

## VOLUME 9 — TOLERANCES

*(Expanded – BS EN 1090-2:2018 + ISO 13920 + Eurocode 3)*

*(All organization names replaced with XXXXXX)*

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### 1. GENERAL REQUIREMENTS

#### 1.1 Scope

This section defines the dimensional tolerances for:

- Structural steel components
- Fabricated assemblies
- Welded joints
- Bolted connections
- Erected steel structures
- Base plates and anchor bolts

Tolerances ensure:

- Fit-up during assembly
  - Structural performance
  - Aesthetic alignment
  - Compatibility with other trades
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#### 1.2 Standards

Tolerances shall comply with:

- **BS EN 1090-2:2018 – Annex D**
- **ISO 13920 – General tolerances for welded constructions**
- **BS EN ISO 2768 – General tolerances**
- **BS EN 10034 – Structural steel I and H sections**
- **BS EN 10279 – Hot-rolled channels**
- **BS EN 1993-1-1 – Eurocode 3**

Where tolerances conflict, the most stringent requirement applies.

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#### 1.3 Execution Classes

Tolerances vary by Execution Class:

### Execution Class Tolerance Level

EXC1	Basic
EXC2	Standard (default)
EXC3	Enhanced
EXC4	High precision

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## 2. MATERIAL TOLERANCES

### 2.1 Hot-Rolled Sections

Shall comply with:

- **BS EN 10034** (I/H sections)
- **BS EN 10279** (channels)

Typical tolerances:

- Depth:  $\pm 3$  mm
  - Flange width:  $\pm 3$  mm
  - Web thickness:  $\pm 0.3$  mm
  - Straightness: L/1000
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### 2.2 Plates

Shall comply with:

- **BS EN 10029**

Typical tolerances:

- Thickness: Class A or B
  - Flatness: 3–7 mm per meter
  - Edge camber: L/1000
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### 2.3 Hollow Sections

Shall comply with:

- **BS EN 10210 / 10219**

Typical tolerances:

- Outside dimension:  $\pm 1\%$
- Wall thickness:  $\pm 10\%$
- Straightness:  $L/1000$

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### 3. FABRICATION TOLERANCES

#### 3.1 Member Length

Member Type	Tolerance
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Cut length	$\pm 2$ mm
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Fabricated length	$\pm 3$ mm
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Built-up girder	$\pm 5$ mm
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#### 3.2 Straightness

Member Type	Tolerance
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Beams	$L/1000$
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Columns	$L/750$
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Bracing	$L/500$
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#### 3.3 Squareness

- Deviation from  $90^\circ$ :  $\leq 2$  mm per 100 mm
- Maximum:  $\leq 6$  mm

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#### 3.4 Flatness of Plates

- $\leq 3$  mm per meter
- $\leq 6$  mm overall

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#### 3.5 Hole Tolerances

Shall comply with **BS EN 1090-2 Table 11**:

Hole Type	Tolerance
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Standard	+1.0 mm
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Oversized	+3.0 mm
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Short-slotted	+2.0 mm
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Long-slotted	+3.0 mm
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### 3.6 Web and Flange Deviation

- Web out-of-plane:  $\leq 3$  mm
  - Flange tilt:  $\leq 2^\circ$
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## 4. WELDING TOLERANCES

### 4.1 Weld Size

#### Weld Type Tolerance

Fillet weld +2 mm / –0 mm

Butt weld +1 mm / –0 mm

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### 4.2 Weld Alignment

- Misalignment:  $\leq 10\%$  of thickness
  - Root gap: per WPS
  - Angular distortion:  $\leq 3^\circ$
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### 4.3 Weld Profile

Shall comply with:

- ISO 5817 Quality Level B/C/D depending on EXC
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## 5. ASSEMBLY TOLERANCES

### 5.1 Fit-Up

- Gap between members:  $\leq 3$  mm

- Offset between members:  $\leq 2$  mm
  - Bearing surfaces: full contact required
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## 5.2 Bolt Hole Alignment

- Misalignment:  $\leq 2$  mm
  - Bolt insertion shall not require force
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## 5.3 Stiffener Alignment

- Deviation:  $\leq 3$  mm
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## 6. ERECTION TOLERANCES

### 6.1 Column Plumbness

Height (H)	Tolerance
$H \leq 10$ m	H/1000
$10$ m $< H \leq 30$ m	H/1500
$H > 30$ m	H/2000

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### 6.2 Beam Level

- $\pm 5$  mm over span
  - $\pm 10$  mm overall
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### 6.3 Beam Sweep

- L/1000
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### 6.4 Base Plate Position

- $\pm 3$  mm in plan
  - $\pm 2$  mm elevation
  - Rotation:  $\leq 1^\circ$
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## 6.5 Anchor Bolt Position

- $\pm 2$  mm in plan
  - $\pm 3$  mm projection
  - Verticality: H/100
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## 6.6 Bracing Alignment

- $\pm 5$  mm at connection points
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## 7. STRUCTURAL FRAME TOLERANCES

### 7.1 Gridline Position

- $\pm 5$  mm

### 7.2 Storey Height

- $\pm 5$  mm

### 7.3 Overall Building Drift

- H/1000
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## 8. SPECIAL TOLERANCES FOR HIGH-PRECISION STRUCTURES (EXC4)

Applicable to:

- Stadium roofs
- Long-span trusses
- Bridges (if included)
- Critical infrastructure

### Enhanced tolerances:

- Column plumbness: H/2000
  - Beam level:  $\pm 3$  mm
  - Hole alignment:  $\pm 1$  mm
  - Weld misalignment:  $\leq 5\%$  of thickness
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## 9. INSPECTION OF TOLERANCES

### 9.1 Measuring Equipment

- Calibrated laser levels
  - Total stations
  - Digital inclinometers
  - Vernier calipers
  - Feeler gauges
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## 9.2 Inspection Frequency

- After fabrication
  - After assembly
  - After erection
  - Before grouting
  - Before handover
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## 9.3 Documentation

Inspection reports shall include:

- Measured values
  - Tolerance limits
  - Deviations
  - Corrective actions
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## 10. NON-CONFORMANCE & CORRECTION

### 10.1 Non-Conforming Tolerances

Examples:

- Excessive sweep
  - Misaligned holes
  - Out-of-plumb columns
  - Incorrect beam level
  - Distorted plates
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### 10.2 Corrective Actions

- Mechanical straightening
  - Flame straightening
  - Re-drilling or reaming
  - Shimming (approved only)
  - Re-fabrication
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### **10.3 Re-Inspection**

All corrected items shall be re-measured and documented.