



# SiWIM Bridge Weigh-in-Motion

**Matjaz Sokol**  
Project Manager  
[matjaz.sokol@cestel.si](mailto:matjaz.sokol@cestel.si)

**CESTEL**

# CESTEL & SiWIM

## CESTEL

- Established in 1978.
- Located in Slovenia, EU.
- 100% private company.
- Main business areas:
  - Dynamic weighing (SiWIM)
  - Static weighing & vehicle dimensions control
  - Exceptional transport control
  - Environment monitoring



# CESTEL & SiWIM

## SiWIM – portable B-WIM

- Bridge Weigh-In-Motion technology.
- Own development and production.
- First SiWIM measurement in year 2000.
- Bridge used as a weighing platform.
- Collects real time data on gross weight, axle loads, axle distances, speed, vehicle class,...
- Identifies the true behaviour of the bridge.
- Portability – permanent or short term measurements.



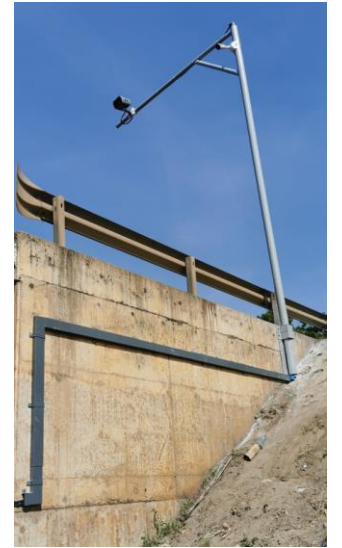
# SiWIM in Africa

- **Seeing is believing!**
- Installation: February 2022
- Location: Tegeta bridge, Dar es Salaam, Tanzania
- Main goals:
  - show the usability
  - to proof the accuracy



# Installation

- Quick and easy installation.
- No damage to the structure.



# Installation

- HW protection against (possible) vandalism.



# Visitors

- A lot of interest → new technology in Africa



# Accuracy test

- Weigh control at static weigh station.



# Accuracy test

- Comparison of the results.

TANZANIA NATIONAL FOODS AGENCY  
KUSASIA YASAR DAR ES SALAAM  
UNITED REPUBLIC OF TANZANIA

Date: 03.03.2022 Time: 12:58 Station: KUNDUCHI WEIGHBRIDGE STATION  
Location: KUNDUCHI WEIGHBRIDGE DAR ES SALAAM Station Code: DAR/KUN Ticket No: TLAMZTH913A

**PART A: TRANSPORT INFORMATION**

Transporter: TANZANIA LTD  
VIN: 100224003  
Address: 210 Tanga  
Destination: UBUNGU  
Origin: Tanga  
Axle Configuration: 5S DB T5S

Driver: Ally Mohamed  
Reg. No: T★C★  
Trailer No: T★★K  
Special Load Permit No:  
Cargo: Lime

**PART B: AXLE WEIGHTS AND FEES**


	Measured	Allowed	Adjusted	Overload (Kg)	Fee (\$)
axle Group 1	5500	8000.00	8400.00	0	0
axle Group 2	17550	18000.00	18900.00	0	0
axle Group 3	22350	22500.00	23025.00	0	0
GVM	45500	48500.00	48500.00	0	0

Total Chargeable Fee: 0

**PART C: PENALTIES**

Demerit Points: 0 Cumulative Demerit Points: 0  
Operator: Daniel yvito Sign:  
Driver: Ally Mohamed Sign:

Action taken: Vehicle Vision Limit  
not satisfied with the findings and you may want to appeal. tick the box




## Vehicle:



Add note

**Mass:** 45.71 t

**Distribution:** 5.87 t – 6.42 t – **11.34 t (26%)** – 7.52 t – 7.43 t – 7.34 t

**Axle distance:** 3.13 m – 1.36 m – 6.19 m – 1.33 m – 1.33 m

**Tyre types:** 1 – 2 – 2 – 1 – 1 – 1

**Time:** 3. 3. 2022 12:58:01

**Classification:** I32

**Axle group:** 1-2-3

**Lane:** 2

**Direction:** Dar es Salaam

**ANPR:** 1★11★Y (Front)

**Speed:** 31.35 km/h

# Accuracy test

- Comparison of the results.

