

Tisza-bridge at Záhony



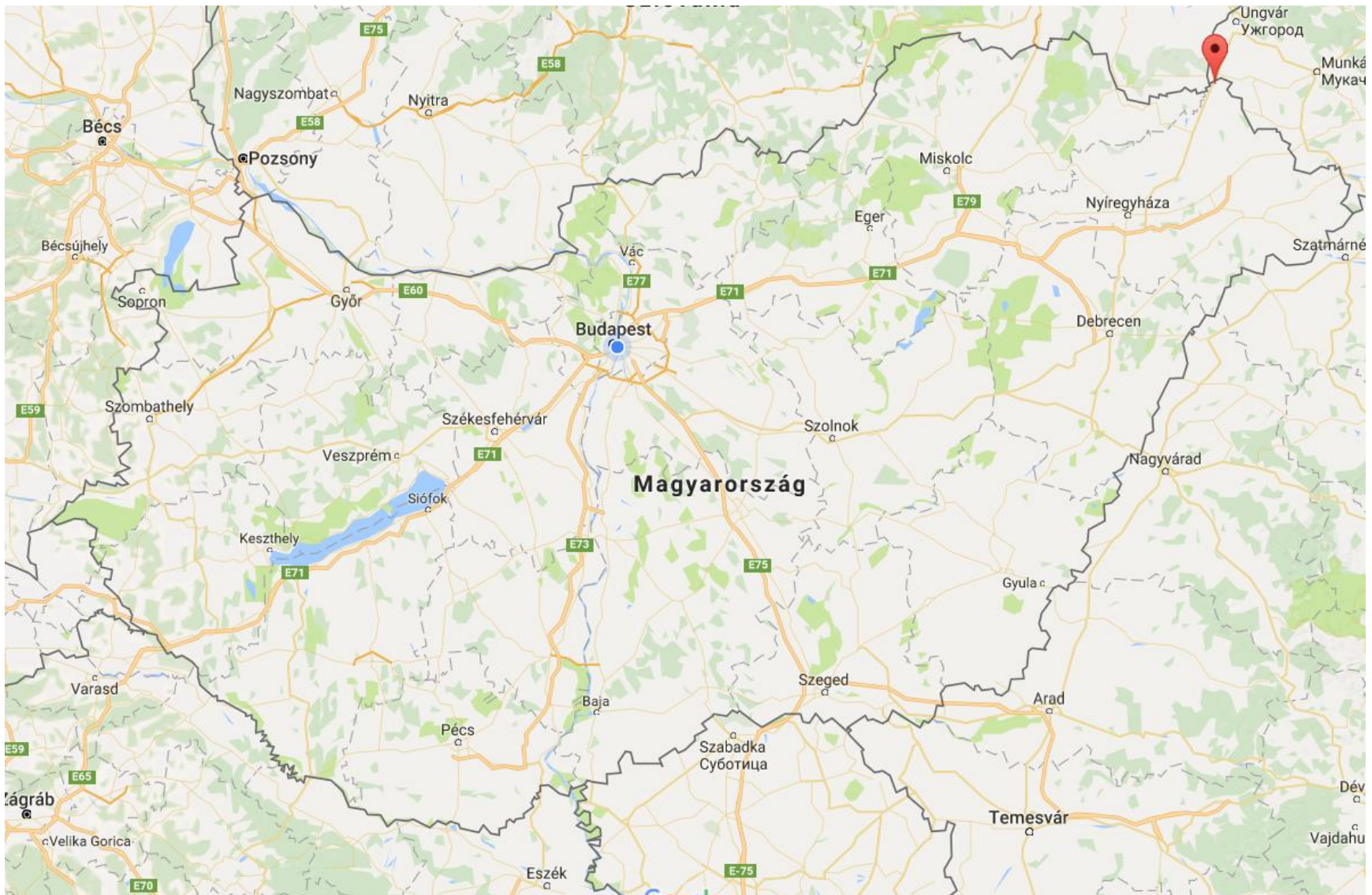
3 span continous girder
steel superstructure with box section
orthotropic bridge deck with flat plate stiffeners



huge heavy traffic load → **fatigue check**



Location of the bridge



Structure of the bridge



Cross section of the bridge



Tisza-bridge at Záhony



damages in the asphalt layer



8-9 years lifetime for the asphalt



increased direct stress on the steel deck plate

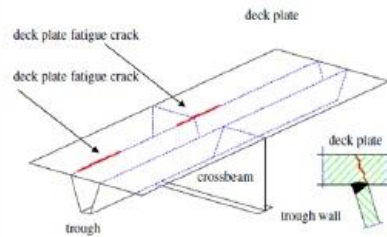
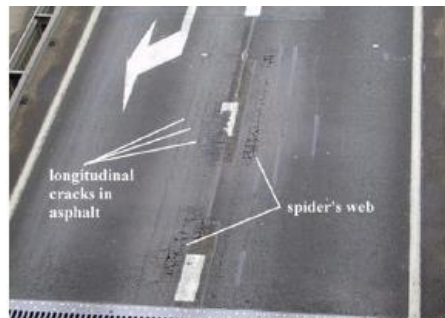


