Detailed Design Drawing

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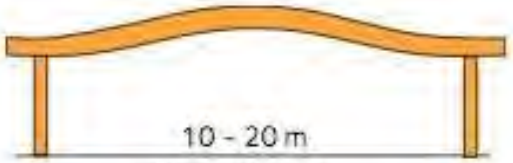
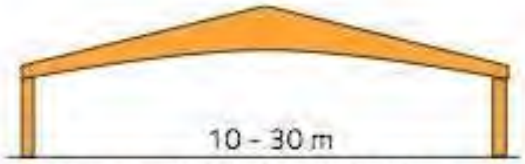
2022-2023

What is beam and column

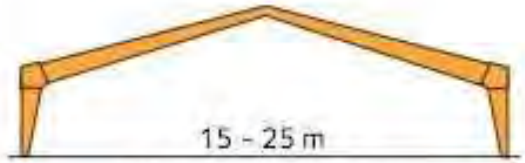
- Steel beams are horizontal structural members that resist loads applied laterally to their axis.
- Columns are vertical structural members that transfer compressive loads. It can be used to form the skeleton of a building.



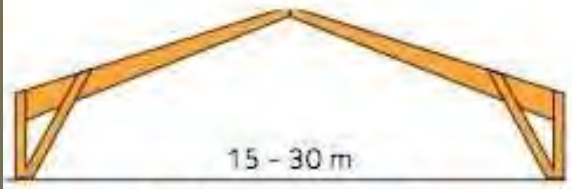
Curved beams



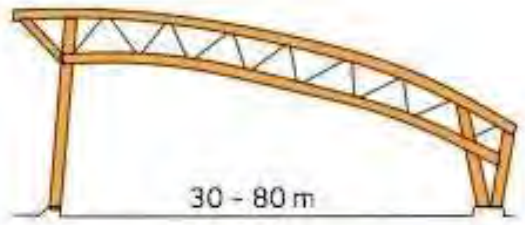
Symmetrical double pitched beam with curved underside



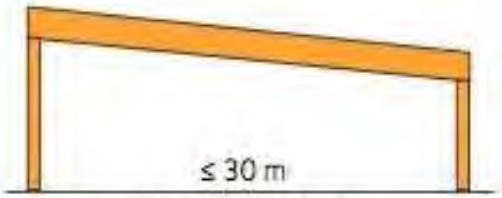
Three-pin portal frame with finger-jointed haunches



Knee braced portal frame

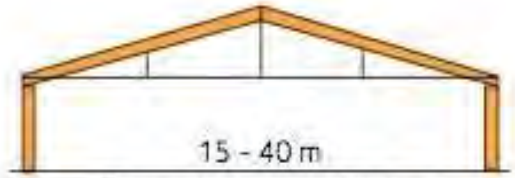


Trussbeam

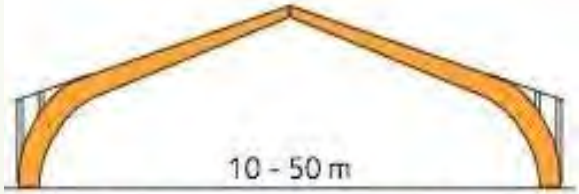


Beam and column

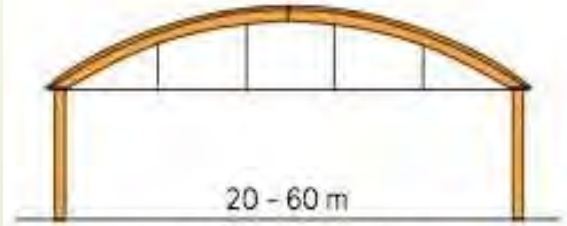
Symmetrical double pitched beam



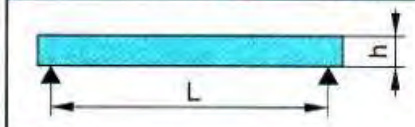
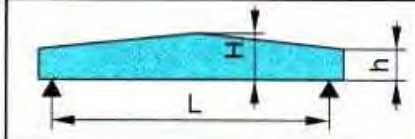
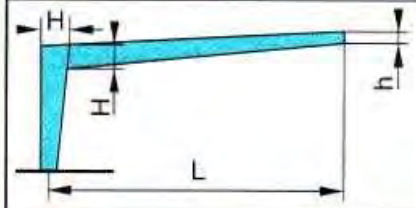
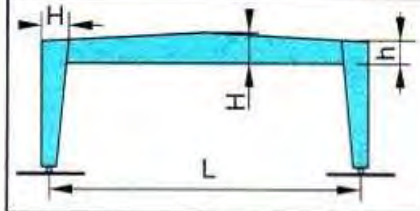
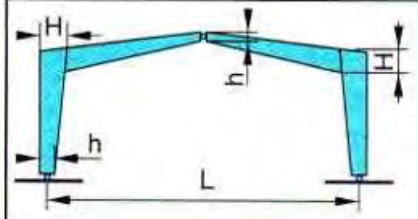
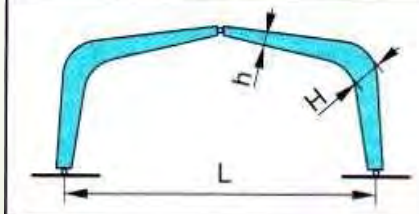
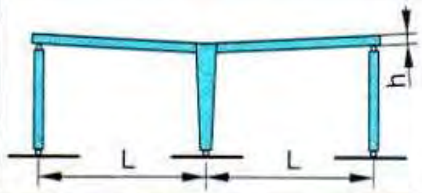
Three-pin trusses with ties



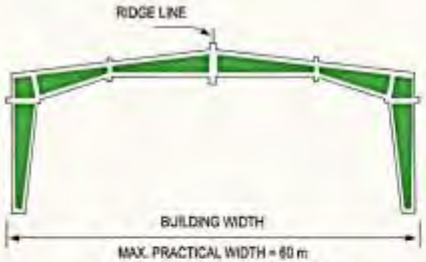
Three-pin portal frame with curved haunches



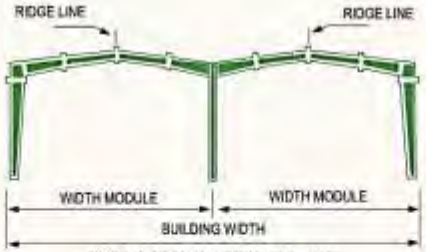
Three-pin arches with ties

Formes	Portée L (m)	h	H
	8 - 50	L/17	
	10 - 50	L/30	L/15
	5 - 15	L/45	L/10
	10 - 40	L/45	L/20
	10 - 50	L/40	L/17
	20 - 50	L/40	L/20
	10 - 30	L/20	

Different forms of conventional roof trusses and lattice girders

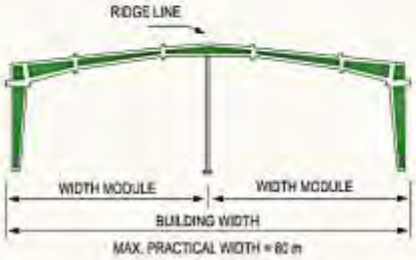


Tapered Column Clear Span (TCCS)

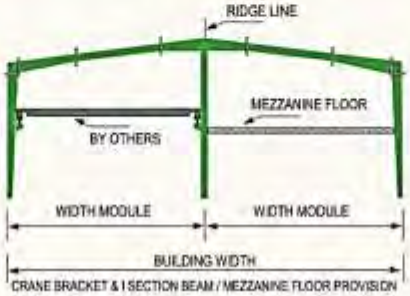


Multi Gable (MG)

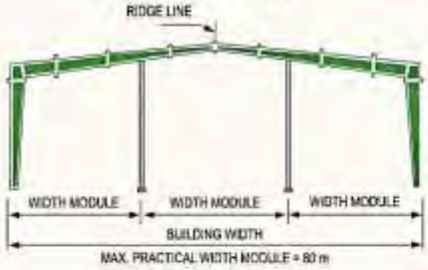
Arched Multi Span



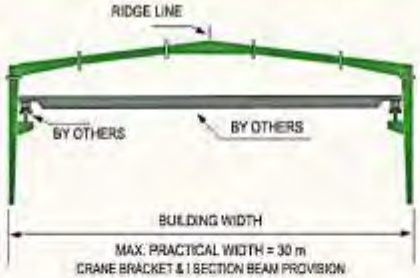
Multi Span "1" (MS-1)



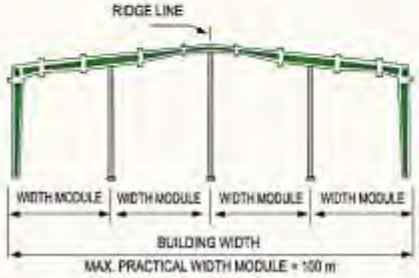
Mono Slope



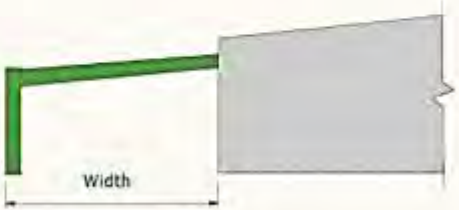
Multi Span "2" (MS-2)



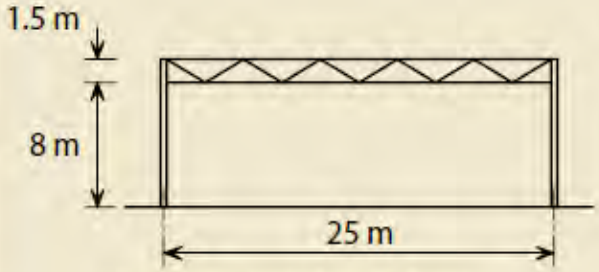
Roof System



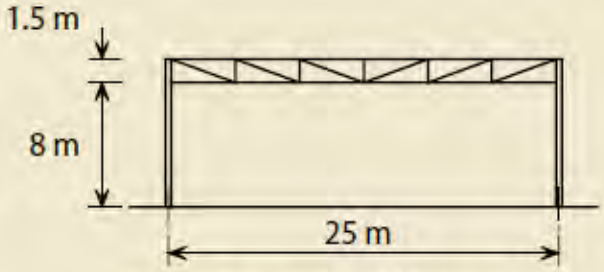
Multi Span "3" (MS-3)



