

DYNAMIC BEHAVIOR OF PRE-STRESSED SLAB BRIDGES

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- Pre-stressed in-situ slab bridges in last 10 years have been used for overpasses on road junctions where height of the bridge deck and space under the superstructure is limited by the levels of roads.
- Because of the technology that has developed and become more economical, this type of bridge is easy and fast to build.
- Highway bridges are subjected to the dynamic forces imposed by traffic. These forces are stochastic in their nature and impact load significantly exceed static loads.
- Dynamic loads influence bridge load carrying capacity - can cause deformations, vibrations, deterioration and can cause cracking of concrete structures.



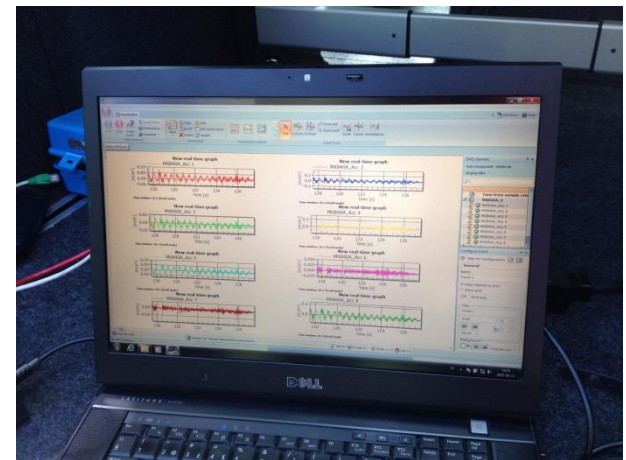
Two modal analysis methods:

- Experimental modal analysis (EMA),
- Operational modal analysis (OMA).

Traffic is a random loading, therefore characterized by probabilistic analysis.

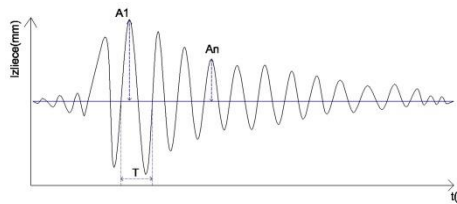
Operational modal analysis (OMA) - relatively cheap equipment (accelerometers) and simple way of recording data.

Measurements can be analysed in two domains – frequency and time domain.

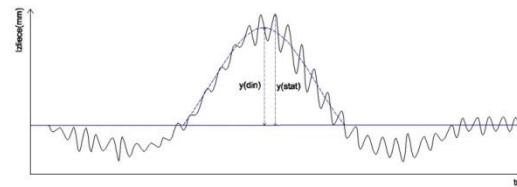




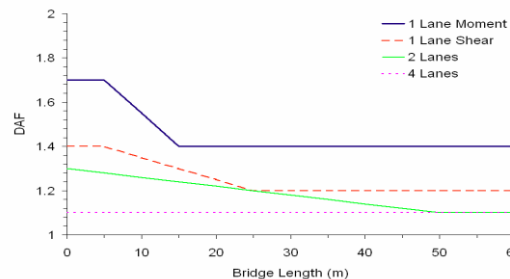
- Natural frequency
- Acceleration
- Logarithmic decrement - Damping
- Dynamic amplification factor (DAF)



$$\delta = \frac{1}{n} \ln\left(\frac{A_1}{A_n}\right)$$



$$DAF = \frac{\mathcal{E}(dyn)}{\mathcal{E}(stat)}$$



- Multiplying the static live load by DAF or built-in value of a live load model
- DAF – as a function of the bridge span length



Bridges: 1 RC and 3 PRC slab bridges ,1 ribbed RC and 3 PRC ribbed slab bridges

Bridge	Span length (m)	Width (m)	Height (m)	Span /depth ratio	Structure	Nr. of ribs	Calculated 1 st mode natural frequency, Hz	Measured natural frequency, Hz	Maximum DAF
Bridge over Lauce River	11,41	8	0,5	23	Simply supported (s.s) RC slab	1	8.88	9	2
Bridge on Road A12	34	10,5	1,4	24	Simply supported (s.s)PRC slab	1	2.45	3	1,5
Bridge over Railway Jelgava - Tukums	18	11,53	0,8	23	PRC slab frame	1	5,23	5,5	1,9
Overpass over Railway Riga - Krustpils	22,5	13	0,9	25	PRC slab frame	1	4,3	5	3,5
Bridge over River Dīvāja	25,5	15	1,3	20	Simply supported (s.s) PRC ribbed slab	2	5.68	7.3	2
Overpass on road A6	19,5	11,3	1,0	20	RC ribbed slab frame	3	5.56	6	2
Overpass on road P8	27,4	11,45	1,1	25	PRC ribbed slab frame	2	3,93	4	1,3
Overpass on road E22	30	19,5	1,1	27	PRC ribbed slab frame	3	4,8	4,9	5



