Revision of the South African Pavement Design Method

SAPDM: Intelligent Compaction

RPF, Pretoria
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R Leyland

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Introduction

- Intelligent Compaction (IC):
  - Compaction of road materials using rollers equipped with an in-situ measurement & feedback control system
  - GPS based mapping & GIS incorporated
- Allows:
  - Real-time corrections
  - Continuous record of roller passes
  - Roller-generated material stiffness measurements
  - Precise location of the roller
- Specifications:
  - Germany, Austria, Sweden
  - ISSMGE
  - Minnesota
  - NHCRP proposals

Objectives

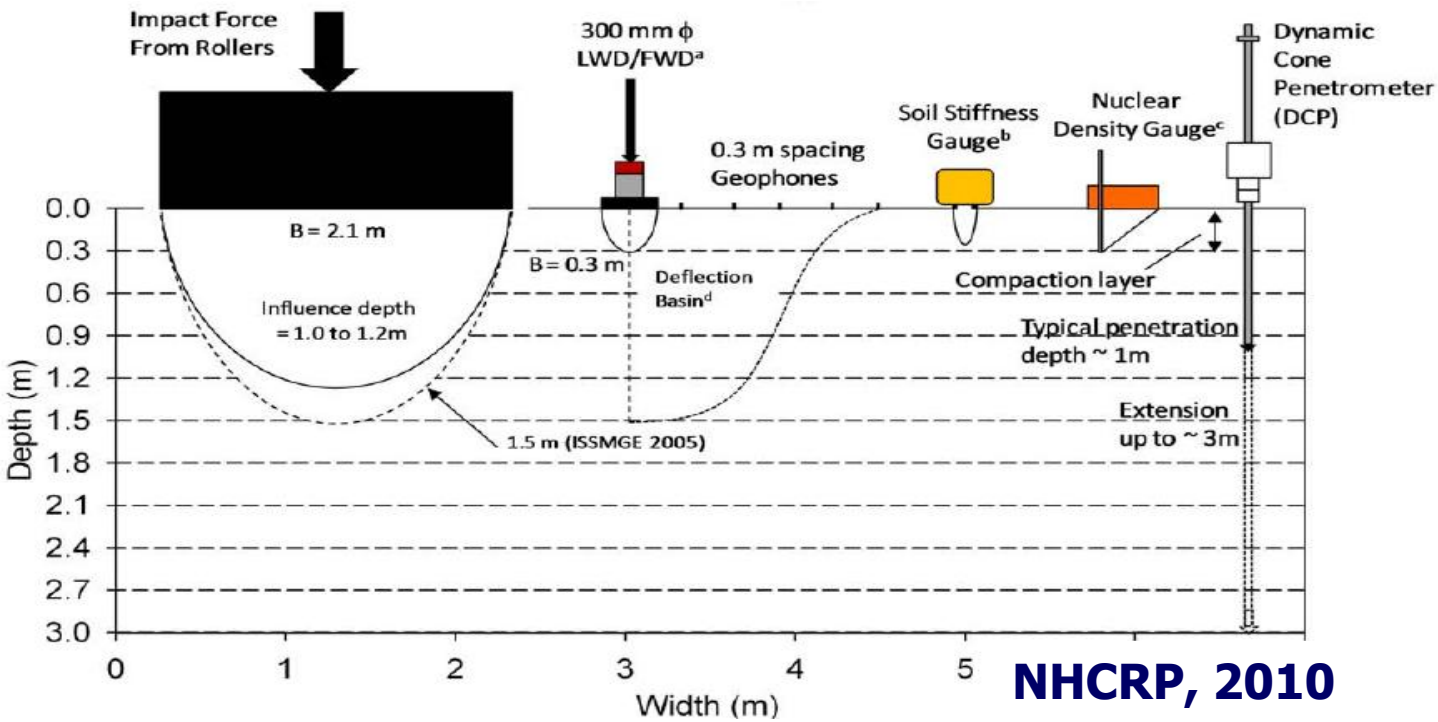
- Investigate correlations between:
  - Different roller Measurement Values (MVs)
  - MVs & traditional acceptance tests
  - MVs & future acceptance tests
  - Statistical evaluation of compaction quality & uniformity
- Develop IC specifications & QC/QA procedures

Literature

- Definitions differ on what IC is:
  - Relative vs absolute testing systems
  - Adapts process (continuous compaction control)
  - Records info
  - GPS/GIS
- Effects on measurements
  - Relative stiffness
  - Moisture
  - Stress dependant moduli
  - Drum behaviour

Literature

- Depth of influence
  - 2 ton = 0.4-0.6 m
  - 10 ton = 0.6-1 m
  - >12 ton = 0.8- ? m



NHCRP, 2010

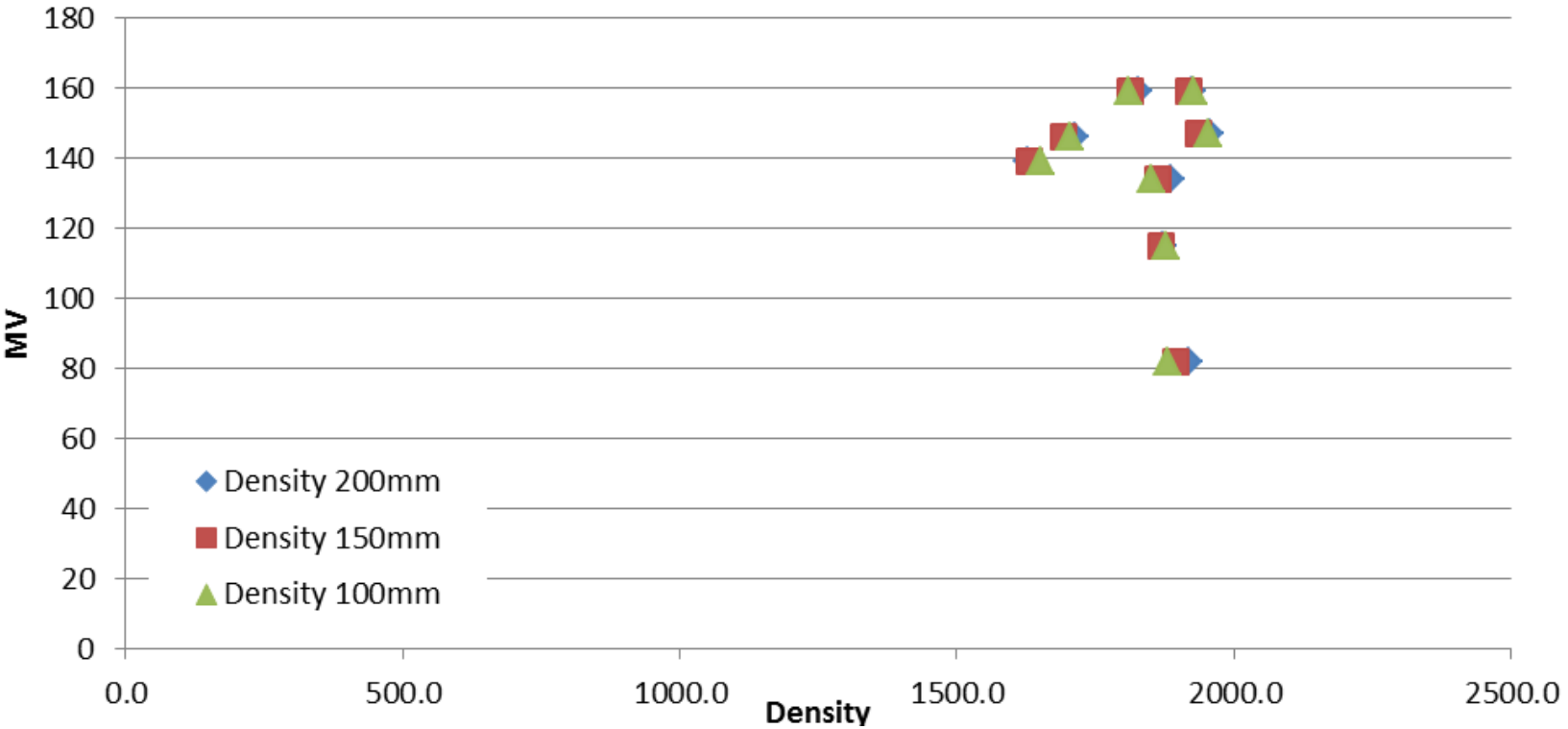
Literature

- Correlations
  - "…possible if the compacted layer is underlain by relatively homogeneous and stiff supporting layers" NHCRP (2010)
- Compaction curves
  - Repeated compaction and "decompaction" after approaching the maximum values (NHCRP, 2010)
- Inconsistent relationships
- Practical issues
  - Speed
  - Averaging by software

