INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Torsional capacity of Lean Duplex Stainless Steel Semi-Elliptical Hollow Section members – a finite element study**

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SHORT ABSTRACT

Lean Duplex Stainless Steel (LDSS) offers the combined benefit of low initial cost (due to low nickel content of ~ 1.5%) and relatively superior material property (high strength, good corrosion resistance, good weldability, fracture toughness etc.) and making LDSS as one of the promising grades of stainless steel family. It may be mentioned that, lean duplex stainless steel has been included for the first time in EN 1993-1-4 (2006) *via* a recent amendment (A1:2015). Adequate understanding of the LDSS material, its performance under various structural loadings and efficient design rules are vital to further disseminate the structural uses of lean duplex stainless steel members (such as LDSS tubular sections) among engineers and architects, in the construction domain.

Hence, in this thesis, a systematic parametric study was conducted on cold-formed lean duplex stainless steel (EN 1.4162 (LDX 2101) / UNS S32101) semi-elliptical hollow section members under torsion, using finite element (FE) analysis. Effects of geometric parameters of semi-elliptical hollow section *viz*. length of curve element, aspect ratio and size of section, and member length, on its torsional capacity were investigated. Based on the FE study, it was observed that, while higher curve length, higher section aspect ratio and lager section size were found to provide higher torsional capacity; member length was observed to affect the torsional capacity insignificantly. Based on the results obtained from the parametric study, torsion design equations were proposed, following the formats of EN 1993-1-4: 2006+A1 (2015) and Direct Strength Method. Further, a new deformation based method (in line with Continuous Strength Method) was also proposed.

The study was extended to perforated cold-formed lean duplex stainless steel semi-elliptical hollow section members subjected to torsion. A single circular perforation at mid length of member, positioned either on flat or curve element of semi-elliptical hollow member, of varying perforation size were considered as parameters of the study. Influence of perforation on torsional capacity was assessed. Based on the parametric study, it was found that perforation on curve element is more deteriorating to member torsional capacity compared to the one on flat element. Additionally, the reduced torsional strength due to the influence of perforation was also seen to be dependent on perforation size and cross-section slenderness. Design equations were then proposed for perforated members (considering both perforation size and cross-section slenderness).

The study was supplemented by an investigation on the recovery of reduced torsional capacity (equivalent to that of unperforated torsional strength) for various stiffener patterns around perforation. Four different stiffener patterns (i.e. horizontal, vertical, square frame, ring) of various dimensions were adopted. Based on the study, it was found that, both square and ring stiffeners were able to achieve the unperforated strength, as compared to horizontal and vertical stiffeners. Based on the study for LDSS SEHS member, optimum stiffener dimensions capable of partial or full recovery of torsional capacity, were arrived.