TRANSPORT RESEARCH LABORATORY

Assessment summary of the PANDA CONE PENETROMETER for compaction testing

The following notes are a summary of a report carried out by the Transport Research Laboratory on the Panda Dynamic Cone Penetrometer.

The in-situ evaluation was undertaken using four trenches. Polyethylene piping was placed and surrounded by pea gravel. The trenches were then reinstated to the surface with granular Sub-base Type 1 (GSB1) and the material was compacted using a 50kg vibrotamper. Each trench design was either in full compliance with the New Roads and Street Works (NRSW) code of practice (commonly known as HAUC Specification) or modifications were made to the layer thickness or number of compaction passes per layer.

The four scenarios were:

Trench 1: back filled to NRSWA Code of Practice (150 mm layers 8 passes for each layer)

Trench 2: 250mm layers, 8 compaction passes on each layer.

Trench 3: 150mm layers, 4 compaction passes on each layer.

Trench 4: 300mm layers, 2 compaction passes on each layer.

After the compaction of each layer, in situ densities were taken using a Nuclear Density Gauge. The TRL Dynamic Cone Penetrometer and the Panda Dynamic Cone Penetrometer tests were performed at 0.5m intervals on the finished surface. A representative sample of GSB1 was also tested in the laboratory to determine particle size distribution moisture content and dry density in accordance with the Specification for Highway Works.

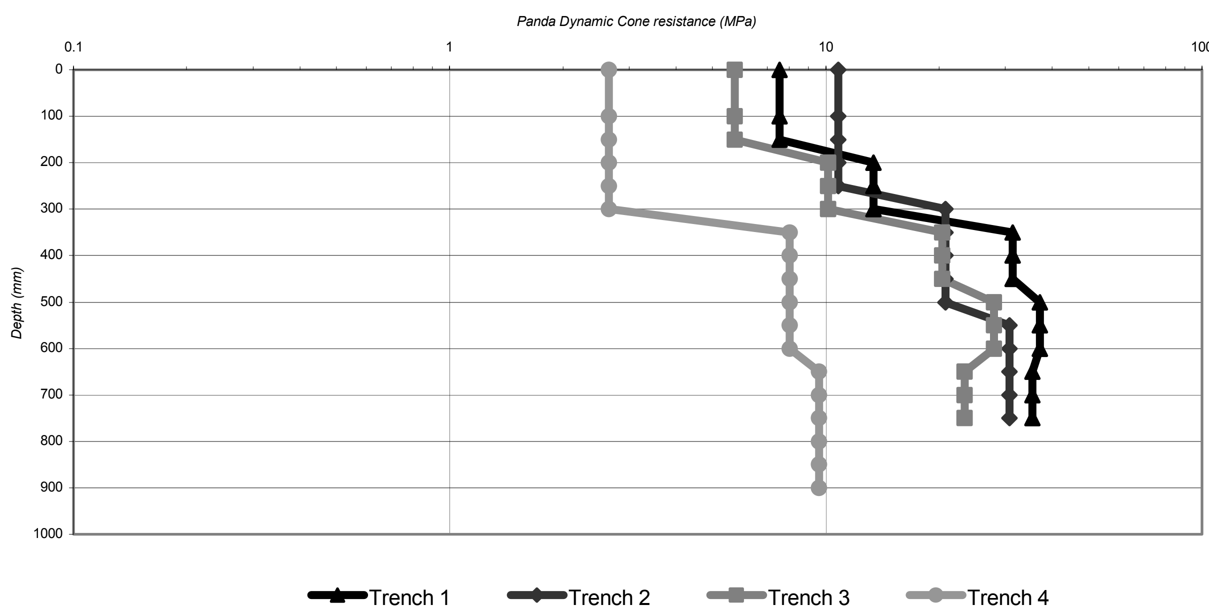


Figure 1: Average Panda cone resistance recorded for each layer of each trench.

Figure 2: Average TRL DCP for each trench.

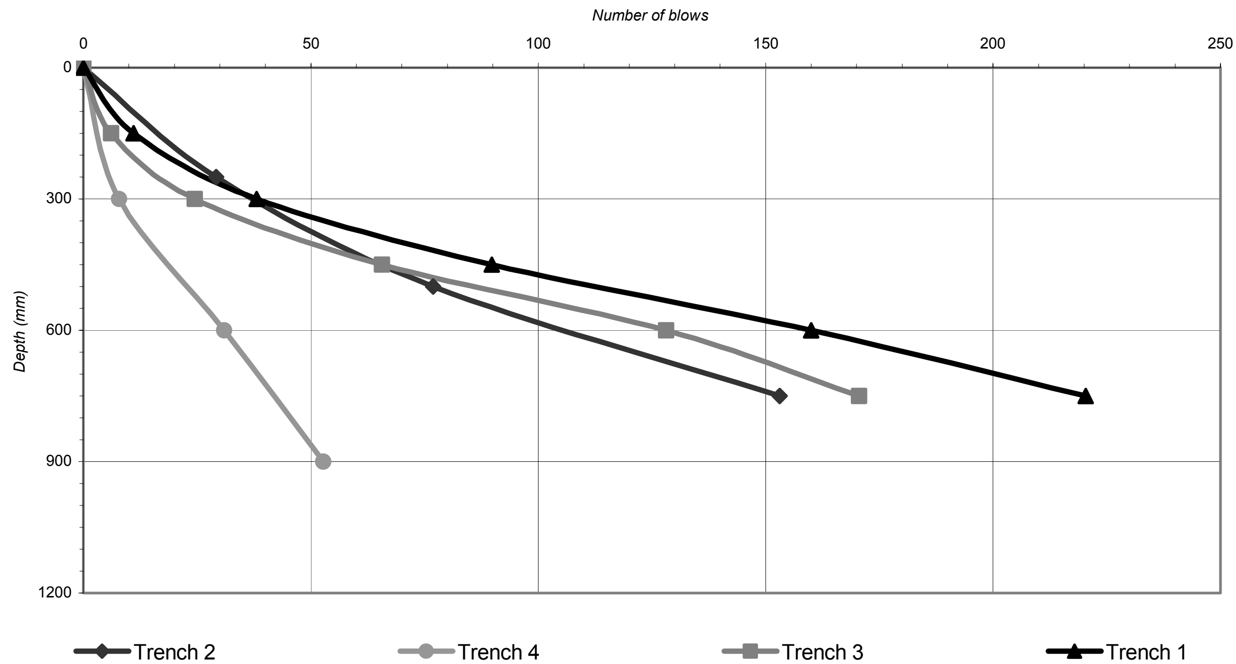
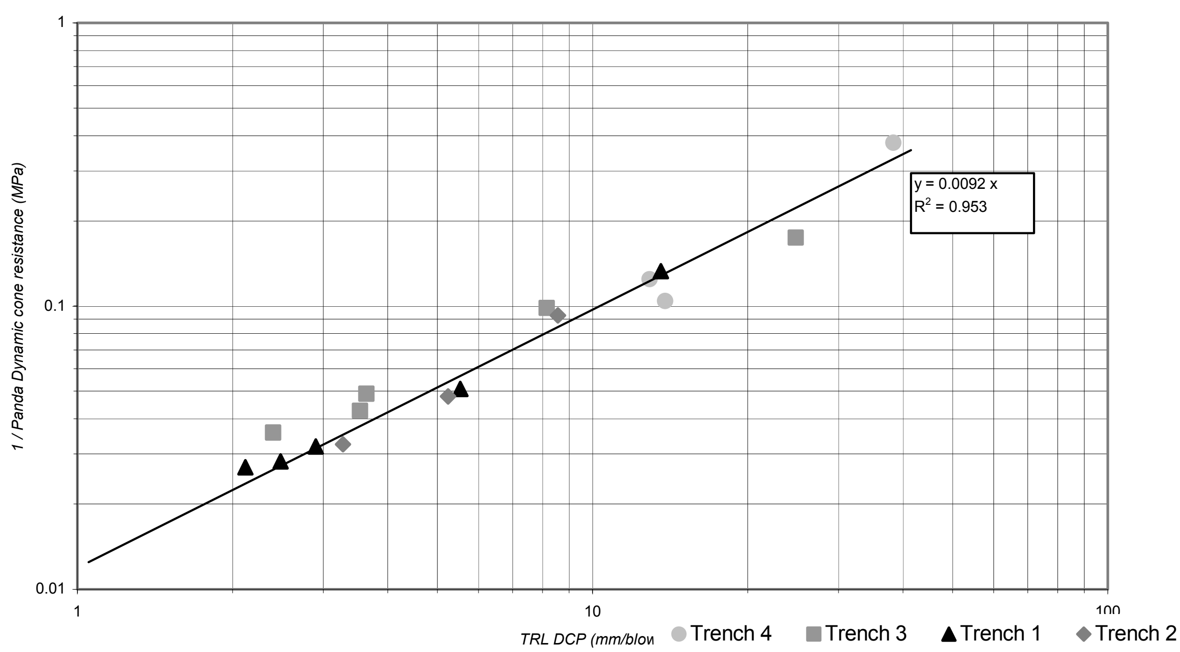


Figure 3: The relationship between Panda cone resistance and TRL DCP mm/blow.



Figures 1 and 2 show the average values recorded for each layer of each trench for the Panda and the TRL probes. Both pieces of apparatus ranked the trenches in a logical order reflecting layer thickness and compactive effort. The unedited Panda data clearly showed layer thickness where over sized layers had been used (see Figures 4 and 5).
Figure 3 shows the linear relationship between Panda cone resistance (MPa) and TRL (mm/blow). As this relationship has been proved Panda cone resistance data can easily and reliably be converted to TRL mm/blow and visa versa. Moreover with the existence of this relationship a reliable correlation to CBR can be obtained by reworking the TRL road note 8 equation.

TRL road note 8: $\log_{10}CBR = 2.48 – 1.057 \times \log_{10} (mm/blow)$
Panda equation: $\log_{10}CBR = 0.352 – 1.057 \times \log_{10} qd\ (MPa)$

CBR (%) values obtained (from depths greater than 300mm):

	TRL	Panda
Trench 1	110	102
Trench 2	73	84
Trench 3	100	76
Trench 4	22	20

Extracts from the TRANSPORT RESEARCH LABORATORY report:

“ Following the analysis of the in situ and laboratory data, a comparative study was undertaken to establish the relationship between the two penetrometers. A strong relationship was found and it was concluded that it is possible to relate the outputs from each instrument, when using GSB1 material.”

“The TRL DCP and the Panda DCP both ranked the trenches in a logical order considering the compactive effort applied. Trench 1 is the strongest followed by trench 3, trench 2 and trench 4.”

“The layer boundaries can be identified by the changes in cone penetration resistance allowing layer thickness to be calculated. The layers are particularly noticeable on trench 2 and trench 4 which both received reduced compactive effort”

“The trench rankings suggest that, oversized layers are a bigger factor in reducing trench strength than the number of compaction passes applied.”

“Converting the PANDA data into normalised TRL DCP blows would have the added advantage of producing a smooth linear relationship that could be easily analysed using a regression line. Existing CBR relationships for the TRL DCP could also be used for the Panda negating the need to develop reference and refusal lines for unfamiliar materials.”

“ There is a strong relationship (R^2 = 0.953) between Panda dynamic cone resistance with depth and the number of TRL DCP blows with depth.”

Note that these simple principles for reinstating trenches can be applied to any type of fill (embankments, dams, made ground and highway subgrades). The user can use either the existing database of materials included in the Panda software (106 different materials) to obtain an equivalent proctor density or proven relationships to CBR to verify the performance of the method of compaction being used.

Note also site investigation applications, the Panda can be used as either a comparative tool especially useful for ground improvement, or directly by correlating to SPT, CPT, other DCP’s of undrained shear strength.

Figure 4: Panda data trench 2:

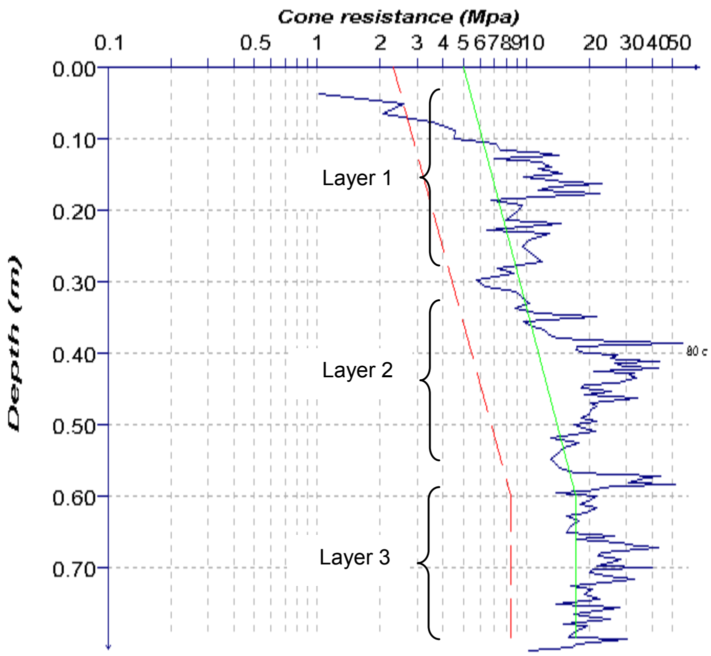
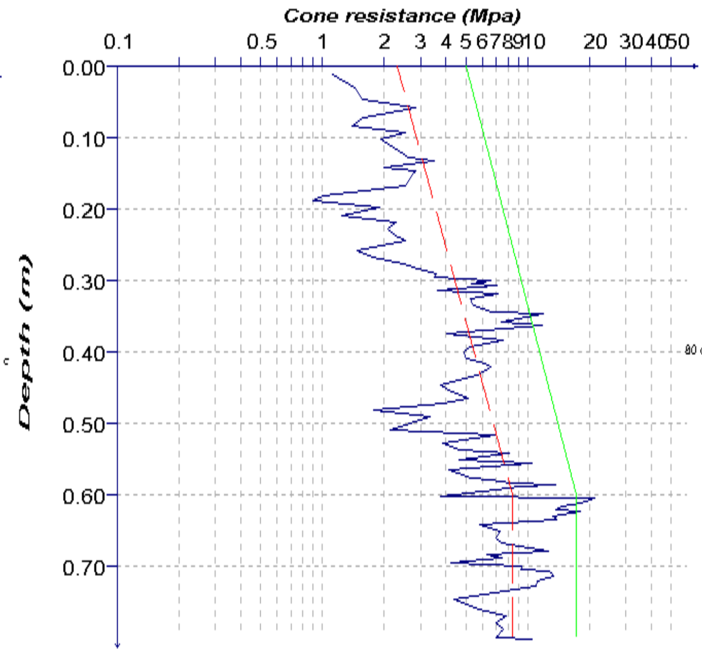


Figure 5: Panda data trench 4:



<u>Current users of the PANDA for trenching applications:</u>

Brunswick Construction
Cornwall County Council
GeoMac Construction
Laing Technology
Mc Nicholas Construction Ltd
Midlands Electric
Moywest Ltd
Northamtonshire County Council
Northumberland County Council
NTL/Diamond Cable
Severn Trent Water
South West Water
Thames Water
Transco
Tyne & Wear Materials Laboratory