Study on stability assessment of a bridge structure subjected to flooding loads

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The significant change in climate is evident from the records of increased temperature, changed precipitation pattern, increased frequency of extreme weather events like storms, floods, and so forth, and like other infrastructure, bridges also suffer the consequences of these climate change. Recent assessments have suggested hydraulic actions in shape of floods as the major cause of bridges collapses in Mozambique.

Bridges subjected to flooding loads may fail due to scour, bank erosion, hydraulic forces on piers and hydraulic forces on the superstructures. However, actions to prevent failure of bridges due to lateral stability of superstructures during this these extreme events are usually not prioritized, as these arts are commonly designed assuming that the water level will never reach the bridge soffit (bottom of girder) during its lifecycle.

For the case of Mozambique, a research to investigate the vulnerability of the bridge superstructures failure as a response to the scenario from the last flood event, characterized with water levels exceeding the height of main bridges, is supported by the fact that significant part of bridges in Mozambican road network having been designed based on the Portuguese design code named RSA (1961) which only refer to hydrodynamics pressure on piers, neglecting the possibility of development of lateral forces due to flooding on the superstructure.

The mechanism of bridge behavior when subjected to forces induced by floods was studied based on the hydrodynamic interaction system and considering a Mozambican design situation. The bridge loadings were estimated using reliable flood history and rainfall data from DNRH (National Directorate of Water Resources), combined to an existing concrete girder bridge carrying traffic over one of the most important rivers in Mozambique.

To establish a better understanding, an analytical approach based on the principles stated by FWHA (Federal Highway Administration) and PWRI (Public Works Research Institute) experiences was carried out and compared supported by a numerical analysis performed through OpenFOAM, a Volume of Fluid (VOF) software aimed to simulate the interaction between an incompressible fluid and a rigid body.

The estimation of bridge functionality was performed through the evaluation of strength of different connection modes, namely, friction connection between concrete girder and steel bearing, bolted connection and application of anchor bars.

The study reveals that more detail is taken on the PWRI approach and the values are more conservative, but in general the results have a very good agreement.