Vehicle-Pavement Interaction Software

SCI/NARC Conference: Asphalt – What's around the corner

20th March, 2014

narc

Nottingham Asphalt Research Consortium

cvdc

Cambridge Vehicle Dynamics Consortium

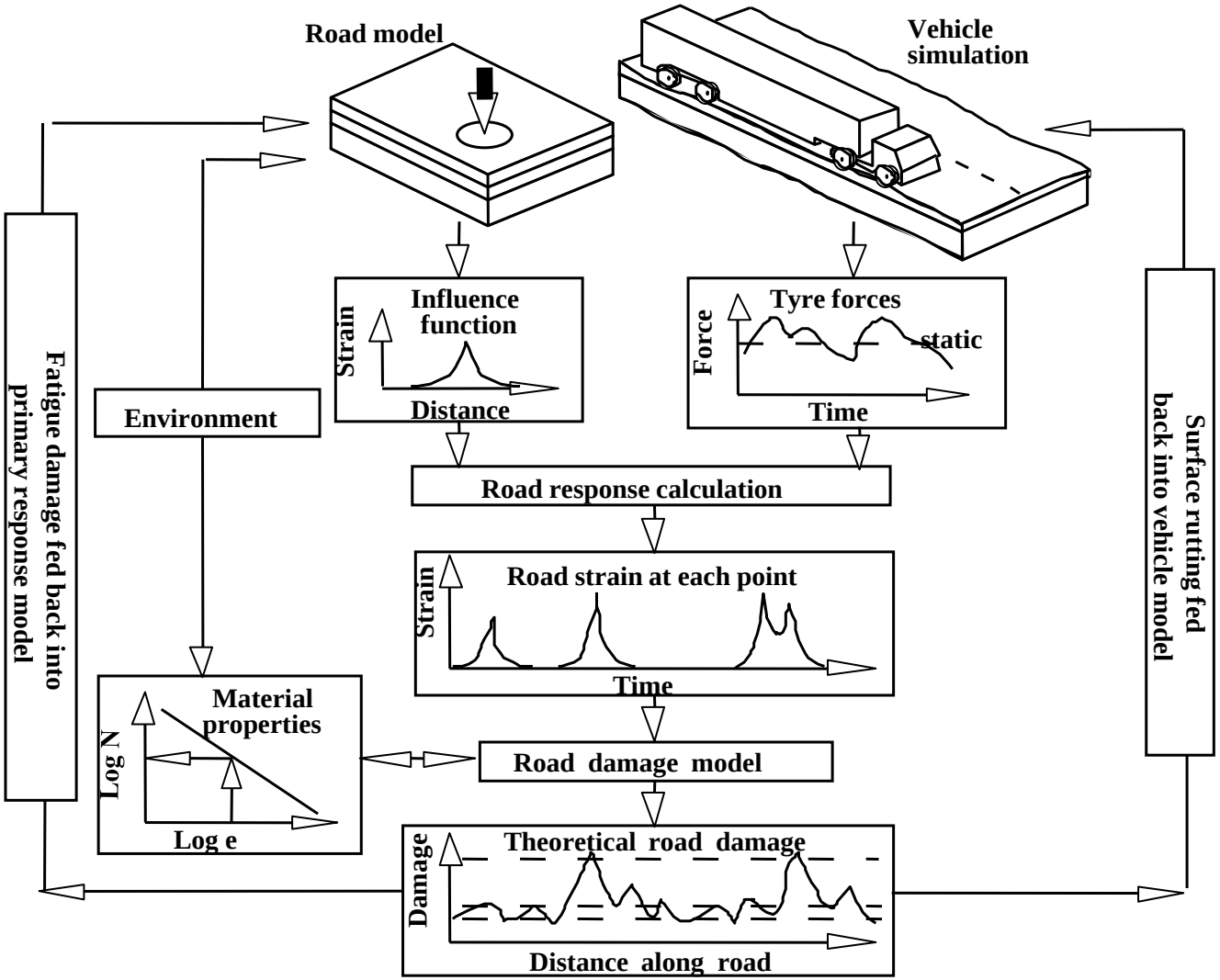
