



RECLAIMED MATERIAL FOR ROAD CONSTRUCTION

Road Pavement Forum
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INTRODUCTION

This work is in cooperation with eThekweni Municipality

For sustainability reuse assessment is required. Integral to this process is the maximum/optimum use of reclaimed material (C&D)



INTRODUCTION

Material reclaimed from construction and demolition works of buildings, roads, and bridges consists of:

17 01 concrete, bricks, tiles and ceramics (used for this research)

17 02 wood, glass and plastic

17 03 bituminous mixtures, coal tar and tarred products

17 04 metals (including their alloys)

17 05 soil (including excavated soil from contaminated sites), stones and dredging spoil

17 06 insulation materials and asbestos-containing construction materials

17 08 gypsum-based construction material

17 09 other construction and demolition waste

Material classification according to the European Waste Catalogue



PILOT PROJECT

AIM TO DEVELOP PROTOCOLS FOR:

- **deconstruction**
- **stockpiling**
- **crushing**
- **blending**
- **spreading**
- **compaction as well as to determine the material characterisation and behaviour under load**



NATAL COMMAND

Natal Command was established in 1937 and had about 70 buildings

eThekweni municipality started the deconstruction on April 2011



NATAL COMMAND

Map of Natal
Command

Chapel

White House

68 buildings demolished
Except the chapel and the White
House (main building)



DECONSTRUCTION PROTOCOL



Selective deconstruction:
remove the materials by type and separate them for reuse or recycling.



DECONSTRUCTION PROTOCOL

Walls



Floors



Masonry

Concrete

reclaimed material for
trial embakment

STOCKPILING PROTOCOL

Buildings 68 No

Deconstructed

produced

Concrete

12,390 m³

Masonry

6,086 m³



Masonry- red material



Concrete - white material

Hardstand to
avoid
contamination
Care and water
to minimise
segregation

CRUSHING PROTOCOL

The machines were set to give G2 grading:

- Woodpecker
- Screener: Atlas Copco HCS 3715
- Impact Crusher: Atlas Copco PC1060

