

# STAY CABLE BRIDGE LIFESPAN SERVICES



Monitoring



Inspections and Assessments



Maintenance

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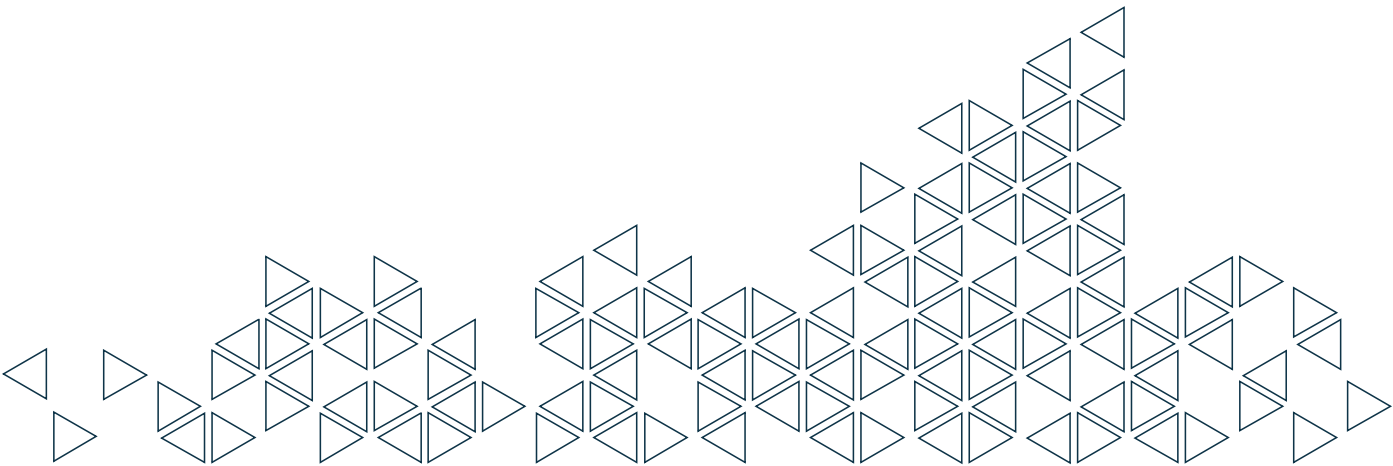
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# The Emerging Infrastructure Crisis

## MITIGATING THE EMERGING INFRASTRUCTURE CRISIS

As you know, building and maintaining bridges today requires dealing with unprecedented challenges:

- Population growth
- Higher traffic loads
- Corrosive pollution
- Aging infrastructure

Hightlighted by the recent Morandi Bridge collapse in Genoa, an increasing list of global bridge ‘health problems’ threaten public safety.

In short, public infrastructure investments have not kept pace with advances in architecture, scientific engineering, data communications, and urbanization. We’re helping change that.



“At our current pace it’ll take 80 years to repair all the structurally deficient bridges in the US”  
cnn - 2 april 2019



America’s Roads and Bridges Cost Too Darn Much  
bloomberg - 26 jul 2019



Collapsed Italy bridge investigators find corrosion on main stay cables  
new civil engineer - 17 aug 2018

# Aging infrastructure

MAIN ISSUE:

AGING INFRASTRUCTURE

Although the bridges of the '60s and '70s were built to last 100 years, the reality of wear and tear means that bridges need a lot more care in the last 30 years of their life.

We need cost-effective ways to lower:

- Risks to assets and public safety
- Maintenance expenditures
- Repair and strengthening costs



TIME

It's Time to Fix America's Aging Bridges

Out of the 614,000 US bridges circa 40% are more than 50 years old and almost 10% need significant maintenance or replacement. On average, 188 million vehicles cross structurally deficient bridges each day. Of the 250 most heavily travelled bridges that need repairs, 85 percent were built before 1970.



