

CONTECComissão de Normalização
Técnica**SC-04**

Civil Construction

Roadway and Pavement Design1st Erratum

This is the 1st Erratum to PETROBRAS N-2724 REV. B, and it is used to alter the text of the Standard in the part(s) indicated below:

NOTE 1 The new(s) page(s) with the performed amendment(s) is (are) placed in its corresponding position(s).

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

CONTENTS OF THE 1st ERRATUM - 02/2022

- Subsection 6.1.5:

Text change.

CONTECComissão de Normalização
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Civil Construction

Roadway and Pavement Design**1st Amendment**

This is the 1st Amendment to PETROBRAS N-2724 REV. B 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 - 04/2014

- Section 2:

Exclusion of ABNT NBR 9780.

- Subsection 6.2.2:

Exclusion of ABNT NBR 9780.

Roadway and Pavement Design

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.

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

CONTEC

Comissão de Normalização
Técnica

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 08/2013) of PETROBRAS N-2724 REV. B 11/2012. 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 premises to be followed for the road and pavement designs of:

- a) road accesses;
- b) avenues and roads;
- c) parking, loading and unloading areas;
- d) administrative areas;
- e) storage yards;
- f) sphere areas;
- g) pipeways and pipeline rights-of-way;
- h) heliports and helipads;
- i) areas of process units;
- j) scraper areas.

1.2 This Standard applies to procedures beginning from its issue date.

1.3 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.

Portaria [COMAER N° 256/GC5](#), de 13 de maio de 2011 - Dispõe sobre as Restrições Relativas às Implantações que Possam Afetar Adversamente a Segurança e a Regularidade das Operações Aéreas, e dá Outras Providências;

Portaria [COMAER N° 271/GC5](#), de 06 de junho de 2012 - Dispõe sobre as Restrições Relativas às Implantações que Possam Afetar Adversamente a Segurança e a Regularidade das Operações Aéreas, e dá Outras Providências;

Portaria [DNC N° 44](#) de 29 de Setembro de 1997 - Estabelece para os Aditivos Asfálticos de Reciclagem para Misturas à Quente o Regulamento Técnico DNC n° 04/97 e a Tabela que Acompanham à Portaria;

Resolução [ANP n° 30](#) de 09/10/2007 - Especificações de Asfaltos Diluídos de Cura Rápida e Cura Média - Regulamento Técnico N° 02/2007;

DNER [EM-364/97](#) - Alcatrões para Pavimentação;

DNIT [022/2006-ES](#) - Drenagem - Dissipadores de Energia;

DNIT [029/2004-ES](#) - Drenagem - Restauração de Dispositivos de Drenagem Danificada;

DNIT [031/2006-ES](#) - Pavimentos Flexíveis - Concreto Asfáltico;

DNIT [032/2005-ES](#) - Pavimentos Flexíveis - Areia-Asfalto a Quente;

DNIT [047/2004-ES](#) - Pavimento Rígido - Execução de Pavimento Rígido com Equipamento de Pequeno Porte;

DNIT [048/2004-ES](#) - Pavimento Rígido - Execução de Pavimento Rígido com Equipamento de Fôrma-Trilho;

DNIT [049/2009-ES](#) - Pavimento Rígido - Execução de Pavimento Rígido com Equipamento de Fôrma-Deslizante;

DNIT [137/2010-ES](#) - Pavimentação - Regularização do Subleito;

DNIT [138/2010-ES](#) - Pavimentação - Reforço do Subleito;

DNIT [139/2010-ES](#) - Pavimentação - Sub-Base Estabilizada Granulometricamente;

DNIT [140/2010-ES](#) - Pavimentação - Sub-Base de Solo Melhorado com Cimento;

DNIT [141/2010-ES](#) - Pavimentação - Base Estabilizada Granulometricamente;

DNIT [142/2010-ES](#) - Pavimentação - Base de Solo Melhorado com Cimento;

DNIT [143/2010-ES](#) - Pavimentação - Base de Solo-Cimento;

DNIT [144/2010-ES](#) - Pavimentação Asfáltica - Imprimação com Ligante Asfáltico Convencional;

DNIT [145/2010-ES](#) - Pavimentação - Pintura de Ligação com Ligante Asfáltico Convencional;

DNIT [146/2010-ES](#) - Pavimentação - Tratamento Superficial Simples com Ligante Asfáltico Convencional;

DNIT [147/2010-ES](#) - Pavimentação Asfáltica - Tratamento Superficial Duplo com Ligante Asfáltico Convencional;

DNIT [148/2010-ES](#) - Pavimentação Asfáltica - Tratamento Superficial Triplo com Ligante Asfáltico Convencional;

DNIT [149/2010-ES](#) - Pavimentação Asfáltica - Macadame Betuminoso com Ligante Asfáltico Convencional por Penetração;

DNIT [150/2010-ES](#) - Pavimentação Asfáltica - Lama Asfáltica;

DNIT [151/2010-ES](#) - Pavimentação - Acostamento;

DNIT [152/2010-ES](#) - Pavimentação - Macadame Hidráulico;

PETROBRAS [N-38](#) - Critérios para Projetos de Drenagem, Segregação, Escoamento e Tratamento Preliminar de Efluentes Líquidos de Instalações Terrestres;

PETROBRAS [N-381](#) - Execução de Desenhos e Outros Documentos Técnicos em Geral;

PETROBRAS [N-1602](#) - Construção de Pavimentos;

PETROBRAS [N-1645](#) - Critérios de Segurança para Projeto de Instalações Fixas de Armazenamento de Gás Liquefeito de Petróleo;

PETROBRAS [N-1674](#) - Projeto de Arranjo de Instalações Industriais Terrestres de Petróleo, Derivados, Gás Natural e Álcool;

ABNT [NBR 7207](#) - Terminologia e Classificação de Pavimentação;

ABNT [NBR 9781](#) - Peças de Concreto para Pavimentação.



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 Terms and Definitions

For the purposes of this document, the terms and definitions of contained in PETROBRAS [N-381](#), [N-1602](#), [N-1674](#) and ABNT [NBR 7207](#) are applicable, complemented by the definitions indicated in 3.1 to 3.7.