	Axle Group 1	Axle Group 2	Axle Group 3	GW				
Siwim	5670	6420	11340	7520	7430	7340	45720	
	5670		17760			22290		Axle Group Loads in kg
Static scales	5900		17650			22350	45920	
	230		-110			60	200	Deviation in kg
	3,90%		-0,62%			0,27%	0,44%	Deviation in percentage

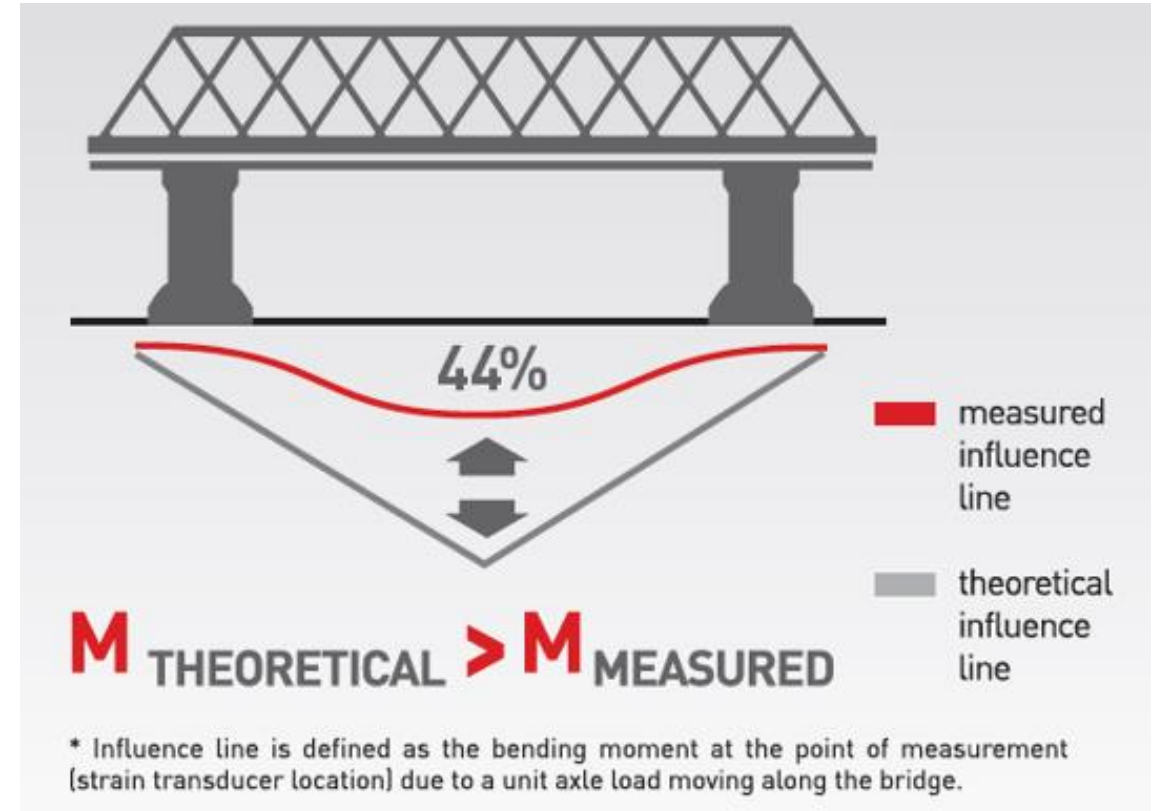
# Much more than just traffic data

- Actual traffic loading (from **any WIM** system):
  - axle loads,
  - spacings,
  - speed,
  - vehicle class,...
- ...and **4 structural parameters** measured on the bridge and **only with Bridge-WIM (SiWIM)**:
  - Strain records
  - Influence lines – IL
  - Distribution of traffic loading over structure
  - Dynamic loading – DAF

# What is the real condition of the bridge?

This can be determined with data collected with SiWIM.

