Economical Structural Steelwork

edited by

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AUSTRALIAN STEEL INSTITUTE

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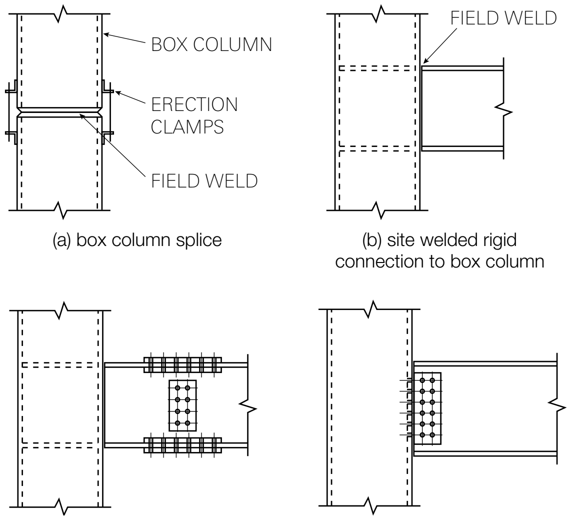


(a) box column splice
(b) site welded rigid connection to box column
(c) stub girder connection to box column
(d) angle cleat connection to box column

FIGURE 8.16: Connections to box columns

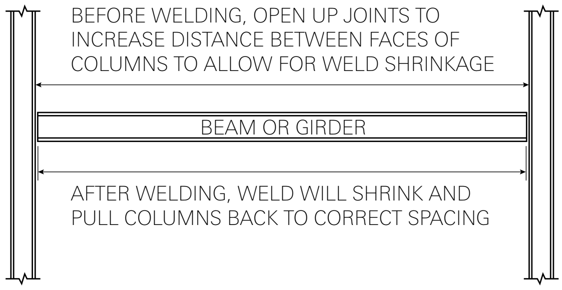


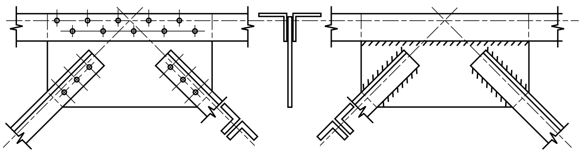
FIGURE 8.17: Spreading of columns to allow for weld shrinkage

8.4 Trusses

Welded trusses have in the past provided very efflcient building elements because of the favourable mass/span ratio possible. Although for many industrial building applications, such systems as saw-tooth trusses have been superseded by the portal frame system, there are still many long span applications where truss portals provide an economic solution (see Clause 4.3).

In general, trusses fabricated by welding should preferably use specially developed details suitable for economical welded truss fabrication rather than details borrowed from the days of riveted construction. For too long the old riveted details have been used on welded trusses, on the basis of simply replacing rivets by equivalent welding (see Figure 8.18). This leads to uneconomic fabrication, since it introduces an unnecessary amount of welding and, most importantly, since it requires the truss to be turned during fabrication to weld the angles to the gussets on each side.

Several alternative details offer far more economic welded truss fabrication. Figure 8.19 shows a detail where single angles have been used as both the truss chords and the web members. This provides for the most economic truss fabrication since all welding can be done from one side, thus avoiding turning of the truss during fabrication. Additionally, the gussets have been eliminated by using a long leg angle as a chord member. Obviously this detail requires the designer to consider the eccentricities involved in the design, but it appears in most cases that the use of slightly heavier angles will cater for these eccentricities.



Rivetted truss (previously economic).
Welded equivalent (uneconomic detail).

FIGURE 8.18: Equivalent truss detailing

Alternatively a T-section can be used for truss chord members with single angle web members welded to the vertical leg of the tee (see Figure 8.20). The T-sections would usually be split universal beam or column sections – an operation that can be economically carried out by most fabricators.