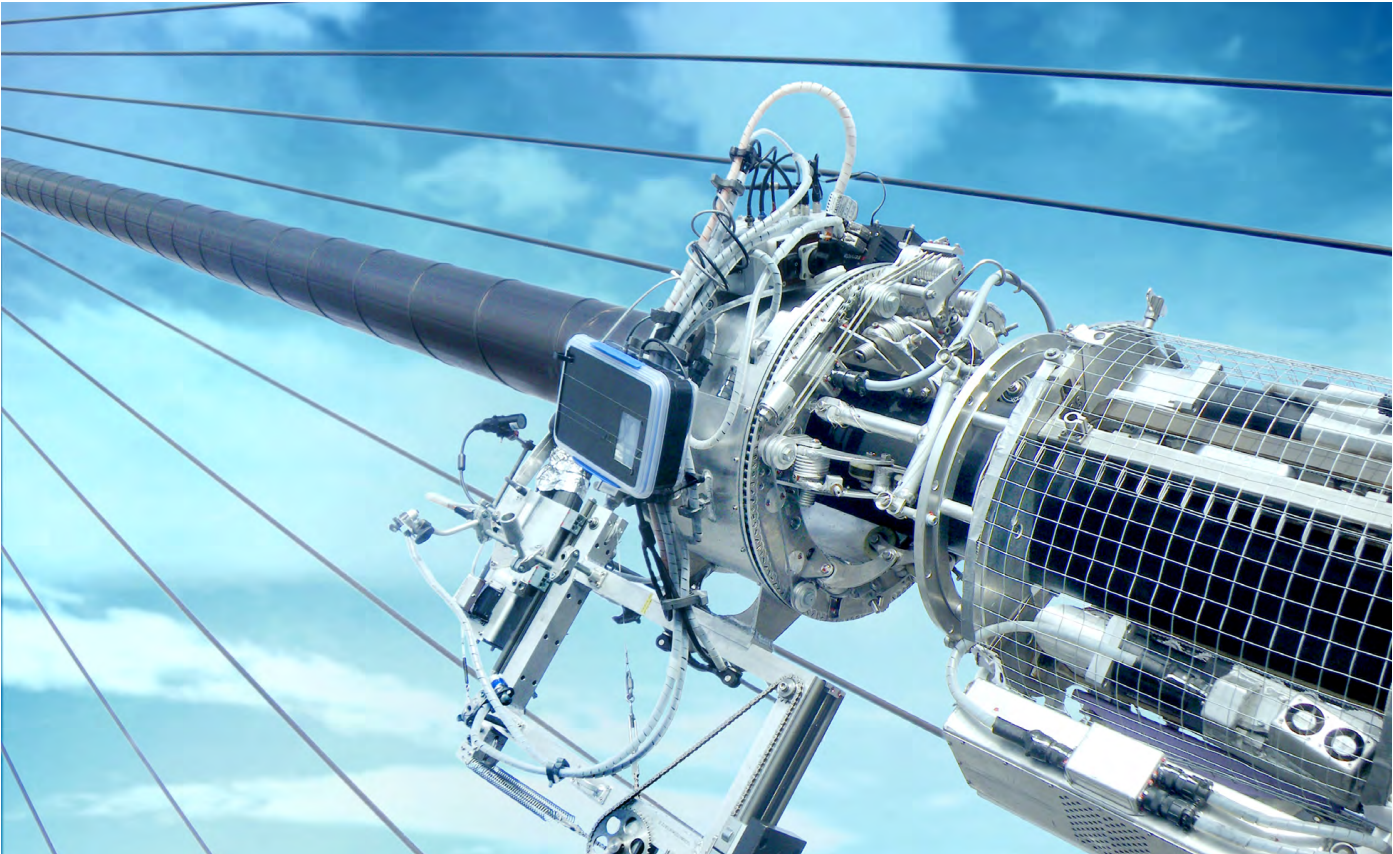
Germany – Yes, Germany – Has an Infrastructure Problem

Crumbling bridges and traffic jams are staining Germany's global reputation for efficiency. The infrastructure in Europe's largest economy as in the United States.

The Telegraph

Genoa Bridge Collapse: Are Ageing Bridges Cause for Concern?

# Emerging Trends for Bridge Durability



Proactive maintenance

Maintain to preserve not simply repair entire bridges and their components. Extend service life through cost effective upkeep and preservation of structural integrity. Prevent future deterioration and improve their overall condition.

Smart technology

Infrastructure systems remain among the least digitally transformed in the global economy. Expect to see huge advances in smart bridge technology:

- Wireless sensors
- BIM
- Smart city IoT
- Robotics

Quantitative data

Add monitoring and data backed assessments of bridge conditions on top of traditional visual inspections and condition ratings.

With this information, bridge engineers make better decisions about repairs.

Predictive analytics & reporting

Monitoring data in real time enables faster detection and reduces response time.

From interpretation, statistical analysis, and predictive modelling, the overarching systems for data analysis and reporting are evolving.



# A New Bridge-Lifespan Approach



DYWIDAG has been engineering bridge technology since 1880.

Microsoft has been processing data since 1975.

Together we're researching ways to improve infrastructure through smart city technology.



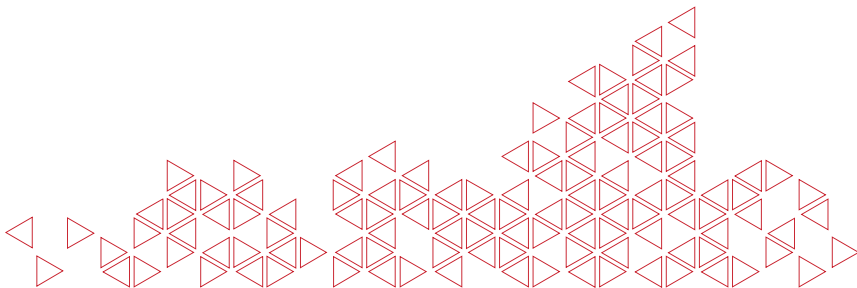
The demand on infrastructure is growing. We're deepening our partnership with Microsoft by investing in smart tech and lifespan services that improve bridge management. Helping bridge owners and operators take the right action at the right time.

Matti Kuivalainen,  
CEO, DYWIDAG



# A New Bridge-Lifespan Approach

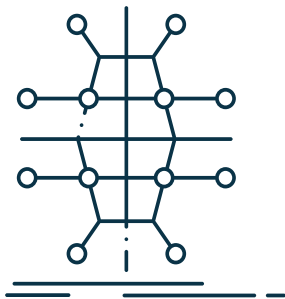
Data-backed services specific to the age, size, and requirements of your bridge.



## Safer bridges through inspections and technology

A safe bridge is always under surveillance. Using robotic inspections of stay cables and advanced monitoring schemes for the entire bridge structure, we track and model structural and environmental phenomena.

This is coupled with an in-built 24/7 alert and escalating alarm system for increased safety.



## Stronger bridges through corrective strategies.

A strong bridge collects qualitative and quantitative data. So when problems arise you can accurately access the structural weaknesses and formulate corrective strategies.

