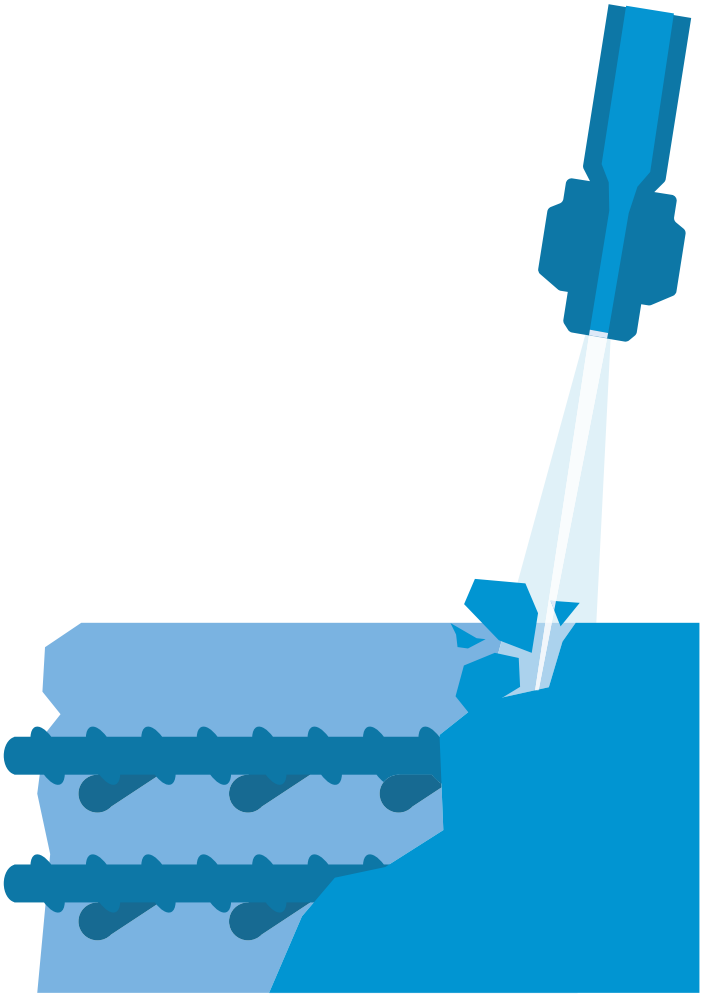
European Water Jetting Institute



Why use hydrodemolition?

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Test slab after hydrodemolition removed the weaker 20MPa concrete, and the stronger 40MPa concrete remains, casted as a stairway. Rebars are removed.

Different types of applications such as bridges, ports, airports, parking garages, tunnels, dams, canals, etc.

Hydrodemolition is a technology that removes concrete selectively with high-pressure water without causing damage to the remaining structure. “Selectively” means that the weak concrete is removed down to a pre-set quality level while the good concrete remains.

The technology is mainly used on sensitive structures such as bridges, tunnels, parking decks, dams, locks, and canals.

