

Pavement Design Task Group Feedback

APT steering committee meeting
12 October 2005

Sequence of events

- 1st Meeting
 - Discussion of role and operation of the task group
 - Presentation on potential improvements to mechanistic-empirical (ME) design method
 - *Unpacking of ME design method core*
- 2nd Meeting
 - Presentation on a project performance based design method
 - Presentation of simulation models
 - Discussion of the deliverable from the process

Sequence of events

- **3rd Meeting**
 - Integration of the performance based information system and the ME-design component into a single design method
 - Design sensitivity analysis based on the current ME design method
 - Details of the performance based information system
- **4th Meeting**
 - Unpacking the details of the ME-design component
 - Development of a R&D matrix and rating of the R&D areas

Deliverable from the task group

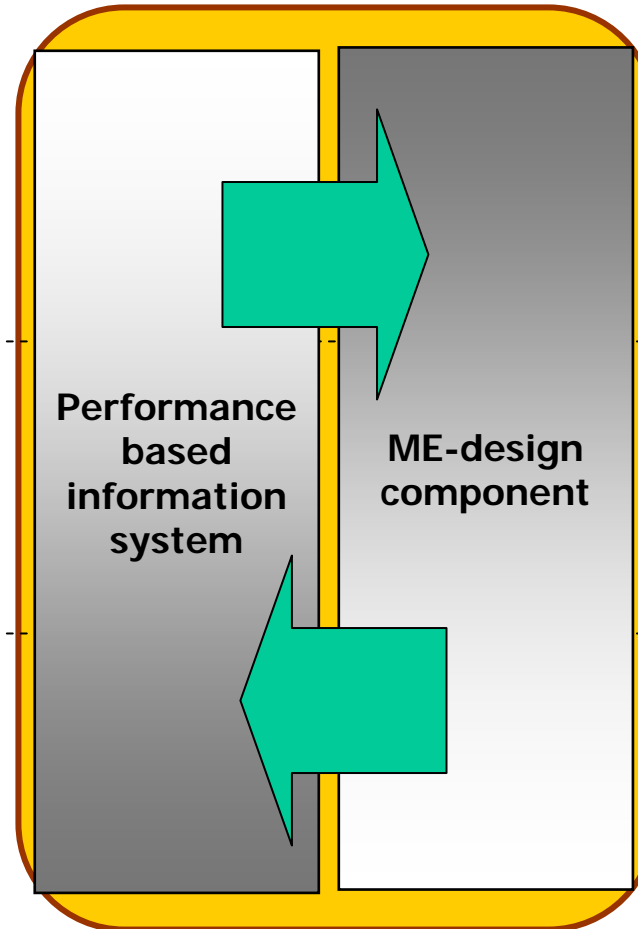
- The task group will deliver a research and development (R&D) plan that will guide the development of a pavement design method for southern Africa that
 - allows for a range of design applications of different importance and
 - caters for a user group with different levels of design experience
- R&D plan to be executed under the auspices of the Road Pavement Research Advisory Committee (RPRAC)
 - Project management may be referred back to sub-groups of the task group

Integration of performance based and ME-design components

Entry level

Intermediate level

Advanced level



Design scenario:

- Routine design
- Low design experience
- Use only known materials
- Conventional material classification

Design scenario:

- Important design
- Seasoned professional designer
- Test input parameters for materials

Design scenario:

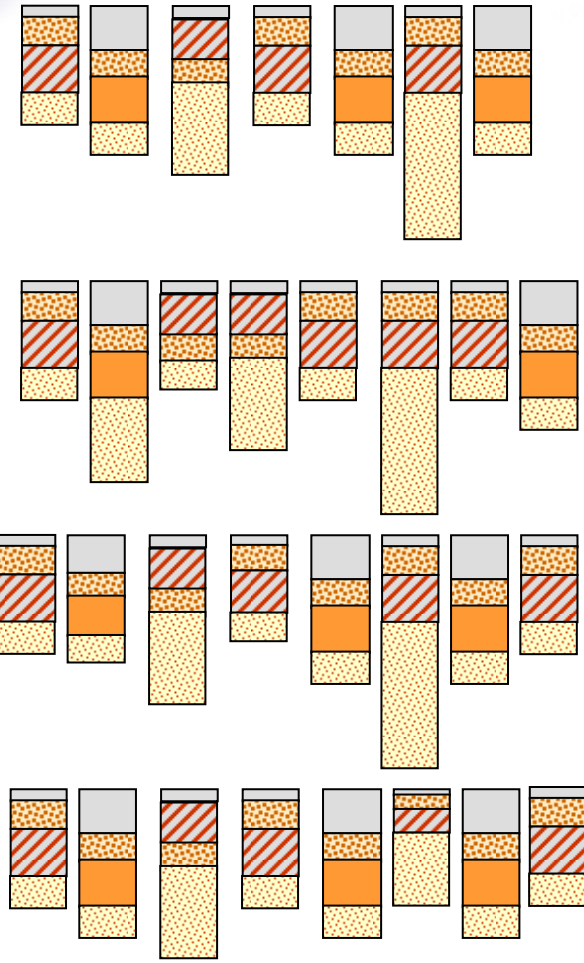
- Very important design
- Special investigations
- Specialist designer
- Unusual materials
- Test input and performance of materials

