Prediction of Deterioration of Asphalt Pavements by Mechanistic-Empirical Methods

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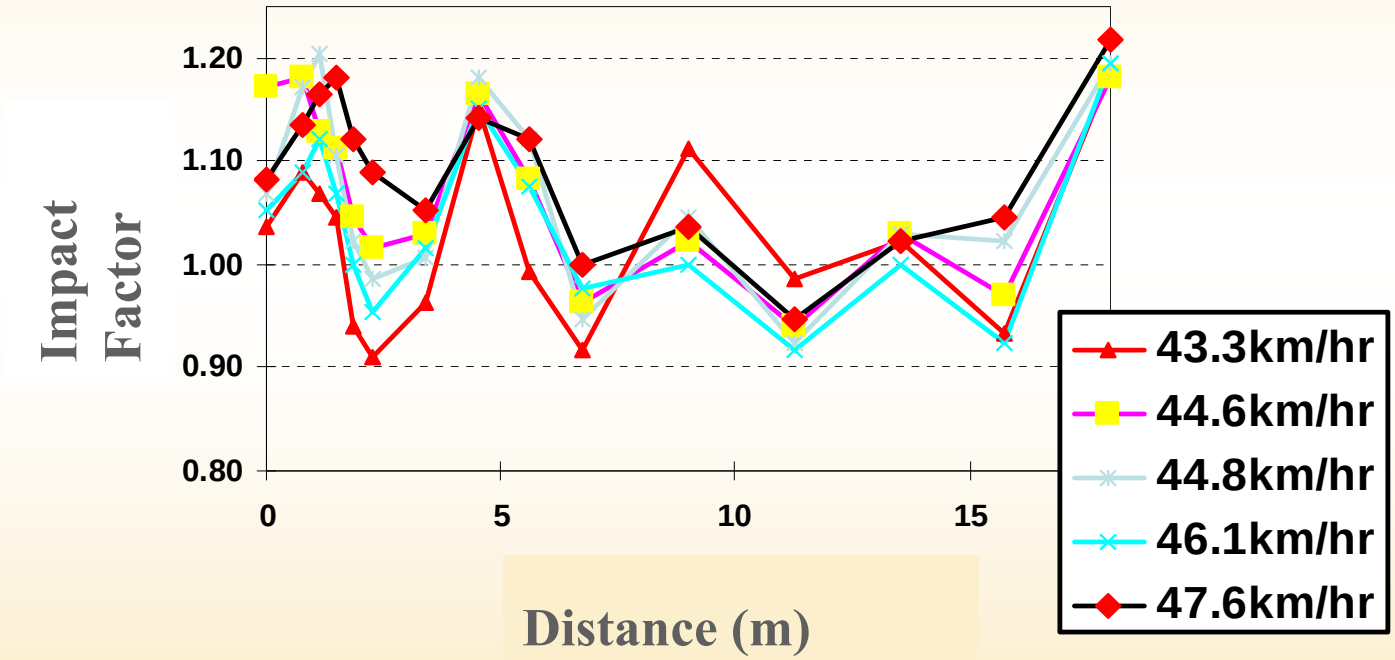
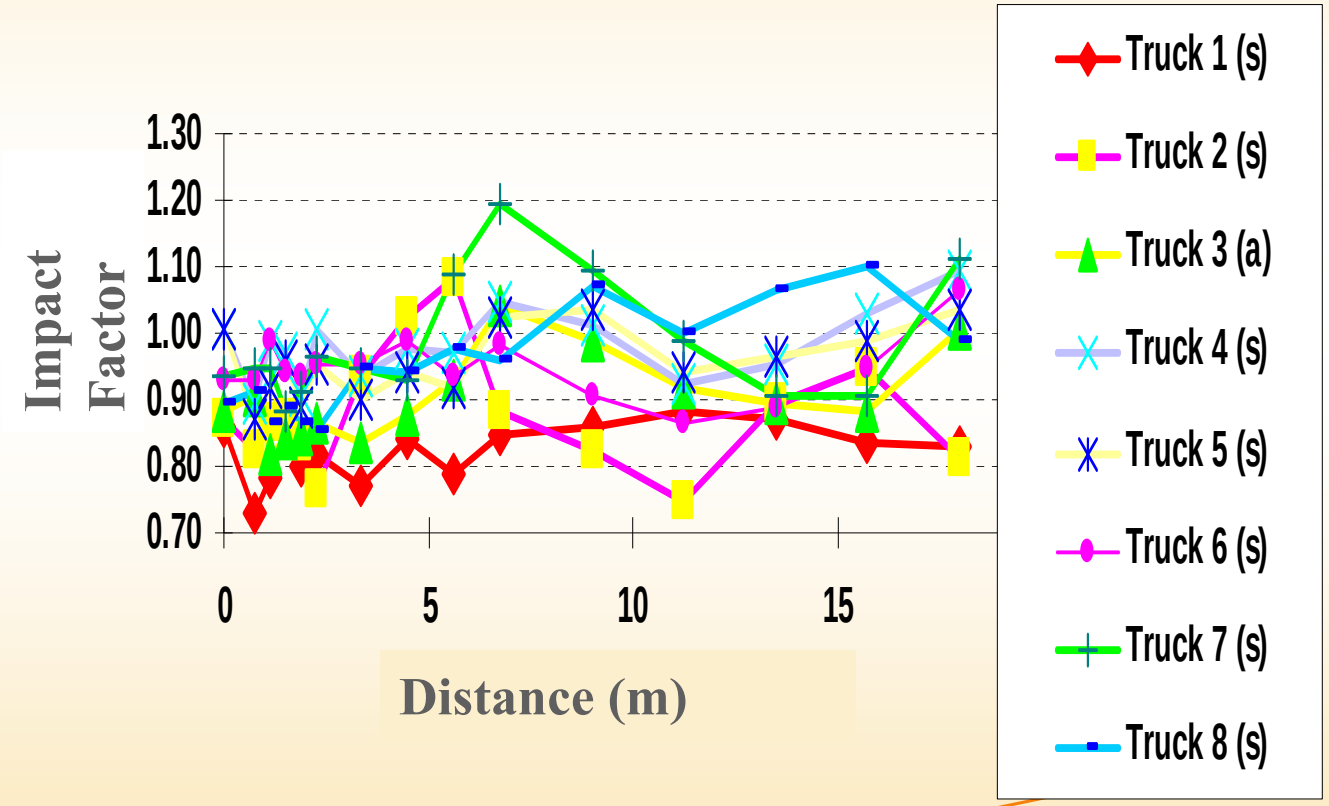
Trucks bounce & rock; axles hop....

