASTM C150/C150M](#) and [AASHTO M 85](#)?

## Answer

Specifying a low-alkali portland cement by itself is not a recommended approach for mitigating ASR, and relying solely on the historic optional limit led to questionable results in the field. To make portland cement specifications [ASTM C150/C150M](#) and [AASHTO M 85](#) consistent with current guidance on ASR, the optional alkali limit was removed from the specifications; however, reporting of the alkali content of the cement is now mandatory.

## Background

[ASTM C150](#) and [AASHTO M 85](#) are common specifications for portland cement. Around 1961, an optional maximum limit of 0.60 percent equivalent alkali content by mass was inserted in these standards to represent a low-alkali cement. Specifications for concrete could invoke this limit for portland cement to be used with aggregates potentially susceptible to ASR.

The equivalent alkali content (% Na<sub>2</sub>O<sub>eq</sub>) is a chemical characteristic of cement defined as shown in the following equation

$$\% \text{Na}_2\text{O}_{\text{eq}} = \% \text{Na}_2\text{O} + 0.658 \times \% \text{K}_2\text{O}$$

## Specification changes

In 2018, [ASTM](#) and [AASHTO](#) committees independently reviewed and approved proposals to replace the optional maximum limit of 0.60 percent equivalent alkalis for low-alkali portland cement with a requirement to report the equivalent alkali content on mill test reports. The revised portland cement specifications, [ASTM C150](#) and [AASHTO M 85](#), were published in April 2019. Included with those changes was a note referencing [ASTM C1778](#), “Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete,” or [AASHTO R 80](#), “Standard Practice for Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction,” to provide the most current guidance on establishing concrete mixture proportions to minimize ASR. Options for mitigation include both performance and prescriptive approaches.