MEMORIAL UNIVERSITY

Newfoundland & Labrador, Canada

Structural Steel Design
Plate Girders

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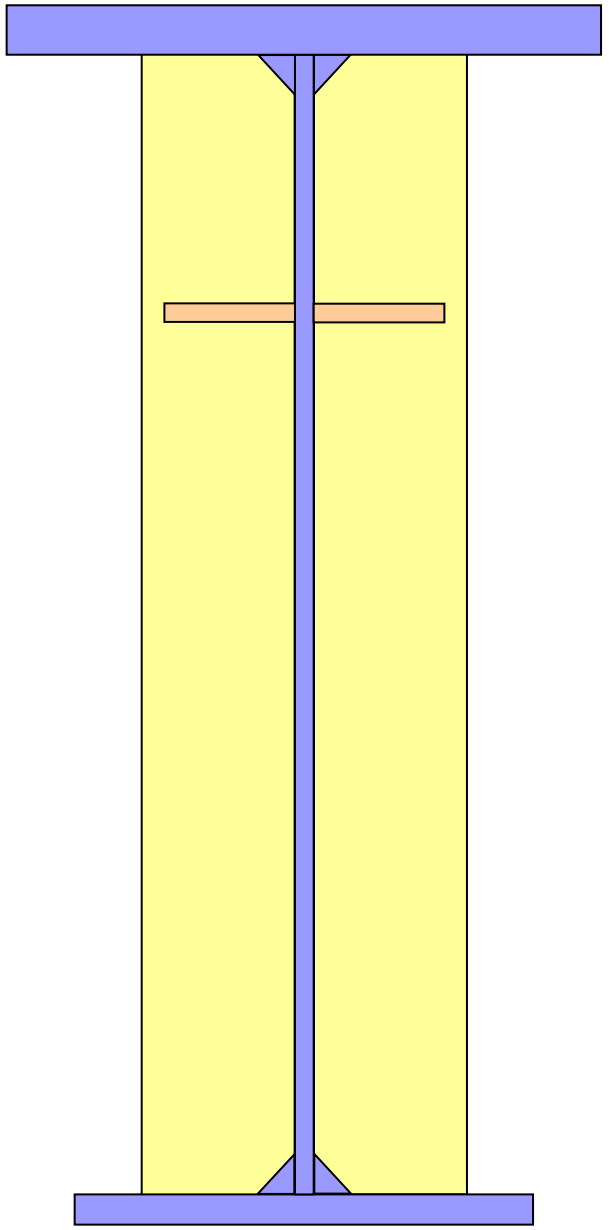
Plate Girders

- Deep girders
  - Three plates
  - Welded or bolted
  - Rolled sections not enough
  - Usually 3’-20’ deep
  - WWF sections in the handbook can be used
  - Web buckling
    - stiffeners
  - Variable c/s



