

CONTECComissão de Normalização
Técnica**SC-04**

Civil Construction

Design of Steel Structures12st Amendment

This is the 1st Amendment to PETROBRAS N-279 REV. G and it is used to alter the text of the Standard in the parts indicated below:

NOTE 1 The news pages with the performed amendments are placed in its corresponding positions.

NOTE 2 The amended pages, indicated the date of the amendment, are placed at the end of this standard, in chronological order, and shall not be used.

CONTENTS OF THE 1st AMENDMENT - 06/2014

- Subsection 4.1.1:

Inclusion of the Note.

- Figure A.7

Inclusion of the Note.

- Figure A.12:

Inclusion of the Note.

- Figura A.15:

Exclusion of the figure.

Design of Steel Structures

Procedure

This Standard replaces and cancels its previous revision.

The CONTEC - Authoring Subcommittee provides guidance on the interpretation of this Standard when questions arise regarding its contents. The Department of PETROBRAS that uses this Standard is responsible for adopting and applying the sections, subsections and enumerates thereof.

Technical Requirement: A provision established as the most adequate and which shall be used strictly in accordance with this Standard. If a decision is taken not to follow the requirement ("non-conformity" to this Standard) it shall be based on well-founded economic and management reasons, and be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by imperative nature.

Recommended Practice: A provision that may be adopted under the conditions of this Standard, but which admits (and draws attention to) the possibility of there being a more adequate alternative (not written in this Standard) to the particular application. The alternative adopted shall be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by verbs of a nonmandatory nature. It is indicated by the expression: **[Recommended Practice]**.

Copies of the registered "non-conformities" to this Standard that may contribute to the improvement thereof shall be submitted to the CONTEC - Authoring Subcommittee.

Proposed revisions to this Standard shall be submitted to the CONTEC - Authoring Subcommittee, indicating the alphanumeric identification and revision of the Standard, the section, subsection and enumerate to be revised, the proposed text, and technical/economic justification for revision. The proposals are evaluated during the work for alteration of this Standard.

"This Standard is exclusive property of Petróleo Brasileiro S. A. - PETROBRAS, internal application and PETROBRAS Subsidiaries and shall be used by its suppliers of goods and services under contracts or similar under the conditions established in Bidding, Contract, Agreement or similar.

The use of this Standard by other companies / organizations / government agencies and individuals is the sole responsibility of the users.."

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Comissão de Normalização
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SC - 04

Civil Construction

Introduction

PETROBRAS Technical Standards are prepared by Working Groups - WG (consisting specialized of Technical Collaborators from Company and its Subsidiaries), are commented by Company Units and its Subsidiaries, are approved by the Authoring Subcommittees - SCs (consisting of technicians from the same specialty, representing the various Company Units and its Subsidiaries), and ratified by the Executive Nucleus (consisting of representatives of the Company Units and its Subsidiaries). A PETROBRAS Technical Standard is subject to revision at any time by its Authoring Subcommittee and shall be reviewed every 5 years to be revalidated, revised or cancelled. PETROBRAS Technical Standards are prepared in accordance with PETROBRAS Technical Standard N-1. For complete information about PETROBRAS Technical Standards see PETROBRAS Technical Standards Catalog.

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Foreword

This Standard is the English version (issued in 04/2014) of PETROBRAS N-279 REV. G 04/2013. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

1 Scope

1.1 This Standard establishes the conditions required for the design of steel structures, stairways, access platforms, davits for load hoisting purposes, supports and bases for columns located in industrial facilities belonging to PETROBRAS.

NOTE The requirements of this Standard shall also be used for preparation of preliminary designs, pre-dimensioning, and other types of studies relating to the subject.

1.2 The application of this Standard is limited to designs of metallic structures made of carbon steel and manganese carbon.

1.3 This Standard is applicable to steel structure designs developed as of its date of issuance.

1.4 This Standard contains Technical Requirements and Recommended Practices.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

[NR-12](#) - Segurança no Trabalho em Máquinas e Equipamentos;

PETROBRAS [N-134](#) - Anchors for Use in Concrete;

PETROBRAS [N-293](#) - Fabricação e Montagem de Estruturas Metálicas;

PETROBRAS [N-381](#) - Execution of Drawing and Other General Technical Documents;

PETROBRAS [N-1550](#) - Metallic Structure Painting;

PETROBRAS [N-1710](#) - Coding of Technical Engineering Documents;

ABNT [NBR 6120](#) - Cargas para o Cálculo de Estruturas de Edificações;

ABNT [NBR 6123](#) - Forças Devidas ao Vento em Edificações;

ABNT [NBR 8196](#) - Desenho Técnico - Emprego de Escalas;

ABNT [NBR 8402](#) - Execução de Caracter para Escrita em Desenho Técnico;

ABNT [NBR 8403](#) - Aplicação de Linhas em Desenho - Tipos de Linhas - Larguras das Linhas;

ABNT [NBR 8404](#) - Indicação do Estado de Superfícies em Desenhos Técnicos;

ABNT [NBR 8800](#) - Projeto de Estruturas de Aço e de Estruturas Mistas de Aço e Concreto de Edifícios.

NOTE For documents referred in this Standard and for which only the Portuguese version is available, the PETROBRAS department that uses this Standard should be consulted for any information required for the specific application.

3 General Conditions

3.1 Applied Loads

In the design and calculations of stairways, access platforms, davits and supports, the types of loads and stresses mentioned in items 3.1.1 to 3.1.3 shall be considered, except where otherwise indicated by PETROBRAS. In those cases not covered by this Standard, ABNT [NBR 6120](#) shall be consulted.

3.1.1 Permanent Loads

3.1.1.1 The own weight of structure, including all accessories considered to be an integral part thereof.

3.1.1.2 The fireproofing used on the structure.

3.1.1.3 The weight of fixed equipment, including internal parts, heat insulation, fire proofing on supports, interconnections of piping, instruments, etc.

3.1.1.4 The weight of piping without insulation and working fluids.

3.1.1.5 Platform structures and floor plates shall be estimated in 1 kN/m^2 of designed area, except for stout beams larger than those indicated in the Annex A of this Standard.

3.1.1.6 Piping support structures shall be designed considering the following requirements:

- a) piping over 12" in diameter shall be considered individually as concentrated loads at support points;
- b) piping having a diameter equal to or smaller than 12" shall be considered an evenly distributed load, not less than $0,5 \text{ kN/m}^2$, in the region where it will be laid.

3.1.2 Accidental Loads

3.1.2.1 In supporting structures of vessels or piping, the weight of the test fluid as well as of their insulations shall be considered.

3.1.2.2 The following overloads shall be considered for the calculation of:

- a) platform structures: $2,5 \text{ kN/m}^2$;
- b) stairways and landings: $2,5 \text{ kN/m}^2$.

NOTE For the specific design of platform floors, 5 kN/m^2 shall be adopted.

3.1.2.3 For platforms subject to temporary support of heavy accessories, a specific study shall be conducted for each case.

3.1.2.4 For wind loads, standard ABNT [NBR 6123](#) shall be consulted.

3.1.2.5 Vibrations of machinery and/or equipment shall be considered, and manufacturers shall be consulted in that respect. Vibrations transmitted by piping shall also be taken into consideration.

3.1.2.6 When structures are provided for removal of tube bundles, channels and covers of horizontal heat exchangers, such structures shall be designed for a horizontal force equal to the weight of the largest bundle removed, and a vertical force equal to 1,25 times the weight of the largest bundle. When a temporary structure is adopted, those same loads shall be considered for purposes of calculating support points.

3.1.2.7 For assembly and/or dismantling of equipment, davits and other structures shall be designed with an impact factor of 1,25 to be applied to the vertical load, adopting at least 5 kN. A horizontal loading of 20% of the weight of the largest part shall also be considered. For other circumstances of use, the definitions set out in Figure A.19 shall be followed.

3.1.2.8 Impacts caused by working fluids (surges, water hammer) shall be considered.

3.1.2.9 The temperature variation range of each region shall be considered for structures exposed to the sun and for protected structures, with due regard for the provisions contained in standard ABNT [NBR 8800](#).

3.1.2.10 Heat transmitted from hot vessels and piping to structures shall be considered, where applicable.

3.1.2.11 For structures connected to vessels and piping, stresses due to thermal expansions of these elements shall be considered, including differential situations.

3.1.3 Load Combinations

The design conditions of all structures shall be investigated according to the possible loading combinations described in items 3.1.3.1 to 3.1.3.3.

3.1.3.1 For assembly conditions, the following loads shall be considered:

- a) the own weight of structure without fireproofing;
- b) the own weight of equipment without internal parts assembled in the field, insulation and platforms;
- c) wind.

3.1.3.2 For testing conditions, the following loads shall be considered:

- a) the own weight of structure with fireproofing;
- b) the own weight of equipment with internal parts, insulation, refractories, fireproofing, platforms, piping and test fluid;
- c) the own weight of pipe with thermal insulation and test fluid;
- d) wind.

3.1.3.3 For normal operating conditions, the following loads shall be considered:

- a) the own weight of structure with fireproofing;
- b) the own weight of equipment with internal parts, insulation, refractories, fireproofing, platforms, piping and working fluids;
- c) the own weight of pipe with thermal insulation and working fluids;
- d) accidental load of platforms in accordance with 3.1.2.2;

- e) vibrations;
- f) load due to impacts caused by working fluids (surges, water hammer);
- g) temperature variations in accordance with 3.1.2.10;
- h) wind.

3.2 Materials and Allowable Stresses

Steels for structures, rivets and bolts as well as their allowable stresses shall conform to the standards mentioned in Section 2.

NOTE The use of wide flange shapes instead of sloped flange shapes is recommended.
[Recommended Practice]

4 Specific Conditions

4.1 Operational and Maintenance Facilities

4.1.1 The minimum width of access walkways and platforms shall be 75 cm, which shall be increased to 90 cm when facing manholes of towers, vessels and to 120 cm when facing heat exchanger channels. A space 2 m high and free from obstacles shall be left above platforms, walkways and other floors. Floors of platforms and walkways shall consist of checker plates, gratings or other non-slip materials. The minimum thickness of the floor plates shall be 1/4" (6,35 mm).

NOTE The floor plates shall be checked for displacement and vibration given the serviceability limit states defined by ABNT [NBR 8800](#).

4.1.2 Regarding inclined stairways, consider that:

- a) the minimum width shall be 75 cm;
- b) the maximum height of each flight shall be 3,00 m;
- c) landings between flights shall be at least 75 cm long;
- d) inclined stairways with mirror shall form angles between 30° and 38° with the horizontal;
- e) inclined stairways without mirror shall form angles between 45° and 50° with the horizontal.

4.1.3 Regarding vertical stairways, consider that:

- a) the minimum width shall be 45 cm;
- b) the maximum height of each flight shall be 6,00 m;
- c) the rest platform between two flights shall have a minimum length of 75 cm, according to Figure A.2;
- d) for the steps of vertical stairways, round bars with cross elements (CA-50 steel) measuring 1" (or 25 mm) in diameter shall be used, according to detail "A" in Figures A.1 and A.2.

4.1.4 Floor plates of platforms, which are not required to be dismountable, may be welded to the framework. Dismountable plates shall be fastened to the framework by bolts. The maximum weight of removable plate panels shall be 0,5 kN. There shall be 2 holes 3 cm diameter on each panel to facilitate removal. Platform floor plates shall have a 1,2 cm diameter drainage hole for every square meter of plate area.

4.1.5 Guard rails shall be obligatorily placed on all unprotected sides of all platforms, landings, floors and in all inclined stairways. A hand rail shall be installed on the protected side of inclined stairways. This requirement does not apply to stairs attached directly to equipment. On all vertical stairways over 3 m in height guard-rails shall also be placed from 2 m above the base to 1,10 m above the last working level (see Figures A.1 e A.2). Vertical stairways shall also have safety chains at the upper end.

4.1.6 Stairways and hand rails shall be harmonized with the architecture of the unit where they are applied. Hand rails may be constructed from tubular sections or angle irons.

4.1.7 The maximum spacing between guardrail balusters shall be 1,10 m. For inclined stairways this maximum spacing shall be 1,10 m measured on the horizontal projection. For dismountable guardrails, balusters may be bolted to angle irons securely attached to the floor or be fitted with another securing system allowing their removal. Guardrails of platforms, floors and stairways shall be 1,10 m tall.

4.1.8 Platform floors shall leave a clearance of, at least, 15 cm around walls of towers, tanks and other vessels, regardless of whether or not they have heat insulation. Holes on platforms and other floors, for passage of vertical piping, shall leave a clearance of 5 cm outside the pipe wall or heat insulation, if any.

4.1.9 Flat bar baseboards of 4" x 1/4" (or 100 mm x 6,00 mm) shall be placed at the following locations:

- a) on all sides of platforms, landings and other floors, wherever there are guardrails, or wherever there is a horizontal clear span larger than 5 cm up to any wall or other obstacle;
- b) all around the openings for passage of stairways and any other openings with clear spans larger than 5 cm.

NOTE For access ways to machines and equipment, the requirements and guidelines of [NR-12](#) shall be applied.

4.1.10 Provision shall be made for drainage holes of sufficient diameters to drain off the water from points where it may accumulate.

4.1.11 Closed spaces, such as inside tubular columns, shall be hermetically sealed with welds to prevent possible corrosion.

4.2 Connections

4.2.1 When basic drawings are not provided by PETROBRAS, or whenever these drawings do not indicate the type of connection among parts, the designer may detail, at its option, welded, bolted or riveted connections.

4.2.2 Beams and columns shall be fastened in such a manner as to allow assembly keeping the columns in strict verticality. The clearance between the column and the beam shall not be greater than 15 mm, unless this is required by thermal expansion.

4.2.3 Beams requiring supporting connections are joined together through angle iron connections on the lower flange of the beam. The web of the beam shall be connected to the column by fastening elements. On webs of columns with fireproofing, use shall be made of angle iron type connections attached from the top to the web for settling connections.

4.2.4 Connections made at the plant may be either welded or riveted at the manufacturer's option.

4.3 Joints

4.3.1 Circumferential welds for pipes shall be positioned in such a manner that the minimum distance between adjacent weld beads is equal to one diameter, and not less than 1 000 mm. Additionally, there shall be no more than 2 circumferential joints at any 3 m. The minimum distance between longitudinal weld beads shall be 30° or 300 mm, whichever is smaller.

4.3.2 Butt welds in structural elements shall be positioned in such a manner as to avoid the cross-hatched zones shown in Figure 1. The distance between 2 joints shall be at least the height of the structural element and not less than 1 000 mm. The type of joint shall be defined by the designer.