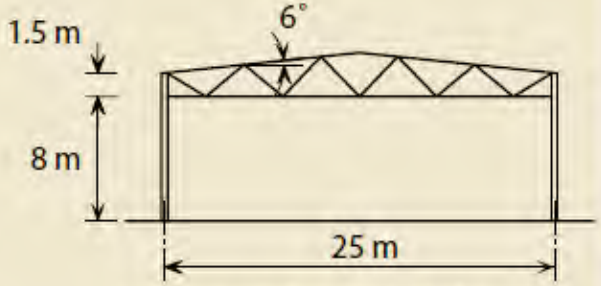
Lean-To



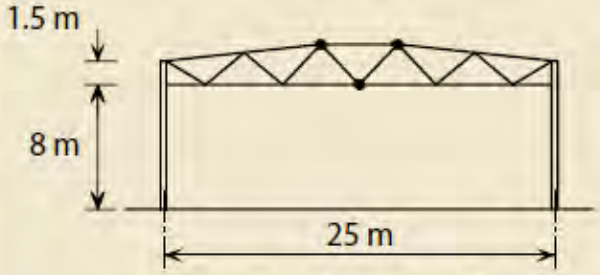
(a) Lattice girder - W form



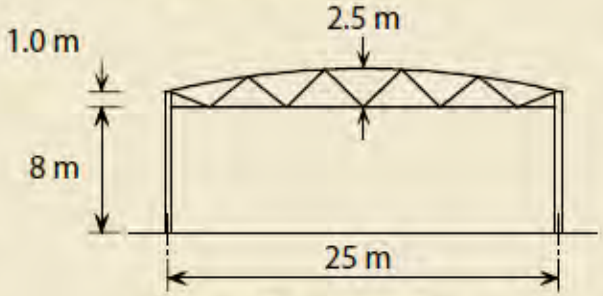
(b) Lattice girder - N form



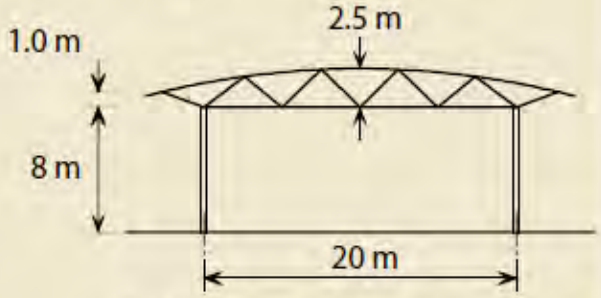
(c) Duo-pitch lattice girder



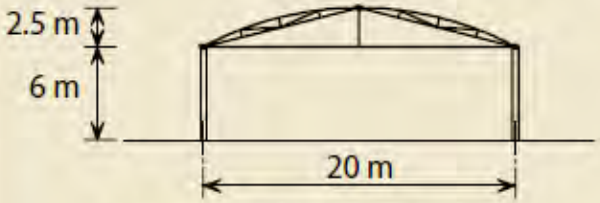
(d) Articulated lattice girder



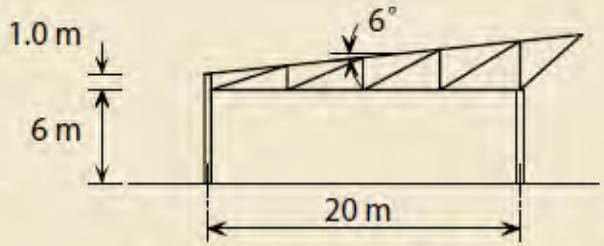
(e) Curved lattice girder



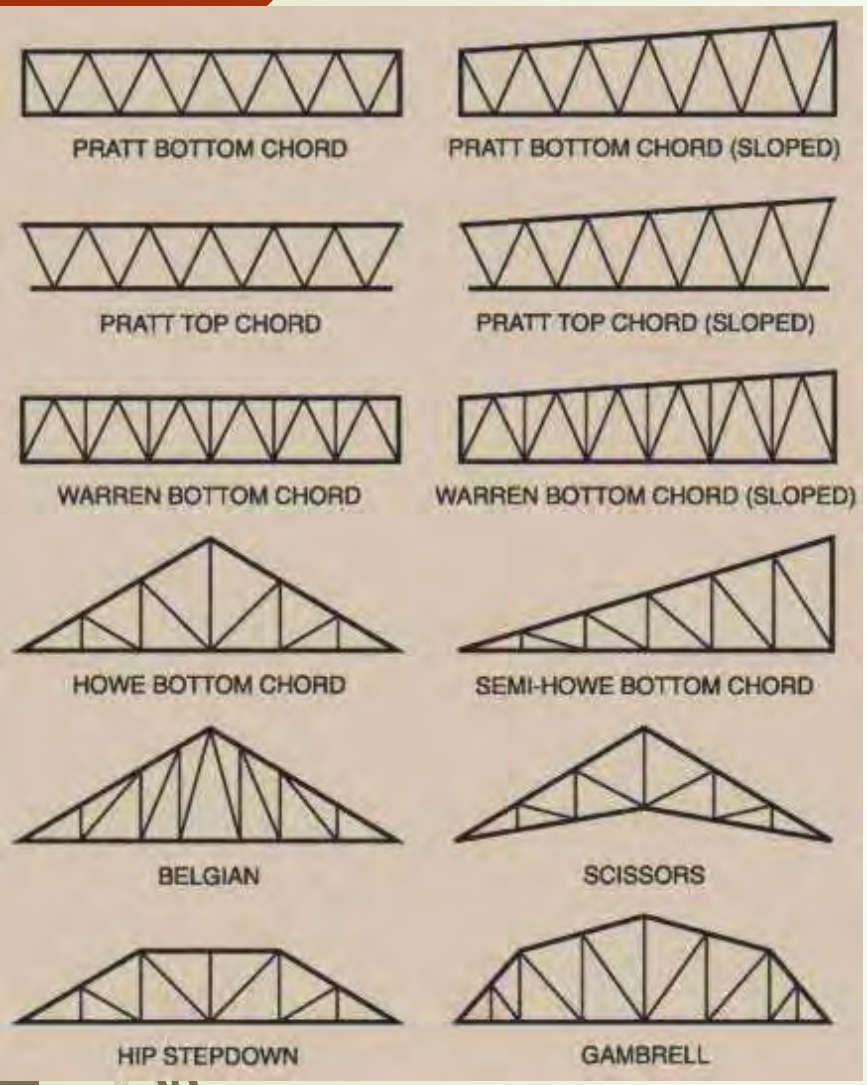
(f) Curved lattice truss and canopy

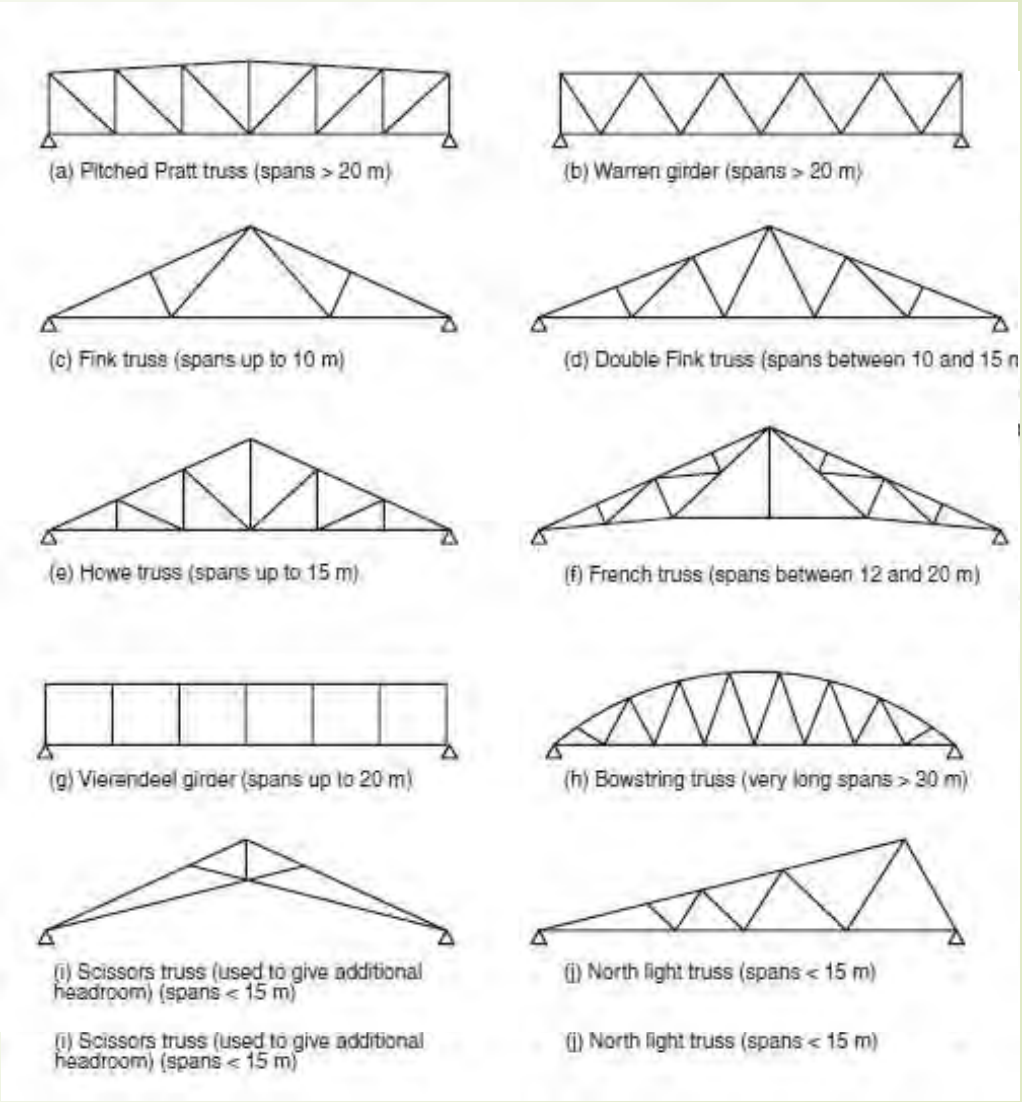


(g) Articulated bow-string

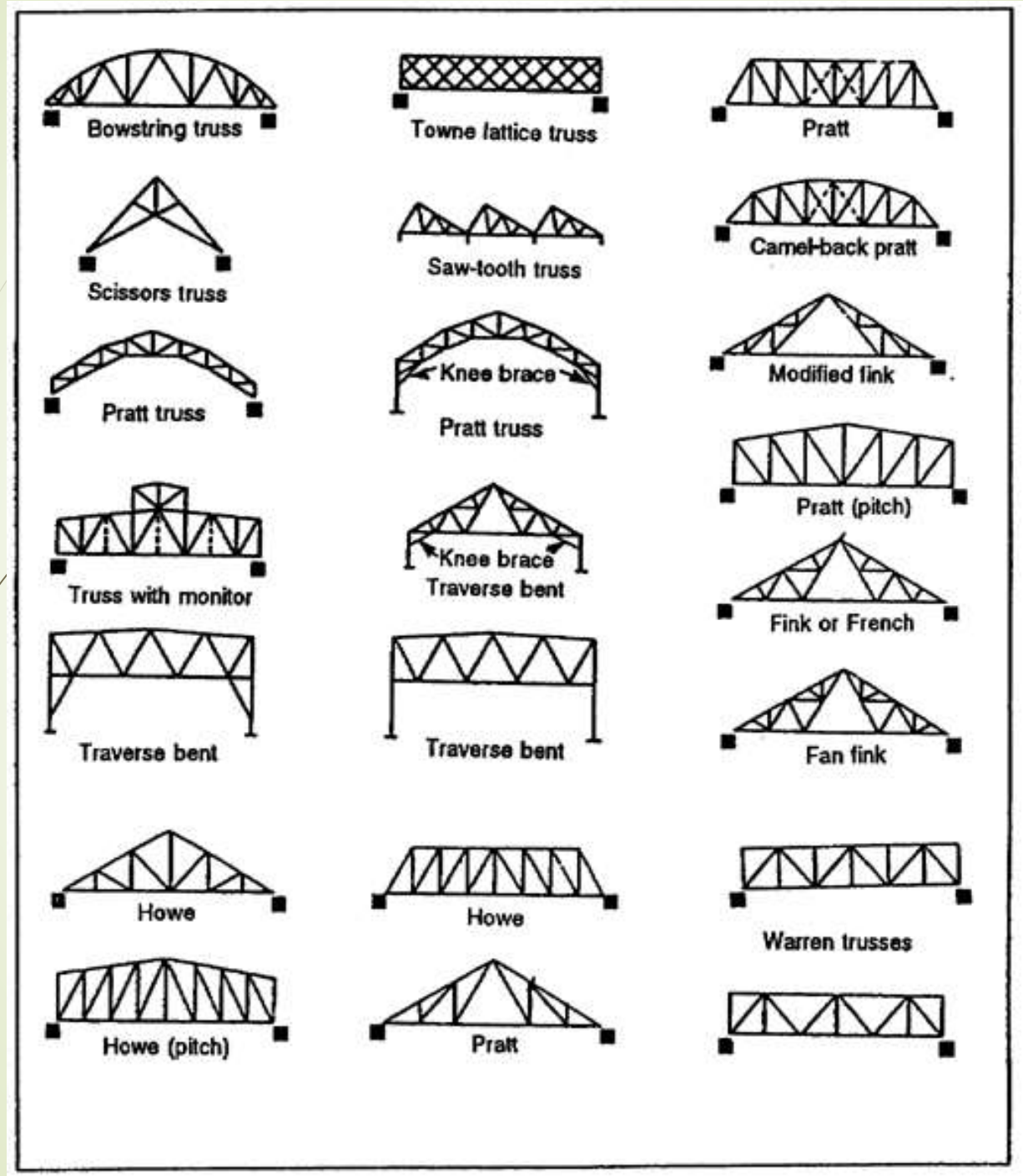


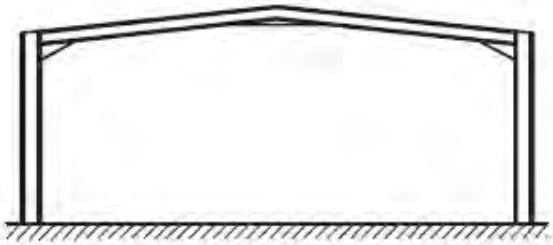
(h) Mono-pitch lattice girder with canopy



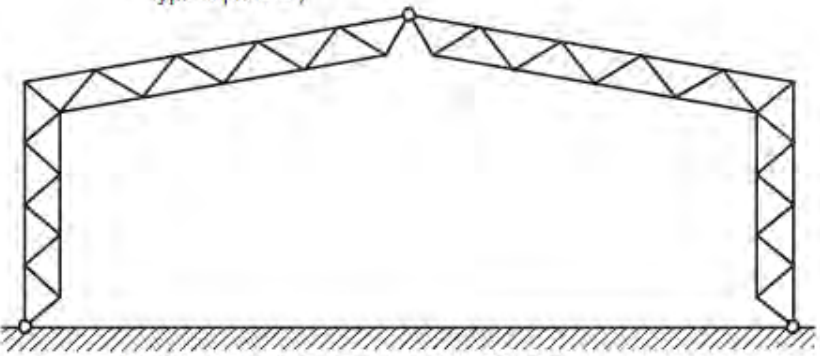


(i) Scissors truss (used to give additional headroom) (spans < 15 m)
(j) North light truss (spans < 15 m)

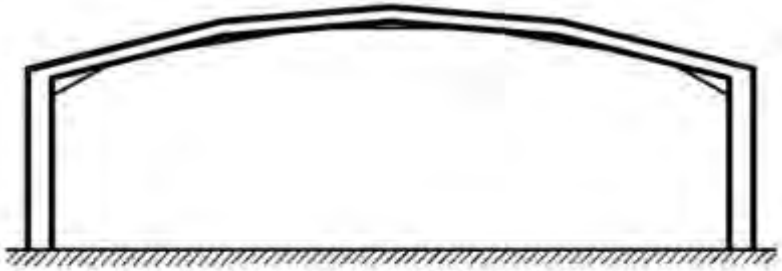

Bowstring truss
Towne lattice truss
Pratt
Scissors truss
Saw-tooth truss
Camel-back pratt
Pratt truss
Knee brace
Pratt truss
Modified fink
Truss with monitor
Knee brace
Traverse bent
Pratt (pitch)
Fink or French
Traverse bent
Traverse bent
Fan fink
Howe
Howe
Warren trusses
Howe (pitch)
Pratt



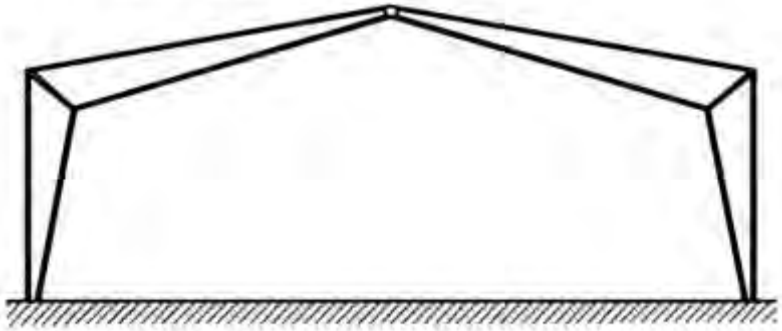
(a) Standard portal (typical span 15 m to 45 m, typical pitch 6°)



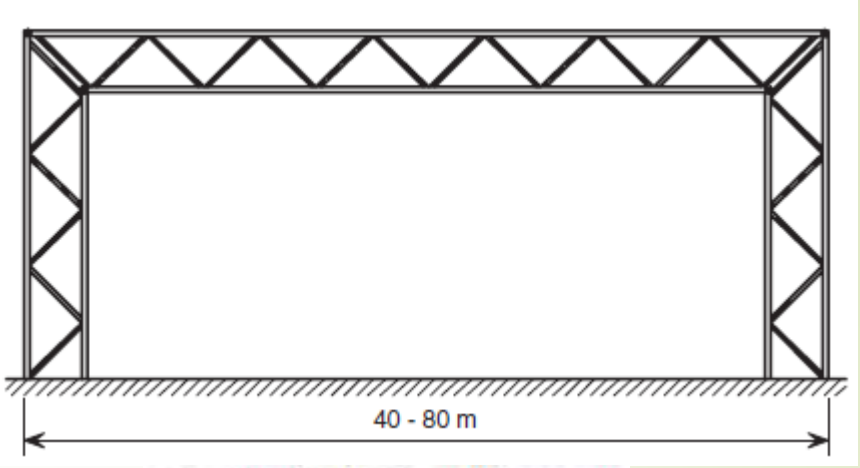
(b) 3 pinned lattice portal (spans up to 80 m)



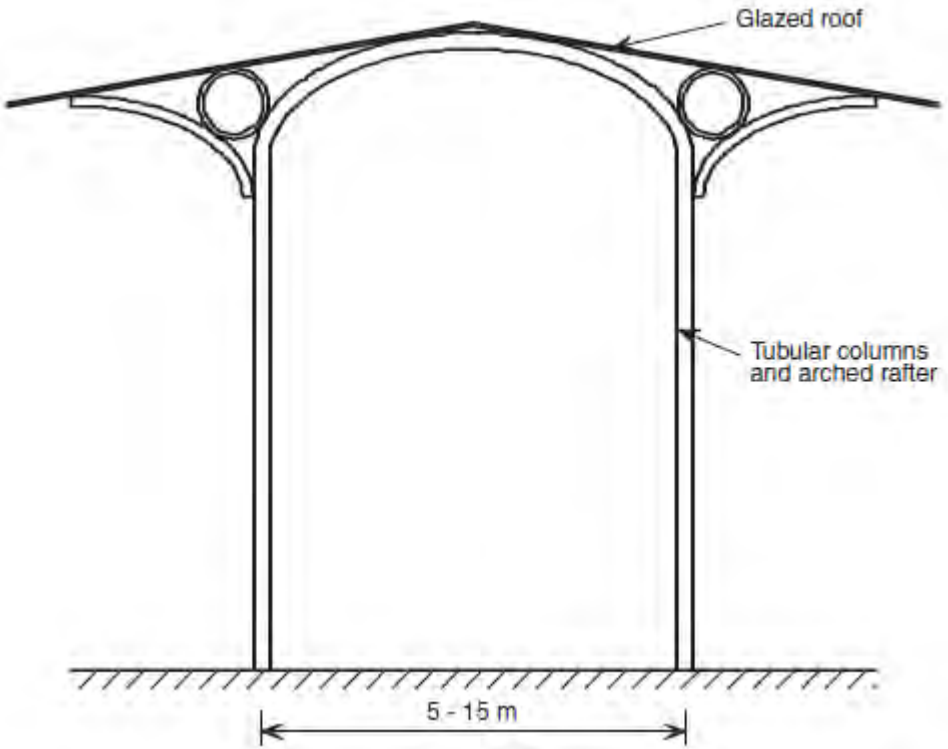
(c) Mansard portal (spans up to 60 m)



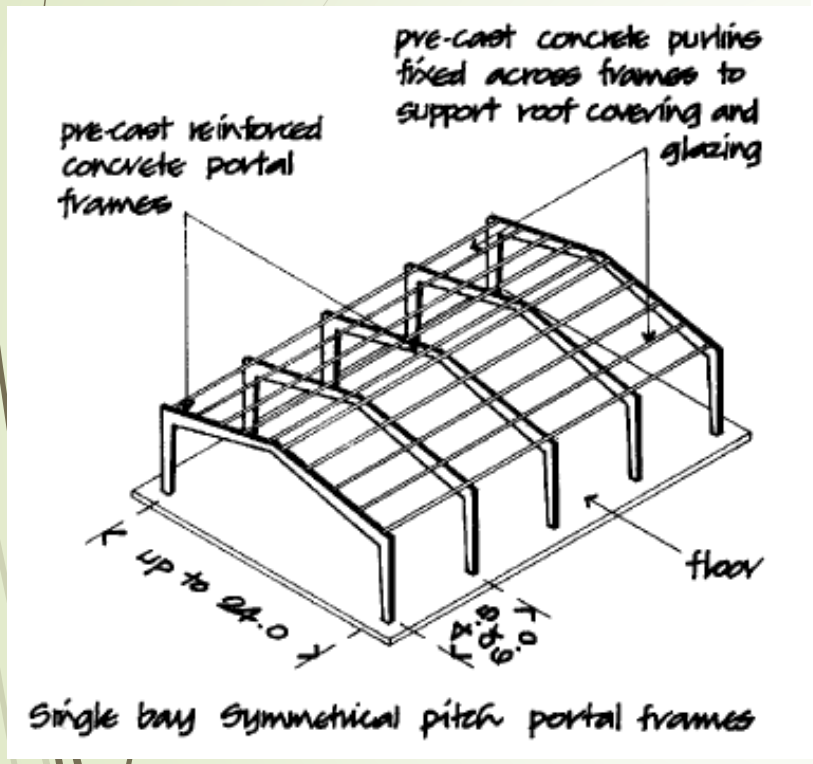
(d) Tapered portal fabricated from plate (spans up to 60 m)

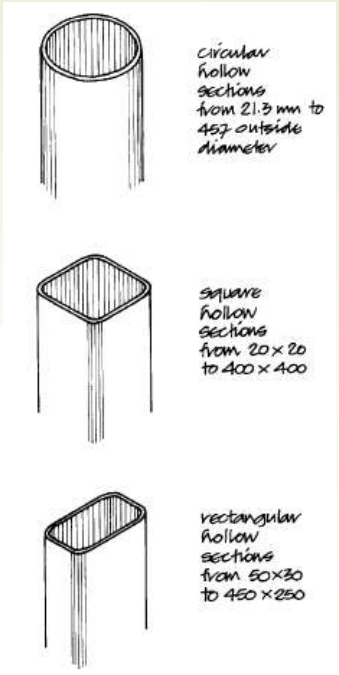


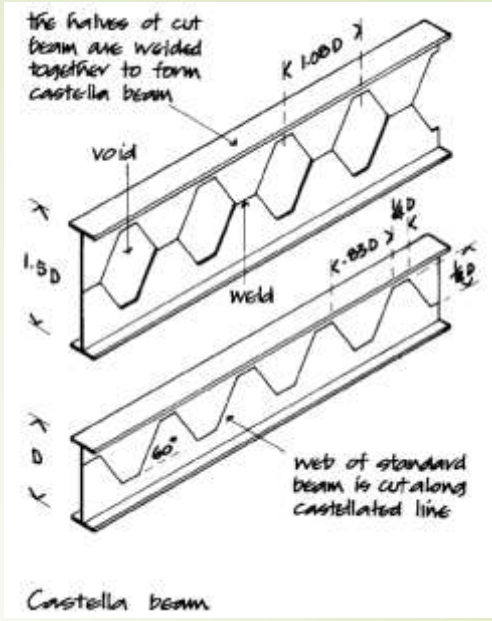
3.9 Articulated lattice portal structure (often using tubular sections)

