www.petschacher.at

PEC
PSP

Sustainability is our mission.

iBridge Monitors

Helping engineers make *informed* decisions.

iBridge Monitors

How much is traffic damaging your bridge?

iBWIM –Real-time measurement of heavy goods vehicles.

How much is your bridge deviating from design?

iSHM –Long-term measurement of structural integrity.

2 Systems, built around a common core.

Hybrid systems can be tailored to individual needs.

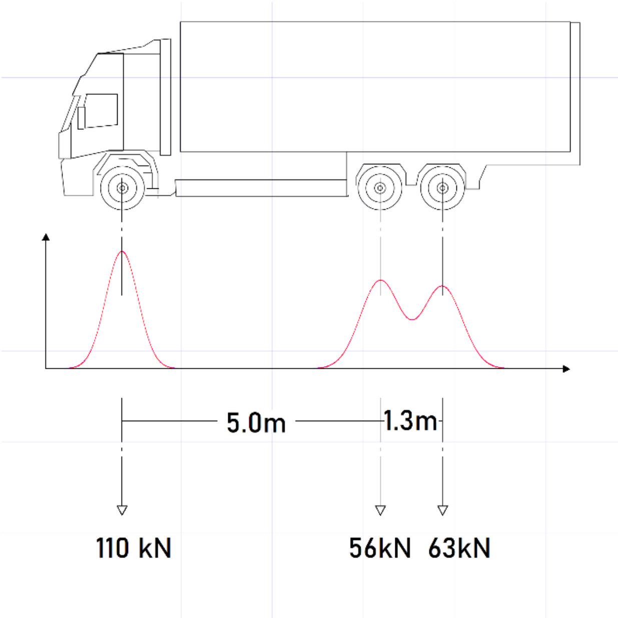

iBWIM
Real-time vehicle weighing
Easy to install.
Easy to run.
73.5 kN
73.2 kN
73.3 kN
75.6 kN
54.5 kN

iBWIM

Heavy goods vehicle passes over bridge, the bridge deforms, we measure the strain induced by axles.

We deduce:

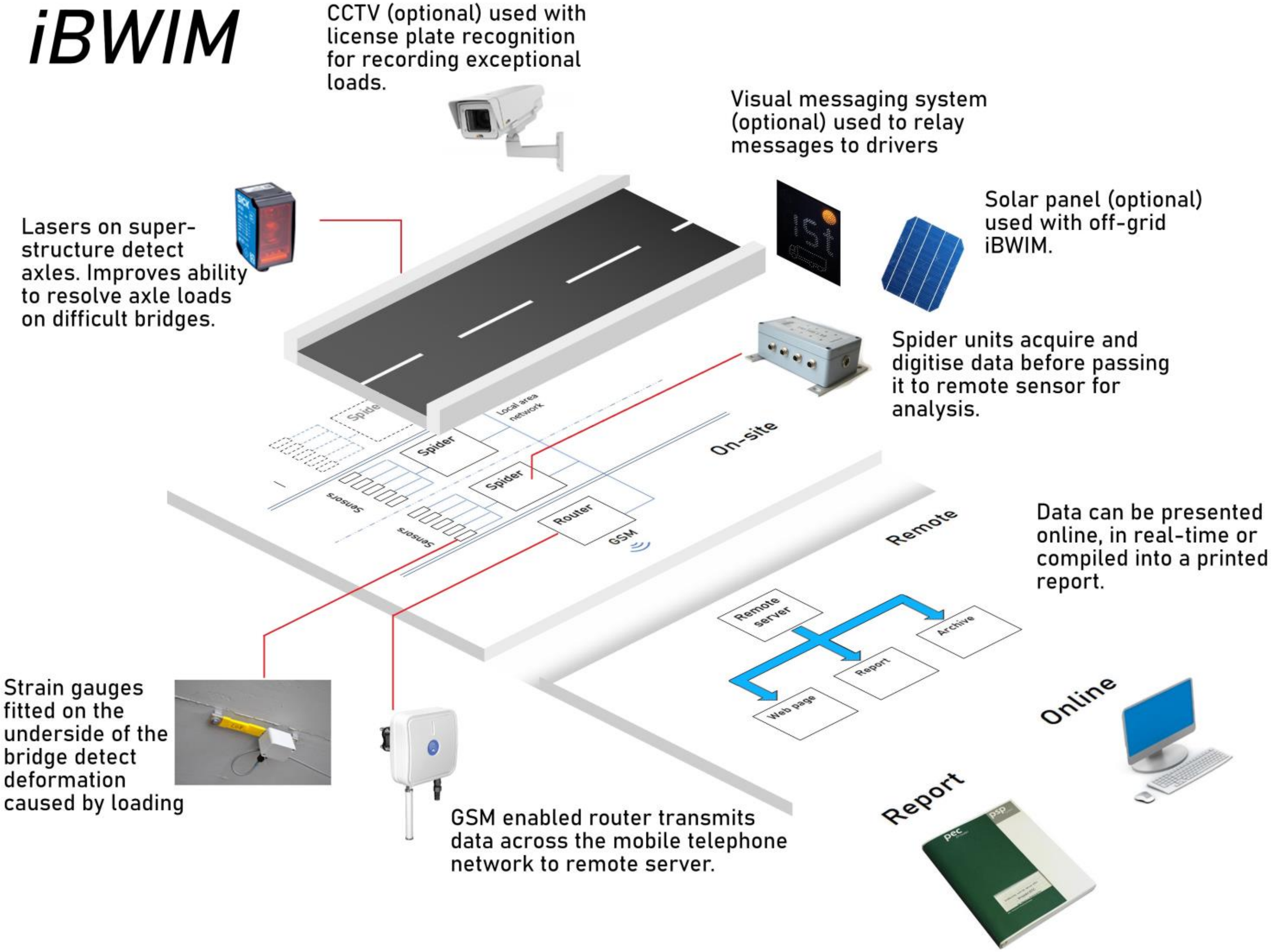
- Axle loads
- Axle separation
- Vehicle velocity