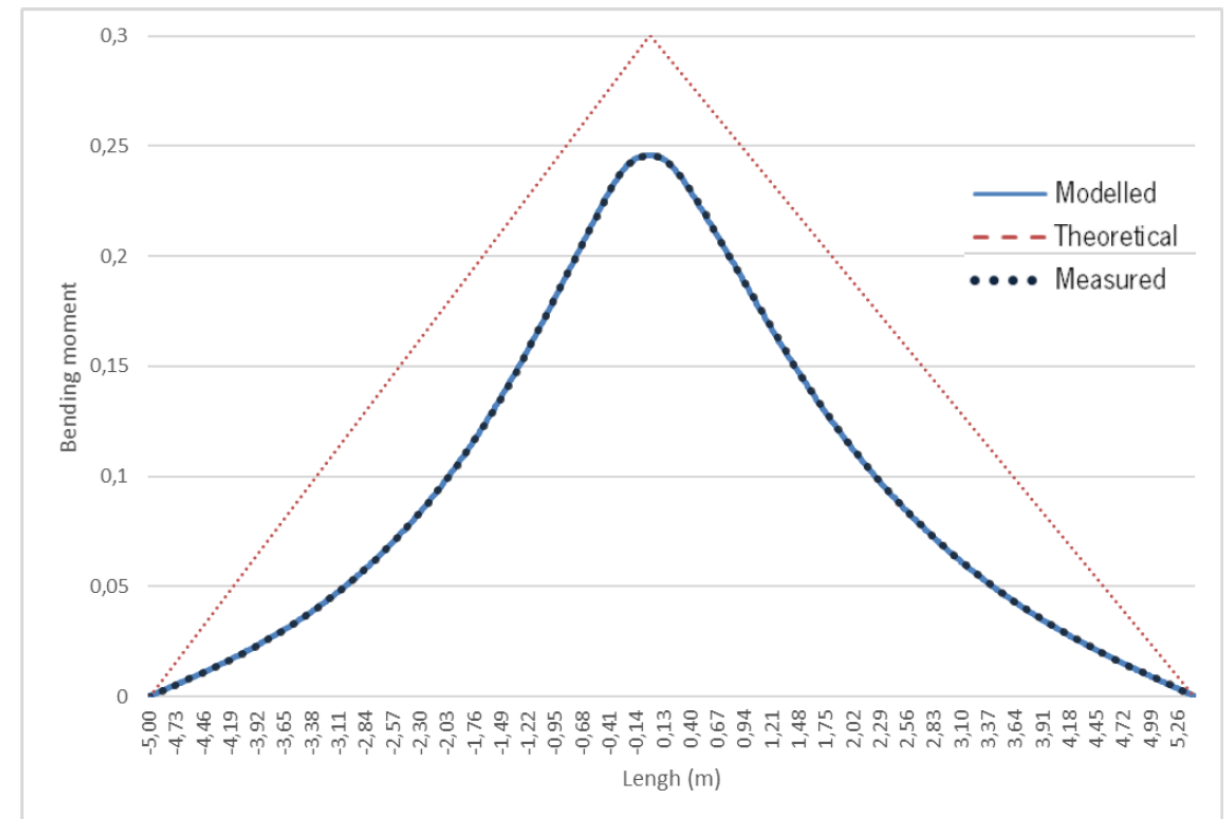
- **Influence line** → crucial information about condition of the bridge
- SiWIM provide an influence line information based on a real loads, which is compared to the theoretical influence line (calculated in design phase).