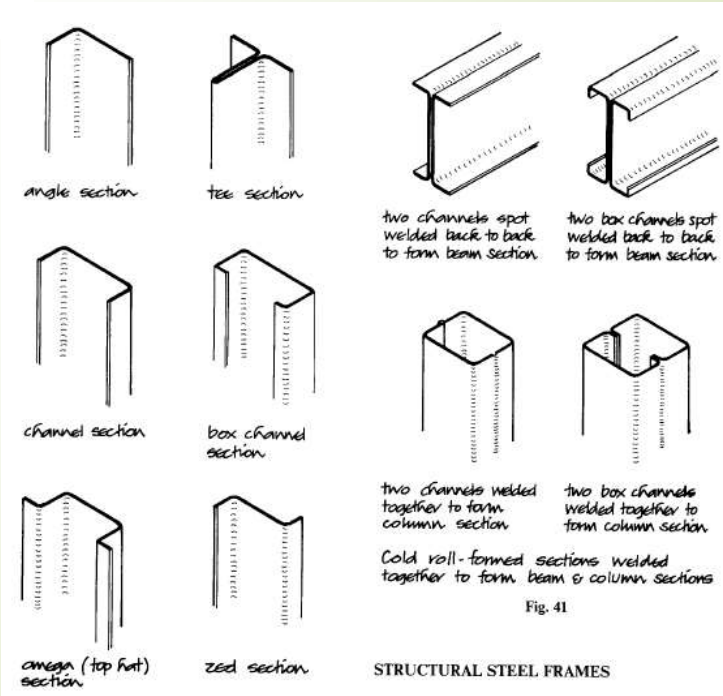


3.10 Arched portal using tubular sections


pre-cast concrete purlins fixed across frames to support roof covering and glazing
pre-cast reinforced concrete portal frames
floor
Single bay Symmetrical pitch portal frames


circular hollow sections from 21.3 mm to 457 outside diameter
square hollow sections from 20 × 20 to 400 × 400
rectangular hollow sections from 50×30 to 450 × 250
Structural hollow sections


the halves of cut beam are welded together to form castella beam
void
weld
web of standard beam is cut along castellated line
Castella beam


angle section
tee section
channel section
box channel section
omega (top hat) section
zed section
two channels spot welded back to back to form beam section
two box channels spot welded back to back to form beam section
two channels welded together to form column section
two box channels welded together to form column section
Cold roll-formed sections welded together to form beam & column sections
Fig. 41
STRUCTURAL STEEL FRAMES

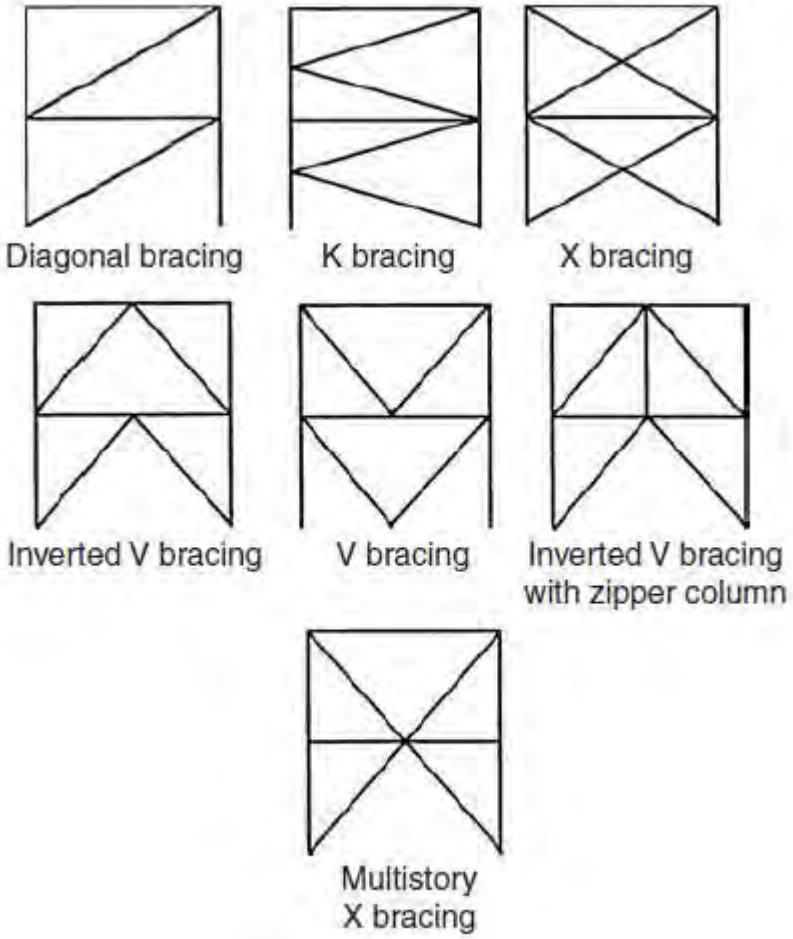
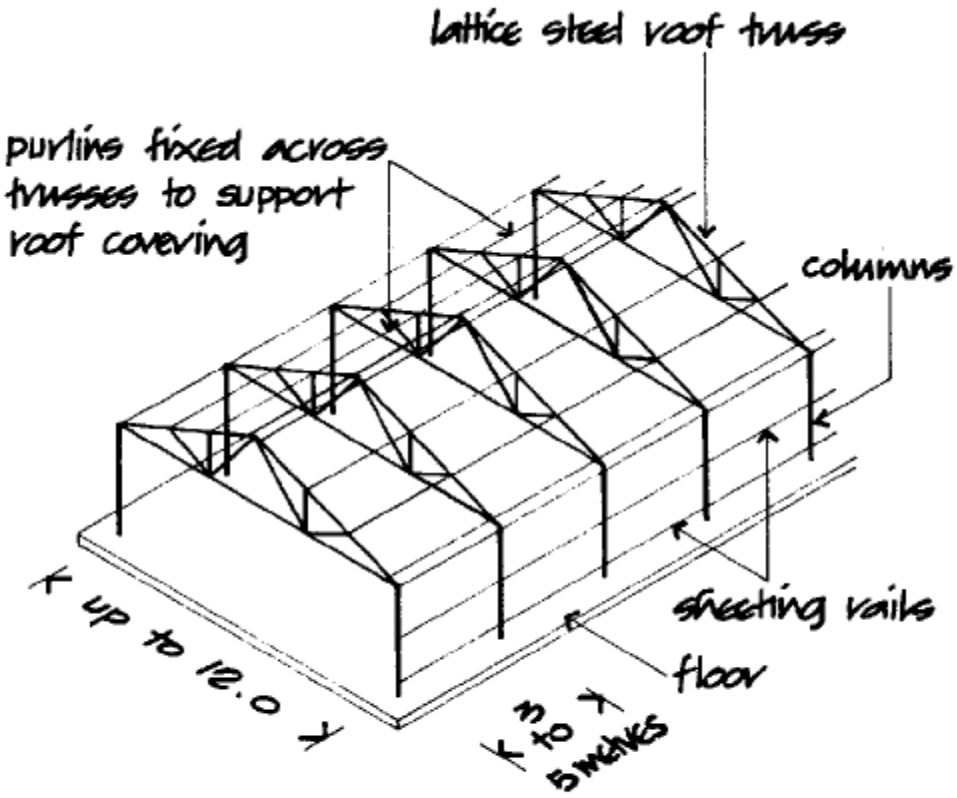
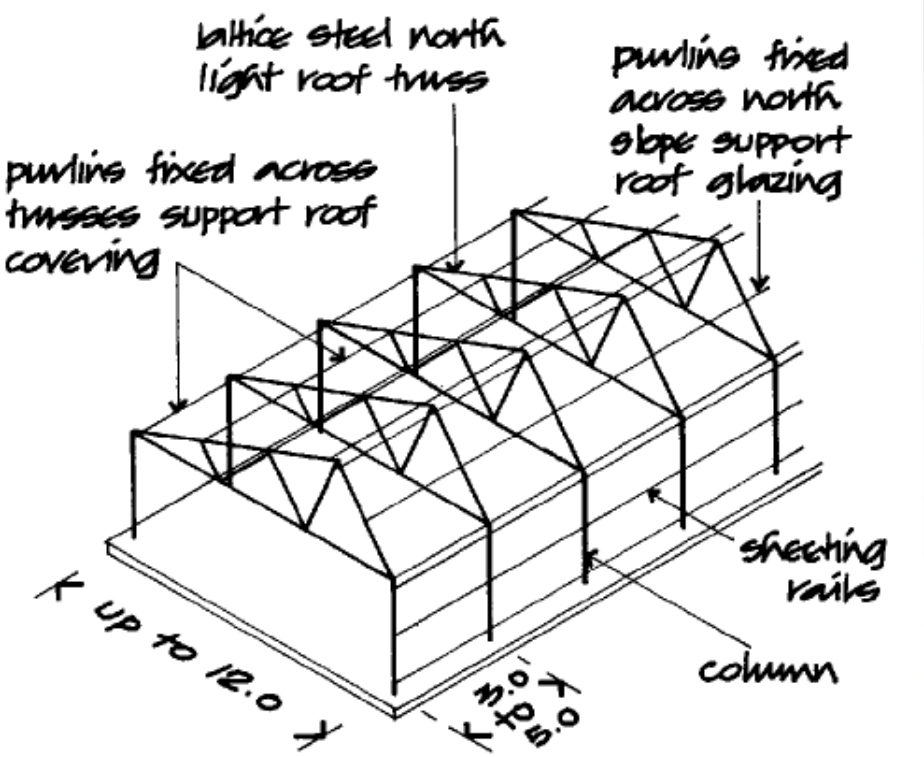


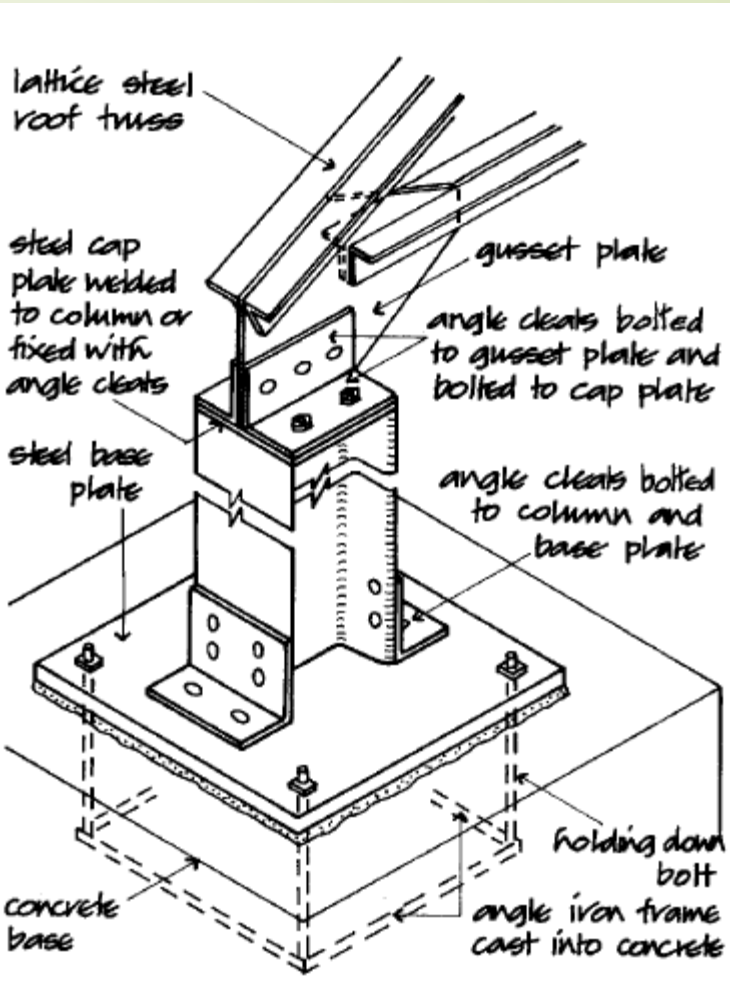
FIGURE 8.6 Typical configurations of concentric braced frames.



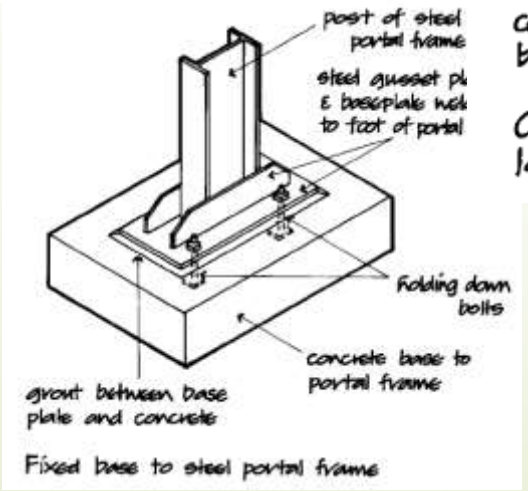
Single bay symmetrical pitch lattice steel roof on steel columns