## Smarter management through accurate diagnosis

A smart bridge predicts problems before they become serious. From early detection, to more informed budgeting decisions by understanding the symptoms, pinpoint the root cause of your bridge problems.



# A New Bridge-Lifespan Approach

## AN APPROACH DESIGNED FOR EACH LIFE PHASE

From the first monitoring system, to the challenges of aging infrastructure, we support you through all phases of the bridge lifespan.

**New-life phase**  
**0-4 YEARS**

Tracking the bridge's status from it's very first sensor pulse.

We learn how your bridge behaves (compared to its intended design) and identify any lingering issues or needed modifications.

**Early-life phase**  
**5-24 YEARS**

Early-life bridges need to settle into their environment.

We study your bridge's interaction and behaviour through regular inspections and establish a baseline monitoring profile and protection program.

**Mid-life phase**  
**25-59 YEARS**

Detect problems early and prevent accelerated aging.

With enough data about the behaviour of the bridge, we can offer complete care through sophisticated inspections and monitoring, as well as specialist repair and strengthening services.

**Advanced-life phase**  
**60+ YEARS**

This phase requires the most attention. Through frequent inspections and comprehensive monitoring, we track the operability of the bridge.

We offer prevention and preservation maintenance to extend the useful service life.



# Advanced-life phase

## ADVANCED LIFE PHASE: 10 YEAR SERVICE EXAMPLE

Inspections	Maintenance	
<ul style="list-style-type: none"><li>• Visual and magneto inductive robotic inspection</li><li>• Damper inspection</li><li>• Corrosion inspection</li><li>• GPR tendon inspection</li><li>• Force/strain measurements</li><li>• Vibration measurement</li></ul>	<b>Bridge Deck</b> <ul style="list-style-type: none"><li>• Repair and retrofit of PT tendons</li><li>• Retrofitting with external Wire EX tendons</li><li>• Tendon re stressing</li><li>• Vacuum grout repair</li><li>• General structural concrete repair</li><li>• CFRP installation</li><li>• Bearing replacement</li></ul>	<b>Stay Cable</b> <ul style="list-style-type: none"><li>• Exchanges of entire cables, single strand, and PE ducts</li><li>• Damper repair and retrofit</li><li>• Installation of fire protection</li><li>• Hardening against blast</li><li>• Cable wrapping for corrosion and UV protection</li><li>• PE welding of sheathing and ducts</li><li>• Cable capping replacement and repair</li><li>• Cable cleaning</li><li>• Stainless steel brushing</li><li>• Re grouting</li></ul>

Monitoring

Implement structural health monitoring to confirm design and manage long term performance



# Why us?

## Why us?

Our bridge smart systems are standardized \*but\* your configuration is unique. Anyone offering a “one size fits all” approach is increasing your risk. Custom bridge conditions and demands are best supported by a custom team. Once we understand what your bridge needs, we bring in the appropriate expert(s) from our 50+ global offices.

Our civil engineers and bridge specialists have worked on more than 500 bridge projects around the world, including some of the world's longest stay cable bridges.

We've been evolving bridge technology since 1880 and that mandate is still at the heart of our business. You can leverage this experience (and continuous R&D) through all of your bridge's phases no matter its age, size, or condition.

### New lifespan thinking

tailored to project requirements and maintenance needs.

### Reduced downtime and scaffolding

by using drones, gantries and motorised rope access.

### A sensor agnostic data hub

powered by Microsoft Azure. Connect our sensors or use 3rd party sensors. No problem.

### Bridges are our core competence

and we have the strict industry accreditations\* to match.

- Monitoring: PCL, RISQS, FORS, UDVB
- Certified paint inspectors, Bridge inspectors: VFIB
- SCC certificates: DIN EN ISO 473, 12944, DIN 1076
- Management certificates: ISO 9001 & SCC



# Lifespan Management

At DYWIDAG, our goal is to build long term partnerships with our customers. We work with you to understand and deliver the best solutions now and over time while providing a flexible way to manage operating expenses with our multi year agreements.

## Managed pricing

- Better managed operating expenses
- Improved cash flow through increased visibility of costs
- Long term service contract agreements



## Dedicated project support

- Fast resolution of issues
- Predictive maintenance
- Dedicated asset management
- The right monitoring equipment for your present and future needs



## A strategic partnership

- Customized programs for your technical and operational needs
- Yearly review of agreement and quality of service
- More time spent on managing your bridge and less time spent on renewing contracts