Spatial Repeatability – same truck on same stretch of road

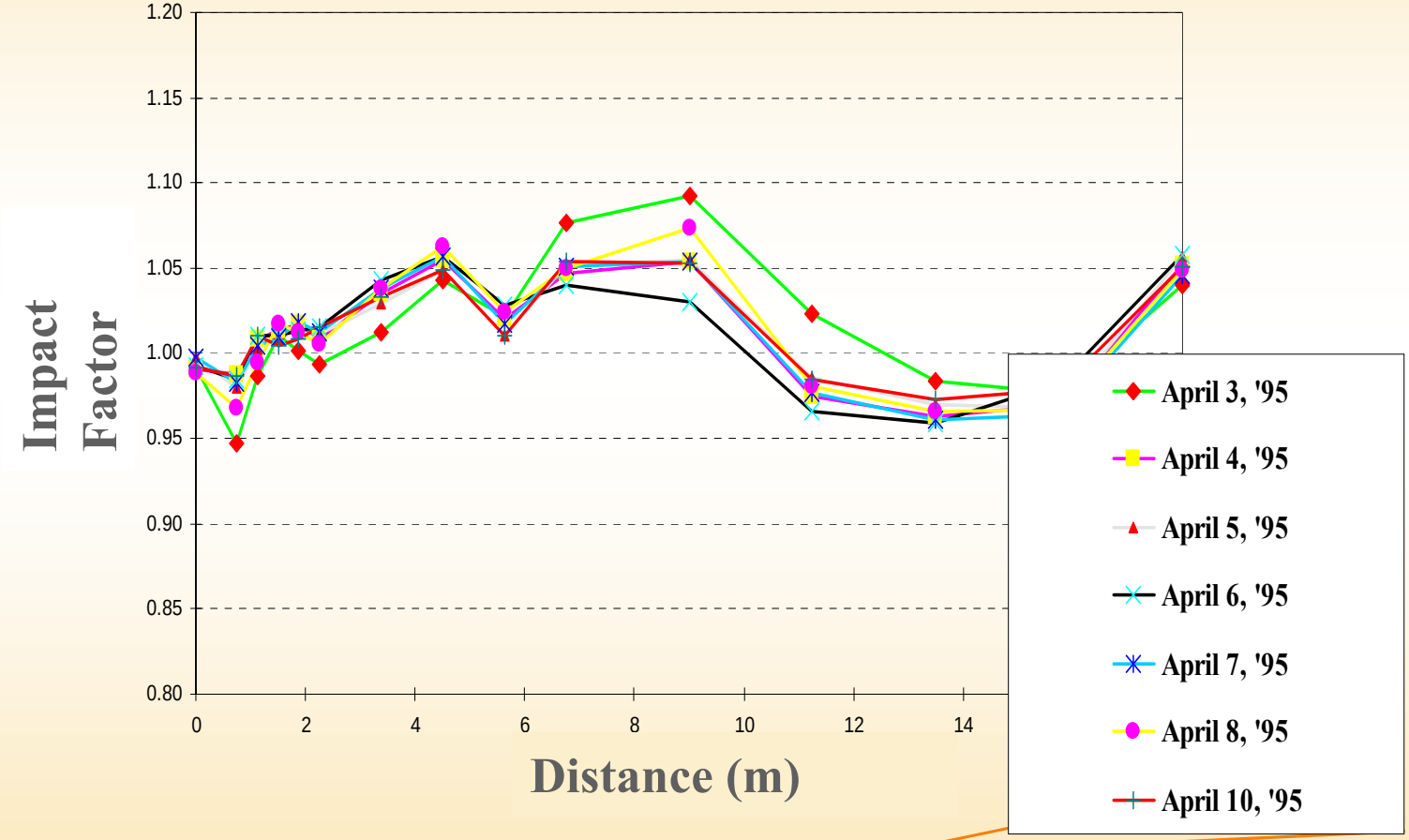


Spatial Repeatability can be detected with multiple-sensor WIM

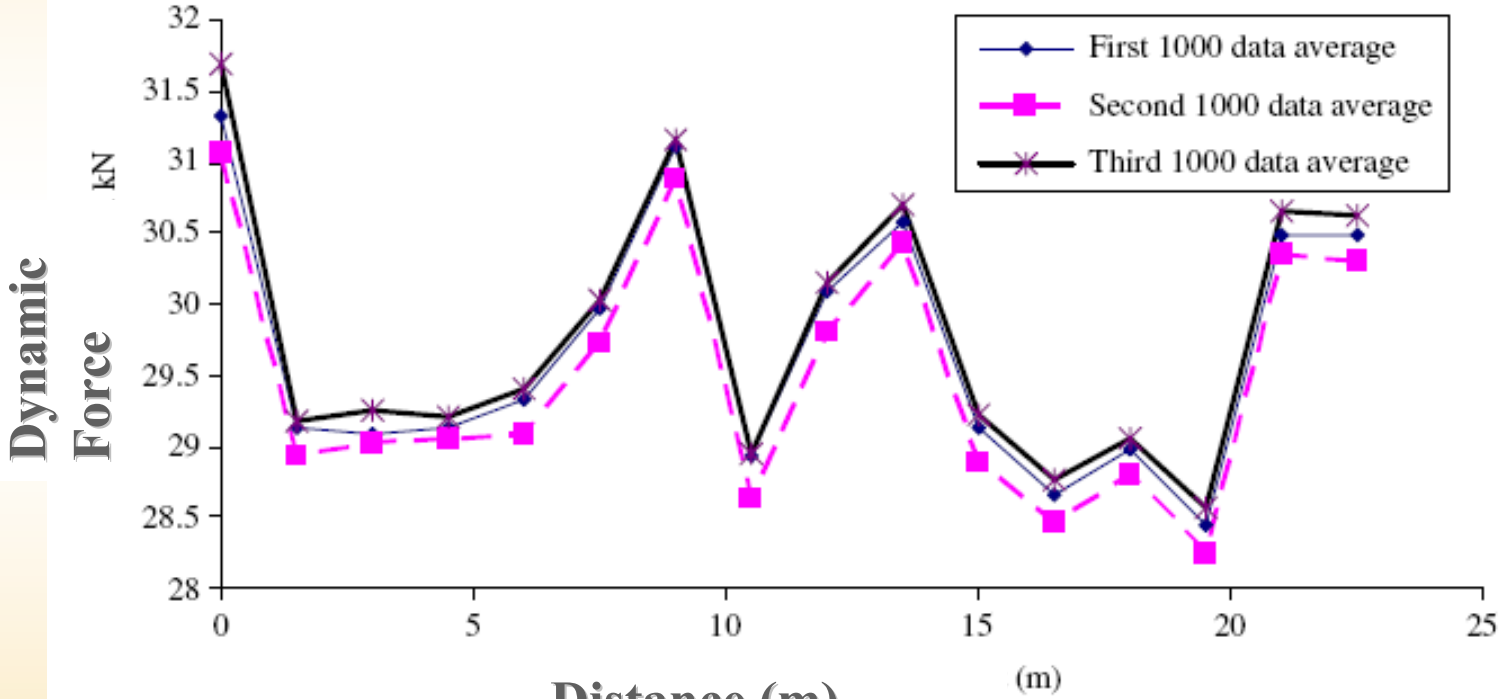
Lack of Spatial Repeatability for ‘similar’ trucks



‘Statistical’ Spatial Repeatability (France)



‘Statistical’ Spatial Repeatability (Netherlands)

