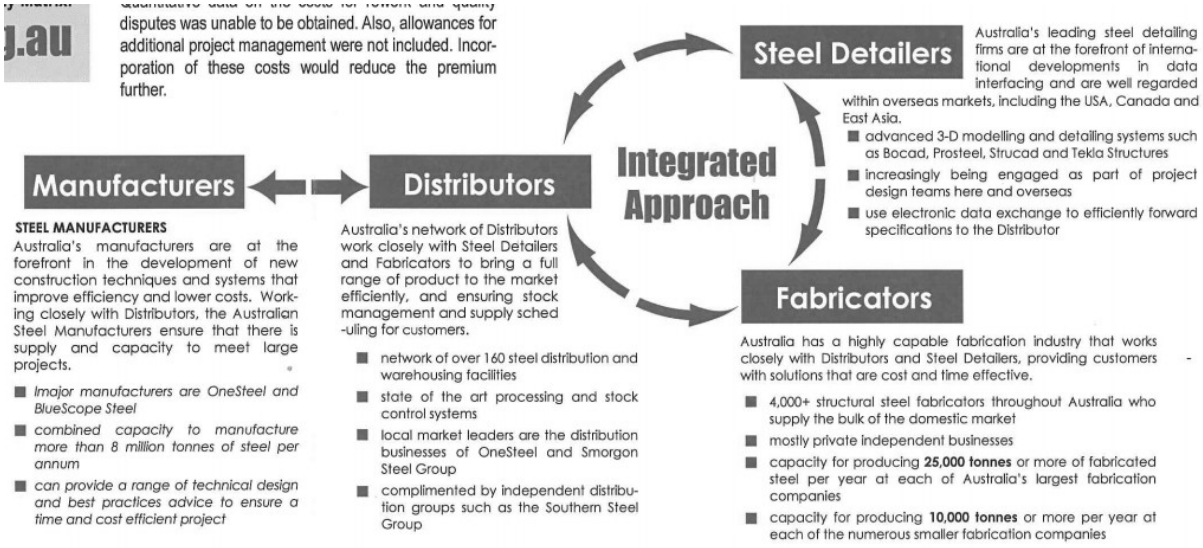
Steel & Concrete Study Notes

Intro to steel & concrete systems:

steel structures	materials and framing systems bolted and welded connections portal frames and frame design
industrial ground slabs	construction methods design of floor slabs on grade
basement construction	waterproofing solutions basement construction and retention systems
piling systems	sheet piles, continuous flight auger piling under bentonite
tilt slab construction	materials and components planning and construction detailing and design considerations
precast concrete frames	Transfloor, Ultrafloor, Hollowcore
hybrid construction systems	AFS structural wall, Bubbledeck system, Rocla columns

Australian Steel Industry

Australian Steel Institute = nation's peak body representing the entire steel supply chain. Marketing and technical leadership to promote Australian−made steel as the preferred material. (steel.org.au)



- in Australia, we use more concrete than steel because we have more skilled workers for it, and it's cheaper to get steel from overseas rather than manufacture it here

Structural Steel Sections

Hot Rolled Structural Steel sections

- are manufactured to AS/NZS 3679.1 Structural Steel – Hot Rolled Bars and Sections
- 300Plus is the standard grade manufactured by OneSteel and exceeds the minimum requirements of AS/NZS 3679.1 grade 300.
  - **300 = yield stress**
- 300Plus replaced Grade 250 as the base grade for these sections in 1994 - **250 = older buildings**
- 300Plus – tensile strength (f_u) is 440MPa

Welded Steel sections

- are manufactured to AS/NZS 3679.2 Structural Steel – Welded I Sections
- These sections are welded from plates – *not rolled, but ASSEMBLED*
- 300Plus is the standard grade
- Grade 400 is also available.
- Maximum lengths = 30m

