Focus on CSIR research in
STRESS-IN-MOTION (SIM)

CSIR Built Environment
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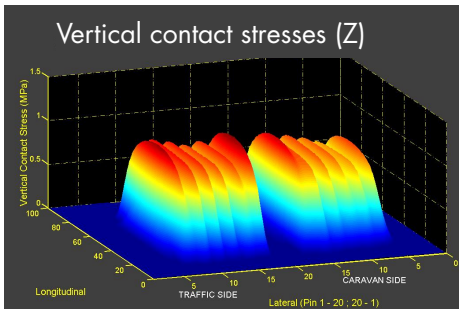
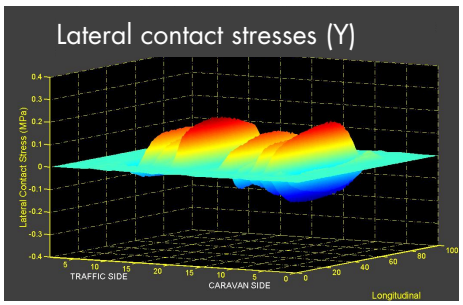
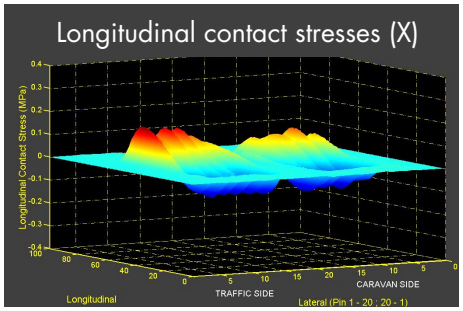
STRESS-IN-MOTION (SIM)

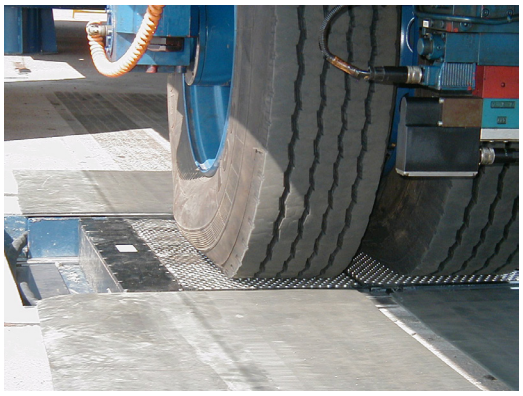
SYSTEM FOR TYRE/ROAD/PAVEMENT INTERFACE CONTACT STRESSES







Above and right:
SIM systems as part of a vehicle monitoring station and results



Tyre/road interface stresses are those induced by vehicular traffic running on roads, and are the primary cause of surfacing problems.

The cost of asphalt layers is often the most significant in road construction and maintenance work. It is therefore of great importance to design towards an optimum asphalt layer type and thickness in relation to the supporting road structure, and the expected axle/tyre loading and tyre contact stresses.

CSIR Built Environment, in association with industry, has developed a unique system that simultaneously measures the vertical (Z), transverse (Y) and longitudinal (X) vehicle tyre/road interface contact stresses under a moving wheel load. This technology, dubbed Stress-in-Motion (SIM), provides some of the most important inputs into modern mechanistically-based road pavement design for optimising the cost of roads over their design life.

The SIM system has been developed since the early 1990s as part of Heavy Vehicle Simulator (HVS) road testing (see photo top right); partly industrialised versions are available as SIM Mk V.

As a component of road pavement research, it was once introduced into vehicle monitoring stations in South Africa (see photo top left). SIM technology could be made available for specific client-defined measurement programmes as a product or service.

System Overview

The SIM MARK V SYSTEM measures the 3D contact stresses of slow moving vehicle tyres on a road surface.