Single bay north light lattice steel roof trusses on steel columns



Cap and base of steel column support for lattice steel truss



Fixed base to steel portal frame

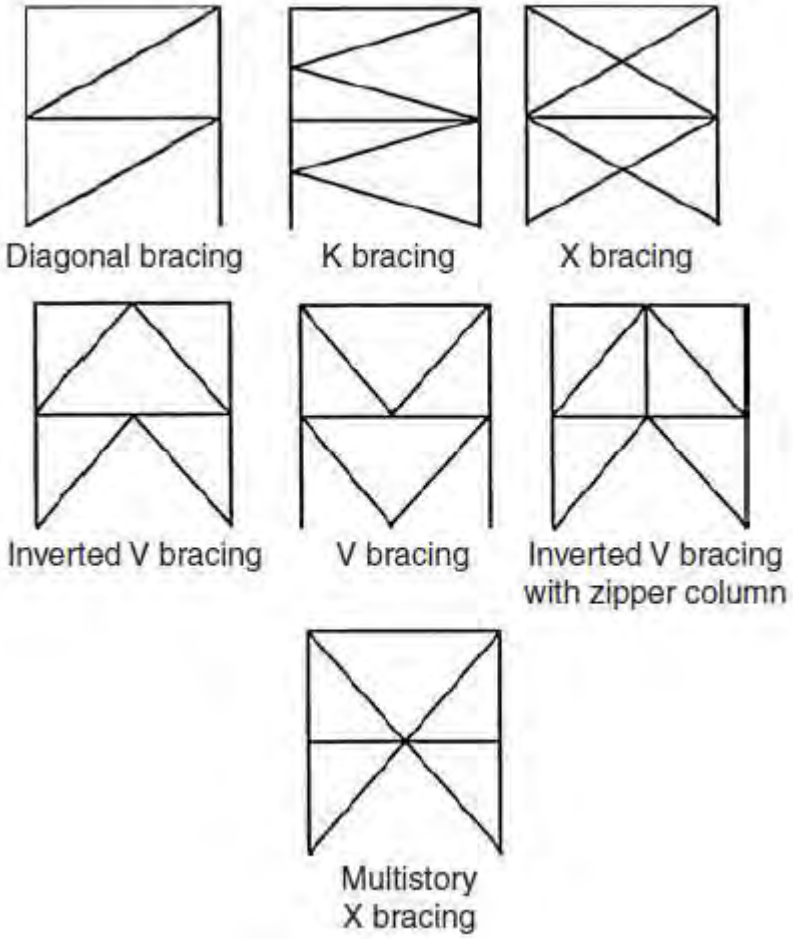
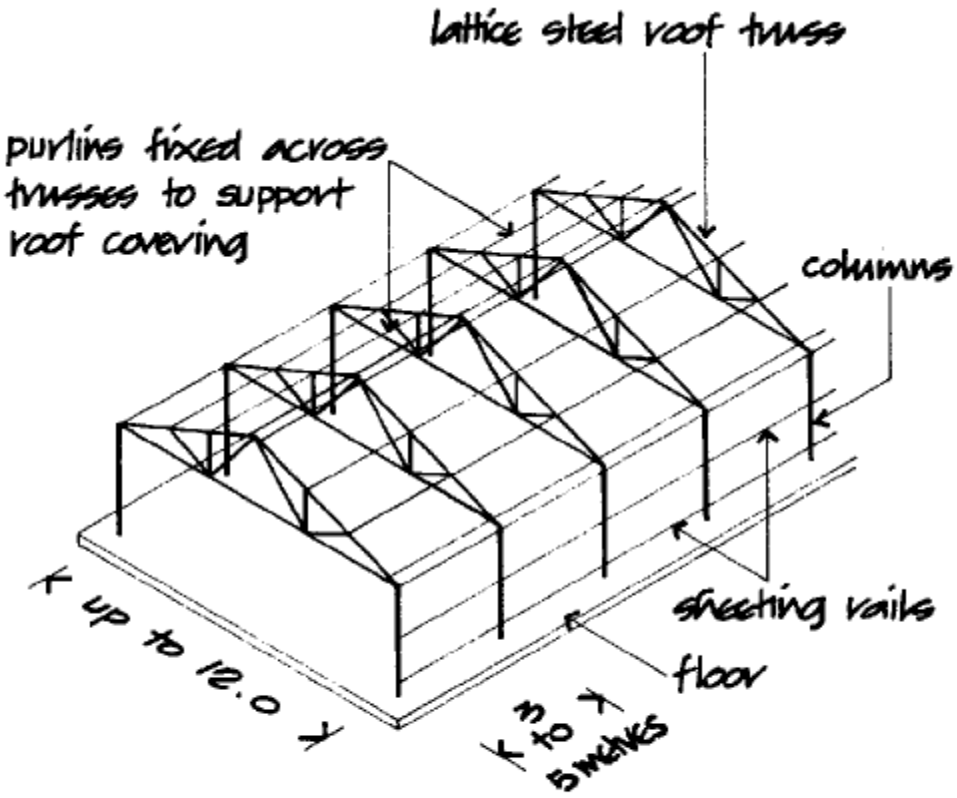
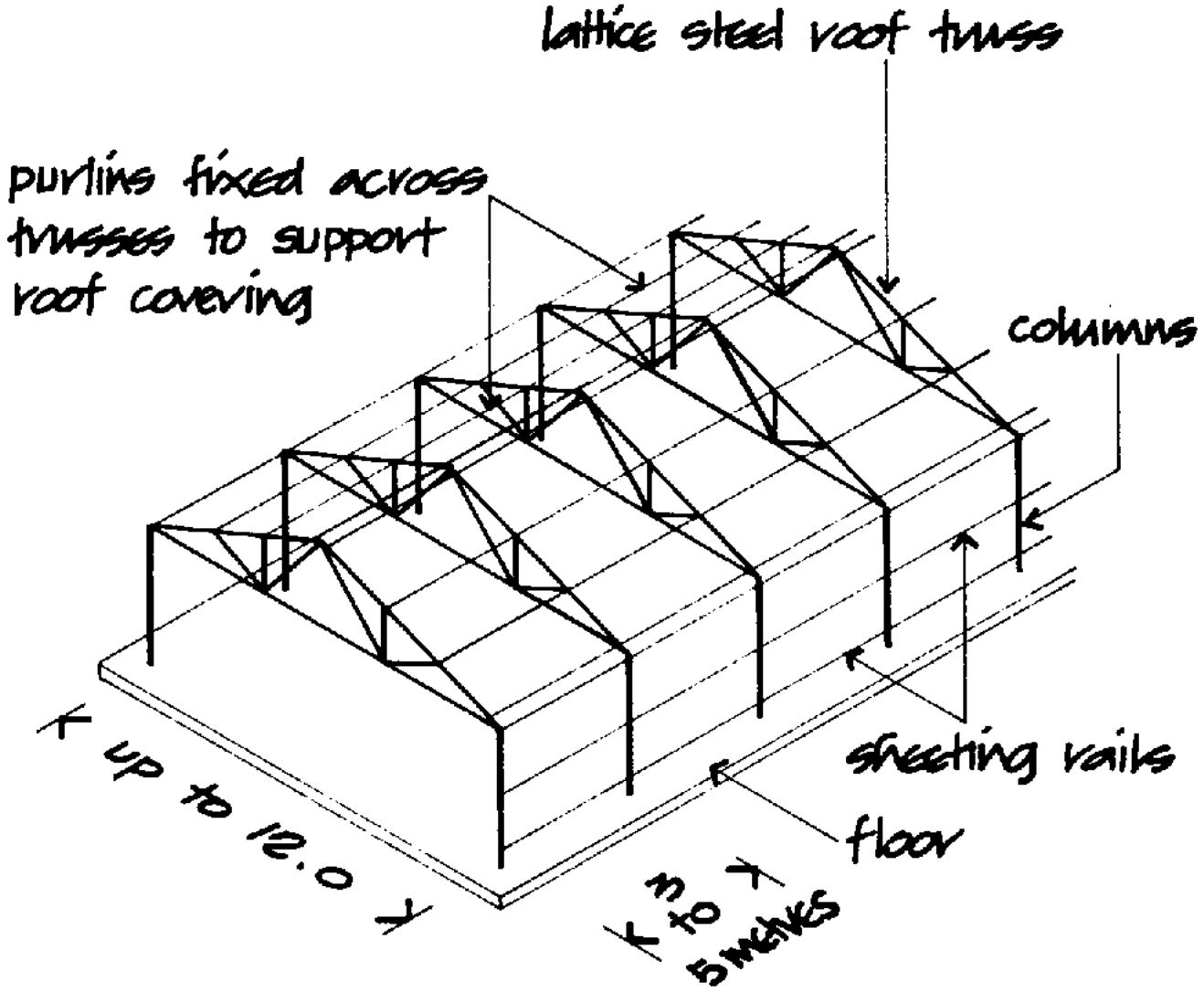


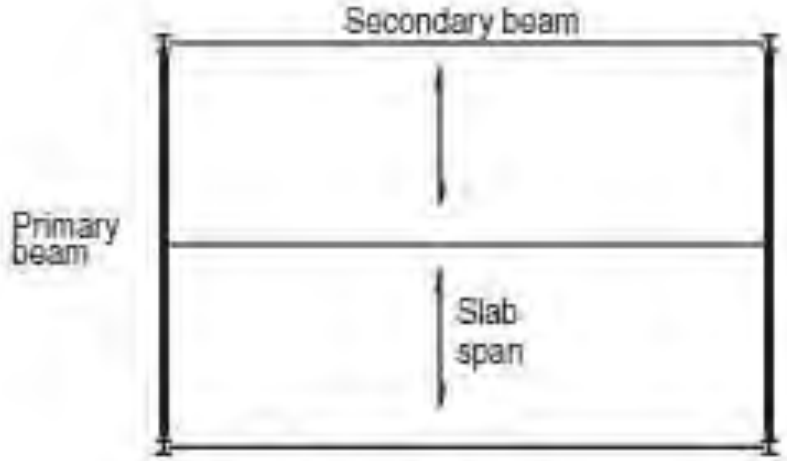
FIGURE 8.6 Typical configurations of concentric braced frames.



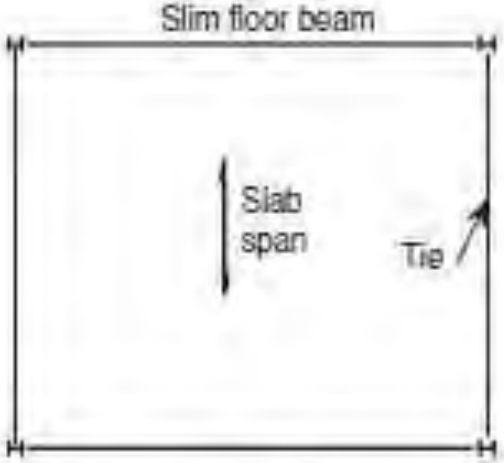
Single bay symmetrical pitch lattice steel roof on steel columns



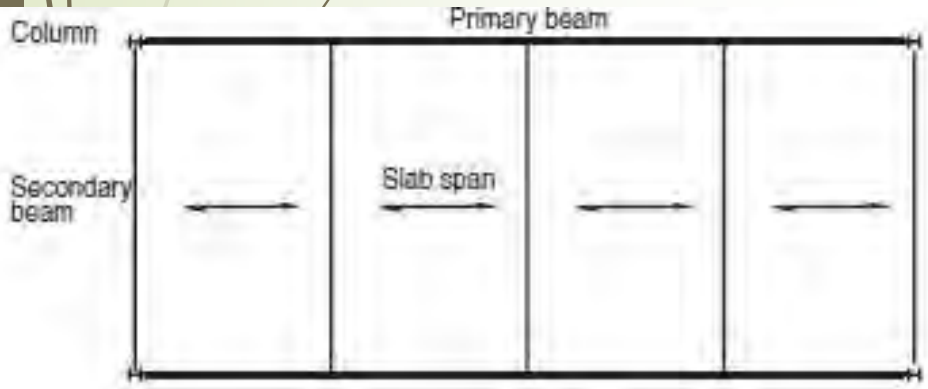
Single bay symmetrical pitch lattice steel roof on steel columns



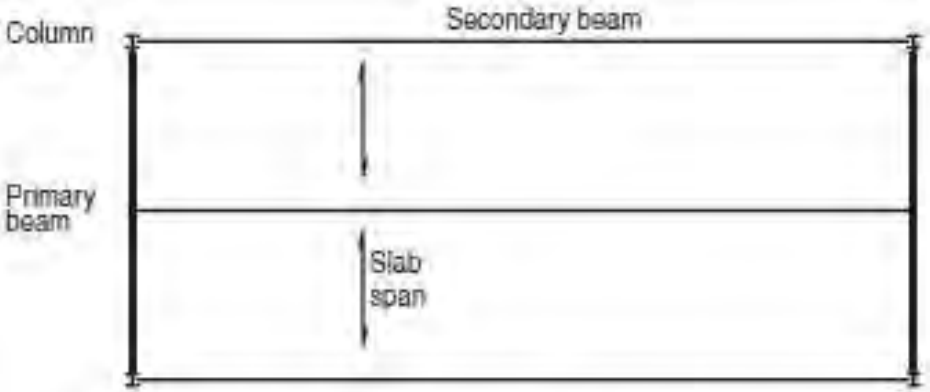
(a) Typical floor layout where beams are of equal depth (Note: orientation of columns means secondary beams are of equal length)



(b) Typical floor layout using slim floor beams (Note: ties embedded in slab)



(c) Long-span floor beams (scheme 1 – heavily loaded primary beams) (Note: framing into major axis of column)

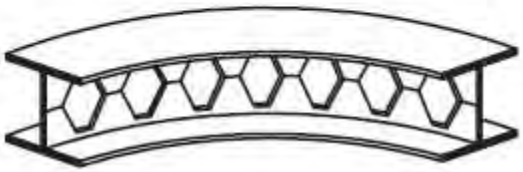


(d) Long-span floor beams (scheme 2 – short-span primary beams)

Table 4.2 Minimum bending radii for common steel sections

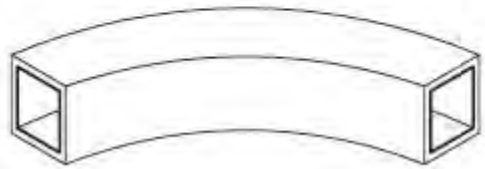
	Section	Typical radius
	**Joists and Universal Beams (*x–x* axis)**	
	610 × 305 × 238 kg/m UB	40.0 m
	533 × 210 × 122 kg/m UB	30.0 m
	406 × 178 × 74 kg/m UB	15.0 m
	254 × 203 × 82 kg/m RSJ	3.5 m
	203 × 152 × 52 kg/m RSJ	2.2 m
	152 × 127 × 37 kg/m RSJ	1.6 m
	**Universal Columns (*x–x* axis)**	
	152 × 152 × 37 kg/m	2.0 m
	203 × 203 × 86 kg/m	3.0 m
	254 × 254 × 167 kg/m	4.0 m
	305 × 305 × 283 kg/m	5.0 m
	All sections up to 356 × 406 UC	
	**Channels (*x–x* axis)**	
	127 × 64 × 14 kg/m	2.0 m
	203 × 89 × 29 kg/m	3.0 m
	254 × 89 × 35 kg/m	5.0 m
	305 × 102 × 46 kg/m	7.0 m
	All sections up to 432 × 102 × 65 kg/m	
	**Joists, beams and columns (*y–y* axis)**	
	127 × 76 × 16 kg/m	0.8 m
	230 × 133 × 30 kg/m	1.5 m
	457 × 191 × 98 kg/m	2.5 m
	610 × 229 × 140 kg/m	3.0 m
	All sections up to 1016 × 455 × 488 kg/m	

Castellated and cellular beams (x–x axis)	
305 × 133 × 30 kg/m	4.0 m
458 × 165 × 54 kg/m	8.0 m
609 × 178 × 74 kg/m	12.0 m
800 × 210 × 122 kg/m	16.0 m
915 × 305 × 238 kg/m	20.0 m



Castellated and cellular beams (y–y axis)	
305 × 133 × 30 kg/m	2.0 m
458 × 165 × 54 kg/m	3.0 m
609 × 178 × 74 kg/m	4.0 m
800 × 210 × 122 kg/m	6.0 m
915 × 305 × 238 kg/m	8.0 m

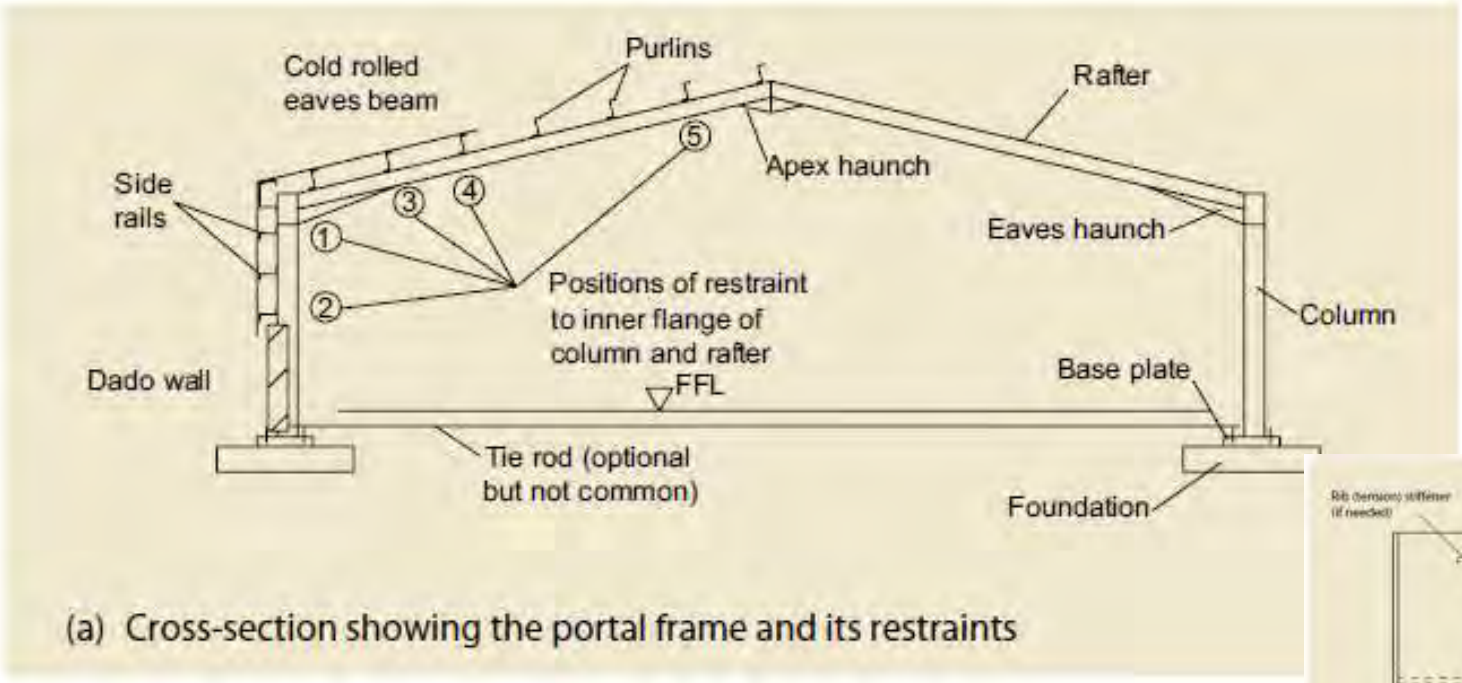
Circular Hollow Sections	
60.3 × 5 mm	0.4 m
114.3 × 6.3 mm	0.7 m
168.3 × 10 mm	0.9 m
219.1 × 12.5 mm	1.1 m
Most sizes up to 610 mm o/d × 35 mm	

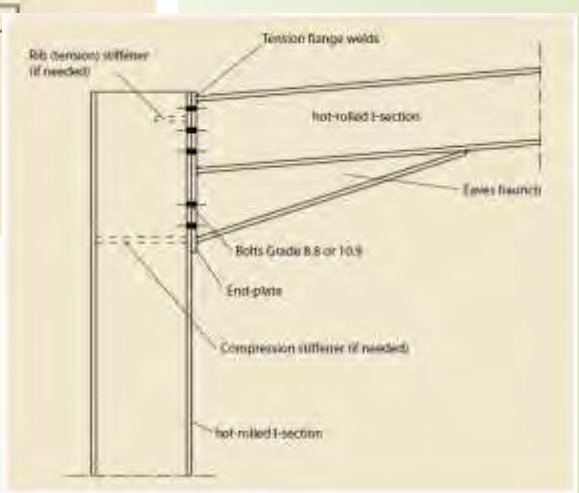


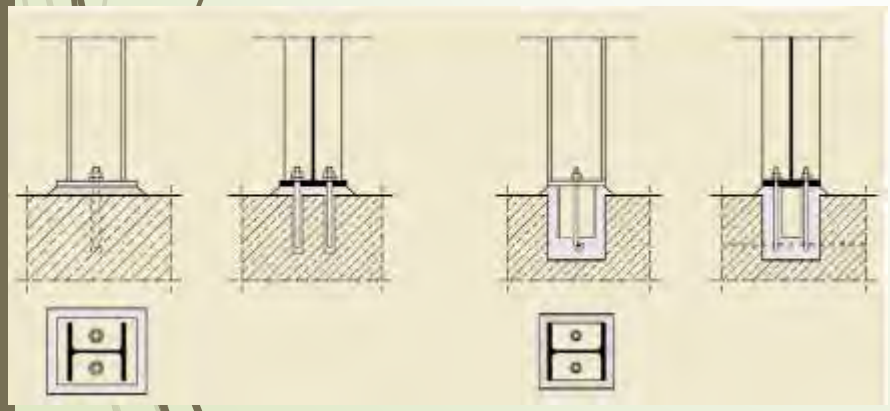
Square and Rectangular Hollow Sections	
50 × 50 × 5 mm	0.6 m
100 × 100 × 6.3 mm	1.1 m
150 × 150 × 10 mm	1.4 m
200 × 200 × 12.5 mm	2.0 m
All sizes up to 400 × 400 × 16 SHS and 500 × 300 × 20 RHS	