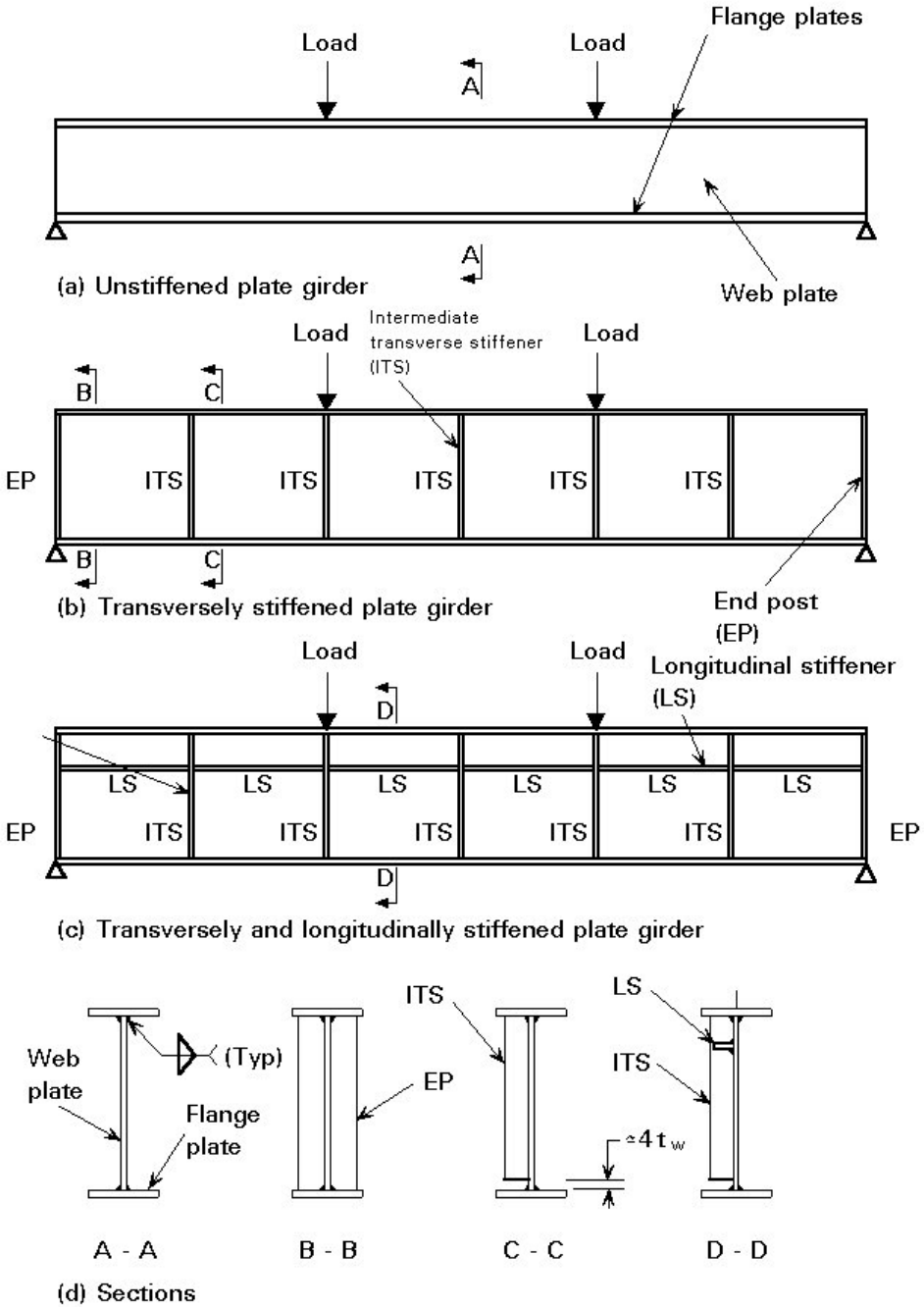


Figure 2 Stiffened and unstiffened plate girders

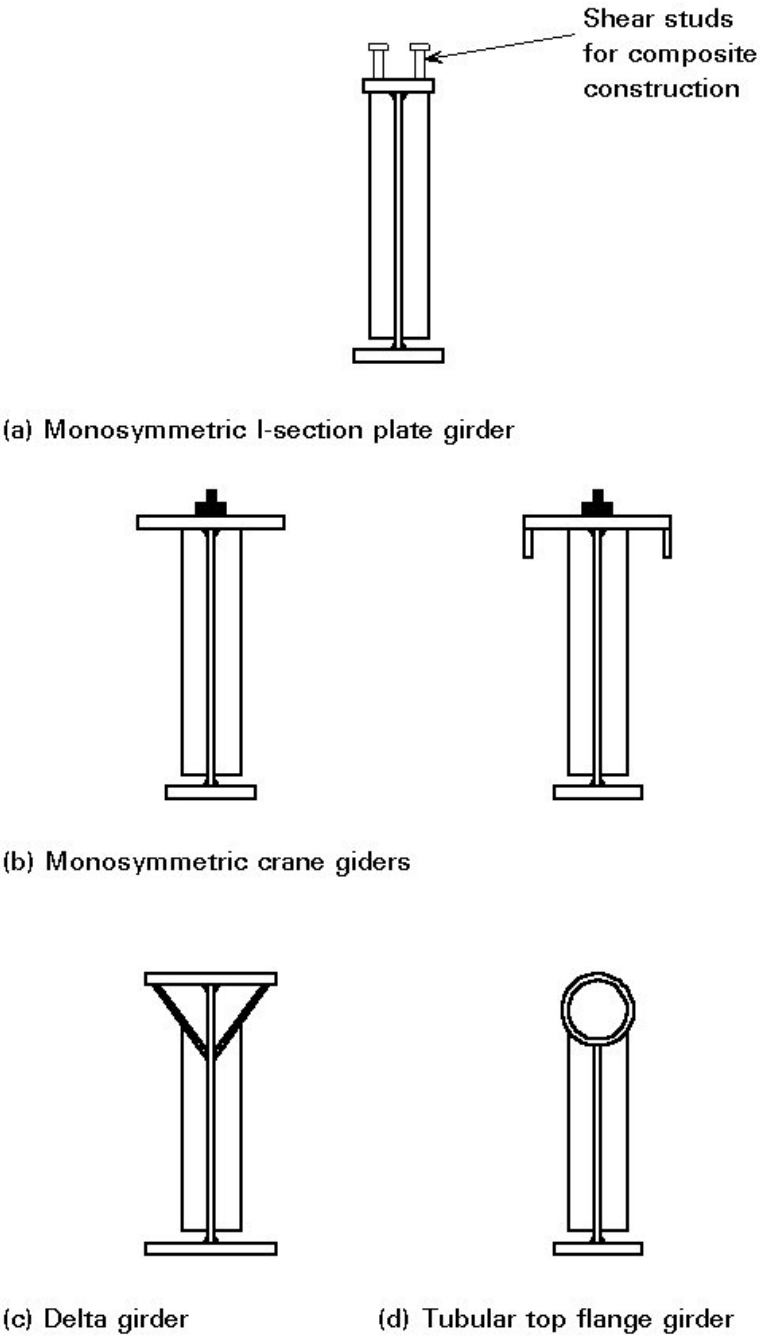


Figure 3 Plate girder cross-sections

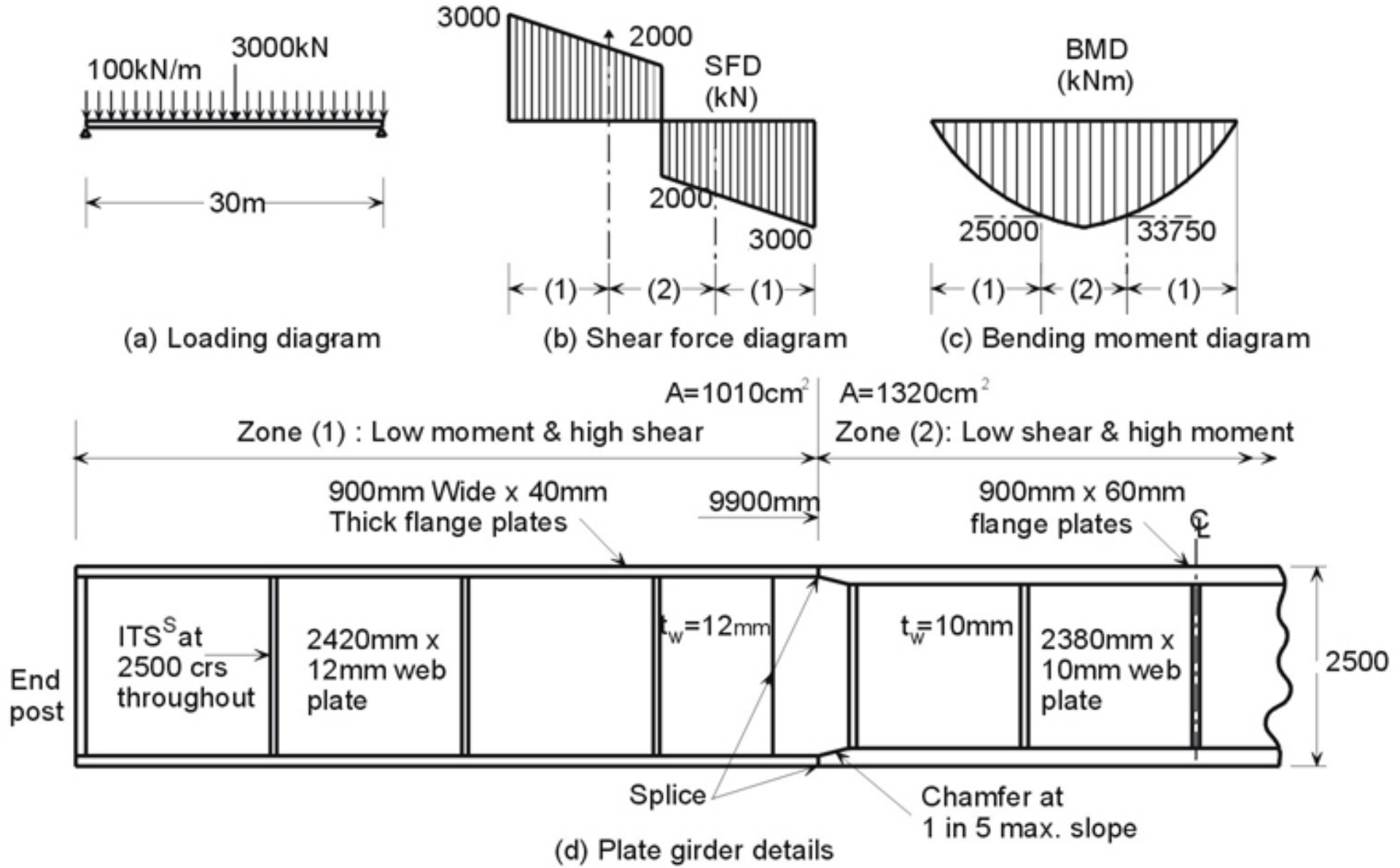


