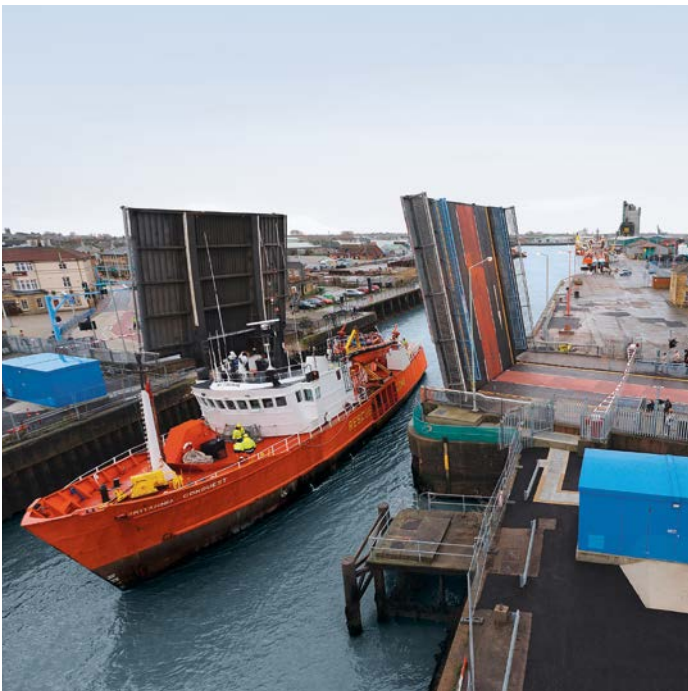


# System Solutions for Civil Engineering: Long-Life, Robust and Safe



# In Demand Worldwide

To protect human beings from the elemental forces of the water as well as to turn water power to ingenious account: Hydraulic Drive & Control technology in Civil Engineering supplies both. Hydraulics reach a great power density, compact dimensions, enormous robustness at low maintenance requirements and excellent controllability. For decades Bosch Rexroth has been building up comprehensive and international demanded knowhow in civil engineering solutions and therefore has become the leading supplier for hydraulic-solutions in every task of size and performance.



## ▲ Deriner Dam, Turkey

### 04 Water power

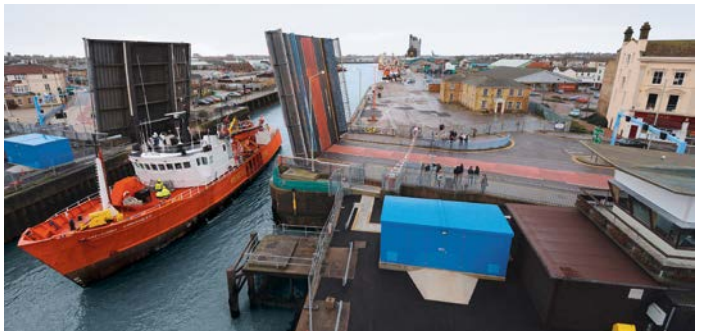
Worldwide power demand increases. The significance in gaining energy from water power is growing.

## ▼ Panama Canal, Panama

Photo ©ACP

### 10 Navigation

Ship locks and elevators provide an economical use of inland waterway transportation.



## ▲ Lowestoft Bridge, United Kingdom

### 16 Connection

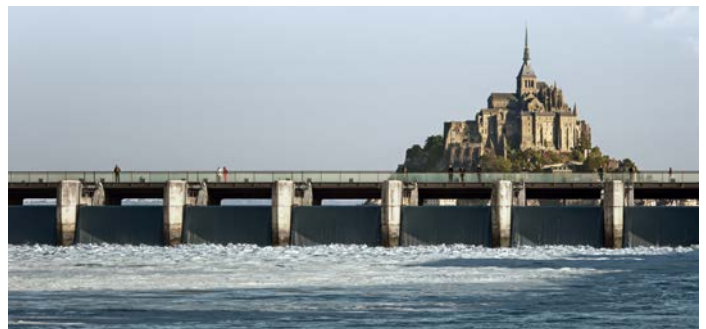
Bridges connect, they play an important role in modern transport and traffic systems and bring people closer together.

## ▼ Couesnon Barrier, France

Photo ©Thomas Jouanneau

### 19 Life

Flood barriers provide protection and open up new living space. Irrigation dams ensure effective water storage and distribution.



# System Partner for Turnkey Civil Engineering Solutions

Wherever a civil engineering project comes into being, we are the right partner on site. As a global player with a presence in over 80 countries, we always speak your language and know the local conditions. In this way, we give you access to our worldwide experience in a range of applications.

It is often the details that are decisive for success or failure: Is the structure exposed to a humid tropical climate or sub-polar cold? What does this mean for the drive system, what protection is needed? We can handle these details, because Rexroth has already realized all kinds of civil engineering projects in all climate zones and on all continents.

At the same time, we make cooperation easy: One contact person who coordinates all Rexroth activities and therefore assists you. Our sector management bundles our worldwide application experience, and produces customized solutions. Rexroth employees from your country or region maintain contact with you and are always nearby. Therefore, we also know the regional technical and regulatory requirements and comply with them. With our extensive range of services, we increase long-term availability with low maintenance costs.



