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GENIA: Tool for Digitizing the Operational Flow Associated with the Main Inspections of Highway Bridges

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Abstract. This paper presents a value-based assessment method to assess the condition of a road bridge based on visual inspection. The method has been developed following MIVES, a multi-criteria model for decision making that evaluates alternatives through an index value. This method increases the objectivity and consistency in the assessment of bridges condition by establishing general criteria to identify damage and automatically quantifying their relative importance. For this purpose, firstly, bridge components and types of damage have been classified, secondly, damage indicators have been defined, and finally, relative weights and value functions have been assigned to each indicator. The value-based assessment method has been implemented in a tool called GENIA, a user-friendly tool that facilitates data management and processing, and provides additional utilities as visualization of results, reporting of specific warnings for indicators that exceed alarm thresholds and recommendation for repair conditions.

This paper does not pretend to carry out a commercial activity of the tool but to communicate the science behind the methodology.

Keywords: Road bridges · Main inspections · Multi-criteria model · Condition index · Data management

1 Introduction

Currently, the social and professional importance attached to the task of bridge inspection is on the rise, although it is still low. In fact, there is a national and international need to do these main inspections in a more efficient, affordable and homogeneous way.

The main inspections in the passage works follow the recommendation to be carried out every five years, with a reduction in the term in the event of unforeseen situations that may damage the structure or affect the environment. The conservation of the structures is an important aspect for public bodies since, frequently, they have limited economic resources and need to promote the sustainable development.

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Table 3. Global condition index

Index	Definition
1	Apparently undamaged structure or minor defects with no consequences
2	The structure has defects that can evolve into structural damage or might need to be repaired in the short or medium term
3	The structure has defects that indicate onset of structural damage
4	Defects in the structure indicate that there is an ongoing process of structural damage. This situation requires a more detailed inspection in the short term, or a repair action in the short or medium term
5	The bridge has damage that cause a modification of the structural behavior. A special inspection or repair action is needed in the short term
6	The damage are such that the structure is approaching its serviceability limit state. The bridge must be closed or its use restricted. A special inspection and an urgent repair action are required

It was developed in its process of digitizing the operational flow associated with the main inspections and providing a service that allows, on the one hand, greater objectivity and transparency in the results and, on the other, to generate a database that allows the client a greater control of investments in order to optimize the budget for infrastructures.

Given that none of the existing tools satisfied the team's demands, it was finally decided to make an ad-hoc tool, based on the experience and knowledge of the business area in the field of main inspections on highway bridges.

This tool has been tested on more than 200 highway bridges. During the different work phases, it was found that, for example, at the beginning of the work, the tool requires the effort to feed it by entering the bridge configuration. Once the configuration is made, in most cases the bridge does not usually have changes in its configuration (except for lane extensions, displacement of piers, etc.). Moreover, during the field work phase, it takes time to get used to the new way of collecting information and it is always good that staff is familiar with the tablets and the tool itself beforehand. The tool requires an internet connection.

Once all the damage observed in each of the bridge elements have been inserted, office work is necessary for processing the data: verification of damage, photos and the record of relevant notes as well as validation of the condition index. It should be noted that the damage remains in the tool's database and will be updated in the next inspection. That is, the damage is migrated to the next inspection and its evolution is registered.

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References

1. MIVES I Project (2002) Integrated model for a sustainable constructive design. Application to industrial and service buildings. Ministry of Science and Education, Madrid, Spain
2. MIVES II Project (2005) Sustainability through value analysis applied to several fields. Ministry of Science and Education. Madrid, Spain
3. MIVES III Project (2009) Towards sustainability in construction through value analysis with and without uncertainty. Ministry of Science and Education, Madrid, Spain
4. MIVES IV Project (2010) Quantification of sustainability in construction engineering with and without uncertainty. Ministry of Science and Education, Madrid, Spain
5. Ministry of the Presidency (2008) RD1247/2008 (July, 18), approving the structural concrete instruction (EHE-2008). Official State Gazette, 203, of August 22, 2008, pp 35176–35178
6. Ministry of the Presidency (2011) RD751/2011 (May, 27), approving the structural steel instruction (EAE). Official State Gazette, 141, of June 23, 2011, pp 67148–67151
7. Piñero I, San-José JT, Rodríguez P, Losáñez MM (2017) Multi-criteria decision-making for grading the rehabilitation of heritage sites. Application in the Historic Center of Havana. J Cult Herit 26:144–152. https://doi.org/10.1016/j.culher.2017
8. Piñero I, García D, Nicolás O, De La Cruz R, San-José JT (2014) Prioritization for the rehabilitation of buildings in the historic center of Havana. REHABEND, pp 1397–1405
9. Piñero I, Díez J, Salgado D, Cuadrado J, Orbe A (2020) Genia: inspection, evaluation and bridge management tool. REHABEND, pp 2593–2603
10. Ministry of Development (2012) Spanish guidelines for main roadway bridge inspections, Madrid, Spain. ISBN 978-84-498-0907-1
11. Saaty TL (2006) Fundamentals of decision making and priority theory with the Analytic Hierarchy Process, Pittsburg. USA. AHP series, vol VI. ISBN 978-0962031762
12. Alarcon B, Aguado A, Manga R, Josa A (2011) A value function for assessing sustainability: application to industrial buildings. Sustainability 3(1):35–50