Figure 4 Plate girder with splice and variable cross-section

Plate Girders

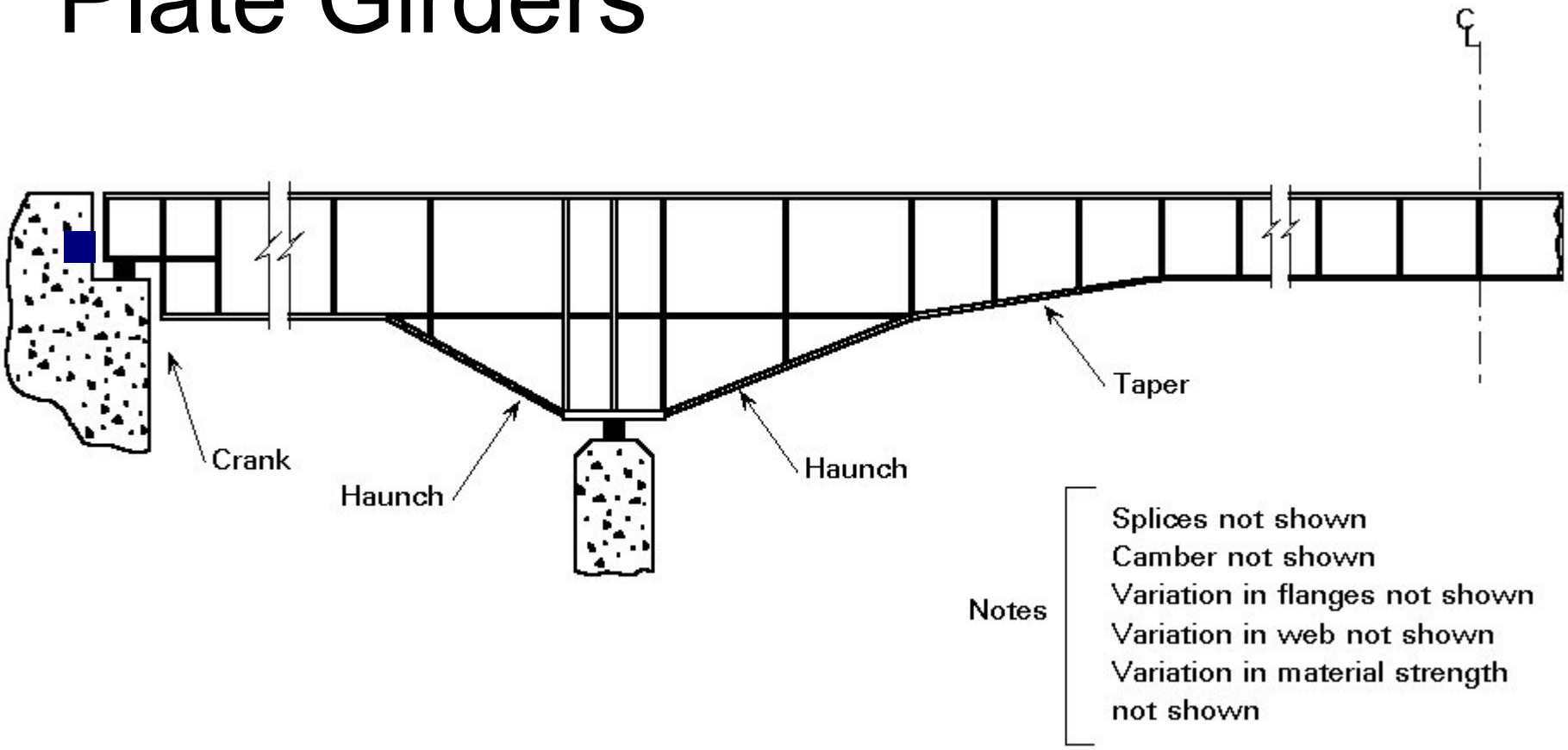


Figure 5 Plate girder with haunches, tapers and cranks

Plate Girders

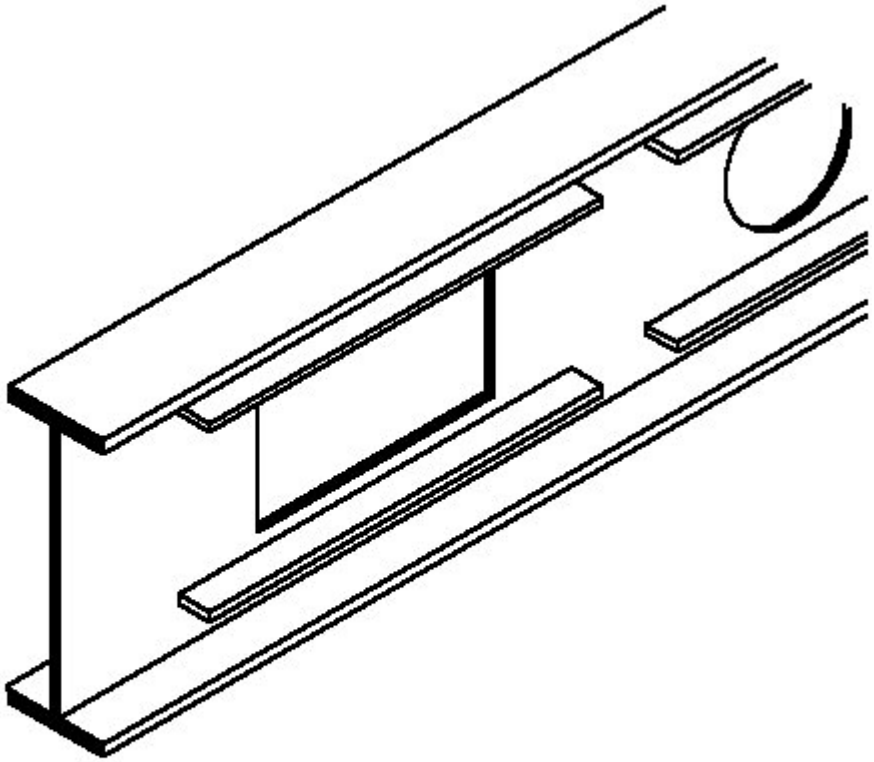
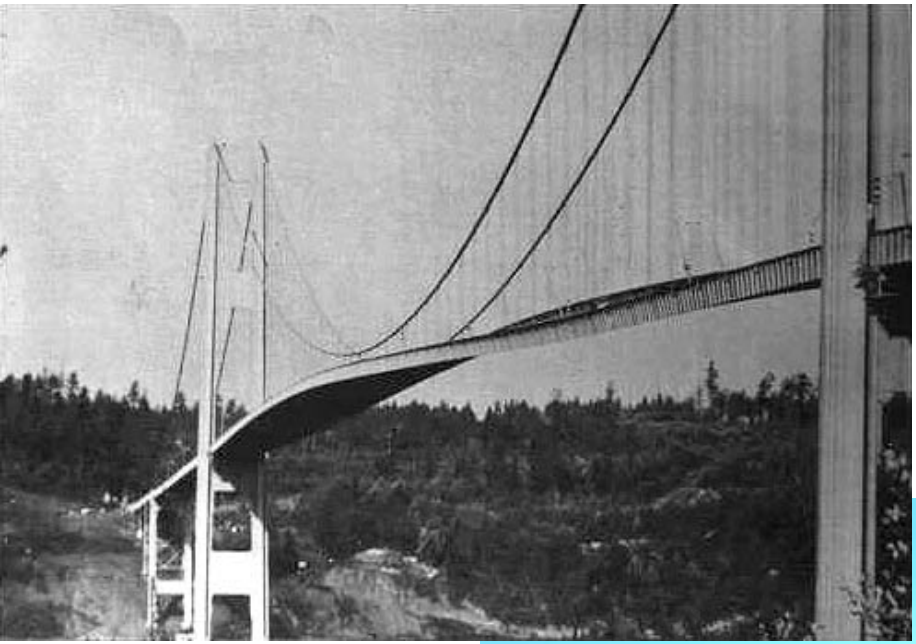


