Calculating a Bridge Assessment Dynamic Ratio
Using a Bridge Weigh-In-Motion system

Jason Dowling
Overview

1. Bridge Weigh-In-Motion
2. Model Description
3. Assessment Dynamic Ratio
4. Theoretical Simulations - New Algorithm
5. Conclusions
Instrumented Bridges....

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Moses Algorithm (1979)

\[ \text{Err} = \sum (M^{\text{th}} - M^{\text{me}})^2 \]

\[ \frac{\partial \text{Err}}{\partial W_i} = 0 \]
Typical ‘Measured’ Response, $M^{me}$...
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\[ M(x) = \sum_{i=1}^{N} W_i I(x - \sum_{i=1}^{N-1} a_{i,i+1}) \]
Moses Algorithm (1979)

\[
\text{Err} = \sum (M^{\text{th}} - M^{\text{me}})^2
\]

\[
\frac{\partial \text{Err}}{\partial W_i} = 0
\]

Matrix solution technique:

\[
\{W\} = [F]^{-1}\{B\}
\]
Model Description

Truck Model...

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Road ‘Carpet’ Profile

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Model Description

Statistical Data - GVW & Velocity
- Axle Spacing & Axle Weights

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Definition:

\[ ADR = \frac{\text{characteristic total load effect}}{\text{characteristic static load effect}} \]

associated with a return period

i.e. not a single event.
Trends in ADR

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Source: SAMARIS (2006)

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Trends in ADR

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Source: OBrien et. al (2009)
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Theoretical Simulations - ADR

10 years...

(500,000 trucks/year)

25m Bridge

Class ‘A’

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50 years

25m Bridge
Class ‘A’

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50 years

25m Bridge
Class ‘A’

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Simulation Variability...

Five 10 year simulations

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Theoretical Simulations - Errors...

Tendency to under-weigh Steer Axle...

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Cause of under-estimation of ADR...

Theoretical Simulations - Errors...

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Theoretical Simulations - New Algorithm

Dynamic Response - Time & Freq. Domains

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10 Responses represented in the Freq. Domain

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Filtered Response - Time & Freq Domains

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Incorporating filtering of dynamic signal...

![Graph showing original and filtered signal frequencies and amplitudes.](image-url)
‘Measured’ Influence Line

Theoretical Simulations - New Algorithm

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Static BM using New Approach

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Example 1:

10 years...

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Example 2:

10 years...

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Max Static BM Errors using New Approach...

Theoretical Simulations - New Algorithm

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Worst Case: Max Static BM Error...

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Worst Case: Max Static BM Error...

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In Summary:

General ADR trends in keeping with recent findings...

The Classic Moses Algorithm over-estimates Maximum Static Strain...

Incorporating Filtering of the dynamic signal improves predictions...
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Thank you for listening.