Local Bucklingand Inelastic behaviour of Flexural Members Fabricated from 800MPa Tensile-Strength Steel

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Summary

Flexural tests on full-scale I-shaped beams, built up from high-strength steels (HSB800 and HSA800) with a nominal tensile strength of 800 MPa, was carried out to study the effect of flange slenderness on flexural strength and rotation capacity. The primary objective was to investigate the appropriateness of extrapolating current stability criteria (originally developed for ordinary steel) to high-strength steel. The performance of high-strength steel specimens was very satisfactory from the strength, but not from the rotation capacity, perspective. The inferior rotation capacity of high-strength steel beams was shown to be directly attributable to the absence of a distinct yield plateau and the high yield ratio of the material. When a higher rotation capacity is required as in plastic design, the testing clearly showed that high-strength steel beams were vulnerable to brittle fracture when full-height transverse stiffeners were welded to the tension flange in the plastic hinge region. Residual stress measurements reconfirmed that the magnitude of the residual stress is almost independent of the yield stress of the base metal.

Keywords: high strength steel; local buckling; width-thickness ratio; rotation capacity; tensile fracture; full-scale test.

1. Introduction

Constructional steelswith a yield stress higher than 450MPa (65ksi) are often called as high-strength steel. Flexural tests of steel beams made of high-strength steel with a yield stress of 690 MPa or greater (ASTM A514) date back as early as the late 1960s (McDermott 1969). The A514 steelhas not been popular in civil engineering applications because of the difficulties in weldability, high cost, and insufficient deformation capacity in the form of shapes when used for beams and girders (Galambos et al. 1997; Bjorhovde 2004). However, because of technological advances in steel making nowadays, high-strength steels can be economically produced by the thermo-mechanical control process (TMCP), and can provide good weldability and notch toughness. The benefits of high-strength steels combined with economical steel making have stimulated a great interest in developing high-strength steels for use in building and bridge applications in Korea and other countries.

Recently two types of high-strength steels, HSB800 and HSA800, with anominal tensile strength of 800MPaare under development in Korea for bridge and building applications, respectively. Table 1 summarizes the target material specifications for both steels. HSA800 has a tighter control on material properties as it specifies an upper limit on the yield ratio (0.85) as well as tensile strengths. Carbon equivalent to ensure weldability is comparable.

The local and lateral stability criteria contained in the 2005 AISC Specification for flexural member design were developed based on tests of ordinary steels. Ordinary steels have a stress-strain

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