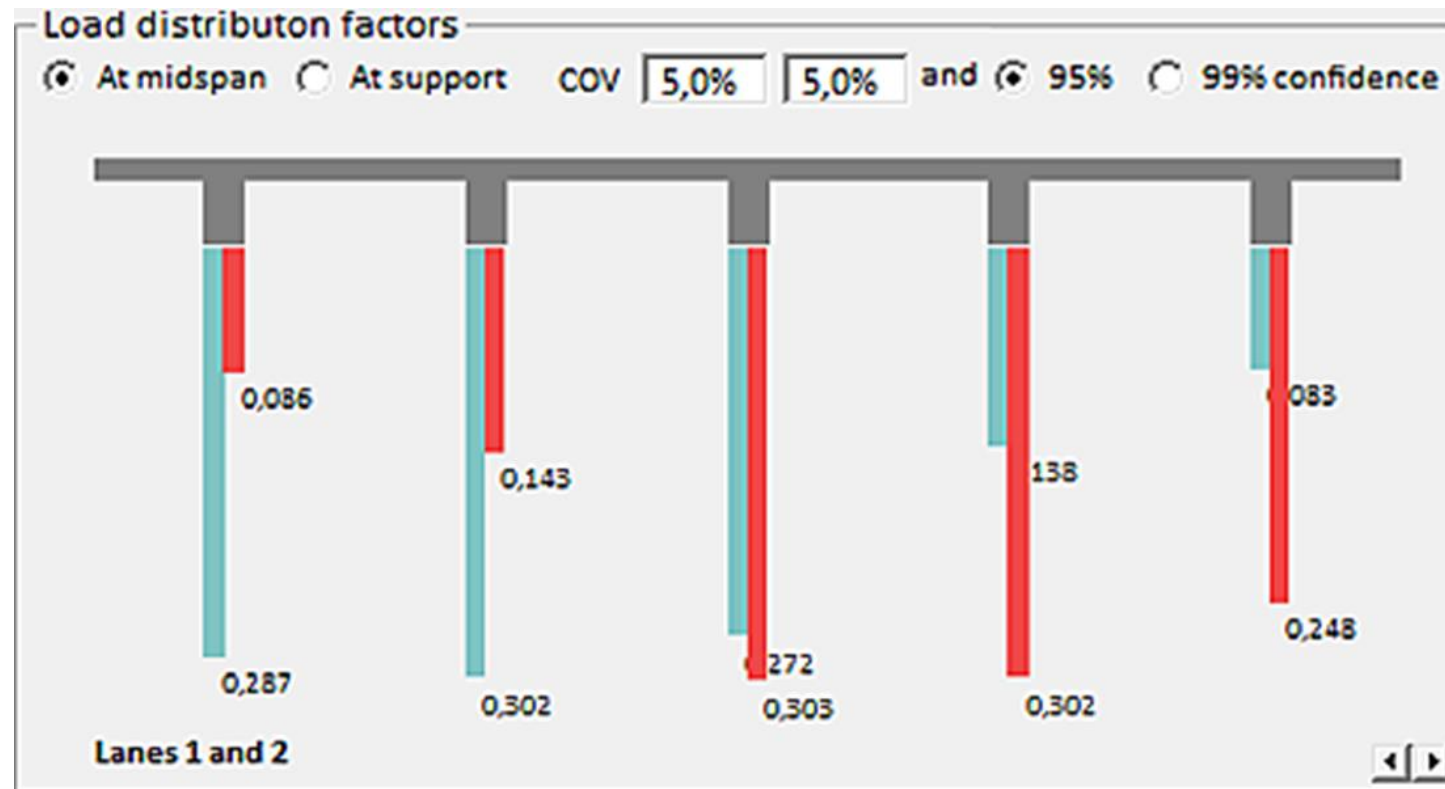
# Influence line → theoretical vs. measured

For weighing and for bridge assessment purposes it is recommended to use the true influence lines (IL) instead of the theoretical ones.

- In the tested bridge the maximum value of IL decreased for **17%**.