Research aim:

Selection of the optimal solution:

- renewal of the asphalt layer
- precast concrete panels
- no asphalt layer needed

Fatigue of orthotropic bridge deck



stress distribution by the asphalt layer



failure of the asphalt layer



increased fatigue damage probability



detailed fatigue assessment needed

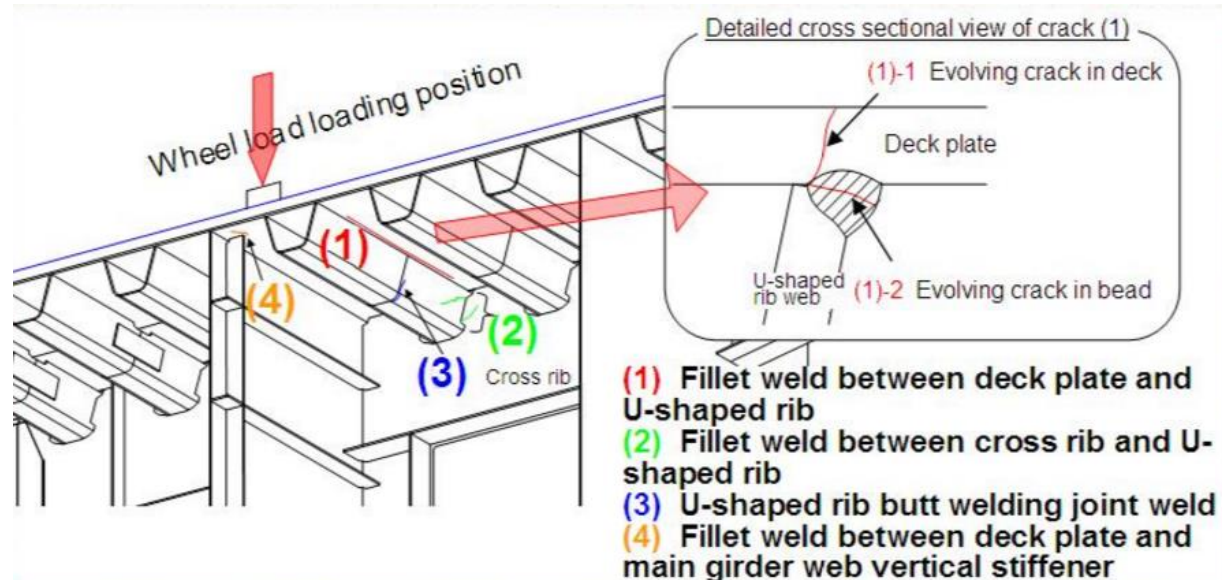
On-site measurements



- real stress range spectra
- real traffic volume (weight of vehicles)



most reliable fatigue design



Measurement preparation



Measurement preparation



36 strain gauges are placed on the bridge deck system.

On-site real-time measurements during traffic

measuring period: 2,5 days

measured trucks: 265 trucks

strain gauges: 36 pieces

analysed fatigue detail classes:

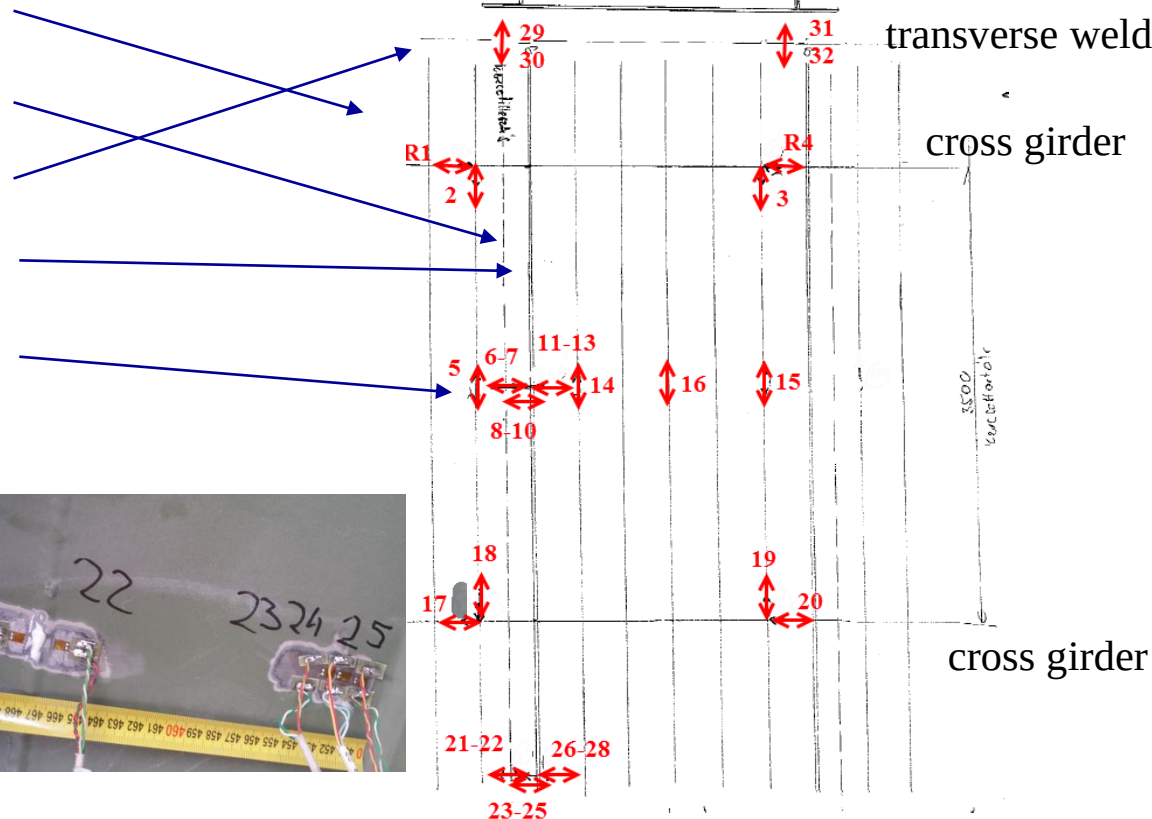
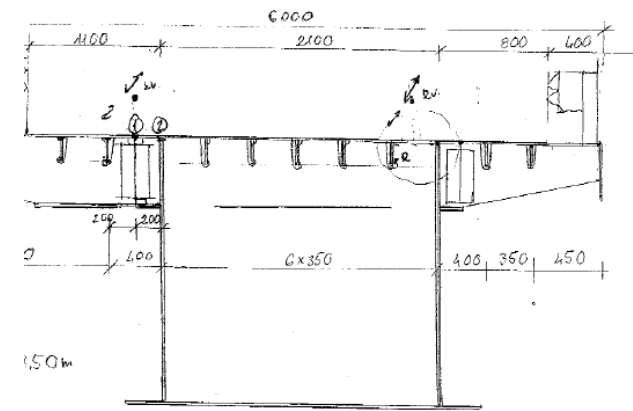
cross girder – stiffener connection

