Consultants Advice Notice 6690-CAN-0001

Subject:	Analysis of YOLK bike rack
Project No.	6690
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Assumptions:

The following assumptions were made during the analysis:

- Bikes are loaded evenly on the rack, from the center.
- The bike rack is configured so that the SHS in the tow hitch is extended as much as possible (bolt/pin holes closest to each end used).
- Centre of mass of the bike is halfway between the wheel axles horizontally, and halfway from the axle height to the top of the frame vertically.
- SHS minimum yield strength is 350MPa.
- Welds are 5mm fillet welds.
- All bolts are grade 8.8.

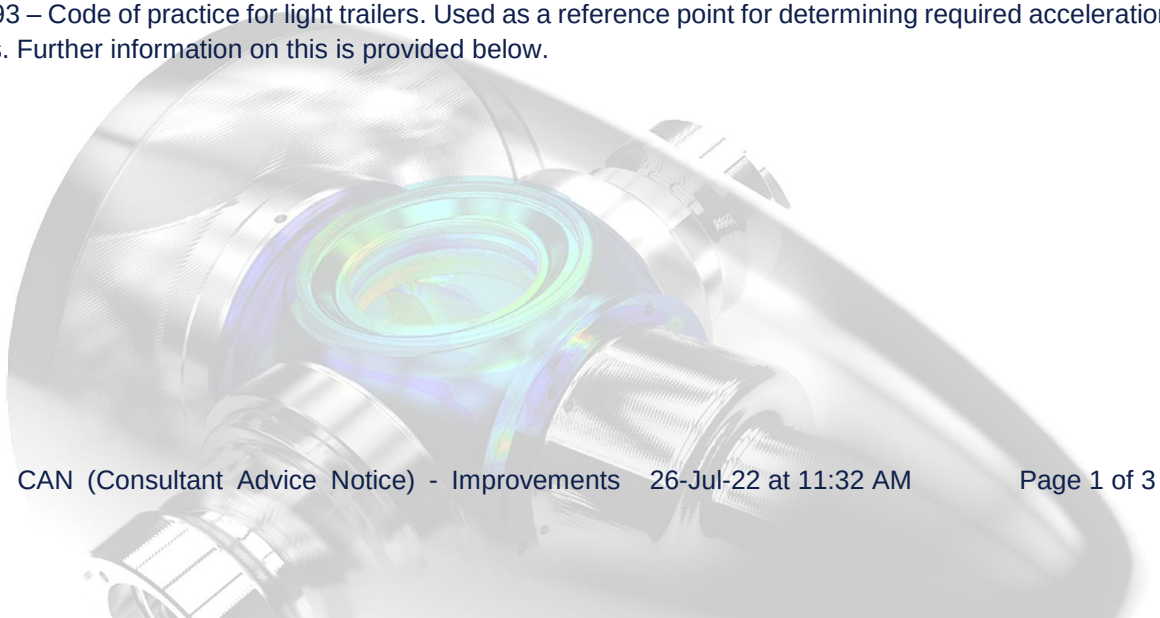
Means of Compliance:

The standards used to determine the maximum accelerations, and fatigue cycles are listed below.

NZS3404:1997 – Steel Structures. Used to determine the capacity of sections and connections.

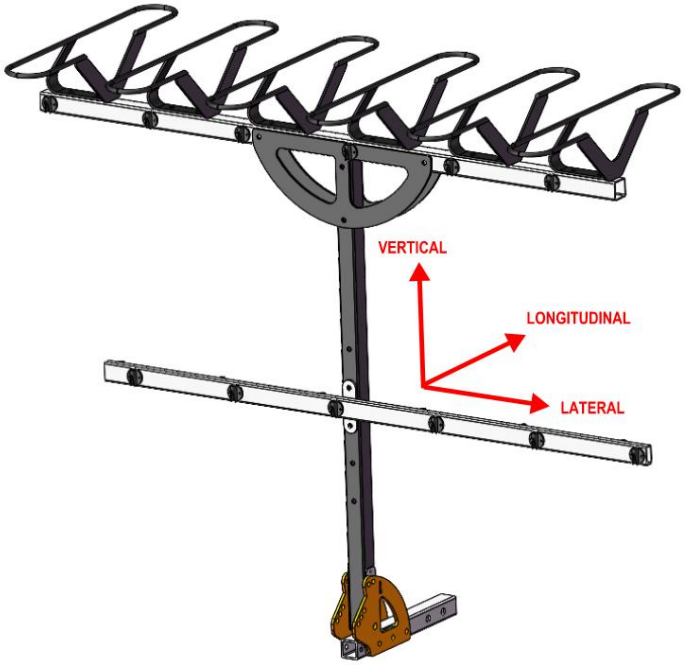
BS7608:2014 - Guide to fatigue design and assessment of steel products. Used to determine maximum fatigue cycles for the rack.

NZS5467:1993 – Code of practice for light trailers. Used as a reference point for determining required accelerations and fatigue cycles. Further information on this is provided below.



Load Cases:

The bike rack has been analysed under acceleration loads in the vertical, longitudinal and lateral directions, as shown below. Self-weight of the rack was considered, as well as a total bike weight of 120kg (average bike weight of 20kg, individual bike weight limit is 30kg).



Maximum static loads:

The maximum static accelerations (a single loading event), are listed below.

Table 1: Maximum static accelerations.

Vertical	Longitudinal	Lateral
1.0 g + gravity	1.0 g + gravity	0.9 g + gravity

NZS5467 specifies the following minimum accelerations for use in calculations:

Longitudinal tension or compression: 1.0 x the specified towing capacity
Transverse loading (lateral): 0.3 x the specified towing capacity
Vertical tension and compression: 0.3 x the specified towing capacity

For the bike rack, the “specified towing capacity” can be taken as the total weight of the bikes, plus the self-weight of the bike rack.

Fatigue:

Fatigue is assessed by determining stresses in each part of the bike rack, and determining the maximum number of cycles for that part. If the stresses in the part are high, the number of cycles it can withstand before failure will be lower than a part with low stresses. Fatigue cycles have been determined for the stress range only, mean stress correction has not been considered.

Fatigue loading has been assessed with reference to NZS5467. The requirements for minimum number of allowable fatigue cycles is 400,000 cycles for commercial trailers and 40,000 cycles for domestic trailers at the accelerations provided above.

The maximum number of cycles the bike rack can undergo for a number of levels of acceleration are listed below.

Table 2: maximum fatigue cycles and accelerations.

	Vertical		**Longitudinal**		**Lateral**	
Acceleration	0.3g	1.0g	0.3g	1.0g	0.3g	1.0g
Maximum number of cycles	34 million	920,000	10 million	200,000	1.3 million	35,000

As shown above, the bike rack is able to undergo at least 400,000 cycles in all directions for a 0.3g acceleration. In the longitudinal direction, it has been found that the rack can undergo 400,000 cycles at a slightly lower longitudinal acceleration of 0.80g.

Other than comparing the number of fatigue cycles to existing standards, we aren't able to provide further information on the expected design life of the product without appropriate testing data.

Recommended Bolt Torques:

Maximum bolt torques have been determined based on the strength of the SHS flange under compressive loading from the bolt. It is recommended that all M12 bolts are tightened to 25Nm, the maximum allowable bolt torque is 30Nm, when the washer is directly against the SHS. Higher torques are possible when there is a doubler plate present (such as the M12 bolts at the base of the rack).

Tightness of the M16 hinge bolt is not critical to the design, this should be tightened enough to prevent excessive play, but left loose enough to allow the rack to pivot.

Tightness of all bolts should be checked regularly.

Disclaimer: