BRIDGE OPERATION & MAINTENANCE

COWI

A WORLD LEADER

For the past 80 years, COWI has been dedicated to providing state-of-the-art services in bridge operation and maintenance. Over the same period, our world-class engineers have pushed the boundaries of bridge design, designing more than 3,000 bridges across the globe – including several of the world's longest suspension and cable-stayed bridges.

Today, we are a world leader – not just in bridge design, but also in bridge operation and maintenance (O&M). It is a position we have achieved over time, through building up our skills, knowledge and experience, and by developing our methodologies and technological applications. Our people are among the best in the industry – comprehensively trained and committed to delivering outstanding services in all aspects of bridge operation and maintenance.

A bridge is a long-term investment. Taking excellent care of it is paramount to achieving and extending its intended service life. COWI has the expertise to develop and deliver the right strategies and solutions to keep your investment safe and operational for years to come.

We are driven by innovation. We can provide lean services as well as high-technology solutions to take your bridge into the future. Our O&M services cover all stages of the bridge life cycle, ranging from service-life design through to caretaking and decommissioning.

With a full repertoire of world-class competencies in operation and maintenance, we are ready to advise and support bridge owners on any bridge, anywhere in the world – no matter its condition, size or age.

Together, we will deliver the right solutions to keep your bridge in satisfactory condition for continued operation.

WORLDWIDE REACH

At COWI, we take pride in our achievements. For nearly a century, we have been at the forefront of bridge operations and maintenance, setting the standard for tomorrow's best practices.

We are present in more than 90 countries, with offices all over the world. In close partnership with our customers, our teams are involved in operation and maintenance projects around the globe, providing services tailored to project requirements, local regulations and codes of practice. Our assignments range from conventional road, rail and pedestrian bridges to landmark bridges.

TOTAL EMPLOYEES:
6,400+

BRIDGE, TUNNEL and MARINE EMPLOYEES:
1,200+

O&M ENGINEERS:
250+

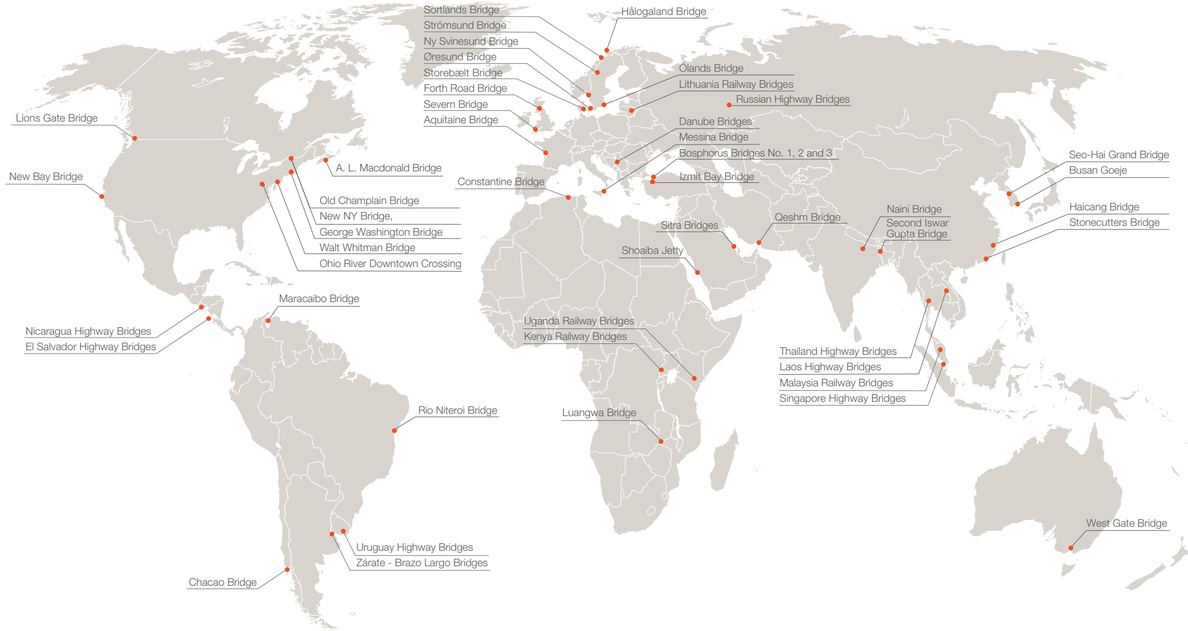
OFFICES
Denmark (head office)
Norway
Sweden
United Kingdom
Germany

Qatar
United Arab Emirates
Bahrain
India

Hong Kong
Korea

USA
Canada

SELECTED GLOBAL ENGAGEMENTS



DIFFERENT NEEDS
DIFFERENT SERVICES

SERVICE-LIFE DESIGN
COWI has a reputation as a leading bridge design company that delivers bridges designed to last. We have built this reputation by always adhering to the highest standards, best practices and strong management principles. Our signature designs utilise durable materials, minimise fatigue, offer effective drainage details as well as easy access for inspection, maintenance and replacement. We can even provide you with a lifetime budget for operating the bridge.

O&M SYSTEMS
We perform operation and maintenance in a structured, systematic and transparent way. We have procedures to keep track of bridge condition and maintain records, and we can even provide you with an intelligent bridge management system. Our approach is tailor-made to your specific requirements.

CONCRETE DEGRADATION AND REPAIR
Our experts can inspect the condition of your concrete on site as well as in our laboratory. We have the latest NDT tools, and can provide corrosion monitoring using smart sensors, detecting corrosion before it develops into a serious durability problem.

INSPECTION AND CONDITION ASSESSMENT
Our inspection engineers are specialists in their field of knowledge. Some hold rope access certificates while others are certified to fly drones or are experts in long-term instrumentation. For every task, we provide a carefully chosen team for assessing your structure.

REHABILITATION AND STRENGTHENING
When it is time for rehabilitation, we design, plan, manage and supervise on site together with the permanent O&M team. By combining our leadership in bridge design with our maintenance knowledge, we deliver durable solutions that minimise the impact on traffic. We have experience in all types of rehabilitations, from replacing bearings and expansion joints to cables and pavement.

EMERGENCIES
In case of an emergency, we are here to assist. Whatever the incident, trained experts will be readily available to provide the necessary guidance and support. We have the experience and know-how to put together the right response team to handle and mitigate any unforeseen incident.

CORROSION PROTECTION
We can specify the right materials to protect your bridge against corrosion, whether you need a repaint or a retrofit of a dehumidification system. We will assess the environment and the bridge condition, look at the costs and provide you with the most suitable solution.

STRUCTURAL HEALTH MONITORING SYSTEM
We provide new or retrofitted structural health monitoring systems (SHMS) designed to obtain additional information on bridge operation and overall condition. We can use the system to provide short-term assessments as well as long-term predictions on structural performance, on a scale agreed with you. Further benefits can be achieved by integrating the results with visual inspection data through the use of a bridge management system.

CABLE REHABILITATION
The cable systems are a principal element of most large bridges and need to be kept in excellent condition. Our experts provide assessments of cables, suspenders and hand ropes – and then recommend the right solution to any issues that arise, whether it is water causing corrosion or wind that is causing vibrations and fatigue. Cable dehumidification and vibration dampers are among our core competencies.

SURVEYING OF GEOMETRY AND LOADS
By combining teams of surveyors and structural experts, and applying advanced laser technology, we can determine the geometry and loads of bridge decks as well as cable systems.

OPERATION
We aim to keep your bridge open for traffic, even in severe weather. No one can control the weather, but we have the experience, tools and techniques to deal with wind, falling ice or vibrations that may cause disruption. We will help you to ensure maximum uptime of your bridge.

OUR TEAMS

Since designing our first bridge in 1938, COWI has actively recruited, trained and coached the best engineers. Now, our O&M teams are among the best in the world, adopting the latest techniques as well as cutting-edge technologies and materials. We push boundaries to innovate and maximise value, but at the same time, our engineers are focused on finding workable solutions.

Every bridge job is unique, so we select a specific team to deliver a solution tailored to you.

O&M TEAM LEADER

An experienced chief project manager or specialist heads up each O&M team and will complete the assignment in close cooperation with the customer.

STRUCTURAL ENGINEERS

Structural engineers provide structural assessments by analysing and modelling the structure and help find the right solutions.

CABLE EXPERTS

Our cable experts have extensive experience and insight so they are able to identify any problem and find the right solution, even for complex cable systems.

DRONE INSPECTION TEAM

Our experienced drone inspection team can provide aerial screening of bridge structures using drones, to determine the full condition of the bridge.

ROPE ACCESS TEAM

Our rope access team are not only excellent IRATA-certified climbers, they are also experienced qualified inspection engineers.

SURVEYING TEAM

The surveying team are experienced surveyors using state-of-the-art technology and tools such as 3D laser scanning and photo mapping, and are supported by structural experts who link geometry with bridge condition.

FATIGUE EXPERTS

Our fatigue experts identify any cracks and can make a prediction on the remaining service life of a structure.

CORROSION ENGINEERS

Corrosion engineers have an experienced eye for identifying the corrosion mechanism and the knowledge to select the right corrective maintenance.

PAINT AND COATING SPECIALISTS

Paint and coating specialists assess existing coatings and provide a cost-effective solution for renewing paint and coatings.

PAVEMENT EXPERTS

Pavement engineering is a specialist area that requires our experts to have excellent knowledge of condition assessment together with the capability to pick the right design for a durable pavement.

STRUCTURAL HEALTH MONITORING SYSTEM EXPERTS

Our team of SHMS experts and engineers combine the science of instrumentation and knowledge of methodologies to extract useful data about structural performance and condition.

WIND ENGINEERS

Our wind engineers assess wind climate and bridge loads through sophisticated numerical models, measurements and laboratory tests.

SEISMIC EXPERTS

Seismic experts can model local seismic conditions and combine that with structural models to identify any requirement for retrofit designs as well as criteria for operation and monitoring.

OPERATION FROM DAY 1

To ensure full and safe bridge operation, O&M should be carried out from day one of the service life. However, it is never too late to start taking care of your bridge assets.