ASSET

RTA

Presentation Contents

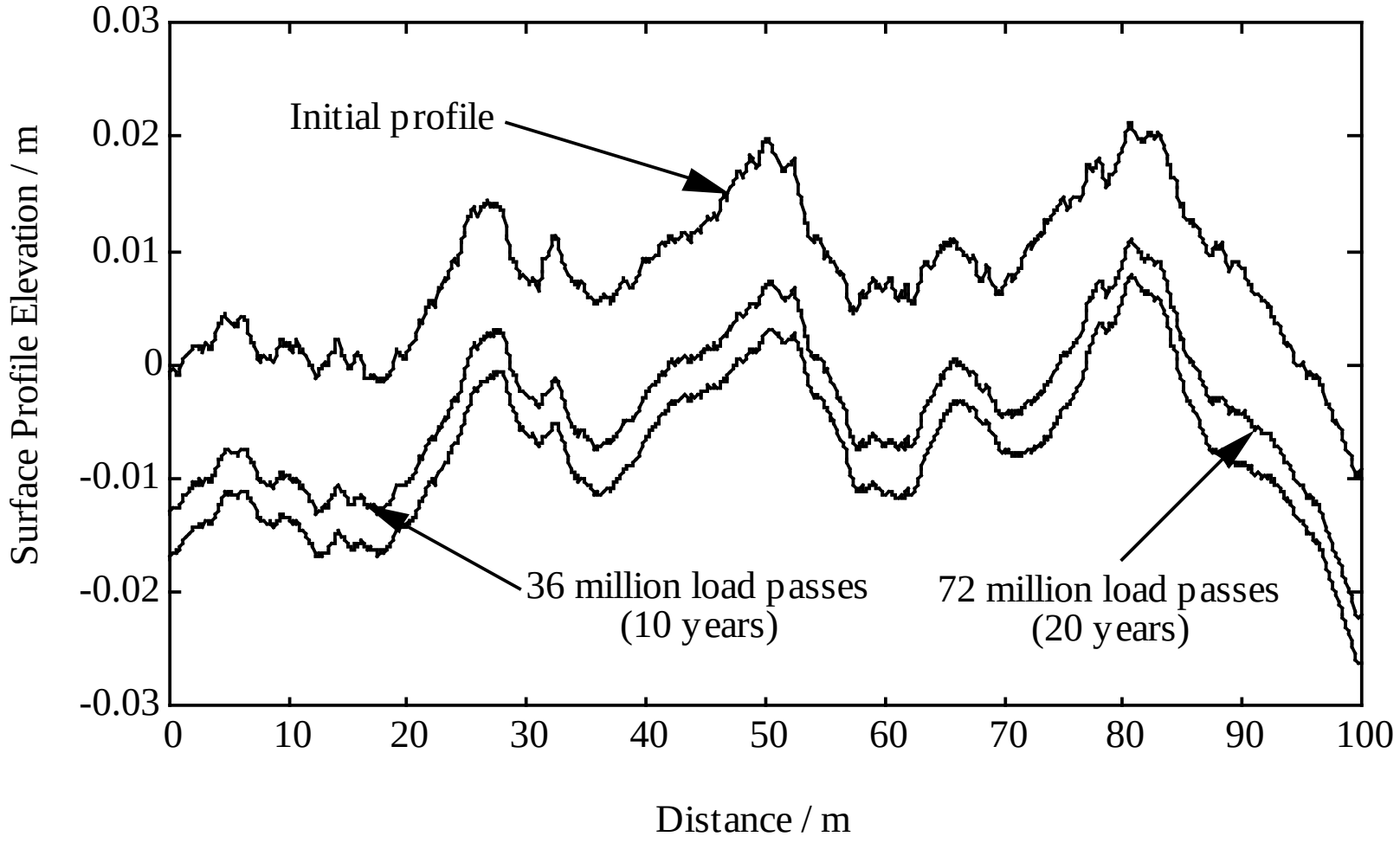
1. Background
2. Vehicle-pavement interaction modelling
3. The VPI framework
4. Conclusions

Background



Collop and Cebon (1995)

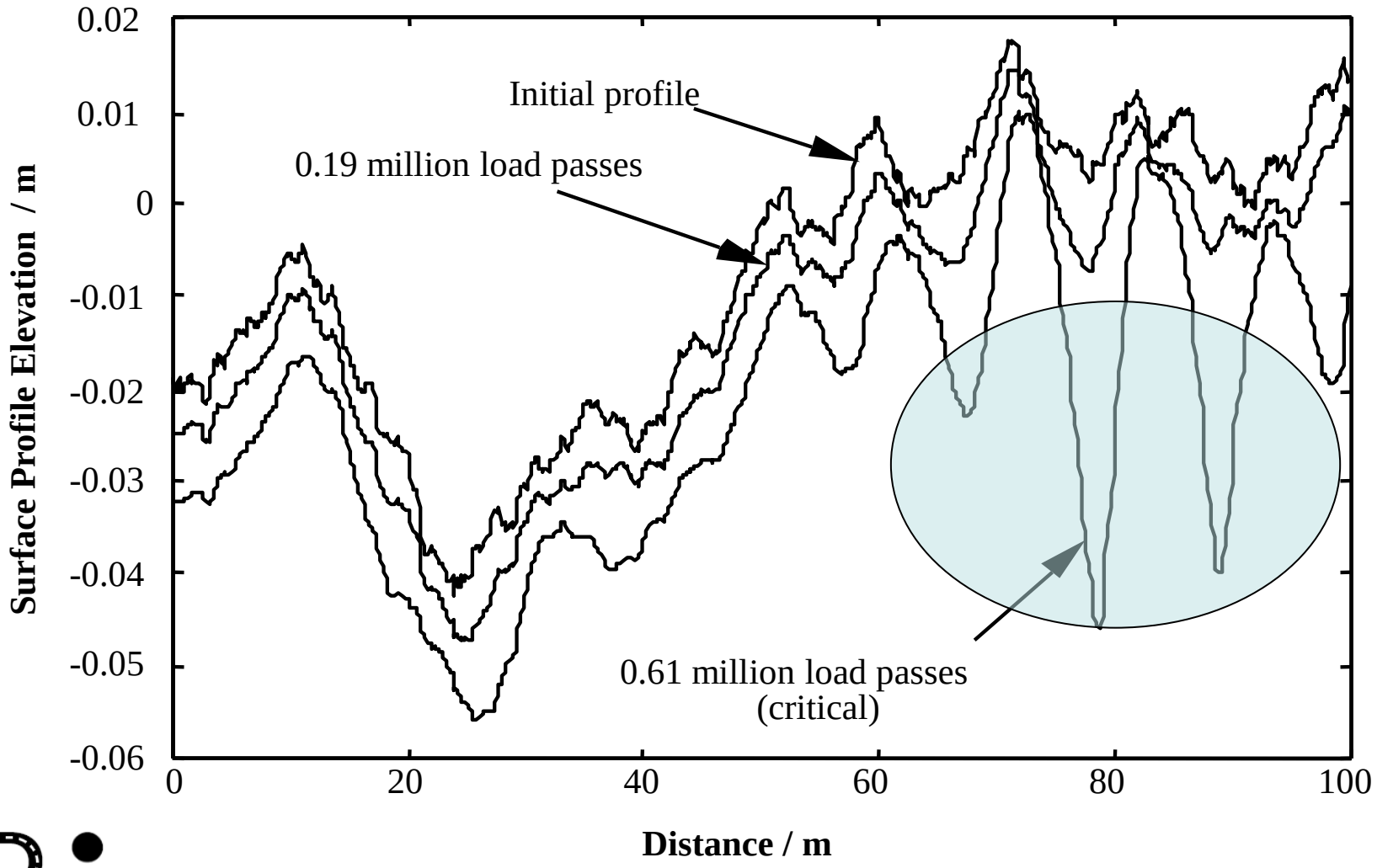
Steel Suspensions, Major Road



Collop and Cebon (1995)

Rutting of a Motorway

Steel Suspensions, Minor Road

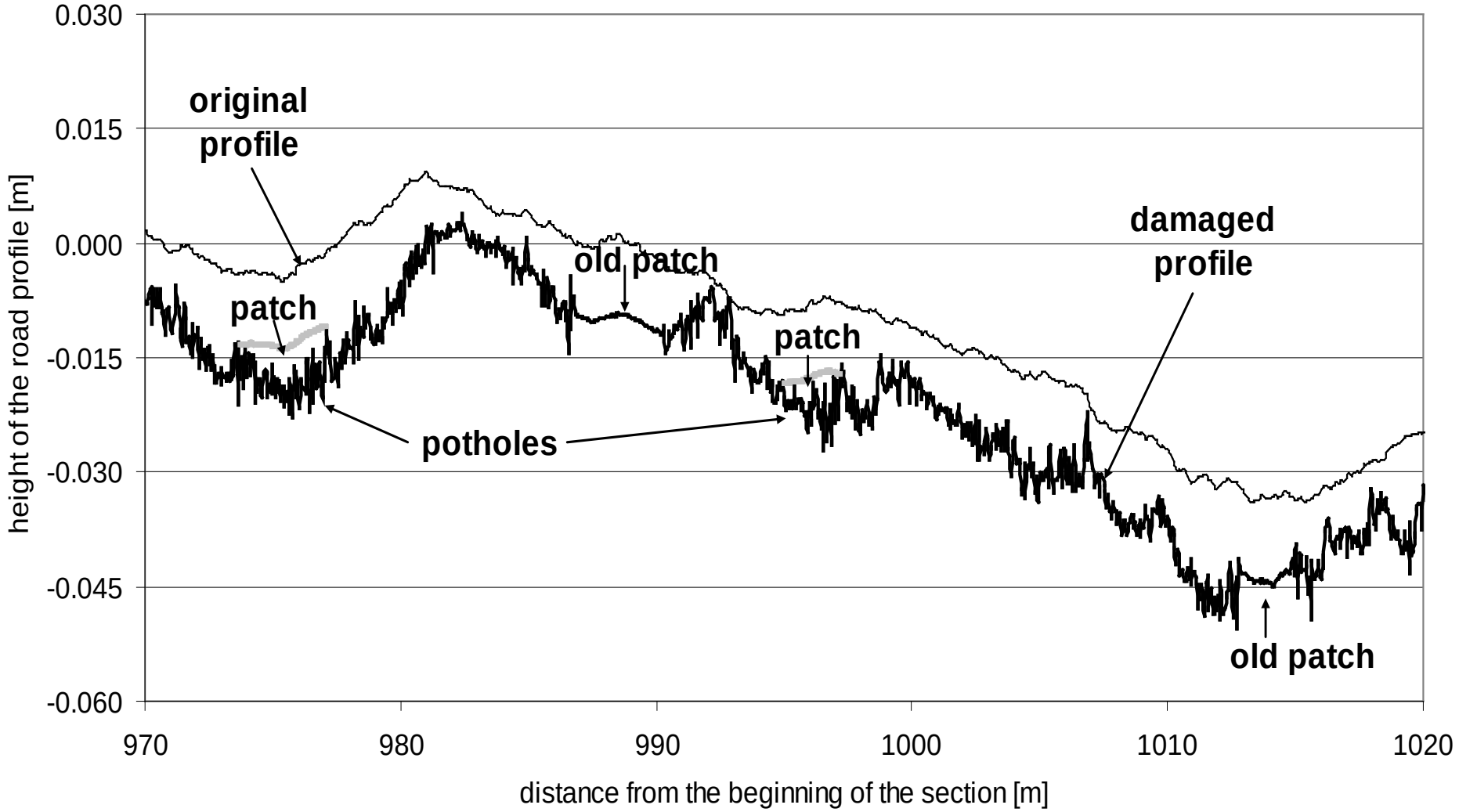


Collop and Cebon (1995)