▲ Radial spillway gates  
La Yesca Dam,  
Guadalajara, Mexico  
◀ Neckargemünd ship lock,  
Germany

## Rexroth drive solutions in civil engineering

- ▶ **Energy**      Dam equipment  
                    Water turbines
- ▶ **Navigation**    Locks  
                    Ship lifts
- ▶ **Connection**    Movable bridges  
                    Ferry ramps
- ▶ **Life**             Coastal protection  
                    Irrigation systems

## The Rexroth portfolio for turnkey system solutions

- ▶ Power units
- ▶ Cylinders
- ▶ Local pipework
- ▶ Electric control systems, including software
- ▶ Visualization
- ▶ Service, maintenance, repair, modernization
- ▶ Training



## Energy: Dams, Weirs and Turbines

Hydroelectric power stations are the world's most important source of renewable energies. Very high construction costs are offset by earnings over decades – provided the automation reliably and optimally regulates the water flow. This is exactly what Rexroth guarantees. With reliable automation components for turbine control and system solutions for overflow and outlet gates.

◀ Deriner Dam, Turkey, with open outlet gates

▶ Power unit for outlet gates



◀ **Outlet gate (orifice)**

Cylinder piston  $\varnothing$  900 mm  
 Cylinder rod  $\varnothing$  360 mm  
 Stroke 6,000 mm  
 Max. pulling and pushing force 12,000 kN

▼ **Flap gate at overflow**

Cylinder piston  $\varnothing$  560 mm  
 Cylinder rod  $\varnothing$  250 mm  
 Stroke 5,710 mm



Safety-relevant equipment, for example turbine Intake gate, has to be able to close at high speeds up to 20 m/min but also move smoothly to their end position.



◀ **Rogun Dam, Tajikistan, outlet drive**

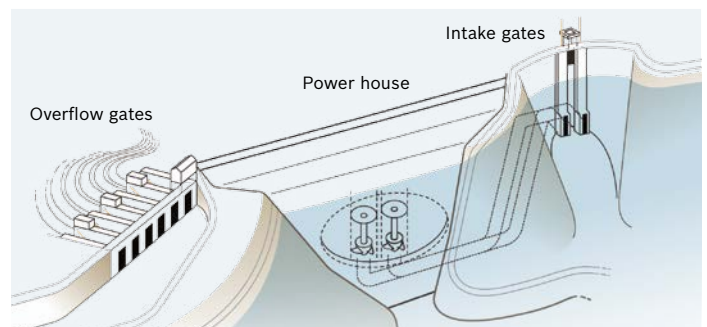
Cylinder piston  
 $\varnothing$  1,060 mm  
 Rod  $\varnothing$  450 mm  
 Stroke 7,600 mm  
 Max. pulling force  
 16,000 kN  
 Max. pushing force  
 12,000 kN

▶ **Nezahualcóyotl Dam (Malpaso), Chiapas, Mexico**

▼ **Deriner Dam, Turkey, overflow**



**Guri Dam, Venezuela, power unit**  
 Nominal size 5,700 l



In addition to the "classic" Bosch Rexroth drive solutions for civil engineering, a range of new solutions is constantly being implemented and developed. Hägglunds motors are an effective alternative here, for example for powering segment valves.

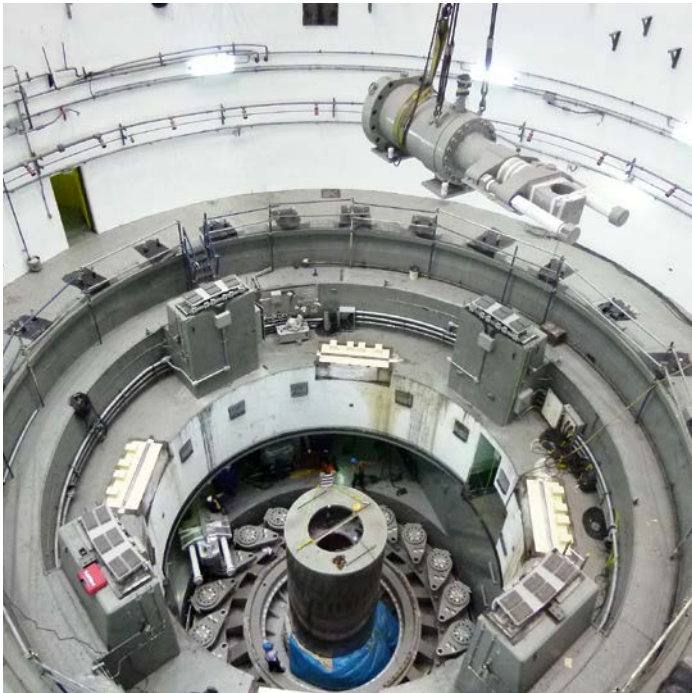


▲ **Movement of segment valves**

6 x Hägglunds motors  
CB840 and with brake  
BICA160

◀ **3 weather-proof housings including Hydraulic power unit and electrical control cabinet**

Optimum turbine output through automation: Turbine control requires high positioning accuracy, short response times as well as high dynamics. Regulation of the turbine guide wheel provides optimum efficiency and maximum operational safety. Using newly developed and specially adapted valve series, Bosch Rexroth power units guarantee high performance efficiency, compact design, and the maximum possible safety. With accumulator units hydraulic turbine regulation systems from Bosch Rexroth are perfectly tailored for every turbine construction requirements.

