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Addendum n° 5377.V.BES.1700.1

Addendum to LUMMUS NEDERLAND B.V. SPEC. A. 101
Engineering specification for foundations and
miscellaneous civil construction

1.00 - GENERAL -

1.1 - Code classification Index

This first part of paragraph is canceled.

2.00 - CONCRETE DESIGN -

2.4 - Plant elevation

2.4.1 - delete and substitute

For convenience in the preparation and reading of engineering drawings, the actual elevation of the high point of paving shall be arbitrarily called

- on process area = 99 750

- on off-site = + 150 mm above surrounding grade elevation

2.5 - Design loadings

2.5.3.- conditions of loadings

delete last paragraph and substitute :

c) testing :

- for spheres only

dead load + test load + live load + earthquake

- for other equipment

dead load + test load + live load

2.8 - Anchor bolts

2.8.1 - delete tensile stress of 850 kg/cm² and substitute tensile stress of 1.000 kg/cm²

Add :

all anchor bolts shall have coarse threads

3.00 - MAJOR FOUNDATIONS -

3.1 - Spread footings

3.1.2 - delete second paragraph and substitute

type of foundations	loading conditions	mini factor of safety	
		type I	type II
octogonal	normal operating	2	1,5
rectangular	normal operating	1,75	
all types	erection	1,50	

3.5 - Foundations for rotating and reciprocating equipment

3.5.2 - delete and substitute

Large heavy duty centrifugal pumps centrifugal and reciprocating compressors and other equipment subject to considerable vibration shall be supported on reinforced concrete foundations with a minimum foundation to equipment weight ratio of 5/1 and a maximum calculated vibration amplitude as indicated on the graph of RATHBONE under the curve "GUT" the RATHBONE graph is printed in RAUSCH handbook for machine foundation 3rd Edition 1959, page 260.

5.2 - Concrete paving -

- 5.2.4 - delete 15 mm and substitute 12 mm
delete 15 m and substitute 30 m

6.00 - MISCELLANEOUS CONCRETE CONSTRUCTION -

6.2.2 and 6.2.3 - delete and substitute

sumps shall be provided with checkered steel plate covers, except in Process area and traffic areas where covers and frames shall be made of cast iron (see standards PROCON/TECHNIP).

7.00 - ROADS -

- 7.3 - Bituminous macadam roads
7.4 - Asphaltic concrete roads
7.5 - Sheet asphalt roads

These paragraphs are deleted and substituted by the specification for installation of construction roads PETROSUL - Req. 6877.S.2507 and Job specification PROCON/TECHNIP n° 5377.V.BES.1450.1.

12.00 - PILING -

This paragraph is canceled.

15.00 - FOUNDATIONS FOR STORAGE TANKS -

This paragraph is deleted and substituted by the specification for installation of construction tank foundation PETROSUL - Req. 6877.S.2507 and Job specification PROCON/TECHNIP n° 5377.V.BES.1440.1.

16.00 - SPECIFIC JOB REQUIREMENT -

16.2 - Concrete design

1°/ Add :

- regulamento de betoes de ligantes hidraulicos
 - Caderno de Encargos e sen anexo para o fornecimento e recepção "Portland normal" (decreto n° 40 870 du 22.11.56
41 127 du 24.05.57)
- e da portaria n° 18 189 du 5.01.61.

eventually

- caderno de Encargos e sen anexo para o fornecimento e recepção do cimento pozolânico normal
- caderno de Encargos e sen anexo para o fornecimento e recepção do cimento de alto forno 60/80 (decreto n° 49 371 du 11.11.69).

2°/ Add :

- B 225 for elevate concrete structure
 B 300 for basins, separators and cooling lower bassin

3°/ Delete :

reinforcement spec.

A 50 welded wire fabric for paving & trenches

A 40 T and/or A 24 for other reinforcing with prominences

16.3 - Site conditions -

a) allowable soil bearing pressure

delete 3 kg/cm² to 5 kg/cm²

add :

allowable soil bearing pressure to be determined from current soil investigation.

A Allowable bearing pressure may be increased by 25 % for earthquake or exceptional wind loading.

b) depth of foundations

delete and substitute.

Depth shall be define at the proposal of engineering.

c) rainfall

add 80 mm/h for 10 mn.

16.4 - Elevations

Delete and substitute.

Elevation 100.000 equals elevation 42,90 m (NGP)

grade elevation of product storage area = 41,90 m (NGP)

" " process area = 42,65 m (NGP)

" " crude storage area = 44,30 m (NGP)

Elevation high point of paving on process area = 99 750

Elevation top of foundations = 100.000 (include grout).

In process area

elevation floor slabs + 99,900

elevation crown of road + 99,950

In off-sites area

elevation floor slabs = + 150 mm above surrounding grade elevation

" crown of roads + 200 mm " " " "

" top of rail road + 200 mm " " " "

16.5 - Anchor bolts

Delete and substitute.

Material specification according ANSI standards allowable design stress - 1.000 kg/cm².

16.9.- Standard drawings

1°/ Add : standard drawings AN 6877.104.J
structural standards typical dykes details

2°/ Add : for execution of this contract, see standards drawings issue by
PROCON/TECHNIP.

JN 6877

Petrosul
Sines, Refinery

A-101

ENGINEERING SPECIFICATION.

FOR

FOUNDATIONS AND MISCELLA-
NEOUS CIVIL CONSTRUCTION

CODE OF ACCOUNTS CLASSIFICATION - AA

Rev. 0 - "Approved for Construction" - 22-2-1973
Rev. 1 - "Revised" - 29-3-1973
Rev. 2 - Revised pages 5 & 20
Added Section 16 with attms - 6-4-1973
Rev. 3 - Revised page 5 - 4-5-1973
Rev. 4 - Revised pages 4, 10, 12, 16, 18
and Section 16, pages 2, 3, 11, 13 - 16-5-1973
Rev. L5 - Revised as per $\triangle 5$ - 29-6-1973
Rev. L6 - Revised as per $\triangle 6$ - 30.8.1973
Added Attachment No. 1
Rev. L7 - Revised as per $\triangle 7$ 30/10/74

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1.0 GENERAL

1.1 Code Classification Index

- AA - Foundations - Major
- AB - Foundations - Minor
- AC - Paving
- AD - Miscellaneous Concrete Constructions
- AE - Roads
- AF - Railroad Sidings
- AG - Dikes
- AH - Fences
- AI - Site Clearing
- AJ - Piling
- AK - Earthwork
- AL - Culverts and Road Crossings
- AM - Storage Tank Foundations

1.2 Intent

The intent of this specification is to define qualitatively the various civil engineering elements which may be included in the plant. It is intended that this specification shall be used as a basis and guide for the preparation of detailed engineering drawings and requisitions for materials.

1.3 Scope

This specification covers the general requirements for the design, construction and testing of various civil engineering plant elements listed in par. 1.1 - Code Classification Index. The specific plant elements which are included in the plant shall be listed and defined in the Project Specifications.

1.4 Specific Job Requirements

Section 16 - Specific Job Requirements is intended to cover modifications to this specification, local requirements as well as specific job data pertinent to this specification. Where section 16 is in contradiction to other sections of this specification, section 16 shall govern.

2.0 CONCRETE DESIGN

2.1 Codes

- 2.1.1 The design, mixing, placing, control and testing of reinforced concrete construction shall be in accordance with the applicable Portuguese concrete Code, except where modified by local government regulations and/or special requirements.
- 2.1.2 Design loadings including wind and earthquake shall be in accordance with the Portuguese Building Code or in accordance with other local governing regulations.

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2.0. CONCRETE DESIGN (Cont'd)

2.1. Codes (Cont'd)

2.1.3 The requirements of the Codes referred to in the preceding paragraphs shall be considered as the minimum requirements. Modifications for local government regulations and/or special requirements shall be made only if they exceed the requirements of the Codes.

2.2. Materials

2.2.1 Material specifications for cement, aggregates, water reinforcing bars and wire or welded wire fabric shall generally be in accordance with or equivalent to the requirements of the norms and specifications of Portugal referred to therein or shall be the approved substitute as manufactured outside of Portugal.

2.2.2 Specific material specifications for cement, aggregates, and metal reinforcement as well as the ultimate strengths of the concrete, to be used in the design are covered in section 16 - Specific Job Requirements.

2.3. Soil Bearing Pressure and Depth of Foundations

2.3.1 The design value for the allowable soil bearing capacity and required depth of foundations shall be based on competent soil investigations and recommendation.

2.3.2 General design values are specified in section 16 - Specific Job Requirements. These design values are based on a soil investigation report (estudo dos terrenos de fundação da refinaria Petrosul em Sines prepared by the "Laboratório Nacional de Engenharia Civil".

2.3.3 Allowable soil bearing pressures for various portions of the site may differ based on local subsurface conditions as well as on an analysis of the type of equipment and structure loading. It is the General Contractors responsibility that correct soil bearing values are taken and therefore the General Contractor shall in each individual case ensure himself that the General Design figures can be maintained or the deviating figures are to be used.

2.4. Plant Elevation

2.4.1 For convenience in the preparation and reading of engineering drawings, the actual elevation of the high point of paving shall be arbitrarily called 100.000

2.4.2 Elevations of high points of paving, tops of foundation ground floors, etc. are specified in section 16-Specific

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2.0 CONCRETE DESIGN (Cont'd)

2.5 Design Loadings

2.5.1 Wind loadings to be used are as follows:

Habitual - Exentional

90 Kgf/m ²	150 Kgf/m ²	for height from 0 to 15m
105 Kgf/m ²	180 Kgf/m ²	for height from 15 to 40m
120 Kgf/m ²	210 Kgf/m ²	for height from 40 to 120m
135 Kgf/m ²	240 Kgf/m ²	for height from 120 to 200m

Reduction factor for circular shapes: 0,6.

2.5.2 Earthquake coefficients of zone A are to be used. The choice of the coefficient depends on the nature of construction and its foundations. In general the earthquake coefficients to be used range from C= 0,10 to C= 0,30.

However the General Contractor shall contact the "Laboratório Nacional de Engenharia Civil" (LNEC)-Structural D to verify for each individual case the coefficients to used.

2.5.3 Foundations shall be designed for all of the following conditions of loadings:

Type I

- erection - dead load + habitual wind
- operating- dead load + operating load + live load + habitual wind
- testing - dead load + test load + live load

Type II

- erection - dead load + earthquake or exencional
- operating- dead load + operating load + live loa + earthquake or exentional wind.
- testing - dead load + test load + live load + earthquake.

2.5.4 Minimum live loads for structures and platforms, increa for impact and reduction for multi-level structures sh be in accordance with the Engineering Specification fo Structures, Code Classification J-101.

2.6 Allowable Unit Stresses

- 2.6.1
- Allowable unit stresses shall be as stipulated in cable Portuguese Concrete Codes except where modif by local requirements.
 - The stresses obtained by using the load combinatic pe I, multiplied by a coefficient C=1.5, may not exc the yield stress.
 - The stresses obtained by using the load combinatic pe II, multiplied by a coefficient C=1, may not exce the yield stress.
 - It is obvious that in order to obtain the most ext condition (stress), calculations are to be performe both load combination types (types I and II)

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2.0 CONCRETE DESIGN (Cont'd)

2.7 Reinforcing Steel

Reinforcing bars shall be deformed and of an intermediate grade billet steel conforming or equivalent to the Portuguese specifications. Plain bars may be used when so indicated by local practices and Codes.

2.8 Anchor Bolts

2.8.1 Anchor bolts shall be designed for all conditions of loading indicated in par. 2.5.1 and shall be based on maximum allowable unit tensile stress of 850 kg/cm² at the root of the thread for carbon steel bolts.

2.8.2 Anchor bolts for all equipment installations such as towers, tanks, exchangers, pumps and compressors, shall be provided with sleeves. No sleeves are required for structural steel columns.

2.9 Grout

2.9.1 The tops of all foundations shall take into consideration a minimum allowance of 25 mm for grout.

2.9.2 All grout shall be composed of one part cement and two parts clean sand. A suitable non-shrink agent shall be added for grout supporting heavy loads where close alignment must be maintained. Non-shrink grout be used for compressors, turbines, generators, etc.

2.10 Exposed Concrete

2.10.1 All exposed edges of concrete foundations, piers and footings shall have a minimum chamfer of 25 mm.

2.10.2 All exposed concrete surfaces shall be left reasonably smooth and free of excessive form marks and honeycombing. No general rubdown of concrete surfaces shall be made except where specifically called for on the design drawings.

3.0 MAJOR FOUNDATIONS

3.1 Spread Footings

3.1.1 Spread footings of octagonal shape shall normally be used for supporting towers, vertical tanks and drums, chimneys and stacks. Circular foundations may be used.

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3.0 MAJOR FOUNDATIONS (Cont'd)

3.1 Spread Footings (Cont'd)

3.1.2 Foundations for towers, stacks and similar equipment shall be designed with a minimum factor of safety against overturning as follows:

Type of Foundation	Loading Conditions	Min. Factor of Safety
Octagonal	Normal Operating	2,0
Rectangular	Normal Operating	1,75
All types	Erection	1,50

For the erection loading condition, it shall be assumed that backfill is in place and that tower platforms have been attached. Removable tower internals shall be assumed as having not been installed.

3.2 Combined Footings

Combined footings may be used when supported loads are so close as to make individual footings nearly touch or overlap. For uniform load distribution, the centroid of the bearing area shall coincide with the resultant of the applied operating load but excluding live loads.

3.3 Mat Foundations

Mat foundations may be used where uneven soil conditions exist and where differential settlement is to be avoided.

3.4 Piers and Pedestals

3.4.1 Small footings for piers and pedestals supporting equipment such as exchangers, horizontal tanks, etc. shall normally be separate and individual.

3.4.2 Piers and footings supporting exchangers shall, except for horizontal loads due to earthquake conditions, be designed for vertical loads only. When tube bundles are removable and pulling beams or dead men are being provided, the fixed end pier and fitting shall be designed for a horizontal force in addition to the normal loading condition.

3.4.3 Where equipment is subject to thermal expansion, the pedestal at the moving end of the equipment shall be provided with a steel slide plate.

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3.0 MAJOR FOUNDATIONS (Cont'd)

3.5 Foundations for Rotating and Reciprocating Equipment

3.5.1 Foundations for centrifugal and slow acting reciprocating pumps or other rotating equipment shall normally be of the block type of plain concrete. Foundation pads for small pumps may be set on floor pad or paving with expansion bolts.

3.5.2 Large heavy duty centrifugal pumps, centrifugal and reciprocating compressors and other equipment subject to considerable vibration shall be supported on reinforced concrete foundations with a minimum foundation to equipment weight ratio of 5:1 and a maximum calculated vibration amplitude of 10μ for table tops and 25μ for block foundations.

3.5.3 Foundations for groups of large reciprocating equipment shall be tied together in a common foundation slab where practical.

3.5.4 Foundation designs for large reciprocating or rotating equipment such as compressors, turbines, generators, etc. shall be reviewed by the equipment manufacturer.

3.6 Building Foundations

Building foundations supporting building columns shall normally be of the individual block type, square or rectangular. Where soil conditions permit, circular under-reamed footings may be used. Reinforced concrete grade beams shall be used to support masonry walls. Footings for masonry buildings shall be proportioned for dead load.

3.7 Yard Structure Foundations

Foundations for yard structures such as pipe support bents and stanchions, poles, etc. shall normally be of the individual block type, square in shape. Where soil conditions permit, circular under-reamed footings may be used. In paved areas, footings for columns with load less than 2,5 metric tons may be set on the paving slab

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4.0 MINOR FOUNDATIONS

Minor foundations which include such foundations as stair pads, ladder pads, small miscellaneous piers, etc. may be either doweled into or be independent of paving :

5.0 PAVING

5.1 General

- 5.1.1 Unless indicated otherwise in section 16 - Specific Job Requirements, all paving within battery limits of process units shall be of reinforced concrete.
- 5.1.2 Unpaved areas both inside and outside of battery limits may be surfaced with earth, crushed stone, gravel, shell, cinders, bricks or other native or local material as specified in section 16 - Specific Job Requirements.
- 5.1.3 The extent and type of paving and surface treatment of unpaved areas shall be as indicated on the general paving drawing.
- 5.1.4 Roads shall be as specified under par. 7.0.