Damage to a Minor Road

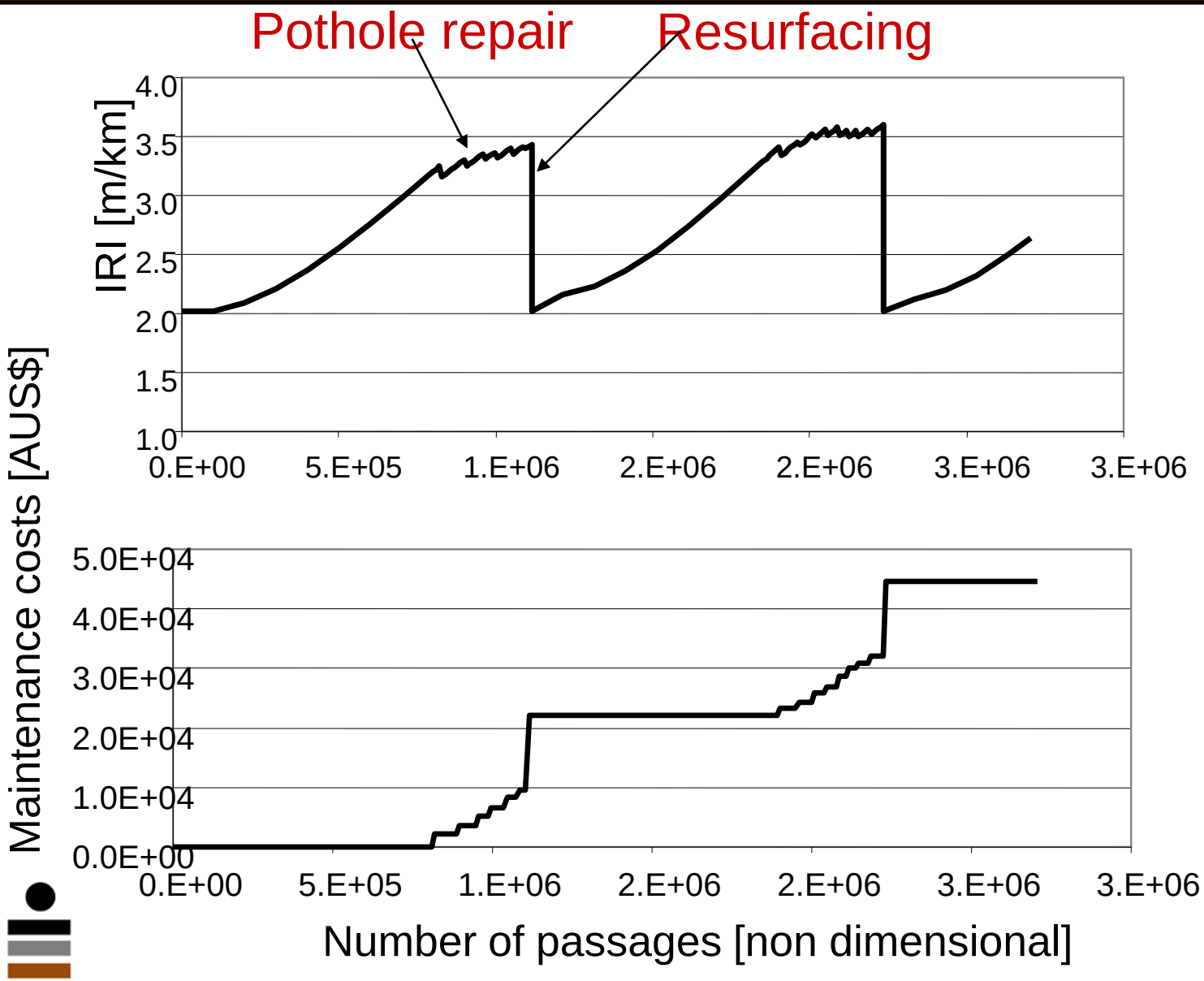
Road Profile – Leaf Springs

Costanzi and Cebon (2007)



Surface Roughness: Leaf Spring Suspensions

Costanzi and Cebon (2007)



Results – Weak Roads

COMPOSITION OF THE FLEET				
Type of suspensions	Fleet #1	Fleet #2	Fleet #3	Fleet #5
Leaf springs on the trailer	100%	0%	0%	0
Air springs – well maintained shock absorbers	0%	100%	0%	50%
Air springs – poorly maintained shock absorbers	0%	0%	100%	50%
AVERAGE RESURFACING COST [AUS$/km/1000 tonnes payload] for each lane				
Concessional Mass Limits Mass limit for (6 axle) tractor with semi-trailer: 43.5t	0.53 (ref.)	**0.45** **(-14.3%)**	0.68 (+28.7%)	0.56 (+4.5%)
Higher Mass Limits (GVW = 45.5t) Mass limit for (6 axle) tractor with semi-trailer: 45.5t	Not allowed	**0.52** **(-1.2%)**	0.77 (+46.2%)	0.63 (+20.8%)

Costanzi and Cebon (2007)

General Purpose Modelling Tool

VPI (Vehicle-Pavement Interaction)

