The University of Nottingham

Long-term flexible pavement performance modelling

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NTEC
Nottingham Transportation Engineering Centre

Outline

- Introduction
- LTPPM
- Summary & future developments

Introduction

- Long-Term Pavement Performance Model (LTPPM) developed with University of Cambridge in late 1990s (Prof. Cebon)
- Original objective was to investigate the effects of dynamic loading on long-term pavement performance (move away from 4th power law)
- **Deterministic** iterative procedure (profile tracking)
- Flexible (asphalt) pavements

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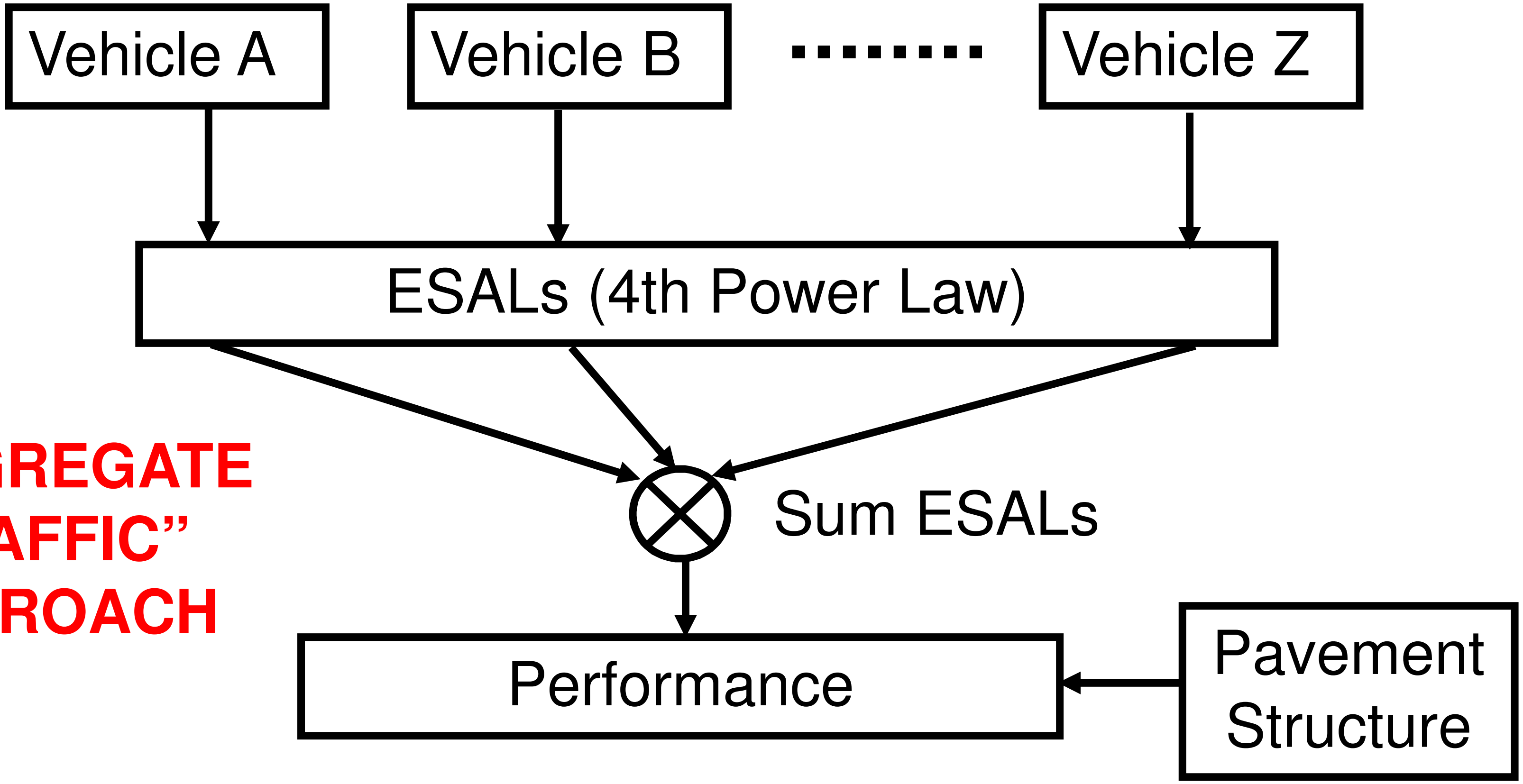
Aggregate traffic approach