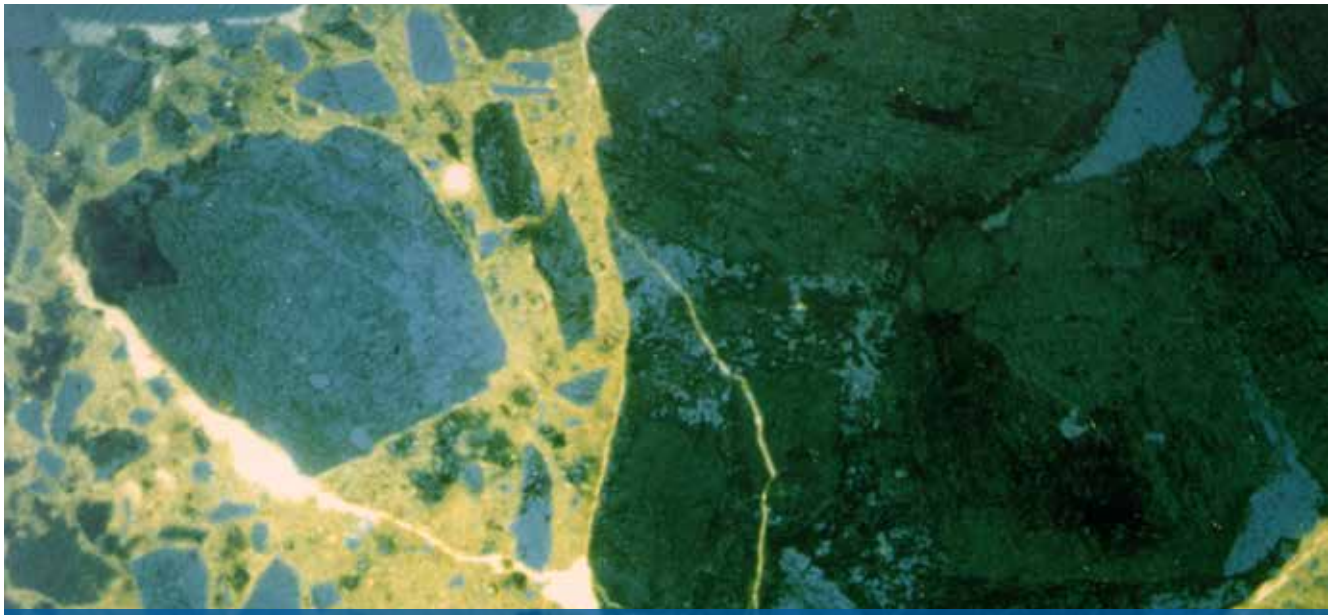
The tool is a robot that removes the concrete, and the removal process is controlled remotely by an operator.

The unit that removes the concrete consists of a special hydrodemolition robot that moves a high-pressure water lance along a feed beam at a certain speed and pattern. Further is a large high-pressure pump creating the flow and the water pressure for the lance mounted on the robot.

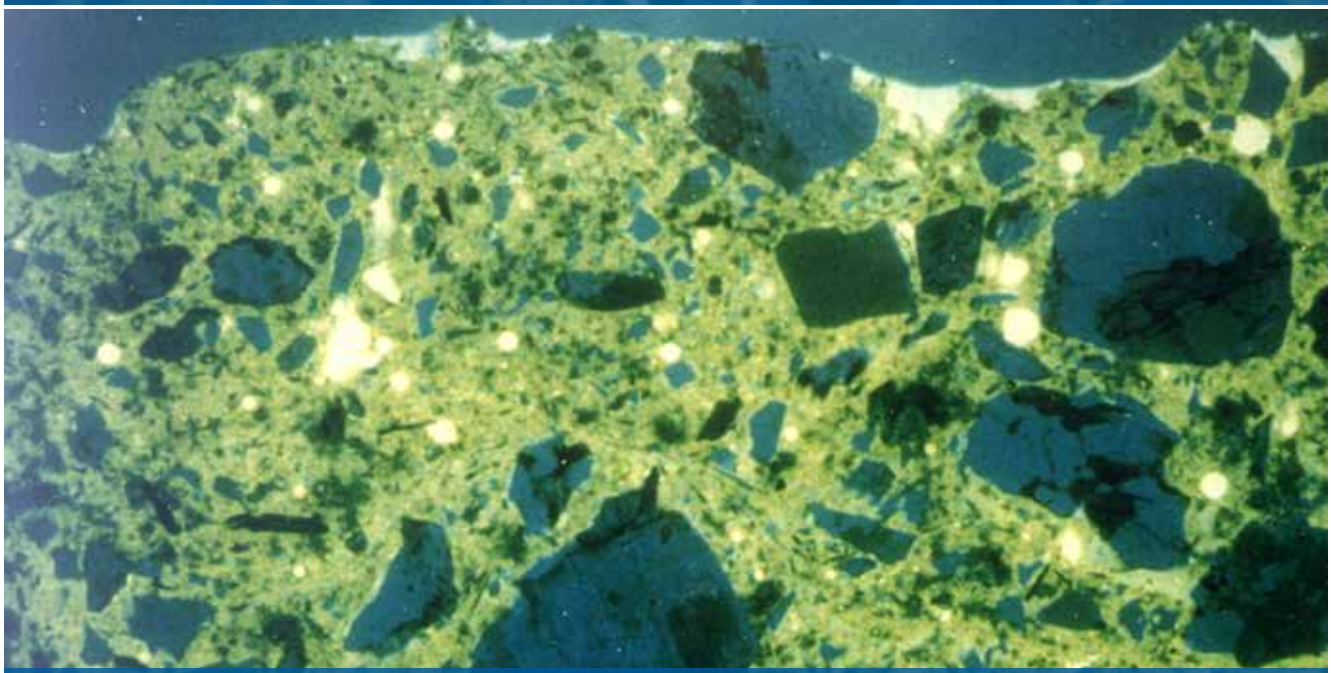
The robot is remotely operated which makes the process efficient and safe.