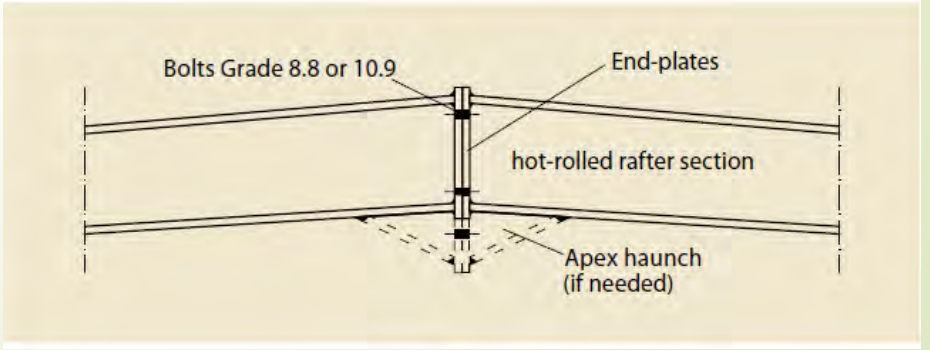
For free spans up to 25 m, hot-rolled sections are preferred

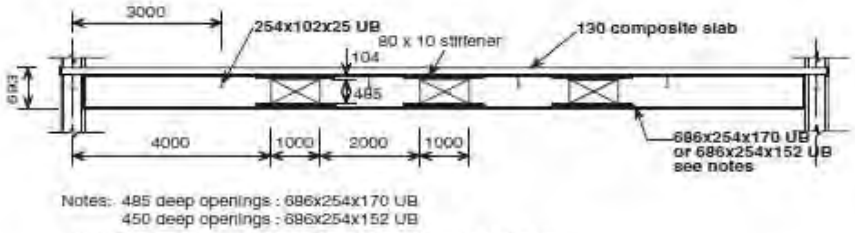
For longer spans trussed beams are a popular alternative


Cold rolled
eaves beam
Purlins
Rafter
Apex haunch
Side
rails
Eaves haunch
Column
Positions of restraint
to inner flange of
column and rafter
FFL
Dado wall
Base plate
Tie rod (optional
but not common)
Foundation
(a) Cross-section showing the portal frame and its restraints


Tension flange welds
hot-rolled I-section
Eaves haunch
Bolts Grade 8.8 or 10.9
End-plate
Compression stiffener (if needed)
hot-rolled I-section

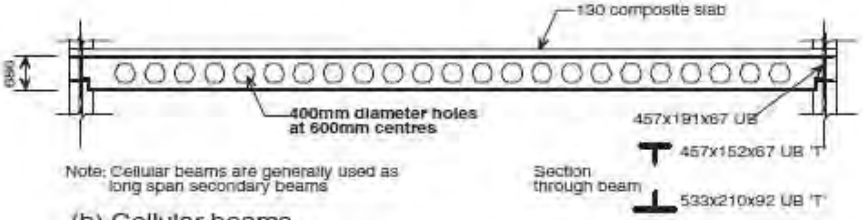



Bolts Grade 8.8 or 10.9
End-plates
hot-rolled rafter section
Apex haunch
(if needed)



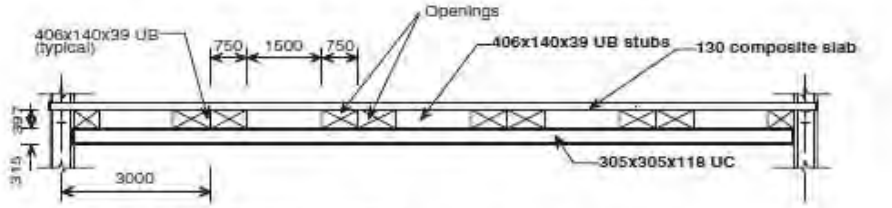
Notes: 485 deep openings : 686x254x170 UB
450 deep openings : 686x254x152 UB

(a) Beam with rectangular web openings



Note: Cellular beams are generally used as long span secondary beams

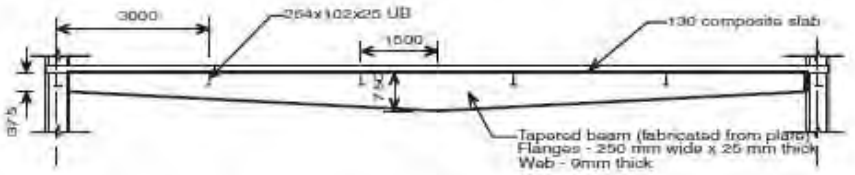
(b) Cellular beams



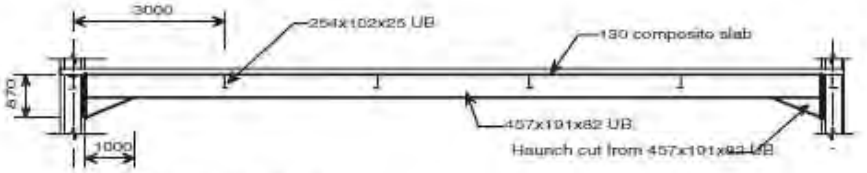
Note: Requires propping during construction

Note (to all figures): Shear connectors not shown

(c) Stub girder

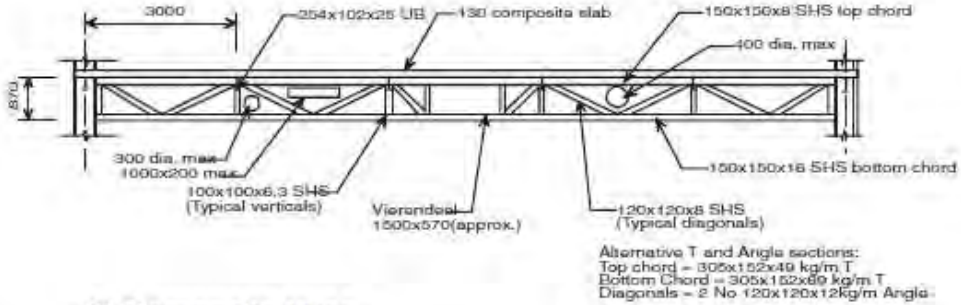


(d) Tapered beam



Note: Requires heavier columns

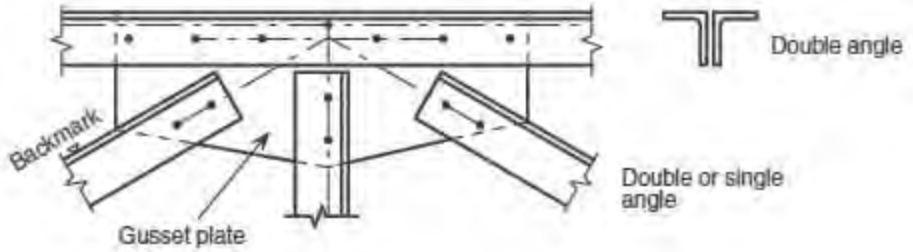
(e) Haunched beam



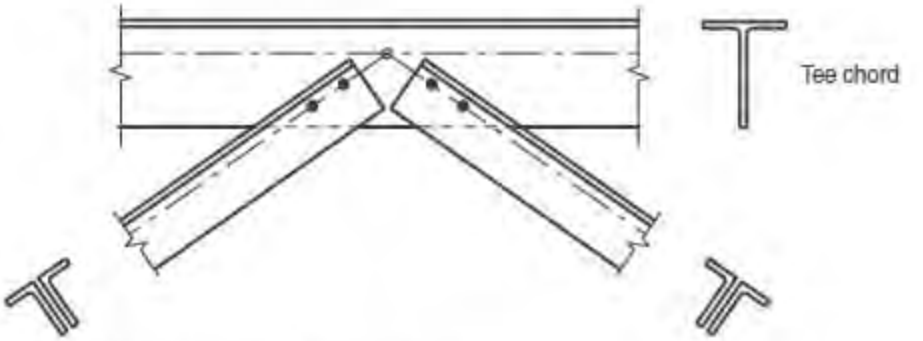
(f) Composite truss

Note(to all figures): Shear connectors not shown

4.10 Long-span composite beams offering the facility for service integration (designed for 15 m × 6 m floor grid)

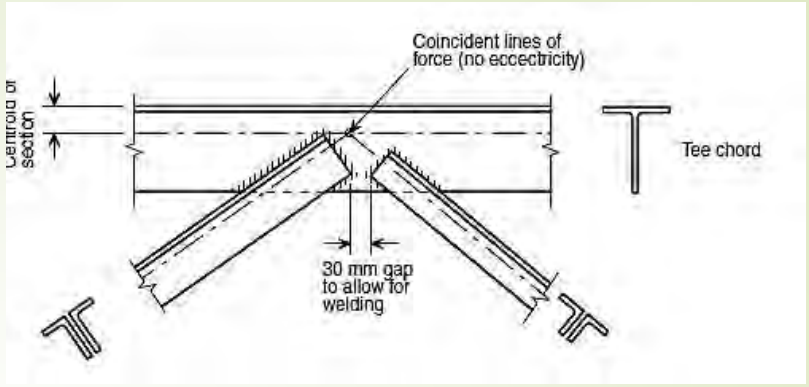


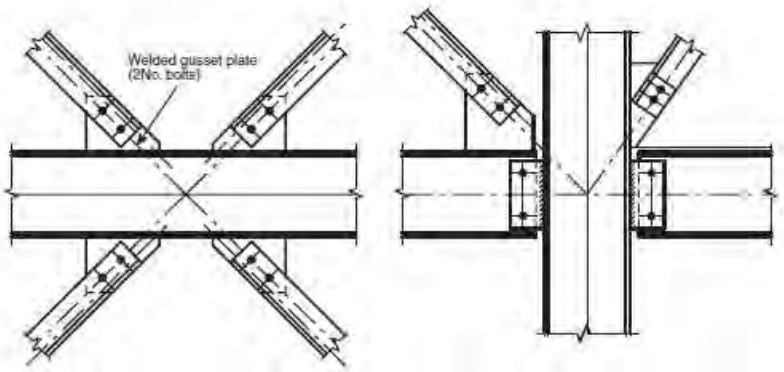
(a) Typical bracing-chord bolted connection using angle chords



(b) Typical bracing - chord connection using T section chord

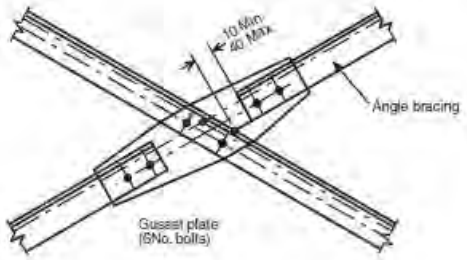
5.12 Traditional bolted connections in trusses





(a) Bracing connection to beam

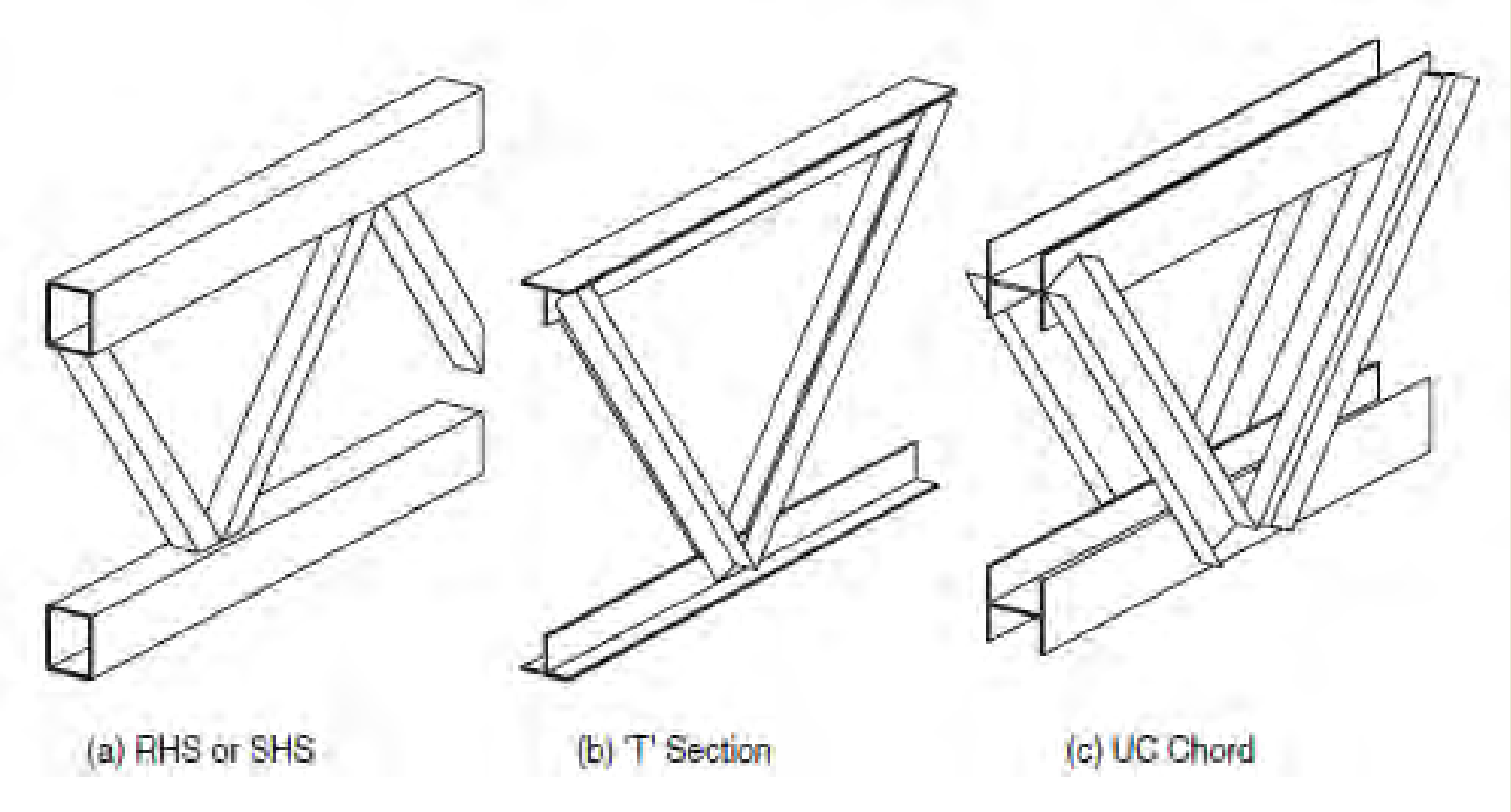
(b) Bracing connection to either beam or column



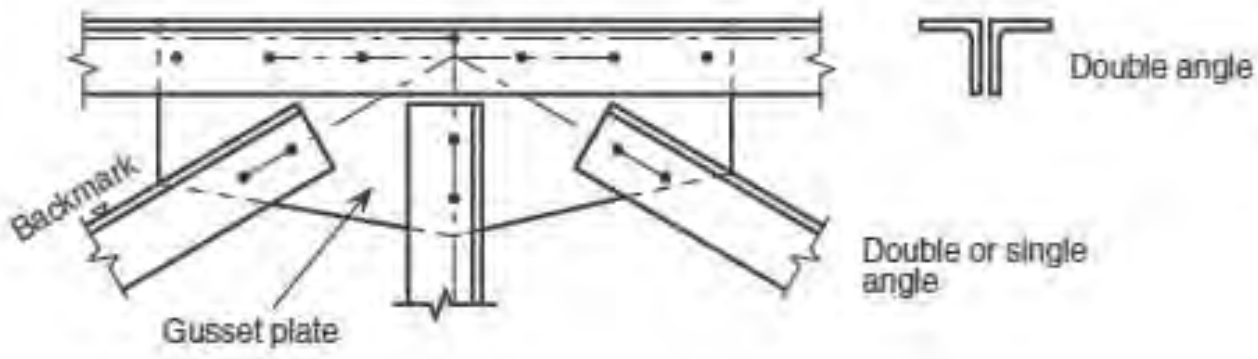
(c) X-Bracing (back to back or single angle)

