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Involving user delays resulting from infrastructure failure and maintenance in Life Cycle Cost analysis

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ABSTRACT:

In the recent years, the number of infrastructure failures has increased due to ageing of infrastructure, more extreme weather events, and increased traffic loading. Accordingly, the number of maintenance projects and resulting (partial) closures of the transport network has increased. This leads to a growing interest for making robust, cost-effective decisions on maintaining and upgrading infrastructure to prevent failures. Transport infrastructure owners are moving from reactive infrastructure management toward proactive management, by prioritising upgrades for critical network assets. Nowadays, such predictive maintenance techniques incorporate measuring the condition of assets, combined with life cycle costs analysis (LCC). Associated costs do not only involve reconstruction costs, but also costs experienced by users of the transport network. The LCC usually computes these user costs (e.g. caused by congestion and detour) by multiplying the (assumed) increased travel time by the number of travellers [1].

However, this basic method of computing user delays does not incorporate the aspect of user behaviour. For example, travellers may depart a little late to reduce experienced congestion time, shift to another mode, or cancel the trip completely. Additionally, this might result in delays for travellers who do not travel along the failed infrastructure object. Likewise, a simple multiplication of assumed increase in travel time for a group of travellers does not suffice.

Therefore, we introduce the Disruption Transport Model [2] that simulates decisions made by travellers during infrastructure closures, both planned (e.g. maintenance) and unplanned (e.g. sudden failure caused by a natural hazard or ageing infrastructure). We focus on infrastructure failures in the European TEN-T network, consisting of the main roads, railways and inland waterways, for both passenger and freight traffic. We use a novel approach of modelling the region around the infrastructure disruption in a very detailed manner, whereas the rest of Europe is modelled in a more basic way (Fig. 1). This enables us to model impacts of disruptions in high detail, whereas also effects throughout Europe are considered, within reasonable computation time. The output of our model can be incorporated in advanced LCC analysis to consider effects of user delays in developing maintenance plans.

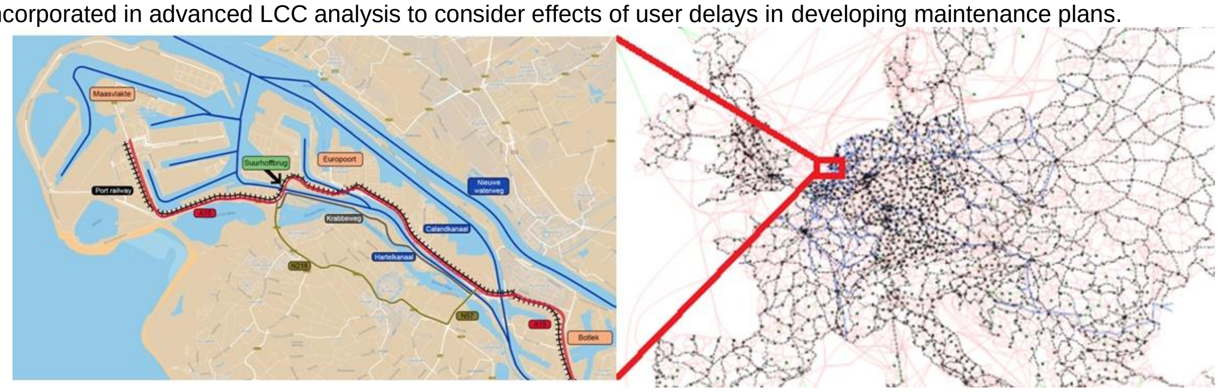

Fig. 1. *Example split of Port of Rotterdam into a local disruption (left) and a global spill-over model covering Europe (right).*

References:

1. M. Liu, D. Frangopol, 2006. Optimizing Bridge Network Maintenance Management under Uncertainty with Conflicting Criteria: Life-Cycle Maintenance, Failure, and User Costs. Journal of Structural Engineering, 132(11), 1835-1845.
2. M.S. van der Tuin, A.J. Pel, 2019. SAFE-10-T Deliverable D2.2 Report on Network Model.

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InfraQuest COMPETENCE CENTRE FOR ROADS & STRUCTURES

Improving durability of asphalt pavement by means of Hydronic Pavement

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ABSTRACT:

The asphalt pavement lifetime is strongly influenced by the variation of material temperatures; during the summer, the surface of asphalt layers could reach up to 70°C [1], which causes the formation of ruts in the surface while in winter, at low temperatures, thermal cracking takes place. These distresses lead to decrease service life of the asphalt pavement and, as a consequence, increase the cost for maintenance, because of early replacement. There are different possibilities to keep material temperatures oscillating in a specific temperature span, and as a consequence, the formation of rutting and thermal craking can be significantly reduced and, therefore, the durability of the asphalt pavement is enhanced [2] [3]. Studies focusing on temperature control through Hydronic Pavements by means of a network of embedded pipes within the layer structure, found that desired material properties are contrarious. Since the materials are responsible for the transport of energy, their thermal properties need to be taken into account [2]. The aim of this contribution is to propose a concept for Hydronic Pavement that can enhance the durability of asphalt pavement with a suitable mix design that provides an appropiate balance between the thermal conductivity and absorptive capacity of the asphalt material.

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References:

[1] S. Wu, M. Cheng, J. Zhang, "Laboratory investigation into thermal response of asphalt pavements as solar collector by application of small-scale slabs" Journal of Applied Thermal Engineering 31, 1582-1584., 2011

[2] R. Hess, A. Abdul-Zahra, A. Wagner, H. Grafmuller, C. Karcher, K. Kubanek, R. Roos, M. Bucherl, K. Schaber, M. Steffen and I. Bach, "Tempered Road System – Feasibility Study," *Federal Ministry of Transport, Building and Urban Development, Fachverlag NW im Carl Schünemann Verlag*, Bremen, 2013.

[3] R. Hess, T. Shulz, B. Steinhauser, B. Steinauer, D. Kemper, I. Petry and R. Wagner, "Potential of geothermal energy as a contribution to the winter road service," *Federal Ministry of Transport Building and Urban Development*, 2012.