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Bridge Traffic Loading:
The Implications of Some Recent Findings

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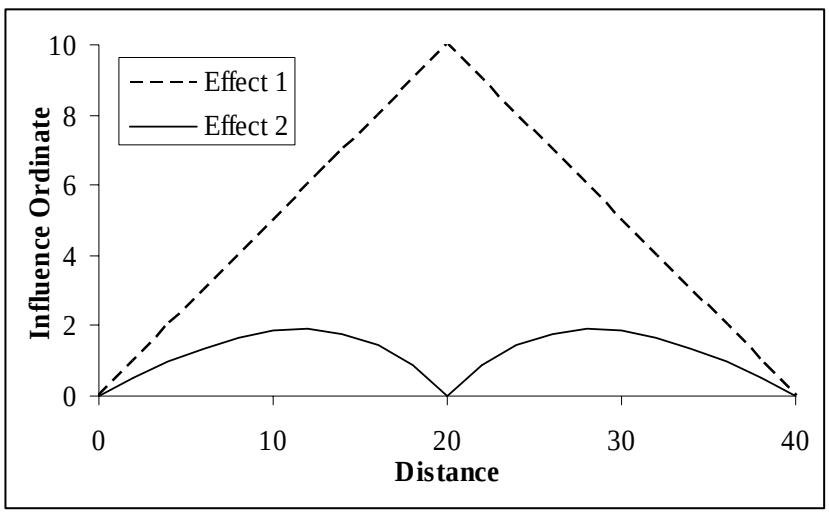
Basis of Research

- Real traffic is measured using **Weigh-In-Motion** technology

- The traffic's **characteristics** are statistically modelled

- **Monte Carlo simulation** from these models allows much more traffic to be studied



- Generated traffic is passed over the **influence lines** of interest to obtain the bridge traffic load effect

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Basis for Statistical Analysis

Weaknesses in the statistical analysis of bridge traffic loading arise from:

1. **Choice of Population:**

   Must be appropriate to model, e.g. stationarity.

2. **Distribution of Extreme Load Effects:**

   Use Generalized Extreme Value distribution to avoid a priori decisions.

3. **Estimation:**

   Use minimum variance estimators, e.g. maximum likelihood.

4. **Choice of Thresholds:**

   Use the correct model for the data, avoiding the 'tail' data problem.

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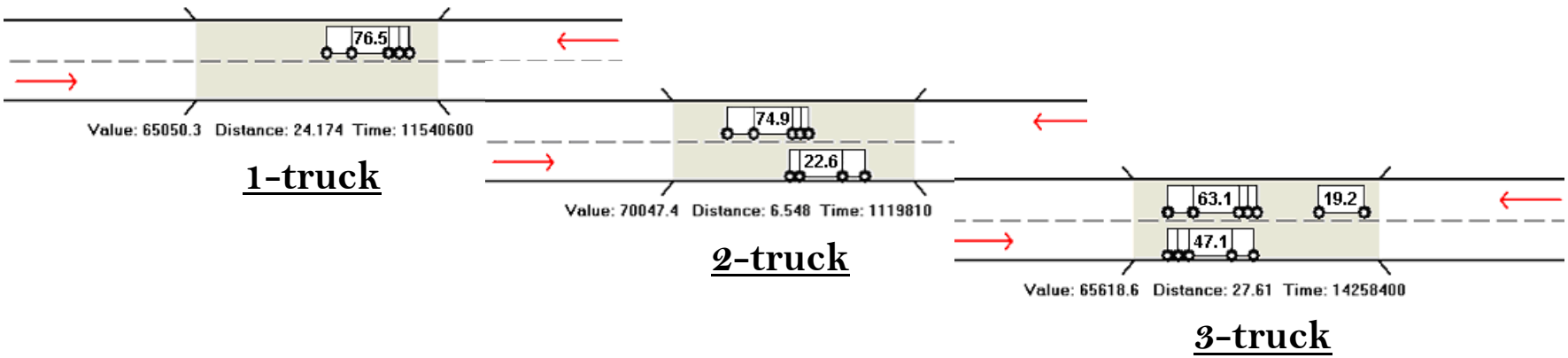
Latest Statistical Analysis - I

In bridge traffic loading, different events occur:



These loading events have different statistical distributions…

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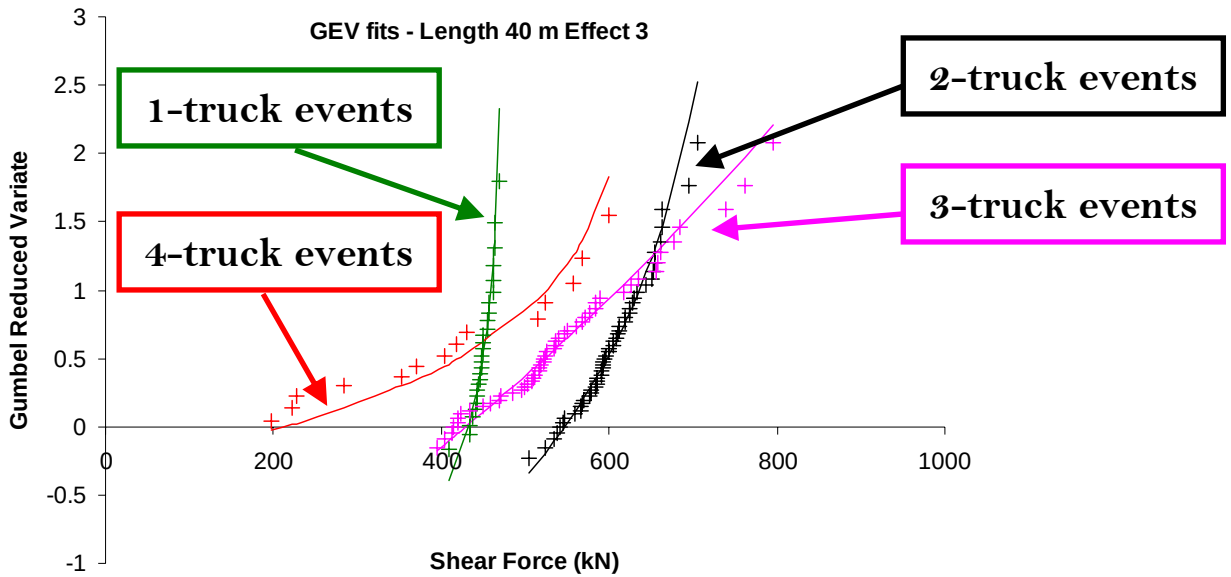
Latest Statistical Analysis - II



Thus a new composite distribution of load effect was developed:

Composite Distribution → $G_C(z) = \prod_{i=1}^{N} G_i(z)$ ← Individual Event-type Distribution

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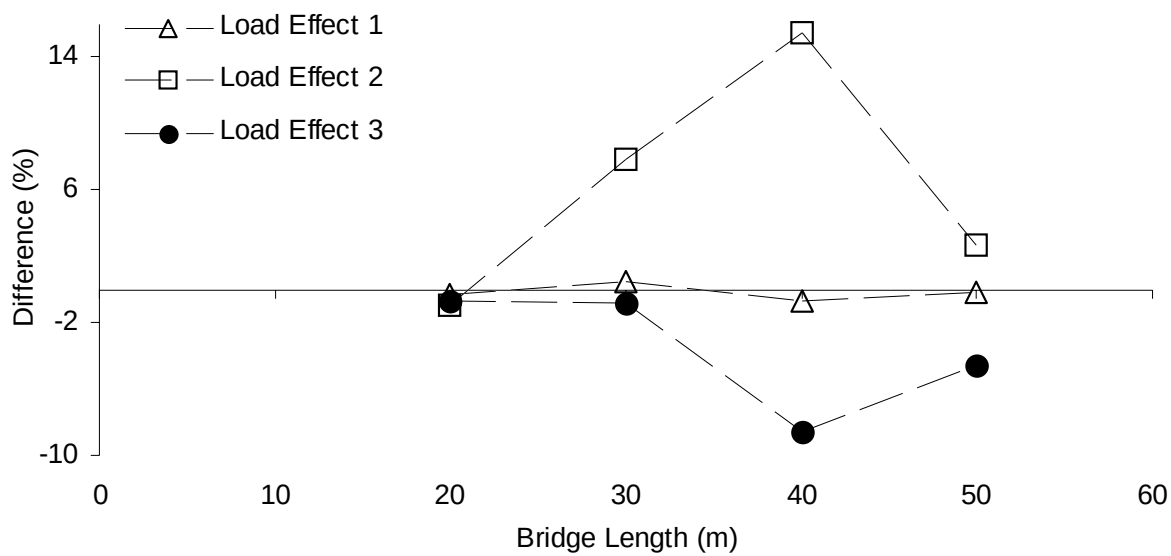
Sample Static Results

Prediction variability is allowed for by using predictive likelihood.

