Bolted Splices in Compression – Splice Plate Member Checks

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Introduction
The Steel Construction New Zealand publication *Steel Connect* (SCNZ 14.1 and SCNZ 14.2) provides structural engineers with a rapid and cost-effective way to specify the majority of structural steelwork connections, in accordance with accepted fabrication industry norms. Specification of these connections also facilitates the development of reliable cost estimates by designers, fabricators, consulting quantity surveyors and constructors.

Steel Connect contains bolted beam splice (BBS) and bolted welded beam splice (BWBS) connections. An example of a bolted beam splice connection is shown in figure 1. A number of limit states are checked. The connection capacity is based on the limit state that results in the lowest joint capacity. In *Steel Connect* there are checks for the flange splice design tension loads and a flange plate compactness requirement. However there are no specific checks for flange plate member (buckling) under compression axial forces. This article sets out the plate member axial capacity requirements.

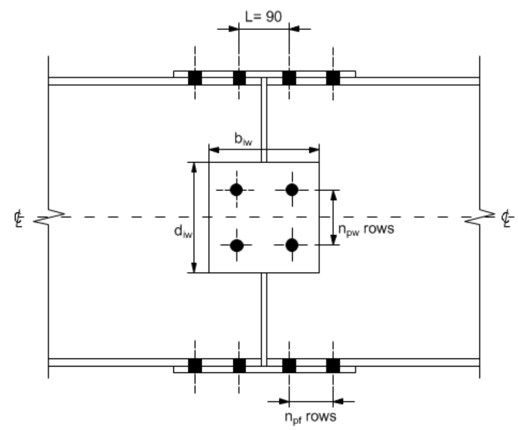

Figure 1: Bolted Splice – Non Bearing (Hyland et al, 2008)

Splice Plate Member Axial Compression Design Strength Limit
The splice plate member axial compression capacity is determined using clauses 6.3.2 and 6.3.3 of NZS 3404 (SNZ, 2007). The flange splice plate will be treated as a column element.

The effective length (L_e) of the splice plate compression member is:

$$L_e = k_e L$$

where:

L = length between bolt rows each side of the splice
k_e = the member effective length factor determined in accordance with 4.8.3 NZS 3404
$k_e = 0.7$

The splice plate member axial compression capacity is:

$$\phi N_{ic} = \alpha_c \phi N_{is}$$

where:

ϕN_{is} = the design section capacity of the splice plate

$$\lambda_n = \left(\frac{L_e}{r}\right)\sqrt{k_f}\sqrt{\left(\frac{f_{yi}}{250}\right)}$$

r = radius of gyration
k_f = the form factor, taken as 1.0
f_{yi}=plate yield stress (MPa)

Values of the member slenderness reduction factor (α_c) may be obtained directly from table 6.3.3(2) NZS 3404 using the value of the modified member slenderness (λ_n) and the appropriate member constant (α_b) given in table 6.3.3(1) NZS 3404. For splice plates α_b = 0 should be used.

Alternatively, α_c may be calculated as follows.

$$\alpha_c = \xi\left\{1 - \sqrt{\left[1 - \left(\frac{90}{\xi\lambda}\right)^2\right]}\right\}$$

$$\xi = \frac{\left(\frac{\lambda}{90}\right)^2 + 1 + \eta}{2\left(\frac{\lambda}{90}\right)^2}$$

$$\lambda = \lambda_n + \alpha_a \alpha_b$$

$$\eta = 0.00326\ \ \lambda - 13.5\ \ \geq 0$$

$$\alpha_a = \frac{2100\ \ \lambda_n - 13.5}{\lambda_n^2 - 15.3\lambda_n + 2050}$$

Example of Determining Flange Splice Member Axial Compression Design Strength Limit
An 8mm thick flange plate is selected for a bolted splice. The distance between bolt rows is 90mm. The yield stress (f_{yi}) is 250 MPa. What is the flange compression splice plate member axial compression capacity expressed as a percentage of plate section capacity?

Determine modified member slenderness (λ_n *)*

$$\lambda_n = \left(\frac{L_e}{r}\right)\sqrt{k_f}\sqrt{\left(\frac{f_y}{250}\right)}$$

where:

$$L_e = k_e L = 0.7 \text{ x } 90 = 63\text{mm}$$

$$r = 0.289 t_{if} = 0.289 \text{ x } 8 = 2.312$$

$$k_f = 1.0$$

$$f_y = 250\,\text{MPa}$$

$$\therefore \lambda_n = \left(\frac{63}{2.312}\right)\sqrt{1}\sqrt{\left(\frac{250}{250}\right)} = 27.2$$

Determine member slenderness reduction factor (α_c)

Using table 6.3.3(2) NZS 3404 for $\alpha_b = 0$:

$$\alpha_c = 0.95$$

$\therefore$ splice plate member axial compression capacity is 95% of splice plate section capacity

References

Hyland C., Cowie K., Clifton C., Structural Steelwork Connections Guide: Design Procedures, SCNZ 14.1 2007, Steel Construction New Zealand (Inc), Manukau City, 2008

Hyland C., Cowie K., Bird G., Structural Steelwork Connections Guide: Connection Tables, SCNZ 14.2 2007, Steel Construction New Zealand (Inc), Manukau City, 2008

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