What is iBWIM used for?

- Pre-selection—overloaded vehicles detected and filtered out without disrupting traffic
- Measuring traffic flow
- Estimating damage induced by heavy goods vehicles
- Measuring economic value of bridge
- Planning maintenance

iBWIM


CCTV (optional) used with license plate recognition for recording exceptional loads.
Visual messaging system (optional) used to relay messages to drivers
Solar panel (optional) used with off-grid iBWIM.
Lasers on super-structure detect axles. Improves ability to resolve axle loads on difficult bridges.
Spider units acquire and digitise data before passing it to remote sensor for analysis.
Spider
Local area network
Spider
Spider
Sensors
Sensors
Router
GSM
On-site
Remote
Data can be presented online, in real-time or compiled into a printed report.
Remote server
Archive
Report
Web page
Online
Report
Strain gauges fitted on the underside of the bridge detect deformation caused by loading
GSM enabled router transmits data across the mobile telephone network to remote server.

Applications of iBWIM

BWIM strain measurements

↓

Vehicle identification

↓

Traffic analysis
- GVM histogram
- Axle load histogram
- Speed vs GVM chart
- Headway histogram
- Convoy statistics

↓

Traffic model

Vehicle Description
- GVM
- Axle load distribution
- Speed
- License plate

↓

Vehicle description report

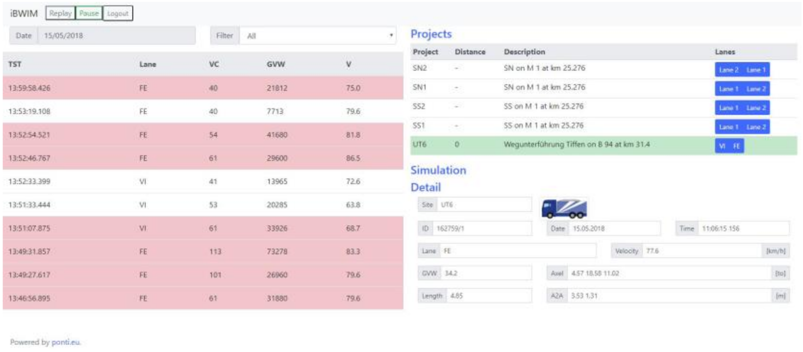
Vehicle Impact
- High impact events
- Bridge response
- Fatigue analysis