3.1

avenues

access and circulation roads for vehicles that cross the industrial facility entirely or almost entirely, whether North-South or East-West, with considerable traffic of vehicles. Roads placed beside main pipeways or pipe-racks are also deemed as avenues

3.2

roadway design

geometric design of avenues and roads intended for interconnecting and providing access to the various areas of an industrial unit or complex of industrial units, so as to ensure long-lasting stability for the safe and comfortable circulation of vehicles

3.3

pavement design

design of structure of the various layers of pavements of avenues and roads defined in the roadway design, so as to ensure long-lasting stability for the safe and comfortable circulation of vehicles

3.4

limited access roads

access roads where the normal traffic of motor vehicles is forbidden, being its use limited to situations in which safety measures are met. They shall be fitted with gates, rising barriers or chains

3.5

unit internal roads

internal access roads to process and utility units, intended to make the maintenance and firefighting easy

3.6

main roads

access and circulation roads for vehicles interconnecting various areas or units and which traffic of vehicles is moderate. Access roads that shall allow the passage of cargo handling equipment and access roads to product loading are also considered main roads

3.7

secondary roads

access and circulation roads for vehicles which surround process units, utility areas, tank basins, scraper areas, sphere parks, and which traffic of vehicles is limited to maintenance and emergency response exclusively for those areas

4 General Conditions

The provisions established below shall be complied with, complemented by the description of PETROBRAS [N-1674](#) Section 6.

4.1 The pavement of roads and areas shall be defined by types of use, containing minimum recommendations for avenues, main roads, secondary roads, parking areas, loading and unloading areas, industrial areas, accesses and intersections.

4.2 The roadway design shall consider the levels obtained in the earthwork design.

4.3 When choosing the type of pavement and its sizing, the local weather conditions shall be considered.

4.4 The design shall consider the materials available in the region and their technical and economic characteristics in order to be used.

4.5 The purpose of the facility for which the design is intended shall be considered.

4.6 The roadway design shall consider the indications provided by the layout plan or master plan, such as: location and destination of roads, yards and other areas to be paved.

4.7 The reservoirs of paving materials shall be defined according to the characteristics obtained in geotechnical investigations and shall be compatible with the design.

4.8 The description of all documents generated in the design shall be presented, as well as the reason for the adopted solutions.

4.9 The design shall consider traffic estimates based on the types of vehicles, axle load and frequency, and cover at least 2 alternatives for the traffic of heavy loads inside industrial units.

4.10 The pavement sizing shall consider the information obtained in geotechnical investigations.

4.11 Drainage devices in accesses and roads outside the limits of PETROBRAS shall be defined respecting the recommendations of the agencies responsible for maintenance of the sections.

4.12 Bridges, level crossings, viaducts, tunnels and trenches for passage of industrial piping shall be deemed to be special structures.

5 Specific Conditions

The following design criteria shall be adopted:

- a) compatibility among the various designs involved
- b) use of materials and constructive methods compatible with the regional characteristics and other parts of the job;
- c) ease of maintenance and possibility of expansion of paved areas;
- d) prevision of passage and movement of large equipment parts during the construction and assembly phase;
- e) desired quality standard and service life.

5.1 Road Accesses

The intersection of the road providing access to the industrial unit with the existing roadway or road shall be designed respecting the guidelines established by the agency responsible for the road (DNER/MT, DER or others).

5.2 Avenues and Roads

5.2.1 All roads providing access to the industrial facilities shall be paved with coating compatible with the loading conditions of the traffic required for the operation and maintenance of the facility.

5.2.2 The geometric detailed design of the roads shall comply with the data indicated on the master plan or general layout plan of the industrial units and shall contain the following information:

- a) coordinates of all centerlines;
- b) elevation of center, high point and low point;
- c) levels obtained in the earthwork design;
- d) coordinates of the centers of curvature and radii of curves;
- e) horizontal transition;
- f) vertical transition;
- g) inclination of ramps.

5.2.3 The roadway sizes shall comply with the provisions established in Section 6 of standard PETROBRAS [N-1674](#).

5.2.4 The inner radii of curvature of the avenues and main roads shall be at least 10,0 m.

5.2.5 The avenues and roads shall have a side slope in relation to the gutters of 2 %.

5.2.6 It is recommended that the intersections of roads and accesses to units are run in level.
[Recommended Practice]

5.2.7 Ramps shall be, preferably, located on straight sections between the tangent points of the curves of the roads. The installation of ramps on curves with a radius of curvature of at least 50 m is acceptable. **[Recommended Practice]**

5.2.8 Guard-rails shall be used for avenues and roads along pipeways or side slopes. Guard-rails shall not interfere with facilities for access to firefighting, emergency control, operation and maintenance activities.

5.2.9 All roads shall be provided with curbs with at least 0,15 m of difference in relation to the pavement.

5.2.10 For road drainage design criteria, standard PETROBRAS [N-38](#) and the service specifications of DNIT [022/2006-ES](#) and DNIT [029/2004-ES](#) shall be followed.

5.2.11 The roads providing access to tank truck loading and unloading areas shall have a minimum radius of curvature of 13 m.

5.2.12 It is recommended that all bends and maneuvering of tank trucks are paved with rigid coating. **[Recommended Practice]**

5.2.13 Every block reserved for a process unit shall have road accesses in all its sides.

5.2.14 It is recommended that main roads have a minimum distance of 2,50 m from the margin of pipeways, dyke bases and topographic slopes. **[Recommended Practice]**

5.2.15 When 5.2.15 cannot be followed, guard-rails shall be used for the roads along pipeways or slopes, and adjacent to industrial facilities. Guard-rails shall not interfere with facilities for access to firefighting, emergency control, operation and maintenance activities.

5.2.16 The roadway design shall provide for accesses to hydrants, fixed monitorial cannons, hose cabinets and foam making for firefighting. Those accesses shall be designed so that the parked vehicle does not block the traffic in the given road or avenue.

