MARINE EROSION PROTECTION  
Product: Ballasted Filter Mattress

Problem
Venice has always drawn its unique character from its surrounding waters and it will continue to do so. Being Venetian has always meant being part of this "water city", living with and enjoying the positive aspects whilst confronting specific problems.

Amongst Venice's most evident problems are those related to the particular nature of the transport, the waterborne traffic and the inconvenience caused by the acqua alta (literally, "the high water").

Since the beginning of the 1900s, high waters have become more frequent and intense. The common image of Venice "sinking" reflects a real problem. The lagoon area floods ever more frequently because the relationship between water and land has been profoundly modified, particularly during the last hundred years.

Solution
To provide complete protection for all built-up areas in the lagoon from high waters of all levels, an integrated system of various measures (the MO.S.E. System - Modulo Sperimentale Elettromeccanico - Electromechanical Experimental Module) has been developed. This includes rows of gates to be installed at the lagoon inlets able to isolate the lagoon from the sea during high tides above the established level and construction of breakwaters outside the inlets designed to attenuate the level of the most frequent tides.

At the heart of the system are rows of gates installed on the seabed in the three inlet channels, housed in a line of caissons. When not in operation, the gates are full of water and rest in the caissons on the bed. When a tide higher than the safeguard level is forecast, compressed air is introduced into the gates, expelling the water. As the water is expelled from the gates, they rotate around the axis of their hinge, until they emerge and block the tidal flow entering the lagoon. Once there, the gates remain in position until the tidal event has passed.
In order to protect the gates and caissons from erosion of the lagoon bed caused by tides and vessel movements in the lagoon, rockfill protection was designed to maintain the sea bed level. Fundamental to the success of this solution is the stability of the rock erosion protection on the sea bed. The project designers required a filter layer which would not only guarantee the hydraulic performance required, but also was heavy enough to keep the filter in contact with the sea bed at all times and in all sea conditions. In this way, instability of the seabed and potential damage to the operation of the flood gates, is avoided.

The Maccaferri Venice Project Consortium (Adanti S.p.A, Officine Maccaferri Group and Sarti S.p.A) developed a system for the production of a unique Ballasted Filter Mattress (BFM), and a launching system to meet the client’s demands, in lengths to seamlessly protect the entire width of the lagoon inlets (from 130-200m long).

The BFM of thickness 4-5cm, consists of:
- Industrial polypropylene geomat reinforced with double twist PVC coated steel wire mesh
- Granular ballast filler material
- Tough geotextile filter layers, above and below the reinforced ballast core
- Riveted fixing system to connect the BFM layers

A bespoke dockside BFM assembly yard was set up. In addition marine work-vessels were specifically adapted to accept and deploy the large rolls of BFM onto the sea bed.

The installation of the large mattresses (10 m wide) at a depth of 13 - 18 metres, is achieved by means of a complex and innovative integrated system of packaging, transport and unrolling of the individual elements on the sea bed. Each individual mattress is wound around floating drums and delivered to a launch pontoon. Using anchored winch and winding systems on the launch pontoon, individually controlled by satellite GPS, the rolls are deployed into the works to within very accurate tolerances at the seabed.

The correct positioning of the mattresses is checked not only by on-board control equipment, but also by physical underwater inspections, to confirm the structural soundness and positioning of the mattresses.

Throughout this demanding and unique project, The Maccaferri Venice Project Consortium proved their innovation, expertise and entrepreneurialism in solving and achieving their client’s demands to help secure the Venice World Heritage Site from future inundation.