longitudinal weld of the deck plate

transversal weld of the deck plate

weld between web and deck plate

longitudinal stiffeners at midspan



On-site real-time measurements during traffic



Location of the measurement system



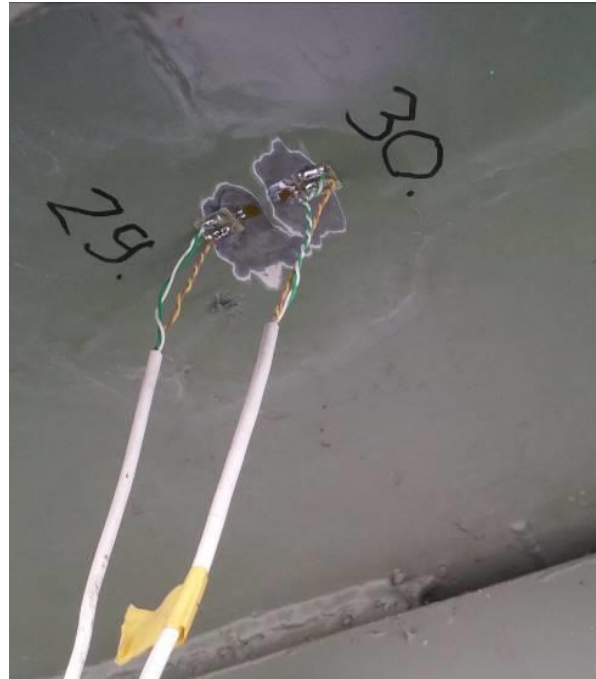
Position of the strain gauges



Position of the strain gauges



Position of the strain gauges



On site real-time measurements during traffic

Measuring and registration of the traffic volume



On site real-time measurements during traffic

Measuring and registration of the traffic volume



265 trucks are measured → stresses and weights are measured and recorded

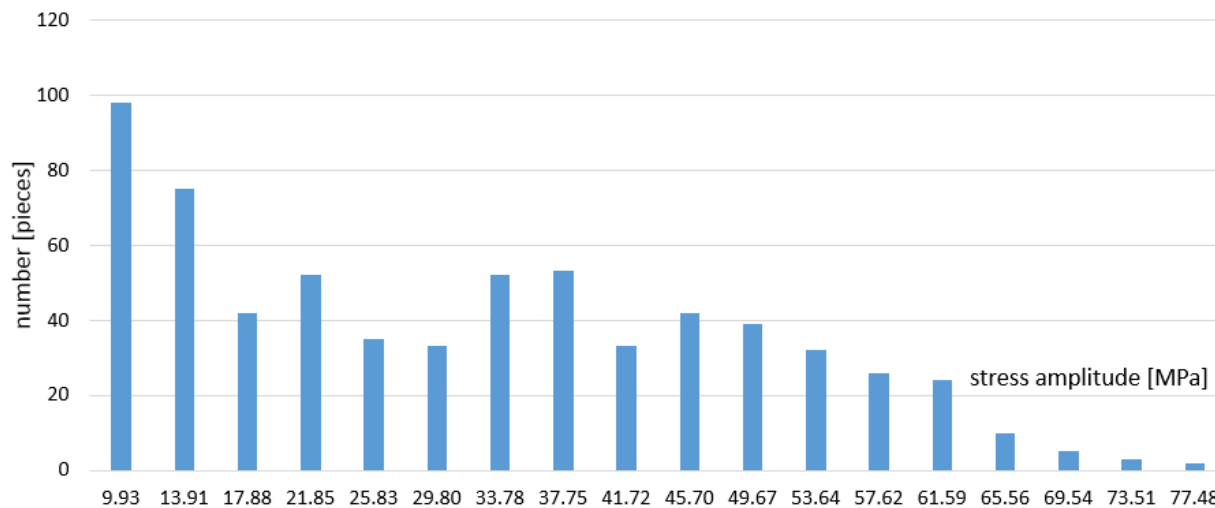
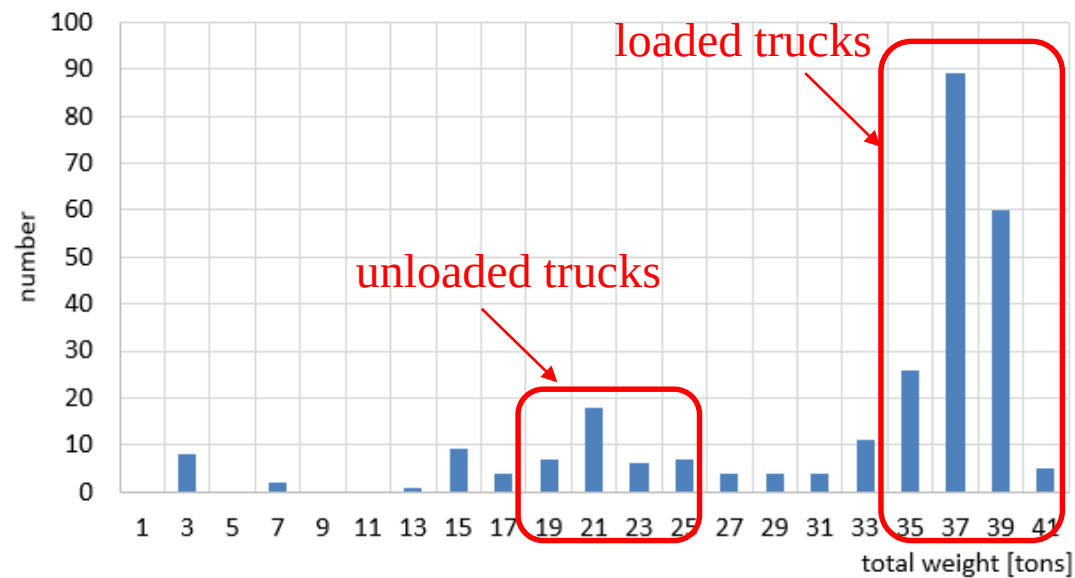
A	B	F	J	O	P	Q	R	S	T	U
Time	Reg. Number	Total weight [t]	Measured file	Wheel size	Note	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5
14:16	BC5841AI	37.36		0		8.17	9.49	6.12	6.47	6.89
14:12	BK0985BB	31.84	048 MGC	0		6.94	8.74	4.92	5.24	5.25
14:09	BK0983BB	36.3	046 Quantum	0		7.1	9.16	6.34	6.43	6.57
14:04	AT7594AK	34.08		0		6.68	7.77	6.31	6.41	6.64
14:02	LHX338	36.58		0		6.72	9.47	6.23	6.57	6.76
13:58	MBK646	34.06		0		6.95	9.51	5.24	5.83	5.85
13:49	AO6187BA	35.64		0		7.36	10.03	5.81	5.93	6.13
13:42	BK4613BT	36.4		0		6.28	8.8	6.8	7	6.98