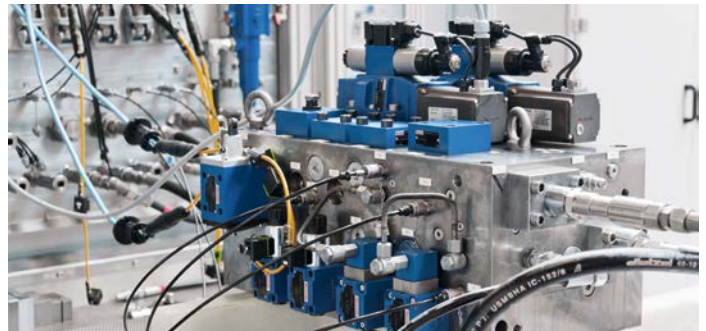


◀ **Turbine control cylinder, Guri Dam, Venezuela**

Cylinder piston Ø 950 mm  
Cylinder rod Ø 350 mm  
Stroke 960 mm

▶ **Guide vane servo motors, Sao Manoel, Brazil**

Cylinder piston Ø 520 mm  
Cylinder rod Ø 210 mm  
Stroke 885 mm



▲ **Manifold for turbine control on a test bench**

◀ **Turbine control power unit, Muskrat Falls, Canada**

Nominal size 24,800 l

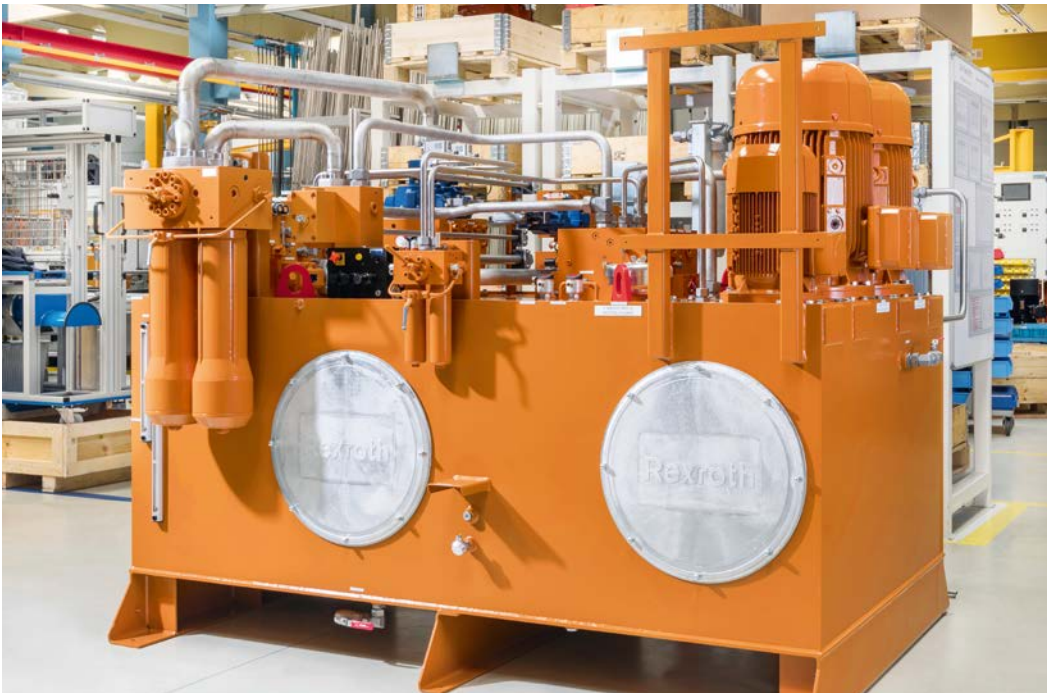


◀ **Xayaburi accumulator unit, Laos**

2 x 1,850 l hydraulic medium, 7 x 1,250 l N<sub>2</sub>

▶ **Accumulator unit, Shardarinskaya, Kasachstan**

400 l hydraulic medium  
800 l N<sub>2</sub>



▲ **Turbine control power unit, RADAG, Germany**  
Nominal size 3,200 l

◀ **Turbine control valves 4WRLE with sandwich plate**

▶ **Standard turbine control power unit**  
Nominal size 100 l





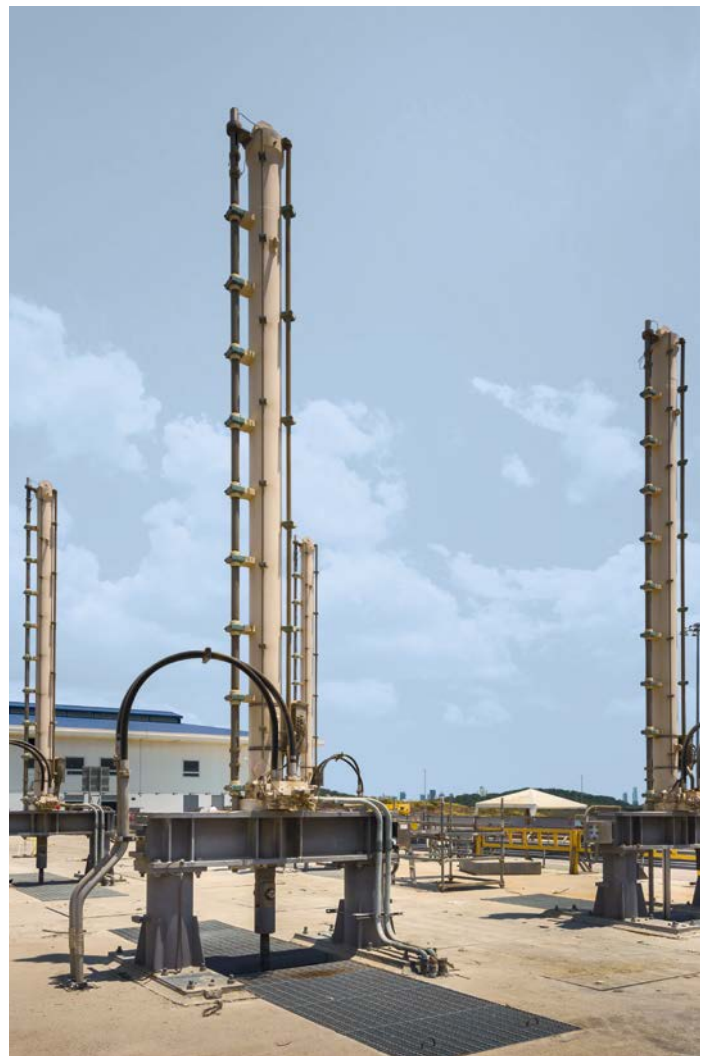
## Navigation: Locks and Canals

Locks and ship lifts make many waterways economically meaningful. Whether inland or for connection between seas and oceans, whether for modernizations or new constructions, large-scale projects, or single locks: Work together with the world's most successful system partner for the automation of lock systems. Profit from the experience and proven plug & play system solutions – from Rexroth.