5.15 Examples of bracing connections in frames using angle sections

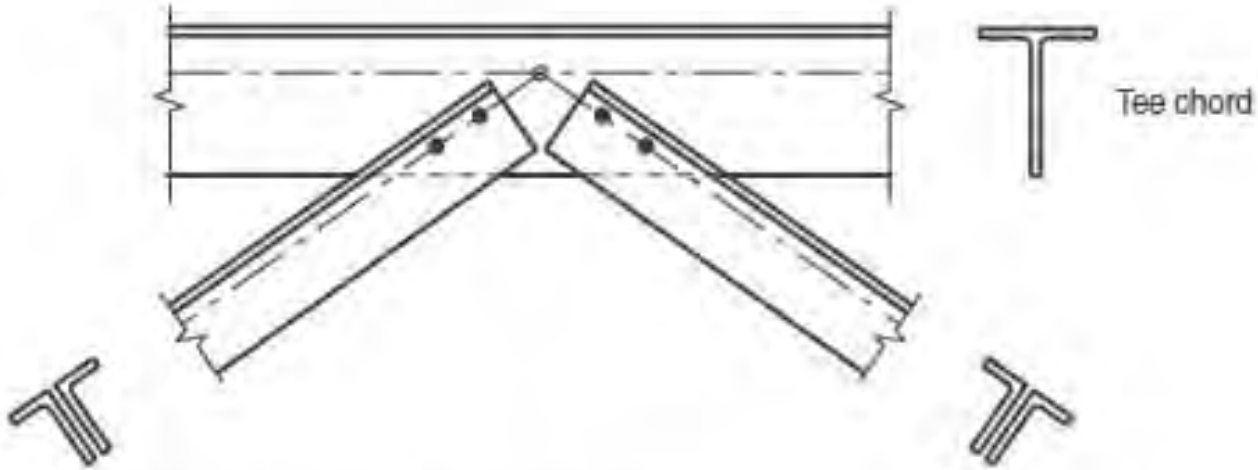
Different Types of Steel Section used in Trusses



Traditional bolted connections in Trusses

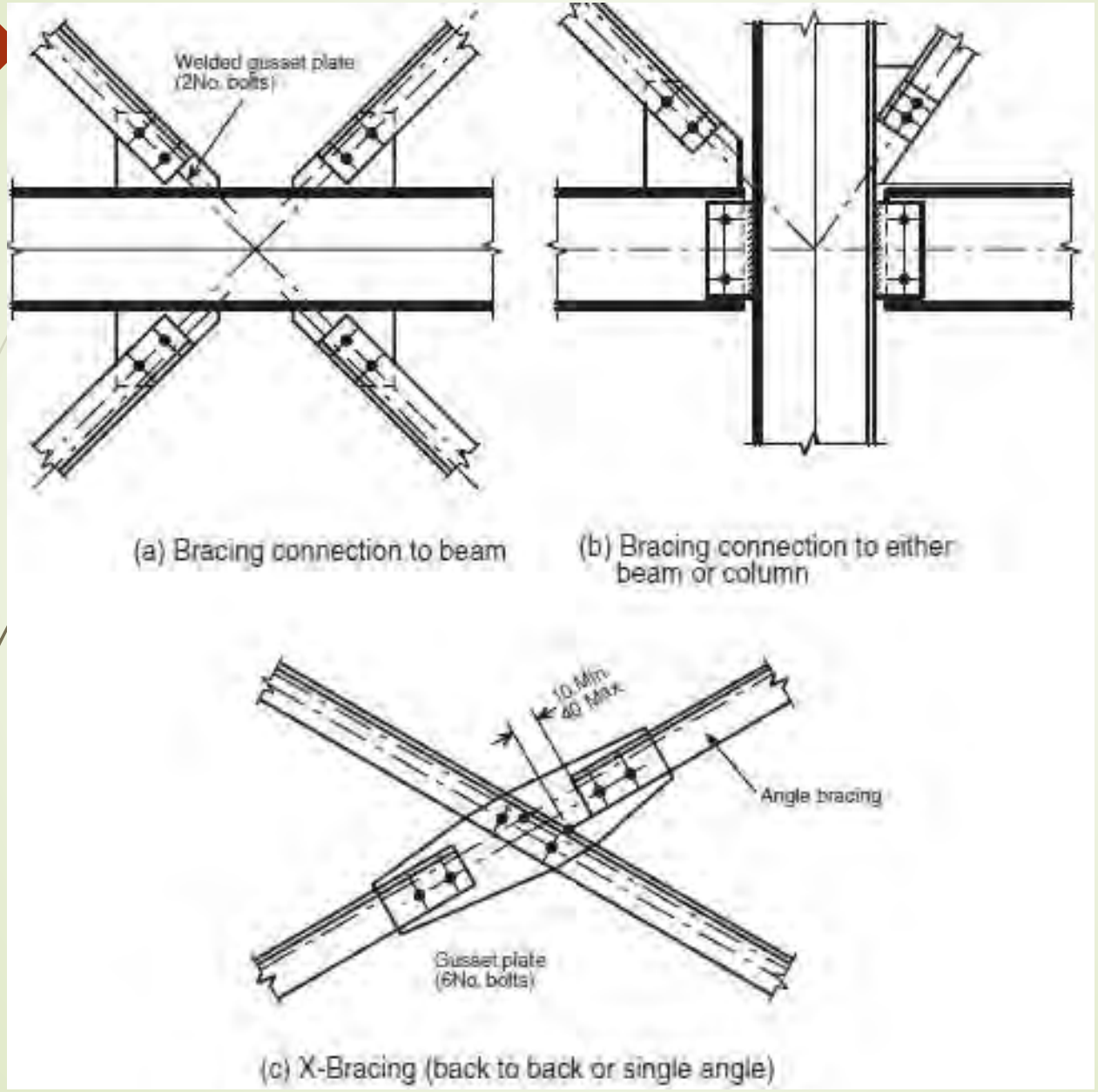


(a) Typical bracing-chord bolted connection using angle chords



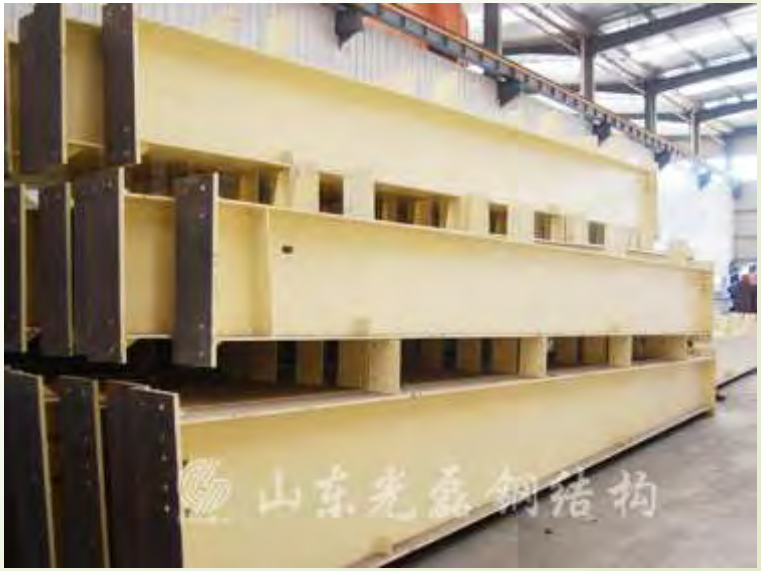
(b) Typical bracing - chord connection using T section chord

Examples of bracing connections in frames using angle secti



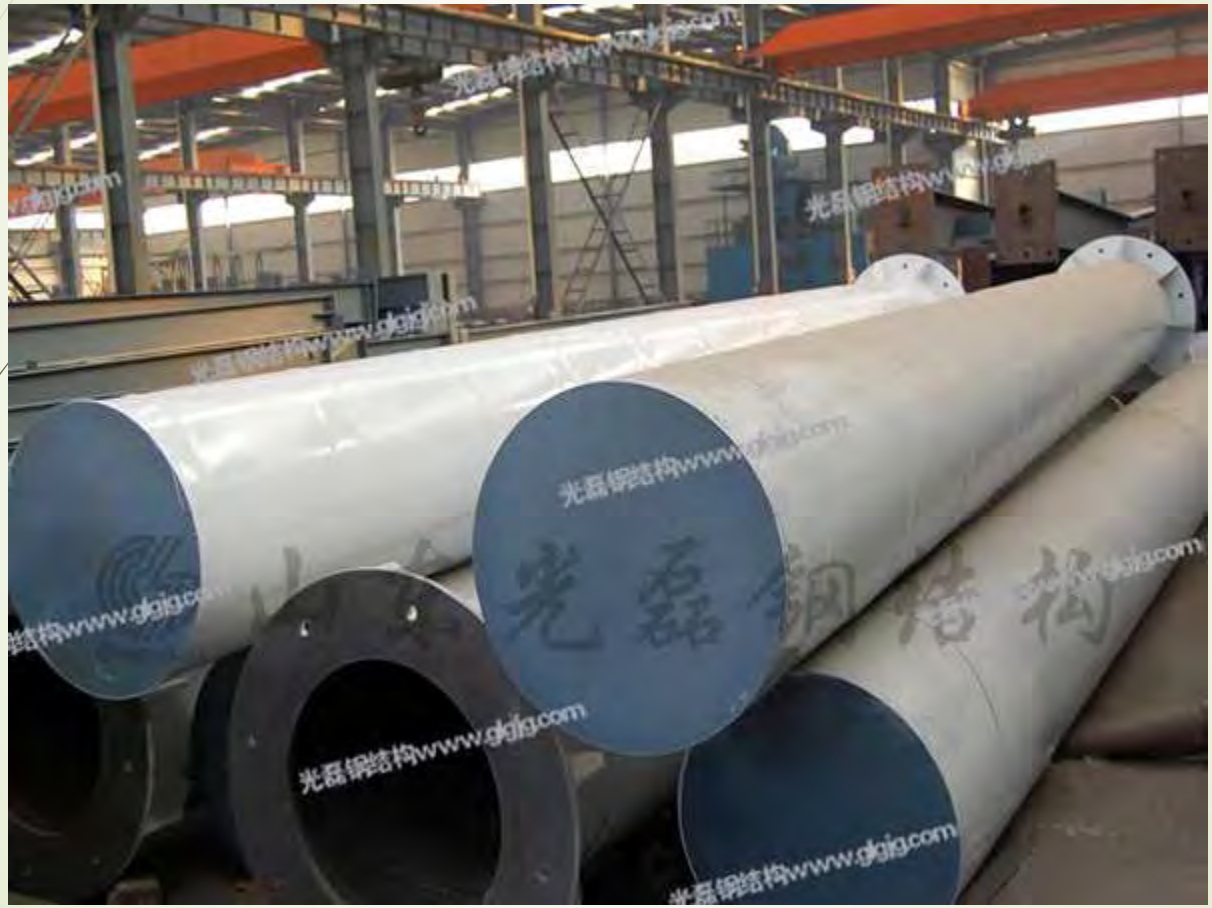
Types of Columns

- H beam, Steel Column
- **Lattice Column**
- Round Column
- Box Column
- Cross-shaped Column



Lattice column

Circular Column



Box column

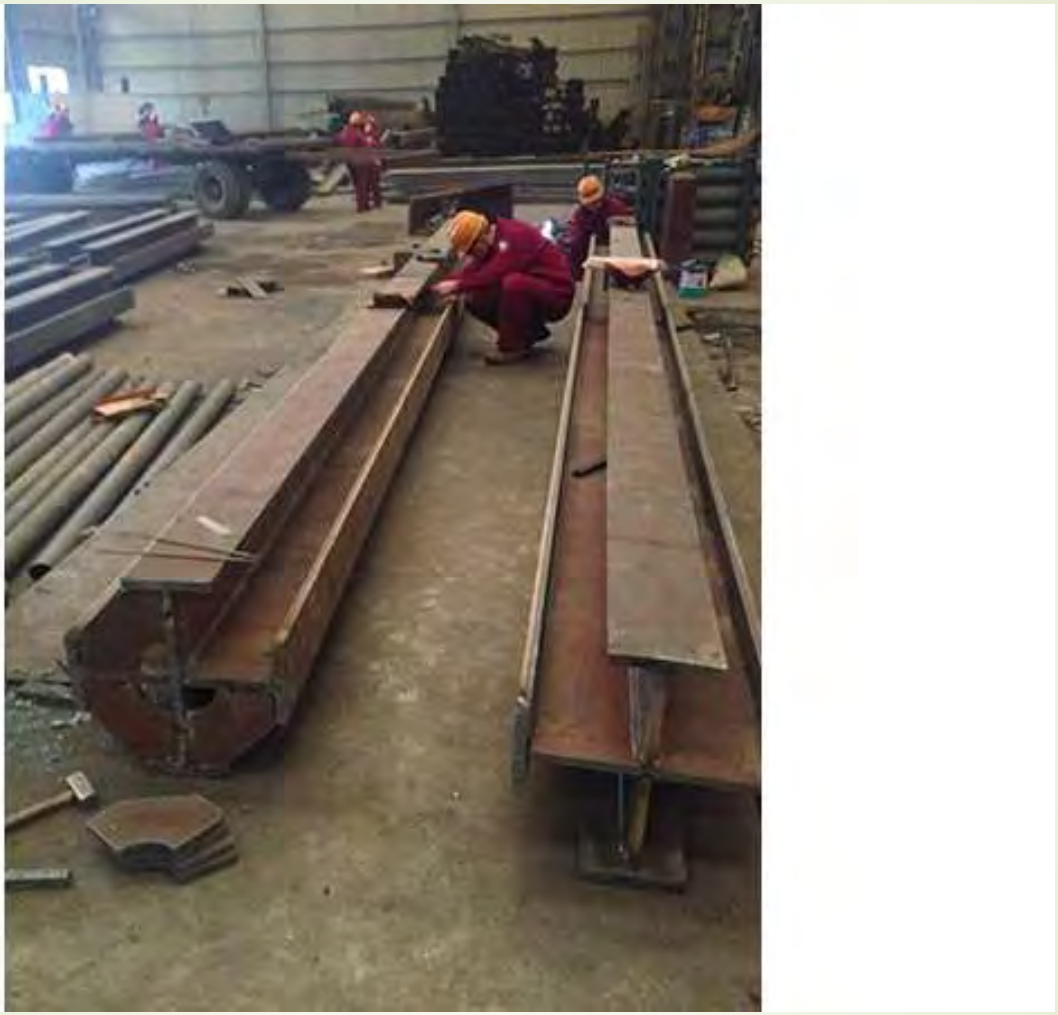


Photo courtesy Thinkstock

The connection between beams and column

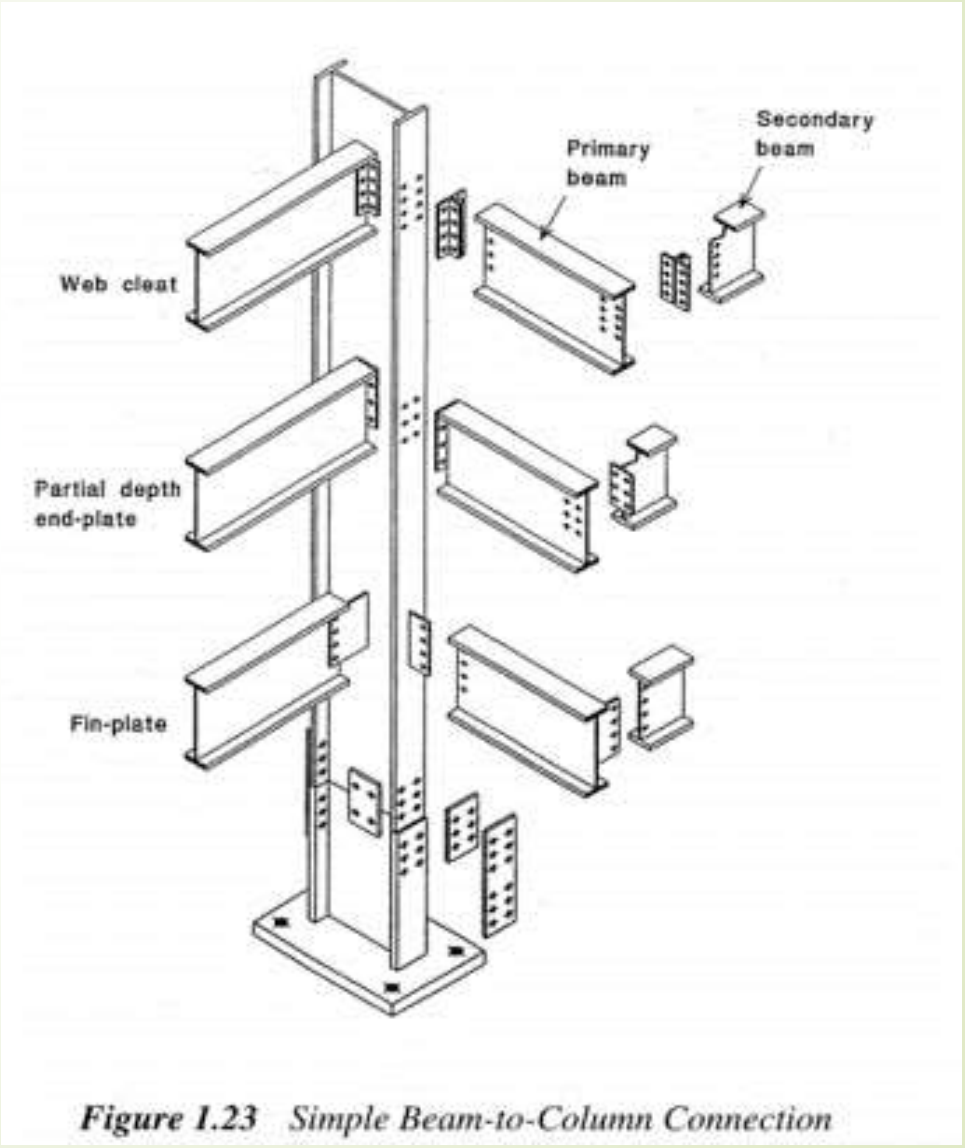
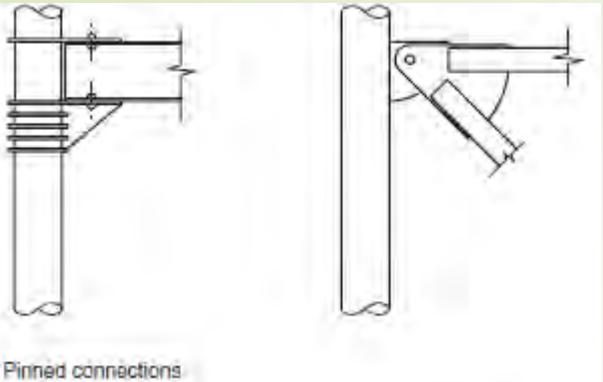
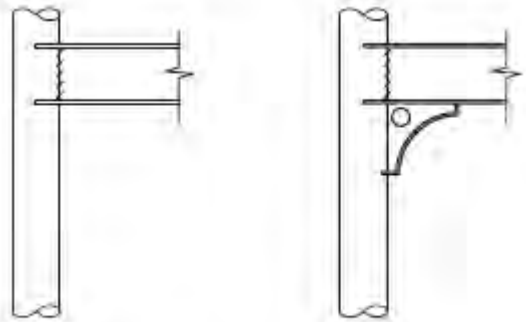


