LCM 2019 WORKSHOP — iaLcce —

Workshop on
Life Cycle Management
27-29 October Rotterdam

InfraQuest
COMPETENCE CENTRE FOR ROADS & STRUCTURES

Life-cycle management of civil infrastructure integrating risk, resilience and sustainability

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ABSTRACT:

In their decades- or even centuries-long life-cycle, civil structures and infrastructure systems are facing threats from structural deterioration, increasing demand and various natural and man-made hazards. In wake of the recent disasters, it has been demonstrated repeatedly that civil infrastructure plays a central role in the preparedness, resistance, response, and recovery of communities under adverse events. Recently, the American Society of Civil Engineers (ASCE) outlined the Grand Challenge for civil engineers — "to significantly enhance the performance and value of infrastructure projects over their life cycles by 2025 and to foster the optimization of infrastructure investments for society". To fulfil this challenge, the civil engineering profession needs to rethink and innovate life-cycle management philosophies and methods. This presentation overviews the life-cycle management with emphasis on the techniques recently developed at Lehigh University [1]. These techniques integrate life-cycle risk, lifetime resilience, and overall sustainability in the decision-making process of various managerial actions throughout the service life of infrastructure assets (e.g. maintenance, repair, retrofitting, and rebuilding).

As a performance indicator, life-cycle risk combines failure probability of structures with failure consequences. Given the limitation of financial resources, this combination provides a more rational appraisal of intervention needs of infrastructure assets. The importance of network-level risk assessment is highlighted in particular [2]. Lifetime resilience [3,4] is a novel concept proposed to embed resilience analysis into the life-cycle management of deteriorating structures. It can consider the interaction between long-term structural deterioration and punctuated performance disturbance due to multiple hazards. Finally, sustainability-informed decision-making is introduced to cover social and environmental aspects of life-cycle intervention actions. This allow for the shift from the conventional life-cycle cost analysis to overall life-cycle sustainability assessment [5], one step further towards the solution for the ASCE Grand Challenge.

References:

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