

# INSTRUMENTATION

HVSIA MEETING

2006



# Content

- Gautrans instrumentation project outcomes
- Wireless instrumentation
- PSPA study

# Gautrans instrumentation project outcomes

- Regular evaluation of current instrumentation
- Evaluate
  - Parameters to be observed
  - Appropriate instruments
  - Appropriate data analysis and use

# Phase 1 – Parameters

- Objective to identify parameters to be monitored
- Evaluated, agreed and continued with selection of appropriate instruments – 2005 HVSIA

# Phases 2 and 3

- Phase 2: Evaluation of current and new instruments to meet needs
  - Model list of instrumentation for APT and LTPP experiments, listing instruments used both locally and internationally
- Phase 3: Recommendations for developments and / or procurement on instrumentation
  - Recommendations on the most appropriate suite of instruments for APT and LTPP experiments, including guidelines on the availability and requirements for development of instruments.
- Full report sent to all HVSIA members for comments
- Completed

**Gautrans / Transportek  
Accelerated Pavement Testing  
Instrumentation and Data Acquisition System**

<b>Instrumentation / System</b>	<b>Use</b>	<b>Notes</b>	<b>Links / Suppliers</b>
Thermocouple Wire	Type K thermocouple wire for general purpose temperature measurements in concrete, asphalt and ambient air	The wires are twisted together at one end and a plug (Part No. 4559764 - Type 'K' mini T couple) are attached to the other end of the wire.	RS Components SA <a href="http://www.rssouthafrica.com">www.rssouthafrica.com</a>
Temperature buttons (i-buttons)	Programmable to measure temperatures within a pavement structure or ambient air.	Thermochron i-buttons temperature / humidity buttons	Fairbridge Technologies Po. Box 865 Wendywood 2144 S.A. <a href="http://www.ibuttons.com">http://www.ibuttons.com</a>
Linear Vertical Displacement Transducers. (E300)	Measurements of Permanent Deformation and Elastic Deflection within a pavement structure	LVDT's LUCAS Schaevitz Sensors E300	Accutronics PO.box 4211 Rivonia 2128 South Africa <a href="http://www.schaevitz.com">www.schaevitz.com</a>
Linear Vertical Displacement Transducers. (E300)	Measurements of Permanent Deformation and Elastic Deflection within a pavement structure	LVDT's MACRO Sensors E 750 /300 (larger centre hole)	Accutronics PO.box 4211 Rivonia 2128 South Africa <a href="http://www.schaevitz.com">www.schaevitz.com</a>
Multifunction Data Acquisition System. National Instruments (PC card PCI-MIO-16E-1)	Logging of temperature and LVDT data.	Easy to setup extra modulus, Software written in Labview (pc card)	<a href="http://sine.ni.com/nips/cds/view/p/lang/en/nid/1045">http://sine.ni.com/nips/cds/view/p/lang/en/nid/1045</a>
SCXI Modular Data Acquisition and Signal Conditioning System. National Instruments	Single system for the integration of temperature, load, acceleration, LVDT, etc.		<a href="http://sine.ni.com/nips/cds/view/p/lang/en/nid/1604 / 1663">http://sine.ni.com/nips/cds/view/p/lang/en/nid/1604 / 1663</a>
Temperature Data acquisition. (TC-2095) National Instruments	Connecting thermocouples.	Plug in the thermocouples.	<a href="http://sine.ni.com/nips/cds/view/p/lang/en/nid/1676">http://sine.ni.com/nips/cds/view/p/lang/en/nid/1676</a>
Laser Profilometer System	Measures the profile of the pavement surface.	Built by the CSIR.	Transportek (CSIR)
RSD (Road Surface Deflectometer)	Measures the surface deflections of a pavement.	Built by the CSIR.	Transportek (CSIR)
LabVIEW Data acquisition and Control Software. National Instruments	Collecting, filtering, logging and display of data.	Software written by Peter Westwood / Jeremy Lee.	<a href="http://sine.ni.com/nips/cds/view/p/lang/en/nid/1382">http://sine.ni.com/nips/cds/view/p/lang/en/nid/1382</a>



