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Technical Direction – TD 00019:2024

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Title: Design of sign structures

BTD 2009/01 Rev 1 was issued in 2010 to specify fatigue design requirements for sign structures in accordance with *Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, Fifth Edition 2009. It aims to minimise the risk caused by fatigue that sign structures would experience during the service life.

This technical direction is issued by the Asset Management Branch (AMB) to align the requirements of sign structure design with AS 5100 and *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, First Edition 2015.

This technical direction supersedes BTD 2009/01.

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1 Scope

This technical direction provides the design requirements for sign structures that align with AS 5100 and *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.

The purpose of this technical direction is to:

- Establish the criteria for the design of new sign structures and the reuse of existing structures, to minimise risks to motorists caused by the failure of the sign supports.
- Provide guidance and standards for the design of sign structures that satisfy structural design, road safety, traffic operation and urban design objectives.

2 Application

This technical direction applies to TfNSW personnel, consultants and contractors who are engaged in the design of sign structures that are installed on TfNSW roads.

This technical direction applies to the design of all sign structures that are part of transport assets and those that will be owned by TfNSW in the future.

This technical direction does not apply to advertising signs mounted on the bridges and signs in the rail corridor.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

Australian standards

AS 5100.1 *Bridge design – Part 1: Scope and general principles*

AS 5100.2 *Bridge design – Part 2: Design loads*

AS 5216 *Design of post-installed and cast-in fastening in concrete*

AS/NZS 1163 *Cold-formed structural steel hollow sections*

AS/NZS 1170.2 *Structural design actions – Part 2: Wind actions*

AS/NZS 4680 *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*

AS/NZS 5131 *Structural Steelwork – Fabrication and erection*

Transport for NSW standards

TS 00033 *Supply of Bolts, Nuts and Washers (ATS 5420-20, Ed 1.0 MOD)*

TS 00170 *Road Traffic Asset Structures – Inspection and Maintenance Manual* (available on request to standards@transport.nsw.gov.au)

TS 01730.1 (IC-QA-B59) *Bored Cast In Place Reinforced Concrete Piles (Without Permanent Casing) – QA*

TS 01730.2 (IC-DC-B59) *Bored Cast In Place Reinforced Concrete Piles (Without Permanent Casing) – DC*

TS 01733.1 (IC-QA-B80) *Concrete Work for Bridges – QA*

TS 01733.2 (IC-DC-B80) *Concrete Work for Bridges – DC*

TS 01744.1 *Steel Fabrication (ATS 5410-23, Ed 2.0 MOD)*

TS 01746 *Protection of Steelwork by the use of Paint Coatings (ATS 5450, Ed 1.0 MOD)*

TS 04981 (T MU MD 20001 ST) *System Safety Standard for New or Altered Assets*

Legislation

Work Health Safety Act 2011 (NSW)

Other referenced documents

American Association of State Highway and Transportation Officials (AASHTO) *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*

Austrroads Technical Specification ATS 5860 *Bonded Anchors*

NSW Government's Procurement Board Direction PBD 2016-03.

Safe Work Australia, *Safe Design of Structures*, Code of Practice

4 Terms, definitions and abbreviations

AASHTO American Association of State Highway and Transportation Officials

CAFT constant-amplitude fatigue threshold

utilisation ratio ratio of the design action effect to the design capacity

cross-road gantry portal type of structure with more than one vertical support spanning across road

cantilevered a sign support structure, either horizontal or vertical, supported at one end only

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5 Safety requirements

5.1 Safety in design

The design of sign structures shall incorporate safety design. *Work Health Safety Act 2011* (NSW) provides requirements for safety design.

Guidance on the safe design of structures is provided in Safe Work Australia, *Safe Design of Structures, Code of Practice*. Refer to AS 5100.1 for additional requirements.

The design of sign structures shall take into account safety considerations for construction, operational maintenance, decommissioning, demolition, and interface of the workers and users with the structures.

The designer shall establish and implement a design process that manages safety across the full life cycle of the structure. The design process shall comply with TS 04981 and *Safe Design of Structures*.

5.2 Risk assessment

Where a sign structure is installed on a structure or traffic barrier that presents a risk of falling onto a traffic lane, the risk of the sign structure being impacted by a vehicle shall be assessed. If this results in a high impact risk, mitigation measures shall be implemented to prevent the sign structure from falling onto the traffic lane underneath.

6 Durability requirements

For metal elements requiring protective coatings, the type of coating shall be selected to ensure the coating life to first maintenance is as close as possible to the element's design life.

See Section 8 for durability requirements of specific structural elements.

7 Sign structures

The sign structure denotes all supporting structures for static signs and electronic signs.

