

# **StrafloMatrix™**

Chievo Dam - Italy



# Chievo Dam StrafloMatrix™

## Harnessing hydropower at a 19th century dam



In Verona's district of Chievo a dam and adjacent ship lock were built in the 19th century on the Adige River to establish the Camuzzoni canal. The abandoned ship lock downstream of the Chievo dam owned by Consorzio Canale Camuzzoni was modified to harvest the unused hydropower potential of the abandoned lock without compromising its flood discharge capabilities.

The core element of the Chievo dam HYDROMATRIX® plant is the steel-fabricated module, which is located at the downstream end of the lock. The bottom part is formed by five draft tubes arranged in one row. On top of the draft tubes, a submersible equipment gallery houses the hy-

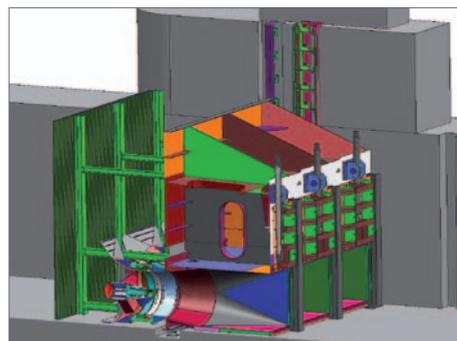
draulic power unit and the power cables. At the upstream end of the draft tubes five StrafloMatrix™ TG-units are arranged in one row. They can be separately switched on and off by opening or closing individual draft tube gates. The entire module can be lifted and lowered by a gantry hoist system under balanced conditions in order to evacuate the lock chamber prior to flood release.

By minimizing the amount of required civil work, the HYDROMATRIX® technology allowed the building of a hydropower plant with no negative impact on the beautiful historical site and surrounding recreational area.

The HYDROMATRIX® plant at Chievo dam in Verona was successfully commissioned in the fall of 2009 and meets the energy needs of around 10.000 households. In 2010 ANDRITZ HYDRO received the Austrian State Prize for Environmental and Energy Technology for this innovative project.

### Technical data:

<b>Unit Output:</b>	270 kW
<b>Voltage:</b>	690 V
<b>Head:</b>	3.8 m
<b>Speed:</b>	250 rpm
<b>Runner diameter:</b>	1,320 mm
<b>Number of units:</b>	5
<b>Average yearly prod.:</b>	12 GWh



# Chievo Dam StrafloMatrix™

## Development process & plant concept

The development of the project took about 5 years from the initial idea to the signing of the contract. Apart from the owner (Consorzio Canale Industriale Giulio Camuzzoni of Verona, Italy), the consultant Studio Frosio out of Brescia, Italy and ANDRITZ HYDRO were the key members of the development team. Inspired by the design of existing HYDROMATRIX® plants, Studio Frosio suggested to the dam owner to develop this

existing site using the same technology. Once the general plant concept was agreed, Consorzio Canale Camuzzoni went through the permitting process which took about 3 years.

One of the key challenges at the Chievo dam was the owner's requirement that the current flood discharge capacity of the lock had to be maintained. This require-



ment precluded the construction of any permanent hydropower components inside the lock. Another important aspect was the request to preserve the architectural appearance of the existing lock structure itself which included the civil structures along with the mechanical components such as the crane. Since the owner wanted to use existing buildings in the vicinity of the lock which offered very limited space for the electric switchgear equipment, a low voltage level had to be chosen to fit these components.

As part of the new construction project, the owner also decided to modernize the control system of the Chievo dam gates and adjacent Camuzzoni canal headworks.

A hydraulically operated trashrack cleaning machine is also provided to remove floating debris which collects in front of the vertical trashrack mounted onto the module.

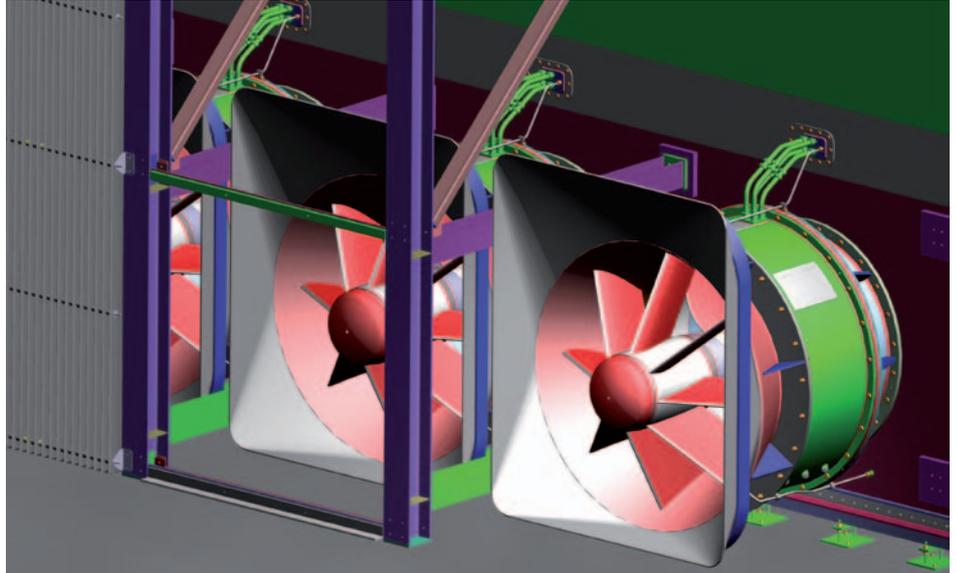
To improve the fish migration on the river Adige at the Chievo dam, the owner chose to construct a vertical slot fish bypass.

