Dr. Colin C. Caprani

PhD, BSc(Eng), DipEng, MIEI, MIABSE

UCD Civil Engineering

2006

Proposed Research Programme

A Universal Approach to Traffic Loading on Highway Bridges

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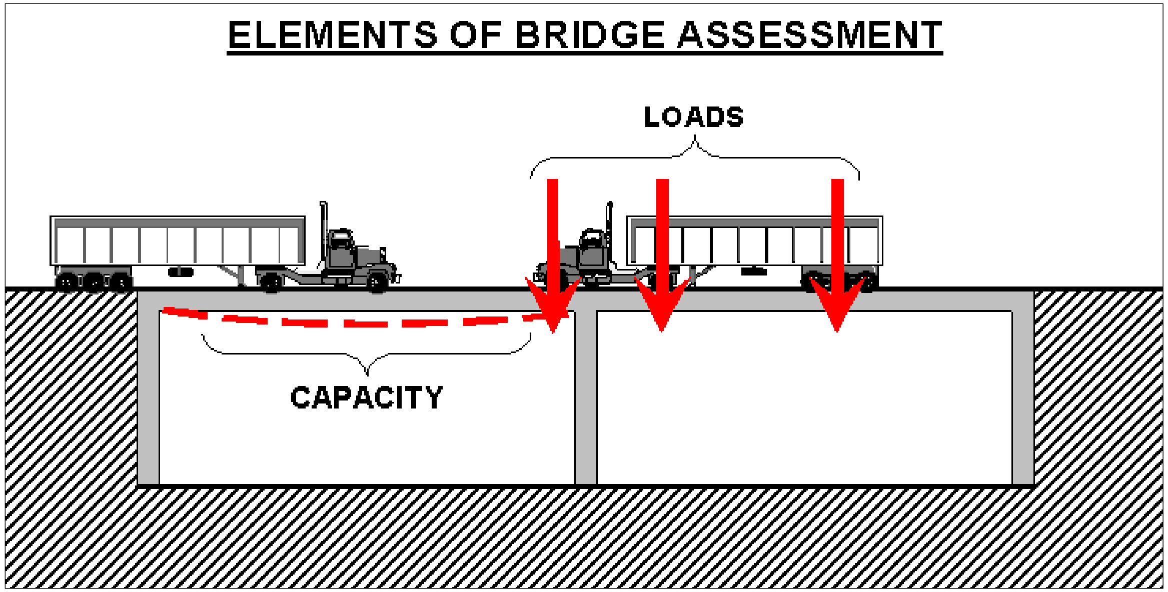
Dr. Colin C. Caprani

Background

- Bridges are assessed on an ongoing basis

- Rehabilitation/replacement is costly & very disruptive



- The assessment of bridge capacity is relatively accurate

- Load assessment is difficult & less accurate due to large variations in traffic