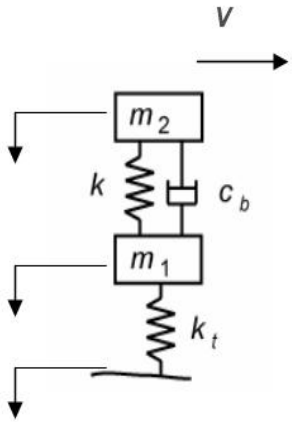


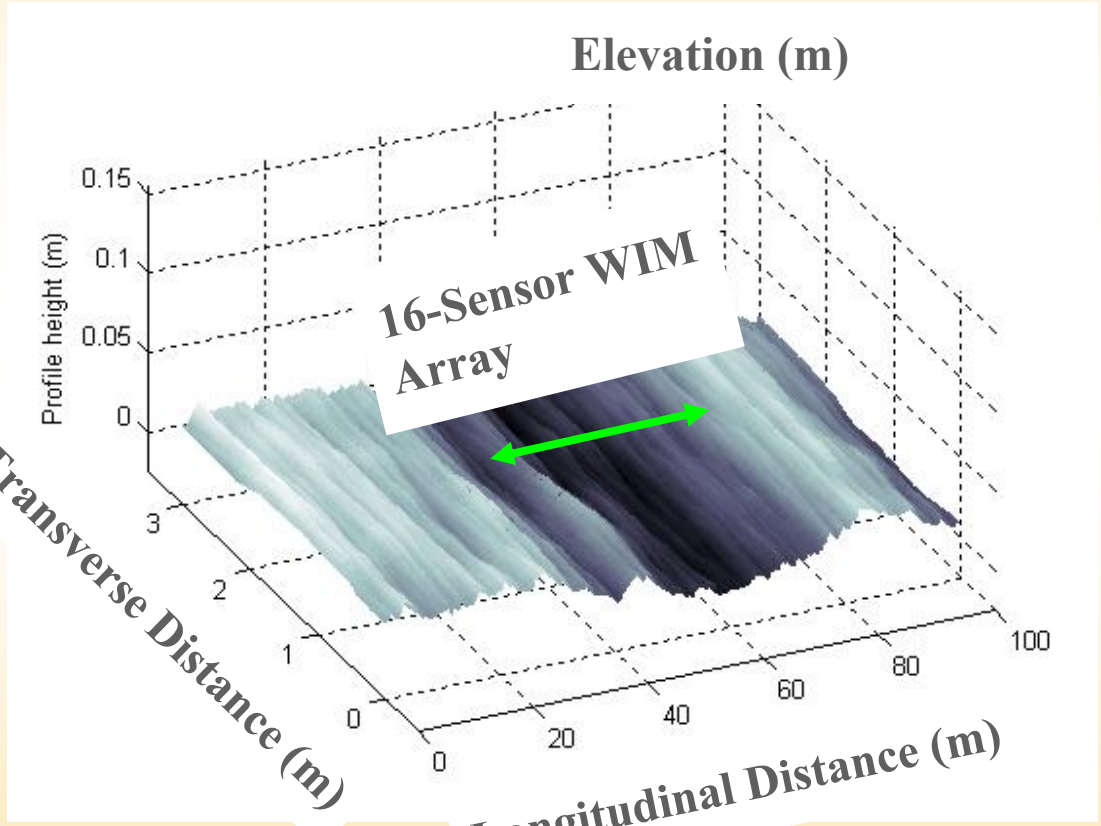
Implications for Road Damage

- Traditionally assumed that impact force was applied at random locations along pavement
- In fact, certain locations will repeatedly attract high impact loading
- This damages & changes the road profile
- New road profile changes pattern of Spatial Repeatability
- Feeds on itself: Road profile influences truck dynamics ⇒ spatial repeatability pattern ⇒ change in profile ⇒ change in spatial repeatability pattern ⇒ .....

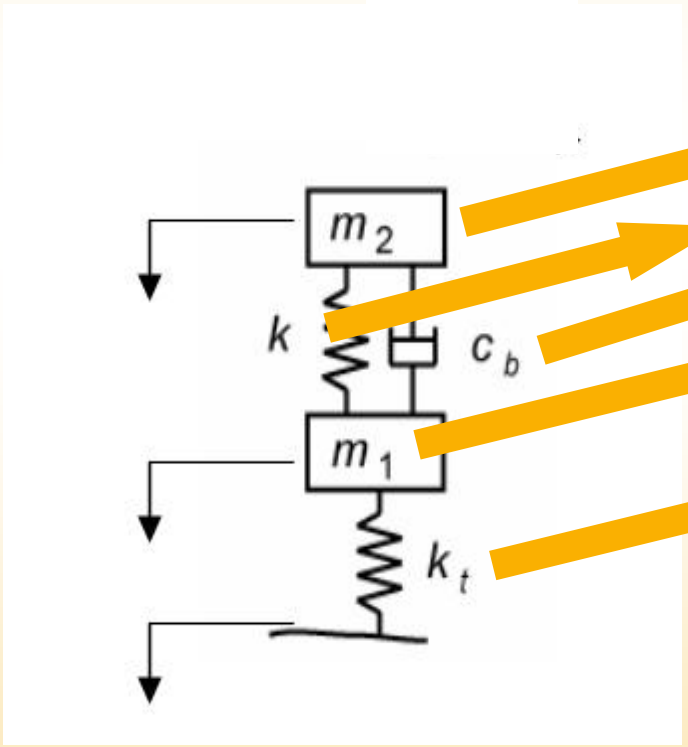
Computer model to represent truck dynamics

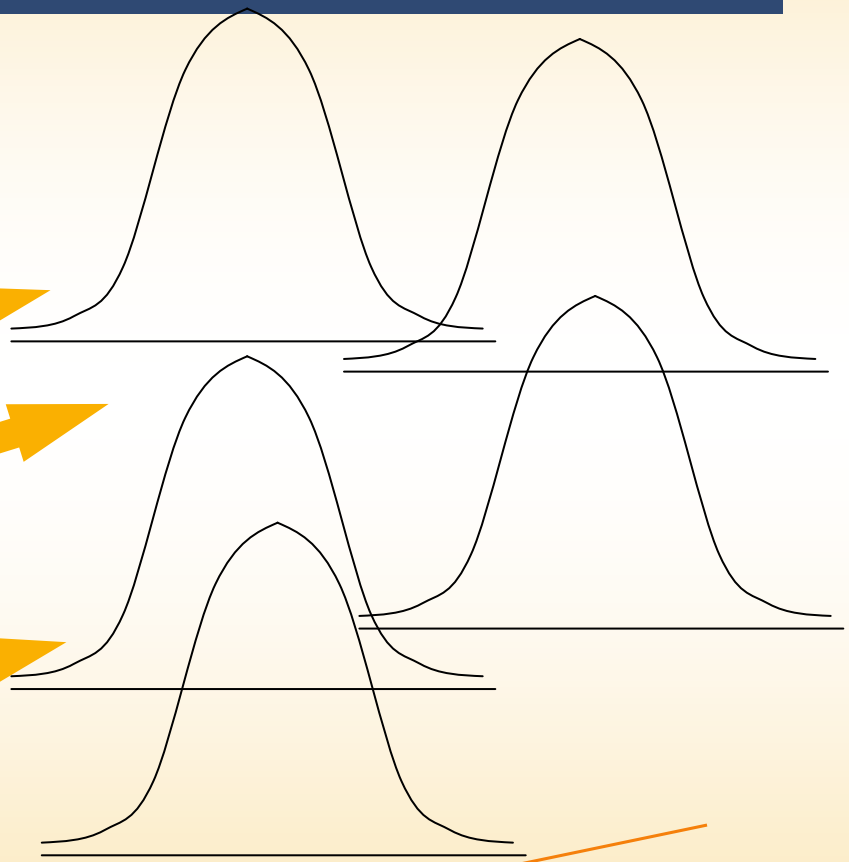
Quarter Car Model used to represent entire truck fleet