Rollers

Manufacturer	Static mass (ton)	IC system
BOMAG	14.9	BCM 05+GPS – V 3.0.2098.1
CAT	19	GCS 900
Hamm	19.8	HCQ 900 0057/ Soil version

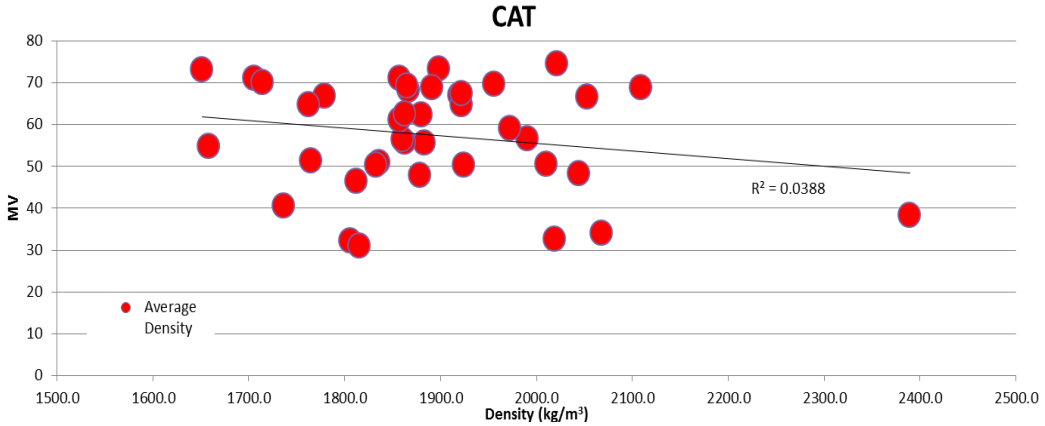
South bound results

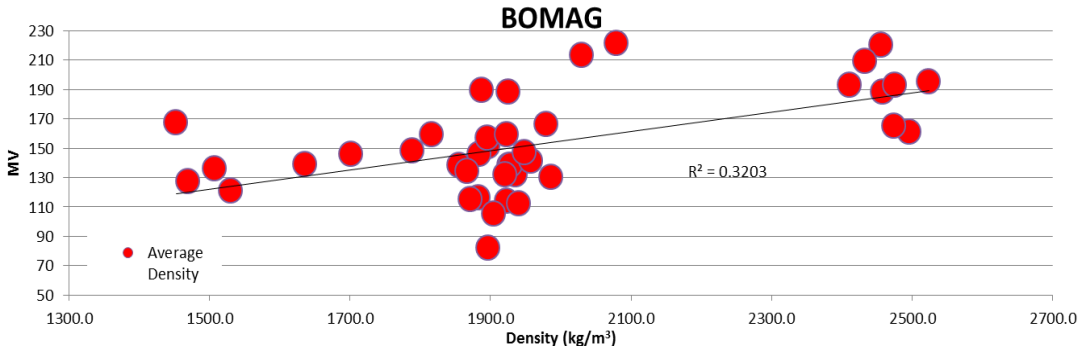


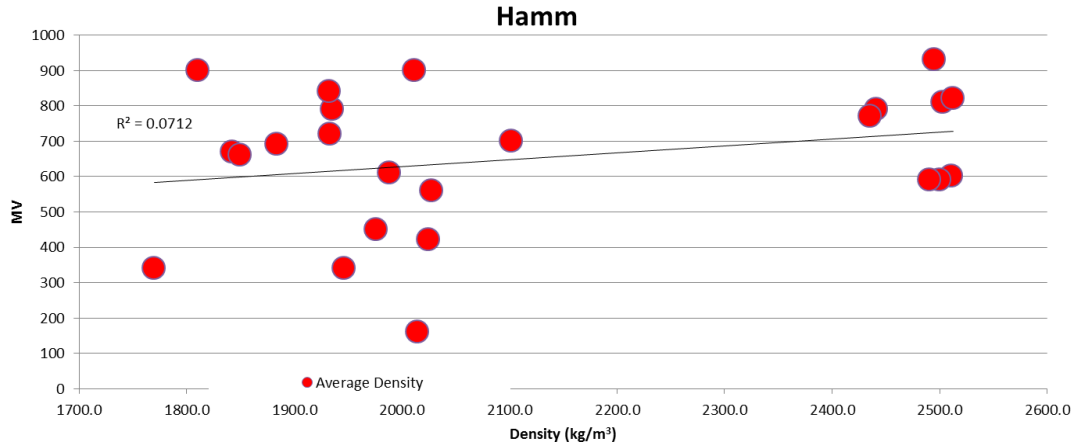
South bound results

- Correlating different MVs
  - Very unstable
  - "Decompaction"
  - Abandoned
- Density vs. MV
  - No correlation
- DCP (DN upper 200mm) vs. MV
  - No correlation
  - Abandoned
- LWD modulus vs. MV
  - Poor trends for two rollers

North bound (Density)







