ACT Government

Engineering Advisory Note EAN 23

Updates to Standards and Specifications for flexible granular pavements

Background

Through the Roads ACT Pavement Inspection Program, Roads ACT have identified several road pavements which are experiencing accelerated pavement failure. These failures have been assessed as structural and require rehabilitation below the asphalt wearing course layer. The roads which are experiencing accelerated failure all have the following characteristics:

- Constructed as part of subdivision works
- Date of opening is less than 15 years ago
- Road classification: collector road[1]
- Form part of a bus route
- Have a pavement design that is flexible granular pavement[2]

The roads identified by Roads ACT that are experiencing accelerated structural failure will require some form of rehabilitation within their designated design life. Such pavement rehabilitation is expected to incur significant costs to the Territory. As of the date of this Engineering Advisory Note (EAN), the list of roads identified that are experiencing accelerated structural failure are listed below. Photos showing a sample of the pavement failures are provided in **Annexure 1**.

Road	Date of opening
David Walsh Avenue, Forde	2010
Kingsland Parade, Casey	2013
Overall Avenue, Casey	2009
Bernard Heinze Avenue, Moncrieff	2016
Steve Irwin Avenue, Wright	2013
Harold White Avenue, Coombs	2014
Annabelle View, Coombs	2014

[1] The term 'collector road' is used to represent both a 'minor collector road' and a 'major collector road' under the ACT Road Hierarchy system. The requirements in *Engineering Advisory Note 23* which apply to 'collector roads' apply to both 'major collector roads' and 'minor collector roads'.

[2] Flexible granular pavement is sometimes referred to as a 'Granular pavement with thin asphalt surfacing'.

Road	Date of opening
Hazel Hawke Avenue, Whitlam	2021
Plimsoll Drive, Casey	2010 to 2013
Whitrod Avenue, Casey	2013
Yeend Avenue, Casey	2010
Dudley Street, Yarralumla*	2021

*Dudley Street was not constructed as part of subdivision works and is not a bus route. However, its pavement design is a flexible granular pavement. The assessment of the root cause of the accelerated pavement failure of Dudley Street gives valuable insight into one of the mechanisms for accelerated failure of this pavement type.

Roads ACT has worked in collaboration with several industry subject matter experts to undertake geotechnical investigations, review pavement designs, review Works as Executed information, and assess the likely root causes for the accelerated pavement failure at the above-listed roads. Roads ACT has then engaged a local subject matter expert to peer review all available information and work collaboratively with Roads ACT to develop updates to the Municipal Infrastructure Standards (MIS) and the Municipal Infrastructure Technical Specifications (MITS) to mitigate the risk of such accelerated pavement failure for future road construction. This has also included engagement with representatives from Transport for New South Wales (TfNSW) responsible for the development of the TfNSW standards and specifications for pavements.

The updates to the MIS and MITS presented in this Engineering Advisory Note represents the culmination of several projects, and significant research by Roads ACT and industry subject matter experts. Whilst some of the proposed updates may appear onerous or conservative, they are deemed by Roads ACT to be necessary to prevent the occurrence of accelerated pavement failure of newly constructed roads.

Updates to MIS 03 Pavement Design

Scope of MIS 03 Pavement Design

MIS 03 Pavement Design applies to municipal roads in the ACT and does not apply to roads classified under the ACT roads hierarchy system as arterial or sub-arterial roads, and does not apply to roads where the design traffic load is equal to or greater than 1×10^7 ESA. **Table 1** outlines the amendments to Clause 1.1.1.1.

Table 1 – Amended scope and applicability of MIS 03

MIS 03 reference	Amendment
C1.1.1.1	*Amend second paragraph, last line* Change 'greater than 2×10^6 ESA' to 'equal to or greater than 1×10^7 ESA'
C1.1.1.1	*Amend last line in Clause* Change 'greater than 2×10^6 ESA' to 'equal to or greater than 1×10^7 ESA'

Minimum pavement design life

The minimum pavement design life of 40 years is to be adopted for all flexible pavements except for pavements with lower classification than collector roads. **Table 2** outlines the amendments to the design life requirements for flexible pavements.

Table 2 – Amended design life requirements for flexible pavements

MIS 03 reference	Amendment
C2.4.4.2	• Design life for sub-arterial roads, arterial roads and highways/freeways should be 40 years • Design life for collector roads should be 40 years • Design life for deep lift or full depth asphalt pavements for all road categories should be 40 years • Design life for all other pavements with lower classification than collector roads should be 20 years • Notwithstanding the above requirements, the design life of an asphalt surfacing layer should be 15 years

Design traffic

For collector roads, designers are required to calculate the expected traffic loads, not adopt the minimum traffic load as the default.

All collector roads must be designed to carry at least one bus service, plus potential loads from construction traffic, plus the in-service traffic post construction. If it is expected or planned that a collector road will carry multiple bus services, then this shall be accounted for as part of the calculation of design traffic loading.

As documented in the *Zero-Emission Transition Plan for Transport Canberra*, the ACT Government plans to transition to a zero-emissions bus fleet by 2040. As such, the specified bus loading is based on the Yutong E12 electric bus currently in service, with an average ESA of 3.74 per bus movement. Refer to **Annexure 2** which contains calculations for design traffic loadings for such buses.

The potential total construction traffic load on new collector roads must take account of the following:

1. The load from future construction traffic required to construct the estate.
2. If the collector road is to be utilised as an access road for construction of subsequent stages of an estate development, then the load from future construction traffic required to construct such subsequent stages of the estate development shall also be considered.
3. The load from future construction traffic required to construct the dwellings and other facilities and buildings for the estate.