"AGGREGATE TRAFFIC" APPROACH

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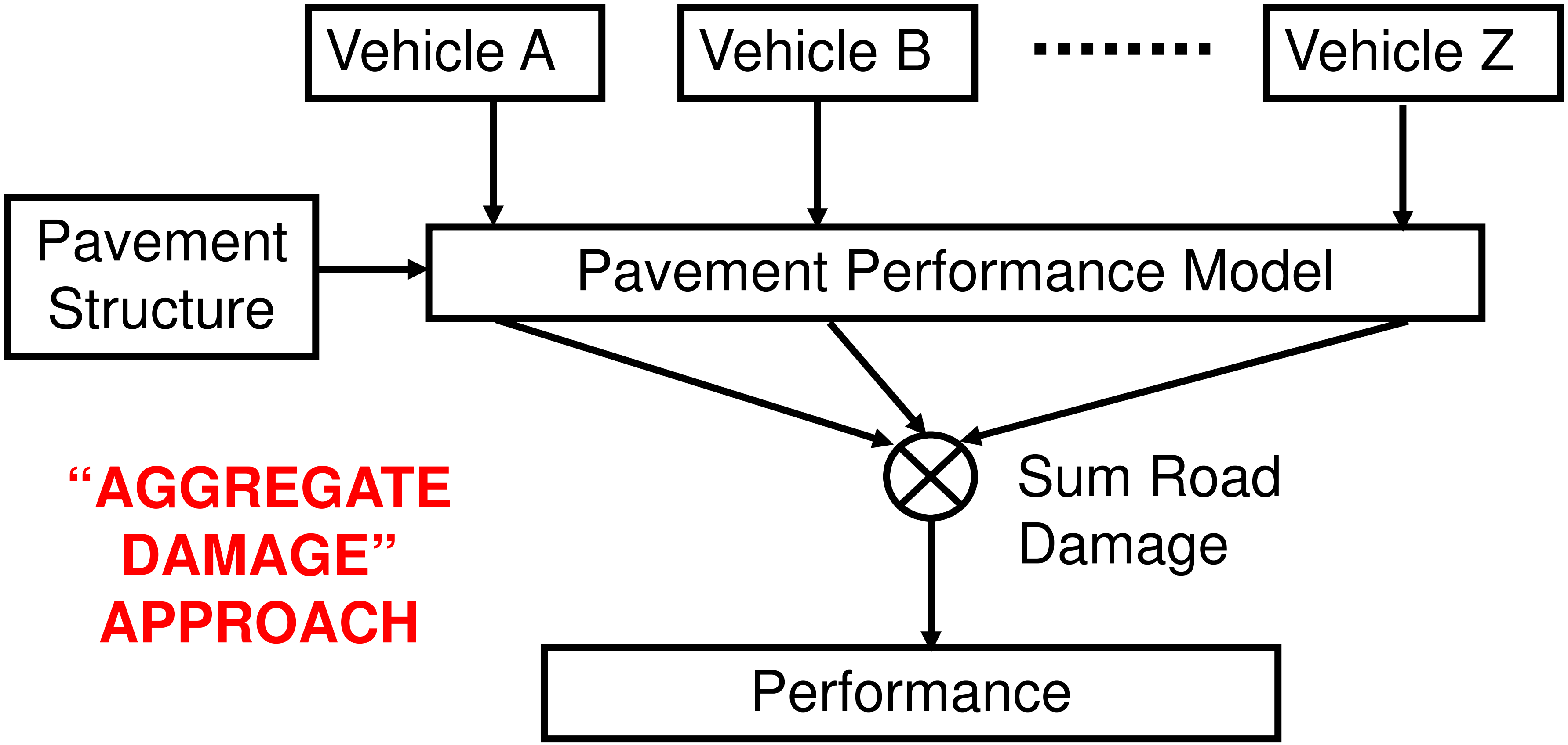
Aggregate damage approach



"AGGREGATE DAMAGE" APPROACH

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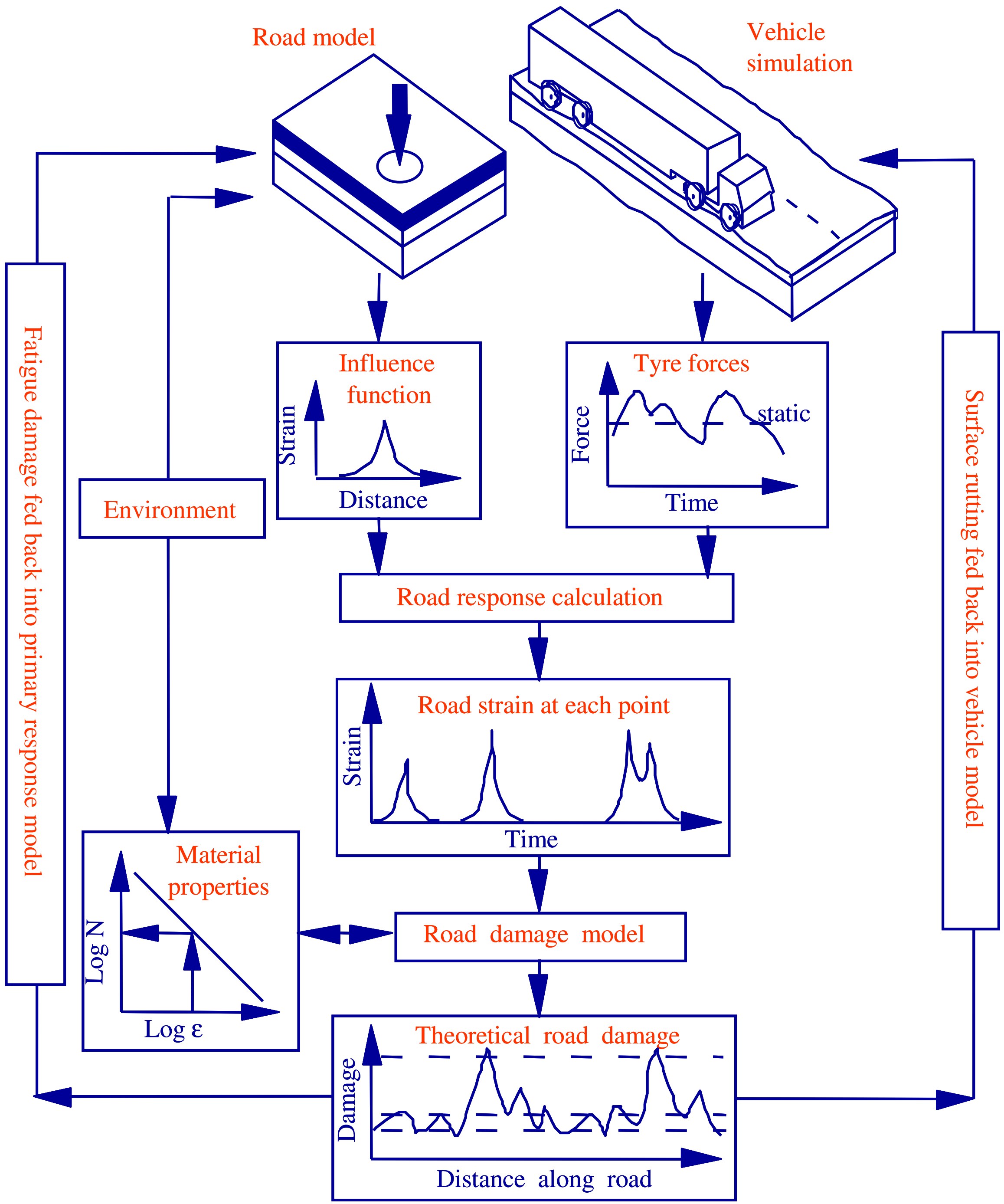
Damage prediction

