Laying down caissons with millimetre precision is controlled under the supervision of Movicon 11 for the Mose project

The Mose caissons to house the flood gates were installed with millimetre precision using hi-tech engineering. With the help of Movicon, the result is assured.

MOSE (MOdulo Sperimentale Elettromeccanico) is the work of civil engineering within an environmental and hydraulic context that is still under construction. The aim of the MOSE project is to protect Venice and its lagoon basin from high tides, by building a row of mobile flap flood gate barriers placed at the mouth of the Lido, Malamocco and Chiogga ports (the inlets that connect the lagoon to the open sea). These storm surge barriers are used to isolate the Venice lagoon basin from the Adriatic sea in the event of high tides.
Mose together with other measures, such as coastal reinforcement and raising of quaysides and paving plus the re-modification of the lagoon, have been implemented to ensure that Venice and the lagoon basin are protected in the event of high tides as well as extreme tidal conditions: a project has been engineered to protect Venice and the lagoon basin from high tides up to 3 meters and is currently in operation for high tides exceeding 110 cm.
The Mose project consists of four barriers. Each barrier is composed of a row of 78 mobile flood gates which function independently from each other to temporarily separate the lagoon from the sea. To be more precise there are two barriers at the Lido inlets consisting of 21 flood gates across the north inlet and 20 flood gates across the south inlet. The other two barriers are connected to each other by an artificial and intermediating island; one barrier consists of 19 flood gates at

1. Venice inlet with threshold and shoulder casissons

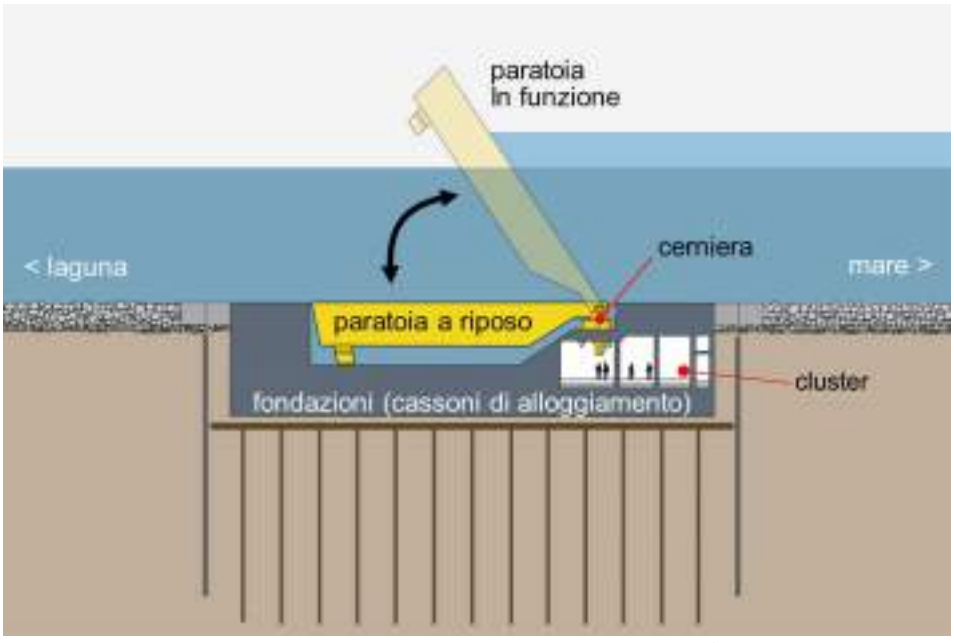
the inlet of Malamocco and the other consists of 18 floodgates at the inlet of Chiogga.

General Description

The mobile barriers are composed of a row of mobile flood gates that are metal box shape structures that in normal tidal conditions fill with water and rest housed horizontally within the caisson structure installed at the bottom on the seabed. Each floodgate is fixed to this structure with two hinges. The floodgates rotate upwards on the axis of their two hinges, until reaching the prefixed upright operation position when compressed air is injected into them to expel the water.
The flood gates then oscillate freely and independently with the motion of the waves. By exploiting this buoyancy the floodgates are able to maintain the difference in height between the lagoon and sea tides.