The calculation of construction traffic loading for an estate will require that the designer estimate the quantities to be imported to site, such as imported fill material, drainage elements, asphalt and granular materials. This estimate of quantities is to be utilised to estimate the total number of construction vehicles which will utilise the collector road to access the site in order to import such materials to site. Guidance on the ESA for fully loaded construction vehicles is provided in **Annexure 2**.

The post construction, in-service traffic loading is based on the Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design (AGPT02-17), Appendix O, Table O 2*. This data excludes buses because they are separately considered as described above. Note that Table O 2 in *AGPT02-17* may be updated as part of future revision to *AGPT02*. For convenience, the data in Table O 2 of *AGPT02-17* is also presented in **Annexure 2**.

Annexure 2 also includes full traffic load distribution tables for bus in-service loading. Such is provided because pavement thickness design based on the mechanistic-empirical design method in *AGPT02* is required for collector roads.

Table 3 outlines the amendments to the requirements for the calculation of design traffic loads.

Table 3 – Amended requirements for calculation of design traffic loads

MIS 03 reference	Amendment
C2.4.1	*Add to > points:* > All collector roads must be assumed to carry at least one bus route at a frequency applicable to the location. > All roads carrying buses must, as a minimum, have the pavement designed as for collector roads.
C2.4.2, first line	*Insert after 'Municipal roads':* , excluding collector roads,
C2.4.2 Table 03-1	*Delete bottom two rows of the table*
C2.4.4.1, second paragraph	*Add at end of paragraph:* The minimum design traffic for collector roads is 1.0 x 10^6 ESA.
C2.4.4.7	*Add to end of Clause:* The design traffic loads for collector roads must be calculated as the sum of four components: (a) the load from buses for the design period, with an average ESA per bus of 3.74 and a traffic load distribution as listed in Annexure 2, Table A2-1; (b) the load from future construction traffic required to complete the estate, and all future stages of estate development, if applicable, assuming all heavy vehicles are fully loaded (refer Annexure 2, Table A2-3); (c) the load from construction traffic required to construct the expected dwellings or other facilities, assuming all heavy vehicles are full laden – a default value of 25% of the traffic applicable for item (b) may be adopted for estate development; and (d) the load from the design traffic for the design period based on the in-service traffic model, based on an average ESA per heavy vehicle of 1.30 and traffic load distribution according to *AGPT02-17, Table O 2* or equivalent as listed in Annexure 2, Table A2-2.

Acceptable criteria for the adoption of flexible granular pavements

Due to issues with the performance of recently constructed flexible granular pavements, such pavements may only be used for access roads and collector roads with a design traffic load less than 1 x 10^7 ESA.

In addition, based on TfNSW pavement design methodology, flexible granular pavements with a design traffic load equal to or greater than 5 x 10^6 ESA are required to incorporate Class 1 DGB materials as specified in *TfNSW Specification 3051*. The use of Class 1 DGB material is not covered by *MITS 04 Flexible Pavements*. In addition, such pavements must be designed in accordance with *AGPT02* and *RMS Supplement to Austroads Guide to Pavement Technology Part 2*, and must be constructed in accordance with the TfNSW suite of specifications for pavements.

Table 4 outlines the amended requirements relating to the adoption of flexible granular pavements. Discussion of paragraph (ii) in **Table 4** is included in the next section.

Table 4 – Amended requirements for the adoption of flexible granular pavements

MIS 03 reference	Amendment
C3.3.1.1 third paragraph	*Delete paragraph and replace with new paragraphs:* High design traffic: The following applies: i. Flexible granular pavements must not be used for a design traffic equal to or greater than 1 x 10^7 ESA. ii. Flexible granular pavements for roads with a design traffic load equal to or greater than 1 x 10^6 ESA and less than 1 x 10^7 ESA must use AC14 asphalt surfacing 45 mm thick with an A15E PMB over a prime and 10 mm spray seal. iii. Unbound thickness of the base layer and the combined base plus subbase layers must be at least the thicknesses required by *AGPT02, Figure 8.4*. The thickness of the asphalt surfacing may be considered to contribute to the required total thickness over the in situ subgrade, but does not affect the required thickness of granular base or subbase. Other surfacing types (such as sprayed seals) are considered to make no contribution to the required thickness of granular material. iv. Flexible granular pavements with a design traffic load equal to or greater than 5 x 10^6 ESA and less than 1 x 10^7 ESA must be designed using a mechanistic-empirical method in accordance with the latest versions of *AGPT02* and the *RMS Supplement* to *AGPT02*, and constructed in accordance with *TfNSW QA Specifications R71*, *R106* and *R117* (or *R116* if applicable) and referenced specifications.

Pavement design (flexible granular pavements)

To mitigate the risk of the accelerated structural failures which have been observed from recently constructed flexible granular pavements, the design of flexible granular pavements require the employment of enhanced design principles. These enhanced design principles primarily apply to collector roads and similar highly trafficked or highly stressed road pavements.

For collector roads, the designer is required to adopt the mechanistic-empirical design method set out in *AGPT02*. The adopted elastic modulus of the pavement layers, except for asphalt, is not to exceed the default values listed in Section 6 of *AGPT02*. The elastic modulus of the asphalt materials must be calculated using the RMS software described in **Table 5**. Notwithstanding the results of this design, the thickness of the combined granular base and subbase layers must not be less than the thickness required by *AGPT02, Figure 8.4*, to ensure there is an adequate thickness of granular materials should the asphalt surface lose stiffness due to cracking.

The use of natural in situ material as Select Material above the design subgrade level is limited for collector roads and other similar roads, as discussed in a subsequent section of the EAN. Designers must not, by means of drawing notes or other manner, override the requirements of *MITS 02B Bulk Earthworks* in this regard.

