INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title:
Lean Duplex Stainless Steel (LDSS) Flat Oval Hollow Columns under Axial Compression – a Finite Element Study

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SHORT ABSTRACT

Construction industry has been witnessing an increasing use of stainless steel members, especially, when there is a demand for higher strength to weight ratio, good corrosion resistance, low maintenance cost, high ductility, impact resistance, fire resistance, durability, recyclability etc., despite their higher material cost as compared to carbon steel. However, it has now become possible to offer cost-effective stainless steel material, with the introduction of a relatively new class of stainless steel called Lean Duplex Stainless Steel (LDSS / LDX 2101 / EN 1.4162 / UNS 32101). LDSS offers relatively cheaper cost (as compared to austenitic stainless steel), higher strength, acceptable weldability and fracture toughness properties, improved high temperature properties, etc. It may be mentioned that, in a recently amended EN 1993-1-4 (2006; A1:2015), LDSS has been included. Thus, in this thesis, an attempt has been made to systematically investigate the structural behavior of aesthetically pleasing and relatively new LDSS flat oval (a composite section of flat and curve elements) hollow columns under pure compression.

Parametric study on the structural behaviour (e.g. deformation modes, load capacity) of fixed ended LDSS flat oval hollow section stub column, is presented, considering variation of l_f (flat length), r (curvature radius), t (thickness), keeping w (flat plate spacing) and h (height of column) constant, using the finite element (FE) analyses. Based on the study, an expression has been proposed for calculating the effective thickness of curve elements of slender ($w/t \geq 40$) sections, for reliable load capacity predictions when used with ASDM, AS/NZS 4673, and EN 1993-1-4 equations. Applicability of DSM (Direct Strength Method) and CSM (Continuous Strength Method) have also been verified.

The FE study has been extended to analyse the structural behavior of fixed ended LDSS flat oval hollow slender columns, of stocky and slender section, under axial compression, by varying l_f, r , t, w and h. From the investigation, three key deformation mechanisms have been identified. Appropriateness of EN 1993-1-4, AS/NZS 4673, DSM and modified versions of AS/NZS 4673 and DSM for the design of LDSS flat oval hollow slender cross-section have been examined.

Additionally, the study of LDSS flat oval hollow stub columns, has been extended further by incorporating single square perforations. The effects of single square perforation in relation to perforation size and location (i.e. along transverse and longitudinal directions, on both the flat and curve elements) have been investigated. A design approach based on ASDM has been proposed (based on modified effective thickness) to address the inclusion of single square perforation for the estimation of design capacity of single square perforated flat oval LDSS hollow columns.