NATIONAL TRANSPORT RESEARCH ORGANISATION

Best Practice Guide

The Evaluation of Marginal and Non-standard Materials in Road Construction

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Version History

Version	Release Date	Release Notes
1.0	December 2025	Initial release of NTRO Best Practice document

Foreword

NTRO Best Practice Guides exist to articulate how a transport network owner or operator should require a specific, contemporary issue/challenge to be solved/resolved to ensure that it is delivering positive outcomes and meeting its statutory safety-, serviceability- and sustainability-related obligations effectively and efficiently. Rather than being totally prescriptive, NTRO Best Practice Guides identify the key building blocks to be followed to arrive at a desired outcome or solution and how they interrelate and combine. They are supported by NTRO and other specifications and/or test methods that set out which things must be done and specifically how they are to be done.

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1. Introduction

1.1 Scope

This Best Practice Guide provides a structured approach for the evaluation of marginal and non-standard materials in road construction through large-scale laboratory testing. It is intended for situations where materials fall outside conventional specification frameworks and where small-scale laboratory tests are insufficient to reflect field performance due to scale-related limitations (e.g. edge effects and unrealistic confinement).

1.2 Referenced Document

The following document is referenced in this Best Practice Guide and is essential for its application:

AGPT-T054-15, *Determination of permanent deformation characteristics of unbound granular materials by the wheel-tracking test*.

1.3 Terms, Definitions, Acronyms/Abbreviations

Abbreviations and definitions are listed in Table 1.1.

Table 1.1: Abbreviations and definitions

Term/Acronym	Definition
APT	Accelerated pavement testing – a large-scale testing system used to simulate traffic loading (e.g. performed at the Accelerated Loading Facility)
CBR	California Bearing Ratio – the ratio of the load required to penetrate a material to a standard depth, compared to the load required to penetrate a standard crushed stone to the same depth
DoS	Degree of saturation – the ratio of the volume of water to the volume of voids in a material, expressed as a percentage
Large-scale testing	Testing that bridges the gap between small-scale bench testing and full-scale field evaluation
LTPP	Long-term pavement performance
Marginal materials	Unbound granular materials that do not fully meet standard specifications but are only slightly outside acceptable limits
Non-standard materials	Unbound granular materials that fall well outside specification limits
OMC	Optimum moisture content – the moisture level at which a material achieves its maximum dry density under a standard Proctor compactive effort
Permanent deformation	Irreversible vertical downwards movement (e.g. rutting) of the pavement surface (or wheel-tracking specimen)
PSD	Particle size distribution – proportions of particles of different sizes present in a soil, aggregate or other granular material
RLT	Repeated load triaxial – a laboratory test used to assess a material's response to traffic loading. It applies repeated axial loads to a cylindrical sample under constant pressure, simulating the stress conditions in pavement layers caused by passing vehicles
Small-scale testing	Laboratory tests conducted on relatively small, simplified specimens under controlled conditions
Standard materials	Unbound granular materials that satisfy specification limits
UCS	Unconfined compressive strength – maximum axial compressive stress that a cylindrical specimen can withstand under unconfined (no lateral support) conditions
UGM	Unbound granular material – a compacted granular pavement material not bound by cementitious or bituminous agents. Unbound granular material may include crushed rock, natural gravels and sand, and recycled materials

2. Context and Rationale

Common laboratory tests used to assess the compliance of unbound granular materials (UGM) include particle size distribution (PSD), Atterberg limits, moisture-density relationship, California Bearing Ratio (CBR), repeated load triaxial (RLT) and unconfined compressive strength (UCS). These tests are often limited to smaller sample specimens (e.g. 150 mm diameter).

While compliance with standards provides a minimum level of assurance regarding field performance, a growing number of road agencies and project proponents are exploring the use of non-standard, marginal or innovative materials in pavement layers due to sustainability goals, cost considerations or supply chain constraints.

Full-scale testing methods (such as accelerated pavement testing (APT)) can offer highly realistic performance data for evaluating such materials. However, these methods are:

- time consuming and costly
- logistically complex
- inaccessible for most routine material approval processes
- extremely limited in availability.

Between these small-sample laboratory-based tests and full-scale testing there is a gap in current practice for testing that uses dimensionally larger samples of material. Addressing this gap provides a cost effective, laboratory based and less resource-intensive approach that more accurately reflects field loading conditions. A large-scale laboratory testing method that meets the minimum dimensional and validation criteria outlined in AGPT/T 054 (such as Austrack XL-WT) is recommended to help bridge this gap.

3. Equipment Requirements, Testing and Data Management

The equipment specifications (condition, precision, calibration, etc.), data specifications (parameters, units, etc.), testing methods and data management methods used to undertake the evaluations of the marginal and non-standard materials shall be as outlined by the relevant test methods (e.g. AGPT/T 054).

4. Reporting

In addition to the outputs specified in the respective test methods (e.g. AGPT/T054), the following parameters shall also be reported:

- permanent deformation (rut depth in mm) at 1,000, 5,000, 10,000 and the end of testing cycles
- the number of cycles it takes to reach 5, 10, 15 and 20 mm rut depth to the nearest whole number (if reached).

If a material is tested at different moisture levels, these parameters shall be plotted against relative moisture content (percentage of OMC) or DoS.