Figure 6 Plate girder with hole for services

Bridge girders



Beams in Bridges

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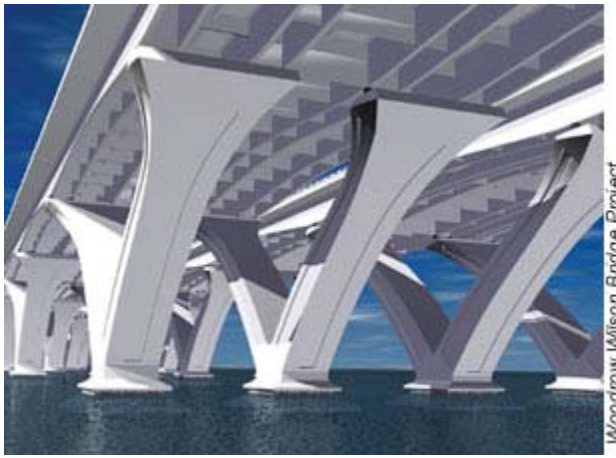
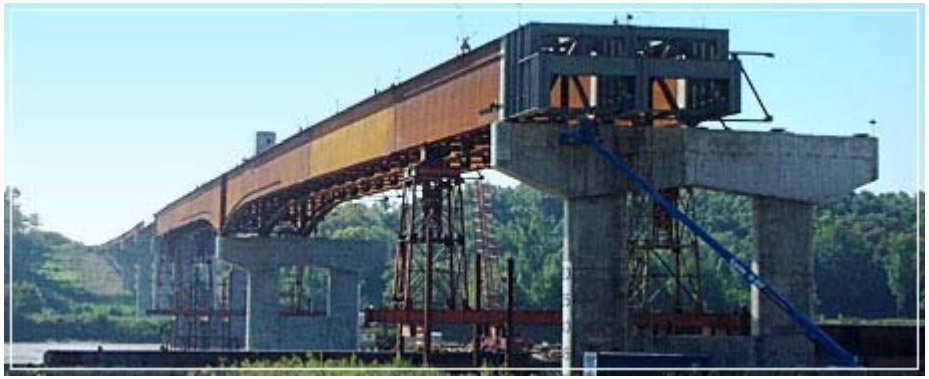


