



Anse du Portier

Principality of Monaco



**Elliptical
Jet Grouting**

Owner :

S.A.M. L'ANSE DU PORTIER

Main Contractor :

Bouygues Travaux Publics

Duration of works:

2019 - 2020

Project description

With its tree-lined boulevards and overlooking the deep blue waters of the Mediterranean Sea, the **Principality of Monaco is the smallest city-state in the world after Vatican City.**

Its particularly advantageous taxation policy (*income tax was abolished in 1869*) has attracted many wealthy people and it is now estimated that almost a third of its residents have millionaire assets. It is estimated that 70% of its population is of foreign origin, while only 10,000 residents are true Monegasques.

The Principality currently has a surface area of around 200 hectares, of which almost 100 were reclaimed from the sea in past years under Prince Rainier III, nicknamed the 'Prince Builder', so it is easy to see that the population density

Throughout the construction, a team of independent scientists and technicians will ensure the constant monitoring of water quality in the areas surrounding the site. Although it is a completely artificial extension, the project envisages the creation of a Mediterranean landscape with tall pine trees and other native vegetation to *"give the feeling that the buildings are immersed in a natural environment"*.

The architectural solutions adopted for the roofs of the buildings will protect them from the sun in summer and help recover heat in winter. Forty per cent of the district's energy needs will be provided by solar panels and pumps using sea water to heat and cool the buildings.

The topography of the extension will reflect the development of Monaco, with structures gradually rising in height from low villas



is particularly high.

Continuing the expansive tradition, Prince Albert II, currently reigning, has given the green light for a new **"urban extension project by the sea"** that will accommodate up to 1,000 residents with housing solutions consisting of both luxurious villas and flats. The new neighbourhood will be completed with a park, public facilities, a car park, a seafront with pedestrian quays, a landscaped park, a promenade and a Japanese garden. There will also be a small marina.

The name of this extension to the sea is **Anse du Portier**, and it has been **conceived and designed by the Renzo Piano Building Workshop** and will certainly change the face of the Principality.

Anse du Portier is designed for complete integration into the existing coastal landscape, and the architectural solution adopted respects and maintains the natural flow of the current along the coast.

to imposing buildings, mirroring the principality's evolution from a fishing paradise to a luxurious holiday resort.

"Bouygues Travaux Publics" has completed the perimeter maritime structures and the filling in of the area, the first step in the city's six-hectare expansion into the sea. This maritime infrastructure consists of a volume enclosed by a band of **18 trapezoidal reinforced concrete caissons** that will serve as a base for the construction of the new eco-neighbourhood.

The caissons, 26 metres high and weighing 10,000 tonnes each (*22,000 tonnes once ballasted*), are intended to form a dam **to protect against waves up to 9 metres above sea level.** Both the new volume built, and the caissons were filled with aggregates from Italy and France; this material will form the artificial ground on which the construction of buildings can begin.

Fondations

The construction of the buildings required the preliminary consolidation of the seabed soils. In fact, part of the marine sediments on which the works are carried out can be subject to the phenomenon of liquefaction in case of earthquake.

