Statistical Analysis of DCP Data to Evaluate Resilient Modulus of Reclaimed Stabilized Base

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Study Goals

- Determine if the Dynamic Cone Penetrometer (DCP) can be used to reliably measure resilient modulus (M_R) of reclaimed stabilized bases.

- Determine if it is reasonable to develop a performance based specification for reclaimed stabilized base layers using the DCP.

DCP Overview / Demonstration

- 8-kg hammer dropped 575mm. Drives a 60mm cone with a 60-degree angle.
- A “measurement” is number of blows and distance penetrated.
- Raw data is converted to a DCP Penetration Index (PI) in units of mm/blow
- 25mm of penetration between readings to prevent inaccurate readings in granular material.

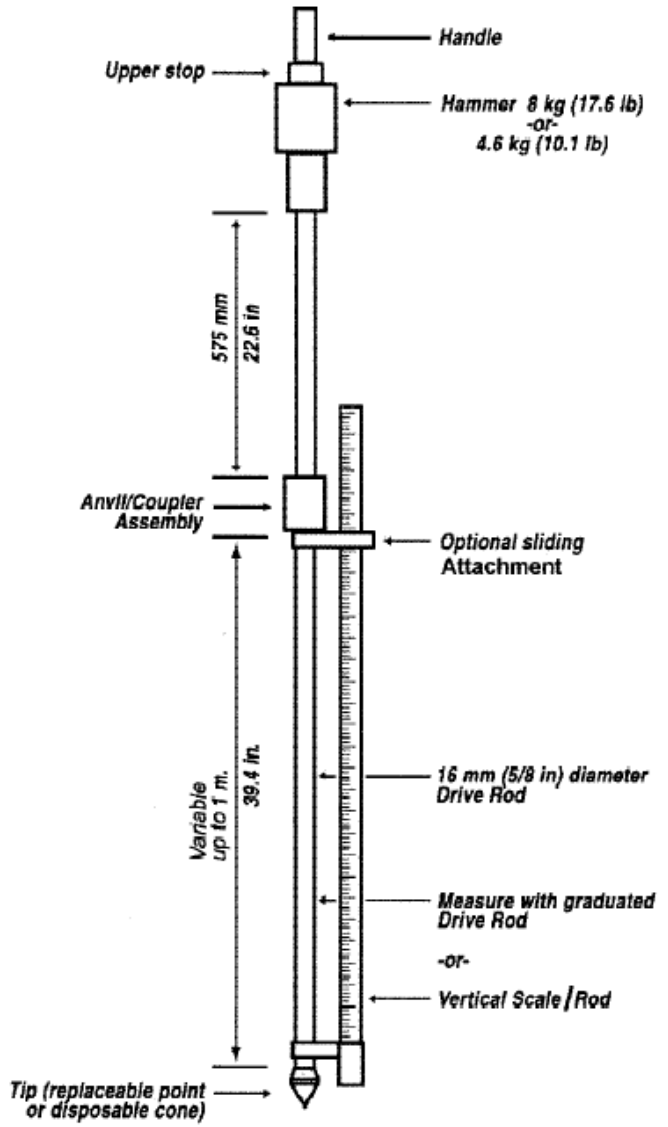


FIG. 1 Schematic of DCP Device

DCP – Resilient Modulus Correlation

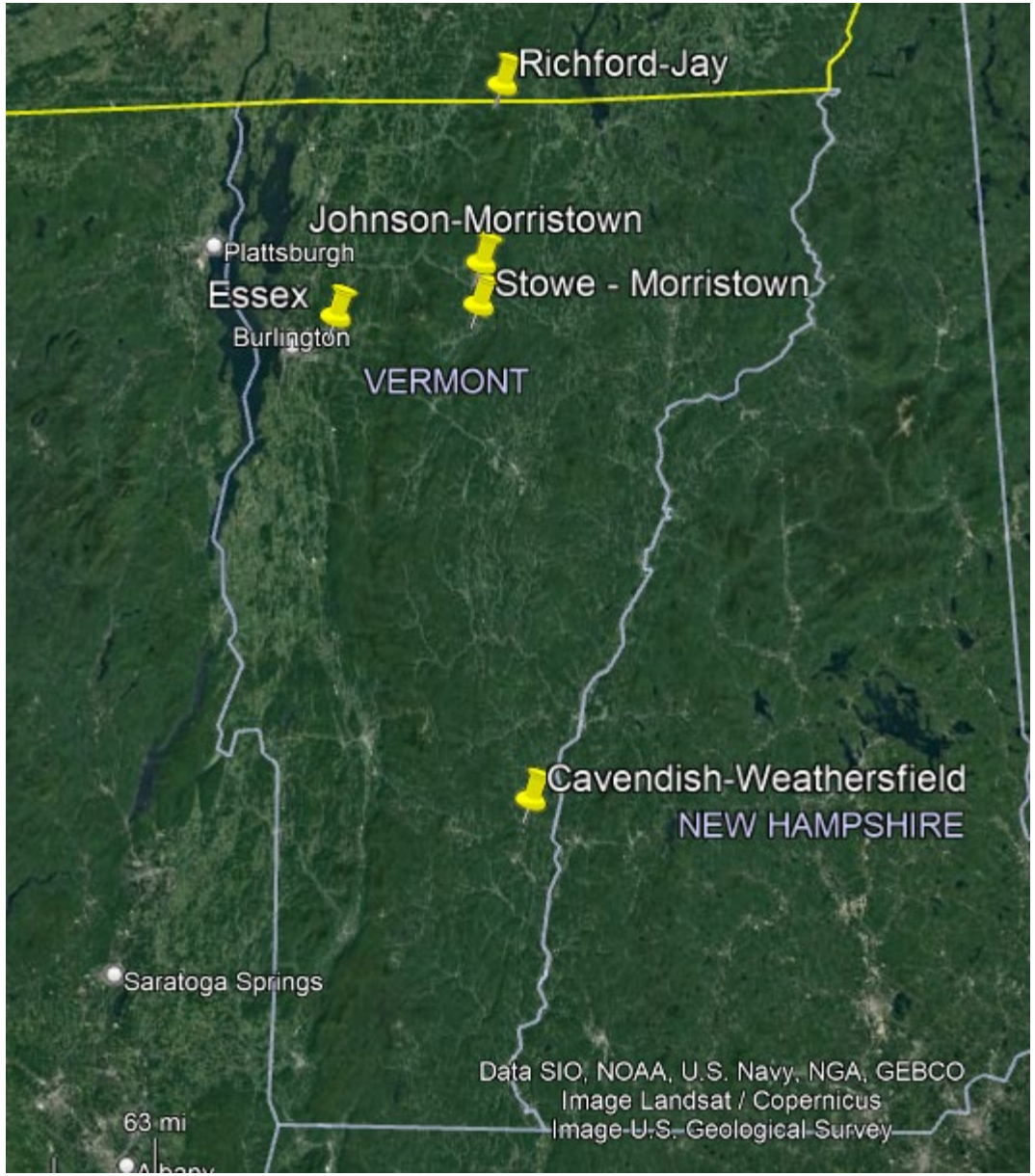
- DCP to Resilient modulus is a “double correlation”.
- $CBR = 292/PI^{1.12}$
- $M_R = 2555 * CBR^{0.64}$

- The above correlations are commonly used by AASHTO, USACOE, and FHWA. However, there is little published information available regarding the use of these correlations for stabilized materials.

DATA AVAILABLE

- We received 821 individual DCP tests over 5 different reclamation projects. Data was collected at the time of constructed between 2018 and 2021.

- 490 individual FWD tests from three of these projects were later collected in the Spring of 2022 to use for a comparative analysis to the DCP data.

