3.7. Mechanical

3.7.1. Approval Sheet

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<tr>
<td>APPROVED BY:</td>
<td>SIGNED: Con Shakas</td>
</tr>
<tr>
<td></td>
<td>DATED: 12th July 2005</td>
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<td>MANAGER</td>
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<td>TRAFFIC ENGINEERING TECHNOLOGY</td>
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For further information, contact:
CADD Policy Officer
RTA CADD Advisory Group
Telephone: (02) 8837 0522
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### 3.7. Mechanical

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3.7.3. **Overview**

3.7.3.1. **Scope**

This document sets out the Authority’s requirements for the organisation of CADD data and the presentation of Mechanical and Structural Design Drawings for the manufacture and installation of Mechanical equipment and Support Structures required by our clients for the management of the roads.

3.7.3.2. **Objective**

The objective of this guideline is to provide Mechanical and Structural Design drawings in a format that can be readily read and stored by the Authority on its equipment. The presentation of designs shall conform to the Australian Drawing Standards so that these can be clearly understood by Manufacturers and Installers of the designed Mechanical Equipment and Support Structures.

It defines the way in which data is to be organised and how it is to be presented to the authority.

3.7.3.3. **Audience**

This Guide has been prepared to assist persons and/or organisations that use CADD for the preparation of drawings associated with Mechanical and Structural Engineering, with the RTA as the intended final client.

3.7.3.4. **Usage**

The use of this Guide is limited to the production of the various drawings required to convey information for the manufacture of Mechanical and Structural components, for Machinery and for Support Structures. This document is complemented by the design brief for the works.

3.7.3.5. **CADD Packages**

The MEDU utilises the CADD package MicroStation Version 8 (2004). A three dimensional computer aided design package to produce drawings.

**FORMAT**

<table>
<thead>
<tr>
<th>DATA FORMAT</th>
<th>DESCRIPTION</th>
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</thead>
<tbody>
<tr>
<td>MicroStation document file</td>
<td>MicroStation’s binary drawing file format (.dgn).</td>
</tr>
</tbody>
</table>

3.7.3.6. **Document Status**

This is a controlled document, which is the responsibility of the RTA CADD Advisory Group. Submissions to amend this are to be forwarded to the Secretary, RTA CADD Advisory Group.

Interpretation and clarification of issues contained within this document can be obtained by contacting the Secretary, RTA CADD Advisory Group.
3.7.4. Reference Documents

The following documents are to be read in conjunction with this Guideline.

DESIGN BRIEF

CADD DATA EXCHANGE STANDARDS

AUSTRALIAN STEEL DETAILERS’ HANDBOOK
- Australian Steel Institute

DESIGN CAPACITY TABLES FOR STRUCTURAL STEEL
Volume 1 – Open sections third edition - Australian Steel Institute

DESIGN CAPACITY TABLES FOR STRUCTURAL STEEL
volume 2 - Hollow sections second edition- Australian Steel Institute

INTERIM GUIDE TO SIGNS AND MARKINGS MANUAL

MATERIAL SUPPLIERS SPECIFICATIONS

3.7.4.1. Current Australian Standards Publications

AS1100.101 TECHNICAL DRAWING GENERAL PRINCIPLES
AS1100.201 TECHNICAL DRAWING MECHANICAL ENGINEERING
AS1100.501 TECHNICAL DRAWING STRUCTURAL ENGINEERING DRAWING
AS1101.1 GRAPHIC SYMBOLS FOR GENERAL ENGINEERING HYDRAULIC AND PNEUMATIC SYSTEMS
AS1101.3 GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING - WELDING AND NON-DESTRUCTIVE EXAMINATION
AS/NZS 1170.0 STRUCTURAL DESIGN ACTIONS - GENERAL PRINCIPLES
AS/NZS 1170.1 STRUCTURAL DESIGN ACTIONS - PERMANENT, IMPOSED AND OTHER ACTIONS
AS/NZS1170.2 STRUCTURAL DESIGN ACTIONS - WIND ACTIONS
AS1554.1 STRUCTURAL STEEL WELDING - WELDING OF STEEL STRUCTURES
AS3600 CONCRETE STRUCTURES
AS4100 STEEL STRUCTURES
AS4600 COLD-FORMED STEEL STRUCTURES
3.7.5. Drawings

3.7.5.1. Guide to Generating Drawings

Two methods are used to generate drawings for the Mechanical Engineering Design Unit:

a) *2D format directly from a Design Model inside a drawing border without attaching reference files from a design model.*

The preferred method Mechanical Engineering Design Unit generates drawings for simple Mechanical and Structural Designs is in a 2D format directly from a Design Model without attaching reference files from a design model. A number of sheets may be required to generate a design.

