Repair
Foreva
by Freyssinet

Steel corrosion control and protection

FREYSSINET

Steel corrosion control and protection

Concrete, steel, masonry, bridges age or undergo changes over the course of time... Freyssinet offers its clients proven solutions for the repair, protection and strengthening of their structures.

Working as a specialist main contractor, we can manage your project to get the best outcomes.

Freyssinet

Founded over 75 years ago, Freyssinet brings together an unrivalled set of skills in the specialist civil engineering sector. With its expertise in the design of elements and structures, the production of materials and equipment and their implementation on site, Freyssinet offers integrated technical solutions in two major fields: construction and structural repair.

Freyssinet's integrated engineering service and involvement in numerous major bespoke projects make it the world leader in its specialist areas of:

Construction - bridges and civil engineering structures, buildings, stadium roofs, wind turbine towers, etc.:

- prestressing;
- construction methods;
- cable-stayed structures;
- structural accessories.

Repair - bridges and civil engineering structures, buildings, industrial infrastructure, marine and waterways structures, water infrastructure, etc.:

- strengthening work using additional prestressing, carbon fibre composites and shotcrete or sprayed UHPFRC;
- protection against the effects of corrosion, earthquakes, fire, chemical attack, etc.;
- maintenance of structural accessories (joints, bearings, prestressing and stay cables).

Freyssinet is a subsidiary of the Soletanche Freyssinet Group, the world leader in soils, structures and nuclear, which also offers a range of digital and consulting solutions for the design, construction and operation of infrastructures. The group brings together an unrivalled set of skills and brands in the construction and engineering industry, applying their technical excellence to enhance the performance and service life of structures.

Cover picture: Cerbère Boom, France

Our primary concern: ensuring everyone's safety

In order to ensure everyone's safety and prevent industrial accidents, the company has produced a set of common international safety rules.

Our primary duty is to protect the physical integrity of our employees and to do all we can to ensure that everyone goes home in good health at the end of the working day. This commitment is reflected in particular through our rules, in-house tools and exemplary behaviour.

It is accompanied by an extensive communication and risk awareness programme, implemented at all of Freyssinet's locations.

"The safe way is the only way"

With FOREVA® solutions, Freyssinet guarantees quality work and a durable repair as part of a **turnkey service**: Freyssinet offers its expertise to designers and principal contractors and supports them at every stage of project, from **assistance in diagnosis, to recommendation of the appropriate solution and implementation of the work**.

Our expertise range covers: survey, investigation, specialist consultancy services, design, material procurement, installation support, commissioning and monitoring.

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Corrosion

The corrosion of structural steel is an electrochemical process that requires the simultaneous presence of moisture and oxygen, whether in atmospheric, soil, water, or other exposure conditions. Essentially, the iron in the steel is oxidized to produce rust, which occupies approximately six times the volume of the original material. This is an issue occurring worldwide. The direct cost of corrosion is estimated at 3% of the Gross Domestic Product (GDP).

Aging infrastructures

One of the most serious corrosion problems is aging infrastructure. The deterioration of reinforced concrete is principally due to the corrosion of reinforcement, which occurs when the concrete has lost its ability to protect it. External pollutants found in air or water enter through the micropores in the concrete. With time, the chemical properties of the concrete in the vicinity of the reinforcement are altered and its pH drops. Once the ambient moisture penetrates to the steel, corrosion begins.

Interventions in both construction and repair

Cathodic protection in reinforced concrete, combined with repair works, offers real optimization potential for port authorities, by extending repair cycles and guaranteeing a long term return on investment. Cathodic prevention is also used in new structures to increase, significantly, the durability of reinforced concrete from the very beginning of the new structure's life.

This corrosion may have natural causes...

- Exposure to saltwater or de-icing salts
- Effect of moisture and temperature inducing carbonation
- External chemical infiltration (polluted air, chlorine, hydrogen sulfide, ...)
- Low cover inducing high speed pollution

... or structural causes:

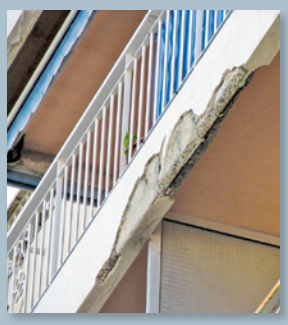
- Use of unsuitable materials
- Design error, poor design or construction (concrete cover, coating quality, ...)
- Material exposure (filling-draining cycles, tides)

The causes of corrosion may also be influenced by usage, such as excessive loading.

