

Repeated Load Triaxial Testing and Rut Depth Modelling for Pavement Materials (granular, modified, local, recycled, waste, stabilised, subgrade)

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What is Repeated Load Triaxial (RLT) Testing?

The RLT (Repeated Load Triaxial) apparatus applies repetitive loading on cylindrical materials for a range of specified stress conditions, the output is deformation (shortening of the cylindrical sample) versus number of load cycles (usually 50,000) for a particular set of stress conditions. Multi-stage RLT tests are used to obtain deformation curves for a range of stress conditions to develop models for predicting rutting.

Resilient Modulus information can also be obtained for pavement design in CIRCLY and Finite Element Models.



Fig 1. RLT Apparatus and Setup.

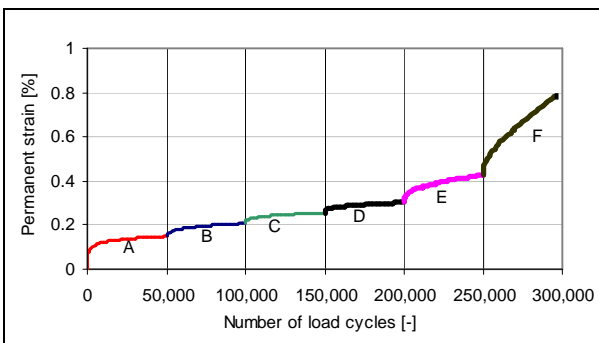


Fig 2. Typical Output from Permanent Strain RLTT.

Analysis of RLTT Results – Rut Depth Modelling.

The method developed by Dr Arnold in his Doctorate studies at the University of Nottingham, UK is used to interpret the results to predict the rut

depth in a pavement. First step is to develop a mathematical relationship between stress (both vertical and horizontal) with permanent strain rate (slope of each deformation curves (Fig 2), e.g % deformation per 1 Million Loads Cycles).

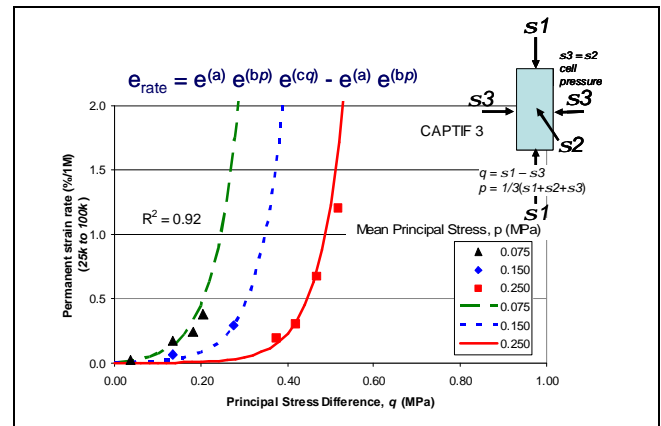


Fig 3. Fitting the Permanent Strain Rate Model to RLTT Results.

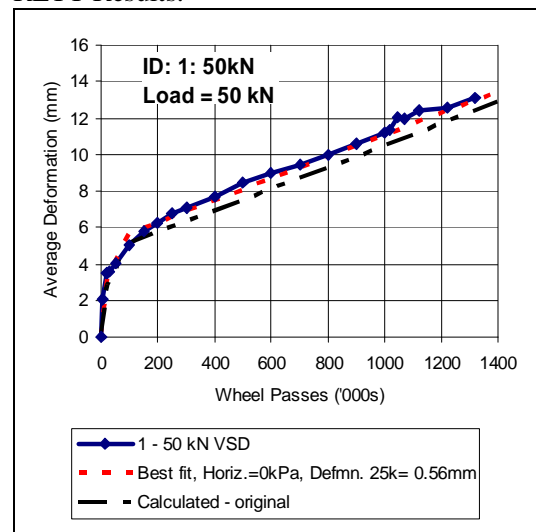


Fig 4. Rut Depth Prediction from RLTT for CAPTIF (Accelerated Pavement Test) Trial.

Next step is to use a finite element model (to model the non-linear elastic behaviour of a pavement material and to avoid discontinuities as occurs in CIRCLY which results in high tensile stresses) to compute the stresses (both vertical and horizontal underneath a standard axle load (8.2 tonne dual tyred axle or higher if designing for ports etc).

Stresses are exported into a spreadsheet to calculate the deformation rate at depth increments in the pavement from the permanent strain model (Fig 3.). Results showed very good predictions of rutting that occurred at CAPTIF (Fig 4.) (Arnold, 2004).

Applications for RLTT and Rut Depth Modelling

Preventing Early Failure

Recent research has shown that even if your aggregate complies with M4 that they do not perform equally. The aggregate may fail by shear (Fig 5) within 6 months after the pavement has been constructed especially if it gets wet. The RLTT can quickly identify aggregates where there may be a risk of this occurring as often the sample fails before the completion of all the stress stages (Fig 2).

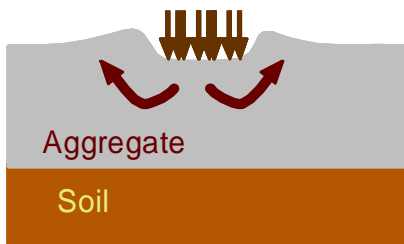


Fig 5. Shear Failure in Aggregate Layer.

Modified/Stabilised Materials for High Trafficked Roads

Small quantities of cement, lime or other additive are classified as a modified aggregate in the Transit New Zealand Supplement to the Austroads Pavement Design Guide. Modified aggregates are recommended in the NZ Supplement for use for high trafficked state highways as an economical alternative to structural asphalt. Using the RLTT will identify the most appropriate amount of additive and using rut depth modelling can predict the amount of extra life that can be obtained through modification compared with the source aggregate.

Modified/Stabilised Marginal Local Materials as a Lower Cost to TNZ M4 (and may perform better!)

RLTT and rut depth modelling allow any material that does not comply with a current specification to be assessed as suitable or not for the chosen application in the pavement. This allows a local material non-compliant with the specifications to be modified by say adding cement to be approved for

use. Transit New Zealand are in the process to develop a RLTT method and associated analysis to approve use of other materials on State Highways.

Local Materials for Local Roads

Footpaths, tennis courts, cul-de-sacs, low trafficked local roads do not need to use TNZ M/4 Basecourse Aggregate meant for State Highways. In fact M4 is difficult to lay and compact for these small local jobs. RLTT and rut depth prediction for the required application can allow say a local but dirty aggregate to be assessed as suitable for low trafficked situations and footpaths.

Waste and Recycled Materials

Waste or recycled materials like glass and reclaimed asphalt mixed with aggregate or otherwise can be tested in the RLT apparatus with rut depth modelling to determine appropriate applications as pavement base material.

PaveSpec Ltd

Dr Greg Arnold is the Director of PaveSpec Ltd which along with offering specialist pavement advice and design is a company that has just recently purchased a state of the art Repeated Load Triaxial apparatus for testing Pavement Materials.

Please contact Dr Greg Arnold if you would like to conduct any Repeated Load Triaxial tests and / or you would like to learn more with a visit at your office by Dr Greg Arnold as he is travelling the country in the next few months:

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References

ARNOLD, G. (2004) Rutting of Granular Pavements. PhD. University of Nottingham, England, UK. (If interested email: greg.arnold@pavespec.co.nz for a copy).