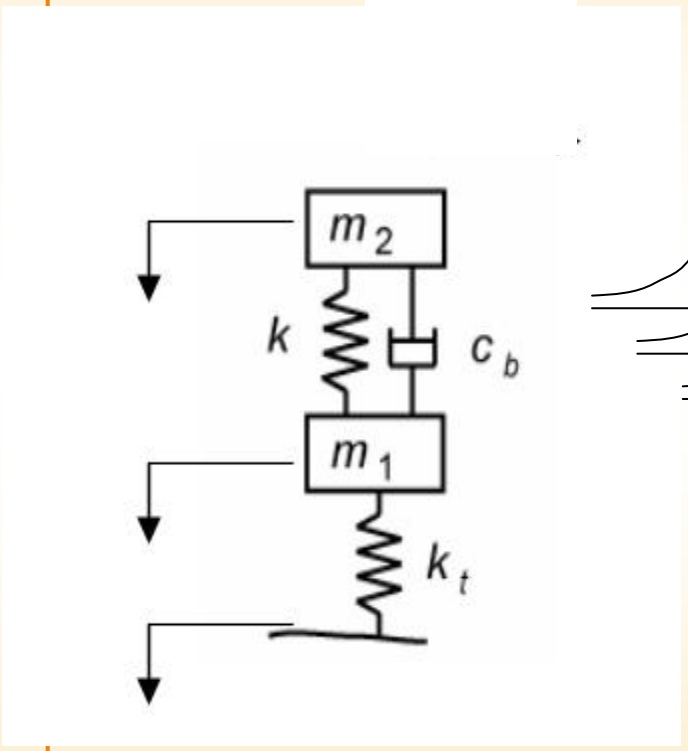


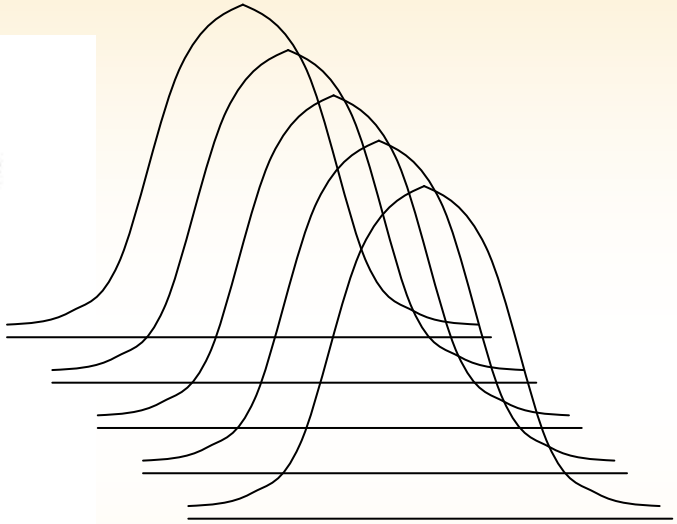
Probabilistic Quarter-Car Model





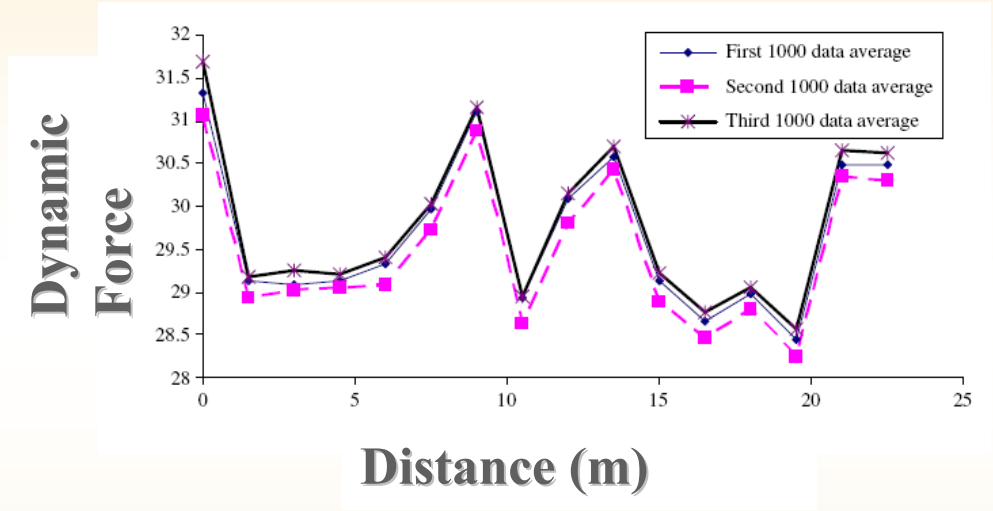
Optimisation to find Quarter-Car Properties





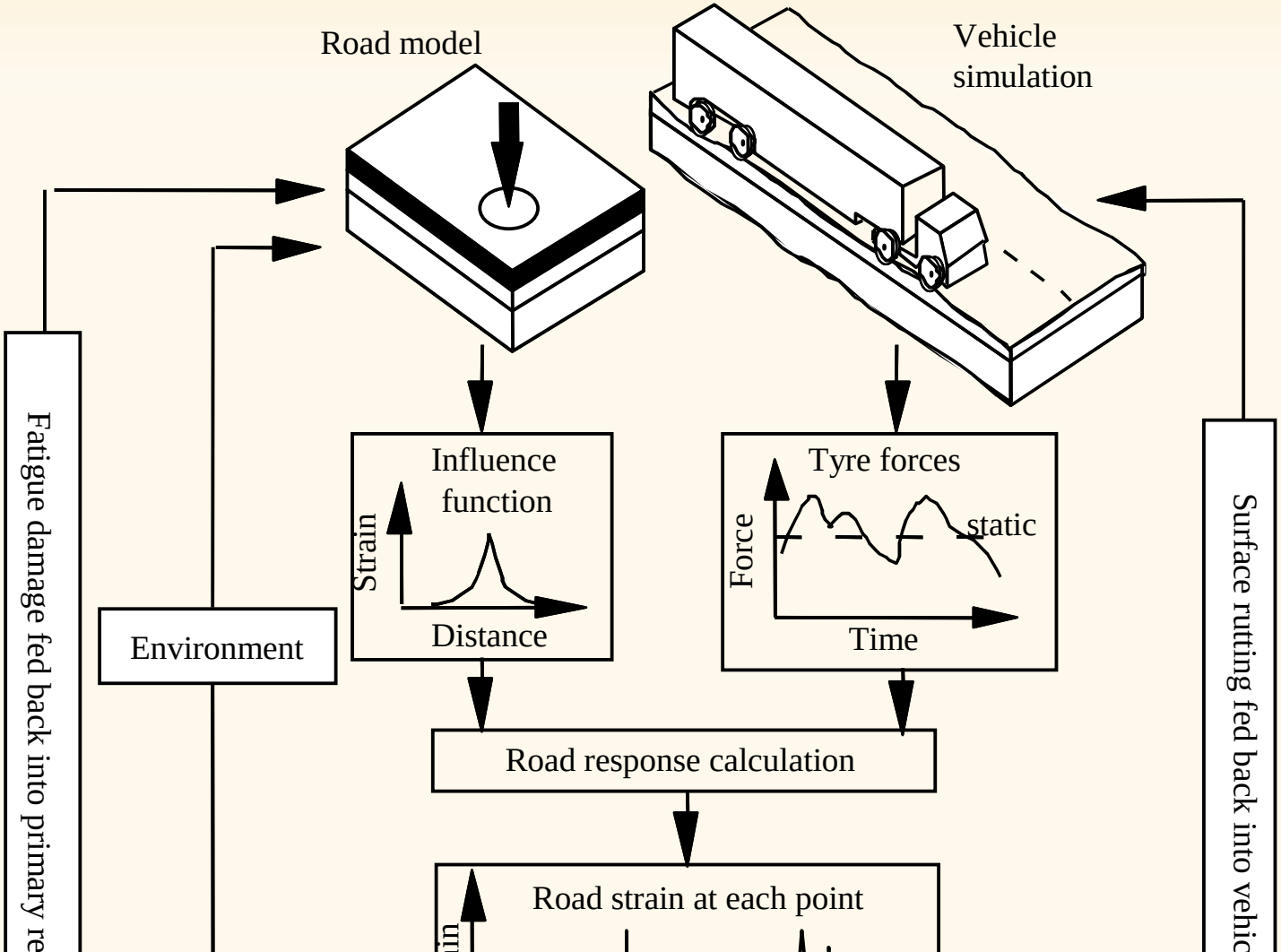
Find μ_i & σ_i which minimise
$\Sigma(SSR_{meas} - SSR_{theory})^2$

