REPEATED LOAD TRIAXIAL TEST FOR UNBOUND PAVEMENT MATERIALS

1. PURPOSE

The purpose of this technical note is to provide a brief description of the Repeated Load Triaxial (RLT) Test and how it can be used to evaluate or compare the performance of granular pavement materials.

The RLT test is a laboratory test method capable of measuring the performance of granular pavement materials in terms of the permanent deformation (rut resistance) and resilient modulus (stiffness).

2. INTRODUCTION

Generally, unbound pavement materials, particularly non-standard natural gravels or ripped rocks, blended materials, recycled materials, or materials containing recycled products often have little or no previous history of field performance. There are risks associated with using these materials if little is known about the performance or conversely, the potential economic benefits of using lower cost materials that might otherwise perform satisfactorily is never realised.

Laboratory measurement of the performance properties of non-standard materials can be ranked against the performance properties of materials with known field performance. This information provides an indication as to whether or not these materials are likely to deliver satisfactory field performance.

In the longer term it should be possible to establish relationships between RLT measured material properties and field performance. If this is achieved it will be possible to develop pavement performance prediction models for unbound pavements. Input parameters such as the traffic loading, material strength and deformation can be used in the models to predict the design life in a similar way as models are currently used to “mechanistically” design asphalt pavements.

3. BACKGROUND

Over the past 30 years the RLT test has largely been confined to research work. Recent developments in technology such as accurate Linear Voltage Transducers (LVTs) and load cells with computerised data acquisition systems have enabled improvements to the apparatus to the extent that the test can now be used for a number of practical applications.

Austroads has undertaken extensive R&D work over the last few years to refine the test apparatus and develop a test procedure to evaluate the performance of granular materials. (References 1 & 2).

4. TEST EQUIPMENT

The RLT test equipment (see Figure 1) includes:

- A standard triaxial cell suitable for specimens 100 mm diameter and 200 mm high, and with a working pressure of at least 500 kPa;
- Dynamic loading equipment capable of applying a vertical dynamic force and a static confining pressure via the air/liquid in the triaxial cell;
- Load and pressure measurement devices to measure the vertical dynamic force and static confining pressure and devices to measure vertical displacement of the sample.

Figure 1 Repeated Load Triaxial Test Equipment

The test equipment is connected to a computer for recording all test data and for pre-programming of the vertical and confining stresses to simulate the actual stresses that the material is likely to be subjected to within the pavement.

The specimen is tested in a drained condition without pore pressure measurement (Reference 2).

5. SPECIMEN PREPARATION

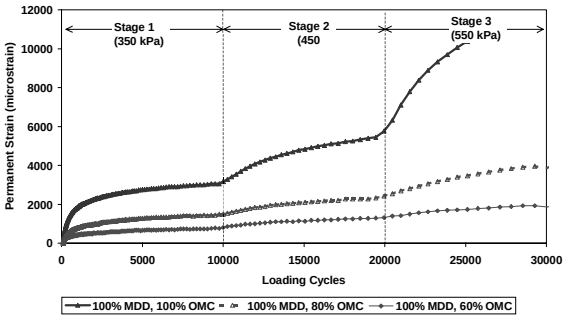
Each specimen is prepared with automatic dynamic compaction equipment to a uniform density in accordance with the Austroads test procedure (Reference 2).

The density ratio of the specimen should be related to the density normally achieved in the field. This may vary from 98% of Modified Dry Density (MDD) for higher plasticity soft rocks and gravels to 102% of MDD for high quality crushed rock base materials. Normally three specimens are prepared and tested at moisture contents ranging from 60% to 100% of Optimum Moisture Content (OMC).

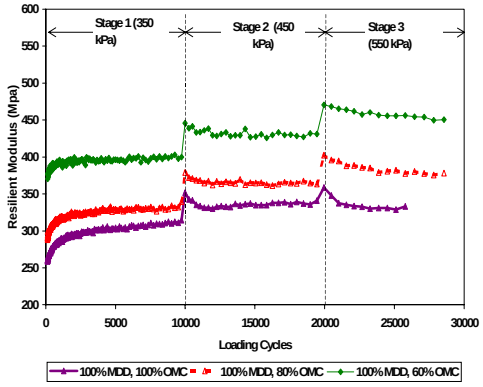
As deformation (rutting) of pavements mainly occurs when the field moisture is at its highest, candidate materials should be tested at moisture contents covering the range of moisture contents experienced during the wet season. In Victoria the field moisture content is at its highest in early spring.

6. TEST OUTPUTS

The test apparatus determines permanent deformation by measurement of non-recoverable accumulated strain in the specimen. The resilient modulus is automatically calculated from the stress applied and the measured recoverable or elastic strain at preset load cycles.



(a) Permanent Strain



(b) Resilient Modulus

Figure 2 Typical Results of RLT Testing

Figure 2(a) shows the typical permanent strain of a material at three different moisture contents and Figure 2(b) shows the typical resilient modulus of the same material at three different stress levels.

These results show the effect that stress has on the resilient modulus of the material (stress dependency) and progression of permanent deformation at different stress levels and moisture content. Each stress condition consists of 10 000 repetitions of vertical stress application.

7. APPLICATION OF THE RLT TEST

To date VicRoads has applied the current RLT test to:

- Rank the performance of various unbound pavement materials within certain material classification groups (i.e. gravels, ripped rocks, fine crushed rocks);
- Determine the reduction in pavement life in a case study where a sub-standard crushed rock was used;
- Compare the performance of recycled crushed concrete against the performance of crushed rock;
- Evaluate the effectiveness of polymer road stabilisers for reducing the moisture sensitivity of marginal pavement materials;
- Compare the relative performance of crushed rocks;
- Compare the laboratory performance of a variety of different materials extracted from in-service pavements with field performance (rut depth and rut progression)

8. REFERENCES

1. **Austroads APRG Document 00/32 (MA)** - Inter laboratory Precision Study of Permanent Strain and Resilient Modulus Testing.

2. **Austroads APRG 00/33 (MA)** - Austroads Repeated Load Triaxial Test Method – Determination of Permanent Deformation and Resilient Modulus Characteristics of Unbound Granular Materials Under Drained Conditions.

3. **Paper by B Vuong** to the 20th ARRB Conference titled - Improved Characterisation of Unbound Pavement Materials.

4. **Paper by R Paul and B Vuong** to the 20th ARRB Conference titled - VicRoads Perspective on Performance of Unbound Pavements and Application of the RLT Test.

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