In a perfect world, the bridge has been designed with due consideration to service life aspects such as durability, access and efficient operation and maintenance. However, bridges also happen to be in the less glamorous world. O&M may have been forgotten for a period, or problems may have been inherited from the construction phase.

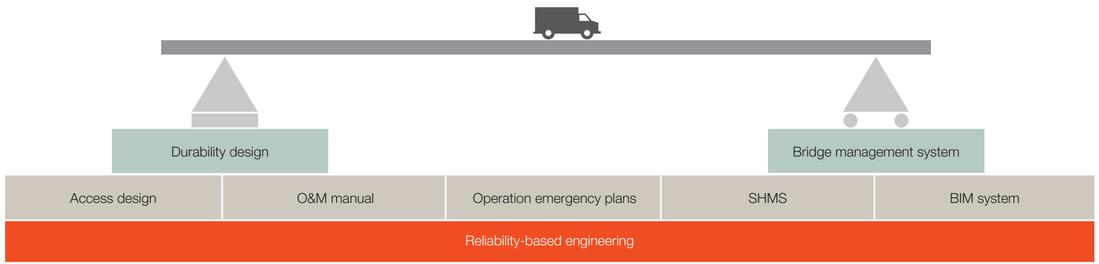
No matter the challenge, COWI has the expertise to help and provide due diligence.

SERVICE-LIFE DESIGN

To achieve a long service life, modern bridge design must take into account durability, access and the right O&M instructions for the management of the bridge. The goal of service-life design is to minimise life cycle costs.

Durability design using reliability-based engineering provides the foundation for achiving the target service life of a bridge with minimum life cycle costs. A comprehensive service-life design also comprises an access strategy ensuring efficiency in operation, inspection and maintenance, and an O&M manual allowing the owner to take over and manage the bridge efficiently from day one.

An important focus is to produce a practical O&M manual adapted to local laws and regulations. With a manual in hand, a bridge management system can be specified and purchased. This allows for effective electronic bridge management and may even be developed into a true 6D BIM system with easy access to as-built data. To optimise O&M, a structural health monitoring system (SHMS) dedicated to the bridge may be used to support and optimise O&M.



CARETAKING 24/7

Every bridge is a unique structure that requires a well-considered caretaking routine of inspection and maintenance activities developed specifically to meet its needs. Having worked on a range of unique bridges, COWI has an exceptional vantage point to recognise the special caretaking needs involved.

INSPECTION

All structures must be inspected regularly to ensure that any changes are recorded, investigated and the significance of any identified defect is understood. This allows the appropriate response to be developed and planned. Structural components that are critical or vulnerable require more frequent inspections than other parts. Knowing the optimum inspection frequencies for different areas and components can result in significant cost savings. We undertake many criticality and vulnerability ratings for complex structures in addition to optimisation of inspection and monitoring programmes.

REHABILITATION

During the service life of a bridge, it may need to undergo some form of rehabilitation. We can conduct assessments and develop a cost-effective plan of strengthening, improvements and enhanced protection measures that enable optimum serviceability levels to be maintained. We have gained valuable knowledge and experience from our extensive repair, refurbishment and strengthening works on a wide variety of bridges, which ensures that the schemes we develop are viable – and that any potential risks are identified, understood and mitigated before work commences.

ASSESSMENT

All bridges need to be assessed from time to time to ensure that assumptions made at the time of design, (e.g. loading, construction workmanship, settlement and creep), remain valid for the bridge to operate as intended. Any changes to the original design assumptions may affect the medium and long-term serviceability of particular components. Our experts can identify the critical and the vulnerable parts of a bridge and develop targeted inspection and monitoring protocols that deliver the data necessary for us to undertake comprehensive structural assessments to enable any areas of concern to be identified.

PROTECTION

Protection measures must be implemented before damage and degradation occur. At COWI, our engineers are well-versed on protection details and the variety of established and developing protection strategies. We strive to be at the forefront of the latest protection measures that are required and how these should best be provided. These include measures such as protective coating systems, dehumidification techniques and cathodic protection options.

INSPECTION

ROPE ACCESS TEAM

The great benefit of rope access is that it allows for inspections without traffic disruption. Normally, damage to bridges cannot be detected without a close look so it is vital that inspectors have access to all parts of a structure. With traditional access methods such as temporary platforms, sky lifts or hoists, it can be difficult to access all components of the bridge, not to mention being time-consuming and expensive. Costs can escalate if traffic lanes need to be closed to make room for such access equipment.

Rope access is a quick and safe way of conducting an inspection.
It avoids lane closures, does not disrupt traffic flow, minimises associated road user costs, making it a far more attractive alternative.

COWI has an in-house rope access team. It is an international IRATA-certified team of qualified engineers with an established record of inspection experience in corrosion, steel coating, cables and concrete.

DRONES

Drone inspections offer an exciting new way of working, where the drones make it possible to perform fast, inexpensive screenings of large areas.

The drone method offers better efficiency, saves time and money, reduces traffic interference, and minimises risk compared to more traditional methods.