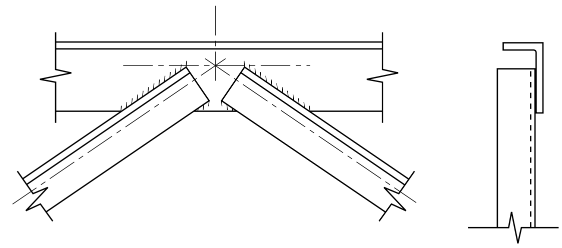


FIGURE 8.19: Single angle welded truss

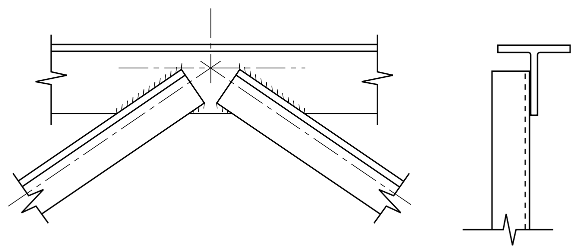


FIGURE 8.20: Split tee welded truss

In large heavy trusses, (i.e. those fabricated from universal beam or column sections), care must be taken with detailing to ensure optimum economy. In these cases the detail at the intersection of members can lead to very costly fabrication and it is suggested that the spreading of intersection points can provide a better detail where members can be plain mitre cut to length rather than having double mitre end preparations. The resulting eccentricity can usually be accommodated by the relatively massive chord members in such trusses. Figure 8.21 illustrates the use of universal sections in a welded truss while Figure 8.22 illustrates the use of rectangular hollow sections. In both cases, detail (b) is preferable to detail (a).

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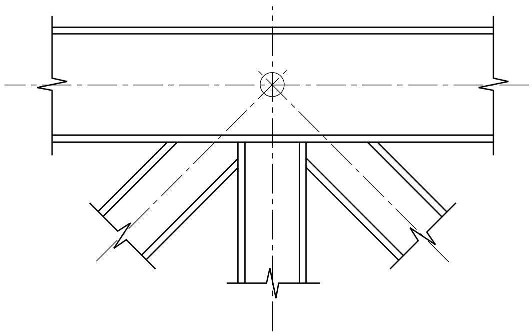
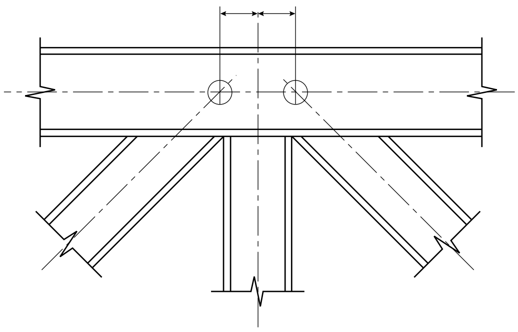
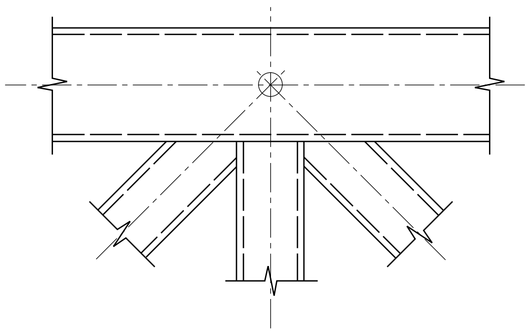


(a) Coincident intersection points. Double mitred member ends.

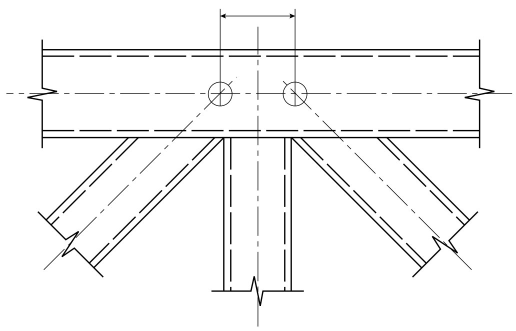


(b) Preferred. Spread intersection points. Single mitred member ends

FIGURE 8.21: Use of universal sections in welded trusses



(a) Coincident intersection points. Double mitred member ends.

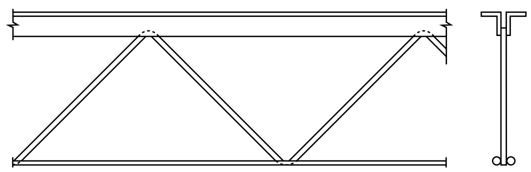


(b) Preferred. Spread intersection points. Single mitred member ends.

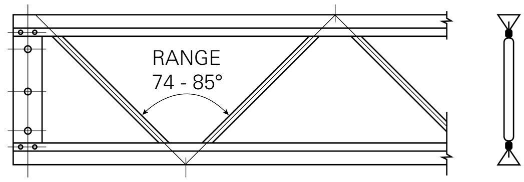
FIGURE 8.22: Use of rectangular hollow sections in welded trusses

Although trusses are usually considered as roof framing members there are other areas where they offer economical light framing members.

Such a case is in multi-storey construction where secondary oor members at relatively close centres are required. Economy can be achieved by the fact that a large number of these members will be required and the use of mass-produced truss members can be considered. In other parts of the world the open web joist lends itself to this application and many notable buildings have incorporated such joists as oor members. Figure 8.23 shows the traditional open web joists (a), as well as a proprietary light weight truss (b). These light weight joists are no longer made as a standard item and are usually uneconomic for structural applications unless large quantities are required.

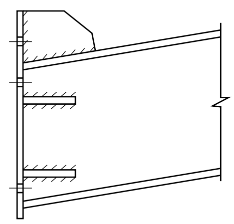


(a)

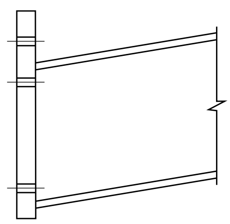


(b)

FIGURE 8.23: Types of open web joist



(a) Non preferred.

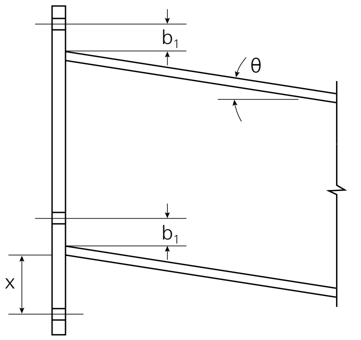


(b) Preferred.

FIGURE 8.24: End plate details

8. Detailing for Economy

TABLE 8.1: Wrench clearances



θ	Recommended Minimum Dimensions b_1	X For Air Wrench*	X For Hand Wrench	Remarks
0°	60	60	60	M20 & M24 Bolts only
5°	60	100	60	
7.5°	60	100	60	
10°	60	100	60	

Note:

* The use of a universal joint does offer some possibility of reducing this dimension, and while this may be seen as an advantage from a design point of view, it should be noted that an impact wrench with a universal joint and socket is generally difficult to handle for an operator some height from ground level. In addition, the use of a universal joint reduces the efficiency of the impact wrench and this can be a problem in tensioning M24 bolts or larger, especially if located some distance from the source of the compressed air supply.

8.5 Portal Frames

8.5.1 CONNECTIONS

A discussion of various aspects of the economics of portal frame steel buildings is contained in Clause 4.2. A number of other items of concern to the economic detailing of these frames is contained in this Section.

In portal frames using bolted end plate connections for the knee and apex joints (see Figure 4.2), close attention must be paid to the detailing of these connections, especially where tensioned bolts (8.8/TB category) are employed - the most common practice. Any cost savings obtained by simplifying connection details to make fabrication simpler can be lost during site erection if clearance problems are encountered during site assembly. Recommended dimensions for such connections, extracted from Ref. 1, are given in Table 8.1. These dimensions are sufflcient to ensure that the bolts can be installed and tensioned, since sufflcient clearance is provided to accommodate either hand or air wrenches.

In the design of the end plates, designers can approach the proportioning of the end plate to resist the bending moment developed due to the behaviour of the plate under loading in two ways:

(a) Use a thick unstiffened end plate.

(b) Use a thin stiffened end plate.

Figure 8.24(a) shows an excessively stiffened thin end plate which would be an extremely expensive detail compared to the thicker end plate detail of Figure 8.24(b). For this reason, (b) is much preferred. Another problem with excessively stiffened end-plates is that insufflcient clearance may then exist to allow the bolts to be installed. Design guidance on the design of end plates without stiffening may be found in Ref. 2.

At a bolted apex joint, care must also be taken to allow sufflcient clearance between the adjacent purlin cleat and the end plate to enable the end plate bolts to be installed and tensioned. The dimension 'Z' (see Figure 8.25) must be larger than the bolt length to be installed plus a clearance dimension, and also be large enough to permit the wrench socket to be placed on the nut.

Where split universal sections are used to haunch a portal frame rafter (see Figure 4.2), stopping short the fllet weld joining the split haunch to the   ange of the rafter is suggested as an economical and structurally sound device. Any fllet weld placed in the tight conflnes of the junction is likely to be of doubtful quality due to the difficult access involved – see Figure 8.26.

The recommended method of attaching purlins and girts in portal frame buildings is illustrated in Figure 8.27.

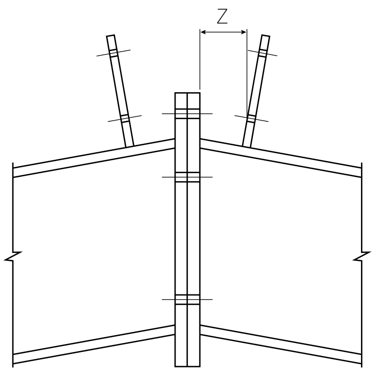


FIGURE 8.25: Clearance at apex joint