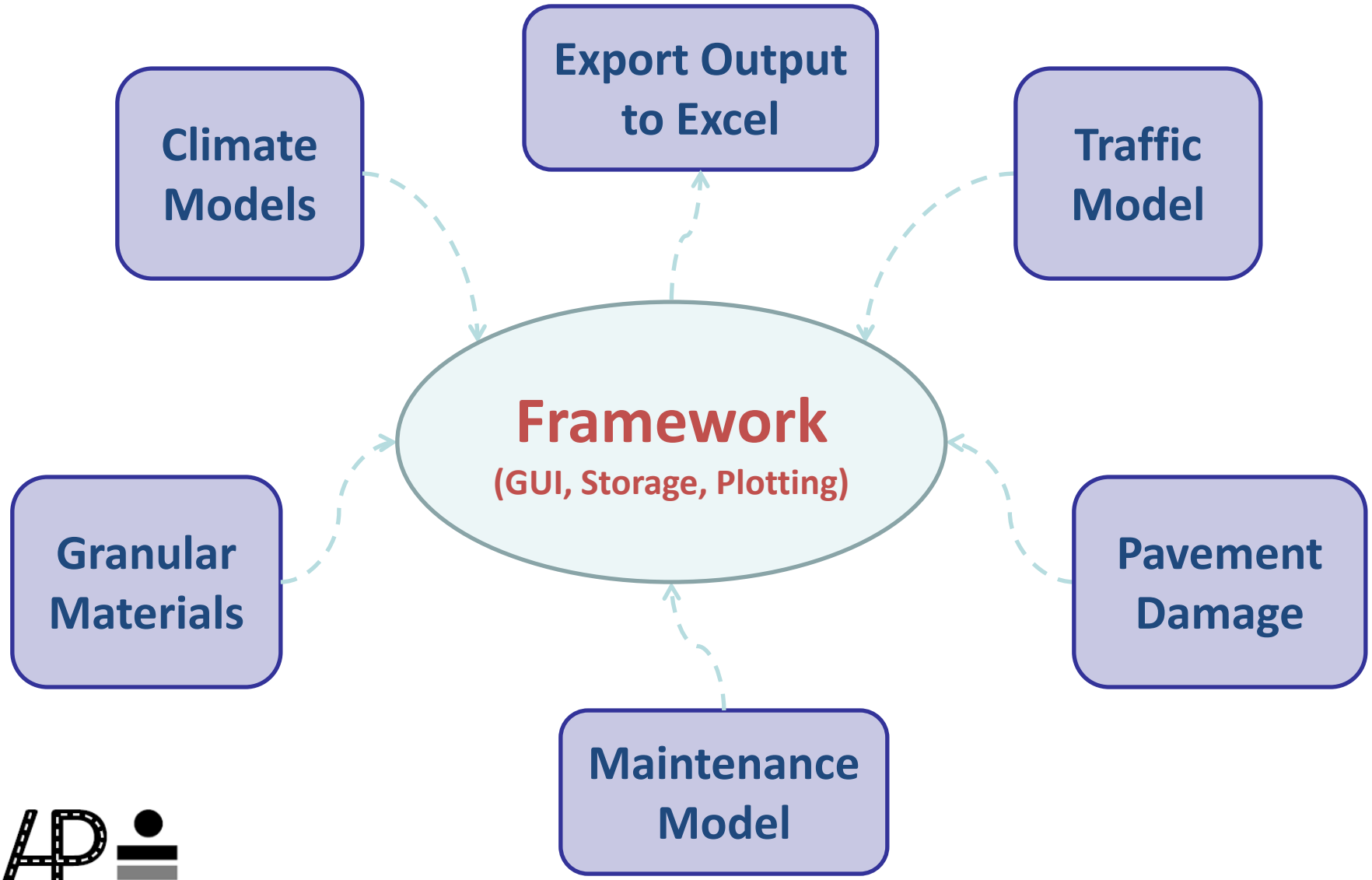
The Need

- A user friendly software tool to model vehicle-pavement interaction with:
  - dynamic vehicle models
  - road life and damage models
  - road maintenance and cost estimation
- User extendable to area of interest
- For use by:
  - Researchers
  - Highway practioners
  - Vehicle industry