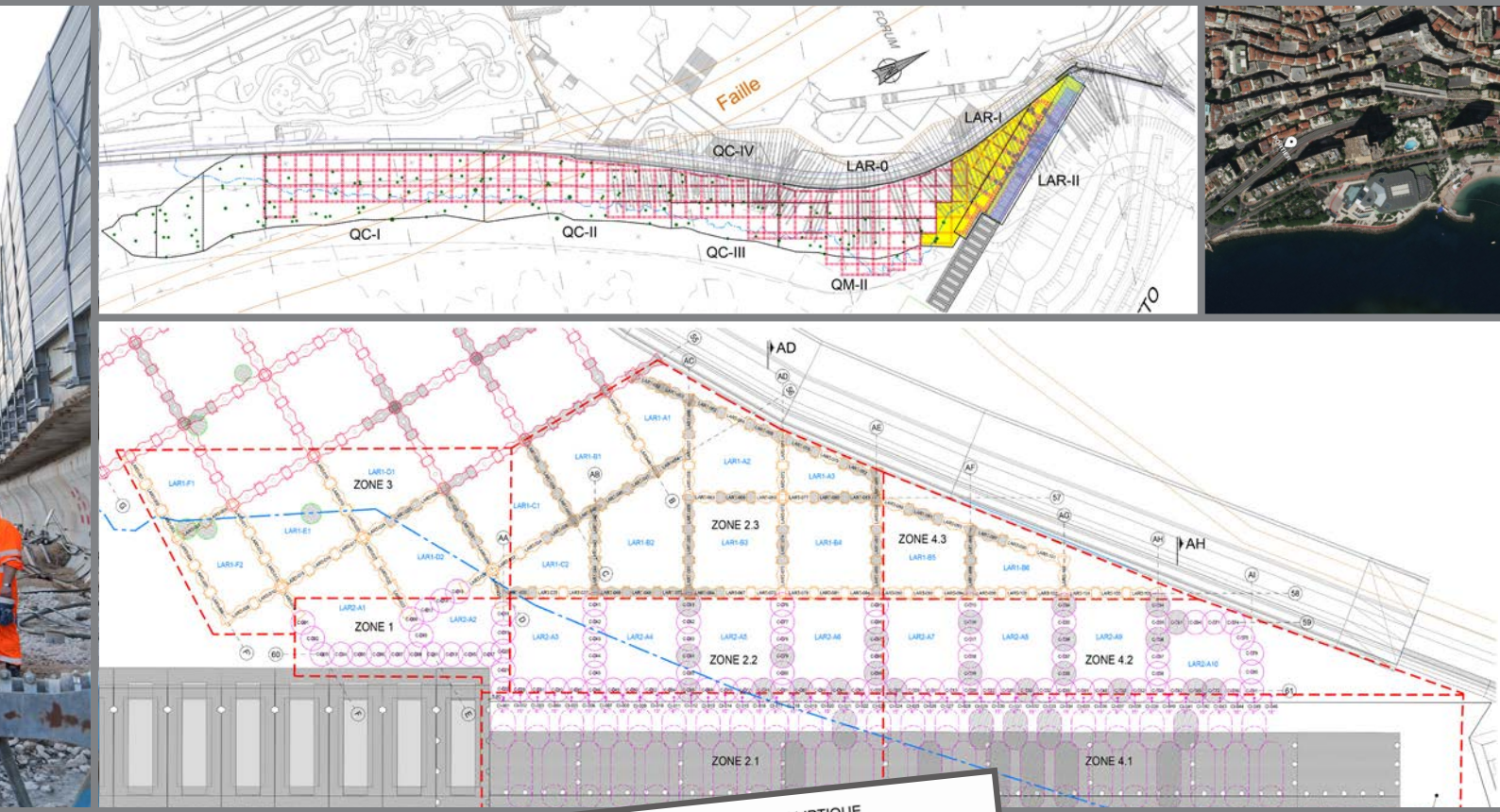
For this purpose, the following two types of intervention were adopted:

- **Soil compaction by vibro-replacement columns:** this type of intervention, which reduces the voids index, densifying the soil increase its resistance to seismic cycling stresses that could induce liquefaction.
- Construction of a **structural cellular grid**, made up of elements of soil treated with **jet grouting technology**: with this

The intervention covered a strip of coastline approximately 250 metres long and 30 metres wide, located near the existing breakwater wall. In the **north-eastern area** of the platform, where the soil treatment was close to the coastline of the Larvotto marine reserve, circular jet grouting columns were constructed using **single fluid technology** in order to prevent the pollution of the seabed potentially induced by the execution of the high energy double fluid treatment.

The entire process of creating the anti-liquefaction cells involved the execution of more than 1,330 jet grouting columns, for a total of over 24,500 m³ of treated soil.

