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MOSE PROJECT: STATE-OF-THE-ART AND FUTURE DEVELOPMENT

Giovanni Cecconi
Consorzio Venezia Nuova – Thetis SpA

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Eng.. Giovanni Cecconi Consorzio Venezia Nuova – Thetis SpA,
Castello 2737/f – 30122 Venice, Italy
+39 335 1379177

giovanni.cecconi@consorziovenezianuova.com

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THE PROBLEM. “ ACQUA ALTA”FLOODING

Since the beginning of the 1900s, high waters have becoming ever more frequent as the level of the land has dropped with respect to the sea. Flooding causes inconvenience for inhabitants and damage to architecture and buildings. There is also an ever present risk of a catastrophic event such as the 4 November 1966 flood when Venice, Chioggia and other areas in the lagoon were completely submerged.

| <i>Flooding above 140 cm since 1910</i> | <i>Increase in the frequency of high waters in Venice from 1910 to 2010 (number of events equal to or higher than 110 cm per decade)</i> |
|--|---|
| | N° of events |
| Cm | |
| 16 April 1936..... 147 | 1901- 1910..... 3 |
| 12 November 1951.....151 | 1911 - 1920..... 3 |
| 15 October 1960 145 | 1921- 1930..... 2 |
| 4 November 1966..... 194 | 1931- 1940..... 8 |
| 3 November 1968 144 | 1941 - 1950..... 6 |
| 17 February 1979..... 140 | 1951 - 1960..... 18 |
| 22 December 1979..... 166 | 1961 - 1970..... 29 |
| 1 February 1986..... 159 | 1971 - 1980..... 31 |
| 8 December 1992..... 142 | 1981 - 1990..... 28 |
| 6 November 2000 144 | 1991 - 2000..... 45 |
| 16 November 2002 147 | 2001 - 2010..... 64 |
| 1 December 2008..... 156 | 2011 - 2012 19 |
| 23 December 2009..... 144 | |
| 25 December 2009..... 145 | |
| 24 December 2010..... 144 | |
| 1 November 2012 143 | |
| 11 November 2012 149 | |
| 12 February 2013..... 143 | |

MOSE SYSTEM: WHAT IS MOSE AND HOW DOES IT WORK

The Mose System to safeguard Venice from high waters consists of mobile barriers able to temporarily separate the lagoon from the sea. It is being constructed at the lagoon inlets of Lido, Malamocco and Chioggia, the three openings in the barrier island through which tides propagate in the lagoon.

The mobile barriers consist of rows of 78 flap gates. In normal tidal conditions, the gates rest in caissons on the bed in the inlets, completely invisible and without modifying exchanges between sea and lagoon. During high waters, they are raised and prevent the tide from entering. At present, the tidal level at which the gates will be raised has been set at 110 cm, the level to which Venice has been protected by raising quaysides and paving. This means that the gates would be activated an average of 3/5 times per year for a period of 4/5 hours each time. However, the level at which the gates are raised can be changed whenever necessary. When the gates are in operation, the continuity of port operations will be guaranteed by a lock for large shipping at the Malamocco inlet.

The Mose system can protect the lagoon and its cities from tides of up to 3 m and will therefore be effective even if the level of the sea rises significantly during the next decades.

Mose is necessary today, but will become indispensable in the future given the expected rise in sea level. The phenomenon of high waters could, in fact, be further aggravated by sea level rise resulting from climate change. With regard to this problem, together with reinforcement of the entire coastline (already completed for 45 km), Mose has been designed on the basis of a precautionary criterion to cope with eustatism of up to 60 cm. Management of Mose is flexible enough to cope with an increase in high waters in various ways, depending on the characteristics and scale of the tidal event. Depending on the situation, the defence strategies can involve simultaneous closure of all three inlets in case of an exceptional event or alternatively and according to the winds, pressure and amplitude of the forecast tide, differentiated closure of the inlets, or again, partial closure of each inlet, as the gates are all independent.

Mose is the last and most important element in the plan of measures implemented by the Water Authority through the Consorzio Venezia Nuova to safeguard the lagoon area. Its construction has been preceded by a work programme unequalled anywhere in the world for the size of the area involved, nature of the problems and scale and characteristics of the measures implemented.

Examples already completed include defence from sea storms with reinforcement of 46 km of beach, protection of the ecosystem with securing of industrial dumps and canals at Porto Marghera (45 km) and restoration of lagoon habitats such as salt marshes and tidal flats (more than 1500 hectares).

MOSE SYSTEM: PROGRESS

Construction of Mose is part of an ecosystem restoration programme authorised on 3 April 2003 by the "Comitatone", responsible for the policy, coordination and control of activities to safeguard Venice, and is due to be completed in 2016.

The decision was taken with the collaboration of all levels of government (the State, the Veneto Region and the Local Authorities) at the end of a complex procedure during which Mose was compared with various alternatives and chosen and approved by the relevant technical control bodies and institutions. The contract between the Venice Water Authority and the Consorzio Venezia Nuova also introduced the "closed price" criterion. In other words, the contract with the State defines the schedule and costs in relation to a complex and definite flow of funding.

The total cost amounts to €5,500 million as, in addition to the cost of work at the lagoon inlets, it also includes the requirements of third parties (Europe, other authorities) in order to improve the lagoon morphology and integrate the new structures into the landscape.

Work sites

More than 75% of the work proceeding in parallel at all three inlets, Lido, Malamocco and Chioggia, has been completed. About 4000 people are currently involved in the construction of Mose, with 1000 employed at the lagoon inlets.

The work sites are organised to receive almost all material, plant and personnel by sea to avoid interfering with the fragile coastal areas.

The female elements and connector assembly are currently being installed in the housing structures and the caissons that will host the gates for the Lido north barrier have been launched and assembled into their final location in the seabed in the Lido Northern inlet channel of Treporti.

Next steps: 2013 - 2014

The first section of the Treporti row of mobile gates will be installed in May 2013 and made operational for testing.

In November 2013 the Lido South barrier will be launched and assembled in the seabed of the Lido San Nicolò inlet channel.

By the end of 2014 the whole barriers of lido inlet will be operational for effective closures, while the remaining two of Malamocco and Chioggia by December 2016.

Lido inlet

The coast on the north side of the inlet (Cavallino-Treporti) has been extended and reshaped with construction of a large small craft harbour consisting of two basins, vast areas of protected water allowing small craft and emergency vessels to shelter and transit through the lock when the gates are raised during a high water event, closing the channel providing access to the lagoon.

At the centre of the inlet, work has been completed on the new island which will act as the intermediate structure between the two rows of mobile gates, necessitated by the size of the inlet and presence of two channels of different depths. Work is now underway to construct service buildings and operational plant on the island. Work is also underway on the "abutment" structures for the two rows of gates.

Along the south side of the inlet (San Nicolò), the existing jetty has been enlarged to avoid siphoning and flow-over of water when the gates are raised to close the inlet. Work to construct the abutments for the row of gates to be installed in the south channel (San Nicolò) is also well advanced.

Work has been completed in both channels in this inlet to prepare the area where the gates will be installed and protect adjacent sections of seabed. Consolidation of the underlying seabed is also largely completed.

Outside the inlet, a 1000 m long curved breakwater has been completed.

Malamocco inlet

Outside the inlet, work has been completed to construct a 1,300 m long breakwater for protecting the entrance to the navigation lock for large ships heading for the port of Marghera. The lock will avoid all negative interference with port activities when the gates are in operation.

Alongside the lock, a temporary work site has been set up to construct the gate housing caissons for the rows of gates at Malamocco and Lido San Nicolò. At the end of construction, since November 2013, the housing structures will be launched using the Syncrolift system and transported to their final position in the seabed in the lagoon inlets.

The gate abutment structures are well advanced on both banks.

Preparation of the area of the inlet channel where the gates will be installed and consolidation of the underlying and nearby seabed has been completed.

Chioggia inlet

Outside the inlet, a 500 m long curved breakwater has been completed.

