

Printing Imperfections: Development of Buckling Patterns to Improve Strength of 3D Printed Steel Plated Elements

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Abstract : Traditional structural steel manufacturing routes normally produce prismatic members with flat plate elements. In these members, plate instability in the lowest buckling mode often dominates failure. It is proposed in the current study to use a new technology of metal 3D printing to print steel-plated elements with predefined imperfection patterns that can lead to higher modes of failure with increased buckling resistances. To this end, a numerical modeling program is carried out to explore various combinations of predefined buckling waves with different amplitudes in stainless steel square hollow section stub columns. Their stiffness, strength, and material consumption against the traditional structural steel members with the same nominal dimensions are assessed. It is found that depending on the slenderness of the plate elements; it is possible for an 'imperfect' steel member to achieve up to a 30% increase in strength with just a 3% increase in the material consumption. The obtained results shed some light on the significant potential of the new metal 3D printing technology in achieving unprecedented material efficiency and economical design in the future steel construction industry.

Keywords : 3D printing, additive manufacturing, buckling resistance, steel plate buckling, structural optimisation

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