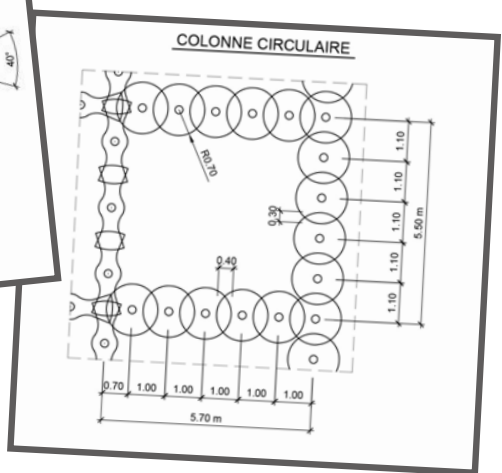
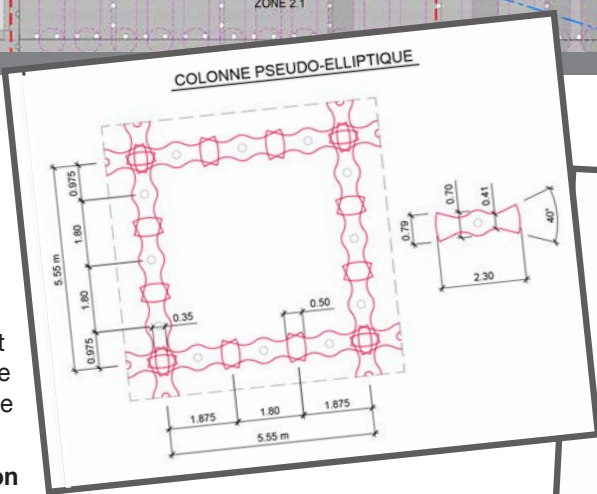
Thanks to this consolidation work, it will be possible to build the foundation piles for the district's structures and minimise the risks of soil liquefaction and buildings damage in the event of an earthquake.

