

# Quality Management of Earthworks with Deflection-Based Devices

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**Webinar Resources** (Webinar event originally held 11AM AEST, 14 May 2020)

A full recording of the webinar can be accessed via this link:

[\*View the Webinar\*](#)

The Presentation Slides can be accessed online:

[\*View the Presentation Slides\*](#)

## **Questions and Answers from Webinar:**

**Q. Is modulus testing suitable to assess both earthworks (fill) & pavements?**

A. Modulus testing is suitable for both earthworks & pavements.

**Q. There were a few slides that showed that modulus is higher when the material is dry of OMC. Did you examine modulus of material compacted at OMC and then dried back to at least 70% or OMC?**

A. If you are referring to slide 24, We did as you suggested. The results are presented in the slide but due to lack of time not extensively emphasized.

**Q. How were the stiffness values determined from PLT – static or repeat load values?**

A. Our specification is for two cycles of a static test PLT.

**Q. The challenge around convincing road authorities to introduce modulus as a conformance criterion in the Spec, how have you guys got this over the line in the past?**

A. Great question. The best results are achieved when the researcher, owner reps and contractors work together. The marketing should be that we will improve by co-operating, not imposing specifications unilaterally.

**Q. How is the rutting criteria can be satisfied with modulus?**

A. As indicated, the same design algorithm were used with the designed moduli and with those measured in the field.

**Q. What additive type & content for the stabilised material?**

A. 6% Lime.

**Q. With your case study at the end of the presentation, where remaining life was less than 100%, what would the contractor do on site to improve this given the density outcomes....?**

A. As I indicated, with proper process control the modulus can be achieved. In the case study, the contractor did a high-quality job. The problem was that the designer assumed a high modulus for the subgrade. This could have been solved inexpensively by a change order by the owner to either compact the raw subgrade better or stabilize the clay deeper.

**Q. Any thoughts on the assumed relationship with road subgrades i.e. Modulus = 10 x CBR?**

A. The relationship is reasonable but the constant of 10 is highly variable with the type of soil. There is a good discussion of the (known) high variability of the CBR – E relationship in an Austroads publication.

**Q. Any study regarding correlation between different LWD?**

A. Yes. Please see: <https://journals.sagepub.com/doi/abs/10.3141/2641-08>.

There is also further discussion between different LWD types as observed in Australian studies in ARRB / NaCoe (e.g. [http://nacoe.com.au/wp-content/uploads/2018/06/PRP16036\\_P60-Year-1-Report-Final.pdf](http://nacoe.com.au/wp-content/uploads/2018/06/PRP16036_P60-Year-1-Report-Final.pdf)) and other published technical papers (e.g. [https://www.issmge.org/uploads/publications/25/26/ISC5\\_163.pdf](https://www.issmge.org/uploads/publications/25/26/ISC5_163.pdf))

**Q. Any experience regarding non-nuclear density gauges?**

Yes. Please see NCHRP 10-84 report, or

[https://www.researchgate.net/profile/Mehran\\_Mazari/publication/259890843\\_EVALUATION\\_OF\\_THREE\\_MOISTURE\\_AND\\_DENSITY\\_DEVICES\\_ON\\_UNBOUND\\_PAVEMENT\\_MATERIALS/links/00b4952e6a6ac904d0000000/EVALUATION-OF-THREE-MOISTURE-AND-DENSITY-DEVICES-ON-UNBOUND-PAVEMENT-MATERIALS.pdf](https://www.researchgate.net/profile/Mehran_Mazari/publication/259890843_EVALUATION_OF_THREE_MOISTURE_AND_DENSITY_DEVICES_ON_UNBOUND_PAVEMENT_MATERIALS/links/00b4952e6a6ac904d0000000/EVALUATION-OF-THREE-MOISTURE-AND-DENSITY-DEVICES-ON-UNBOUND-PAVEMENT-MATERIALS.pdf)

**Q. How does LWD tie in with proof rolling subgrades?**

A. Proof rolling is a visual method while LWD is more mechanistic. I prefer proof rolling via an Intelligent Compaction Roller to find relatively less stiff or highly variable regions.

The LWD acts to quantitatively assess small deflection magnitudes - and the LWD fills the space where deflection magnitudes are undiscernible to the naked eye - LWD has a maximum deflection measure of approx. 2mm, whilst the naked eye can only observe surface deflections from 2 mm and up (as per RMS Proof Roll discussion).

**Q. Are there any correlation between modulus from LWD result and shear strength or others parameters?**

A. I know that there are relationships between lab determined modulus parameters and shear strength but I have never seen a direct correlation between  $s_u$  and LWD.

**Q. How did the Inland Rail trial normalise the impacts of moisture?**

A. Test results were presented as 'raw' LWD modulus outputs. Further information is included in upcoming technical papers for the Conference on Railway Excellence (CORE) 2021.

**Q. Are the test in this slide [Slide 42] along Chainages?**

A. Slides 39 and 42 are both chainage along x axis, chainages omitted for commercial reasons

**Q. How do you control moisture content without adopting traditional methods?**

A. Thanks for indicating that traditional moisture control is important. This activity is incorporated as part of the process control step. Although outside the specific scope of the presentation, there are numerous techniques available for rapid assessment of field moisture content.

**Q. You have both identified that one advantage is the quick turnaround of the LWD. However, if you have to determine an OMC at each location, that is still time dependent. Has there been any research on quicker ways to get an OMC?**

A. Determination of OMC is considered as an upfront work and should not interfere with quick acceptance of the material. In current Australian project-specific specifications, field measurement of insitu moisture conditions at the time of the LWD are being utilised to dynamically adjust the target modulus threshold required to be demonstrated at any test point - with the relationships determined upfront (and monitored throughout the project) as not to interfere with near-instantaneous acceptance / failure of the material.

**Q. How does this method impact any variability of material quality?**

A. The method demonstrates the level of variability in the material properties - and, although present, this variability in the stiffness parameter is just not currently being identified through traditional methods. Through process control that variability can be controlled. Perhaps with a little more cost but significant improvement in the performance and longevity of final product.

**Q. Any testing and results using LWD was performed on the sustainable materials such as using crushed sand in pavement layers and measured with conventional testing?**

A. There are some studies out there. Please search for them in TRID database.

**Q. [Andrew...] Are you aware of QMR investigation of the LWD as an Intelligent Compliance Test (vs AS 1289.5.1.1) ?**

A. Jeffrey and I have broadly discussed the ongoing NACOE research on intelligent compaction (IC), and IC is something that I am keen to see trialled on Inland Rail particularly with respect to uniformity (ref Soheil's slide 27). I understand that there will be future publications/presentations by NACOE on their IC research.

**Q. Is the choice of LWD mass critical to the results? Can the 15kg weight be used across all layer types?**

A. Depends on the stiffness of the soil or the magnitude of the design stress that is required to be replicated by the onsite testing. Usually the drop weight is included in the determination of the target values. As you are using the LWD to measure pressure vs. deflection, the use of a 15 kg mass just provides a different reference value for the pressure component.

**Q. How the results vary with cohesive to non-cohesive fill?**

A. The actual and target moduli of the two material will be different, as will the material's moduli response to varying moisture content.

**Q. Hi – is there access to the European Railway Standards mentioned earlier?**

A. Yes - Many of these can be readily accessed online from the appropriate agencies / regulatory bodies

**Q. What key references do you use to identify/correlate the modulus for subgrade materials?**

A. I am sorry I do not understand the question.