↓

Bridge status report

iBWIM: Outputs

Record of bridge crossings online, updated in real-time.


iBWIM Replay Pause Logout

Date 15/05/2018 Filter All

TST	Lane	VC	GVW	V
13:59:58.426	FE	40	21812	75.0
13:53:19.108	FE	40	7713	79.6
13:52:54.521	FE	54	41680	81.8
13:52:46.767	FE	61	29600	86.5
13:52:33.399	VI	41	13965	72.6
13:51:33.444	VI	53	20285	63.8
13:51:07.875	VI	61	33926	68.7
13:49:31.857	FE	113	73278	83.3
13:49:27.617	FE	101	26960	79.6
13:46:56.895	FE	61	31880	79.6

Projects

Project	Distance	Description	Lanes
SN2	-	SN on M 1 at km 25.276	Lane 2 Lane 1
SN1	-	SN on M 1 at km 25.276	Lane 1 Lane 2
SS2	-	SS on M 1 at km 25.276	Lane 1 Lane 2
SS1	-	SS on M 1 at km 25.276	Lane 1 Lane 2
UT6	0	Wegunterführung Tiffen on B 94 at km 31.4	VI FE

Simulation

Detail

Site UT6

ID 162759/1 Date 15.05.2018 Time 11:06:15 156

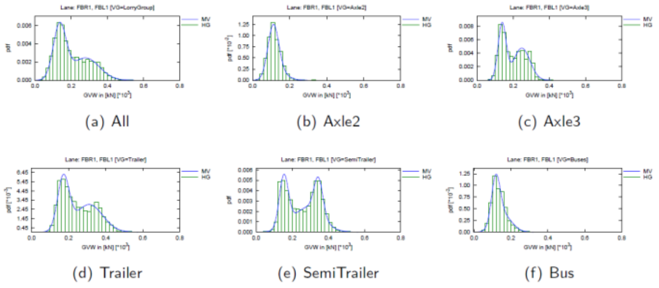
Lane FE Velocity 77.6 [km/h]

GVW 34.2 Axel 4.57 18.58 11.02 [to]

Length 4.85 A2A 3.53 1.31 [m]

Powered by ponti.eu.

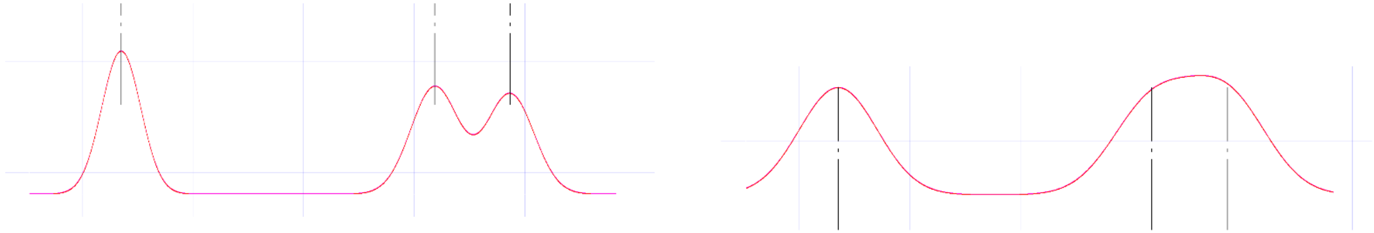
Statistical models of bridge loading.


(a) All (b) Axle2 (c) Axle3

(d) Trailer (e) SemiTrailer (f) Bus

iBWIM: Hard Bridges

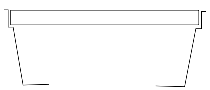
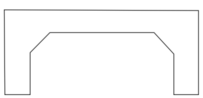
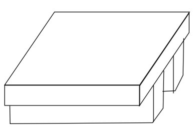
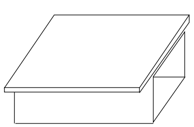
In longer or stiffer bridges, the impacts of the axles merge—makes it harder to resolve the axles and accurately calculate the loads. Bridge harmonics corrupt strain measurements.