5.2 Concrete Paving

- 5.2.1 Concrete paving around pumps, exchangers and small equipment shall be considered as "light duty" paving and shall consist of 100 mm thick concrete reinforced with 4 mm x 150 x 150 wire fabric.
- 5.2.2 Concrete paving in areas subject to mobile equipment loads shall be considered as "heavy duty" paving and shall consist of 150 mm thick concrete reinforced with 2 layers of 6 mm x 150 x 150 wire fabric.
- 5.2.3 Concrete used for paving shall contain a suitable agent for control of air entrainment.
- 5.2.4 15 mm expansion joints shall be provided at a maximum spacing of 15 m and around all foundation and piers and projecting through the paving. Expansion joints shall be filled with a standard preformed resilient joint filler over the width and depth of the concrete contact section.

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5.0 PAVING (Cont'd)

5.2 Concrete Paving (Cont'd)

5.2.5 Concrete paving shall be laid over well compacted backfill.

5.2.6 Concrete paving shall be properly sloped to provide adequate drainage. A minimum slope of 1:100 shall be provided. The surface of concrete paving shall be wood float finished.

△

△
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5.3 Ground Floors

Floor slabs under structures and roofs other than those in buildings shall be executed in the same manner as specified in par. 5.2 - Concrete Paving.

6.0 MISCELLANEOUS CONCRETE CONSTRUCTIONS

6.1 Pipe and Cable Trenches

6.1.1 Pipe trenches shall be constructed of reinforced concrete. Trench walls and floors shall have a minimum thickness of 125 mm and 100 mm respectively. Where site conditions are such that natural drainage exists, trench floors may be omitted.

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6.0 MISCELLANEOUS CONCRETE CONSTRUCTION (Cont'd)

6.1 Pipe and Cable Trenches (Cont'd)

- 6.1.2 Pipe trenches shall be provided with checkered plate or concrete covers supported on curb angles. Trench covers shall be designed for a specific concentrated load based on the trench location or a minimum loading of 500 kg/m² whichever is the greater. Trench covers shall be flush with adjacent paving and paving shall slope away from the trench.
- 6.1.3 Pipe trenches which have concrete floors, shall be suitably sloped and drained. Concrete floors shall be provided at intervals of 30m with an expansion joint.
- 6.1.4 Pipe trench dimensions shall be such as to provide a minimum of 100 mm clearance between pipe flanges and trench walls or floors.
- 6.1.5 Pipe trenches for acid piping containing valves, flanges or other fittings subject to leakage shall be lined with acid resistant brick, plaster or concrete.
- 6.1.6 The installation of underground electrical cables shall be carried out in accordance with the Engineering Specification for installation Code Classification H-107.
- 6.1.7 When the latter specification calls for installation of cables in trenches, trenches shall be constructed of reinforced concrete with walls having a minimum thickness of 125 mm. No trench floor is to be provided.
- 6.1.8 Cable trenches are to be filled with sand and are to be provided with red concrete covers.
- 6.1.9 The installation of underground instrument piping shall be carried out in accordance with the Engineering Specification for Piping, Code Classification H-101 and/or Instruments, Code Classification K-101.
- 6.1.10 When the latter specifications call for the installation of underground instrument piping in trench trenches shall be constructed in the same manner as cable trenches described in par. 6.1.7 and 6.1.8 above.

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6.0 MISCELLANEOUS CONCRETE CONSTRUCTION (Cont'd)

6.2 Sewer Sumps

- 5
- 6.2.1 Sewer sumps shall be of reinforced concrete construction in accordance with standard sewer sump designs.
 - 6.2.2 Sumps shall be provided with a 600 mm diameter cast iron cover set in a cast iron frame flush with top of concrete paving or finished grade in unpaved areas.
 - 6.2.3 Sumps deeper than 1200 mm shall be provided with cast iron manhole covers.
 - 6.2.4 Sumps in acid service shall be lined with acid resistant brick.

6.3 Valve Pits

- 6.3.1 Valve pits shall be of reinforced concrete construction with walls and floor of a minimum thickness of 125 mm and 100 mm respectively. Where site conditions are such that natural drainage is available, pit floor may be omitted.
- 6.3.2 Valve pits shall be provided with checkered plate covers with hinged openings for T wrench operation of valves. If valves are so situated that valve parts extend above the valve pit, the pit shall have an open top provided with guard railing.

6.4 Septic Tanks

- 4
- 6.4.1 Septic tanks shall meet local Code requirements. Prefabricated manufacturer's standard septic tanks may be used where available.
 - 6.4.2 Tanks shall be provided with a 500 mm cast-iron manhole cover flush with grade level.
 - 6.4.3 Top of septic tanks shall be located at a minimum depth of 300 mm below finished grade.

6.5 Cooling Tower Basins

- 6.5.1 Cooling tower basins shall be of reinforced concrete construction designed to meet the requirements of the cooling tower loads, hydrostatic loads and buoyancy.

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6.0 MISCELLANEOUS CONCRETE CONSTRUCTION (Cont'd)

6.5 Cooling Tower Basins (Cont'd)

- 6.5.2 The depth of the basin shall be governed by the hold-up time required.
- 6.5.3 The peripheral supports of the cooling tower shall be carried on concrete piers built integrally with the basin walls. Intermediate supports shall rest directly on the basin floor.
- 6.5.4 Cooling tower basins shall be provided with removable screens at outlets to the pump suction chamber. Type and dimensions of the pump suction chamber shall be as required for the pumps specified in the Engineering Specification for Pumps and Drivers, Code Classification G- 101.
- 6.5.5 For horizontal type pumps, a pump pit and adjoining suction stilling chamber shall be provided. The pump pit shall be provided with guard rails and access ladder.
- 6.5.6 For vertical pumps, a pump pit shall be provided covered with a concrete slab suitable for supporting pumps and drivers. Concrete cover slab shall be provided with a 500 mm manhole and manhole cover. Pump pit shall be provided with cast iron manhole steps.
- 6.5.7 Pump pit and stilling chamber floors shall be provided with corner sumps and floors shall be sloped towards sumps.

6.6 Separators

- 6.6.1 Type, design basis and appurtenances for oil-water gravity separators shall be as specified elsewhere in the Project Specifications.
- 6.6.2 Oil-water separators shall be of reinforced concrete construction suitable to meet the requirements of hydrostatic loads and buoyancy.

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6.0 MISCELLANEOUS CONCRETE CONSTRUCTION (Cont'd)

6.7 Firewalls

- 6.7.1 Where space requirements are limiting, firewalls around storage tanks containing flammable liquids may be of reinforced concrete construction.
- 6.7.2 The diked area shall be square or rectangular in shape and the capacity of the diked area shall be in accordance with the National Fire Protection Association Codes and local government regulations and as specified in par. 9 - Dikes.
- 6.7.3 Reinforced concrete firewalls shall be designed to withstand hydrostatic loads based on the diked area full of water. Firewalls in between tanks shall be designed for hydrostatic loads on either side.

7.0 ROADS

7.1 General

- 7.1.1 Roads shall be concrete, bituminous, gravel or crushed stone, shell, earth or other material as specified in section 16 - Specific Job Requirements.
- 7.1.2 Extend of roads shall be as indicated on the plotplan.
- 7.1.3 Roads shall be placed on firm foundations and shall be suitably crowned for adequate drainage.
- 7.1.4 Locally available materials and local road commission regulations and recommendations shall be taken into consideration in the design of foundations and wearing courses.

7.2 Concrete Roads

- 7.2.1 Reinforced concrete roads shall consist of 150 mm thick concrete reinforced with 6 mm x 150 x 150 wire fabric. The concrete shall contain a suitable agent for control of air entrainment. Concrete pavement shall be laid on a well compacted and well drained subgrade of uniform density.

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7.0 ROADS (Cont'd)

7.2 Concrete Roads (Cont'd)

7.2.2 Where subgrade is of poor soil, it shall be replaced with broken stone, gravel, cinders, or other suitable material which may be locally available.

7.2.3 The thickness of subgrade shall depend on the subsoil encountered. In no case shall the compacted thickness of subgrade foundations be less than 150 mm.

7.3 Bituminous Macadam Roads

7.3.1 Bituminous Macadam Roads shall consist of a layer of aggregate on a subgrade foundation and impregnated with an asphalt binder.

7.3.2 Foundations shall be of broken stone, slag, gravel or other suitable locally available material. Thickness of foundations shall depend on the subsoil encountered, but in no case shall the compacted thickness be less than 75 mm.

7.3.3 The wearing course shall consist of a minimum of 75 mm of compacted broken stone, bound with asphalt binder shall be applied in two layers separated by a layer of 18 mm stone chips.

7.3.4 The surface is to be finished with stone chips, pea gravel or coarse sand applied to the second binder coat prior to final rolling.

7.4 Asphaltic Concrete Roads

7.4.1 Asphaltic concrete roads shall consist of a layer of plant mixed asphaltic concrete placed on a suitable prepared foundation.

7.4.2 Foundations for asphaltic concrete roads shall be as specified in par. 7.3 - Bituminous Macadam. Foundations shall be bound with a rolled course of screenings varying from 13 mm to dust.

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7.0 ROADS (Cont'd)

7.4 Asphaltic Concrete Roads (Cont'd)

7.4.3 The asphaltic concrete shall consist of plant mixed, hot laid mixture of aggregate and bituminous cement and shall be laid to a minimum thickness of 50 mm consisting of a 25 mm binder course and a 25 mm surface wearing course.

7.4.4 Recommendations of the asphaltic concrete mixture manufacturer shall be taken into consideration in the design of asphaltic concrete roads.

7.5 Sheet Asphalt Roads

7.5.1 Sheet asphalt roads shall consist of a layer of plant mixed asphalt laid on a suitable foundation.

7.5.2 Foundations for sheet asphalt roads shall be as specified in par. 7.3 - Bituminous Macadam. Base shall be bound with asphalt. Binder shall be applied in two layers separated by a layer of 18 mm stone chips.

7.5.3 The sheet asphalt shall be supplied in two layers, a binder course and a wearing course. The binder course shall consist of a plant mixed, hot laid mixture of asphalt cement with broken stone, slag or crushed gravel, laid 25 mm thick.

7.5.4 The wearing course shall consist of a plant mixed, hot laid mixture of asphalt cement with a hard, durable, finely graded sand and a fine filler such as limestone dust, slate dust or Portland cement.

7.6 Gravel Roads

7.6.1 Gravel roads shall be constructed on a suitable foundation. The gravel shall preferably be of trap rock but may be of granite, limestone or sandstone. The gravel shall be bound with rock dust obtained from the gravel containing a binder to avoid wash out by rain.

7.6.2 Gravel roads shall have a minimum thickness of 150 mm applied and rolled in two layers.

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8.0 RAILROAD SIDINGS

The design and construction of railroad facilities including bed preparation, ballast, curve radii, switch design, clearances, ties, rails, etc. shall be in accordance with the specifications and requirements of the local Railroad Company servicing the siding as well as other regulating authorities.

9.0 DIKES

9.1 Dikes shall be provided around storage tanks containing flammable materials to the extent indicated on the plotplan.

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9.2 Unless limited by space requirements, dikes shall be of well compacted earth construction. All dikes shall have a minimum width at the top of 1.000 mm. The sides shall have a slope consistent with the angle of repose of the earth used.

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9.3. Where the local soil used for dike construction is too porous to prevent liquid penetration, the dike shall either be lined with a well compacted 200 mm minimum thickness layer of clay or other suitable impervious material or be covered with a layer of a bitumen/sand mixture.

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9.4 The area within the dike shall be graded and sloped away from the tank to a suitable valved off drain. Area to be protected to prevent ground from oil contamination.

10.0 FENCES

Unless indicated otherwise in section 16 - Specific Job Requirements, fences are to be of the chain link, barbed wire topped type. The extent of fences and location of gates shall be as indicated on the plotplan.

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11.0 SITE CLEARING

- 11.1 The site shall be cleared of all trees, brush, vegetation and other designated obstructions and brought to rough grade as indicated on the plotplan or other engineering drawings.
- 11.2 Stumps of trees with their major roots shall be removed to a depth of at least 1500 mm below finished grade.

12.0 PILING

12.1 General

- 12.1.1 Type of piling shall be as indicated in section 16 - Specific Job Requirements.
- 12.1.2 Types of piling may be precast reinforced concrete, cast-in-place concrete or pipe.
- 12.1.3 The allowable pile loading shall be based on competent soil investigations and recommendations.

12.2 Cast-in-Place Concrete Piles

- 12.2.1 The selection of the type of cast-in-place concrete pile shall be based on competent soil investigations.
- 12.2.2 Piles may be either of the permanent or removable steel shell type, may be open or closed end and may be of plain or reinforced concrete.
- 12.2.3 Concrete for piles shall have a minimum 28 day compressive strength of 225 kgf/cm². Where soil investigations indicate the likelihood of considerable sulfate attack, consideration shall be given to the use of Type II or Type V portland cement as specified in ASTM C150 - Specifications for Portland Cement.
- 12.2.4 To prevent injury to cast-in-place concrete piles no pile shall be driven without 1.5 m of a freshly poured pile until at least 3 days after pouring.



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12.0 PILING (Cont'd)

12.3 Precast Concrete Piles

Concrete for precast piles shall have a minimum 28 days compressive strength of 320 kg/cm². Where sub-surface investigations indicate the likelihood of considerable sulfate attack, consideration shall be given to the use of Type II or Type V portland cement as specified in ASTM C150 - Specifications for Portland Cement.

13.0 EARTHWORK

13.1 Excavation

Provisions shall be made for controlling water seepage into excavated areas by pumping, sheet piling, concrete seal coat or other suitable means depending on local field conditions.

13.2 Backfill

13.2.1 Excavated areas shall be backfilled to the grad designated on the engineering drawings.

13.2.2 Backfill material shall be obtained from excavated soil, surplus earth from grading or from a designated suitable source. In the latter case approval is to be obtained from owner. No topsoil or material containing vegetation shall be used as backfill material.

13.2.3 Backfill shall be placed in layers not exceeding 300 mm and each layer shall be well compacted.



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13.0 EARTHWORK (Cont'd)

13.3 Drainage

- 13.3.1 Area drainage shall generally be handled by stabilized earthen ditches running adjacent to road shoulders and pipeways.
- 13.3.2 The slope and shape of drainage ditches shall be such as to minimize erosion and sedimentation.
- 13.3.3 Where natural topography of the area creates excessive slopes, ditches may be cascaded or lined with 50 mm of concrete.

14.0 CULVERTS AND ROAD CROSSINGS

- 14.1 Drainage culverts and pipe crossings under roads shall be of reinforced concrete design.
- 14.2 Culverts and crossings shall be laid on firm soil. Backfill shall be carefully tamped as it is placed on the sides of the culverts to provide firm support.
- 14.3 To prevent drainage water from entering and running through pipe crossings under roads, the invert elevation of the culvert shall be higher than the adjacent drainage ditches.
- 14.4 Drainage culverts and pipe crossings under public roads and railroads shall conform to local government regulations.

15.0 FOUNDATIONS FOR STORAGE TANKS

- Foundations for storage tanks shall be designed in accordance with API Std. 650 - Appendix B, Recommended Practice for Construction of Foundations.
- The recess, required to accommodate the tank drain sump(s), to be installed after finishing of tank pad and to be made of same construction as tank pad.

16.0 SPECIFIC JOB REQUIREMENTS

- Section 16 - Specific Job Requirements which follows is a part of and supplements this specification.