# Lifespan Management



**Key facts:**  
Year of completion: 1995  
Length: 754m

**Services:**  
Robotic cable wrapping

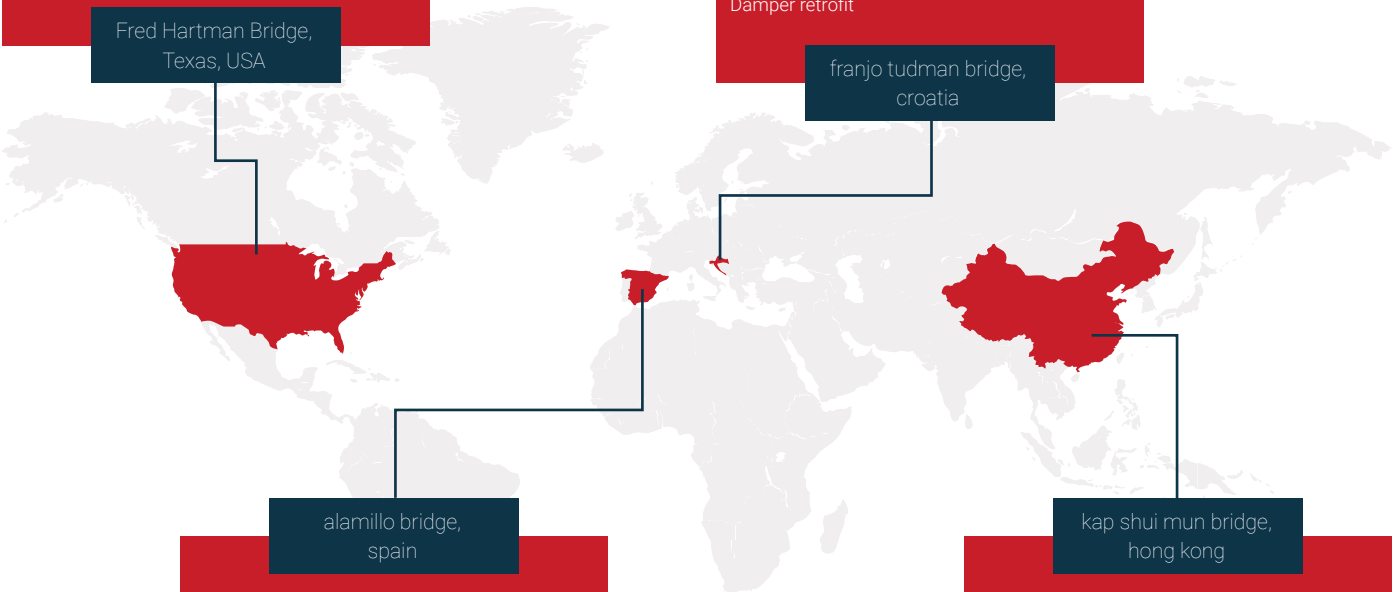
Fred Hartman Bridge,  
Texas, USA



**Key facts:**  
Year of completion: 2002  
Length: 518m

**Services:**  
HDPE pipe repair  
Damper retrofit

franjo tudman bridge,  
croatia



alamillo bridge,  
spain

**Key facts:**  
Year of completion: 1992  
Length: 250m

**Services:**  
Cable replacement  
Damper retrofit  
Bridge inspections



kap shui mun bridge,  
hong kong

**Key facts:**  
Year of completion: 1997  
Length: 750m

**Services:**  
HDPE pipe repair  
Guide deviator repair



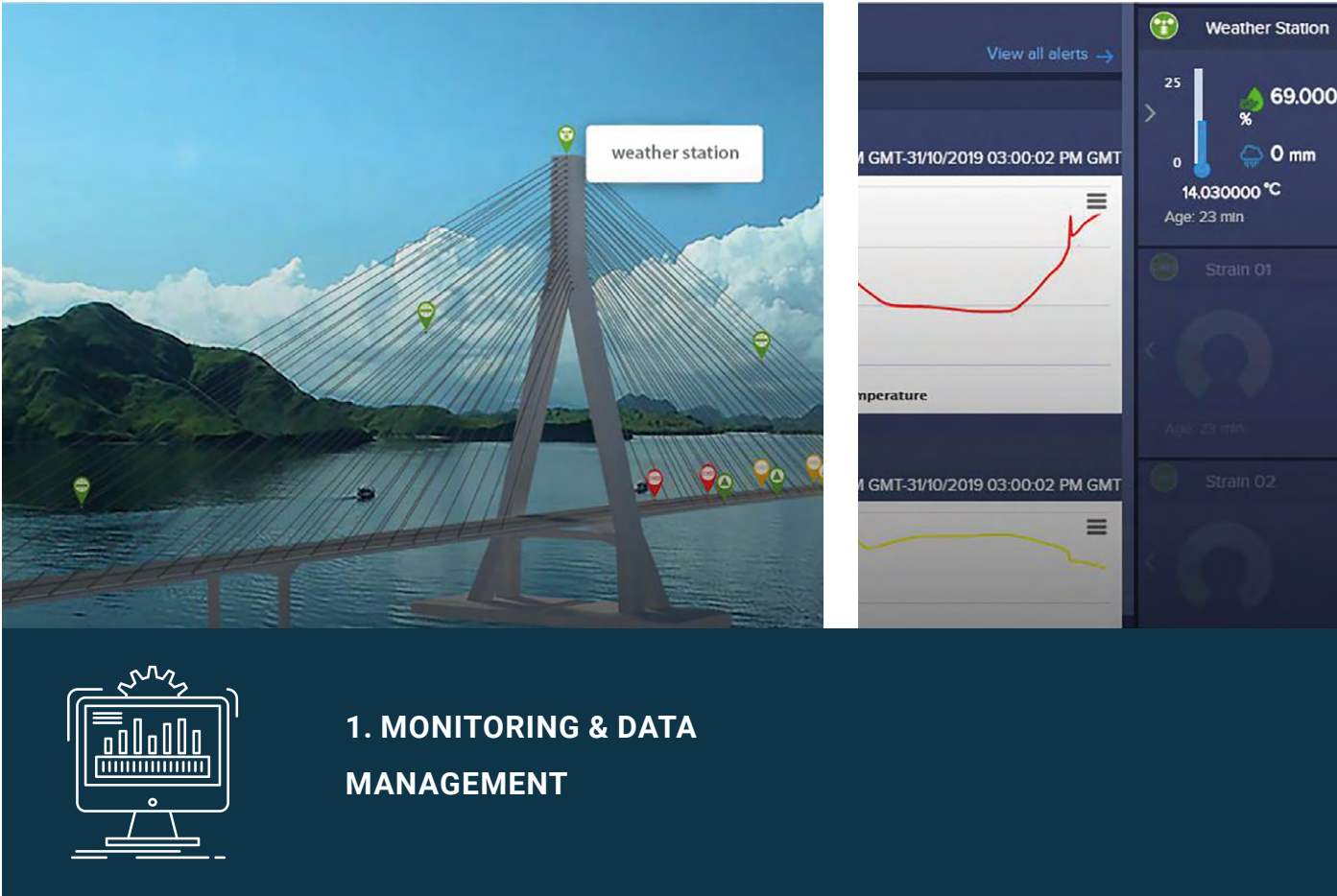
# Three Services



**THREE SERVICES**  
Take the Right Action at the Right Time



# Monitoring & Data Management



## 1. MONITORING & DATA MANAGEMENT

A complete picture of your asset through continuous surveillance.

Since 1999, we have designed new and retrofitted monitoring schemes to gather information for short-term assessments and long-term performance predictions. This data can be used to evaluate real behaviour and plan follow-up inspections, if required.

While a single bridge monitoring scheme may feature 100 to 500 sensors, we actively manage 650+ monitoring schemes with over 31,200 individual sensors reporting on different frequencies around the world— that's 11 million individual measurements daily and >4 billion each year in all kinds of structures.

From design, construction, and operations, we can monitor every phase of your bridge's lifespan.

