

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

TECHNICAL SPECIFICATION

ROADS, PAVING, SURFACING, SLOPE PROTECTION AND FENCING

PTS 34.13.20.31

NOVEMBER 2010



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This revision of PTS **34.13.20.31– ROADS, PAVING, SURFACING, SLOPE PROTECTION AND FENCING** (November 2010) has been updated incorporating PETRONAS Lessons Learnt, Best Practice and information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font.

The previous version of this PTS (**April 2003**) will be removed from PTS binder/ e-repository from herein onwards.

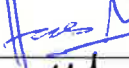
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Revision History

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PREFACE

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1. INTRODUCTION

1.1 SCOPE

This PTS specifies requirements and gives recommendations for the design and construction of roads, paving, surfacing of unpaved areas, cable trenches, erosion protection of slopes, and fencing and gates.

The minimum technical requirements as laid down in this specification shall be applied. Supplementary to these requirements, the design and construction shall be in accordance with generally accepted theories, codes, methods and good working practices. Examples of acceptable codes are referenced in this PTS. The climate, topography, soil conditions and local requirements shall be taken into account as well as the specific requirements of the Principal. Equipment, materials and working methods shall, unless specified otherwise, be subject to approval by the Principal.

Requirements described herein relate to and are limited to work above the sub-grade. If a functional minimum property of the subgrade is required, that property will be stated without further discussion.

Geotechnical, foundation engineering and surfacing aspects, including the stability of slopes, roads, bund walls, tank pits and tank pads, are not within the scope of this PTS. For these aspects, reference is made to PTS 34.11.00.11. and PTS 34.11.00.12.

This PTS is a revision of the PTS of the same title and number dated April 2003. A summary of changes since the previous edition is given in (1.5).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of the PETRONAS or managed by a Group company, and to Contractors and Manufacturers nominated by them (i.e. the distribution code is "F" as defined in PTS 00.00.05.05.).

It is intended for use in oil refineries, chemical plants, gas plants, or any such facility related to manufacturing activities and, where applicable, in exploration, production and distribution. When PTSs are applied, a Management of Change (MOC) process should be implemented. This is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this PTS, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with respect to safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this PTS which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this PTS as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Note: Refer to Figure 1.1 and Figure 2.1 for illustration of common terms.

Site

An area comprising the total of all on-plot and off-plot areas, which may be located either onshore, nearshore, offshore, or at a combination of these locations.

Off-site

Areas associated with the site, but located at a distance, e.g., water wells.

On-plot area

An area designated for utility and processing units, including associated control rooms, electrical sub-stations, analyser houses, stacks, associated pipe tracks and plant roads.

Off-plot areas

An area designated for all facilities not in the on-plot area which may include administration buildings, workshops, laundries, warehouses, materials yards, storage tank compounds, pump stations, flares, fire-fighting station, training grounds, cooling water intake station, cooling towers, cooling water settling ponds, cooling water discharge channels, jetties, harbour, associated pipe tracks and roads.

Battery limit

The operational boundary of individual processing or utility units.

Sterile zone

An area dedicated to one kind of activity and/or equipment. This area should be free of unrelated equipment and/or activities. An example of a sterile zone is the area around a flare.

Laydown area

A subsection of the battery limit being an area in which process equipment parts may be laid down during erection in the construction phase or maintenance overhaul.

Contractor's area

An area located in the off-plot area to be made available for the Contractor's activities which may include storage of construction materials and equipment, assembly, painting, fabrication, temporary contractor's offices. Different areas may be allocated for construction and operation.

Sub-grade

The surface prepared to support a pavement system.

Sub-base

The engineered granular fill placed on the sub-grade with the purpose of supporting the bound materials of the pavement system.

Base Course

Sub-layer material placed directly on top of the undisturbed soil so as to provide a foundation to support the top layer(s) of the pavement.

Binder Course

Coarse aggregate with a bituminous binder between the base course and the wearing course of a pavement.

Wearing Course

Part of the surfacing directly supporting the traffic.

Road width

The distance between the outside edges of the road pavement. This does not include the width of shoulders.