Predicting Statistical Spatial Repeatability

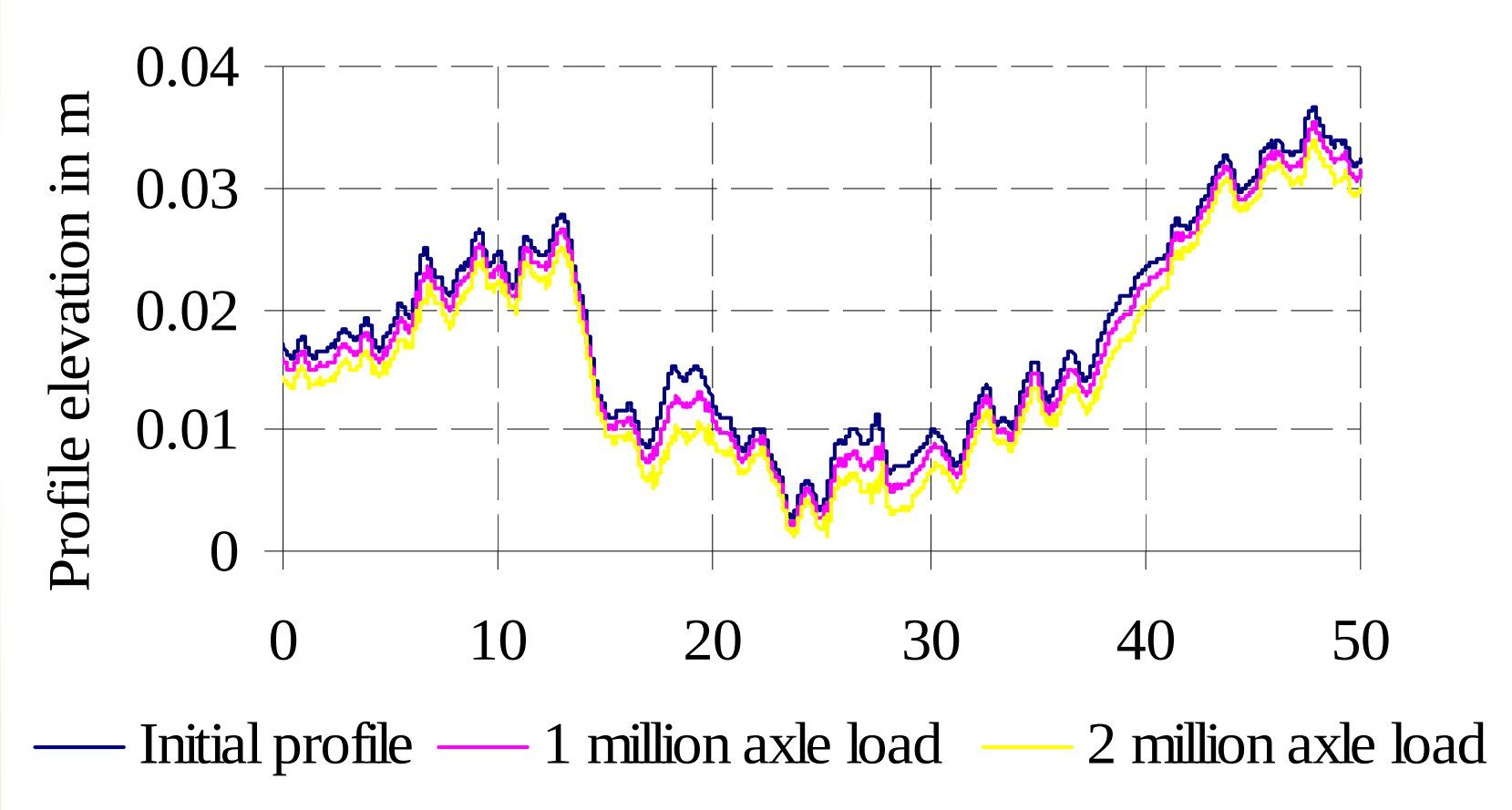


Knowing μ_i & σ_i, we can *predict* patterns of SSR for *any* profile

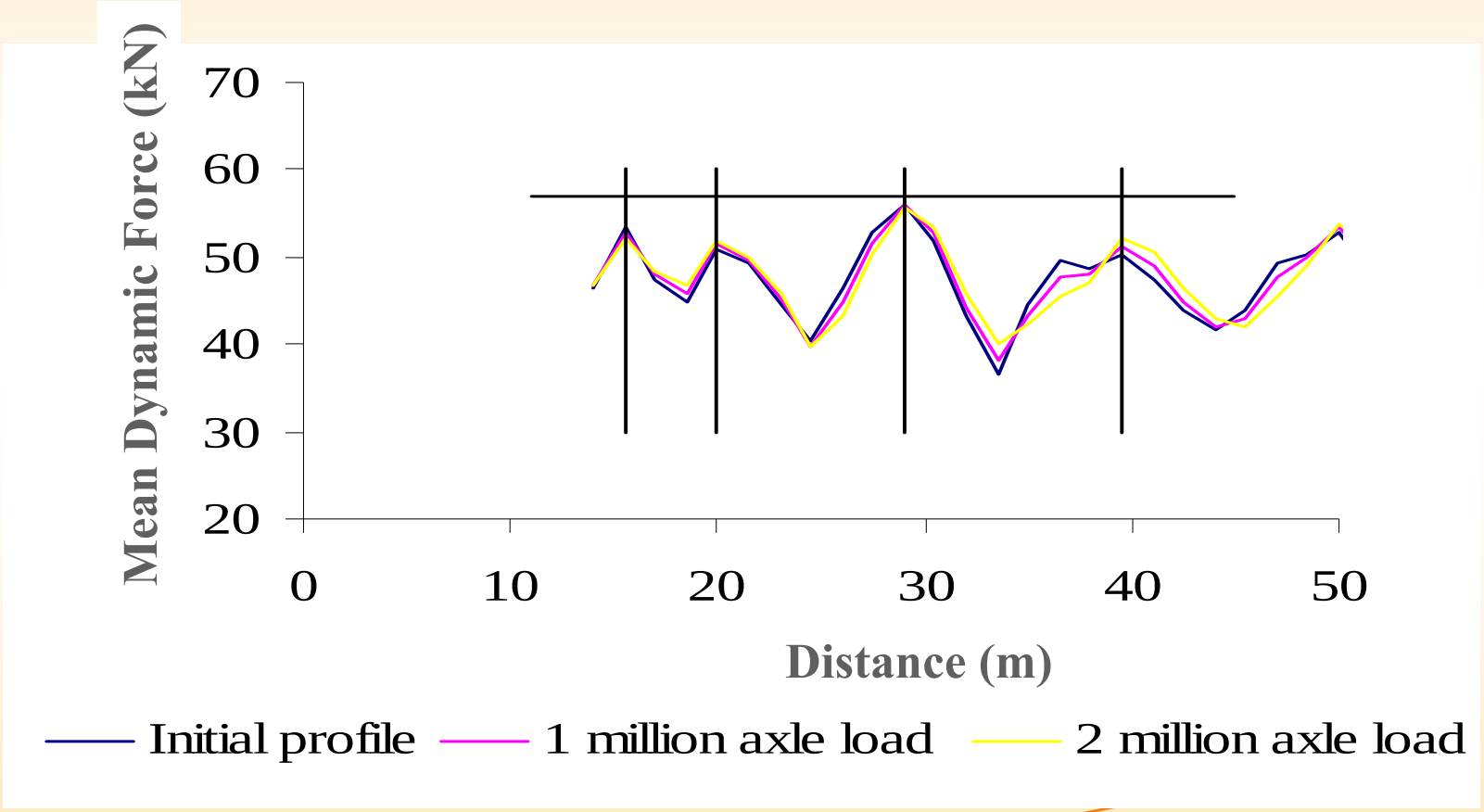
Road Damage Model – Collop & Cebon



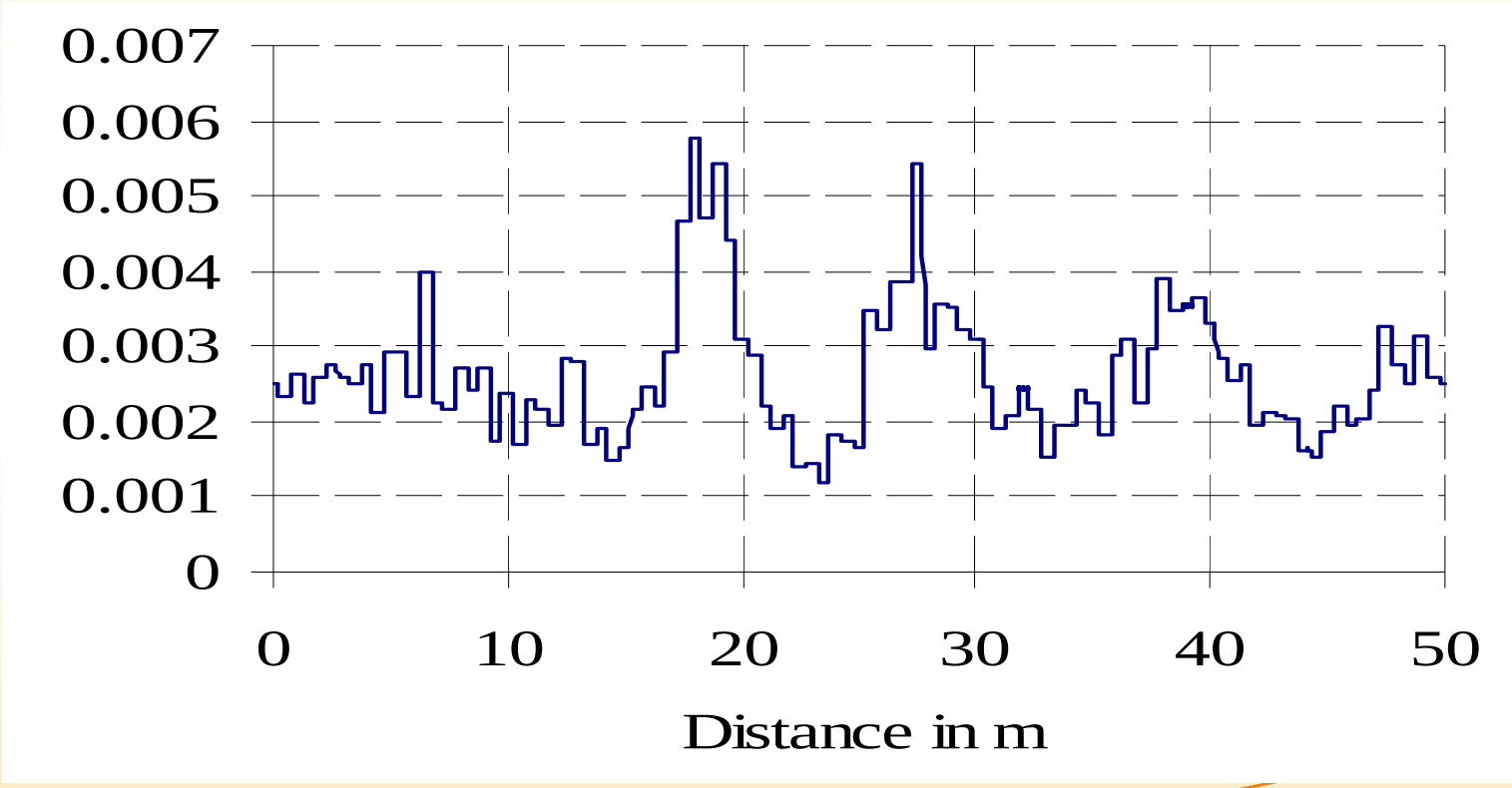
Surface profile evolution – 1st 3 million axles



