**Manual**

**Traffic and Road Use Management**
**Volume 3 – Signing and Pavement Marking**

# Part 5: Design Guide for Roadside Signs

**November 2018**

Queensland Government

**Translating and interpreting assistance**

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# 1 Scope and introduction

## *1.1 Scope*

This *Guide* sets out guidelines for the design and erection of roadside signs.

This *Guide* does not cover cantilevers and gantries that overhang the carriageway.

## *1.2 Application*

This *Guide* is applicable to all types of roads under normal operating conditions.

## *1.3 Objective*

The objective of this *Guide* is to provide a set of uniform guidelines for the design and erection of roadside signs throughout Queensland.

## *1.4 Introduction*

The procedure for the design of signs in this *Guide* should be applied from the initial design of the sign face through to the ordering of each sign component. The software program TraSiS guides the user through the design process. Appendix A provides details on the program together with information on how to purchase a copy.

## *1.5 Referenced documents*

Australian Standard AS/NZS 1170.2 2011 *Structural Design Actions*, Part 2: *Wind Loads* is referenced in this *Guide*, as are the Transport and Main Roads Specifications Manual and the Standard Drawings Manual.

## *1.6 Definitions*

For the purpose of this *Guide*, the following definitions apply.

***Table 1.6 – Definitions***

| | |
|---|---|
| Built-up area | A road in a built-up area is defined as any road upon which there is a system of street lighting. |
| Clear zone | The total roadside border area, starting at the edge of the travelled way, available for safe use by errant vehicles and for the display of official traffic signs. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope and/or a clear run-out area. The minimum clear zone width is dependent upon speed environment, AADT and roadside geometry. |
| Shall | The word shall is to be understood as mandatory. |
| Should | The word should is to be understood as a recommendation. |
| Sign ground clearance | The minimum distance in metres between the lower edge of a sign and the ground level directly below the lower edge of the sign. |
| Sign height | The height in metres between the lower edge of a sign at the edge closest to the travelled way and the level of the nearest edge of the travelled way, generally the edge line. The edge line is used as the reference point for determining the clear zone. |
| Speed limit | The maximum speed at which a motor vehicle is legally permitted to travel on a particular section of road. |

# 2 Design wind pressure

## *2.1 General*

Earlier versions of this *Design Guide* dating back to 1993 adopted a strategy of using an appropriate probability of exceedance of the wind speed to derive support structure sizing that was considered acceptable to both structure ‘design life’ and road safety (collision). The chance of exceedance in 50-year and one-year return periods was 96% and 6.5% respectively. This updated Edition derives similar design wind pressures, determined in accordance with the current Australian Standards and with the application of a pressure reduction factor, R.

The following sections outline the structural assumptions made in this *Guide*. The design process is based on AS/NZS 1170.2-2011.

## *2.2 Safe failure mode*

The design strategy is based on a safe failure mode of support post yielding and bending prior to failure of the sign face and its attachment to the posts. To ensure that signs are not blown off before the poles bend, aluminium stiffener rails and sign face are designed to accommodate peak edge pressures generated by the critical 45-degree wind approach angle, Terrain Category 2 (fully exposed) and with an additional safety factor of 1.5 applied to the post design pressure.

## *2.3 Importance Level*

Importance Level 1 in accordance with AS/NZS 1170:0 Appendix F is used on the basis of ‘small or moderate’ economic consequence and safe failure mode with failure unlikely to endanger human life. A design working life of 25-year design life is considered appropriate and this yields an annual probability of exceedance of 1 in 100 (1/100) for cyclonic and non-cyclonic wind speed.

## *2.4 Pressure reduction factor*

A pressure reduction factor, R = 0.5, is applied to the ultimate support post design pressure derived in accordance with AS/NZS 1170.2-2011. This factor is applied to the resultant pressure derived from wind speed and drag co-efficient.

## *2.5 Regions*

Signs in the different geographic regions defined in AS/NZS 1170.2 (A, B, C and D) are designed for the wind speed related to that region. Region D is included to facilitate design charts for Exposed Region C locations (refer to Section 2.6 following).

## *2.6 Terrain Category*

To simplify the design procedure, design charts are derived to suit general exposure as applicable to Terrain Category 3 (terrain with numerous closely spaced obstructions 3m to 5m high). To cater for exposed locations (Terrain Category 2 – open terrain, grasslands with few, well scattered obstructions), the design method calls for use of charts applicable to the next higher wind region.

## *2.7 Gantries and cantilevers*

The design philosophy outlined in sections 2.2, 2.3 and 2.4 does not apply to sign gantries or cantilevers that extend over traffic lanes, which are excluded from the *Guide*. These signs should be designed in accordance with the *Design Criteria for Bridges and Other Structures*.

### *2.8 Special locations*

High-risk areas likely to be exposed to high wind speeds regularly should be identified and the risk assessed. This risk can be reduced by the use of the exposed category (Category 2 of AS/NZS 1170.2) or an increased section size. Typical locations that should be considered are:

- Houghton Highway (across water adjacent Moreton Bay)
- Gateway Bridge (high, exposed position)
- some sections of Gateway Arterial, adjacent to Brisbane Airport, and/or
- Gold Coast Highway at Kirra and other coastal positions.

### *2.9 Selection of region and exposure*

For those locations not listed in Section 2.8, the following procedure for the selection of the appropriate Design Table is recommended:

1) Identify Region A, B, C – refer to Figure 2.1.
2) Consider whether or not the region is particularly exposed or at risk. If so, increase Region A to B, B to C, and C to D.
3) Refer to Table 2.1 to determine the appropriate figure. Figures B.2–B.13 can be found in Appendix B to this *Guide*.

Situations outside the scope of these tables, or standard sections, should be checked and designed by a structural engineer. Extrapolation of these tables is neither appropriate nor acceptable.

### *2.10 Additional information*

The Traffic Engineering and Data Unit, Engineering and Technology Branch holds design calculations, which outline the basis for the design charts.

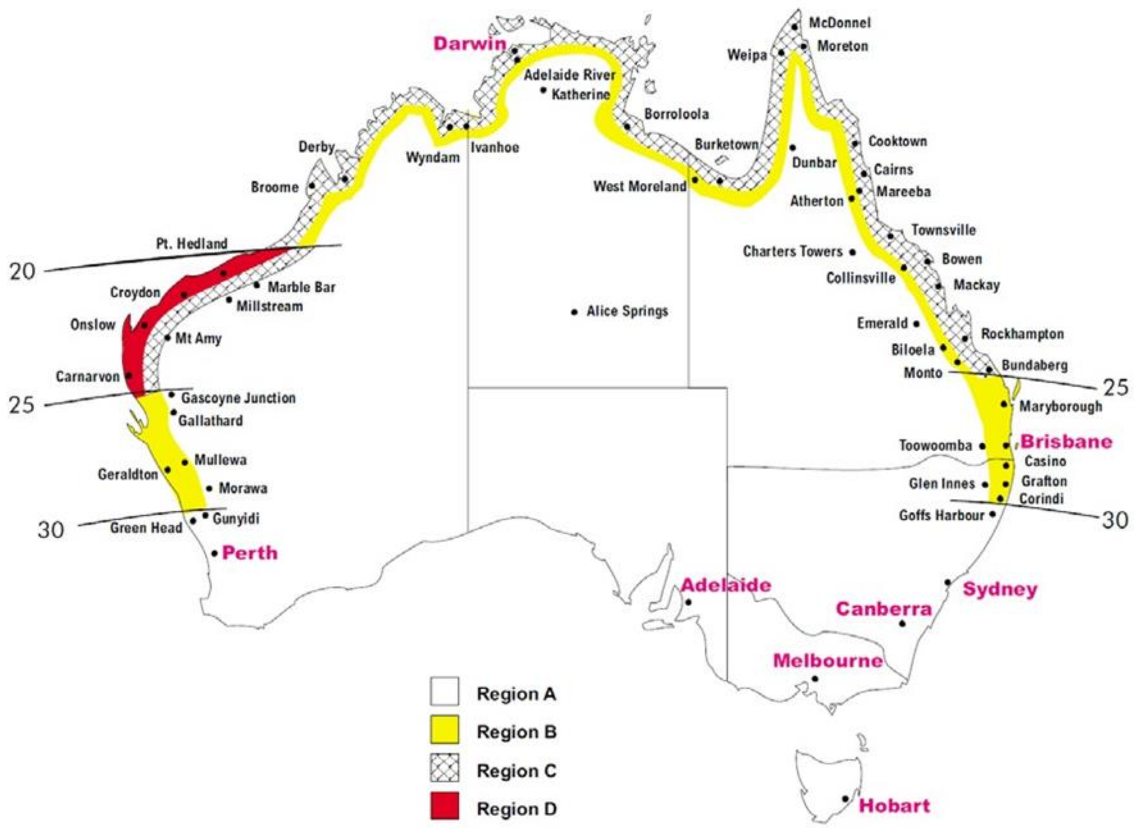
Based on various Australian Standards, assumptions have been made on the performance of the sign structure as a whole. Full scale structural testing is recommended to confirm these assumptions.

***Table 2.10 – Application tables for regions***

| Region | Sign size range | Applicable figure |
|---|---|---|
| A – General | 0–10 m²<br>10–28 m²<br>28–40 m² | B.2 (RHS/CHS)<br>B.6 (RHS/CHS)<br>B.10 (RHS) |
| A – Exposed<br>B – General | 0–10 m²<br>10–28 m²<br>28–40 m² | B.3 (RHS/CHS)<br>B.7 (RHS/CHS)<br>B.11 (RHS) |
| B – Exposed<br>C – General | 0–10 m²<br>10–28 m²<br>28–40 m² | B.4 (RHS/CHS)<br>B.8 (RHS/CHS)<br>B.12 (RHS) |

| Region | Sign size range | Applicable figure |
|---|---|---|
| C – Exposed<br>D – General | 0–10 m²<br>10–28 m²<br>28–40 m² | B.5 (RHS/CHS)<br>B.9 (RHS/CHS)<br>B.13 (RHS) |
| D – Exposed | 0–10 m²<br>10–28 m²<br>28–40 m² | B.5 (RHS/CHS) Increase one section size<br>B.9 (RHS/CHS) Increase one section size<br>B.13 (RHS) Increase one section size |

***Figure 2.10 – Geographic region***



# 3 Clear zone criteria

## *3.1 General*

Refer to Austroads' *Guide to Road Design* Part 6 Section 4.2.2 for calculating clear zone distances.

# 4 Sign face construction

## *4.1 Sign face materials*

Refer to MRTS14 *Road Furniture* for details regarding the sign face material requirements.

## *4.2 Sign face construction*

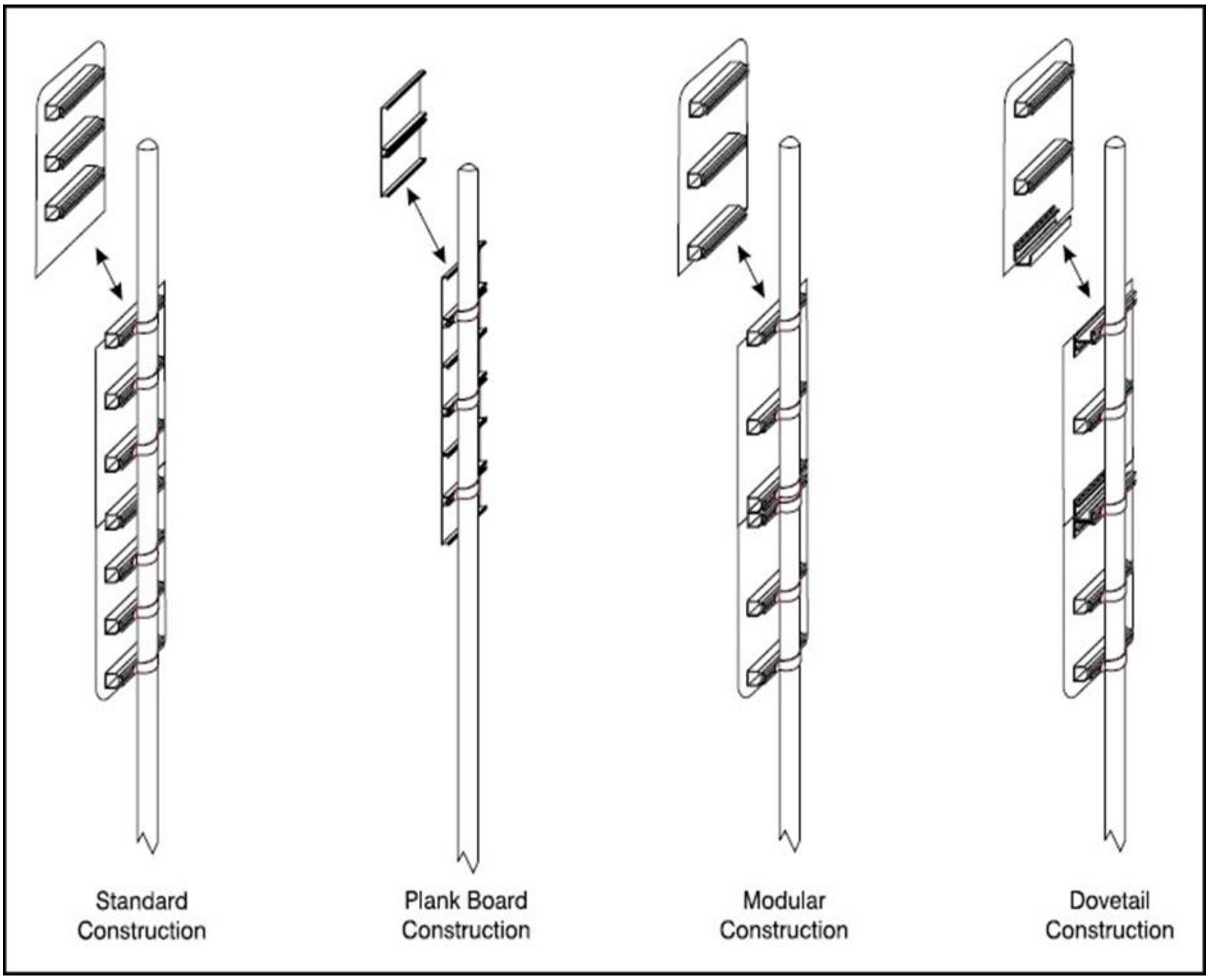
### 4.2.1 Construction types

Section 5 describes how to determine the number and placement of stiffeners required for the sign face.

For larger signs, using the maximum stiffener spacing can lead to problems when attempting to erect a large sign in one piece. Several alternate sign face designs have been devised to overcome this problem. Such alternative construction methods shown in Figure 4.2.1, include:

- standard
- plank board
- modular, and/or
- dovetail.

***Figure 4.2.1 – Standard, plank board, modular and dovetail construction***

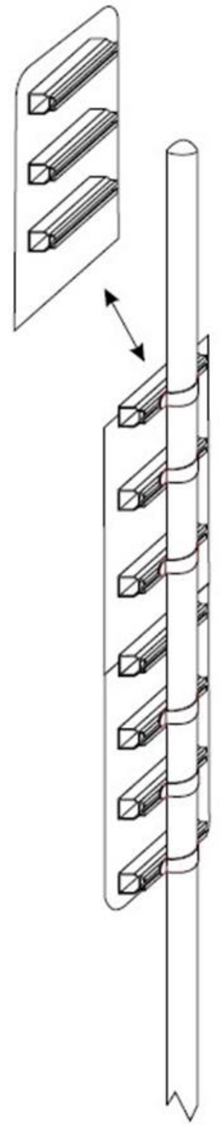


### 4.2.2 Standard construction

The standard way of supplying a sign in sections is shown in Figure 4.2.2.

The stiffener rail is used to span the horizontal joint and the sections are usually predrilled then riveted on site. The depth of panels varies depending on the stiffener spacing and cut plate sizes.

***Figure 4.2.2 – Standard construction (stiffener on sign edge)***



A system which uses panel modules of 1.2m is the recommended method for large sign construction, when the sign cannot be transported in a single piece. An alternative approach is to use specialist stiffeners such as the Signfix Dovetail system.

### 4.2.3 Plank board construction

Plank boards signs comprise interlocking planks extruded from high tensile aluminium in depths of 200 and 300mm. Figure 4.2.3(a) shows a typical plank sign detail, with another plank about to be attached.