COWI employs a team of highly skilled drone pilots and inspectors with global experience. Our advanced drones make it possible for the inspectors to operate a separate live camera feed that they can control independently. This ensures that no areas are missed and any damage or defects are registered as the inspectors monitor the structure themselves. Furthermore, the drone photos can be used to provide a 6D BIM-like user interface to inspection and as-built data.

Drones can also be equipped with different sensors such as a thermographic sensor, which makes it possible to detect delamination and flaws in pavements or in concrete.

ASSESSMENT

SURVEYING

Surveying deals not only with geometry, but also with loads and bridge conditions. We provide long-term monitoring of bridge movements to account for geometry, settlement, bridge condition and loads. COWI has a large surveying unit of 400+ employees and can provide a specialist surveying team to perform surveys with high-precision equipment.

The surveying teams carry out measurements to monitor ground movement, earthquake impacts and other incidents, delivering a time-efficient service with high-quality results. If required, conventional high-precision surveying may be extended to include 3D laser scanning.

3D laser scanning also allows as-built dimensions to be established by sampling a point cloud. This can then be used to set up very accurate drawings of the available space and access options when performing inspections, maintenance and larger rehabilitations. For instance, the replacement of bridge elements such as bearings, expansion joints and cables etc. may be critical with respect to the available space for using access ways and installing new bridge elements.

Virtual reality tools may be used to mazimise the interaction and understanding of such data.

3D laser scanning is also an effective tool for scanning the geometry of cable systems and assessing their condition and loads. A large number of cables can be measured over a very short period, thereby minimising the impact on traffic flow. It may even be carried out during a single night. Through the use of these structural models, our specialists can efficiently extract valuable insights from gigabytes of data.

STRUCTURAL MONITORING

A structural health monitoring system (SHMS) is essential for optimising inspection and maintenance of bridges. COWI's SHMS can provide a safe and cost-efficient way for the bridge manager to operate the bridge with minimal traffic restrictions.

For all bridge structures where a structural monitoring system is considered necessary, COWI carries out initial analyses for recognised hazards and deterioration mechanisms to map out the requirements for the SHMS. We can then establish the parameters of the on-structure installations and the functions of the data management and control in order to secure the most reliable, easy-to-operate and cost-efficient system to design and install.

By monitoring the actual exposure conditions and performance of the structures through the SHMS systems, the bridge manager can compare the data collected against the fundamental design assumptions and make an assessment of the structure's remaining service life and plan hands-on inspections if required. The data can also be used to identify areas where mitigation may be necessary before significant degradation occurs, minimising future maintenance costs and enhancing the bridge's service life.

COWI's SHMS consists of four important technical elements:

- Sensors placed on the structure. These modules house various types of sensors, depending on the nature of the structure. This also includes a signal collection and conditioning unit.
- A data communication system for the transfer of the collected data to a remote computer.
- A database application, which collects, stores and processes the sensor data in real time, providing an evaluation of the condition of the structure based on application areas such as user safety, trouble shooting, natural disaster follow-up and maintenance optimisation.
- Processed data can be used to derive service life models, enabling the bridge owner to decide if structural components shall be replaced or whether the service life of the component can be prolonged.

PROTECTION

DEHUMIDIFICATION

COWI is a pioneer in using dehumidification systems for corrosion protection and has been a leader in the field for more than 45 years. It is a state-of-the-art technological solution that has been adopted for large bridge structures all over the world.

A dehumidification system blows dry air through the main cables or box girders, keeping the atmosphere so dry that corrosion cannot occur. Integrated monitoring components provide real-time data from the dehumidification systems and automatically indicate areas that require maintenance or repair, avoiding the need for regular manual inspections. Life-cycle cost analyses show that dehumidification systems are a sound investment and increase the overall life expectancy of steel structures.

COWI started designing dehumidification systems with the box girders of the New Little Belt Bridge in Denmark in 1970. Later, in 2003, the main cables were retrofitted with elastomeric wrapping and connected to a dehumidification system. These areas of the bridge have been protected from corrosion successfully ever since.

Since then, COWI has designed dehumidification systems for corrosion protection on new and existing suspension bridges all over the world including the Great Belt Bridge in Denmark, Höga Kusten, Älvsborg, Walt Whitman, George Washington, Izmit Bay Bridge and the A.L. Macdonald Bridge.

CABLE INTEGRITY

COWI has many years of international experience in inspecting and maintaining cable systems. We offer a wide range of valuable services.

Our specialists provide solutions for coping with fatigue damage, corrosion damage, fire damage as well as water in cable systems. We have assisted owners with replacing suspenders, cable stags and main cables. We have experience with inspecting all types of cable systems with components, such as wires and strands, HDPE coatings, paints, anchorages, sealants, dampers and deviators.

Our experts solve vibration problems by designing and installing vibration dampers such as hydraulic, friction, impact and stockbridge dampers. This serves to prevent further fatigue damage while addressing public concern about cable vibrations.

To help owners be proactive, COWI offers planning of inspections, NDT and monitoring programmes. Where feasible, we also contribute with design and installation of cable monitoring systems for vibrations, corrosion and water ingress. Proactively, we secure improved drainage conditions and sealing systems and install cable dehumidification and fire protection.