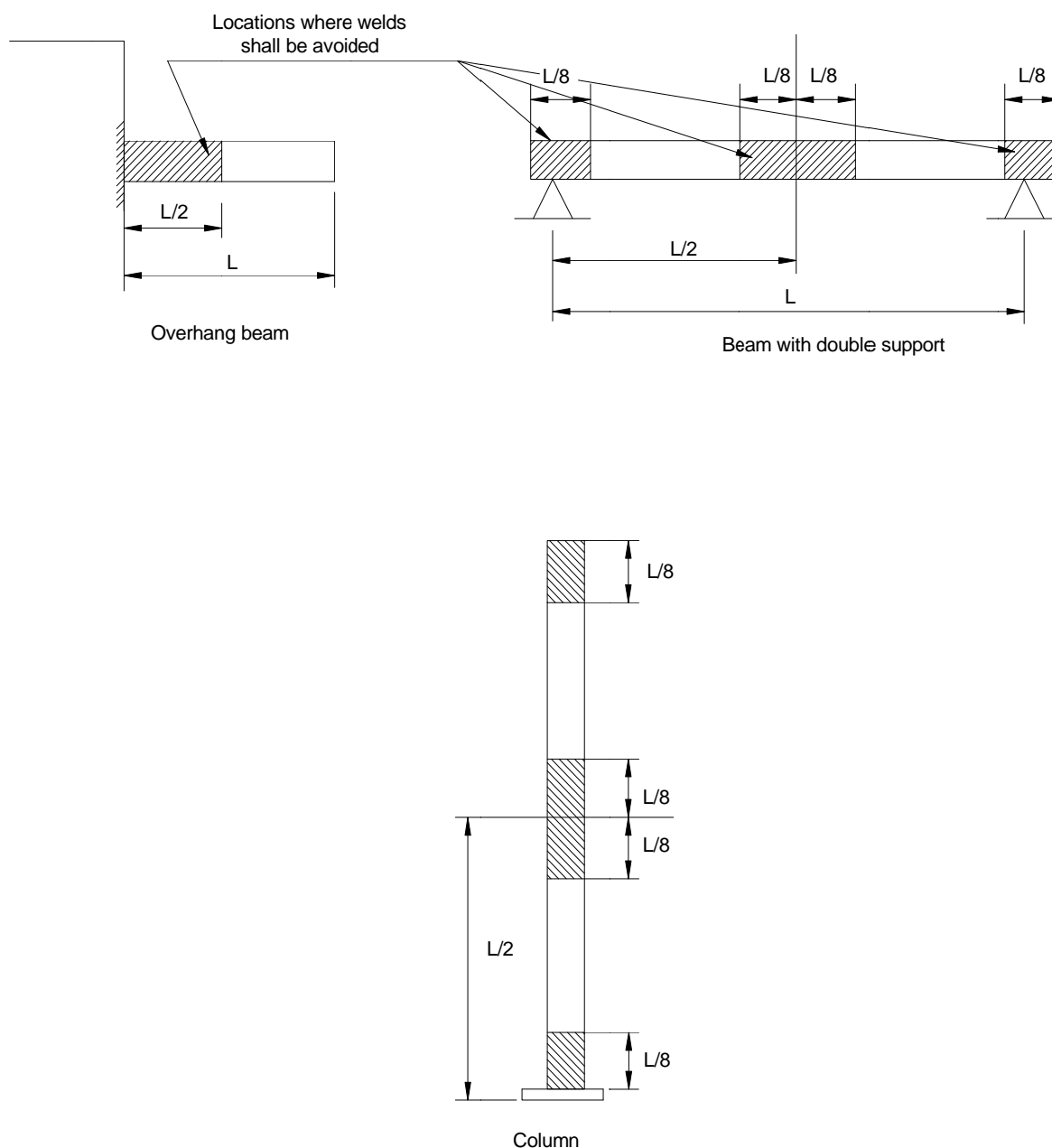


Figure 1 - Positioning of Weld in Sections

4.4 Anti-Corrosive Protection

All steel structures shall be protected against corrosion in accordance with ABNT [NBR 8800](#) and PETROBRAS [N-1550](#).

4.5 Design Standards

Figures A.1 through A.20 of Annex A standardize stairways, platforms, dimensions of bases for steel columns and davits for load hoisting purposes.

5 Presentation

5.1 General

5.1.1 The design shall be elaborated according to PETROBRAS [N-381](#).

5.1.2 The project shall be made of the following documents:

- a) list of design documents;
- b) descriptive memorandum;
- c) calculation notes;
- d) drawings;
- e) design recommendations for construction and assembly.

5.1.3 A The documents codification shall be in agreement with PETROBRAS [N-1710](#) or as defined by PETROBRAS.

5.2 Descriptive Memorandum

5.2.1 The descriptive memorandum shall contain the following information:

- a) objective;
- b) design description;
- c) other necessary information for the perfect understanding of design.

5.2.2 The descriptive memorandum shall be presented in an organized way, using the standardized forms according to PETROBRAS [N-381](#).

5.2.3 In the design description shall be presented the justification of the adopted solutions viewing the basic designs, the local conditions and in way to assist the aesthetic, structural and economic aspects.

5.3 Calculation Notes

5.3.1 The calculation notes shall be presented in an organized way, using the standardized forms according to PETROBRAS [N-381](#).

5.3.2 They shall contain the following information:

- a) structural calculation including:
 - structural layout;
 - load diagram and its formulation;
 - material specification;
 - stress calculation and covering determination;
 - structural elements sizing;
 - deformation and displacement calculation (if necessary);
 - connections sizing;
 - anchor bolts sizing;
 - adopted overloads and load combinations for assembly, test and operations stages;
- b) identification of the adopted computer program used in calculation and in the list of inlet and outlet data;
- c) other necessary information for the perfect understanding of design, including adopted standards and bibliography, as well as the specific requirements for pre-fabrication and assembly procedures.

5.3.3 The tables and calculation methods used shall be mentioned and identified which are integral part of the documents of the calculation notes.

5.3.4 The sizing of the anchor bolts for bases of reinforced concrete, shall be in accordance with PETROBRAS [N-134](#).

5.4 Drawings

5.4.1 The drawings shall obey, in its elaboration and presentation, to the determination in PETROBRAS [N-381](#) and in ABNT [NBR 8196](#), [NBR 8402](#), [NBR 8403](#), [NBR 8404](#) and [NBR 8800](#).

5.4.2 The design execution includes the elaboration the dimensional and/or fabrication drawing preparation of the design.

5.4.3 The dimensional drawings shall include:

- a) key plant (index draw);
- b) general dimensions plants, including location, orientation and all the elevations for perfect identification of the structure;
- c) structural elements representation through their axis including cross section identification and profiles weight;
- d) sections and views;
- e) main connections specification;
- f) secondary connections stress indication;
- g) counter deflections indication;
- h) detail indication of structure supports and stresses in the sustentation structure;
- i) material list, including used materials specification and theoretical total weight;
- j) fire protection existence indication.

5.4.4 The details drawings for production and assembly shall include:

- a) key plant (index draw);
- b) elements arrangement including structural elements identification;
- c) details of the structural elements;
- d) connections details among elements;
- e) counter deflection indication (if necessary);
- f) support details, including anchor bolts;

- g) hoist systems;
- h) assembly and fixation systems, with indication of the assembly sequence.

5.4.5 The key plant (index draw) shall be presented in reduced scale, in the General Notes field, whenever in the drawing the location of the whole group is not represented. In the main plant shall be indicated the part of the structure represented in the drawing.

5.4.6 In the graphic representation of the elements arrangement the location of the reference axes shall be indicated, with the relative distances between its axes and external distances, plants with levels indication, elevations, views and details that best illustrates the understanding of the structure.

5.4.7 It shall be foreseen in the fabrication design drawings all the necessary devices (boring, openings, fastened) for connection among equipment items supported by the structure and the structure itself.

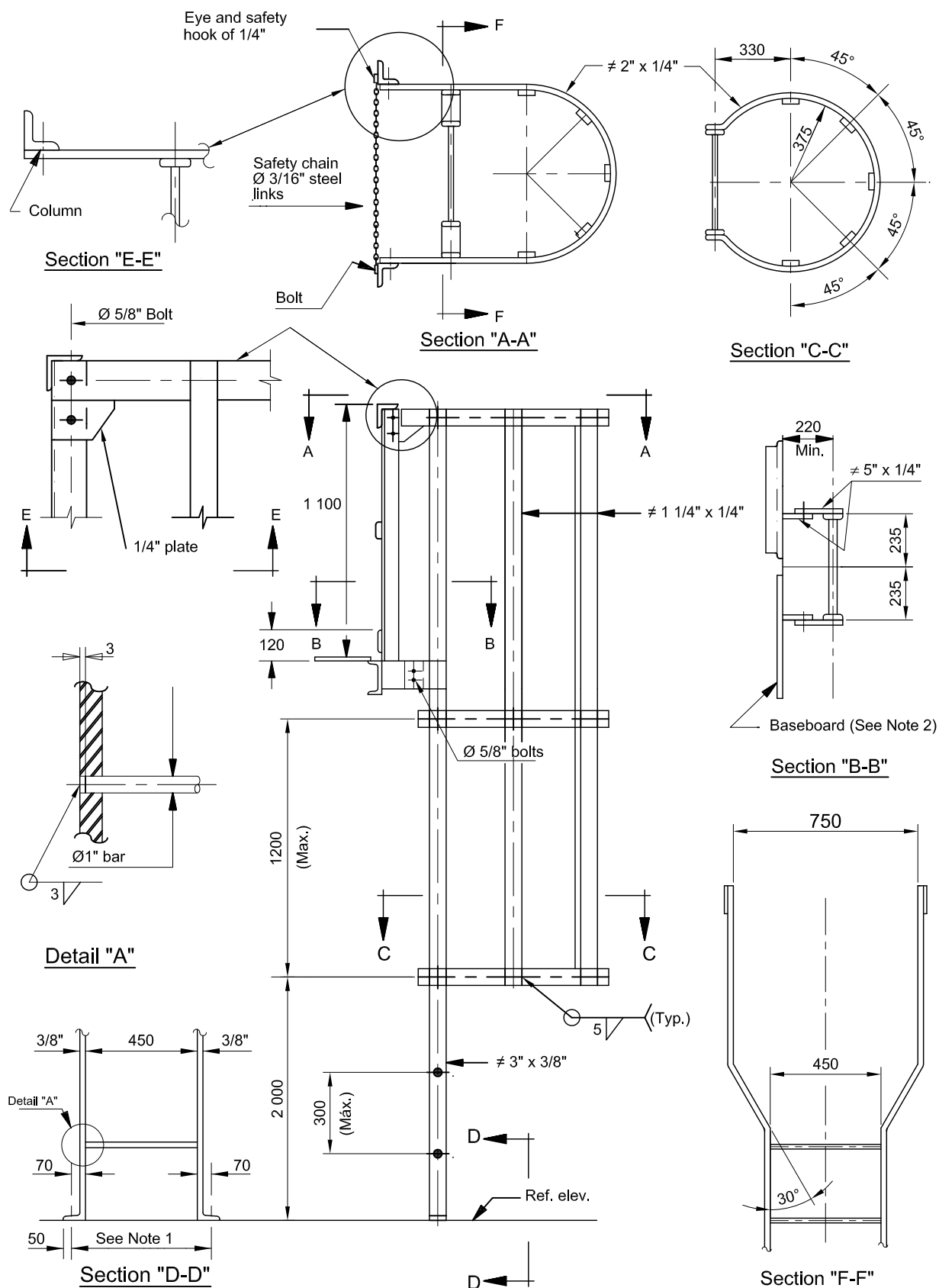
5.5 Design Recommendations for Construction and Assembly

5.5.1 It shall contain the following elements:

- a) objective;
- b) scope of services;
- c) specifications of services (see standard PETROBRAS [N-293](#));
- d) annex documents;
- e) list of the reference documents;
- f) dear amounts plan of materials and service.

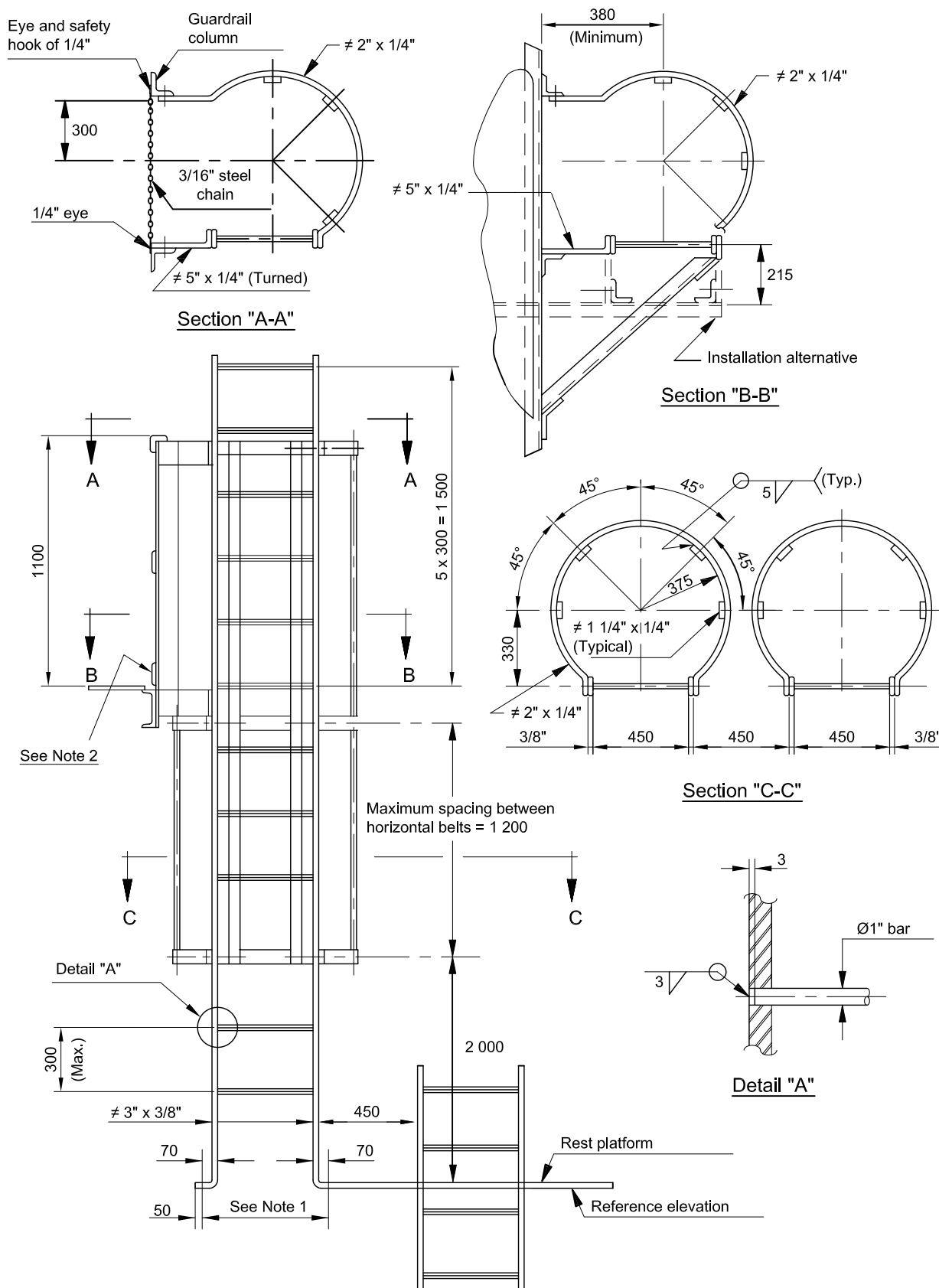
5.5.2 The design recommendations for construction and assembly shall be presented in an organized way, using the standardized forms according to standard PETROBRAS [N-381](#).