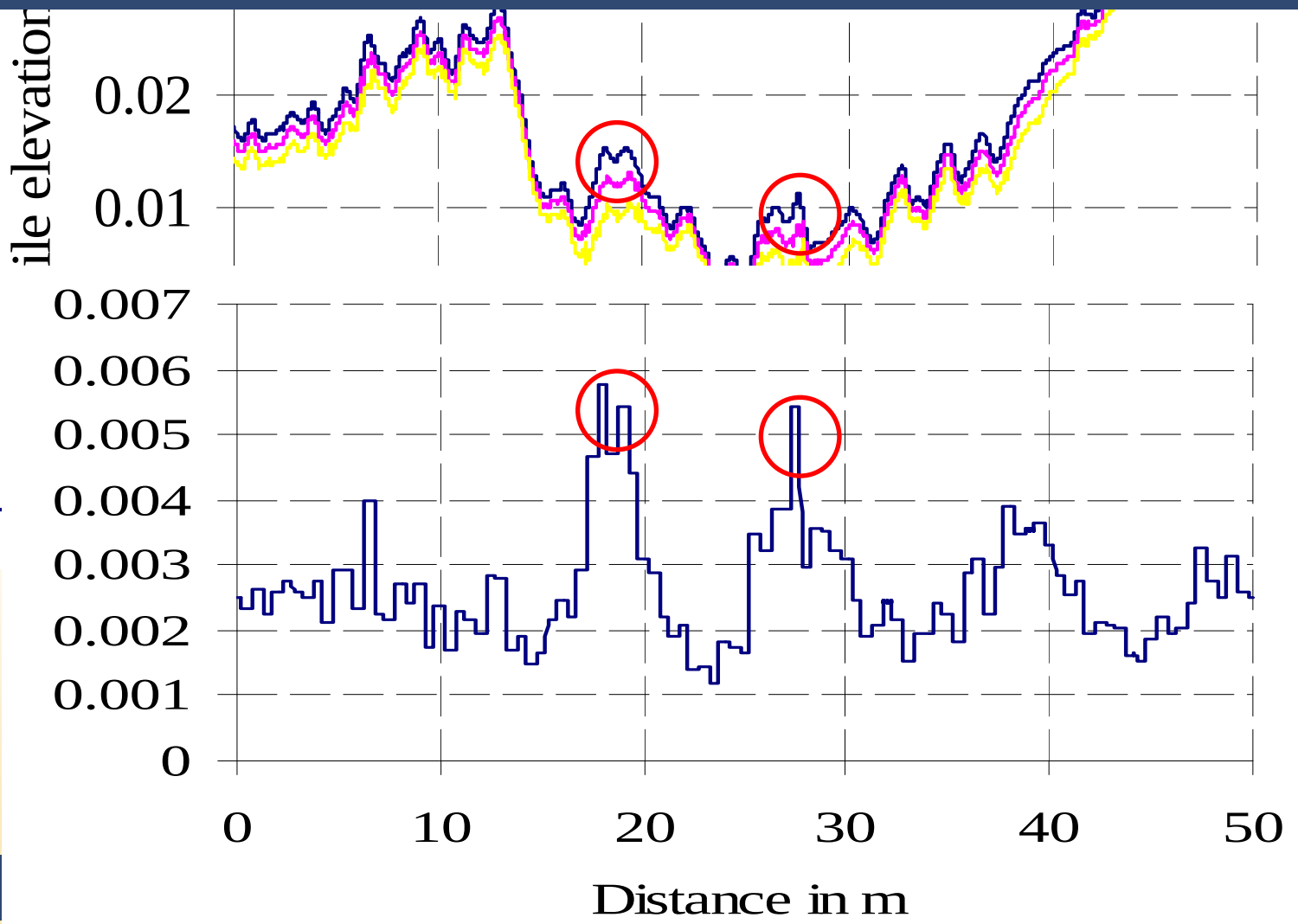
Mean dynamic force – 1st 3 million axles



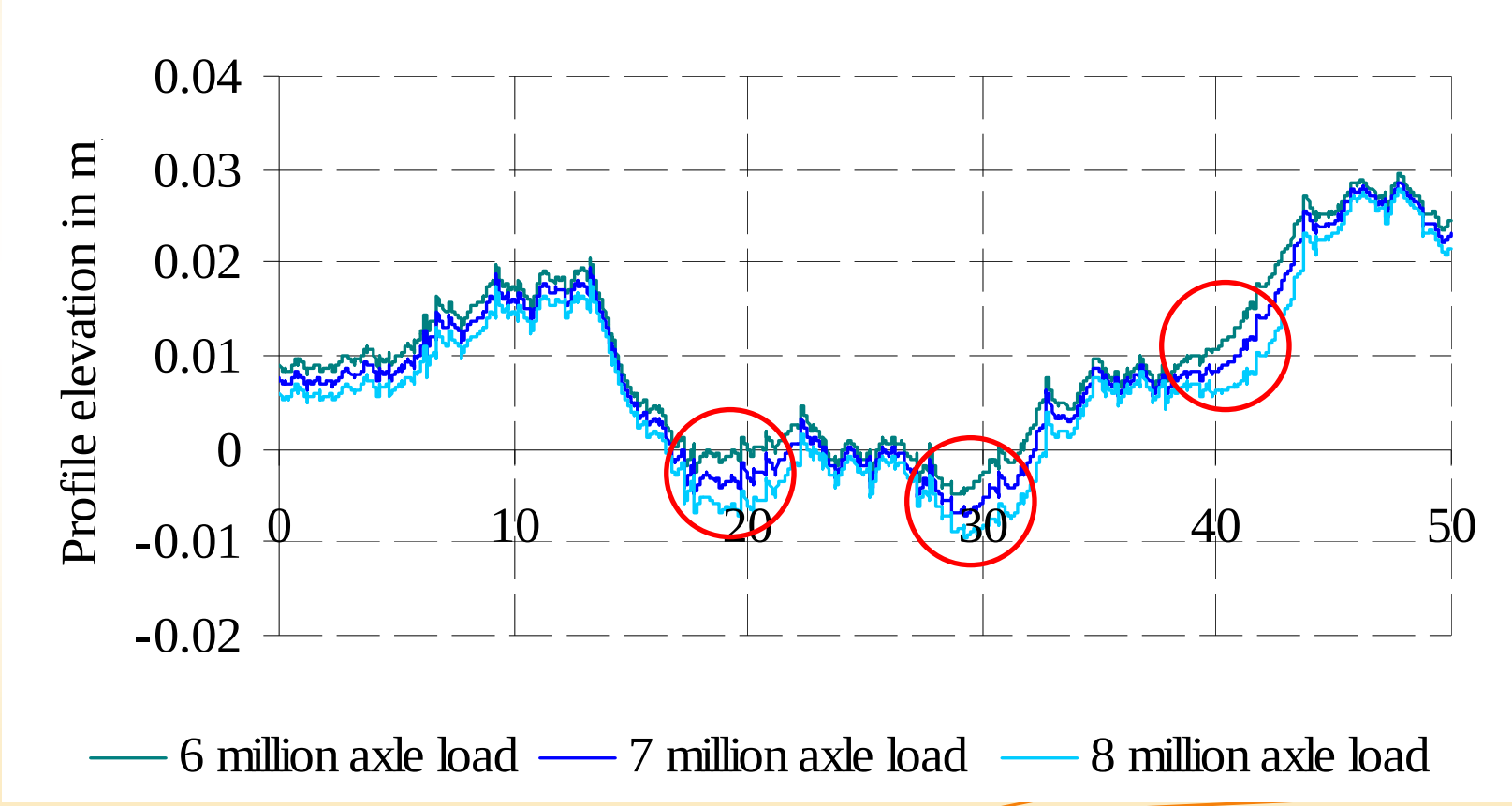
Surface profile change – 1st 3 million axles



