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A methodology to determine the most sustainable bridge intervention strategies

Since bridges, as vital links in the road infrastructure deteriorate over time, preservations are required to ensure that they continue to provide an adequate level of service. Over the last two decades an increasing number of computer aided bridge management systems (BMS) have been developed to help infrastructure managers determine optimal intervention strategies (OISs) for their bridges. As can undoubtedly be seen the current way of determining which projects are candidates for intervention is only loosely related to something that can be seen as optimal, and it leaves much to be desired in terms of determining "sustainable" intervention strategies, i.e. strategies that result in the maximum benefit to society, taking into consideration their total impact on humans, which can be grouped as either economic impacts, societal impacts and environmental impacts (Brundland, 1987). Consideration of impacts of other types, in addition to those on incurred to the owner in terms of the costs of intervention can result in entirely different intervention strategies being considered optimal than if they are not considered (Thoft-Christensen, 2008).

Determination of the most sustainable intervention strategies for bridges is challenging due to the wide variety of elements and materials and the long periods of time between interventions for each element and for the object as a whole. It is also challenging due to the fact that some impacts are related directly to elements (such as the amount of concrete that needs to be poured to repair a concrete abutment or the amount of paint that needs to be applied to the steel girders), while other impacts are only related indirectly to elements (such as the traffic control efforts required to close a lane on a bridge during an intervention, the additional travel time of the user due to waiting in the traffic jam that is created due to the intervention on the bridge, and additional emissions created from vehicles travelling longer routes due to closure of bridge lanes during interventions).
Although the impacts on humans related to bridge performance are not considered in the determination of the optimal element level intervention strategies in existing BMSs, they are considered to some degree in the building of work programs through the use of agency rules (Robert, 2002; Adey, et al., 2005). These agency rules are normally devised to avoid, for example, that a bridge is a candidate for intervention in successive years, implicitly recognizing that this may result in excessive travel time costs to users.

With the current state-of-the art in BMSs and the increasing desire for sustainability in the management of our infrastructure, coupled with recent advances in operations research methods and computing capacity it is now time to develop a methodology to be used in BMS to help infrastructure managers determine the most sustainable intervention strategies for their bridges.

This research will contribute to the state-of-the-art through the evaluation of most advanced methodologies and determination of a new methodology to determine the most sustainable bridge intervention strategies, and a new modelling of the connection between how stakeholders are impacted and the physical behaviour of the individual elements of the bridge without having combinatoric explosion. The result will be a methodology to be implemented into bridge management systems.