# Chievo Dam StrafloMatrix™ Turbine-Generator Units

Due to the space constraints at the Chievo dam project, ANDRITZ HYDRO chose to utilize StrafloMatrix™ turbines.

The StrafloMatrix is an axial straight-flow turbine, where the upstream and downstream reservoirs are connected by a straight tube. The synchronous permanent magnet generator rotor is placed directly on the periphery of the turbine runner. This results in a very compact arrangement and makes StrafloMatrix units consume less space. Not only are the StrafloMatrix units smaller than the conventional HYDROMATRIX turbines but also lighter and therefore offer significant advantages at locations with limited space.

Each unit consists of a distributor cone with integrated intake structure, the generator stator, the generator rotor and fixed propeller type runner forming one integral unit and the intermediate flange connecting the TG-unit to the module. ANDRITZ HYDRO employs state-of the art permanent magnet technology for the synchronous generators which can be easily connected to the local grid with no need for power factor compensation.



The turbine runner blades of the StrafloMatrix™ turbines are precision cast of corrosion resistant steel. After the blades have been welded to the runner hub, the yoke ring will be lowered over the turbine runner. The turbine runner is then welded onto the inner rim of the yoke ring. Once the welding process is completed the welding seams and turbine blades are ground to meet the standards for hydraulic turbines. The final step of the rotor manufacturing is the machining of the yoke ring's outer rim. The final assembly of the individual components of the turbine generator units takes place in ANDRITZ HYDRO's

own generator workshop in Weiz, Austria. To achieve a watertight generator assembly, rotor and stator are filled with a sealing and insulation compound.

**Main characteristics of StrafloMatrix™ TG-units:**

- Straight-flow fixed propeller turbine
- Oil sump-lubricated roller bearings
- Mechanical Face seal
- Permanent magnet generator rotor technology

# Chievo Dam StrafloMatrix™

## Electromechanical equipment

### Module steel structure

The core element of the Chievo dam HYDROMATRIX® plant is the module steel structure. It was fabricated using mild steel. Due to transport limitation the module was horizontally split into two parts, which were separately trucked to site.

The module's bottom part is formed by five draft tubes arranged in one row. The top part consists of a submersible equipment gallery which houses the hydraulic power unit for the draft tube gates as well as the power and control cables for the generators. Using one of the two manholes, the equipment gallery can be accessed for inspection. The intake trashrack structure is bolted to the upstream face of the module. The trashrack panels are made of a fibre-glass reinforced compound and feature a hydraulically optimized profile to minimize intake losses.

Prior to shipping the module was test assembled in the workshop. At site the two module parts were lowered into the lock using a mobile crane and subsequently welded together. The complete module was then moved under the hoist system using hydraulic jacks.

With a height of 6.4 m, a length of 6.2 m and spanning the 12.3 m wide Lock the fully assembled module weighs 180 metric tons.

### Electrical equipment

The core elements of the electrical equipment line-up are the low voltage generator switchgear and associated control and protection system. Our integrated automation system NEPTUN is used together with the PLC-type control hardware to allow fully automatic and remote operation of the entire power station.



The electrical equipment setup is completed by step-up transformers, high-voltage switchgear, and station service equipment. At the Chievo dam all these systems have been placed in two operation buildings located in close vicinity to the module. The power and control cables of the turbine generator units are run inside of the module gallery and are collectively routed to the landside generator switchgear using a flexible cable chain, cable trays and conduits.