Robot in operation, the picture shows the cutting head moving from side to side.

2 Why should you use Hydrodemolition?



This is a picture of thin slices of concrete exposed in a microscope. The picture shows the cracks created by the use of a percussion tool such as jackhammer.



This picture shows the result after using hydrodemolition technology. In the picture, there are no cracks at all, so using hydrodemolition will ensure a better bonding and longer life span of the structure.

Using the hydrodemolition technology ensures that the remaining structure, after the damaged concrete is removed, remains in good condition without any micro-cracks.

Apart from the fact that no micro-cracks are created, the technology will remove only the bad concrete down to a pre-set quality level. This is called “selective removal” and creates a rough surface to ensure that the bonding between the old and the new concrete is more than twice as strong as when percussion methods are used. (European Norm, EN 1504, is a norm that requires a bond of 2mPa for sensitive structure, structural structures, in Europe) This means that the owner of the structure will get a far better repair of their structure as opposed to using the percussion methods such as jackhammers.

There are not only technical advantages, but the operation at the site will also proceed much faster as the robot will replace between 20-25 operators. This means that fewer people will be required and, with fewer man-hours, the contractor will be exposed to fewer accidents.

The use of a robot and a high-pressure pump, which is remotely operated, ensures that the operator is not exposed to certain risks, such as: “white fingers” and vibrations caused when jackhammers are used, silica dust from the water used, etc. Additionally, there is less noise as vibrations are not transferred to the structure as opposed to percussion methods.

The concrete wastewater generated by using this technology can be handled by equipment that cleans the water and adjusts the PH level so it can be drained into the local sewage system.

Consequently, the use of hydrodemolition will extend the life span of the structure and decrease the number of repairs over time.

With a large number of sensitive structures in need of repair, the use of hydrodemolition will increase the process rate and provide a better-quality result than when conventional methods are used.

Robot in operation on a bridge and vacuum trucks taking care of debris and concrete slurry.

The Robot removes deteriorated concrete on the bridge deck while the debris is being removed by the vacuum in front of the robot.

3 The background, history of the hydrodemolition development

The first semi-automatic robot prototype built by Atlas Copco. Djuröbron, outside Stockholm, Sweden.

"We can't afford to use Jackhammers"
(Statement by Swedish National Road Administration)

A statement from the early '80s done by the Swedish National Road Administration (SNRA). They were facing major problems with the repair method by using jackhammers on bridge structures.

When the concrete on a bridge was damaged and in need of repair, the traditional method of repair was to use jackhammers. However, when core samples were taken, there were several cracks identified in the old part of the structure, the part that was supposed to remain. The consequences of these micro-cracks were that the bonding between old and new concrete was not good enough. Such repair started to delaminate within a rather short period. This was of major concern to SNRA as it affected the quality of the repair, the life length of the repair, as well as the overall life of the entire bridge.

SNRA expressed, *"We can't afford to use jackhammers we need to find a new and better solution to remove deteriorated concrete on the bridges"*. SNRA initiated a project, stated the criteria, and started to find some partners to participate.

The partners - Atlas Copco AB, a large manufacturer of construction and mining equipment, was contacted to develop and produce a machine that could meet the requested criteria; ABV (today NCC - Nordic Construction Company), a contractor that could operate the machine and verify that the machine fulfilled the criteria when operating on the bridge; Stockholm Street and Laboratories; and CBI (Cement och Betong Institutet - New name is RISE), were organizations involved to test and verify so the stipulated criteria were obtained from the scientific point of view.