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16.0 SPECIFIC JOB REQUIREMENTS

I N D E X

- 16.1 General
- 16.2 Concrete Design
- 16.3 Site Conditions
- 16.4 Elevations
- 16.5 Anchor Bolts
- 16.6 Paving
- 16.7 Roads
- 16.8 Modifications
- 16.9 Standard Drawings
- 16.10
- 16.11 Fencing
- 16.12 Reference



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16.0 SPECIFIC JOB REQUIREMENTS (Cont'd)

16.1 General

Job Number	N 6877
Owner	Petroșul
Type of Plant	Refinery
Location	Sines, Portugal

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16.2 Concrete Design

Materials	See specification of Portug "Regulamento de Estruturas de Betão Armado"
Concrete Spec.	B-180 for paving
Aggregate Spec.	B-225 for all other concret work except otherwise noted
Reinforcement Spec.	A-50 welded wire fabric for paving & trenches A-40 for all other reinforc with prominences.
28 days cube comp. strength	
Foundations	225 kgf/cm ²
Paving	180 kgf/cm ²
Basins & Separators	300 kgf/cm ²
Other (cooling tower basin)	300 kgf/cm ² (With supersulphated cement)

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16.3 Site Conditions

Allowable Soil Bearing Pressure	3 kgf/cm ² for all foundatio less than 5 m ² and large fou dation over 5 m ² , where 5 kgf/cm ² should be use in 1000 mm below grade.
Depth of Frostline	Not applicable
Depth of Foundations	600 mm below grade.
Windload	See Specification 2.5.
Ground Water Level	Varies from -0,5m to 1.5 m see soil Investigation Repc
Rainfall	Max. 1 hr = 25,4 mm 24 hrs = 70. mm 1 month = 151,9 mm
Earthquake Factors	For seismic coefficients see Attachment No. 1

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16.0 SPECIFIC JOB REQUIREMENTS (Cont'd)

16.4 Elevations

Elevation 100.000 equals grade elevation 42,10m of product storage area.

(Grade elevation 42,85 of process area = 100.750)

(Grade elevation 45,00 of crude stor.area = 102.900)



Elevation high point of paving = grade elevation
Elevation tops of foundations = grade elev.-250
(incl.grout)

Elevation floor slabs = grade elev.+150

Elevation crown of roads = grade elev.+200

Elevation top of railroad = grade elev.-200

16.5 Anchor Bolts



Material Spec. according German "DIN" Standards
Allowable Design Stress - 850 kgf/cm²

16.6 Paving



Within battery limits	Reinforced concrete
Outside battery limits	Crushed stone 75 mm thick on 50 mm sand bitumen mix
Treatment unpaved areas	Crushed stone or compacted earth
Footpaths	Precast concrete slabs 600 : wide and 50 mm thick laid on 50 mm bed of fine materials

16.7 Roads



Within battery limits	Concrete type
Outside battery limits	Bitumen surface type

16.8 Modifications



The requirements of the national and/or local regulations shall be adhered to and the more stringent shall prevail.

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16.0 SPECIFIC JOB REQUIREMENTS (Cont'd)



16.9 Standard Drawings

AN 6877-102	Anchor Bolt type A&B
102A	Anchor Bolt type C&CC
102B	Anchor Bolt type D&DD
102C	Anchor Bolt type G
102D	Anchor Bolt type H
102E	Sleeve type
104	Steel Sliding Plates for Exchangers
104A	Steel Sliding Plates for Horizontal Vessel
104B	Cover Support Details
104C	Pipe Sleepers
104D	Joints For Concrete Paving
104E	Typical Road Details
104F	Tank Foundations
104G	Equipment Drain type "A" & "B"
104H	Area Drain type "C"

16.0 SPECIFIC JOB REQUIREMENTS (Cont'd)

16.11 Fencing

For fencing spec. see attachment.

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16.12 Reference

For general reference, see applicable Portuguese specifications and standards.

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16.0 SPECIFIC JOB REQUIREMENTS

16.11 FENCING

16.11.1 General

Scope: This specification covers material and erection of combination chain link and barbed wire fencing for permanent and possible temporary fencing surrounding the site as shown on the drawings including gates.

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16.11.2 Grade and Alignment

A. Grades and Profiles/Permanent Fencing:

The ground shall be graded to meet the finish grades as established on the drawings. The profile of the bottom of the fence shall follow these finish grades with a tolerance of 50 mm.

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B. Grades and Profiles/Temporary Fencing:

The existing ground line shall be rough graded to remove minor irregularities. The profile of the bottom of the fence shall follow the rough grade within a tolerance of 100 mm. Temporary fencing might be installed by the general contractor during construction only. Company specified fence is considered permanent.

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C. Alignment:

Relation of fence line to property line to conform to local legal requirements. The fence shall follow the property or survey line within a tolerance of 12 mm.

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16:0 SPECIFIC JOB REQUIREMENTS (CONT'D)

16.11 FENCING (Cont'd)

16.11.3 Finishes

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- A. Zinc Coating: All steel and iron parts, including fabric and tension wire, shall have a minimum zinc coating of 60 mg/cm² of uncoated surface.
- B. Fence Fabric: The fabric shall be zinc-coat. Hot-dip coating shall be applied after weaving. Electrolytic coating with pure zinc (98%), shall be mill-applied to wire before weaving. Alternate: Fabric can be plastized.
- C. Test of Finishes: All hot dipped zinc-coated steel and iron parts, including the fence fabric and tension wire, shall withstand a minimum of 8, one-minute immersions by the Preece test (see ASTM A 239-41 - reapproved 1965). Electroplated and hot dipped fence fabric wire shall be given the ASTM A-90 stripping test to determine the weight of the zinc coating.

16.11.4 Materials

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- A. Fabric: Use Nr. 9 U.S. Steel Wire Gage (0.143 inch nominal diameter before zinc coating) chain link, woven in 50 mm diamond mesh (maximum distance measured perpendicular to direction of wires). Top and bottom selvage twisted and barbed. Weave fabric from basic open hearth copper (ladle analysis 0.20% minimum) bearing steel wire.
- B. Fittings, Bands, etc.: Use malleable, wrought iron or pressed steel fittings.
- C. Barbed Wire: Use ASTM A-121, Class 3, Nr. 12-1/2 gage steel wire double twisted with 4 point barbs spaced approximately 100 mm apart.
- D. Reinforcing Wire: Use Nr. 7 U.S. Standard gage spring steel tension wire. (4.3 mm).
- E. Posts: Posts shall be made of either steel pipe or reinforced concrete. Any pipe used shall be new, unrejected pipe which is galvanized in & outside. Concrete quality to be 300 Kg/cm².

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16.0 SPECIFIC JOB REQUIREMENTS (CONT'D)

16.11 Fencing (Cont'd)

16.11.4 Materials (Cont'd)

F. Concrete for Post Setting: Concrete base to have a minimum of 100 mm of concrete between the buried post and ground contact surface. Design concrete base to take ordinary strain and shock. Crown concrete at top of ground to shed water.
Concrete quality to be 300 Kg/cm².

G. Rails, Braces and Gate Frames: Fence gates with a width of 1800 mm and over to have a frame of steel pipe with a diameter of 1 7/8" O.D.

If required, toprail and bracing of fences be made of steel pipe 1 5/8" O.D. diameter. For fences 1800 mm and less in width, see local specifications for schedule of sizes for posts, rails and braces, etc.

16.11.5 Construction

A. Line Posts: The standard distance between posts is normally not more than 3000 mm. Line posts are usually set 900 mm and other posts 1050 mm deep. Extension arms to have an angle of 30° turned outwards from the property area for three (3) strands of bar wire at ± 8 inches distance.

B. General: For all other details of construction follow local specifications.

C. Reinforcing Wire: Reinforcings (tension) shall be installed in first mesh from top to bottom of fence. Top wire may be omitted if top rail is called for in requisition.

D. Gates: Type and width of gate openings shall be shown on the plot plan.

16.11.6 Grounding Connections

Fence grounding, when required, shall as specified in . The engineering specification for installation Code Classification N-107.

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16.0 SPECIFIC JOB REQUIREMENTS

16.12 Site Clearing-Earthwork

This specification covers the requirements for earthwork, no work shall be commenced without the written permission of the owner.

16.12.1 Scope

In general the scope of this specification includes the clearing and grubbing, removal of waste materials, stripping, excavating, filling, compacting, rough grading, tank pad and road base preparation, ditching, supplying and installing culverts, culvert head walls, riprapping, slopes other accompanying work as called for and defined this specification and indicated on the drawings. The contractor shall satisfy himself as to the nature of the ground and subsoil so far as is practicable.

Trial holes may have been taken on the works and particulars of the materials thereby obtained and soil data prepared by others, would be available to the General Contractor on request, but guarantee is given of the sufficiency thereof.

16.12.2 Work

All buildings, walls, fences, trees, hedges and other obstructions on the site of the works shall be cleared and disposed off.

Site stripping of vegetable soil shall be carried out to + 20 cm (average) depth.

The excavated material shall be disposed and stored as directed by the owner.

The General Contractor is responsible for the supervision, surveying, labor, equipment, tools, materials and services, including transportation and jobsite facilities required to perform the work indicated.

16.12.3 Surveying

The General Contractor shall provide all surveying a field layout required to locate and establish lines and grades for the work.

Survey reference monuments for horizontal and vertical are located adjacent to the construction work area. Using these reference monuments, the contractor shall perform all surveying and staking required to complete the work described in this specification.

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16.0 SPECIFIC JOB REQUIREMENTS (Cont'd)

16.12 Site Clearing-Earthwork (Cont'd)

16.12.3 Surveying (Cont'd)

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The reference monuments shall be protected during the grading operation and shall remain in place. If the General Contractor shall encounter conditions or obstructions, which could not have been reasonably foreseen, or indicated on the drawings, he shall immediately notify the owner and shall take such further action as directed by the owner.

16.12.4 Temporary Site Drainage

If required, before any extensive excavation and grading are undertaken, the ground shall be clear as specified above and temporary culverts, drainlines and ditches shall be installed as required, so as to effectively drain the site during construction.

The culverts and ditches shown on the grading plans are to drain the site after the rough grading work is completed.

16.12.5 Fill Material

All material proposed for fill or backfill material shall be approved by the owner before starting any filling or backfilling operations. Hardcore used for filling shall not exceed compact thickness of the layers.

16.12.6 Filling and Compacting

The percent compaction shown in this specification and on the grading and earthwork drawings refers to the percent of the maximum density obtainable as determined by the method described under ASTM D 1557 Method of Test, latest revision.

Compacted fills shall be constructed to the lines and grades shown on the drawings.

Before placing compacted fills, the subgrade shall be scarified and recompact as called for this in this specification.

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Fill soils shall be placed in horizontal loose layers, of which the thickness shall be determined economy. The contractor shall be responsible for conditioning the fill soils to a moisture content favorable to compaction.

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16.0 SPECIFIC JOB REQUIREMENTS (Cont'd)

16.12 Site Clearing-Earthwork (Cont'd)

16.12.6 Filling and Compacting (Cont'd)

This may require drying or wetting the fill soils to obtain the specified compaction. The water for wetting shall be fresh water. The fills shall be compacted to not less than 90 percent. Water will be available at the construction site at no charge.

16.12.7 Rough Grade

The contractor shall grade the site to the elevations shown on the drawings. This grade shall be within plus or minus 3 cm of these elevations at the time of acceptance of the work by owner.

16.12.8 Rock Excavation

Rock excavation shall consist of the excavation of boulders 0,35 m³ or greater in volume, and all rock in ledges, bedded deposits and conglomerate deposits so firmly cemented as to present all the characteristics of solid rock and which would normally be removed by drilling and blasting, rocks that protrude above the final subgrade of roads, etc. shall be removed.

16.12.9 Ditches

If required, the contractor shall construct all drainage and road side ditches to the sections and inverts shown on the drawings.

16.12.10 Slopes

Form all cut and fill slopes to a slope of two horizontal to one vertical, unless otherwise noted on the drawings. Steep slopes to be riprapped and joints, mortar filled.

16.12.11 Inspection and Tests

The Owner shall inspect the General Contractor's procedure workmanship and final results during placing and res compaction of fill and backfill material. An independent testing laboratory may be engaged by owner to make compaction and density tests, to assure owner that the required quality of work is being obtained.

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16.0 SPECIFIC JOB REQUIREMENTS (Cont'd)

16.12.11 Site Clearing-Earthwork (Cont'd)

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Owner shall have access to the work at all times. The General Contractor shall make available any or all parts of the work at any time, to the Owner. The General Contractor shall provide such reasonable assistance as may be required to obtain samples, verify dimensions, or identify material or equipment. The acceptance of all work covered by this specification shall be by the Owner.

16.12.12 Permits

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The General Contractor must provide all social and industrial permits and certificates concerning the activities of his company and the Owner can anytime ask for those documents. He also must have an official representant at the city Sines as an engineer responsible for those activities. He shall comply with the requirements of all local and governmental laws that govern his work. Owner will provide the official permits as designer in all the necessary Government Departments.

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16.12.13 Clean-UP

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The General Contractor shall maintain the site in a clean and orderly fashion. The General Contractor is responsible that upon completion of the work under the site clearing and earthwork subcontract, all false work, forms, equipment, temporary structures or buildings and rubbish shall be removed from the site.

A T T A C H M E N T No. 1SEISMIC COEFFICIENTS

For the Sines Refinery site the seismic (earthquake) factors of Zone "A" are to be used.

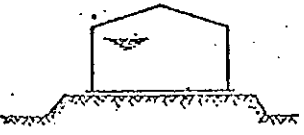
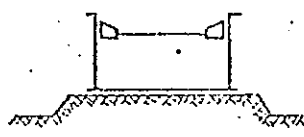
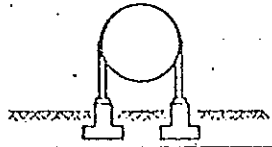
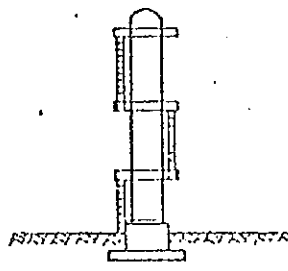
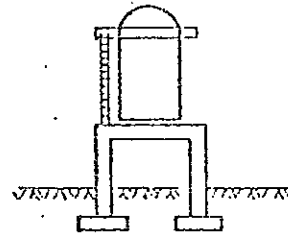
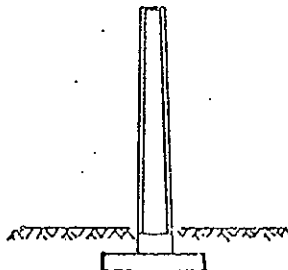

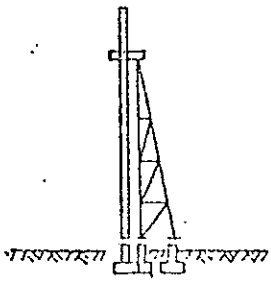

The coefficient to be used depends on the nature of the construction (equipment) and its foundations.

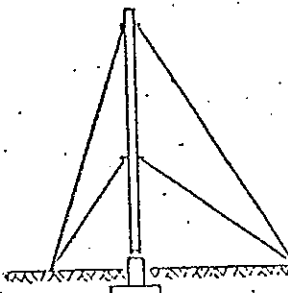
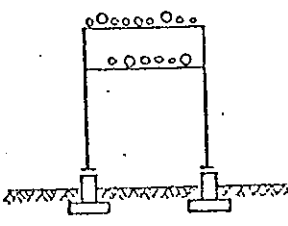
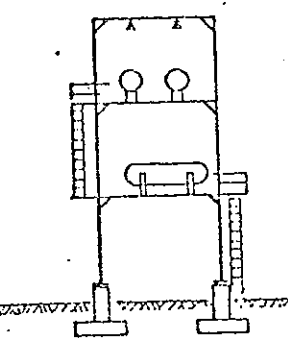
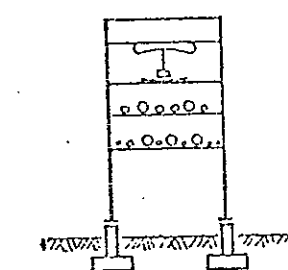
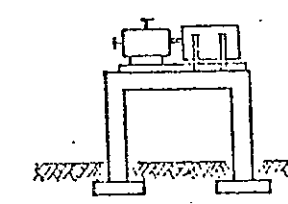
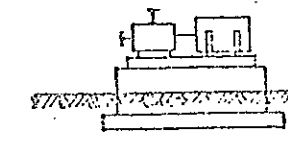
In general these coefficients range from $C = 0.06$ up to $C = 0,30$.

