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Tow Hitch Mounting Bolts and Safety Chain Attachments

The following document has been prepared by TCS to provide guidance to vehicle modifiers when installing a tow hitch onto a vehicle.

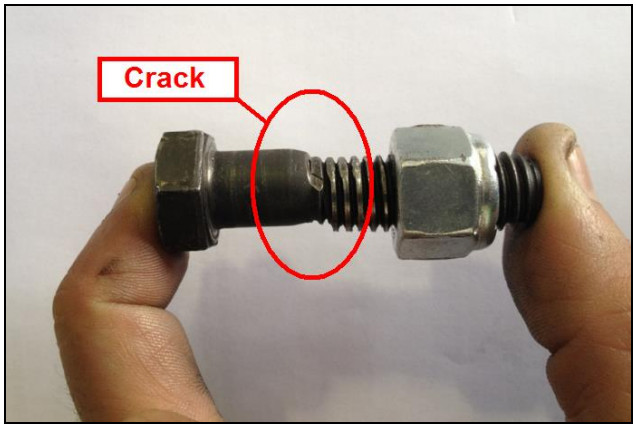
These guidelines are supplied without prejudice and TCS will not be held liable for any problems that arise from misinterpretation of these guidelines or from the introduction of new rules after the issue date of these guidelines. The following documents take precedence over this document and should be read in conjunction with the guidelines in this document:

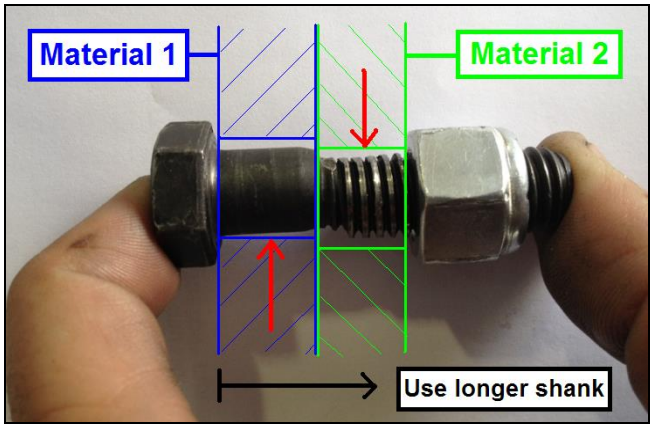
1. Vehicle Standard (Australian Design Rule 62/xx – Mechanical Connections Between Vehicles)
2. VSB-6 Sections H & P: National Code of Practice for Chassis Modifications and Tow Coupling Installations on heavy vehicles
3. Disclaimer on the last page of this document.

All modifications must be carried out by a suitably qualified tradesperson in accordance with the relevant Australian Design Rules, Australian Standards and National Codes of Practice. Any uncertainties should be discussed with TCS prior to commencing the modification.

When installing a tow hitch cross member to a vehicle, the mounting bolts should be installed in accordance with the above mentioned rules and the manufacturer's instructions. Further to these rules and instructions, TCS recommends that the shank (unthreaded region) of all mounting bolts should extend past the interface of the vehicle chassis and the tow hitch cross member. Failure to adopt this method can increase the likelihood of the mounting bolts breaking if the tow hitch experiences a sudden jolt.

An example of this type of failure is shown in the figure below; the bolt is being held together for the photo, but it sheared in half during physical testing. The physical testing was being conducted on a component unrelated to a tow hitch, but the lessons learnt from the testing have been applied to all situations where this failure could potentially occur, including the installation of tow hitches. Material 1 represents the vehicle chassis and Material 2 represents the tow hitch cross member.





