

Assignment of CBR and Percent Swell to Earthworks Fill and Pavement Materials

1. General

This Code of Practice sets down the principles and procedure for the assignment of California Bearing Ratio (CBR) and Percent Swell for:

- Type A or Type B earthworks fill material supplied to the road from a single source,
- Insitu cementitiously stabilised earthwork materials, and
- Pavement materials, where a minimum CBR value is specified and the material source does not have an assigned Los Angeles Value.

NOTE: All testing aspects of RC 500.20 have been transferred to VicRoads Test Method RC 324.01.

Assignment of CBR and Percent Swell is based on testing of samples taken after field compaction, excluding insitu cementitiously stabilised materials

Assignment of CBR and Percent Swell for insitu cementitiously stabilised materials shall be based on samples taken from the proposed road length to be stabilised. Samples are to be representative of the material to be stabilised.

Appendix A provides informative guidance on sampling, pre-treatment and testing of material (excluding cementitiously stabilised material) from a source, prior to placement in the road bed.

Appendix B provides normative direction (mandatory when applicable) on sampling, pre-treatment and testing of material proposed to be cementitiously stabilised.

2. References

- VicRoads Standard Specification for Roadworks and Bridgeworks, referred to hereinafter as VicRoads Standard Specification Section ###.
- Test Methods

In general, VicRoads has adopted Australian Standards (prefix AS) for the testing of materials and work. Where necessary, VicRoads has developed VicRoads Test Methods (prefix RC).

| Number | Title |
|---|--|
| AS 1141.3.1 | Sampling—Aggregates |
| AS 1289.1.2.1 | Sampling and preparation of soils—Disturbed samples—Standard method. |
| AS 1289.1.4.2 | Sampling and preparation of soils—Selection of sampling or test sites—Stratified random number method. |
| AS 1289.3.1.1 | Determination of the liquid limit of a soil—Four point Casagrande method. |
| AS 1289.3.1.2 | Determination of the liquid limit of a soil—One point Casagrande method. |
| AS 1289.3.2.1 | Determination of the plastic limit of a soil. |
| AS 1289.3.3.1 | Calculation of the plasticity index of a soil. |
| AS 1289.3.6.1 | Determination of the particle size distribution of a soil. |
| AS 1289 5.1.1 | Determination of the dry density/moisture content relation of a soil using standard compactive effort. |
| AS 1289 5.2.1 | Determination of the dry density/moisture content relation of a soil using modified compactive effort. |
| AS 1289 6.1.1 | Determination of the California Bearing Ratio of a soil—Standard laboratory method for a remoulded specimen. |
| RC 301.05 | Pretreatment of Soils and Pavement Materials by Repeated Compaction. |
| RC 316.10 | Selection of test sites within a test lot (random stratified sampling method) |
| RC 324.01 | Calculation of Assigned CBR and Assigned Percent Swell |
| Austrroads AGPT02-12, or latest version | Guide to Pavement Technology Part 2 - Pavement Structural Design. |

3. Definitions

3.1. CBR

Test value of a re-moulded specimen as determined by AS 1289.6.1.1.

3.2. Percent Swell

Test value of a re-moulded specimen as determined by AS 1289.6.1.1.

3.3. Assigned CBR

The CBR assigned in accordance with this Code to a source of Type A or Type B fill material or pavement material.

3.4. Assigned Percent Swell

The Percent Swell assigned in accordance with this Code to a source of Type A or Type B fill material.

4. Scales of Assessment

There are three scales of assessment of materials properties used for assignment of CBR and Percent Swell to the requirements of VicRoads Standard Specification Section 204. The detailed assessment procedure is provided in Section 7 of this Code, and as a test method, RC 324.01.

4.1. Scale A Assessment

The Scale A assessment procedure shall apply to Type A or Type B earthworks fill material and lower subbase material used for the following road types:

- Freeways and National Road Network roads, including ramps;
- Arterials and Highways; and
- All other roads with an Average Annual Daily Traffic (AADT) volume of more than 10000 vehicles per day (vpd), or where there are more than 15000 m² of new pavement represented by the testing.

Scale A requires soaked CBR and Percent Swell tests to be performed on six separate representative samples.

Scale A assessment is not required to be used for strength characterisation of pavement or pavement subbase materials from sources managed through the VicRoads Quarry Accreditation Program.