5.3 Parking, Loading and Unloading Areas

5.3.1 Parking for Passenger Cars

- a) the parking lot may be transverse or oblique: **[Recommended Practice]**
 - the transverse parking lot, with a central corridor of 6,0 m, shall have parking spaces 2,50 m wide and 5,0 m long (see Figure A.1 of Annex A);
 - the oblique parking lot, with a central corridor of 4,5 m, shall have parking spaces 2,50 m wide and 5,0 m long (see Figure A.2 of Annex A);
- b) the route system in the parking lot shall allow entry and exit of vehicles, as well as their return, without adversely affecting the flow of traffic within the parking lot.

5.3.2 Parking for Tank Trucks

- a) the parking area may be transverse or oblique (Figures A.3, A.4 and A.5 of Annex A);
- b) the parking space shall be at least 4 m wide and have enough length to accommodate the vehicle out of the flow range;
- c) the parking area shall be designed so as to allow transit of vehicles without the need for reverse maneuvers at its entrance and/or exit.

5.3.3 Tank Truck Loading and Unloading Areas

5.3.3.1 The parking lots in these areas shall be paved in rigid pavement, with strength and durability compatible with the product. The parking lots shall be positioned in parallel with minimum dimensions of 3,5 m in width and enough length to accommodate the vehicle out of the flow range, and a drainage system shall be provided.

5.3.3.2 The loading bays where the loading arms and valves are located shall be at least 2,5 m wide, with an elevation of 0,20 m above the level of the loading yard, and shall be paved in rigid pavement, with strength and durability compatible with the product.

5.3.3.3 In coke loading areas, the use of asphaltic or interlocked pavements is allowed too.

5.4 Administrative Areas

Provision shall be made, along the curb and accesses of pedestrians to administrative areas, for sidewalks at least more than 1,0 m wide.

5.5 Storage Yards

5.5.1 They shall be paved with coating suitable to the type of material that shall be stored in accordance with Table 1, sloping toward the specific drainage system.

Table 1 - Type of Pavement for Each Type of Stored Material

Material to be stored	Pavement
Pipes and general equipment	Base of compacted material
Hazardous solid waste	Base comprised of concrete or another material preventing leaching and percolation of substances to the soil and ground waters.
Waste classes II (non-inert) and III (inert)	Impermeable base

5.5.2 The specific standard shall be consulted according to the nature of the material to be stored.

5.6 Sphere Areas

The recommendations described in PETROBRAS [N-1645](#) shall be adopted.

5.7 Pipeways and Pipeline Rights-of-Way

5.7.1 The bed of pipeways shall be compacted and covered with a 10,0 cm layer of non-classified coarse aggregate, using mechanisms to prevent grass growing or with a simple concrete coating.

5.7.2 In pipeways, the areas subject to leaks, such as: areas near vents, flanges, valves, drains, and other accessories, shall be contained in accordance with recommendations of PETROBRAS [N-38](#).

5.8 Heliports and Helipads

5.8.1 Heliports and helipads shall be design according to Ordinances COMAER [No; 256/GC5](#) and [No. 271/GC5](#).

5.8.2 Helipads shall be provided with an access route for a firefighting truck.

5.9 Areas of Process Units

5.9.1 In the process units, the unit floors and internal roads shall be paved with concrete. The free areas, between the battery limit of the unit and the curb of the road, shall be clean, without vegetation, compacted and with crushed stones on the surface.

5.9.2 The paved floor shall be sloped for drainage.

5.10 Scraper Areas

The scraper area shall be paved in concrete and be provided with a specific drainage system, as per PETROBRAS [N-38](#).

6 Sizing

6.1 Geotechnical Data and Traffic Estimate of Avenues and Roads

6.1.1 Avenues and Roads

For sizing the pavement, at least the following specifications shall be considered:

- a) standard road load per axle equal to 82 kN;
- b) tire-pavement contact pressure equal to 0.56 Mpa (average pressure for filling tires);
- c) number of repetition of load equivalent to that of an axle considered to be the standard type ("N") equal to at least 1×10^6 .

6.1.2 Parking, Loading and Unloading Areas

In loading bays, the concrete pavement admitted shall be sized considering the loading of a single axle of 150 kN.

6.1.3 Storage Yards

The support base of the stack of pipes, after preparation, shall present a compressive strength equal to or greater than 1 kgf/cm².

6.1.4 Heliports and Helipads

For sizing of heliports and helipads, the provisions contained in Ordinances [No. 256/GC5](#) and [No. 271/GC5](#) shall be considered.

6.1.5 Area of Process Units

The areas within the limits of process units subject to traffic shall be paved in concrete sized for the load required for operation and the maintenance of the equipment, and the minimum load shall be 22 kN per wheel.

6.2 Flexible and Rigid Pavements

6.2.1 The sizing shall be performed in accordance with a methodology acclaimed by the technical community.

6.2.2 Interlocked concrete pavements, flexible pavements, shall follow the provisions established in ABNT [NBR 9781](#).

7 Signaling

7.1 Vertical signaling (lateral and/or suspended in relation to the road) and horizontal signaling (painting on the road itself or on the shoulders) shall be design the meet the internal safety requirements of the industrial unit, of the user and of the Visual Identity Manual of PETROBRAS.

7.2 Heliports and helipads shall be identified in accordance with the provisions of Ordinances COMAER [No. 256/GC5](#) and [No. 271/GC5](#).

8 Design Presentation

The project shall be made of the following documents:

- a) design premises;
- b) calculation notes;
- c) drawings;
- d) technical specifications;
- e) service quantity sheet;
- f) service notes;
- g) complementary information, when necessary.

8.1 Design Premises

The design premises shall contain the following information:

- a) basic design data;
- b) material specification;
- c) design methodology;
- d) other required information for the complete understanding of the design.

8.1.1 Basic Design Data

They are composed by the following information:

- a) layout plan or master plan;
- b) earthwork design;
- c) geotechnical investigation report;
- d) traffic estimates;
- e) indication of reservoirs;
- f) weather conditions.

8.1.2 Material Specification

It shall contain the description and characterization of materials.

8.1.3 Design Methodology

The design methodology shall have:

- a) purpose of the facility;
- b) design description;
- c) reason of the solution adopted for the design.