- Dynamic vehicle/axle group models
- Primary response calculation
- Asphalt layer thickness variations
- Damage calculation
- Feedback mechanisms



Spatial repeatability

- All heavy goods vehicles are reasonably similar in design
- They travel at similar speeds
- With similar magnitude loads
- Over a similar surface profile
- Are the loads applied to the pavement surface random or do the peak loads occur in similar locations (spatial repeatability)?

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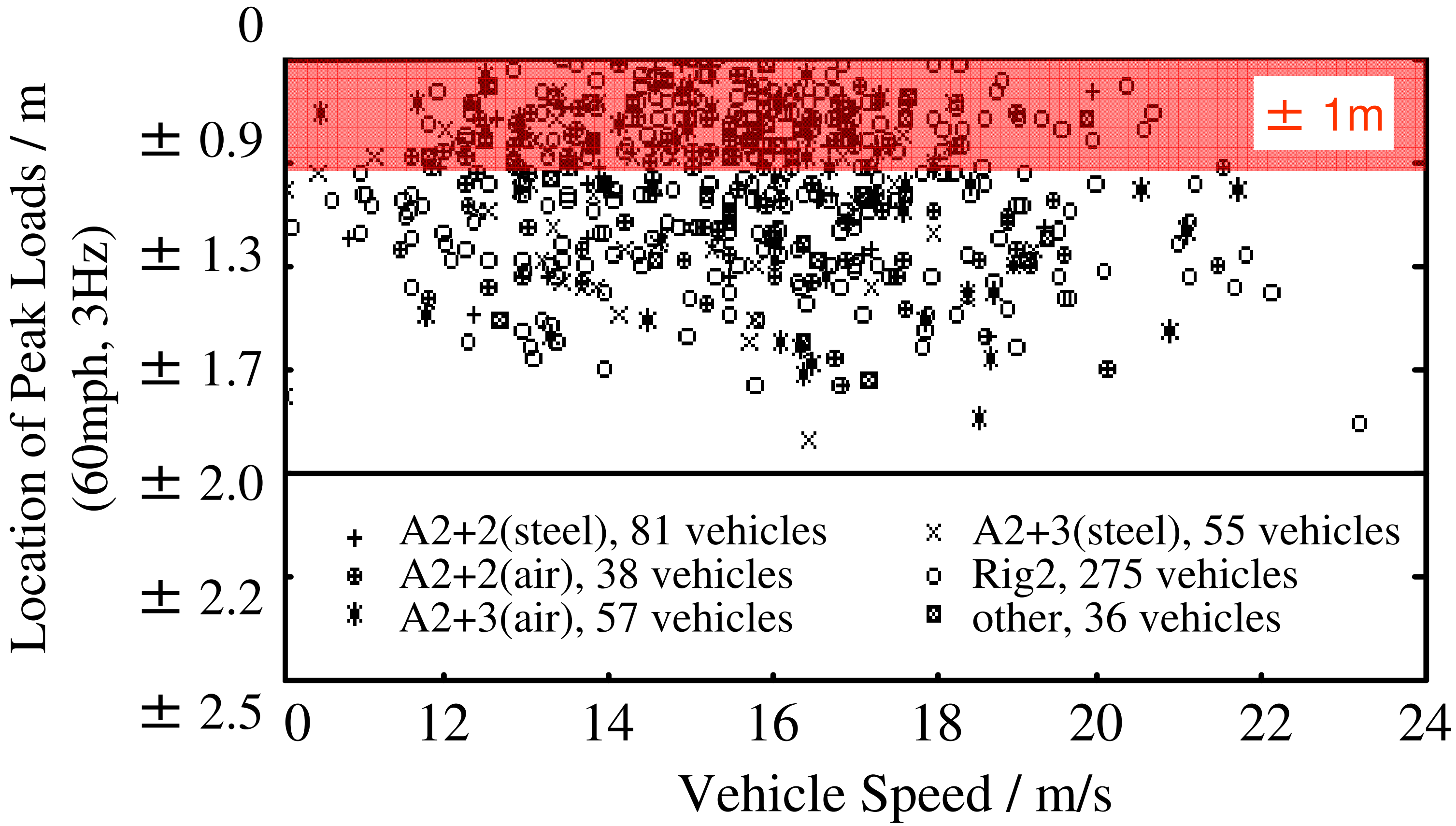
Full-scale experiments