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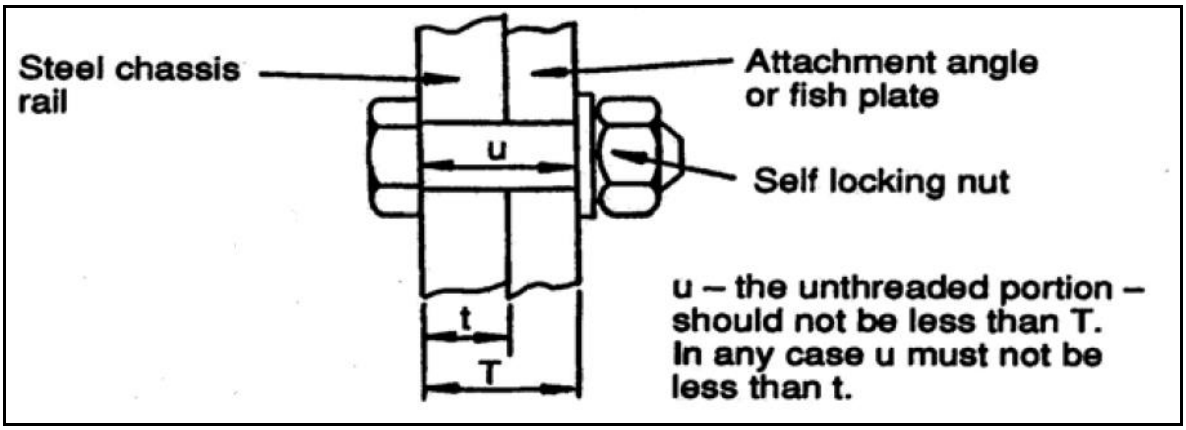
This is also stated in Section P of VSB6 (see diagram below from page 14 of Section P). Obviously there must be sufficient thread available to properly engage the nut.



There is a common misunderstanding by many people in the industry that safety chain attachment points are not required if an automatic pin coupling is installed on the tow hitch cross member. This is not always correct. Evidence for this is provided below:

ADR 62/00:

6.2. Safety Chain Attachments
The 'Towbar' must be fitted with safety chain attachments to withstand the loads imposed. Vehicles having a towing capacity (i.e. the 'Aggregate Trailer Mass' for which the towing vehicle is designed) of 2.5 tonnes or more must be fitted with 2 safety chain attachments mounted one on either side of, and adjacent to, the tow 'Coupling'.

ADR 62/01:

13.4.1. For vehicles other than those designed for use in 'Road Trains' , the 'Towbar' must be fitted with two safety chain attachments, of strength meeting the requirements of clause 13.4.2, mounted one on either side of, and adjacent to, the tow 'Coupling'.

ADR 62/02:

13.4.1. Except for vehicles designed for use in 'Road Trains', the 'Towbar' must be fitted with two safety chain attachments, mounted either side of and adjacent to, the tow 'Coupling'.

The conditions under which safety chains must actually be used are defined in the relevant ADRs.

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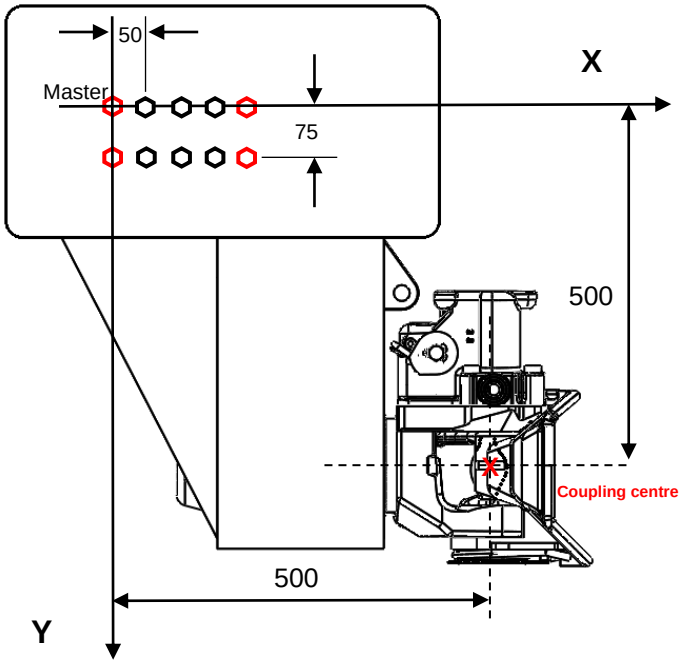
Bolt Spacing Guidelines

The arrangement of the bolts on the side mounting plate of the towbar must be done in a way that minimizes the shear stress at the bolts. Certain arrangements are more likely to fail than others. Two simple cases are presented below as an example. Calculations have been conducted using arbitrary dimensions/values for example purposes and are not to scale.