8.2 Calculation Notes

8.2.1 It shall have the following elements:

- a) brief description and reason of adopted calculation criteria;
- b) geometric characteristics;
- c) service life of pavement;
- d) structural sizing of pavement.

8.2.2 They shall be presented in a clear and legible way, observing the conditions established in PETROBRAS [N-381](#), mentioning adopted codes and standards, and shall be signed by the professional responsible for preparing the design.

8.2.3 The calculation methods used shall be indicated, with the respective reason for their adoption.

8.2.4 The calculation of geometrical elements of the roadway design shall be submitted.

8.2.5 The calculation of service life of the pavement as a function of the period of use of roads shall be submitted.

8.2.6 The structural sizing of pavement as a function of geotechnical characteristics, traffic and load estimates shall be submitted, as well as the technical and economic reason of materials used in the layers.

8.2.7 The methods and details related to special care to be taken which sub-surface drainage of pavement layers shall be indicated.

8.2.8 The used tables and calculation methods shall be mentioned and are integral parts of the calculation notes.

8.3 Drawings

8.3.1 When preparing and presenting the drawings, they shall comply with the provisions in standard PETROBRAS [N-381](#).

8.3.2 The roadway and road drawings shall contain:

- a) roadway plan;
- b) pavement plan;
- c) cross sections;
- d) longitudinal profiles;
- e) details of intersections, returns, and accesses;
- f) details of complementary jobs;
- g) location of reservoirs;
- h) signaling.

8.3.2.1 The roadway plant shall have the following elements:

- a) coordinate system of design;
- b) elevations of road axes;
- c) inclination of ramps;
- d) horizontal transitions;
- e) right-of-way, in case of roads and accesses.

8.3.2.2 The pavement plan shall have the following elements:

- a) types of pavement;
- b) sequence of performance;
- c) details of joints;
- d) types of grouting.

8.3.2.3 The cross sections shall contain the following elements:

- a) pavement platform width;
- b) identification of different layers, with the respective symbology (typical sections);
- c) layer thickness;
- d) index of support of layers;
- e) slopes.

8.3.2.4 The drawings of profiles shall present at least sections of longitudinal profiles where there are changes of inclination, presence of interferences and underground structures, containing the information required for the job execution.

8.3.2.5 The drawings of intersections, returns, and accesses shall contain all elements required for a perfect geometric characterization, such as:

- a) centerlines and borders of lanes and branches;
- b) lines of offsets of embankments and rights-of-way;
- c) values of curve radii;
- d) lanes and branches width;
- e) planialtimetric survey;
- f) superelevations;
- g) traffic flow sheets.

NOTE The earthwork, drainage, bridge, pavement, signaling and landscaping designs of intersections shall meet the provisions in the respective design scope items.

8.3.2.6 Drawings of complementary jobs shall indicate the required jobs for finishing the pavement services, such as:

- a) sideways;
- b) guard-rails;
- c) curb and gutters;
- d) surface drainage;
- e) subsurface drainage;
- f) protection of slopes;
- g) works of art.

8.3.2.7 The drawing of location of reservoirs shall indicate the distances from the job site to the reservoirs adopted for paving services, as well as identify the available materials with characteristics obtained in geotechnical investigations.

8.3.2.8 The signaling drawing shall contain the information required for its implementation. The signaling may be vertical (lateral and/or suspended in relation to the road) and horizontal (painting on the road itself or on the shoulders). **[Recommended Practice]**

8.4 Technical Specification

It shall be presented observing the conditions established in PETROBRAS [N-381](#).

8.4.1 Description of Services

The objectives, conditions, scope and description of all stages referring to services of roadway, pavement and complementary jobs shall be informed.

8.4.2 Material Specification

It shall contain the indication of materials to be used in pavement services, in accordance with the following standards and specifications:

- a) Technical Regulation No. 2/2007, from Resolution ANP [Nº 30](#), establishes the specifications of Fast-Cure and Medium-Cure Diluted Asphalts, marketed all over the national territory, and specifications of Asphaltic Additives of Recycling for Hot Mixtures – Technical Regulation DNC in 04/97 – Ordinance [nº 44](#) from 09/29/1997 from DNC, mentioned in Section 2 of this Standard; and
- b) for other materials: the following road standards of pavement service specification from DNIT shall be used as a reference: [DNIT 137/2010-ES](#); [DNIT 138/2010-ES](#); [DNIT 139/2010-ES](#); [DNIT 140/2010-ES](#); [DNIT 141/2010-ES](#); [DNIT 142/2010-ES](#); [DNIT 143/2010-ES](#); [DNIT 144/2010-ES](#); [DNIT 145/2010-ES](#); [DNIT 146/2010-ES](#); [DNIT 147/2010-ES](#); [DNIT 148/2010-ES](#); [DNIT 149/2010-ES](#); [DNIT 032/2005-ES](#); [DNIT 031/2006-ES](#); [DNIT 150/2010-ES](#); [DNIT 151/2010-ES](#); [DNIT 152/2010-ES](#); [DNIT 049/2009-ES](#); [DNIT 047/2004-ES](#); [DNIT 048/2004-ES](#); [DNER EM-364/97](#).

8.4.3 Execution and Control Procedures

The required guidance for all roadway and pavement services shall be presented, covering the following items:

- a) preliminary services;
- b) subgrade regularization;
- c) subgrade reinforcement;
- d) sub-base execution;



- e) base execution;
- f) compactation control;
- g) priming execution;
- h) execution of flexible or rigid coating.