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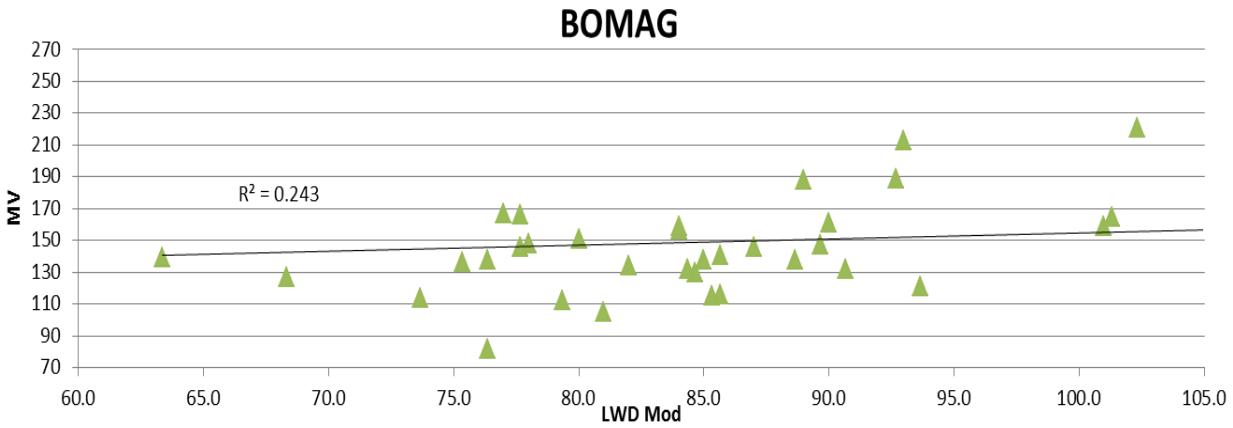
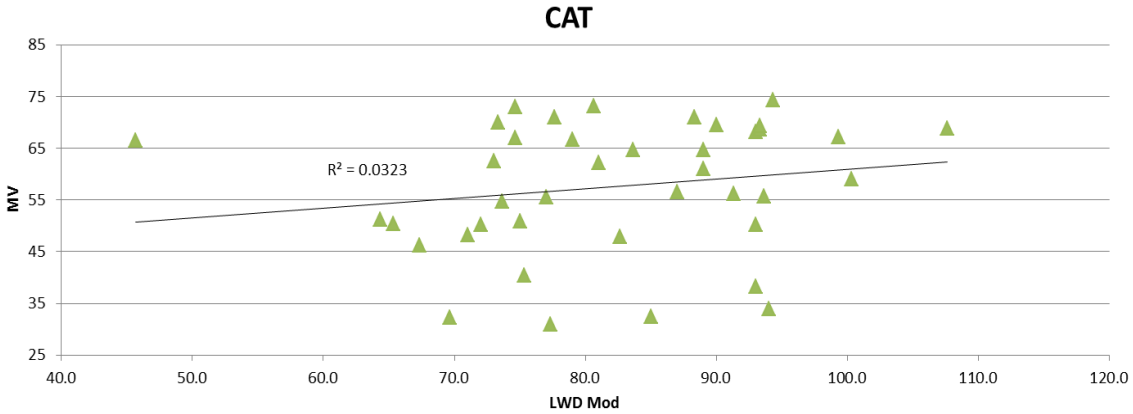
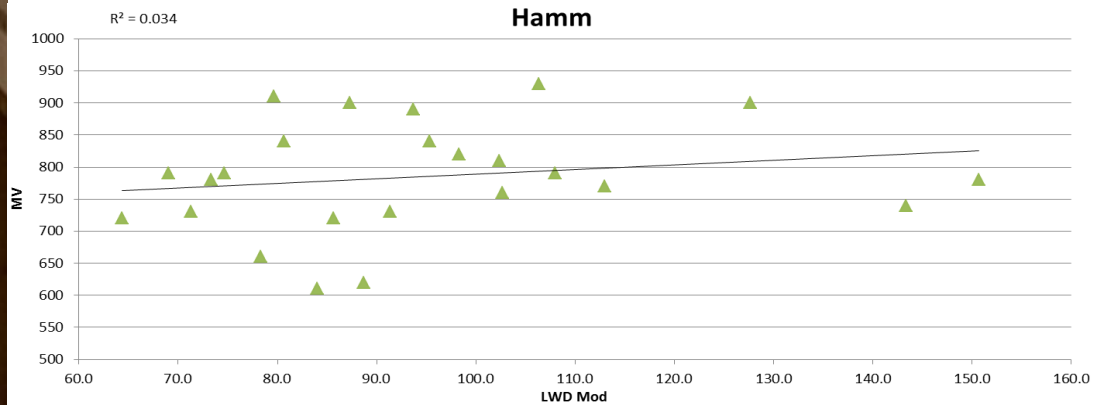
North bound (LWD)







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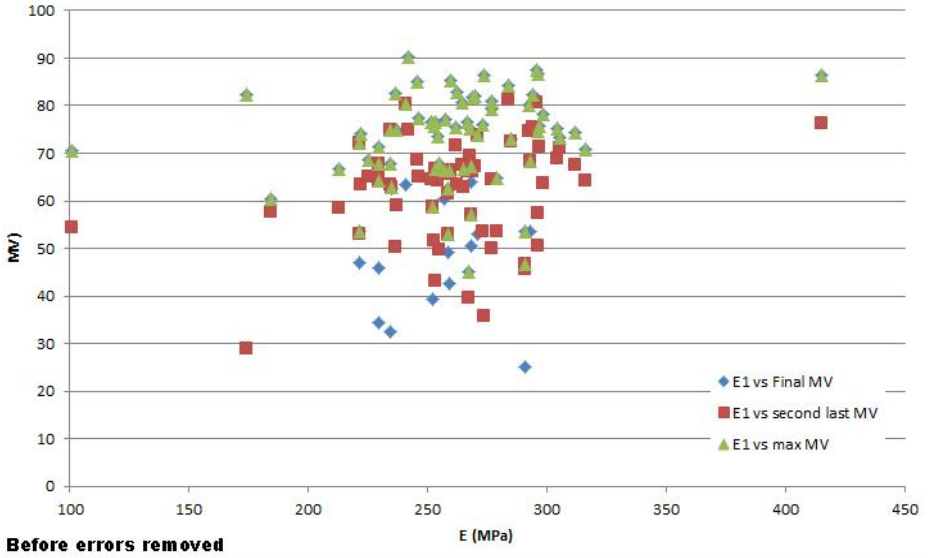
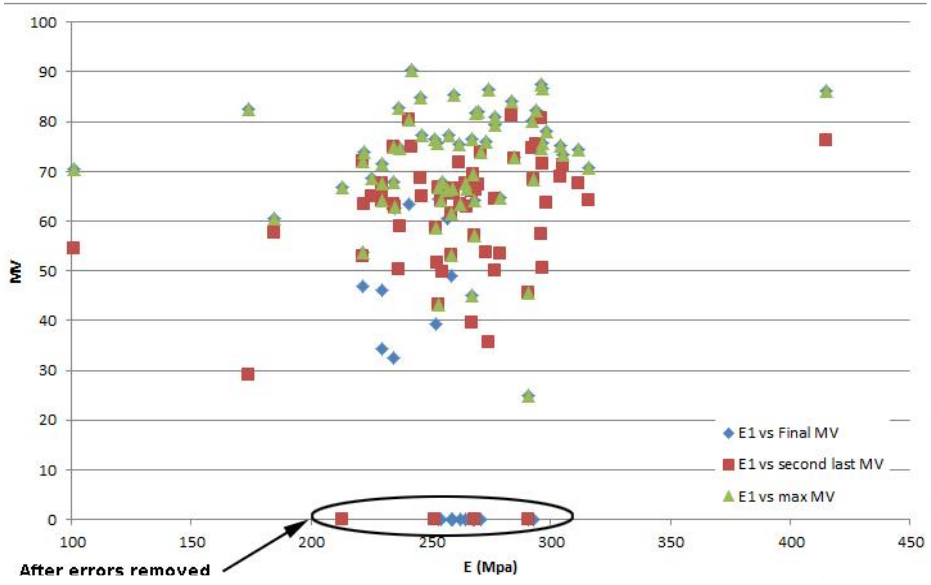
North bound (FWD)

- 3 layer FWD moduli
- Correlation plots
- Remove "bounce" measurements
- Repeat correlation plots



