AAPA 2011 Study Tour

Agenda

Wednesday, 7 September 2011

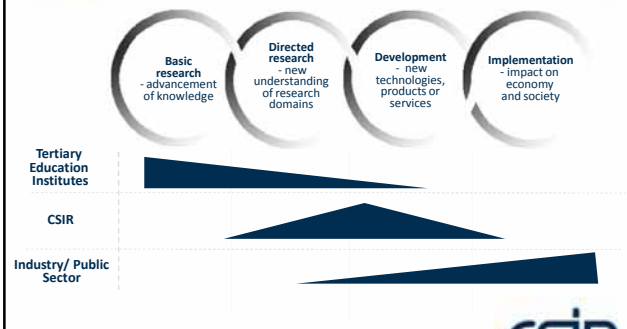
Welcome!

09:00	09:30	Welcome & introduction to CSIR R&D projects (including APT)	B Verhaeghe
09:30	10:15	Part B: Binders - Specifications for bituminous binders	J O'Connell
10:15	11:00	Part B: Binders - Bitumen-rubber/Sasobit	J Muller
11:00	11:15	**Coffee break**	
11:15	13:15	Part C: Improving pavement performance - SAPDM and management of the road network	L Kannemeyer H Theyse
13:15	13:45	**Lunch**	
13:45	14:30	Part C: Improving pavement performance - High Modulus Asphalt and Agrement South Africa	E Denneman

Overviews of CSIR Activities

Benoît Verhaeghe

Strategic Position in the National System of Innovation



The CSIR spans the research and innovation value chain but its role is differentiated from universities and commercial R&D

CSIR at a glance

Our foot print

- CSIR head office in Pretoria
- 10 regional offices across the country

CSIR People

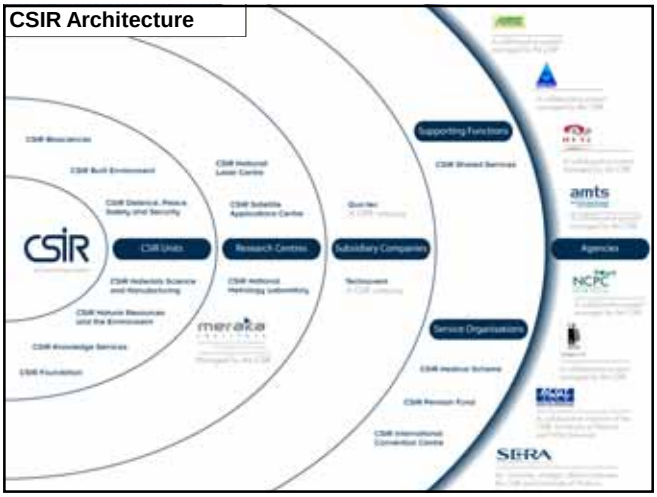
- 2 400 staff
- 1 500 staff in science, engineering and technology base
- 757 staff with Master's and PhDs

CSIR financials

- Total operating income: R1 723.6 m
  - Parliamentary Grant: R535.3 m
  - Contract research: R1 175.1 m
  - Royalty income: R8.7 m
  - Other income: R4.5 m

(figures as at 31 March 2011)

CSIR Architecture



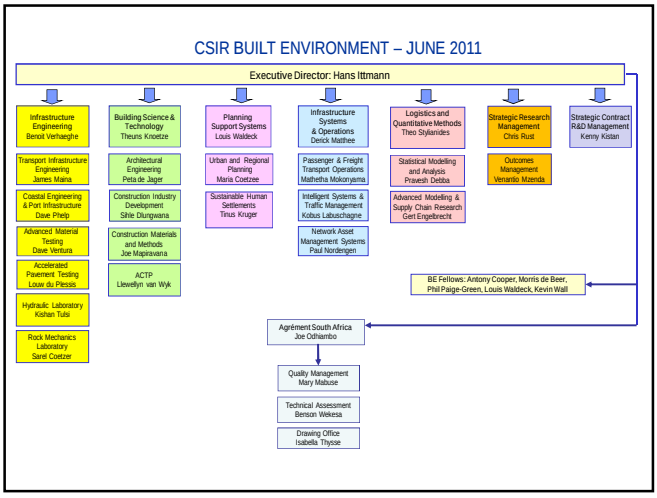
CSIR Research Impact Areas

CSIR Built Environment

Core focus: Support South Africa's competitive performance and welfare through development of efficient and globally competitive built environment systems; appropriate and efficient components and relevant technologies to support, through R&D, technological innovation and selected specialised value-added services