### Water saving basins for the environment

The principle of water saving basins, developed in Germany with the collaboration of Rexroth, is being applied in increasing numbers of large-scale projects. Lock chambers are connected to the water saving basins by communicating pipes. Ships are raised by Rexroth drives opening corresponding feed pipes, and water from the saving basins gravity filling the lock chambers. As opposed to existing technology, the water flows back into the basins once lock operation has finished.

The result in figures, using the example of the Panama Canal: Despite considerably larger lock chambers, this technology reduces the fresh water consumption by sixty percent compared to the existing locks without this facility, thereby helping to conserve the regional water balance.



#### Panama Canal, Miraflores lock with saving basins:

- ▶ **Power unit with control system**
- ▶ **Saving basin closing drive** 72 x  
Cylinder piston Ø 220 mm  
Cylinder rod Ø 100 mm  
Stroke 6,700 mm  
Power unit 760 l
- ▶ **Equalization drive** 16 x  
Cylinder piston Ø 200 mm  
Cylinder rod Ø 70 mm  
Stroke 4,200 mm  
Power unit 570 l
- ▶ **Culvert drive** 64 x  
Cylinder piston Ø 260 mm  
Cylinder rod Ø 100 mm  
Stroke 6,700 mm  
Power unit 1,320 l





### Engineering partner for large-scale projects

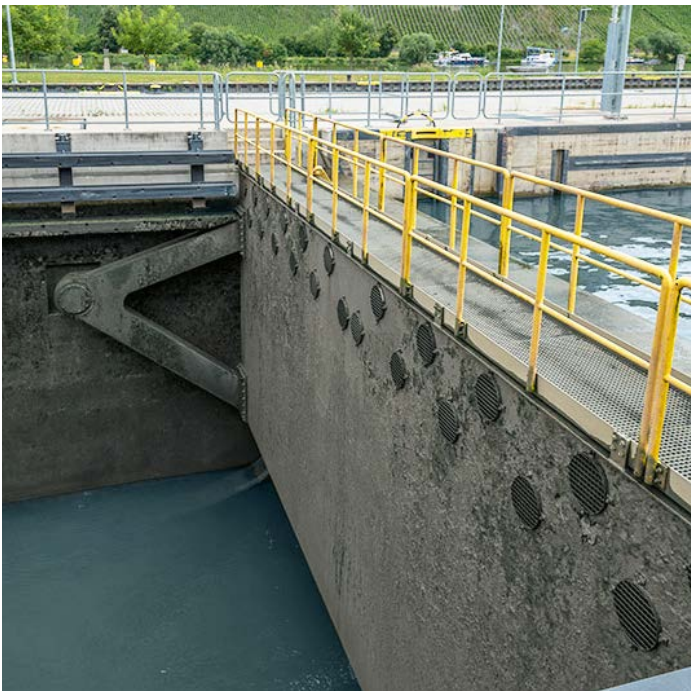
As the engineering partner for automation, Rexroth is able to take on the project planning, design, coordination, installation, and startup. We do this by bundling our resources as a global player. Specialists from different industries and technologies and from several continents work closely with their fellow experts on site. This means we relieve a considerable amount of strain on the client.