Data from 542 vehicles



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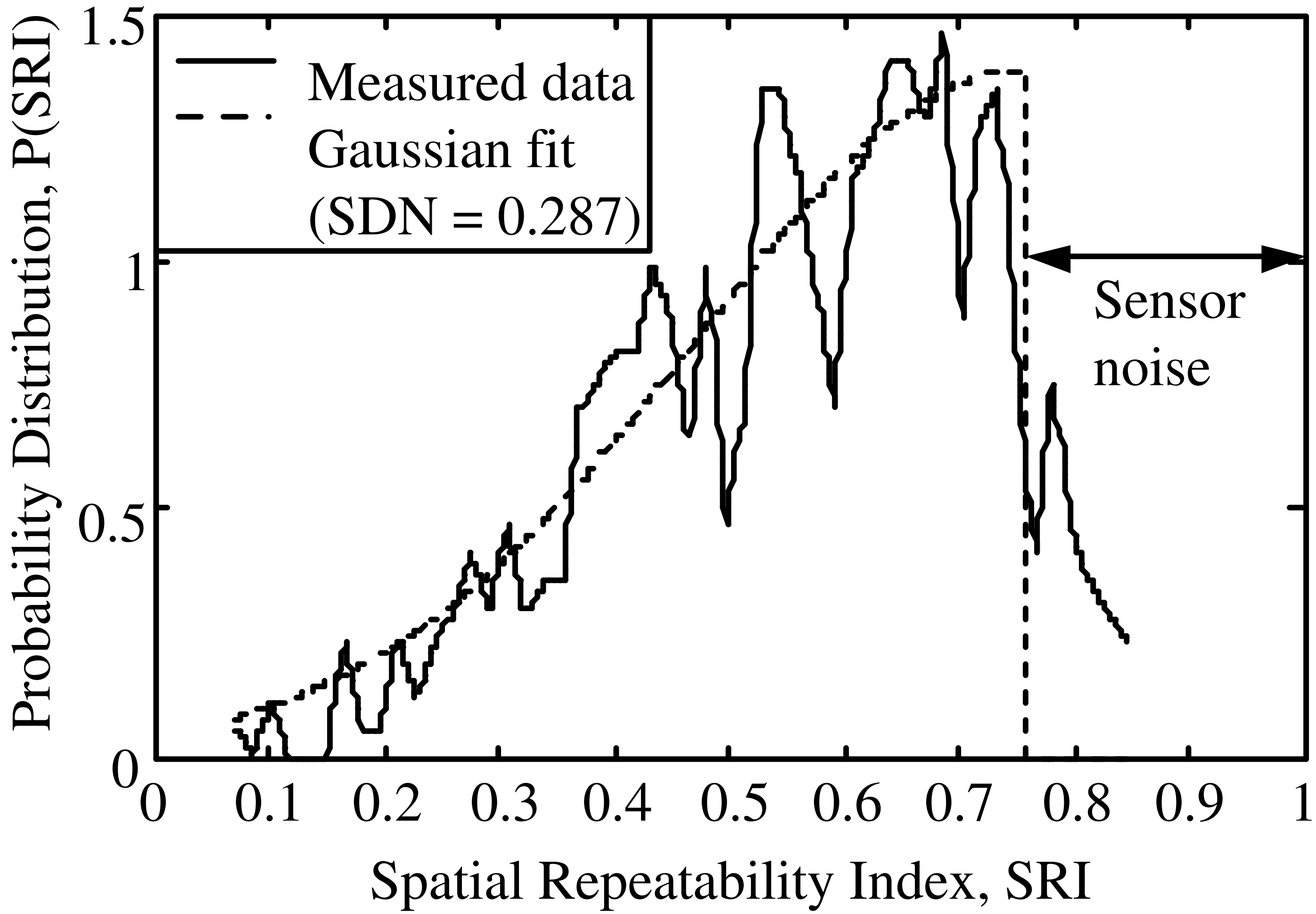
Spatial Repeatability Index



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Asphalt damage

- Fatigue damage included as a loss in stiffness of the asphaltic material
- Data from ALF trials in Australia used to develop relationship
- FWD tests undertaken regularly
- Back-calculated asphalt stiffness related to expected level of fatigue damage
- Minimum normalised stiffness of 0.2