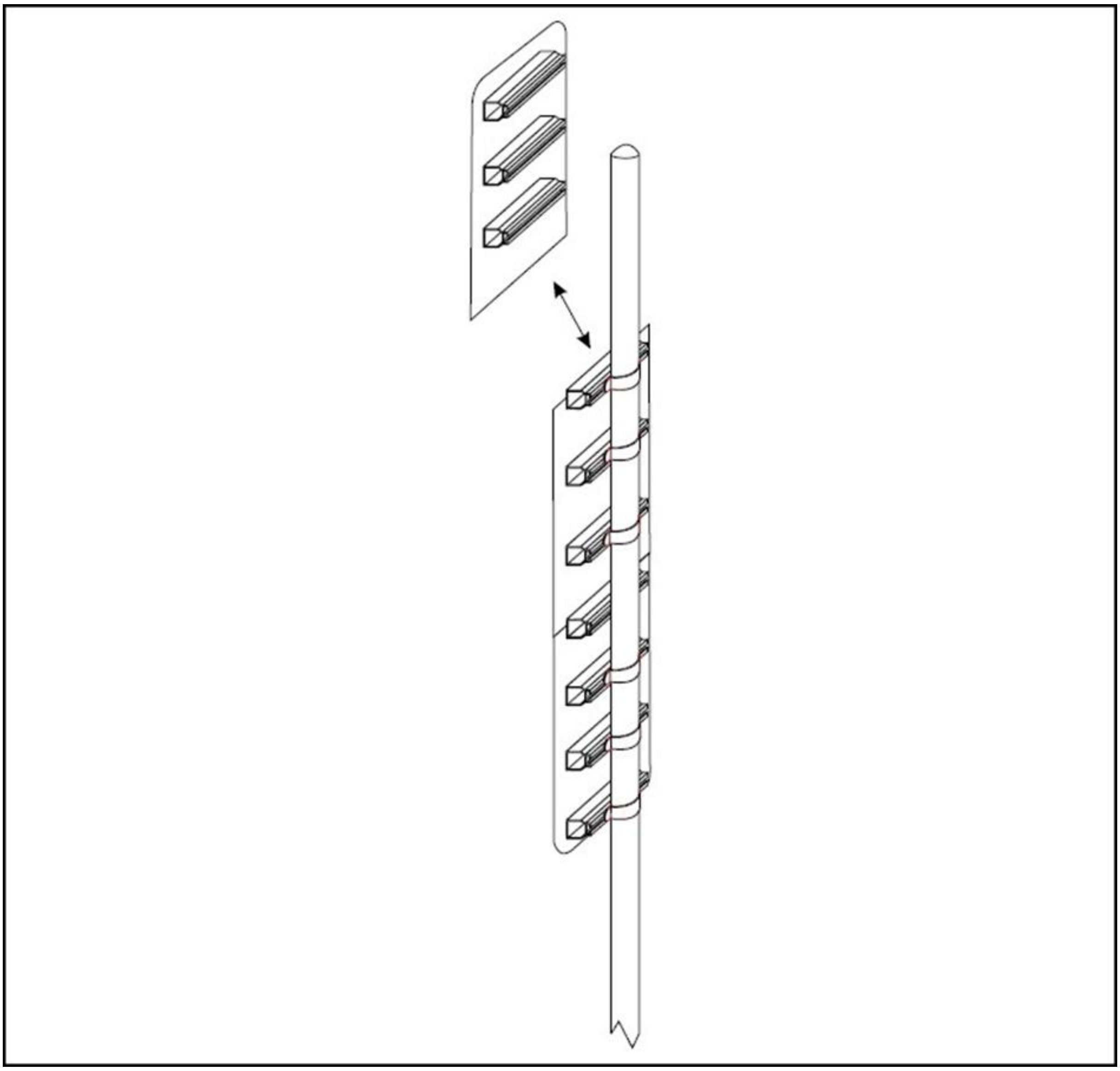
To construct a sign using planks, each individual plank is layered on top of another and held in place using plank clips. The centre channel is then attached to the sign supports by a saddle bracket.

Where staggered joints are allowed to be used channel couplings are required to be used across each joint. Figure 4.2.3(b) shows a typical channel coupling and plank clip.

Plank boards are recommended for larger signs, gantries, cantilevers and sites where transport or erection could be difficult. For small signs erection is possible using ladders rather than cranes.

The use of planks for street name, stream name and other signs 200mm and 300mm deep is also recommended due to the planks stiffeners and the need for less saddle fittings.

***Figure 4.2.3(a) – Plank board construction***



**Advantages**

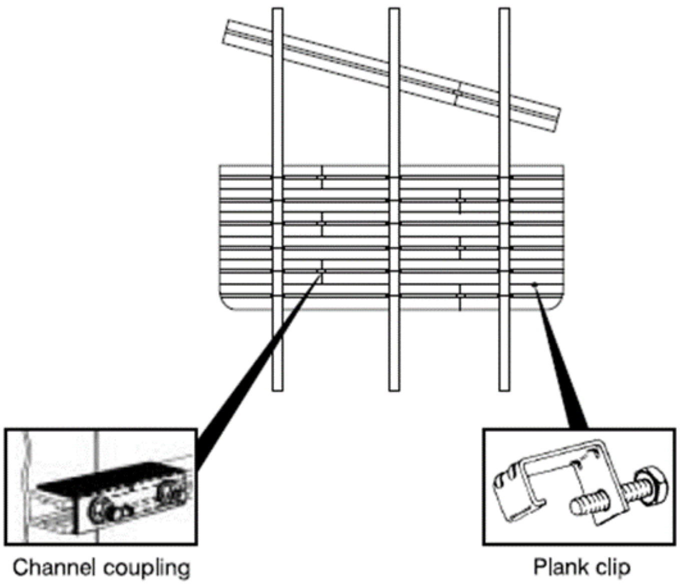
- Readily available
- sign surface is rivet free
- easy to transport, move and handle than plate signs
- can be installed using ladders
- can be stored on edge without damaging the retro-reflective film

- increments of 100mm can be achieved when calculating sign size of 300mm and 200mm planks available
- individual planks can be replaced rather than the whole sign
- fast erection times are achievable
- appearance can be improved as no rivets or buckling, and
- planks can be re-sheeted and re-used easier than plates.

**Disadvantages**

- Higher material costs due to a thicker cross section
- higher wastage due to more off-cuts
- design of the sign face should allow positioning of legends away from plank edges
- rounded sign corners are not obtainable without hand jigsaw cutting
- difficult to cut lengths, as a cutting saw rather than a guillotine is required
- plank clips and additional saddle fittings are required compared to a plate sign
- more potential for dirt ingress and weathering on the cut edges of the Class 1 film signs, and
- screen-printing is difficult across planks.

***Figure 4.2.3(b) – Plank board construction***

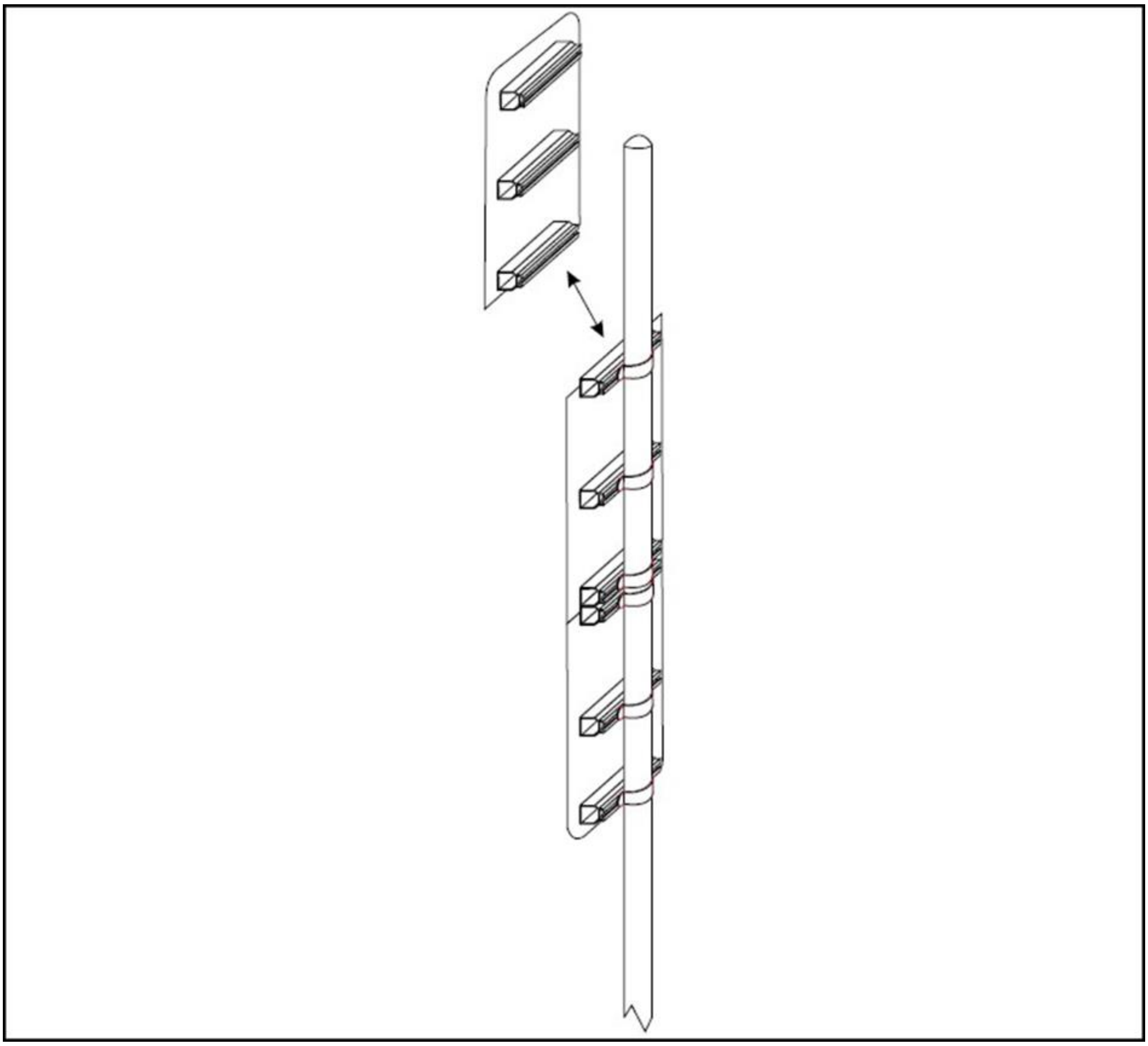



### 4.2.4 Modular construction

Modular sign panels may be used for larger signs to reduce the difficulty of handling and erecting different size sections or a single large sign.

Figure 4.2.4(a) shows a general arrangement for the assembly of modular panels. Each panel is 1.2m high constructed as a normal panel sign except for the stiffener spacing and location.

***Figure 4.2.4(a) – Modular construction***



The modular system requires the stacking of panels on top of each other. The stiffeners are located to allow positioning on top of each other while the sign face sheeting overlaps to present an appearance of a smooth sign face.

Saddle fittings are used to clamp the sign face to the supports avoiding the need for on-site riveting.

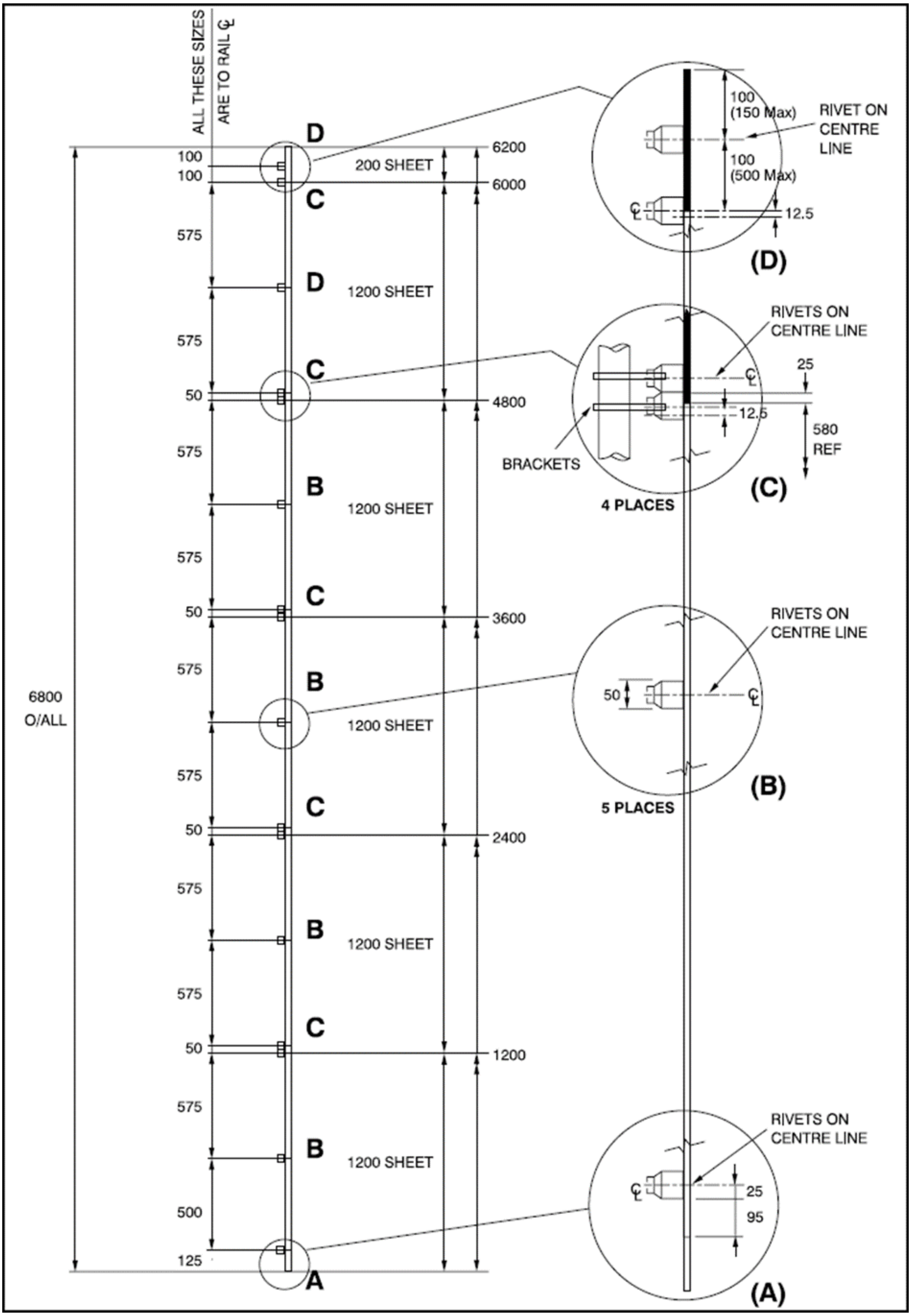
Figure 4.2.4(b) shows a detailed sketch of a modular sign using aluminium plate and Type 2A stiffeners.

The location of the upper and lower stiffeners is not critical, provided panel overhang between the stiffener and the top or bottom of the sign does not exceed 150mm.

Detail A and B on Figure 4.2.4(b) shows the location and attachment of a typical Type 2A stiffener.

For the top of the modular panel and bottom of the next panel, the stiffener rails are arranged as shown in Detail C. Firstly, the lowest panel is attached by saddle fittings to the supports. The bottom stiffener of the second panel is then rested on top of the stiffener of the first panel, before being attached by its own saddle fitting to the support. This is repeated until the sign is completed, or a smaller panel is attached at the very top as per Detail D.

***Figure 4.2.4(b) – Modular sign panel details***



For signs where the 580mm spread of stiffener rails could affect the visual appearance, due to minor deformation between stiffeners, 2mm thick sheeting or additional stiffener rails should be considered.

The use of the modular system is recommended for all large signs (deeper than 1.2m) that have to be assembled on site.

The following is a summary of advantages and disadvantages of the use of a modular system.

**Advantages**

- No riveting required on site
- appropriate size for transporting
- reasonable size of section for lifting by crane
- reduces the stress on cover strips and rivets during erection
- appropriate size for storage
- transportable face to face to protect retro-reflective sheeting face
- easier removal by sections and re-erection if required, and
- formalises existing practice of transporting large signs in sections to assemble on site.

**Disadvantages**

- Additional stiffeners required, and
- no advantage for regions close to the sign manufacturer, where large cranes are readily available and the whole sign is transportable.

#### 4.2.5 Dovetail construction

Dovetail construction is a variation of the standard construction (stiffener on sign edge) that utilises a two-part interlocking channel section (dovetail) rather than two complete abutting channel sections.

Figure 4.2.5(b) illustrates the two-section dovetail construction. The advantages of this system are

1) improved rigidity and resistance to deflection
2) savings on the cost of channels, and
3) savings on the number of fixing clips, as illustrated on Figure 4.2.5(c) which shows how a single clip in the dovetail system replaces two in the conventional system.