We provide real-time data and actionable insights for you to make informed decisions by tracking physical and functional characteristics. This enables you to plan service models, and structural work, and helps you decide if a bridge lifespan can be prolonged.

# Monitoring & Data Management

**TYPICAL PARAMETERS INCLUDE MOVEMENT, DISPLACEMENT, LOADS & ENVIRONMENTAL FACTORS.**

Critical Conditions – Detected at an Early Stage – Save Costs and Improve Safety

01

Configure a high-quality monitoring scheme

To mitigate risk by tracking temperature, weather, impact, and movement. We'll incorporate any special access issues, specialist requirements, measurement frequency, and detailed reporting.

And we'll likely use our robotic technology for comprehensive installation and service delivery.

02

Implement an early response alarm system

Based on agreed protocols with clear alerts. This escalating alarm system is supported by real time updates and a 24/7 rapid response team.

By pinpointing the exact sensor, this system identifies the particular issue, saving crucial time and resources.

03

Get real-time data about the bridge

Our bridge management system processes and records billions of data points every 30 seconds from our sensors and 3rd party data sources—i.e. video footage, weather feeds, inspection reports, photos & 3D renderings—and then presents critical information in an easy to interpret information hub.

A cloud connection between you and your bridge.

04

Run intelligent cross platform reporting

In real-time from any device, helping you track and identify reactive and proactive mitigation issues.

With personalized stakeholder views, we serve up the information you need.



# Monitoring & Data Management

# Monitoring & Data Management

## ACTUAL MONITORING SCHEME:

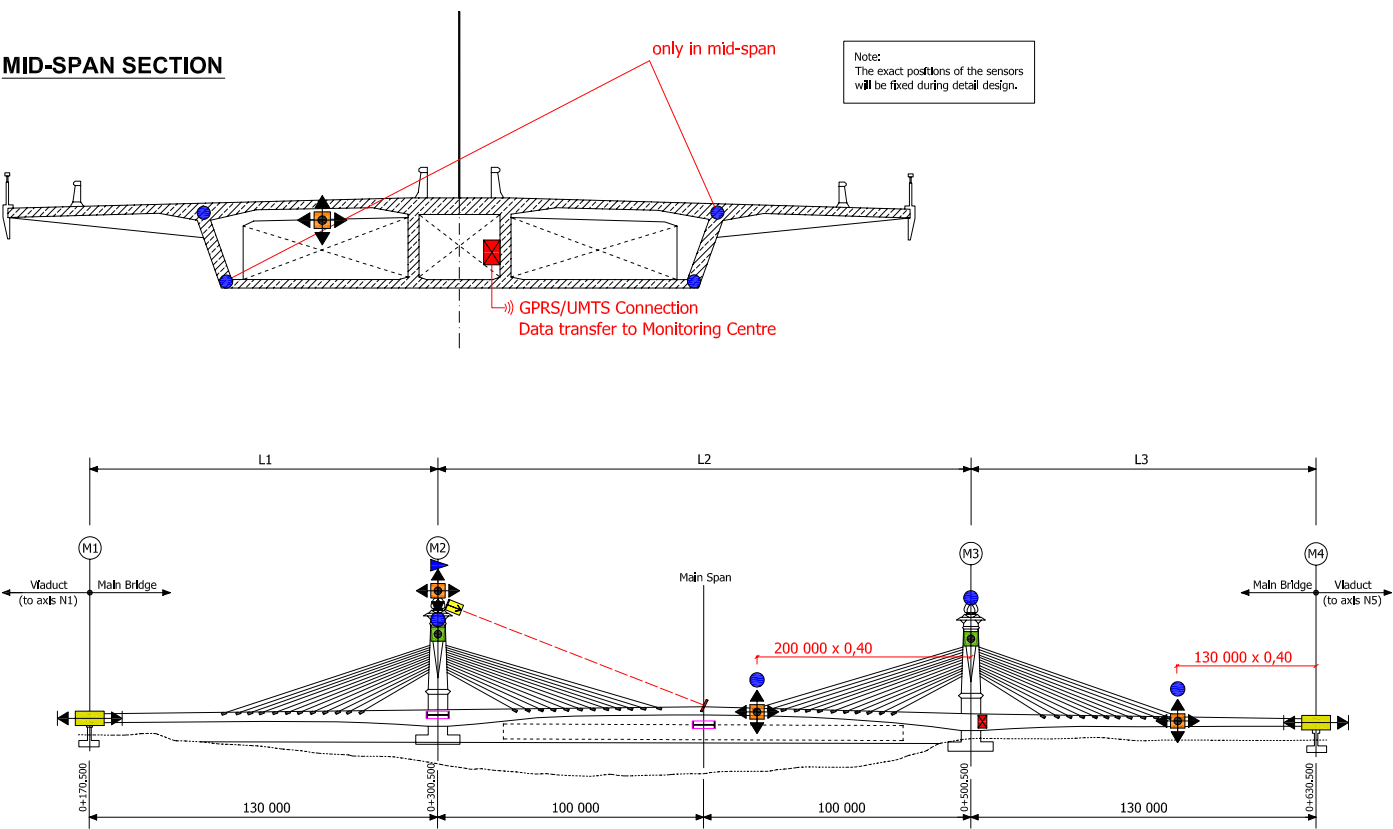
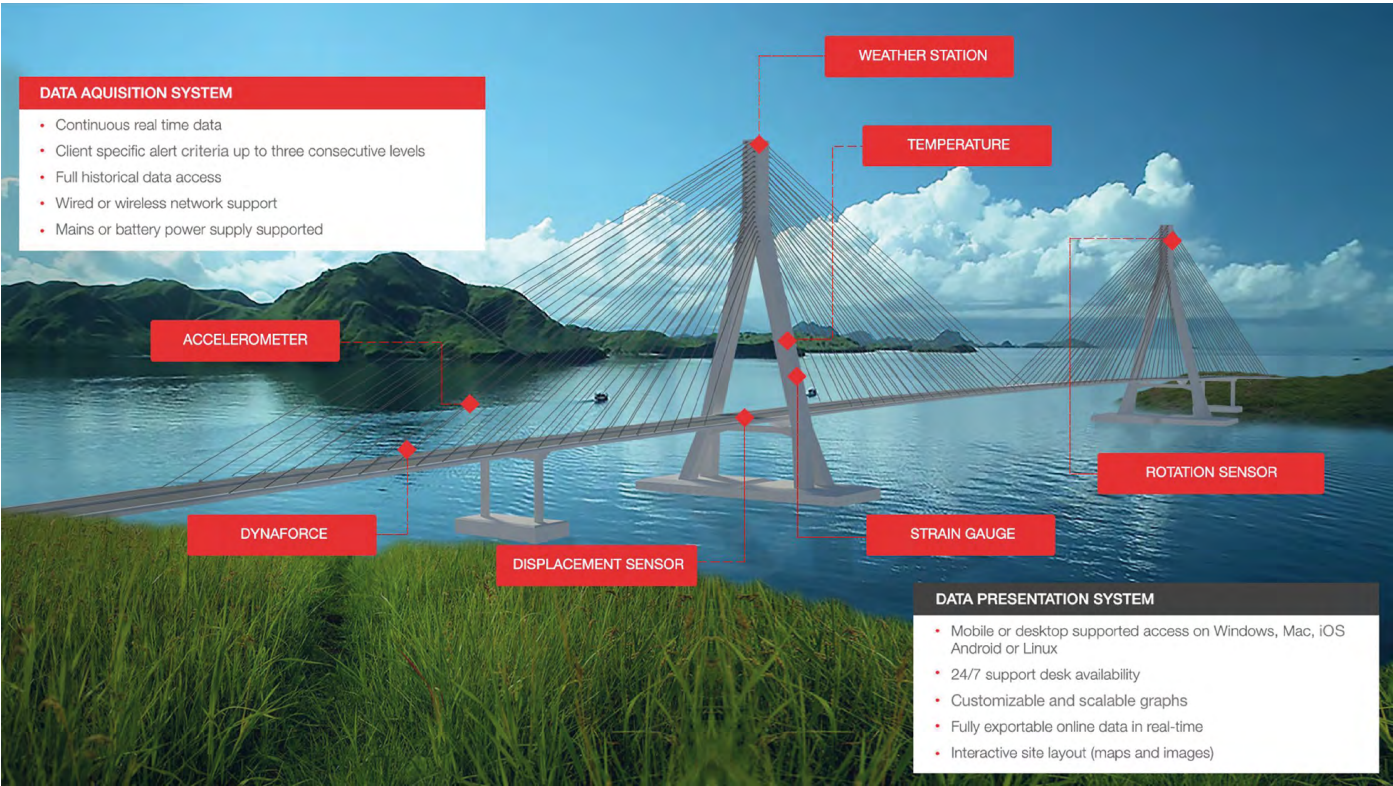
Nonthaburi Bridge Thailand

Measurement of:

- Temperature
- Wind
- Inclination and movement
- Strain
- Bearing displacement
- Seismic
- Cable forces with DYNA Force®

### Caption of Sensors

3D-Accelerometer	Inclinometer	Strain Sensor	Displacement Transducer
Temperature Sensor	Anemometer	Central Unit	Laser
			Reflecting Unit