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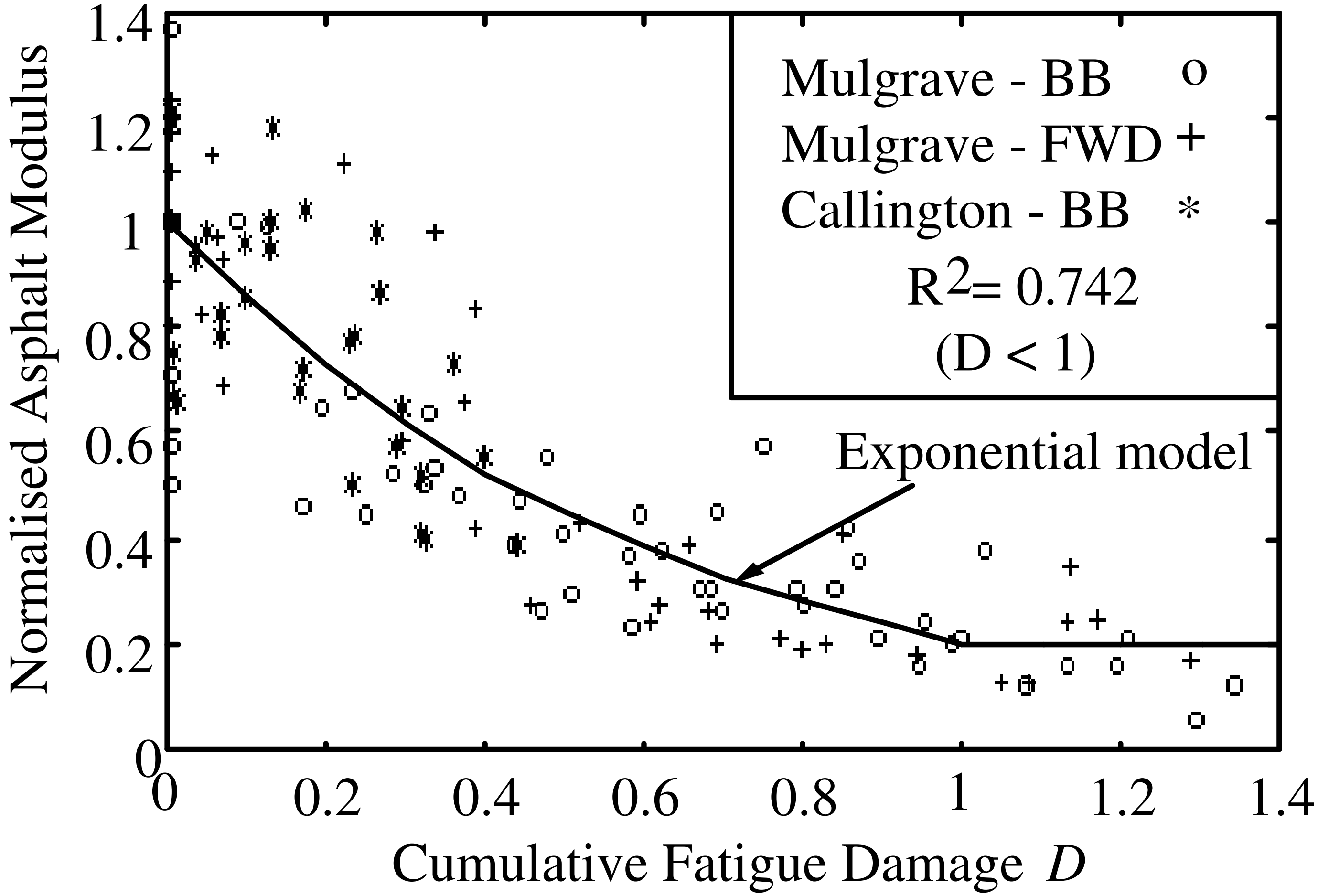
Normalised stiffness



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Example

- Simulations to investigate the effect of changing to “road friendly” air suspensions
- Major road (350mm asphalt)
- Minor road (150mm asphalt)
- 3 layer structure
- Quarter car vehicle model
- 4-18^{o}C temperature variations
- Results compared to EU approach

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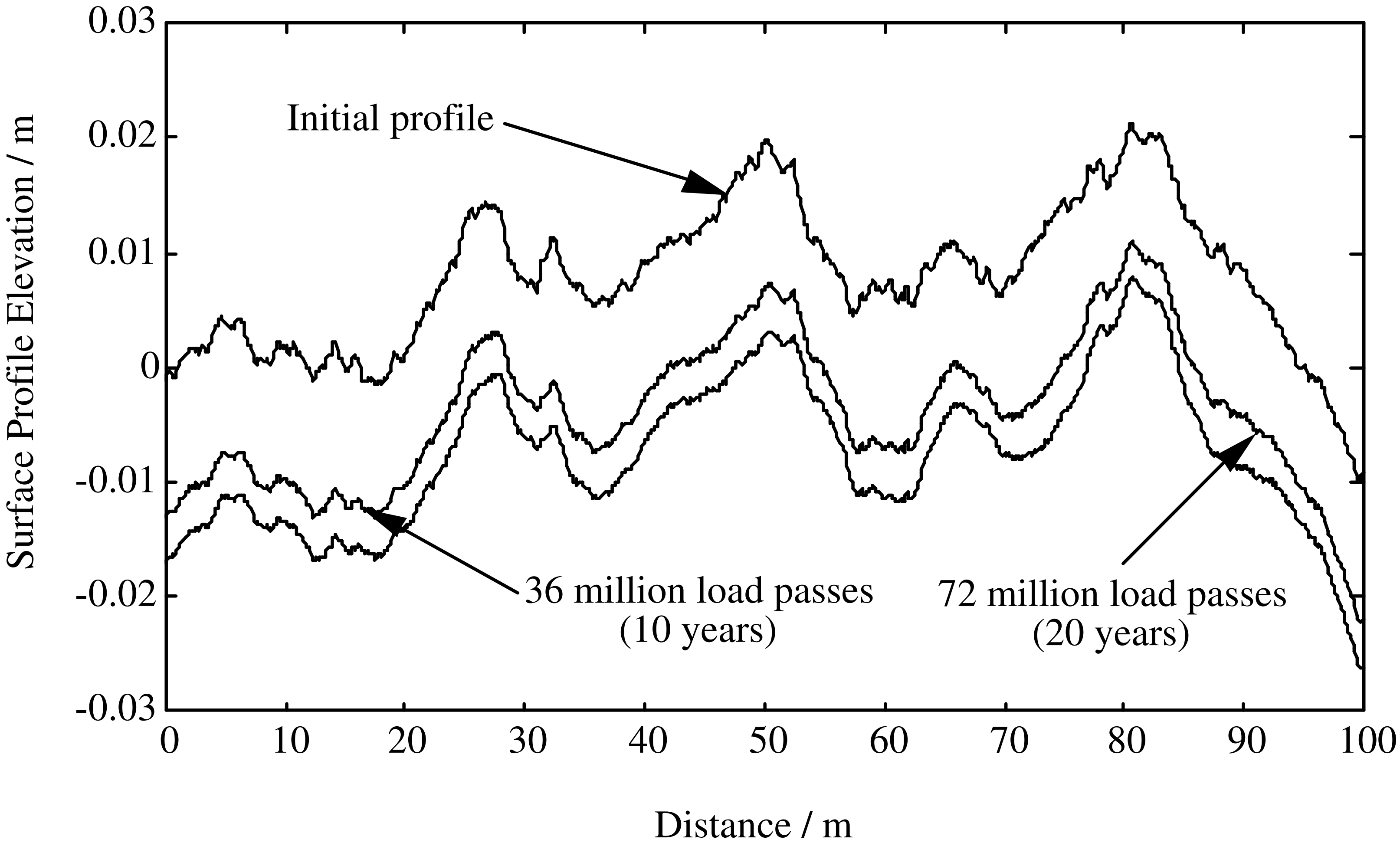
Surface profile evolution