Performance based information system

- Based on performance data collected from
 - Rehabilitation investigation documentation
 - APT test results
- Statement of fact rather than interpretation of data and modelling

Performance based information system

Performance Database



✓

- 8 Years to Resurface
- 1278 H/day
- 8 MESA to Rehab
- Terminal Rut = 16 mm

✓

- Not Resurfaced
- 987 H/day
- 5 MESA to Rehab
- Terminal Rut = 12 mm

✗

- 11 Years to Resurface
- 1250 H/day
- 9 MESA to Rehab
- Terminal Rut = 14 mm

✓

- 10 Years to Resurface
- 1400 H/day
- 12 MESA to Rehab
- Terminal Rut = 17 mm

[Click here for Design Report](#)
[Click here for Situation Summary](#)
[Click here for Rehab. Report](#)

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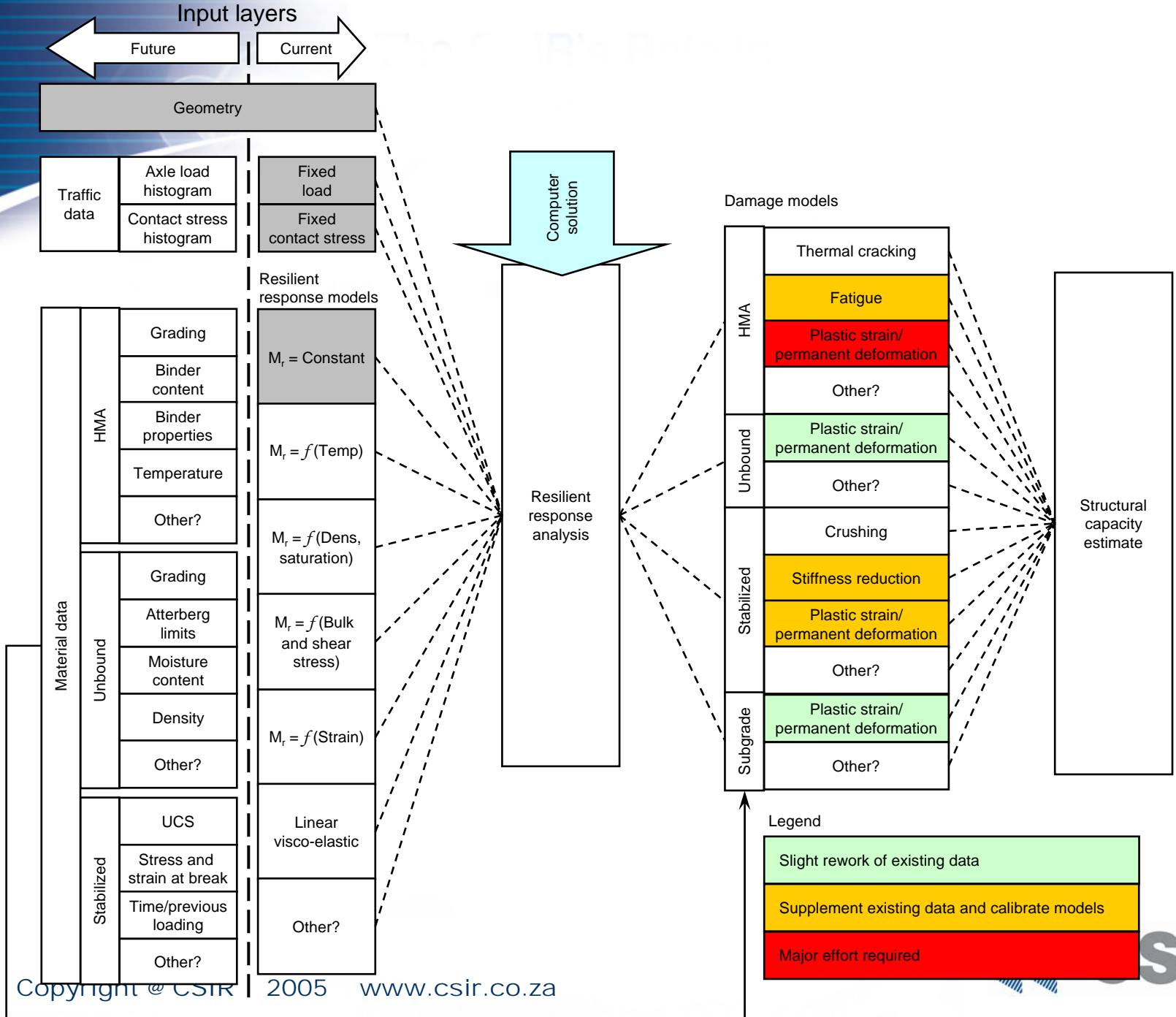
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Design Option