The threshold and shoulder caissons

The floodgates and the caissons are the two main components of the Mose system. The threshold caissons together with the shoulder caissons are concrete blocks that are positioned and partially embedded in trenches that are dredged below the seabed. These concrete blocks vary in size according to the length of the floodgates that they house and according to the depth of the inlet: this varies from



2. Floodgate cross-section

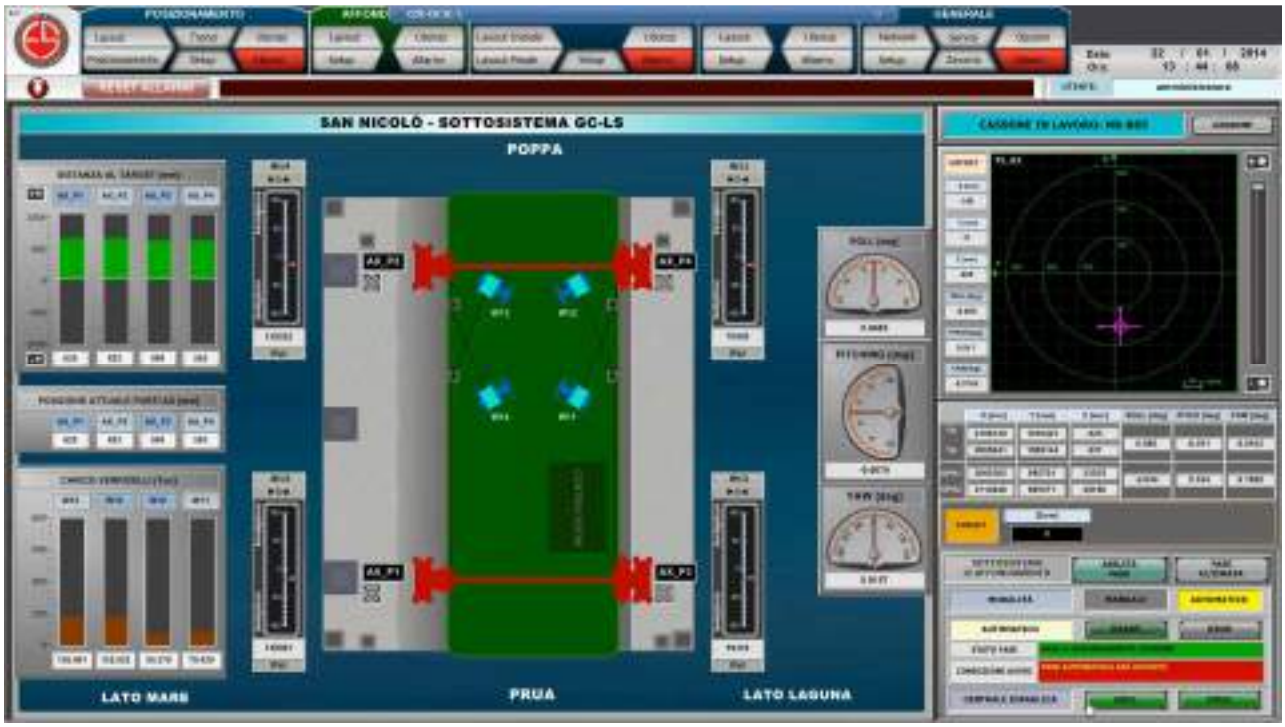
3. A threshold caisson

the smallest which are installed at the Lido inlet measuring 60mt x 36 mt x h 8,7mt to the biggest installed at Malamocco measuring 60mt x 48mt x h 11,55mt. The threshold caissons are aligned with each other to form the inlet flood barrier. The shoulder caissons create an interface between the threshold caissons and mainland to which they are anchored to. The caissons are prefabricated with clusters that are either filled with water and/or cement or left empty as access shafts for plant engineers and workers to carry out maintenance. The shoulder caissons are the most impressive structures of the barrier. For instance at Malamocco this structure reaches a height of 28 meters and covers an area surface of 60 meters by 24 meters which equals the size of three basketball courts.

System Description

Eureka System Srl, Movicon system integrators and Solution Providers, designed engineered and developed the automation control system for installing the caissons at the Lido, San Nicolo and Malamocco inlets. The client specified that Eureka Systems should find solutions to accommodate the following functions:

- Dynamic assembling of threshold caissons using winches
- lowering down of the threshold caissons into the seabed using hoists with stability control
- watertight placing of threshold caissons