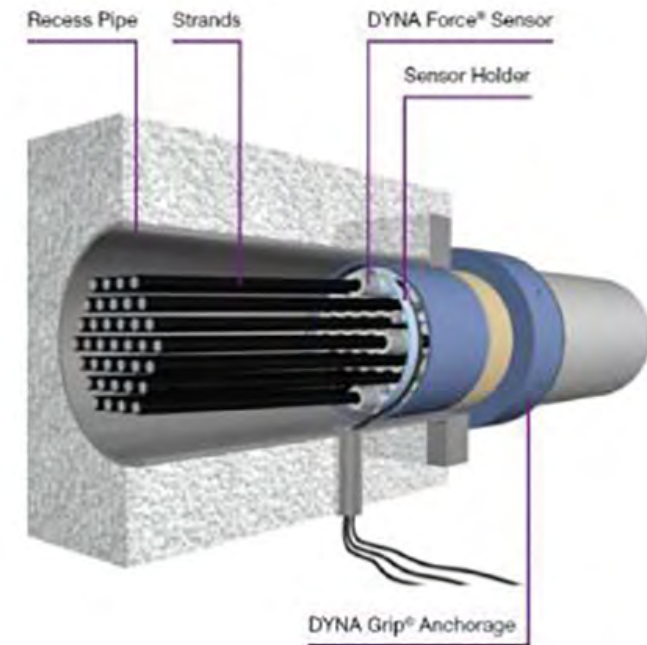


# Monitoring & Data Management

## DYNA FORCE® MONITORING SYSTEM

The DYNA Force® Monitoring System measures the force in steel bars and strands during construction and service life. This structural health monitoring system for cable stayed and overdosed bridges is currently used in over 85 projects worldwide:

- Based on the elasto-magnetic properties of ferromagnetic materials
- No overloading of sensor, no mechanical wear
- Resistant against dust, humidity, shock
- Permanent monitoring of post-tensioning forces in steel tendons



Introducing DYNA Systems

01

DYNA Force® Stay Cable System

Maintenance-free monitoring of single strand forces during construction and permanently under service conditions

02

DYNA Force® and Wire EX tendons

Retrofit application for the accurate monitoring of external tendons

03

DYNA Force® and Infrastructure Intelligence

Data analysis and visualized delivery with the advanced, customizable platform—interactive, web based, multi-channel dashboard

# Inspections & Condition Assessments



## 2. INSPECTIONS & CONDITION ASSESSMENTS

All bridges must have regular inspections to test behaviour, durability and conditions to keep it operable. With the right inspection schedule you improve longevity and reduce overall costs.

From visual inspection, magnetic inductive tendon testing, to fully automated visual inspections and predictive behaviour testing, our team of inspection engineers develop protocols that are right for you.

You need data to assess vulnerabilities and create the right maintenance programs. We offer inspection services that use the latest in robotics and automated inspection methods to provide this data.



# Inspections & Condition Assessments

## AUTOMATED VISUAL INSPECTION

Inspects the entire testable cable length whatever the diameter.

Examination in accordance with German standard DIN 1076 by a certified bridge inspector.

A zoomable high resolution panorama image of the whole surface.

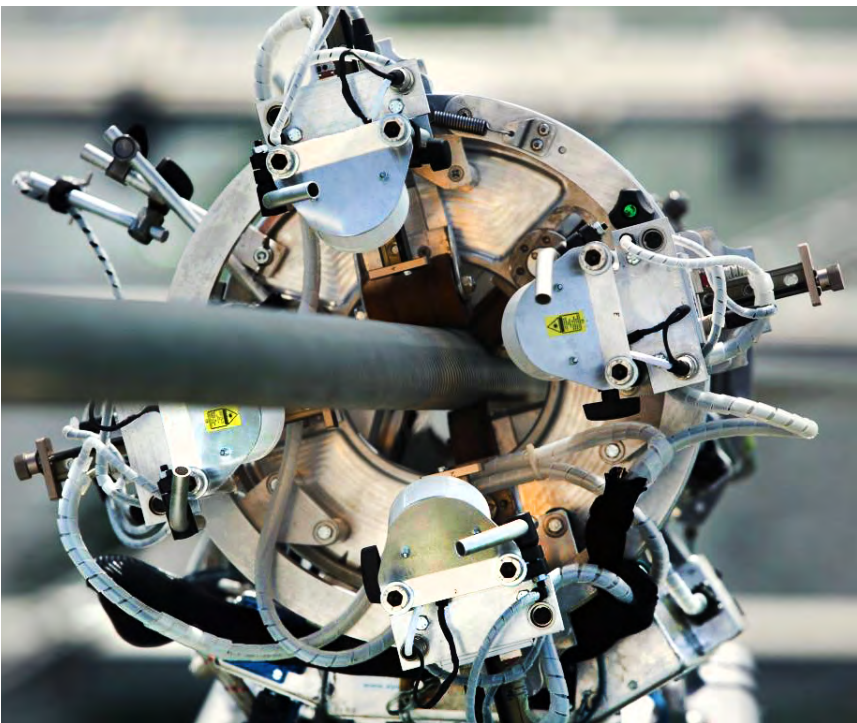
A report with noticeable findings and further advice.