1.4 CROSS-REFERENCES

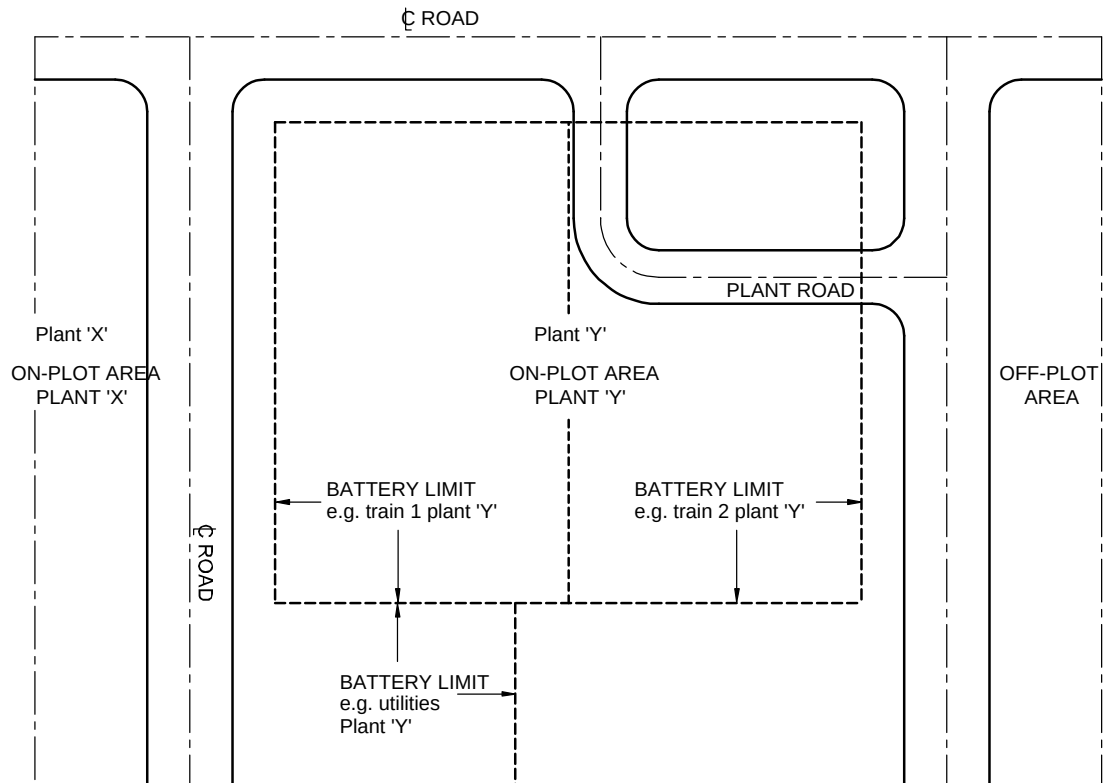
Where cross references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (9).

1.5 SUMMARY OF CHANGES SINCE PREVIOUS EDITION

The previous edition of this PTS was dated April 2003. Other than editorial and formatting revisions, the following are the main changes to that edition:

Old section	New Section	Change
1.3.2	1.3.2	To include the definition for wearing course , binder course and base course
Figure 2.1 Detail I	Figure 2.1 Detail I	To change "Bituminous" term to "Binder Course"
Figure 2.1 Detail II	Figure 2.1 Detail II	To indicate "Steel reinforcement" in the cross section
2.2	2.2	To add reference for geometric design of roads
2.4.3	2.4.3	To update latest revision of AASHTO guideline
-	2.4.12	To add new item for concrete kerbs requirements
-	2.6	To add requirement for Road Traffic Signs & Road Markings
8	8	To add requirement for road maintenance responsibility
-	7.5.4	To include requirement for electrical grounding
9	9	To update references list

Figure 1.1 Schematic Diagram Showing Typical Terms Used



2. ROADS

2.1 DETAILED SCOPE

This section outlines the minimum requirements for permanent roads and bridges within the site.