4.2. Scale B Assessment

The Scale B assessment procedure shall apply to Type A or Type B earthworks fill material and lower subbase material used for the following road types:

- All other roads where either AADT is less than 10000 vpd, or where the area of new pavement represented by the testing is more than 5000 m² but less than 15000 m²; and
- Unclassified roads where the area of new pavement represented by the testing is more than 15000 m².

Scale B requires soaked CBR and Percent Swell tests to be performed on three separate representative samples.

Scale B assessment is not required to be used for strength characterisation of pavement or pavement subbase materials from sources managed through the VicRoads Quarry Accreditation Program.

4.3. Scale C Assessment

Unless otherwise specified, the Scale C assessment shall only be used for Type A or Type B fill material used for roads where the Scale B test procedure is not warranted as described in Clause 4.2 above.

Scale C assessment requires only the use of historic information or default values.

5. Determining Assigned CBR

For all materials, excluding cementitiously stabilised earthwork material, Assigned CBR and Assigned Percent Swell for a material shall be determined from samples taken from the road bed after placement and compaction is completed, in accordance with RC 324.01.

For insitu cementitiously stabilised materials, Assigned CBR and Assigned Percent Swell shall be based on representative samples taken from the proposed road length to be stabilised in accordance with Appendix B and RC 324.01.

The Assigned CBR shall be confirmed during construction from samples taken from the road bed in accordance with Appendix A of RC 324.01, at the frequency specified.

6. Testing Principles

6.1. Maximum Dry Density and Optimum Moisture Content

For each sample, determine the Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) of the material passing the 19 mm sieve. Unless otherwise specified, Standard compactive effort shall be used for Type A and Type B filling and Modified compactive effort shall be used for all pavement materials.

6.2. CBR and Percent Swell

The determination of the CBR and Percent Swell of a soil shall be in accordance with AS 1289.6.1.1 and the specific requirements detailed in this VicRoads Code of Practice. The test is performed on the fraction of material passing the 19 mm sieve. Material retained on the 19 mm sieve shall be discarded. Material must not be crushed and returned to the sample.

Specimens compacted for CBR shall be re-moulded from the sample material using the same criteria as used in the determination of MDD/OMC defined in either AS 1289.5.1.1 or AS 1289.5.2.1, for dynamic compaction.

Specimens for CBR testing shall be re-moulded in the laboratory in accordance with the following requirements:

- Density Ratio at 98 % \pm 1 % of the MDD for the material; and
- Moisture Ratio within the range 95 % to 105 % of the OMC for the material.

NOTE: These requirements both (a) apply to Clause 6(e), and (b) differ from the default position in Clause 5(i), of AS 1289.6.1.1.

Surcharge for soaking period: The surcharge to be applied during the soaking period shall be 4.5 kg. This surcharge shall be in addition to the mass (1.0 kg) of the stem and perforated plate placed on the specimen during soaking. The total mass applied during the soaking period shall be 5.5 kg.

Surcharge for penetration test: The surcharge to be applied during the CBR penetration test procedure shall be 4.5 kg. The surcharge shall be applied in accordance with Clause 8(a) of AS 1289.6.1.1.

Testing: The laboratory four-day soaked CBR and Percent Swell shall be determined for each specimen.

Individual values of CBR and Percent Swell shall not be rounded before calculating mean values.

6.3. Particle Size Distribution

For each sample as taken from the road bed, the particle size distribution shall be determined and reported in accordance with AS 1289.3.6.1.

6.4. Plasticity Index

For each sample as taken from the road bed, Plasticity Index shall be determined and reported in accordance with AS 1289.3.3.1. Liquid Limit shall be determined in accordance with AS 1289.3.1.1 or AS 1289.3.1.2, as appropriate, and Plastic Limit shall be determined in accordance with AS 1289.3.2.1.

7. Assignment of CBR and Percent Swell

7.1. Scale A Assessment

7.1.1. CBR

The CBR assigned to a material, under Scale A assessment, shall be the lower of either:

- the second lowest CBR value, or
- the mean of the lowest three values

of the six soaked CBR test values obtained from six representative samples taken after field compaction.

NOTE: The material can be regarded as inconsistent when for a set of six test values, the mean of the highest three soaked CBR test values is more than 10 above the mean of the lowest three soaked CBR test values.