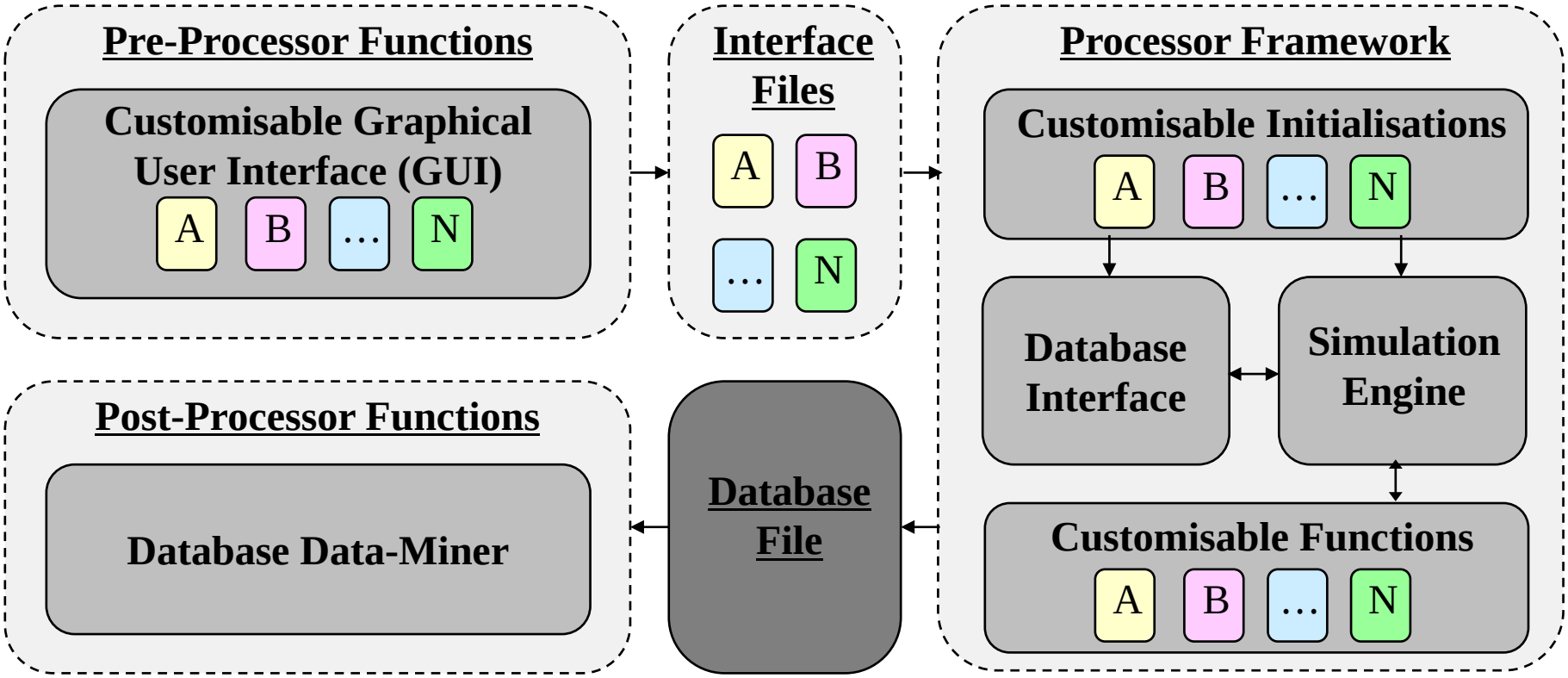
Key Features

1. Practicalities:
   - Database to handle large amounts of data
     - Many vehicle models
     - Many points of interest on road surface
   - Computationally efficient
2. Example uses:
   - Measure road ‘friendliness’ of suspensions
   - Quantify effects of road and vehicle design on maintenance costs of both

Software Concept for Modelling Road Damage

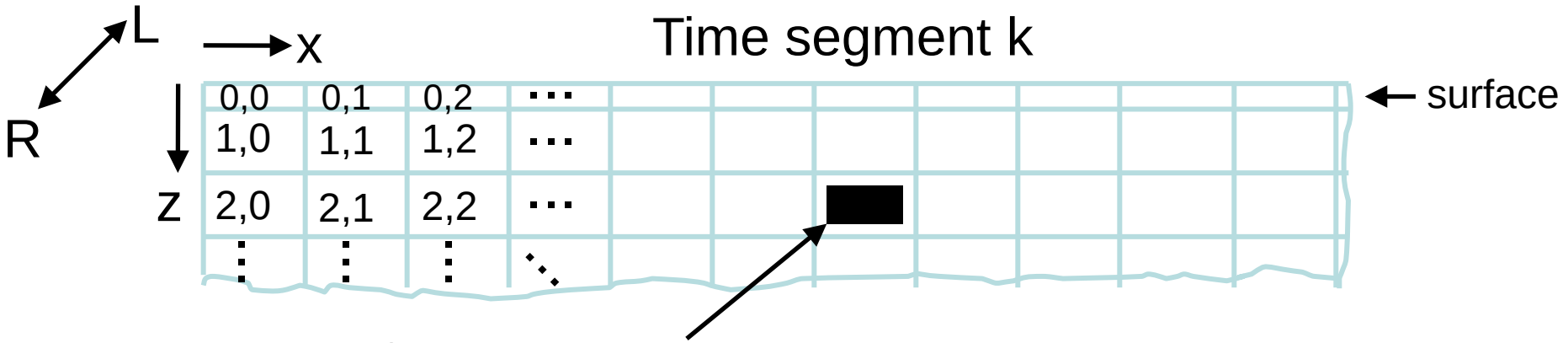


Overall Software Architecture



A B … N indicates areas customisable using example modules A to N

Data Storage Requirement



- Record for each element contains:
  - Geometry
    - Thickness
    - Length
  - Microclimate
    - Average temperature
    - Moisture level
  - Environment
  - Primary response
  - Drainage
  - Materials properties
  - ...

- 4 road layers * 2000 points along road * 1250 weeks in 25 years = 10^7 records

Setup Run Analyse Export Exit

Setup Menu

- Save from current tab
- Load to current tab
- Save from all tabs
- Load to all tabs
- Help for current tab

Space for placing relevant contents.