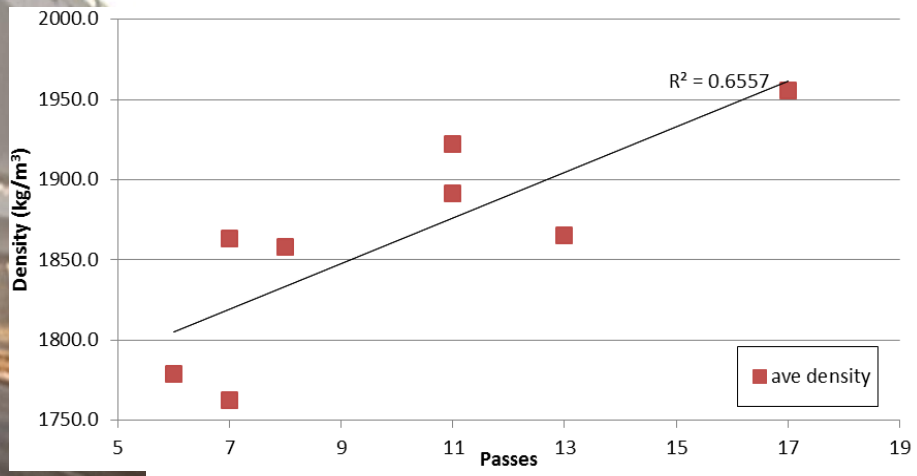
Before errors removed

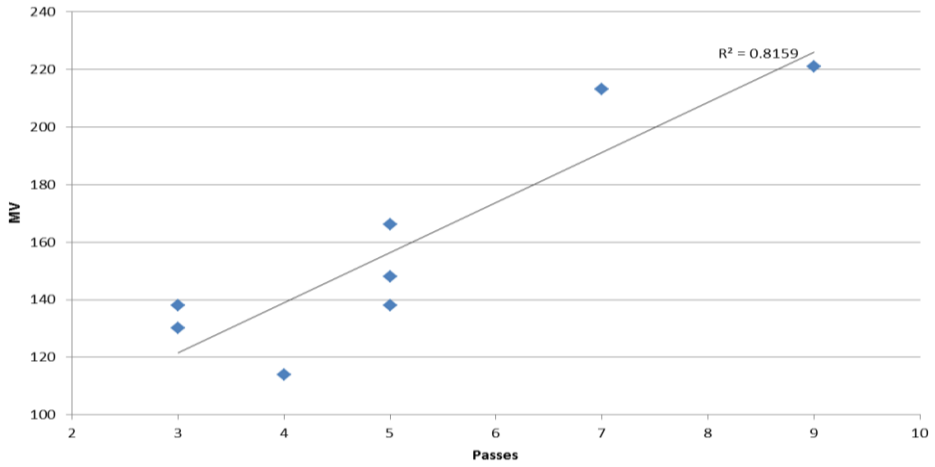


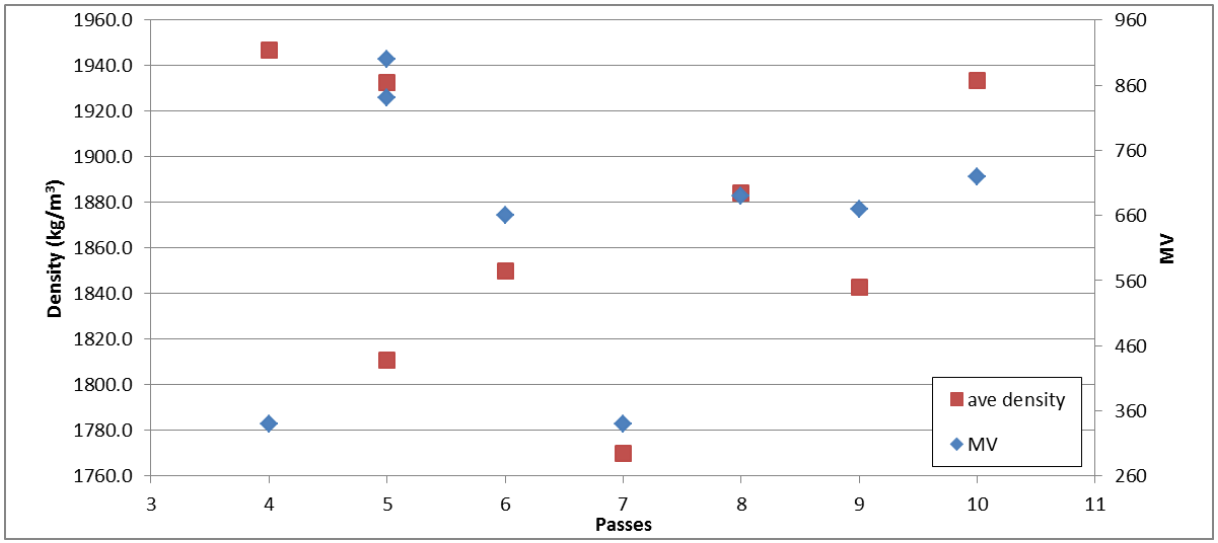
After errors removed

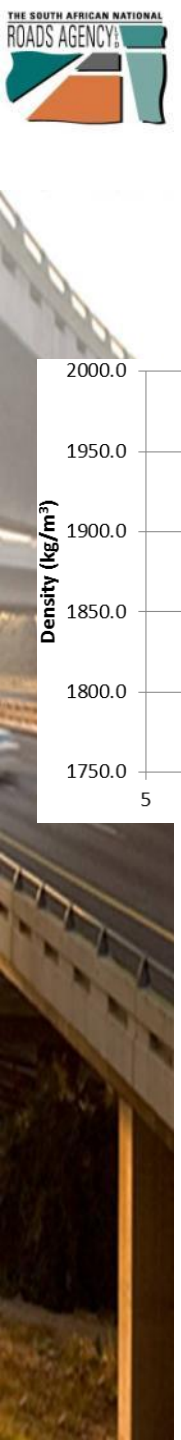
North bound (Section analysis)

- Density & MV increase with passes?









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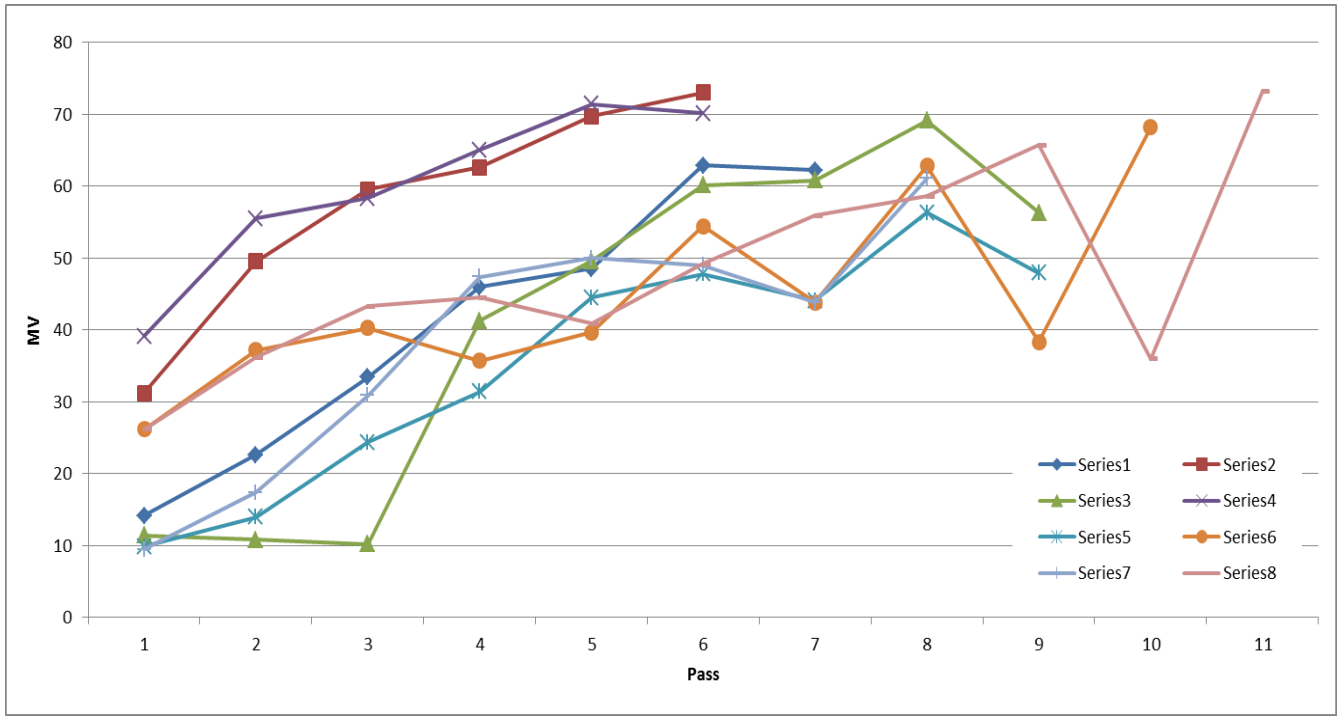
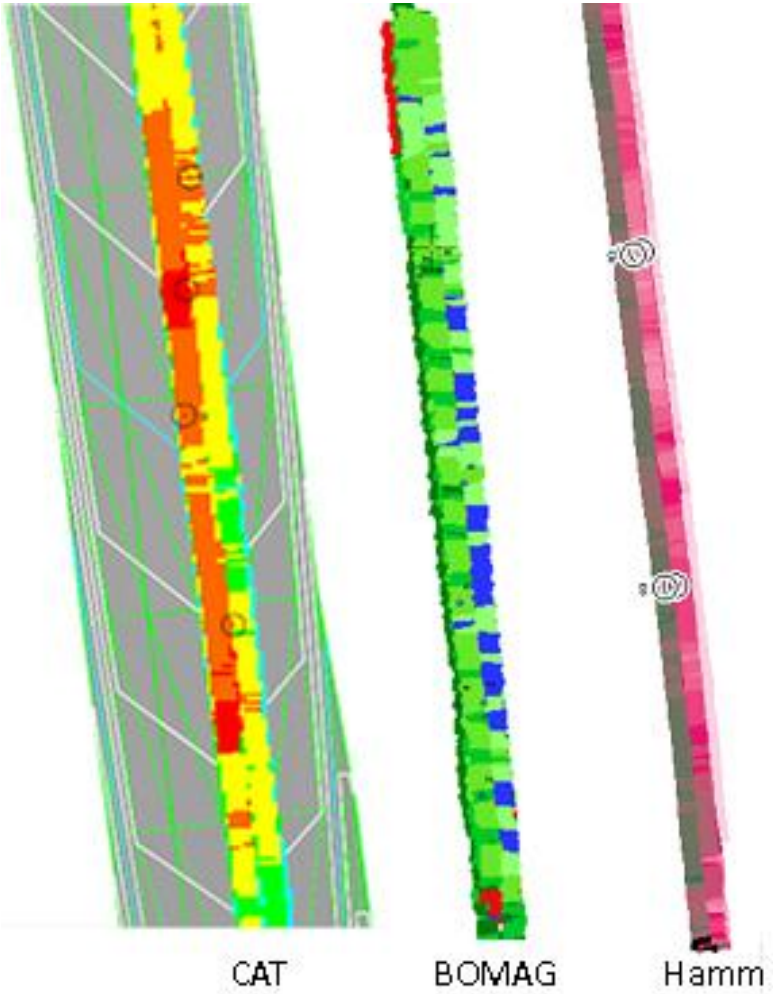
North bound (Section analysis)