All sheets for a design are located under one file/drawing number unless noted otherwise. If a part or item is common to several Designs then a separated drawing shall be created and referred to under Item number in the Material List.

Creation of hard-copy prints of MEDU designs, in the form of drawings, requires initial setting up of Sheet models.

With this method ‘a’, the drawing border is scaled up (or down) to cover the required area in the design, all text and dimensioning must be scaled the same amount, also, this is to ensure that when the scaled print is created, text and dimensioning elements are at the correct physical size.

To simplify this process within RTA, scaled selected boarders from k:\mechanical\template directory\border library have attached associated standard named levels, named filter for each sheet, line attributes, text attributes and dimensions. For all new drawings, borders shall be selected from the border library then saved with the new allocated drawing number so that all standard attributes are imported into the sheet model file. For existing drawings standard text and dimension attributes from the template directory can be imported into a file.

b) *A Sheet model typically consisting of a collection of design model references that are scaled and positioned as necessary to create a drawing, inside a drawing border, which can be printed. The referenced views can be in a 2D and 3D format.*

This method is used for complex designs that are created from a 3D Design Model references.

The advantage of this method is it allows the designer to create sheet models of complex general arrangement, assembly and detail part drawings of a product in both 3D and 2D format this is done by referencing in saved views from a design model. A view in 3D and 2D format allows a client, manufacturer, erector and maintenance personnel to easily interpret a design. It has also the advantage of views being automatically updated in the sheet model if any modifications are required to the design model.

When creating Maintenance manuals to clarify Assembly or Maintenance procedures of a complex product, exploded Assembly views of that product’s parts, in 3D format shall be created. To indicate correct Assembly procedure lines showing points of assembly to fitting parts shall be drawn.

Note: Refer to CADD software manual for methods to create a drawing.

By creating a Design Model, animation of a design concept can be created by using visualization techniques.

Animation can be used for marketing of a conceptual design, training of Maintenance personnel and for seeking feedback from the general public.
3.7.6. **General Drawing Standards**

3.7.6.1. **Line Attributes**

The MEDU has adopted six line thicknesses to be used in the presentation of drawings. All drawing details are to be represented by using these line thicknesses. On electronic plans, single vector lines of specified colour are used to represent these line thicknesses. The correlation between line colour, weight and thickness is as shown in Table 1.

<table>
<thead>
<tr>
<th>Line Thickness</th>
<th>Weight</th>
<th>Colour</th>
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<tbody>
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<tr>
<td>0.25 mm</td>
<td>1 #</td>
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</tr>
<tr>
<td>0.35 mm</td>
<td>2 #</td>
<td>red</td>
</tr>
<tr>
<td>0.5 mm</td>
<td>3 #</td>
<td>green</td>
</tr>
<tr>
<td>0.7 mm</td>
<td>4 #</td>
<td>cyan</td>
</tr>
<tr>
<td>1.0 mm</td>
<td>5 #</td>
<td>yellow</td>
</tr>
</tbody>
</table>

*Table 1: Line colour, weight and thickness*

3.7.6.2. **Text Attributes**

The general requirements for the text font that is to be used in drawings are laid down in AS 1100.101. The Authority requires the following criteria be met:

- The font is vector based.
- General form of characters to be as per ISO 3098/1 type B upright.
- Cell size / aspect ratio to be 0.9.
- Characters to be monospaced.

To comply with these requirements it is suggested to use the ISO 3098. The MEDU has adopted four text heights in presentation of the drawings. These text heights enable a half size drawing to be clearly interpreted. All text on the drawings is to be represented by using these text heights. The correlation between text use and sheet size is as shown in Table 2. The correlation between text height, weight and colour is as shown in Table 3.