# Loading Distribution of the bridge

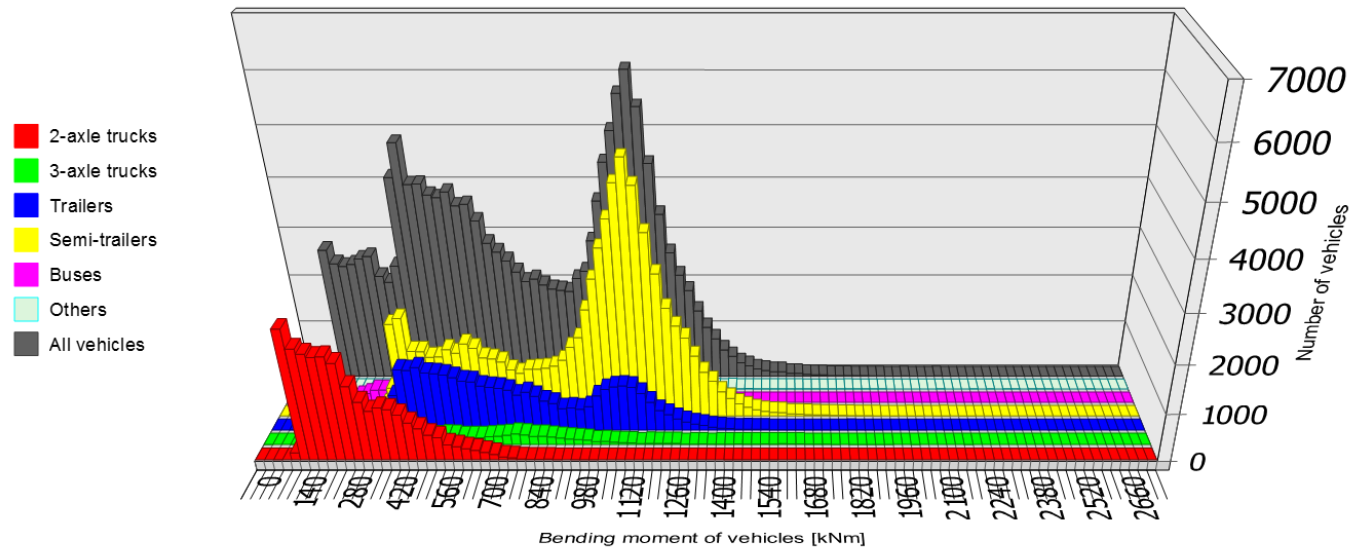


*Actual example of vertical load distribution factors on a bridge for two lanes.*

# Traffic load modelling – SiWIM

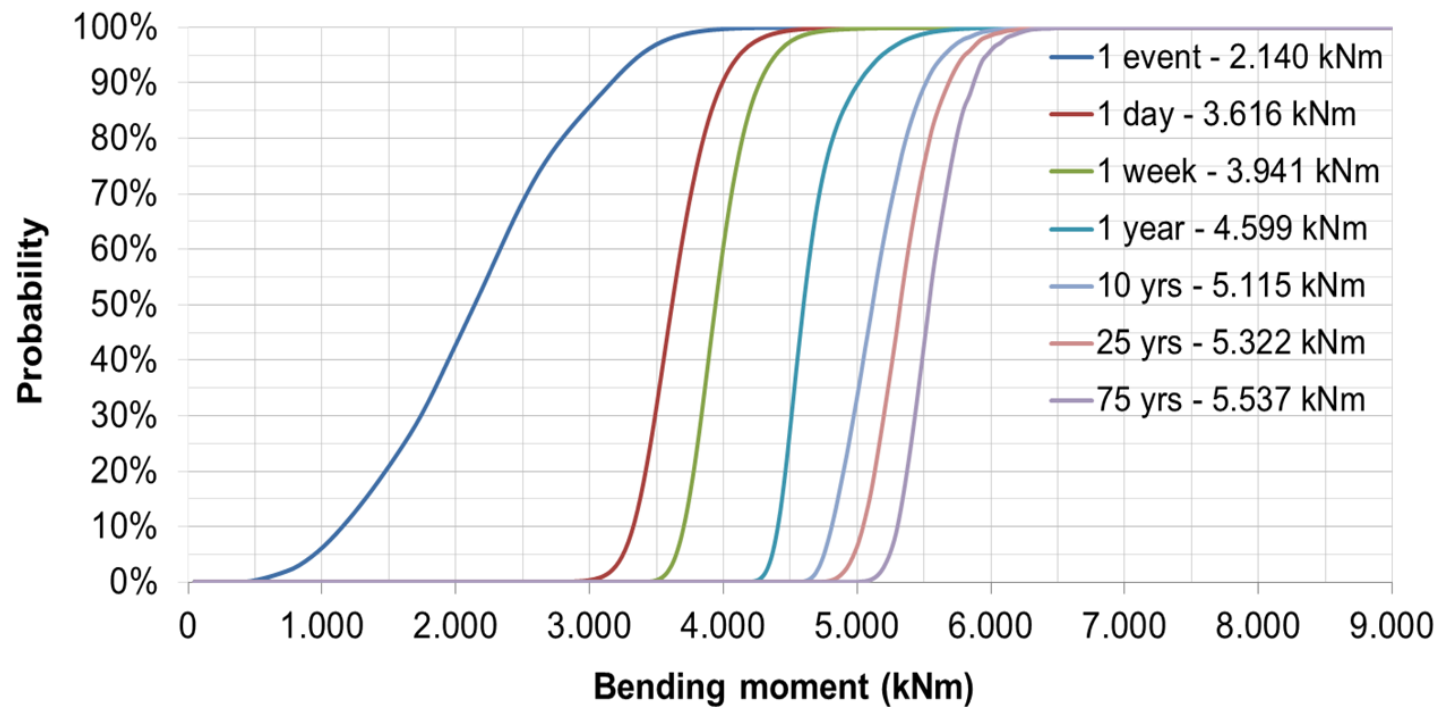
- Histogram shows bending moments/shear forces according to the vehicle group and its loading effects.