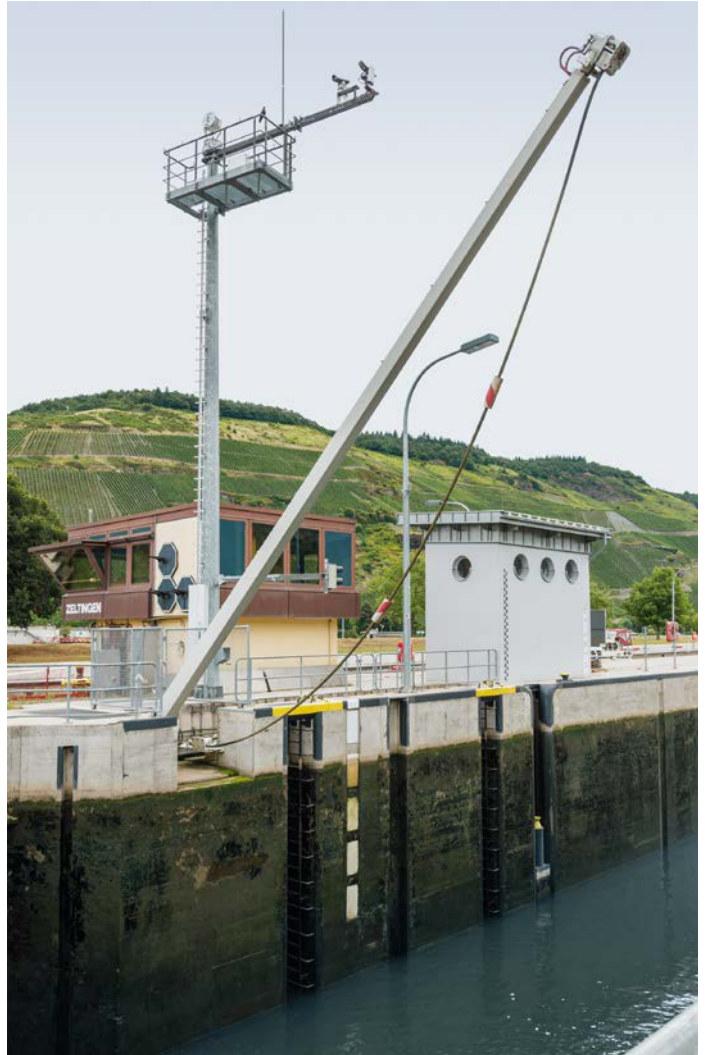
#### Mosel lock, Zeltingen, Germany:

##### ► Rising segment gate drive with locking mechanism

Cylinder piston  $\varnothing$  520 mm, Cylinder rod  $\varnothing$  280 mm, Stroke 2,200 mm

- ▼ Segment gate
- ▼ Segment gate drive unit
- ◀ Torsion drive





► **Ship arrestor**  
▼ **Boom cylinder**  
Piston Ø 200 mm,  
Rod Ø 125 mm,  
Stroke 1,100 mm





**Dortmund-Ems Canal,  
Münster lock, Germany**

◀ **Miter gate cylinder**

Cylinder piston  
Ø 200 mm  
Cylinder rod  
Ø 125 mm  
Stroke 2,200 mm

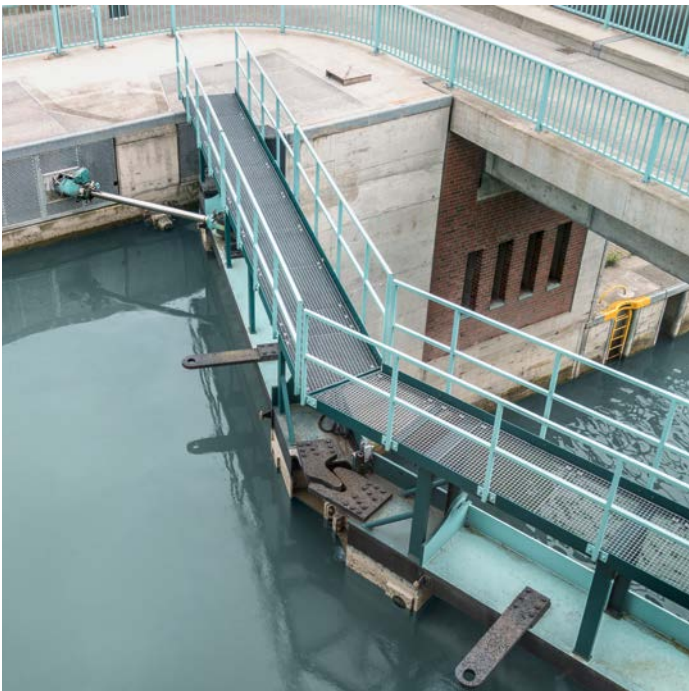
▼ **Miter gate drive**

▼ **Culvert drive**

Cylinder piston Ø 140 mm  
Cylinder rod Ø 80 mm  
Stroke 3,000 mm

▶ **Flap gate drive cylinder**

Cylinder piston Ø 180 mm  
Cylinder rod Ø 125 mm  
Stroke 8,100 mm







## Connection: Movable Bridges and Ferry Ramps

Movable bridges and ferry ramps create connections for overland routes and waterways. But they also place special requirements on the automation: It has to prevent damaging resonance vibrations on bridges and withstand storm waves for ferry ramps.

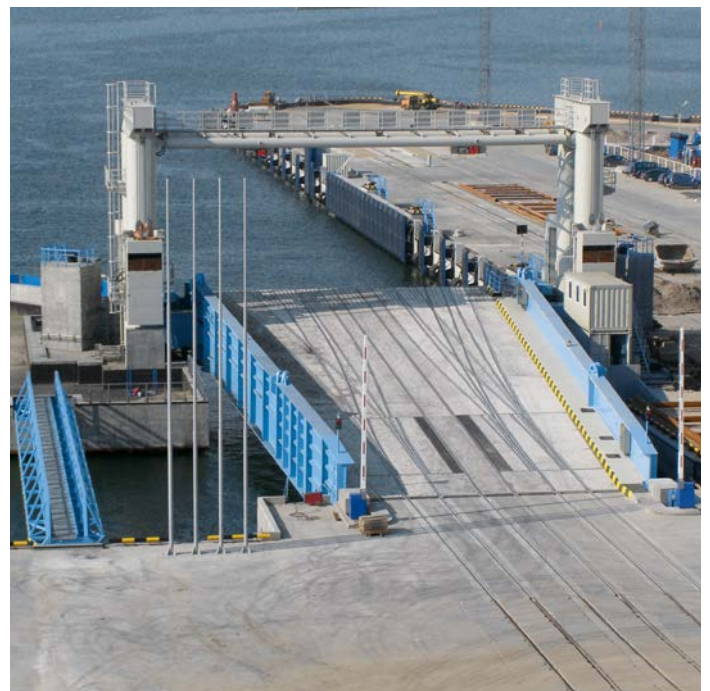


- ▲ Lift bridge, Oudenaarde, Belgium
- ◀ Bascule bridge, Lowestoft Bridge, United Kingdom
- ▶ Bascule bridge, Tower Bridge, London, United Kingdom
- ▼ Baltiysk ferry ramp, Russia