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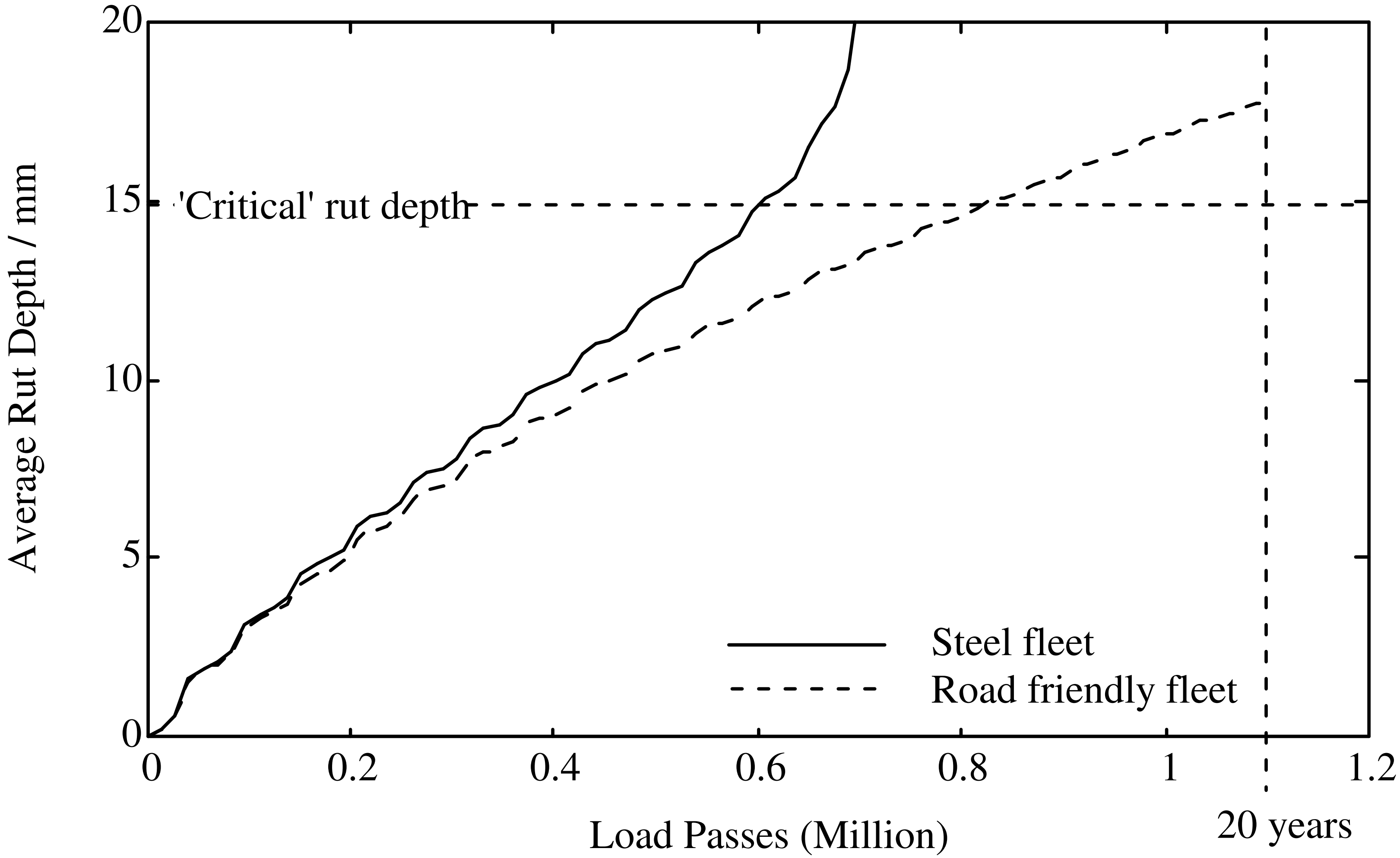
Rutting evolution