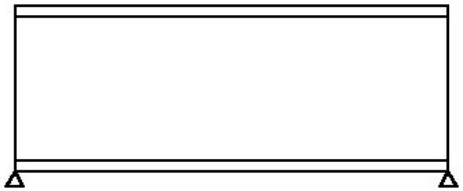
Plate girders



Fabrication

Plate Girders

- **Steel plate girders**
  - Class 3 flanges & class 4 webs
  - Reduce web area for M_r
  - Stiffen the web to increase V_r
- Useful in pure bending as well as in beam-columns
- **Design Clauses: CAN/CSA-S16**
  - Bending strength as per Clauses 13.6 & 7
  - Shear strength as per Clause 13.4
  - Local buckling check: Clause 11 (Table 2)
  - Special provisions: Clause 14
  - Deflection limits: Appendix D



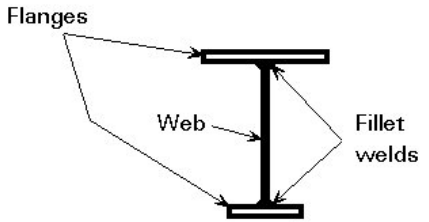


Figure 1 Plate girder composed of three plates

Plate buckling

- Different types of buckling depending on
  - b/t ratio
  - Webs and flanges have different limits
  - end conditions for plate segments
  - Use Table 2 for beams and beam-columns

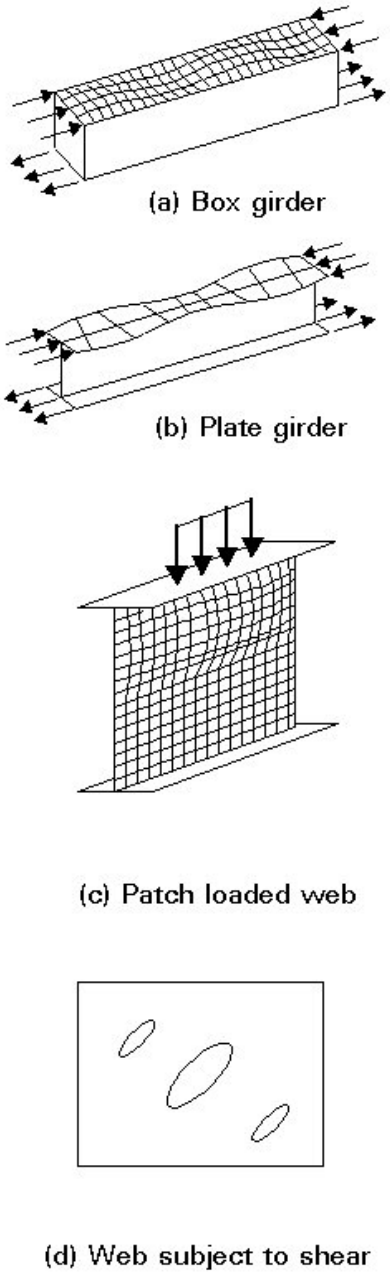


Figure 1 Types of plate buckling

Plate Girders

- Slender webs buckle easily due to shear or bending
  - Use reduced effective c/s

  or
  - Use reduced capacity

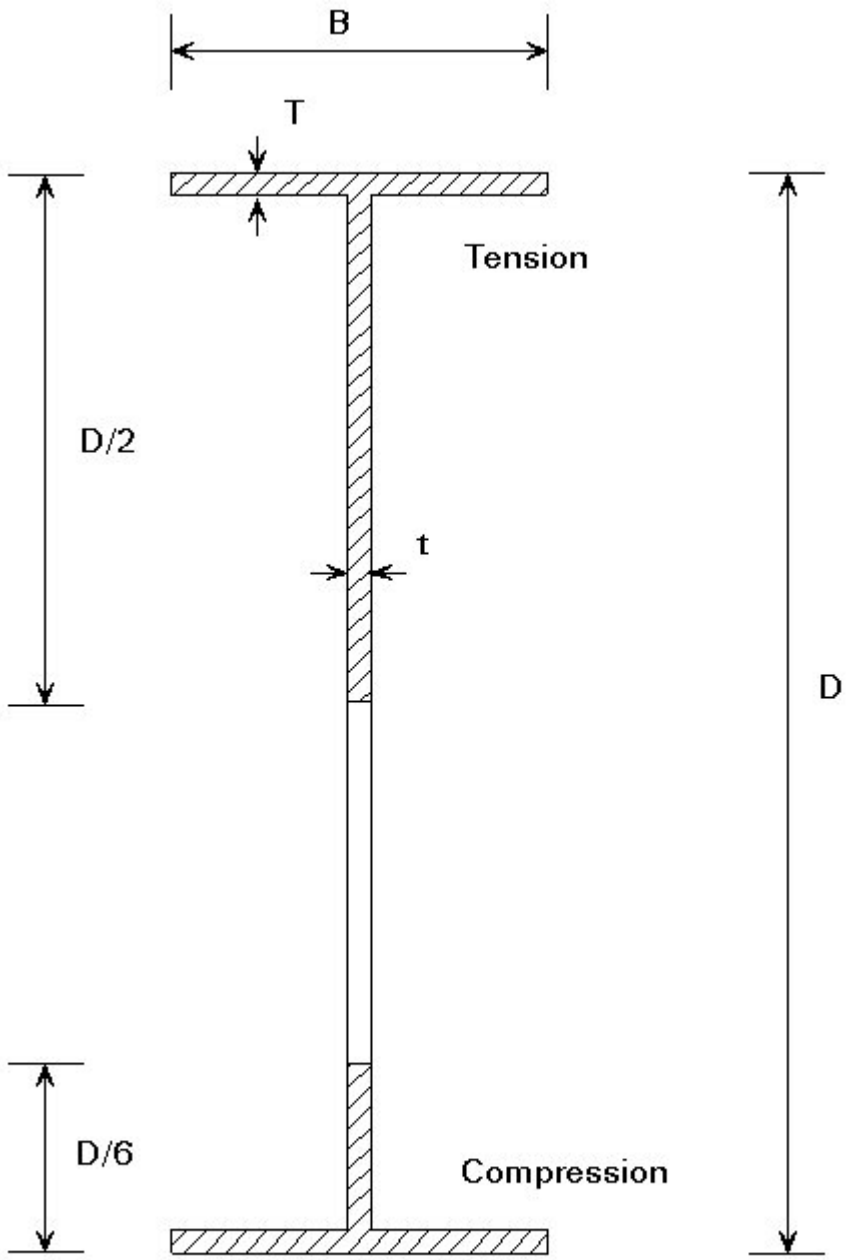
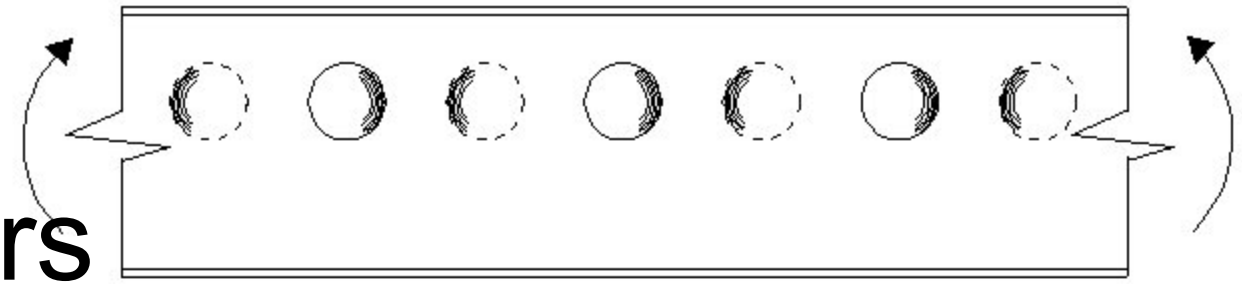