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This system consists of the following main components (see figures 1 to 4).

a. 350 mm measuring width: One single SIM pad placed in a road surface, with 21 (3D: X, Y, Z) measuring pins.
b. 700 mm measuring width: Two SIM pads placed in a road surface, with 2 X 21 (3D: X, Y, Z) measuring pins.
c. 1 050 mm measuring width: Three SIM pads placed in a road surface, with 3 X 21 (3D: X, Y, Z) measuring pins.
d. 2 100 mm measuring width: Two sets of three SIM pads placed in a road surface, each pad with 21 measuring pins. Using all six pads, a width of more than 2 100 mm can be measured.
e. A Pad Enclosure Assembly (PEA) attached to each of above-mentioned two sets of pads.
f. A triggering and speed system assembly, mounted on each pad, to start the acquisition process and measure vehicle speed.
g. A power supply assembly is included in the PEA of each set of pads.
h. A main computer assembly, with data acquisition hardware and application software, is also included in each PEA.
i. Interconnecting cables for all of these.
j. A detection sensor to gather information about the number of axles for each vehicle.
k. A user PC station has to be supplied and set up by each user. The description of this station is not included here.

Nominal technical details (product description) SIM Mk V

Mechanical:

- Overall dimensions (per pad):
  - pad only: 840 mm x 370 mm x 136 mm;
  - controller housing: 600 mm x 760 mm x 136 mm;
  - customer supply: PC with display (main computer)
- Weight (per pad):
  - pad only: ~ 200 kg;
  - controller housing: ~ 120 kg;
- Effective measuring width per system (see figures 1 to 4):
  - 350 mm for single SIM pad;
  - 700 mm for double SIM pads;
  - 1 050 mm for three SIM pads;
  - Up to 2 100 mm for 6 x SIM pads;
- Calibration needs:
  - Pin Calibration by manufacturer;
  - the central measuring section has to be calibrated in 3D (X, Y, Z direction) once a year -
    - normally at the manufacturer as special tooling is required
    - vertical verification tooling is available to check calibration needs, such as total loading;
- Speed Measurement:
  - integral vehicle speed measurement of up to ~ 30 km/hr;
- Triggering mechanism:
  - integral activation
- Loop vehicle/axle detector:
  - a loop detector is required to determine number of axles per vehicle;

Electrical/electronic/software:

- Power requirements:
  - 220/240 V AC regulated;
- Ethernet interface to PC: 100 base TCP/IP;
- USB interface to PC for set-up
- temperature range:
  - -20 to +50 degree C;
- output to PC is a matrix with forces in the X, Y, Z directions for each measuring sensor;
- PC software: SIM application software on main computer;

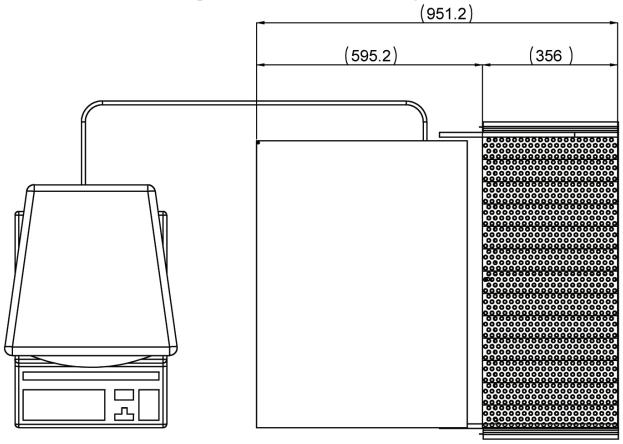
Measuring principle:

- Rolling tyre – triggered by integral trigger

Data acquisition:

- PC/notebook minimum requirements:
  - Pentium class PC with colour screen, keyboard, mouse, one unused serial port, hard disk and at least 16 Megabytes of RAM
  - MS DOS operating system (or Windows 95/98, running in DOS mode)
- X, Y, Z sampling rates:
  - pin data will be sampled continuously and placed in a buffer (or file) for processing
  - Maximum sample rate of 1 kHz per channel for normal use and adjustable via a command in *config file* over Ethernet.

SIM modular concept (Mk V) - See figures 1 to 4



1 PAD ASSY

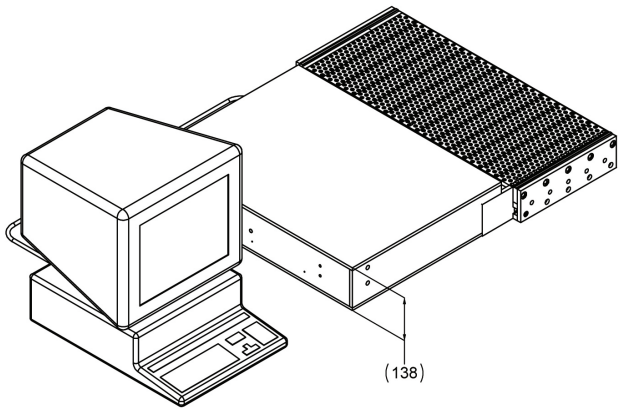


Figure 1: Single SIM pad assembly (350 mm measuring width)