OPERATION

SAFEGUARDING OPERATIONS

Historically, carrying out maintenance activities has required lane closures, carriageway closures and, in some cases, bridge closures.

Customers often ask us to develop alternative methods or strategies to minimise such traffic disruption, which is costly for the owner and an inconvenience for users. Furthermore, traffic management activities often have health and safety implications that need to be addressed.

Through experience and insight, we know the degree of traffic disruption that can result from maintenance activities. Based on our customer's preferences for limiting such restrictions, we can propose alternative processes to be considered and developed.

For instance, the use of drones or high-definition photography to record the condition of structures above road level are means to avoiding the disruption caused by providing access for a visual inspection team. Another example is the installation of temporary bridging units to enable work to remove and replace expansion joint units to be undertaken outside peak traffic hours.

EMERGENCY RESPONSE

Unforeseen and unexpected emergencies do sometimes occur. When this happens, bridge owners know that they can call upon us to provide rapid support to deal with the consequences of incidents such as vehicle fires, accidents, ship collision or sudden failure of a major component.

Bridges are usually closed or severely restricted whilst damage assessments are undertaken. A prudent amount of pre-planning for such emergencies can ensure that disruption and loss of use are minimised as far as possible.

Our experienced teams can work with you to help identify 'unlikely but high-consequence' incidents and to proactively develop a range of emergency procedures.

DIFFERENT CHALLENGES
DIFFERENT TOOLS

At COWI, we have a comprehensive set of expert competencies and array of tools to help deliver the solution to your challenge. This list shows a selection of the tools we use.

STRAIN GAUGE
The strain gauge is a device used to measure strains and stresses, and evaluate steel and concrete fatigue. Connected to a data logger, it can be used for testing as well as for continuous long-term monitoring.

SURVEYING
Surveying instruments such as 3D laser scanning of geometry, 3D photo mapping, GPS coordinate measurements and inclinometer slope monitoring provide important information about the global and local geometry.

ENDOSCOPE INSPECTION
The endoscope inspection uses an instrument to check out inaccessible locations such as small cavities, channels and tubes. The results may be documented with photos or movies.

BEARINGS INSPECTION
Feeler gauges are used to measure clearances and the wear between sliding surfaces to help determine the remaining surface life of sliding components.

THERMOGRAPHIC CAMERA
The thermographic camera takes images using infrared radiation. The technique utilises variations in the exchange of heat. The camera captures possible defects and moisture in concrete, coatings and sealings.

DRONES
Instrument-carrying drones are used to conduct complete inspections of large structures. The drone is controlled by a drone pilot paired with an experienced inspection engineer controlling the camera. The drone identifies defects effectively over large areas.

ACCELEROMETER INSTRUMENTATION
Accelerometers are used to measure the oscillations of decks, pylons and cables. Connected to a data logger, they can be used for testing as well as for continuous long-term automatic structural monitoring.

CONCRETE NDT
Handheld NDT tools are primarily used to inspect concrete. The GalvaPulse is used to measure the speed of corrosion while the Impact-Echo Hammer, MIRA tool, Schmidt-hammer and georadar are used to check for delamination and cavities in the concrete.

CABLE TESTING
Cable load measurements using jacks can be supplemented with COWI's frequency testing or laser scanning techniques. In addition, electromagnetic or ultrasound scanners can be used to identify faults in the cables.

COATING NDT
A coating thickness gauge is used to assess the condition of coatings. This handheld device can be used to obtain samples from structures and determine its remaining service life. A pull-off test may be needed to check coating quality.

MAINTAINED AND INSPECTED BY COWI

GREAT BELT EAST AND WEST BRIDGES, DENMARK

FACTS
- Year of completion: 1998
- Type: Suspension and twin girder bridge (road and rail)
- Length: 17 km with East Bridge 1,624 m main span
- Period of services: 1998-ongoing
- Client: A/S Storebælt.

SERVICES
- Serviceability design
- Inspection and maintenance manual
- Advanced structural and corrosion monitoring systems
- O&M assistance
- Railway expansion joints testing
- Vibration and fatigue assessment of deck and suspenders
- Principal and special inspections of steel and concrete
- Emergency assistance on ship damages.

THE ÄLVSBORG BRIDGE, SWEDEN

FACTS
- Year of completion: 1966
- Type: Suspension bridge
- Length: 933 m with 408 m main span
- Period of services: 1999-ongoing
- Client: Trafikverket (Swedish Transportation Agency).

SERVICES
- Principal and special inspections
- Cable force measurements
- Replacement of suspenders
- Maintenance of pendulums
- Maintenance of expansion joints
- Dehumidification of main cable
- Operational safety analysis.

IZMIT BAY BRIDGE, TURKEY

FACTS
- Year of completion: 2017
- Type: Suspension bridge
- Length: 2,682 m with 1,550 m main span
- Period of services: 2010-2017
- Client: IHI Corporation.