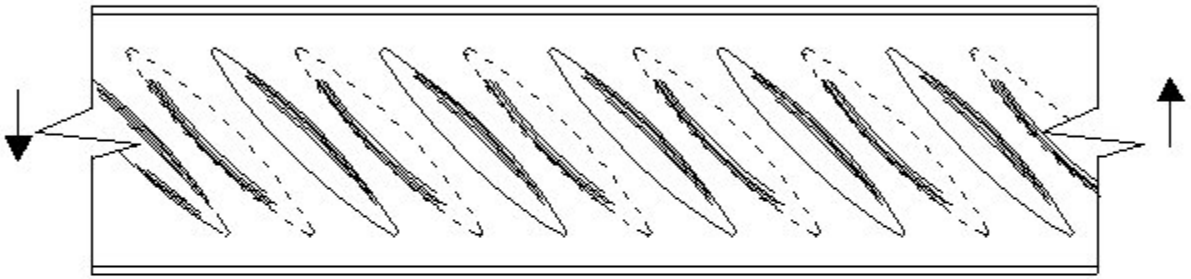
Figure 11 Reduced effective cross-section

Plate Girders

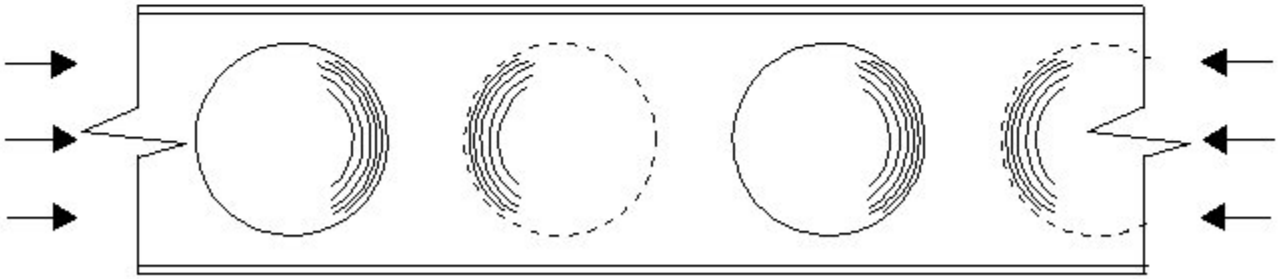


(a) Bending

- Slender webs buckle easily due to shear or bending



(b) Shear



(c) Compression

Web buckling

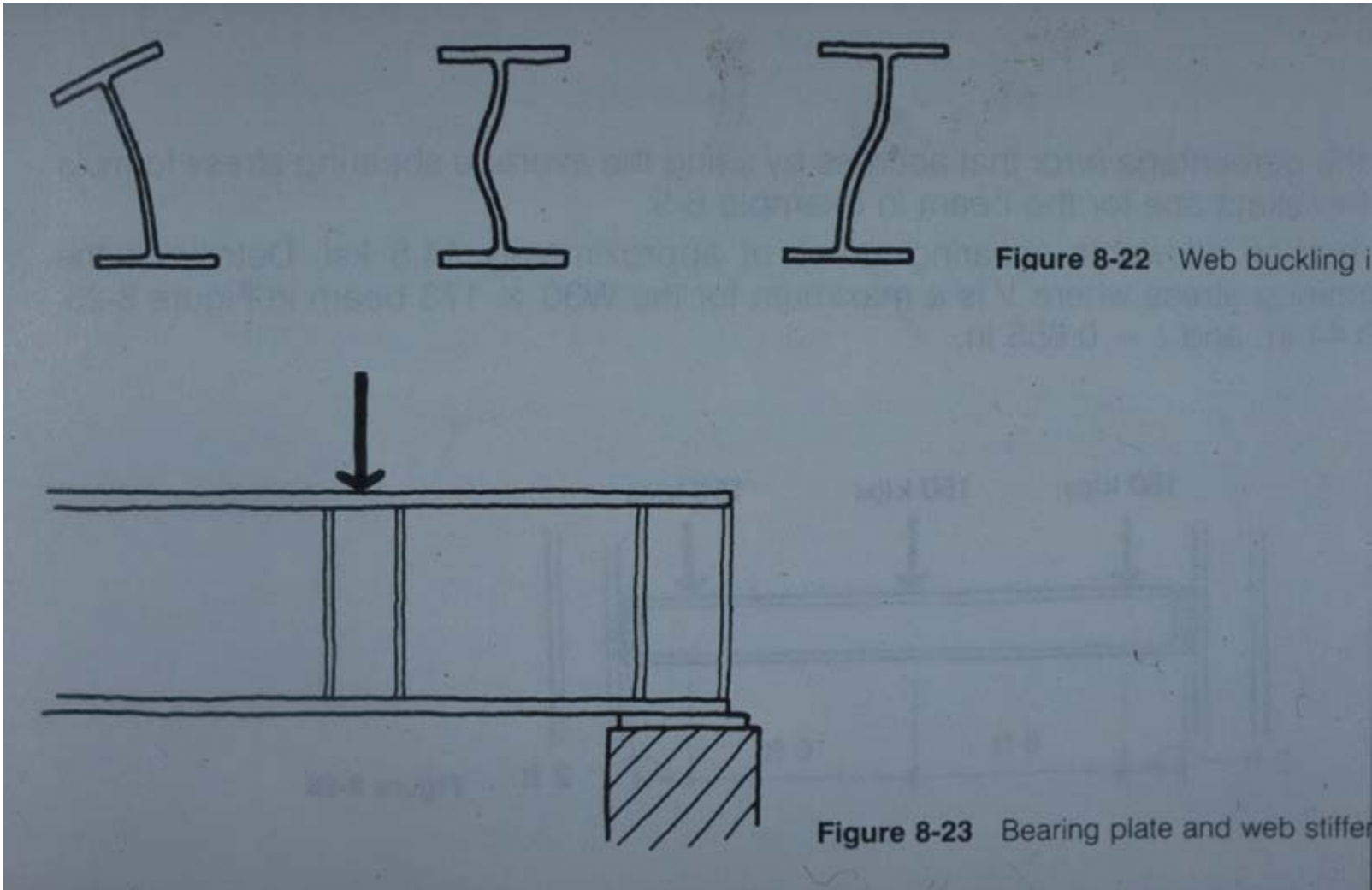


Figure 8-22 Web buckling i

Figure 8-23 Bearing plate and web stiffe

Plate Girders

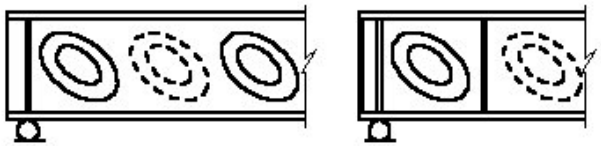