Competence areas

- Planning support systems
- Infrastructure engineering
- Building science and technology
- Infrastructure systems and operation
- Logistics and quantitative methods



Infrastructure engineering

R&D areas within infrastructure engineering:

Transport infrastructure engineering and accelerated road testing	Coastal engineering and port infrastructure
(e.g. design, construction and maintenance of transport infrastructure assets - roads and airports; sustainable and cost-effective transport network; accelerated testing of roads and advanced testing of materials, including traditional, waste and novel materials; engineering design, analysis and modelling; vehicle-pavement and infrastructure-environment interaction; geotechnical engineering and rock mechanics; environmental engineering and sustainable construction; performance data capturing techniques and instrumentation; international research collaboration in accelerated pavement testing)	(e.g. predictive engineering solutions and decision support for safe and cost-effective development and operation of ports and coastal structures; physical modelling of environmental impact on ports and coastal structures; physical and numerical modelling of moored and manoeuvring ships; wave fore and hind-casting, and wave diffraction, refraction and reflection modelling; collect and manage real-time environmental data on waves, tides, currents, wind, weather and bathymetry for ship and port operations; monitor impact of marine environment on coastal structures specialist support to local and international port/harbour authorities, consultants and contractors)

CSIR physical model facility in Stellenbosch

Physical model hall

- Established 1965; top four in world
- Used for local and international studies
- 3D basins and 2D flumes available
- Training and research (SU collaboration)

3D Wave basin

- Accurate bathymetry cement screed (1mm)
- Active and passive wave absorption

Basin calibrated to prototype wave measurements

Asphalt and Bituminous Binders Laboratory

Staff complement

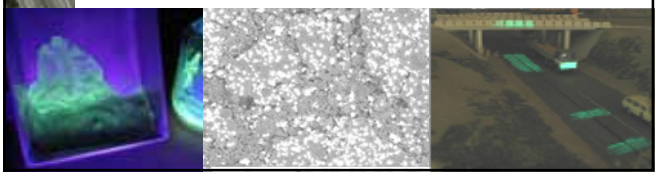
- 71 permanent staff members
- Qualifications
  - 7 staff members holding a PhD
  - 9 staff members holding a Masters degree
  - 3 staff members studying towards a PhD
  - 6 staff members studying towards a Masters degree
- Location
  - Transport Infrastructure engineering
    - Research staff & laboratories : CSIR Campus (Bld 2)
    - Satellite office : UCD, California
    - HVS activities : Field test sites
  - Costal engineering & port infrastructure : CSIR, Stellenbosch

Research Areas

- **Recycled** Materials - Secondary cementation
- Chemical and liquid **stabilisers** - physical bonding
- Durability and performance of **stabilised** materials - carbonation Theories
- **Stabilised** material curing – Laboratory versus field
- Application of **soil mapping** to infrastructure/geotechnical engineering
- **Structural failures** in the road environment: Slope stability
- **Climate Change** mitigation and adaptation
- **Nano technology** applications in pavement materials technology
- **Performance** prediction of bitumen based on chemical analysis
- Chemical properties of materials- Accelerated laboratory **ageing** – long-term performance
- Environment-friendly materials and processes
  - Alternative materials and by-products
  - Cold-mix technology
  - Warm-mix technology
  - Manufacturing process

Nano-Technology Applications

- Visibility of roads and road furniture is vital for road safety
- New developments in nano-technology investigates the development of nano-phosphors
  - Nano-phosphors can be synthesized, blended and engineered for specific properties
  - Ability to engineer a material to be luminescent in terms of colour, duration and intensity
  - Activated by UV through the day, luminescent at night (broadly speaking)
  - Add to cement, road binder, transparent paint etc
- Combination of nano-phosphors and infrastructure materials may lead to low-energy visibility