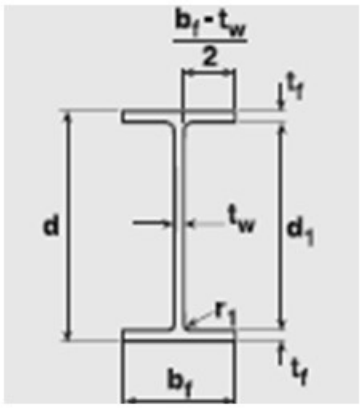
ANYTHING LARGER THAN 610 UB MUST BE WELDED

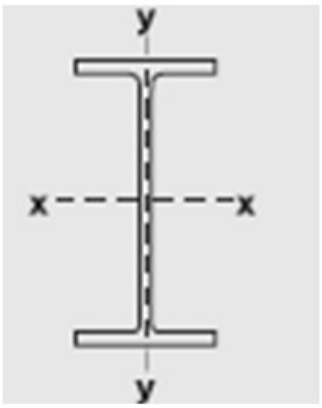
Cold formed sections (THINNER)

- channels and angles, available from BlueScope, either zinc coated or uncoated, 1.0mm, 1.6mm, 2.5mm and 3.0mm BMT (Base Metal Thickness) – e.g. Bondeck
- Steel is 300MPa minimum yield stress to either AS/NZS 1397−2001 or AS/NZS 1594−2002

Steel Section Size & Properties

Universal Beams (rectangular shaped) ***UB***





- 4 rollers, each of which can be adjusted
  - I_xx, I_yy, and axes
  - r_xx r_yy = radius of gyration.

- shear stress is carried by the WEB

- top & bottom flange = SAME

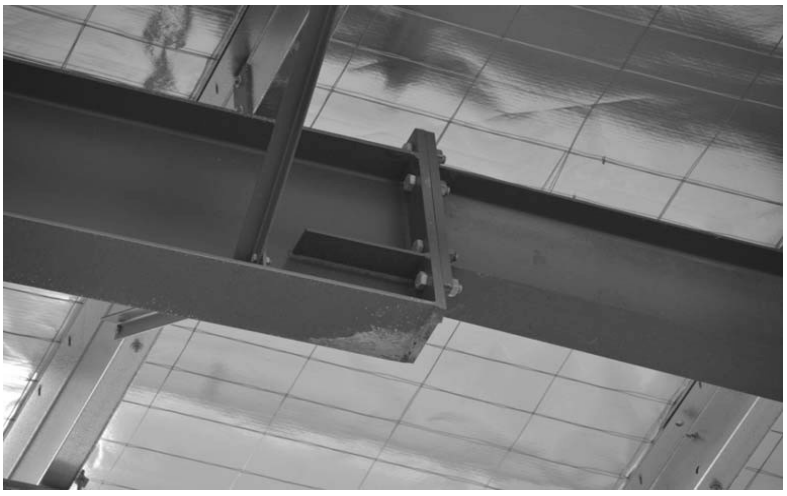
Table 13 Universal Beams - Dimensions and Properties

Designation	Depth of Section	Flange		Web Thickness	Root Radius	Depth Between Flanges
		Width	Thickness			
	d	b_f	t_f	t_w	r_1	d_1
kg/m	mm	mm	mm	mm	mm	mm

- $r_x = \sqrt{\frac{Ixx}{A}}$

Greater r_x = more axial load can be carried

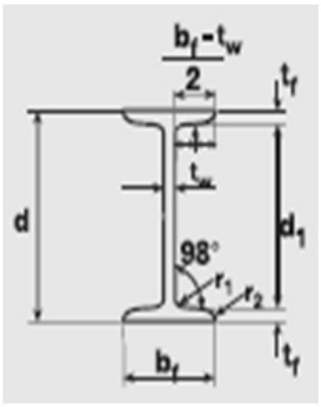
2nd moment of area = how much material is away from the neutral axis



- Only use 1 bolt size for continuity and efficiency
- Double the bolts to how many you can see (e.g. there is 8 for this example)
- Weld THEN bolt (welding on site is more expensive and takes longer)
  - therefore: weld up to a transportable length at the fabrication yard & bolt later