***Figure 4.2.5(a) – Dovetail construction***

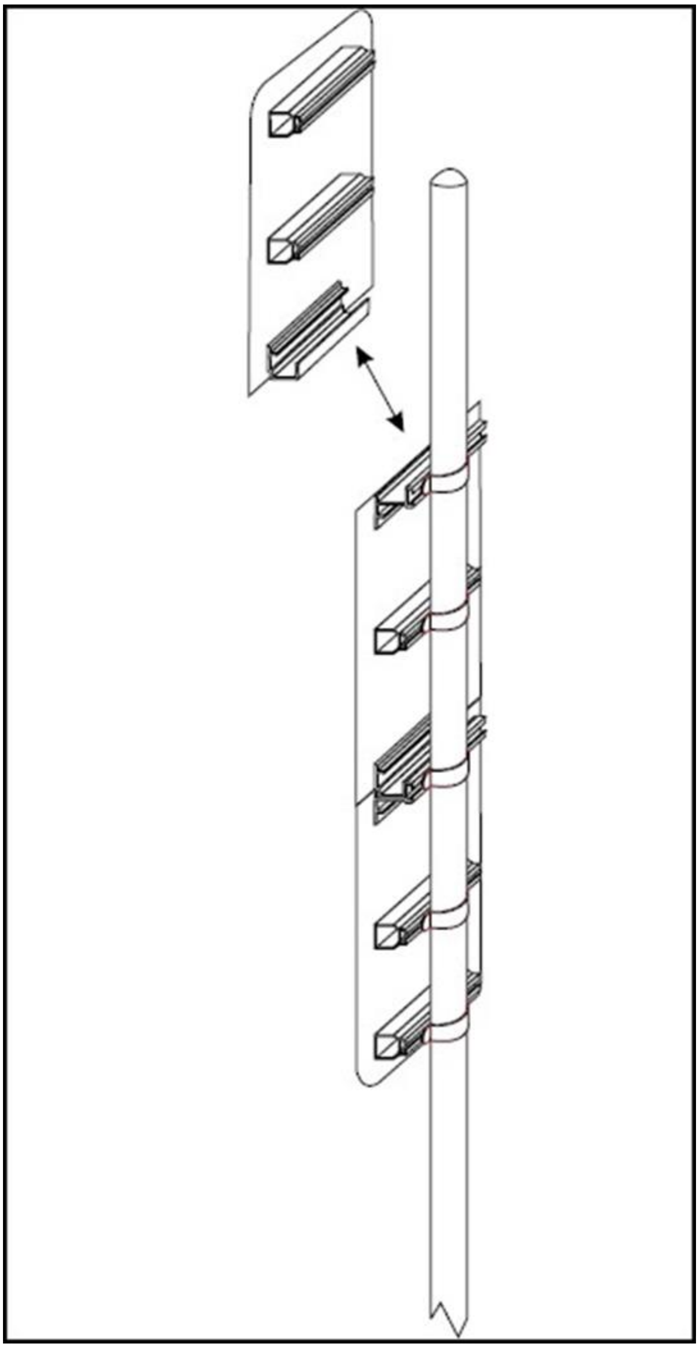


***Figure 4.2.5(b) – Dovetail channel sections***

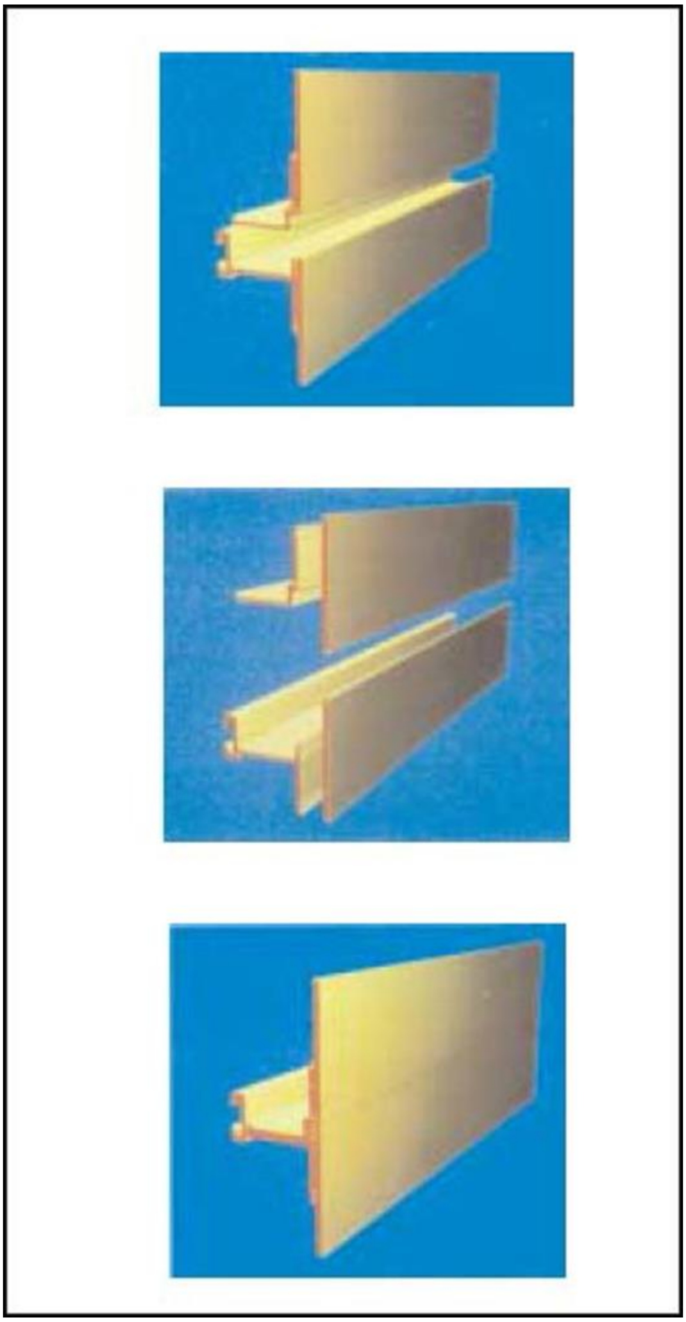
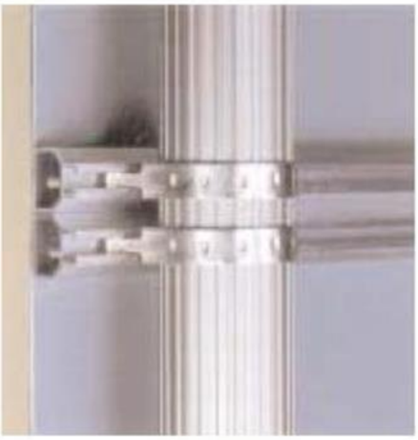


***Figure 4.2.5(c) – Dovetail post fixing***



conventional

dovetail

# 5 Sign supports

## *5.1 Post size and selection*

A graphical method of post selection is used in this *Guide*, similar in format to that used in AS1742.2-2009. Each geographic wind region is catered for with a separate table for clarity and ease of use. The post size is chosen directly from the table for a given sign size, height and number of posts. An option is given for either CHS or RHS posts.

## *5.2 Single post signs*

### 5.2.1 Signs up to 950mm wide

Standard regulatory, parking, warning and guide signs up to 950mm wide are generally erected without panel stiffeners and are supported on a single post. Sign panels greater than 700mm wide and 1000mm deep are sometimes prone to twist and panel deformation. For this reason, consideration should be given to stiffening with Type 1 panel stiffeners.

Boltholes should be provided in sign panels up to 950mm wide and 1000mm deep. The suggested rules for boltholes are listed in Table 5.2.1(a).

***Table 5.2.1(a) – Hole spacing for sign blanks***

| Sign width (mm) | Sign height (mm) | Number and spacing of holes (mm) |
|---|---|---|
| < 950 | < 250 | 1 |
| < 950 | < 350 | 2@200 |
| < 950 | < 550 | 2@300 |
| < 950 | < 800 | 2@500 |
| < 950 | < 1000 | 2@750 |

This assumes even vertical hole spacings of 200, 300, 500 and 750mm.

It is recommended that flattened posts not be used. However, if refitting existing signs to the existing flattened posts than the spacings in Table 5.2.1(b) must be specified when ordering.

***Table 5.2.1(b) – Hole spacing for imperial flattened posts***

| Sign width (mm) | Sign height (mm) | Number and spacing of holes (mm) |
|---|---|---|
| < 950 | < 250 | 1 |
| < 950 | < 350 | 2@205 |
| < 950 | < 550 | 2@310 |
| < 950 | < 800 | 2@510 |
| < 950 | < 1000 | 2@735 |

### 5.2.2 Sign posts

For standard regulatory, parking, warning and guide signs refer to Standard Drawing SD1368 *Traffic sign – Single traffic sign support* for typical brackets used. Flattened posts with corresponding holes are no longer in general use in most districts and brackets are recommended instead.

For signs less than 1 m² in area, the post size is generally 50 DN x 3.2mm CHS. Refer to Appendix B for determination of post sizes suitable for larger signs or heights.

Single posts will generally be CHS, although RHS should be considered for larger signs to increase resistance to twisting.

### 5.2.3 Fittings

Standard Drawing SD1369 *Traffic sign – Details of sign stiffening extrusion* shows several basic types of fittings referred to as Fittings B1, B2, B3, and B4. These are only for 50 DN posts and are a basic standard only. Alternative brackets and variations on these themes are readily available and in most cases equally effective. The user will have to consider their individual requirements before selecting a bracket for a particular purpose. Brackets for 65 DN are available but will not normally be required.

Fittings B1 and B2 are generally used for the erection of single sided standard signs. Fitting B3 is used to erect back-to-back standard signs on a common post.

Fitting B4, wing saddle brackets, are used for single-sided signs. These brackets provide resistance to movement but require site drilling of the post.

### 5.2.4 Signs over 950mm wide

For sign faces over 950mm wide, the use of multiple support posts is generally recommended to avoid panel twist due to vandalism or wind buffeting. For situations where a two-post support is not possible (for example, narrow urban median strips), a single post may be used with panel stiffeners fixed in accordance with Standard Drawing SD1368 *Traffic sign – Single traffic sign support* for signs up to 1800mm wide. Refer to Appendix B for the design procedure.

If breakaway posts are required (refer to Section 5.3.4), the slip base detail given on Standard Drawing SD1368 *Traffic sign – Single traffic sign support* is recommended for single post signs subject to impact from any direction. The fuse plate detail is unnecessary and should not be used with single post signs.

Brackets are available that resist twisting, such as the Signfix Type 5 Bracket.

### 5.2.5 Posts in sleeves

There are certain situations where it is advisable to install the post into a sleeve inserted into the footing, such as:

1) where a sign is located on an urban median strip where it may be struck frequently, or
2) where it may need to be removed occasionally, to accommodate the swept path of over-dimensioned vehicles when turning.

This arrangement is only appropriate for small posts up to 50 DN.

Details of a typical sleeve assembly are presented in Standard Drawing SD1368 *Traffic sign – Single traffic sign support*. An alternative assembly called the 'loc Socket' is also shown on Standard Drawing SD1368 *Traffic sign – Single traffic sign support*. This is a commercial product and variations on the basic theme are just as effective.

## *5.3 Multiple support signs*

For sign widths greater than 950mm, panel stiffener rails are attached to the sign face and connected to two or more supports (refer to Section 5.2.4 for discussion of the single post alternative).

The term support here refers to a CHS or RHS post. This *Guide* may be used for signs up to 8m in height and up to 8m in width, with a maximum area of 40m².

### 5.3.1 Panel stiffener rails

Two panel stiffener sections are used in fabrication of signs greater than 950mm in width, Type 1 and Type 2A. Refer to Standard Drawing SD1369 *Traffic sign – Details of sign stiffening extrusion* for specification of aluminium extrusions.

Stiffener type and number is derived from Appendix B, tables B.1, B.2 and B.3 for a particular sign width, height and location. Table B.1 presents three options for choice of stiffener type and number of supports:

**Option 1:** The most economical option using a minimum number of supports spaced at the standard spacing of 60% and 35% of sign width for two and three support signs respectively.

**Option 2:** This alternative arrangement may be adopted where an additional support is used to achieve ‘frangible’ section sizes. Note the limitations on support spacing to achieve a satisfactory ‘frangible’ solution. This option maintains the standard support spacings to derive the maximum sign width; however, reduced post spacing may be used as long as the maximum stiffener overhang is not exceeded.

**Option 3:** An option for signs requiring two widely spaced supports, for example, straddling a footpath, where the minimum overhang is 10% of sign width.

For sign widths less than the tabulated limits, the support spacing may be reduced below the standard spacing ratio to suit the site conditions; however, the maximum stiffener overhang specified in Table B.2 must not be exceeded.

Additional posts may be used to achieve ‘frangible’ section sizes if required; however, increasing the number of posts is not a valid method for resultant post spacing less than 1.5m, due to the increased likelihood of collision with two posts

Deviation from the specified stiffener / support arrangements will require calculation of width limits in accordance with the appropriate formulae.

General constraints on stiffener arrangements are as follows:

- 500mm maximum stiffener spacing, and
- 150mm maximum panel overhang between stiffeners and top and bottom of sign.

For large signs erected using modular panels, refer to Section 4.

### 5.3.2 Sign supports

Tubular steel posts are used to support the stiffened sign panel, either Circular Hollow Section (CHS) or Rectangular Hollow Section (RHS).

The number of supports and options for support type (RHS / CHS) are determined from the procedure in Appendix B. The selection of support type is influenced by the following considerations:

CHS has generally been the preferred post type due to:

- availability as pregalvanised (300g/ms), which saves the cost and inconvenience of hot dip galvanising RHS
- less wastage in fabrication due to 6.5m length stock sizes compared to 8m for RHS

- less tolerance on length required due to ease of pipe cutting and capping on site
- less tolerance on alignment with sign face required
- availability of fittings, and
- more easily realigned if bent over by wind or vehicle impact.

RHS posts are significantly more efficient than CHS as structural sections, particularly with the benefit of availability as Grade C350/450.

In regions of Mild and Moderate Atmospheric Classification[1], advantage may be taken of pregalvanised (100g/ms) RHS which has recently become available for sizes up to 125 x 75 and is half the cost of equivalent capacity galvanised CHS. This cost saving should be considered against the erection advantages of CHS.

Note: [1]Atmospheric Classification is as defined in AS2312 with Moderate zones having rainfall less than 1000mm p.a., average humidity 50 to 80% and being situated further than 15km from the coast, with only light industrial activity.

In urban areas, the likelihood of corrosion from dog urine should also be considered. Although urine will attack all levels of galvanising, the heavier hot dip galvanised coating will give greater protection to the steel.

Posts for signs located in 'high risk' areas which are 'non-frangible' (refer Section 5.3.4), must be hot dip galvanised after fabrication of slip baseplate and fuse plate hinge details as specified in Standard Drawing SD1365 *Traffic Sign – Traffic sign support breakaway post details (two or more supports)*.

The cost and convenience benefits inherent in having CHS pre-galvanised are therefore removed and the cost savings of RHS, as discussed previously, should be considered.

Posts in sleeves (refer Section 5.2.5) must be CHS posts.

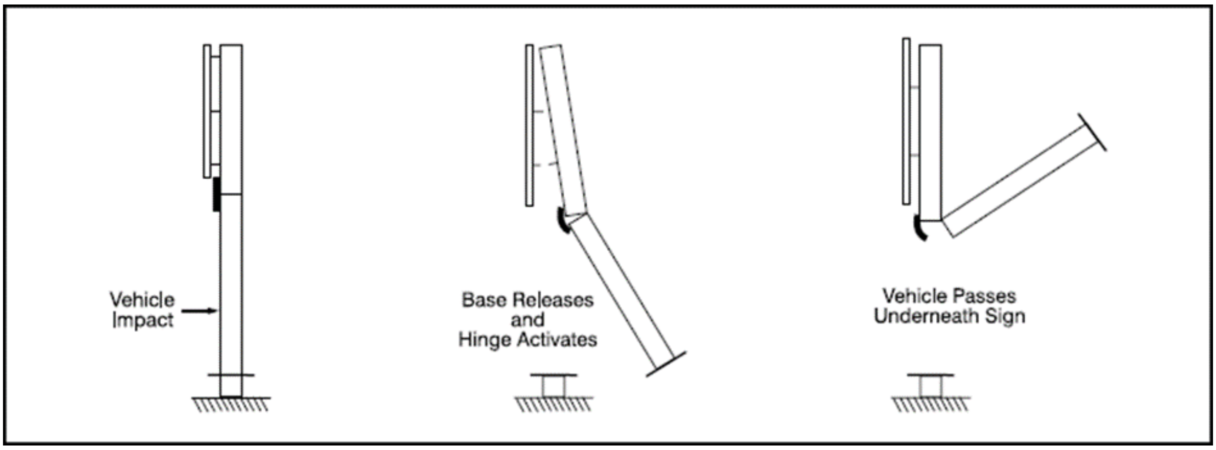
### 5.3.3 Alternative post section sizes

Table B.5 presents some alternative post section sizes for CHS posts to those called up in Figures B.2–B.13. The preferred sizes, based on structural efficiency and availability, are highlighted in Table B.5.

### 5.3.4 Breakaway supports

The function of breakaway supports is to support the sign under normal wind load conditions, yet fail in a relatively safe manner when struck by a vehicle.

***Figure 5.3.4 – Impact performance***




Breakaway supports are fabricated using RHS or CHS steel tube with both a slip baseplate and a fuse plate hinge (except for single post signs). Failure occurs when the vehicle impact force overcomes the frictional force between the baseplate and tension tearing of the fuseplate weld. Breakaway support details are designed to accommodate impact from both traffic directions, to cater for use in median strip and gore areas.

The slip base and fuse plate details are not required for small posts, which are considered to be ‘frangible’ in collisions. Refer to Table 5.3.4.

***Table 5.3.4 – Small size steel posts considered as frangible***

| Likely collision speed (km/h) | Post size | |
|---|---|---|
| | Diameter nominal (mm) | Outside diameter (mm) |
| < 60 | 100 | 114.3 |
| 60 to 80 | 80 | 88.9 |
| > 80 | 65 | 76.1 |

Galvanised steel pipe posts up to 65 DN will rarely be found to cause injury to the occupants of cars or heavier vehicles which collide with them. The same applies to low-speed urban type conditions involving steel pipe up to approximately 100 DN (RHS 75 x 50). For RHS, 75 x 50 posts may be considered as ‘frangible’.

Consideration should be given to the use of an additional post that may reduce the required post size to within the ‘frangible’ limits. Increasing the number of posts is not a valid method for resultant post spacing less than 1.5m, due to the increased likelihood of collision with two posts.

To maximise road safety and minimise cost, the intention should always be to locate signs in ‘low risk’ regions where breakaway posts are not required.

‘Low risk’ regions are:

- outside the Clear Zone defined in Section 3
- behind a guard rail or other barrier device, or
- at the bottom of a steep embankment or top of a steep cutting.

‘High risk’ regions are those within the Clear Zone defined in Section 4 which are not protected by a barrier device or steep slope.

Breakaway posts should be avoided where secondary accidents involving the impacting vehicle or dislodged pole and sign are significant. This is particularly relevant in urban areas where pedestrians may be struck by falling pieces.

To achieve satisfactory performance of the breakaway supports, the following criteria should be met:

- The clearance of the sign above the ground should be a minimum of 2.1m to avoid penetration of an impacting vehicle windscreen.
- Proper functioning of the slip base depends on control of clamping pressure between the base plates produced by bolt tensioning. It is important for the specified bolt torque to be adhered to. The drawings specify shop assembly of slip bases, to minimise the inaccuracies of torque controlled bolt tensioning. Pre-assembled slip bases will also enable supports to be plumbed prior to pouring concrete footings.
- For CHS / RHS posts, the fuse plate hinges have been designed to resist 45% of the post moment capacity. Signs with panel height (‘B’) greater than 165% of the clearance (‘H’) between the ground and sign produce a bending moment which exceeds the fuse plate hinge capacity. For these signs the post size should be increased to the next section size. The allowable panel height is then twice the clearance.

Breakaway support details are presented in Standard Drawing SD1365 *Traffic sign – Traffic sign support breakaway post details (two or more supports)* for CHS / RHS posts

## *5.4 Fittings*

### 5.4.1 Connection straps

Stiffener rails are generally fixed to supports with circular or rectangular connection straps. Galvanised steel connection straps for CHS supports (including trusses) and RHS posts are detailed on Standard Drawing SD1364 *Traffic sign – Connection strap and erection cleat details*.

### 5.4.2 Erection cleats

To assist the erection of RHS posts, cleats may be welded to the posts to support the top stiffener rail. Slotted cleats allow the sign to be levelled, as connection straps are fitted to the remaining stiffener rails. Erection cleats are detailed on Standard Drawing SD1364 *Traffic sign – Connection strap and erection cleat details*.

## *5.5 Proprietary sign supports*

Refer to *Traffic and Road Use Management* manual Volume 1 Part 10 Section 4.5.3-1.