The roll-on/roll-off ramps, or RoRos, permit loading of trains and other vehicles onto ferries, as well as providing safe access for passengers. They actively compensate for the level of the water and the draught of the ferry when the load status changes. Rexroth has developed sophisticated calculation methods for this purpose, which permit predetermined loading operations regardless of the water level with minimal deviations.

Simulation programs developed by Rexroth not only incorporate the interaction of all drive technology components, but also other factors such as natural oscillations or axial forces caused by wind loads, currents, or extreme swells. These have allowed Rexroth to equip the world's first storm-proof (typhoon) ferry ramp. Results from simulations have enabled us to design the automation so that it has even withstood the strongest tropical storms over many years.

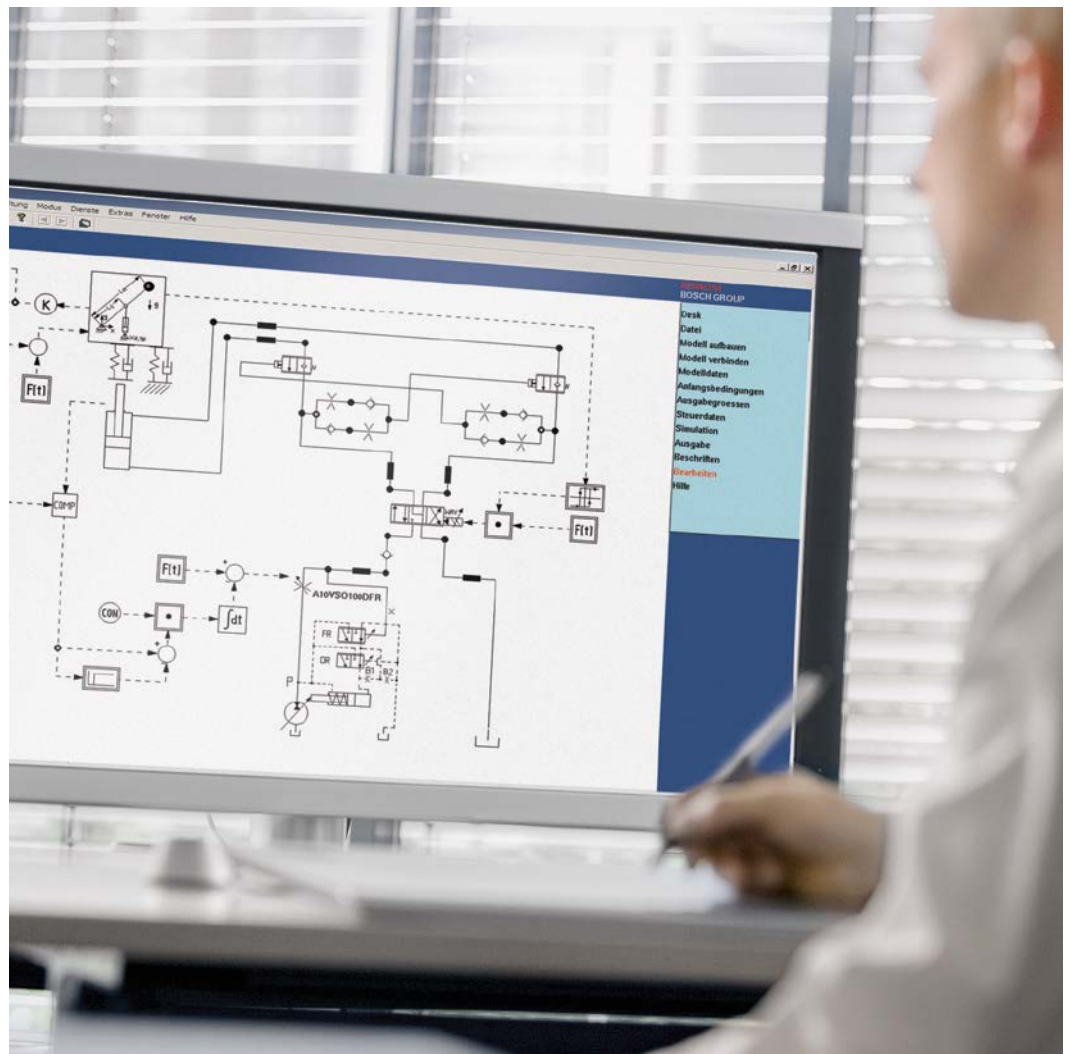


# Extra Efficiency and Safety: Simulation and Visualization

One result of increasing complexity is that the development process for civil engineering projects has to include feasibility studies, so that the correct systems and components are selected. Rexroth caters for this by providing simulations of integrated drive systems, and it evaluates them based on productivity, dynamic drive behavior, and efficiency optimization.