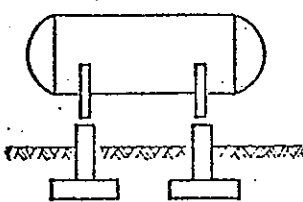
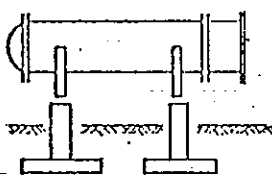
For various types of equipment and structures, which are most commonly used in a refinery, the "Laboratório Nacional de Engenharia Civil" (LNEC) (Located at the Avenida do Brasil - Lisboa 5) has indicated on the following three pages the seismic coefficients to be considered.

Since the soil at the Sines Refinery site can be considered as being soft foundation soil, the coefficients for condition b) should be taken.

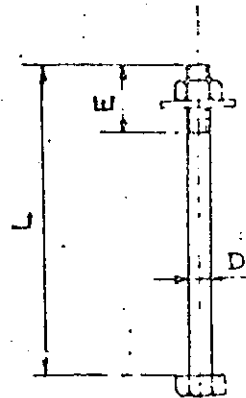
However the General Contractor shall contact the L.N.E.C.- Structural Department to have specific studies performed about the seismic behaviour of each individual case and to verify that the correct coefficient is used.

	DESCRIPTION	REMARKS	Appl. Seismi Coeffi
	<p>CONE AND DOME ROOF STORAGE TANKS</p>	<p>For storage of Crude Oil and Oil Products, etc. Maximum capacities: Cone Roof - 45 000 m³ Dome Roof - 23 000 m³</p>	<p>0.10 0.15</p>
	<p>FLOATING ROOF STORAGE TANKS</p>	<p>For storage of Crude Oil and Oil Products, etc. Maximum capacities: 100 000 m³</p>	<p>0.10 0.15</p>
	<p>SPHERES</p>	<p>For storage of LPG etc. Maximum capacity: 3 000 m³</p>	<p>0.10 0.15</p>
	<p>PROCESS TOWERS AND PROCESS VESSELS ON SPREAD FOOTINGS</p>	<p>Approximate dimensions of biggest tower: ø 9.0m' x 60.0m' height</p>	<p>0.08 0.10</p>
	<p>REACTORS ON CONCRETE TABLE TOP CONSTRUCTIONS</p>	<p>Approximate dimensions of longest reactor: ø 3.3m' x 39.0m' long Table top approx. 3.0m' height</p>	<p>0.10 0.15</p>
	<p>STACK (CONCRETE) ON SPREAD FOOTING</p>	<p> Height of stack to be approx. 100 à 150 m' above grade 233 m</p>	<p>0.06 0.10 0.12</p>
	<p>FLARESTACK WITH SUPPORT STRUCTURE (STEEL) ON SPREAD FOOTINGS</p>	<p> Height of flarestack to be approx. 60 m' above grade Diameter of flarestack is approx. 16" à 20" 100 m</p>	<p>0.08 0.10 0.10</p>

	DESCRIPTION	REMARKS	App. Seisri Coeffi
	<p>GUIDED FLARE STACK ON SPREAD FOOTING</p>	<p>Height of flarestack to be approx. 60 m' above grade Diameter of flarestack is approx. 16" à 20"</p>	<p>0.06 0.10</p>
	<p>PIPE RACK (STEEL OR CONCRETE) ON SPREAD FOOTINGS</p>	<p>Width of piperack ~ 8.00 m' Height of lowest level of piperack at least 6.00 m' above grade.</p>	<p>0.10 0.15</p>
	<p>STEEL AND CONCRETE STRUCTURES CARRYING EQUIPMENT ON SPREAD FOOTINGS</p>	<p>C.O.C. columns approx. 8.0 m' Platform levels at approx.: + 3 000 mm above grade + 6 000 " " " + 9 000 " " "</p>	<p>0.10 0.15</p>
	<p>AIRCOOLERS ON TOP OF PIPE RACK OR OTHER STRUCTURE ON SPREAD FOOTINGS</p>	<p>Top elevation of Aircooler at approximate 12.0 m' above grade</p>	<p>0.10 0.15</p>
	<p>COMPRESSORS ON CONCRETE TABLE TOP FOUNDATION</p>	<p>Table Top height is approx. 3.0 m' above grade</p>	<p>0.15 0.20</p>
	<p>PUMPS AND COMPRESSORS ON CONCRETE BLOCK FOUNDATIONS</p>	<p>Foundations blocks projecting approx. 300 mm above grade</p>	<p>0.1 0.2</p>

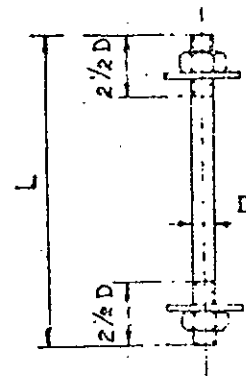
	DESCRIPTION	REMARKS	App. Seisri Coeffi
	<p>HORIZONTAL PROCESS VESSELS ON SPREAD FOOTINGS</p>	<p>Underside of vessel from 1 000 mm to 3 000 mm above grade</p>	<p>0.15 0.20</p>
	<p>HORIZONTAL EXCHANGERS ON SPREAD FOOTINGS</p>	<p>Underside of Exchangers approximate 1 000 mm above grade</p>	<p>0.15 0.20</p>
<p>REMARKS:</p>	<p>a) hard foundation soil b) soft foundation soil c) dynamic analysis strongly advisable</p> <p>i) the figure indicated as applicable seismic coefficients should be taken as rough values for a first design approach and they refer to ultimate design criteria.</p> <p>ii) dynamic analysis should be performed for maximum horizontal ground accelerations of 0.20g for soft soils and 0.15g for hard soils</p>	<p>8/8/73</p>	

MARK	BOLT DIA	L MM	E MM
1	1/2"	140	28
2		180	28
3		240	40
4		300	40
5	5/8"	140	35
6		180	35
7		240	50
8		300	50
9	3/4"	140	40
10		180	40
11		280	55
12		380	55
13	7/8"	160	50
14		200	50
15		320	65
16		440	65
17	1"	180	55
18		220	70
19		360	70
20		500	70
21	1 1/4"	200	60
22		240	75
23		400	75
24		540	75



TYPE A

MARK	BOLT DIA	L MM
1	1/2"	LENGTH INDICATED ON DRAWING AND IN REQUISITION
2	5/8"	
3	3/4"	
4	7/8"	
5	1"	
6	1 1/4"	



TYPE B

NOTE :

THREAD : UNIFIED COARSE-THREAD (UNC-2A ASA.B1.1-1960)
 NUTS : HEXAGON TO ANSI.B18.2.2-1972
 BOLTS-TYPE "A": HEXAGON TO ANSI.B18.2.1-1972

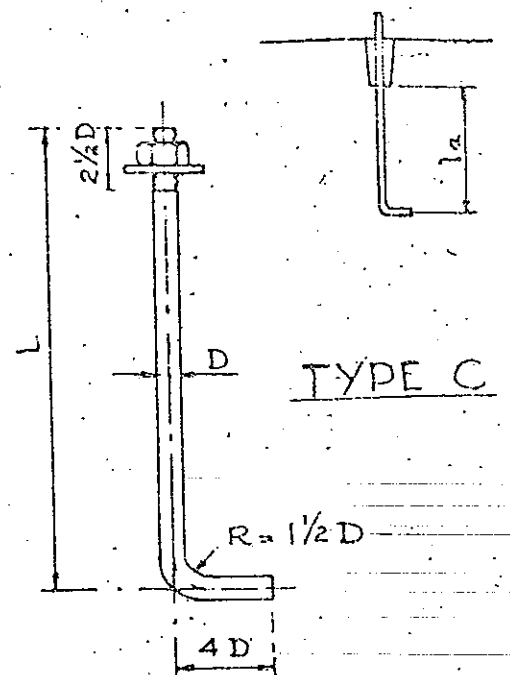
MATERIAL : BOLTS AND NUTS , CARBON STEEL : TYPE "A"-ASTM-A 307 GRADE-A,
 TYPE "B"-ASTM-A307 GRADE-B.

WASHERS : CARBON STEEL ASTM-A 283 GRADE-C :

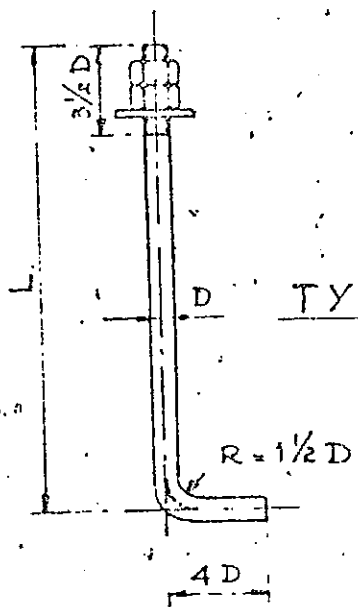
						LUMMUS NEDERLAND N.V.
						ANCHORBOLT STANDARD
						TYPE A & B
						CONFORMS TO ASTM REQUIREMENTS
						APPROVED FOR CONSTRUCTION

MARK	BOLT DIA.	L MM	MAX ALLOWABLE		MM
			TENSION KG	SHEAR KG	
1	1/2"	190	300	250	120
2	1/2"	310	600	250	230
3	5/8"	260	600	500	170
4	5/8"	430	1200	500	340
5	3/4"	240	600	400	140
6	3/4"	370	1200	750	280
7	3/4"	510	1800	750	410
8	7/8"	280	900	600	170
9	7/8"	440	1700	1100	330
10	7/8"	600	2600	1100	490
11	1"	320	1200	700	200
12	1"	510	2300	1350	400
13	1"	710	3500	1350	590
14	1 1/4"	340	1400	900	220
15	1 1/4"	560	2800	1700	430
16	1 1/4"	770	4200	1700	640
17	1 3/8"	400	2100	1200	270
18	1 3/8"	670	4200	2400	530
19	1 3/8"	930	6200	2400	790
20	1 5/8"	470	2800	1700	310
21	1 5/8"	770	5700	3300	620
22	1 5/8"	1080	8500	3300	920

MIN EMBEDDED LENGTH
(la) EXCL. SLEEVE FOR
MAX ALLOWABLE TENSION



TYPE C



TYPE CC

NOTE :

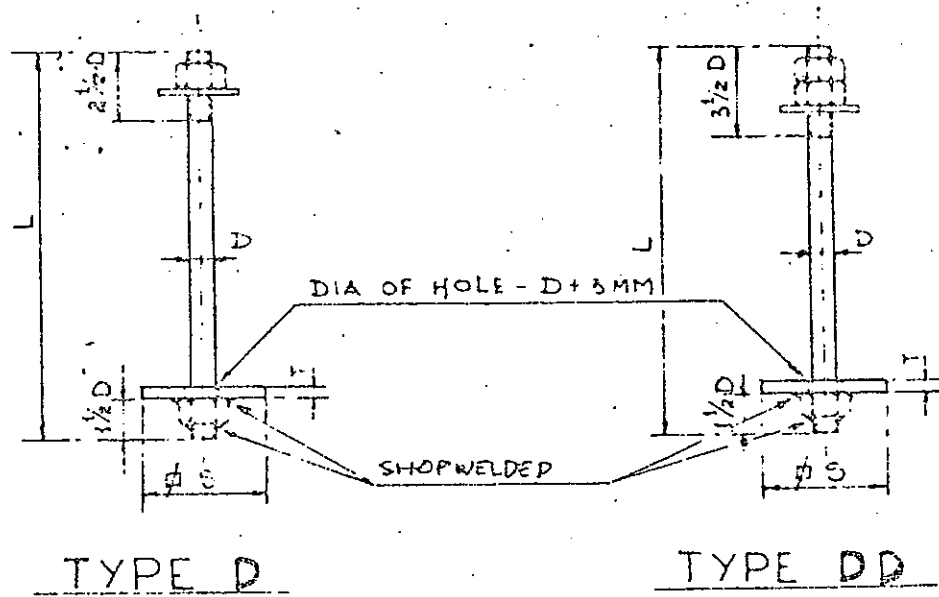
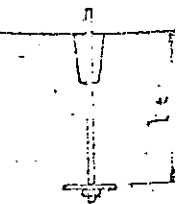
THREAD : UNIFIED COARSE-THREAD (UNC.2A ASA B1.1.1960)
BUN (B-THREAD SERIES, FOR BOLTS OVER 1" DIA.

NUTS : HEAVY HEXAGON ANSI B18 2.2-1972 DOUBLE CHAMFERED

MATERIAL : BOLTS AND NUTS; CARBON STEEL ASTM. A 307 GRADE B
WASHERS: CARBON STEEL ASTM A 283 GRADE C

LUMMUS NEDERLAND N.V.
ANCHORBOLT STANDARD
TYPE C & CC
ANSI AN 6077-102 A-C

MARK	BOLT DIA.	L MM	S MM	T MM	MAX ALLOWABLE		MIN EMBEDDED LENGTH (l _e) INCL. SLEEVE FOR MAX ALL TENSION
					TENSION K.G.	SHEAR K.G.	
1	1"	260	50	10	6000	250	150
2	1 1/4"	280	50	10	12000	500	160
3	3/4"	310	80	12 1/2	18000	750	170
4	7/8"	390	80	12 1/2	26000	1100	230
5	1"	420	110	16	35000	1350	250
6	1 1/4"	480	110	16	42000	1700	270
7	1 1/2"	560	130	19	62000	2400	350
8	1 3/4"	610	130	22	85000	3300	370



NOTE :

THREAD : UNIFIED COARSE THREAD (UNG. 2A ASA B1.1. 1960)
 BUN (8-THREAD SERIES; FOR BOLTS OVER 1" DIA.

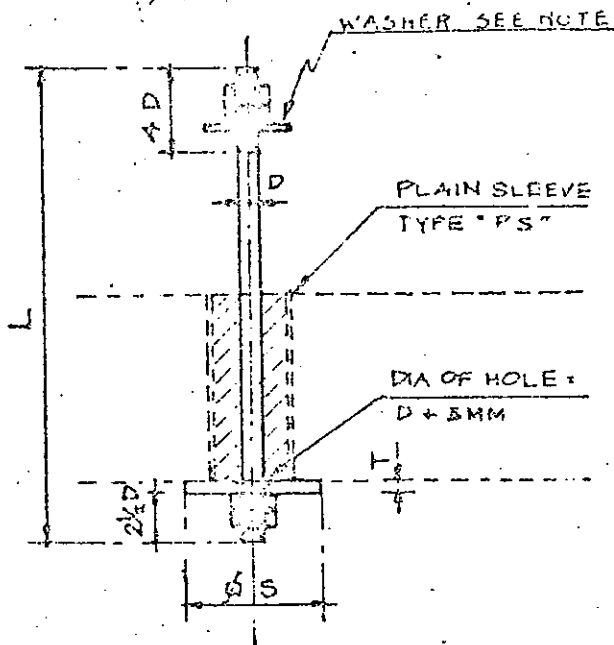
NUTS : HEAVY HEXAGON ANS: B18.2.2-1972 DOUBLE CHAMFERED

MATERIAL : BOLTS AND NUTS ; CARBON STEEL ASTM. A 307 GRADE B
 WASHERS ; CARBON STEEL ASTM. A203 GRADE C
 PLATES ; CARBON STEEL ASTM-A 307 GRADE A.