Case 1- Bolts are spaced in close proximity to each other:



Forces at the coupling are transferred directly to the bolts.

Calculations can be done to show the bolts are more highly stressed than those in case 2 (on page 4) due to the bolts not being spread out as much as possible. These highly stressed bolts are shown in red on the diagram.

The calculations show that bolt strength and size alone are not the only factors to consider when mounting a towbar; bolt spacing and layout must be considered too.

The results from the calculations are summarized in Table 1 below.

Table 1- Bolt calculation summary for the closely spaced bolts

Inputs					Loading Case 1 (Forward, Upwards)	Loading Case 2 (Forward, Downwards)	Loading Case 3 (Backward, Upwards)	Loading Case 4 (Backward, Downwards)
Bolt #	x (mm)	y (mm)	Diameter (mm)	ISO Grade	Compliance factor	Compliance factor	Compliance factor	Compliance factor
Master	0	0	16	10.9	1.01	0.59	0.59	1.01
2	50	0	16	10.9	1.83	1.10	1.10	1.83
3	100	0	16	10.9	5.72	2.18	2.18	5.72
4	150	0	16	10.9	2.33	0.98	0.98	2.33
5	200	0	16	10.9	1.15	0.55	0.55	1.15
6	0	75	16	10.9	0.90	0.55	0.55	0.90
7	50	75	16	10.9	1.35	0.88	0.88	1.35
8	100	75	16	10.9	1.89	1.22	1.22	1.89
9	150	75	16	10.9	1.52	0.82	0.82	1.52
10	200	75	16	10.9	1.00	0.52	0.52	1.00
11								
12								
Hitch	500	500						
				FAIL				

Standard loading cases applied to hitch				
	Total H (N)	Total V	Per-side H (N)	Per-side V (N)
Case 1	350000	120000	175000	60000
Case 2	350000	-120000	175000	-60000
Case 3	-350000	120000	-175000	60000
Case 4	-350000	-120000	-175000	-60000

A 'Compliance Factor' of '1' or greater indicates compliance with worst case ADR62/02 loads; a Compliance Factor of less than '1' indicates non-compliance.

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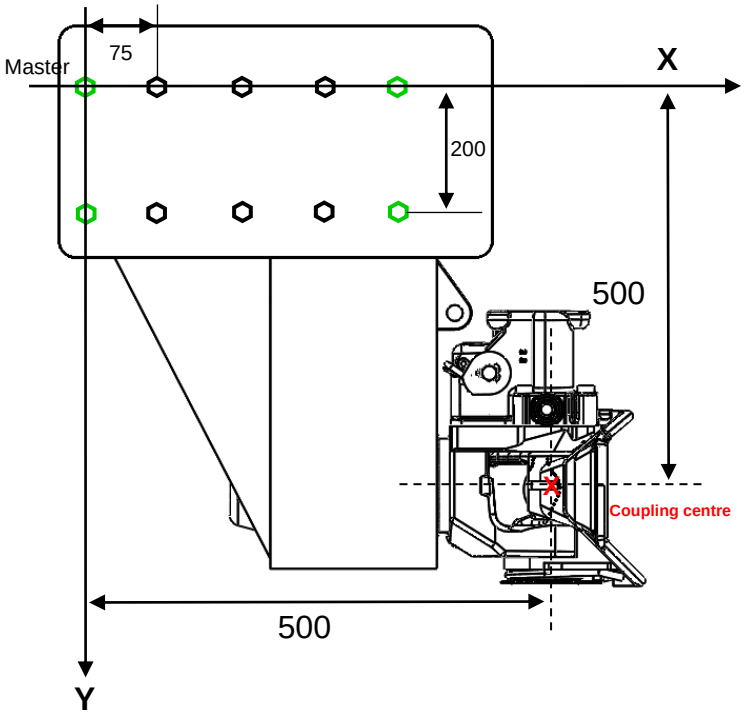
Case 2- Bolts are spaced further apart from each other, same loads through coupling.