SERVICES
- Durability design
- Access design
- Inspection and maintenance manual
- Advanced structural health monitoring
- Main girder dehumidification system
- Main cable dehumidification system.

NAINI BRIDGE, INDIA

FACTS
- Year of completion: 2004
- Type: Cable-stayed bridge
- Length: 610 m with 260 m main span
- Period of services: 2004-ongoing
- Client: National Highway Authorities of India.

SERVICES
- Bridge asset management for the owner
- Inspection and maintenance manual
- Advanced structural health monitoring
- Principal and special inspections
- Pavement and deck assessment.

HUMBER BRIDGE, UK

FACTS
- Year of completion: 1981
- Type: Suspension bridge
- Length: 1,410 m main span
- Period of services: 2000-ongoing
- Client: Humber Bridge Board.

SERVICES
- Inspections
- Fatigue assessment of deck
- Structural assessments
- Load monitoring
- Replacement of hangers and handstrands
- Resurfacing
- Supervision of works.

CLIFTON SUSPENSION BRIDGE, UK

FACTS
- Year of completion: 1864
- Type: Suspension bridge (national heritage)
- Length: 214 m main span
- Period of services: 2006-ongoing
- Client: Clifton Suspension Bridge Trust.

SERVICES
- Emergency response to failure
- Investigation
- Structural assessment
- Replacement of hangers
- Resurfacing
- Strengthening
- Asset management.

WEST GATE BRIDGE, AUSTRALIA

FACTS
- Year of completion: 1978
- Type: Cable-stayed bridge
- Length: 2,600 m with 336 m main span
- Period of services: 1970-1978
- Client: Roads Corporation of Victoria.

SERVICES
- Strengthening scheme due to traffic increase
- Maintenance and damage repair.

OLD CHAMPLAIN BRIDGE, CANADA

FACTS
- Year of completion: 1962
- Type: Steel truss and concrete girder bridge
- Length: 3,440 m
- Period of services: 1991-ongoing
- Client: Jacques Cartier and Champlain Bridges Incorporated.

SERVICES
- Assessment
- Emergency repair
- Structural strengthening and repair
- Minimisation of disturbances to traffic.

FARO BRIDGES, DENMARK

FACTS

- Year of completion: 1985
- Type: Cable-stayed bridge and concrete girder bridges
- Length: 3,332 m with 290 m main span
- Period of services: 1985-ongoing
- Client: The Road Directorate.

SERVICES

- Inspection programmes
- Principal and special inspections
- Maintenance and repair of expansion joints and bearings
- Cathodic protection of piers
- NDT and frequency testing of cables
- Cost estimates
- Seabed surveys
- Rope access inspections.

TJÖRN BRIDGE, SWEDEN

FACTS

- Year of completion: 1981
- Type: Cable-stayed bridge
- Length: 664 m with 366 m main span
- Period of services: 2010-ongoing
- Client: Trafikverket (Swedish Transportation Agency).

SERVICES

- Principal and special inspections
- Improvement of access conditions and drainage of cable anchorage
- Laser surveying and monitoring of cable forces
- Calibration of finite element model to bridge full-scale performance
- Safety assessment of cable system
- Laboratory test of corroded cables
- Cable replacement with specification, procurement and supervision.

ERSKINE BRIDGE, SCOTLAND

FACTS

- Year of completion: 1976
- Type: Cable-stayed bridge
- Length: 1,320 m with 305 m main span
- Period of services: 1998-ongoing
- Client: Renfrewshire Council, Amey Infrastructure Services, Scotland Transerv.

SERVICES

- Inspections
- Structural assessment
- Strengthening design
- Resurfacing design
- Supervision of works
- Improved access
- Upgrading of vehicle barriers
- Enhanced public safety barrier
- Impact damage
- Emergency assessment and repair after ship impact.

UDDEVALLA BRIDGE, SWEDEN

FACTS

- Year of completion: 2000
- Type: Cable-stayed bridge and girder bridges
- Length: 1,712 m with 414 m main span
- Period of services: 2001-ongoing
- Client: Trafikverket (Swedish Transportation Agency).

SERVICES

- Principal and special inspection
- Assessment of ingress of water into cable stays
- Monitoring programme
- Repair of broken upper cable anchorage
- Rope access inspections
- Inspection of cable-stay friction dampers.

NEW SVINESUND BRIDGE, NORWAY-SWEDEN

FACTS

- Year of completion: 2005
- Type: Arch bridge with suspender and approach bridges
- Length: 704 m with 247 m main span
- Period of services: 2010-2011
- Client: Statens Vegvesen (Norwegian Road Agency), Trafikverket (Swedish Transportation Agency).

SERVICES

- Inspection manual
- Principal and special inspections
- Assessment of water in cable stays
- Assessment of structural cracking
- Rope access inspection.

SEVERN BRIDGE, ENGLAND

FACTS

- Year of completion: 1966
- Type: Suspension bridge
- Length: 1.6 km with 988 m main span
- Period of services: 1976-ongoing
- Client: Department of Transport, Highways Agency, Severn River Crossing plc.

SERVICES

- Inspections
- Structural assessment
- Strengthening design
- Replacement of hangers and handstrands
- Resurfacing
- Supervision of works.