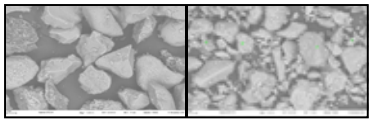


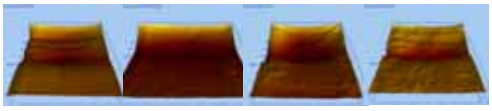
Agriculture-Based Binders

- Findings
  - Proven in principle
  - Similar to bitumen in some respects, cementitious materials in other respects
  - Properties (example):
    - ITS > 1700 kPa
    - E > 10 GPa
- Spin-offs
  - Processing of waste produce from agriculture
  - Small agricultural industries (local producers/farmers of solid and solvent)

Research Areas (advanced measurements)

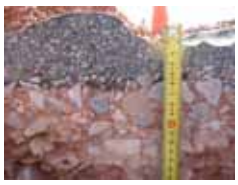
- Advanced **observational** techniques of materials – 3D laser scanning, CT Scans, SEM and Atomic Force Microscopy
- Advances in **existing test methods** – i.e. strain-at-break, tri-axial, shear testing, DSR, etc
- Concept development of **new-generation HVS** & associated equipment





Research Areas (pavement engineering)

- **FEM** development and verification, including development/improvement of PADS suite
- **Limit state design** of concrete & fracture mechanics
- Advanced deflection **analyses** - Differences between the deflection and hence stiffness results from different devices
- Concrete pavement studies – focus on **environmental issues**
- **Mitigation of solar radiation** – focus on temperature and durability
- **Long-life pavements**



Accelerated Pavement Testing

- **Rigid pavements**
  - Structural design
  - Ultra-thin reinforced concrete
  - Fibre-reinforced concrete
  - Roller compacted concrete

- **Flexible pavements**
  - Stabilisation technology
  - HMA grading optimisation
  - Binder technology
  - HiMA technology

Vehicle-Pavement Interaction and Full-Scale Assessment

- **Heavy Vehicle Simulator (HVS)**

Ultra-Thin Reinforced Concrete

Ultra Thin Continuously Reinforced Concrete Pavement

- 20 to 60 mm Layer Thickness **(160 – 230)**
- 50 x 50 mm (Ø4mm to Ø8mm) Welded Mesh
  - **Up to 4.5% Steel (0.6% for Traditional CRCP)**
- Ultra High Strength Cement (UHSC) Paste
  - **Compressive Strength = 120 - 140 MPa (35 – 40)**
  - **Flexural Strength = 7 – 15 MPa (4.2 - 4.5)**
- Water Cement Ratio = 0.27- 0.30 **(0.32 – 0.40)**
- Steel- and polypropylene fibres.

GFIP – N12 Freeway

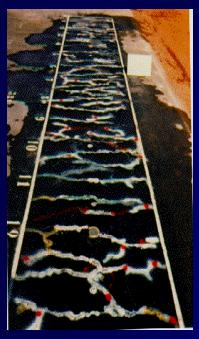
N1 Freeway

Cold in-place recycling

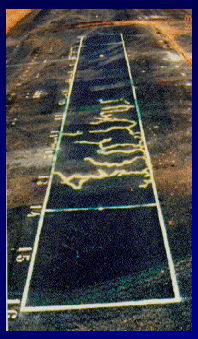
- Deep in-situ recycling with cement, bitumen emulsion and foamed-bitumen

- **Advantages**
  - Conservation of natural aggregates
  - Energy savings
  - Minimises traffic disruption and time delays
  - Wide range of distresses can be rectified
  - Significant cost savings

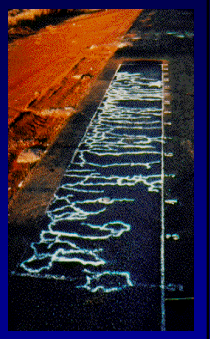
Bitumen-Rubber fatigue trials



75 mm Conventional
175,000 reps @ 40 kN
25,000 reps @ 80 kN



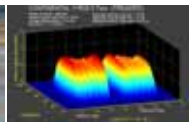
38 mm BR-HMA-GG
175,000 reps @ 40 kN
62,000 reps @ 80 kN
13,000 reps @ 5ºC