- ▲ Bascule bridge, Peenemünde, Germany, wind loads result in high demands on the stability of the drive technology
- ▶ Calculating the system behavior of a miter gate with the aid of simulation tools





## Life: Coastal Protection, Reservoirs and Irrigation Systems

Storm tides and the rise of the sea level pose huge challenges for coastal areas. Rexroth is the engineering partner for coastal protection with its unique experience in realization of a wide range of concepts.

Global climate change is increasingly demanding technical solutions such as barriers to protect the population from storm tides, for coastal protection as well as for control or effective distribution of large quantities of water.

Rexroth is a project partner that has already provided numerous movable barriers along the North Sea coasts and the Mediterranean. They keep the waterways free and usable for shipping, and they can build a protective barrier

when needed. Rexroth system solutions apply extremely high forces for this.

We are incorporating our decades of experience in automation of such systems into numerous ongoing projects. We accompany these projects worldwide from the first idea, through the conception and simulation, right up to realization. Operational reliability is our main focus.



▼ **Hartelkering tidal barrier,  
Netherlands**

▶ **Couesnon barrier,  
Le Mont-Saint-Michel,  
France**

Photo © Thomas Jouanneau



### **Irrigation systems for better living conditions**

Increasing numbers of people as well as agricultural areas in dry regions have to be reliably supplied with water. With its robust and easy to operate automation solutions, Rexroth ensures supply is reliable even over long distances.

▼ **Ouirgane drinking water  
reservoir, Morocco  
(in cooperation with  
AIC Métallurgie)**



# From component up to system solution

Are you looking for safety and cost effectiveness? Components and system solutions optimized for use in civil engineering have been proving their worth for decades on all continents in every imaginable application.

All civil engineering projects have one thing in common: They require extremely robust, powerful, and low-maintenance automation solutions. Rexroth offers you a globally unique product portfolio in this field. We clarify all interfaces, and in our system solutions we match components perfectly to each other.

Through continuous enhancements based on the world's largest number of installed large cylinders in civil engineering and offshore applications, Rexroth has developed the Enduroq industrial surface technology. It covers a wide spectrum of coating processes and material combinations that give ultimate corrosion resistance in every environment – for hydraulic and electromechanically powered cylinders.



## LHC – Large Hydraulic Cylinder

- ◀ Panama Canal
- ▼ Guri Dam

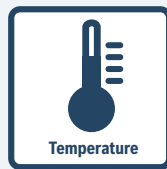




- ▲ Enduroq 2000/2200: Surface protection using HVOF technology
- ◀ Tribology
- ▶ CIMS – the position measurement system integrated directly in the cylinder



The five most important factors influencing the piston rods of large cylinders as well as the application areas for surface technologies in the context of the piston rod material



▼ Piston rod material	► Ambient conditions	▼ Surface technologies	Non or low corrosive indoor, protected area	Moderate corrosive, outdoor, protected area	High corrosive, outdoor, unprotected area	Very high to extreme corrosive, outdoor, unprotected area in saltwater environment
Carbon steel	Chromium	•				
Carbon steel	Nickel/chromium	•		•		
Stainless steel	Chromium	•		•	•	
Carbon steel	Enduroq 2000	•		•	•	
Carbon steel	Enduroq 2200	•		•	•	•

# One-Stop Supply: Skillful combination of expertise

As part of our continuous ongoing development and the increasing requirements for visual and digital monitoring to protect hydraulic drive systems, we combine reliable and tested Rexroth solutions with innovative systems from Bosch to provide an unbeatable concept from a single supplier. Using the Bosch video system for monitoring Rexroth miter gate drives on a lock is just one of many examples of how this cross-company cooperation can achieve excellent results.

When planning the video system, we take into account your individual requirements and the specific features of your location, as modern video systems are able to monitor numerous areas of a system using the integrated video sensor technology. The objective of this planning is to ensure that any incidents occurring can quickly be identified and analyzed by looking at just a few video images.

In addition to the usual directives and standards, Bosch Rexroth complies with other key requirements in terms of the safety requirements in civil engineering:

- ▶ State of the art video technology for observation of the waterway
- ▶ High-performance camera technology for monitoring critical areas
- ▶ Communication system for contact with waterway users (ELA)
- ▶ Fixed and mobile communication equipment for employees and ongoing service operations
- ▶ Integrated control center for operating and safety systems (with redundancy where required)
- ▶ Interfaces to process control technology

Targeted positioning of the video cameras also enables virtual inspection rounds to be performed, which reduces the workload for your safety personnel and can help to reduce costs.



# The Intelligent Standard Power Unit: Configurable, networked, energy efficient

Hydraulic power units for mechanical engineering are being subjected to higher requirements than ever before: They should be powerful, energy efficient, and quickly available, yet also intelligent, flexible, and of course, cost effective at the same time. With its new standard power units, Bosch Rexroth has come up with a convincing response to this challenge. Your entry into Industry 4.0?



A sophisticated standard power unit for all areas where hydraulic solutions are used, a pressure supply unit is required, and continuous safety technology monitoring is necessary – for example in control of water turbines.

### **Smart condition monitoring with Open Core Interface**

An extended sensor package and open interfaces provide the basis for web-based visualization of operating states and condition-based maintenance. The operating states of the individual components and the entire power unit are visualized directly by the ABPAC by evaluation of the sensor technology.

### **Increased modularization in mechanical engineering**

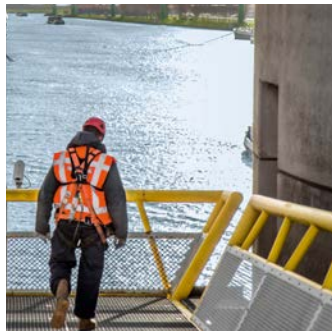
The compact IndraControl FM control hardware combines machine PLC, I/Os and an Open Core Interface for applications with Industry 4.0 capability and is specially designed for cabinet-free automation concepts.