Annex A - Figures



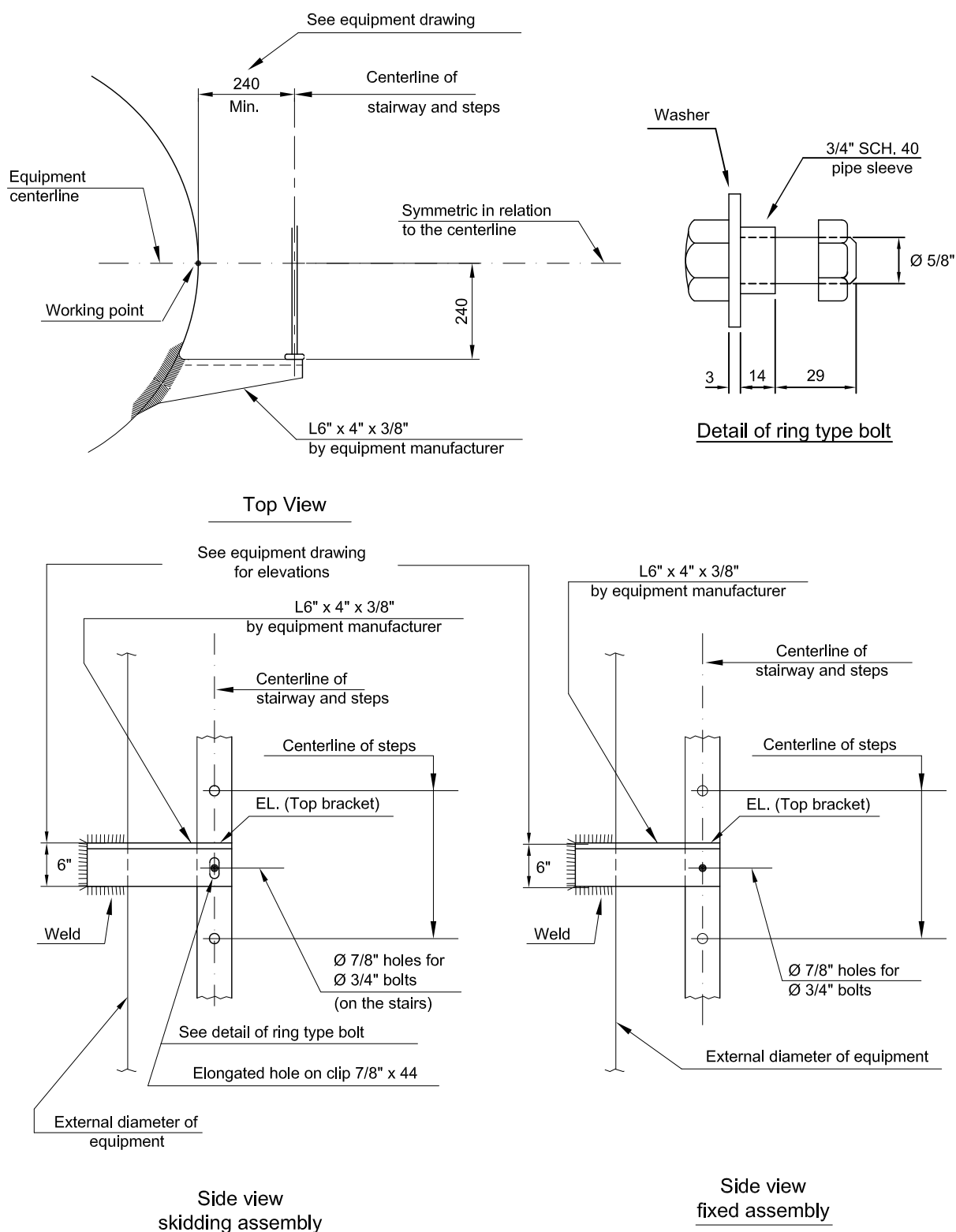
- NOTE 1 Ø 15/16" holes for Ø 3/4" anchor bolts on floor.
 NOTE 2 Continuous baseboard along all openings.
 NOTE 3 Guardrail not required when length is ≤ 3 000.
 NOTE 4 Maximum length of each flight of stairs: 6 000.
 NOTE 5 Dimensions in millimeters, except where otherwise indicated.

Figure A.1 - Vertical Stairway and Guardrail with Front Exit



- NOTE 1 Ø 15/16" holes for Ø 3/4" anchor bolts on floor.
NOTE 2 Continuous baseboard along all openings.
NOTE 3 A 5/8" bolt shall be used to fasten the stairway to metallic supports.
NOTE 4 Guardrail not required when length is $\leq 3\ 000$.
NOTE 5 Maximum length of each flight of stairs: 6 000.
NOTE 6 Dimensions in millimeters, except where otherwise indicated.

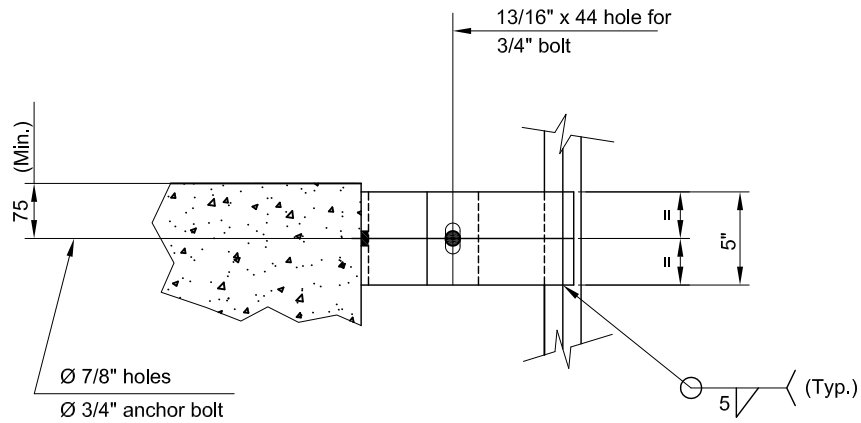
Figure A.2 - Vertical Stairway and Guardrail with Side Exit



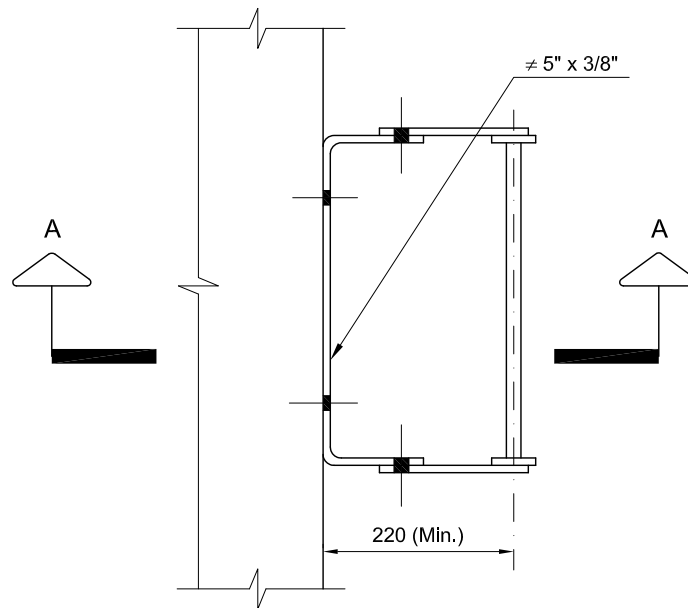
NOTE 1 Dimensions in millimeters, except where otherwise indicated.

NOTE 2 Maximum spacing between clips: 3 000.

Figure A.3 - Vertical Stairway-to-Equipment Attachment



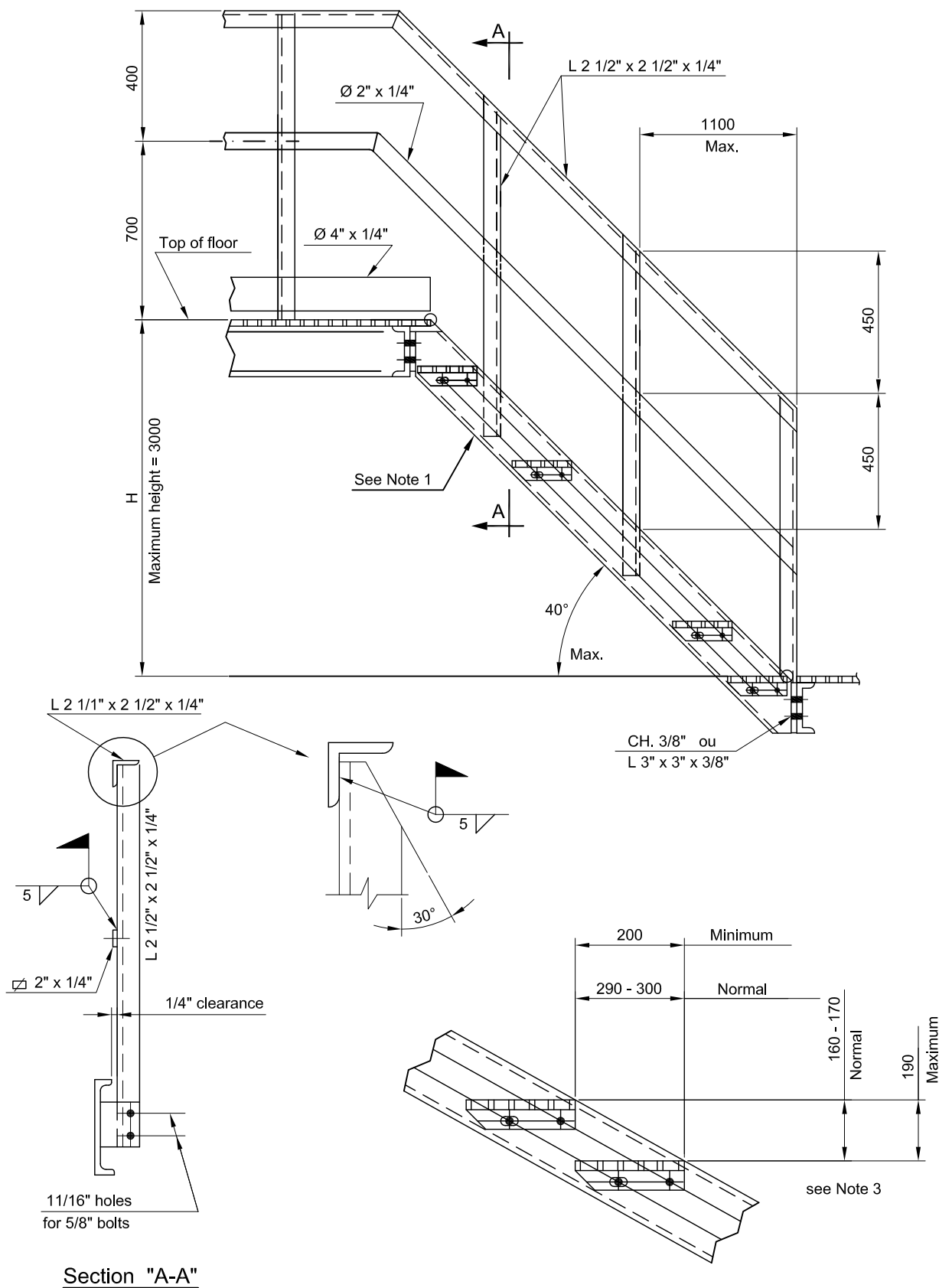
Section "A-A"



Plan

NOTE Dimensions in millimeters, except where otherwise indicated.

Figure A.4 - Vertical Stairway-to-Concrete Structure Attachment



NOTE 1 Use C 6" x 12,2 kg/m.

NOTE 2 Dimensions in millimeters, except where otherwise indicated.

NOTE 3 Use dimensions for mirrors and steps resulting in inclination within the limits established in 4.1.2.

Figure A.5 - Inclined Stairway for Walkways

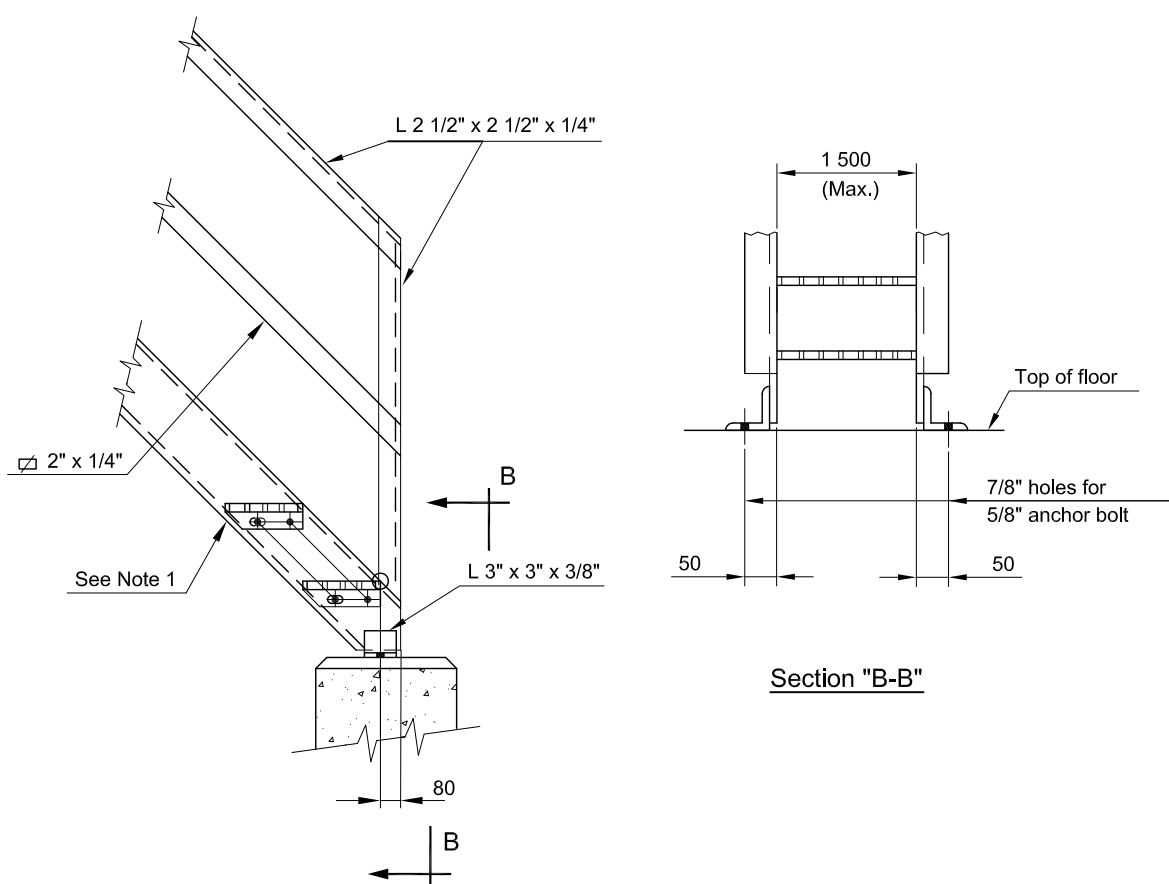


Figure A.5.1 - Detail of Inclined Stairway

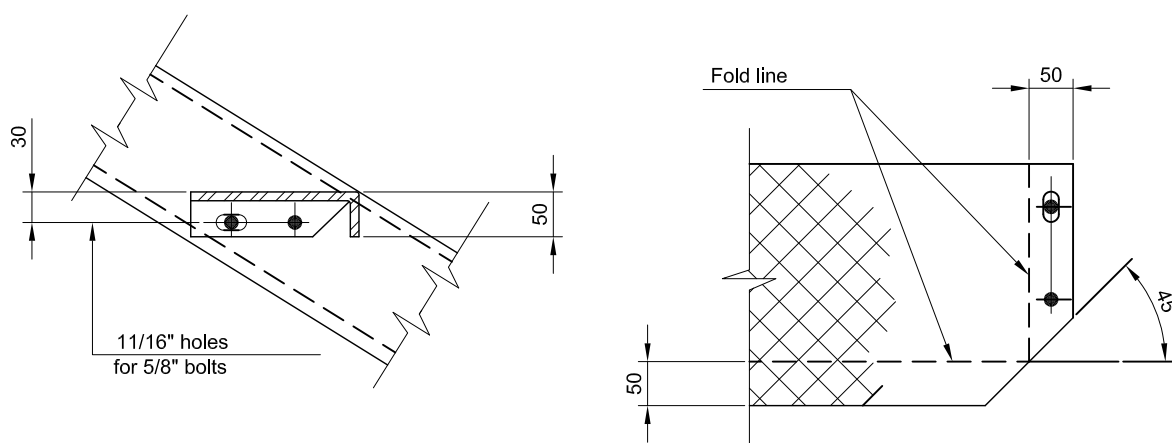


Figure A.5.2 - Detail of Checker Plate Type Step

NOTE 1 For heights $H < 3\,000$ use C 6" x 12,2 kg/m.

NOTE 2 For heights $H > 3\,000$ use C 8" x 17,1 kg/m.

NOTE 3 Dimensions in millimeters, except where otherwise indicated.