7.1.2. Percent Swell

The Percent Swell assigned to a material, under Scale A assessment, shall be the higher of either:

- the second highest value, or
- the mean of the highest three values

of the six Percent Swell test values obtained from six representative samples taken after field compaction.

7.2. Scale B Assessment

The CBR assigned to the material, under Scale B assessment, shall be the mean value of the two lowest values from three soaked CBR test values on representative samples taken after field compaction.

NOTE: If the mean value of the two lowest values is both:

- less than 6; and
- the difference between the highest and lowest CBR test value is greater than 15 when using the Scale B assessment test procedure;

then the Scale A assessment procedure shall be adopted. This requires the CBR testing of three additional samples.

The Percent Swell assigned to the material, under Scale B assessment, shall be the mean value of the two highest values from three Percent Swell test values obtained from three representative samples taken after field compaction.

7.3. Scale C Assessment

The Assigned CBR is based on default CBR values for the material types as defined in Table 5.4 of Austroads AGPT02-12 - *Pavement Structural Design*, supported by other previous test results and historical data.

The swell potential shall be estimated from Table 5.2 of Austroads AGPT02-12 - *Pavement Structural Design*, or as in the current version of AGPT02.

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VicRoads Code of Practice - Revision Summary

RC 500.20 - Assignment of CBR and Percent Swell to Earthworks Fill and Pavement Materials

| Date | Clause | Description of Revision | Authorised by |
|--------------|---|---|---|
| October 2019 | Cl 1 & 5 Appendix A Appendix B | Added text relating to cementitiously stabilised materials Modified text New (normative) | Principal Advisor – Pavements Geotech. & Materials |
| June 2017 | Cl 1 & 2(b) Cl 5.2 Cl 6.2 para 5 Cl 7.1.1 Note Cl 7.3 Cl 7.4 Cl 8 | Added RC 324.01 Text deleted (included in RC 324.01) Surcharge for penetration test now 4.5 kg, dot points deleted First dot point deleted AGPT02 update in 2017 Deleted – confirmation of assigned values covered in specifications, eg Section 204 Deleted – Reporting is not part of a CoP | Principal Advisor – Pavements Geotech. & Materials |

APPENDIX A Sampling, Pre-Treatment and Testing of Material from the Source, (Informative only) prior to placement (excluding materials to be cementitiously stabilised)

In some cases, checks on the suitability of material to be selected and supplied as Type A or Type B fill may need to be made prior to placement in the road bed and field compaction.

Appendix A is informative only, and provides guidance on one process to check if a material from an extractive source or stockpile might be capable for use in a specific earthworks application. The check process described in Appendix A does not provide a valid Assigned CBR value, and does not replace or override the normative main text of Code of Practice 500.20.

(a) Sampling and Testing

Sampling and testing should be undertaken by a suitably qualified and experienced testing officer from a laboratory that meets the requirements of AS ISO/IEC 17025 for sampling and site selection methods. All test reports/certificates should be endorsed in accordance with the AS ISO/IEC 17025 accreditation for that laboratory. The testing laboratory should comply with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025. (In Australia, the National Association of Testing Authorities (NATA, <https://www.nata.com.au>) is a signatory to the ILAC MRA, and can offer accreditation against the requirements of AS ISO/IEC 17025.)

(b) Selection of Sample Sites

Sampling sites within the source may be selected at random using the techniques described in AS 1289.1.4.2 or RC 316.10. The number of samples to be taken will depend upon the intended use of the material.

Sufficient samples should be taken and tested to assess the source material for classification as consistent or inconsistent (Clause 7). Use of inconsistent material should be reviewed.

- for improvements to the way the material is mixed; or
- for separate assessment of different material types for specific uses.

The contractor should nominate how sampling at various depths is to be carried out.

(c) Obtaining the samples

Sampling should be undertaken by a suitably qualified and experienced testing officer from a laboratory accredited for sampling and site selection methods by NATA. The samples taken should be representative of the material to be used for the intended purpose. Material may be mixed and stockpiled prior to samples being taken to simulate the degree of mixing normally achieved when the material is supplied to a road works project.

Obtain samples from the source in accordance with AS 1141.3.1 or AS 1289.1.2.1, as appropriate.

(d) Sample Pre-treatment

Pre-treat the sample of material in accordance with VicRoads Test Method RC 301.05 using three cycles of compaction.