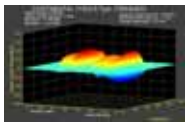


25 mm BR-HMA-GG
175,000 reps @ 40 kN
62,000 reps @ 80 kN

Vehicle-Pavement Interaction and Full-Scale Assessment

- **Stress-in-Motion (SIM)**

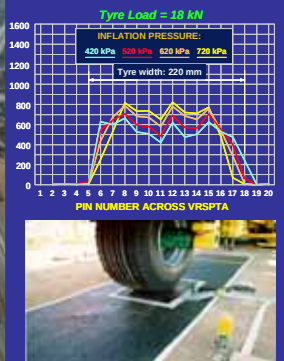


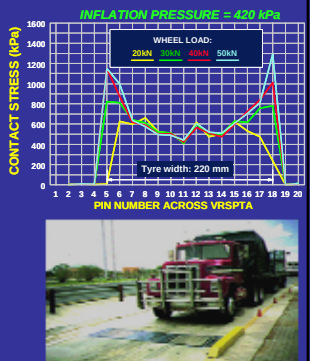


- 7-day average maximum temperature: 58 ºC
- Minimum surface temperature: -0.6 ºC
- Test conducted over 40 ºC to 60 ºC temperature range

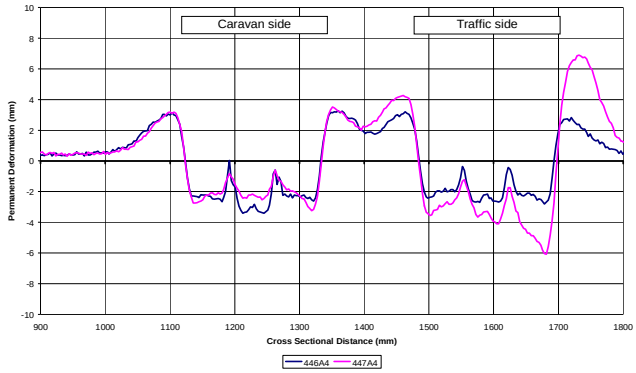
Accelerated Pavement Testing site

Standard versus n- and M-shape contact stresses

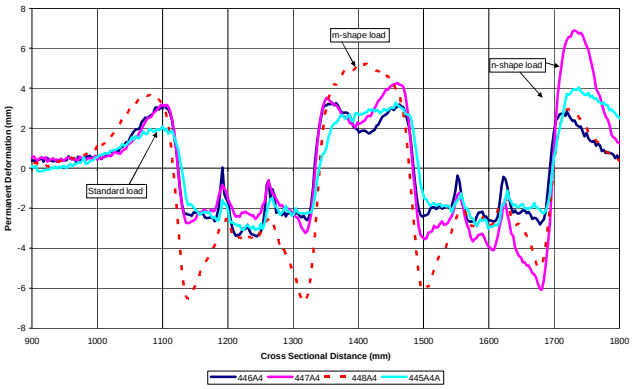




Uni- versus bi-directional traffic

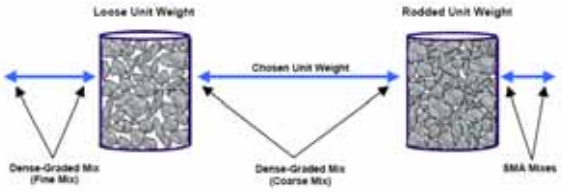


Standard versus n- and M-shape contact stresses



Assessment of rut-resistant mixes

- Bailey method:



Fine-graded mixes:	<90% of loose unit weight
Coarse-graded mixes:	95-105% of loose unit weight
Stone-mastic asphalt:	>100% of rodded unit weight

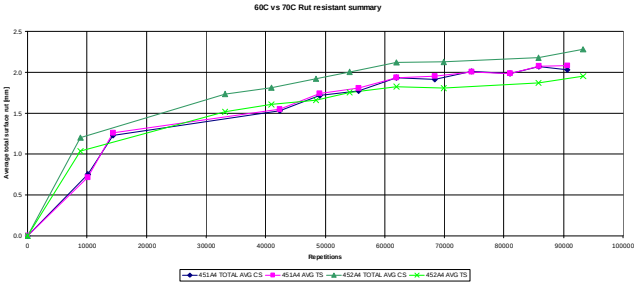
Aggregate packing

Mix	Bailey CA CUW	DASR porosity
Reference	74 % (fine)	52 % (fine)
East Rand	99 % (coarse)	48.3 % (coarse)
West Rand	105 % (coarse)	46.9 % (coarse)