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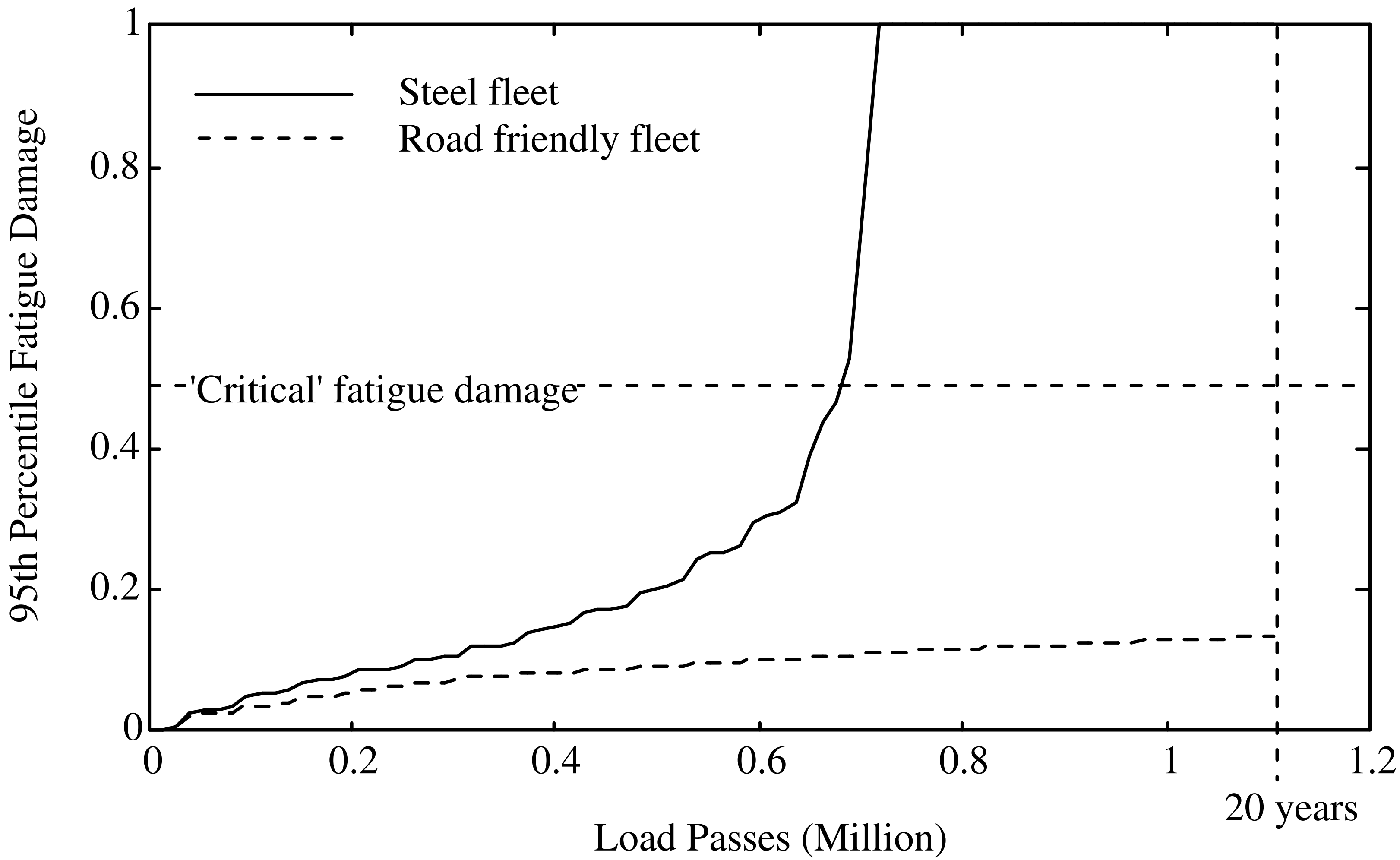
Fatigue evolution



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Example predictions

- Percentage increase in life changing from steel to road friendly (air) suspensions

	Major	Minor
EC	24%	42%
LTPPM	0% - 3%	39% - 90%

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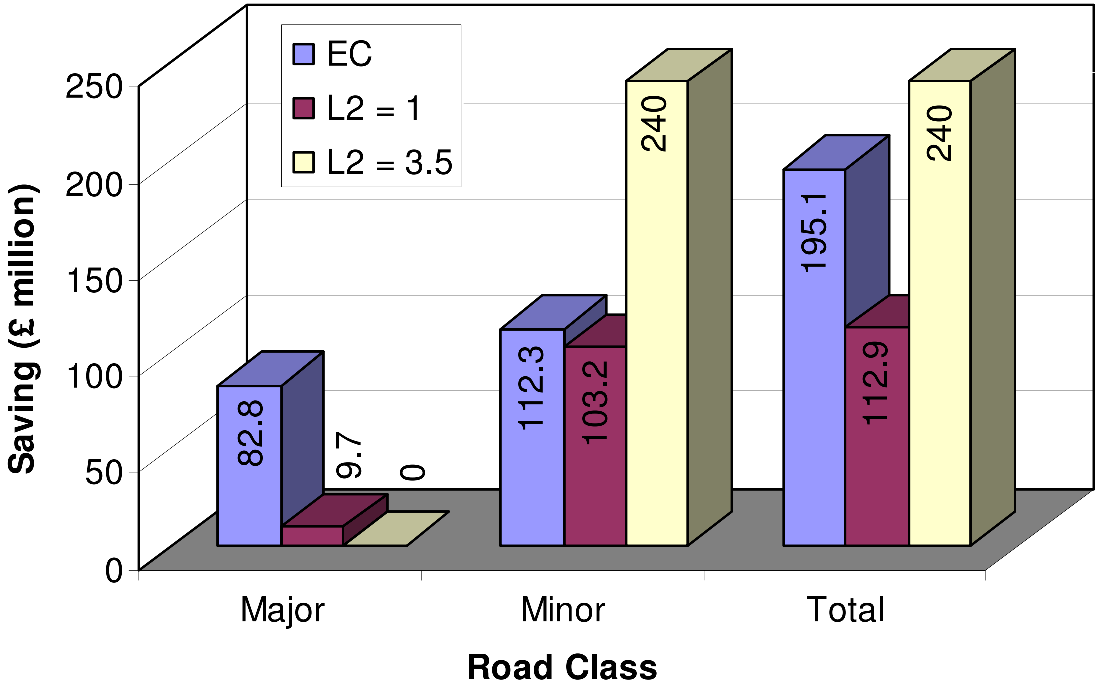
Economic evaluation