- Isolated LWD modulus correlation with MV
  - $R^2 \approx 0.50 - 0.60$
- Compaction/decompaction



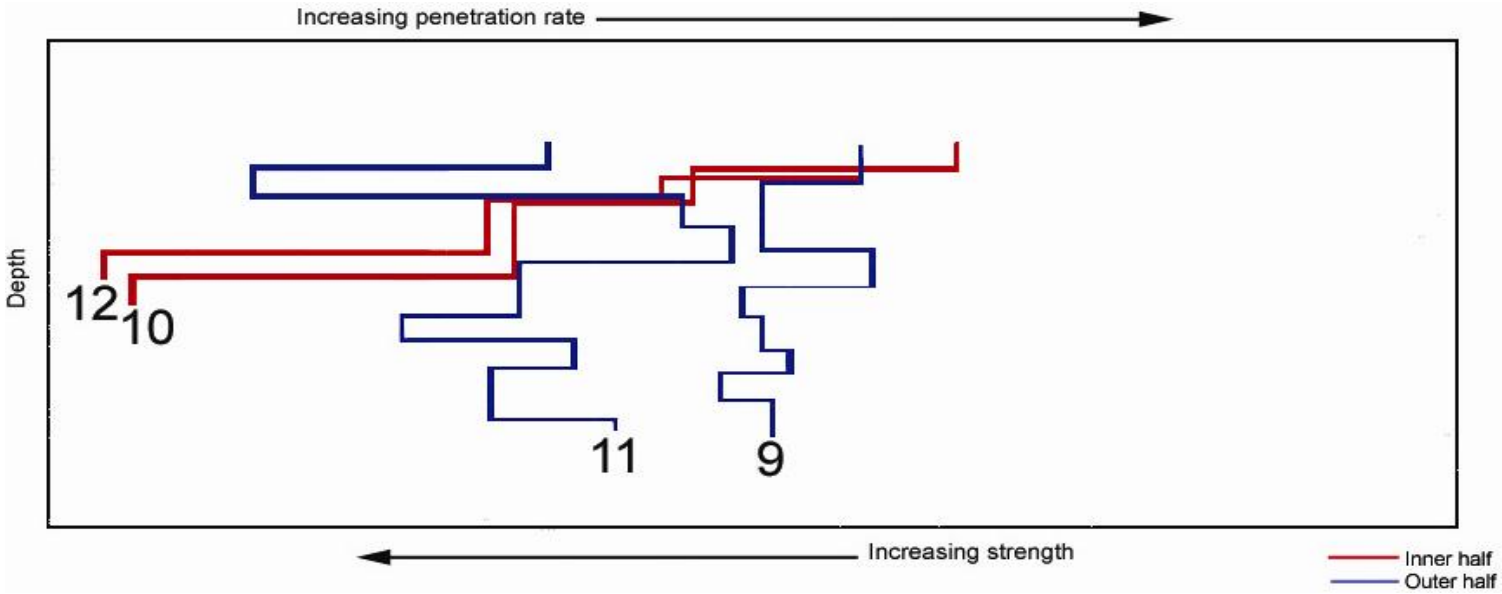
North bound (Section analysis)

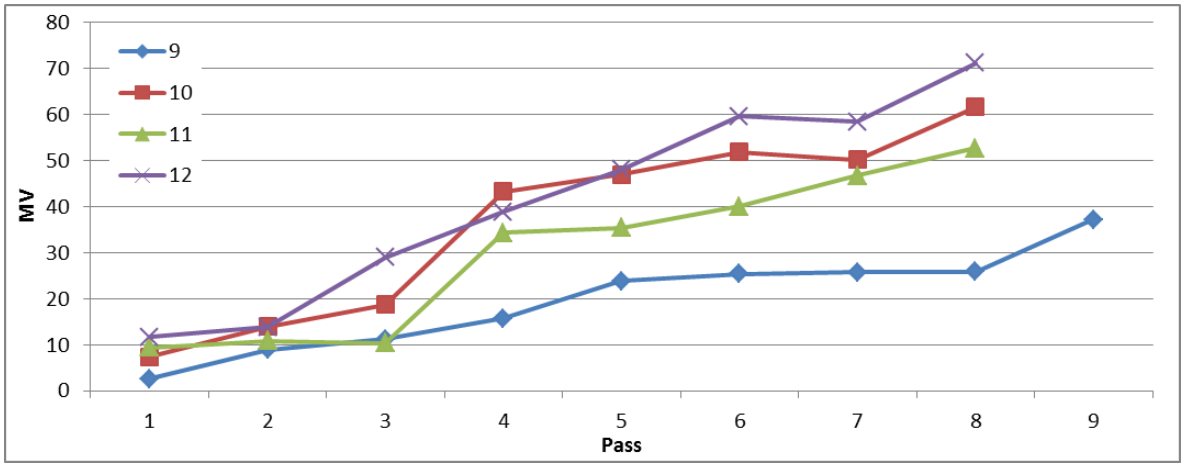
- Inner and outer half variations



North bound (Section analysis)