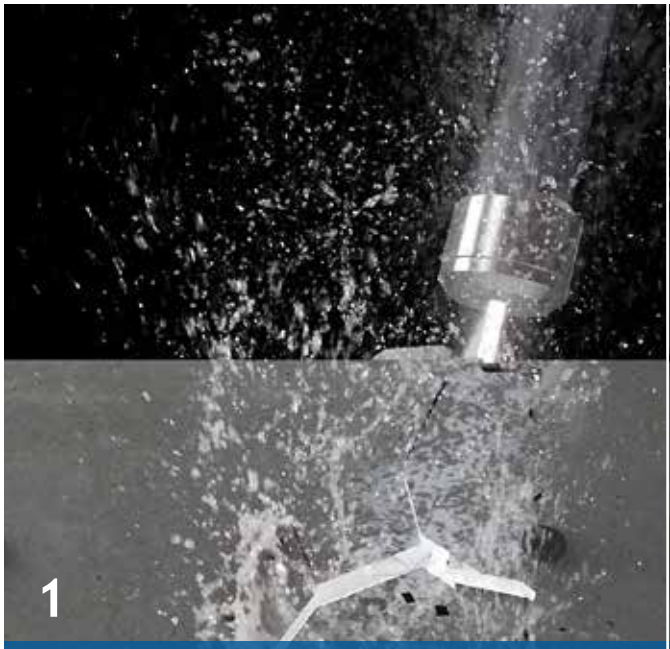
A new non-destructive method was invented.

A new process, hydrodemolition, was developed to remove the bad concrete without causing damage to the remaining concrete. In other words, it is a non-destructive method invented for the removal of damaged concrete mainly used on sensitive concrete structures. A simple semi-automatic prototype robot was built and used to proceed with testing on a bridge. Djuröbron, outside Stockholm, Sweden.

An early version of a hydrodemolition robot removing concrete at Pearl Harbour.

Robot in the early days operating at the Panama Canal.

4 How does this technology work?



The water jet penetrates existing cavities and cracks.

By exposing the concrete with the water jet for a certain time, you reach the desire depth.

By changing the angle, the remaining material under the rebar (the shadows) will be removed.

A perfect removed area of deteriated concrete which now is ready for a new layer of concrete.

The **high-pressure water jet** creates overpressure in the structure when it enters the concrete by using the permeability in the concrete. When the pressure exceeds the **tensile strength** of the concrete, then the concrete will be removed without causing any damage to the remaining structure.

Hydrodemolition - Selective removal - Robotic process

The water jet travels over the surface by means of a robot carrier at a constant speed and a pressure range of 1000-1600bar. The "low-pressure" hydrodemolition method has a selective effect on the concrete. This means that the poor and deteriorated concrete will be removed, and sound concrete will remain. The sides and the bottom of the cut will be rough because it follows the strength quality of the concrete.

Hydromilling - None-Selective removal or Controlled depth removal - Robotic process

The water jet travels over the surface by means of a robot carrier at a constant speed and a pressure range of 2000-3000bar. Higher pressure has more of a cutting effect on the concrete and the result will be more even both on the sides and in the bottom of the cut. It will remove what is set in the control system, regardless of the concrete quality consequently is it a non-selective removal.

Hydrodemolition - Concrete removal using high pressure, ~1000-1600bar.

Hydromilling - Concrete removal using high pressure, ~2000-3000bar.

Water jetting - Non-Selective removal - Manual operation

The water jet is a manual operation, the most common is 2000-3000bar. The operator is using a hand lance, mainly used on areas that are not accessible for the robot to reach. The maximum reaction force is 250N so this method is slow compared to the robotic process.

Hand lance operation is sometimes needed in confined areas where it is difficult to use a robot or the concrete quantity to be removed is limited.

5 Which are the applications of hydrodemolition?

Gold Gate Bridge in San Francisco, CA, USA Preparation of the concrete surface to enclose the entire pillar with a steel structure to strengthen the pillar as a safety precaution against the possibility of earthquakes that can occur in the region.

Hydrodemolition technology is almost strictly used for applications on sensitive structures. The robots used for removing the concrete can be used for the different surfaces described below as they are or modified with an attachment that can reach the surface needed to be removed.

Bridges

The bridge slab, side beams, pillars (round, square or rectangular), bridge joints, bridge bearings, and foundations for the structure.

Bridge joint being removed, Rebars remain intact, so it is easy to replace the joint.

Tunnels

The tunnel roof, the slab which is installed and exposed to deterioration, if it is a round tunnel done by a tunnel boring machine.

Robot is removing concrete, operating from a train wagon so the equipment can be moved fast in and out of the tunnel.

