IN-SITU EVALUATION OF COVER CONCRETE QUALITY OF ROAD BRIDGES IN THAILAND AND MYANMAR

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1. Introduction

For concrete structures, conditions at the time of construction can have a large impact on long-term performance. The cover concrete, in particular, has been identified as playing a crucial role in protecting the reinforcing steel against environmental action, and failure to assure the quality of this layer may contribute to reduced durability and premature deterioration. The Torrent air permeability test, which quickly and non-destructively measures the air permeability of the cover concrete using a two-chamber vacuum cell system, has become a popular and reliable method for evaluating cover concrete quality, and its results have been found to correlate well with deterioration factors. Subsequently, systems for verifying durability based on the cover concrete quality of new construction were developed in Japan and Europe, but there are few examples of application to aged concrete infrastructure.

This paper presents the results of a pilot study on the in-situ application of the Torrent air permeability test for evaluating the cover concrete quality of existing concrete bridges in Thailand and Myanmar, with the goal of developing useful information for improving long-term durability at the design and construction phases.

2. Investigation program

In this study, the cover concrete qualities of three bridges were investigated (Table 1). Both Bridges A and B cross river mouths in rural areas within 500 meters of the ocean, whereas Bridge C is situated in an urban area away from the ocean. All three bridges are several hundred meters or more in length, and are exposed to tropical conditions typical of Southeast Asia.

The inspected members of each bridge are shown in Figure 1. For each member, the surface moisture content, electrical resistivity, and surface air permeability were measured at several locations, and the results examined comparatively to consider the differences in moisture content of the concrete.

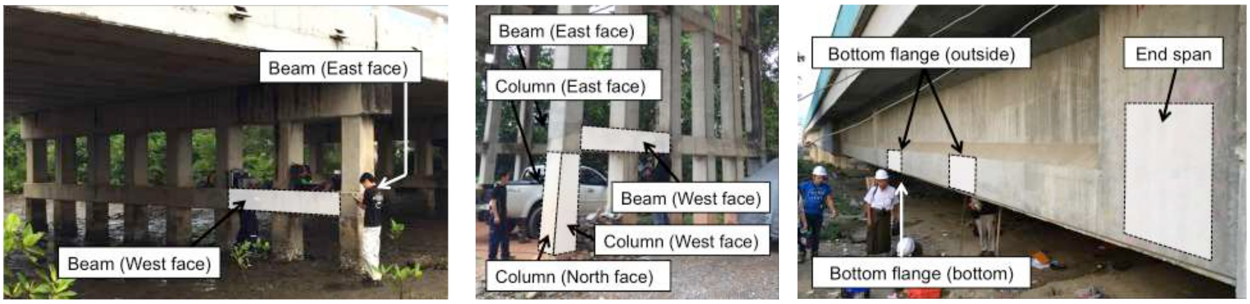
3. Results

3.1. Variation in surface air permeability

Figure 2 shows the variation in surface air permeability for the inspected locations. For Bridge A, it can be seen that the mean values for the east and west faces of the beam are relatively similar, and the data has a similar spread in values. For bridge B, the east and west faces of the beam again have similar means and data

Table 1 Overview of selected bridges

Label	Country	Age	Structural type	Inspected members
A	Thailand	~10 years	Reinforced concrete (RC)	Cross beam in substructure
B	Thailand	~21 years	Reinforced concrete (RC)	Cross beam and column in substructure
C	Myanmar	<1 year	Prestressed concrete (PC)	PC girder



Bridge A Bridge B Bridge C

Figure 1 Inspected areas of structural members

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spread, but are two orders of magnitude higher than that of the beam in Bridge A. The north and west faces of the column have similar values, but the west face appears to be one order of magnitude higher than the other faces. Finally, for Bridge C, the outer face of the bottom flange has the lowest values, whereas the flange bottom and end span are both roughly one order of magnitude higher.

3.2. Classification of cover concrete quality

The resistivity and air permeability values for all measured locations were plotted together against the quality levels proposed by Torrent (Figure 3). It can be seen that, at similar levels of electrical resistivity, there is still a wide spread in the cover concrete quality. These range from “Normal” to “Very bad” in Bridges A and C, whereas nearly all values for Bridge B fall in the “Very bad” category. Relative to the other bridges, the surface moisture content in Bridge B was much lower (roughly 2%), and, furthermore, it is believed that Bridge B was constructed using fly ash concrete, so these would both affect the electrical resistivity measurement.

