World Academy of Science, Engineering and Technology
International Journal of Civil and Environmental Engineering
Vol:14, No:7, 2020

Non-Linear Finite Element Investigation on the Behavior of CFRP Strengthened Steel Square HSS Columns under Eccentric Loading

Authors : Tasnuba Binte Jamal, Khan Mahmud Amanat

Abstract : Carbon Fiber-Reinforced Polymer (CFRP) composite materials have proven to have valuable properties and suitability to be used in the construction of new buildings and in upgrading the existing ones due to its effectiveness, ease of implementation and many more. In the present study, a numerical finite element investigation has been conducted using ANSYS 18.1 to study the behavior of square HSS AISC sections under eccentric compressive loading strengthened with CFRP materials. A three-dimensional finite element model for square HSS section using shell element was developed. Application of CFRP strengthening was incorporated in the finite element model by adding an additional layer of shell elements. Both material and geometric nonlinearities were incorporated in the model. The developed finite element model was applied to simulate experimental studies done by past researchers and it was found that good agreement exists between the current analysis and past experimental results, which established the acceptability and validity of the developed finite element model to carry out further investigation. Study was then focused on some selected non-compact AISC square HSS columns and the effects of number of CFRP layers, amount of eccentricities and cross-sectional geometry on the strength gain of those columns were observed. Load was applied at a distance equal to the column dimension and twice that of column dimension. It was observed that CFRP strengthening is comparatively effective for smaller eccentricities. For medium sized sections, strengthening tends to be effective at smaller eccentricities as well. For relatively large AISC square HSS columns, with increasing number of CFRP layers (from 1 to 3 layers) the gain in strength is approximately 1 to 38% to that of unstrengthened section for smaller eccentricities and slenderness ratio ranging from 27 to 54. For medium sized square HSS sections, effectiveness of CFRP strengthening increases approximately by about 12 to 162%. The findings of the present study provide a better understanding of the behavior of HSS sections strengthened with CFRP subjected to eccentric compressive load.

Keywords : CFRP strengthening, eccentricity, finite element model, square hollow section
Conference Title : ICACE 2020 : International Conference on Advances in Civil Engineering
Conference Location : Tokyo, Japan
Conference Dates : July 14-15, 2020