The asphalt wearing course for collector roads and similar roads, with flexible granular pavements and a design traffic load equal to or greater than 1 x 10^6 ESA, must be AC14 with an A15E Polymer Modified Binder (PMB) for enhanced fatigue and cracking resistance. The asphalt wearing course thickness of 45 mm must be specified to aid in the reduction of fatigue stresses. The design must also include a prime and sprayed seal below the asphalt.

To reduce the development of pavement distress along the edges and ends of splitter islands and medians, all pavement layers up to the underside of the asphalt surfacing must extend at least 600 mm behind the back of kerb at traffic islands and concrete medians.

Table 5 outlines the amended requirements relating to the pavement design for flexible granular pavements.

Table 5 – Amended requirements for the pavement design for flexible granular pavements

MIS 03 reference	Amendment
C2.2.1	*Insert new paragraph at end of Clause* The designer must not override the requirements of ***MITS 02B Bulk Earthworks*****, Clause 1.4.11.2, Use of natural in situ material as replacement for Select Material**. The use of in situ material above the design subgrade level is prohibited for sub-arterial roads, arterial roads and highways.
C2.3.3 fourth paragraph 'Material properties'	*Insert at end of paragraph:* The elastic modulus of asphalt to be calculated using the NSW RMS 'AC Modulus' software, available from pavements@rms.nsw.gov.au.
C3.1.1.1	*Amend 'Pavement extent:':* Pavement extent at edge of kerb or gutter: *Add additional paragraph* Pavement extent under splitter islands or paved medians: Continue full pavement structure, including subgrade, Select Material and granular base material, up to base of asphalt surfacing layer for at least 600 mm behind the back of kerb at traffic islands and medians.
C3.2.2 paragraph after Table 03-2	*Amend '> 40 mm for major collector roads or 25 mm for other municipal roads':* > Greater than or equal to 45 mm wearing course with A15E polymer modified binder for collector roads or pavements subjected to high shear forces and/or high volumes of heavy vehicles (noting Clause 3.3.1.1(ii) for flexible granular pavements), or > 30 mm for other municipal roads
C3.3.1.1 second paragraph	*Change the phrase 'or mechanistic design in accordance with AGPT02 Chapter 8' to:* and mechanistic design in accordance with the requirements of *AGPT02*.

MIS 03 reference	Amendment
C3.3.1.1 third paragraph	*Delete paragraph and replace with new paragraphs:* High design traffic: The following applies: i. Flexible granular pavements must not be used for a design traffic equal to or greater than 1 x 10^7 ESA. ii. Flexible granular pavements for roads with a design traffic load equal to or greater than 1 x 10^6 ESA and less than 1 x 10^7 ESA must use AC14 asphalt surfacing 45 mm thick with an A15E PMB over a prime and 10 mm spray seal. iii. Unbound thickness of the base layer and the combined base plus subbase layers must be at least the thicknesses required by *AGPT02, Figure 8.4*. The thickness of the asphalt surfacing may be considered to contribute to the required total thickness over the in situ subgrade, but does not affect the required thickness of granular base or subbase. Other surfacing types (such as sprayed seals) are considered to make no contribution to the required thickness of granular material. iv. Flexible granular pavements with a design traffic load equal to or greater than 5 x 10^6 ESA and less than 1 x 10^7 ESA must be designed using a mechanistic-empirical method in accordance with the latest versions of *AGPT02* and the *RMS Supplement* to *AGPT02*, and constructed in accordance with *TfNSW QA Specifications R71*, *R106* and *R117* (or *R116* if applicable) and referenced specifications.
C3.3.1.1 fourth paragraph	*Delete paragraph*

Updates to MITS 04 Flexible Pavements

Material properties for DGB20

The majority of the specified material property requirements for DGB20 outlined in *MITS 04* are the same as those in *TfNSW Specification 3051* for a Class 2 DGB20 material. However, the limits for the percentages retained between sieves and the minimum aggregate wet strength differ slightly between *MITS 04* and *TfNSW Specification 3051*.

To ensure uniform material properties for a DGB20 material under the *TfNSW Specification 3051* and *MITS 04*, the requirements in *MITS 04* regarding sieve percentage limits and aggregate wet strength are adjusted to match that of *TfNSW Specification 3051*.

This will serve a dual benefit. It will ensure improved performance for DGB20 materials and will also simplify the production of DGB20 materials.

Table 6 outlines the amended material property requirements for DGB20 material.

Table 6 – Amended material property requirements for DGB20

MITS 04 reference	Amendment
C1.3.1.5 Table 4-5 column 3 percentage retained between sieves	*Amend percentage ranges:* Replace with values from *TfNSW Specification 3051* for Class 2 DGB
C1.3.1.6 Table 4-6 Aggregate wet strength	*Replace 50 kN for DGS20 and DGS40:* 75 kN

Moisture content testing and dryback

MITS 04 Edition 1 Revision 0 (*MITS 04 Ed1 Rev0*) contains limits on the moisture content of granular base and subbase materials in two cases. The first case is during initial compaction when the acceptable range is 60% to 90% of Standard optimum moisture content to ensure sufficient, but not excessive, moisture for compaction. The second case is immediately prior to sealing, in which case the moisture content of the base course materials must not exceed 70% of the Standard optimum moisture content. This process of achieving a reduced moisture content of 70% of the Standard optimum moisture content is referred to as dry back.

Note the proposed compaction moisture requirements are the values in *MITS 04 Ed1 Rev0* and require no amendment. The dry back moisture limits in *MITS 04 Ed1 Rev0* are the range 60% to 80%. As part of this EAN, the upper limit is reduced to 70% and the lower limit is removed.