Sign structures are typically in the form of ground based free standing structures (including steel structure and foundation) or with the structural support mounted or partially supported on other infrastructure. The common structural types of sign structures are cross-road gantries, cantilevered, cantilevered with zero or minor eccentricity, multiple posts support, and bridge/tunnel portal mounted supports.

8 Sign structure design requirements

Sign structures shall be designed in accordance with AS 5100.1 and AS 5100.2. Additional sign structures design requirements are provided in Section 8.1 to Section 8.7.

8.1 Wind load

Site wind condition assessment shall be carried out in accordance with AS/NZS 1170.2 taking into account terrain, topography, elevated height, and openness along the road corridor.

Hill/escarpment, large embankment and ramp shall be taken into account in the wind assessment.

Terrain category shall be based on the site wind assessment with 2.5 as the least severe terrain condition. The directional and shielding effects shall be ignored.

Average recurrence intervals for the ultimate and service wind load shall comply with Clauses 24.2 and 24.3 of AS 5100.2:2017.

The wind pressure caused by 0° and 45° wind on a sign board shall be assessed with an aerodynamic shape factor for hoarding in accordance with AS/NZS 1170.2 and applied perpendicularly to the sign board. The eccentricity of the wind load on the sign board caused by 45° wind shall be imposed for the ultimate limit state only.

All direct supports of traffic control devices and their connections shall be designed for the same or greater wind load as the main structure on which the supports are mounted.

8.2 Fatigue design

All sign structures shall be designed for fatigue solely in accordance with *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, First Edition 2015 and all subsequent interim editions. This shall not be mixed with any other standards.

Fatigue category together with fatigue importance factor shall be determined in accordance with *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*. However, structures that present a risk of collapsing onto the road traffic lanes shall be taken as fatigue category I.

Each type of fatigue load in accordance with *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* shall be treated as an individual load case. The fatigue load shall not be combined with any other loading when assessing the structural fatigue capacity.

The natural wind gust fatigue loading shall be applied perpendicular to the sign.

Bridge or tunnel mounted support shall be designed for fatigue loading caused by galloping, natural wind gust and truck-induced gust.

Sign structures shall be designed or checked for infinite fatigue life by using the typical connection details with CAFT specified in Table 11.9.3.1-1 of *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, First Edition 2015. The remaining fatigue life shall not be assessed for lack of reliable data.

The designer shall develop an efficient and cost-effective structural design for fatigue.

Considerations include, but are not limited to the following:

- Fully utilise the stress limits of CAFT in *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* which are for infinite fatigue life.

- Adopt different configurations for the connection details to achieve a higher CAFT in accordance with *LFRD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.
- Explore different structural framing configurations to achieve a more efficient and effective design.
- Exclude galloping load for a cantilevered structure with a four-chord horizontal truss.

8.3 Steel structure

Large structural elements, such as the truss and frame, shall be divided into smaller segments to facilitate application of protective coatings, transport and erection. Bolted connections shall be used for the spliced joints and positioned away from the areas of high stresses.

All spliced connections experiencing wind induced vibration shall use high strength bolts with a direct-tension indication device (DTI), and fully tensioned to form a bearing type joint. The components making up the splice connection and the fabrication procedures shall be carefully detailed to avoid or minimise the distortions caused by the welding and galvanizing process.

All sign structures shall be galvanized in accordance with AS/NZS 4680 and TS 01746 (B220).

Hollow sections shall be fully sealed. Vent or drainage holes shall be provided in accordance with AS 4680 and industry practice to ensure that the hollow sections are fully galvanized inside and out, and the galvanizing fluid can be drained properly. After galvanizing, the exposed vent or drainage holes shall be fully sealed with a proven reliable method to avoid water ingress.

When a member is fabricated by joining short lengths, the welding across the joints shall be full-penetration butt-welds with the welds ground to provide a smooth transition in accordance with Detail 4.2 in Table 11.9.3.1-1 of *LFRD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, First Edition 2015. The joints shall not occur within 1.5 m of any connection.

Oversized hollow sections (diameter > 610 mm or thickness > 12.7 mm) complying with AS/NZS 1163 are generally unavailable in the market. Any proposed use of such oversized hollow sections shall be submitted with proper justifications to the Principal's Representative for approval before proceeding with the design.

8.4 Base connection

Anchor bolts shall be Grade 4.6 and hot dip galvanized in accordance with TS 00033 and fabricated in a rag bolt assembly. Hooks or cogs shall not be used to obtain the required bolt anchorage. Recesses around anchor bolts in the footing concrete shall not be permitted.

The base plate shall be held with a double nut moment joint, consisting of a standard height levelling nut and washer below the base plate, and washer, lock nut and top nut above the base

plate. Bolt holes shall be fully covered by the oversized washers after the nuts are fully tightened.

