DAMAGE CLASSIFICATION FOR CONCRETE BRIDGES

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Introduction

Maintenance of existing facilities is always subjected to limited budges, therefore in all maintenance strategies, definition of priorities is essential. In road system, maintenance of bridges is of high priority since the consequences of failure could be of grave consequences.
To determine the present needs for maintenance, it is necessary to carry away a through investigation of the structure. The main aims of the investigation include the identification of damages and defects of the bridges, as well as the cause of those damages. Also it is intended to determine the extension of the damage, and material properties in order to assess the safety and serviceability of the structure, to provide recommendations on remedial and preventives measures, and to estimate the cost of repair or replacement. Inspection is therefore the key to a successful maintenance strategy.

Field inspection

All the information about the real condition of the bridge must come from the field. Periodic inspection are performed with the purpose of identifying structure defects. One of problems regarding inspection, is that sometimes personnel who carry away the inspections lack of sufficient field experience. Moreover the personnel criteria could be subjective, and consequently lead to different evaluation of the same situation. Therefore, the need for standardization is priority in any inspection procedure, and furthermore in any maintenance strategy. A classification of defects and damage of concrete bridges is presented as an effort towards standardization

Criteria for classification.

Defects in concrete structures have been classified using different criteria: based on the position of the structural elements (infrastructure, superstructure, etc.); based on its importance (principal elements, secondary elements, etc.); based on the materials used (concrete, steel, asphalt, etc.).
The criteria used was basically a functional–positional criteria: the foundations/ abutments/embankments are referred on one group, the joints in another, the bearings in yet another, and so on. Fig.1 shows the main groups of the damage classification, while Figs. 2 to 5 defects subgroups A to D.
Concrete elements and reinforcement/ cables have a very wide scope: they are used to classified each defect, respectively in concrete and in conventional or prestressing steel, regardless of where they may occur.

Damage classification of concrete bridges

- A. Concrete elements
- B. Reinforcement/cables
- C. Foundations/ abutments/embankments
- D. Bearings
- E. Joints
- F. Wearing surface/water tightness
- G. Water drainage
- H. Secondary elements

Fig. 1 Damage Classification of Concrete Bridges

Thus, repeating such defects for specific elements that are covered in others groups, such as sidewalk, foundations, edge beams, etc., is avoided. For example, if spalling is detected in an edge beam, it should be classified simultaneously as A.8 (delamination spalling) and H.9 (deteriorated edge beams).
An effort was made to cover every defect which is liable to be detected in a bridge whose structure is completely made of reinforced or pre-stressed concrete. In order to achieve that

goal, special groups were added such as joints, bearings, secondary elements, etc., which a. not specific to concrete bridges but are essential to its normal functioning. These groups can be used straight forward for any classification that made of defects in steel or composite steel and concrete bridges.

It was also tried to avoid redundancy in the classification presented. The defects were roughly divided according to their similarity, common cause or proximity in order to make it easier to use the list of defects.

A. Concrete elements

A.1 Longitudinal crack
A.2 Transverse crack
A.3 Diagonal crack
A.4 Pattern cracking (map cracking)/Craze/Checking
A.5 Crack over/under bar
A.6 Rust stain/efflorescence/discoloration
A.7 Scaling/peeling/disintegration
A.8 Delamination/spalling
A.9 Swelling
A.10 Honeycombing/ voids/porous area/sand pockets
A.11 Stratification/segregation
A.12 Deflection/deformations

Fig. 2 Defect Group A. Concrete Elements

B. Reinforcement/cables

B.1 Exposed bar
B.2 Exposed duct
B.3 Exposed cable
B.4 Corroded bar
B.5 Bar with reduced cross section
B.6 Broken bar
B.7 Broken cable
B.8 Deficiently grouted ducts
B.9 Corroded anchorage
B.10 Faulty sealing of anchorage

Fig. 3 Defect Group B. Reinforcement/cables

C. Foundation

C.1 Scour
C.2 Settlement
C.3 Displacement/movement of pile/abutment
C.4 Bank/bed erosion
C.5 Embankment slippage
C.6 Heavy vegetation growth
C.7 Obstruction of the waterway by debris
C.8 Silting
C.9 Damaged pile cap

Fig. 4 Defect Group C. Foundation

D. Bearings

D.1 Obstruction due to rust in bearings
D.2 Obstruction due to debris/vegetation growth
D.3 Corrosion
D.4 Broken retainer-bars
D.5 Deteriorated base plate/pot
D.6 Damaged roller
D.7 Roller failure
D.8 Detachment failure of anchor bolts/pins
D.9 Loose/corroded/defective connectors
D.10 Failure of bearing seat
D.11 Frozen bearing
D.12 Displacement of bearing
D.13 Moisture/trapped water

Fig. 5 Defect Group D. Bearings

Final Remarks

Classification of damages for concrete bridges have been presented here, as an step in the standardization process of inspection, since objectivity in this activity is priority in a good maintenance strategy. And since maintenance of existing facilities is the key to safeguard the users of those facilities.

It has been tried to included the defects likely to found in concrete bridges and to avoid redundancy. The list of defects are presented in such a way that results clear and easy to use.

References:

1. Routine maintenance of concrete bridges. ACI committee 345.
2. Draft recommendation for damage classification of concrete structures. Rilem 104-DDC, Materials and Structures, 1994, 27.