Vransko (25.9.2006 14:59:18 to 21.11.2006 12:27:19) - Lane 1



# Traffic load modelling – SiWIM

- Extrapolation (forecasting) of expected means of bending moments.



# Dynamic Amplification Factor (DAF)

- Decrease in DAF with increasing GVW.

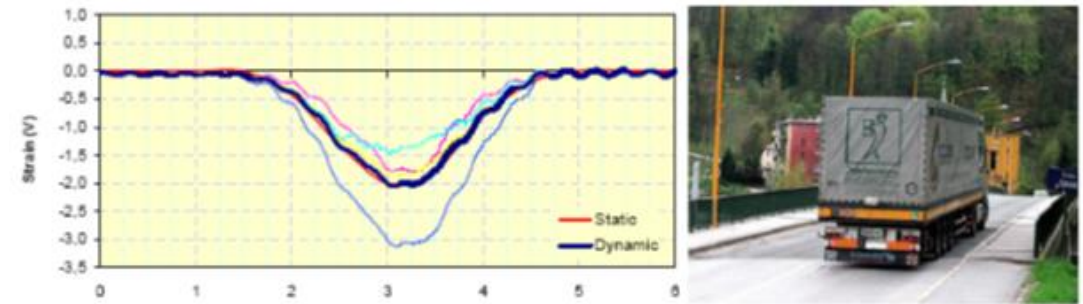
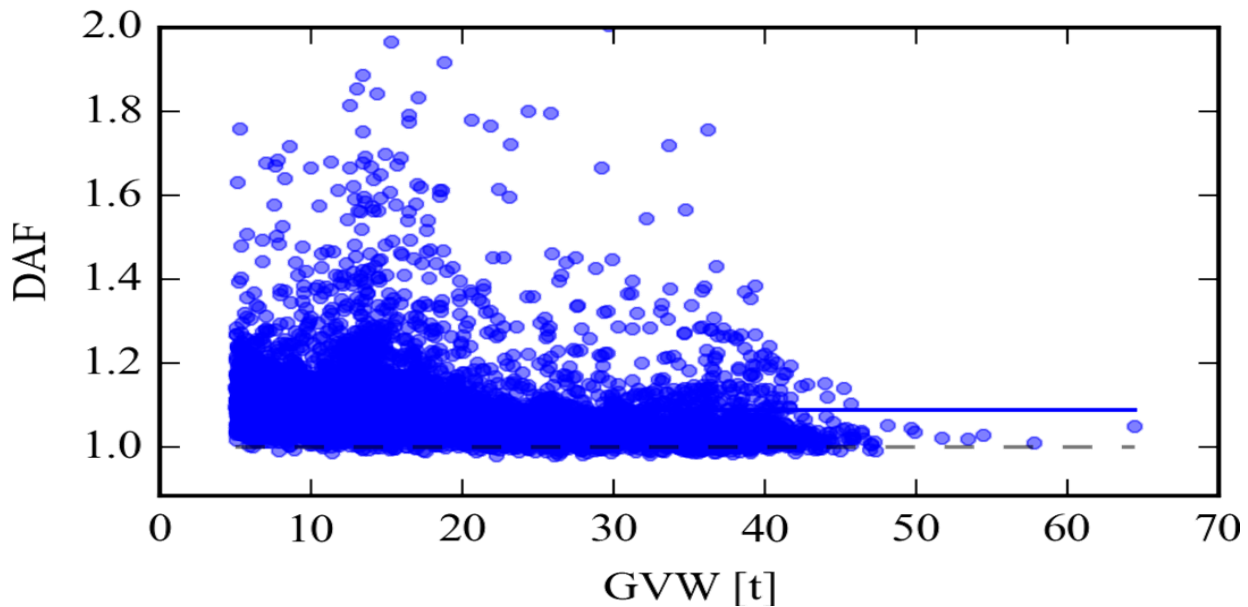


