Extension of Monaco to the sea

Last Juy 2018, began the transfer of the first concrete caisson reinforced with stainless steel rebars, which was towed from its construction site, in the maritime port of Marseille, and finally installed on its site, for the offshore extension of Anse du portier, in Monaco.

195 hectares (approximately 2 Km2), of which 20% corresponds to land reclaimed from the sea in the last decades, and this new extension of the Anse du portier district, with an estimated cost in 2000 M euros will allow its new growth.

The current phases of the Project, corresponding to the submerged infrastructures, will take place until 2020, and then the construction of buildings will proceed until 2025.

These enormous caissons are manufactured in the "Marco Polo", floating construction dock 50 m wide, and 27 m high, built in the Polish shipyard Crist of Gdank , under design of Bouygues TP.

An area of 10,000 m2 was prepared for the construction of the concrete caissons inside the maritime port of Marseille. The transfer of the first caissons was completed during the month of October 2018, and they were then loaded with solid materials to ensure their stability in the final location.

This was the first of 18 huge concrete caissons, which with a length of 30 m, 24 m in height, and a unit weight of 10,000 tons, will form the barrier of protection against the sea for the new extension of 6.5 hectares of the new district of the city, which will lead to the construction of 60,000 m2 of new luxury homes, shops, a park and other public facilities.

The Principality of Monaco currently occupies a space of

The important maritime infrastructure project is developed by the prestigious French construction company Bouygues Travaux publics.

For the construction of the stainless reinforcements, manufactured by the French-

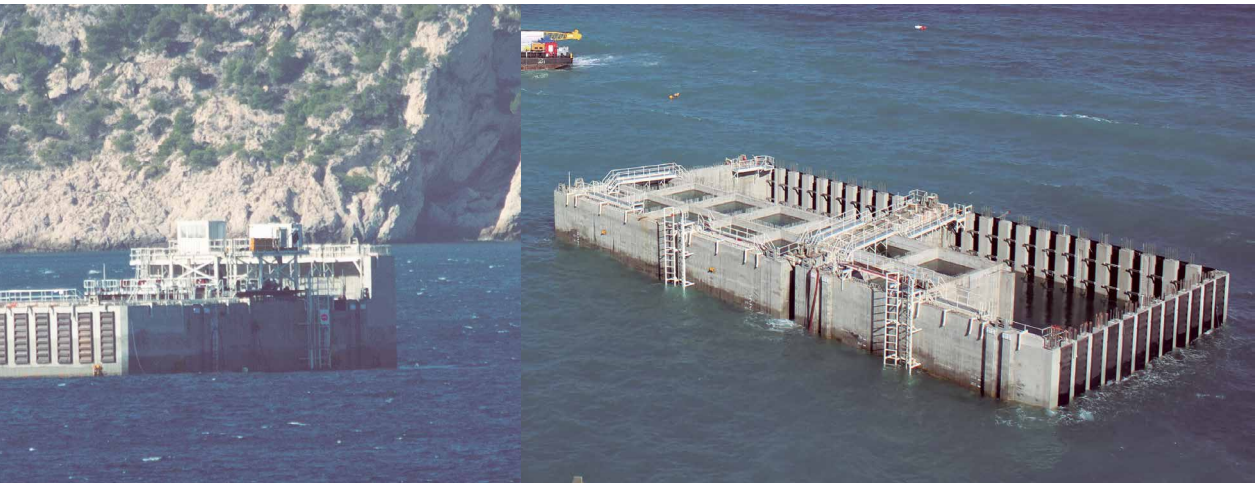
***FIRST PHASE**

Floating dock *Marco Polo*

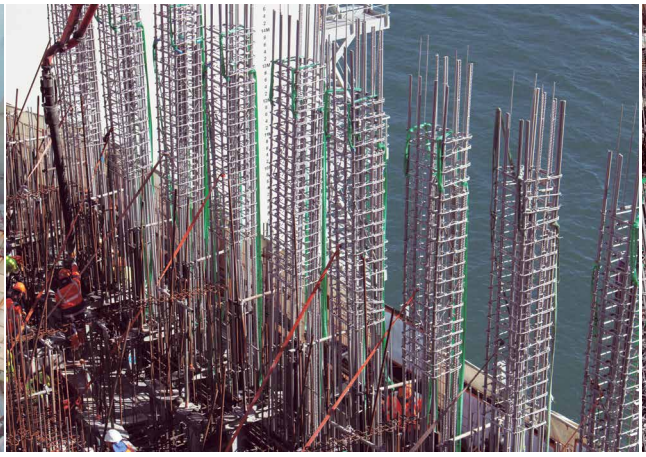
Extension of Monaco project

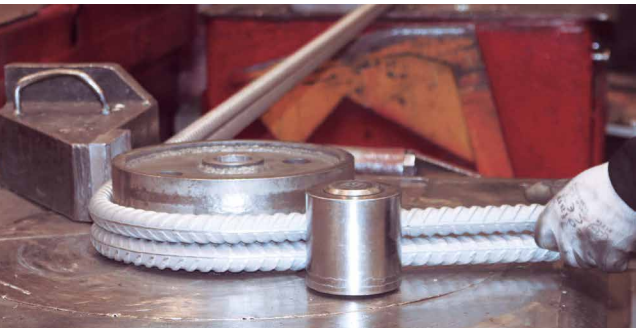
Spanish company Sendin and assembled in Marseille by their own workers, more than 4000 tons of stainless steel rebars, RDN 915-EN 1.4362 AISI 32304 duplex type, have been used, with diameters between 12 and 40 mm, supplied by the company Roldan S.A. , belonging to the Acerinox group, from its Ponferrada (León) plant in Spain.