## *5.6 Sight boards and other signs at T-intersections*

Signs installed parallel to the roadway that include sign stiffeners present a spearing risk to vehicles that impact them end on. Transport and Main Roads has developed new installation guidelines to ensure that signs do not spear through vehicle windscreens when impacted. These revised installation guidelines are given in Standard Drawing SD1452 *Traffic sign – Hazard marker installation details*. The Standard Drawing is to be read in conjunction with Appendix E: *Design of Sight boards and other signs at T-intersections*.

# 6 Storage and handling of signs

## *6.1 General*

In order for the sign to be effective, the surface of the sign must be free from damage, abrasion, dirt, oil or other markings causing loss of legibility.

These problems are especially severe when dealing with reflective material, since night-time legibility is directly related to the quality and clarity of the reflective surface.

## *6.2 General storage*

Signs should be stored vertically on edge, either in a rack or in such a way that they are supported vertically.

Damage is likely to occur to signs stored in contact with each other, or banded together.

Signs stacked tightly together result in pressure points being induced on the reflective sheeting faces, leading to areas not reflecting.

## *6.3 Indoor storage*

Signs stored indoors may be left in their original transport packaging, provided that the storage area will be maintained at a constant room temperature and is well ventilated. However, the banding around any sign should be cut and removed.

If the storage area is a small, non-ventilated area, signs should be unwrapped from their transport packaging (that is, cardboard, bubble wrap, and so on) and only stored for relatively short periods.

## *6.4 Outdoor storage*

Signs stored outdoors must be unwrapped from their transport packaging and stored upright, on edge, using wooden battens on the floor, or as vertical supports, or both.

Signs stored outdoors, especially large direction signs, should be stored using a racking system, providing vertical support, avoiding pressure points on sign faces and allowing adequate air circulation between sign faces to prevent a build-up of moisture.

## *6.5 Sign transport*

When transporting signs by truck or trailer, it is imperative that signs be securely braced vertically, and adequately supported and secured to avoid damage due to scuffing, abrasion and load shifting.

Large direction signs should be braced using wooden stiffeners attached to the extrusions at the back of the sign, and transported with the stiffeners in place to avoid buckling and rivet popping.

## *6.6 Sign erection*

Once signs have been transported to the road site, they should not be laid flat on the ground. Laying signs flat, can result in damage to the reflective face through direct contact with the ground.

When attaching signs to posts, all connecting bolts should be tightened using offset spanners, not socket wrenches. The use of offset spanners minimises tool and hand contact with the sign face and avoids scratching of the surface, as well as allowing the extent of tightening to be observed. Only one end of the nut and bolt should be tightened, preferable tightened from the rear of the sign.

Tightening from both sides can transfer stress into retroreflective sheeting, with a top film resulting in permanent pinwheel style wrinkles.

Avoid over-tightening the connecting bolts, as this can cause specular glare from dimples on the sign face.

Nylon washers should be used between connecting bolt heads and the sign face, to protect the reflective sheeting from the twisting action of the bolt heads.

A circle of diameter slightly larger than the bolt head may be scored in the reflective sign face around the bolt hole, to minimise any fine cracking that may inadvertently occur during bolt tightening.

When erecting large Direction signs, care must be taken to prevent lifting ropes, cables and chains from contacting the sign surface. These can cause permanent visible damage.

After installation, and before leaving the road site, inspect all signs to see that they have not been damaged during erection and are free of oil and dirt residue from fingers and tools. A night inspection will confirm that the surface has not been damaged.

### *6.7 Sign covering*

Covering signs is not recommended. If it is necessary to cover a sign face temporarily after erection, caution must be exercised, as some coverings may cause permanent damage to the sign face following exposure to moisture and sunlight.

Porous cloth covers, which are folded over the sign edges and secured to the back of the sign, have been used successfully for limited periods.

Avoid the use of ropes, wire fasteners or strapping that may abrade the sign surface. Do not apply tape to the sign face, as sunlight will cause it to bond permanently. Premask or application tape must be removed before exposure to sunlight.

Do not use paper or plastic covers as heat and moisture entrapment can cause permanent damage to the reflective sheeting on the sign face.

Consult the sign sheeting manufacturer for advice on how to appropriately cover the sign face to maintain the product warranty.

### *6.8 Sign cleaning*

For maximum performance, signs should be kept clean and free from dirt, road tar, oil, bituminous material and mulch. Primarily, this means cleaning the surface of the reflective sheeting – the essential characteristic of a sign.

A wet, detergent-type, non-abrasive cleaner suitable for high quality paint surfaces is recommended. The cleaner must also be free of strong aromatic solvents or alcohols and be chemically neutral (that is, pH of around 7.0). Following use of any cleaning agent, the sign surface must be thoroughly and immediately rinsed with clean water. In all cleaning operations, care should be taken not to abrade the sign by use of stiff-bristle brushes or by unnecessary scrubbing.

Normal cleaning procedure:

1) Flush the surface with clean water to remove loose, dirt particles. A squeeze (or triggered) hose nozzle is convenient for this purpose.
2) Wash the sign face with a rag or sponge using a suitable detergent or commercial cleaner. Wash thoroughly from the top down. Once suds have been applied, keep a steady stream of water flowing on the sign face to wash away dirt particles.

3) Rinse the entire sign face with clean water and allow the sign to drain dry.

4) Take extreme care in cleaning screened sign faces since some cleaning solvents may damage the screen print.

Use a mild solvent such as mineral spirits for cleaning the sign face. Follow with detergent and water, then rinse with clean water.

Avoid high-pressure sprayers. Do not direct sprays at sign face edges.

## Appendix A: TraSiS

TraSiS is an electronic implementation of the structural design procedures outlined in this *Guide*. Our newest upgrade includes additional features which greatly enhances the sign support structural design task. It replaces the *Sign Design On-Line Software*.

The software automates the design procedure and utilises the following inputs:

- sign size
- terrain cross-section
- use of frangible or non-frangible supports
- selection of wind region (in accordance with AS/NZS 1170.2) and
- foundation strength.

A detailed or summary output is provided, and includes:

- the type (CHS / RHS) and number of supports
- support section details (including variable wall thickness for different grades of steel)
- stiffener type, spacing and number of brackets, and
- footing details.

A significant enhancement to the previous version of the software is the addition of a clear zone module, which calculates clear zone distances based on the following variables:

- Annual Average Daily Traffic (AADT)
- horizontal alignment
- speed environment, and
- terrain cross-section.

The user can consequently specify frangible or non-frangible support, contingent upon the sign location.

For further information contact Principal Engineer Traffic.

# Appendix B: Design procedure for roadside sign support

**Step 1**

Determine sign size.

**Step 2**

Determine Geographic Wind Region A, B, C – refer Figure B.1.

Note: Region D does not exist in Queensland, however post design charts for Region D have been included in this *Guide* to cater for Region C Exposed.

**Step 3**

Determine if the sign has high or low risk collision exposure (refer Section 5.3.4). Signs with high risk exposure may require breakaway support details if the posts are not of frangible size. Sign ground clearance ‘H’ for sign supports with breakaway details should be no lower than 2.1m.

**Step 4**

Select panel stiffener type and number of supports (N) from Table B.1, based on the sign width. For modular sign panels, use only Type 2 stiffeners. For the stiffener design and number of posts required to suit the sign width, the wind region derived from Figure B.1 (Step 2) should be used as these values have been derived for Exposed Terrain Category 2 conditions.

Maximum sign widths are tabulated for three options of support spacing as discussed in Section 5.3.1.

**Option 1** will be most frequently adopted for normal situations to minimise the number of supports.

**Option 2** may be adopted where an additional support is required to satisfy the design figures or is used to achieve ‘frangible’ section size.

**Option 3** caters for widely spaced supports (for example, straddling footpaths). Note that for signs of width less than the limiting values, support spacing may be reduced to less than the ‘standard’ spacing provided that the maximum stiffener overhang specified in Table B.2 is not exceeded.

Select the number of panel stiffeners from Table B.3. For modular sign panels, use three stiffeners (Type 2) at 580mm spacing per 1200mm high sign panel module.

**Step 5**

Select the support (size and type) from Figure B.2-13 for the appropriate Region A, B, C or D and sign area. For exposed locations (unshielded Terrain Category 2 in AS/NZS 1170.2) prone to high wind or where support collapse is more hazardous than normal situations, a Wind Region one step up from that derived from Figure B.1 (Step 2) should be used (only for post design)for example, use Region C design charts for Exposed Region B. If no choice of support size is possible for the number of supports ‘N’ chosen in Step 4, then add an extra support to ‘N’ and choose a support size again from Figure B.2-13 – refer to discussion in Section 5 of the text on the criteria for selection of support type (CHS post, RHS post), for example, requirement for breakaway supports, corrosion protection, erection, structural efficiency, cost, aesthetics.

For breakaway supports, note the limitation on sign panel height relative to sign ground clearance height. For signs supported by CHS / RHS posts, with sign panel height ‘B’ greater than 1.65 x clearance ‘H’, increase the post size as indicated on Figure B.2-13.

**Step 6**

Footings – Refer to Table B.4 for the selection of foundation strength category, based on either simple field identification methods or soil parameters determined by laboratory tests. Note that footings for sound rock or very soft or swampy ground conditions require individual design.

**Step 7**

Refer to Standard Drawings listed in Appendix C for details of fabrication and erection.

***Figure B.1 – Geographic region***

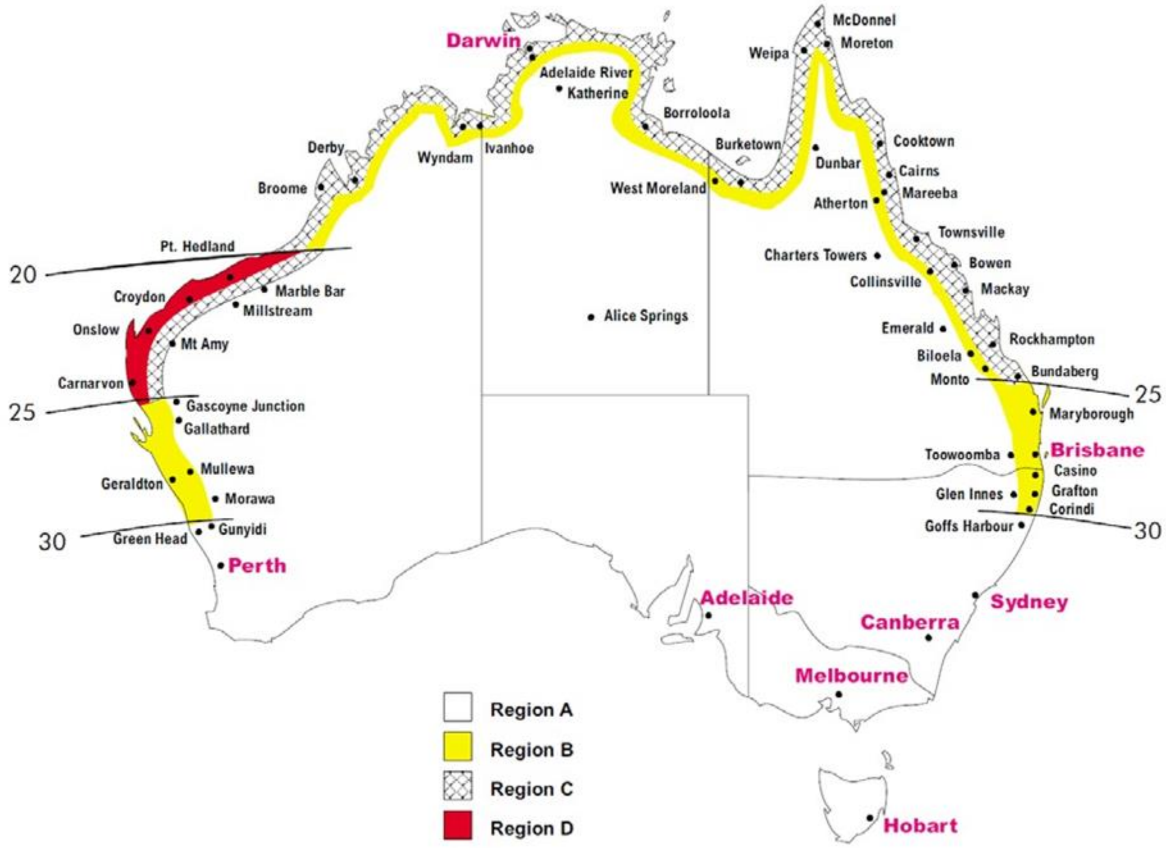


*Table B.1 – Stiffener type and number of supports*

| Option 1 – Minimum no. of supports; standard support spacing[1] | | | | |
|---|---|---|---|---|
| Panel stiffener type | | **Type 1** | **Type 2a** | **Type 2a** |
| No. of supports (N) | | 2 | 2 | 3 |
| Maximum sign width | Region A | 3.5m | 5.5m | 7.3m |
| | Region B | 3.0m | 5.0m | 6.7m |
| | Region C | 2.5m | 4.5m | 6.0m |
| **Option 2 – Additional support; standard support spacing** | | | | |
| Panel stiffener type | | **Type 1** | **Type 2a** | **Type 1** |
| No. of supports (n) | | 3 | 4 | 4 |
| Maximum sign width[2] (standing support spacing[1]) | Region A | 4.7m | 8.0m | 6.3m |
| | Region B | 4.0m | 8.0m | 5.4m |
| | Region C | 3.3m | 8.0m | 4.4m |
| **Option 3 – Minimum 10% sign overhang** | | | | |
| Panel stiffener type | | **Type 1** | **Type 2** | |
| No. of supports (N) | | 2 | 2 | |
| Maximum sign width (10% sign overhang) | Region A | 2.0m | 3.3m | |
| | Region B | 1.7m | 2.8m | |
| | Region C | 1.5m | 2.5m | |

[1]Support spacing may be reduced for signs of width less than tabulated limits provided maximum stiffener overhang specified in Table B.2 following are not exceeded.

[2] Sign width limited to 8.0m maximum.

*Table B.2 – Maximum stiffener overhang*

| **Panel stiffener type** | | **Type 1** | **Type 2** |
|---|---|---|---|
| Maximum stiffener overhang | Region A | 0.7m | 1.1m |
| | Region B | 0.6m | 1.0m |
| | Region C | 0.5m | 0.9m |

*Table B.3 – Number of panel stiffeners*

| Sign height, B (m) | No. of stiffeners (Max. stiffener spacing 500m Max. sign panel overhang 150mm) |
|---|---|
| 0.75 | 2 |
| 1.2 | 3 |
| 1.8 | 4 |
| 2.25 | 5 |
| 2.7 | 6 |
| 3.3 | 7 |
| 3.75 | 8 |
| 3.9 | 9 |

**Sample calculation**

**Step 1**

Normal sign (single panel construction)

| | |
|---|---|
| Sign width, A | 4.8m |
| Sign height, B | 2.2m |
| Sign ground clearance, H | 2.0m |
| Location | Moreton District, rural highway. |

**Step 2**

Region B, not exposed.

**Step 3**

Low risk exposure as behind a guard rail – breakaway details not required.

**Step 4**

Table B.1 (Option 1) – Type 2 panel stiffeners with two posts for 4.8m panel width.

Table B.3 – five panel stiffeners required for 2.2m panel height.

**Step 5**

In Figure B.7 for Region B Sign Area = 4.8 x 2.2 = 10.6m$^2$.

Height to centre of sign, H' = ground clearance height, H + B/2

= 2 + 2.2/2

= 3.1m.

For two posts as determined in **Step 4**, interpolation of the design chart yields post choices of 2/100 DN CHS or 2/100 x 50 x 4.0 RHS.

For the Moreton District maximum corrosion protection is required so the RHS posts would require hot dip galvanising. Select 2/100 DN pregalvanised posts.

**Step 6**

Choose foundation strength category in Table B.4, based on field identification or laboratory testing.

**Step 7**

Refer to drawings in Appendix C for details of fabrication and erection.

For modular sign panels, use three stiffeners (Type 2) at 580mm spacing per 1200mm high sign panel module (refer Figure 4.2.4(a)).

