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VULNERABILITY ASSESSMENT OF BRIDGES EXPOSED TO SCOUR IN A MULTI_HAZARD ENVIRONMENT BY UAV MEASUREMENTS

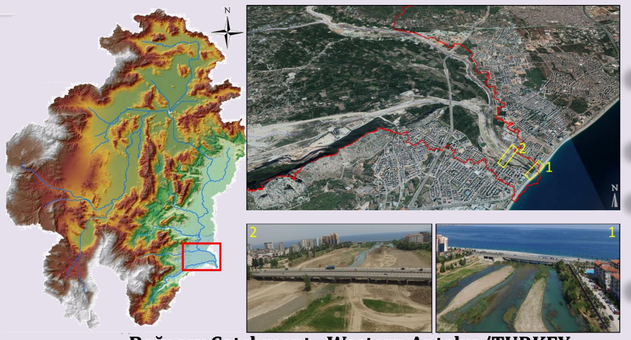
Okan ÖZCAN[1], Orkan ÖZCAN[2]

[1] *Akdeniz University, Civil Engineering, Antalya, Turkey – **ookan@akdeniz.edu.tr***

[2] *ITU - EIES- Istanbul Technical University, Eurasia Institute of Earth Sciences, 34469 Istanbul, TURKEY – ozcanork@itu.edu.tr*

IMPORTANCE & AIM OF THE STUDY

- Bridge foundation scour is the most common cause for the failure of highway bridges. The assessment of local scouring mechanism around bridge piers provides information for decision-making regarding the pile footing design, predicting the safety of bridges under critical scoured conditions, and as a result, may help prevent unnecessary loses.
- Since scour in bridges is the water-induced erosion of soil particles around bridge foundations, the loss of lateral load capacity at bridge foundations may induce bridges to become highly vulnerable to failure when the effects of scour and floods are combined.
- In this study, high definition 3D models of the flood plain and the amount of current scour in bridge piles were acquired by Unmanned aerial vehicle (UAV) based measurements which provide a practical approach and bring high precision solutions considering traditional measurement systems.

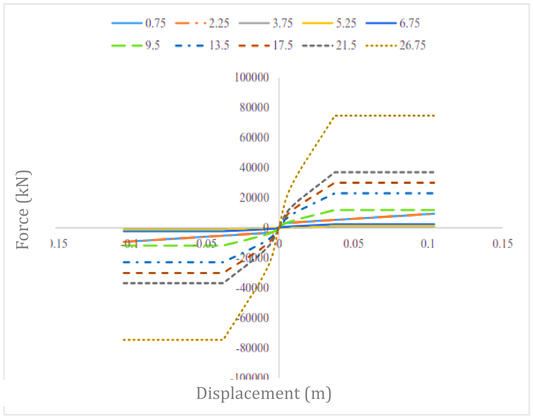


Boğaçay Catchment - Western Antalya/TURKEY

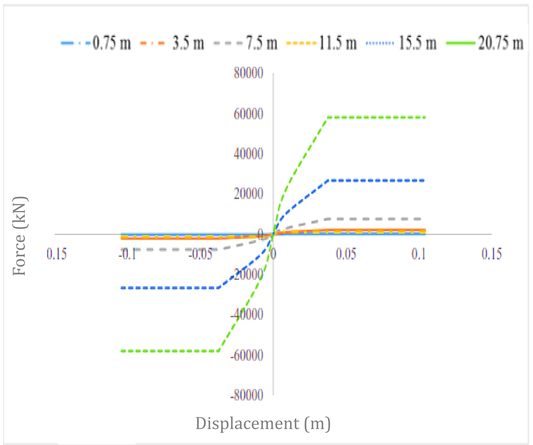
CONCLUSIONS

- The present study evaluated the performance of bridges with reinforced concrete (RC) pile foundations under the effects of local scour and flood. Thus, a RC bridge constructed over Boğaçayı in Antalya, Turkey was selected as the case study.
- The soil-pile foundation-structure interaction was implemented in the finite element models of pile groups.
- The multi-hazard performance of the bridge was evaluated under the maximum predicted scour depth and corresponding flood load.
- In conclusion, as the scour depth increased the fundamental periods, shear forces and the bending moments were observed to increase while the pile lateral load capacities diminished. Therefore, it was ascertained that the scour substantially deteriorated the performance of the bridge under multi-hazard environment.