Notes: Text Heights for Sign Messages are as indicated on Sign Face drawing. For other requirements, refer to AS1100.101 Section 4.
3.7.6.2.1. **Sheet Composition**

Sheet composition considers the overall presentation of detail and associated support documentation in accordance with the design brief. Drawings shall not appear to be cluttered, but shall clearly present the information required in an orderly format. The final product must be fully prepared using electronic means without manual enhancement.
3.7.6.3. **Presentation**

3.7.6.3.1. **Plan Size**

Generally, the RTA prefers its standard presentation sheet to be A3 format. A1 format is accepted, however should only be used if drawing is required to be clearer by using a larger scale and will only fit on an A1 sheet or is requested by client.

3.7.6.3.2. **Plan Borders**

Plan borders are to be in accordance with the RTA standard. Refer to Appendix A – Standard RTA Border Sheets, which gives examples of standard A3 borders, which are supplied by the RTA. A1 standard borders are available on request.

3.7.6.3.3. **Scales**

Scales used on drawings may vary in accordance with the size and character of the feature being detailed or the degree of detailing required.

All drawings shall be to a defined natural scale with the scale being selected so that the drawing may be easily read when reduced to half of its original size.

The following scales are recommended for use:

3.7.6.3.4. **General Arrangement Drawings**

1:10, 1:20, 1:25, 1:50 and 1:100

3.7.6.3.5. **Detail Drawings**

1:1, 1:2, 1:2.5, 1:5, 1:10 and 1:20

*Drawings shall not contain two similar scales, eg a scale of 1:2 shall not be used on the same drawing together with a scale of 1:2.5*

3.7.6.3.6. **Use of Filters**

Filters are a use by MEDU to group associated levels for the purposes of viewing or not viewing as a group. Each Filter would contain levels that control the Name of level, attribute style, weight and colour.
3.7.7. **Drawing Registration**

3.7.7.1. **Drawings**

The Drawing Number for official drawings shall have the prefix **ME** with five digits added to a Drawing number.

3.7.7.2. **Sketches**

The Drawing Number for official sketches shall be similar to drawings except that the prefix **SK** shall be added to a Drawing Number.

3.7.7.3. **Abbreviations**

Refer to AS1100.101, AS1100.201 and AS1100.501 for a list of acceptable Standard Abbreviations for Mechanical and Structural drawings.

3.7.8. **Information to be Shown on Drawings**

The arrangement of upper case letters for each of the abbreviations as shown in each table shall be followed, abbreviations shall not contain a full stop.

3.7.8.1. **General**

Information to be shown on the drawings shall include any required design information and such items as are specified in the respective design codes, or as instructed by the design engineer.

Each drawing shall provide all the information necessary for the construction of the work shown and shall omit irrelevant details. References shall be given to associate drawings for particular details or for showing the relationship with other components, and to schedules.

Information shall include datum’s, such as survey marks, referenced to permanent structures or the Australian Height Datum (AHD).

Written descriptions on drawings shall be clear and concise. Instructions shall be positive and written in the imperative mood. Special requirements relating to construction details shall be noted or referenced on the drawing.

Clarity of detailing and dimensioning is essential.

3.7.8.2. **General Notes**

General notes, where provided, shall be presented with Clause or reference numbers and upper case lettering, either on a separate drawing or on the drawings to which they refer. For the information required on drawings or general notes, reference shall be made to the relevant Standards.

3.7.8.3. **Detail Drawings**

Detail drawings shall show Parts and/or Structural details according to the proposed Manufacturing and erection disciplines required to complete a product.
3.7.8.4. Amendments

An amendment to an issued drawing shall be numbered or otherwise designated and the amendment described in the amendment box. The altered text and pictorial aspects for that drawing issue only shall be highlighted by drawing a cloud, made up of a series of arcs, around the amendment and the cloud designated with the number or other designation, preferably in a triangle.

3.7.8.5. Lines

3.7.8.5.1. Types of lines

Lines on drawings shall be selected according to their application. Preferred types are shown in Table 3.1, AS1100.101 and shall be selected from one of the line groups given in Figure 3.1, AS1100.101.

3.7.8.5.2. Dimensioning

In all cases, dimensions shown on drawings shall be in millimetres and they shall be shown in accordance with AS 1100.101. The use of a space between the third and fourth digit in a four-digit number is optional but is mandatory in a five-digit number.