The dry back requirement is essential to limit the potential for the development of water pressure in the voids of the material under repeated axle loads from vehicles. If pressures do develop, the material loses strength and stiffness which frequently causes cracking in the asphalt surfacing and permanent deformations of the granular material layer. A number of the pavements outlined under Background within this EAN displayed excessive cracking attributed in whole or part to this reason.

Accordingly, if the base layer is compacted wet of 70% and/or the base layer is exposed to water infiltration after compaction and before sealing, then the layer must be dried before sealing. If dry back is required, then the moisture content must be measured just before sealing to ensure the moisture content requirements are achieved. It is noted that dry back may be difficult to achieve during periods of extended wet weather or during winter, and will require careful planning by the Contractor. However, achieving the dry back requirement is critical to ensuring the long term performance of a flexible granular pavement.

The amended requirements for dry back of granular base materials are listed in **Table 7**.

Table 7 – Amended requirements for dry back of granular base materials

MITS 04 reference	Amendment
C1.4.10.1	*Replace existing sentence:* General: For all roads except local access roads, allow granular base material to dry back to less than 70% of Standard optimum moisture content before applying the prime, primerseal or wearing surface. If the moisture ratio in the base material exceeded 70% at the time of compaction and/or the base materials were subject to water infiltration since last tested, test for dry back at same frequency as for compaction testing and close to density test locations. A nuclear density probe calibrated for moisture content for the specific material may be used in accordance with *AS 1289.5.7.1*, and the probe hole filled with cement slurry after testing.

Compaction requirements for granular material

MITS 04 requires compaction of granular base and subbase materials to be at least 102% of Standard maximum dry density.

Note that 102% of Standard maximum dry density is approximately equivalent to 100% of Modified compaction. It should be noted that testing must be to Standard compaction requirements since the moisture content at compaction must meet limits with respect to Standard optimum moisture content. Guidance on this will be incorporated into *MITS 04* as shown in **Table 8**.

Table 8 – Guidance regarding compaction requirements

MITS 04 reference	Amendment
C1.4.7.2	*Add at end of first sentence:* (Note: this is approximately equivalent to 100% Modified compaction for granular base and subbase materials.)

Updates to MITS 02B Bulk Earthworks

Use of natural in situ material as replacement for Select Material

A typical pavement profile design for a collector road that is flexible granular pavement consists of a thin asphalt wearing course, a DGB20 granular material layer, a DGS20 granular material layer, a Selected Material Zone layer and the natural subgrade. For pavements in areas of cut, the subgrade typically represents the floor of the cutting. A typical pavement design for a collector road that is flexible granular pavement is shown in **Figure 1**.

Geotechnical investigations of a number of the pavements listed in the Background to this EAN showed no distinct Selected Material Zone layer above the design subgrade level. This was apparently due to the fact that it is common practice for the industry to utilise natural in situ material as a replacement for Select Material in the Selected Material Zone. The industry is commonly adopting the CBR test as a means of determining whether the natural in situ material can suitably be utilised, as opposed to excavating down to design subgrade level and placing imported Select Material or site won Select Material to the top of the design finished level of the Selected Material Zone. **Figure 1** provides a graphical representation of current industry practice for subdivision projects regarding the use of natural in situ material as replacement for Select Material.

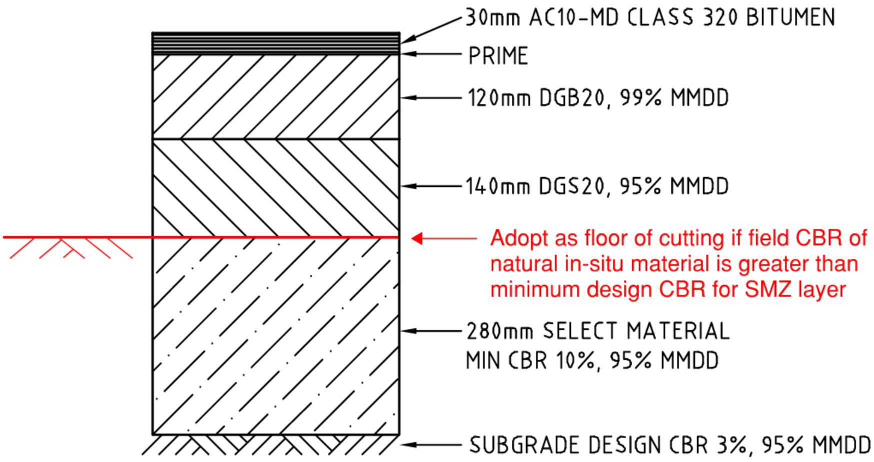

Figure 1 – Typical pavement design for a collector road (including a mark-up showing current industry practice for the use of natural in situ material as replacement for Select Material)

This industry practice currently being employed on subdivision projects presents significant risk to the ACT Government, primarily for three reasons as outlined below. Firstly, investigations of the failed pavements frequently found in situ materials within the Selected Material Zone that did not have the required CBR value, thus not satisfying the design requirements. This is not unexpected due to the significant variability of the predominantly clayey materials in the ACT. Such variability in the material properties of the natural in situ material is not typically identified during construction due to the frequency of testing of such natural in situ material being too low.

Secondly, the current industry approach ignored the expertise of the geotechnical investigation in recommending a suitable design subgrade CBR. For example, if design subgrade CBR of 3 is recommended based on geotechnical investigations undertaken during design phase, then it is highly unlikely that this natural in situ material is suitable as a replacement for Select Material, which will typically have a design CBR requirement of between 8% and 15%.