At the north side of the inlet, work is almost complete to construct a protected small craft harbour with a double lock to guarantee transit in the lagoon for a large number of fishing vessels when the gates are in operation during a high water event. The sea-side basin of the small craft harbour has been sealed and emptied of water for use as a temporary work site for construction of the gate housing caissons, currently in progress. The gate abutment structures are also at an advanced stage of completion.

Preparation of the area of the inlet channel where the mobile barriers will be installed and consolidation of the underlying and nearby seabed have been completed.

The hinges

Fundamental for operation of the defence system, the hinge connector system constrains the gates to the foundation structures, allows the raising and lowering movement and provides a functional connection with technical installations. Currently being fabricated, there will be a total of 156 hinge connector assemblies, two for each gate plus reserves.

LANDSCAPING OF THE NEW STRUCTURES

At the three inlets the new structures will be landscaped by the creation of naturalised areas, paths and other structures to enhance the new areas and make them accessible to Venetians and holidaymakers. Mose will become an integral part of the landscape between sea and lagoon. The remainder of the structure lying underwater will not disturb either the view or navigation. Invisible on the seabed, the gates will be ready to lift up and create the flood barriers needed to protect Venice.

MAINTENANCE AND MANAGEMENT. VENICE ARSENALE

In 2006, concession of 125,000 square metres of the state owned part of the north Arsenale to the Consorzio Venezia Nuova established one of the most important productive sites for this area associated with management, control, operation and maintenance of the Mose system, but also connected monitoring and functional maintenance of the lagoon ecosystem.

For Venice and the Arsenale, these activities represent a major strategic opportunity in connection with the organisation of top level professionalism, confirming and amplifying the employment development already begun with the work underway to construct Mose.

Reconversion of the North Arsenale to house research and production activities is destined to have highly important repercussions on the economy of the entire historic city and the area as a whole, reversing the trend of the current recession.

AUTHORITIES INVOLVED

The Venice Water Authority is a branch of the Ministry of Infrastructure and Transport. Its responsibilities include activities to safeguard Venice and its lagoon according to the Special Law for Venice.

Implementation of the measures is delegated to a single body able to operate according to a systemic vision of the lagoon ecosystem, with a global project integrating protection from high waters with restoration of the biostructuring habitat of the lagoon. The implementing body is the Consorzio Venezia Nuova consisting of national and local Italian companies and working under the surveillance of the Water Authority.

Work began on the Plan of Interventions more than 25 years ago and 85% is now complete.

Mose is a fundamental element in the plan of interventions to safeguard the lagoon: protect against sea storms and safeguard the ecosystem, with securing of dumps and industrial canals in Porto Marghera and restoration of typical habitats such as salt marshes and tidal flats.



Fig.1 Yearly flooding of San Marco Square.