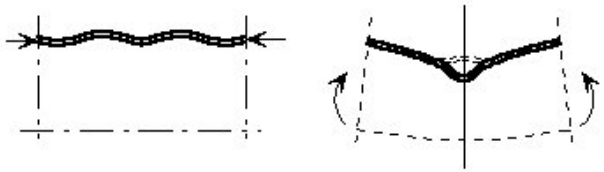
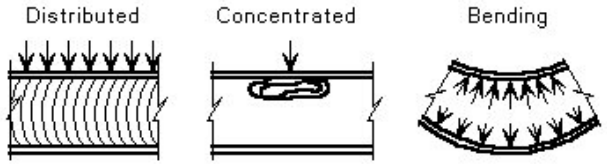
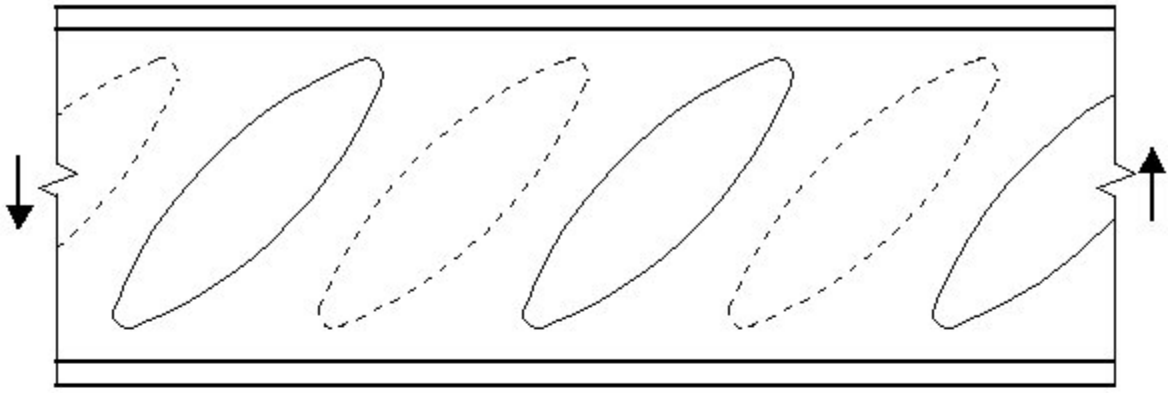
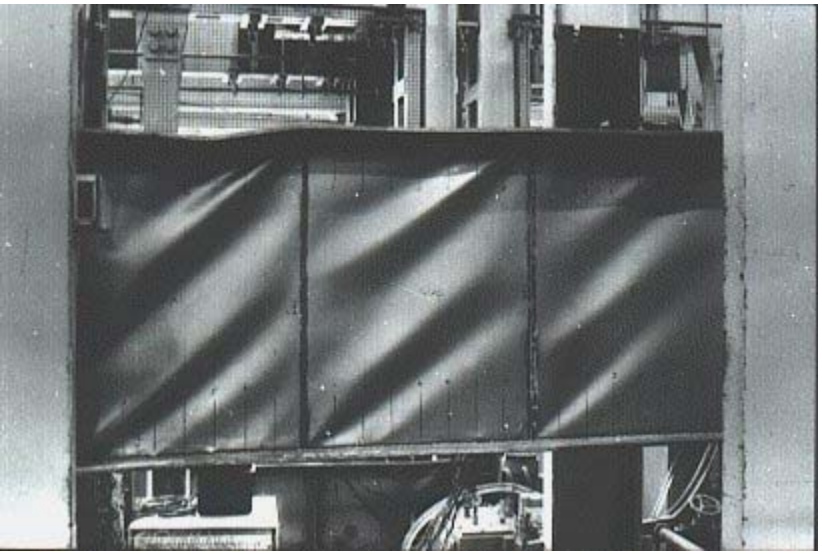
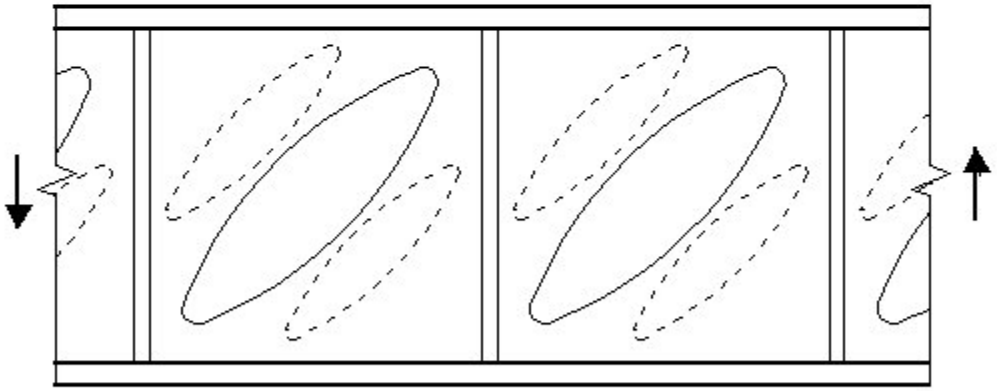
Buckling type	Illustration
Shear buckling of web	
Lateral-torsional buckling of girder	
Local buckling of compression flange	
Compression buckling of web	
Flange induced buckling of the web	
Local buckling of web (due to vertical load)	