Thirdly, an audit of construction practices has shown that the natural in situ materials do not appear to have been tested to meet all the material property requirements for a Select Material, but are only tested for CBR values. This is inappropriate since the pavement design methodology assumes that the materials to be adopted within the Selected Material Zone layer meet all the requirements of the specification.

Due to the above reasons, Roads ACT is of the position that this current industry practice results in an unacceptable risk to the Territory when employed for collector roads.

Accordingly, *MITS 02B* is being amended to limit the practice of the utilisation of natural in situ material as replacement for Select Material to 150 mm thickness above the design subgrade level for pavements with a design traffic load equal to or greater than 1×10^6 ESA and less than 1×10^7 ESA (collector roads). This practice is subject to the material properties of the natural in situ material being compliant with the material property requirements for Select Material. The permitted practice for collector roads is depicted graphically in **Figure 2**. The use of natural in situ material as replacement for Select Material above the design subgrade level is not permitted for pavements with a design traffic load equal to or greater than 1×10^7 ESA.

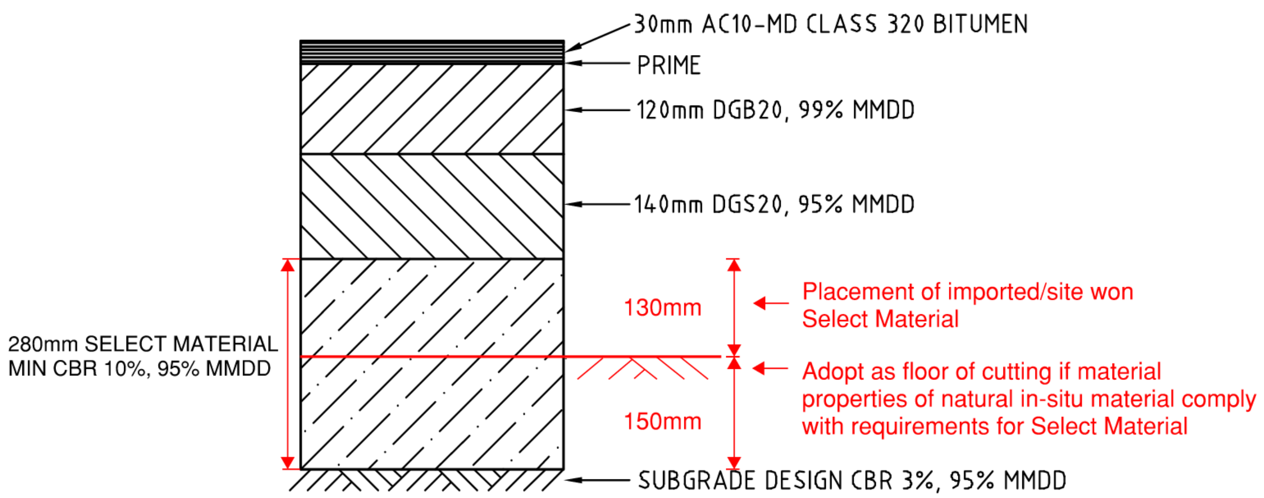

Figure 2 – Graphical depiction of the allowable practice for the use of natural in situ material as replacement for Select Material

In special circumstances where well-compacted high strength natural in situ material is encountered on site (e.g. partly weathered rock), the Contractor can choose to utilise the natural in situ material as replacement for Select Material for the full thickness of the Selected Material Zone layer as has been industry practice prior to the release of *Engineering Advisory Note 23*. However, this is subject to the following:

1. The full suite of material property tests, compaction tests and moisture content tests are required to be undertaken for the natural in situ material within the upper zone and lower zone of the Selected Material Zone layer, in accordance with the requirements of *MITS 02B* for Select Material.
2. The Contractor is to submit a 'Request for Information' to the pavement designer. The pavement designer is to review the material property test results for the natural in situ material to be used in the upper zone and lower zone of the Selected Material Zone layer, and confirm that such natural in situ material achieves the design requirements for this material layer.
3. The Contractor is to submit to a suitably qualified geotechnical engineering firm, the material property test results for the natural in situ material to be used in the upper zone and lower zone of the Selected Material Zone layer. The suitably qualified geotechnical engineering firm is to confirm that such natural in situ material achieves the design requirements for this material layer.

Table 9 lists the amended requirements for the use of natural in situ material as replacement for Select Material above the design subgrade level. Discussion on items (iii) and (iv) in the last row of **Table 9** is included in subsequent sections of this EAN.

Table 9 – Amended requirements for use of in situ material as replacement for Select Material

MITS 02B reference	Amendment
C1.4.4.7	*Add new paragraph after first paragraph* Use of natural in situ material as Select Material by adoption of a subgrade cutting level above the level shown in the drawings must be done in accordance with the requirements of **Selected Material Zone**. This practice is only acceptable for local access streets and collector roads.