Universal Columns ***UC***

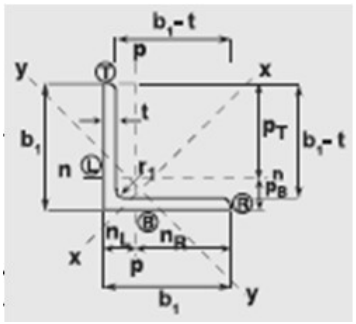
- b & d = almost the same
- For carrying axial loads
- Square shaped



Tapered Flange Beams ⟶
= usually for floor joists

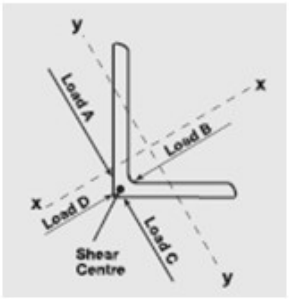
Equal Angles ***EA***

- x and y axes are rotated
- often used as bracing members can't carry a lot of load (good in TENSION not compression)
- need two + other ways of providing lateral stability



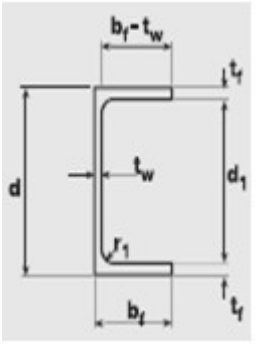
Unequal Angles ***UA***

- 1 leg is longer than the other



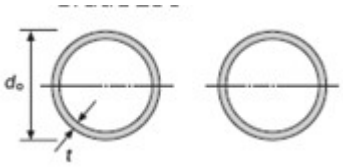
Parallel Flange Channel ***PFC***

- PFC – flange thickness stay consistent right through from the web of the channel till the end of the flange
  - replacement for the taper flange channel.
  - normal washers can be used, connection is easier, increased load−carrying capacity.



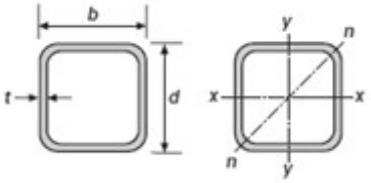
Circular Hollow Sections ***CHS***

- ADVANTAGES: Less drag due to circular shape – used extensively for offshore structures, reduce wind resistance for tall structures
- DISADVANTAGES: difficult to join/ can't be bolted to
- Made by: flat plate rolled up and welded

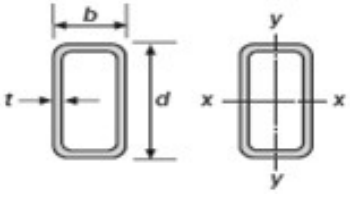


Square Hollow Section ***SHS***

- Same x and y axes strength
- Easier to connect to since flat sides



Rectangular Hollow Section ***RHS***



Use cleats to simplify connection – pinned vs fixed.

Connecting hollow sections to ground:
= welded to end plate and bolted To footing

Welded Columns ***WC***

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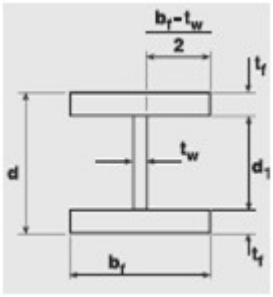

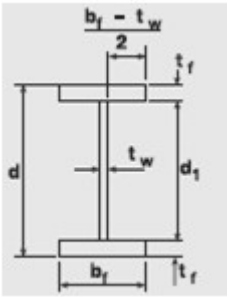

Welded Beams ***WB***

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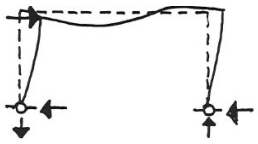
Some sections are too thick or large to roll

Framing Concepts

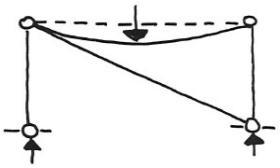
- The framing system and framing layout chosen for a particular application will be influenced by the nature and level of the loads to be resisted, by the requirement and restrictions on usable space and by constraints imposed by architectural requirements.
- One advantage of steel framing is the diversity of solutions possible for any given application.
- Two basic connection types:
    1. **Rigid connections**
    2. **Flexible connections**
- Based on these connection types, 3 basic framing systems are available:
    1) ***Two-way rigid framework***
    2) ***One-way rigid/ One-way braced frameworks***
    3) ***Two-way braced framework***