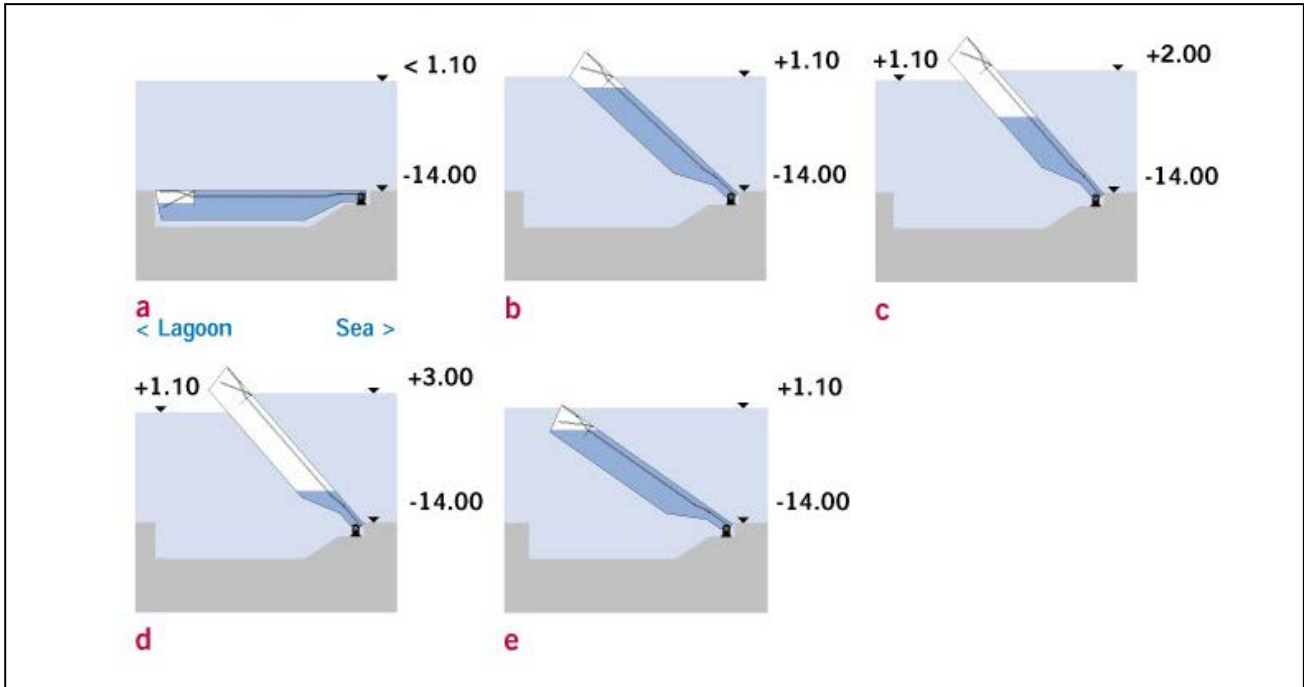


Fig. 2 Mose buoyant Flap gate.