The Robot is removing the vertical surface along the tunnel.

Parking decks

The slabs at different levels, pillars, and access driveways.

Restoration of a car parking deck.

Robot removing the deteriorated concrete on a slab in a car parking.

Dams

The dam crest when dams are required to be increased, spillways, inlet to the turbine and inside the turbine when turbine replacement is needed.

The spillways were refurbished on the Gori dam in Venezuela. The equipment was operated from a movable platform.

Deteriorated concrete being removed by robot at Minab dam in Iran.

Ports

The slab, the front of the quay, underneath the quay and the pillars on which the quay is built are surfaces all subject to concrete removal when in bad shape.

Deteriorated concrete is being removed at the Port of Haifa, Israel.

Viking terminal in Stockholm being refurbished. One robot is removing the horizontal part and the other the vertical part of the quay.

Other applications

Airports, nuclear plants, dry docks, locks, canals, cooling towers, silos, light houses, etc.

Panama Canal in Panama Rail tracks for the locomotive, used to control the position of the ships in the canal, is being replaced. A robot is reaching out with its arm to be able to fast bring the arm to a position not to interfere with the locomotive when it passes the robot. The Canal was in full operation during the project.

6 What are the advantages of using hydrodemolition?

Internal restoration of a Silo in Spain.

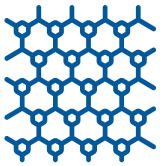
The advantages of using hydrodemolition from

- **The owner's point of view** are that they will get a structure that will last much longer before a repair is needed. The structure will also require a shorter repair period and will be operational earlier.

- **The consultant's point of view** are that they will suggest the best existing method on the market, and they will then increase their reputation on the market and probably receive more projects.

- **The contractor's point of view** are that they will be using hydrodemolition equipment to make sure that the owner gets the highest quality repair. Furthermore, it is ensured that they will not be exposed to warranty issues since the repair will be properly done.

Factors that contribute to these advantages



Structurally

- Low or no impact on the structure
- Rough surface
- No micro-cracks
- Cleans reinforcement (no rust or scale)
- Creates a superior bonding

Financially

- Increases productivity
- Less interference in the infrastructure
- Extends the life of the structure
- Cuts the cost for maintenance over time
- Safety and less labour

EWJI
European Water Jetting Institute

What is EWJI?

The European Water Jetting Institute, **EWJI**, was founded in 2013 to promote the water jetting industry and its applications in Europe, towards the highest standards of safety, professional integrity, and quality of service.

To achieve this mission, **EWJI** works to create and uphold a global network of professionals and information, including companies (contractors, manufacturers and asset owners) and associations, stakeholders and legislators, managers and workers… all of them working together to develop and share best practices, regulations and training.

EWJI encourages the sharing and exchange of knowledge, to foster the development of the water jetting techniques and applications, creating cross border opportunities and growth for the industry.

Objectives

1. To be involved in and have an impact on health and safety standards, best practices, training and legislation related to water jetting
2. To promote European regulations and reference documents on water jetting techniques, to improve the processes and ensure quality
3. To create a network for open communication and exchange among water jetting professionals, companies, associations and related stakeholders
4. To look after, promote and protect the interests of the water jetting industry in Europe
5. To exchange information on techniques, applications and working methods among the industry and with other related industries
6. To foster innovation, through research and cooperation between the industry and universities, and to facilitate the access to funding available for these purposes
7. To support the existing associations and foster the creation of new organizations in Europe, sharing the knowledge and best practices related with water jetting
8. To contact and cooperate with similar organizations in other parts of the world

Related publications

+ Publications

Specialised guides and other tools

Through the creation of specialised working groups, EWJI compiles and produces documentation on topics of interest to the industry, facilitating the dissemination of knowledge about this activity.

These publications are available in physical and digital format.

+ Yearbook

Every year, EWJI prepares a Yearbook to disseminate and promote best practices, new methods, and to foster exchange in the industry.

+ European Water Jetting Industry Report

The Industry Reports carried out by EWJI provide a better understanding of the market and give an overview of the trends in the industry in Europe.

The main objective of these studies is the collection of reference data, which are of high value for all professionals in the sector.

To find out more about EWJI publications, please visit the Library section:

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Have a voice in the future of the water jetting industry

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