### Auxiliaries

Only a few auxiliaries are required to operate the Chievo dam StrafloMatrix™

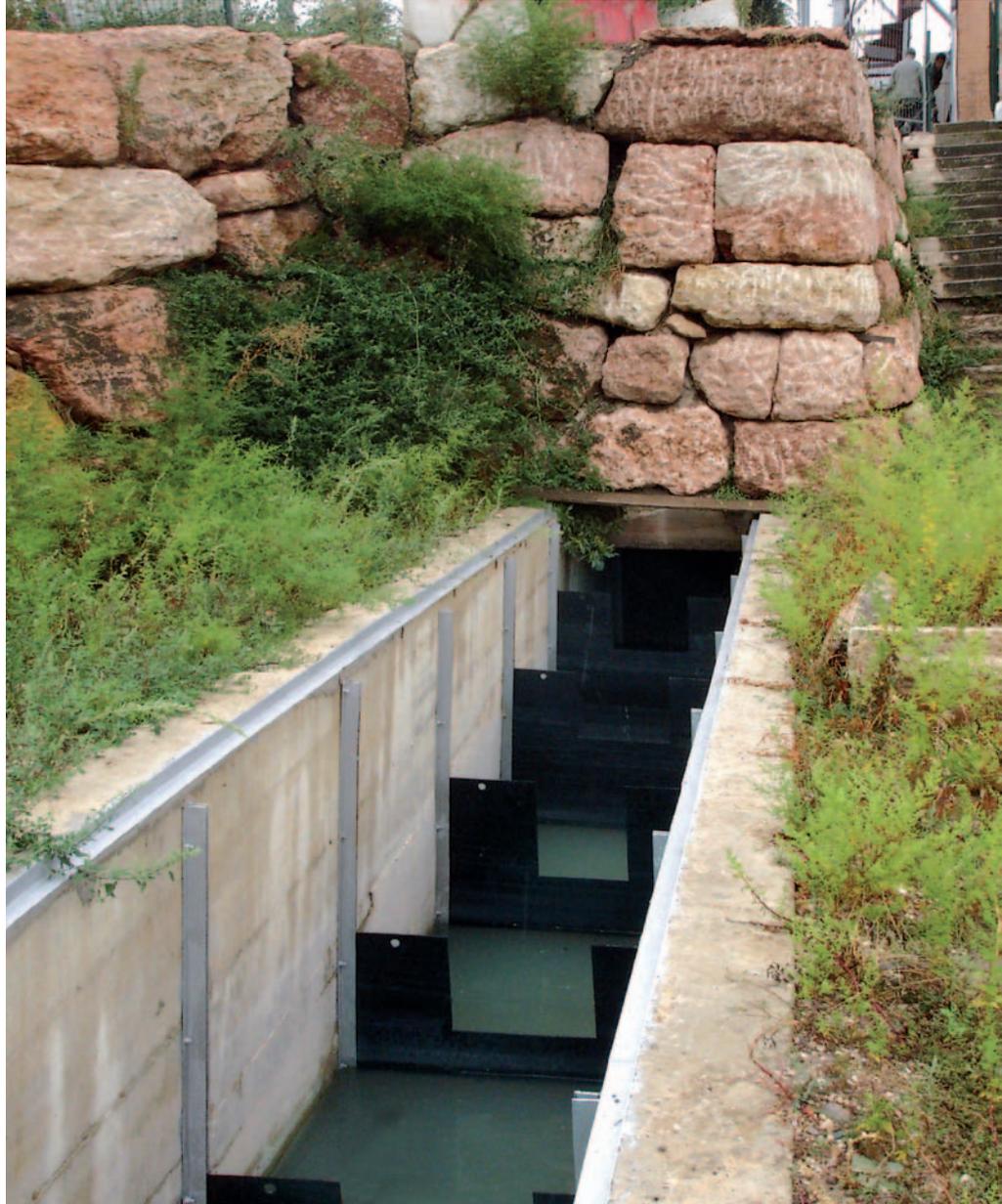
plant. The draft tube gates are operated via a hydraulic power unit which is located inside the equipment gallery of the module. For the initial installation and to allow later removal of the turbine generator units for maintenance purposes, a new hoist gantry crane and associated auxiliary hoist system was installed. It replaced the existing gate hoist and has a higher capacity while maintaining the historic appearance.

A hydraulically operated trashrack cleaning machine removes floating debris which collects in front of the vertical trashrack mounted onto the module.

# Chievo Dam StrafloMatrix™ Fish Bypass

While performing the modifications of the existing lock walls and sill area a fish bypass was constructed along the embankment of the existing lock using prefabricated concrete elements. The bypass is of the standard vertical slot design and runs partially underground. Four vertical access shafts allow service access to the bypass. On its upstream end the fish ladder is directly connected to the lock. The downstream end leads into the Adige river and is well separated from the tailrace of the hydropower plant.

With the intake trashrack, the fish ladder is an important element which enables fish migration and helps to mitigate the environmental impacts of the dam.



# Chievo Dam StrafloMatrix™

## Award of the Austrian State Prize 2010



ANDRITZ HYDRO received the Austrian State Prize 2010 for Environmental and Energy Technology for the Chievo dam HYDROMATRIX® Project.

Together with the other nominees in the categories environment & climate, energy & efficiency and research & innovation, ANDRITZ HYDRO was awarded at the State Prize Ceremony on February 4th, 2010 at the Palais Ferstel in Vienna.

The jury gave these reasons for awarding the prize:

“This form of hydroelectricity requires little intervention in nature, is flexible and broadly applicable and can also be put into operation in already existing hydroelectric sites. Andritz as the worlds leading supplier of Matrix-Turbines and a global player in the field of hydro power technology is of great importance for the competitive situation of the Austrian environmental technology industry and utilizes the HYDROMATRIX® technology to further strengthen its leading position.”