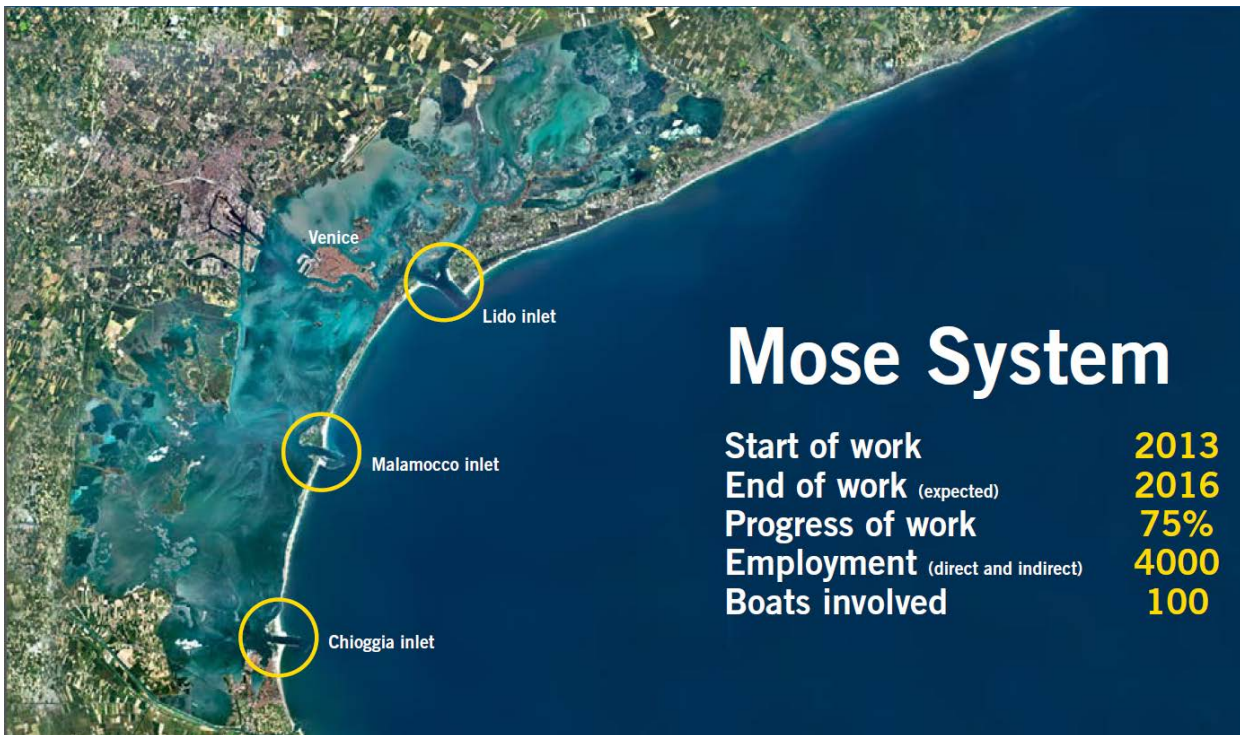


Fig. 3 A total of 78 flap gates for temporary closure of the 3 tidal inlets.



Fig.4 Installation of foundation caissons at Northern lido inlet, June 2012.

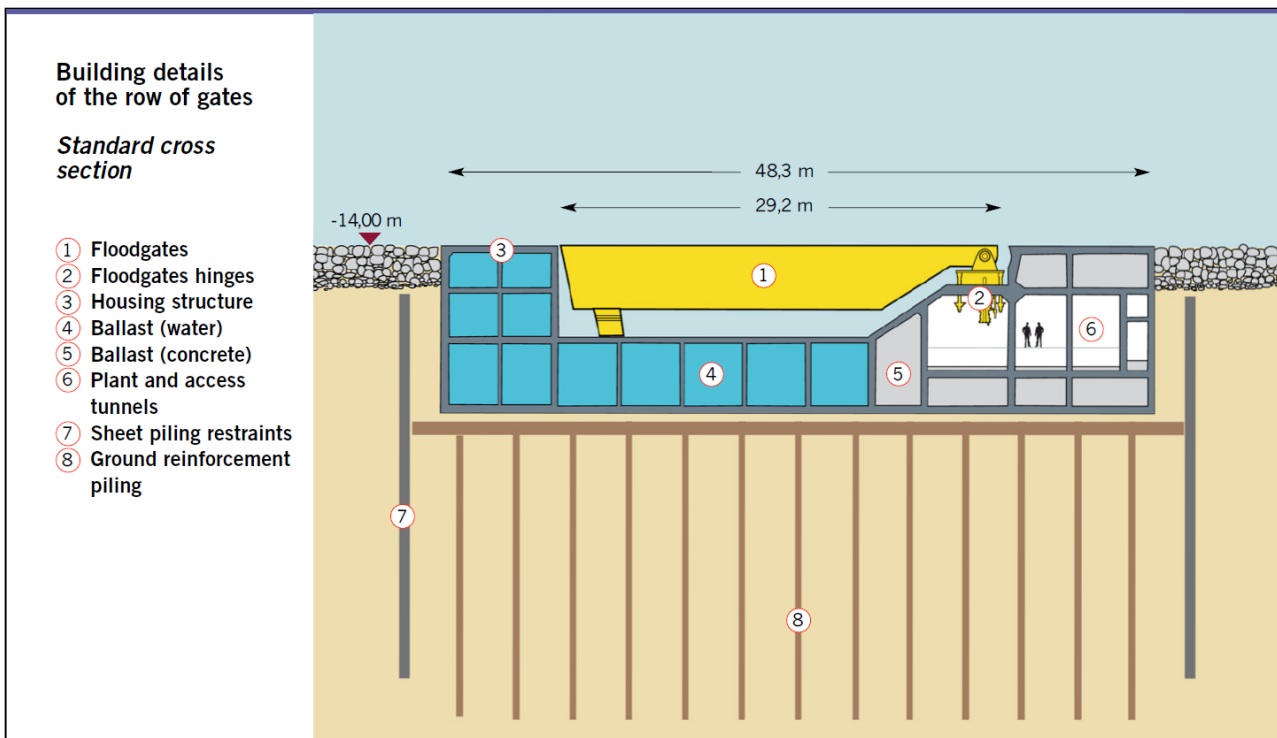


Fig. 5 Flap gate installation on foundation caissons and soil compaction.