The pre-treatment is to be carried out for all material sampled from the source, including any material sampled from the source which breaks down or fractures during compaction, such as soft, ripped rock that is likely to be broken down under the high compactive effort of modern machinery.

Test reports for CBR where this pre-treatment is applicable must state that three cycles of compaction, in accordance with RC 301.05, were used.

Determine and record the percentage of material retained on the 19 mm and 37.5 mm sieves.

Discard the material retained on the 19 mm sieve.

(e) Testing for CBR and Percent Swell

Each sample should be tested for:

- Particle size distribution in accordance with AS 1289.3.6.1;
- Plasticity Index in accordance with AS 1289.3.3.1;
- Liquid Limit in accordance with AS 1289.3.1.1 or AS 1289.3.1.2, as appropriate;
- Plastic Limit in accordance with AS 1289.3.2.1; and
- CBR and Percent Swell of a soil in accordance with AS 1289.6.1.1.

(f) Assessment

Section 7 of Code of Practice RC 500.20, or Section 6 of VicRoads Test Method RC 324.01 may be followed to determine capability of the material, sampled from an extractive source or stockpile, for the intended use; noting that the check process of this Appendix A does not provide a valid Assigned CBR value.

APPENDIX B Cementitiously Stabilised Earthworks: Sampling, Pre-Treatment and (Normative) Testing of Material from the Source, Prior to Stabilisation

For materials to be cementitiously stabilised, the Assigned CBR and Assigned Swell is determined from materials sampled directly from the road length to be stabilised. Sampled materials and representative cementitious binder are mixed and compacted in the laboratory. Sufficient time is expected to be allowed for sampling and testing to be completed and assessed prior to commencement of stabilisation works.

(a) Sampling and Testing

Sampling and testing shall be undertaken by a suitably qualified and experienced testing officer from a laboratory that meets the requirements of AS ISO/IEC 17025 for sampling and site selection methods. All test reports/certificates shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for that laboratory. The testing laboratory shall comply with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025. (In Australia, the National Association of Testing Authorities (NATA, <https://www.nata.com.au>) is a signatory to the ILAC MRA, and can offer accreditation against the requirements of AS ISO/IEC 17025.)

(b) Selection of Sample Sites

Sampling sites within the road length of interest may be selected at random using the techniques described in AS 1289.1.4.2 or RC 316.10. The number of samples to be taken is determined by the road length of interest, the expected variation of material types and the intended treatment or use of the material. Sampling should also address variation of material with depth below finished surface level.

Sufficient samples should be taken and tested to assess the source material for classification as consistent or inconsistent, as defined in Clause 7 (7.1.1). The use of inconsistent material should be reviewed:

- for improvements to the way the material is mixed; or
- for separate assessment of different material types for specific uses, or
- For different treatments for different material types.

(c) Obtaining the samples

The samples taken should be representative of the material to be used for the intended purpose. Material may be mixed and stockpiled prior to samples being taken to simulate the degree of mixing normally achieved when the material is supplied to a road works project.

Obtain samples from the source in accordance with AS 1141.3.1 or AS 1289.1.2.1, as appropriate.

(d) Sample Pre-treatment

Pre-treat the sample of material in accordance with VicRoads Test Method RC 301.05 using three cycles of compaction.

The pre-treatment is to be carried out for all material sampled from the source, including any material sampled from the source which breaks down or fractures during compaction, such as soft, ripped rock that is likely to be broken down under the high compactive effort of modern machinery.

Test reports for CBR where this pre-treatment is applicable must state that three cycles of compaction, in accordance with RC 301.05, were used.

Determine and record the percentage of material retained on the 19 mm and 37.5 mm sieves.

Discard the material retained on the 19 mm sieve, and on the 37.5 mm sieve.

(e) Testing for CBR and Percent Swell

Each sample should be tested for:

- Particle size distribution in accordance with AS 1289.3.6.1;
- Plasticity Index in accordance with AS 1289.3.3.1;
- Liquid Limit in accordance with AS 1289.3.1.1 or AS 1289.3.1.2, as appropriate;
- Plastic Limit in accordance with AS 1289.3.2.1; and
- CBR and Percent Swell of a soil in accordance with AS 1289.6.1.1.
- Assigned CBR and Assigned Swell in accordance with RC 324.01.

(f) Assessment

The outcomes of the testing shall be used to develop an appropriate Assigned CBR and Assigned Swell for use in determining a cementitious stabilisation treatment.