Setup Run Analyse Export Exit

Setup Menu

- Save from current tab
- Load to current tab
- Save from all tabs
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- Help for current tab

Simulation Settings | Climate Model | Road Structure

Number of layers: 2

Layer 1 | Layer 2

Material type: Thickness: 0.2 m

Material name: Load material

Material properties:

Resilient | Plastic | Thermal | Hydraulic

e1p0

n

m

s kPa

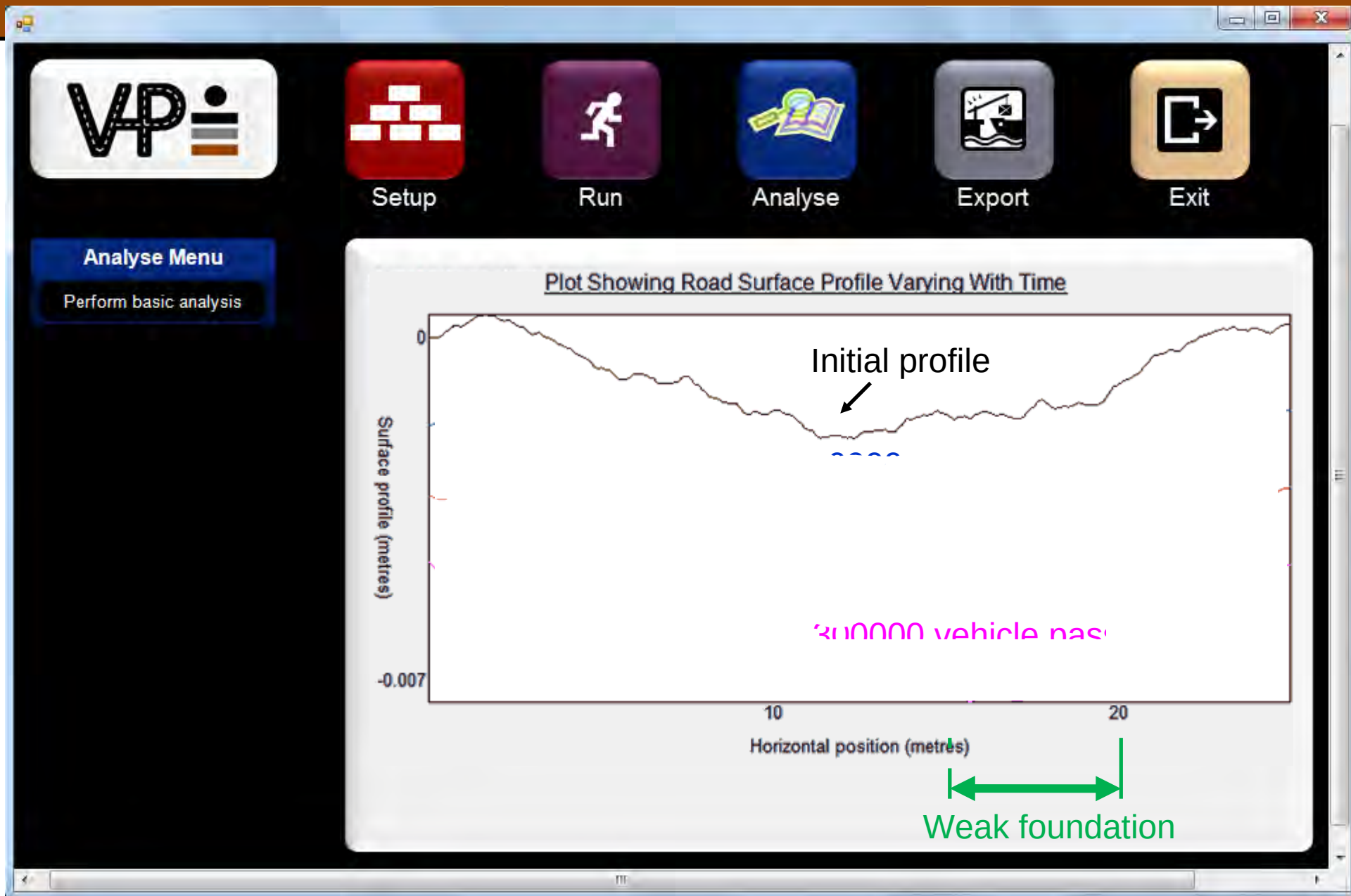
Grading:

Base course

Compacted

Save material

Example Result: Weak Foundation



Conclusions

1. Strong need to model vehicle-pavement interaction
   - Researchers
   - Legislators
   - Highway and vehicle industry professionals
2. VPI software – collaborative tool:
   - User friendly
   - Extendable and adaptable
   - Available Q4, 2014

➔ A framework for future research and practice in pavement engineering