Eccentrically Braced Frames Lateral Restraint of Link Bottom Flange

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Eccentrically Braced Frame, EBF, Restraints

Introduction

Eccentrically braced frames are required to be laterally restrained at both the top and bottom of the active link member ends to ensure reliable performance in a seismic event. There are occasions when direct lateral restraint to the bottom flange is not permitted. In this instance the lateral restraint of the bottom flange of the active link end can be achieved from minor axis bending of the brace. This article presents a simplified procedure for this approach by a way of a design example.

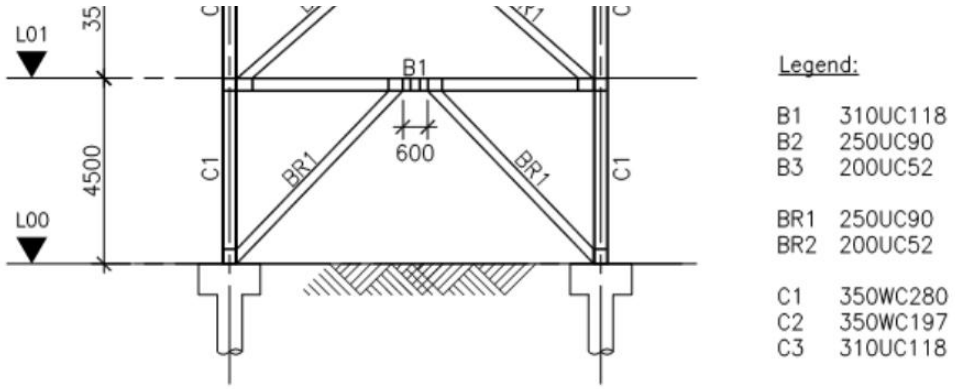


Figure 1: EBF Bottom Frame Example

NZS 3404 Lateral Restraint Requirements for the Active Links of EBFs

The lateral restraint requirements for the active links of EBFs are covered in NZS 3404 cl 12.11.6. Top and bottom flanges of EBF active link members are to be restrained at the ends of the active link member. The Steel Structures Standard requires that the restraints have the capacity to resist a design axial force equal to 2.5% of the beam flange design capacity, with a total lateral displacement of less than 4mm.

Design Example

Design Example Description

The design example covers the active link end restraints of the bottom frame (310UC118) of an eight storey EBF frame. Refer to figure 1.

The bottom frame width (centreline to centreline) is 9m. The frame height is 4.5m. The brace is welded to the collector beam bottom flange. The vertical stiffeners in the collector beam at this location have an area equivalent to the brace flange area.

The purpose of the design example is to check if the lateral restraint of the bottom flange of the active link end can be achieved from minor axis bending of the brace. Lateral restraint is provided at the top flange of the active link end. Lateral restraint is provided at the bottom end of the brace.

Lateral Restraint Force at Bottom Flange
NZS 3404 cl 12.11.6 requires that the restraints have the capacity to resist a design axial force equal to 2.5% of the beam flange design capacity. This is principally required to prevent flexural induced lateral instability in the collector beam.

The restraint is also required to prevent the brace compression induced twist at the intersection point of the brace with the collector beam panel zone. Therefore the restraint should also have the capacity to resist a design force equal to 2.5% of the brace design capacity derived compression force.

Given that the brace compression overstrength force is:

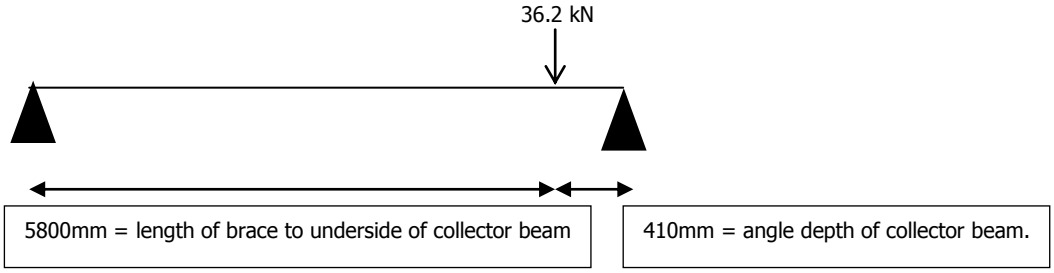
$N^c_{brace} = 1283kN$

Then

$N^*_{restraint} = \max\ 0.025\phi f_y A_{fb}, N^*_{brace}$

$N^*_{restraint} = \max\ 0.025 \times 0.9 \times 280 \times 307 \times 18.7 \times 10^{-3}, 0.025 \times 1283\ = \max\ 32.1, 36.2\ = 36.2\,kN$

Simplified Model
A simplified model is used to check the stiffness requirements of NZS 3404 are met. The brace is modelled as simply supported. The length is equal to the length along the brace between the brace bottom restraint and the collector beam top flange. The restraint force calculated above is applied where the collector beam bottom flange meets the brace. The property of the brace minor axis is used to determine the deflection at the restraint location.



From a 2D computer analysis software the deflection at the active link bottom flange locations is 1.1mm < 4mm limit from NZS 3404

The moment is equal to

$$M^*_y = \frac{36.2 \times 5.8 \times 0.41}{6.21} = 13.9\,kNm$$

The final step is to carry out a biaxial bending check for the brace with M^*_x from the inplane action and M^*_y from the restraint requirements.

Conclusion
This article presents an example to illustrate a simplified approach to meet the restraint requirements of the end of an active link bottom flange for an eccentrically braced frame by consideration of minor axis bending of the brace.

References
SNZ, Steel Structures Standard (Incorporating Amendments 1 and 2), NZS 3404:1997 Part 1 and 2, Standards New Zealand, Wellington, 2007