Results of the weight and stress measurements

Weight of the trucks:

known distribution of the load intensities

Measured stress spectrum (at 36 strain gauges)



→ base of fatigue check

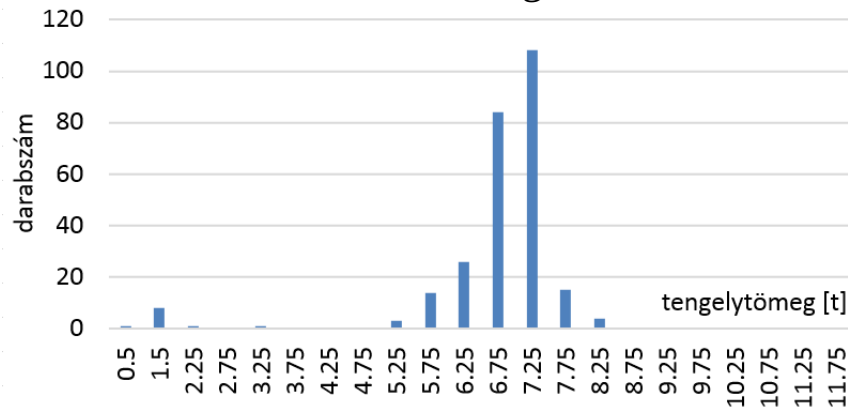
↓
lifetime calculation

↓
strengthening method
decision

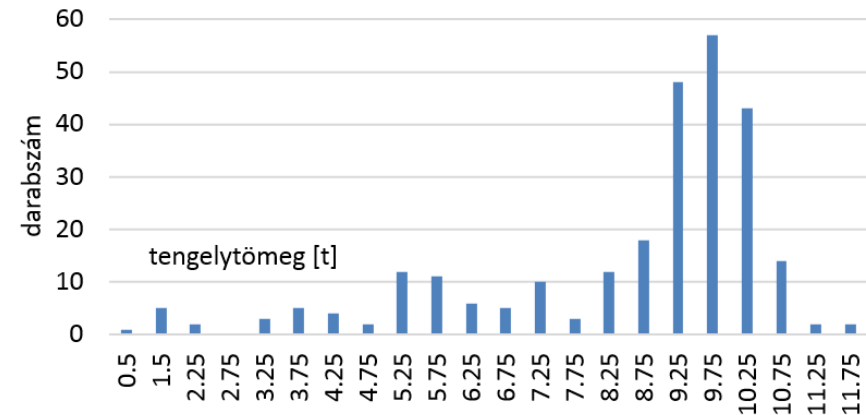
Results of the weight measurements

	Axle 1	Axle 2	Axle 3	Axle 4	Axle 5
Min.	0.13	0.96	1.42	1.6	1.63
Max.	8.42	11.74	10.44	7.89	8.21
Average	6.71	8.50	5.50	5.78	5.96

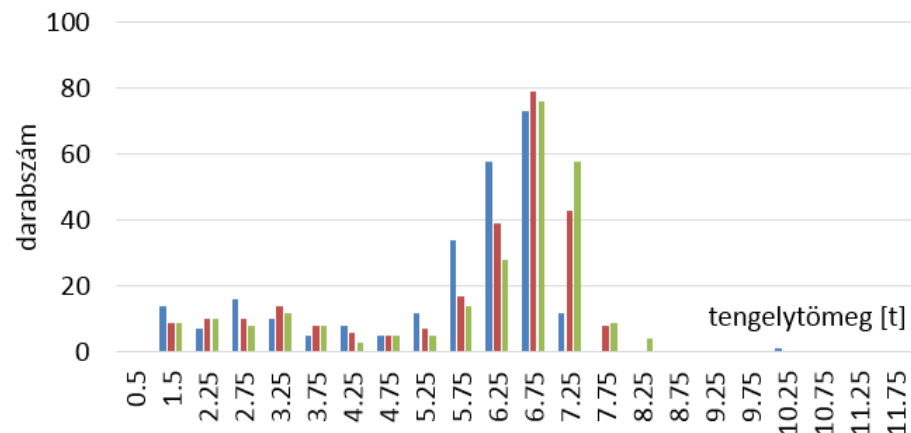
distribution of the weight of Axle 1



distribution of the weight of Axle 2



distribution of the weight of Axles 3-5



Application of measurement data

Location of the wheels

Measurements of 4 longitudinal stiffeners



Question: - average location of the vehicles
- distribution function of the location variation