Plate Girders



(a) Unstiffened web





(b) stiffened web

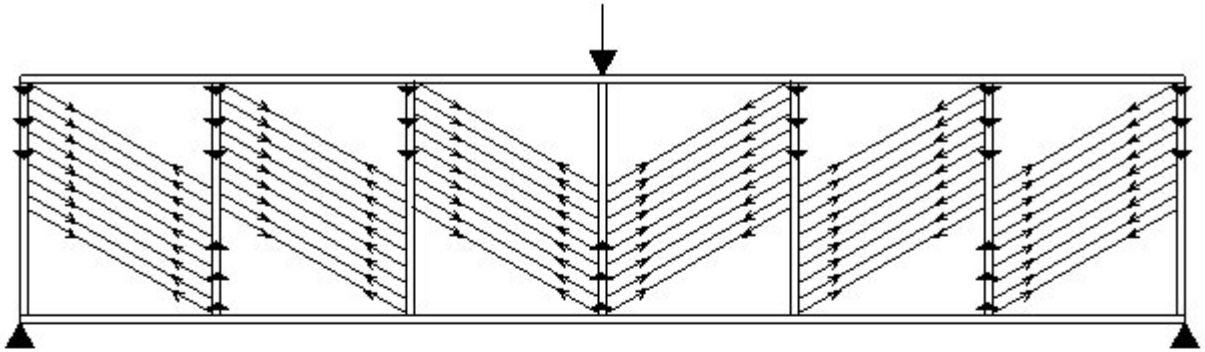
Figure 9 Buckling of slender web under shear

Stiffeners are Important

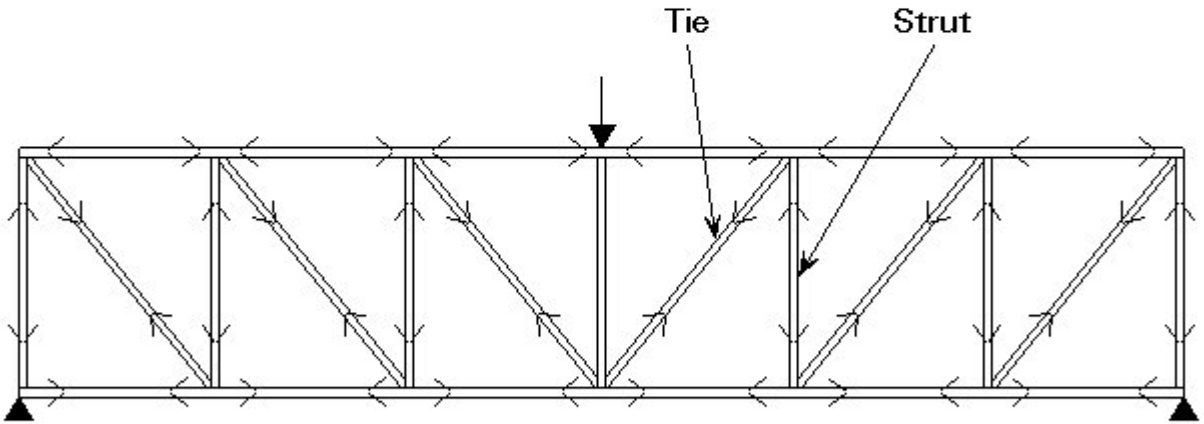
June 1970, Milford Haven bridge over the River Cleddau in the UK

Plate Girders

- Recall compression field action in reinforced concrete beams
  - Compression struts develop because of the presence of stirrups
- Plate girder tension field action develops because of the placement of vertical (and horizontal) stiffeners



(a) Tension field action



(b) Pratt or N-truss

Figure 10 Post-buckling tension field action