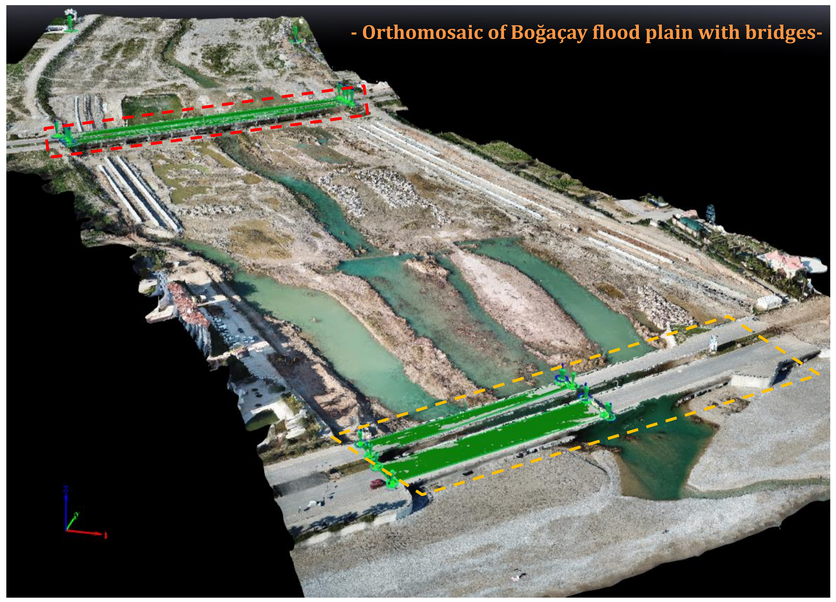
- The nonlinear soil spring properties at pile half-length for sand layers before scouring -

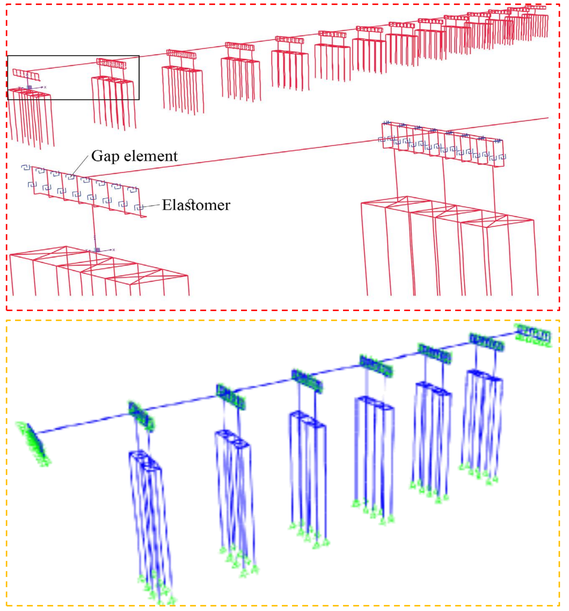


- The nonlinear soil spring properties at pile half-length for sand layers after scouring -

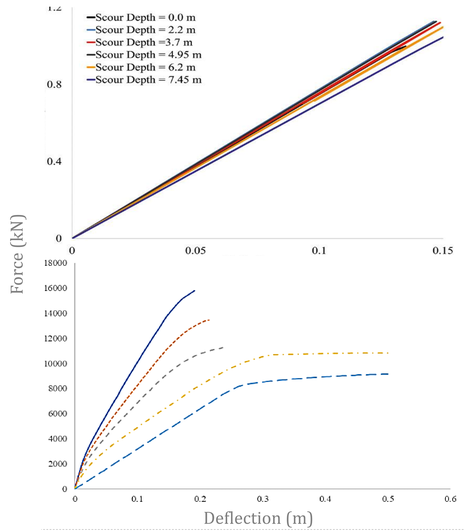


- Orthomosaic of Boğaçay flood plain with bridges-

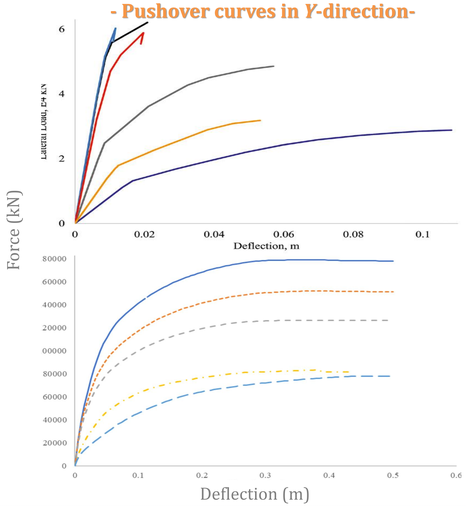




- Pushover curves in *X*-direction-



- Pushover curves in *Y*-direction-



RESULTS

- The vulnerability of the bridge was assessed under flood loading considering the predicted scour amount. The maximum flood loads according to different return periods (5, 20, 50, 100 and 500 years) and the corresponding maximum scour depths were determined by HEC-RAS software.
- As a result, the outputs were regarded as input parameters for the evaluation of lateral behavior of the bridge under consideration.
- The amount of scour occurred in bridge piers was determined realistically, and the behavior of bridge under scour effects was investigated. In the light of the attained scour measurements and expected scour after a probable flood event, the behavior of scour induced RC bridge was determined by pushover analyses under seismic loadings.
- Six different scour depths concentrated only on the mid piers was observed to have a negligible influence on the modal characteristics and the lateral performance in the longitudinal direction regarding lateral stiffness and strength.
- The performance points were evaluated regarding four methods as described in the guidelines of ATC-40 (Applied Technology Council, 1996), FEMA- 356 (Council B.S.S., 2000), and FEMA-440 (Federal Emergency Management Agency, 2005) (for Equivalent Linearization method – FEMA-440EL and Displacement Modification method – FEMA-440DM).