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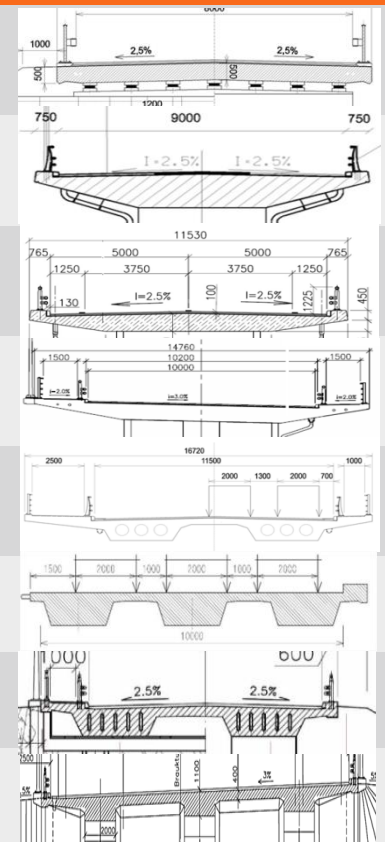
Experimental testing

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Bridges: 1 RC and 3 PRC slab bridges ,1 ribbed RC and 3 PRC ribbed slab bridges

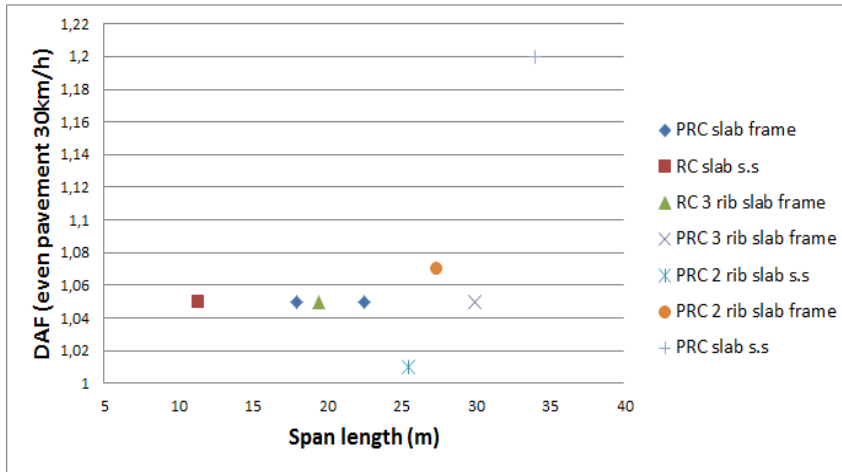
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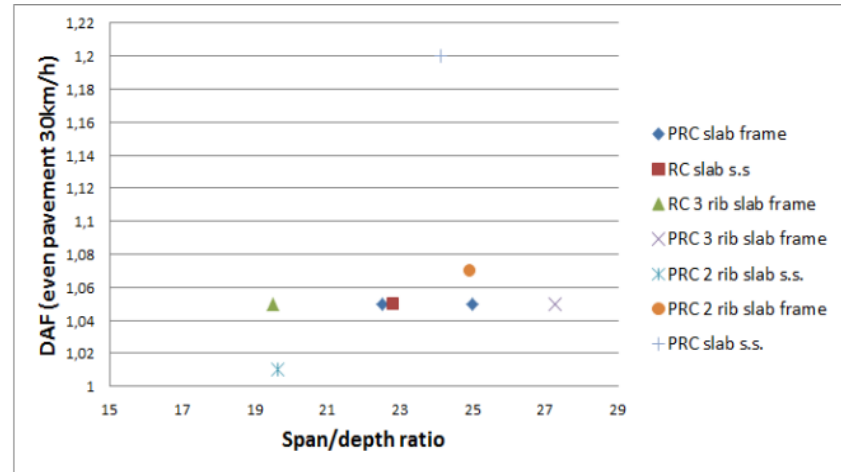