MITS 02B reference	Amendment
C1.4.11	*Insert new Clause 1.4.11.2 and renumber existing Clauses 1.4.11.2 to 1.4.11.5 inclusive* **1.4.11.2 Use of natural in situ material as replacement for Select Material** The requirements of this Clause also apply to the adoption of a subgrade cutting level above the level shown in the Drawings. i. For collector roads, in situ material above the subgrade level shown on the Drawings must not exceed 150 mm thickness* ii. For local access roads, in situ material above the subgrade level shown on the Drawings must not exceed the thickness of the Selected Material Zone iii. The in situ materials must meet the material requirements for **Select Material** and must be compacted as specified for **Select Material** iv. The in situ material must be ripped before compaction to the full thickness of the layer or 150 mm depth, whichever is lesser, and compacted as for **Select Material**. *In special circumstances where well-compacted high strength natural in situ material is encountered on site (e.g. partly weathered rock), the Contractor can choose to adopt Clause 1.4.11.2(ii) for collector roads, subject to the following: • The full suite of material property tests, compaction tests and moisture content tests are required to be undertaken for the natural in situ material within the upper zone and lower zone of the Selected Material Zone layer, in accordance with the requirements of *MITS 02B* for Select Material. • The Contractor is to submit a 'Request for Information' to the pavement designer. The pavement designer is to review the material property test results for the natural in situ material to be used in the upper zone and lower zone of the Select Material Zone layer, and confirm that such natural in situ material achieves the design requirements for this material layer. • The Contractor is to submit to a suitably qualified geotechnical engineering firm, the material property test results for the natural in situ material to be used in the upper zone and lower zone of the Selected Material Zone layer. The suitably qualified geotechnical engineering firm is to confirm that such natural in situ material achieves the design requirements for this material layer.

Material test requirements for any materials to be adopted for the Selected Material Zone

As noted above, only testing Select Material for CBR is not consistent with the expectations of the design methodology and increases the risk of unsatisfactory in-service performance. Accordingly, all Select Materials, including natural in situ material to be utilised as a replacement for Select Material, must be tested to ensure it meets all the requirements of Table 2B-5 of *MITS 02B*.

Compaction requirements for Selected Material Zone

MITS 02B Edition 1 Revision 0 contains contradictory requirements for the compaction of Select Material within the Selected Material Zone. **Table 10** outlines the amendment to resolve this contradiction, thus requiring 100% Standard compaction for Select Material within the Selected Material Zone.

Table 10 – Amended requirements for compaction of Select Material within the Selected Material Zone

MITS 02B reference	Amendment
C1.4.16.3	*Delete 6th line as follows:* Delete '> Each layer of the selected material zone as specified in **Selected Material Zone**'

Tolerance for finished level of Selected Material Zone

The *MITS 02B* currently permits a tolerance of +25 mm on the level of the top of the Selected Material Zone, implying that a portion of the granular subbase thickness may be replaced by Select Material. This is not acceptable, so the tolerance has been amended as shown in **Table 11**.

Table 11 – Amended requirements for tolerance on finished level of Selected Material Zone

MITS 02B reference	Amendment
C1.4.11.4	*Amend last line:* Replace '+25mm' with '+0 -25mm'

Updates to MITS 00B Quality Construction

Selection of sampling and testing locations

MITS 00B Quality Construction is being amended such that random sampling techniques are to be adopted to ascertain test locations for each lot for both in situ sampling and for control of compaction for each continuous layer of earthworks, flexible pavement and asphalt. **Table 12** shows the amended requirements for the determination of sampling locations.

Table 12 – Amended requirements for determining sampling and testing locations

MITS 00B reference	Amendment
C1.2.6.1 sixth paragraph	*Replace sixth paragraph with:* Sampling locations: Except where Clause 1.2.6.5 applies, propose sampling locations for approval prior to proceeding.
C1.2.6.5 first paragraph	*Replace first paragraph with:* Requirement: Use random sampling techniques for each lot for in situ sampling and for the control of compaction of each continuous layer of earthworks, flexible pavement and asphalt.

Updates to minimum test frequency requirements for bulk earthworks (Sub-annexure C1)

MITS 00B Edition 1 Revision 0 does not include requirements for frequency of testing of all required parameters, particularly those for the material properties of Select Material (imported or site won) and for natural in situ material used as replacement for Select Material above the design subgrade level. The minimum test frequencies adopted for the Selected Material Zone are amended to mitigate the risks associated with the high variability of this type of material. **Table 13** shows the amended test frequency requirements for bulk earthworks to be adopted.

