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Current and Future Directions towards Civil Infrastructure 4.0

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The ageing energy and transport structures alongside with the extreme climatic conditions, the limited financial and human resources pose significant challenges for the long-term resilience of critical civil infrastructure. Cascading effects of structural failures to other types of critical infrastructure have been evident by many recent cases, such as the Oroville dam incident (2017), with substantial costs for asset owners, insurers and maintainers and significant disruption to civil society.

The last two decades, there is a growing trend that employs Information Communication Technology (ICT) and Operational Technology (OT) systems in industrial sectors to improve the control and maintenance of various industrial systems. The intelligent autonomous management in the industrial sector is entitled Industry 4.0 (I4.0) and involves advanced capabilities to managers and asset owners (Kagermann et al., 2013). These include autonomous real-time decision making, bottom-up participatory approaches for data gathering, self-diagnostic features, predictive maintenance and adaptive control based on a number of parameters from different scientific areas. The transferability of such developments in different sectors such as civil infrastructure could therefore enhance substantially the management and as a result the long-term resilience of structural systems.

This study aims to introduce this upcoming trend that is entitled Civil Infrastructure 4.0 (CI4.0) and primarily focuses on the Intelligent Asset Management. CI4.0 aims to enlarge the focus from the single structure to the infrastructure system perspective. The principles of CI4.0 are presented for smart infrastructure systems which are primarily based on monitoring systems (Michalis et al., 2015) coupled with artificial intelligent methods (Valyrakis et al., 2015) and Virtual and Augmented Reality systems that enable to obtain real-time and forecasted insights that enable autonomous decision making with minimum human intervention. These decisions and actions are derived based on a number of factors including a combination of climatic risks, together with engineering, social and economic parameters. Examples of recent failure incidents with interconnected effects of infrastructure systems are presented. The study finally focuses on main aspects with regards to the interoperability and adaptive capabilities between structures towards enhancing the decision-making processes and the proactive asset management of civil infrastructure systems.

References:

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