Figure H8. Hrastnik Bridge – low dynamic amplification due to a 5-axle semi-trailer

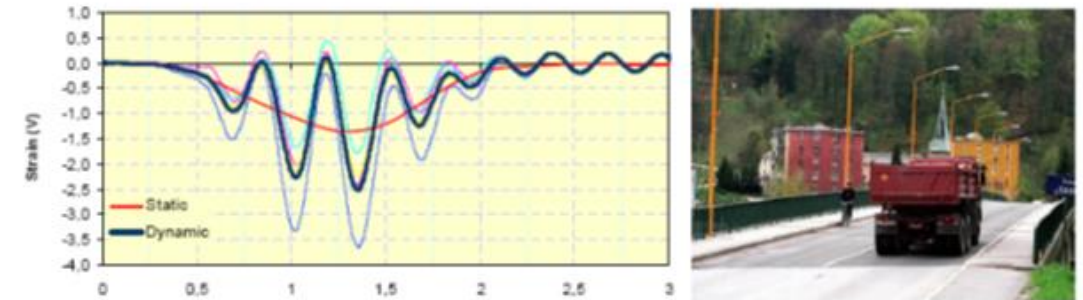


Figure H9. Hrastnik Bridge – Extreme dynamic amplification due to a 3-axle truck

# Why perform load tests using SiWIM?

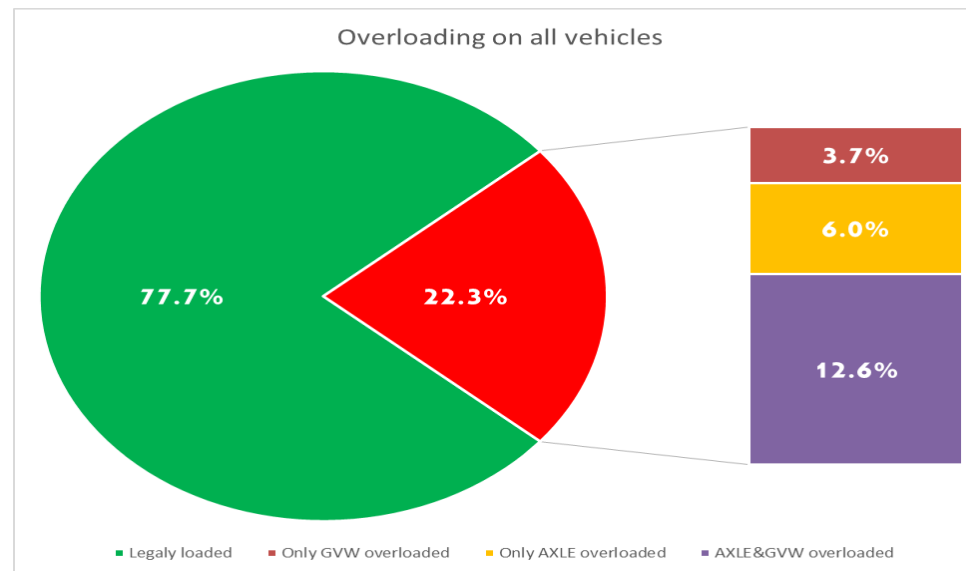
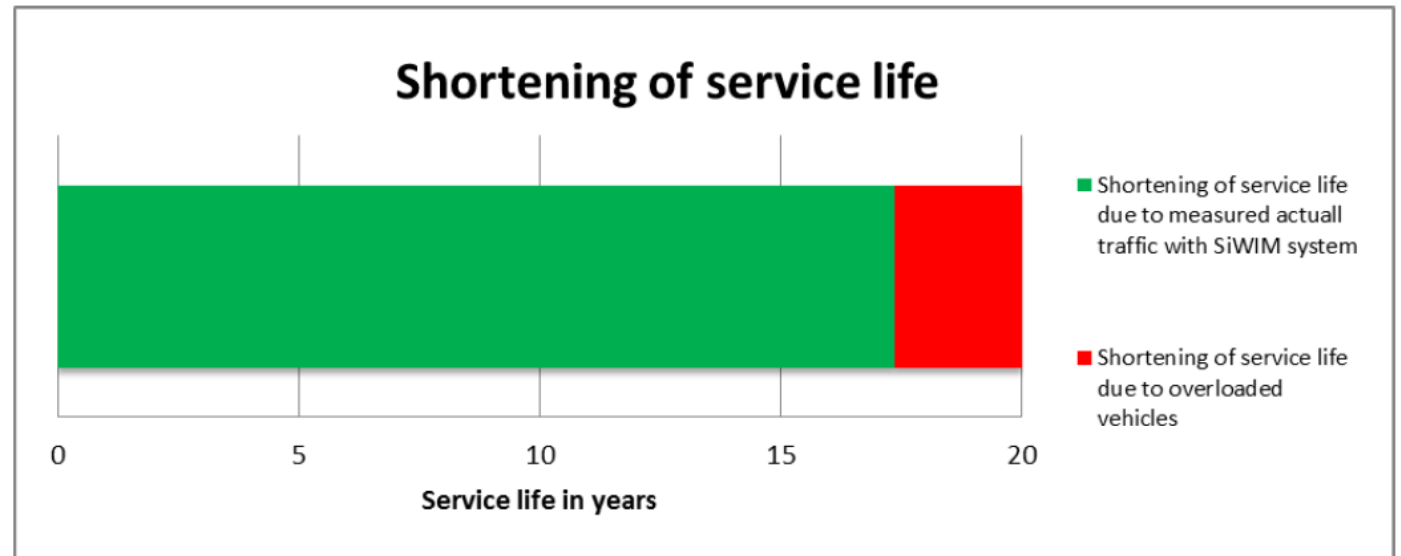
- Load tests are used for bridge assessment and to update structural models.
- Traditional load tests require closing the bridge, **while using SiWIM system doesn't.**



# Traffic analysis

Different purposes of data collection used for:

- maintenance (traffic studies before each bridge/road reconstruction),
- planning phase before building a new road/bridge,
- calculation of a lifetime of the road based on the real loads.



# SiWIM +

- SHM
- ANPR
- ADR
- VMS
- Traffic counter
- Traffic control center



# Visit our stand num. 15

...or contact us via email [sales@cestel.si](mailto:sales@cestel.si)



**Thank you for your attention!**

SiWIM you soon!

**CESTEL**