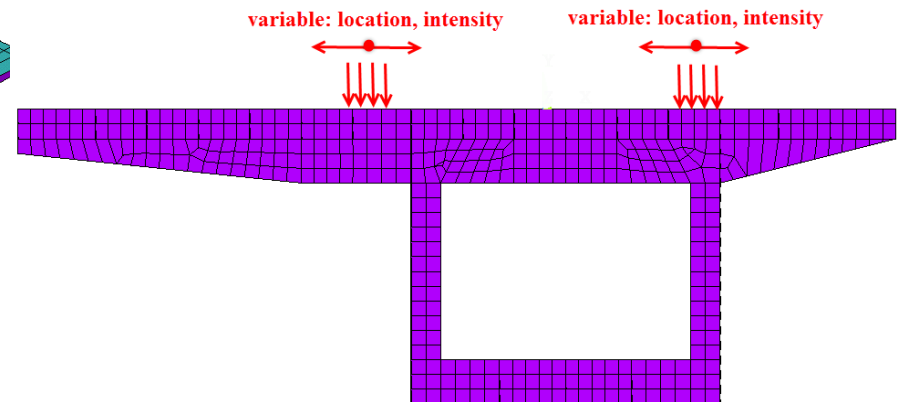
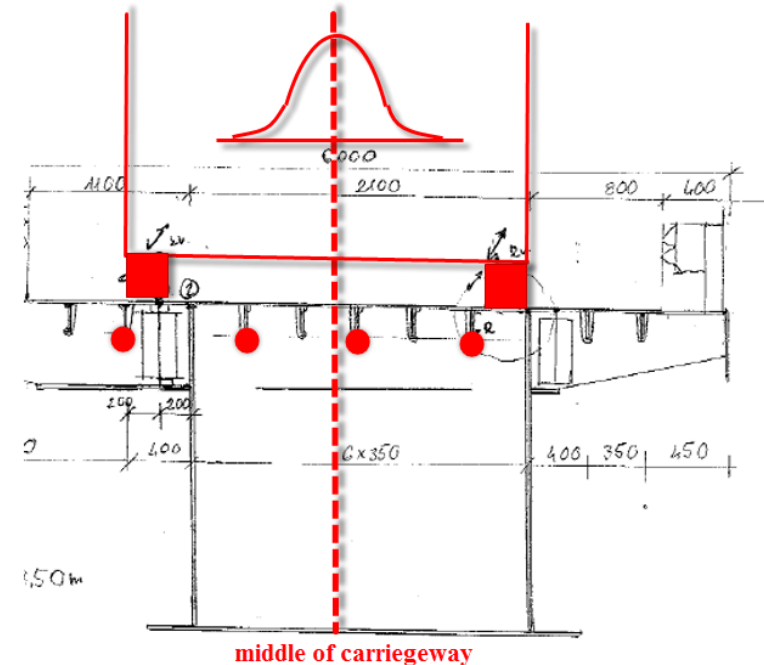
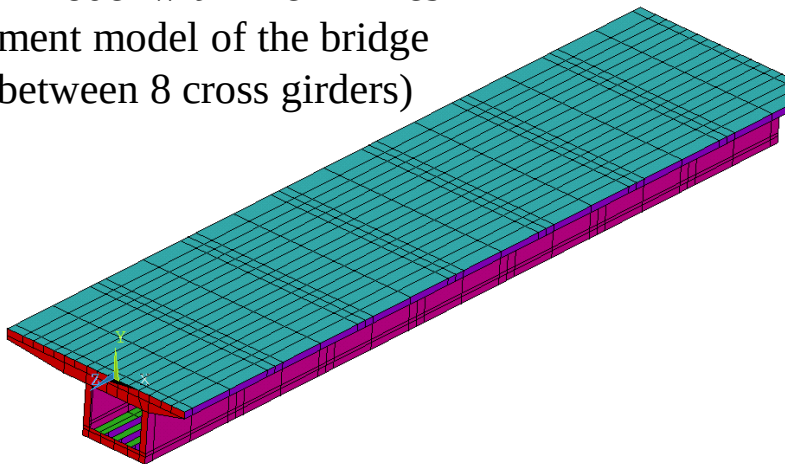


Solution method:

- numerical model vs. test results
- statistical analysis of measured data
- Monte-Carlo simulation using num. model

Applied numerical model:

shell model with fine FE mesh
segment model of the bridge
(between 8 cross girders)

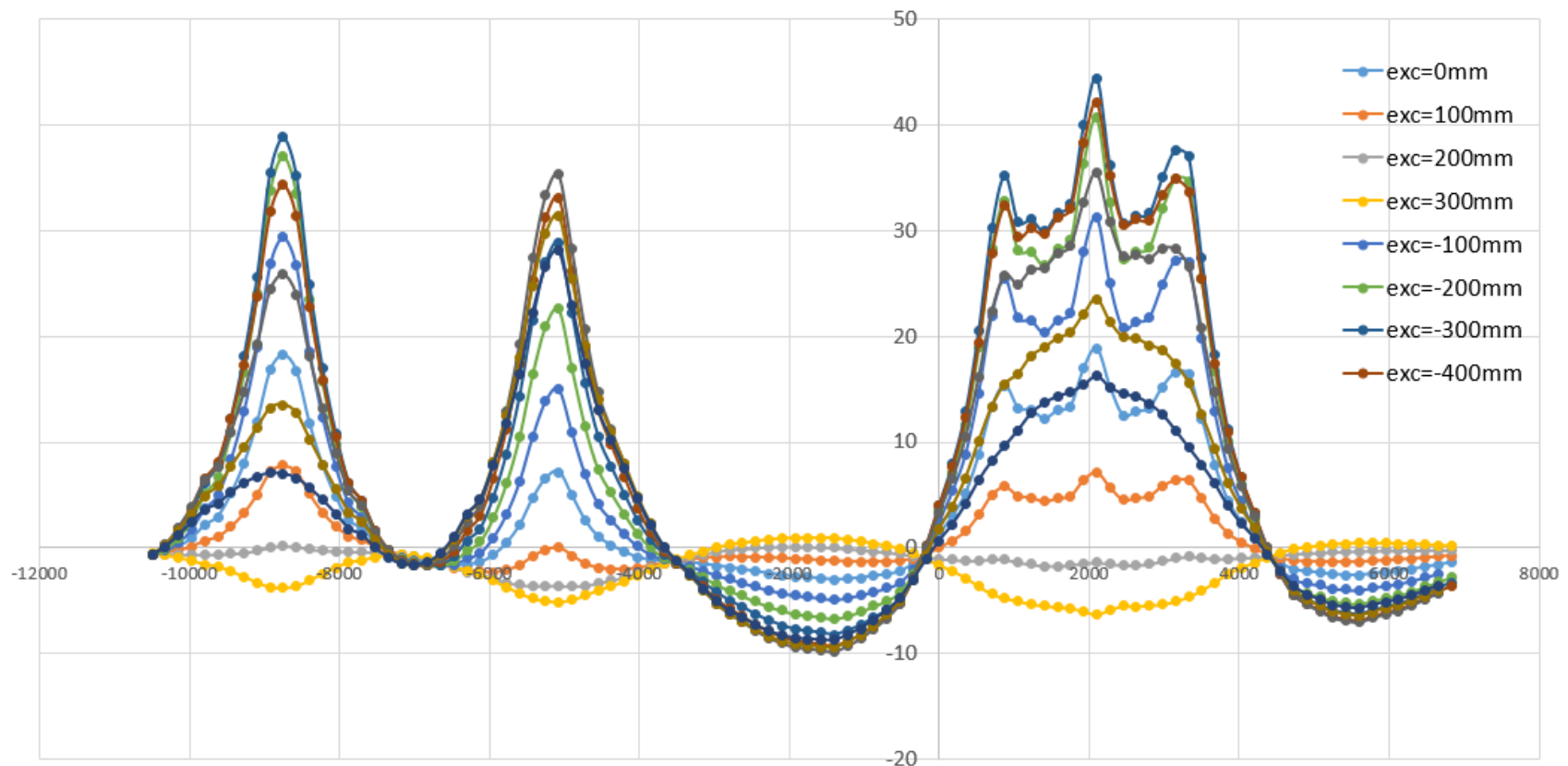


Results of the numerical calculations

Stress change amplitudes

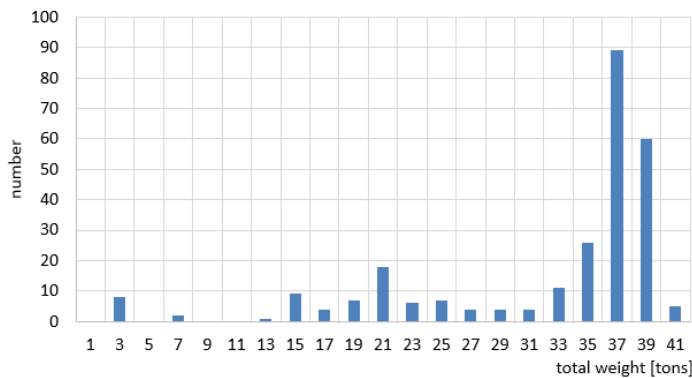
Numerical results: stress changes for average truck load
for 8 different eccentricities