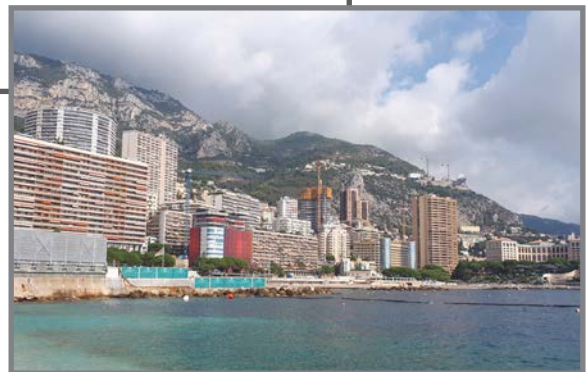
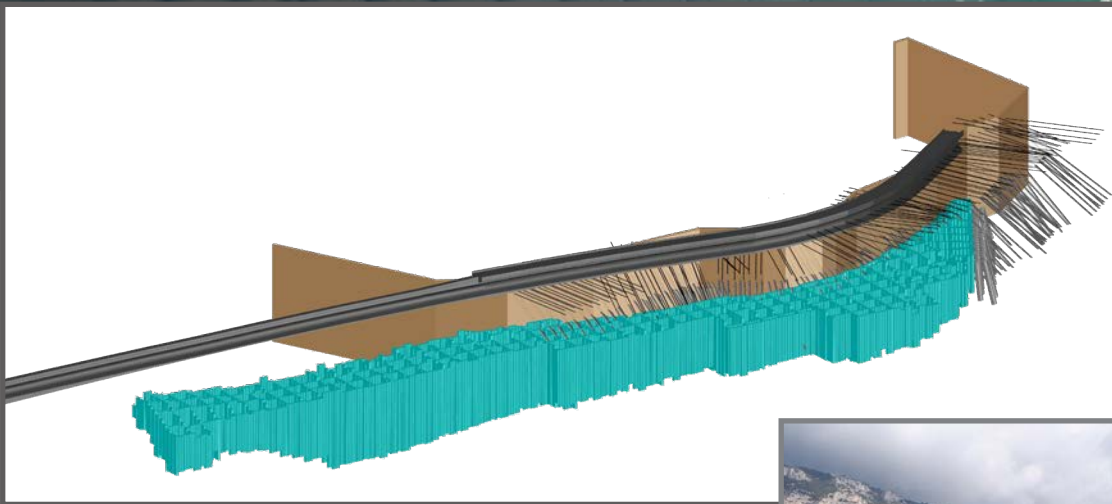
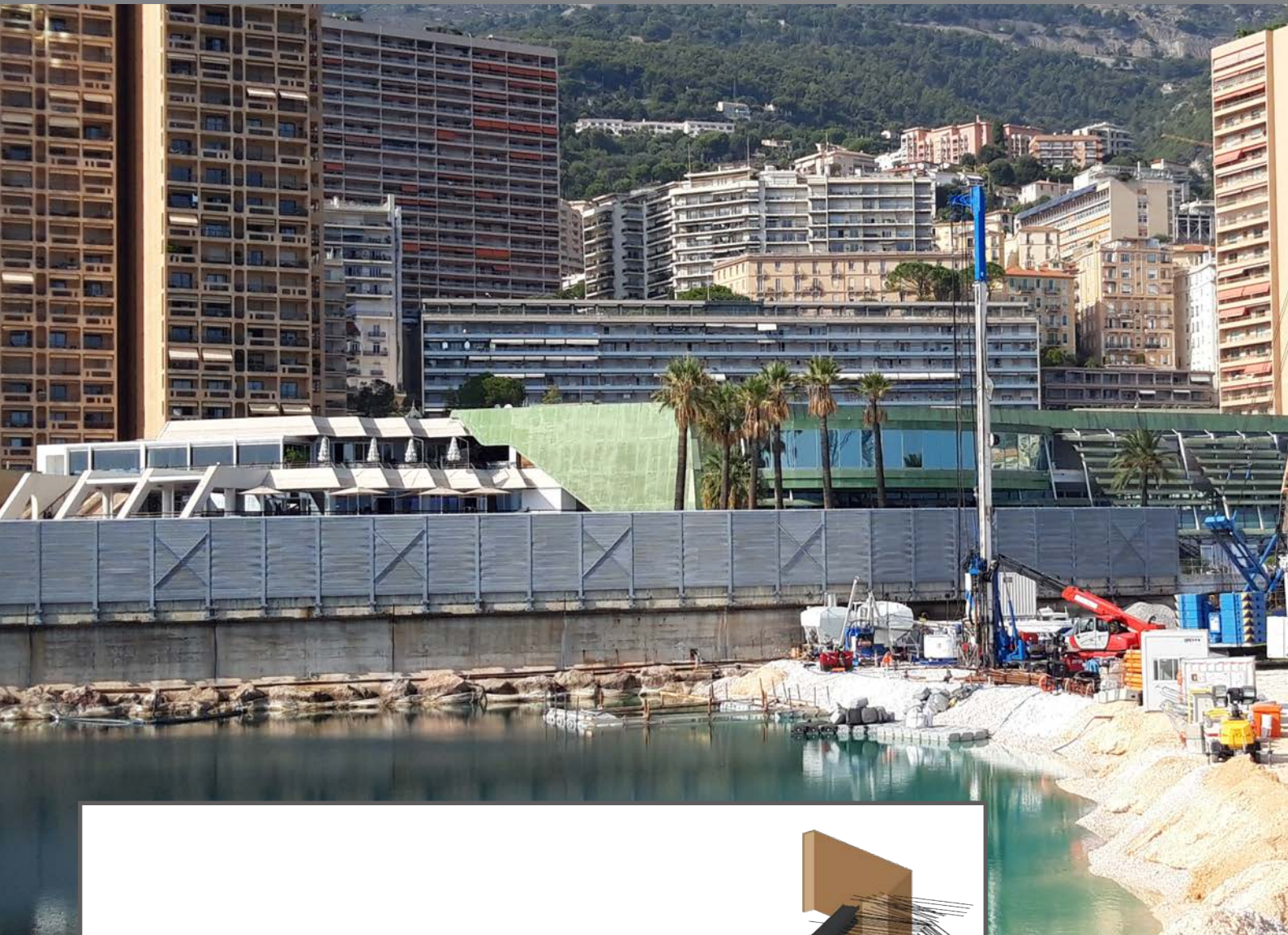


intervention, the pore pressures remain confined within the cells which, characterised by their own structural resistance, prevent the increment of the pore pressure avoiding to reach the liquefaction limits of marine sediments.

The first type of intervention was not applicable in the area closest to the original coastline due to the presence of a buried rocky reef.

The jet grouting solution, on the contrary, was adequate in this area as well. The structural cellular lattice was constructed using pseudo-elliptical elements using double fluid jet grouting technology.





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