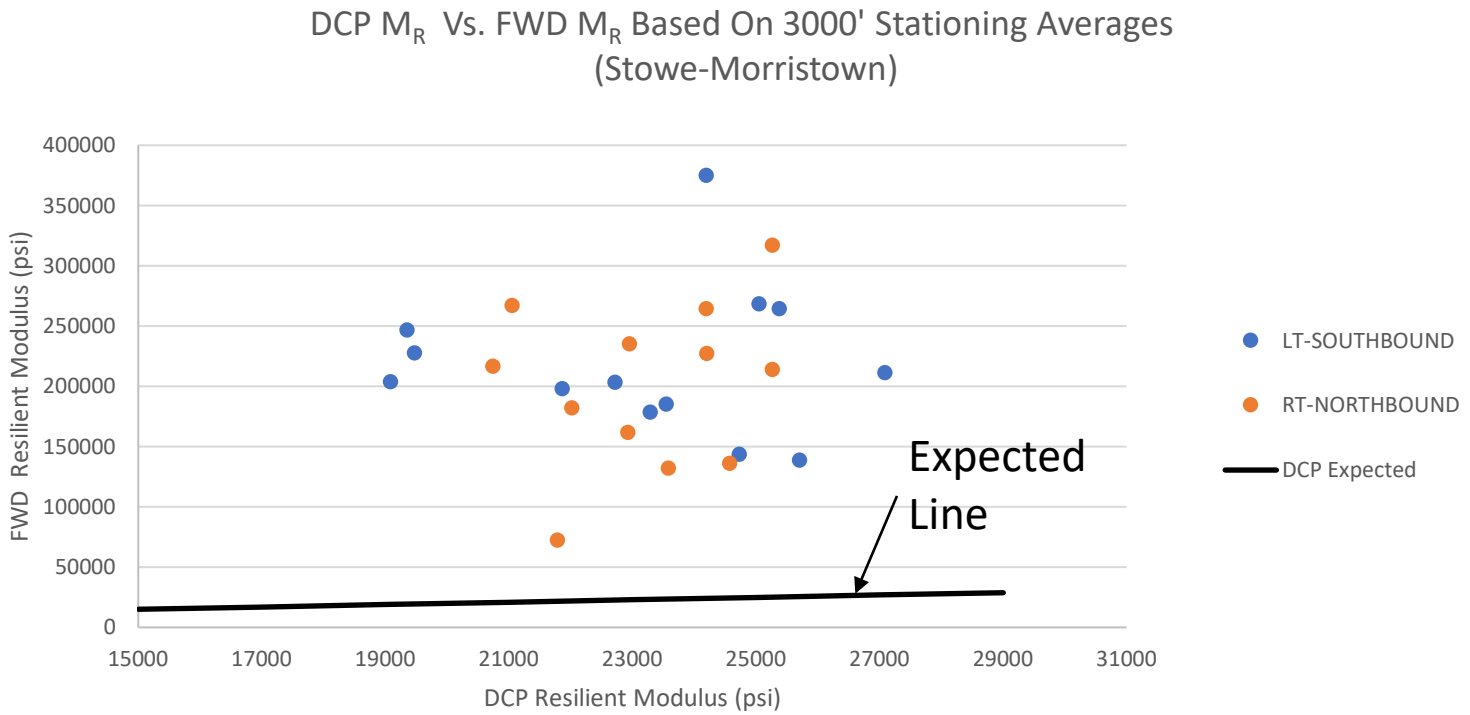


Data Review – Less Variation Observed with DCP Vs. FWD

PROJECT	DIRECTION	Length of Project	ALL DATA DCP M_R RSB (psi)	OUTLIERS REMOVED [2] DCP M_R RSB (psi)	ALL DATA FWD M_R RSB (psi)	OUTLIERS REMOVED [2] FWD M_R RSB (psi)
Cavendish-Weathersfield[1]	Eastbound	8.953 Miles (47,275 Ft.)	Mean = 23541 SDev. = 3638 **COV = 16%** Sample Size = 44	Mean = 24572 Sdev. = 2731 **COV = 11%** Sample Size = 38	Mean = 959901 SDev. = 732904 **COV = 76%** Sample Size = 95	Mean = 959901 Sdev. = 732904 **COV = 76%** Sample Size = 95
	Westbound		Mean = 22516 SDev. = 4267 **COV = 19%** Sample Size = 58	Mean = 23217 SDev. = 3518 **COV = 15%** Sample Size = 54	Mean = 959901 SDev. = 732904 **COV = 76%** Sample Size = 96	Mean = 959901 SDev. = 732904 **COV = 76%** Sample Size = 96
Richford-Jay	Eastbound	7.438 Miles (39,274 Ft.)	Mean = 23981 SDev. = 3598 **COV = 15%** Sample Size = 152	Mean = 24276 SDev. = 3352 **COV = 14%** Sample Size = 146	Mean = 36153 SDev. = 36833 **COV = 102%** Sample Size = 78	Mean = 25906 SDev. = 17520 **COV = 68%** Sample Size = 71
	Westbound		Mean = 23935 SDev. = 4047 **COV = 17%** Sample Size = 150	Mean = 24332 SDev. = 3708 **COV = 15%** Sample Size = 143	Mean = 128857 SDev. = 78841 **COV = 61%** Sample Size = 55	Mean = 159652 SDev. = 35868 **COV = 22%** Sample Size = 26
Stowe-Morristown	Northbound	7.550 Miles (39,861 Ft.)	Mean = 23457 SDev. = 3562 **COV = 15%** Sample Size =56	Mean = 23803 SDev. = 2983 **COV = 13%** Sample Size = 53	Mean = 193356 SDev. = 141926 **COV = 73%** Sample Size = 81	Mean = 155450 SDev. = 104013 **COV = 67%** Sample Size = 70
	Southbound		Mean = 22290 SDev. = 4586 **COV = 21%** Sample Size = 54	Mean = 23413 SDev. = 3021 **COV = 13%** Sample Size = 49	Mean = 217699 SDev. = 115393 **COV = 53%** Sample Size = 79	Mean = 201431 SDev. = 98571 **COV = 49%** Sample Size = 74