SIM modular concept (Mk V) - See figures 1 to 4 (cont)

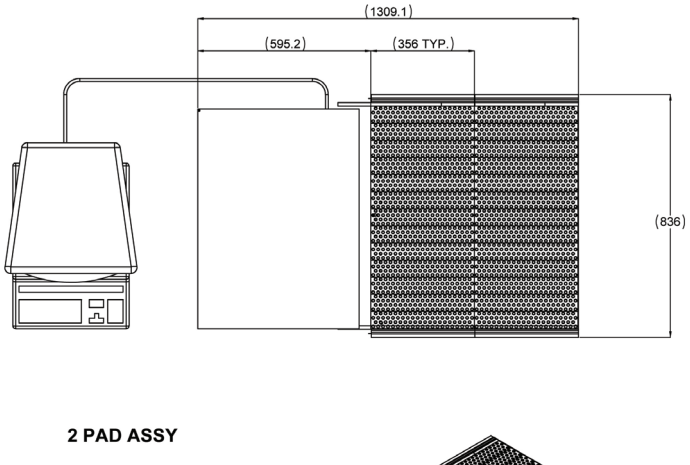


Figure 2: Dual SIM pad assembly (700 mm measuring width)

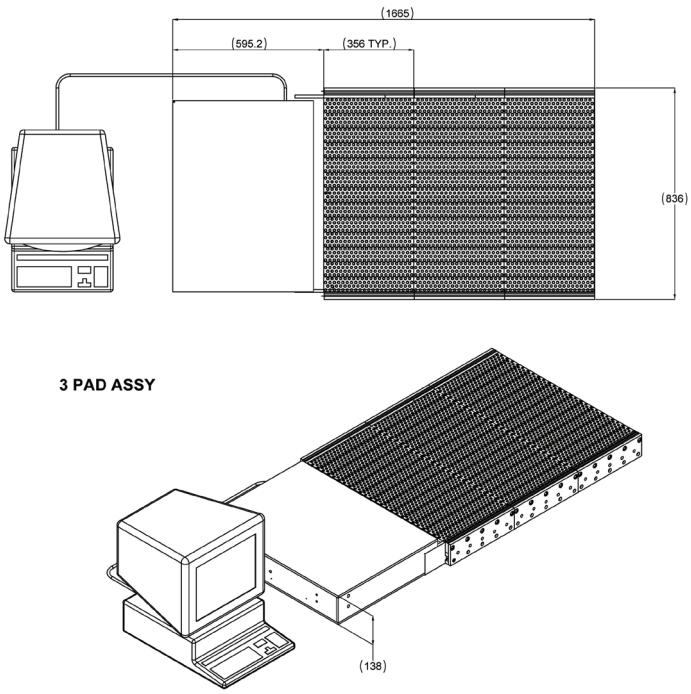


Figure 3: Triple SIM pad assembly (1 050 mm measuring width)

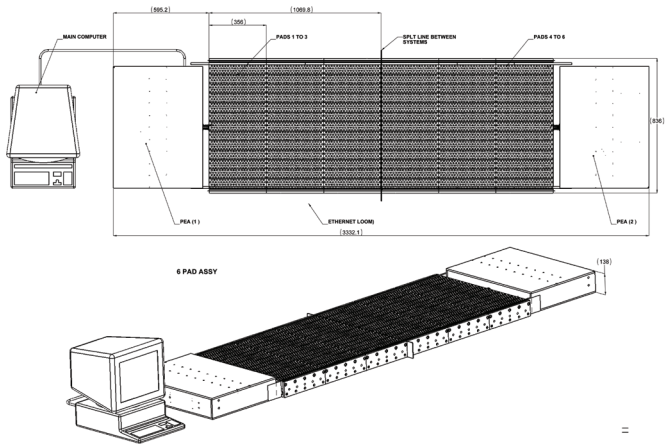


Figure 4: 2 x triple SIM pad assemblies (2 100 mm measuring width)

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(Patent, licencing and trademarks pending)

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