All levelling nuts shall be accurately installed to the same level first, and after the structure is in place, adjusted to suit the post back-tilting if required. After alignment, all top nuts and levelling nuts shall be tightened to snug-tight to capture the base plate from both sides.

The unsupported length of the anchor from the top of the footing to the bottom of the levelling nut shall not be greater than one anchor diameter.

Base plates shall be grouted with flowable shrinkage compensated cementitious grout with a minimum 28-day compressive characteristic strength of 50 MPa and applied in accordance with the manufacturer's instructions.

Load effects on the anchor bolts shall be determined by ignoring the presence of the grout.

Anchor bolts and base connections shall be exposed where possible. Where anchor bolts and base connections are buried, they shall be made readily accessible for future inspection and maintenance.

Maximum protrusion of the footing shall not be greater than 200 mm above the finished ground level. The surrounding finished ground shall be properly constructed and graded to disperse the water away from the footing.

All faces of the bottom 400 mm of the post, base plate and the bolt holes shall be treated with approved epoxy paint with a minimum dry film thickness of 100 µm over the galvanizing coating.

8.5 Requirements for post-installed anchors

Post-installed anchors may be used for minor structural elements such as when mounting a bracket and or frame on an existing structure, where cast-in anchors cannot be used. Post-installed anchors shall not be used for all other structures.

Chemical anchors shall be certified in accordance with Clause 6.1 of ATS 5860, Edition 1.0.

Chemical anchors with a 100-year working life and high reliability and performance under vibrating fatigue load shall be used.

Proof load test shall be carried out for all chemical anchors subject to tensile load in accordance with Clause 10 of ATS 5860, Edition 1.0.

Mechanical anchors shall be certified in accordance with Appendix A of AS 5216:2021.

Mechanical anchors of expansion type and screw anchors shall not be used on the connections experiencing wind load vibrations.

For all post-installed anchors, the maximum combined ultimate utilisation ratio shall not be greater than 70%. The maximum utilisation ratio of the design strength of each concrete failure mode and adhesive bond under the fatigue loading shall not be greater than 50%.

Post-installed anchors under sustained tension should be avoided by adopting more reliable positive connections, such as bolts through or clamps around the full depth of the elements being connected to. Where chemical anchors cannot be avoided under a sustained tension load, the chemical anchor capacity shall be reduced in accordance with Clause 6.2.5.2 of AS 5216:2021.

Post-installed anchors shall be installed strictly in accordance with the manufacturer's instructions. The substrate shall be prepared in accordance with the condition required for the anchor performance. If the substrate or the anchor suitability is uncertain, ultimate load test shall be carried out in accordance with ATS 5860.

Measures shall be taken to avoid any damage and adverse impact on the structural integrity of the existing structure on which the sign structure is mounted.

8.6 Existing sign structures

Where the sign on existing sign structures is modified, the loading on the structure shall not be increased from the existing loading condition unless approved by TfNSW.

The existing sign structures shall be inspected and rated in accordance with TS 00170. The structure shall be free of structural defects with an overall condition rating of 1 in order to be reused.

All structural defects detected during inspection shall be reported to TfNSW.

Modification of sign and other attachments shall not be conducted unless the existing structure has been restored to a condition rating of 1 with the proposed corrective repair work approved by TfNSW.

8.7 Records management

The sign structure identification number shall be inscribed in weld material on post 1000 mm above the base plate.

9 Construction requirements

Materials and fabrication of sign structures shall comply with PBD 2016-03. Steel sign structures shall be fabricated by TfNSW prequalified or registered fabricators.

Steel sign structure designated construction category (CC) and associated traceability type shall be specified in accordance with AS/NZS 5131. They shall be CC3 unless specified otherwise.

The design documentation shall include all project specific requirements necessary for completeness of the technical specifications. Drawings shall include notes referencing to relevant TfNSW standards and Australian standards for materials, fabrication and installation requirements.

Unless otherwise specified on drawings, the technical specifications for steel sign structure fabrication and construction shall be in accordance with TS 00033, TS 01744, TS 01746.

Unless otherwise specified on drawings, the technical specifications for reinforced concrete for the structural footings shall be in accordance with TS 01733.

Unless otherwise specified on drawings, the technical specifications for reinforced concrete bored pile shall be in accordance with TS 01730.

For sign structure materials not covered by TfNSW standards, the project shall develop appropriate additional technical specifications from specialist technical literature to ensure that the designed works can be properly specified and constructed to adequate engineering performance levels and achieve its design life.

Authorisation:

Approved by	Director Civil Infrastructure Engineering Asset Management Branch Planning, Integration and Passenger
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