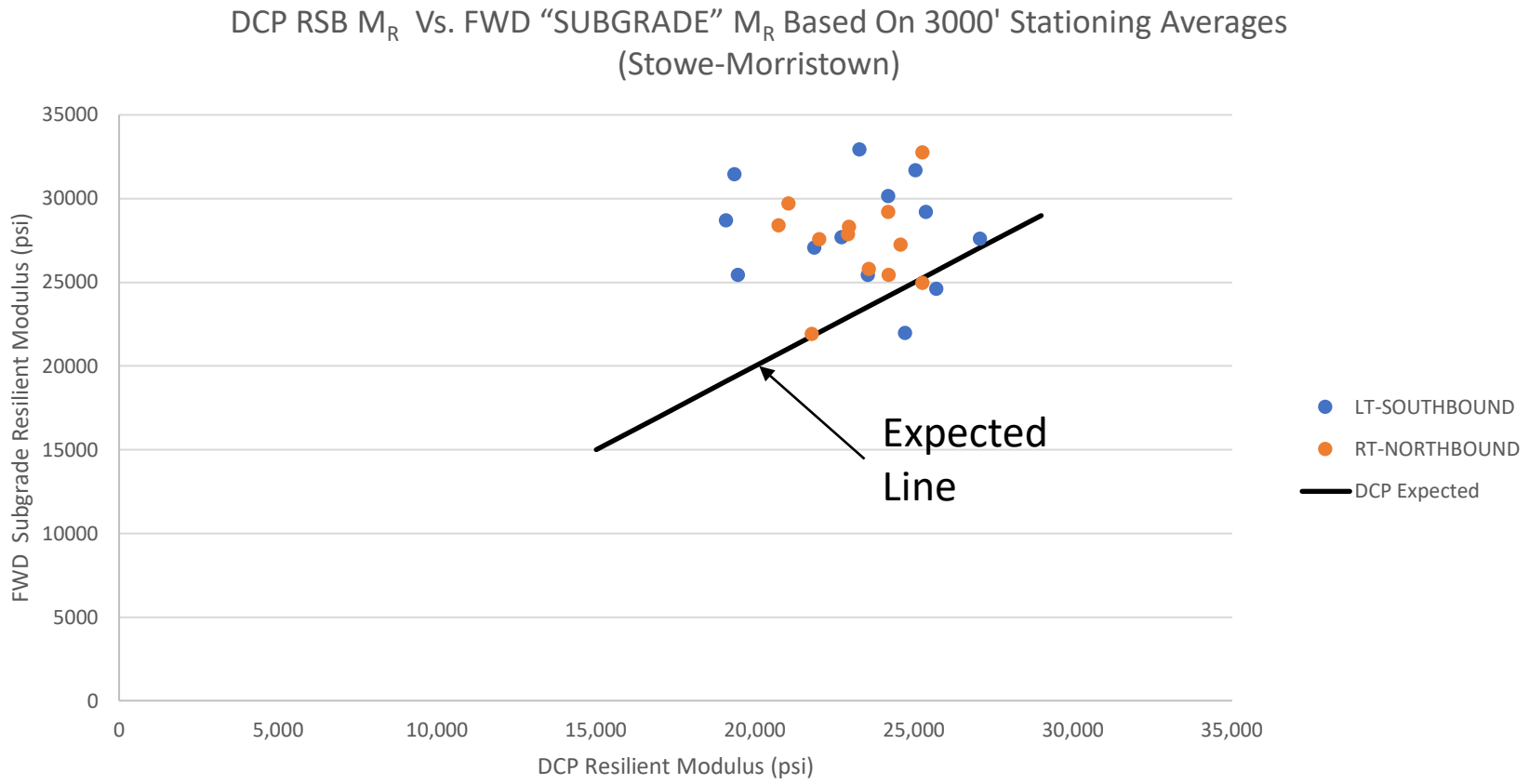
Data Review –

Poor correlation observed between DCP and FWD for the reclaimed stabilized base. Expect this to be primarily due to variation in curing time for the stabilizing agent (months for FWD vs. hours for DCP).



Data Review –

Better Correlation when comparing DCP values to FWD values of underlying un-stabilized base material where curing time is not a factor.



Key Takeaways:

- DCP testing was performed too soon after placement and compaction of the reclaimed stabilized base. (Insufficient curing time).
- DCP and FWD testing need to be performed at the same time, conditions, and locations for a suitable comparison.
- DCP is unlikely to be a reasonable tool to evaluate M_R for a cement stabilization since expected values are above the useful range of DCP.
- DCP could potentially be used to evaluate M_R of asphalt emulsion stabilizations, but additional testing is required. The outline of a suggested testing program has been provided.

Key Takeaways:

- Use of DCP in a performance based specification for a reclaimed stabilized base may be impractical.
- For VTrans purposes, DCP use may be better suited to the characterization of existing unbound base, subbase, and subgrade materials at the design level.

Questions?