Effect of these latest improvements:



Changes in static loading of up to 14%

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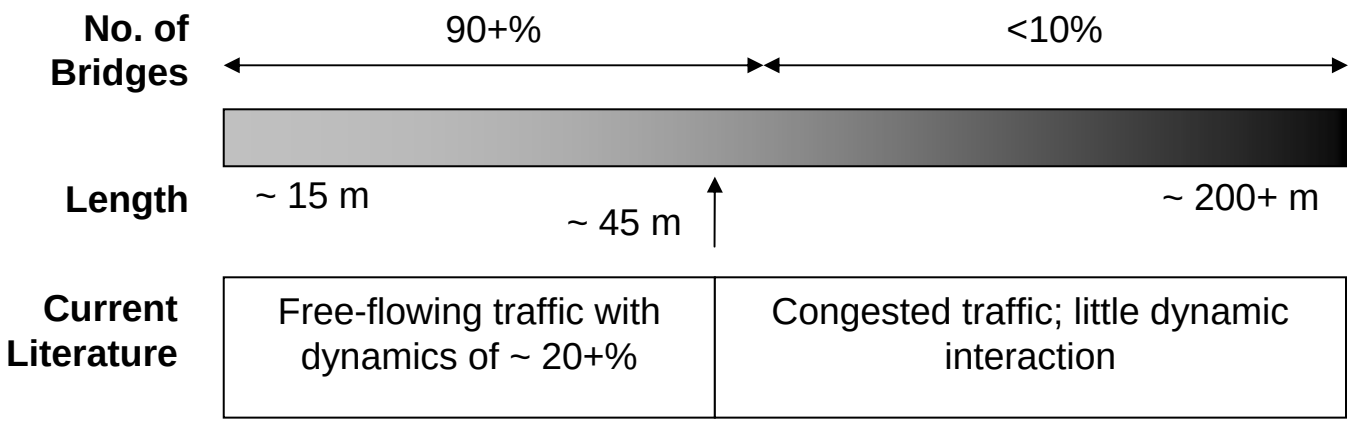
Governing Loading Scenarios

- Two loading scenarios govern a certain range of bridge lengths



Thus: it is important to quantify extreme dynamic effects

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Allowing for Dynamics - I

- Total load effect includes the dynamic effects of traffic.
- Static load effect does not.
- Both may be considered as random variables
- The relationship between them is the dynamic amplification factor (DAF)

To determine the lifetime DAF to be applied:

- Establish extreme populations of static and total load effect
- Perform a bivariate extreme value analysis
- Simulate lifetime DAFs
- Take the charateristic lifetime DAF

