It is standard practice to design bolted end-plate connections as rigid splices. However, behind that apparent simplicity lies a nuanced plastic mechanism that must be handled with precision. What follows is a structured, expert-level framework grounded in the static (lower bound) theorem of plasticity.

STATIC (LOWER BOUND) THEOREM — DESIGN PHILOSOPHY

The resistance of the connection is established by assuming a **statically admissible** plastic stress field in the bolts and plates. The key requirements are:

- **Global equilibrium** with external actions is satisfied.
- **No component exceeds its design resistance.**
- Internal forces are **free to redistribute** plastically.

This freedom is not decorative—it is the engine of the method. It allows:

- Linearized compression blocks in plate contact zones.
- Concentration of tensile forces in the outermost bolt rows.
- Maximization of the internal lever arm z, and therefore bending resistance.

In short: you are not guessing the stress field—you are choosing the most efficient admissible one.

LOAD TRANSFER MECHANISMS — NO AMBIGUITY ALLOWED

Each action must have a clear and mechanically consistent load path:

- **Axial force (N) & bending moments (M)** → Bolt tension + plate-to-plate compression.
- **Shear (V)** → Bolt shear (shank resistance + bearing in plate).
- **Torsion (T)** → Distributed bolt shear ± friction (if preloaded).

If the load path is unclear, the design is wrong—even if the numbers “work”.

BOLTS UNDER COMBINED TENSION AND SHEAR

Verification follows the bilinear interaction from EN 1993-1-8:

$$\boxed{\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4\,F_{t,Rd}} \leq 1.0}$$

Where:

- $F_{v,Ed}$ = applied shear per bolt
- $F_{v,Rd}$ = shear resistance
- $F_{t,Ed}$ = applied tension
- $F_{t,Rd}$ = tension resistance

This interaction is not conservative fluff—it captures the real degradation of bolt capacity under multi-axial demand.

COMPRESSION TRANSFER — CONTACT MECHANICS

Compression is transmitted by direct plate contact, typically aligned with the compression flange.

Two critical points often overlooked:

- The resultant compression location defines the lever arm z.
- Even in nominally full compression, ≥25% of N must be transferable through bolts and plates (robustness requirement).

Ignoring this is how brittle failure modes sneak into “safe” designs.

STEP-BY-STEP DESIGN WORKFLOW

❶ **Geometry & Materials**

Define section (I/H profile), plate thickness, bolt layout, bolt class (8.8 / 10.9), and steel properties.

❷ **Compression Zone Definition**

Locate the effective contact area and its centroid → this fixes the internal lever arm.

❸ **Plastic Force Allocation**

Assign tensile forces to bolt rows (typically the farthest). Exploit redistribution to maximize efficiency—but stay admissible.

❹ **Bolt Checks**

- Tension resistance
- Shear resistance
- Bearing on plate
- Combined interaction (mandatory)

❺ **End-Plate Bending (T-Stub Behaviour)**

The plate behaves as a T-stub with possible prying forces.
Check the governing failure mode:

- Mode 1: full plate yielding
- Mode 2: combined bolt failure + plate yielding
- Mode 3: bolt failure

Prying is not a secondary effect—it can govern the design.

❻ **Connected Member Verification**

- Compression: flange/web crushing and stability
- Shear: web yielding and block tearing
- Local effects at the connection zone

DESIGN CHECKS AT A GLANCE

Component	Action	Verification Basis
Bolts	Tension	EN 1993-1-8 Cl. 3.6.1
	Shear	EN 1993-1-8 Cl. 3.6.1
	Bearing	EN 1993-1-8 Cl. 3.6.1
	Tension + Shear	Interaction formula
End Plate	Bending + prying	T-stub model (Cl. 6.2.4)
Connected Member	Compression / shear	Cl. 6.2.6 / Cl. 3.10.2

FINAL INSIGHT

A rigid splice is not “rigid” because we declare it so—it is rigid because we design it to be so, by deliberately shaping the plastic force flow to achieve strength, stability, and ductility.

Design the stress path. Control the mechanism. Build the performance.