Examples of damages due to steel elements' corrosion

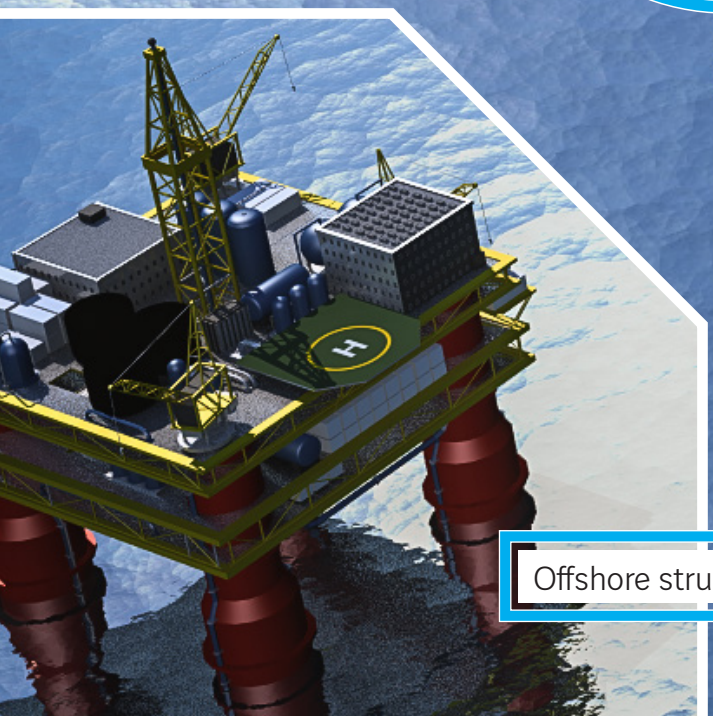
- Concrete delamination
- Concrete spalling
- Concrete cracking
- Partial destruction or failure of elements
- Excessive deformation
- Fluid leaks (water, sewage, petrochemical liquid, oil, ...) and infiltrations




APPLICATIONS

As far as corrosion matters are concerned, Freyssinet offers an unparalleled range of design and construction repair, strengthening, retrofit, upgrade, protection and maintenance services across a range of market sectors.



Offshore structures


Water and sewage treatment plant
Transport pipeline
INDUSTRY
Parking facilities
BUILDING
Swimming pool and spa
Water reservoir

SAINT-CLOUD VIADUCT
FRANCE

Cathodic protection of the concrete segments.
Small diameter discrete anodes for a highly steeled structure.

Corrosion control by Freyssinet

Freyssinet has been a major solution provider in the corrosion industry for over 25 years. Strengthened by our large and diverse experience in this market, we integrate knowledge of an experienced technical team with proven engineering methods.

Strong technical support for complete solutions

With its technical department consisting of civil, structural and materials engineers, materials experts and corrosion specialists, Freyssinet has a proactive policy for the development of repair solutions and products, validated by laboratory on-site trials and feedback from job-site experience.

Key references

With a proven track record and international expertise, Freyssinet has strong references on sustainable repair for reinforced concrete structures and steel structures all over the world:

- Saint Cloud viaduct, Paris, FRANCE
- Webb Dock, Melbourne, AUSTRALIA
- Kwai Chung Terminal, HONG KONG
- Sydney Opera, Sydney, AUSTRALIA
- Ajaccio commercial dock, FRANCE
- New coastal road viaduct, La Réunion, FRANCE
- Forth Road Bridge, Edinburgh, UK
- Shaik Khalifa Bin Salman Marine Bridge, Bahrain, UAE...

Specialist Teams

The know-how of our specialist teams enables Freyssinet to meet our clients' requirements in terms of quality, schedule, cost, safety and the environment. Our substantial network of locations enables local service and offers clients great reactivity.

Methodologies with low impact on the environment

As a company fully engaged in the provision of sustainable technology, our solutions integrate the appropriate environmental factors and always minimize the impact on nature: optimization of the quantities of harmful substances, waste management on the work sites etc.