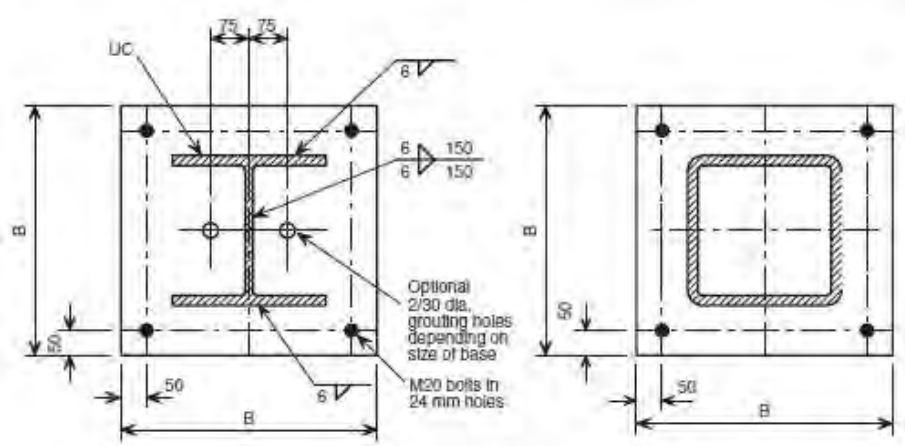
Figure 1.23 *Simple Beam-to-Column Connection*



Pinned connections

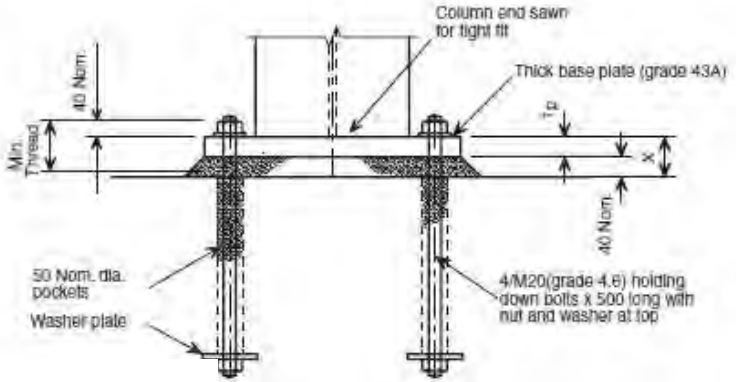


Rigid connections

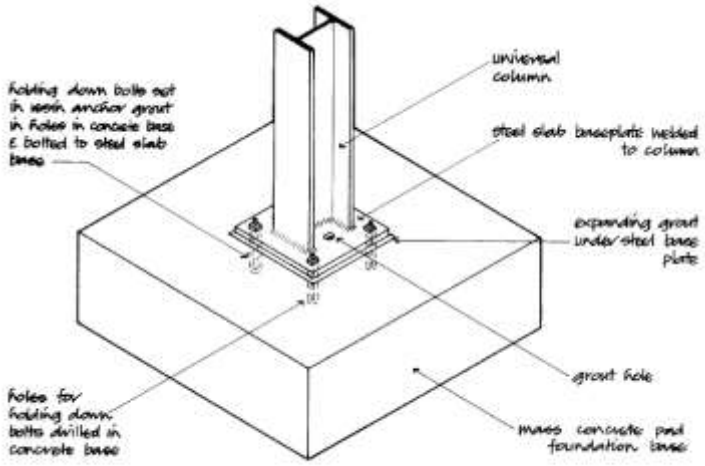


Universal Column

Rectangular Hollow Section

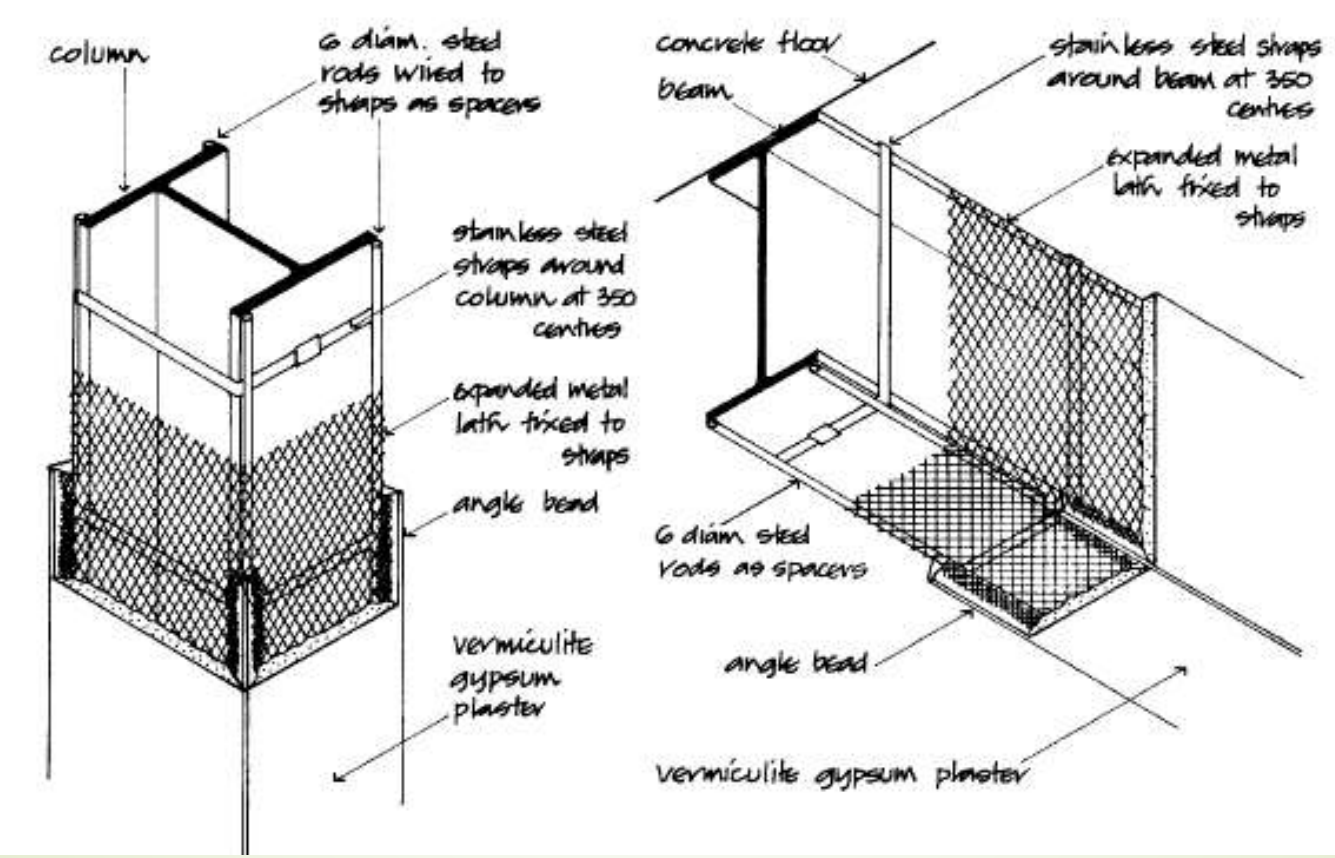


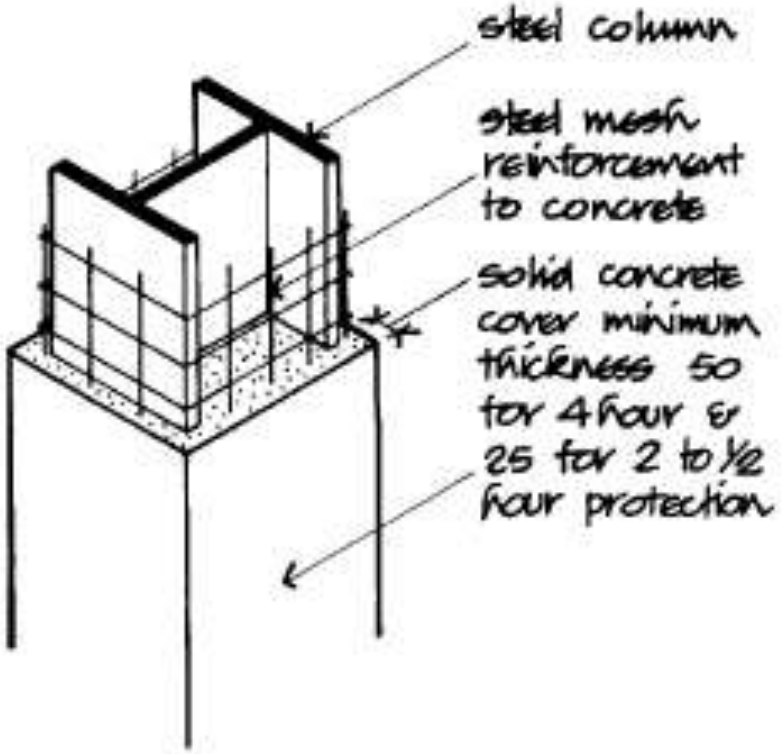
4.24 Tubular columns with pinned or rigid connections



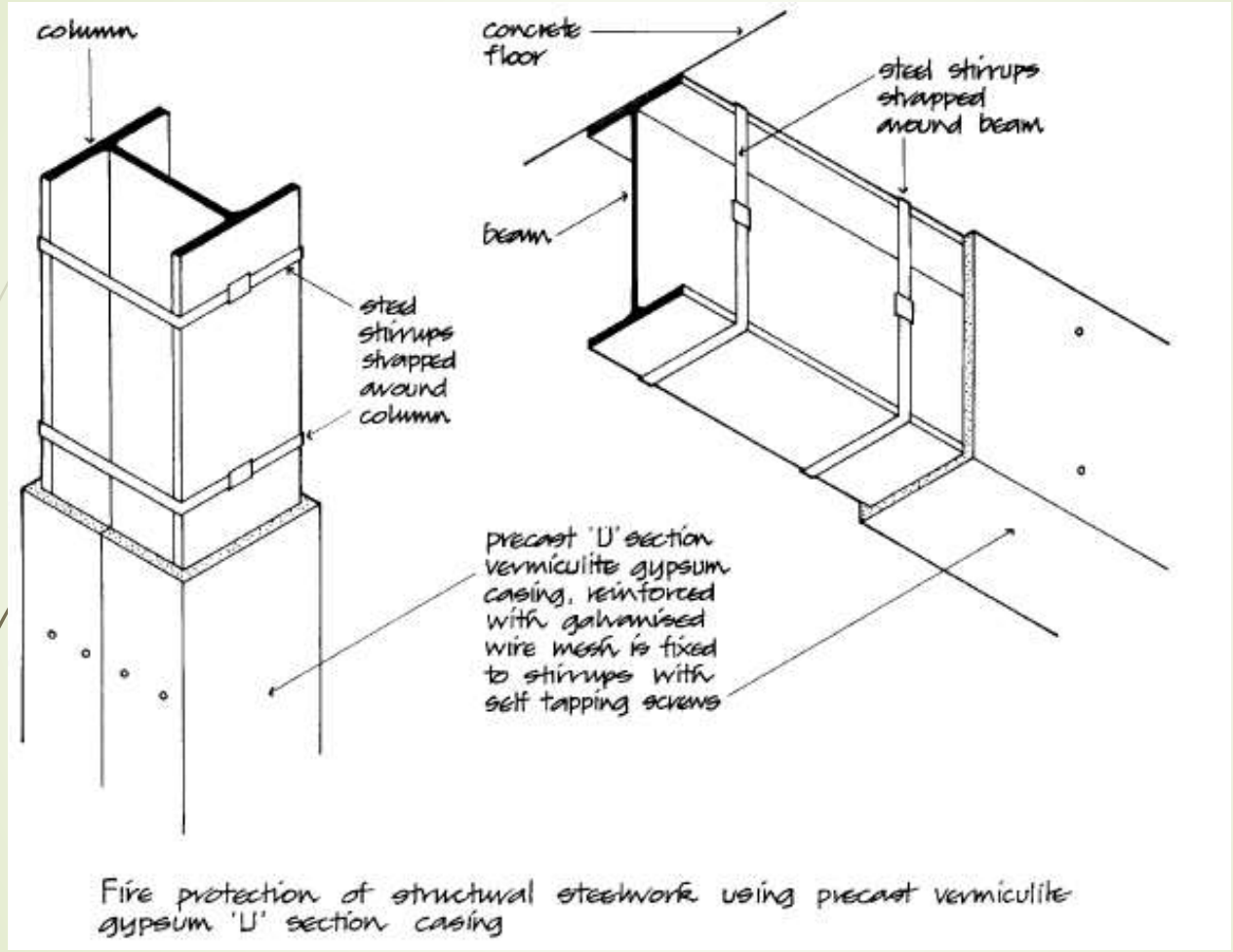
Steel slab base on concrete pad foundation

Fire Protection of Structural Steelwork using Metal lath and plaster casing



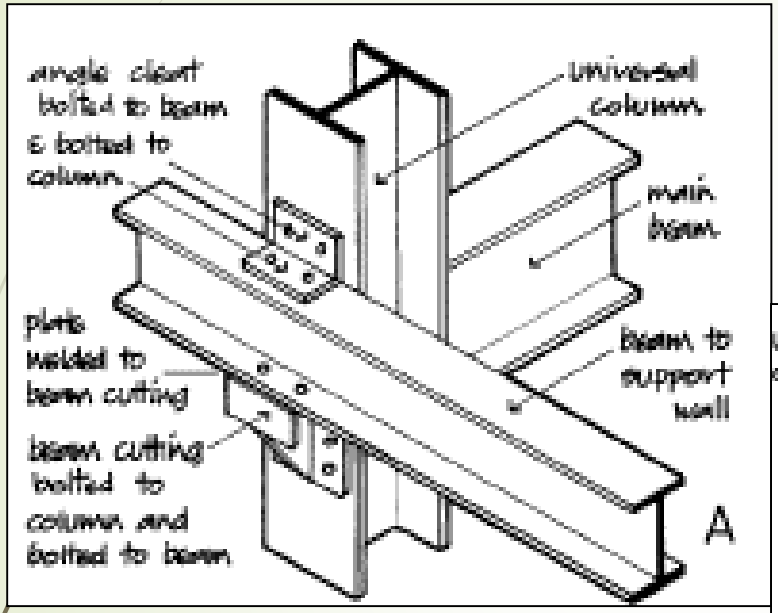


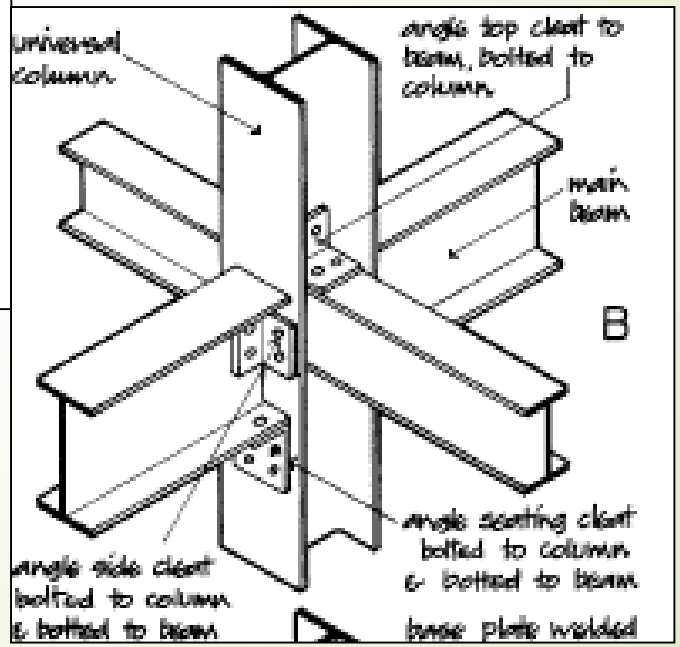
Non structural solid concrete fire protection to steel column