- Based on annual expenditure on maintenance of roads in England in 98/99 (£ million, 94/95 prices)



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Summary (1)

- Deterministic LTPPM described based on "aggregate damage" approach
- LTPPM comprises:
  - i. Dynamic vehicle simulation
  - ii. Pavement primary response simulation
  - iii. Material damage simulation
  - iv. Deterioration feedback
- Different modes of deterioration predicted for different classes of pavement

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Summary (2)

- Changing from steel to air increases life of major road by <3% (<£10 million)
- Changing from steel to air increases life of minor road by between 40% and 90% (£100 million - £240 million)
- Most significant savings predicted on minor (thin) roads
- 4th power approach overestimates benefits on major roads and underestimates benefits on minor roads

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Future developments

- Funding from EU (ASSET), NARC & NSWRTA
- Produce a validated user-friendly long-term flexible pavement performance model
- Will Goodrum (Cambridge): Oct 08 – Sept 10
- Dr Riccardo Isola (Nottingham): Feb 09 – Jan 11
- Programmer (Cambridge): Nov 09 – Nov 10

ASSET

narc Nottingham Asphalt Research Consortium

NSW GOVERNMENT

RTA

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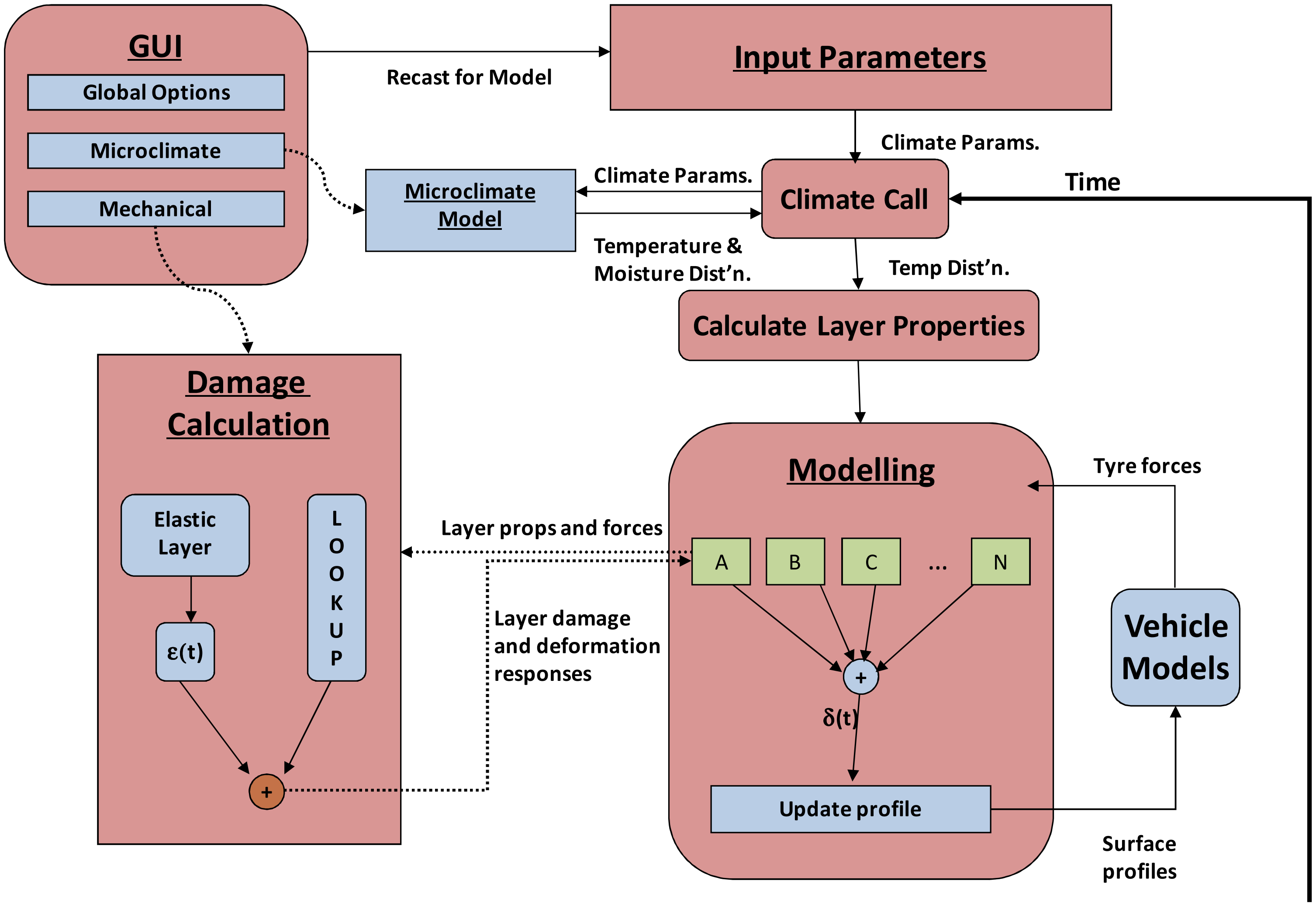
Program structure



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