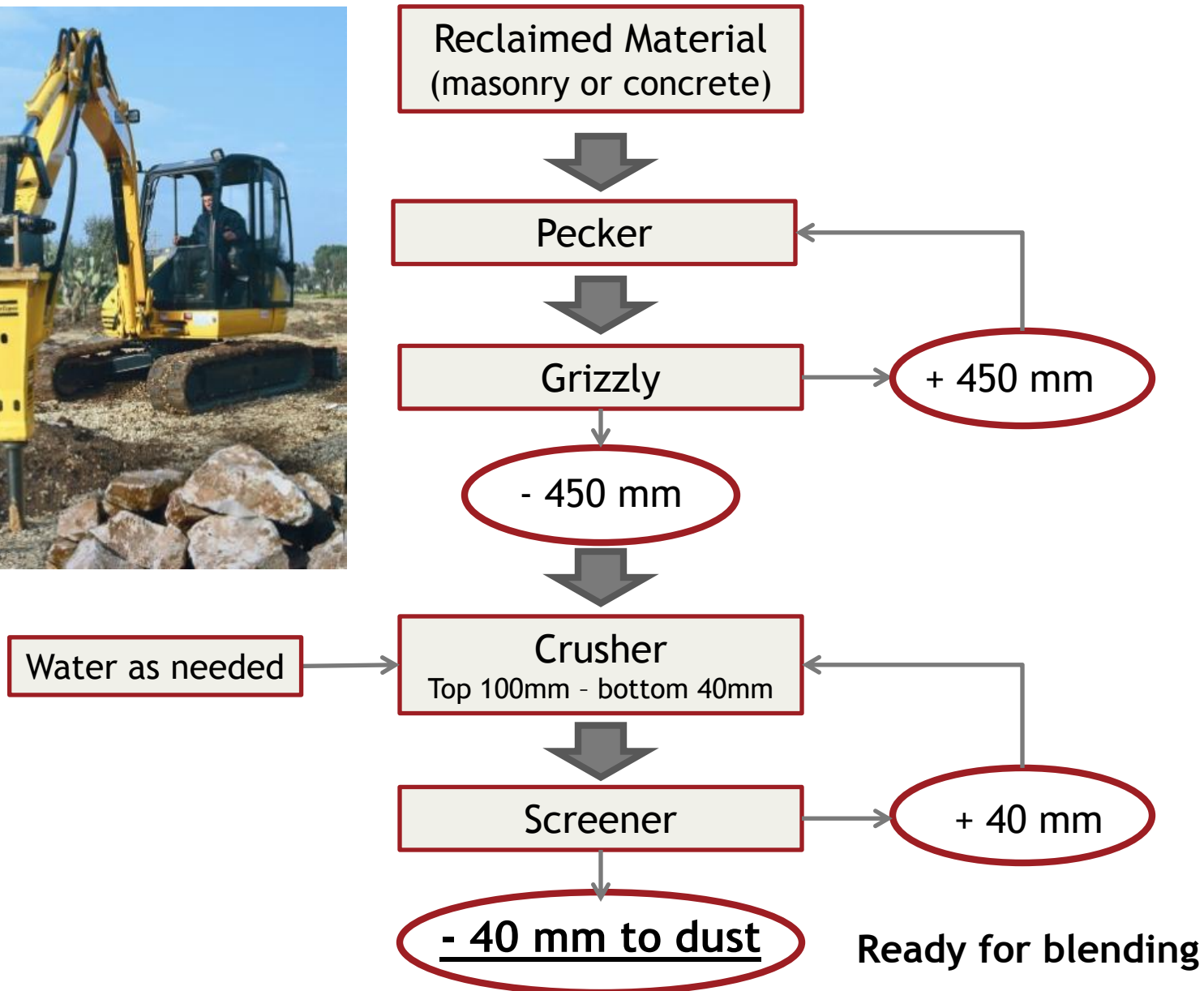


Concrete - white material



Masonry- red material

CRUSHING PROTOCOL



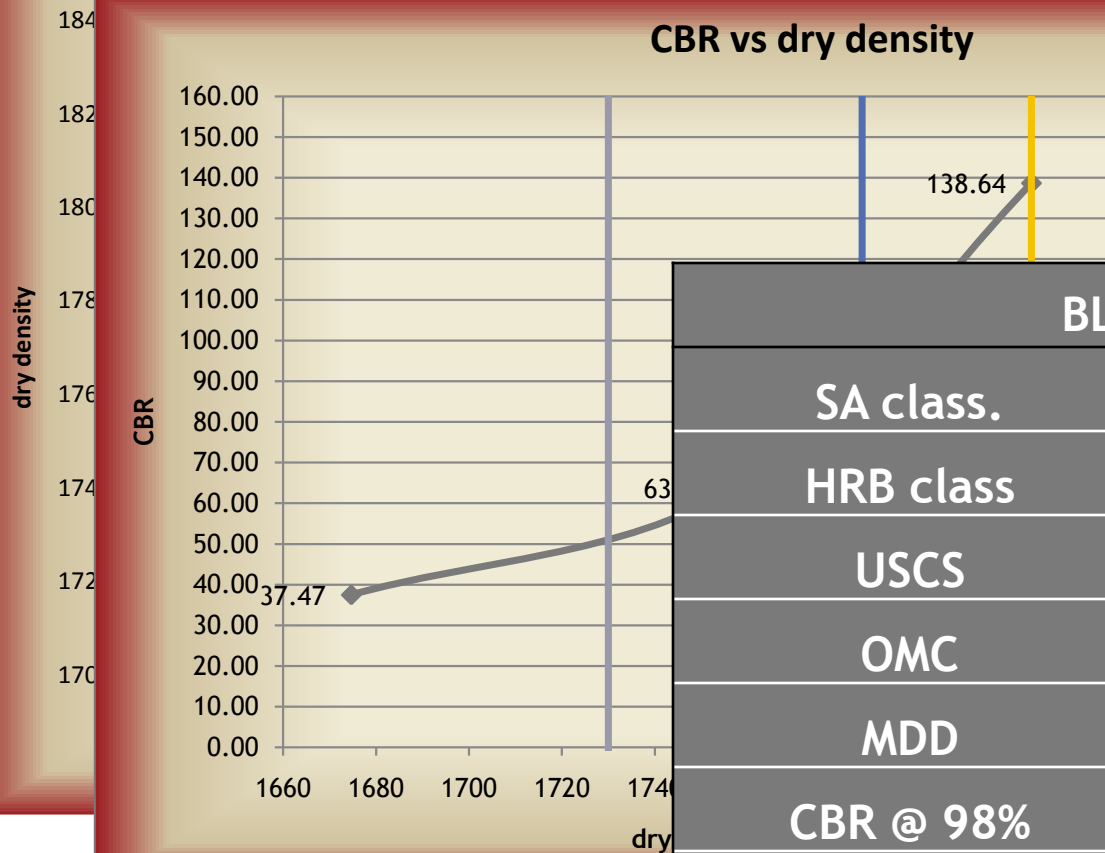
CHARACTERIZATION AND BLENDING PROTOCOL