8.5 Service Quantity Sheet

All services related to roadway and pavement designs shall be listed and quantified, in accordance with the drawings, calculation notes, and technical discrimination. This list covers the following items:

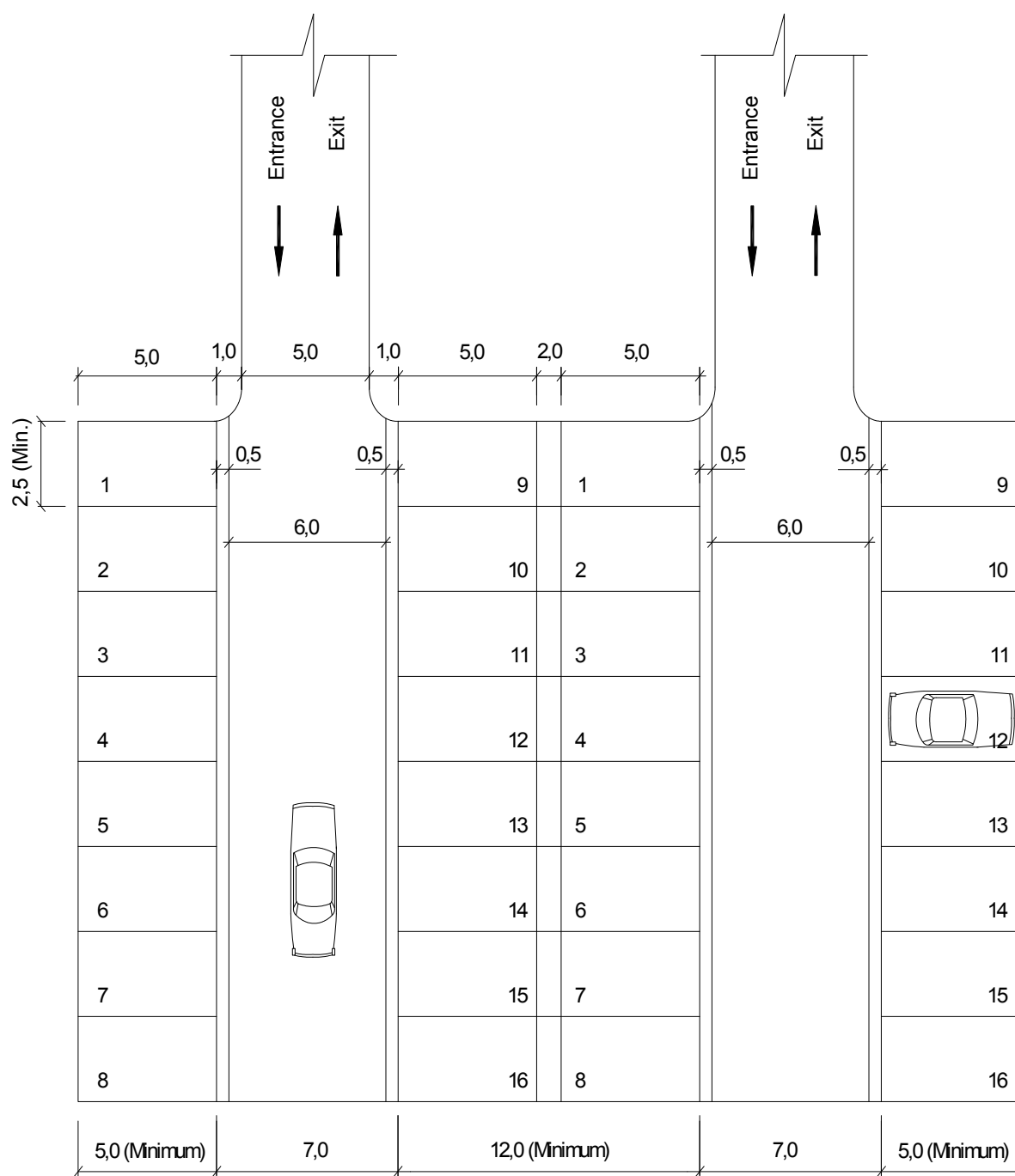
- a) preliminary services;
- b) subgrade regularization;
- c) subgrade reinforcement;
- d) sub-base execution;
- e) base execution;
- f) compactation control;
- g) priming execution;
- h) execution of flexible or rigid coating;
- i) supplying and seating of curb
- j) execution of gutter;
- k) execution of manholes;
- l) supplying and seating of guard-rails.

8.6 Service Notes

8.6.1 All geometric elements required for the performance of roadway and pavement shall be indicated, in accordance with the roadway and pavement plans, cross sections, and longitudinal profiles.

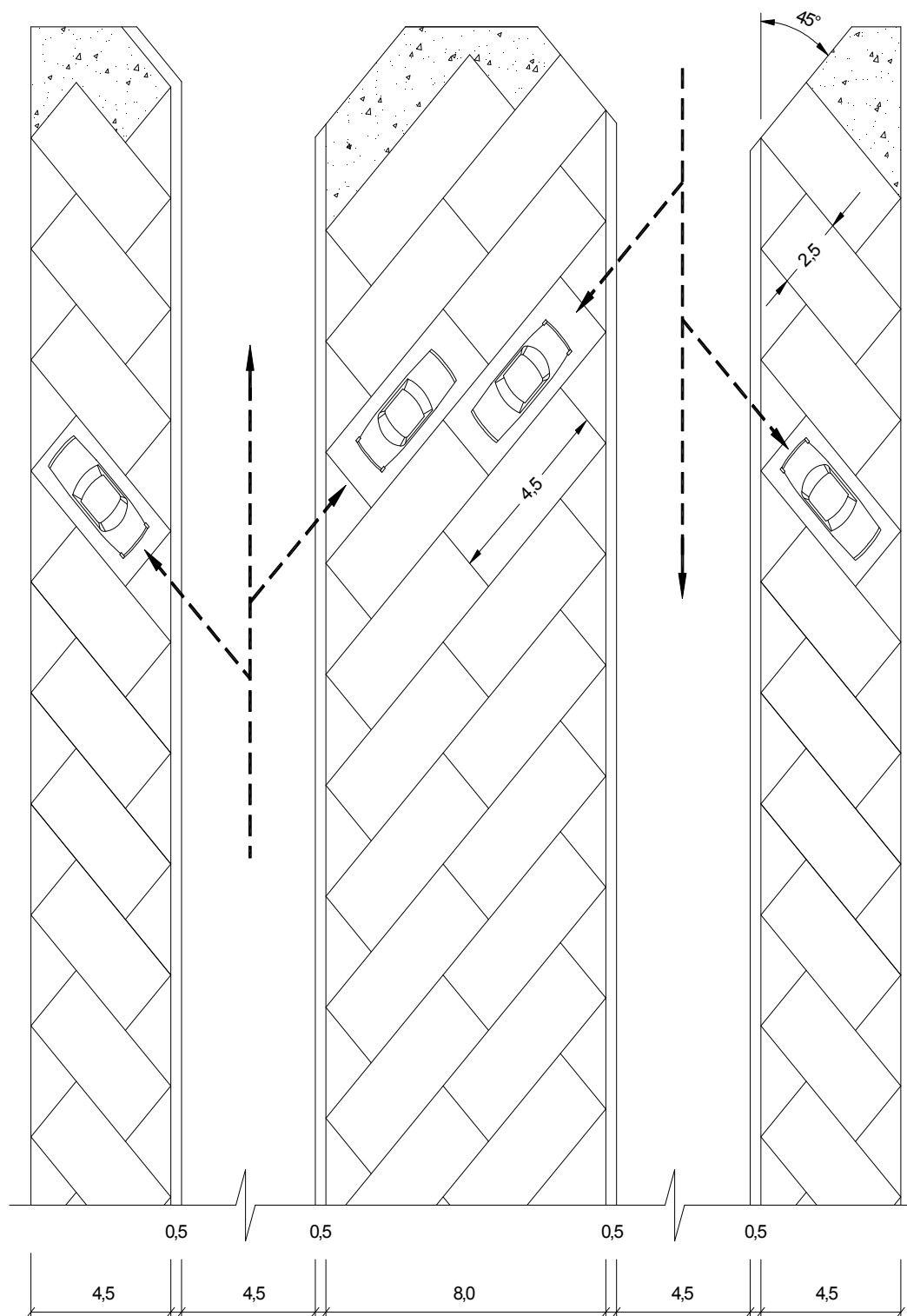
8.6.2 This indication covers the following data:

- a) entire and fractional piles;
- b) characteristic elements of design in plan and profile;
- c) widths of semi-regularization in 2 sides;
- d) superelevation in each pile of curves;
- e) design grade level;
- f) differences between reference side level and 3 lines (centerline, external side and internal side of curves);
- g) distances from offsets to sides;
- h) data obtained in field through leveling of sides and axis;
- i) elevations of cut or embankment in each point.

Annex A - Figures


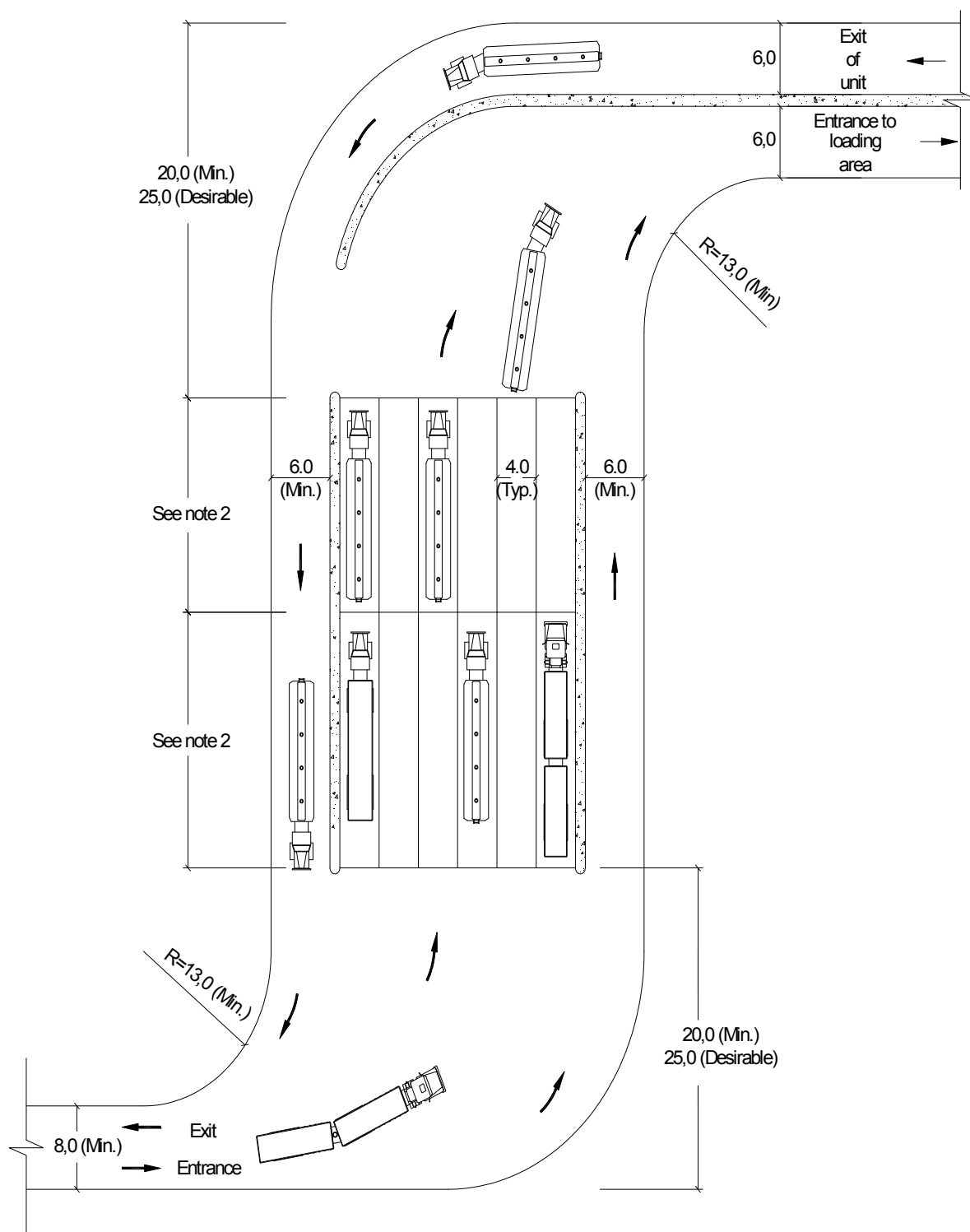
NOTE Sizes in m.

Figure A.1 - Parking Area of Passenger Cars - Transverse



NOTE Sizes in m.

