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Stress - In - Motion (SIM) Technology in South Africa

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Layout of Presentation:

- Background: South African Pavements
- Heavy Vehicle Simulator (HVS) and Stress-In-Motion (SIM) Equipment
- 3D SIM Results
- Conclusions



EXTENT OF PROVINCIAL (RURAL) ROADS

Extent of the *non-urban* provincial road network in SA is 580 000 km;
300 000 km of gravel roads;
57 000 km surfaced (paved) roads;
Note: 6 713 km National Roads;





CONDITION OF PROVINCIAL (RURAL) ROADS

- Note: Current value of *all* provincial roads is R 205 bn (23 % of GDP);
- > Only 31 % in *good to very good* condition;
- > Approximately 40 % *poor to very poor* condition;
- Therefore, immediate risk to loose R 80 bn of provincial road infrastructure – condition worsening by the day – loosing approx. R 10 bn annually – loose ALL provincial roads in 10 – 15 years !;
- Deep rural connectors or access roads more a *socioeconomic* issue.













Potholes & Patching...

POTHOLES : Water & Loads ...

Sub-grade Failures....

SURFACE DISINTEGRATION

Water & Safety...

TyreS TyreS **TyreS TyreS TyreS TyreS TyreS TyreS TyreS**





Truck Tyre Inflation Pressure in South Africa:



~20 % Increase in 20 Years



c:/capsaf1.wmf

I believe that part of the problem is that :

"In Pavement Engineering, worldwide today, the representation of pneumatic tyre/pavement contact stresses is *oversimplified* by using a circular disc of uniformly distributed pressure, *equal or less* than the tyre inflation pressure".

...Strong indications suggests that this may be far from real - world conditions....



HVS Mark IV+



Vehicular Load Modes





<u>NEW HVS MkIV (PLUS): TYPICAL DYNAMIC LOAD</u> <u>HISTORY</u>





Dynamic Load (HVS Mk IV Plus)







Moving Dynamic Load



Uni-directional Load







Permanent Surface Deformation



11.00 - R22.5 RADIAL HVS TYRES (AFTER CULLINAN ROAD 2388 TESTS)





315/80 R22.5 HVS Tyre ON VRSPTA



425 /65 R22.5 HVS Tyre ON SIM SYSTEM: EXAMPLE OF FOOTPRINT TO FOLLOW.....

CONTACT STRESS DATA (BOLD TYRE): Extreme Loading

FIGURE 6 : Typical contact stress distributions measured with the VRSPTA system for a slow moving (1,2 km/h) free rolling smooth single truck tyre (Goodyear 11.00 X 20, 14 Ply rating)

TYRE "FINGER PRINTING":

LOAD

(HVS : SIM : 11R22.5 TYRE)

INFLATION PRESSURE

Inflation Pressure 520 kPa at Variable Loads of 15 kN - 50 kN

SIM - HVS04 Caravan Side (Tyre 11R22.5 Treaded)

TRUCK AXLE WITH DUAL TYRES (DEFLECTOGRAPH - TYRE TYPE: 11.00 X 20, 14 Ply India Supertex 238)

TYPICAL LAYOUT OF THE VRSPTA MARK III SIM SYSTEM WITH A TYPICAL TRUCK AXLE (DUAL TYRES)

SIM3.DRW

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Deflectograph Truck (80kN, 650 kPa): Vertical Contact Stress

Lateral (Pin Numbers)

Deflectograph Truck (80kN,650 kPa): Lateral Contact Stress

Lateral (Pin Numbers)

Deflectograph Truck (80kN,650 kPa): Longitudinal Contact Stress

Lateral (Pin Numbers)

DEFLECTOGRAPH (OCTOBER 1998)

Test 038-z

MANTSOLE TRAFFIC CONTROLL CENTRE (TCC) ON NATIONAL ROAD NR 1 (N1)

Full Axle SIM

North

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MANTSOLE TCC

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AXLE 5

Vertical Maximum Contact Stress (kPa)

COMPUTER ANALYSES OF ROAD PAVEMENT STRUCTURES

✓ SYMPLISTIC ANALYSIS: MULTI-LAYER - LINEAR - ELASTIC THEORY;

COMPLEX: FINITE ELEMENT
 METHOD + NON – LINEAR - ELASTIC
 THEORIES;

Radial Distance (mm)

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UNIFORM VERTICAL STRESS (520 kPa) STRAIN ENERGY OF DISTORTION (SED)

NON-UNIFORM STRESS (EDGE) (420 kPa) STRAIN ENERGY OF DISTORTION (SED)

Colour maps of Shape distortion (Symplectic Engineering Corporation)

0.911 (May Stress)

MODELED TYRE

KEY:

SIM - 600 kPa, 35 kN

100 kN Axle WHEEL 25 kN 25 kN 25 kN 25 kN LOAD Road Percentile Load Contact Category Values (%) **Radius Stress** [TRH4 (1996)] (kPa) (mm) D **50 660** 110 C 80 865 96 B **90** 975 **90** A 95 **985** 90

RECOMMENDED (INTERIM) TYRE CONTACT STRESSES

CONCLUSIONS AND RECOMMEDATIONS....

- 1. SIM Technology resulted in improved pneumatic tyre/pavement contact stress definitions;
- 2. Tyres to be "finger printed" for pavement design;
- 3. Potential for *more rational* pavement design, performance and analysis methods;
- 4. Potential savings of ECUmillions, if effectively employed...
- Safety: Need to test at higher speeds-including car tyres – Europe ? (TNO Automotive) - Gerotek !?;
- 6. Need for tyre test track of International standard ?;
- 7. Institute of tyre/pavement technology ??;
- 8. International Co-operation ?.

I Thank You all !!