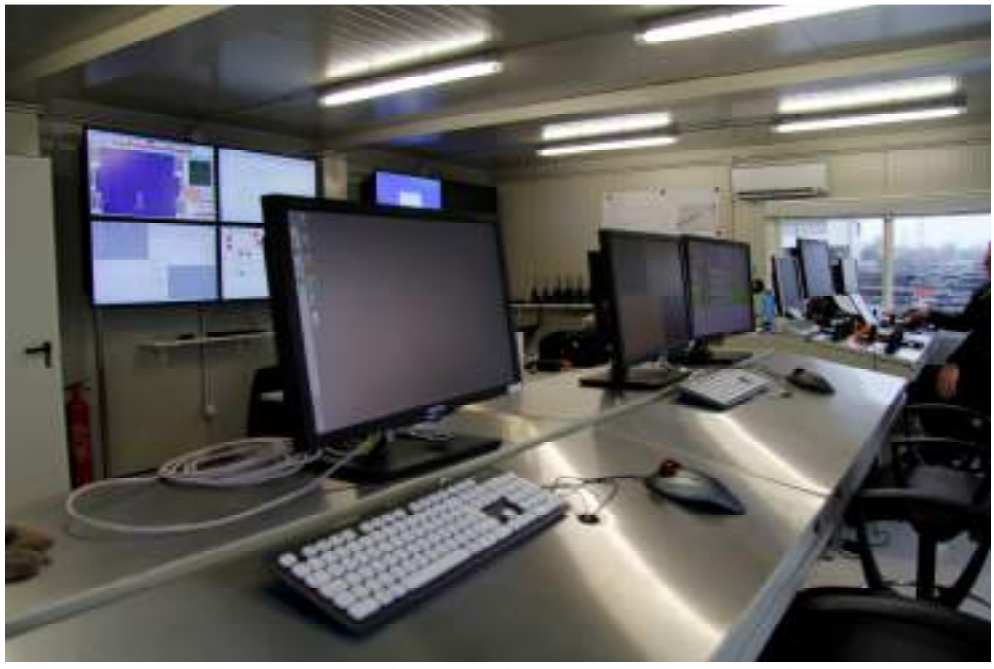


4. Movicon threshold cassion display screen

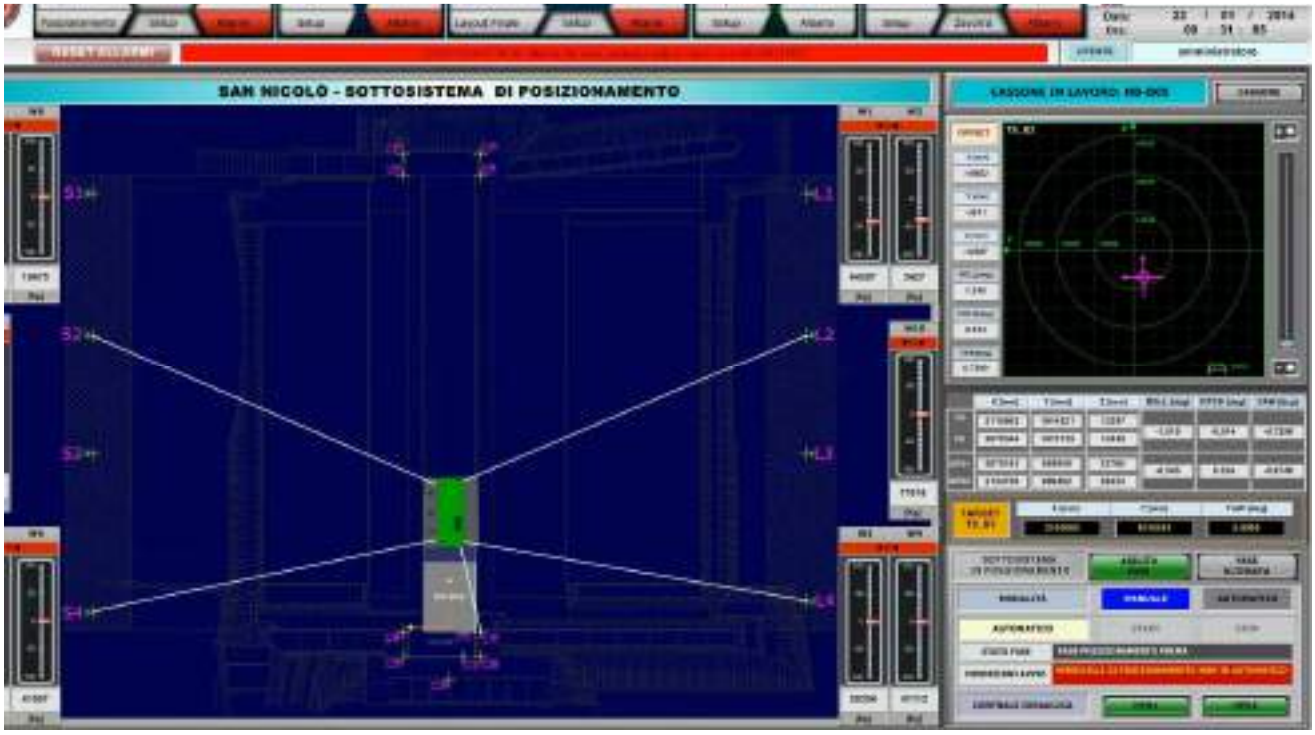
alongside each other with seal proof control - levelling of the two submerged shoulder caissons placed respectively at the beginning and end of the barrier with adjacent threshold caissons alignment.
In order to realize this application a very simple principle was used. The caissons are prefabricated concrete boxes which are empty or partially ballasted so that they can float and therefore be transported by tugboats.
Once reaching their designated position, the caissons are immersed and put through a series of operations in the subsequent ballasting phase according to their type, in this case shoulder or threshold during the for the Ballasting process.
The operations to transport the threshold caissons are simply performed using a tugboat which tows them into position where they are then immersed to rest on the seabed. Once this has been accomplished the Ballasting process begins. This is where the Movicon 11 supervision system enters into operation with the task to fill the various Clusters and to make sure that the caisson structure remains constantly level in the horizontal position. The immersion pontoon 2 dedicated to ballasting the threshold caissons is setup with battery operated silos that inject cement into the Clusters. The supervision system also controls the pontoon buoyance stability using the same principle applied for the ballasting process. The Pontoon is in fact equipped with ballasting tanks which are emptied and refilled according the buoyance variation registered on board the pontoon. Emptying and filling the silos with cement causes a significant variation in weight that in extreme weather conditions may cause the pontoon to capsize.

The operations to place the threshold caissons are more complex and are performed using Pontoon 1. These caissons also have clusters but are ballasted to a point where they are unable to float by themselves unless aided by their winch supports. These winches are used to lower the caissons without using the Ballasting technique. This method is used because the caissons have to be lowered and positioned with a precision tolerance of +/- 25mm. It is a tricky game of weight and balance played with caissons of enormous size and mass.
The true hi-tech engineering is seen in laying the next caisson where the positioning system is supervised in telemetry both aboard locally or in remote from the Treviso offices using Movicon 11. This system is called Dynamic Winch Positioning and it is the only one of its kind in Italy.

The system architecture
Eureka System has design engineered, developed and provided a control system for the two pontoons using a supervision solution based on the Movicon 11.4 SCADA. This solution uses 1 server and 3 clients installed on Hypervisor VMware Vsphere 5 + VMware con Horizon-View + Domain-Controller Win Server 2008 R2 64bit system and respective virtual machines with a 64 bit Win7Pro O.S.



4. Control Room with Movicon 11 screens displayed on video wall



6. Movicon screen showing graphics and parameters for caisson positioning

The pontoon 1 has the most complex system because it has been equipped with 5 local command and control HMI workstations based on Zero-Client Monitor connected to the Hypervisor using PCoIP protocol and 2 Video-Wall 2x2 matrix systems utilizing 46" display and supervision screens that screen mirror the HMI workstation screens that are connected using the lagoon Wi-Fi network. In addition this system can also be accessed by remote using VPN and through the internet using 4G phone cards.

Advantages gained in using this architecture

The virtualization of all the ICT infrastructure of the Control-Room has enabled the command and control system to be created with completely hardware-free front-end stations that can be managed centrally for Backup, System Upgrading, remote tele-assistance and UPS purposes.

Description of the final target as required by the client

Operations that are extremely critical to perform within a marine environment require great reliability, userfriendliness, detailed graphics and effectiveness at a glance, fast and in-depth diagnostics in problematic events with detailed data logging of all transactions.
The storm 'windows' for laying the caissons (22,000 tons in weight and 60x40x16 meters in size) were determined by the tidal conditions. In fact the lagoon of Venice is like a big basin that empties or fills up according to the weather conditions. This phenomenon can cause rather strong sea currents that have an impact on the walls of the caissons while being laid causing misalignment and imprecision positioning with adjacent caissons. Therefore the application has been designed to be Time-Critical and irreversible because once the caissons have been immersed in the water, the process to lay them cannot be aborted. "We decided to use Progea's Movicon 11 software, a product well known for its reliability, customization, Client-Server architecture in a virtue context and ultimately for its powerful graphical interface. It was adamant that the graphical representation techniques used had to be accurate and intuitive. The visual design was studied in every minute detail in order to combine both the right aesthetics and functionality of the graphics in the best possible way. Some of the process values are represented both in numeric and graphical

formats. In some cases we had to extend beyond the standard techniques used when it came to implementing graphics such as Bar-Graphs, Gauges and Trends. This we did by squeezing the most out of Movicon's flexibility to create a new dimension of screen graphics. The careful structuring of the MS-SQL database combined with the event management balanced out the load between the PLC and HMI which allowed us to historically log everything the customer required. This also satisfied the need to apply post-operation analysis on all the operations performed in a way similar to play back mode", commented Contò from Eureka System. He further added that "Thanks to the engineering marvel of the floating pontoon 1, the construction company's technicians can lay 22 thousand ton caissons 25 meters under water with millimetre precision by commanding each operation from the control cabin situated on the actual pontoon. The pontoon is in fact equipped with remote systems of every type linked to a computerized position sensing system that permits the technicians to know at which precise depth and position the caisson is being laid".

Eureka System Srl
Eros Contò