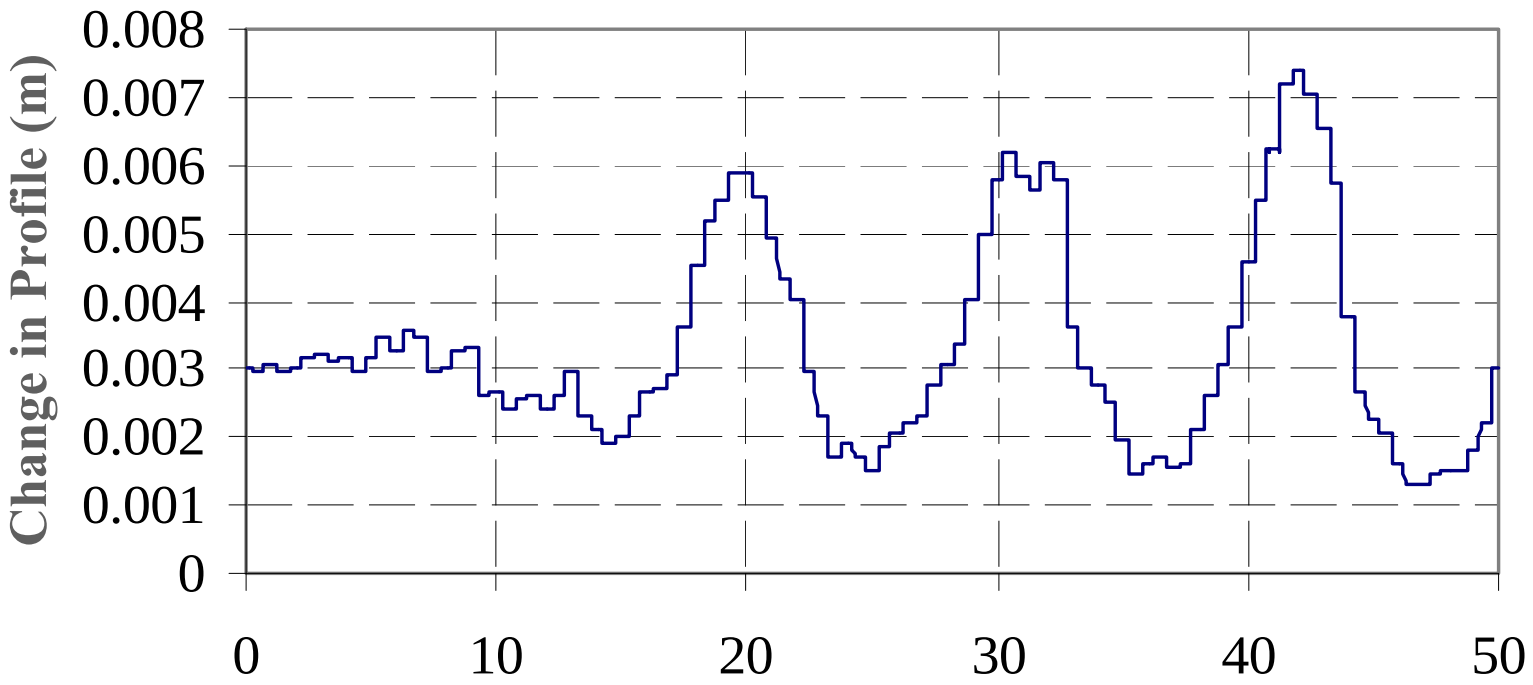
Main profile changes – 1st 3 million axles



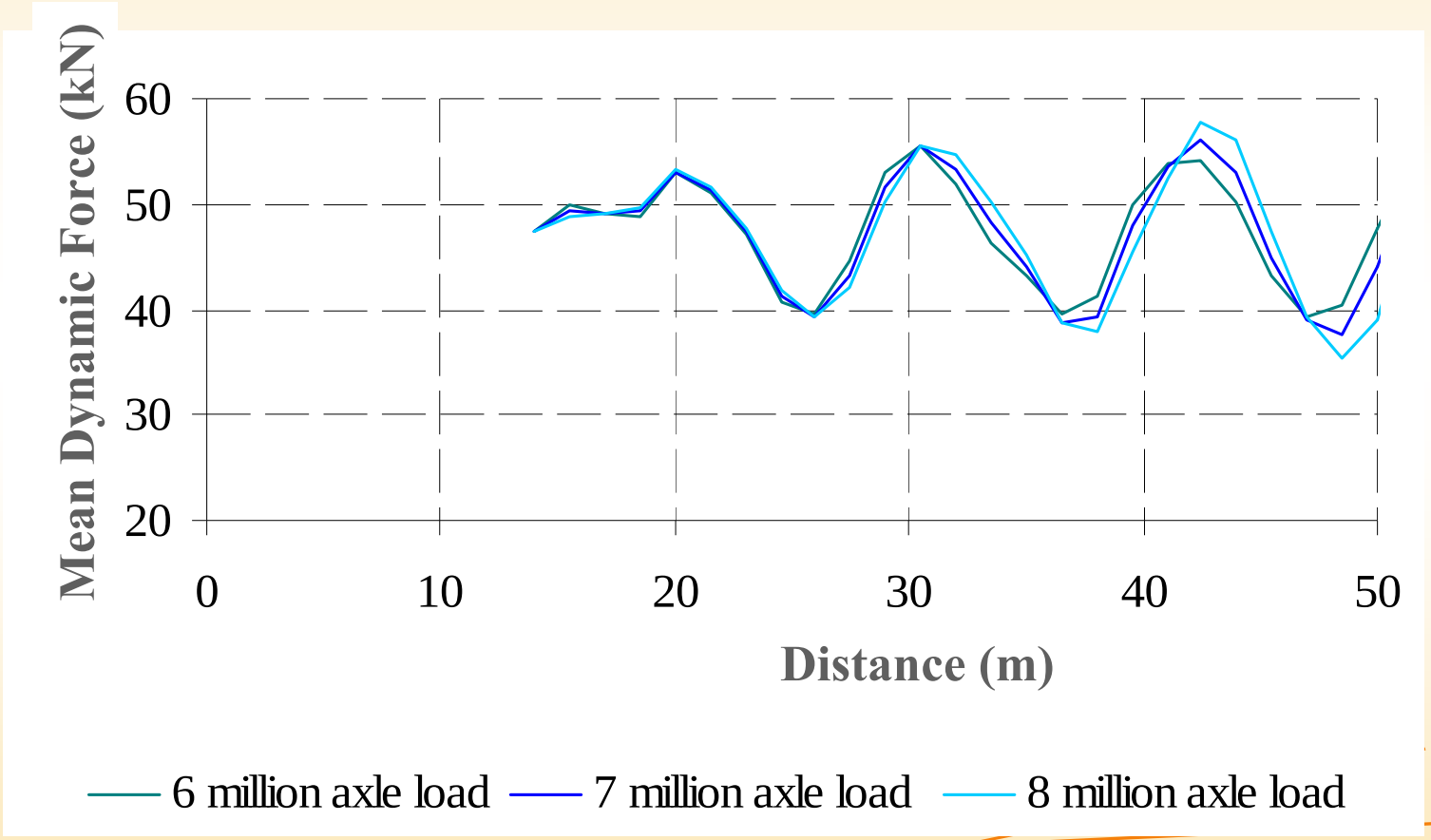
Profile after 6th, 7th & 8th million axles