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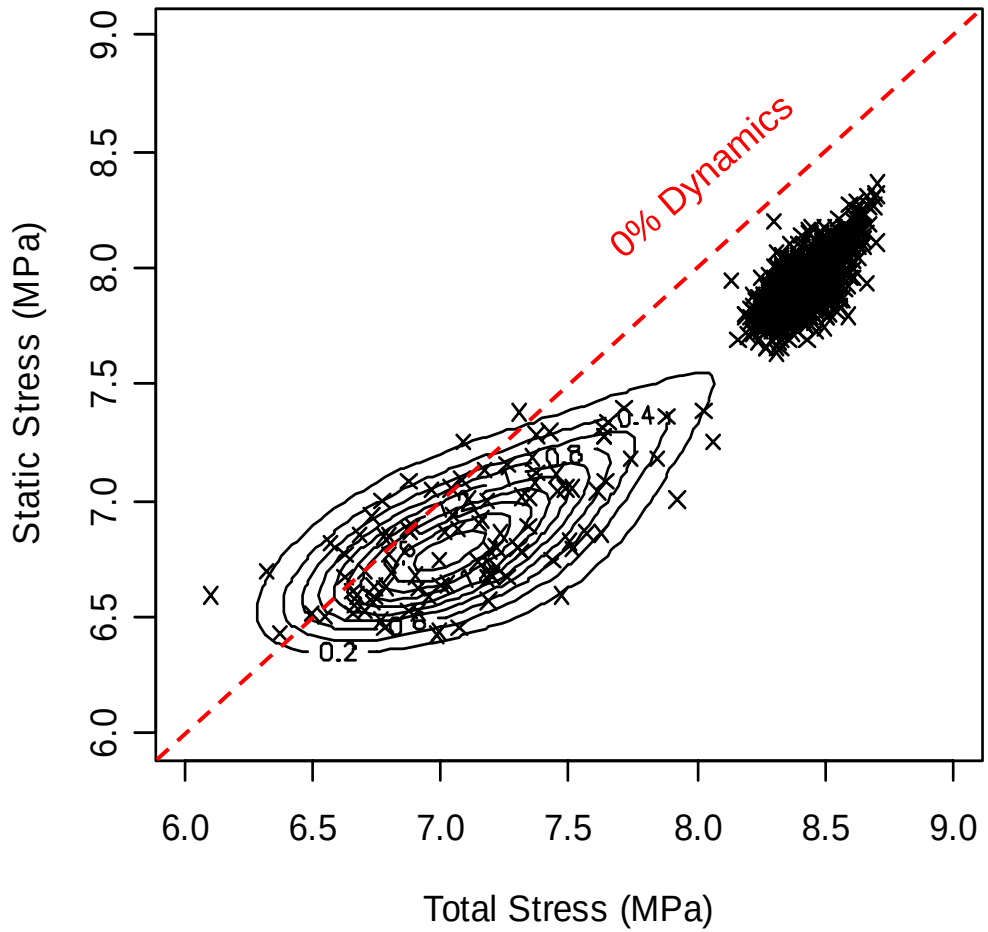
Allowing for Dynamics - II



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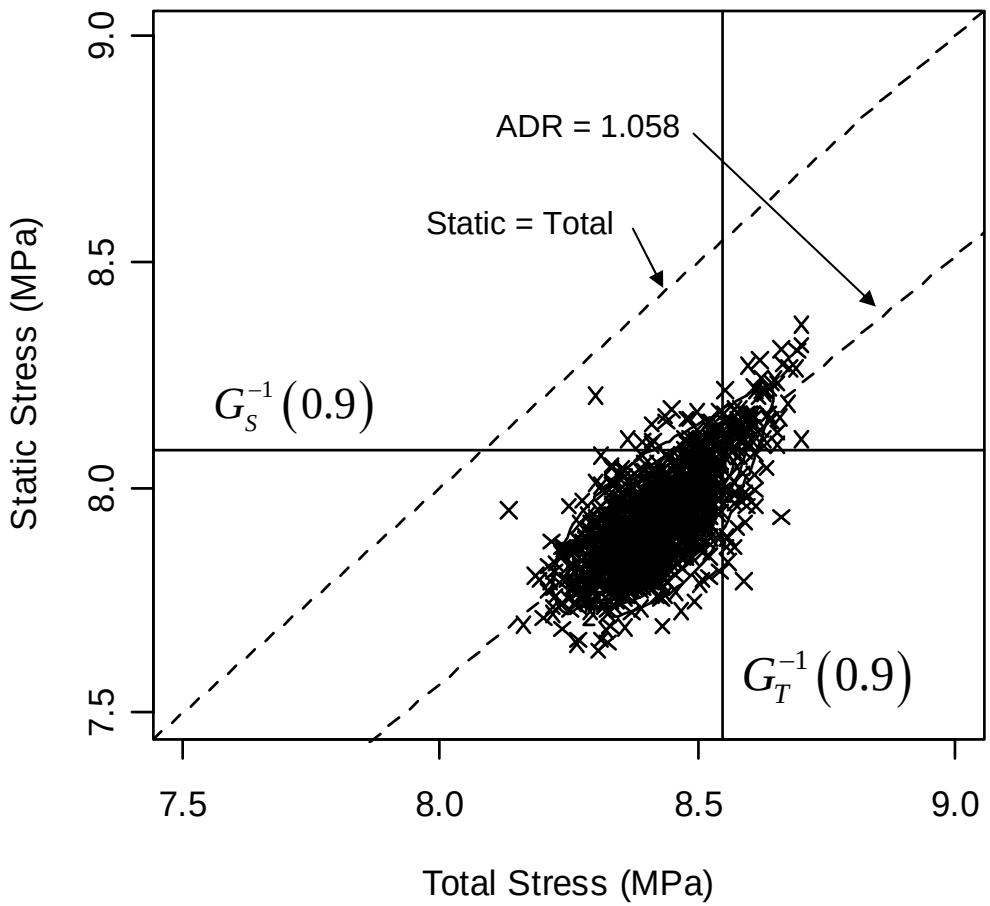
Allowing for Dynamics - III