Advantage over concrete structures = quicker and reaches full strength immediately (no waiting 28 days)
Every structure must be STRONG IN TWO DIRECTIONS

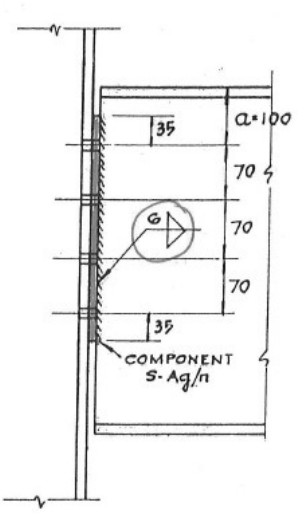
Connection Types:



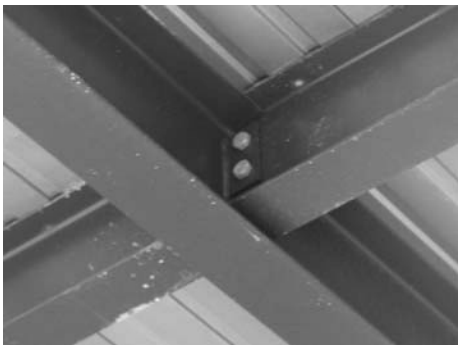
- AS4100 permits the use of three different design method:
    i. Rigid Construction: the connection has sufficient rigidity to hold the original angles between members
    ii. Semi−Rigid Construction: may not have sufficient rigidity to hold the original angles between the members unchanged, but assumed to have a capacity to furnish a known degree of flexural restraint.
    iii. Simple Construction: connections are assumed not to develop bending moments. The stability of structure is therefore provided by bracings.
    = *can rotate relative to the other member*

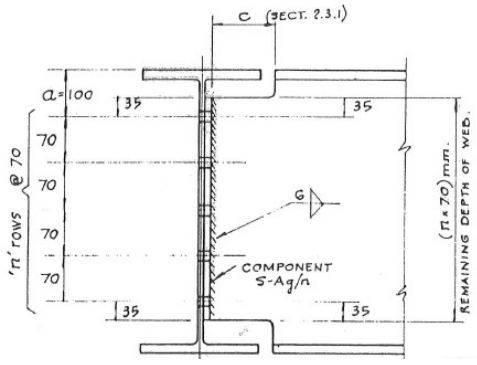


*Flexible (pin/simple) Connections***:**



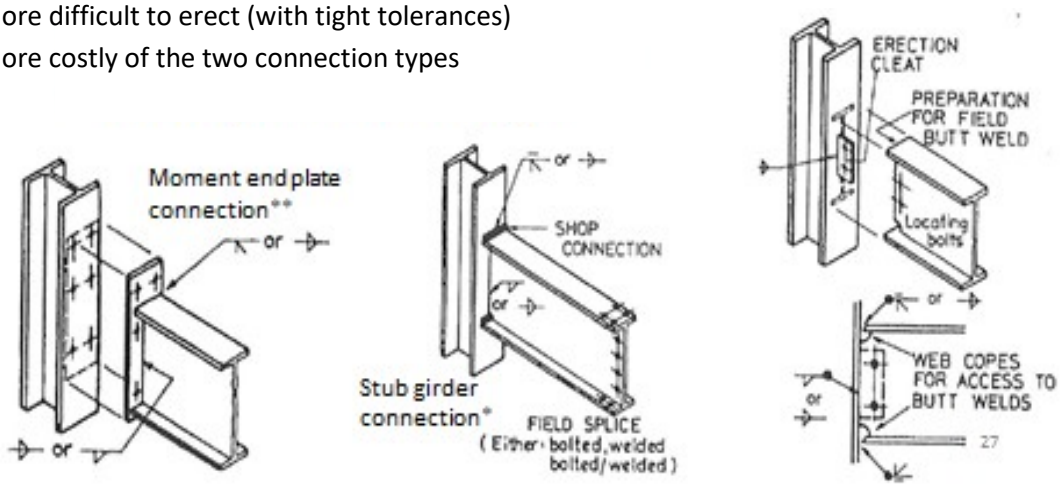
- These connections offer low restraint to beam rotation
- These connections are designed to carry shear forces only
- These connection is through web of the member
- These connections are:
    - Assume to have a simple support
    - Simple to fabricate
    - Simple to erect
    - The less costly of the two connection types