***Table B.4 – Foundation strength category***

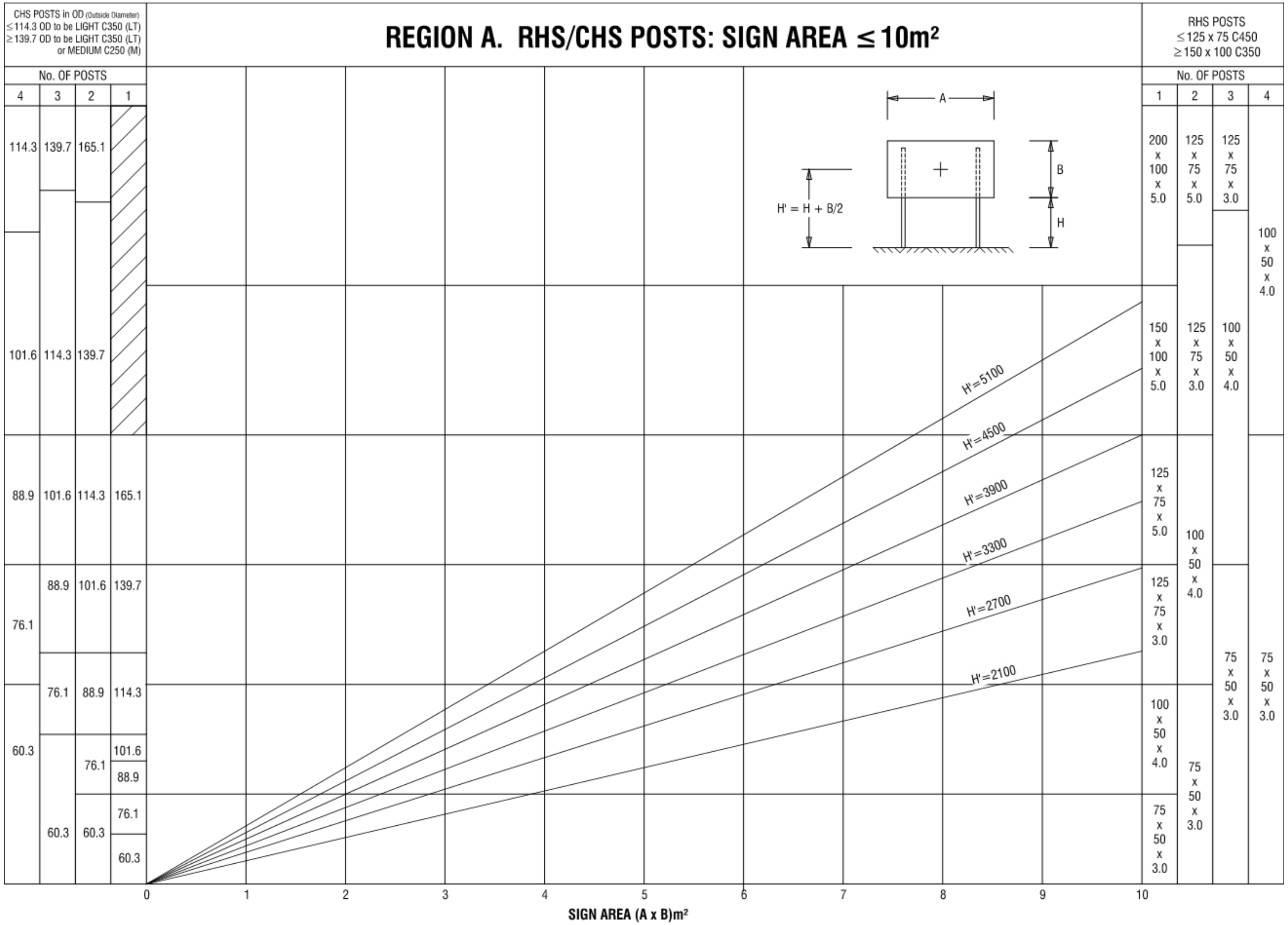
| **Cohesive clay soils** | | |
|---|---|---|
| **Strength category** | **Firm to stiff** | **Stiff to hard** |
| Undrained shear strength, Cu (kPA) | 75 | 150 |
| Elastic modulus, E (kPa) | 8000 | 16,000 |
| Subgrade reaction modulus, k ($MN/m^3$) | 30 | 60 |
| Field identification | Effort is required to penetrate with thumb or remould with fingers | Only indented by thumb and not possible to remould in fingers without adding water |
| **Cohesionless sand soils** | | |
| **Strength category** | **Loose to medium dense** | **Dense** |
| Friction angle | 35 | 45 |
| Elastic modulus, E (kPa) | 40,000 | 80,000 |
| Coefficient of modulus variation, ($MN/m^3$) | 3 | 9 |
| Field identification | No significant resistance to excavation with spade penetration by crowbar | Noticeable resistance to excavation with spade or little penetration by crowbar |

***Table B.5 – CHS post section equivalence table***

| **Post section from Figure B.2-13** | | | | **Equivalent post section** | | | |
|---|---|---|---|---|---|---|---|
| **DN** | **Grade** | **CHS outside diameter** | **Wall thickness (mm)** | **DN** | **Grade** | **CHS outside diameter** | **Wall thickness (mm)** |
| *50LT | LIGHT C350 | *60.3 | 2.9 | 50H | HEAVY C250 | 60.3 | 4.5 |
| *65LT | LIGHT C350 | *76.1 | 3.2 | 65H | HEAVY C250 | 76.1 | 4.5 |
| *80LT | LIGHT C350 | *88.9 | 3.2 | 80H | HEAVY C250 | 88.9 | 5.0 |
| 90LT | LIGHT C350 | 101.6 | 3.2 | 90H | HEAVY C250 | 101.6 | 5.0 |
| *100LT | LIGHT C350 | *114.3 | 3.6 | 100H | HEAVY C250 | 114.3 | 5.4 |
| 125LT | LIGHT C350 | 139.7 | 3.5 | *125M | MEDIUM C250 | *139.7 | 5.0 |
| 150LT | LIGHT C350 | 165.1 | 3.5 | *150M | MEDIUM C250 | *165.1 | 5.0 |

* Indicates Preferred Post Sizes

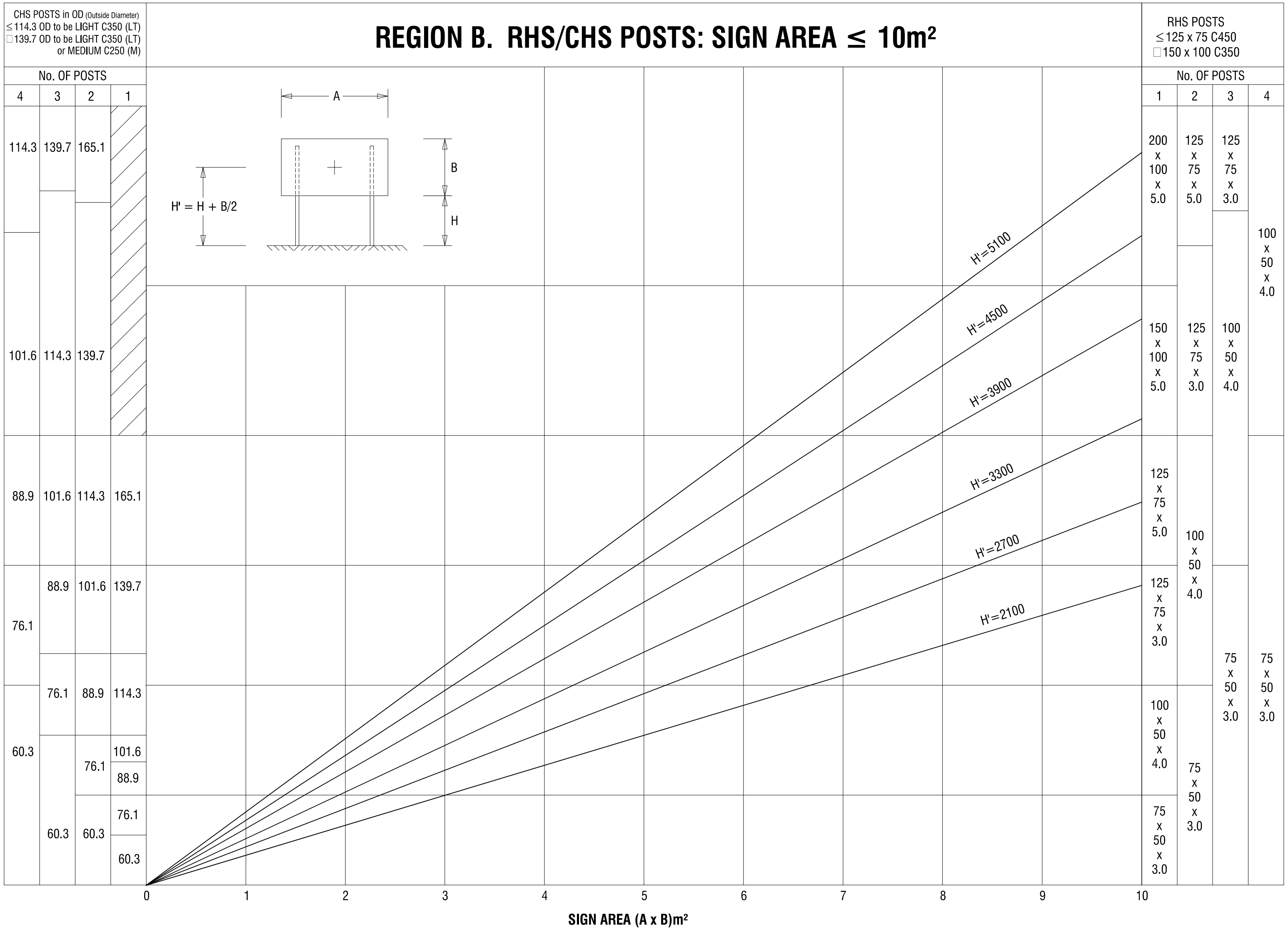
***Figure B.2 – Region A, RHS / CHS posts: Sign area ≤10m²***



NOTES: REGION A. RHS/CHS POSTS: SIGN AREA ≤10m²

1. On uneven ground H = height of the tallest post.
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For larger signs, refer also to Figure B.6., Region A. RHS / CHS Posts: sign area ≤28m² and Figure B.10, Region A. RHS / CHS Posts: sign area ≤40m².
5. LT = light (C350), M = medium (C250). Refer Table B.5.

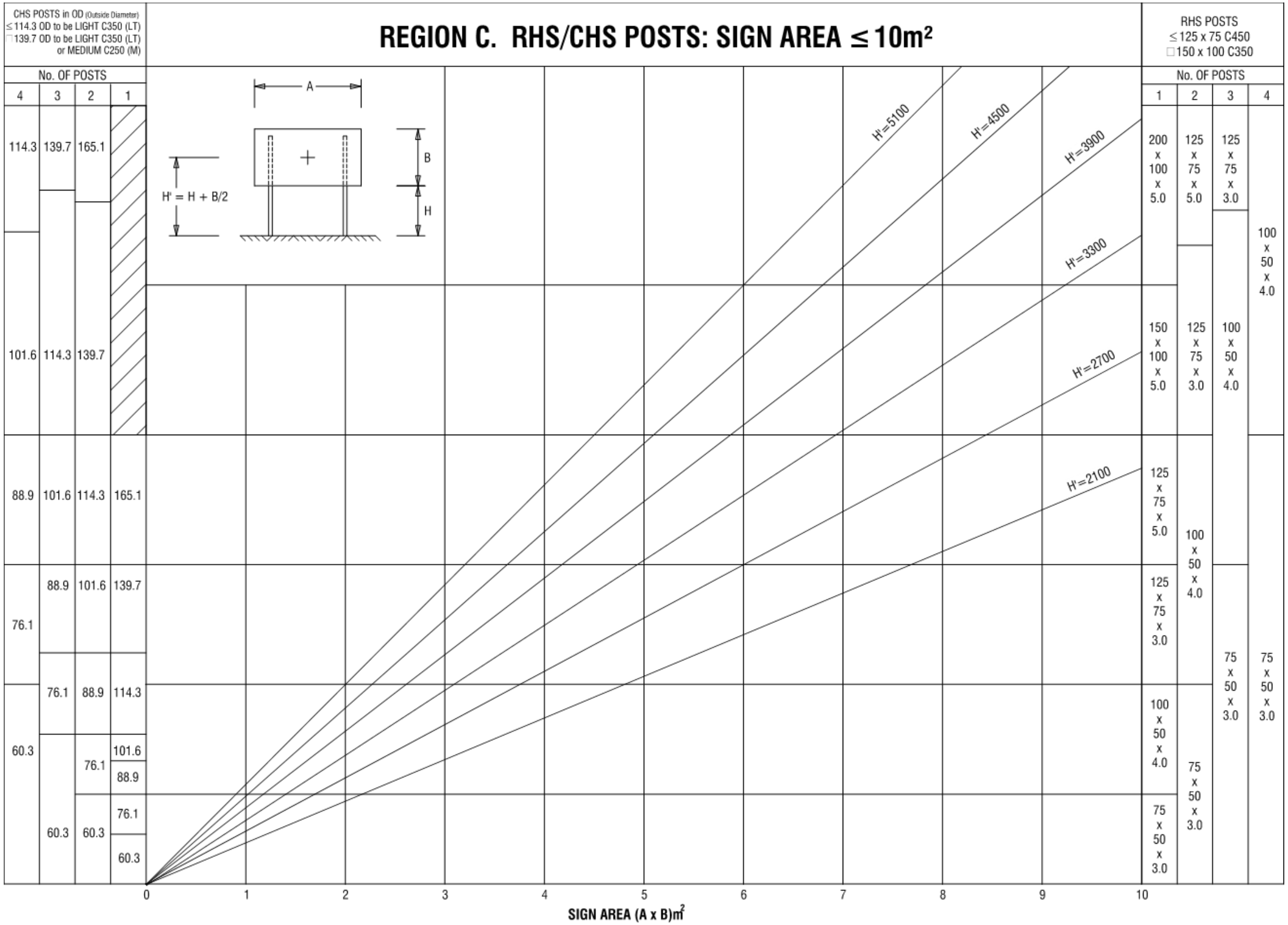
***Figure B.3– Region B, RHS / CHS posts: Sign area ≤10m²***



NOTES: REGION B.RHS / CHS POSTS: SIGN AREA ≤10m²

1. On uneven ground H = height of the tallest post.
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For larger signs, refer also to Figure B.7., Region B. RHS / CHS Posts: sign area ≤28m² and Figure B.11., Region B. RHS / CHS Posts: sign area ≤40m².
5. LT = light (C350), M = medium (C250). Refer Table B.5.

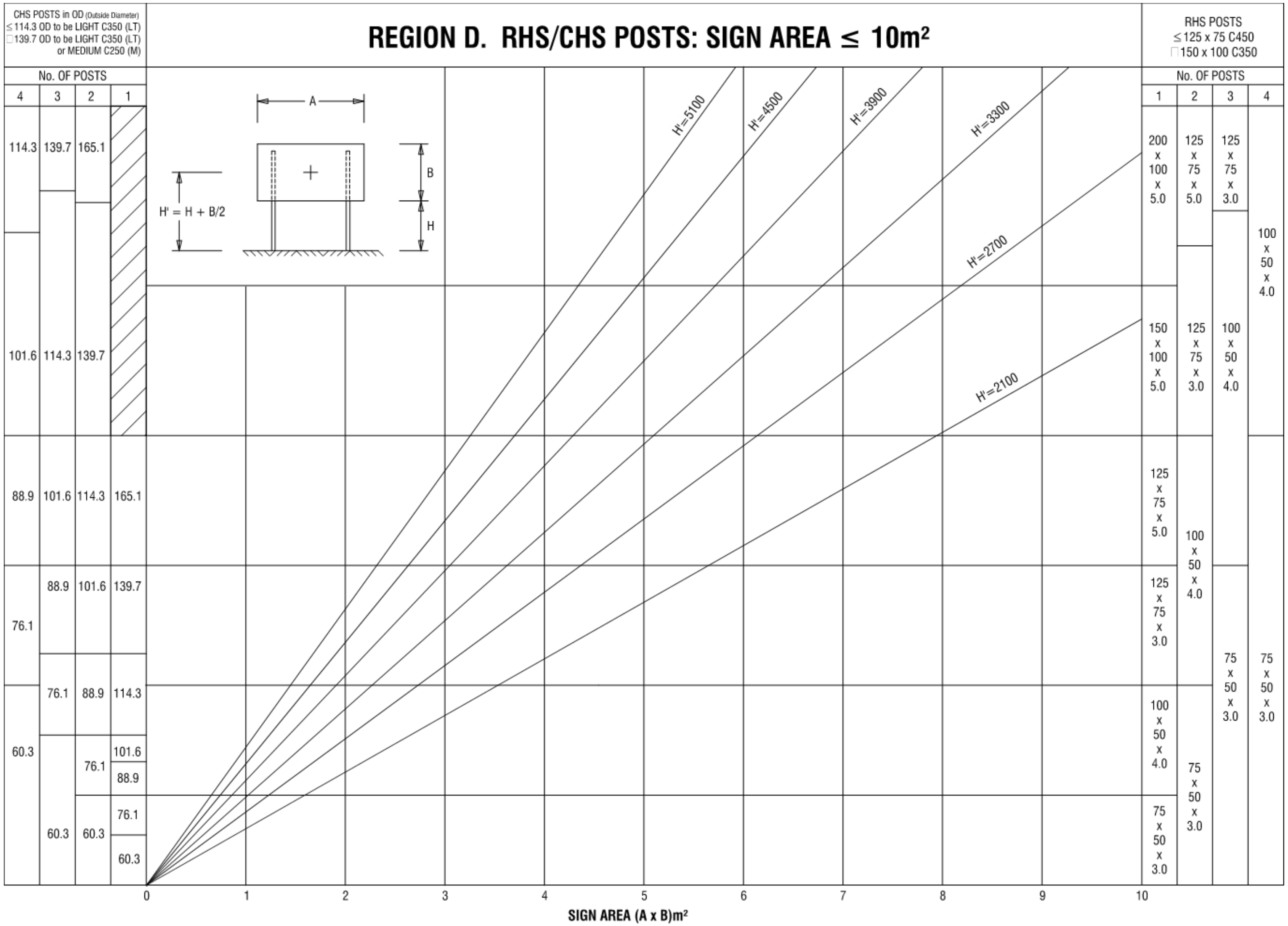
***Figure B.4 – Region C, RHS / CHS posts: Sign area ≤10m²***



NOTES: REGION C. RHS / CHS POSTS: SIGN AREA ≤10m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For larger signs, refer also to Figure B.8., Region C. RHS / CHS Posts: sign area ≤28m² and Figure B.12, Region C. RHS / CHS Posts: sign area ≤40m².
5. LT = light (C350), M = medium (C250). Refer Table B.5.

