	TMC – Tinni Management Consulting	Issue No. 59
	PAVEMENT INFORMATION NOTE	
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Conflict between PIN 57* and the RTA Earthworks Specification R44

*(PIN 57 – Pavements on Highly Expansive Clays)

It has been pointed out to me that the suggestions listed in PIN 57 on how to reduce the effect of the highly expansive clays in road formations will contravene a number of the requirements of technical Specifications. The basic principle was to compact the material at roughly the estimated Equilibrium Moisture Content (EMC) and then limit the ingress of moisture and its movements in the subgrade.

Purpose

This PIN draws attention to the existing technical clash in the specified compaction moisture content requirement and the established construction practice with highly expansive clays and the incorrectness in specifying the fixed Benkelman Beam deflection requirement at the subgrade level, regardless of the material, in the Earthworks Specification R44. As a consequence, there is the domino effect resulting from the compaction moisture affecting the material's strength and thus increasing the deflections under the BB test.

Earthworks Specification R44

The Specification requires that compaction should take place at 60% to 90% of the Optimum Moisture Content (OMC) – regardless of the material and that the Characteristic Deflection on the underside of the Selected Material Zone (SMZ) is less than 1.2 mm and on top of the SMZ 1.0 mm (again, regardless of the material). It further requires that the Standard Deviation (SD) of the deflection measurements at the underside of the SMZ must not exceed 0.2 mm.

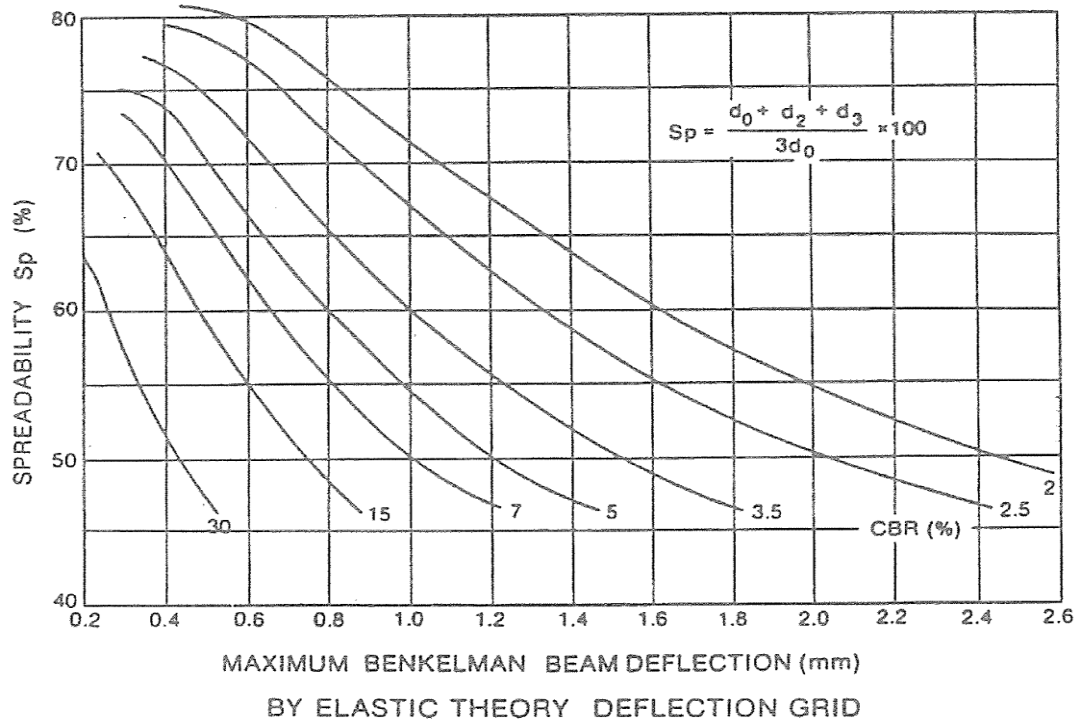
Issues with Compaction

For best results, it is normal to compact clays dry of OMC and granular materials wet of OMC. Depending on the geographic location of the project, Equivalent Moisture Content (EMC) could be less or more than the OMC. More often it is greater. PIN 57, amongst other precautions, also listed the need to compact close to the EMC. Hence to compact at an EMC that is outside the specified range of 60% to 90% of the OMC will contravene the Specification requirement. The result will be that the higher m/c will probably reduce the CBR strength of the soil and may not provide the specified degree of compaction.

Benkelman Beam Testing

At 100% compaction, there can still be significant variations in the rebound deflections as these are dependent on the subgrade material CBR strength, which in turn will vary with the moisture content.

Hereunder is the RTA Elastic Theory Deflection Grid, extracted from the RTA Supplement to the Austroads Pavement Design Guide. It can be seen that for a fixed Spreadability (Sp) value, there is a large variation (up to 600%) in the Benkelman Beam deflections depending on the quality of the material. Here the assumption also is that maximum degree of compaction is achieved at OMC.



Hence, for a Spreadability of 50% the deflections can vary as below and it is not realistic to nominate a maximum deflection regardless of the material encountered

Material Strength CBR%	Expected Max Deflection mm
30	0.4
15	0.6
7	1.0
5	1.2
3.5	1.6
2.5	2.0
2	2.4

A very arbitrary, but practical Rule-of-Thumb for reduction of deflections in earthworks operations is 1 mm/m of fill. It assumes that the quality of material improves as the embankment rises.

Recommendations

From the above, it can be seen that there are three issues that need to be resolved with the Client as early as possible:

1 If it is obvious that there may/will/could be problems with highly expansive clays, the methodology described in PIN 57 should be proposed. (This is a bigger problem with flexible pavements than with concrete ones).
2 The issue of variations in the BB deflections due to the CBR strength of the subgrade material should be flagged, using this PIN as an explanation.
3 Attention should also be drawn to the fact that by compacting at approximately EMC, there could be a domino effect on the material's CBR and hence, also the BB deflections.

Info Notes

1 According to the Elastic Theory Grid, any material that at the underside of the SMZ has a CBR <7% will fail the specified deflection criteria.
2 This is irrelevant in the rigid pavement design as the Equivalent Subgrade Strength is calculated over a metre depth below the subbase using the Japanese Public Works Formula as per the Austroads Pavement Design Guide. A subgrade material of CBR 3% which is overlain by a SMZ of 150 mm 2 % lime modified CBR 15% and 150 mm of CBR 15% material will actually have a CBR_{eq} = 6.2%. (Using a SMZ of CBR 30% would provide a CBR_{eq} of 7.2%).
3 Any CBR value above 5% will not effect the design thickness of the concrete base.