Blend Material: 25% concrete and 75% masonry by volume

Sieve analysis

Maximum Dry Density

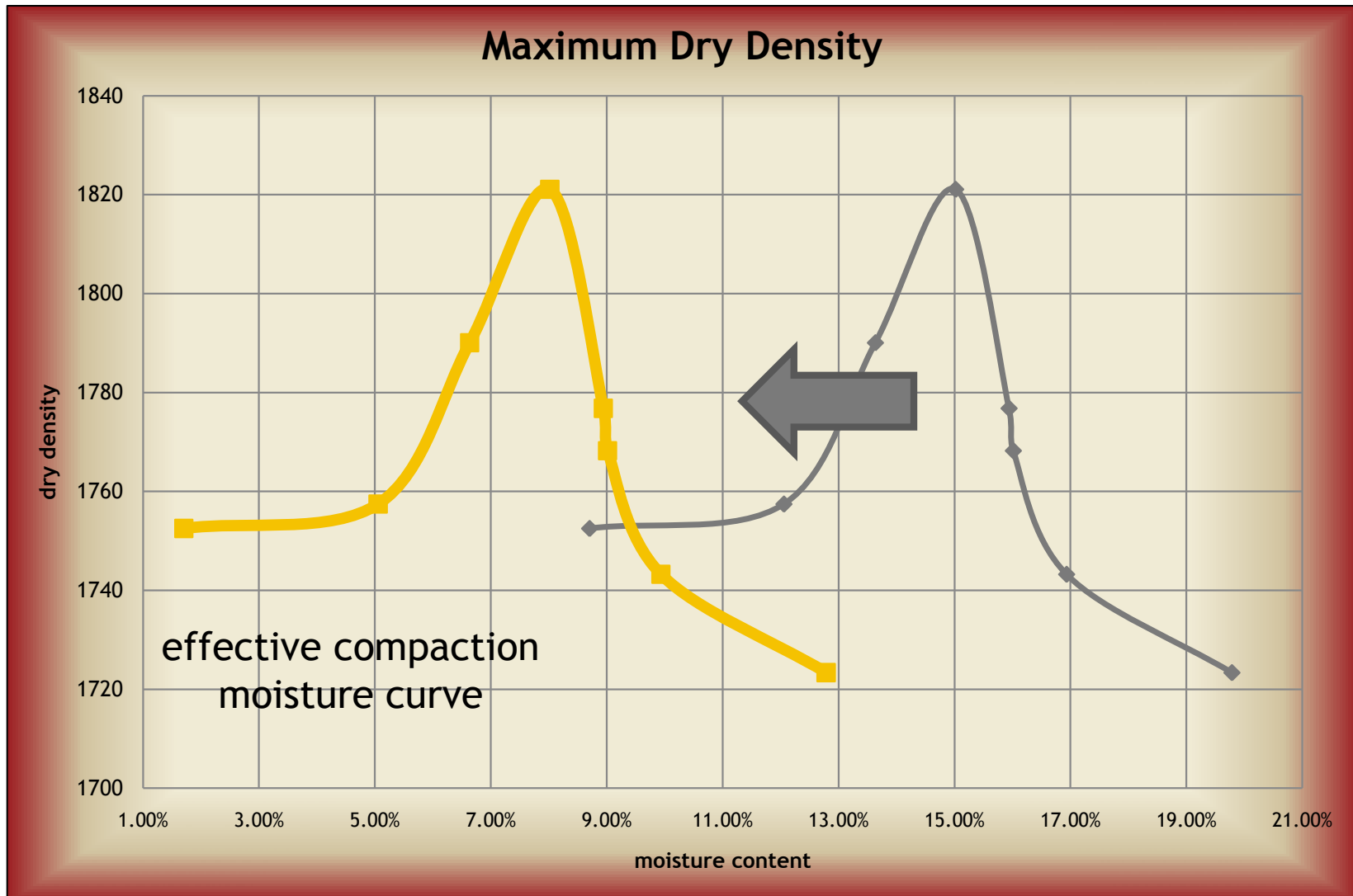
CBR vs dry density



BLEND	
SA class.	G3
HRB class	A1 a
USCS	SW
OMC	15%
MDD	1821 kg/m ³
CBR @ 98%	90
SWELL	0.008 %