Table 13 – Amended minimum test frequency requirements for bulk earthworks

<table>
<tr><th>MITS 00B reference</th><th>Amendment</th></tr>
<tr><td>Sub-annexure C1
Table 0B-4
Embankments – Select zone</td><td>Delete row ‘Embankments – Select zone’ and replace with the following:
<table>
<tr><th>Activity</th><th>Key quality verification requirements</th><th>Maximum lot size</th><th>Minimum test frequency</th><th>Test method</th></tr>
<tr><td>Selected Material Zone (imported or site won)</td><td>Geometry</td><td>One layer 10,000 m²</td><td>1 cross section per 25 m</td><td>Survey</td></tr>
<tr><td></td><td>Material quality:</td><td></td><td></td><td></td></tr>
<tr><td></td><td>- Liquid Limit</td><td>10,000 m²</td><td>1 per 275 m³</td><td>AS 1289.3.1.1</td></tr>
<tr><td></td><td>- Linear Shrinkage</td><td>10,000 m²</td><td>1 per 275 m³</td><td>AS 1289.3.4.1</td></tr>
<tr><td></td><td>- Passing 0.075 mm sieve</td><td>10,000 m²</td><td>1 per 275 m³</td><td>AS 1289.3.6.1</td></tr>
<tr><td></td><td>- Plasticity Index % Pass 0.425 sieve</td><td>10,000 m²</td><td>1 per 275 m³</td><td>AS 1289.3.3.1</td></tr>
<tr><td></td><td>- % swell in CBR test</td><td>10,000 m²</td><td>1 per 275 m³</td><td>AS 1289.6.1.1</td></tr>
<tr><td></td><td>- 4 day Soaked CBR (100% ±1% Standard Compaction)</td><td>10,000 m²</td><td>1 per 275 m³</td><td>AS 1289.6.1.1</td></tr>
<tr><td></td><td>Compaction/moisture content</td><td>One layer 5,000 m²</td><td>1 per 500 m²</td><td>AS 1289.5.1.1
AS 1289.5.4.1
AS 1289.5.7.1</td></tr>
</table></td></tr>
<tr><td>Sub-annexure C1
Table 0B-4</td><td>Insert new row:
<table>
<tr><th>Activity</th><th>Key quality verification requirements</th><th>Maximum lot size</th><th>Minimum test frequency</th><th>Test method</th></tr>
<tr><td>Selected Material Zone (natural in situ material)</td><td>Geometry</td><td>One layer 10,000 m²</td><td>1 cross section per 25 m</td><td>Survey</td></tr>
<tr><td></td><td>Material quality:</td><td>One layer</td><td></td><td></td></tr>
<tr><td></td><td>- Liquid Limit</td><td>10,000 m²</td><td>1 per 400 m²</td><td>AS 1289.3.1.1</td></tr>
<tr><td></td><td>- Linear Shrinkage</td><td>10,000 m²</td><td>1 per 400 m²</td><td>AS 1289.3.4.1</td></tr>
<tr><td></td><td>- Passing 0.075 mm sieve</td><td>10,000 m²</td><td>1 per 400 m²</td><td>AS 1289.3.6.1</td></tr>
<tr><td></td><td>- Plasticity Index % Pass 0.425 sieve</td><td>10,000 m²</td><td>1 per 400 m²</td><td>AS 1289.3.3.1</td></tr>
<tr><td></td><td>- % swell in CBR test</td><td>10,000 m²</td><td>1 per 400 m²</td><td>AS 1289.6.1.1</td></tr>
<tr><td></td><td>- 4 day Soaked CBR (100% ±1% Standard Compaction)</td><td>10,000 m²</td><td>1 per 400 m²</td><td>AS 1289.6.1.1</td></tr>
<tr><td></td><td>Compaction/moisture content</td><td>One layer 5,000m²</td><td>1 per 500 m²</td><td>AS 1289.5.1.1
AS 1289.5.4.1
AS 1289.5.7.1</td></tr>
</table></td></tr>
</table>

Updates to minimum test frequency requirements for flexible pavement base and subbase (Sub-annexure C5)

For testing for compaction, moisture content and dry density, Sub-annexure C5 of *MITS 00B Edition 1 Revision 0* specifies 3 tests per lot for a lot size smaller than 5,000 m^2. This will be adjusted to 1 test per 500 m^2 for consistency and to simplify the test frequency requirements for the industry. Requirements for testing of the moisture content after dry back are also incorporated into Sub-annexure C5. Sub-annexure C5 is also updated to reference the test method in *AS 1289.5.7.1*, as this is a simple test for measuring field moisture content. **Table 14** shows the amended test frequency requirements for flexible pavement base and subbase to be adopted.

Table 14 – Amended minimum test frequency requirements for flexible pavements base and subbase

<table>
<tr><th>MITS 00B reference</th><th>Amendment</th></tr>
<tr><td>Sub-annexure C5
Table 0B-8
Placement</td><td>Adopt the following tests for ‘Compaction/moisture content/dry density testing’ for ‘Placement’:
<table>
<tr><th>Activity</th><th>Key quality verification requirements</th><th>Maximum lot size</th><th>Minimum test frequency</th><th>Test method</th></tr>
<tr><td>Placement</td><td>Compaction/moisture content/dry density testing</td><td>One layer 5,000 m^2 or max 1 days placement</td><td>1 per 500 m^2 layer</td><td>T130
AS 1289.5.1.1
AS 1289.5.3.2
AS 1289.5.4.1
AS 1289.5.7.1</td></tr>
<tr><td></td><td>Moisture content testing after dry back (only for base)</td><td>As for compaction lot</td><td>1 per 500 m^2 layer (close to density test locations)</td><td>AS 1289.5.7.1</td></tr>
</table></td></tr>
</table>

Administrative Arrangement

MIS 03 Pavement Design, *MITS 00B Quality Construction*, *MITS 02B Bulk Earthworks* and *MITS 04 Flexible Pavements* will be updated in the future to reflect the requirements outlined in this Engineering Advisory Note.

This Engineering Advisory Note will take effect from the latest date of endorsement by the Authorised Person/s.

Prepared by:

Dr Jonathon Dragos

Senior Engineering Director,
Technical Services Unit,
Infrastructure Planning

Transport Canberra and City Services

Date: 13/12/2023

Checked by:

Owen Earl-King

Senior Director,
Infrastructure Planning

Transport Canberra and City Services

Date: 13/12/2023

Authorised by:

Tim Rampton

Executive Branch Manager,
Roads ACT

Transport Canberra and City Services

Date: 13/12/2023

Annexure 1 – Photographs showing accelerated failure of flexible granular pavements

David Walsh Avenue, Forde

Kingsland Parade, Casey

Overall Avenue, Casey


BUS
STOP

Bernard Heinze Avenue, Moncrieff

Steve Irwin Avenue, Wright

Annabelle View, Coombs

Plimsoll Drive, Casey

Whitrod Avenue, Casey

Annexure 2 – Traffic load data

Traffic load distribution tables for the E12 Electric Bus

Table A2-1 below provides the traffic load distribution applicable for the Yutong E12 electric buses that are currently part of the Transport Canberra bus fleet as of the date of this EAN. The loads are based on an adopted average passenger loading of 100% capacity during one weekday peak period per day, 50% capacity at other times on weekdays and Saturdays, and 25% on Sundays. The relative number of assumed trips is based on present bus services in the Gungahlin district.