Dimensions shall be placed on drawings using the 'aligned' method with each dimension being placed parallel to its dimension line in order that it may be read from either the bottom or the right hand side of the drawing.

An overall dimension except where dimensional tolerances are of critical importance shall cover a chain of dimensions.

Where several dimensions are to be given to a common datum surface, either the line method or the point method may be used.

Dimensions and notes shown with leaders shall be inscribed using the unidirectional method.

Where it is necessary to indicate that a particular dimension on a drawing is not shown to the same scale as the view or detail in which it appears, the dimension shall be underlined with a full thick line. This method of representing details drawn out of scale shall not be applied to entire details that are shown 'NOT TO SCALE'.

All dimension attributes shall be saved under a named dimension style. This is particularly important if it is necessary to cross-reference to a detail of a scale which is different to the main scale on the drawing sheet e.g. Slot detail of an item.

Radii shall be dimensioned by the use of a dimension line, which passes (or is in line with) the centre of the arc and terminates at the lead end with a single arrowhead. However, radii of arcs that need not have their centres located shall be dimensioned using one of the methods shown in AS 1100.101.

Dimensions for radii shall be preceded by the conventional abbreviation 'R'.

Geometric tolerance shall be used when geometry characteristics are critical for the assembly of components into a finished product.

3.7.8.5.3. Symbols

Symbols shall conform to an Australian or a joint Australian/New Zealand Standard appropriate to the type and class of the work.

3.7.8.5.4. Hatching and Shading Standards

See Appendix B of this guide for acceptable hatching and shading standards for items commonly represented on Mechanical and Structural drawings prepared for the RTA.
3.7.9. Conventions for Cross Referencing

3.7.9.1. General

The convention for elevation, section and detail cross-references is complementary, i.e. the cross-reference given on the sheet from which an elevation, section or detail is taken is complemented by the cross-reference on the associated sheet where the elevation, section or detail is shown.

3.7.9.2. Elevations

Elevations shall be drawn as a view seen from a vertical plane immediately in front of the element under consideration and shall be projected from that element's 'PLAN' view.

3.7.9.3. Sections

Sections shall be drawn as a view from a cutting plane located through an element previously drawn as an Elevation or Plan.

Generally, only the details at the cutting plane of the section should be shown, however, details beyond the cutting plane may be included provided that the included details are not confusing to the main details being shown.

Sections, where possible, shall be drawn adjacent to the plan or elevation to which they relate. Where section details cannot be shown on the sheet of origin, they shall be cross referenced in accordance with AS 1100.501.

3.7.10. Steel Structural Detailing

3.7.10.1. General

In all cases where Structural Steel Elements are specified, the material used shall be in accordance with the relevant Australian Standards, Material Specification and Weld Details. This shall be stated on the drawings.

Structural steelwork drawings shall show sufficient detail for the complete fabrication of a particular item or sufficient detail to enable the fabricator to prepare detailed shop drawings for the particular item.

Each item of fabricated steelwork shall be detailed in the form that when the item is released from the fabrication shop, each part that is attached in the fabrication shop be shown as part of the total assembly. Fabricated items that form part of the total assembly need not be detailed as separate items nor shall the quantity of those items shown separately unless unduly complicated and in such a case, the quantity of those items be shown separately with the detail of the item.

In the majority of cases, it is sufficient to detail a fabricated item in one or two views, with enlarged details of the more complex portions as necessary viz:

- A normal plate with holes in it would require a plan view only.
- A tapered plate would require a plan and a section.
- A universal beam type girder would require an elevation and cross section.
- A fabricated item with a longitudinal axis of symmetry, such as a built-up plate girder, steel trough girder or steel box girder, would require an elevation and sections to depict different plate sizes and part plans to show all relevant details.
3.7.10.2. Welding

The necessary information concerning the location, type, size, category and length of welds in welded joints and whether the welds are to be made in the shop or at the site shall be given on the drawings with the use of standard symbols.

All symbols shall be in accordance with AS 1101.3.

3.7.10.3. Closing Dimensions

In accordance with industry practice, overall dimensions of steel items shall be provided to enable the correct manufacture of the items.