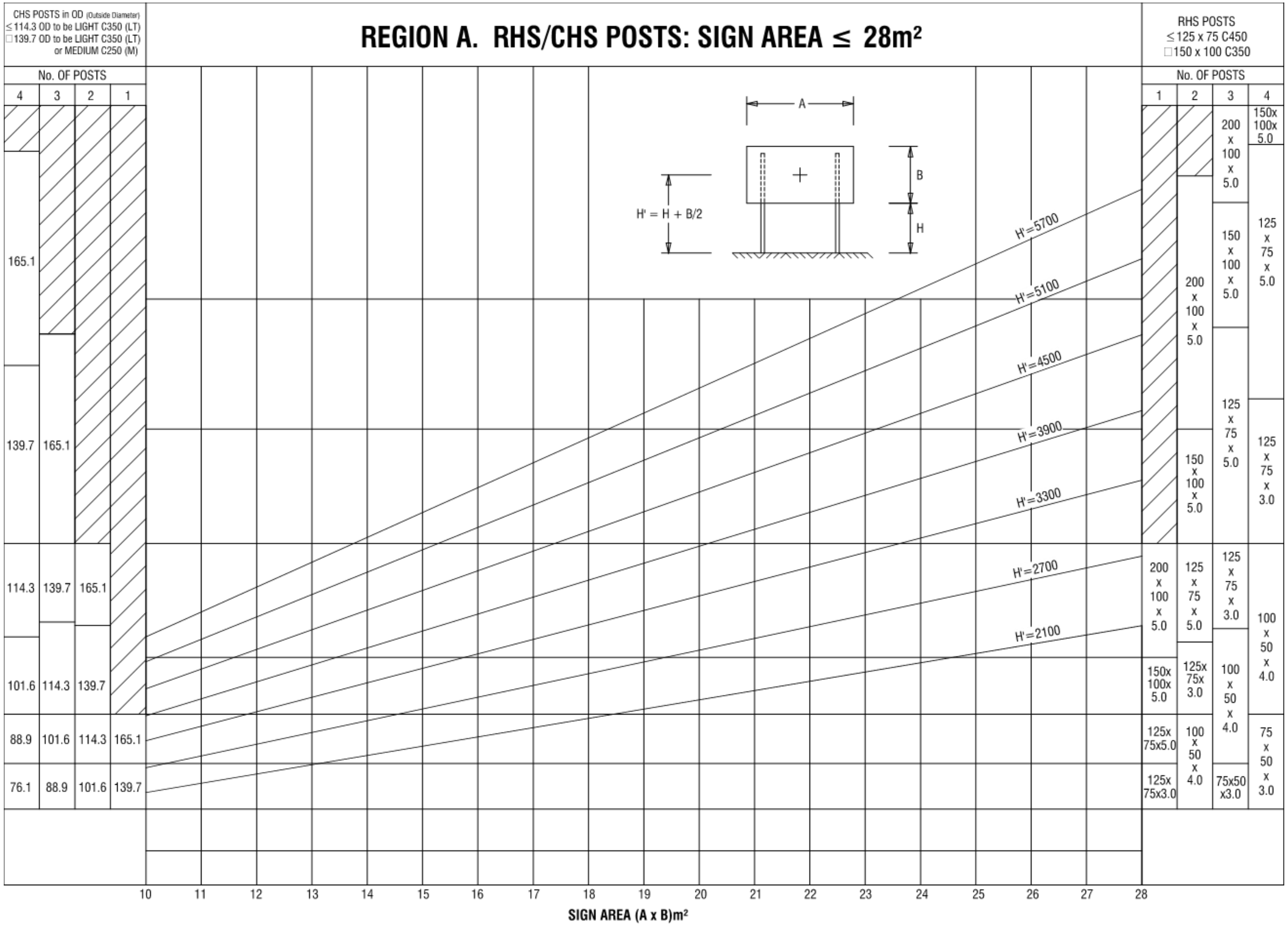
***Figure B.5 – Region D, RHS / CHS posts: Sign area ≤10m²***



NOTES: REGION D. RHS / CHS POSTS: SIGN AREA ≤10m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For larger signs, refer also to Figure B.9., Region D. RHS / CHS Posts: sign area ≤28m² and Figure B.13, Region D. RHS / CHS Posts: sign area ≤40m².
5. LT = light (C350), M = medium (C250). Refer Table B.5.

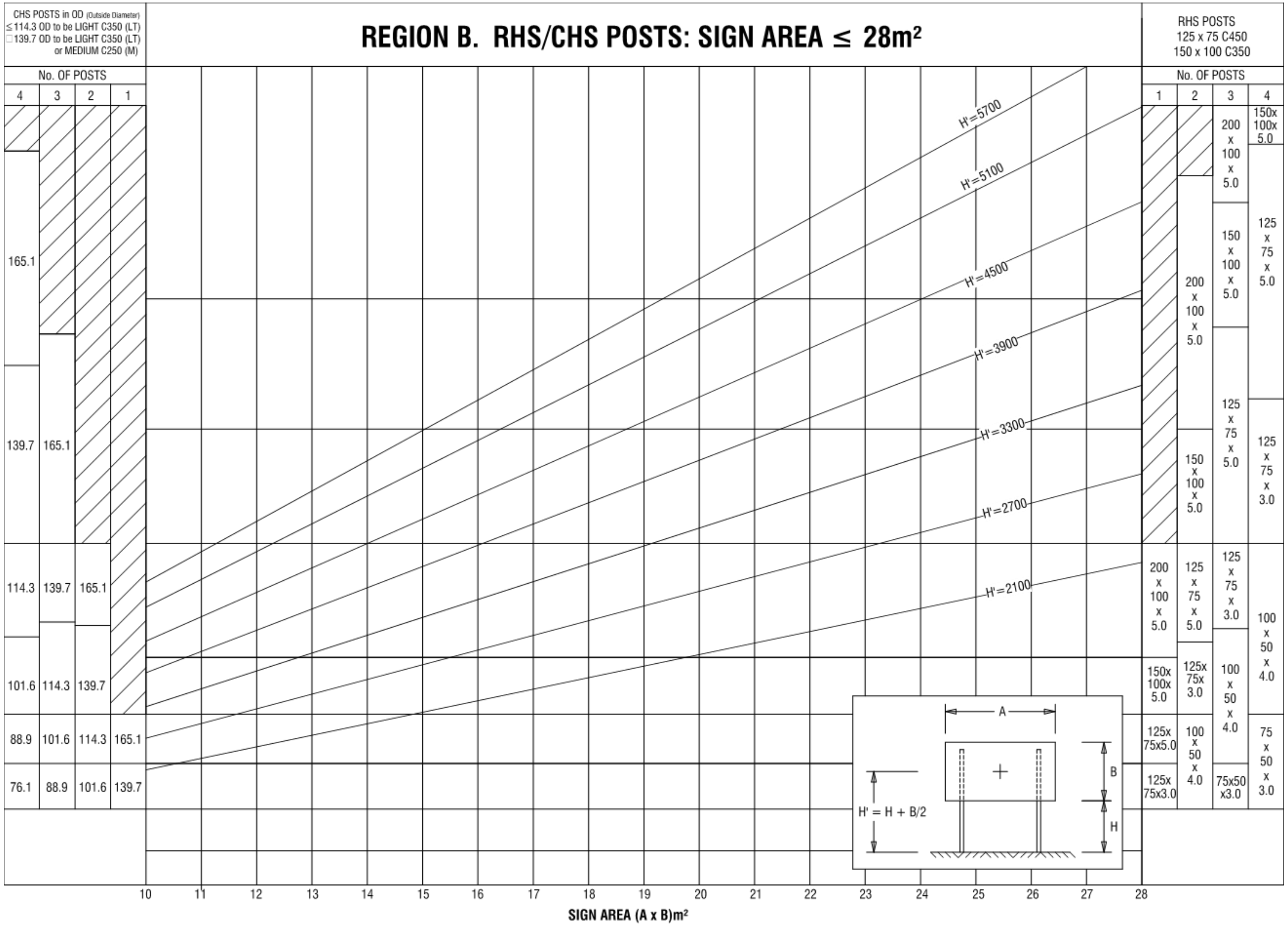
***Figure B.6 – Region A, RHS / CHS posts: Sign area ≤28m²***



NOTES: REGION A. RHS / CHS POSTS: SIGN AREA ≤28m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For larger signs, refer also to Figure B.2., Region A. RHS / CHS Posts: sign area ≤10m² and Figure B.10., Region A. RHS / CHS Posts: sign area ≤40m² respectively.
5. LT = light (C350), M = medium (C250). Refer Table B.5.

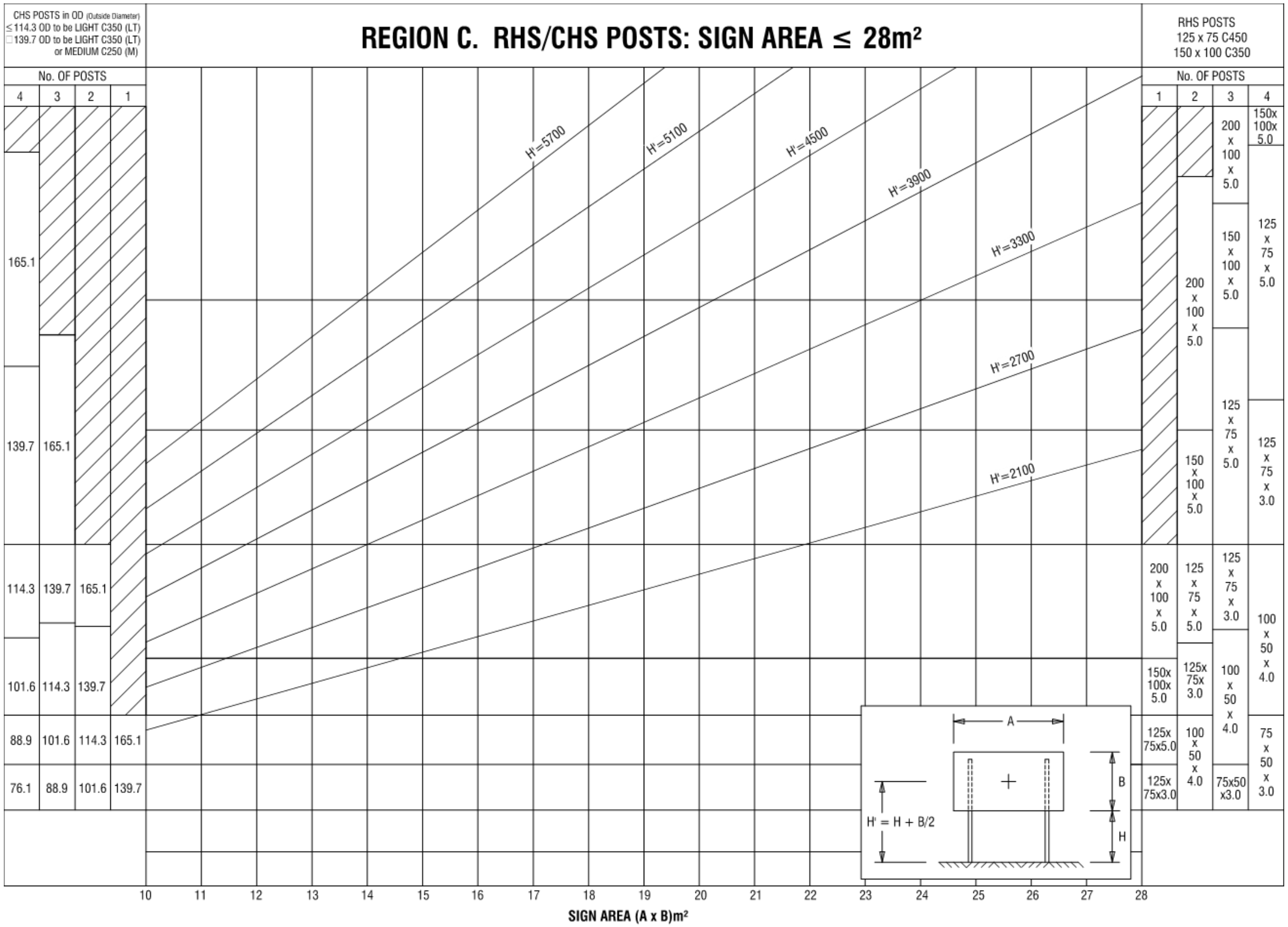
***Figure B.7 – Region B, RHS / CHS posts: Sign area ≤28m²***



NOTES: REGION B. RHS / CHS POSTS: SIGN AREA ≤28m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For larger signs, refer also to Figure B.3., Region B. RHS / CHS Posts: sign area ≤10m² and Figure B.11., Region B. RHS / CHS Posts: sign area ≤40m² respectively.
5. LT = light (C350), M = medium (C250). Refer Table B.5.

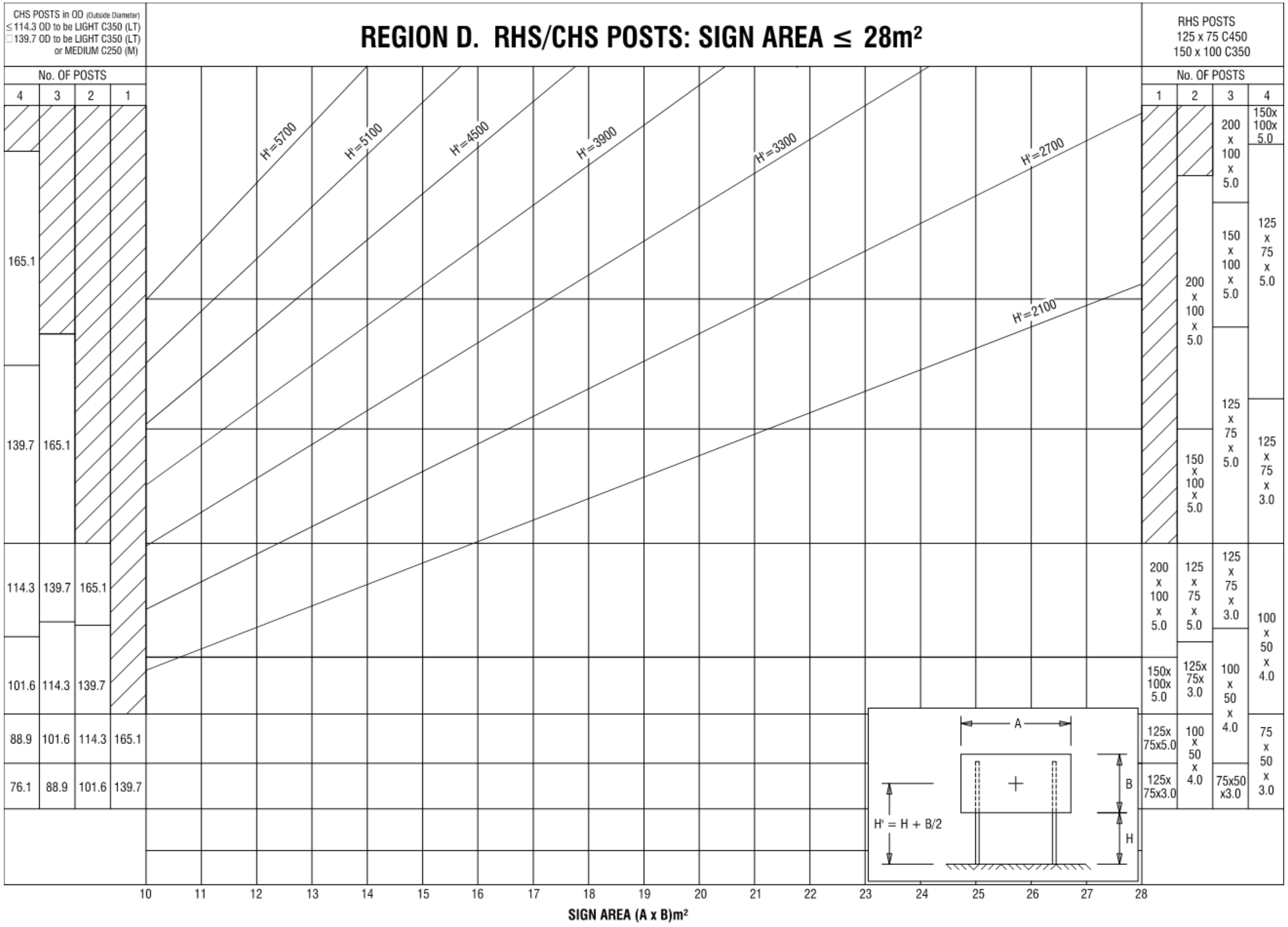
***Figure B.8 – Region C, RHS / CHS posts: Sign area ≤28m²***



NOTES: REGION C. RHS / CHS POSTS: SIGN AREA ≤28m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For larger signs, refer also to Figure B.4., Region C. RHS / CHS Posts: sign area ≤10m² and Figure B.12., Region C. RHS / CHS Posts: sign area ≤40m² respectively.
5. LT = light (C350), M = medium (C250). Refer Table B.5.

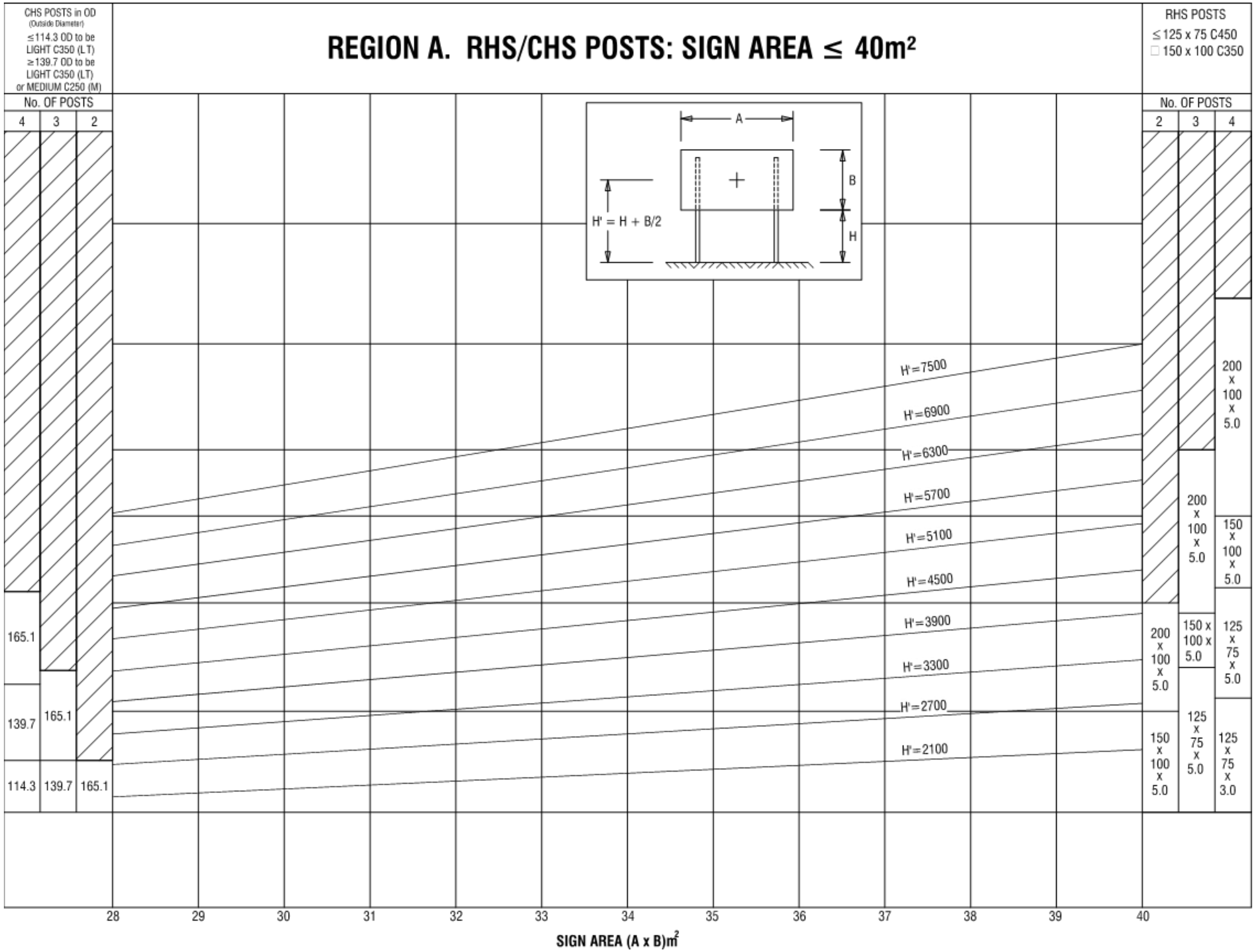
*Figure B.9 – Region D, RHS / CHS posts: Sign area ≤28m²*



NOTES: REGION D. RHS / CHS POSTS: SIGN AREA ≤28m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For larger signs, refer also to Figure B.5., Region D. RHS / CHS Posts: sign area ≤10m² and Figure B.13., Region D. RHS/CHS Posts: sign area ≤40m² respectively.
5. LT = light (C350), M = medium (C250). Refer Table B.5.