Table A2-1 – Traffic load distribution for E12 electric buses

	Axle group type	
Axle group load (kN)	**SAST %**	**SADT %**
40	0.0000	0.0000
50	34.5516	0.0000
60	54.2752	0.0000
70	11.1733	0.0000
80	0.0000	2.1199
90	0.0000	53.0943
100	0.0000	21.7973
110	0.0000	22.6538
120	0.0000	0.3347
130	0.0000	0.0000
140	0.0000	0.0000
150	0.0000	0.0000
160	0.0000	0.0000
Total	**100.0000**	**100.0000**
Proportion of each axle group	0.5	0.5

Measure	Value
NHVAG	2.0
ESA/HVAG	1.87
ESA/HV	3.74

Equivalent traffic load distribution from AGPT02-17, Table O 2

The post construction, in-service traffic loading is based on the Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design (AGPT02-17), Appendix O, Table O 2* for collector roads with no buses. Table O 2 has non-standard load values (i.e. not multiples of 10 kN) so **Table A2-2** is provided with the load frequencies adjusted to give the same ESA/HV with standard load values.

Table A2-2 – Equivalent traffic load distribution for *AGPT02-17, Table O 2*

Axle group load (kN)	Axle group type		
	SAST %	**SADT %**	**TADT %**
20		11.3547	
30	14.4998	6.9213	9.5890
40	43.5421	14.5484	20.0277
50	35.5839	11.0550	
60	6.3741	8.7695	
70		16.8167	
80		21.6303	
90		8.9041	16.1282
100			6.1715
110			
120			
130			
140			15.4782
150			32.6054
160			
Total	**100.0000**	**100.0000**	**100.0000**
Proportion of each axle group	0.451	0.262	0.287

Measure	**Value**
NHVAG	2.22
ESA/HVAG	0.59
ESA/HV	1.30

ESA and axle loads for typical fully loaded construction vehicles

Table A2-3 below shows the ESA and corresponding axle loads for fully loaded construction vehicles which are typically utilised for estate development works.

Table A2-3 – ESA and axle loads for typical fully loaded construction vehicles

Axle Group Type	SAST (steer)	TAST (steer)	TADT	TRDT
Standard Load	5.40	9.07	13.76	18.55
Allowable Load	6.0	11.0	16.5	20.0
Full Load ESA	1.52	2.16	2.07	1.35

Truck Type	Gross Vehicle Mass	Typical Load Capacity	No of axle groups				Typical ESA
6-axle rigid truck + dog trailer	42.5	25 – 27	2		2		6.2
6-axle semitrailer	42.5	25	1		1	1	4.9
4-axle agitator	27.5	17		1	1		4.2

Notes:
– All loads in tonnes
– Allowable load for TAST steer axle group assuming load sharing
– Allowable load in 3-axle dog trailer 20 t to meet GVM limit

Annexure 3 – Referenced documents

ACT Government plans

Zero-Emission Transition Plan for Transport Canberra

Australian Standards

AS 1289.3.1.1	Methods of testing soils for engineering purposes: Soil classification tests – Determination of the liquid limit of the soil – Four point Casagrande method
AS 1289.3.3.1	Methods of testing soils for engineering purposes: Soil classification tests – Calculation of the plasticity index of a soil
AS 1289.3.4.1	Methods of testing soils for engineering purposes: Soil classification tests – Determination of the linear shrinkage of a soil – Standard method
AS 1289.3.6.1	Methods of testing soils for engineering purposes: Soil classification tests – Determination of the particle size distribution of a soil – Standard method of analysis by sieving
AS 1289.5.1.1	Methods of testing soils for engineering purposes: Soil compaction and density tests – Determination of the dry density/moisture content relation of a soil using standard compactive effort
AS 1289.5.3.2	Methods of testing soils for engineering purposes: Soil compaction and density tests – Determination of the field density of a soil – Sand replacement method using a sand pouring can, with or without a volume displacer
AS 1289.5.4.1	Methods of testing soils for engineering purposes: Soil compaction and density tests – Compaction control test – Dry density ratio, moisture variation and moisture ratio
AS 1289.5.7.1	Methods of testing soils for engineering purposes: Soil compaction and density tests – Compaction control test – Hilf density ratio and Hilf moisture variation (rapid method)
AS 1289.5.8.1	Methods of testing soils for engineering purposes: Soil compaction and density tests – Determination of field density and field moisture content of a soil using a nuclear surface moisture-density gauge – Direct transmission mode
AS 1289.6.1.1	Methods of testing soils for engineering purposes: Soil strength and consolidation tests – Determination of the California Bearing Ratio of a soil – Standard laboratory method for a remoulded specimen

Austroads

AGPT02 Austroads Guide to Pavement Technology Part 2: Pavement Structural Design

TCCS Municipal Infrastructure Standards

MIS 03 Pavement Design

TCCS Municipal Infrastructure Technical Specification

MITS 00B Quality Construction

MITS 02B Bulk Earthworks

MITS 04 Flexible Pavements

TfNSW Specifications

TfNSW QA Specification R71 Construction of Unbound and Modified Pavement Course

TfNSW QA Specification 3051 Granular Pavement Base and Subbase Materials

TfNSW QA Specification R106 Sprayed Bituminous Surfacing (with Cutback Bitumen)

TfNSW QA Specification R116 Heavy Duty Dense Graded Asphalt

TfNSW QA Specification R117 Light Duty Dense Graded Asphalt

TfNSW Supplements to Austroads Guides

RMS Supplement to Austroads Guide to Pavement Technology Part 2: Pavement Structural Design

TfNSW Test Method

TfNSW T130 Dry density/moisture relationship of road construction materials (Blended in the laboratory with cementitious binders)