

## A STUDY ON POTENTIAL ALKALI-SILICA REACTIVITY OF AGGREGATES IN SRI LANKA

C.K.Pathirana<sup>1</sup>, H. Abeyruwan<sup>1</sup>, A.P.N.Somaratna<sup>1</sup> and H.M.G.T.A. Pitawala<sup>2</sup>

<sup>1</sup>*Dept. of Civil Engineering, University of Peradeniya*

<sup>2</sup>*Dept. of Geology, University of Peradeniya*

### Introduction

Alkali-aggregate reaction (AAR) is a critical problem in concrete structures. AAR can be separated into two main categories according to the active mineral component in the aggregate which is involved in the reaction. When this active mineral component is silica, the reaction is called Alkali-Silica Reaction (ASR) and when it is carbonates, it is called Alkali-Carbonate Reaction (ACR). ASR is more common than ACR. However not all aggregates are equally susceptible to AAR. In the early 1940's, the first evidence had been reported as formation of cracks in some concrete pavements in California, USA. The cause of these cracks had been identified as the formation of a layer of gel due to the reaction of high alkali cements and some mineral phases in certain types of aggregates. With the absorption of water, this layer of gel expands. As a result there may be expansion, cracking, increased permeability, and decreased modulus and tensile capacity of concrete. To investigate the potential alkali-silica reactivity the ASTM C 289 method (ASTM, 2007) has been widely used. The aggregates are categorized as deleterious, potentially deleterious and innocuous by this standard test. Still there have been instances where structures containing aggregates classified as non-reactive also have suffered

damages due to AAR. Over the past seventy years, many researchers have indicated that the current standard test methods used are not stringent enough to identify certain levels of the reactivity.

In Sri Lanka too, some observations have been raised on the potential susceptibility of some structures though these have not been confirmed yet. Therefore it is important to identify the capability of recognizing the reactivity level of aggregates before using them in construction.

The purpose of this study is to propose a new parameter and corresponding acceptance levels which may help in the identification of reactive aggregates in Sri Lanka.

### Methodology

Figure X1.1 of ASTM C 289-07 shows the zones of aggregates. It is not reasonable to expect that there would be a sharp boundary to differentiate these groups as shown in the standard curve. There could be a gray area close to the curve which may be mildly reactive. To study the relative reactivity of aggregates in this gray area the following parameter is proposed.

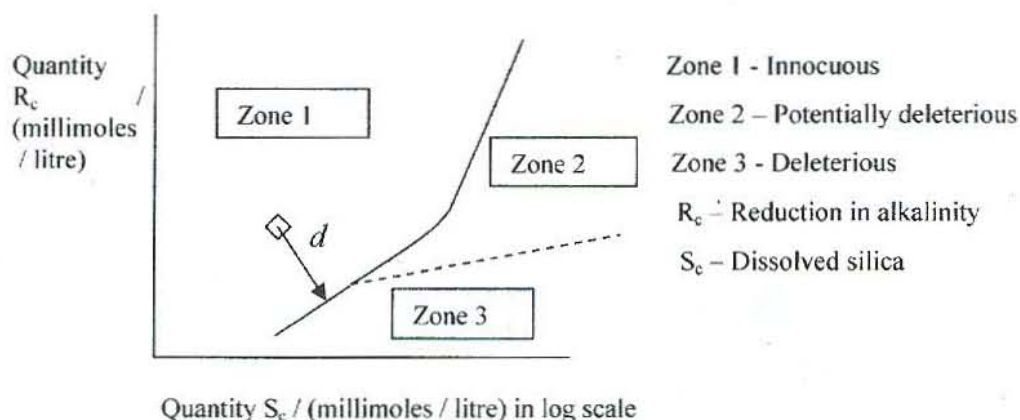
Potential Reactivity Index,

$$PRI = \frac{100}{1+d}$$

where  $d$  is the distance from the corresponding point to the standard curve defined as potential inertness index (Figure 1).

### Petrographic Examination

Aggregate samples from Galaha, Sarasavigama and Haragama were observed under the microscope. Primarily all samples have quartz, feldspar and iron oxide minerals like biotite, magnetite etc. In the samples of Galaha and Sarasavigama there



**Figure 1. Illustration of potential inertness index of a sample aggregate**

Several samples of coarse aggregates and fine aggregates were collected from active quarries in Sri Lanka. Following the procedure given in ASTM C 289 - 07, filtrates of the samples were prepared. Then diluted solution was prepared from the filtrate to determine the dissolved silica and the reduction in alkalinity. For each sample, the point representing the two values was plotted on the graph of reduction in alkalinity versus dissolved silica with the standard curve (*i.e.* Figure X1.1 of ASTM C 289 - 07). The proposed parameter for aggregate samples were obtained and plotted.

Thin sections (of 50  $\mu$ m thick) from selected aggregate samples were examined under the petrographic microscope.

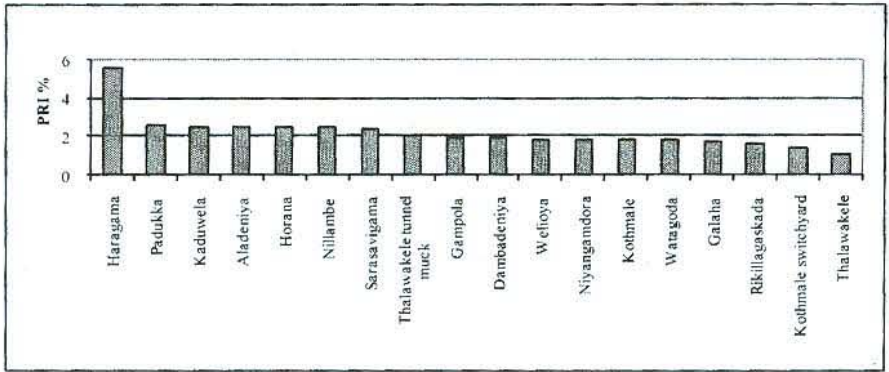
were crystalline materials present and in Haragama sample both amorphous and crystalline bladed phases were present.

### Experimental Results

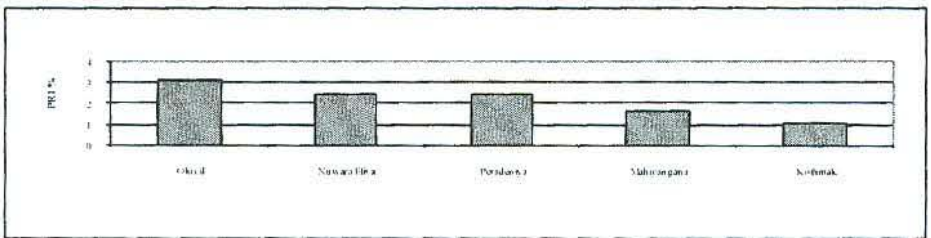
Figure 2 and Figure 3 show the variation of the potential reactivity index of tested aggregates.

### Discussion

According to the proposal in this study, a point that has a higher potential reactivity index is closer to the zone boundary. Figure 2 shows that Haragama sample has the highest index of 5.62. It is closer to the boundary of zone 3 wherein aggregates are considered deleterious. In addition, according to petrographic examination results, these aggregates from Haragama contained an amorphous phase which may lead to



**Figure 2. Variation of potential reactivity index for crushed rock**



**Figure 3. Variation of potential reactivity index for river sand**

potential reactivity. It is felt that there should be some ancillary testing to confirm it. Therefore, further investigation is suggested using method of testing the deformation of the concrete bars in compliance with the ASTM C 1293, together with the mortar bar expansion in compliance with the ASTM C 227, the accelerated mortar test in compliance with the ASTM C 1260 which are long-term methods and a rapid method developed by the General Building Research Corporation of Japan (GBRC rapid method) on autoclaved concrete samples.

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**References**

American Society for Testing Materials, ASTM C 289 – 07, Annual Book of ASTM Standards (2007). Vol. 04.02, Concrete and Aggregates.