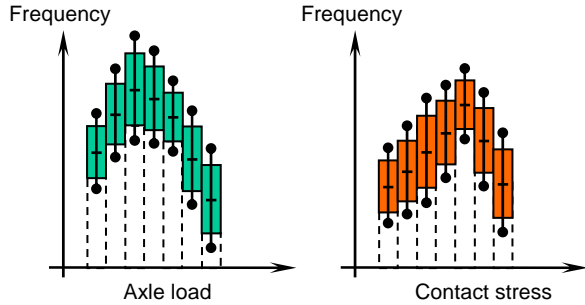
Mechanistic-empirical design component

- Basic ME procedure
 - Fully determines the accuracy of the design method
 - Requires engineering knowledge and understanding
- Various implementation schemes
 - Allows for spatial and time-based variation
 - Enhances the interpretation of results
 - Requires mathematical and computer programming skills



Pre-processing

Traffic loading



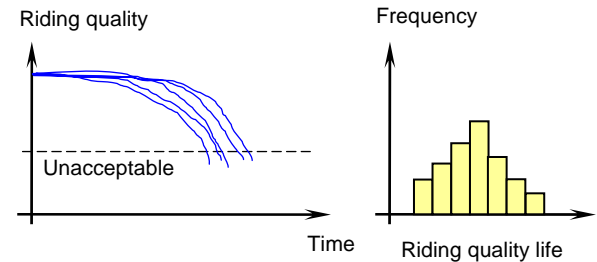
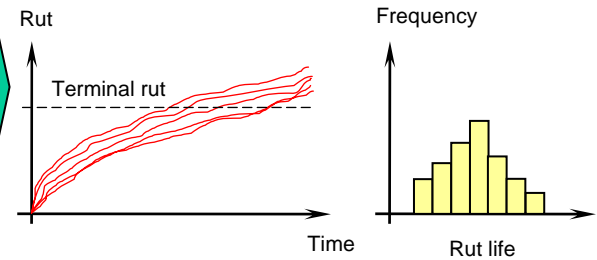
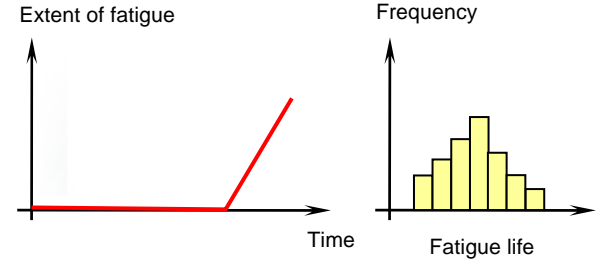
Spatial variation of field variables

Layer thickness
Temperature
Binder content
Relative density
Saturation
Grading
etc.

T_1	T_2	T_3	T_n
RD_1, S_1	RD_2, S_2	RD_3, S_3	
σ^1_b, ϵ^1_b	σ^2_b, ϵ^2_b	σ^3_b, ϵ^3_b	

Basic me-design module

Post-processing



Research & Development Matrix

- Main components of R&D plan
 - Integration level project
 - Performance based information system
 - Demand analysis
 - Traffic and natural environment
 - Material response models
 - Pavement response models
 - Damage models
 - Probabilistic and recursive implementation schemes
- R&D needs formulated for each component
- Short, medium and long-term actions formulated for each R&D need
- Each action rated in term of benefit/impact and effort/cost

R&D Matrix rating

- Integration level project
 - Integrate output from R&D projects into single design method
 - Reality checks and validation
 - Develop manual on use of method
- Average benefit/impact rating – 4.3
- Average benefit/cost ratio - 260 %