Figure A.5 - Inclined Stairway for Walkways

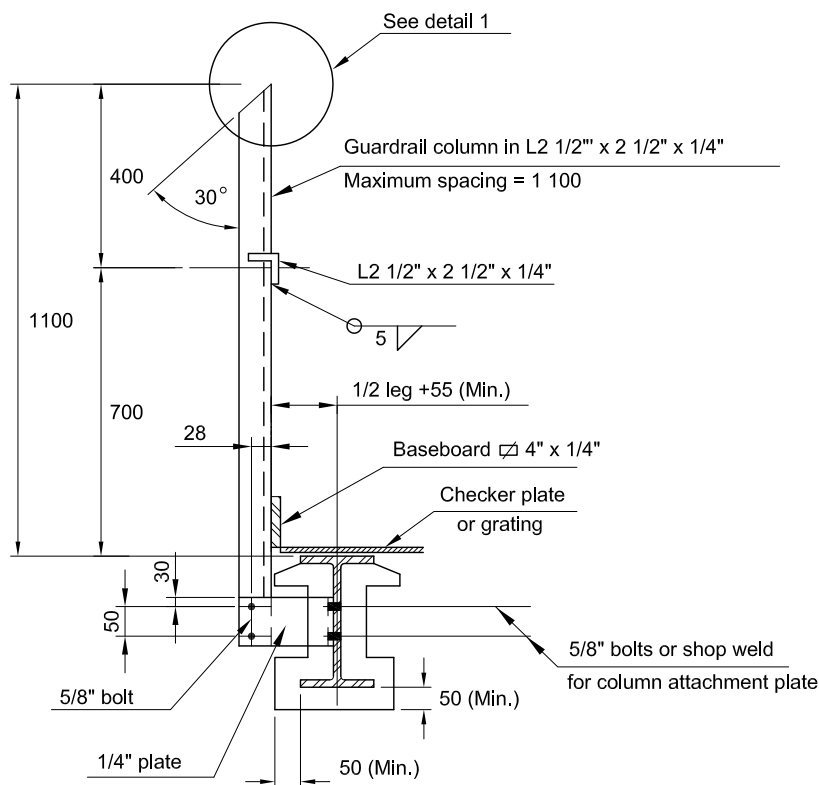


Figure A.6.1 - Typical Guardrail in I Beam with Fire Protection

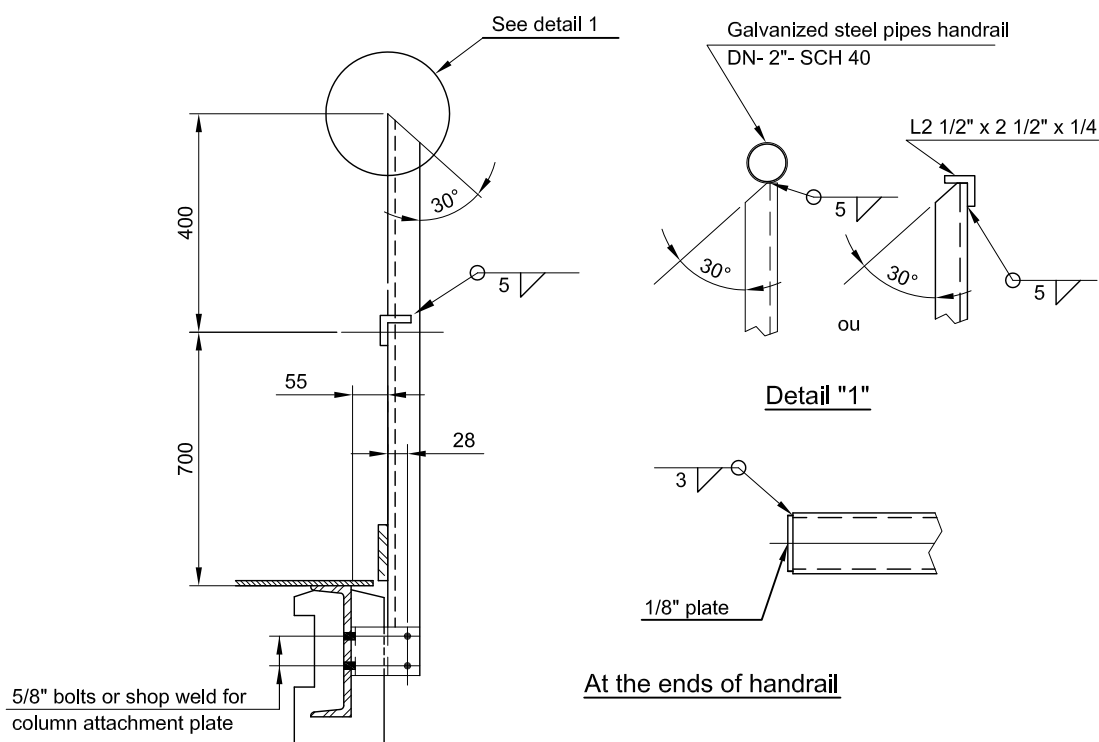


Figure A.6.2 - Typical Guardrail in U Beam with Fire Protection

NOTE 1 For dimensions not specified in Figure A.6.2, see Figure A.6.1.

NOTE 2 For welds not specified in Figure A.6.1, see Figure A.6.2.

Figure A.6 - Guardrail, Walkways and Platforms

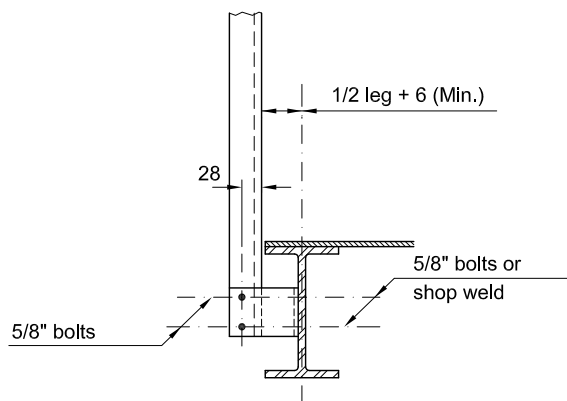


Figure A.6.3 - Attachment to I Beam Without Fire Protection

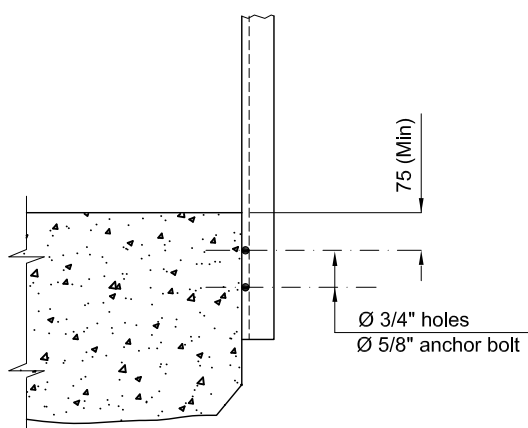


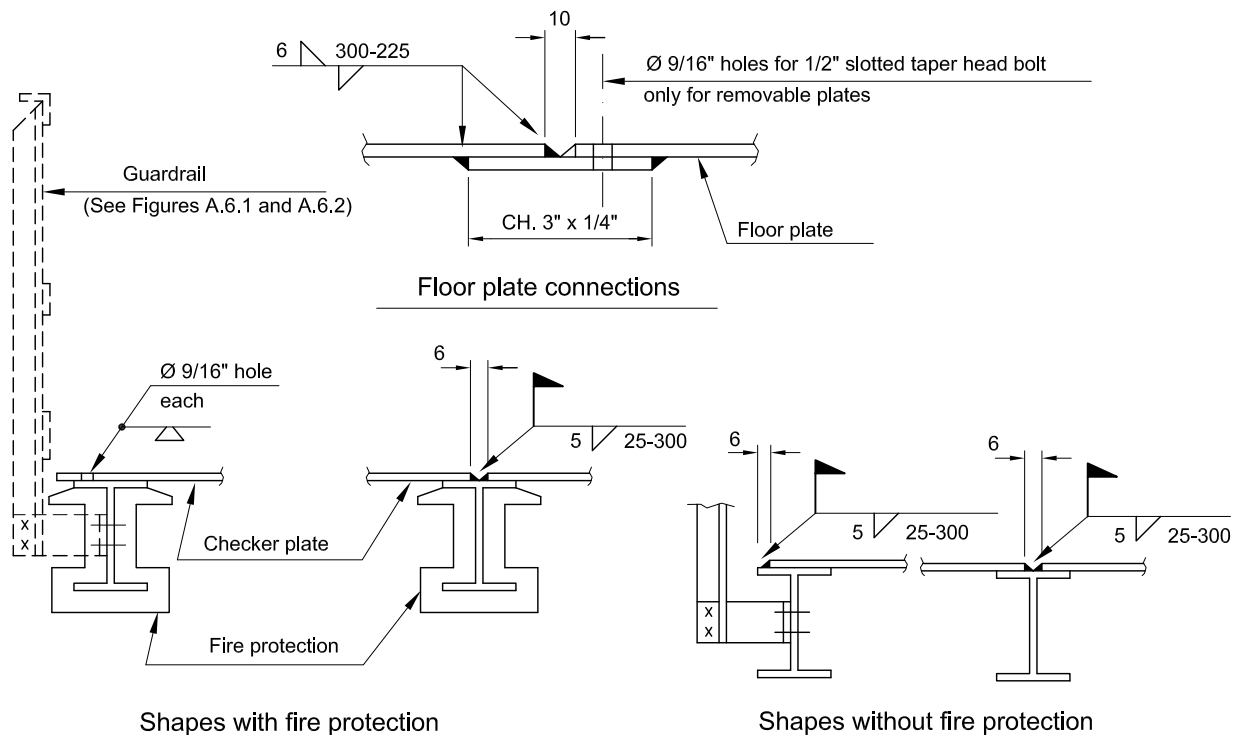
Figure A.6.4 - Attachment to Concrete

NOTE 1 For dimensions not specified in Figures A.6.3 and A.6.4, see Figure A.6.1.

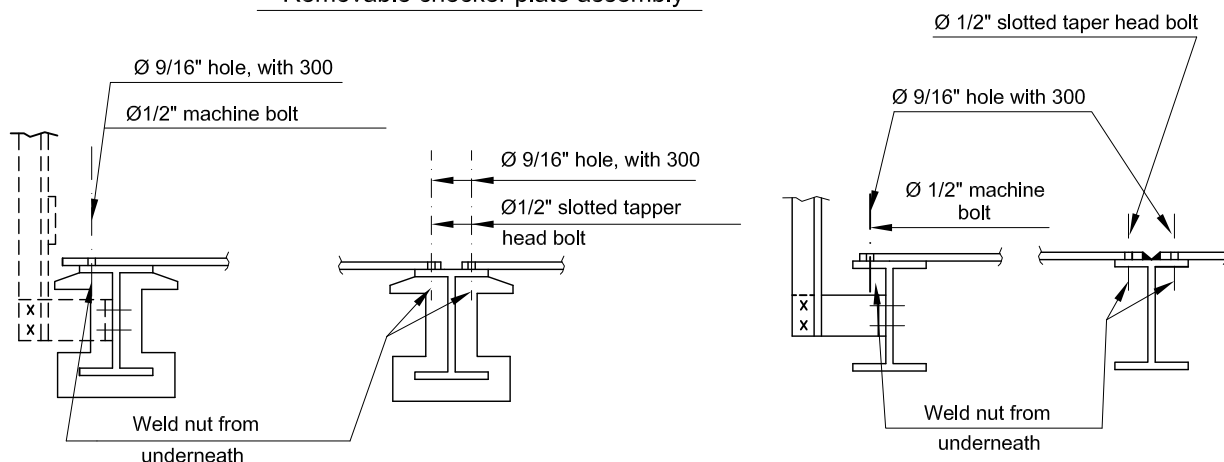
NOTE 2 For welds not specified in Figures A.6.3 and A.6.4, see Figure A.6.2.

NOTE 3 Dimensions in millimeters, except where otherwise indicated.

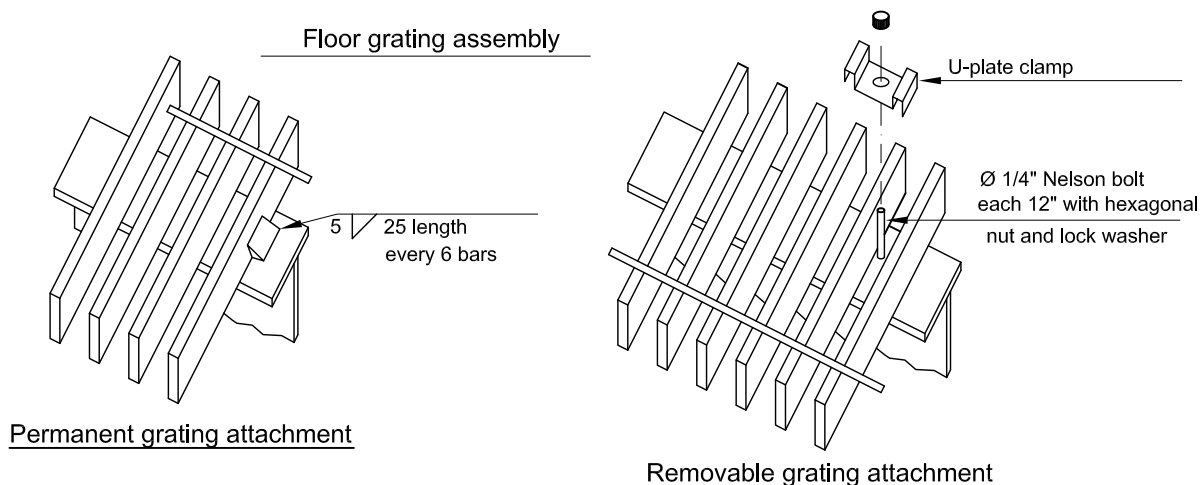
Permanent checker plate assembly



Removable checker plate assembly



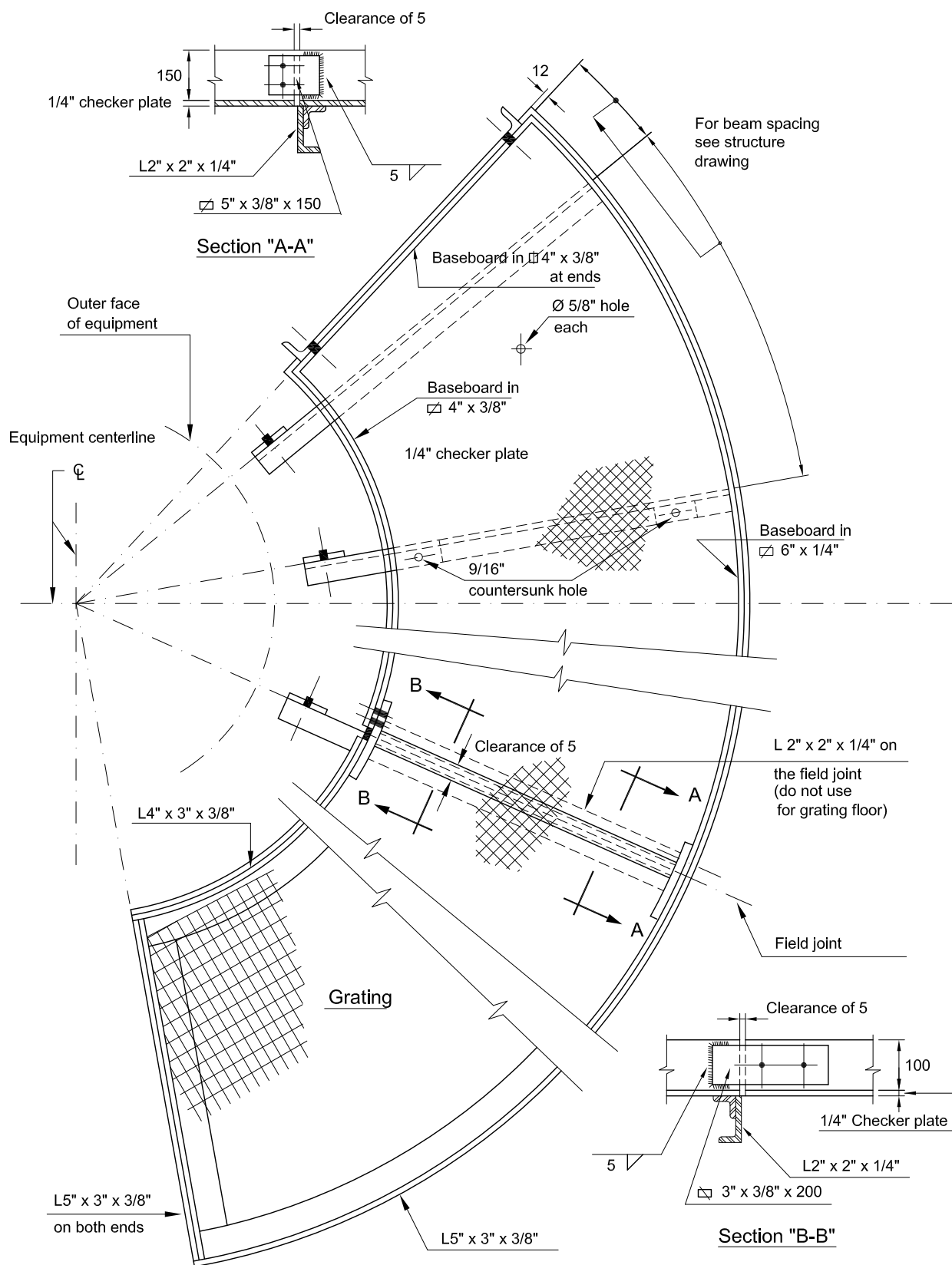
Floor grating assembly



NOTE 1 The details shown in the figures shall be considered as suggestions, as they are beyond the scope of engineering design.