CHARACTERIZATION AND BLENDING PROTOCOL



CHARACTERIZATION AND BLENDING PROTOCOL

MASONRY

CONCRETE

Los Angeles Test Abrasion (SABS 846)

$W = 55.88 \%$

$W = 35.69 \%$

BLEND MATERIAL

ACV - aggregate crushing value (TMH1 - B2)

$ACV = 25.3 \%$

TRH14: ACV max G1 and G2 29%
COLTO: depending on material between 21-30%

Relationship between 10%FACT and ACV

$ACV = 38 - 0.08 \times 10\% \text{ FACT}$ Weinert, 1980

10% FACT = 158 kN TRH14: 10%FACT dry min G1 and G2 110kN



EMBANKMENT: CONSTRUCTION

For further characterisation of the material under traffic, an instrumented trial embankment was constructed.

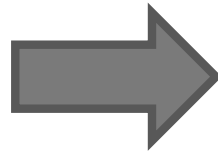
The aim was to reach at least 95% as upper selected layer or better 98% as required for G3



EMBANKMENT CONSTRUCTION PROTOCOL

Embankment:

- 50 m long
- 5 m wide
- 8.1% gradient



Layers:

- Natural Subgrade
- Stabilized soil (natural soil+reclaimed concrete)
- Pioneer 300 mm layer of blend
- 5 x 300 mm layers of blend

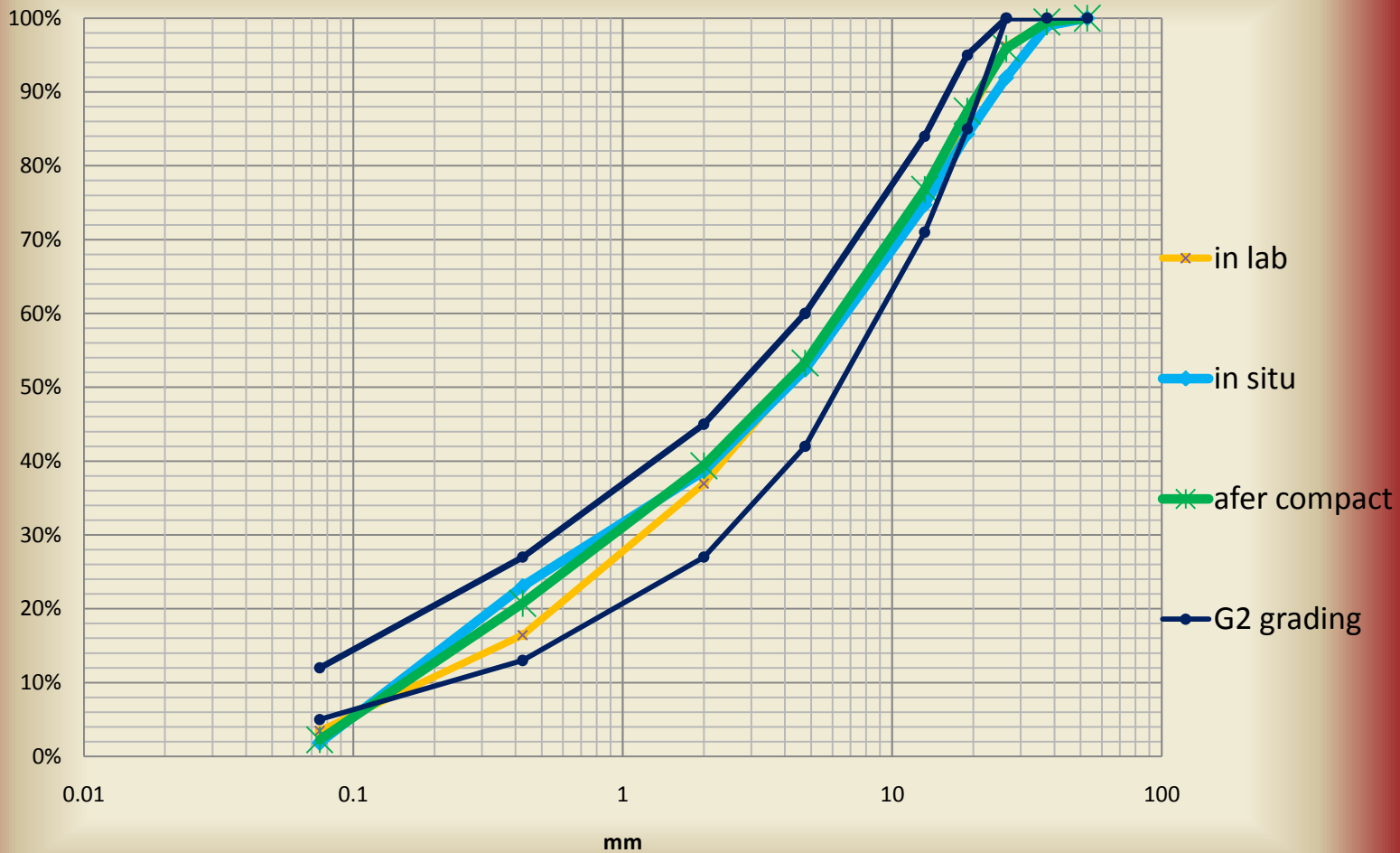
Machines used:

- Grader: Sany GR11 PQ190IIA
- Roller: Caterpillar CS-533C (smooth drum compactor)



EMBANKMENT: TESTS RESULTS

Sieve analysis Blend



EMBANKMENT: TESTS RESULTS



Nuclear Gauge Test

Date: 22/02/2012 on the 2nd layer

point	MC	DD	compact.
1	7.90%	1803 kg/m ³	99.00%
2	7.20%	1832 kg/m ³	100.60%
3	7.40%	1827 kg/m ³	100.40%

Nuclear Gauge Test

Date: 23/02/2012 on the 3rd layer

point	MC	DD	compact.
1	7.90%	1837 kg/m ³	100.90%
2	9.90%	1836 kg/m ³	100.80%
3	6.70%	1814 kg/m ³	99.60%

Nuclear Gauge Test

Date: 24/02/2012 on the 4th layer

point	MC	DD	compact.
1	9.00%	1879 kg/m ³	103.20%
2	8.70%	1814 kg/m ³	99.60%
3	9.60%	1840 kg/m ³	101.00%

Nuclear Gauge Test

Date: 27/02/2012 on the 5th layer

point	MC	DD	compact.
1	5.60%	1722 kg/m ³	94.60%
2	4.90%	1796 kg/m ³	98.60%
3	6.00%	1825 kg/m ³	100.20%