FATIH SULTAN MEHMET BRIDGE, TURKEY

FACTS

- Year of completion: 1988
- Type: Suspension bridge
- Length: 1,510 m with 1,090 m main span
- Period of services: 2005-2009
- Client: KGM (General Directorate of Highways).

SERVICES

- Structural assessment
- Bridge specific live load assessment
- Development and implementation of structural health monitoring systems
- Inspection and strengthening planning.

THE HÖGAKUSTEN BRIDGE, SWEDEN

FACTS

- Year of completion: 1997
- Type: Suspension bridge
- Length: 1,867 m with 1,210 m main span
- Period of services: 2004-ongoing
- Client: Trafikverket (Swedish Transportation Agency).

SERVICES

- Principal and special inspections
- Main cable dehumidification system
- Assessment of suspender vibrations
- Rope access inspections
- O&M assistance.

THE CHACAO BRIDGE, CHILE

FACTS
- Year of completion: 2021 (expected)
- Type: Consecutive suspension bridges
- Length: 2,635 m, two main spans of 1,055 and 1,100 m
- Period of services: 2014-ongoing
- Client: MOP (Ministry of Public Transportation).

SERVICES
- Independent checker and advisor on:
- Durability design for a 100-year service life
- Access design
- O&M organisation
- Inspection and maintenance manual
- Dehumidification project
- Operational risk analysis
- Structural health monitoring.

VIADUC TRANSRHUMEL, ALGERIA

FACTS
- Year of completion: 2014
- Type: Cable-stayed bridge with access bridges
- Length: 1,119 m with 259 m main span
- Period of services: 2012-2014
- Client: Construtora Andrade Gutierrez S.A.

SERVICES
- Durability design
- Access design
- Inspection and maintenance manual
- Geotechnical instrumentation and monitoring
- Structural health monitoring.

YAVUZ SULTAN SELIM BRIDGE (3RD BOSPOROUS BRIDGE)

FACTS
- Year of completion: 2016
- Type. Suspension-cable stay Bridge
- Length: Main span 1408 m
- Period of services: 2016
- Client: ICA (Ictas Construction and Astaldi).

SERVICES
- Commissioning inspections of construction works for the contractor.

THE NEW N.Y. BRIDGE (TAPPAN ZEE), USA

FACTS
- Year of Completion: 2018
- Type: Twin cable stay bridges with approach bridges
- Length: 4,800 m with 365 m main span
- Period of services: 2012-2018
- Client: Tappan Zee Constructors.

SERVICES
- Corrosion protection plans
- Access strategy
- Access and inspection manual
- Operation and maintenance manual
- Life cycle cost estimate
- Structural monitoring system.

NEW LITTLE BELT BRIDGE, DENMARK

FACTS
- Year of completion: 1970
- Type: Suspension bridge
- Length: 1,700 m with 600 m main span
- Period of services: 1970-ongoing
- Client: The Road Directorate.

SERVICES
- Operation, inspection and maintenance
- Rehabilitation of expansion joints, pavement, concrete, steel coating etc.
- Vibration monitoring and damping
- Noise and wind screens for road
- Dehumidification of girder and main cables
- Drone inspections
- Emergency assistance on fire damages to cable systems.

ZÁRATE-BRAZO LARGO BRIDGE, ARGENTINA

FACTS
- Year of completion: 1977
- Type: Cable-stayed bridge
- Length: 550 m with 320 m main span
- Period of services: 1996-2000
- Client: Direccion Nacional de Vialidad (National Road Administration).

SERVICES
- Structural assessment after cable failures
- Inspection, testing and NDT
- Emergency strengthening
- Stuctural analysis
- Reliability assessment
- Rehabilitation design and tender
- Inspection and maintenance manual.

LUANGWA BRIDGE, ZAMBIA

FACTS
- Year of completion: 1968
- Type: Cable-stayed bridge
- Length: 222 m main span
- Period of services: 1993-1997
- Client: Ministry of Works and Supply.

SERVICES
- Inspection and NDT
- Condition and bearing capacity assessment
- Structural analysis
- Project for replacement of cable stays and strengthening of girder and towers
- Tendering
- Site supervision.

AQUITAINE BRIDGE, FRANCE

FACTS
- Year of completion: 1967
- Type: Suspension bridge
- Length: 1,776 m with 400 m main span
- Period of services: 1999-2003
- Client: DDE de la Gironde, Bordeaux.

SERVICES
- Feasibility study for main cable replacement
- Tender rehabilitation design
- Tender evaluation
- Technical follow-up during construction.

ÖLAND BRIDGE, SWEDEN

FACTS
- Year of completion: 1972
- Type: Consecutive girder bridges
- Length: 6,000 m
- Period of services: 2003-2014
- Client: Trafikverket (Swedish National Road Administration).

SERVICES
- Principal and special inspections
- Condition assessment
- Preparation of maintenance strategy
- Preparation of concrete repair methods
- Design of cathodic protection
- Tender and supervision assistance.