NOTE 2 Details can also be used for application in expanded metal steel sheet.

Figure A.7 - Checker Plate-to-Floor Grating Attachment

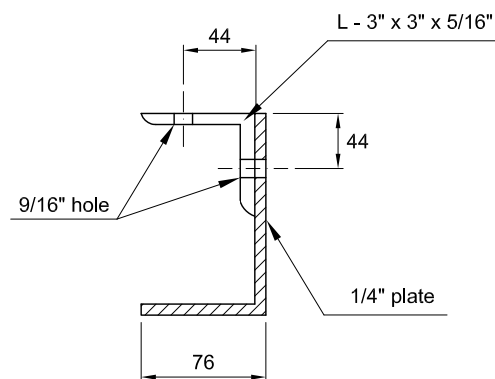
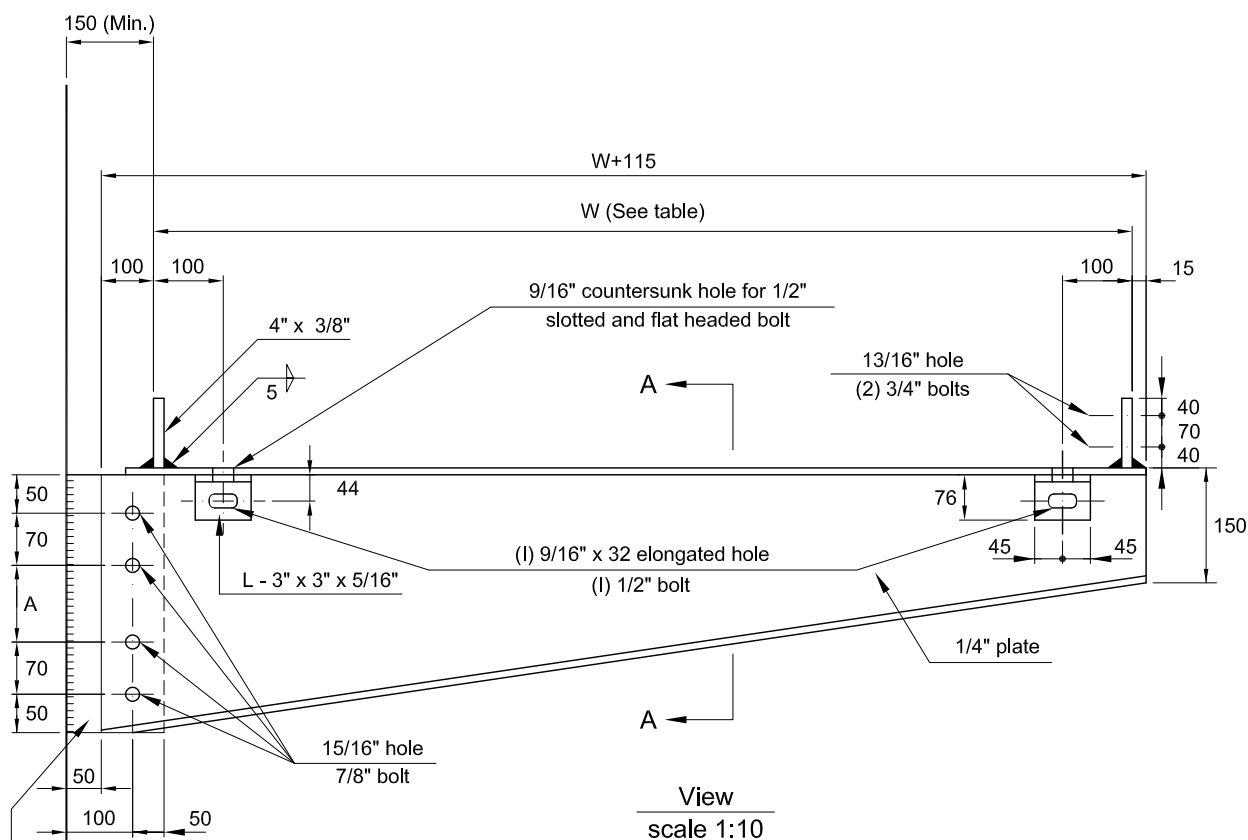


NOTE 1 A maximum angle of 150° is recommended between field joints and/or terminating support beams

NOTE 2 Dimensions in millimeters, except where otherwise indicated.

NOTE 3 According 4.1.3.

Figure A.8 - Circular Platform for Equipment

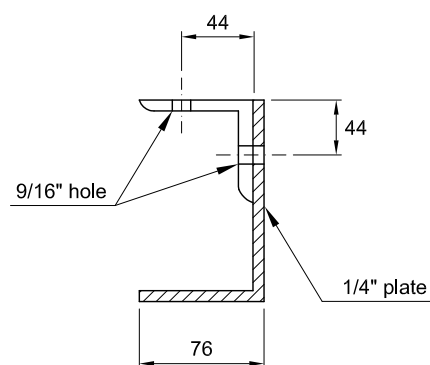
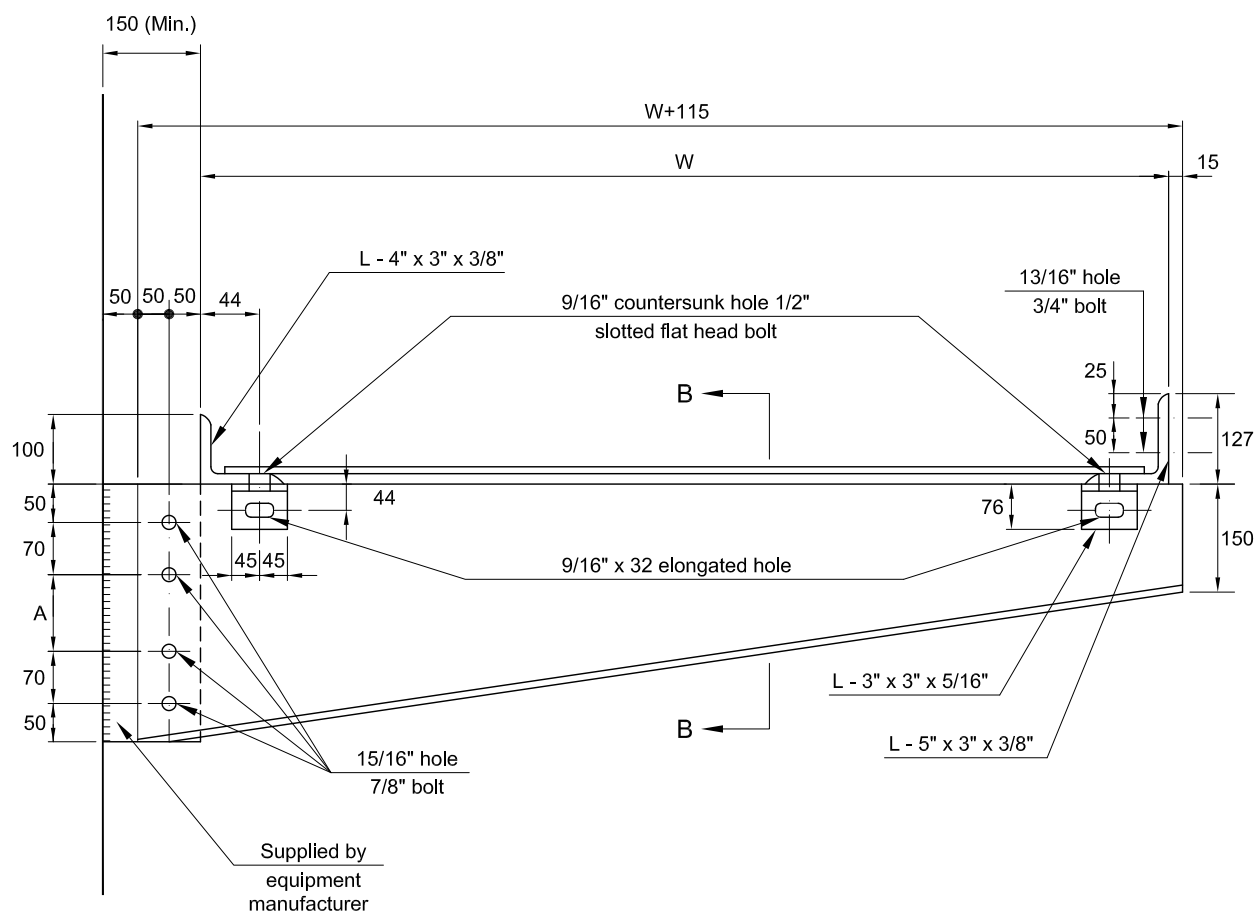


Section "A-A"
scale 1:5

Tabela:

Platform width "W"	A
Up to and including 1 000	70
From 1 000 to 1 500	140

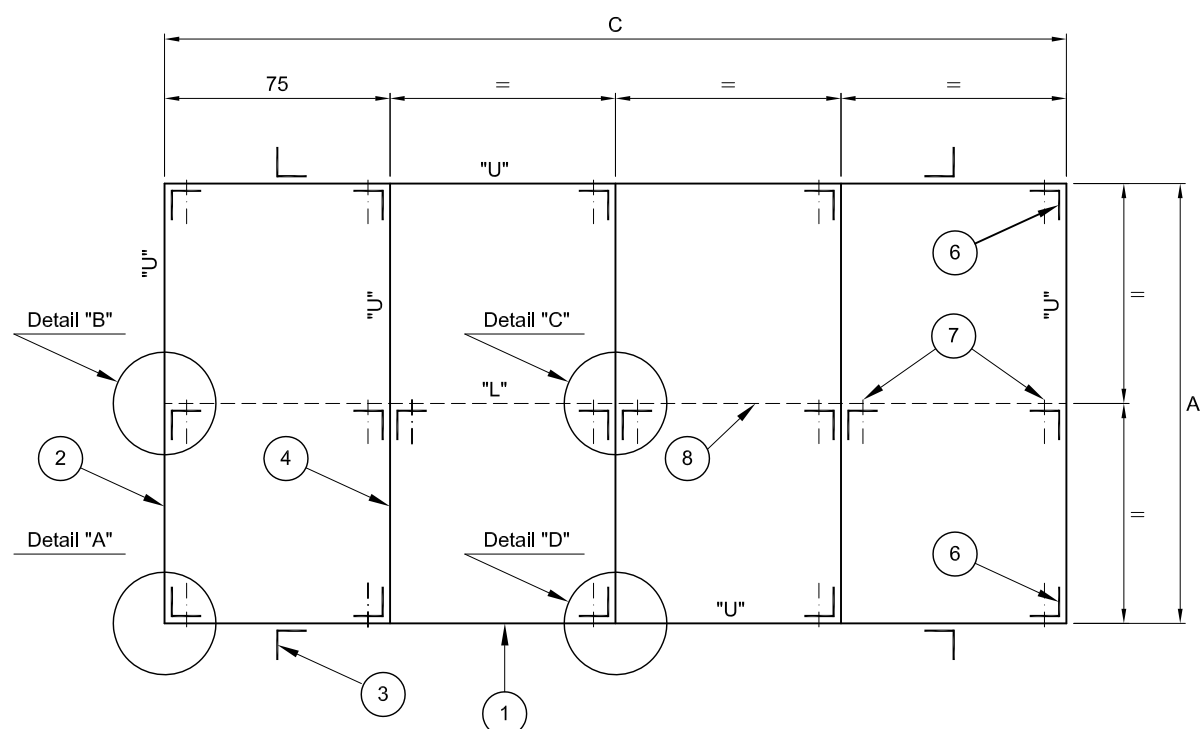
Figure A.9 - Beam for Circular Platform - Plate Floor

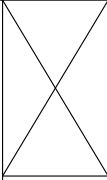
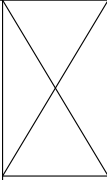


Section "B-B"

NOTE For sizes "W" and "A", see table of Figure A.9.

Figure A.10 - Beam for Circular Platform - Grating Floor



Type	A x C	B	1	2	3	4	5	6	Bolt		7	8
									Quant.	Ø x L		
A-1	75 A 100 x 150	100	U4"-8,04	U4"-8,04	L-4" x 4" x 3/8"	U4"-8,04	Checker plate or grating (1/4" thick)	L-2 1/2" x 2 1/2" x 1/4"	20	1/2" x 1 3/4"	L-2 1/2" x 2 1/2" x 1/4"	
A-2		200										
A-3		300										
B-1	75 A 100 x 300	100	U6"-12,2	U4"-8,04	L-4" x 4" x 3/8"	U4"-8,04	Checker plate or grating (1/4" thick)	L-2 1/2" x 2 1/2" x 1/4"	28	1/2" x 1 3/4"	L-2 1/2" x 2 1/2" x 1/4"	
B-2		200										
B-3		300										
C-1	150 x 150	100	U4"-8,04	U6"-12,2	L-4" x 4" x 3/8"	U4"-8,04	Checker plate or grating (1/4" thick)	L-2 1/2" x 2 1/2" x 1/4"	24	1/2" x 1 3/4"	L-2 1/2" x 2 1/2" x 1/4"	L-2 1/2" x 2 1/2" x 1/4"
C-2		200										
C-3		300										
D-1	150 x 300	100	U6"-12,2	U6"-12,2	L-4" x 4" x 3/8"	U4"-8,04	Checker plate or grating (1/4" thick)	L-2 1/2" x 2 1/2" x 1/4"	33	1/2" x 1 3/4"	L-2 1/2" x 2 1/2" x 1/4"	L-2 1/2" x 2 1/2" x 1/4"
D-2		200										
D-3		300										
E-1	200 x 300	100	U6"-12,2	U6"-12,2	L-4" x 4" x 3/8"	U4"-8,04	Checker plate or grating (1/4" thick)	L-2 1/2" x 2 1/2" x 1/4"	33	1/2" x 1 3/4"	L-2 1/2" x 2 1/2" x 1/4"	L-2 1/2" x 2 1/2" x 1/4"
E-2		200										
E-3		300										

NOTE 1 In case of platforms with lengths that are multiples of tabulated lengths, the longitudinal girder ① shall be spliced using lugs ①

NOTE 2 All welds shall be 6 mm fillet welds.

NOTE 3 Numbers within parentheses represent quantity.

NOTE 4 All dimensions in millimeters, except A x C and B which are in centimeters or where indicated

NOTE 5 Bolts for fastening the transverse girder to the longitudinal girder will be used to connect the guardrail column.