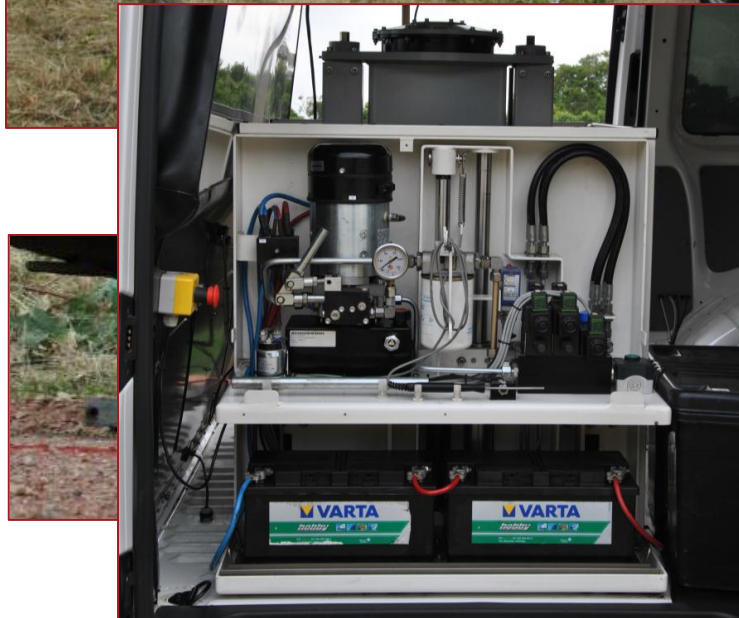
it was raining during the night

MDD: 1821 kg \m³



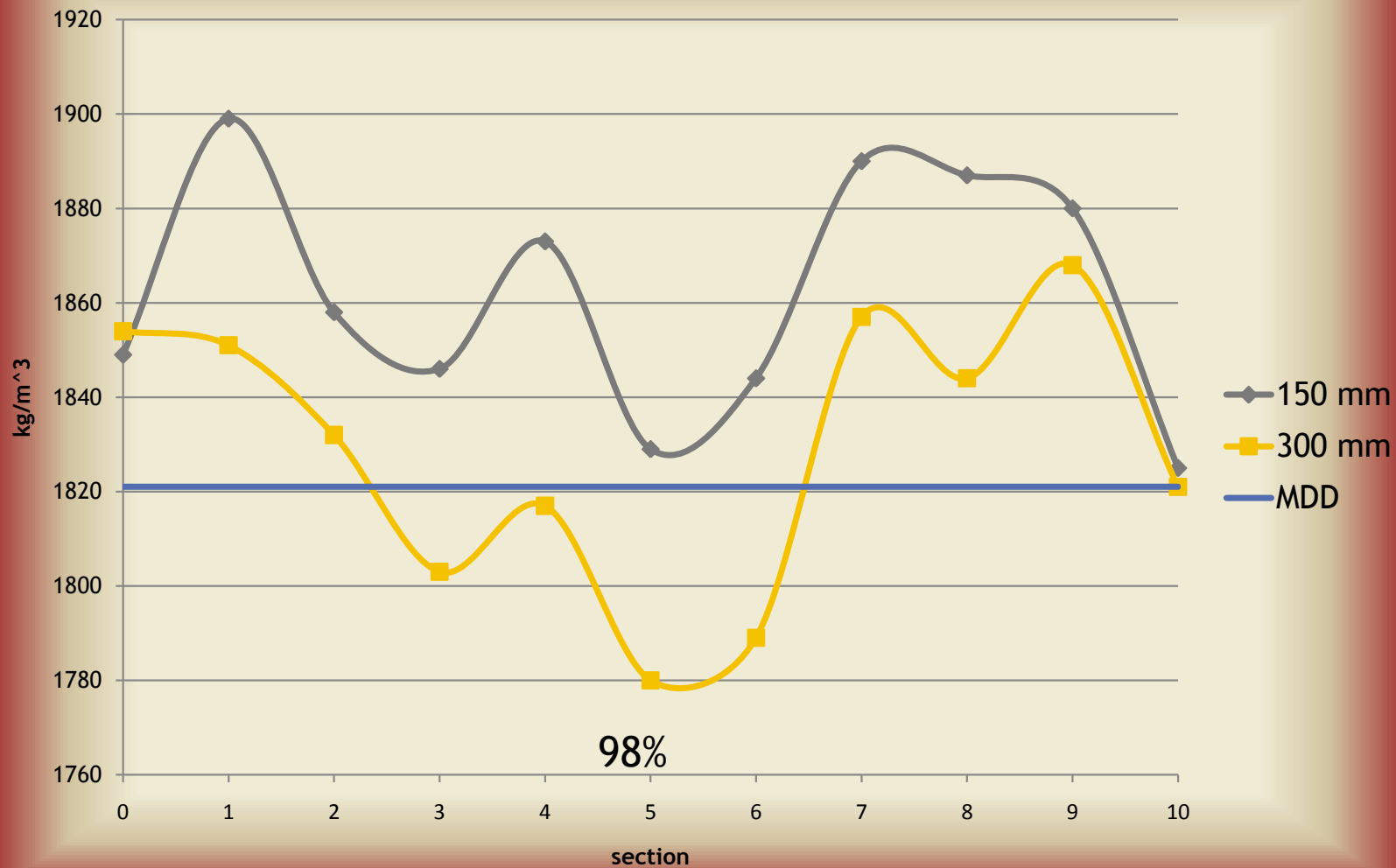
EMBANKMENT: TESTS RESULTS

VNA carried out FWD test with high technology instrumentation



EMBANKMENT: TESTS RESULTS

Dry Density along the centre line



EMBANKMENT: INSTRUMENTATION

3 groups of instruments at 3 different depths (900mm, 600mm, 300mm)

- Modified LVDTs (displacement)
- Pressure cells (vertical pressure)
- TDRs (moisture)
- Thermocouples (temperature)