3.3. Effect of surface wetting

To investigate the effect of surface moisture content on the electrical resistivity and surface air permeability, selected structural members of the bridges in Thailand were wrapped with towels and wetted for between 30 to 120 minutes. Figure 4 shows the change in the resistivity and air permeability values due to wetting. It can be seen that wetting leads to a notable reduction in both values, but the surface air permeability is particularly affected. When examining the change in surface air permeability against the quality levels shown in Figure 3, it is clear that increasing the moisture content may increase the perceived quality of the cover concrete, as the surface air permeability coefficient decreases more quickly than the electrical resistivity. This is particularly important for measurement in Southeast Asia, where the relative humidity is often very high for most of the year.

4. Conclusion

The pilot study showed that the cover concrete quality varies widely within the same structural element, even at similar moisture contents. The surface moisture content has a large effect on the observed quality, and thus is important to consider in areas with high relative humidity. It will be necessary to clarify the expected levels of surface concrete quality to use as a baseline for comparison with the aged structures, and to build relationships between surface air permeability and long-term durability performance.

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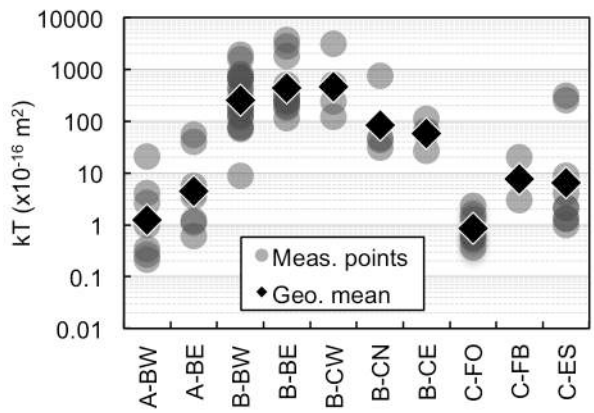

Figure 2 Variation in surface air permeability kT

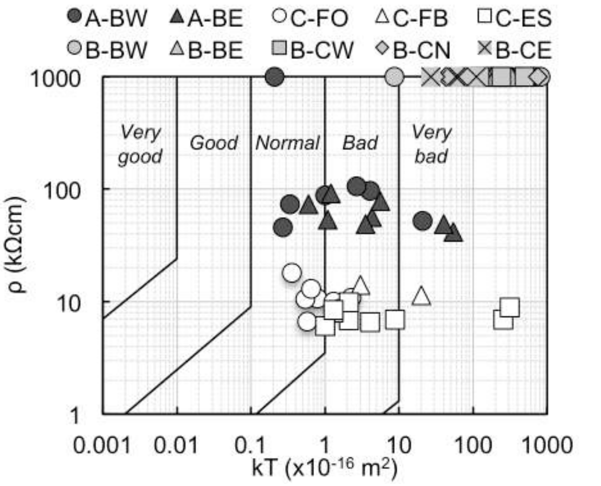

Figure 3 Relationship between surface air permeability kT and electrical resistivity

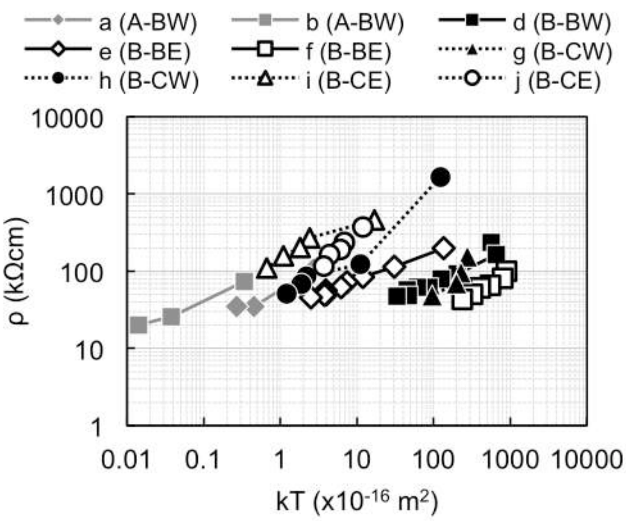

Figure 4 Effect of surface wetting on surface air permeability kT and electrical resistivity ρ