- Inner and outer half variations = support variations





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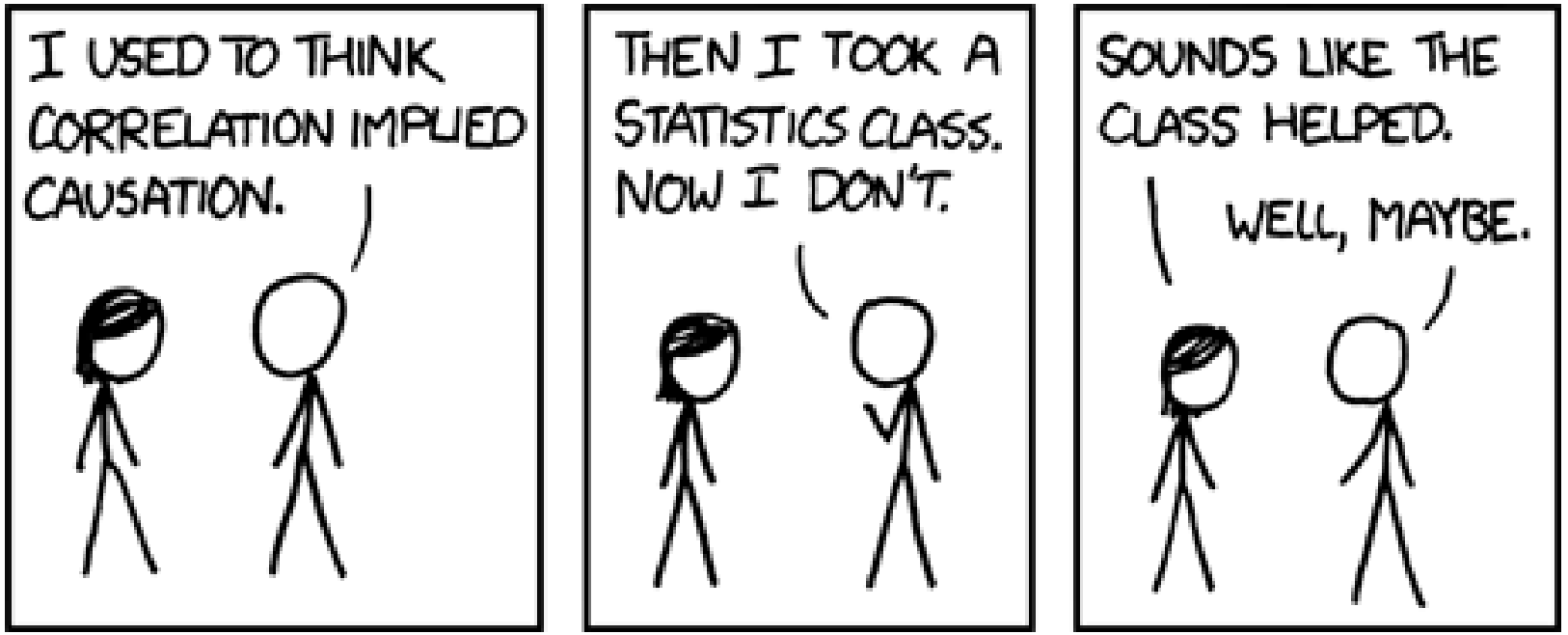
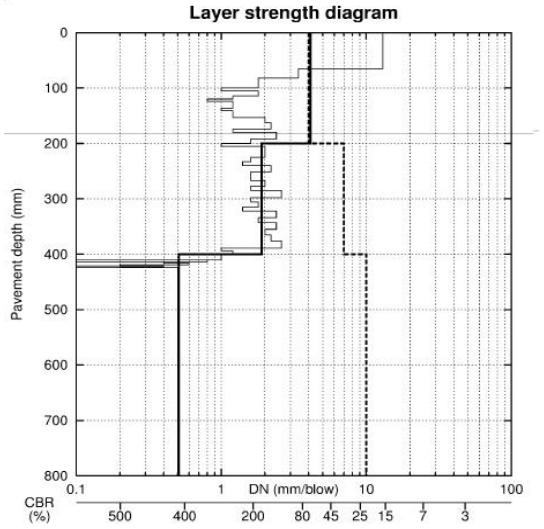
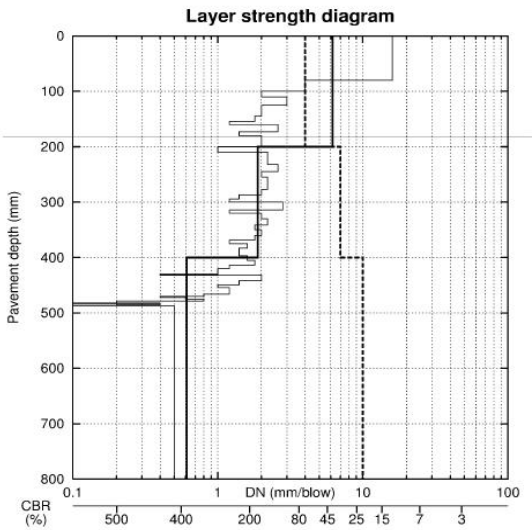


North bound (Section analysis)

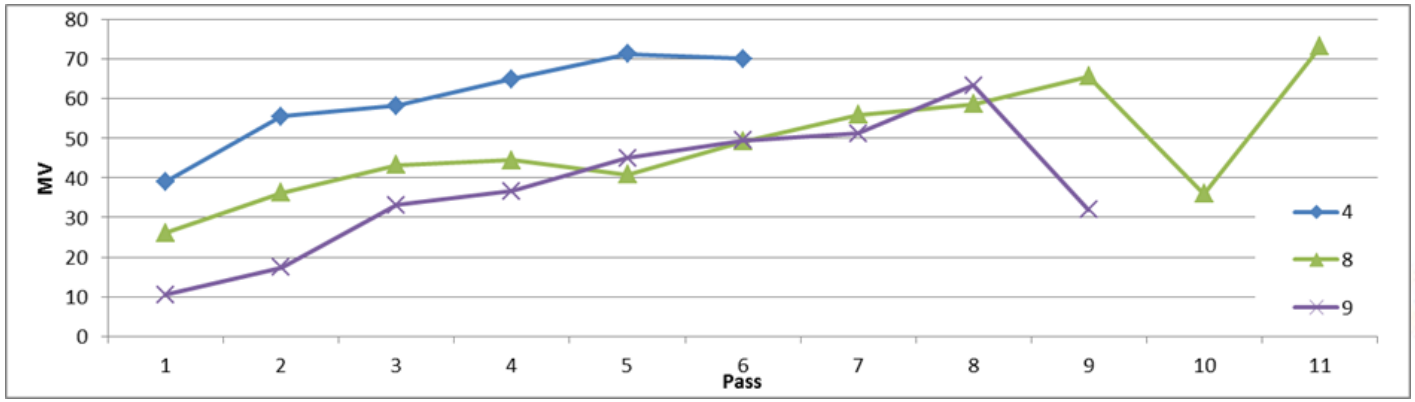
- Inner and outer half variations = curve variations



Point 8 Inner half



Point 9 Outer Poor Half



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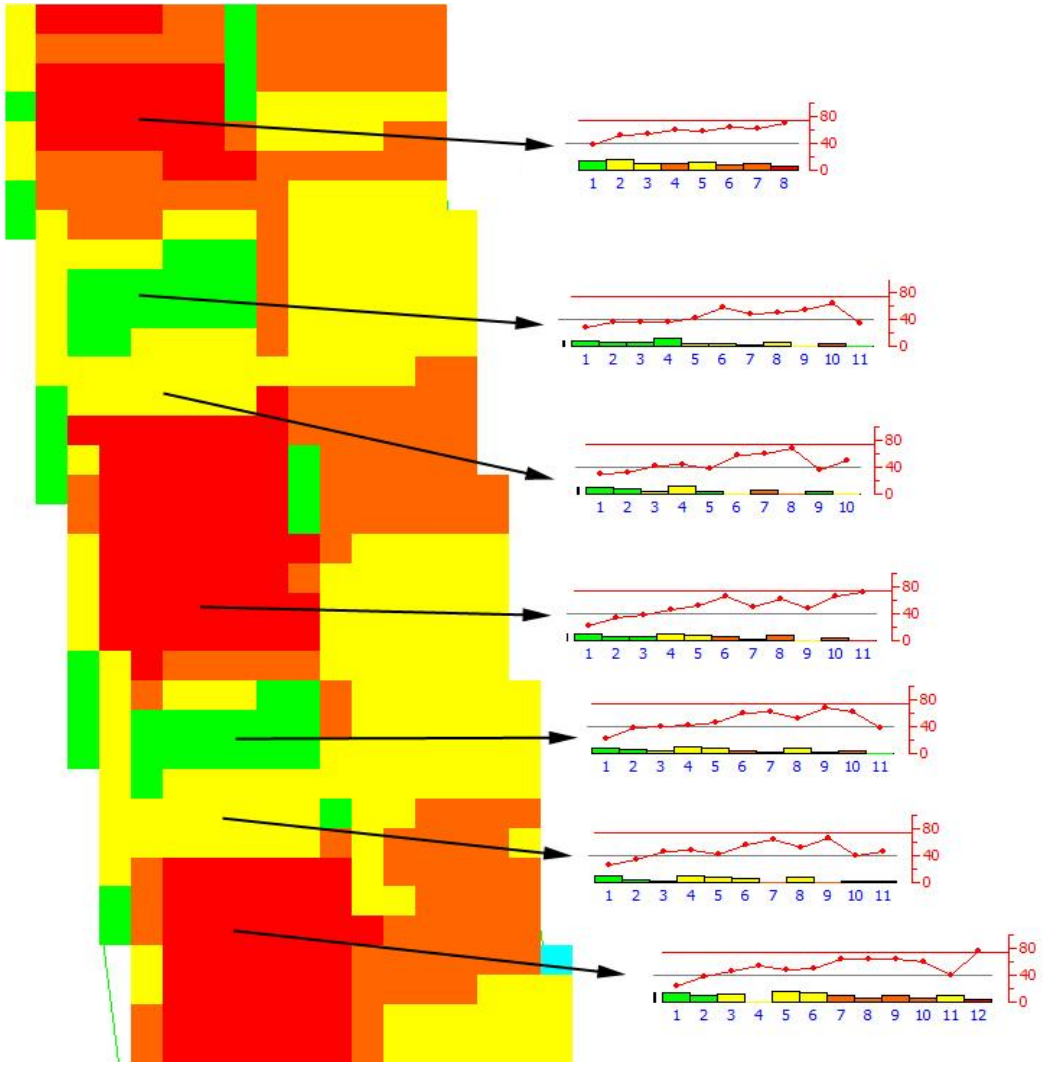
North bound (Section analysis)

- Inner and outer half variations = curve variations



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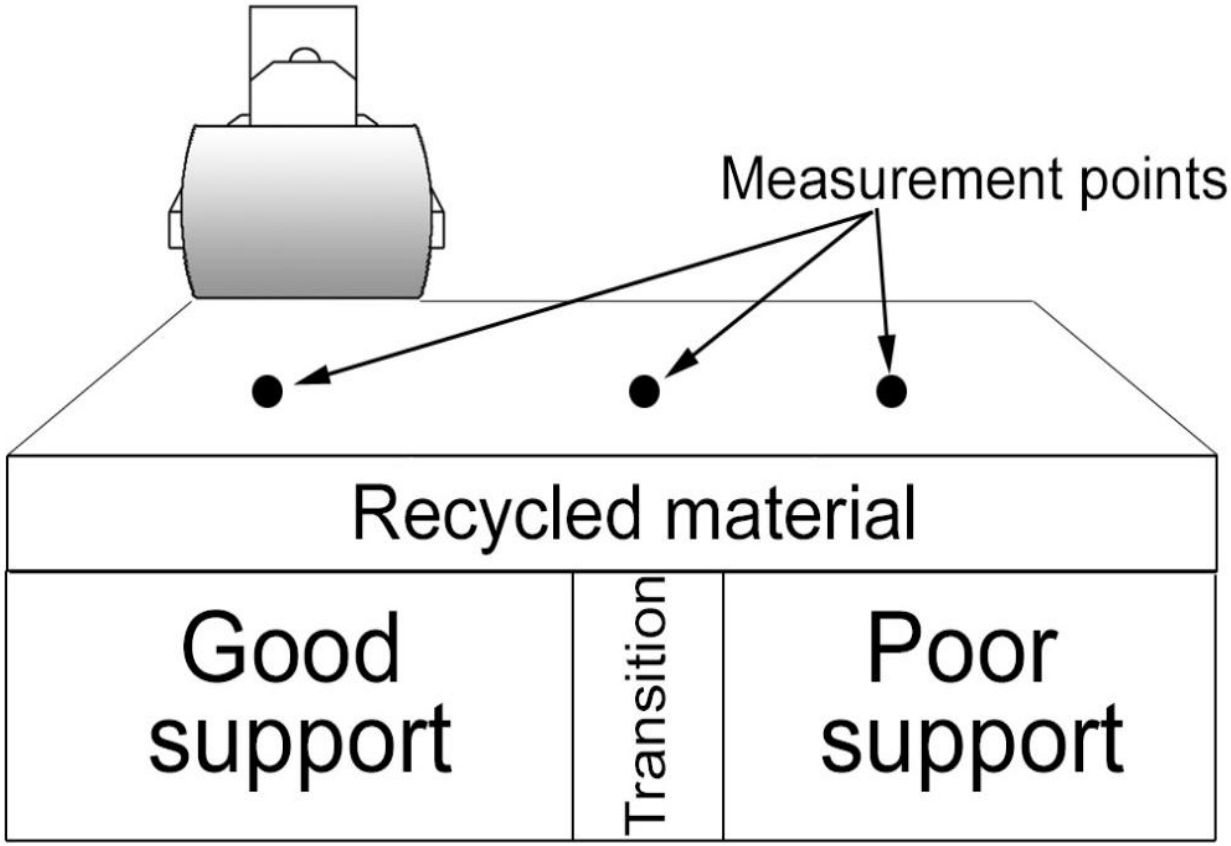
Practical considerations



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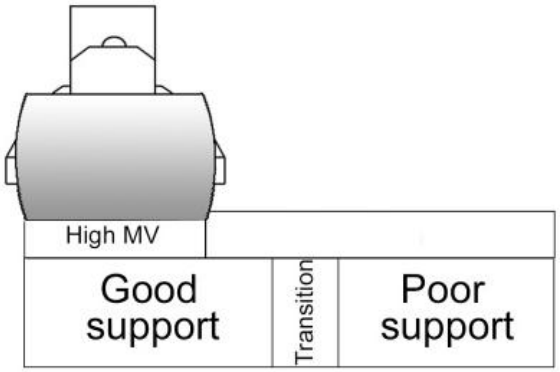