EMBANKMENT: INSTRUMENTATION PLACEMENT

-300 mm

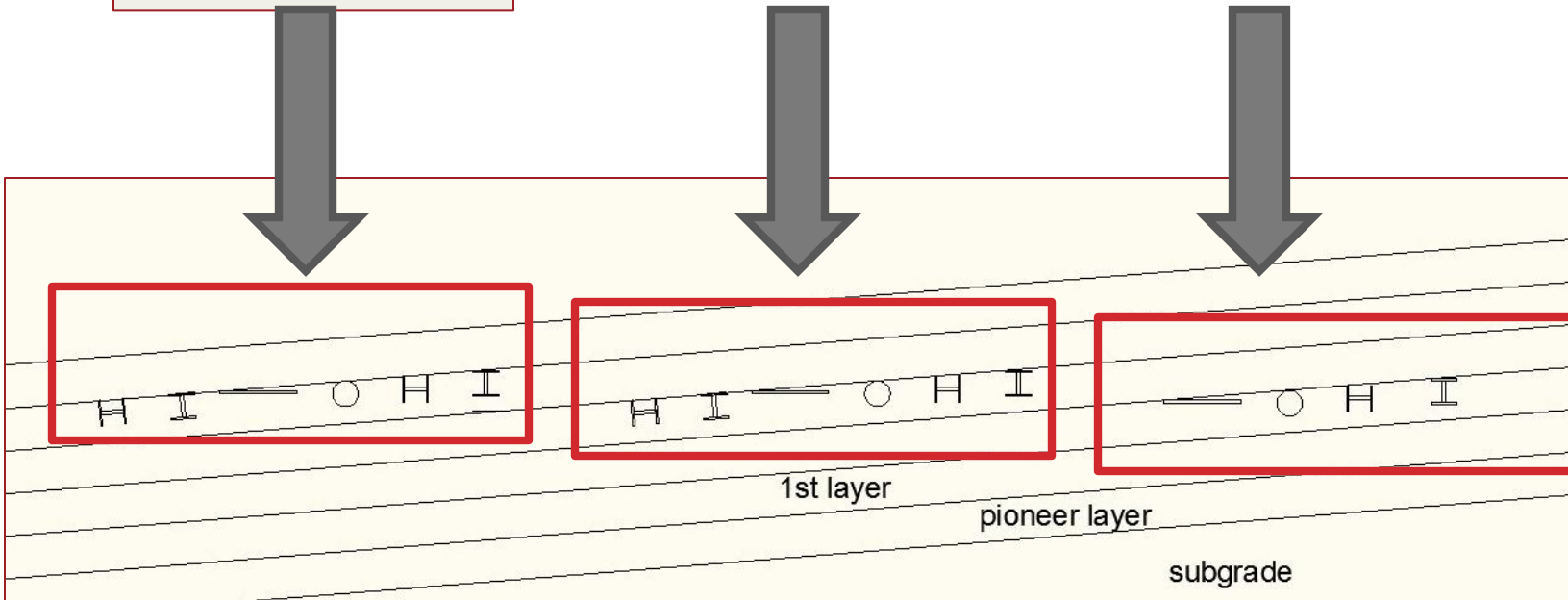
5 LVDTs
1 pressure cell
1 TDR
2 thermocouples

-600 mm

5 LVDTs
1 pressure cell
1 TDR

-900 mm

3 LVDTs
1 pressure cell
1 TDR



EMBANKMENT: INSTRUMENTATION INSTALLATION



EMBANKMENT: DATA COLLECTION



Data Acquisition System (Mccdaq):

- Daqbook 2020 (main module)
- 2 modules DBK 65 (pressure cells and LVDTs)
- DBK7 (TDRs)

Weather condition:

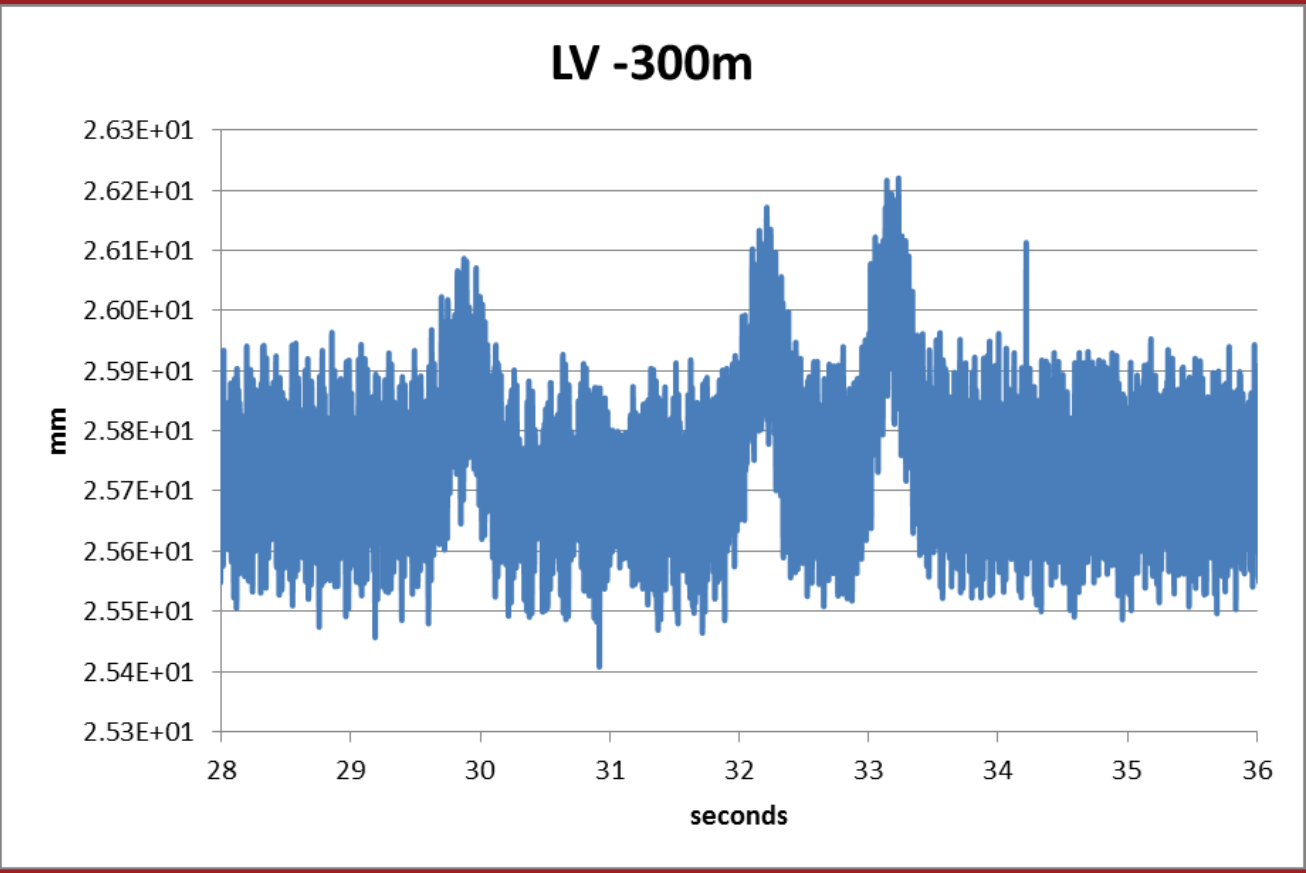
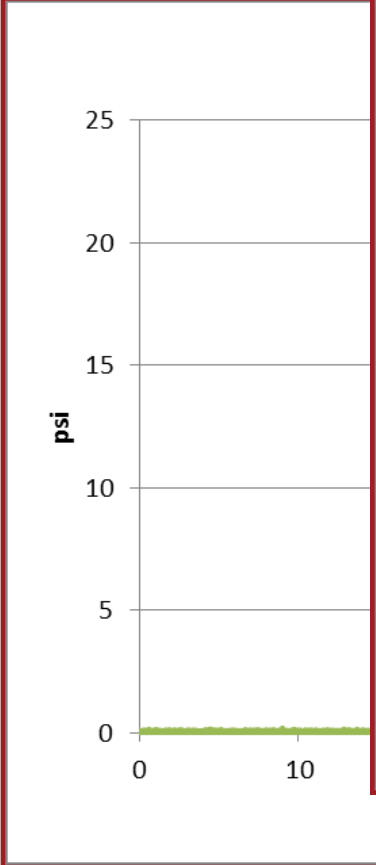
- Temperature
- Precipitation

Truck data:

- Load
- Tyre pressure



INSTRUMENTATION INITIAL READINGS



CONCLUSIONS

- Recycling/reclamation reduces landfill airspace
- Processed, reclaimed material is excellent base/subbase
- Further experience needed due to heterogeneity of material



FURTHER DEVELOPMENT

- Accurate characterisation of load carrying capacity by backanalysis using instrumentation data.
- Other blends, increasing or decreasing concrete effects on characterization
- Further development/refinement of protocols
- Investigation of variability of reclaimed materials and
- Development of quality assurance protocols



THANKS FOR YOUR ATTENTION AND TO:

