

Measuring and modeling for APT: Measuring

WJvdM Steyn – CSIR Built
Environment

1

Measuring and modeling for
APT:
Measuring



Contents

- Background
- Why
- Principles
- Procedures
- What to measure
- Data storage
- APT specific issues

2

Measuring and modeling for
APT:
Measuring



Background

- Measuring for **APT**
- What are the issues
- What is different

3

Measuring and modeling for
APT:
Measuring



Why do we measure

- When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the state of science - Lord Kelvin
- Lord Kelvin was obviously not an engineer, but maybe he was not wrong

4

Measuring and modeling for
APT:
Measuring



Why do we measure

- APT engineers are pretty destructive creatures
- Civil engineers build pavements, we break them
- If you do not measure then you are just a common vandal



5

Measuring and modeling for
APT:
Measuring

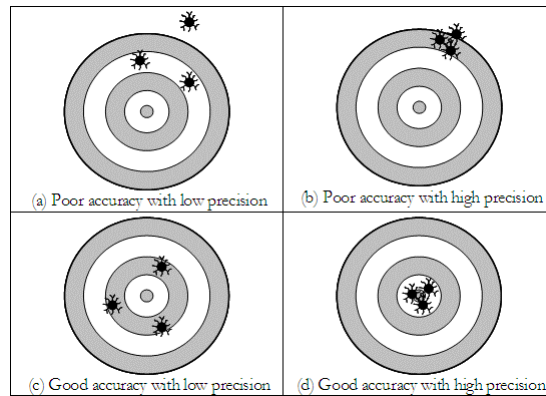




Principles of measurement

- Measurement - process of **estimating** the **magnitude** of some attribute of an object **relative to some standard**
- Act of measuring involves using a **calibrated** measuring instrument to compare the measured attribute to a measurement unit
- Measurements **always have errors** and therefore uncertainties
- **Reduction of uncertainty** is central to the concept of measurement
- Every measurement has three components
 - estimate
 - margin of error or uncertainty or error bound
 - confidence level

Principles of measurement



9

Measuring and modeling for
APT:
Measuring

CSIR
our future through science

3rd International Conference
APT'08
ADVANCED PROCESSING TECHNOLOGY

Procedures

- A system / procedure is required to ensure that the process is well thought through
- 18 Steps for instrumentation planning



10

Measuring

18 Steps for measurement planning

1. Define project conditions
2. Predict mechanisms which control behaviour
3. Define questions to be answered
4. Select parameters to be measured
5. Predict magnitudes of parameters
6. Assign tasks to field personnel
7. Select instrumentation and testing conditions
8. Select measurement and instrument locations
9. Plan recording/measuring of factors that may influence measured data

11

Measuring and modeling for
APT:
Measuring



18 Steps for measurement planning

10. Ensure that operators are familiar with testing procedures
11. Prepare draft budget
12. Plan instrument installation and testing program
13. Plan regular calibration and maintenance
14. Appraise complete testing program critically
15. Plan data collection, processing, interpretation, presentation and reporting
16. Revise the budget
17. Start the HVS test
18. Process, interpret and present data

12

Measuring and modeling for
APT:
Measuring



What to measure / monitor

- Loading conditions
- Environment
- Pavement response
 - What does the road tell me
 - Which part of the road is talking
- Anything else?
 - What else can influence my data
- www.hvsia.co.za – Instrumentation matrix

13

Measuring and modeling for
APT:
Measuring

CSIR
our future through science

3rd International Conference
APT'08
ADVANCED PAVEMENT TECHNOLOGIES

HVSIA Instrumentation Matrix

More information on the Instrumentation and or Systems per Institution/Organisation can be obtained by clicking on the relevant coloured block below.

PARAMETER	PROGRAMME					
	RSA/ Gautrans	Florida	Caltrans	Finland/ Sweden	CoE-ERDC	CoE-ERDC -Hanover
Structural						
Permanent deformation						
- Surface	R	F	C	V		
- In-depth	R		C	V		
Elastic deflection						
- Surface	R		C			
- In-depth	R		C	V		
Strain		F		V		
Stress		F		V		
Environmental						
Temperature	R	F	C	V		
Moisture				V		

start | HVSIA Instrumentation... | Novell GroupOffice - M... | 2 Measuring.ppt | 07:35

14

Measuring and modeling for
APT:
Measuring

CSIR
our future through science




3rd International Conference
APT'08
ADVANCED PAVEMENT TECHNOLOGIES

Untitled Document - Mozilla Firefox

http://www.gautrans-rivis.co.za/rivisa/instrumentation_gautrans.html#1

Mail & Guardian Online: The smart news sou... | Spaceflight now | Breaking News | China lau... | Untitled Document | Google Image Result for http://www.mses...

Gautrans APT Instrumentation and Data Acquisition System

Instrument / System		Use	Notes
Linear Vertical Displacement Transducers. (E300)		Measurements of Permanent Deformation and Elastic Deflection within a pavement structure	LVD's LUCAS Schaevitz Sensors E300
Linear Vertical Displacement Transducers. (E300)		Measurements of Permanent Deformation and Elastic Deflection within a pavement structure	LVD's MACRO Sensors E 750 /300 (larger centre hole)
JDM0 (Click on images to enlarge)		Rigid pavement surface deflection	
MDD		In-depth deflection and deformation	

Done:

start | Untitled Document - ... | Novel Groupware - M... | Measuring.ppt | 07:36

15

**Measuring and modeling for
APT:
Measuring**

CSIR
our future through science

3rd International Conference
APT'08
MEASURING, MODELING AND MONITORING

What to measure

Loading conditions

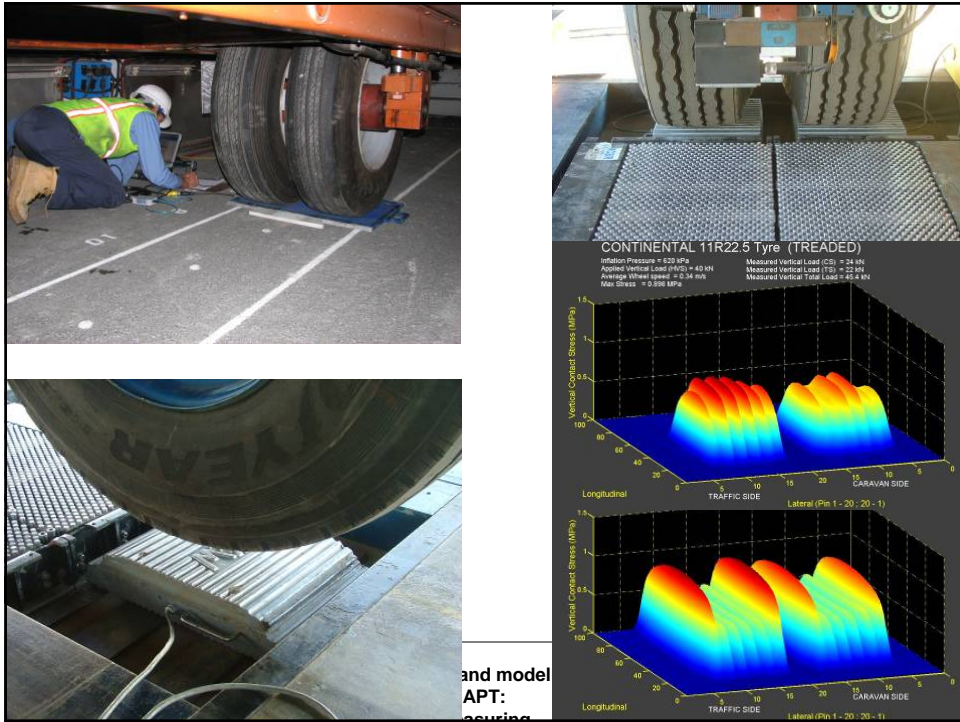
- Load
- Tire inflation pressure
- Contact stresses
- Speed
- Tire type (and tread and condition)
- Location

16

**Measuring and modeling for
APT:
Measuring**

CSIR
our future through science

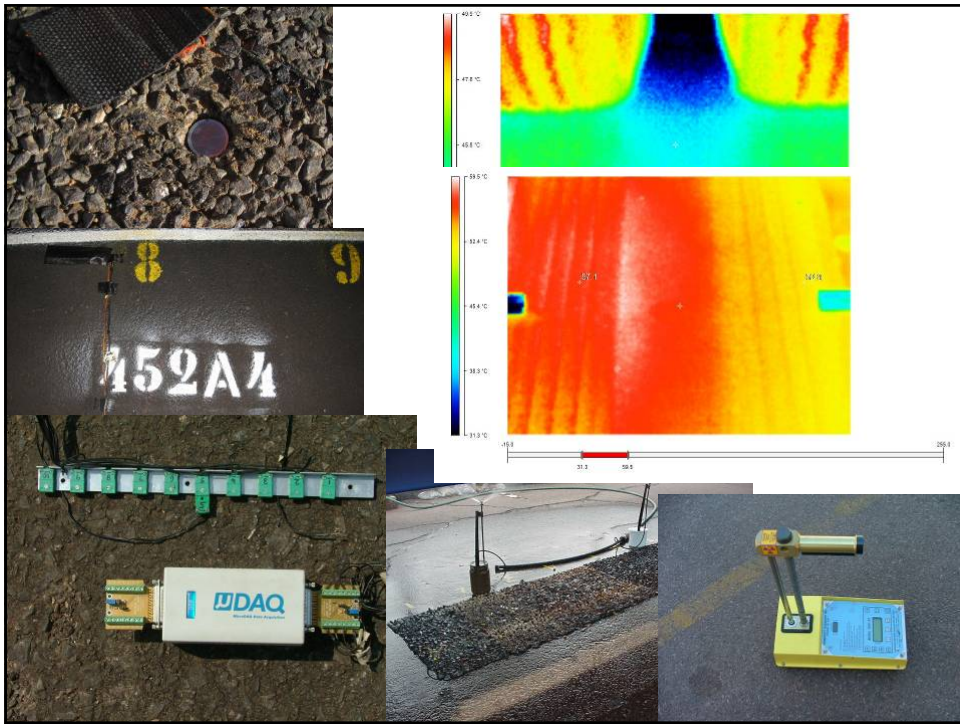
3rd International Conference
APT'08
MEASURING, MODELING AND MONITORING



and model
APT:
measuring

What to measure *Environment*

- Largely material dependent
- Granular
 - moisture
- Asphalt
 - temperature
- Stabilised
 - both?
- Natural and simulated environment



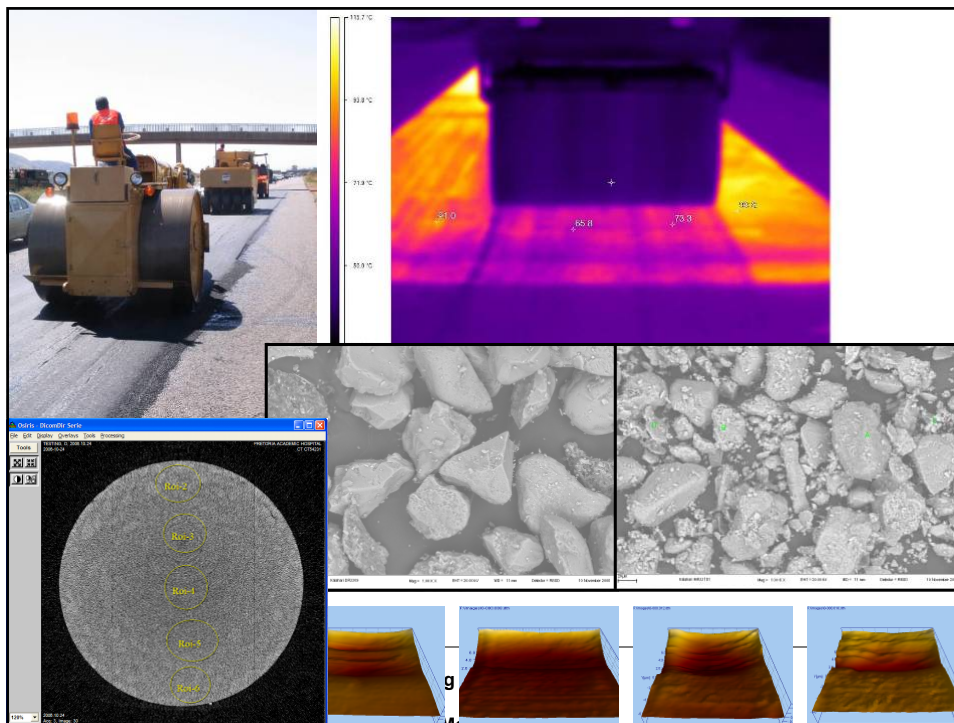
What to measure *Pavement response*

- Visual
 - Photos, videos, GPS, Google earth
- Permanent deformation
 - Surface and in-depth
- Fatigue / cracking
 - Surface and in-depth
 - Early detection
 - Quantification / classification?
- Stiffness – direct
 - PSPA
- Load response / deflection
 - Surface and in-depth deflections
 - Speed / temperature / moisture dependency



What to measure *Anything else?*

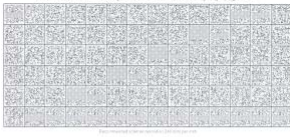
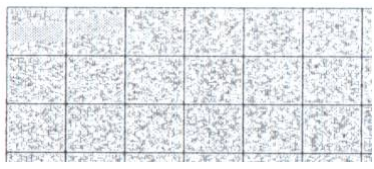

- Links to laboratory measurements
- Look for possible extraneous factors
 - Age of the various layers
 - Construction issues
- Other observational techniques
 - AFM, SEM, CT, etc



Data storage

- The how and why wonderbook of data storage?
- Databases
 - Format, maintenance, usage, etc
- Storage space
 - How much, where, backups, media, etc
- Accessibility of data
 - Which format, level (raw, analysed, etc), by whom, etc
- Available systems and software
 - Commercial, proprietary, etc
- Barcode system
 - Paperback
 - Show example
- Responsibility
 - Engineer, technician, information officer?

HWS 45544 Test Plan via [20080706 09:14:20] (100) (print) page 1 of 1

TEST PROGRAM										TEST LOAD 40 kN		Start Date 20072008			
Section no. 0504										Road No. R90 Westbound		Site Reference 021476		HYPERION Test Plan 04	
REPETITION	DATE	TIME	TESTED	PREPARED	TESTED	TESTED	TESTED	TESTED	TESTED	TESTED	TESTED	TESTED	TESTED	TESTED	TESTED
1	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
2	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
3	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
4	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
5	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
6	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
7	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
8	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
9	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
10	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
11	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
12	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
13	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
14	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
15	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
16	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
17	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
18	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
19	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00
20	20/07/08	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00	10:00

25

Measuring and modeling for APT: Measuring

CSIR our future through science

3rd International Conference APT'08

APT specific issues

- What is different in APT than with other measurement systems
 - Simulated conditions
 - Accelerated conditions
 - Environmental cycles
 - Diurnal cycles
- How to cater for these – think and plan – coincidence is not a planning method

26

Measuring and modeling for APT: Measuring

CSIR our future through science

3rd International Conference APT'08

Summary

- Measuring is important
- Planned, accurate and reliable
- What happens with the data afterwards

27

Measuring and modeling for
APT:
Measuring

CSIR
our future through science

3rd International Conference
APT'08
ADVANCED POLYMER TECHNOLOGY
CONFERENCE

