J-bolt (hook rod) tie-down systems

This bulletin is to provide information to builders, building surveyors, structural engineers and others involved in the design and installation of J-bolt/hook rod tie-down systems. In particular concerns regarding the improper use of 10mm diameter J-bolts based on investigation of lost roofs, laboratory testing and background research.

Background

Building and Energy have investigated roofs that have sustained and caused substantial damage after being blown off in winds assessed as significantly below the design wind speed. These roofs relied on 10mm galvanised J-bolts to tie down the roof frame and the loss of the roofs negatively affected:

- the occupants of the dwellings where the roofs were lost;
- the occupants of the houses which the lost roofs impacted; and
- the builder through reputation damage, the cost of remediation and penalties imposed by the Building Services Board.

The buildings where this occurred comprised:

- a recently completed home; and
- an older home re-roofed from tiles to lighter weight sheet metal.

J-bolts typical uses

The J-bolts are frequently used in:

- existing builds where extra tie-down is required as a heavier weight roof cladding (such as tiles, asbestos) is replaced by a lighter material (such as sheet metal);
- as part of a whole of house roof tiedown system; and
- in new dwellings where J-bolts are used to remedy missing tie-down straps.

J-bolt hook tie-down system characteristics

The characteristics of a typical 10mm diameter hook rod tie-down system that is found in Western Australia comprises a nominal 10mm x 150mm cross-bar (yoke) installed across the masonry cavity (Figure 1) and a nominal 10mm diameter rod approximately 1200mm long with a hook at one end and a thread with nut and washer at the top of the rod (Figure 2). The view of J-Bolt and cross bar configuration as per common installation practice is shown in Figure 3.

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Figure 1
View above of hook and cross bar as purchased.

Figure 2
View above of top of rod, nut and thread.

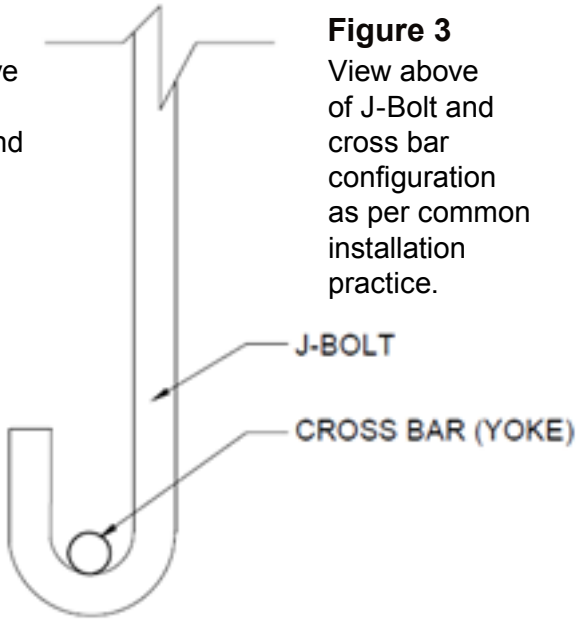

Figure 3
View above of J-Bolt and cross bar configuration as per common installation practice.

Typical tie-down strap versus J-bolt capacity

AS 4773.1 – 2015: Masonry in Small Buildings; Part 1: Design, Table 6.1 (B) gives a maximum connection capacity for a typical 30mm x 0.8mm or 25mm x 1.0mm tie-down strap of 6.5kN (approximately 660kg).

J-bolts do not have a design capacity nominated in Australian Standards, no details were able to be obtained from the supplier and the behaviour around the hooked end is difficult to analyse.

J-bolt testing

Building and Energy are aware of testing carried out by a local university. The tested J-bolts were purchased from a local hardware retailer and appeared to be similar to the rods used to tie down the failed roofs.

All six samples tested opened at the hook, losing grip with the cross-bar prior to damage or visible deformation of the cross bar or vertical section of the J-bolt (Figure 4).

The failure loads for the tested J-bolt systems were 3.05kN, 3.10kN, 3.19kN, 3.20kN, 3.3kN and 4.03kN (approximately 310-410kg).

Testing of 8 coupon specimens of the J rod produced a mean yield strength of 361(MPa) and a mean ultimate tensile strength of 418 (MPa.)

The design capacity of the J-bolt is less than the tested values. An engineer can provide specific advice as to the appropriate capacity and sampling reduction factors.

Tests indicate that the ultimate strength of the J-bolt may be approximately half the maximum capacity nominated for a tie-down strap in AS 4773.1 – 2015: Masonry in Small Buildings; Part 1: Design, Table 6.1 (B).

Figure 4

View of J-bolts and cross bars after testing (pull) note the hook on the rod has been straightened to a right angle and there is nominal deflection of the cross-bar (yoke).

Considerations for J-bolt tie-down systems

The Building Code of Australia contains acceptable construction manuals such as AS 4773.1. This Australian Standard offers deemed to satisfy solutions for the capacity of tie-down systems in masonry construction. A simplified solution for the J-bolt hook tie-down system is not provided in this standard. Therefore J-bolts require specific engineering design and installation comprising the following considerations:

- assessment of the design capacities of tie down systems by an appropriately qualified and experienced engineer with clear installation details included in the design documentation;
- locating the cross-bar anchoring the J-rod an appropriate distance down from the top of the wall to engage enough mass to resist the uplift load;
- ensuring that any brackets used to make the connection from the top of the rod to the roof frame are appropriate to transfer the load (light weight angle brackets connected to a timber rafter via Tek screws may be weaker than the J-rod);
- ensuring that the nut and tread of the J-bolt have adequate capacity;
- ensuring that other components such as the cross-bar and masonry are able to resist the design loads; and
- noting that J-bolts differing to those tested may have different capacities.

The building surveyor and builder should check with the engineer if uncertain or unclear on the tie-down details. Furthermore the builder should not substitute tie-down products or systems without appropriate assessment by the engineer, certification by the building surveyor and approval by the permit authority.

Conclusion

In some cases 10mm diameter J-bolts have been specified and installed on the basis of the J bolts having a greater tiedown capacity than they do. This has resulted in roof tiedown systems failing at below the design wind speeds.

Replacement of roof cladding constitutes building work that may trigger the requirement for a building permit. Please note that all building work must meet the applicable building standards whether a building permit is required or not. Please refer to Industry Bulletin 53 below.

Further related information

Industry Bulletin 102 – Performance Solutions for housing projects
Industry Bulletin 93 – Documentation for timber framed roof construction
Industry Bulletin 53 – Roof cladding replacements – building permit requirements
Industry Bulletin 32 – Durability of roof tie down connectors straps

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Building and Energy| Department of Mines, Industry Regulation and Safety
Level 1, 303 Sevenoaks Street, Cannington WA 6107
P: Locked Bag 14, Cloisters Square WA 6850
T: 1300 489 099 | F: 08 6251 1501
E: BCinfo@dmirs.wa.gov.au
W: www.dmirs.wa.gov.au/building-commission