ORESUND LINK BRIDGE, DENMARK-SWEDEN

FACTS
- Year of completion: 2000
- Type: Cable-stayed bridge with approach bridges
- Length: 7,800 m with 490 m main span
- Period of services: 1997-2000, 2015
- Client: Sundlink contractors and Øresundsbron.

SERVICES
- Service life strategy
- Design of corrosion monitoring system for concrete substructures
- System specifications
- System installation
- System operaton
- Strategy for steel coating maintenance.

BOSPHORUS BRIDGE, TURKEY

FACTS
- Year of completion: 1973
- Type: Suspension bridge
- Length: 1,560 m with 1,074 m main span
- Period of services: 2005-2009
- Client: KGM (National Highways Directorate).

SERVICES
- Structural assessment
- Structural health monitoring system development and installation
- Monitoring of structural behaviour
- Detailed inspection of critical components
- Improved access provision.

A. L. MACDONALD BRIDGE, CANADA

FACTS
- Year of completion: 1955
- Type: Suspension bridge
- Length: 441 m main span
- Period of services: 2005-ongoing
- Client: Halifax Harbour Bridges.

SERVICES
- Suspended spans deck replacement
- Hanger cables replacement
- Dehumidification of main cables and main towers
- Supervisory control
- Inspection.

BUSAN-GEOJE LINK, KOREA

FACTS
- Year of completion: 2011
- Type: Two cable-stayed bridges
- Length: Two bridges with 2,364 m and 1,856 m main spans
- Period of services: 2003-2011
- Client: Daewoo Engineering & Construction Co. ltd.

SERVICES
- O&M system
- O&M organisation
- O&M life cycle costs
- Operation, inspection and maintenance manuals
- Basis for bridge management system.

RIO NITEROI BRIDGE, BRAZIL

FACTS
- Year of completion: 1974
- Type: Consecutive girder bridges
- Length: 13,000 m bridge, 300 m main span
- Period of services: 2015
- Client: Studio Franchetti/Ecorodovias (Operator).

SERVICES
- Special inspections
- Validation of previous inspections.

BJÖRNAFJORD BRIDGE, NORWAY

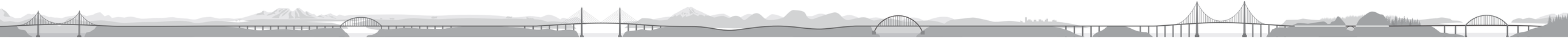
FACTS
- Year of completion: TBC
- Type: Floating cable-stayed bridge
- Length: 4,200 m link
- Period of services: 2015
- Client: Norwegian Road Authority.

SERVICES
- O&M concept for floating bridge
- Access concept design
- Durability concept design.

HAICHANG LINK, CHINA

FACTS
- Year of completion: 1999
- Type: Suspension bridge with approach bridges
- Length: 6,000 m link with 600 m main span
- Period of services: 2000-2003
- Client: Corporation of Xiamen.

SERVICES
- O&M system
- O&M organisation
- Inventory listing
- Operation, inspection and maintenance manuals
- Basis for bridge management system.



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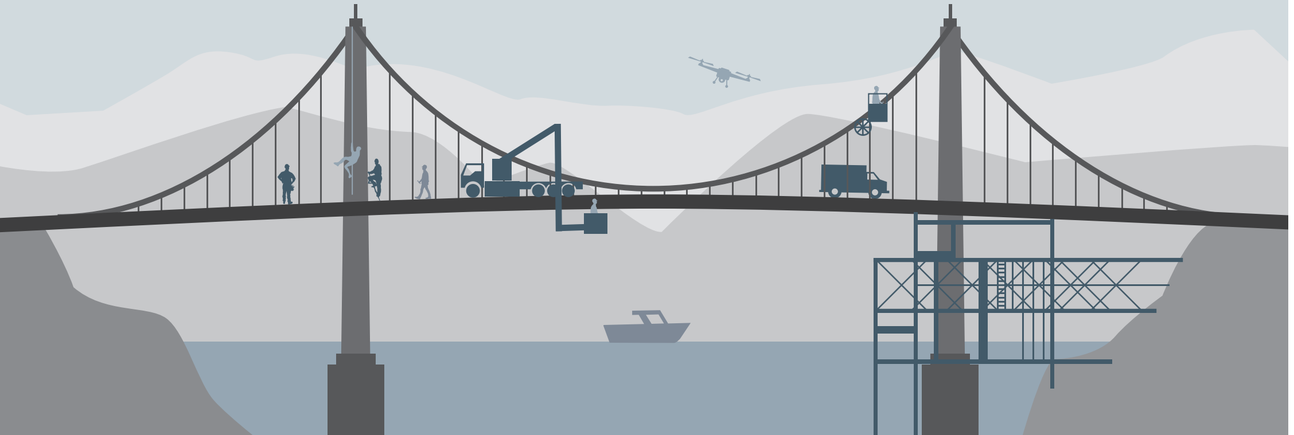

ADDRESS COWI A/S
Parallelvej 2
2800 Kongens Lyngby
Denmark
PHONE +45 56 40 00 00
WWW cowi.com

MEET US AT www.cowi.com

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