Figure 6: Failure Modes of LSBs with Unstiffened Web Openings (Test Specimens 1 to 4)
(a) Test Specimen 5 with Screw Fastening Arrangement 1 (20 screws)

(b) Test Specimen 6 with Screw Fastening Arrangement 2 (8 screws)

Figure 7: LSBs with 102 mm Web Openings and 152x152x1.6 mm Plate Stiffeners
Shear Failure

(a) Test Specimen 7 with 152x168x3.2 mm Plate Stiffeners and Screw Fastening
Arrangement 2

Shear Failure

(b) Test Specimen 8 with 152x168x4.8 mm Plate Stiffeners and Screw Fastening
Arrangement 2

Figure 8: LSBs with 102 mm Web Openings and Thicker Plate Stiffeners
(a) Test Specimen 9 with 102 mm Web Openings, LSB Stud Stiffeners and Screw Fastening Arrangement 2

(b) Test Specimen 10 with 127 mm Web Openings, LSB Stud Stiffeners, 177x168x1.6 mm Plate Stiffeners and Screw Fastening Arrangement 3

Figure 9: LSBs with LSB Stud and Plate Stiffeners
(a) Test Specimen 11 with Screw Fastening Arrangement 3

(b) Test Specimen 12 with Screw Fastening Arrangement 4

(c) Test Specimen 13 with Welded Plate Stiffeners

Figure 10: LSBs with 102 mm Web Openings and Larger 202x168x3.0 mm Plate Stiffeners
(a) Test Specimen 14 with 227x168x5 mm Plate Stiffeners and Screw Fastening Arrangement 3

(b) Test Specimen 15 with 227x168x5 mm Plate Stiffeners and Screw Fastening Arrangement 5

(c) Test Specimen 16 with 177x168x4.8 mm Plate Stiffeners and Screw Fastening Arrangement 3

**Figure 11: LSBs with 127 mm Web Openings and Plate Stiffeners**
Figure 12: LSB with 60 mm Web Openings Using 160x168x1.6 mm Plate Stiffeners and Screw Fastening Arrangement 3
Figure 13: Applied load versus Deflection for LSB with 102 mm Stiffened Web Openings (Test 5)

Note: Vertical and lateral deflections were measured as shown in Figure 5.
Figure 14: Applied load versus Lateral Deflection for LSB with 102 mm Web Openings and Plate Stiffeners (Tests 5 and 6)
Figure 15: Applied load versus Deflection for 200x45x1.6 LSB with 102 mm Web Openings and LSB Stud Stiffeners (Test 9)
Figure 16: Comparison of Load-Deflection Curves of LSBs with and without Stiffened Web Openings
Figure 17: Recommended Plate Stiffener System for LSBs with Web Openings

- $t_{Stiff} = 1.6 \text{ mm} \quad 0.20 < \frac{d_{wh}}{d_1} \leq 0.35$
- $t_{Stiff} = 3.0 \text{ mm} \quad 0.35 < \frac{d_{wh}}{d_1} \leq 0.60$
- $t_{Stiff} = 5.0 \text{ mm} \quad 0.60 < \frac{d_{wh}}{d_1} \leq 0.75$

Lesser of $d_1$ and $(d_{wh} + 100 \text{ mm})$