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Nonlinear Finite Element Analysis of Optimally Designed Steel Angelina™ Beams

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Abstract : Web-expanded steel beams provide an easy and economical solution for the systems having longer structural members. The main goal of manufacturing these beams is to increase the moment of inertia and section modulus, which results in greater strength and rigidity. Until recently, there were two common types of open web-expanded beams: with hexagonal openings, also called castellated beams, and beams with circular openings referred to as cellular beams, until the generation of sinusoidal web-expanded beams. In the present research, the optimum design of a new generation beams, namely sinusoidal web-expanded beams, will be carried out and the design results will be compared with castellated and cellular beam solutions. Thanks to a reduced fabrication process and substantial material savings, the web-expanded beam with sinusoidal holes (Angelina™ Beam) meets the economic requirements of steel design problems while ensuring optimum safety. The objective of this research is to carry out non-linear finite element analysis (FEA) of the web-expanded beam with sinusoidal holes. The FE method has been used to predict their entire response to increasing values of external loading until they lose their load carrying capacity. FE model of each specimen that is utilized in the experimental studies is carried out. These models are used to simulate the experimental work to verify of test results and to investigate the non-linear behavior of failure modes such as web-post buckling, shear buckling and vierendeel bending of beams.

Keywords : steel structures, web-expanded beams, angelina beam, optimum design, failure modes, finite element analysis
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