Figure A.11 - Modulated Straight Platform - Plan

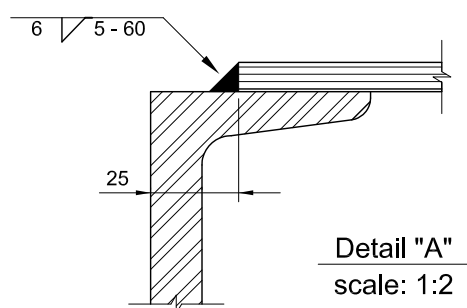
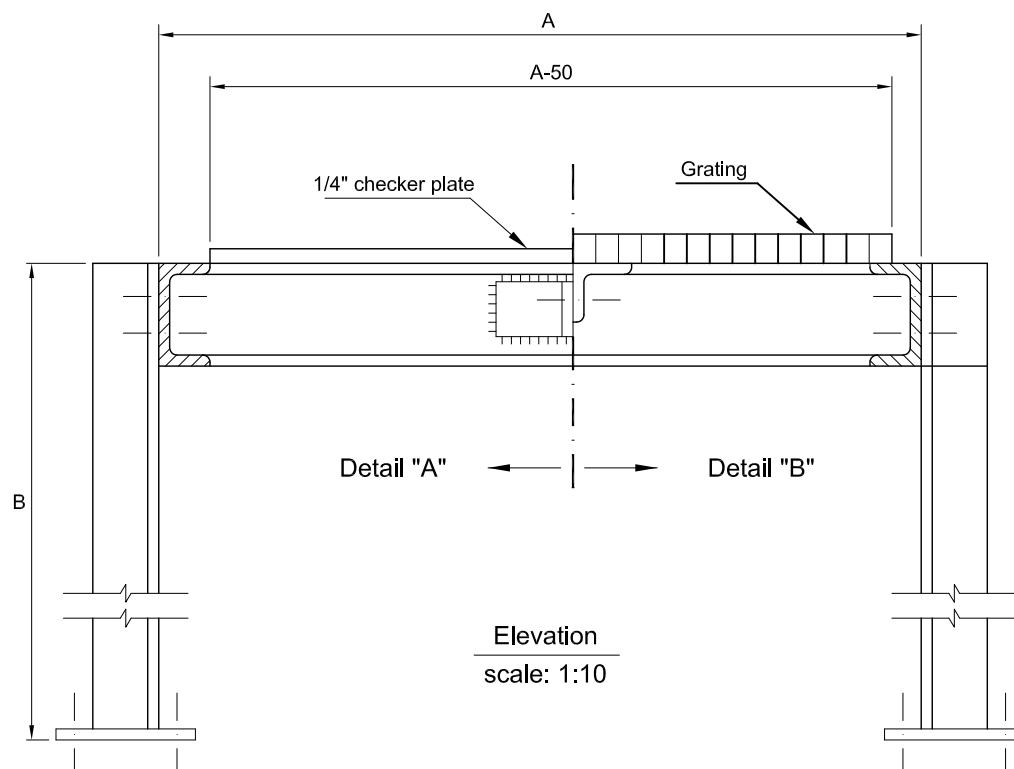
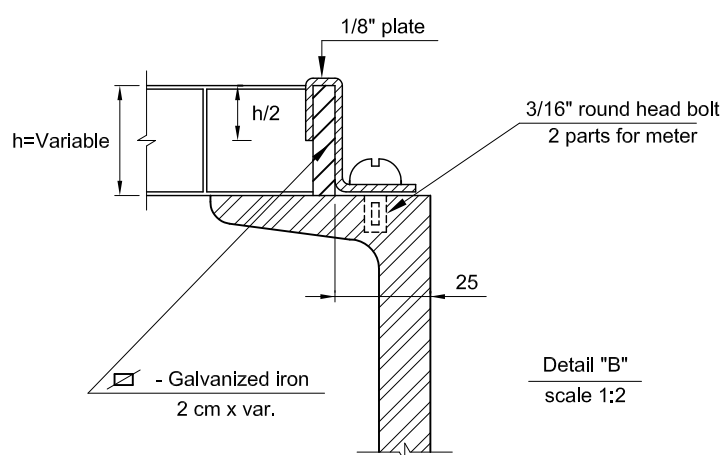


Plate-to-Shape Attachment



Grating-to-Shape Attachment

NOTE 1 Dimensions in millimeters, except where otherwise indicated.

NOTE 2 The details shown in the figures shall be considered as suggestions, as they are beyond the scope of engineering design.

NOTE 3 Details can also be used for application in expanded metal steel sheet.

Figure A.12 - Modulated Straight Platform - Elevation

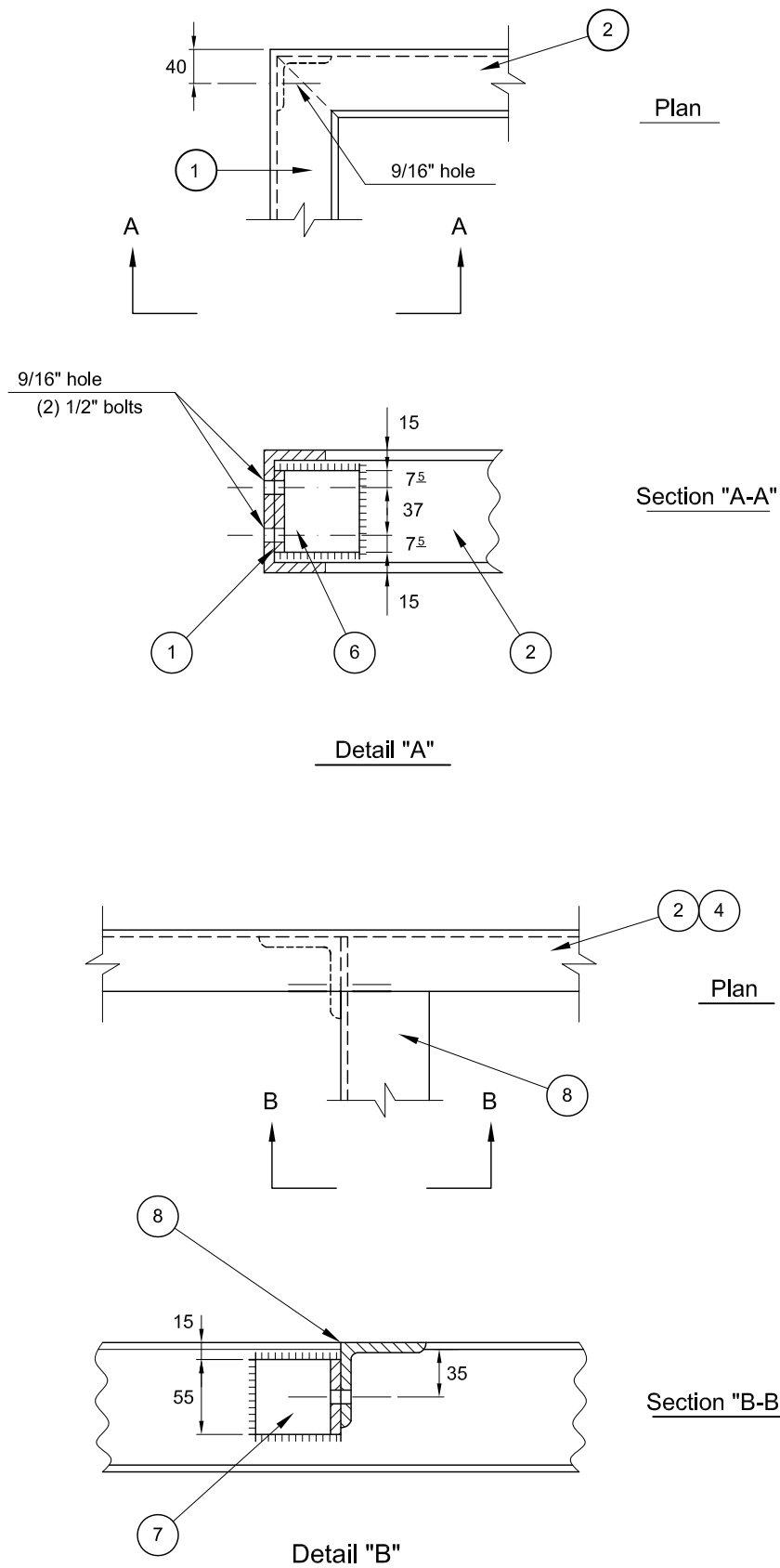


Figure A.13 - Straight Platform Connections

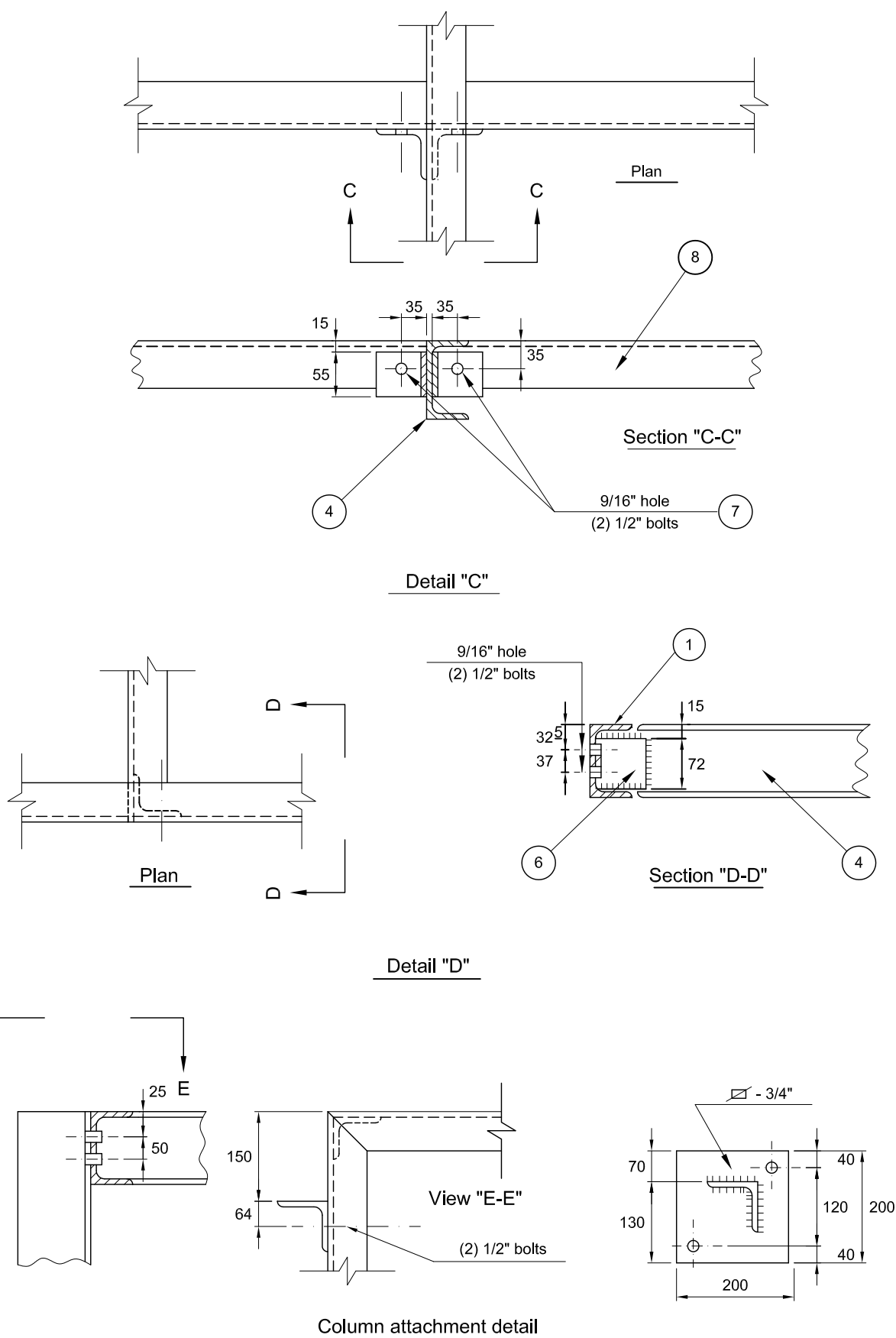
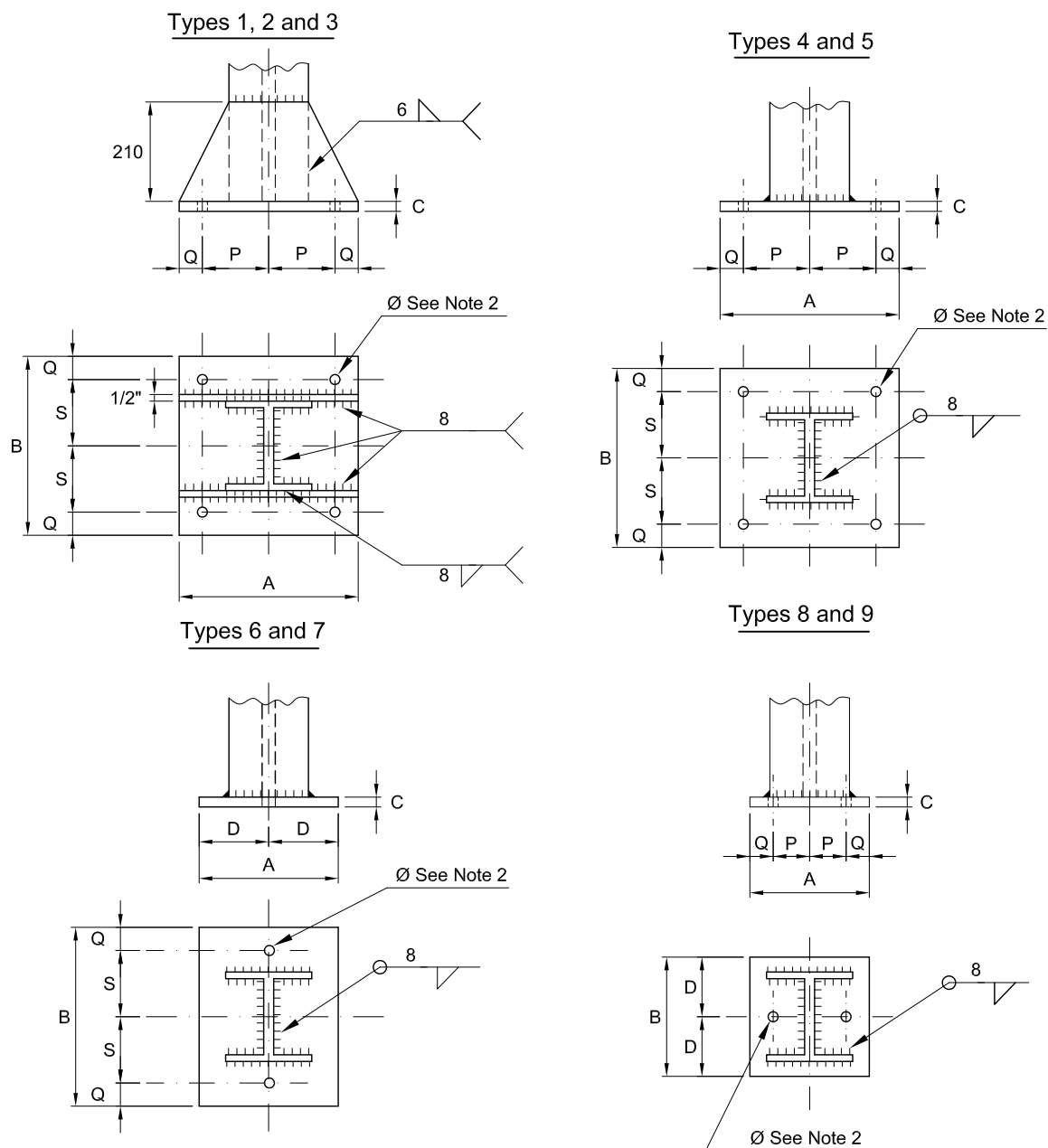