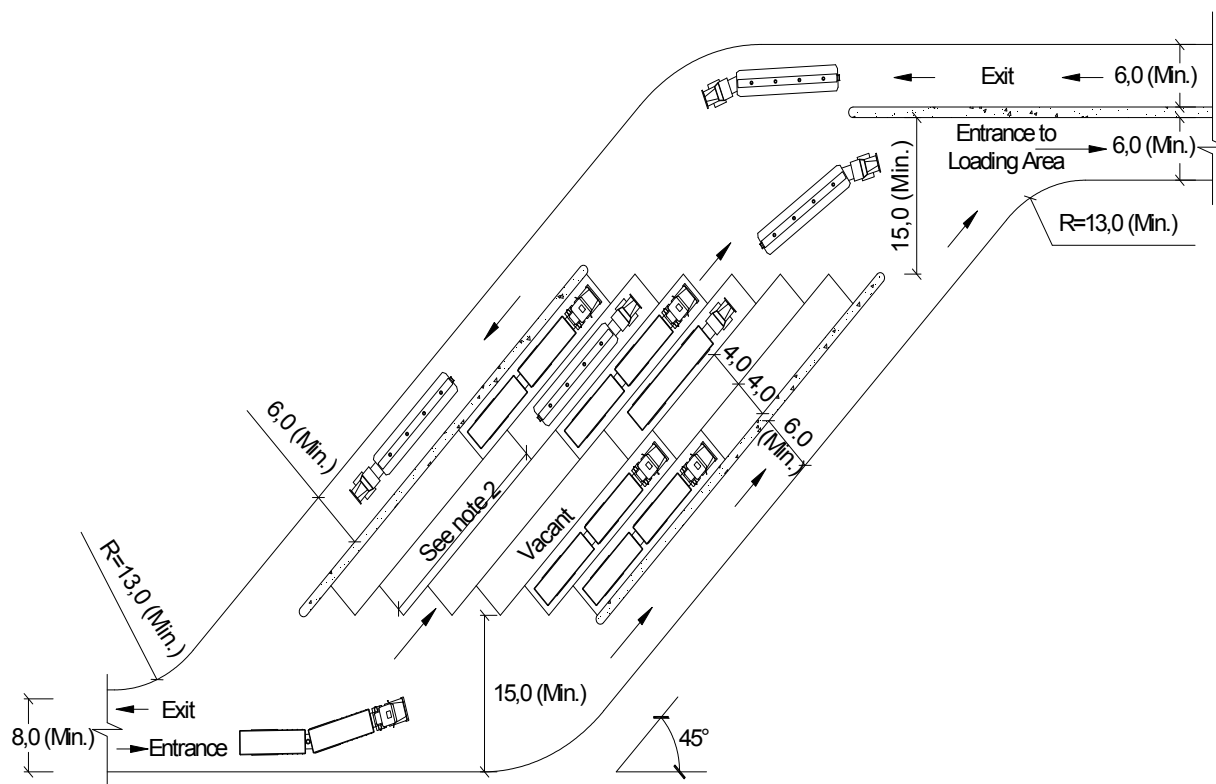
Figure A.2 - Parking Area of Passenger Cars - Oblique



NOTE 1
NOTE 2

Sizes in m.
The length of parking space shall allow the accommodation of the design vehicle, without interference in the parking lot flow.

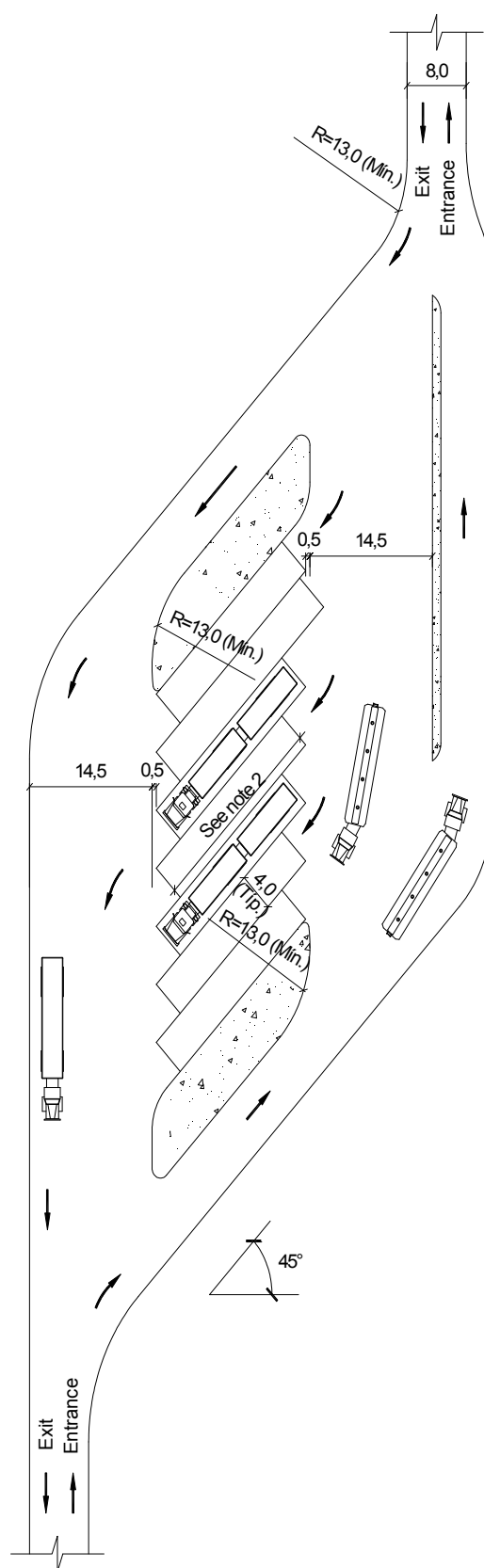
Figure A.3 - Parking Area of Tank Trucks - Transverse



NOTE 1 Sizes in m.

NOTE 2 The length of parking space shall allow the accommodation of the design vehicle, without interference in the parking lot flow.

Figure A.4 - Parking Area of Tank Trucks - Oblique



NOTE 1
NOTE 2

Sizes in m.
The length of parking space shall allow the accommodation of the design vehicle, without interference in the parking lot flow.

Figure A.5 - Parking Area of Tank Trucks - Oblique

[illegible]

5.9 Areas of Process Units

5.9.1 In the process units, the unit floors and internal roads shall be paved with concrete. The free areas, between the battery limit of the unit and the curb of the road, shall be clean, without vegetation, compacted and with crushed stones on the surface.

5.9.2 The paved floor shall be sloped for drainage.

5.10 Scraper Areas

The scraper area shall be paved in concrete and be provided with a specific drainage system, as per PETROBRAS [N-38](#).

6 Sizing

6.1 Geotechnical Data and Traffic Estimate of Avenues and Roads

6.1.1 Avenues and Roads

For sizing the pavement, at least the following specifications shall be considered:

- a) standard road load per axle equal to 82 kN;
- b) tire-pavement contact pressure equal to 0.56 Mpa (average pressure for filling tires);
- c) number of repetition of load equivalent to that of an axle considered to be the standard type ("N") equal to at least 1×10^6 .

6.1.2 Parking, Loading and Unloading Areas

In loading bays, the concrete pavement admitted shall be sized considering the loading of a single axle of 150 kN.

6.1.3 Storage Yards

The support base of the stack of pipes, after preparation, shall present a compressive strength equal to or greater than 1 kgf/cm².

6.1.4 Heliports and Helipads

For sizing of heliports and helipads, the provisions contained in Ordinances [No. 256/GC5](#) and [No. 271/GC5](#) shall be considered.

6.1.5 Area of Process Units

The areas within the limits of process units subject to traffic shall be paved in concrete sized for the load required for operation and the maintenance of the equipment, and the minimum load shall be 220 kN per wheel.



DNIT [048/2004-ES](#) - Pavimento Rígido - Execução de Pavimento Rígido com Equipamento de Fôrma-Trilho;

DNIT [049/2009-ES](#) - Pavimento Rígido - Execução de Pavimento Rígido com Equipamento de Fôrma-Deslizante;

DNIT [137/2010-ES](#) - Pavimentação - Regularização do Subleito;

DNIT [138/2010-ES](#) - Pavimentação - Reforço do Subleito;

DNIT [139/2010-ES](#) - Pavimentação - Sub-Base Estabilizada Granulometricamente;

DNIT [140/2010-ES](#) - Pavimentação - Sub-Base de Solo Melhorado com Cimento;

DNIT [141/2010-ES](#) - Pavimentação - Base Estabilizada Granulometricamente;

DNIT [142/2010-ES](#) - Pavimentação - Base de Solo Melhorado com Cimento;

DNIT [143/2010-ES](#) - Pavimentação - Base de Solo-Cimento;

DNIT [144/2010-ES](#) - Pavimentação Asfáltica - Imprimação com Ligante Asfáltico Convencional;

DNIT [145/2010-ES](#) - Pavimentação - Pintura de Ligação com Ligante Asfáltico Convencional;

DNIT [146/2010-ES](#) - Pavimentação - Tratamento Superficial Simples com Ligante Asfáltico Convencional;

DNIT [147/2010-ES](#) - Pavimentação Asfáltica - Tratamento Superficial Duplo com Ligante Asfáltico Convencional;

DNIT [148/2010-ES](#) - Pavimentação Asfáltica - Tratamento Superficial Triplo com Ligante Asfáltico Convencional;

DNIT [149/2010-ES](#) - Pavimentação Asfáltica - Macadame Betuminoso com Ligante Asfáltico Convencional por Penetração;

DNIT [150/2010-ES](#) - Pavimentação Asfáltica - Lama Asfáltica;

DNIT [151/2010-ES](#) - Pavimentação - Acostamento;

DNIT [152/2010-ES](#) - Pavimentação - Macadame Hidráulico;

PETROBRAS [N-38](#) - Critérios para Projetos de Drenagem, Segregação, Escoamento e Tratamento Preliminar de Efluentes Líquidos de Instalações Terrestres;

PETROBRAS [N-381](#) - Execução de Desenhos e Outros Documentos Técnicos em Geral;

PETROBRAS [N-1602](#) - Construção de Pavimentos;

PETROBRAS [N-1645](#) - Critérios de Segurança para Projeto de Instalações Fixas de Armazenamento de Gás Liquefeito de Petróleo;

PETROBRAS [N-1674](#) - Projeto de Arranjo de Instalações Industriais Terrestres de Petróleo, Derivados, Gás Natural e Álcool;

ABNT [NBR 7207](#) - Terminologia e Classificação de Pavimentação;

ABNT [NBR 9780](#) - Peças de Concreto para Pavimentação - Determinação da Resistência à Compressão;

ABNT [NBR 9781](#) - Peças de Concreto para Pavimentação;

6.2 Flexible and Rigid Pavements

6.2.1 The sizing shall be performed in accordance with a methodology acclaimed by the technical community.

6.2.2 Interlocked concrete pavements, flexible pavements, shall follow the provisions established in ABNT [NBR 9780](#) and [NBR 9781](#)

7 Signaling

7.1 Vertical signaling (lateral and/or suspended in relation to the road) and horizontal signaling (painting on the road itself or on the shoulders) shall be design the meet the internal safety requirements of the industrial unit, of the user and of the Visual Identity Manual of PETROBRAS.

7.2 Heliports and helipads shall be identified in accordance with the provisions of Ordinances COMAER [No. 256/GC5](#) and [No. 271/GC5](#).

8 Design Presentation

The project shall be made of the following documents:

- a) design premises;
- b) calculation notes;
- c) drawings;
- d) technical specifications;
- e) service quantity sheet;
- f) service notes;
- g) complementary information, when necessary.

8.1 Design Premises

The design premises shall contain the following information:

- a) basic design data;
- b) material specification;
- c) design methodology;
- d) other required information for the complete understanding of the design.

8.1.1 Basic Design Data

They are composed by the following information:

- a) layout plan or master plan;
- b) earthwork design;
- c) geotechnical investigation report;
- d) traffic estimates;
- e) indication of reservoirs;
- f) weather conditions.