					LUMMUS NEDERLAND N.V.		
					ANCHOR BOLT STANDARD		
					TYPE D & DD		
2	1000				CONFORMS TO ASTM REQUIREMENTS		
1	2000				AND OTHER FOR CONSTRUCTION		
					DWG. NO. AN 6877-102.1		

MARK	BOLT DIA.	L MM	S MM	T MM	MAX. ALL TENSION KG	PIPE SLEEVE DIAM.
1	1 1/4"	LENGTH INDICATED ON DRAWING AND IN REQUISITION	160	25	5000	3"
2	1 3/8"		160	25	6800	3"
3	1 5/8"		200	30	9700	4"
4	1 7/8"		200	30	13000	4"
5	2 1/4"		240	35	17200	6"
6	2 1/2"		240	40	23000	6"
7	2 3/4"		280	45	29800	6"
8	3"		280	50	37300	6"

PIPE SLEEVE
TO BE USED
WITH THIS
TYPE OF
ANCHOR BOLTS
HAS TO BE
PLAIN SLEEVE
TYPE "PS"



NOTE :

THREAD : UNIFIED FINE-THREAD
(UNF. 2A ASA. B.1.1 1960)

NUTS : HEAVY HEXAGON
ANSI. B.18.2.2.1972.
DOUBLE CHAMFERED.

WASHER : THICKNESS = 1/4 D
O.D. = 2D + 3 MM
I.D. = D + 3 MM

MATERIAL : BOLTS AND NUTS, CARBON
STEEL. ASTM. A 307. GRADE.

: WASHER, CARBON STEEL
ASTM. A 283. GRADE C.

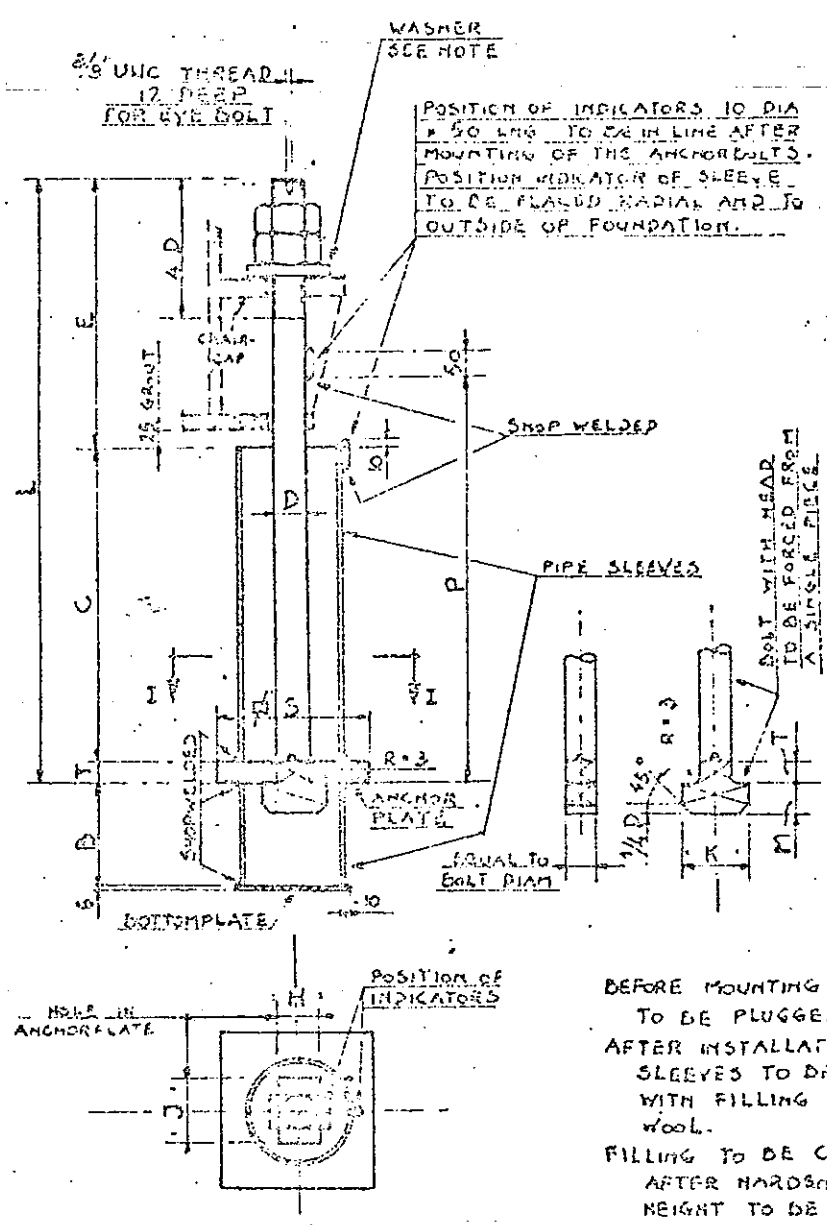
: PLATE, CARBON STEEL
ASTM. A 307. GRADE A.

: PIPE SLEEVE: IN ACC. WITH
ASTM. A 53. GRADE A.
(SCH. 40.)

AFTER EQUIPMENT IS IN POSITION, SLEEVE TO BE FILLED WITH GROUT.

						LUMMUS NEDERLAND N.V.
						ANCHOR BOLT STANDARD TYPE G
						IN ACC. WITH ASTM REQUIREMENTS
						CONSTRUCTION

NO.	D BOLT DIA.	B MM	C MM	E MM	H MM	J MM	K MM	L MM	M MM	P MM	S MM	T MM	MAX ALL TENSION KG	PIPE- SLEEVE DIA.	PIPE HEIGHT MM
1	1 1/4"	100	375	40	33	63	60	795	26	520	160	30	5000	4"	300
2	1 3/8"	130	405	425	39	71	68	860	32	570	240	30	6200	6"	370
3	1 5/8"	150	455	440	47	80	76	935	36	640	240	40	8700	6"	300
4	1 7/8"	170	510	465	53	92	86	1005	42	690	240	40	13000	6"	300
5	2 1/4"	190	550	575	62	105	102	1160	48	750	240	45	17200	6"	400
6	2 1/2"	200	610	595	70	121	115	1255	56	810	320	50	23000	8"	400
7	2 3/4"	200	600	665	78	134	128	1380	62	870	320	55	29800	8"	450
8	3"	200	760	685	86	148	142	1505	70	980	320	60	37300	8"	450



NOTE:

THREAD: UNIFIED FINE-THREAD (UNF. 2A-ASA. B1.1-1960)

NUTS: HEAVY HEXAGON ANSI. B 18.2.2-1972 DOUBLE CHAMFERED.

WASHER: THICKNESS = 1/4 D
O.D. = 2 D + 3 mm.
I.D. = D + 3 mm.

MATERIAL: BOLTS AND NUTS: CARBON STEEL TO ASTM. A 307. GRADE .B
WASHER CARBON STEEL TO ASTM. A 283. GRADE .C
ANCHOR PLATE: CARBON STEEL TO ASTM. A 307. GRADE .A
PIPE SLEEVE: IN ACC. WITH ASTM. A 53. GRADE .A (SCH. 40.)

BEFORE MOUNTING AND POURING OF CONCRETE, SLEEVES TO BE PLUGGED.

AFTER INSTALLATION OF RESP. TOWER AND ANCHOR BOLTS, SLEEVES TO BE FILLED UP TO 60 mm BELOW THE TOP WITH FILLING MATERIAL E.G. VERMICULITE OR GLASS WOOL.

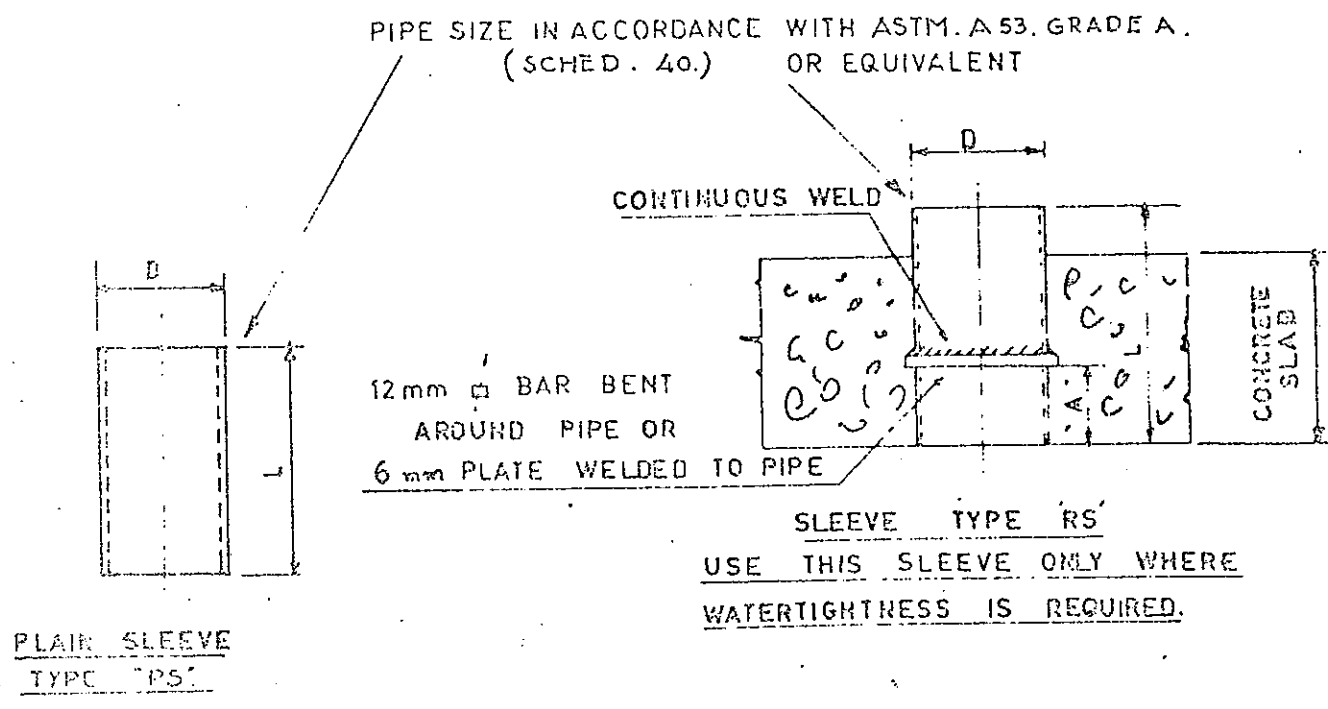
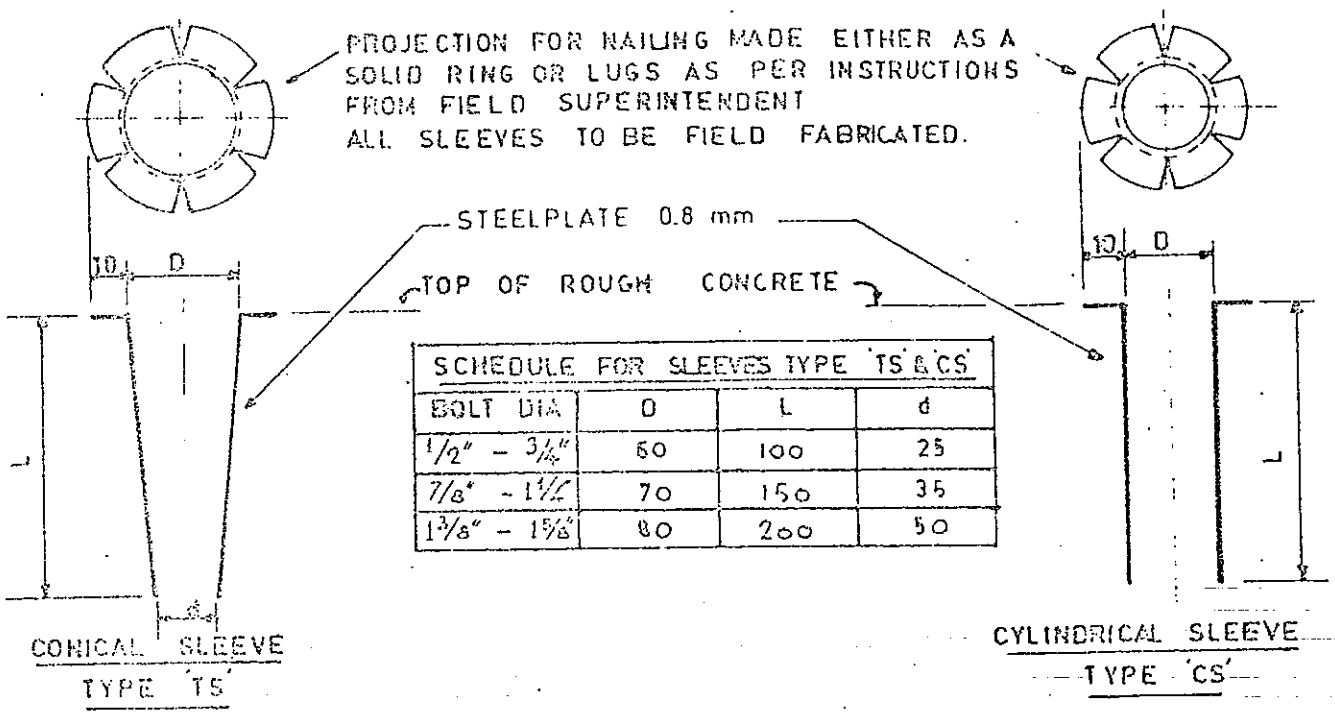
FILLING TO BE COVERED WITH 15 mm CONCRETE AND AFTER HARDENING OF THE LATTER THE REMAINING HEIGHT TO BE FILLED UP WITH ASPHALT.

DIMENSION E HAS BEEN BASED ON THE FOLLOWING ASSUMPTION: 25 mm SHOULDER + CHAINCAP HEIGHT + 2% BOLT DIA. ABOVE CHAINCAP + 10 mm

LUMMUS NEDERLAND N.V.

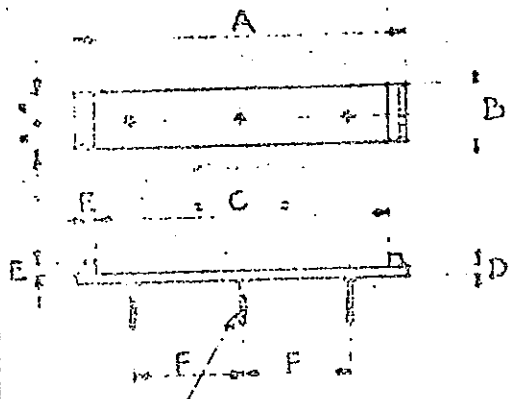
ANCHOR BOLT STAND OFF TYPE H

0	REV. TO ASTM REQUIREMENTS
1	REV. TO ASTM REQUIREMENTS



NOTE: ALL DIMENSIONS ARE IN mm.
CS. OR TS. SLEEVES MADE OF 08mm STEELPL OR FORMED BY USING STYROPOR OR EQUAL.
AFTER EQUIPMENT IS IN POSITION SLEEVES TO BE FILLED WITH GROUT.

				LUMMUS NEDERLAND N.V.	
				SLEEVE TYPES	
2	1/10	1/10	1/10	REV. TO ASTM REQUIREMENTS	
1	1/10	1/10	1/10	APPROVED FOR CONSTRUCTION	



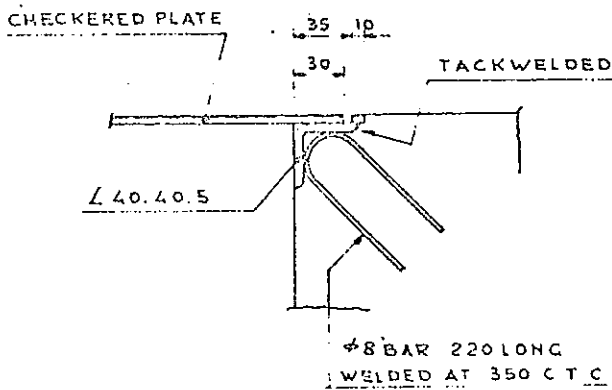
△ MIDDLE ANCHOR ONLY -
FOR VESSELS WITH
A. DIAM. ≤ 2100 mm.