Natural Frequency

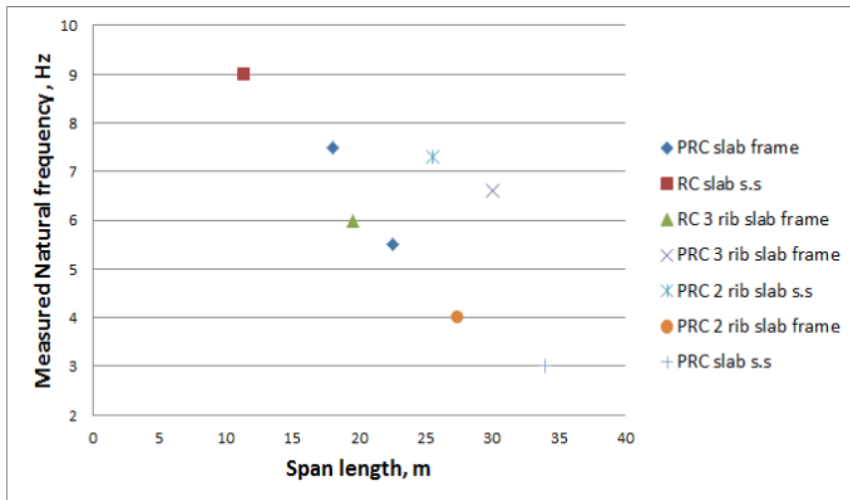
DAF (for even pavement) and span length



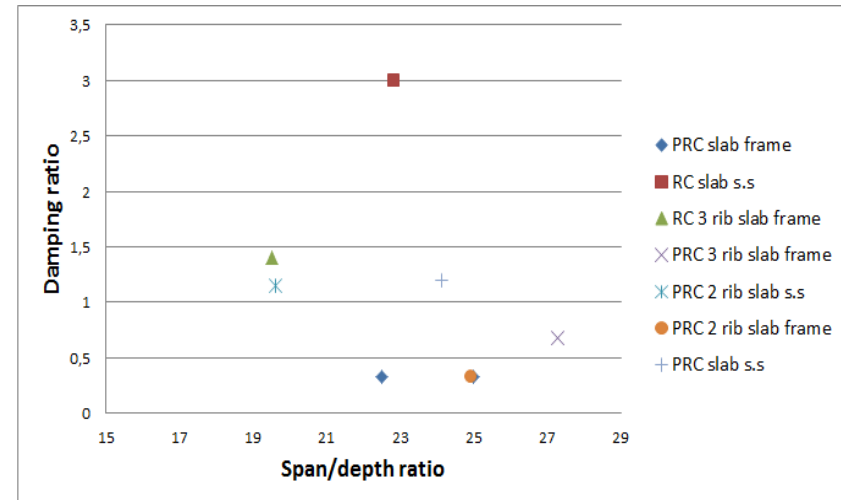
DAF (for even pavement) and span/depth ratio