IndraControl FM is positioned directly on or in the machine with no need for a control cabinet. This enables manufacturers to install and commission decentral intelligent modules completely independently of one another. Elimination of wear parts such as batteries and fans makes the controller maintenance free.



# Rexroth Service – Your key to higher productivity

Maximum equipment availability and high efficiency throughout the entire lifecycle of your machines and plants: These are key factors that determine the productivity of your production processes. Rexroth offers a comprehensive range of services to maximize your machine availability. You benefit from higher productivity.



Our modular service portfolio reduces the complexity and therefore the costs for maintaining and repairing your production equipment. We guarantee rapid availability of our qualified technicians. Thanks to our know-how in drive and control technology, we can meet your needs quickly and reliably. We ensure precise diagnosis and quick delivery of spare parts. At the same time, we minimize costs by using standardized processes and test procedures. Everything is carried out by highly qualified personnel in more than 80 countries around the world.

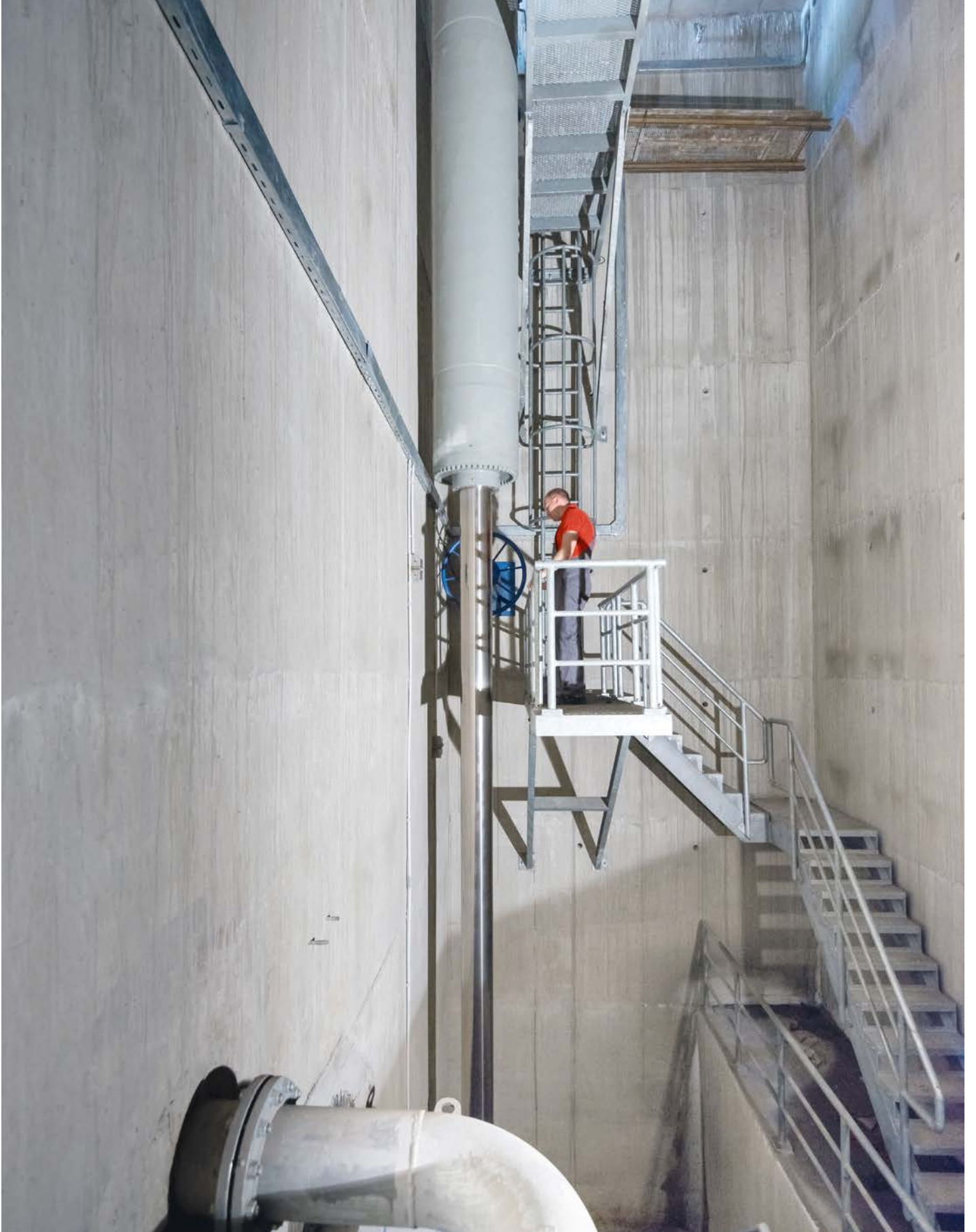


If required, we can keep your machines fit throughout their entire lifecycle with our preventive and predictive services, for example fitness checks and oil analysis. We work with you to analyze the potential of modernization/retrofit measures, and implement them in a practical manner. In summary, we combine higher productivity with better energy efficiency and optimum safety standards – significantly reducing your operating costs. Choose from our range of services – we offer you tailored solutions to meet your requirements.



Detailed information is available at:  
[www.boschrexroth.com/service](http://www.boschrexroth.com/service)





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