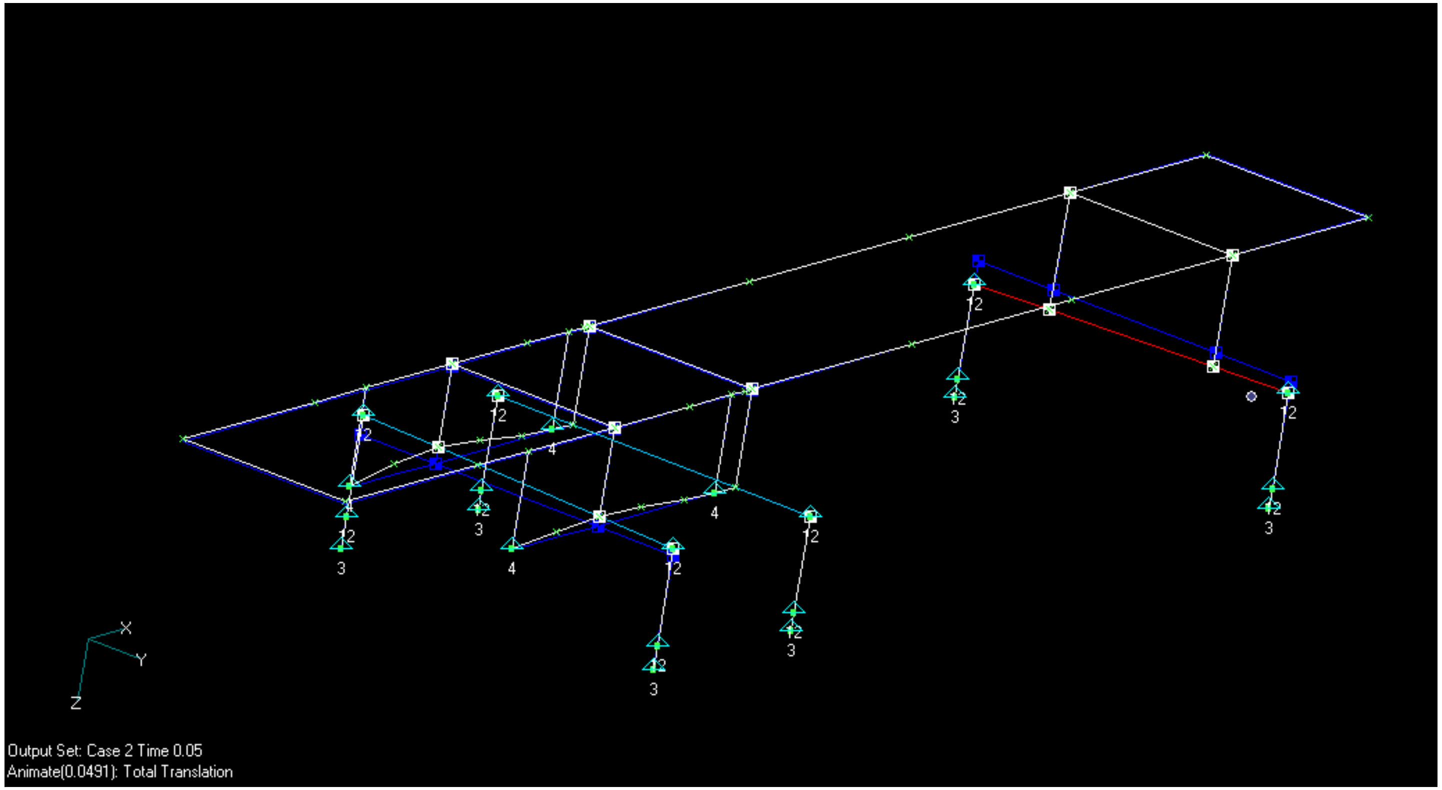
- Better load assessment may eliminate intervention

Conclusion: There are large potential savings through accurate load assessment

Bridge Load Estimation

- Trucks are the critical vehicle type by virtue of weight

- A truck moving at speed dynamically interacts with the road and bridges



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Bridge Load Estimation (contd.)

