PRELIMINARY FIELD SURVEY OF TRAFFIC BRIDGES WITH SHORT SPAN IN NORTHERN VIETNAM BY NON-DESTRUCTIVE METHODS

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1.INTRODUCTION

The importance of understanding the deterioration characteristics of RC structure and its effect on the performance have been long recognized. The structures in developing countries in Asia have been constructed based on mainly American or European design codes which do not take into consideration the effects of hot weather concreting and local material characteristics on the design and construction adequately.

The preliminary surveys to focus on short span bridges in Thailand and Japan had been carried out to study the characteristics of the deterioration (J. Sato et al., 2017). In this study, additional 25 short span bridges were surveyed in Northern Vietnam by visual inspection and non-destructive methods to get the map of deterioration of RC bridges and identify the deterioration factors.

2.FIELD SURVEY OF DETERIORATED SHORT SPAN BRIDGES IN NORTHERN VIETNAM

2.1 Location of bridges

Nowadays, the demand of maintenance work is highly regarded in many developed countries of which most infrastructure has been built long time ago. With the impact of the adverse climate, extreme traffic, natural calamities, etc., many existing bridges in Vietnam are now in critical condition. This has created a situation of inadequacy of safety, degraded physical capacities, and serviceability (Hai et al., 2007). To verify the condition of bridges, a group of short-span bridges located on the North-side of Vietnam was selected as a sample for this study.

Fig. 1. Location of bridges in this study

The group consists of 25 bridges as shown in Fig.1. Since 10 of these bridges located on the route to Haiphong - the port city, it is expected that the chloride ingress into the bridges is one of the influential parameters to the deteriorations. The other 15 bridges are visually damaged according to the Directorate for roads of Vietnam(1).

2.2 Survey methodology and procedure

In this study, we examined the crack location, the extent of cracks, voids, and spalling related to the corrosion. In addition, the cover depth of concrete was measured by using a Profometer5+ cover meter (Fig.2.a).

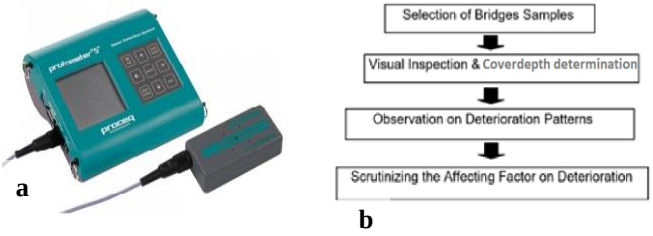

Fig.2. (a) Proceq Profometer5 and **(b)** Flowchart of Survey

Fig.2.b illustrates the procedure of this study. The final goal of this study is to point out the important factors that lead to the deterioration of the structure.

3.DETERIORATION PATTERNS IN THIS SURVEY

During the survey, mainly four kinds of defects were noticed corrosion, spalling, low construction quality and a combination of those. Some of the significant and common defects are reported below.

Fig.3. Corrosion of reinforcement in slab and column

In Fig.3, it is interesting to note the spalling of concrete around the joint connection of precast-concrete slab. In slab, undesirable water from rain through the joint

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drastically accelerated the corrosion of reinforcement. Since slabs are directly subjected to the moving load of vehicles, defects of structure from corrosion could result in serious incidents.

Fig.4. Spalling at the connection of slab and wall column

Fig.4. shows that corrosion of reinforcement at the connection between slab and wall column at which stain caused by leakage water could also be clearly observed. Failure of expansion joint can be attributed to increased traffic loading, component fatigue, construction error, or several other factors, which results in the leakage of water.

Fig.5. Embedment of objects in bridges.

A variety of defects of the structure caused by poor construction work were widely observable. In some bridges, the embedment of wooden plate, or nail inside the slab and beam was found as shown in Fig.5. The embedded objects are usually small and may not affect the load carrying capacity of concrete.

4.RESULTS OF COVER DEPTH MEASUREMENT

Cover depth is an essential parameter for the long-term survival of structure. Thus, the cover depth was measured for deck slab and main girder in this study.

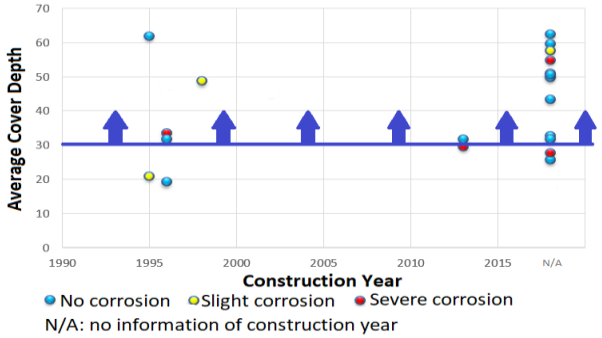

Fig.6. Measurement of cover depth in North-side Vietnam

Fig.6. shows the relation among cover depth, construction year and degree of corrosion. According to the Vietnamese design code, TCVN 9346:2012, the minimum cover depth requirement of protection against corrosion is 30mm for bridge working in brackish water and 40mm in seawater. In this study, 44% of investigated bridges complies with TCVN 9346:2012. From measurement as shown in Fig.6, if the minimum cover depth is over 30 mm, corrosion was hardly observed regardless of construction year.

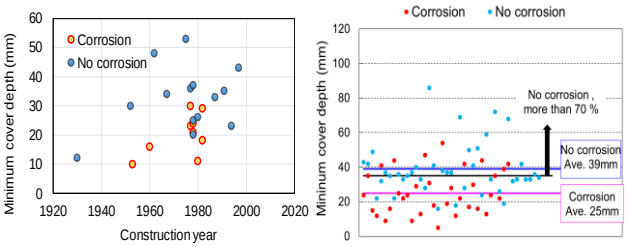

Fig. 7. Measurement of cover depth in Japan (Uwajima) and Thailand (Bangkok)

Fig.7. and Fig.8. showed the relationship between cover depth and corrosion according the survey in Japan and Thailand. In Uwajima-Japan and Bangkok-Thailand, if cover depth is over 40 mm, corrosion hardly occurs regardless of construction years and regions. It might be suggested that the water to cause the corrosion may not follow the simple one-way diffusion and not penetrate into deep steel position under wetting and drying conditions due to water retaining in fine pores. Increased cover with water also inhibits the diffusion of oxygen which is necessary for the corrosion. According to the survey in Vietnam, Thailand and Japan, it is implied that the threshold cover depth to cause the spalling by the steel corrosion would be from around 30 to 40 mm regardless of construction year and environment.

5.CONCLUSION

In conclusion, the deterioration of short span bridges in Northern Vietnam may be related to the initial construction error and thermal deformation due to hot weather condition. In addition, the threshold cover depth to not cause the spalling due to the steel corrosion regardless of environment and construction years would exist

ACKNOWLEDGEMENT

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(1) http://gis.drvn.gov.vn/ official website of Directorate for roads of Vietnam