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HORIZON 2020

Analysis of Reinforced Concrete Structures through the use of Artificial Neural Networks (ARCSNN)

Dr. Demetrios M. Cotsovos , Associate Professor
Senior Director of Studies for Civil Engineering
Institute of Infrastructure and Environment
School of Energy, Geoscience, Infrastructure & Society
Heriot-Watt University

Summary

This work was funded by HORIZON-2020 (H2020-660545) and was carried out by Dr Gregoria Kotsovou (Marie Currie Research Fellow) and Dr Afaq Ahmad (PhD researcher) under the supervision of Dr Demitrios M. Cotsovos.

This work resulted in the development of a computational tool which employs Artificial Neural Networks (ANNs) for accurately predicting the behavior of individual reinforced concrete structural components (beams, T-beams, columns and beam-column sub-assemblages).

The Artificial Neural Networks (ANNs) were trained through the use of published test data (stored in purpose-built databases) and their predictions were compared to their counterparts obtained from relevant design standards and an alternative assessment method. The latter comparative study revealed shortcomings in current code provisions.

The trained ANNs where subsequently used for the development of a new structural analysis procedure capable of accurately predicting the behaviour of RC frame structures by employing hybrid artificial neural network finite element analysis (ANN-FEA) models to realistically represent the structures at hand.

The proposed procedure requires significantly less computational resources compared to more traditional structural analysis methods based purely on the finite element method and can be used to enhance existing structural analysis packages employed in practice.

Conclusions highlight

- ANNs were found to provide an effective tool capable of objectively analyzing the available test data and quantifying the effect of specific parameters on certain important characteristics of RC structural behaviour

- They were also successfully employed to assess the accuracy of the predictions provided by the available design codes for reinforced concrete structures and an alternative assessment method (the Compressive Force Path Method - CFP). Comparative studies revealed that the predictions obtained from the ANNs and CFP method provide a closer fit to the experimental values compared to their counterparts obtained by current RC design codes

- The predictions of the newly proposed ANN-FEA structural analysis procedure were found to be in good agreement with their counterparts obtained by experiment or analysis through the use of the well-known FEA package ABAQUS. The case studies considered also revealed that the proposed method is capable of providing accurate predictions in less time and without requiring significant computational resources

Publications

Kotsovou, G., Ahmad, A., Cotsovos, D. M., & Lagaros, N. D. (2019). Reappraisal of methods for calculating flexural capacity of reinforced concrete members. Proceedings of the Institution of Civil Engineers–Structures and Buildings 173(4): 279–290. https://www.icevirtuallibrary.com/doi/10.1680/jstbu.18.00110

Ahmad, A., Kotsovou, G., Cotsovos, D.M., Lagaros, N.D. (2018) Assessing the accuracy of RC design code predictions through the use of artificial neural networks. International Journal of Advanced Structural Engineering, 10 (4), pp. 349-365. DOI: 10.1007/s40091-018-0202-4

Kotsovou, G.M., Cotsovos, D.M. (2018) Shear failure criterion for RC T-beams. Engineering Structures, 160, pp. 44-55.DOI: 10.1016/j.engstruct.2017.12.044

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Project Website

https://cordis.europa.eu/project/id/660545
https://www.egis.hw.ac.uk/arcsenn/