- Slow moving trucks do not interact dynamically

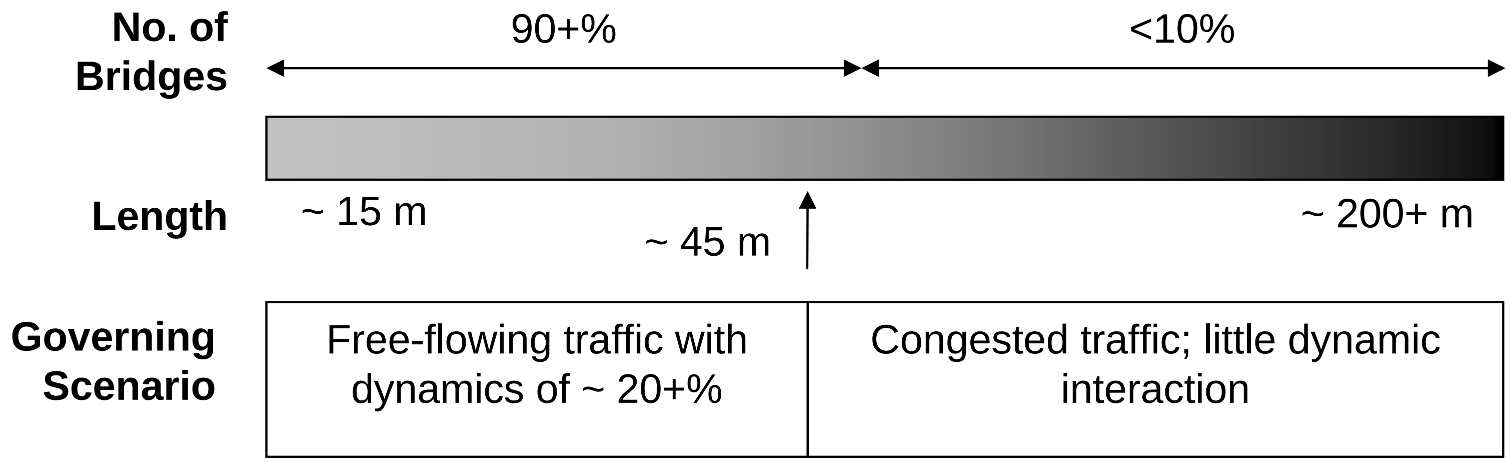
- Congested traffic results in more trucks at closer spaces

- A higher load density results