Figure A.14 - Connections and Support of Straight Platform

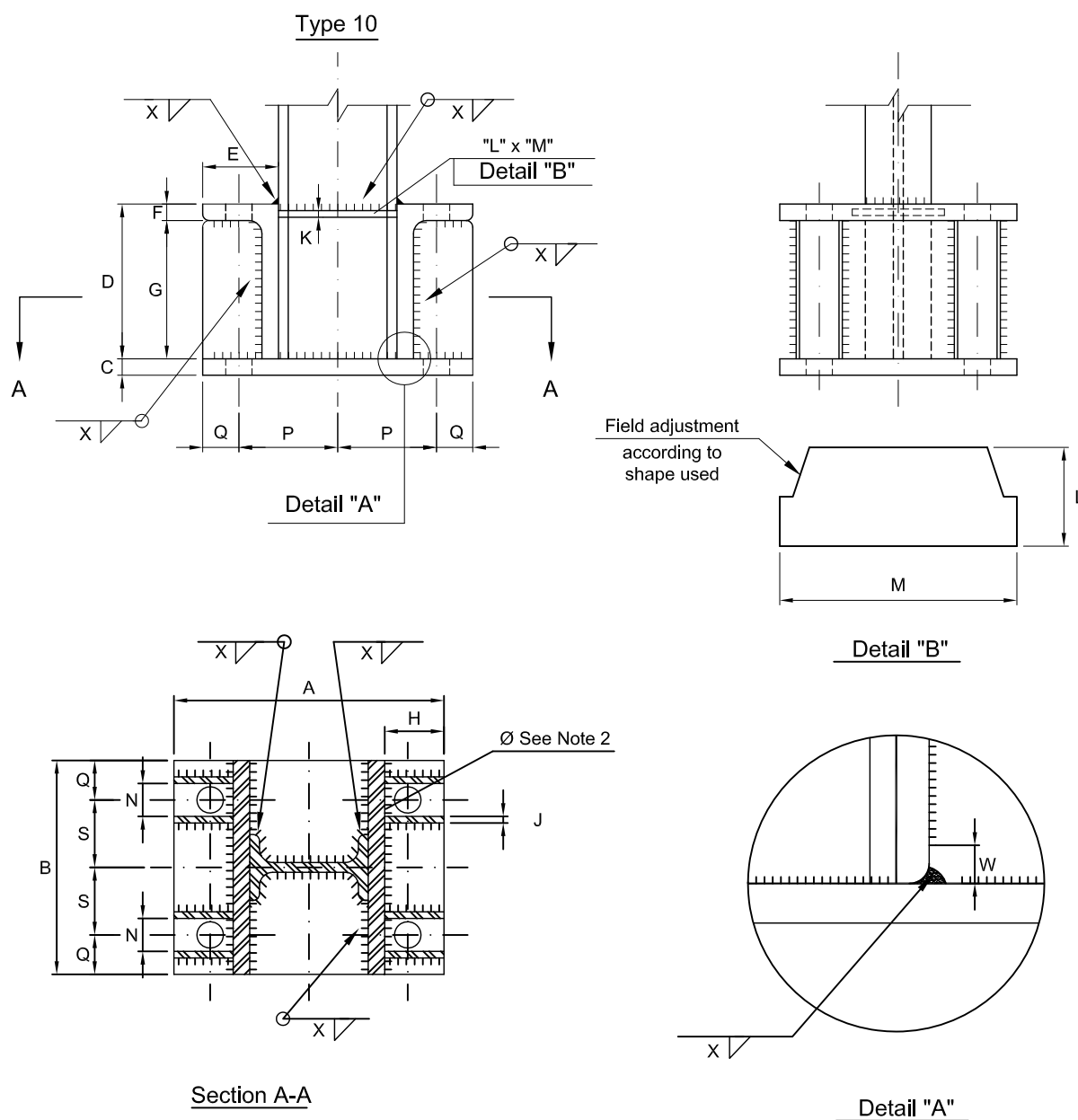


Type	I	Base plate						
		A	B	C	D	P	Q	S
1	6"	380	380	3/4"	–	140	50	140
2	8"	380	430	3/4"	–	140	50	165
3	10"	380	480	1"	–	140	50	190
4	6"	360	360	1"	–	130	50	130
5	8"	400	400	1"	–	150	50	150
6	6"	260	360	3/4"	130	–	50	130
7	8"	300	400	3/4"	150	–	50	150
8	6"	250	250	1/2"	125	75	50	–
9	8"	300	300	1/2"	150	100	50	–

NOTE 1 Dimensions in millimeters, except where otherwise indicated.

NOTE 2 Base plate holes shall have anchor bolt diameter + 6 mm.

Figure A.16 - Base for Column I - Types 1 to 9



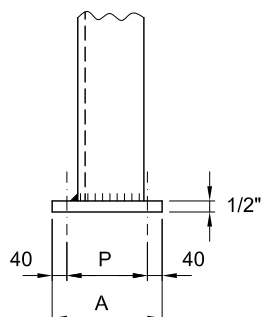
I	Base plate			Angle iron			Ref. plate			Ref. plate									
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	S	X	W	
12"	610	510	1 1/4"	8"	6"	5/8"	187	136	5/8"	5/8"	110	302	80	225	80	175	8	17	
14"	800	660	1 1/2"	8"	6"	3/4"	184	133	3/4"	3/4"	210	493	80	320	80	250	9	19	
18"	900	680	1 1/2"	8"	6"	3/4"	184	133	3/4"	3/4"	250	593	80	370	80	260	9	19	

NOTE 1 Dimensions in millimeters, except where otherwise indicated.

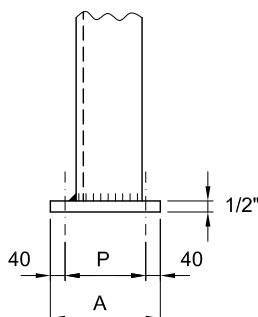
NOTE 2 Base plate holes shall have anchor bolt $\varnothing + 8$ mm.

Figure A.17 - Base for Column I - Type 10

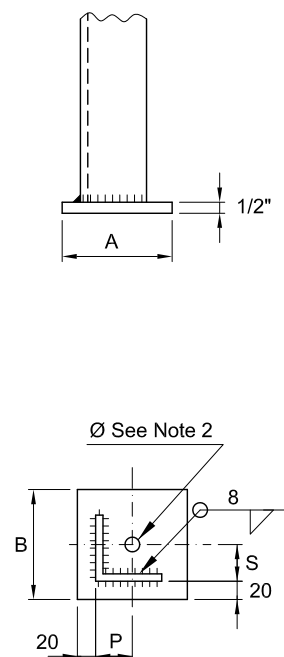
Types 11, 12, 13



Types 14, 15, 16



Types 17, 18, 19 and 20



Type	L	Base plate				
		A	B	S	F	P
11	4" x 4"	210	210	130	–	130
12	5" x 5"	230	230	150	–	150
13	6" x 6"	260	260	180	–	180
14	4" x 4"	210	210	130	75	130
15	5" x 5"	230	230	150	75	150
16	6" x 6"	260	260	180	80	180
17	3" x 3"	150	150	55	–	55
18	4" x 4"	200	200	80	–	80
19	5" x 5"	200	200	80	–	80
20	6" x 6"	250	250	105	–	105

NOTE 1 Dimensions in millimeters, except where otherwise indicated

NOTE 2 Base plate holes shall have anchor bolt diameter + 6 mm.

Figure A.18 - Base for Column L - Types 11 to 20

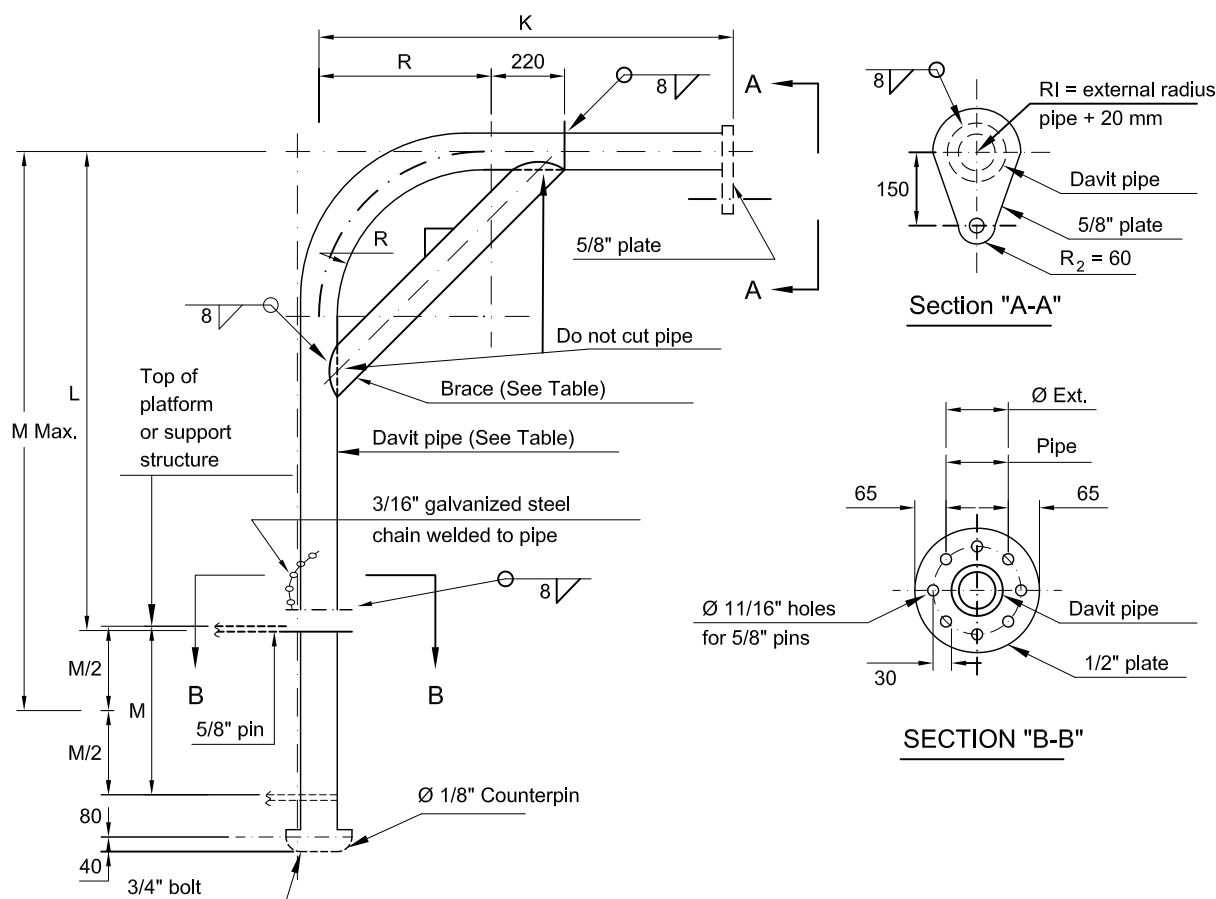


Table for davit loads and dimensions

Loads	k (cm)	Davit pipe	Maximum "H" Heights (cm)		Brace pipe	M
			Without brace	With brace		
0,5 kN	50	2" SCH#40	180	-	-	60
2,5 kN	120 to 150	4" SCH#80	188	260	2"SCH 40	By equipment manufacturer
	151 to 180	4" SCH#160	198	275	Ditto	
	181 to 270	6" SCH#40	365	365	Ditto	
5,0 kN	120 to 150	6" SCH#40	254	350	Ditto	
	151 to 210	6" SCH#80	300	365	3"SCH 40	
	211 to 240	6" SCH#160	345	"	Ditto	
7,5 kN	120 to 140	6" SCH#80	265	"	Ditto	
	141 to 175	6" SCH#160	320	"	Ditto	
	176 to 195	8" SCH#40	355	"	Ditto	
	196 to 230	8" SCH#80	365	"	Ditto	
	231 to 270	8" SCH#80	355	"	Ditto	
10,0 kN	120 to 140	8" SCH#40	365	"	4"SCH 40	
	141 to 180	8" SCH#80	365	"	Ditto	
	181 to 210	8" SCH#80	340	"	Ditto	
	211 to 270	8" SCH#160	365	"	Ditto	

NOTE 1 Davit pipe shall be subjected to hot bending.

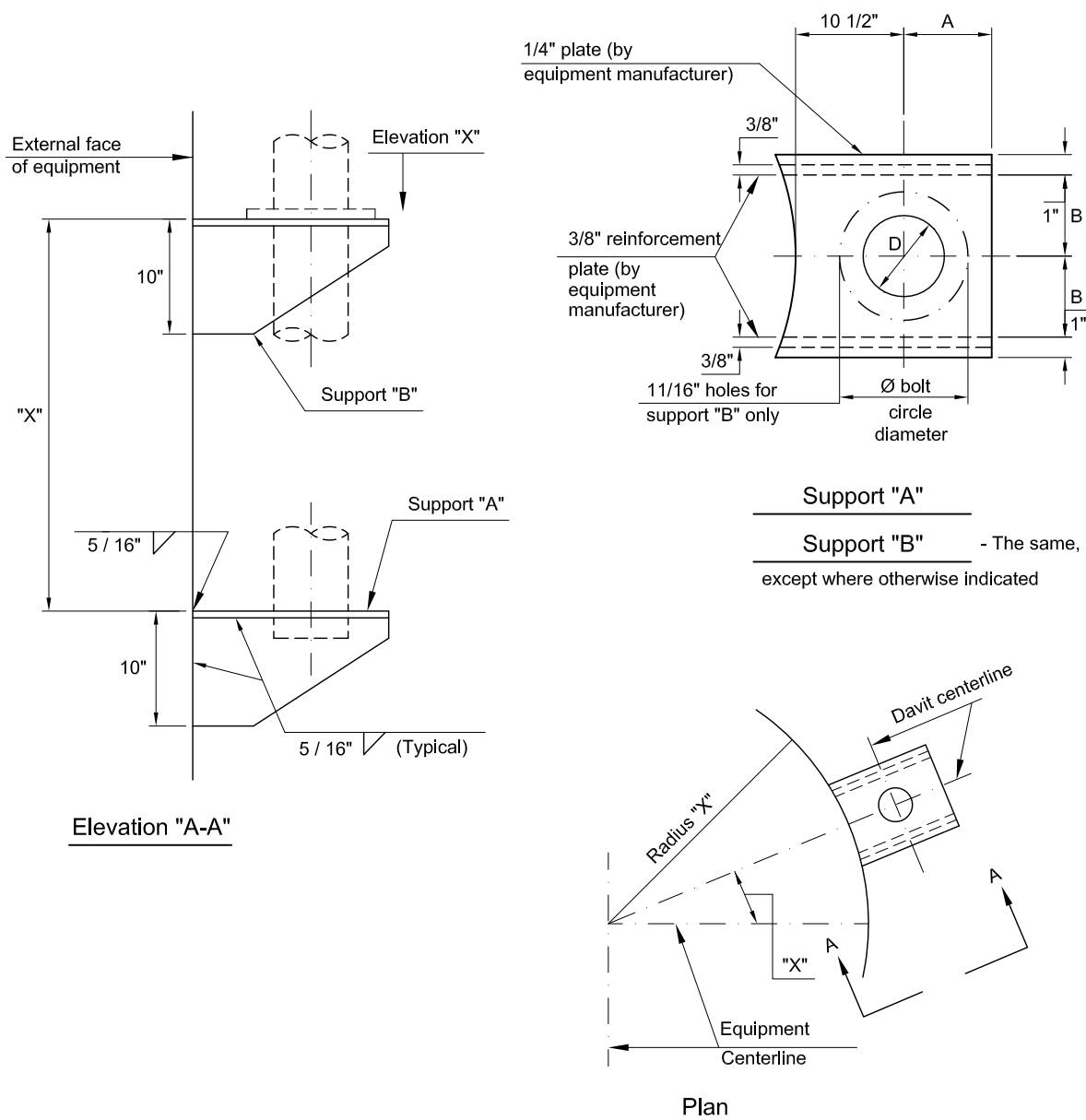
NOTE 2 For dimensions K, L and M, see drawings of metallic structure or equipment.