Plus:

- 400% enlarged views
- Detailed display of damages up to 0.1mm
- Software to view, compare, measure, and document the data with previous inspections
- Quick setup without a crane or scaffolding that reduces setup and bridge downtime

## VISUAL INSPECTIONS SYSTEMS

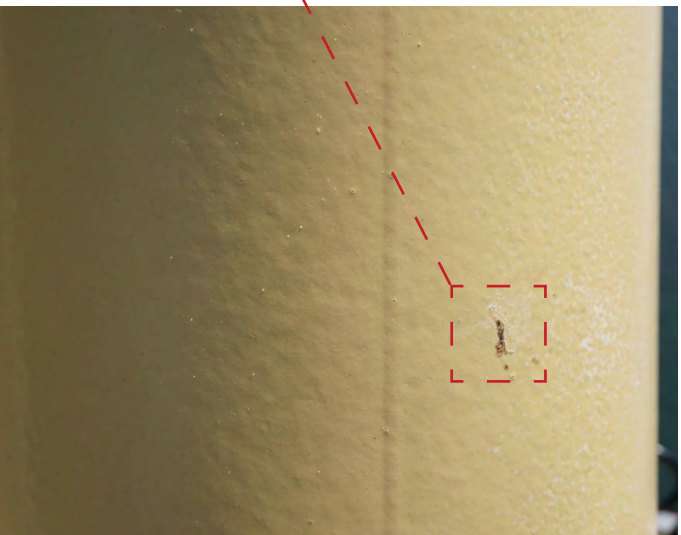
High res 360 images captured by self driving visual inspection robots can be used for historic comparison.



# Inspections & Condition Assessments

## INSECT OR CORROSION?

The value of high-res image capture





# Maintenance



## 3. MAINTENANCE

Understanding bridge health symptoms informs how we conduct works that extend durability.

We can rehabilitate, repair, and strengthen your structure for capacity upgrades, changes in use, changes in design codes, construction defects, ongoing protection, and deterioration damage.

### Prevention

Maintenance stops damage and degradation. We offer measures such as protective cleaning, robotic wrapping systems\*, de-icing, and corrosion protection of stay cables.

### Preservation

Maintenance rehabilitates a bridge to maintain its life. Our experience in repair and strengthening means that potential risks are identified before work commences. We have experience in all types of rehabilitations, from repair of grouting conditions, pylon strengthening and concrete repairs, to shear strengthening, robotic PE welding systems, and external prestressing.

# Maintenance

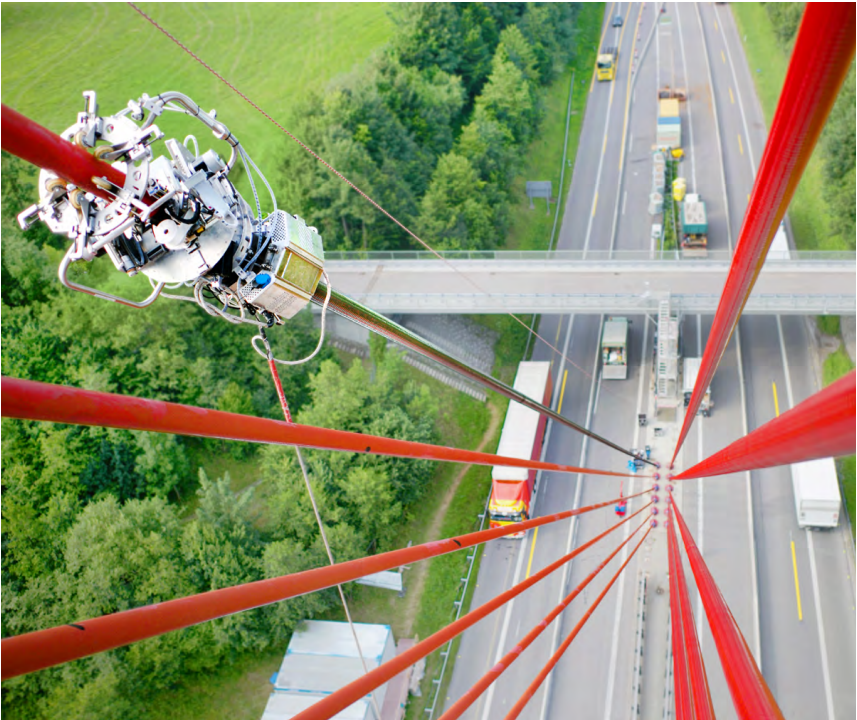
## ROBOTIC CABLE WRAPPING 60+ YEAR LIFESPAN

### Key Features:

- Multiple barriers of independent corrosion protection layers
- No housing, scaffolding, or gantries required
- No obstruction of traffic flow on bridges
- No special surface preparation needed (no removal of paint, dirt etc)
- 100% recyclable; top layer available in various colours
- Corrosion protection fully functional immediately after application
- Combinable with dehumidification systems

## LONG TERM CORROSION & UV PROTECTION

ATIS Cableskin ® European Technical approval (ETA) & ZTV ING is a butyl rubber tape which is wrapped around the bridge cables by self driving robots. Butyl rubber adapts to rough surfaces and avoids air inclusions.





ARGENTINA  
 AUSTRALIA  
 AUSTRIA  
 BELGIUM  
 BOSNIA AND HERZEGOVINA  
 BRAZIL  
 CANADA  
 CHILE  
 CHINA  
 COLOMBIA  
 COSTA RICA  
 CROATIA  
 CZECH REPUBLIC  
 DENMARK  
 EGYPT  
 ESTONIA  
 FINLAND  
 FRANCE  
 GERMANY  
 GREECE  
 GUATEMALA  
 HONDURAS  
 HONG KONG  
 INDIA  
 INDONESIA  
 IRAN  
 ITALY  
 JAPAN  
 KOREA  
 LEBANON  
 LUXEMBOURG  
 MALAYSIA  
 MEXICO  
 NETHERLANDS  
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 QATAR  
 RUSSIA  
 SAUDI ARABIA  
 SINGAPORE  
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