VESSEL DIAM.	ANCHOR DIMENSIONS
600 THRU 2000	φ 5/8" x 150 LG
2100 THRU 4500	φ 3/4" x 200 LG

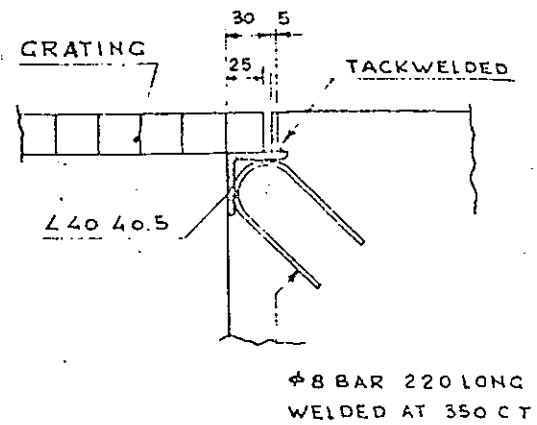
ITEM NO	VESSEL DIAM.	A	B	C	D	E	F
1	600	650		585			190
2	650	670		625			210
3	700	710		665			230
4	750	760		715			255
5	800	800		755			275
6	850	840		795			295
7	900	890		845			320
8	950	930		885			340
9	1000	970		925			360
10	1050	650		605			260
11	1100	680		635			275
12	1150	710	250	665	5/8"	5/8"	290
13	1200	740		695			305
14	1250	770		725			320
15	1300	800		755			335
16	1350	830		785			350
17	1400	860		815			365
18	1450	890		845			380
19	1500	920		875			395
20	1600	980		935			425
21	1700	1040		995			455
22	1800	1100		1055			485
23	1900	1160		1115			515
24	2000	1220		1175			545
25	2100	1260		1205			570
26	2200	1370		1265			600
27	2300	1380		1325			630
28	2400	1440		1335			660
29	2500	1500		1445			690
30	2600	1560		1505			720
31	2700	1620		1565			750
32	2800	1680		1625			780
33	2900	1740		1685			810
34	3000	1800		1745			840
35	3100	1860		1805			870
36	3200	1920		1865			900
37	3300	1980	300	1925	3/4"	3/4"	930
38	3400	2040		1985			960
39	3500	2100		2045			990
40	3600	2160		2105			1020
41	3700	2220		2165			1050
42	3800	2280		2225			1080
43	3900	2340		2285			1110
44	4000	2400		2345			1140
45	4100	2460		2405			1170
46	4200	2520		2465			1200
47	4300	2580		2525			1230
48	4400	2640		2585			1260
49	4500	2700		2645			

ALL DIMENSIONS IN MM.
MATERIAL: CARBON STEEL
ASTM. A283 GRADE C.

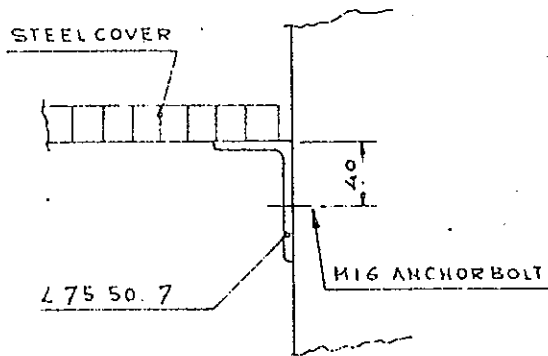
LUMMUS NEDERLAND B.V.
STRUCTURAL STANDARDS
STEEL SLIDING PLATES FOR
HORIZONTAL VESSELS
DWG. NO. AN-6017-100A-0



ANGLE CURB FOR
CHEQUERED PLATE COVER

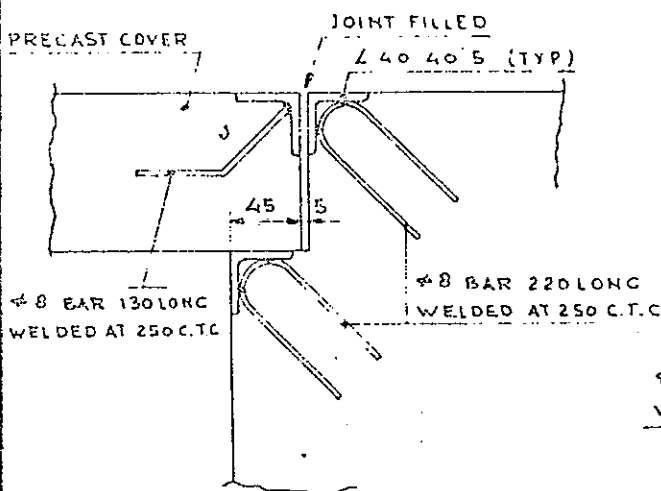


ANGLE CURB FOR
GRATING COVER

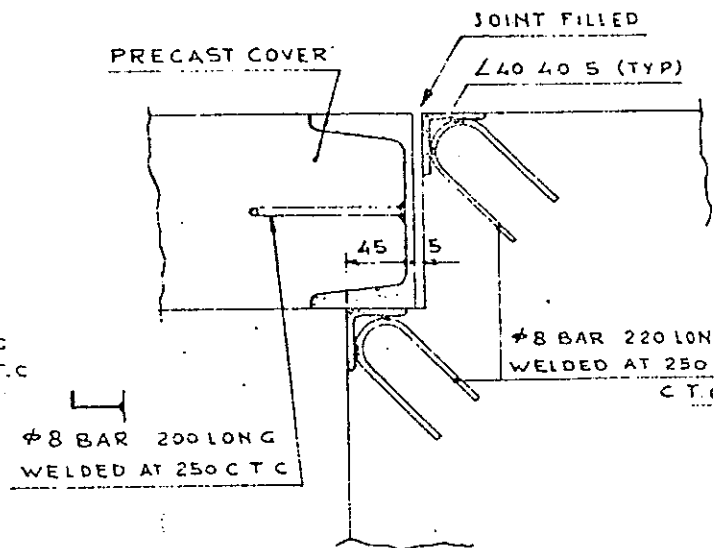


DETAIL STEEL COVER SUPPORT
AT CONCRETE WALLS

ALL DIMENSIONS ARE IN M.M.



ANGLE CURB FOR PRECAST
COVERS FOR TRENCHES IN
PAVED AREA



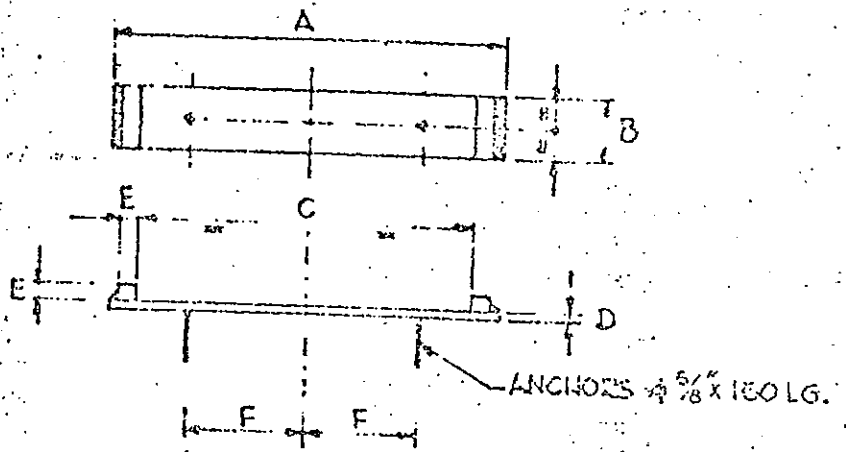
ANGLE CURB FOR PRECAST
COVERS FOR TRENCHES
UNDER ROADS

1	AW	1"						
APPROVED FOR CONSTRUCTION								
DATE	BY	CHKD	APP'D					

LUMMUS NEDERLAND N.Y.

STRUCTURAL STANDARDS
COVER SUPPORT DETAILS.

DWC No AN6877-104 B-1



ITEM NO.	EXCHANGER		A	B	C	D	E	F
	UNIT SIZE INCH	O.P. MM						
1	6	168	175	150	135	1/2"	1/2"	40
2	8	220	195		155			50
3	10	274	245		205			75
4	12	324	275		235			90
5	14	356	300		260			90
6	16	406	325		285			100
7	18	458	375		335			130
8	20	510	425		385			140
9	22	560	445		405			150
10	24	610	475		435			165
11	26	660	505	465	180			
12	28	712	555	515	200			
13	30	762	575	535	215			
14	32	814	645	180	595	5/8"	5/8"	240
15	34	864	665		615			255
16	36	914	715		665			280
17	38	966	755		695			295
18	40	1022	775		715			305
19	43	1098	825		765			330
20	45	1150	855	795	345			
21	48	1226	935	875	380			
22	50	1280	985	925	410			

ALL DIMENSIONS ARE IN MM.

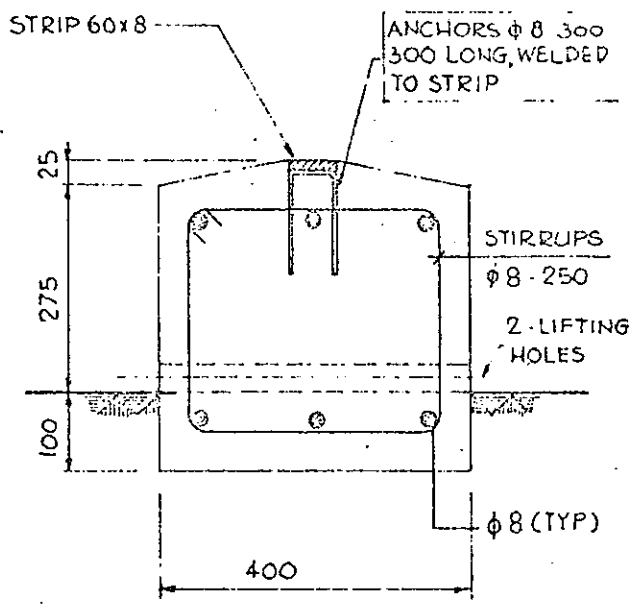
MATERIAL : CARBON STEEL ASTM. A283 GRADE. A.

LUNNUS INGENIERING AB

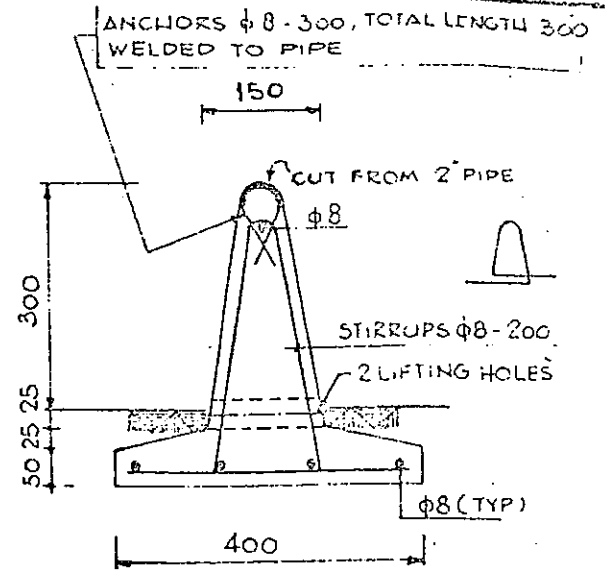
STATION 111111

STEEL DESIGN

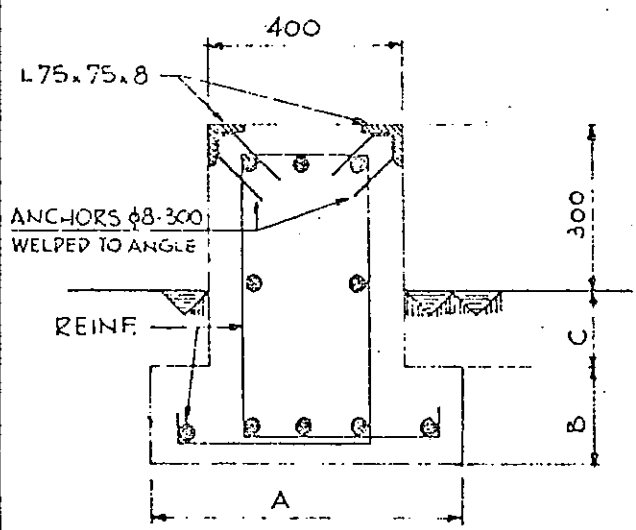
1980 11 11 11 11 11 11



TYPE I

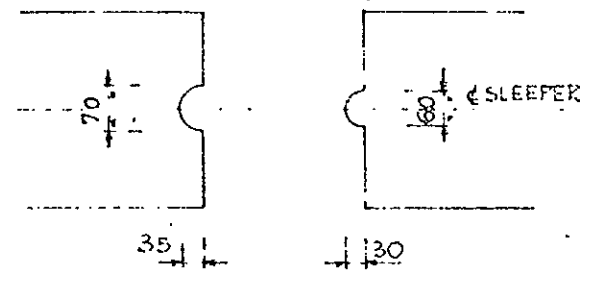


TYPE II



REINF. AND DIMENSIONS A, B & C DEPEND ON:
 a) SOIL CONDITION
 b) FROST DEPTH
 c) PIPE LOADINGS

ANCHORSLEEPER



TOP VIEW SLEEPER
 (SHOWING MALE AND FEMALE DETAIL)

NOTES

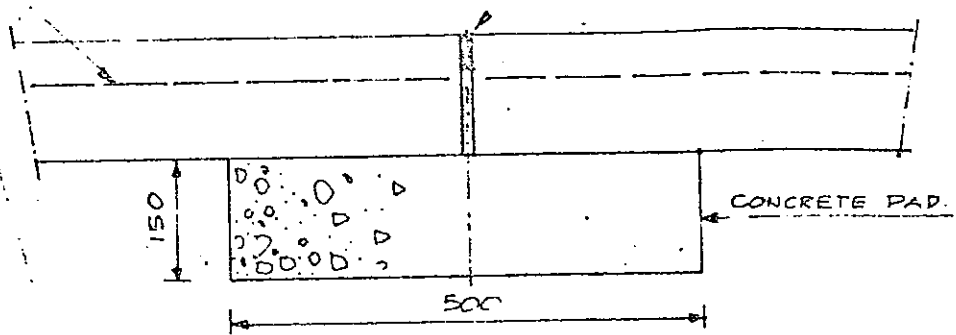
- 1 ALL DIMENSIONS ARE IN MM.
- 2 FIELD TO PROVIDE FOUNDATION OF WELL COMPACTED SOIL, SANDFILL OR LEAN CONCRETE IF SOIL CONDITIONS ARE UNSATISFACTORY.
- 3 LIFTING HOLE $\phi 30$ TO BE MADE AT 200 MM FROM EACH END OF THE SLEEPER.
- 4 ALL SLEEPERS EXCEPT ANCHORSLEEPERS WILL BE MADE IN TWO LENGTH: L = 1500 MM
L = 2000 MM
- 5 WHEN USED TO SUPPORT ALUMINIUM PIPE, EXPOSED STEEL MUST BE GIVEN A COAT OF ASPHALT PAINT.
- 6 ALL SLEEPERS EXCEPT ANCHORSLEEPERS TO HAVE ONE END FEMALE AND ONE END MALE AS SHOWN IN TOP VIEW.

1	2	3	4	5	6	7	8	9	10
REV	DATE	BY	CHKD	DATE	CHKD	DATE	CHKD	DATE	CHKD

LUMMUS NEDERLAND N.V.
 STRUCTURAL STANDARDS
 PIPE SLEEPERS
 APPROVED FOR CONSTRUCTION
 DWG NO AN 6077-104C-1

WIRE FABRIC 4 x 150 x 150 FOR LIGHT DUTY PAVING
 WIRE FABRIC 6 x 150 x 150 FOR HEAVY DUTY PAVING

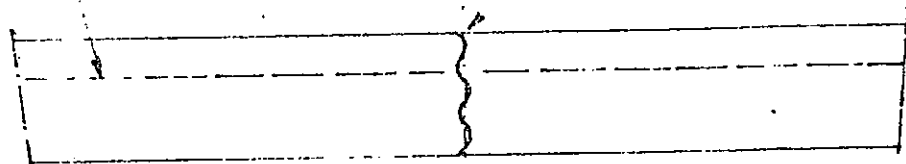
SEE DETAIL "A"



100 FOR LIGHT DUTY PAVING
 150 FOR HEAVY DUTY PAVING

EXPANSION JOINT C.T.C. 30 000 MM.

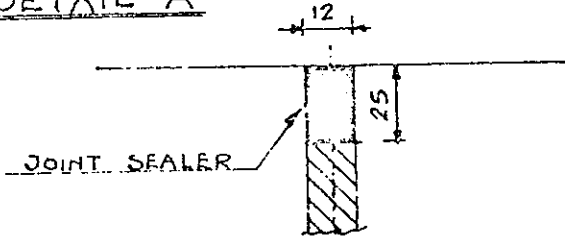
SEE DETAIL "B"



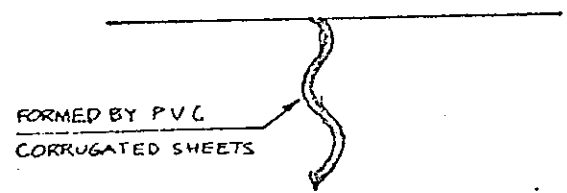
100 FOR LIGHT DUTY PAVING
 150 FOR HEAVY DUTY PAVING

CRACK CONTROL JOINT C.T.C. 7500 MM.

DETAIL "A"



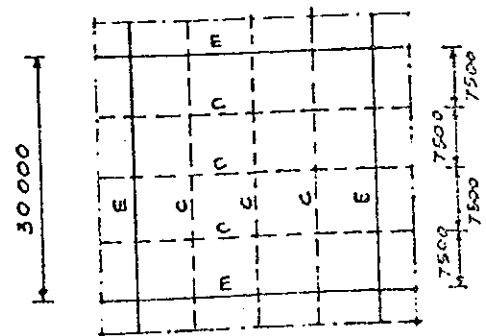
DETAIL "B"



NOTES :

1. ALL DIMENSIONS ARE IN MM
2. EXPANSION JOINT DISTANCE MAX 30000 MM
 CRACK CONTROL JOINT DISTANCE MAX 7500 MM.
3. JOINT SEALER TO BE A WATERTIGHT AND COALTAR SEALER, APPLIED AS SHOWN IN DETAIL "A"
4. SLOPE IN PAVING PREFERABLE 1/80 IN NORMAL AREAS.
5. THE CONCRETE MIXTURE FOR PAVING WILL BE SPECIFIED IN ENG SPECIFICATION.
6. WELD WIRE FABRIC REINF. 4x150x150 FOR LIGHT DUTY PAVING
 AND 6 x 150 x 150 FOR HEAVY DUTY PAVING

JOINTS PLAN



E = EXPANSION JOINT
 C = CRACK CONTROL JOINT

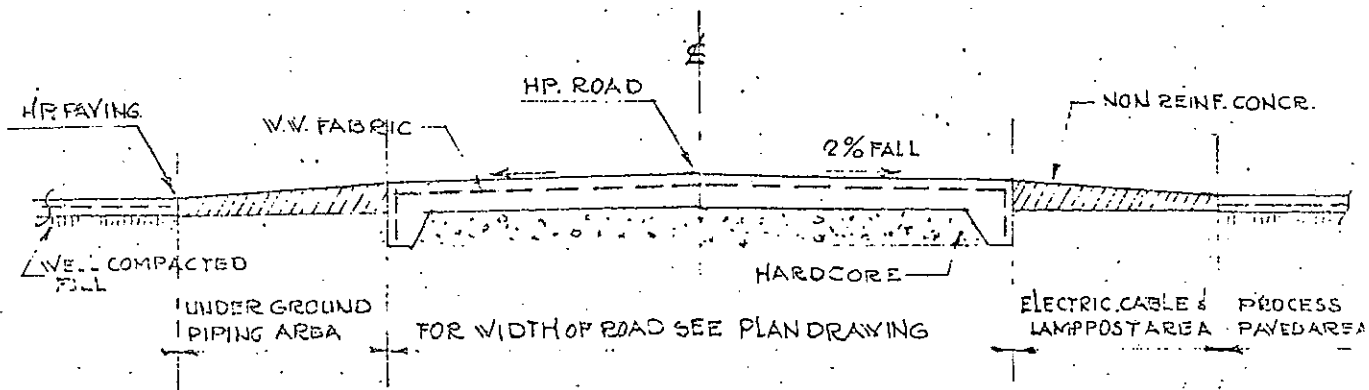
LUMMUS NEDERLAND N.V.

STRUCTURAL STANDARDS
 JOINTS FOR CONCRETE PAVING

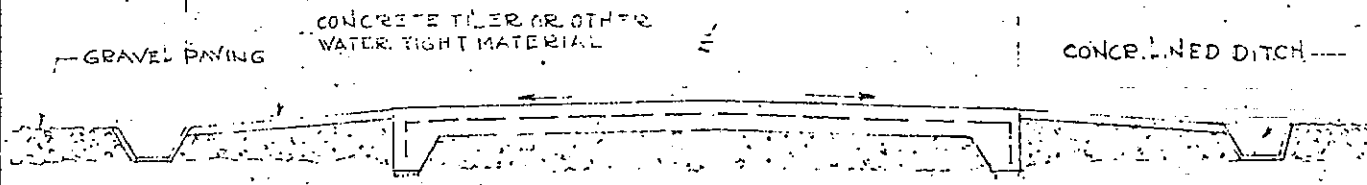
DWG. No. AN.6877-10.4 D-1.

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REV	DATE	BY	CHK	APP					

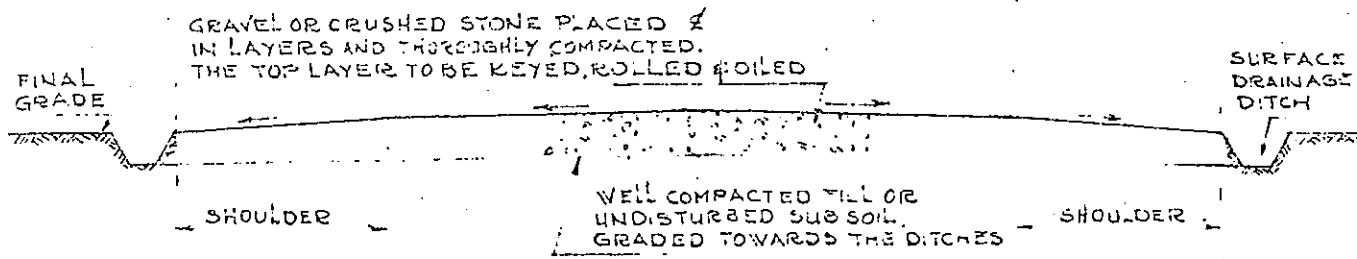
APPROVED FOR CONSTRUCTION



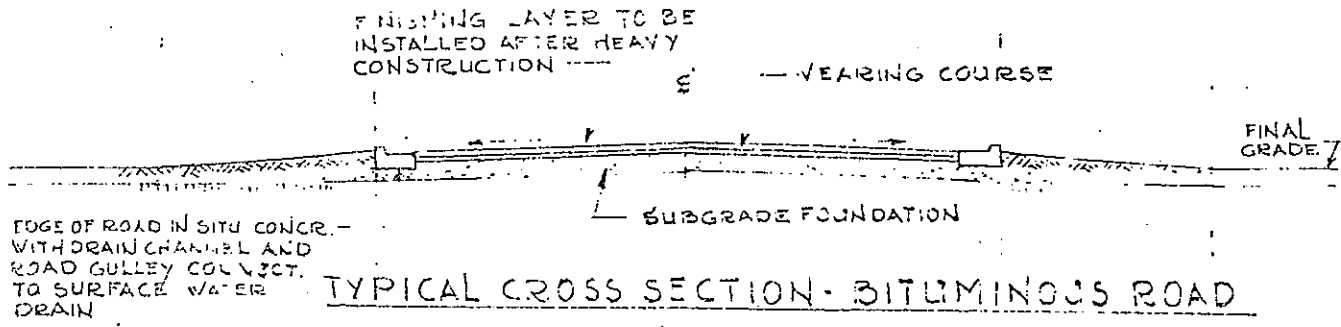
TYPICAL CROSS SECTION - CONCRETE ROAD - A



TYPICAL CROSS SECTION - CONCRETE ROAD - B



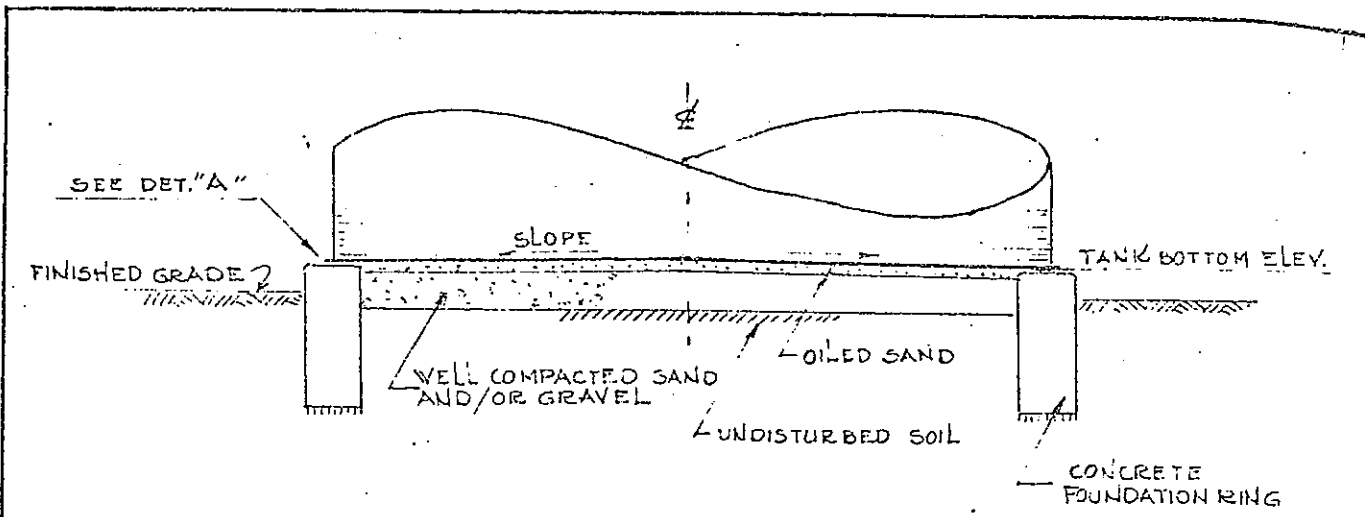
TYPICAL CROSS SECTION - CRUSHED STONE - GRAVEL SURFACE



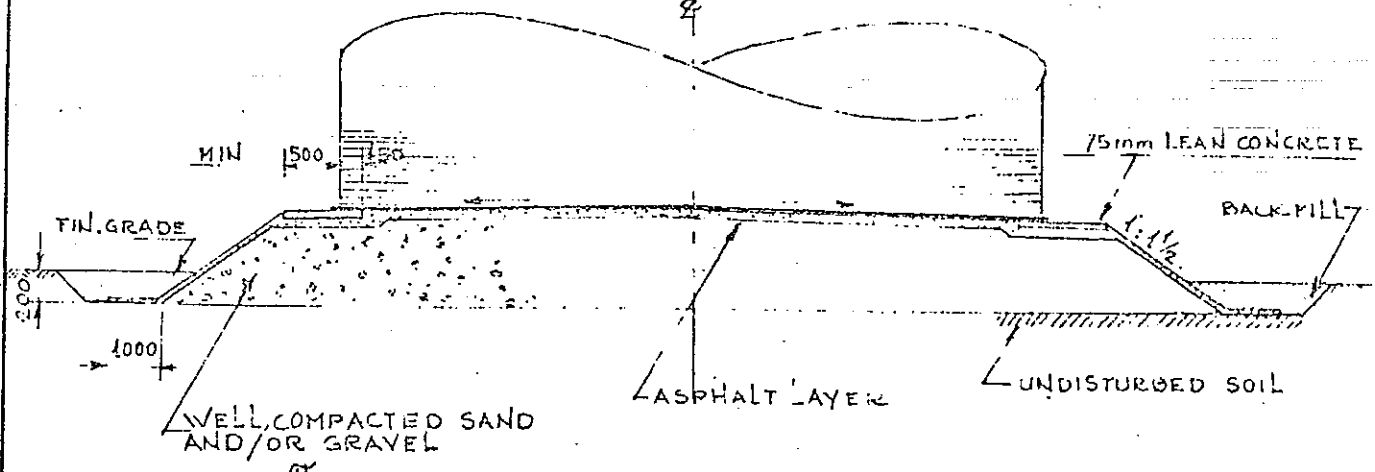
TYPICAL CROSS SECTION - BITUMINOUS ROAD

NOTES: SEE JOB SPECIFICATIONS FOR FINAL ROAD DESIGN AND/OR LOCAL REGULATIONS.

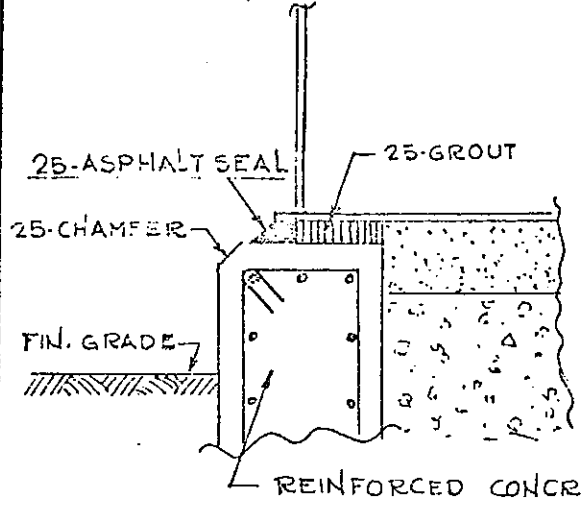
						LUMMUS NEDERLAND N.V.	
						STRUCTURAL STANDARDS TYPICAL ROAD DETAILS	
						SCALE ~	DWG. No AN6877-104 E--
1	2	3	4	5	6	APPROVED FOR CONSTRUCTION	
BY	CHKD	DES	DATE	SCALE	NO.		



TYPE - 1



TYPE - 2

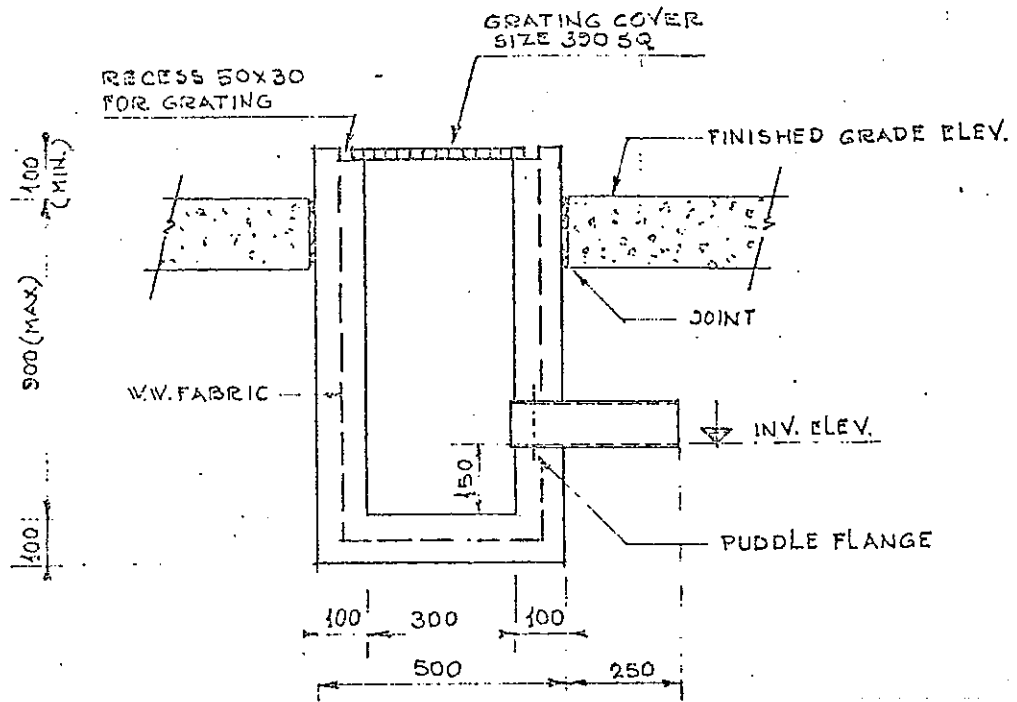


DETAIL "A"

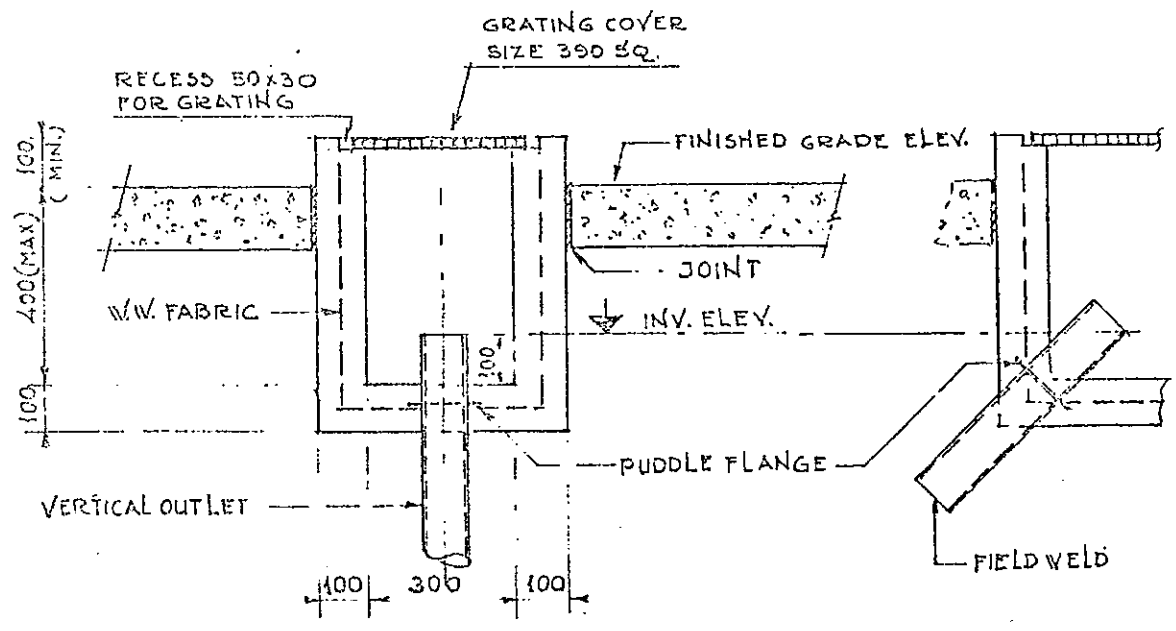
NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. FOR MIXTURE OF ALL MATERIAL AND DEPTH OF FOUNDATION SEE DESIGN DWG.
3. FOR TYPE 1: EXCAVATED SAND LOCALLY OF CONCRETE RING TO BE USED AS FILLING BELOW TANK.
 OILED SAND MIXTURE TO CONSIST OF:
 75% BUNKER C. PREMIXED AT 50°C
 25% CUTBACK BITUMEN. FINE DRY AGGREGATE SAND AT 95°C 9%
 THE ABOVE TO BE THOROUGHLY MIXED BEFORE PLACING AND COMPACTED IN PLACE BY TAMPING OR ROLLING. DRAIN SUMP TO BE INSTALLED AFTER FINISHING OF TANK PAD.
4. FOR SLOPE OF TANKPAD FOUNDATION SEE TANK VENDOR RECOMMENDATION
5. SEE JOB SPECIFICATIONS FOR FINAL DESIGN

						LUMMUS NEDERLAND N.V.
						STRUCTURAL STANDARDS
						TANK FOUNDATIONS
1	2	3	4	5	6	APPROVED FOR CONSTRUCTION



TYPE "A"
(SQUARE)



TYPE "B₁"
(SQUARE)

TYPE "B₂"

NOTES:

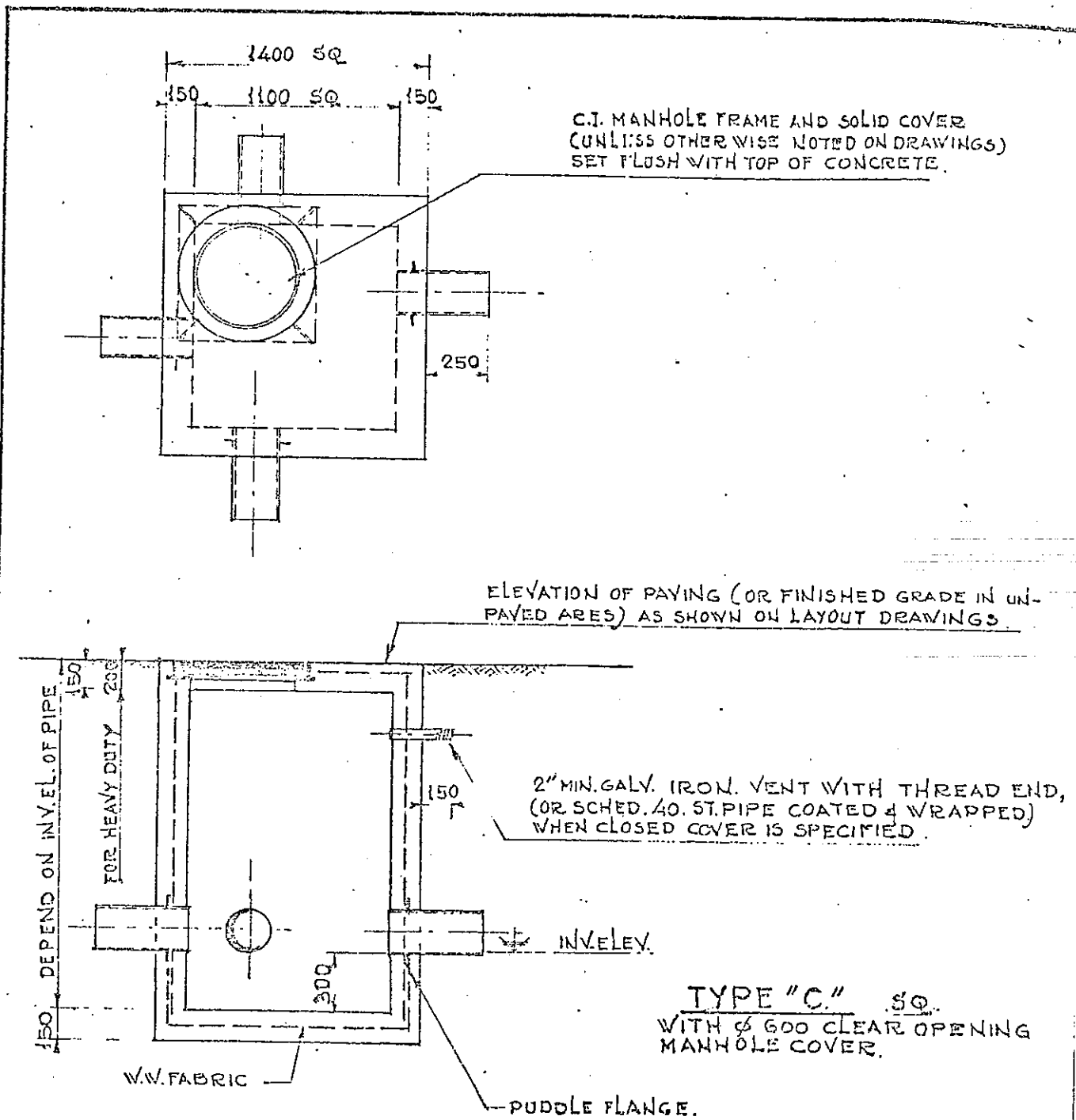
- SEE LAYOUT DRAWING FOR THE FOLLOWING:
 1.) TYPE AND LOCATION OF DRAIN
 2.) INVERT ELEVATION AND SIZE OF PIPE

LUMMUS NEDERLAND N.V.

EQUIPMENT DRAIN STANDARD
TYPE "A" & "B"

APPROVED FOR CONSTRUCTION

SCALE ~ DWG. No. AN.6577-104 G-1

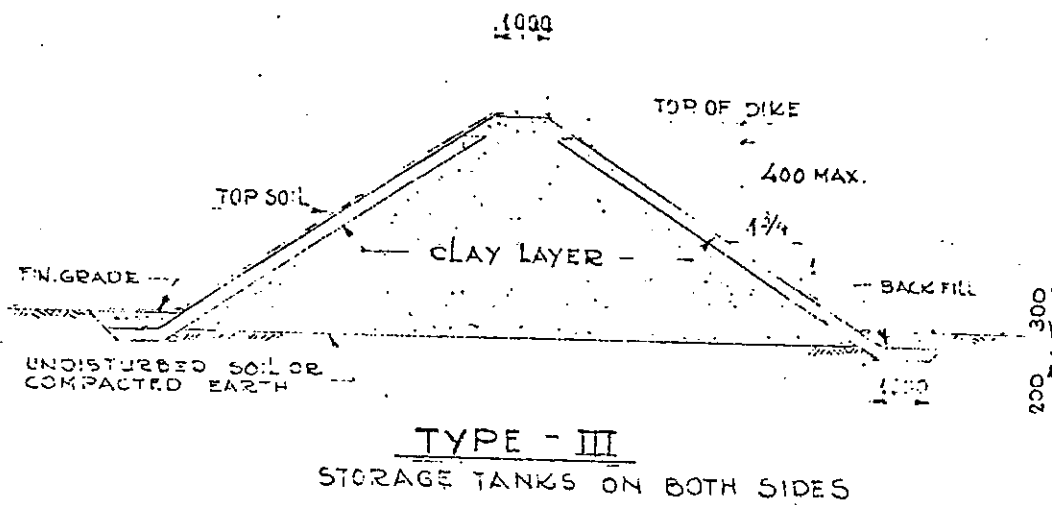
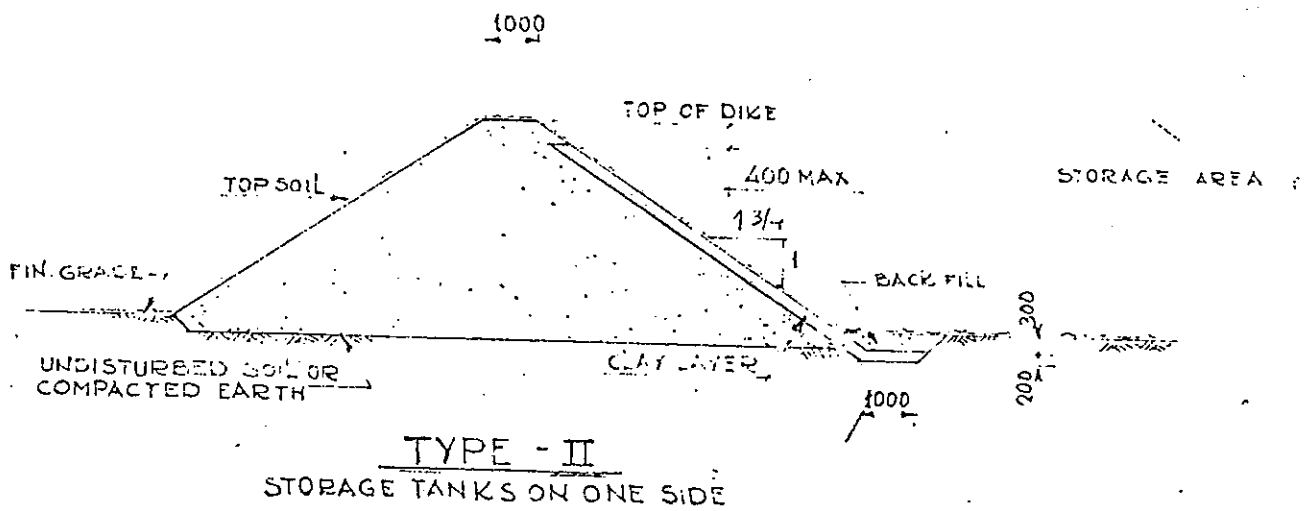
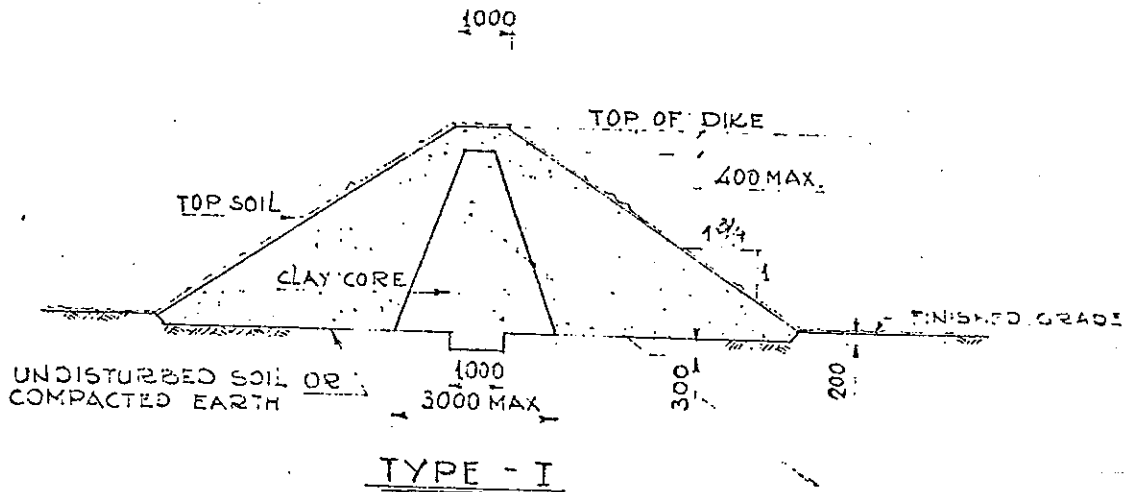


NOTES:

1. SEE LAYOUT DRAWINGS FOR THE FOLLOWING,
 - a. TYPE AND LOCATION OF SUMP
 - b. INVERT ELEVATIONS, SIZES AND LOCATION OF PIPES (ARRANGEMENT OF PIPES SHOWN ABOVE ARE DIAGRAMMATIC)
 - c. NUMBER OF PIPES IN EACH SUMP.
2. THIS SUMP MAY BE USED FOR A OILY SYSTEM DRAINAGE AND FOR SURFACE WATER DRAINAGE.
3. MANHOLE STEP IRONS TO BE PROVIDED ONLY IF CALLED FOR ON DRAWINGS.
4. MANHOLE FRAMES AND COVERS TO BE:
 - a. LIGHT DUTY: IN PLACES NOT REQUIRED TO CARRY WHEELED TRAFFIC.
 - b. MEDIUM DUTY: IN PLACES CARRYING ONLY LIGHT VEHICLE TRAFFIC.
 - c. HEAVY DUTY: IN ROADWAYS CARRYING HEAVY TRAFFIC.
 - d. PERFORATED MANHOLE COVER TO BE USED IF LOCATED IN LOW POINT PAVED AREA FOR DRAINAGE.

				LUMMUS NEDERLAND N.V.	
				AREA DRAIN STANDARD TYPE "C"	
APPROVED FOR CONSTRUCTION.				SCALE ~ DWG. RAN 6977-10/4.1	

NOTE:
MATERIAL FOR DYES
EARTH OR SAND FREE
FROM DEBRIS
WELL TAMPED



										LUMMUS NEDERLAND N.V.		
										STRUCTURAL STANDARDS		
										TYPICAL DIKES DETAILS		
1	1483										APPROVED FOR CONSTRUCTION	
RIV 1208 100 1 5 16												