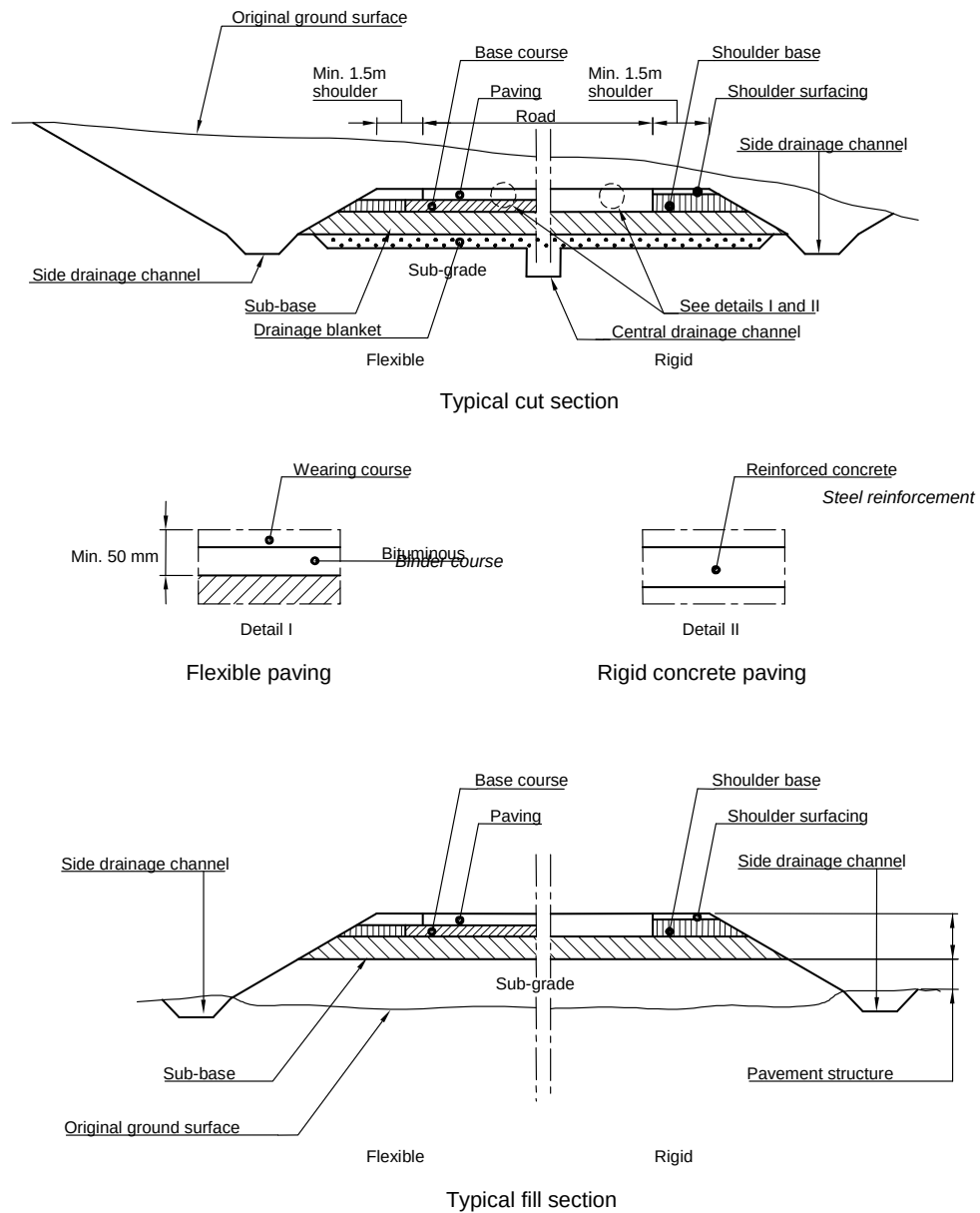
Unless otherwise specified by the Principal, all road widths shall comply with the following table:

Road Type	Road Width (m)	Notes
Main	8	shoulder
Plant	4 to 6	shoulder
off-plot heavy-duty	6	shoulder
off-plot light-duty	4	shoulder
Patrol	3	no shoulder
maintenance track	to suit	no shoulder

General terms used to describe roads and pavements are illustrated in the cross sections presented in Figure 2.1.

The design of contaminated and non-contaminated drainage systems is not covered by this technical specification. The design of these drainage systems is described in PTS 34.14.20.31.

Figure 2.1 Schematic Drawing Showing Typical Cross Sections Of Roads



2.2 GENERAL DESCRIPTION

The road pavement structure shall be supported by the sub-grade and, unless specified by the Principal, shall comprise:

- sub-base;
- paving.

A sub-base is required if the settlement behaviour and/or the bearing capacity of the sub-grade are insufficient to support the paving and traffic without excessive deformations or maintenance during the lifetime of the plant. Where the support by the sub-grade is insufficient, consideration should be given to economic methods of ground improvement, the suitability of which shall be demonstrated by site trials. Details of ground improvement are provided in PTS 34.11.00.11. *Geometric Design of roads shall follow the guidelines outlined in the AASHTO GDHS-5 - A Policy on Geometric Design of Highways and Streets*. Roads shall be of the two-lane type, except for maintenance tracks, patrol roads and other roads as specified by the Principal. Terms are defined and typical cross sections of roads are shown in Figure 2.1.