- There is little associated dynamic effect

Bridge Load Estimation (contd.)

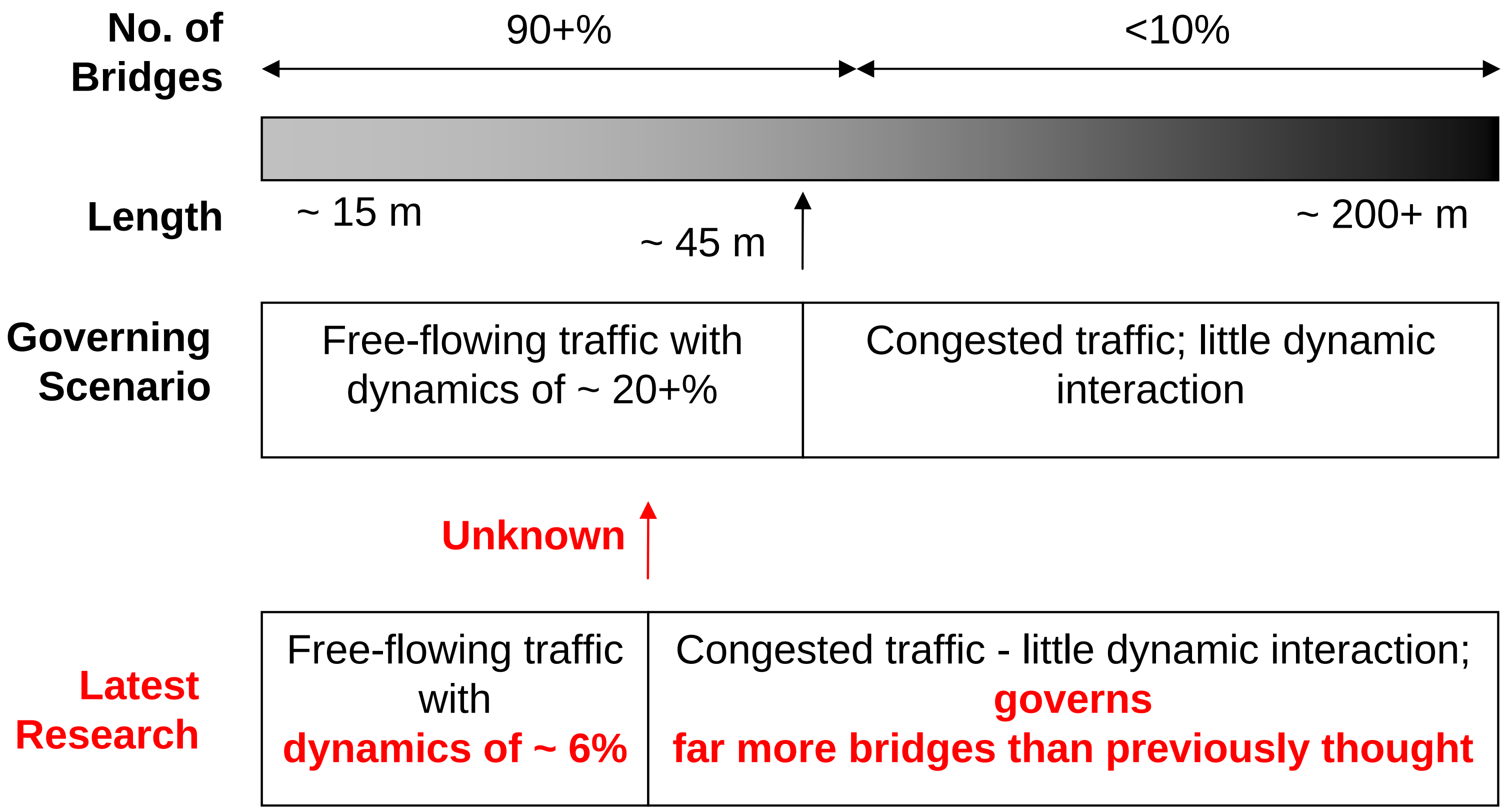
- Both loading scenarios govern a certain range of bridge lengths