NOTE 3 Radius "R" of davit shall be approximately equal to 5 x nominal diameter of pipe.

NOTE 4 Davit pipes have been calculated for tabulated loads, plus 25 % of impact and 100 % of cable thrust, respectively.

NOTE 5 Dimensions in millimeters, except where otherwise indicated.

Figure A.19 - Davit



NOTE "X" indicates information contained in equipment or steel structure drawing.

Figure A.20 - Davit Support

INDEX OF REVISIONS	
REV. A, B, C and D	
There is no index of revisions.	
REV. E	
Affected Parts	Description of Alteration
	Revalidation
REV. F	
Affected Parts	Description of Alteration
1.1	Revised
1.1.1	Included
1.2	Included
2	Revised
3.1.1.3	Revised
3.1.1.4	Revised
3.1.2.2	Revised
3.1.2.3	Revised
3.1.2.6	Revised
3.1.2.9	Revised
3.2	Revised
4.1.1	Revised
4.1.2	Revised
4.1.4	Revised
4.1.5	Included
4.1.6	Renumbered e Revised
4.1.7	Renumbered
4.1.8	Renumbered
4.1.9	Renumbered
4.1.10	Renumbered
4.2.5	Excluded
4.3	Included
4.3.1	Included
4.3.2	Included
4.4	Renumbered
4.5	Renumbered
5.1 a 5.5	Included

[illegible]

- e) vibrations;
- f) load due to impacts caused by working fluids (surges, water hammer);
- g) temperature variations in accordance with 3.1.2.10;
- h) wind.

3.2 Materials and Allowable Stresses

Steels for structures, rivets and bolts as well as their allowable stresses shall conform to the standards mentioned in Section 2.

NOTE The use of wide flange shapes instead of sloped flange shapes is recommended.
[Recommended Practice]

4 Specific Conditions

4.1 Operational and Maintenance Facilities

4.1.1 The minimum width of access walkways and platforms shall be 75 cm, which shall be increased to 90 cm when facing manholes of towers, vessels and to 120 cm when facing heat exchanger channels. A space 2 m high and free from obstacles shall be left above platforms, walkways and other floors. Floors of platforms and walkways shall consist of checker plates, gratings or other non-slip materials. The minimum thickness of the floor plates shall be 1/4" (6,35 mm).

4.1.2 Regarding inclined stairways, consider that:

- a) the minimum width shall be 75 cm;
- b) the maximum height of each flight shall be 3,00 m;
- c) landings between flights shall be at least 75 cm long;
- d) inclined stairways with mirror shall form angles between 30° and 38° with the horizontal;
- e) inclined stairways without mirror shall form angles between 45° and 50° with the horizontal.

4.1.3 Regarding vertical stairways, consider that:

- a) the minimum width shall be 45 cm;
- b) the maximum height of each flight shall be 6,00 m;
- c) the rest platform between two flights shall have a minimum length of 75 cm, according to Figure A.2;
- d) for the steps of vertical stairways, round bars with cross elements (CA-50 steel) measuring 1" (or 25 mm) in diameter shall be used, according to detail "A" in Figures A.1 and A.2.

4.1.4 Floor plates of platforms, which are not required to be dismountable, may be welded to the framework. Dismountable plates shall be fastened to the framework by bolts. The maximum weight of removable plate panels shall be 0,5 kN. There shall be 2 holes 3 cm diameter on each panel to facilitate removal. Platform floor plates shall have a 1,2 cm diameter drainage hole for every square meter of plate area.

4.1.5 Guard rails shall be obligatorily placed on all unprotected sides of all platforms, landings, floors and in all inclined stairways. A hand rail shall be installed on the protected side of inclined stairways. This requirement does not apply to stairs attached directly to equipment. On all vertical stairways over 3 m in height guard-rails shall also be placed from 2 m above the base to 1,10 m above the last working level (see Figures A.1 e A.2). Vertical stairways shall also have safety chains at the upper end.

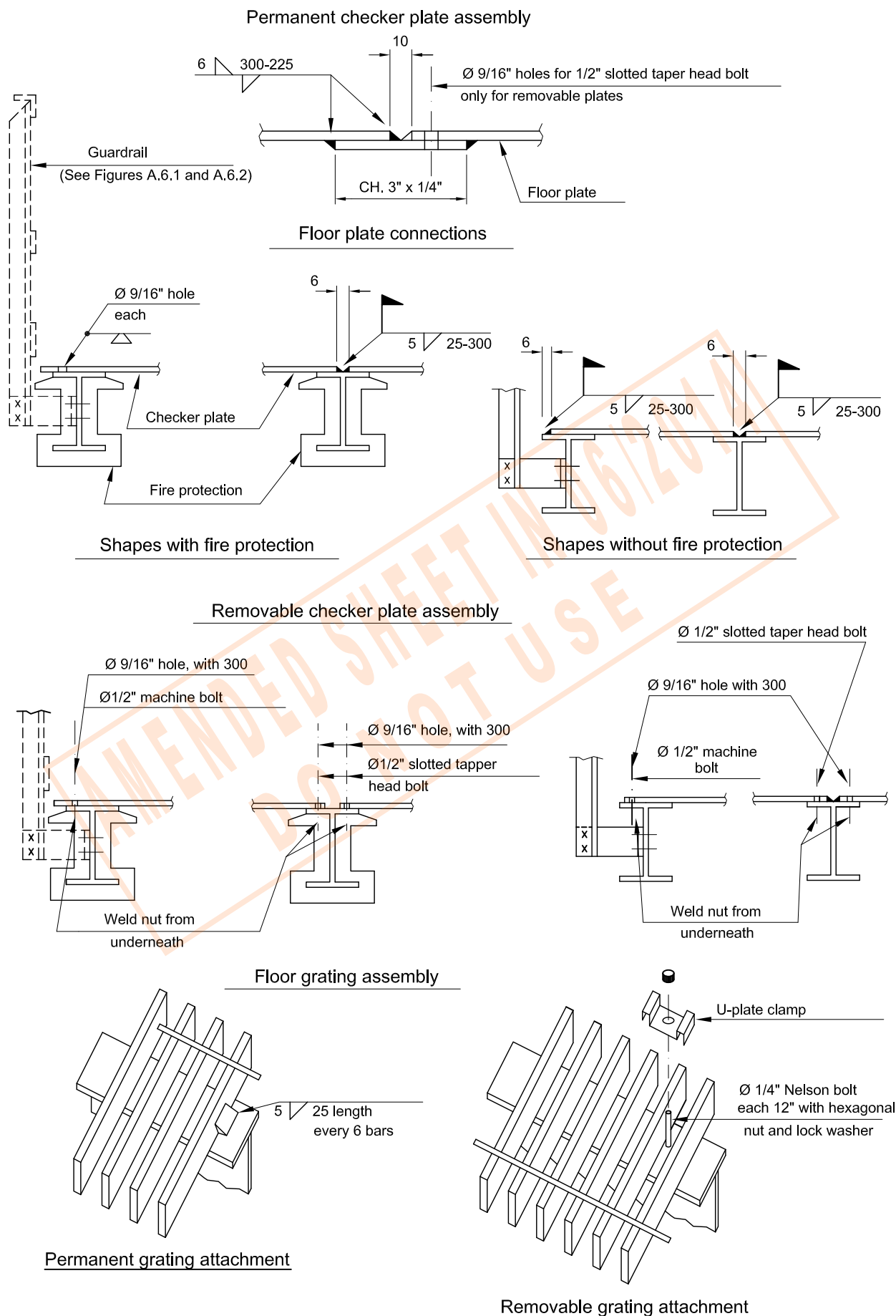


Figure A.7 - Checker Plate-to-Floor Grating Attachment

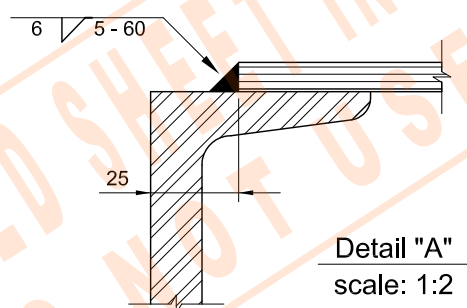
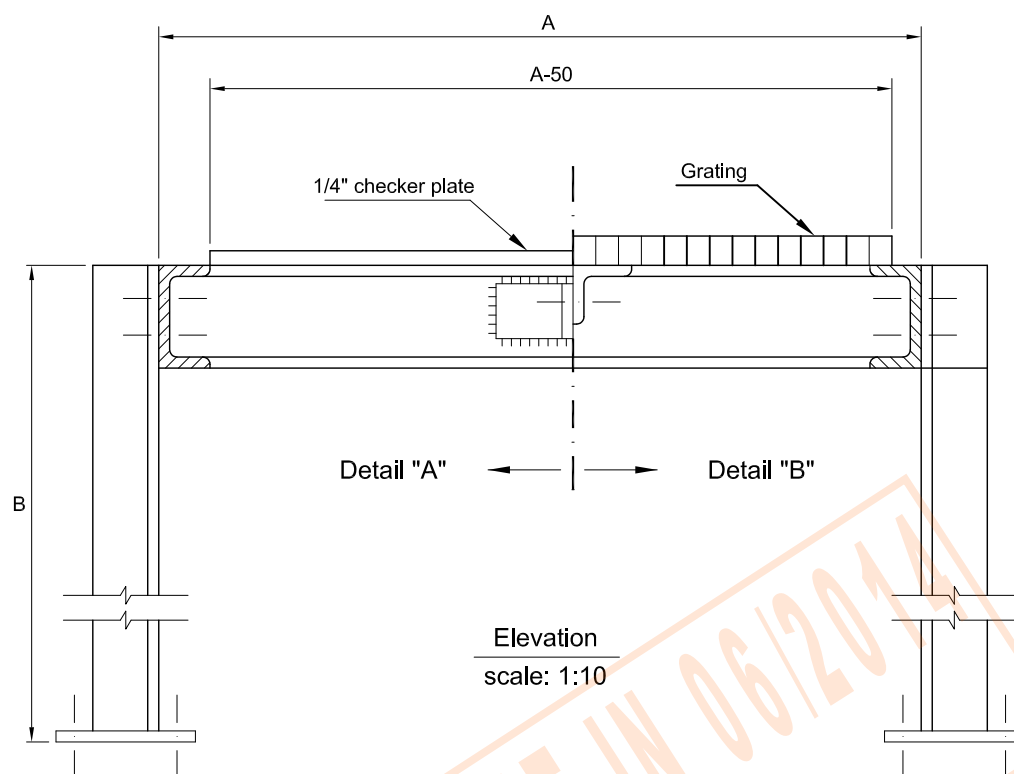
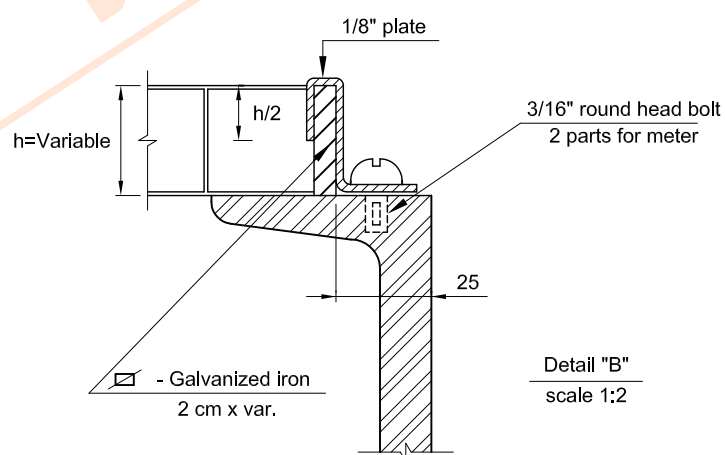


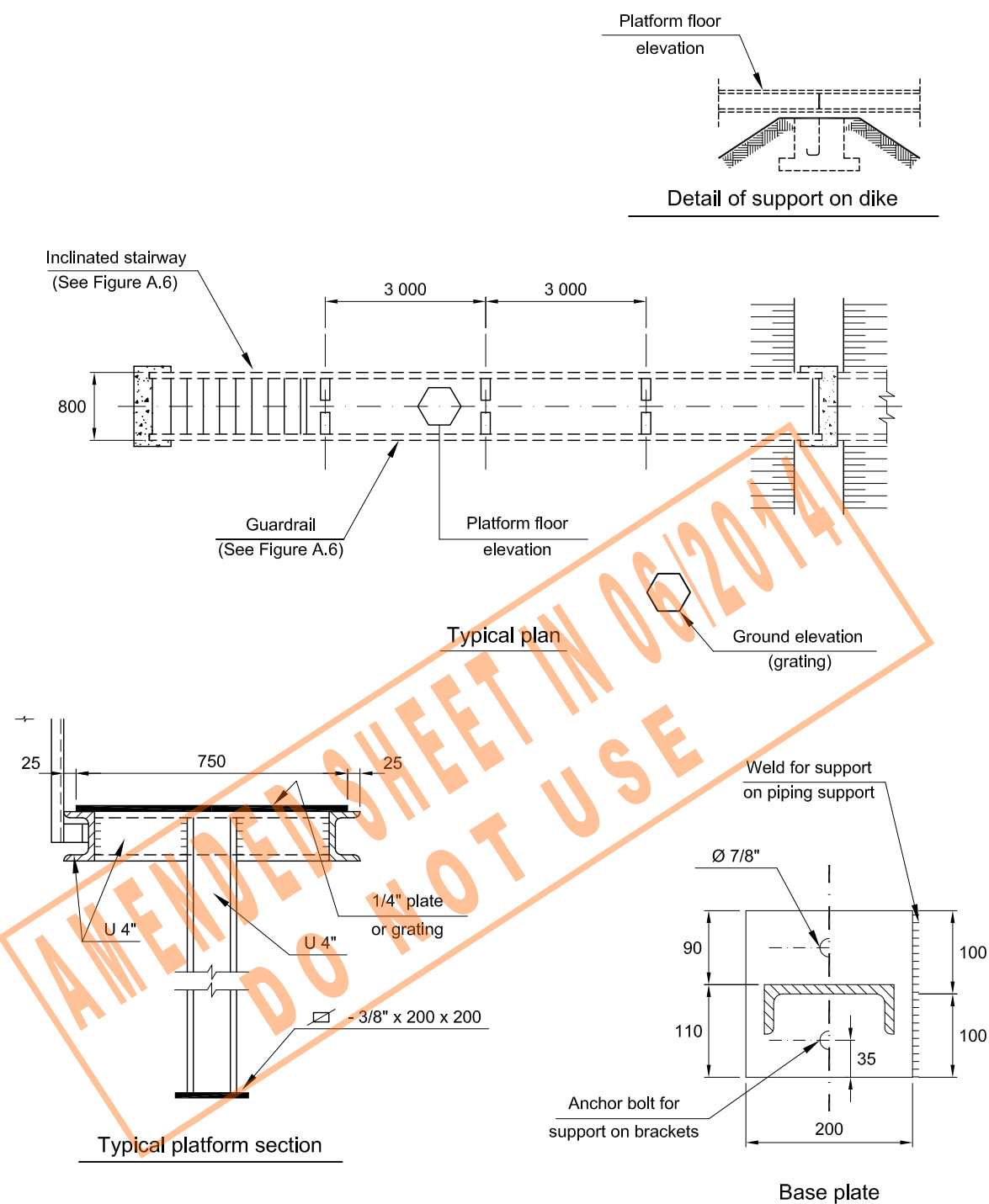
Plate-to-Shape Attachment



Grating-to-Shape Attachment

NOTE Dimensions in millimeters, except where otherwise indicated.

Figure A.12 - Modulated Straight Platform - Elevation



NOTE 1 Coordinates and elevations in meters, other dimensions in millimeters.

NOTE 2 Platform floor shall consist of checker plate 1/4" thick carbon steel or metallic grating.

NOTE 3 Use "U" "E" x 12.2 kg/m for 3 m span and "U" "E" for 4 m span.

Figure A.15 - Work Platform