Natural frequency and span length



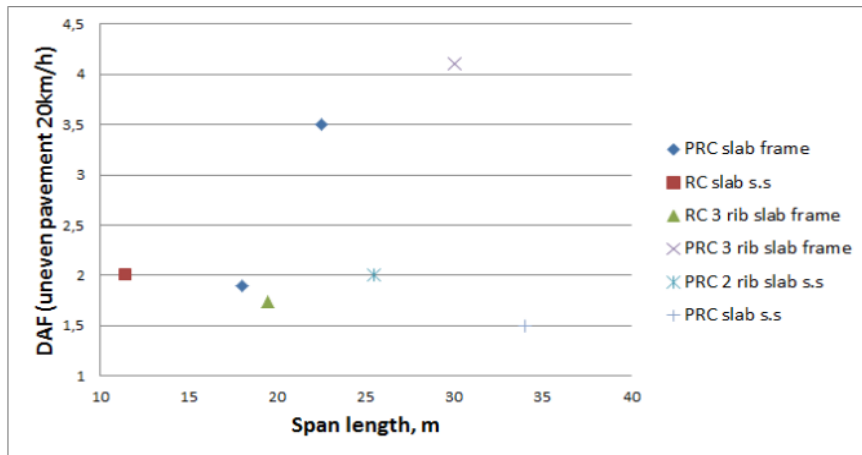
Damping ratio and span/depth ratio



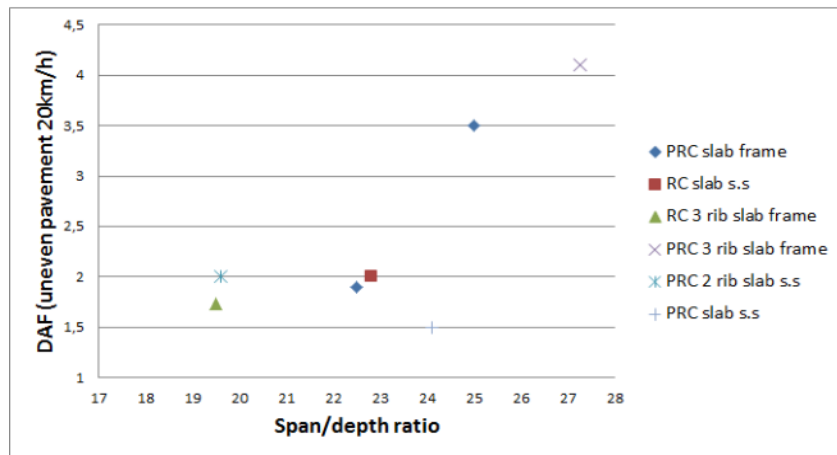


Natural Frequency

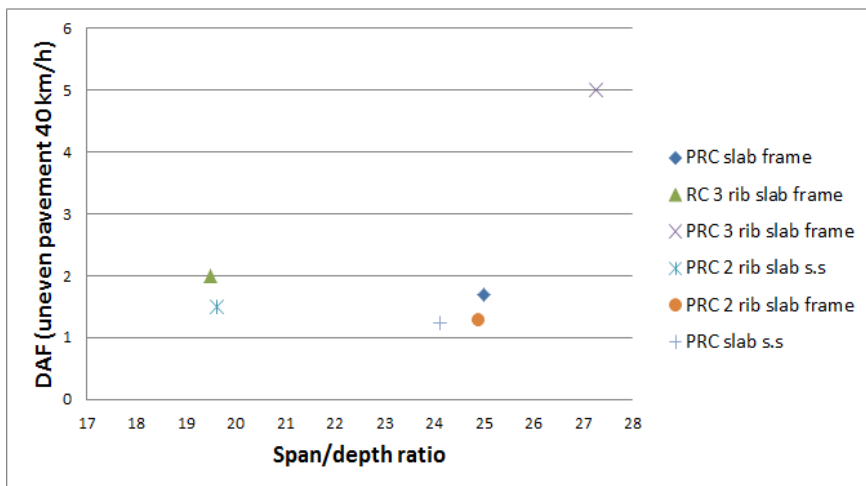
DAF (uneven pavement 20km/h) and span length



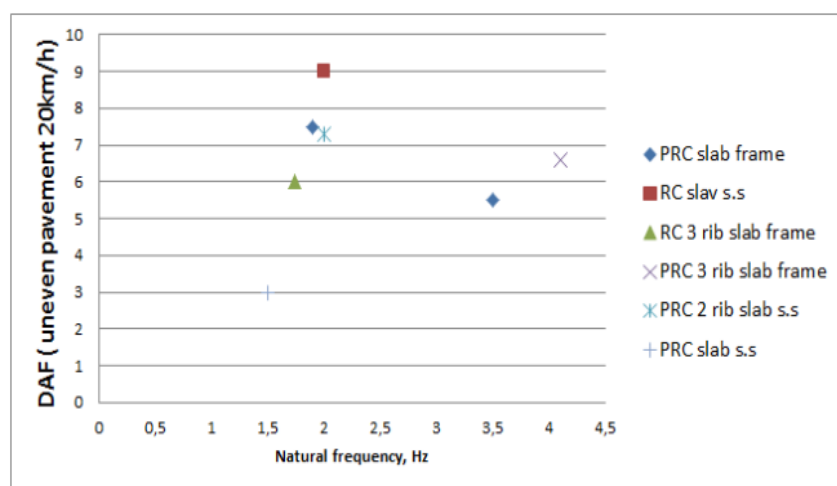
DAF and span/depth ratio



DAF (uneven pavement 40km/h) and span/depth ratio



DAF (uneven pavement 20 km/h) and natural frequency





Conclusions

- Pavement evenness and vehicle speed correlate and results show that for speed of 20km/h DAF can increase up to 2.
- PRC bridges in plan radius or with one sided slopes can have DAF up to 5.
- For PRC bridges span/depth ratio correlate with damping ratio- higher span/depth ratio show decrease in damping ratio.
- For even pavement condition DAF values are lower than 1,4 .

Thank You for your attention!

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