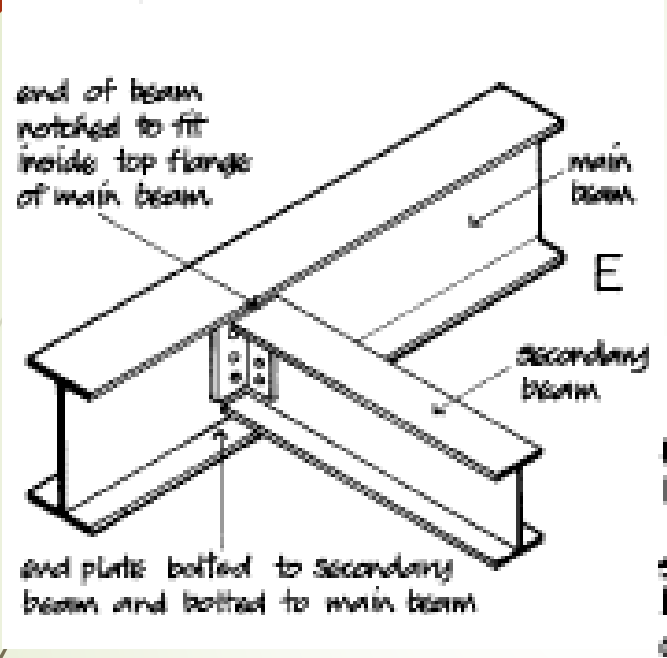


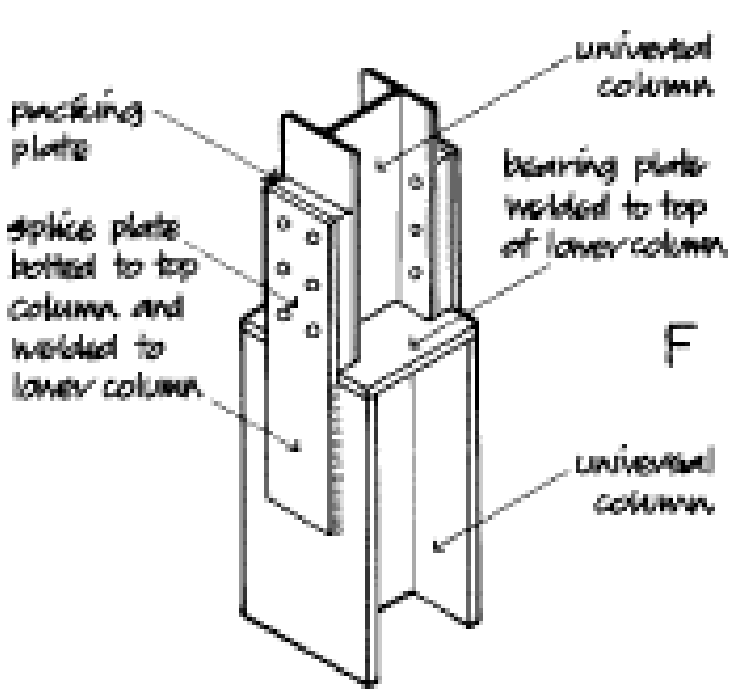
Fire protection of structural steelwork using precast vermiculite gypsum 'U' section casing

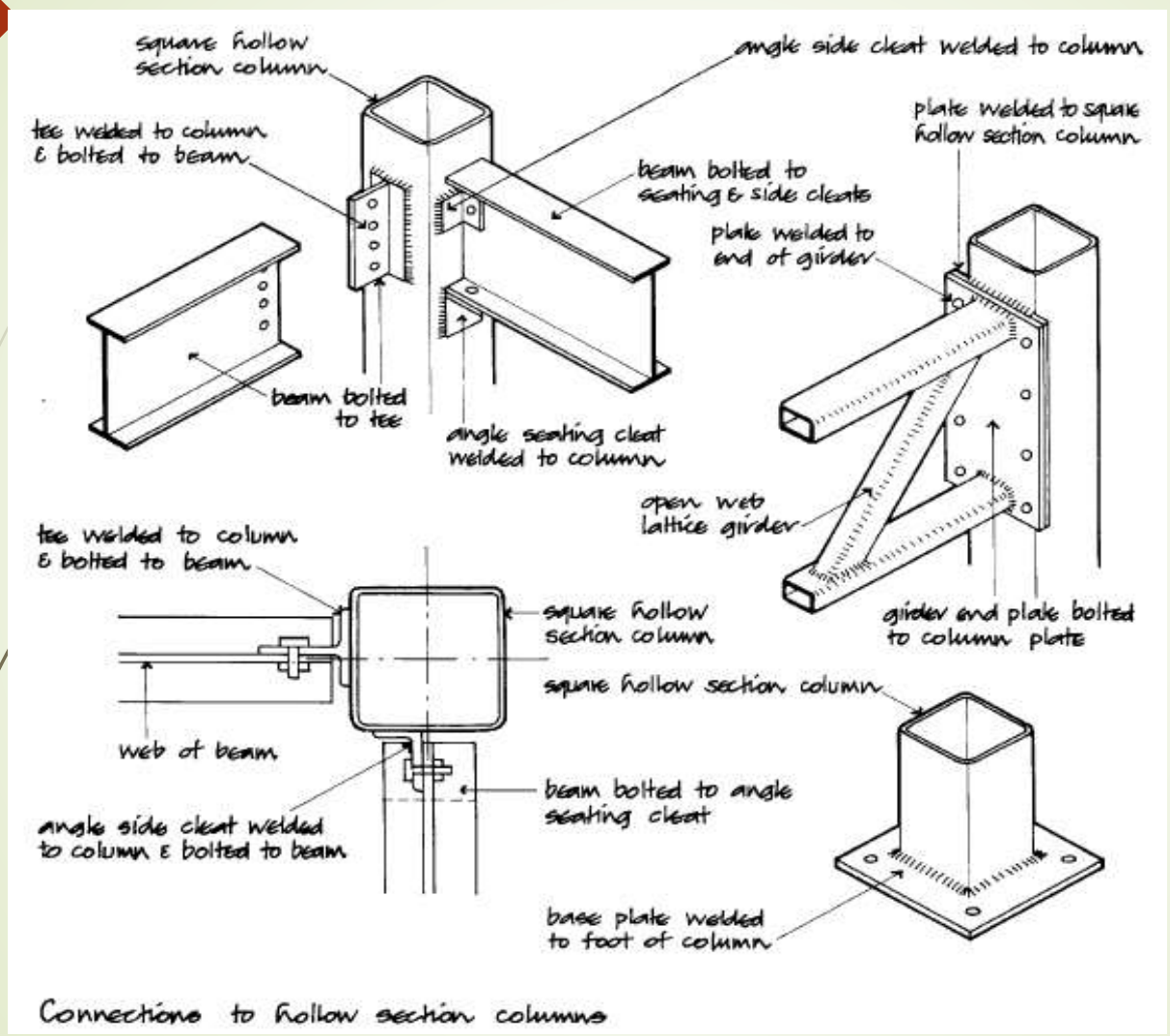
Structural Steelwork Connections





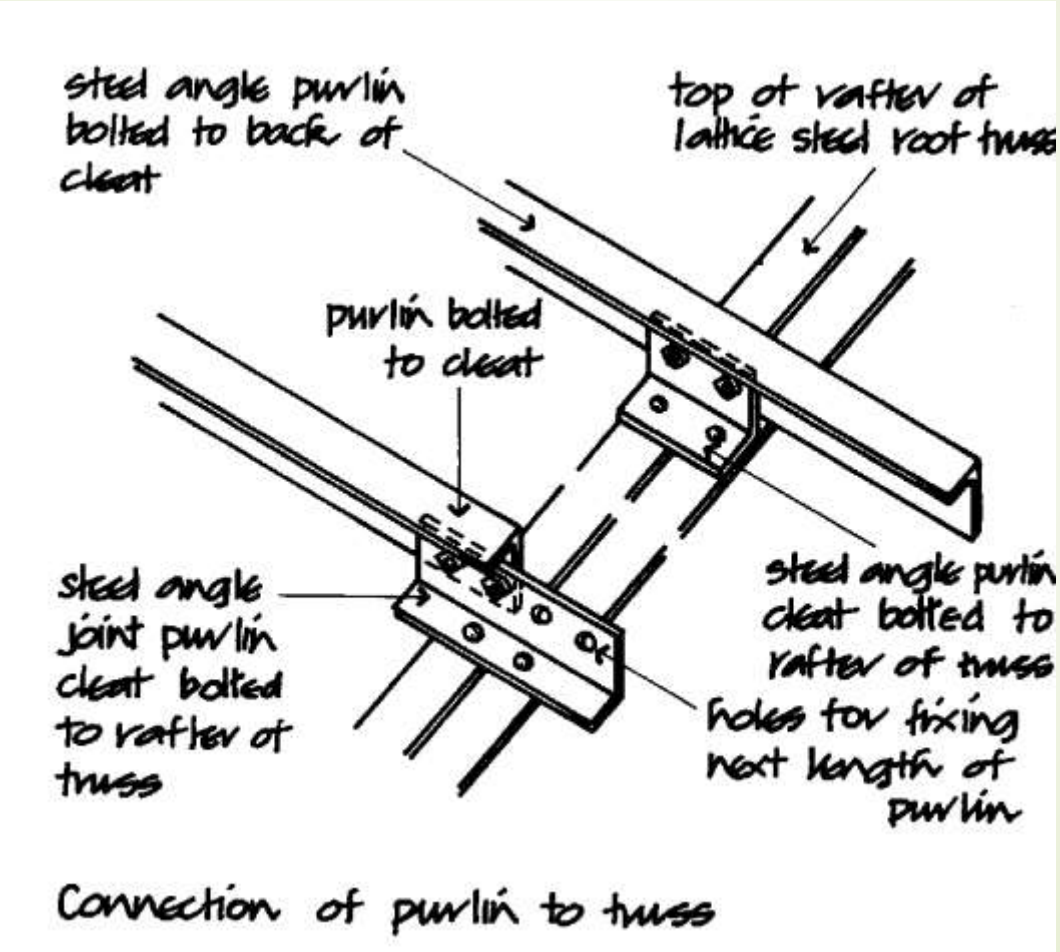

end of beam notched to fit inside top flange of main beam
main beam
E
secondary beam
end plate bolted to secondary beam and bolted to main beam


packing plate
splice plate bolted to top column and welded to lower column
universal column
bearing plate welded to top of lower column
F
universal column



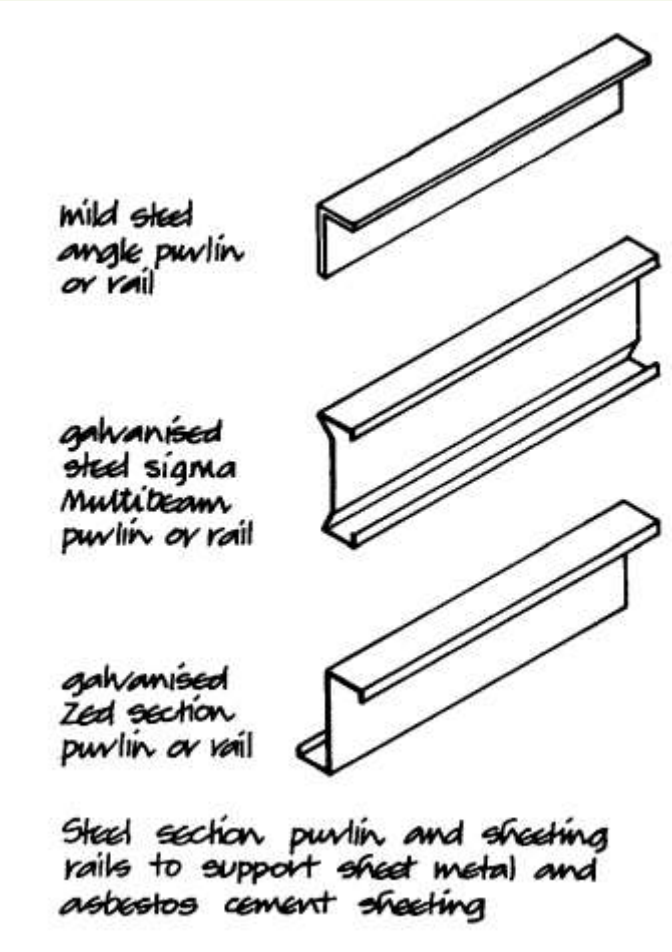
Connections to hollow section columns

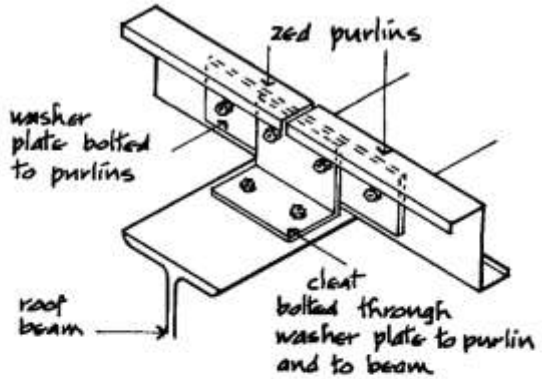
Secondary membranes

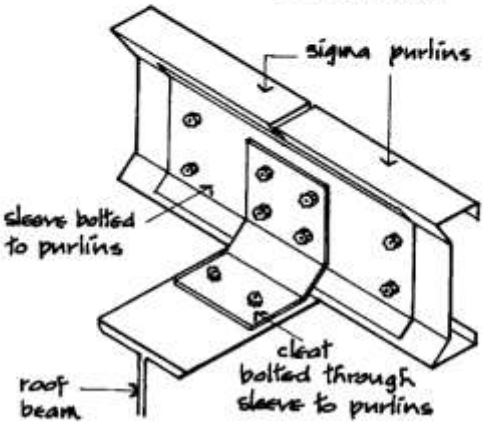


Connection of purlin to truss

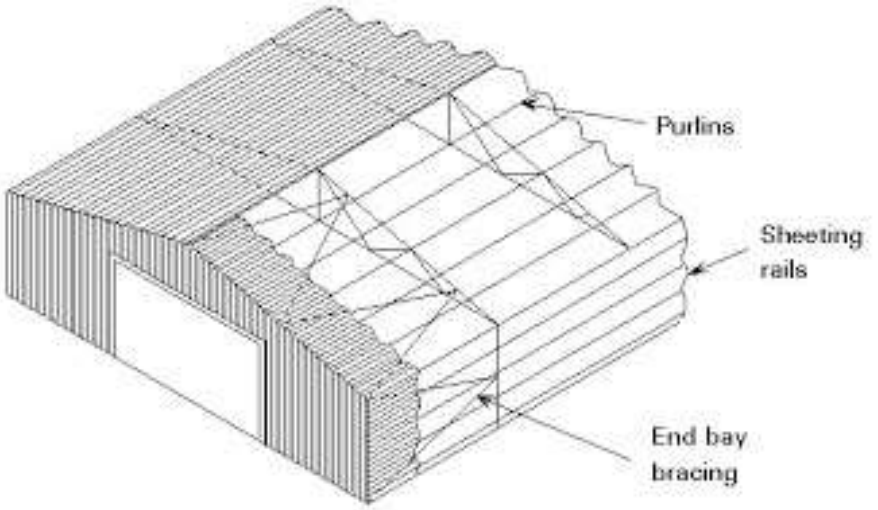
Secondary membranes



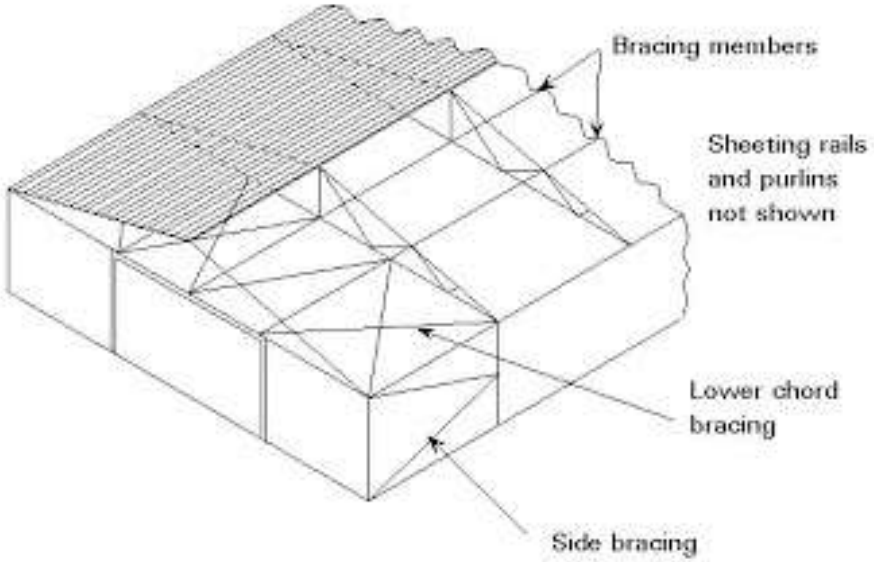




Washer plates and sleeves for continuity over supports



(a) Purlins provide lateral support to top chord of truss



(b) Lower chord bracing system provides lateral support to bottom chord of truss

Figure 10 Lateral support for roof truss