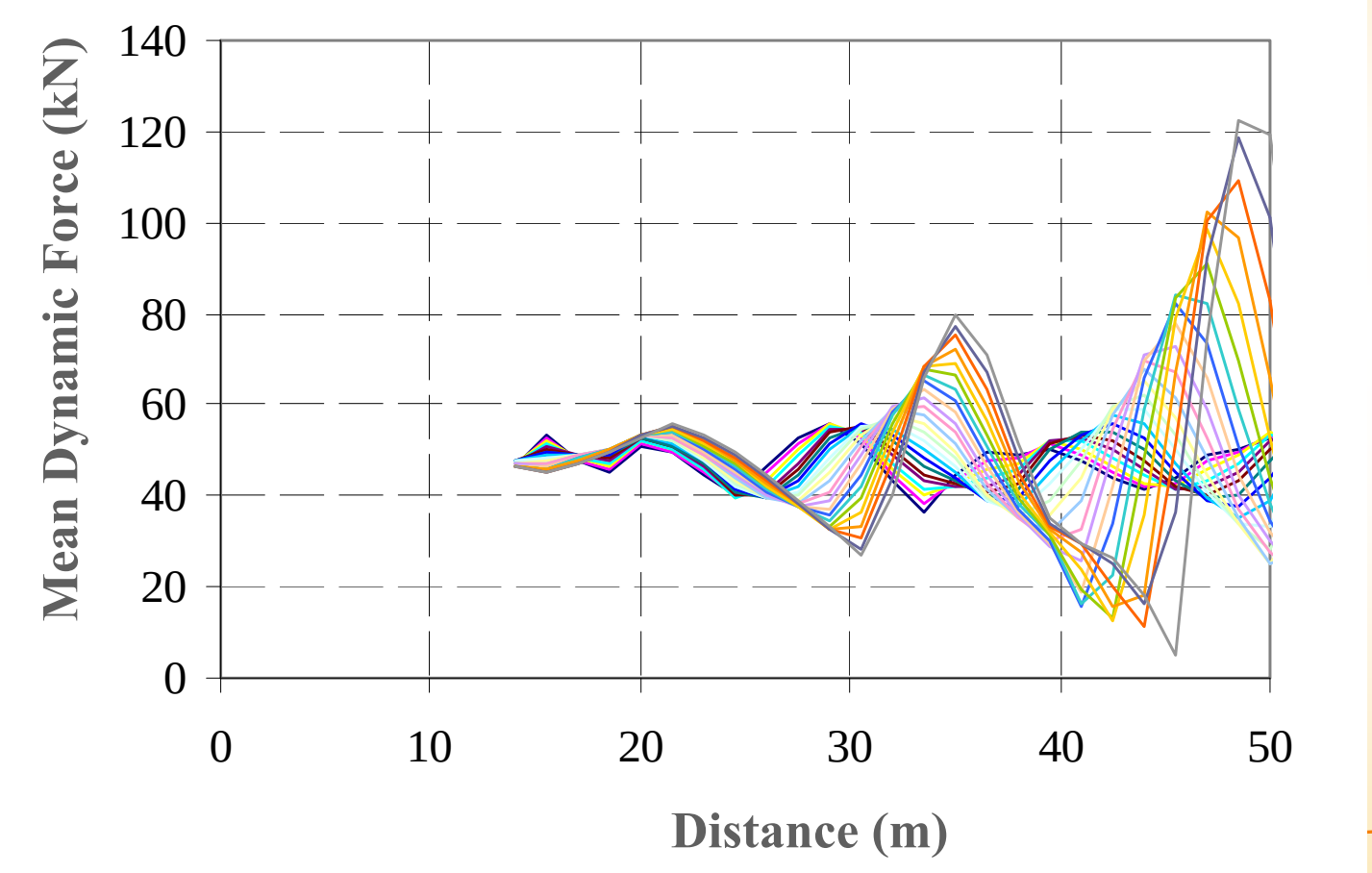
Change in profile after 6th, 7th & 8th million axles



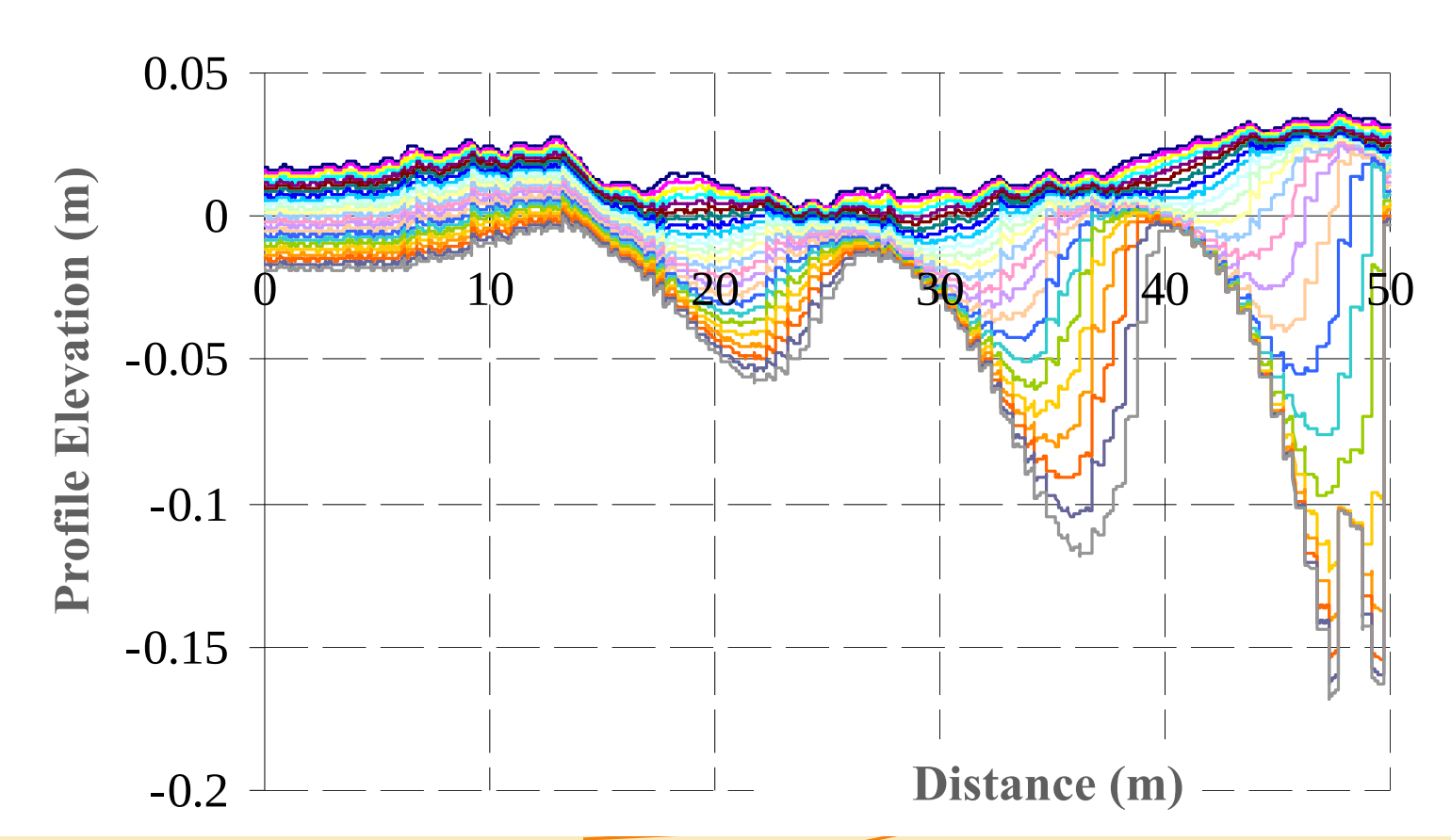
Mean force after 6th, 7th & 8th million axles



Evolution of dynamic forces in pavement life



Evolution of profile during pavement life



Conclusions

- Pattern of Statistical Spatial Repeatability changes during the pavement life
- Pavements with the same properties (stiffnesses, etc.) but different initial profiles have substantially different lives
- Failure eventually occurs at a frequency that relates to applied force patterns