Shoulders shall be capable of supporting, without damage, slow-moving and parked vehicles for which the road is designed. In the design of roads, sufficient shoulder width shall be provided to accommodate cable trenches.

2.3 FUNCTIONAL REQUIREMENTS

The functional requirement for all roads and tracks is to provide:

- stable and durable access to all locations of the site for those transport means for which they are designed and may include cars, trucks, cranes and other mobile equipment such as snow ploughs, fire engines or road sweepers that are required at those locations during the lifetime of the plant;
- stable and durable access to all installations and buildings for fire-fighting equipment and other emergency vehicles under consideration for the site via at least two independent routings under all conditions; see PTS 80.47.10.33.

2.4 DESIGN AND MATERIALS

2.4.1 General

Roads on which a hydrocarbon or chemical spillage is expected during the lifetime of the road shall be surfaced with chemical-resistant paving and may be of a concrete type design. For on-plot roads a rigid concrete pavement is generally used, for off-plot roads a bituminous-type flexible paving is generally used.

In the selection of paving material, consideration shall be given to operational requirements during the life of the plant as well as the cost of construction and maintenance of the pavement. In some circumstances, there may be a requirement to install or access underlying services. In such situations, paving slabs, brickwork or blockwork may provide a suitable low maintenance flexible paving system.

Design, materials and testing procedures, etc., shall be in accordance with international standards and codes, as specified in this PTS.

2.4.2 Interface with site preparation

The design of the sub-grade shall be based on the result of a geotechnical (soil mechanical and geohydrological) survey, including calculations and determination of the grain size distribution, silt content, plasticity index, friction properties, relative density and permeability. The average, high and the highest possible ground water levels, as well as the in-situ permeability, shall also be assessed. The objective of these investigations is to ensure the sub-grade remains stable and durable throughout the life of the plant. Depending on the location of the site, or the processes for which the plant is designed, some sub-grade materials may be affected by swelling, shrinkage or softening due to

changes in moisture content, heave due to frost action, or deterioration due to chemical reaction.

Acceptance criteria for the sub-grade and sub-base shall be developed on the basis of the design requirements of the pavement. Before surfacing, acceptance of the sub-grade and sub-base shall be obtained through compliance testing, the results of which shall meet the requirements of the acceptance criteria. Examples of suitable compliance tests are:

- compaction test (maximum dry density);
- Californian Bearing Ratio test (CBR);
- plate bearing test;
- static cone penetration test (Dutch Cone Penetration Test (DCPT));
- in-situ density tests.

These tests shall be carried out in accordance with test methods in accordance with ASTM Volume 04.03, BS 1377, BS 5930 or equivalent standards. Interpretation of test results shall take into account the maximum moisture content of the sub-base and sub-grade materials that are considered representative for the operating situation.

If the CBR value of the sub-grade is less than 10, special consideration shall be given to the pavement system to ensure a stable and durable design throughout the life of the plant.

The design shall include measures to prevent intermixing of sub-grade material into the sub-base during construction and during the design life of the pavement.

2.4.3 Heavy-and light-duty roads

The pavement of heavy- and light-duty roads shall be designed in accordance with the latest revision of *AASHTO GDPS-4-M - Guide for Design of Pavement Structures* or equivalent standard as acceptable to the Principal.

Details of heavy and light duty roads and patrol roads are presented in Standard Drawings S13.005, S13.006 and S13.007.

Design factors that are prescribed by, but not quantified in, the above guide shall be proposed to and agreed with the Principal. In the case of the AASHTO publication, the design factors include:

- (normally) high ground water level;
- non uniform soil support (settlement/differential settlements of sub-grade);
- soil support value S (flexible paving);
- equivalent single-axle loads;
- regional factor;
- modulus of sub-grade reaction value K (rigid paving);
- working stress of concrete (rigid paving);
- total design life.

The total thickness shall be designed for the total number of axles indicated for the total design life. The recommended number of axle movements for the design of heavy-duty roads is 1.5 million and for light-duty roads 1.0 million.

The terminal serviceability index for heavy- and light-duty roads shall be 2.5 as defined in the AASHTO publication. The concrete working stress as defined in this publication may be derived from the standard splitting strength, see PTS 34.19.20.31.

In design, the following parameters shall be considered:

- reliability, $R = 75\%$ for heavy duty roads;
- reliability, $R = 50\%$ for light duty roads;
- standard deviation $S_o = 0.45$;