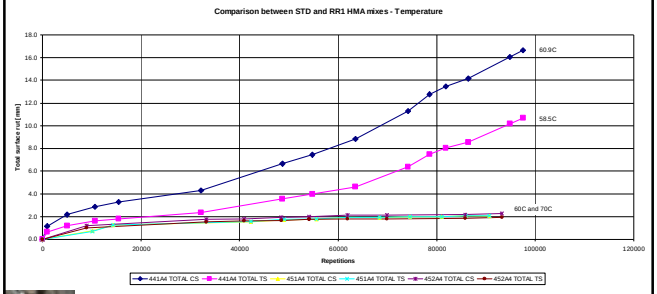
- CA CUW: Coarse Aggregate Chosen Unit Weight
- DASR: Dominant Aggregate Size Range

Gradings

Comparison (channelised)



Comparison (channelised)



HVS International Alliance

HVSIA Activity Matrix (www.hvsia.co.za)

Benefits of the HVS Programme

Impact and Benefits of the SA HVS Programme

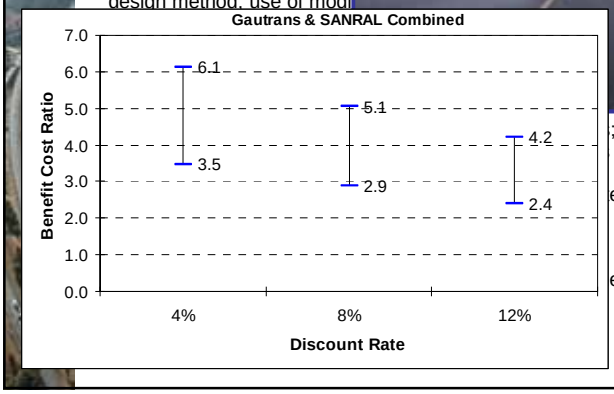
- ✓Gauteng, national & SADC pavement design standards and guidelines
- ✓Material specifications and guidelines
- ✓Development of human resources
- ✓Capacity building in industry
- ✓Innovative products and designs

Breadth of benefits

Materials/methods development of a new large-stone mix design method; use of modified binders in mixes; in situ recycling of materials (using cement, lime, foamed bitumen and bitumen emulsion); block paving (masonry and concrete); coarse power station generator ash; roller compacted concrete; slag; bitumen-rubber; waterbound macadam; recycled asphalt base; upgrading of gravel roads; marginal natural aggregates with various additives; high quality granular bases; evaluation of drainage layers as structural layers; lime-stabilized sand subbases under bitumen; design and rehabilitation procedures for concrete roads; lightly-cemented base pavements; identification and evaluation of cost-effective rehabilitation techniques; evaluation of labour-intensive construction methods; testing various asphalt base pavements and improving the design, analysis and understanding of the behaviour of such pavement types; porous asphalt

Breadth of benefits

Materials/methods develop
design method; use of modi



Formal impact on :

SA pavement design and analysis

- Structural design manual (TRH4)
  Rehabilitation design manual (TRH12)
- SA mechanistic design and analysis method
- The determination of the equivalent damage exponent

SA materials characterization

- Asphalt mix design manual
- Materials classification and selection (TRH14)
- Sabita/AsAc manuals, bituminous stabilised materials, large aggregate mixes for bases (LAMBS)

Benefits (in a nutshell)

- Better understanding and modeling:
  - minimizes under design
    - pre-mature failures prevented
  - minimizes over design
    - most cost-effective solution
- Fill the important gap between lab designs and true field pavement behaviour
- Allows better (optimal) use of funds and natural resources

Product Development

Vehicle-Pavement Interaction and Full-Scale Assessment

- **HVS: Export of technology (in association with Dynatest®)**

Dynatest®

Questions?