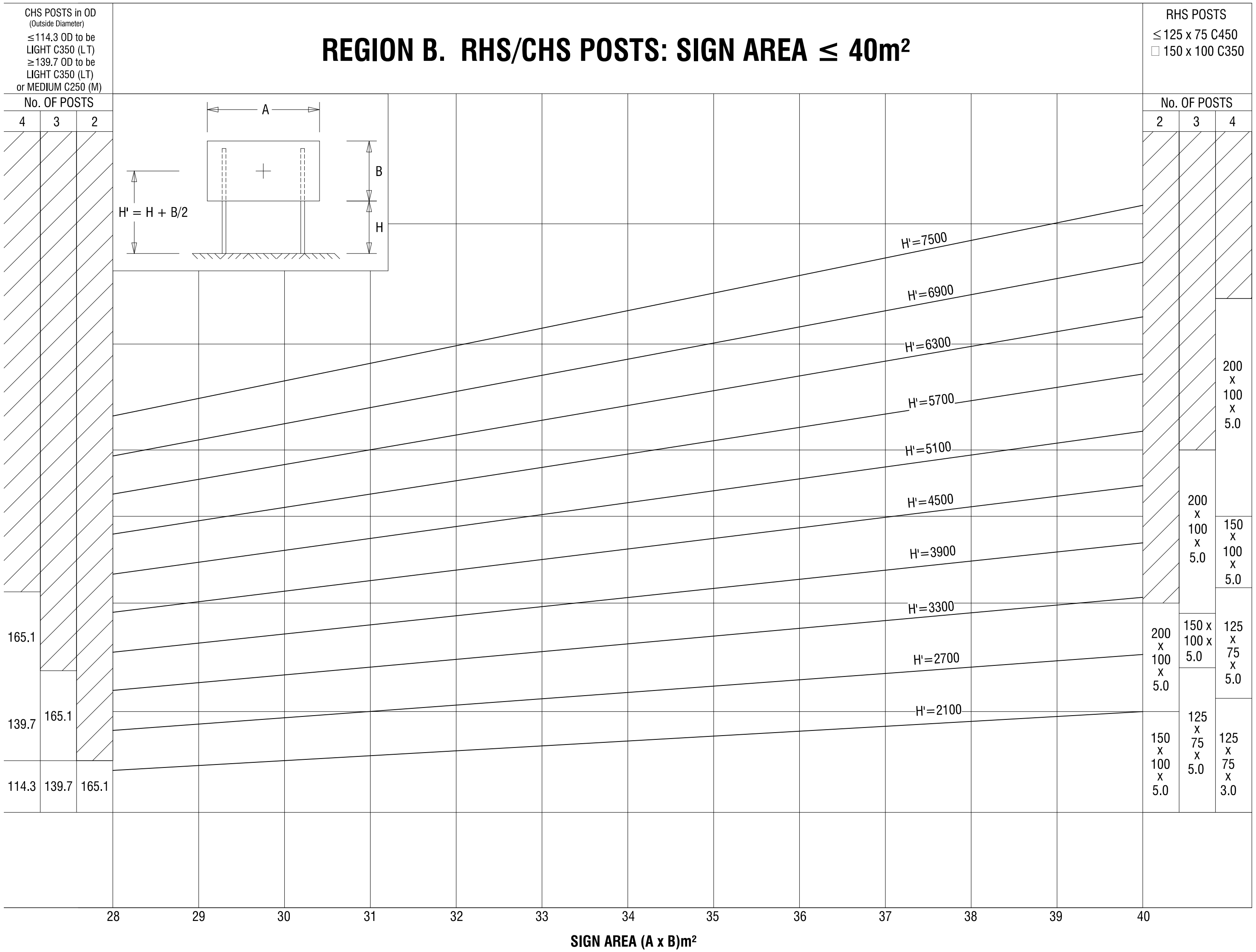
*Figure B.10 – Region A, RHS / CHS posts: Sign area ≤40m²*



NOTES: REGION A. RHS / CHS POSTS: SIGN AREA ≤40m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For smaller signs, refer also to Figure B.2., Region A. RHS / CHS Posts: sign area ≤10m² and Figure B.6., Region A. RHS / CHS Posts: sign area ≤28m².

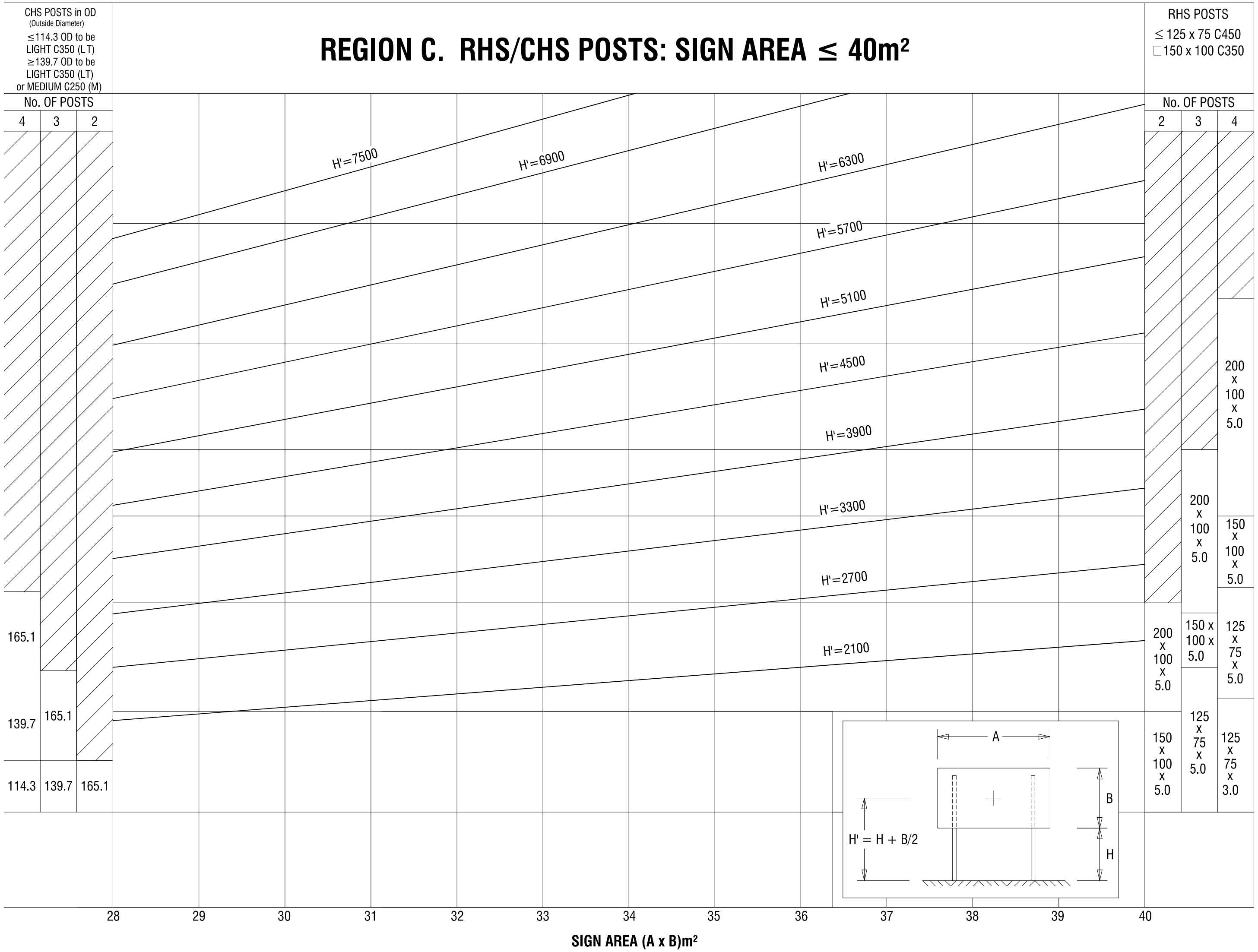
***Figure B.11 – Region B, RHS / CHS posts: Sign area ≤40m²***



NOTES: REGION B. RHS / CHS POSTS: SIGN AREA ≤40m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For smaller signs, refer also to Figure B.3., Region B. RHS / CHS Posts: sign area ≤10m² and Figure B.7., Region B RHS / CHS Posts: sign area ≤28m².

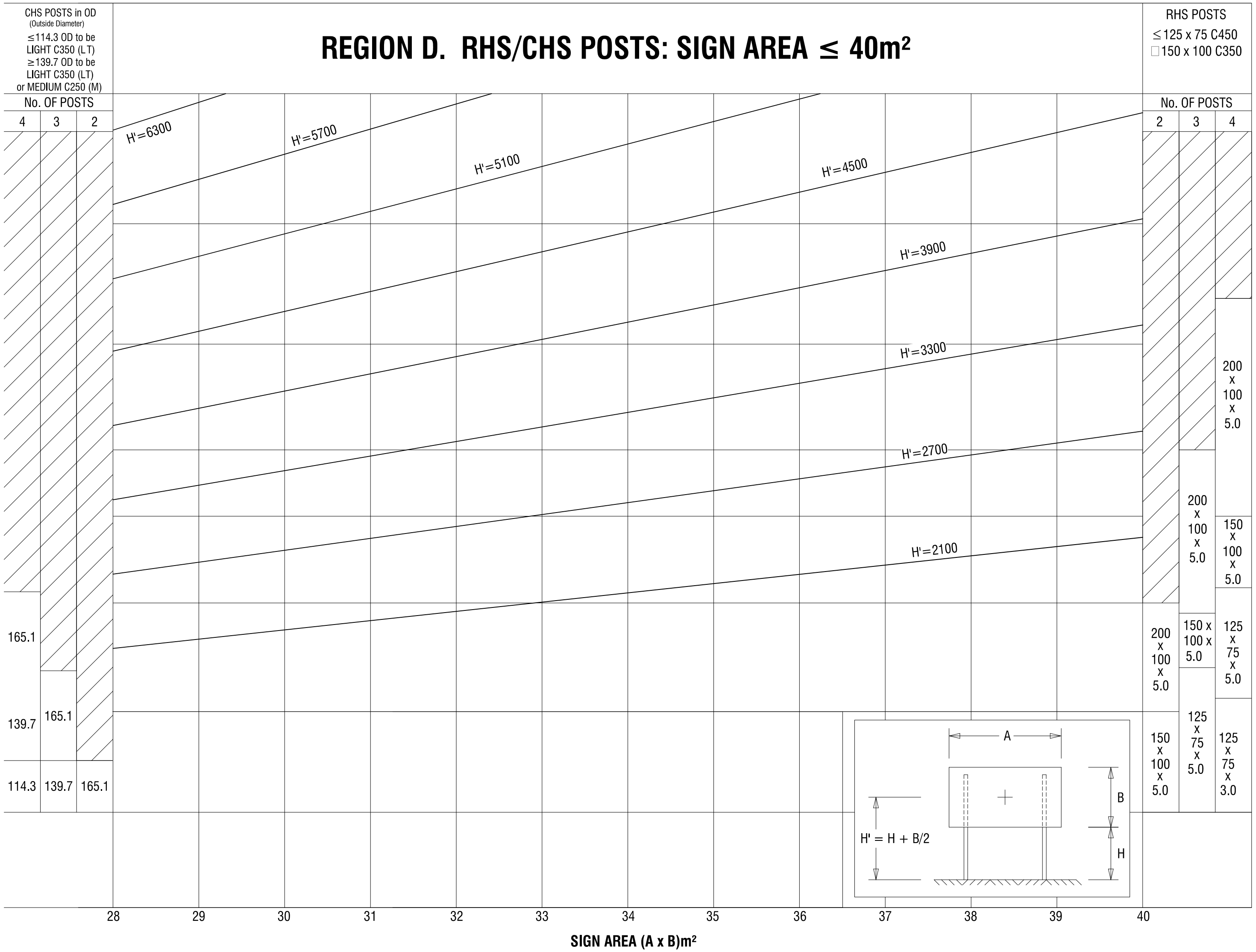
*Figure B.12 – Region C, RHS / CHS posts: Sign area ≤40m²*



NOTES: REGION C. RHS / CHS POSTS: SIGN AREA ≤40m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For smaller signs, refer also to Figure B.4., Region C. RHS / CHS Posts: sign area ≤10m² and Figure B.8., Region C. RHS / CHS Posts: sign area ≤28m².

***Figure B.13 – Region D, RHS / CHS posts: Sign area ≤40m²***



NOTES: REGION D. RHS / CHS POSTS: SIGN AREA ≤40m²

1. On uneven ground H = height of the tallest post
2. For signs in exposed locations prone to high wind (unshielded terrain category 2 in AS1170.2) or where post collapse is more hazardous than normal situations, use charts for next wind region up from that derived from Figure B.1.
3. For breakaway posts with panel height, B, greater than 1.65 x H, select one size up from that derived on the graph. Increase support size additionally to any increase required for exposed locations in Note 2.
4. For smaller signs, refer also to Figure B.5., Region D. RHS / CHS Posts: sign area ≤10m² and Figure B.9., Region D. RHS / CHS Posts: sign area ≤28m².

## Appendix C: Standard Drawings

- Standard Drawing SD1363 *Traffic sign – Multiple traffic sign support – Standard and breakaway posts – Drawings 1 of 2 and 2 of 2*
- Standard Drawing SD1364 *Traffic sign – Connection strap and erection cleat details*
- Standard Drawing SD1365 *Traffic Sign – Traffic sign support breakaway post details (two or more supports)*
- Standard Drawing SD1366 *Traffic sign Traffic sign support detail truss type breakaway*
- Standard Drawing SD1367 *Traffic Sign – Traffic sign support detail truss type breakaway bracing details*
- Standard Drawing SD1368 *Traffic sign – Single traffic sign support*
- Standard Drawing SD1452 *Traffic sign – Hazard marker installation details for rehabilitation of existing (Sheet 1 of 3)*
- Standard Drawing SD1452 *Traffic sign – Hazard marker installation details for new installation (Sheet 2 of 3)*
- Standard Drawing SD1452 *Traffic sign – Hazard marker connection details (Sheet 3 of 3)*

# Appendix D: Development of the 2018 *Design Guide*

The 2018 *Design Guide for Roadside Signs* has been revised from the 2001 *Design Guide*. The primarily structural revisions are:

- use of the current Standard, AS/NZS 1170.2-2011 *Wind Actions* terminology, with an appropriate pressure reduction factor used to derive similar support structure sizes to the 2001 design methodology; the reduction factor is subject to a Department of Transport and Main Roads-approved design exemption, and
- removal of Trusses as a support option.

## *D1 Background*

The 2001 *Guide* was developed from the 1996 draft edition which was released in response to negative feedback from users of the 1991 *Guide* and a perceived deficiency in the treatment and explanation of breakaway posts. This feedback was confirmed in a user survey, with many respondents indicating that the steel posts and footings derived from the 1991 *Guide* to be excessive to that required to support road signs. The survey indicated that users were adopting alternatives to use of the *Guide* including:

- factoring of the 1991 *Guide* Figure B2 to give less conservative post sizes
- use of the pre-1987 *Guide* drawing TC9043, which uses steel yield as the allowable stress, 25-year return period, old shape factor of 1.2 and no cyclone factor, and
- avoidance of breakaway posts by only using CHS for which there are no breakaway details.

Users indicated a strong preference for accepting that some signs may be blown over in a cyclone or storm rather than using larger posts which present an increased traffic hazard. It was seen to be a relatively simple operation to bend smaller posts (particularly CHS) back into position if blown over.

The survey also indicated a preference for use of CHS posts (as discussed further) for which the range of sizes and details are limited in the 1991 *Guide*.

A limited field survey of road signs in Metropolitan District indicated that users are adopting post sizes and details in variance to those prescribed by the *Guide*.

The incorporation of a rational method in accordance with Australian Standards for derivation of acceptable post sizes was considered critical for the success of the revised *Guide*.

Since 1996 there has been multiple cyclonic weather conditions experienced in far north Queensland, including the Category 5 Cyclone Yasi in 2011. Following these high wind events, there has been no reported occurrences of widespread sign face detachment; most signs that did fail, failed in the desired failure mechanism of post bending failure.