- Caprani et al (2006) (ASCE JBE) show that dynamics of only 6% apply to a particular 32 m span bridge

Bridge Load Estimation (contd.)

- This latest finding greatly affects the current approach



Bridge Load Estimation (contd.)

- The 6% finding is for one particular bridge
- This is not the general case
- Also, research thus far has only concentrated on individual parts of the problem

Conclusion

- A method which accounts for all loading situations is required
- This must apply to a wide range of bridge lengths
- It must be computationally feasible and amenable to statistical analysis

This ‘universal’ approach is the subject of the proposed research

The Universal Approach

Consists of several main parts:

1. Quantification of Dynamic Interaction:

The 6% result must be extended to many types of bridges and lengths

2. A New Bridge Traffic Load Model:

This must naturally allow for both congested and free-flowing traffic

3. Statistical Analysis and Computation:

Extensions to both current forms of statistical analysis and computation will be required for the Universal Approach

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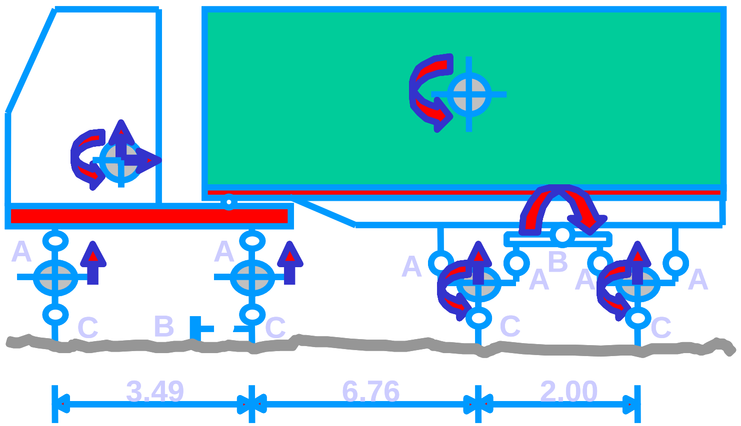
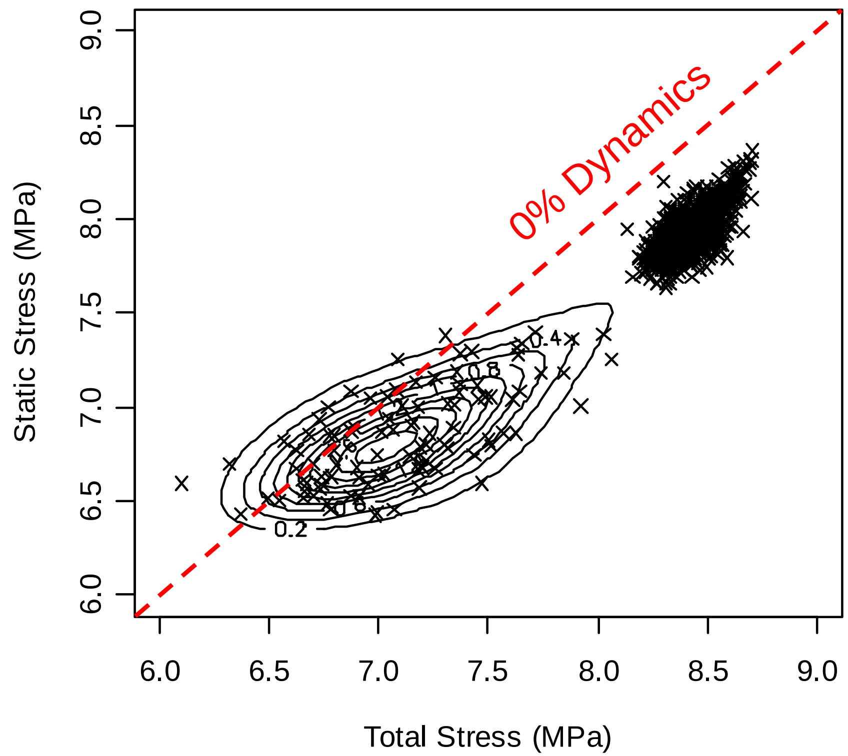
1. Quantification of Dynamic Interaction



A dynamic interaction model which integrates with the load model is required



Static-only and total (static + dynamic) results require joint statistical analysis to determine the appropriate lifetime level dynamic interaction

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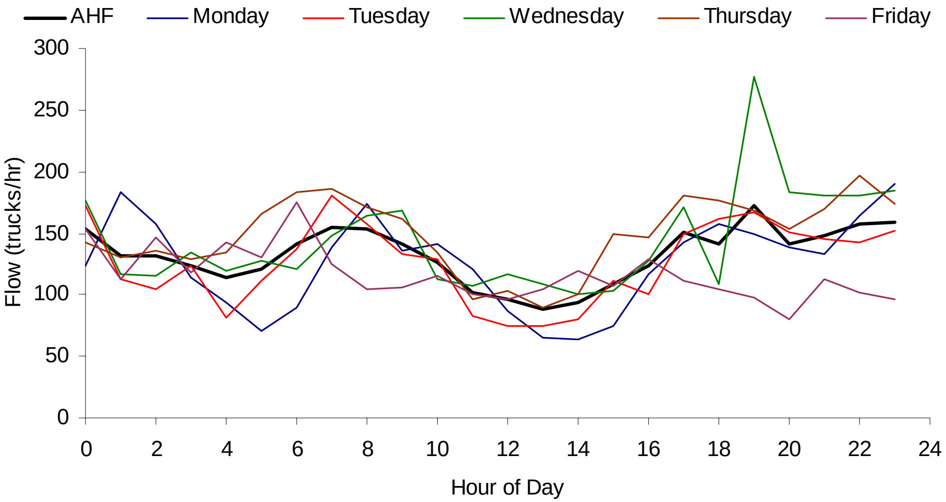
2. A New Bridge Traffic Load Model