Dimensions required for the correct positioning of holes etc in items shall be provided from one end only and as such no closing dimensions shall be given on the drawings.

3.7.10.4. Use of Asterisks and Similar Symbols

Asterisks, filled in dots and triangles, or other like symbols used as a reference to a note, dimension, reduced level, etc, and on a drawing should be used as sparingly as possible. They can be used to avoid repetition of a note or where space precludes the use of a direct note. However, where it is necessary to have references to different items on the same drawing separate symbols shall be used.

3.7.11. Concrete Structural Detailing

3.7.11.1. General

Reinforcement shall be specified by the classification and designation of bar and reference number of mesh (see AS/NZS 4671). Where a schedule is prepared in conjunction with the drawings, a reference number for that schedule shall be given on both schedule and drawing.

Reinforcement shall be specified on the view of the structural element in which the reinforcement will be first placed, e.g. where a bar is placed in a slab and extends into a wall it shall be specified on the plan of the slab.

3.7.11.2. Concrete drawings

Concrete drawings shall clearly show the dimensions and shape of the structural element or elements depicted. The classification and designation, size, shape, extent and location of all reinforcement shall also be clearly shown. Depending on the complexity of the element, the detail drawing may show both the concrete outlines and reinforcement on the same view or provide separate views, or drawings for each.

NOTE: For concrete beams, depth is specified first, for strip footings, width is specified first.
3.7.11.3. Reinforcing Bar and Fabric Mesh Detailing

This shall be in accordance with AS1100.501.

The numbering of reinforcement, whether bars or fabric, shall be in sequential order and shall proceed from the bottom to the top of the element under consideration wherever possible and/or practical.

Bar reinforcement shall be specified by the number or spacing of bars, type, size, spacing and location. If required, by a shape code and bar mark. Spacing is normally specified at right angles to the bar direction and any variation shall be fully detailed, e.g. for skewed bars. One of the following notations shall be used:

NOTE: The use of bar marks, shape codes and bundle marks on engineering drawings is optional. Each set of ‘identical’ bars in a structure shall be given the same bar mark. A group of bars in the same placing zone may be regarded as being ‘identical’ if they have the same type, size and bent shape. If supplied in a set for a tapered section, these can have a varying length.

3.7.11.4. General Arrangement

The General Arrangement shall give an overall picture of the assembly of a Mechanical and Structure Design as it will appear once constructed. The General Arrangement shall include a plan, elevation, typical cross section as required with a list of "General Notes" as required which apply to the entire set of drawings.

3.7.11.5. Front Elevation

Elevations shall be drawn as a view seen from a vertical plane immediately in front of the element under consideration and shall be projected from that element’s ‘PLAN’ view.

Hidden details shall be shown as broken lines in accordance with the line types shown in AS1100.501.

3.7.11.6. Plan View

Plan views shall be drawn as a horizontal view taken immediately above the element under consideration.

Hidden details shall be shown as broken lines where appropriate in accordance with the line types shown in AS1100.501.

This shall contain the following information:

- An outline of the structure;
- The location of any public utilities;
- The Control Line and Carriageway centreline (as appropriate);
- Outlines of the structural elements;
- Relevant horizontal clearances;
- Shapes and slopes of any embankments or cuttings;
- Extent of any protection required; e.g. Safety barriers
3.7.12. **Major Sign Structure General Arrangement Drawings**

Major Sign Structure General Arrangement Drawings shall be create using method a) and shall include the following:

- Font Elevation of Sign Structure viewed from in front of the Sign Face.
- Overall Dimensions a Phantom outline of sign face.
- Dimension from bottom of sign face to ground level.
- Dimension from bottom of sign face to arm or lower arm when two or more arms are required.
- Dimension between arms.
- Dimension from horizontal edge of sign and vertical centre line of sign face mounting holes.
- Dimension between vertical centre lines of sign face mounting holes.

For a double sided sign structure, additional end elevation and rear view is required.