→ eccentricity – $\Delta\sigma$ relationship

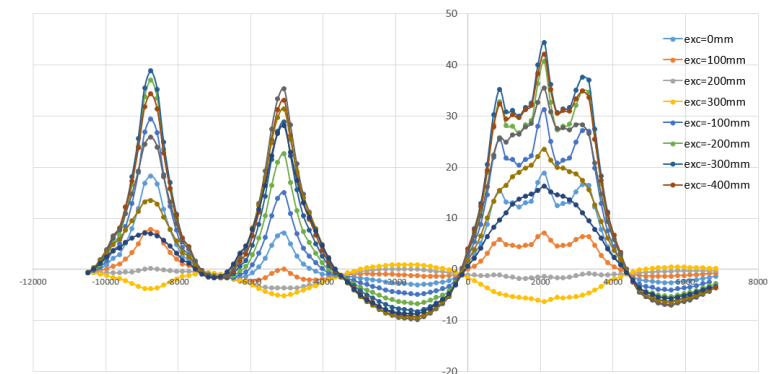


Determination of truck position statistics

number and measured weight of trucks



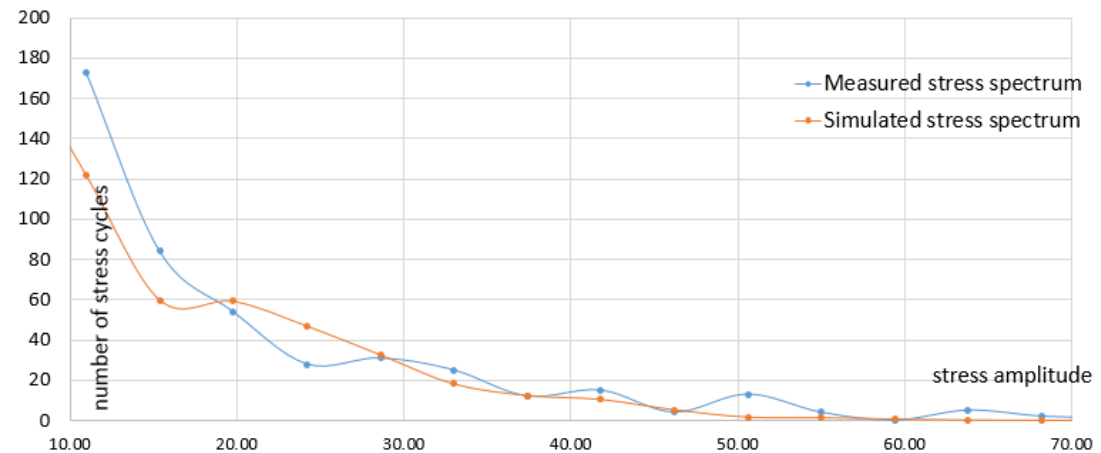
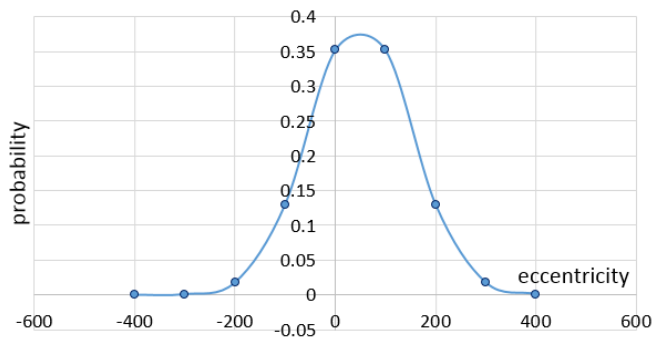
eccentricity – $\Delta\sigma$ relationship



Question: How to combine the different eccentricities to get the measured stress spectra?



Inverse Monte-Carlo simulation to determine the average location and the standard deviation of the trucks



average eccentricity: 50 mm
standard deviation: 100 mm



detailed fatigue
assessment performable



Task of the project work

1. Detailed investigation of the measured data
2. Evaluation of the truck weights
3. Evaluation of the strain measurements – determination of stress spectra
4. Fatigue assessment of the bridge deck (investigated structural details)
5. Further research possibilities