Calculations can be done to show the bolts on the extremities that were previously highly stressed, are now safer by using a larger spacing between the bolts. This is summarized in Table 2 below. This shows reductions of between 55% to 63% in the most highly stressed bolts.

In most cases a larger bolt spacing will achieve a better outcome but this will also depend on other factors such as how many bolts are used, symmetry of bolt pattern, practical considerations etc.

For detailed assessment of your towbar bolts, pleased complete 'Tow Bolt Pattern Assessment'

Table 2 - Bolt calculation summary for the further spaced bolts.

Inputs					Loading Case 1 (Forward, Upwards)	Loading Case 2 (Forward, Downwards)	Loading Case 3 (Backward, Upwards)	Loading Case 4 (Backward, Downwards)
Bolt #	x (mm)	y (mm)	Diameter (mm)	ISO Grade	Compliance factor	Compliance factor	Compliance factor	Compliance factor
Master	0	0	16	10.9	2.36	1.52	1.52	2.36
2	75	0	16	10.9	4.04	2.66	2.66	4.04
3	150	0	16	10.9	11.83	3.72	3.72	11.83
4	225	0	16	10.9	7.69	2.12	2.12	7.69
5	300	0	16	10.9	3.32	1.30	1.30	3.32
6	0	200	16	10.9	1.69	1.15	1.15	1.69
7	75	200	16	10.9	2.07	1.47	1.47	2.07
8	150	200	16	10.9	2.36	1.60	1.60	2.36
9	225	200	16	10.9	2.30	1.36	1.36	2.30
10	300	200	16	10.9	1.95	1.05	1.05	1.95
11								
12								
Hitch	500	500						
				PASS				

Standard loading cases applied to hitch				
	Total H (N)	Total V (N)	Per-side H (N)	Per-side V (N)
Case 1	350000	120000	175000	60000
Case 2	350000	-120000	175000	-60000
Case 3	-350000	120000	-175000	60000
Case 4	-350000	-120000	-175000	-60000

A 'Compliance Factor' of '1' or greater indicates compliance with worst case ADR62/02 loads; a Compliance Factor of less than '1' indicates non-compliance.
The green highlight represents the bolts that were previously highly stressed and are now well within their predicted failure limits.

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ABOUT THESE GUIDELINES:

These guidelines are published by Transport Certification Services (TCS) to assist vehicle modifiers to conduct modifications in accordance with the OEM Requirements, Australian Design Rules, Vehicle Standards Bulletins and good engineering practice. These guidelines are not, nor are intended to be, complete or without exceptions. The guidelines are a guide only and their use is entirely voluntary. Recommendations may not be suitable for, or applicable to, all modifications. Modifiers should consider their own circumstances, practices and procedures when using these guidelines. Modifiers must comply with the Australian Design Rules (ADRs), the Australian Vehicle Standards Regulations, Vehicle Standards Bulletins (VSBs), the Roadworthiness Guidelines and any specific information and instructions provided by OEMs in relation to vehicle's systems and components. No endorsement of products or services is made or intended. Diagrams, where used in these Guidelines, are for illustrative purposes only.
Suggestions or comments about these guidelines are welcome. Please write to the Manager, Transport Certification Services, 14/69 Acacia Road, Ferntree Gully, VIC 3156.

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TCS is committed to continual improvement and as such reserves the right to update or change these guidelines without notice.