# Conclusions

- Large range of potential parameters to be monitored
- Variety of sensors and instruments exist for monitoring
  - Some provide good data, others require improvements to enable consistent reliable data
- Smaller and improved sensors are constantly being developed
- Specific requirements for new or upgraded sensors and instruments
  - GDPTRW APT and LTPP

# Recommendations

- Checklist provided for the planning and execution for instrumentation on APT and LTPP projects should be used to ensure that appropriate parameters are being monitored using appropriate sensors and instruments
- Current suite of sensors and instruments used on the GDPTRW APT and LTPP projects should be kept, with the focus on upgrading of the following instruments:
  - Wireless RSD and profilometer
  - Wireless MDD
  - Improved in situ moisture measurement
- Plan should be developed for a systematic approach towards addressing the potential development of nano- and micro-scale sensors and instruments
- Development of non-destructive thermography for pavement layer evaluation should be addressed





# Wireless instrumentation

- RSD
- Profilometer

# Wireless RSD

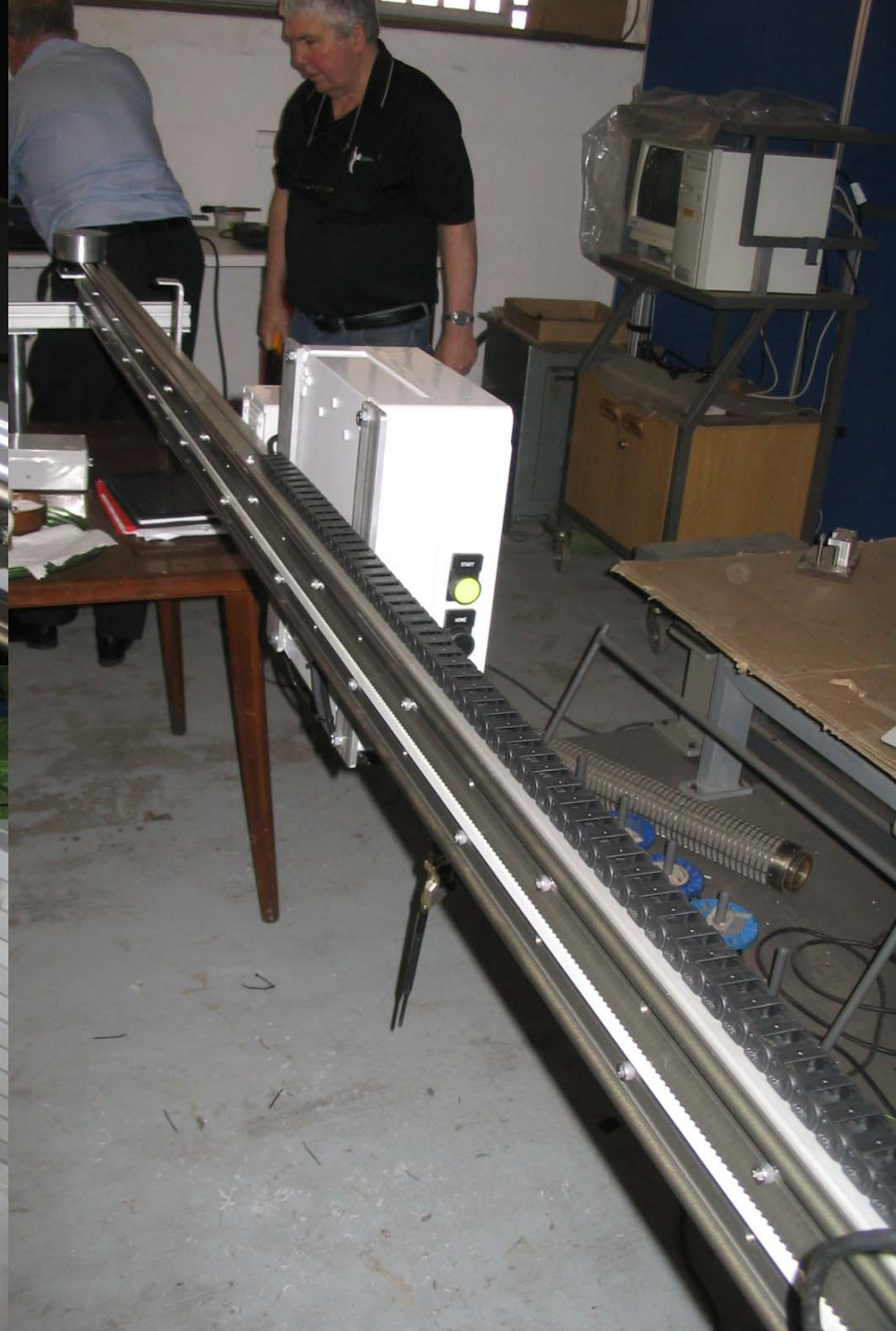
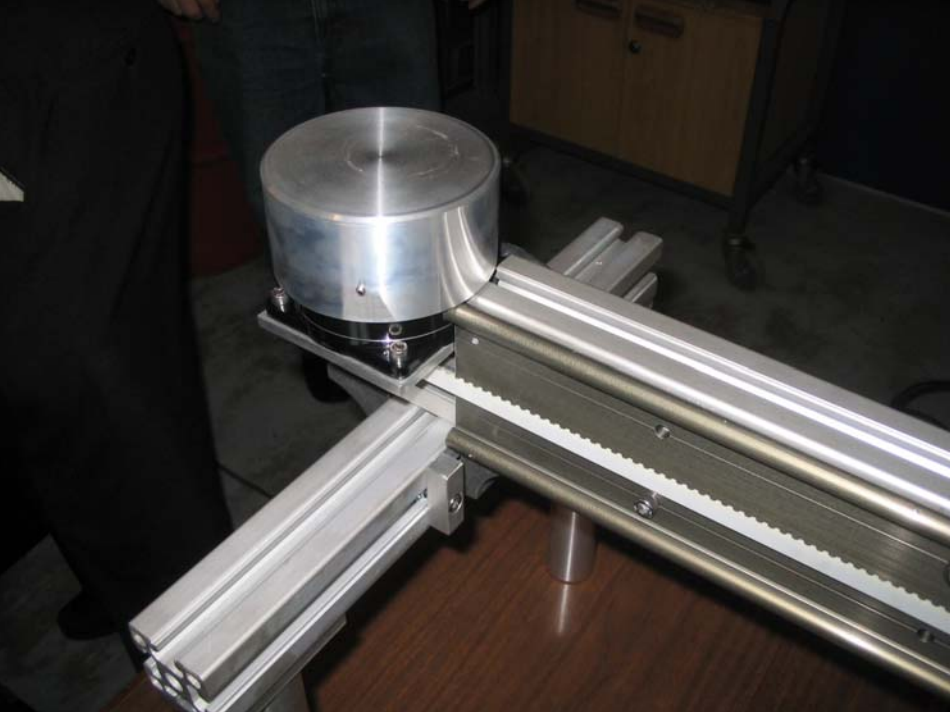
- Same instrument dimensions
- Same DAQ
- Replaced wire with radio
- Size not a problem
- Relatively easy



