

## 4.4. DESIGN AND DETAILING RULES FOR FRAMES WITH CONCENTRIC BRACINGS

### 4.4.1. Design criteria

**4.4.1.1** – Concentric braced frames shall be designed so that yielding of the diagonals in tension will take place before failure of the connections and before yielding or buckling of the beams or columns.

**4.4.1.2** – Diagonal elements of bracings shall be placed in such a way that the structure exhibits similar load deflection characteristics at each storey in opposite senses of the same braced direction under load reversals. In this regard, the following rule should be met at every storey:

$$\frac{|A^+ - A^-|}{A^+ + A^-} \leq 0.05 \quad (4.10)$$

where  $A^+$  and  $A^-$  are the areas of the horizontal projections of the cross-sections of the tension diagonals, when the horizontal seismic actions have a positive or negative direction respectively.

### 4.4.2 Analysis

**4.4.2.1** – Under gravity load conditions, only beams and columns shall be considered to resist such loads, without taking into account the bracing members.

**4.4.2.2** – Diagonals shall be taken into account as follows in an elastic analysis of the structure for the seismic action:

- (a) In frames with diagonal bracings, only the tension diagonals shall be taken into account.
- (b) In frames with V bracings, both the tension and compression diagonals shall be taken into account.

**4.4.2.3** – Taking into account of both tension and compression diagonals in the analysis of any type of concentric bracing is allowed provided that all of the following conditions are satisfied:

- (a) Non-linear static (pushover) global analysis or non-linear time history analysis is used,
- (b) both pre-buckling and post-buckling situations are taken into account in the modelling of the behaviour of diagonals and,
- (c) background information justifying the model used to represent the behaviour of diagonals is provided.

### 4.4.3 Diagonal members

**4.4.3.1** – In frames with X diagonal bracings, the non-dimensional slenderness  $\bar{\lambda}$  as defined in EN 1993-1-1:2004 should be limited to:  $1.3 < \bar{\lambda} \leq 2.0$ .

**4.4.3.2** – In frames with diagonal bracings in which the diagonals are not positioned as X diagonal bracings, the non-dimensional slenderness  $\bar{\lambda}$  should be less than or equal to 2.0.