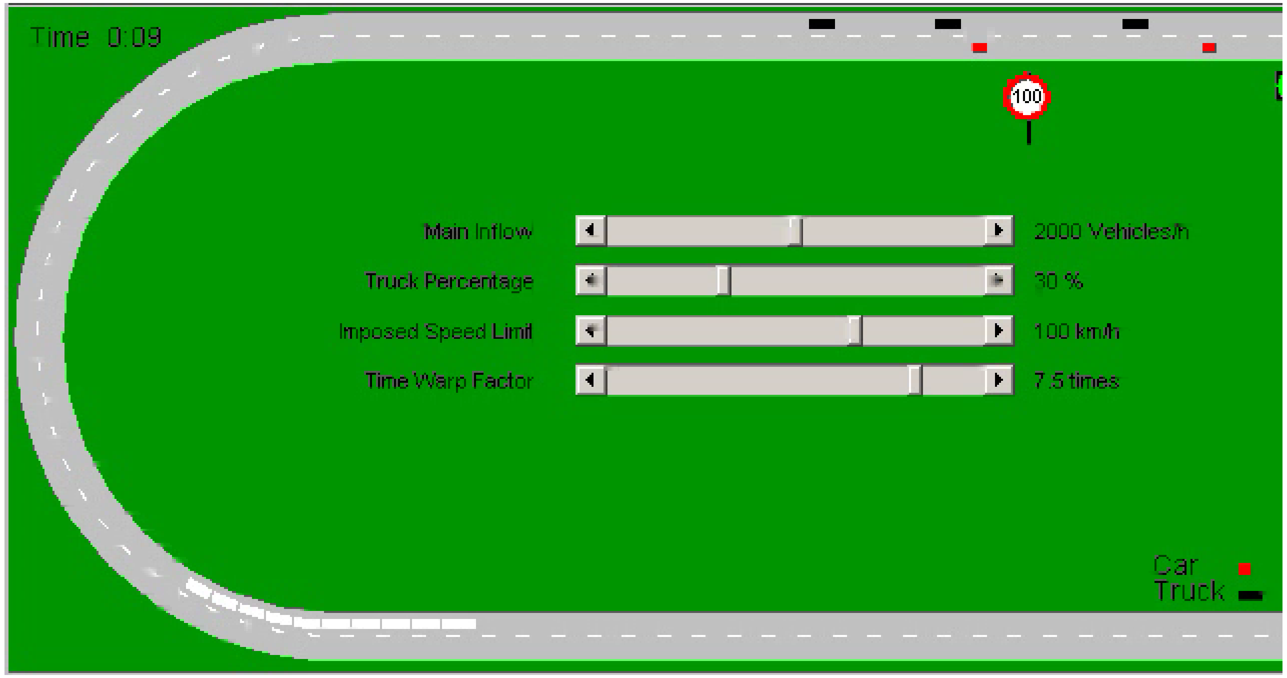


A simulation model which accounts for both free-flowing and congested states allows traffic densities to naturally govern

Micro-simulation of traffic allows for this

Each vehicle is controlled by its interaction with other vehicles

Currently, measured quantities are imposed on the traffic as a whole



Dr Martin Treiber,

University of Stuttgart

3. Statistical Analysis and Computation

The full Universal Approach will consist of:

1. **Micro-simulation of one day of traffic;**
2. **Identification of critical loading scenarios;**
3. **Dynamic interaction modelling of these scenarios;**
4. **Data recording for later analysis;**
5. **Repeat for 1000 days (4 years) or so.**

For the intensive computations, a C++ object-oriented framework is envisaged.

The statistical analysis required will extend those of the author's PhD

The amalgamation of those methods will be a significant area of effort

Benefits of the Universal Approach

The full Universal Approach allows for:

1. All types of loading scenarios;
2. A wide range of bridge lengths.

Therefore:

- Each bridge is considered on a case-by-case basis
- No assumption about the governing loading scenario is required
- Traffic volume and composition is the main input, rather than overly-detailed statistical models

In short:
The proposed approach will encompass all known aspects of the problem and will represent a considerable advance in the current state-of-the-art

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Conclusions

- Many bridges are repaired/replaced needlessly, wasting limited resources
- Accurate assessment of loading can eliminate this problem
- Recent research shows that the governing loading scenario is not known
- Worse still, this applies to the most common type of bridge: ~30 m to ~45 m long

The proposed research will solve this problem, giving

- A new approach to bridge loading assessment
- A change in industry practice
- A reduction in unnecessary bridge repair/replacement
- Significant associated publications