

Repair of Alkali-Silica Reaction Damage in a Massive Arch Skewback

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Summary

Damage due to alkali-silica reaction (ASR) may be found in concrete structures and pavements. Due to the alkalinity of Portland cement, a chemical reaction takes place at the interface between certain types of aggregate and the cement paste. The chemical reaction produces a chemical compound generally referred to as the “ASR gel”. In the presence of moisture, the ASR gel expands causing the aggregate to separate from the surrounding cement paste. This process causes the concrete to deteriorate.

Keywords: Bridge rehabilitation, Alkali-Silica reaction, Post-tensioning, Concrete drilling, Concrete coring, Rock anchors.

1. Introduction

Bayonne Bridge was opened to traffic in 1931 providing a direct highway link between Bayonne, New Jersey, and Port Richmond on Staten Island, New York. The Owner of the bridge is the Port Authority of New York and New Jersey (PANYNJ). The main span of the bridge, shown in Figure 1, is a two-hinged parabolic steel arch 510.54 m (1675 ft.) long, supported on massive concrete skewbacks founded on diabase bedrock. The New Jersey skewback of the main arch consists of a concrete block, measuring approximately 40.54 m x 32.61 m (133 ft. x 107 ft.) at the base and is 12.2 m (40 ft.) high. Over the years, this skewback showed signs of deterioration that manifested itself in the form of cracking of the exposed concrete surfaces. Surface rehabilitation work was conducted in the late 1970's and the mid 1980's but was not successful in stopping further cracking.

Visual inspection and petrographic testing of concrete core samples identified Alkali-Silica Reaction (ASR) as the cause of cracking.

Several possible rehabilitation schemes were studied. A rehabilitation scheme consisting of encasing the original skewback in new concrete and tri-axially post-tensioning the skewback was selected. The project was completed in 2007.

2. Description of the Problem

2.1 Original Skewback

The original skewback consisted of a concrete block with a rectangular foot print measuring 40.54 m x 32.61 m (133 ft. x 107 ft.). The skewback is founded on bedrock at an approximate elevation of -12.00 ft. Two steps at elevations -1.8 m and +1.8 m (-6.00 ft. and +6.00 ft.) reduced the plan dimensions of the skewback to approximately 33.83 m x 21.336 m (111 ft. x 70 ft.). Figure 2 shows a schematic of the east elevation of the skewback. Rough-cut granite facing covered the skewback between elevations -1.8 m and +1.8 m (-6.00 ft. and +6.00 ft.).

The original skewback had heavy reinforcement only in the area surrounding the bearings. One layer of shrinkage reinforcement existed along the remaining exposed surfaces of the skewback.