We can resolve the axles using iBWIM‘s unique features :

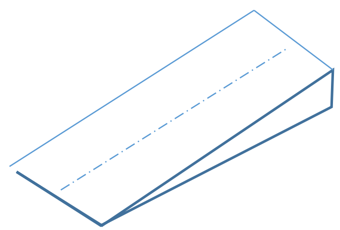
- Laser axle detection
- 32 bit digitisation.
- High sampling frequency (upto 3 kHz).
- Advanced signal processing and data analysis

iBWIM Accuracy for various bridge classes

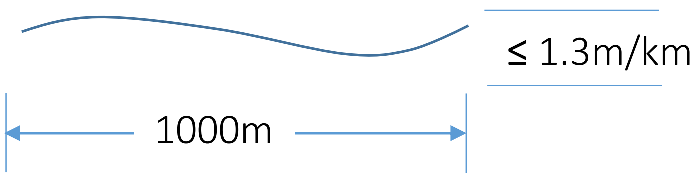
Tolerance * Based on Cost 323 classes	Bridge Length			
Bridge Class	**5 – 10m**	**11 – 23m**	**24-35m**	**>36m**
 Slab	±10%	±5-10%	±10-15%	
 Frame	±5-10%	±5%	±5-10%	
 Beam		±5-10%	±10-15%	
 Steel box girder				±10-15%

Requirements for bridge geometry

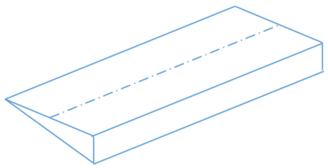
Longitudinal gradient ≤ 1%



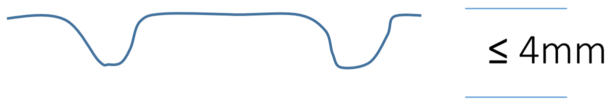
Evenness



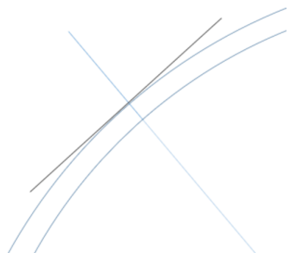
Transverse gradient ≤ 3%



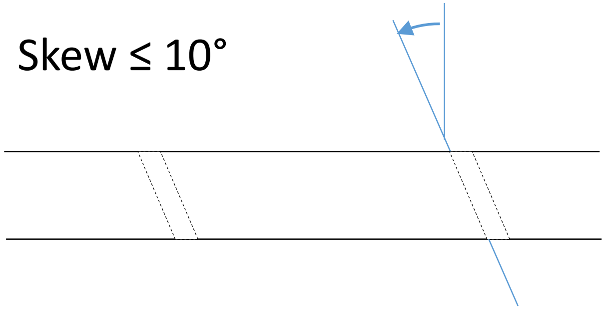
Rutting



Radius of curvature ≤ 1000m



Skew ≤ 10°



How is iBWIM installed on the bridge?

iBWIM is installed *under* the bridge:

- **NO** disruption to traffic.
- **NO** significant impact on the structure
- Needs less than **1 day**.

Vs

How are systems installed?

On-Site

Typical workload, based on 2-man team:

- Installation (1 day)
- Calibration (2 days)
- De-installation (0.5 days)
- Re-installation (0.5 days)

Training

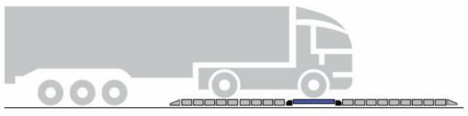
Installation

- Demonstartion installation on pilot bridge.
- Commisioning of a trainee installed system.

Software

- Introduction to online monitoring system.
- Introduction to maintenance planning system.

How is iBWIM calibrated?



- An iBWIM system must be tailored to its bridge.
- Calibration process is integrated into our software.