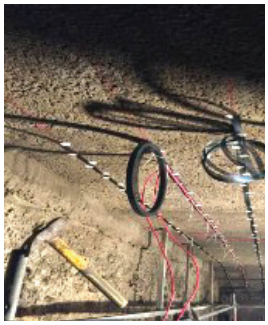
Marine structures – CIVIL ENGINEERING

Marine structures are often more susceptible to corrosion and damage due to the environment in which they are situated. Freyssinet carries out in-depth assessments of various structures including jetties, wharves, quay walls and offshore facilities. We then suggest the most appropriate solution to treat the problem and extend the life of the structure.

Swimming pools and parking facilities – BUILDINGS

Freyssinet has a significant experience repairing building structures and swimming pools. Swimming pools and spas suffer from chloride ingress after less than 25 years of use and design conception especially on basin integrity. A complete repair solution is necessary to maintain the activity and to permit public utilization in safety.

Car parks are also susceptible to chloride ingress due to deicing salts inducing dramatic rebar corrosion on slab, beams and columns. To preserve these assets, Freyssinet is highly capable of preparing turnkey repair solutions including cathodic protection.



PEATS FERRY BRIDGE

AUSTRALIA, NSW

Cathodic protection of the piers

Our services

As a world leader in civil engineering specialties, Freyssinet delivers efficient and sustainable solutions to meet client requirements. We have an in-house engineering design team, which enables us to design and implement technically and economically optimized solutions, approaching each new project individually, offering **complete turnkey solutions** to your corrosion threats.

Corrosion Management

Freyssinet can provide cathodic protection, cathodic prevention, realkalization and electrochemical remediation systems for a range of structures, including reinforced and post-tensioned concrete structures, steel structures, bridges, wharves, jetties and buried pipelines.

The scope of our turnkey service:

1. Survey and inspection to determine the cause, extend and rate of deterioration.
2. Provide recommendations to repair the structure, selecting the appropriate quality and resources for a balanced package with design lives from 10 to 100 years. Freyssinet specialises in in-house detailed designs.
3. Methodology and implementation of the works: precommissioning, commissioning and start-up.
4. Provide specific technical training.
5. Maintenance, environmental controls and expertise with additional remediation work if necessary.

After sales

Once the work is completed, Freyssinet can provide follow-up service on the protected structures thanks to remotely controlled detection equipment monitored by GSM or 4G systems. We then prepare and provide a complete report for the project owner.

«The reinforced concrete corrosion was, in some places, so severe that it had completely corroded the steel to nothing.»

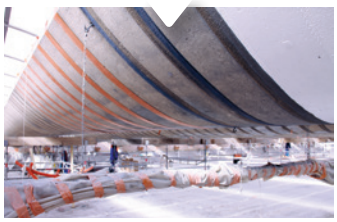
Paul, Project Manager at Freyssinet

Illustrations of Freyssinet's work

BEFORE



AFTER


ADMIRALS SWIMMING POOL

FRANCE

Cathodic protection
of the seven gantries

Our expertise

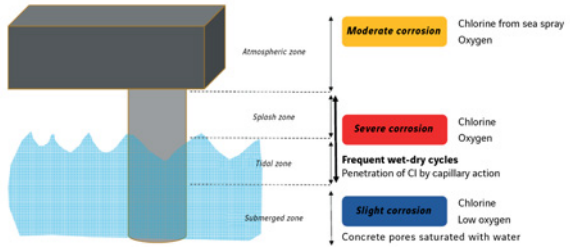
Foreva® solutions enable Freyssinet to carry out repair and retrofit work in line with international and industry standards (ISO, EN, NACE, etc.) and best engineering practices while respecting the environment.

Strong skills and expertise

Freyssinet has a worldwide dedicated corrosion team, member of International and National Corrosion Committees (FIB, NACE, EFC, IABSE, ACA). We have certified cathodic protection engineers and specialists (NACE, ISO 15257) to select the best solution for repairing and protecting a structure.

Different solutions for different corrosion levels

One of the best examples of corrosion is a reinforced concrete pile in marine environment. Our panel of solutions depends directly on the corrosion levels:



What do we do?