## *D2 Design wind pressure*

### D2.1 Previous *Guide*

The 1996 / 2001 *Guides* were based on a reduced structural importance multiplier, Mi. The structural importance multiplier, Mi in AS/NZS 1170.2-1989 represented a probability of exceedance of a design wind speed. For Mi = 1.0, there is a 5% chance of exceedance of the ultimate wind speed in a 50-year return period. The adopted importance multiplier which related to the maximum acceptable chance of exceedance was Mi = 0.75. For Mi = 0.75, the chance of exceedance in 50-year and one-year return periods is 96% and 6.5% respectively. That is, every year there is a 6.5% chance of the sign experiencing its design ultimate wind speed.

AS/NZS 1170.2 allows a directionality factor of 0.95 on wind speed in non-cyclonic regions for overturning calculations to account for the reduced probability of the design wind speed occurring in the critical direction for a structure. This directionality factor was reduced further to 0.9 to account for the fact that (in non-cyclonic regions) the design wind speed will generally come from one direction for a particular locality. As the design wind speed for a particular locality comes from one direction, depending on the road orientation, some signs will never experience the design wind speed in their critical direction. Viewing the performance of the road sign structures globally, rather than designing for directionality in each individual sign, justified the use of the reduced directionality factor of 0.9.

Support sizes were chosen based on wind loads at locations which were assumed to be in the general sheltered terrain categories, TC3 and TC4. For Exposed locations, the method required use of one wind region higher; for example, for an exposed (TC2) location in Region B, Region C design charts were to be used.

A safe failure mode was achieved by post bending prior to stiffener rails and panel fixing failure to prevent flying sign panels presenting a hazard. Stiffener rails were designed for the maximum design wind pressure with an additional safety factor of 1.67 to ensure signs are not blown off before the poles bent over. The factor 1.67 derived from the combination of load factor and capacity reduction factor on the pole (1.5/0.9).

### D2.2 2018 *Design Guide*

The proposed method to be adopted in the revised *Design Guide* is based on the following:

**Safe failure mode**

The design strategy is based on a safe failure mode of support post yielding and bending prior to failure of the sign face and its attachment to the posts. To ensure that signs are not blown off before the poles bend, aluminium stiffener rails and sign face are designed to accommodate peak edge pressures generated by the critical 45 degree wind approach angle, Terrain Category 2 (fully exposed) and with an additional safety factor of 1.5 applied to the post design pressure.

**Importance level**

Importance Level 1 in accordance with AS/NZS1170:0-2002 Appendix F is used, based on 'small or moderate' economic consequence and safe failure mode with failure unlikely to endanger human life. A design working life of 25 years is considered appropriate and this yields an annual probability of exceedance of 1 in 100 (1/100) for cyclonic and non-cyclonic wind speed.

**Pressure reduction factor**

A pressure reduction factor, R = 0.5, is applied to the ultimate support post design pressure derived in accordance with AS/NZS 1170.2-2011. This factor is applied to the resultant pressure derived from wind speed and pressure co-efficient. The R = 0.5 reduction factor accounts for both wind speed increase and the increased force on the windward post under oblique wind directions which was not accounted for in the 1993 *Guide*. The effective design eccentricity is taken as e = 0.1b (Table D2(B) in AS/NZS 1170.2-2011) resulting in a 33% increase in force on the windward post. This eccentricity, which is less than the maximum eccentricity of e = 0.2b for wind at 45 degrees is considered applicable to the very flexible sign support structures which will distribute uneven loads.

Using the formula in AS/NZS 1170.2-2011. Table 3.1 which derives regional wind speeds: VR = 106 - 92R - 0.1 for Region B (for example) – the wind speed which is a reduction of (2/1.33) 0.5 on the regional 100-year return wind speed of V100 = 48m/s is 39m/s. For VR = 39m/s = 106 - 92R - 0.1, R = 26.7-year return period, equivalent to 3.75% annual probability of exceedance. The Region B design pressure is then calculated as
p = 0.0006 * (39 * 0.83 * 0.95) 2 * 1.5 = 0.86kPa.

For wind speed reduction also accommodating the 1.33 windward pole pressure factor, the wind speed which is a reduction of (2) 0.5 on the regional 100-year return wind speed of V100 = 48m/s is 34m/s. For VR = 34m/s = 106 - 92R - 0.1, R = 12.7-year return period, equivalent to 7.8 % annual probability of exceedance. The Region B design pressure is then calculated as
p = 0.0006 * (34 * 0.83 * 0.95) 2 * 1.5 * 1.33 = 0.86kPa.

## *D3 Design method*

### D3.1 Stiffener arrangement

The number of posts and stiffener type, spacing and number are selected directly for a given sign size. Variations to the standard post spacing are catered for by an additional table for widely spaced posts and a table of maximum stiffener overhangs for reduced post spacing.

Sign width limits are tabulated for the four geographic regions to be consistent with the post design method.

### D3.2 Post size and selection

A graphical method of post selection has been maintained in the new *Guide*, similar in format to the Australian Standard AS1742.2-2009. Each geographic region is catered for with a separate set of tables for clarity and ease of use. The post size is chosen directly off the table for a given sign size, height and number of posts. An option is given for either CHS or RHS posts for the smaller signs. Guidance for choice of CHS or RHS is presented in the text.

A section equivalence table has been added to the *Guide* for CHS posts to offer alternative Grade C250 section sizes to those Grade C350 section sizes called up by the *Guide*.

## *D4 Drawings*

Standard Drawing SD1363 *Traffic sign – Multiple traffic sign support – Standard and breakaway posts – Drawings 1 of 2 and 2 of 2*, Standard Drawing SD1364 *Traffic sign – Connection strap and erection cleat details* and Standard Drawing SD1365 *Traffic Sign – Traffic sign support breakaway post details (two or more supports)* have superseded existing Standard Drawings SD1360, SD1361 and SD1362. The Standard Drawings have been organised to cater for breakaway and non-breakaway supports together, rather than providing separate drawings with repeated details.

This assists in providing a less fragmented document. The slip base and fuseplate hinge are simply additional details incorporated as required onto the standard post.

The revised drawings also present CHS and RHS posts together rather than on separate drawings with inconsistent specifications.

Specification of clearances, heights, orientation etc. are referred to the *Manual of Uniform Traffic Control Devices* rather than trying to incorporate some of this information on the structural drawings.

Standard Drawing SD1295 *Sign – Fingerboard, geographical feature and street name signs bracket details* has not yet been altered while Standard Drawings SD1296, SD1297, SD1298, SD1299, SD1300 and SD1360 have been withdrawn.

## *D5 AS4100 Steel Structures Code*

The sign support posts have been designed in accordance with the limit state steel code AS4100-1998. Ultimate design wind speeds were used.

## *D6 Breakaway posts*

### D6.1 Risk

'Low risk' is defined as outside the clear zone and 'high risk' is within half the clear zone distance of the traffic lane edge of the road.

### D6.2 Frangible posts

The size of posts considered to be frangible has not been modified from the 1996 / 2001 *Design Guides*. Crash testing of longitudinal sight boards in 2016/17 commissioned by NSW Centre for Road Safety and Queensland's Department of Transport and Main Roads has confirmed that 65NB posts are readily frangible for vehicle speeds >80km/hr which is consistent with recommendations in the 2001 *Design Guide*. The AS174.2-2009 recommendation for 50NB for speeds >80km/hr is considered to be overly conservative.

### D6.3 Criteria

Criteria for satisfactory performance of breakaway posts is included in the *Guide*.

The American Association of State Highway and Transportation Officials (AASHTO) *Roadside Design Guide* criterion for 2.1m clearance has been incorporated. The AASHTO criteria on post weight will be satisfied for all posts in the range of the *Guide*.

A minimum post spacing of 1.5m has been recommended as the limit for use of additional posts of 'frangible' size to support signs in 'high risk' zones. The AASHTO *Guide* considers all posts in a swept path of 2.1m when checking that the weight of posts is less than the recommended limit.

Design in accordance with the AASHTO *Guide* would therefore require consideration of the combined resistance to impact of all posts within a 2.1m width, rather than designation of individual posts as frangible if smaller than the recommended size. Adoption of a 2.1m swept path would disqualify many signs from use of 'frangible' post support. The 1.5m minimum spacing limit is proposed as an acceptable, less conservative, limit for consideration of impact on posts in isolation.

A limit on sign height relative to clearance has been incorporated to ensure that the fuse plate moment capacity is not exceeded under the design wind speed. The current fuse plate detail appears to be designed for the post capacity which relates to a sign height not greater than the clearance. Many existing signs will not conform to this criterion and will therefore potentially fail at the fuse plate at less than the design wind speed.

### D6.4 Post type

Breakaway post details have been incorporated for both CHS and RHS posts.

## D6.5 Details

### D6.5.1 Slip base

The slip base plates have been detailed to accommodate angled impact from both traffic directions.

The previous *Guides* (1996/2001) specifies the part-turn method of tensioning which is relevant to high strength friction grip bolts tensioned to the bolt Proof Load. AASHTO recommends clamping forces relative to post size for satisfactory slip base performance. Excess bolt tension increases the impact force transmitted to the vehicle. The clamping force recommended in AASHTO relates to very low bolt tension which may cause problems of a loose connection, unserviceable for wind loading. The proposed method is to torque the bolts to 100 Nm. This torque relates to only 1/2 and 1/3 of snug tight for M16 and M20 respectively. AS4100-1998 discourages the use of torque control of bolt tension in favour of load indicating washers due to inaccuracies from thread cleanliness, wrench calibration, thread type and various other factors; however, load indicating washers do not cater for low bolt tension and inaccuracies in torque control can be minimised by oiling the threads and assembling the baseplates in the shop prior to delivery to site. Shop assembly has the added advantage of enforcing the plumbing of the posts prior to pouring concrete rather than casting in the stub below the slip base and then using shims between the baseplates (in the critical slip zone) to plumb the posts, as is currently specified in the *Guide*. It is further noted that AASHTO recommends regular checking of bolt tension for signs in service.

Bolts have been sized with an additional factor of safety to ensure post failure prior to bolt failure. This also recognises the cyclic loading and fatigue regime operable on the bolts.

Additional washers have been specified under the bolt head and nut to enable uniform pressure under the head and nut with the slotted baseplates.

The fillet welds of posts to baseplates have been corrected. The previous *Guide* specification shows fillet weld size increasing with overall post size rather than with tube wall thickness. The weld sizes currently tabulated are generally not compatible with the post strength such that failure would occur at the welds before post bending capacity was mobilised.

### D6.5.2 Fuse plate hinge

The fuse plate detail accommodates impact from both traffic directions. This has been achieved by use of a fuse plate on both sides of the post with a complete separation / cut of the post.

The fuse plate detail has bending capacity to 45% of the post capacity to enable sign height to be up to 165% of clearance (refer to discussion in Section D6.3 previously).

Field inspection along the Gateway Arterial Road indicated that the fillet weld size and length on the fuse plates are frequently less than specified on the Standard Drawings. Cracking was evident in some of these inadequate welds. These inadequate welds could significantly reduce the expected life of the posts, particularly as the welds are subject to cyclic wind gust loading and stress concentration effects. Apart from a recommendation for improved quality control, the detail has been revised with thicker fuse plates to improve the chance of correct weld size. Thicker fuse plates also improve the transfer of wind shear across the cut post. Welding is continuous all around the fuseplates which also alleviates stress concentrations. A smaller 3mm or 4mm weld is specified for the post below the cut to facilitate failure on impact.

Field inspection indicated that posts are susceptible to corrosion along the cut edges and the weld regions. The procedure specifies welding of the fuseplate prior to hot dip galvanising. Additionally, the post splice is specified to be full contact which should enable the galvanising to seal across the cut. The fuse plate is welded all around to effectively seal behind the plate such that the whole assembly can be protected with the hot dip galvanising.

## *D7 Posts types*

The user survey indicated a strong preference for the use of CHS posts rather than RHS. Advantages identified with CHS are pregalvanised; availability; cheaper (availability in 6.5m lengths compared with 8m for RHS leading to less wastage is one consideration); readily cut and capped on site with pipe cutters so less tolerance on post length required; less requirement for alignment with sign face; availability of fittings; and more easily pushed back to alignment if bent over by wind or vehicle collision.

90 NB is included in the graphs but is not readily available.

RHS posts have been retained with further explanation to when they may be economical. The structural efficiency and hence potential cost saving has been identified particularly with the use of pregalvanised RHS. Tubemakers Duragal is only 3% more expensive than black steel and is rated at Grade 450. The cost of a Grade 450 pregalvanised RHS post is half the cost of the equivalent strength CHS. The use of pregalvanised RHS (without further hot dip galvanising) is limited to regions of low corrosion potential due to the reduced thickness of zinc coating (100g/m$^2$ compared to 300g/m$^2$ for hot dip galvanising).

RHS posts may also be cost effective for breakaway posts where the advantage of pregalvanised CHS is lost with the requirement on hot dip galvanising the breakaway posts after fabrication.

## *D8 Stiffener rails*

A maximum stiffener spacing of 500mm with overhang of 150mm is used.

The *Guide* specifies a pole spacing ratio of 0.15 / 0.35 / 0.35 / 0.15 and 0.2 / 0.6 / 0.2 for three and two pole signs respectively. These ratios balance both pole load and stiffener support and span moment.

## *D9 Single post signs*

The 1996/2001 *Guides* included a new system and detail to accommodate the common situation of signs wider than 950mm, which cannot be supported on two posts; for example, on a narrow median strip. The sign panel is stiffened and fixed to a single post with 6mm steel brackets. The steel brackets are screwed into the post to prevent rotation.

## *D10 Footings*

### D10.1 Design strategy

The *Guide* specifies footings sizes for two soil strength categories for both cohesive and non-cohesive soils. Cohesive and non-cohesive soils are distinguished between, due to different mechanisms of soil resistance and hence design formulae. For non-cohesive soils, lateral resistance is dependent on overburden stress, so footings are deeper and narrower than for cohesive soils.

Table B.4 in the Appendix B design procedure enables choice of appropriate foundation strength category by use of either simple field identification procedures or parameters derived by laboratory testing.

### D10.1.1 Cohesive soils

The footings for cohesive soils are designed using the method suggested by Coyle and Bierschwale, *Design of Rigid Shafts in Clay for Lateral Load*, ASCE J Geotech Eng, Vol 109, No 9, 1983. This method determines the ultimate lateral load that can be applied to a pile for a limiting deflection criteria. A pile rotation of two degrees is considered to be the serviceable limit beyond which loosening of the pile may occur due to plastic deformation of the soil. This method produces less conservative results than other methods which limit soil pressure.

### D10.1.2 Non-cohesive soils

The SAA Piling Code (AS2159-1978) was used for design of footings in non-cohesive soils with an appropriately chosen Factor of Safety on ultimate lateral resistance.

### D10.1.3 Other soils

The *Guide* highlights the requirement for special design of footings in very soft or swampy soils and sound rock.

### D10.1.4 Details

The footings have been designed without reinforcement by utilising the combined bending resistance of the embedded post and unreinforced concrete pier.

The diameter and depth of piers have been chosen with consideration to minimising pier depth.

## *D11 Modular sign panels*

Modular sign panels have been included in the *Guide* to facilitate the installation of larger signs. A sketch which details the general arrangement for these signs has been included in the *Guide*. Each 1200mm high sign panel module is required to have three stiffeners at a set spacing of 580mm. The *Guide* design procedure for selection of supports for modular sign panels is exactly the same as for normal signs.

# Appendix E: Design of sight boards and other signs at T-intersections

## *E1 Background*

Appendix E provides design and installation details for sight boards and other signs at T-intersections, parallel to the continuous carriageway. The MUTCD Part 2 Section 2.11 specifies the requirements and sets out the way sight boards and hazard markers are installed at intersections. In many cases, intersection direction signs are installed above the sight board and generally provide sufficient delineation of the T-intersection without the need for a supplementary sight board.

## *E2 Risk characteristic*

Sight boards and other signs installed parallel to the roadway that include sign stiffeners present a spearing risk to vehicles that impact them end on. Sign spearing occurs when a vehicle impacts the post and the weak connection of the post to the rail fails and leaves the rail cantilevered from the trailing posts at windscreen height.

## *E3 Sign design for sight boards and other signs to prevent sign spearing*

Standard Drawing SD1452 was developed and tested to mitigate the risk of sign spearing.

The design concept is that the sign end must be prevented from impacting the windscreen. This is achieved by strengthening of the post connections to ensure the sign is pulled down with the post to prevent the spearing effect.

The new design incorporates:

- heavy duty clamps bolted through the stiffener rails and sign face (refer to Standard Drawing SD1452 Sheets 2 and 3)
- splice plate connection bolted through the stiffener rail and sign face (refer to Standard Drawing SD1452 Sheets 2 and 3)
- a maximum cantilever distance from the end post centreline to the end of the sign is 500 mm (refer to Standard Drawing SD1452 Sheet 2)
- the use of Type 1 stiffener rails only.

Sight boards shall comprise two x D4-1-1-Q03 hazard markers with Type 1 stiffener rails only.

Other signs installed parallel to the roadway shall only use Type 1 stiffener rails and heavy-duty clamps if installed within the windscreen envelope (1.5–1.9 m height). Where intersection direction signs are outside the windscreen envelope, heavy duty clamps may not be required.

## *E4 Guidelines to the installation of new sightboards*

### E4.1 Provision to install a sign board

To remove the risk of sign spearing, consideration should be given if a sightboard is required under MUTCD Part 2 Section 2.11.2 (see following).

> *Sight boards comprising two Unidirectional Hazard markers (D4-1-1) end-to-end may be erected to face the stem of a T-intersection where approach speeds are high on the terminating leg of the intersection, and where standard intersection signposting would not provide sufficient warning of the intersection. Sizes may be varied if necessary to suit visibility requirements. The Bi-directional Hazard marker (D4-2-3) (see Section 4.6.7.2(b)) may be more appropriate where a sight board is required at a low-speed approach.*

### E4.2 Treatment type selection

The following flow chart details the design process for firstly determining whether a sight board is required and then, if so, determining what treatment type to use.

***Figure E4 – Flowchart for design of sightboards and direction signs at T-intersections***