R&D Matrix rating (continued)

- Performance based information system
 - Capture performance of rehabilitation and APT projects
 - Present in user-friendly format
- Average benefit/impact rating – 4.3
- Average benefit/cost ratio - 150 %

R&D Matrix rating (continued)

- Demand analysis
 - Tyre/pavement contact stress information system
 - Average benefit/impact rating – 2.6
 - Average benefit/cost ratio - 88 %
 - Axle load and traffic volume information system
 - Average benefit/impact rating – 4.1
 - Average benefit/cost ratio - 118 %

R&D Matrix rating (continued)

- Demand analysis
 - Guidelines on traffic surveys for pavement design
 - Average benefit/impact rating – 3.6
 - Average benefit/cost ratio - 181 %
 - Vehicle dynamics
 - Average benefit/impact rating – 3.1
 - Average benefit/cost ratio - 116 %

R&D Matrix rating (continued)

- Demand analysis
 - Environmental information system
 - Average benefit/impact rating – 3.6
 - Average benefit/cost ratio - 140 %

R&D Matrix rating (continued)

- Material response models
 - Calibration for appropriate parameters (time, density, saturation, temperature)
 - Average benefit/impact rating – 4.5
 - Average benefit/cost ratio - 143 %
 - Agreement between different methods
 - Average benefit/impact rating – 3.9
 - Average benefit/cost ratio - 111 %

R&D Matrix rating (continued)

- Material response models
 - Documentation on testing and deriving design input
 - Average benefit/impact rating – 4.4
 - Average benefit/cost ratio - 213 %

R&D Matrix rating (continued)

- Pavement response models
 - Correct model of tyre/pavement contact interface
 - Average benefit/impact rating – 2.3
 - Average benefit/cost ratio - 59 %
 - Benchmark of measured stress and strain
 - Average benefit/impact rating – 3.5
 - Average benefit/cost ratio - 118 %

R&D Matrix rating (continued)

- Pavement response models
 - Modeling vertical variation (temperature, density, saturation, stress dependency)
 - Average benefit/impact rating – 3.0
 - Average benefit/cost ratio - 110 %
 - Modeling geometric non-linearity
 - Average benefit/impact rating – 2.5
 - Average benefit/cost ratio - 83 %

R&D Matrix rating (continued)

- Pavement response models
 - Modeling material non-linearity
 - No short-term items

R&D Matrix rating (continued)

- Damage models
 - Improved damage models for asphalt material
 - Average benefit/impact rating – 4.4
 - Average benefit/cost ratio - 132 %
 - Improved permanent deformation models for unbound materials
 - Average benefit/impact rating – 4.6
 - Average benefit/cost ratio - 153 %

R&D Matrix rating (continued)

- Damage models
 - Improved damage models for bound material
 - Average benefit/impact rating – 4.3
 - Average benefit/cost ratio - 213 %
 - Improved modeling of total pavement damage
 - Average benefit/impact rating – 3.6
 - Average benefit/cost ratio - 218 %

R&D Matrix rating (continued)

- Probabilistic and recursive simulation
 - Information system on field variability including effect of time
 - Average benefit/impact rating – 4.0
 - Average benefit/cost ratio - 213 %
 - Guidelines on collection and interpretation of statistical information
 - Average benefit/impact rating – 4.3
 - Average benefit/cost ratio - 153 %

R&D Matrix rating (continued)

- Probabilistic and recursive simulation
 - Probabilistic, linear recursive and non-linear recursive simulation
 - Average benefit/impact rating – 3.5
 - Average benefit/cost ratio - 235 %

R&D Matrix rating

Top 5 impact ratings

- Damage models
 - Unbound materials – 4.6
- Material response models
 - Calibration for appropriate parameters – 4.5
- Material response models
 - Documentation on testing and design input – 4.4
- Damage models
 - Asphalt material – 4.4
- Integration project – 4.3
- Performance based information system - 4.3
- Damage models
 - Bound materials – 4.3
- Probabilistic and recursive simulation
 - Documentation on handling statistical information – 4.3

R&D Matrix rating

Top 5 benefit/effort ratings

- Integration project – 260 %
- Probabilistic and recursive simulation
 - Probabilistic and linear recursive implementation – 235 %
- Damage models
 - Improved modeling of pavement system damage – 218 %
- Damage models
 - Improved damage models for bound materials – 213 %
- Material response models
 - Documentation on material testing and deriving design input – 213 %
- Probabilistic and recursive simulation
 - Information system on field variation – 213 %