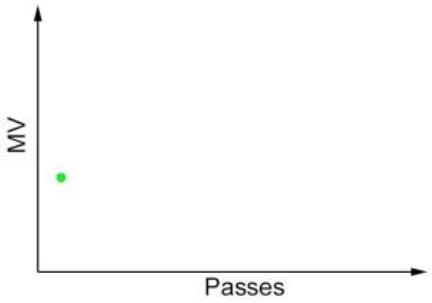

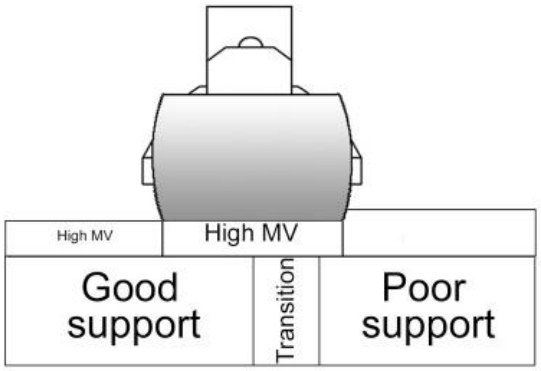

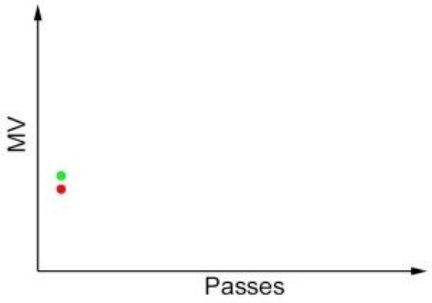

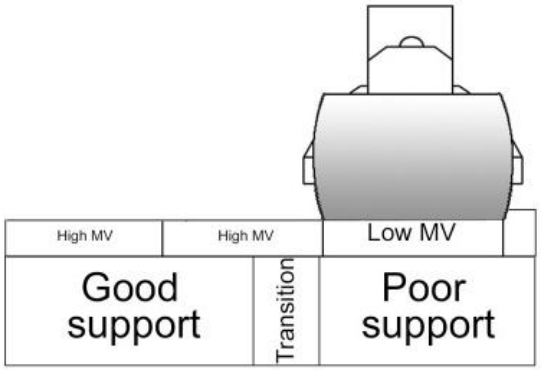

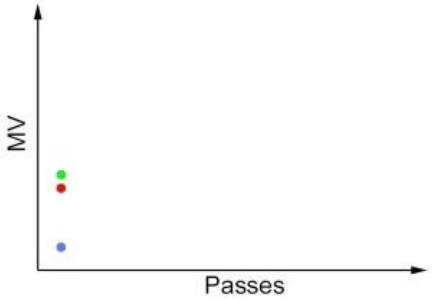

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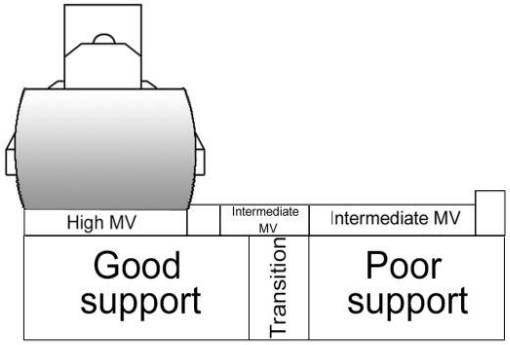
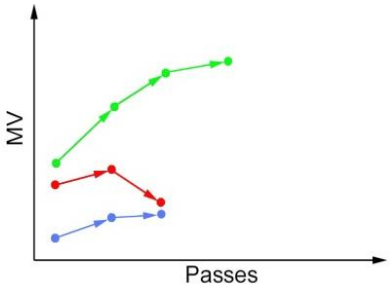
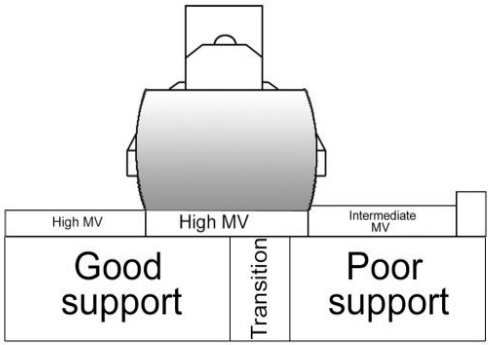
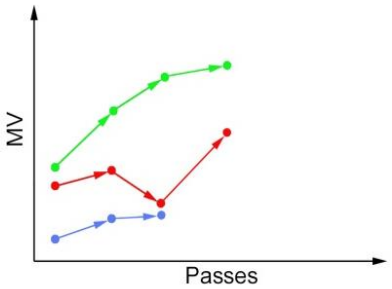
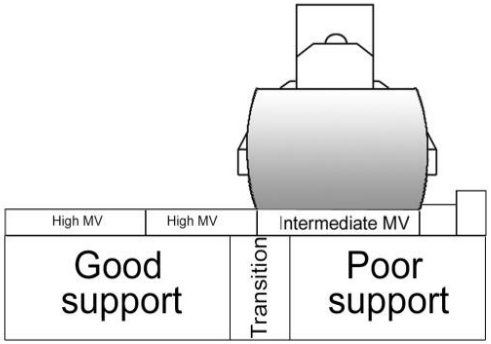
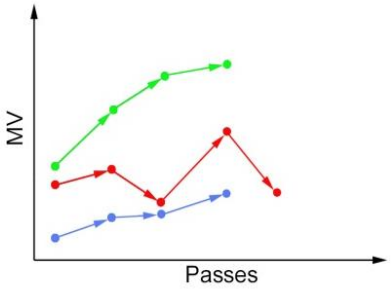






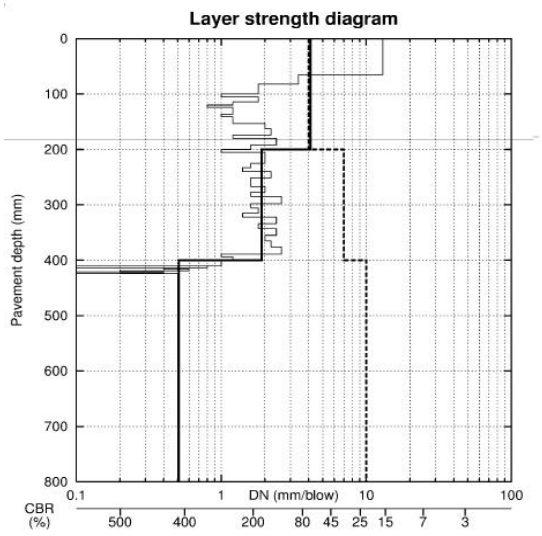


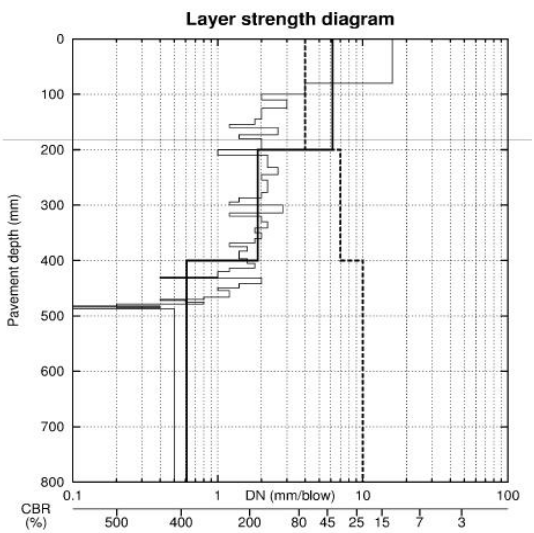


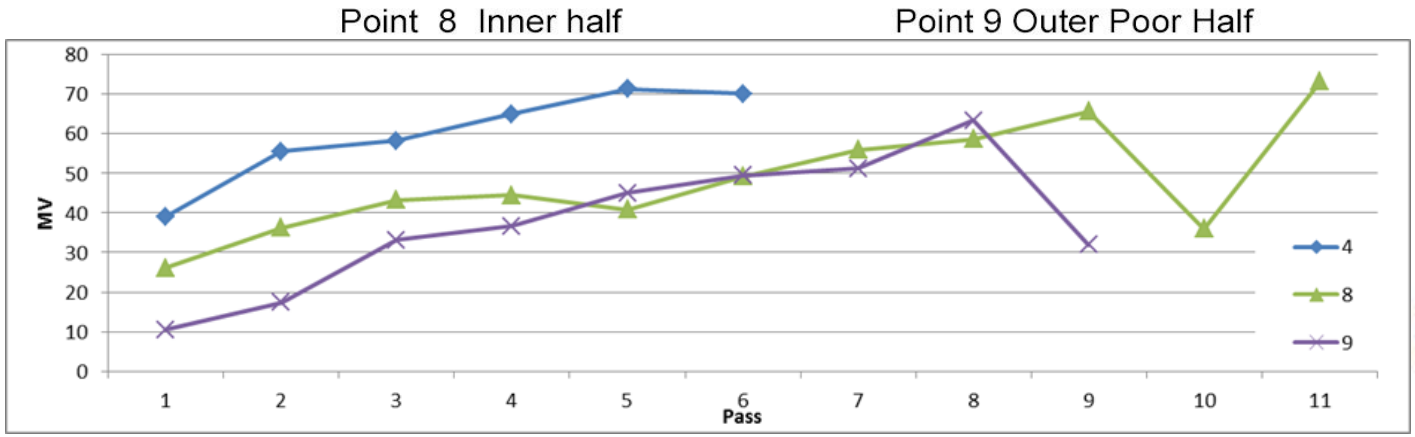


North bound (Section analysis)

- Inner and outer half variations = curve variations = bridging







Preliminary conclusions

- Nothing new
- Stress dependent modulus (Auto control!)
- Sensitivity of MVs:
  - Thin & stiffer than subgrade
  - Support layer strength is not uniform
  - German specification: homogeneous support/subgrades/embankment
  - Minnesota specification: base map
- Correlations:
  - Austrian specification: Not density only modulus

Preliminary conclusions

- Practical limitations
  - Pass overlaps
  - GPS accuracy
- QC/QA
  - Not ideal