With experience in a variety of specialist corrosion control and monitoring techniques, Freyssinet can offer a suitable solution for your corrosion problems tailored to your requirements and budget. Working on the area surrounding the steel or on the reinforcement itself, Foreva® solutions can be used to control the progression of reinforcement corrosion in reinforced concrete structures at all of its stages of development by:

- Mitigating the corrosion initiation, preserving a protective environment around the reinforcement. The solution consists in treating the concrete surface to slow down or stop the penetration of pollutants before they reach the reinforcement.
- Extending the period of protection, minimizing the corrosion initiation process in the steel reinforcement of new structures. This solution consists in removing pollutants from the coating to restore the protective environment around the reinforcement.
- Preventing the corrosion progression in the long term, after repairing the structural damage it has caused. This category of solutions consists in protecting the reinforcement by means of an electrochemical process to minimize the corrosion, without acting on the spread of the pollutant.

Webb Dock

The Webb Dock East Berth 4 & 5 Rehabilitation project is the largest wharf rehabilitation project ever undertaken by Freyssinet in Australia with a scope of work including: concrete repairs and coatings, steel pile patch welding, steel pile protective wraps and encasements, and the installation and ongoing monitoring of an impressed current cathodic protection system.

CERBÈRE BOOM

FRANCE

Cathodic protection of the piers
Deep engraving for a thick cover (7cm) structure

Our solutions

Corrosion affects steel structures in all oxidizing and aggressive environments. Freyssinet has a complete set of preventive or repair solutions according to the damaged structure.

Solutions according to the damaged structure

Freyssinet can implement customized solutions in different types of structure:

· **Steel onshore structures**

Examples of available solutions: coating, stray current mitigation, cathodic protection with galvanic anode or impressed current

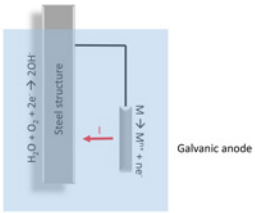
· **Steel offshore structures**

Examples of available solutions: painting, jacketing, cathodic protection with galvanic anode or impressed current

· **Civil engineering structures**

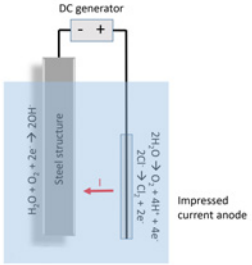
Examples of available solutions: coating, polymer-modified mortar, hydrophobic impregnation, corrosion inhibitor, electrochemical treatments (Electrochemical Realkalization - ER, and Electrochemical Chloride Extraction - ECE), corrosion control by galvanic anode, hybrid anode system, cathodic protection by impressed current

How do our main solutions work?



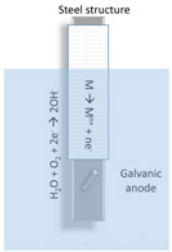
Sacrificial anode cathodic protection (SACP)

ELECTROLYTE (SOIL, WATER, CONCRETE)



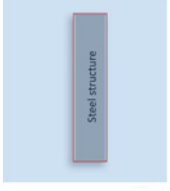
Impressed current cathodic protection (ICCP)

ELECTROLYTE (SOIL, WATER, CONCRETE)



Jacket sacrificial anode cathodic protection (JSACP)

ELECTROLYTE (SEA WATER)



Coating on Steel

ELECTROLYTE (SOIL, WATER)

Coating, hydrophobic impregnation on concrete

ELECTROLYTE (CONCRETE)

Portfolio

Ayala bridge - **PHILIPPINES**

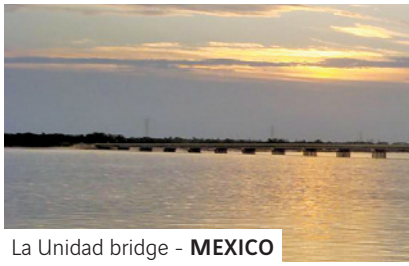
Caltex wharf - **AUSTRALIA**

Cadei building - **FRANCE**

Cerbère boom - **FRANCE**

EXXARO, Lephalale mine
SOUTH AFRICA

Webb Dock wharf - **VIC, AUSTRALIA**



La Unidad bridge - **MEXICO**

Carpark of Heuvelpoort - **THE NETHERLANDS**

New Coastal Road viaduct - **FRANCE**

Forth road bridge - **UK**

Port of Ajaccio - **FRANCE**

Union House at Etihad museum - **DUBAI, UAE**

Kpeme wharf - **TOGO**

Prickwillow bridge - **UK**

Simmon's residence - **NC, USA**

MLC Tower - **NSW, AUSTRALIA**

Doel cooling tower - **BELGIUM**

Tolú wharf - **COLOMBIA**

FREYSSINET
SUSTAINABLE TECHNOLOGY

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