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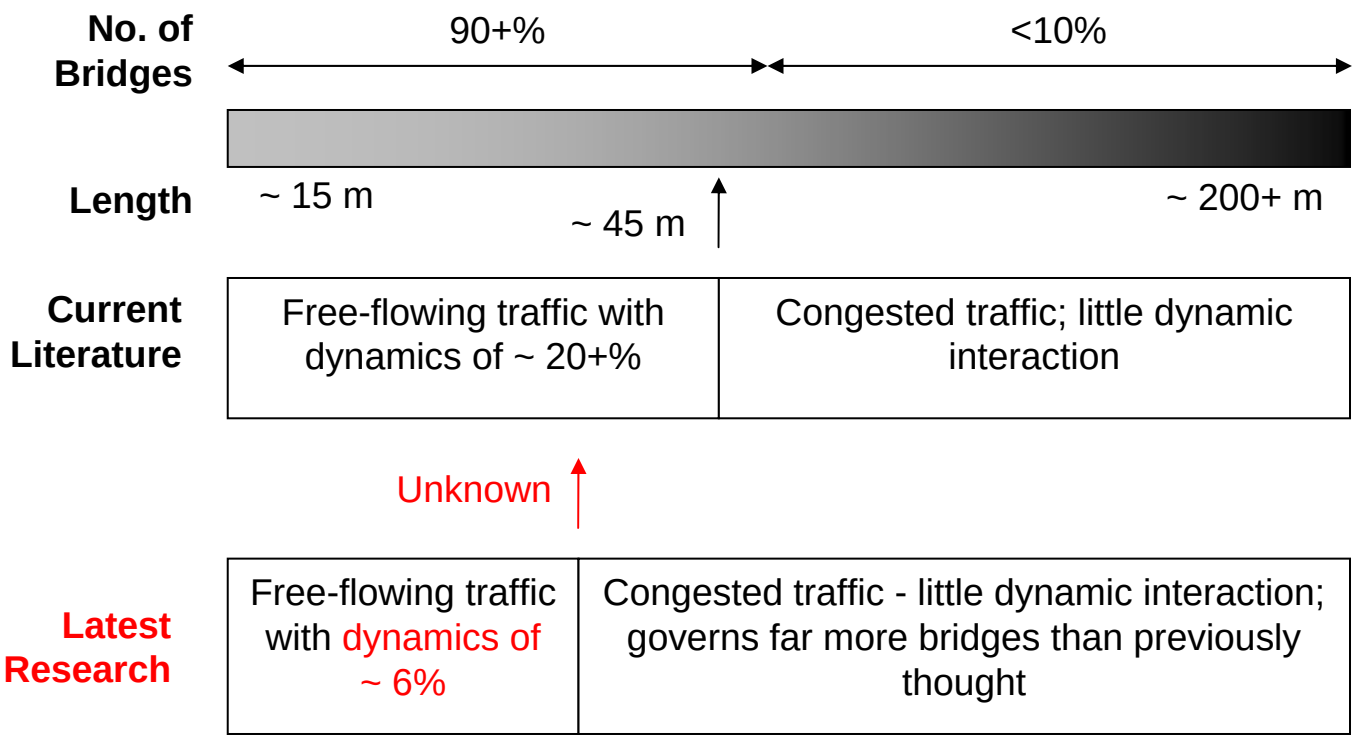
Effect of Result

- This latest finding greatly affects the current approach:



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Conclusions - Future Research

- The assumed governing loading scenarios are not definitive

- Micro-simulation and 'express' dynamic analyses are needed

- Statistical methods can greatly improve loading estimates

- More improved forms of analysis must be employed

The statistical analysis of bridge loading is the best method towards reducing bridge loading requirements.

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Conclusions - Application to Existing Bridges

- Bridge Authorities and assessment codes are necessarily conservative
- The application of the advancing knowledge is therefore limited
- Are there ways to improve this?

Researchers must promote the ongoing work to:

- Relevant practitioners
- Bridge Authorities

Only then are the large saving possible to be realised

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