# Wireless profilometer

- More complicated than RSD
- Smaller technology
- Required larger battery pack
- Operational
- Same DAQ





# MEMS

- Mechano Electronic Measuring Sensors
- Small
- Currently evaluating possibilities
- Limitations
  - Power, placement, durability, what is measured, etc
- Benefits
  - Small, non-intrusive, cheap etc

# PSPA study

- Portable Seismic Pavement Analyser
- Evaluation of instrument for use
- Development of a standard protocol
- Comparisons with U Stellenbosch and ANE devices
- Range of valid data



# Evaluation of PSPA

- Sites
  - LTPP, HMA, UTCRCP, SIM slab, Mozambique
  - > 600 measurements
- Orientation
  - Longitudinal
  - Transverse
  - Look at isotropy effects

# Standard protocol

- Developed document with US
- Standard preparation and locations
- Working on standard evaluation for outputs

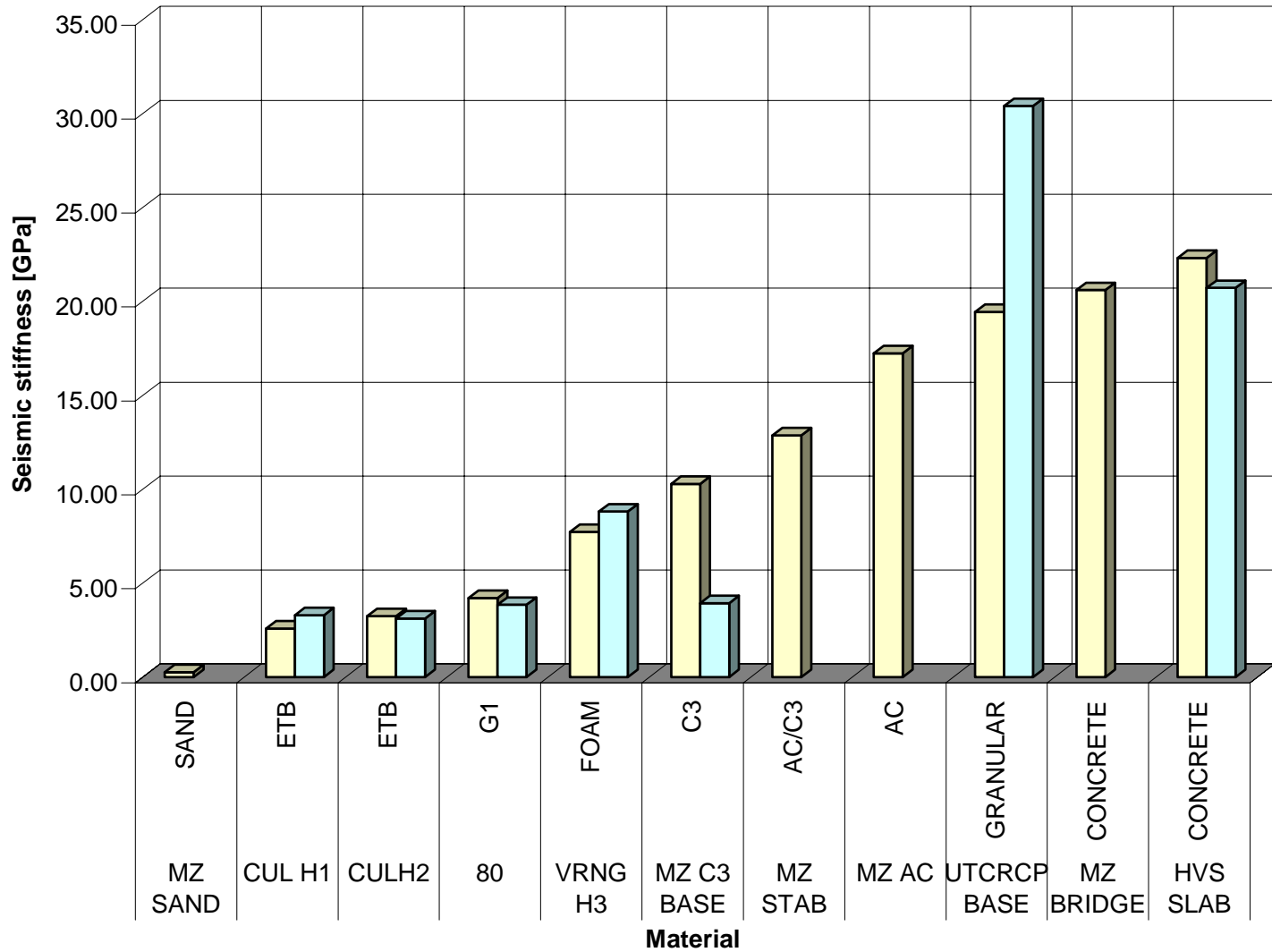
# Comparisons between devices

- Comparisons done on various material types
- Differences occurred – older and newer technology – to be rectified
- Similar trends

# Preliminary outputs

- Different sites evaluated
  - Cemented, granular, concrete
- Ranges of data obtained
- Comparison to published values
- Variability
  - Isotropy
  - Longitudinally

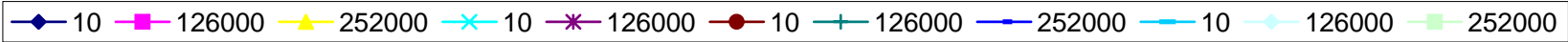
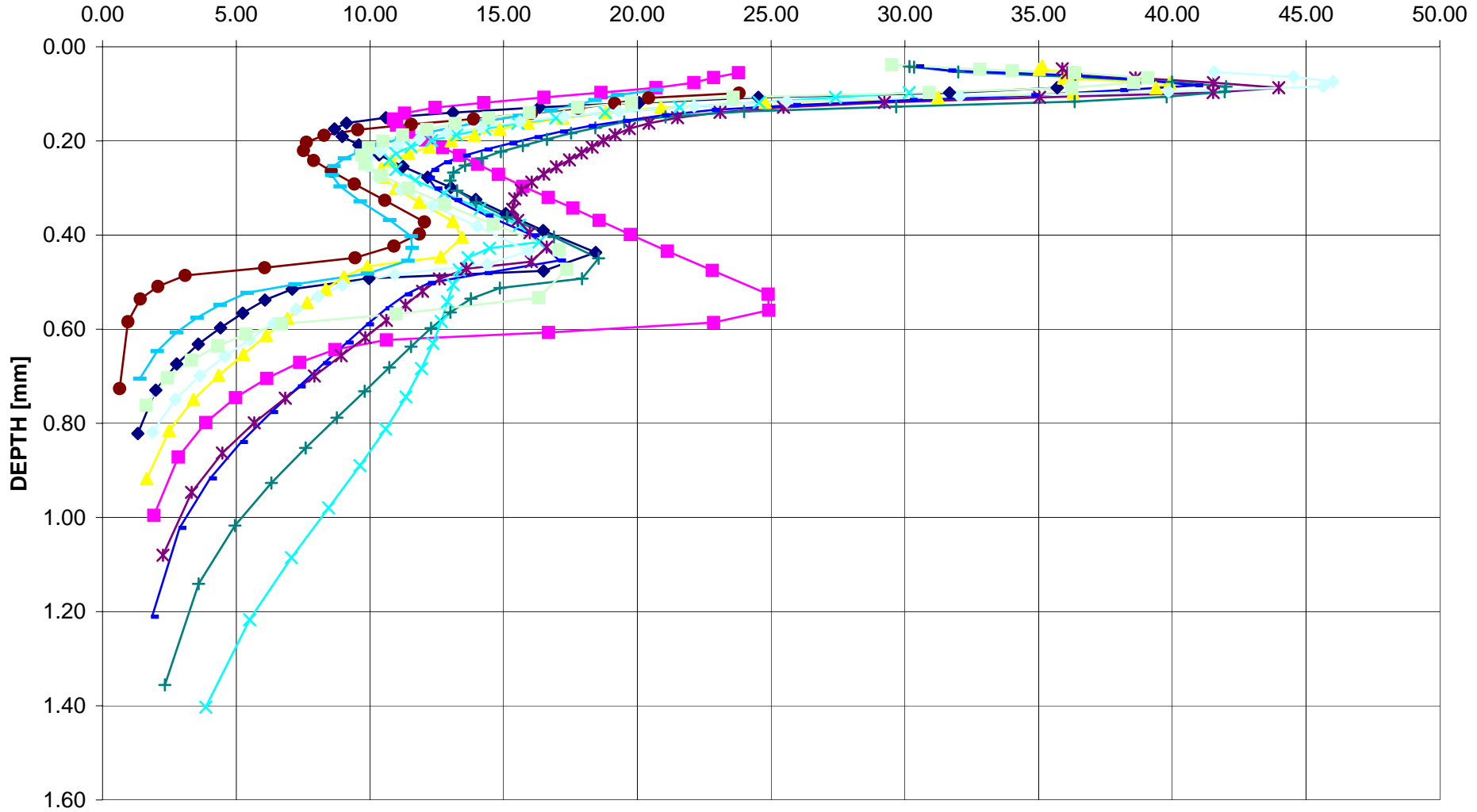
### Summary of initial PSPA data



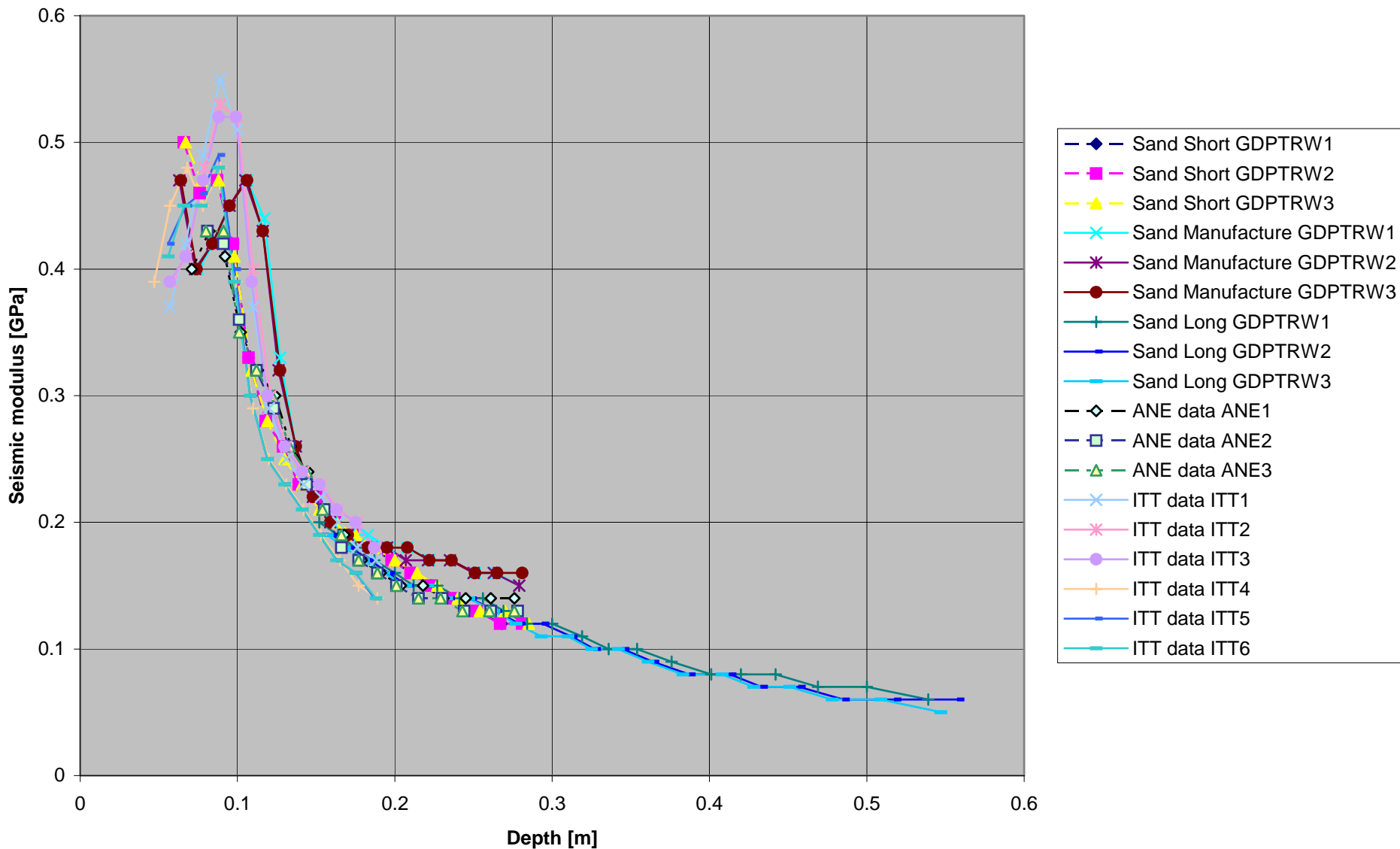
AVERAGE LONGITUDINAL
  AVERAGE TRANSVERSE

# HVS SUMMARY 2

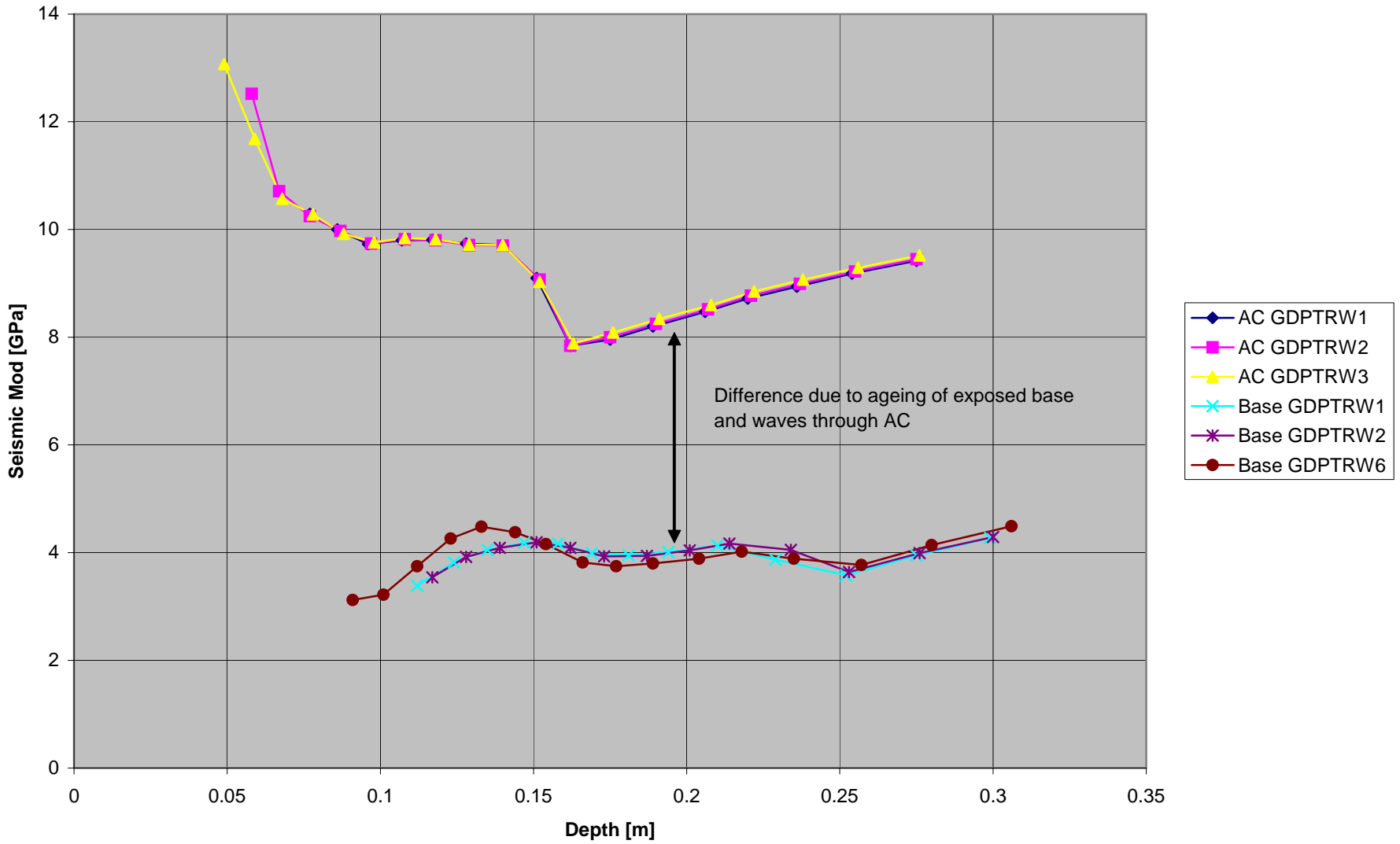
AVERAGE SEISMIC MODULUS [GPa]



# Sand data Manhica



AC and base vs base only Manhica





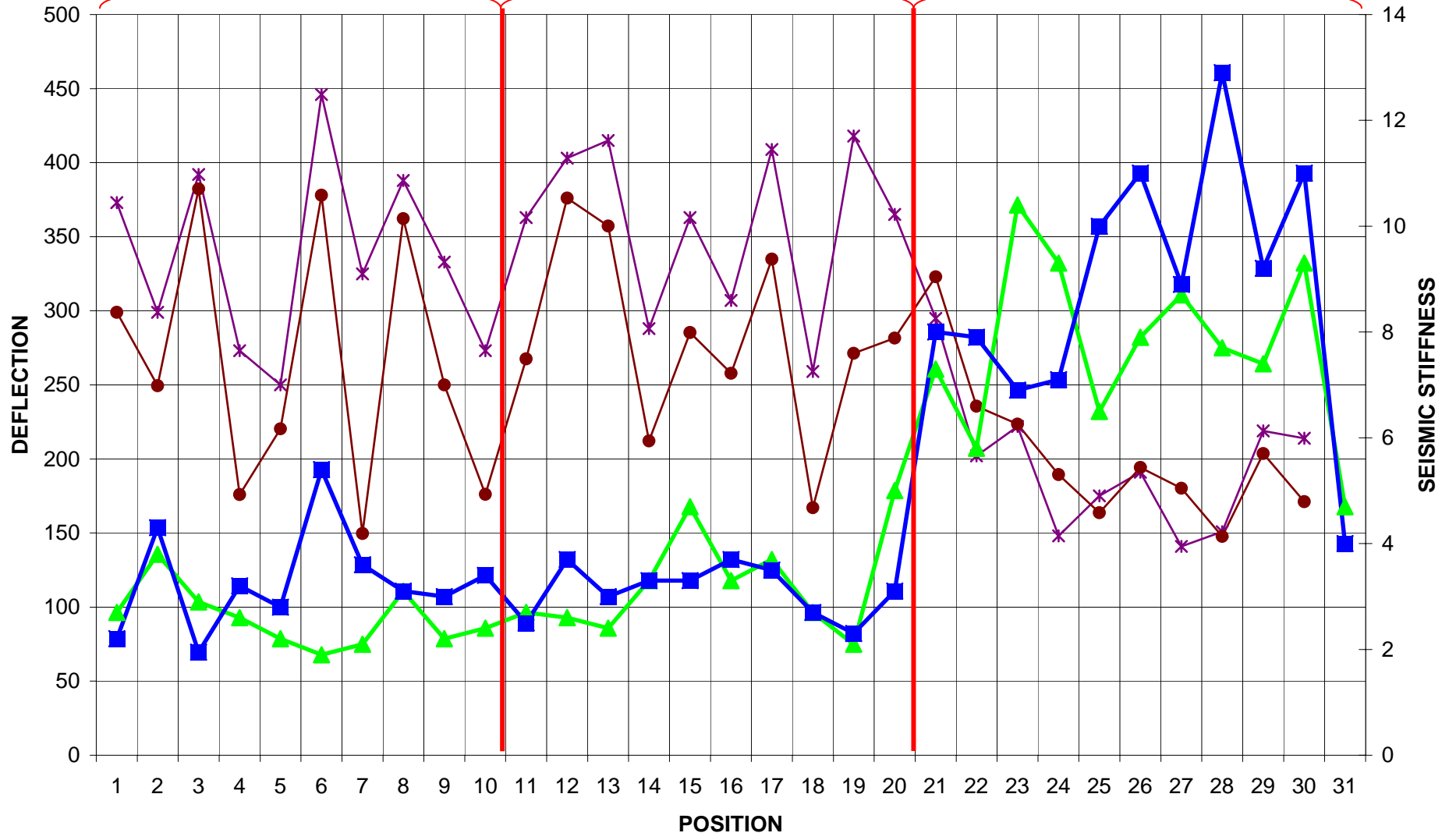


# PSPA vs FWD / RSD

H1

H2

H3



\* FWD OWT    ● RSD OWT    ▲ SEISMIC STIFFNESS BASE LONGITUDINAL    ■ SEISMIC STIFFNESS BASE TRANSVERSE