- Dimension from post to Kerb, Guide rail or/and edge marking.
- Dimension from sign Kerb, Guide rail or/and edge marking.
- Over all Dimension showing the depth of a concrete Pile Footing, Pile Cap or slab footing
- Material List
- Sign Face Message
- Mass of steel structure, Anchor bolts and Reinforcement
- Volume of Concrete
- Plan view of footing showing anchor bolt centres, overall diameter of pile footing or overall plan dimensions of the slab footing showing the location of the anchor bolts
- Utility service both above and below ground level.
3.7.12.1. **Major Sign Structure Detail drawings**

Sheet 2 shall show the following structural details of the following:
- Post Details
- Baseplate
- Flange plate detail
- End Plate

Sheet 3 shall show the following structural details of the following:
- Arm details
- Arm plate detail
- Endplate detail (required if minimum Arm section is greater or equal to 150 mm)
- Vertical member detail
- Vertical member slot detail for the connection of vertical member to arm member.

3.7.12.2. **Order of Drawings**

The order of the sheets in a set of drawings shall follow the logical order of the construction procedure of the structure itself. The numbering sequence shall be as follows:
- Construction Notes
- General Arrangement
- Steel fabrication shop drawings
- Foundations i.e. Piles, Pile /Pile-cap combinations or slab footing

3.7.12.3. **Construction Notes**

Sheet 1 with Standard construction notes and weld details shall be attached to the final design set.
3.7.13. Appendix A Standard RTA Border Sheets
### Foundation and Footings

- **Footings** for ultimate soil bearing capacity shall be designed to resist vertical and horizontal loads, and shall be compatible with the superstructure.
- **Concrete** shall be designed and detailed in accordance with AS 2371-1993.
- **Concrete Curbing** shall be designed in accordance with AS 2371-1993.

### Reinforcement

- **Reinforcement** shall be detailed in accordance with AS 4671-1993.
- **Concrete cover** shall be in accordance with AS 4671-1993.
- **Concrete shall be supported by approved methods** as shown in the drawings.
- **Concrete** shall be designed in accordance with AS 4671-1993.
- **Concrete cover** shall be in accordance with AS 4671-1993.
- **Concrete shall be designed in accordance with AS 4671-1993.

### Concrete Properties

<table>
<thead>
<tr>
<th>Element</th>
<th>ASTM Grade</th>
<th>slump max.</th>
<th>max. agg. size</th>
<th>cement content</th>
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<tr>
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<td>AS 3600</td>
<td>80</td>
<td>20</td>
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</tbody>
</table>

### Steel

- **Steel** shall be in accordance with AS 1469.1, AS 1469.2, and AS 1469.3.
- **Stress Grades** shall be in accordance with AS 1469.1, AS 1469.2, and AS 1469.3.

### Prequalified Welding Consumables

<table>
<thead>
<tr>
<th>STEEL GRADE</th>
<th>WELD METAL CLASSIFICATION</th>
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<tr>
<td>AS 1563</td>
<td>E701 / E701</td>
</tr>
<tr>
<td>AS 1567</td>
<td>E701 / E701</td>
</tr>
<tr>
<td>AS 1579</td>
<td>E701 / E701</td>
</tr>
</tbody>
</table>

### RHH-Flange Plate Connection

- **Welding** shall be performed in accordance with AS 1556.6.
- **Welds** shall be examined in accordance with AS 1556.6.

### Roads and Traffic Authority of NSW

- **Highway** shall be designed in accordance with AS 2890.1.
- **Roads** shall be designed in accordance with AS 2890.1.
- **Traffic** shall be designed in accordance with AS 2890.1.

### Construction Notes

- **Design** and **drawing** shall be reviewed and approved by the appropriate authorities.
- **Drawings** shall be prepared in accordance with AS 1192.
- **Drawings** shall be checked and approved by the project engineer.

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**Diagram** shows a section of a flange plate connection with a bolted joint. The diagram includes dimensions and notes for the design and construction of the connection.
### 3.7.14. Appendix B Standard Hatching and Shading Symbols

<table>
<thead>
<tr>
<th>NAME</th>
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<td>BRASS OR BRONZE PATTERN</td>
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<td>STEEL PATTERN</td>
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<td>CONCRT</td>
<td>CONCRETE PATTERN</td>
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<td>EARTH OR NATURAL GROUND PATTERN</td>
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<td>GRAVEL POROUS FILL PATTERN</td>
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<td>SAND</td>
<td>SAND OR GROUT PATTERN</td>
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<td>BRICK</td>
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<td>STONE</td>
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