- 2 test trucks are weighed using (3rd party) scales, and their axle to axle distances measured.
- iBWIM measures the truck as it passes over the bridge and then self-calibrates.
- Process takes 1-3 days (See COST 323 for details)

Case Study: Sanga Bridge, Estonia

- Part of a survey of heavy goods traffic over Estonian roads, one of 16 bridges measured.
- 10 day measurement campaign, iBWIM unit using two Spider loggers. The iBWIM system was deployed twice at each of 16 locations, over a period of two years. No failures recorded
- Results formed part of a final report, showing distribution of heavy goods traffic over Estonian road network.

NB More case studies in Appendix B.



iBWIM: Summary

- Weighs HGVs without stopping traffic
- Easy to install—no disruption to traffic.
- Off-grid—only requires mobile network coverage.
- Updates a model of the bridge and its traffic that can be viewed from your office in near-real-time.

About PSP

- Founded in 2003
- Combines expertise in structural analysis with excellence in embedded systems and data analysis.
- Develops, installs and runs the iBWIM and iSHM systems.
- Sister company Petschacher Consulting perfroms classical structural inspections and analyses.

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PEC
PSP

Sustainability is our **mission.**

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PSP - Petschacher Software- und Projektentwicklungs GmbH
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Case Study: Mjölby bridge, Sweden

Type:	Highway bridge
Route:	E4
System:	Slab
Span width:	8m

Appendix A: Case Studies

Case Study: Metnitzbach bridge, Austria

Type:	Railway bridge
Route:	Tarvis – Amstetten
System:	Steel lattice framework
Span width	41m

Case Study: Nahon Nayok, Thailand



Description: 2x Road bridges, 2 lanes each.
Construction: Concrete span 13m and 20m
Requirements:Permanent measurement system to observe heavy goods traffic and filter out overloaded vehicles.

Solution: Each bridge was equipped with a two lane, 16 sensor, 2 spider
system, integrated with CCTV and linked to customer's own server.

- Robust topside sensors with specially tailored algorithms.
- Additional signal processing for harmonic suppression
- Axle detection algorithms optimised for Thai vehicles.

Case Study: Zauchen, Austria



Description: Railway, 2 tracks
Construction: Steel box girder (1908)
Requirements: Re-analysis for safety. Bridge approaching retirement, requires surveillance. Measure actual traffic loading.
Technical challenges: Weighing freight trains (typ. 180 axles) at full velocity (120 km/h).

Solution: 1 Spider system, semi-permanent (12 months)
Result: In addition to customer requirements, identified approach for linking stress cycles to single train events--relevant for residual lifetime prediction.

iBWIM

Measures the impact of vehicle axles on the bridge.

- Allows you to build up a Damage Model, i.e. an estimate of the degradation of the bridge caused by heavy goods vehicles.
- Detects and records *exceptional loads* that will inflict discrete damage on the bridge.

Appendix B: COST323 Specifications

COST 323 is one of the actions supported by the COST Transport part of the European Commission's Transport Directorate, DG VII.

COST 323 does not constitute an official standard but provides technical specifications for WIM users and manufacturers and a reference upon which standardisation committees can draw.

COST 323 defines WIM systems by classes based on their level of accuracy. These classes are defined as follows, where the numbers in brackets indicate the confidence interval width:

- Class A(5): Legal purposes such as enforcement of legal weight limits.
- Class B+(7): Enforcement of legal weight limits in particular cases, if the Class A requirements may not be satisfied, and with a special agreement of the legal authorities; efficient pre-selection of overloaded axles or vehicles.
- Class B(10): Accurate knowledge of weights by axle groups, and gross weights, for:
    - infrastructure (pavement and bridge) design, maintenance or evaluation, such as aggressiveness evaluation, fatigue damage and lifetime calculations
    - pre-selection of overloaded axles or vehicles
    - vehicle identification based on the loads.
- Class C(15) or D+(20): Detailed statistical studies, determination of load histograms with class width of one or two tonnes, and accurate classification of vehicles based on the loads; infrastructure studies and fatigue assessments.