Rigid (fixed/moment) Connections:

- These connections offer very high restraint to beam rotation (one can't rotate relative to other = maintains 90^o)
- These connections are designed to carry shear forces and bending moments
- These connection is through web and flanges of the member
- These connections are:
  - More complex in fabrication
  - More difficult to erect (with tight tolerances)
  - More costly of the two connection types

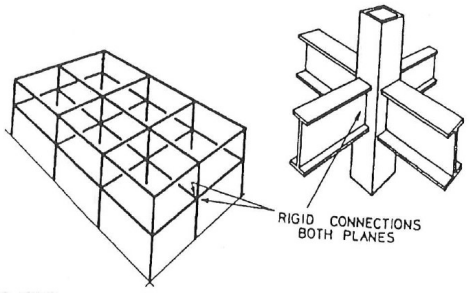


If pinned, only shear/lateral forces are transferred – no moments.
Tension is transferred through bolts

- Thicker column flange on left = carries more load
- Stiffeners added to the web of the column, the full length between flanges
- Cleats or stiffeners to beam end plate = if end plate is not stiff = may bend = needs extra stiffening

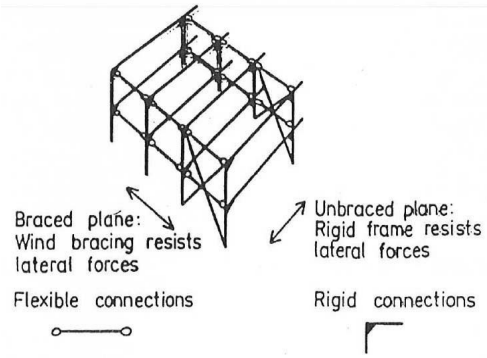
Knee (of portal frame) = extra moment capacity

Basic Framing Systems



1. Two-Way Rigid Framework

- 2 planes of rigid frames intersecting at right angles using common columns at their intersection.
- This framework resist lateral forces in both planes by frame action
- All beam to column connections must be rigid
- Columns need to have approximately equal stiffness in both directions
- Sway within an acceptable limit due to elastic deformation is allowed in the design
- Advantages:
  1. Freedom in planning (open spaces)
  2. Reduction of floor beams sizes
- Disadvantages:
  1. More costly rigid connections
  2. Bigger column sections
- Typical applications: Multi−storey frames, low−rise rectangular frame (with restriction of bracing elements), heavy industrial structures (with bracing restrictions)

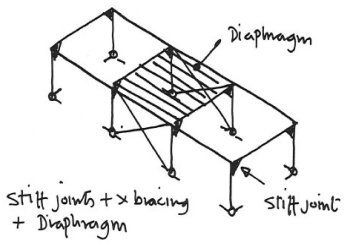


2. One-Way Rigid Framework

- Rigid beam−to−column connections in the unbraced plane
- Simple connections can be utilized in the braced plane
- Restriction in planning of the floor layout for using stabilizing elements

**most of the time bracing can be arranged within the thickness of the perimeter wall*

- Rigid diaphragm can also be used as a bracing element between rigid frames
- Typical applications: Low−rise industrial frames (portal frames) Industrial structures with bracings around



3. Two-Way Braced Framework

- These frameworks rely on stabilizing elements to resist forces from different directions
- Beam to column connections are all flexible (pin) connections
  Therefore: beams are simply supported and columns are axially loaded
- Advantages:
  1. Easier to design
  2. Cheaper connections
  3. Smaller columns
- Disadvantages:
  1. Deeper floor beams
  2. Restriction on planning (braces everywhere)
- Typical application: Low to medium−rise frames