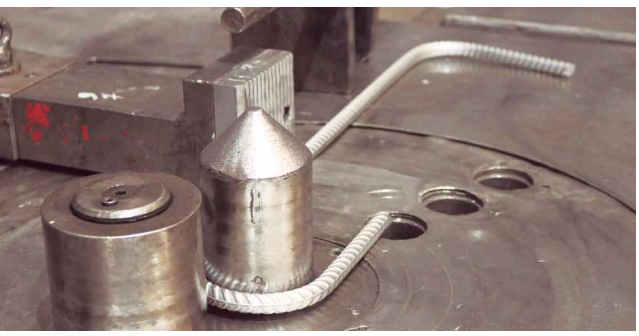
This type of stainless steel with high resistance to corrosion against sea water chlorides, which eventually will penetrate the concrete by capillarity reaching the reinforcements, will provide long durability of these infrastructures, without presenting deterioration due to problems of corrosion, avoiding costly maintenance costs in the future.

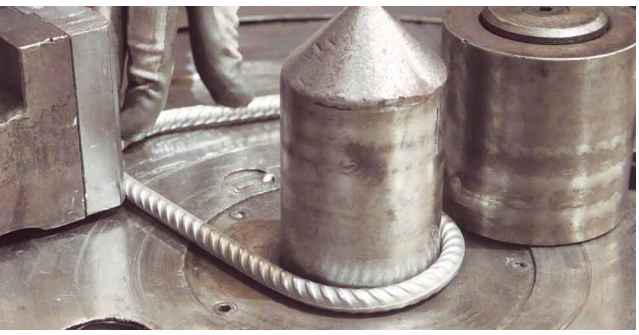


Caissons towed by boat to Monaco









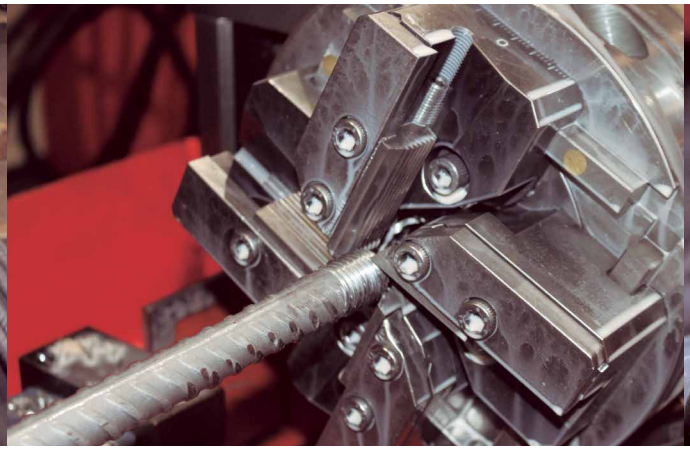
PRODUCTION OF STAINLESS STEEL REINFORCEMENTS (SENDIN TERUEL)

The reinforcement manufacturing works are carried out in the Teruel plant of the company Sendin-Spain, a plant opened in 2010, which has 174 people in that town.

The reinforcement engineering drawings are received at the Teruel plant, sent by the construction engineer's department, with the periodicity appropriate to the progress of the works in Marseille. This documentation is analysed in detail in the technical office of the Sendin plant, and the manufacturing is programmed by computer, making a detailed breakdown of the different items, identifying diameters, lengths and sections of stainless steel needed. After that, a production sequence is launched to the different machines of the plant, so that each bar is assigned to a specific machine, which allows optimizing production times, different manipulations and transport of material between them. Every production order carries its corresponding label, which guarantees and ensures a perfect traceability of the material.

Through this system machines work automatically, without stopping, which results in lower energy consumption and a lower level of emissions. Sustainability is also a fundamental parameter for Sendin.

It is important to emphasize the careful treatment taken with the stainless material in the plant. A special zone has been enabled for its processing, isolating it from the rest to avoid contamination by iron dust, since they also work with conventional steel rebar in other locations of that plant. In the same purpose all


the contact surfaces of the machines have been lined with stainless steel sheet, to avoid contamination of the material and any risk of galvanic corrosion. On other occasions Teflon lining has been used. The packaging and strapping of material is carefully done, so that material cannot be damaged during its handling and transport.

For the joints between bars, they are threaded on machinery specifically adapted for stainless steel and the different stainless steel connectors, duplex type from the company Bartec, are threaded on the end of those rebars. Each connector diameter is identified with a different colour to avoid mixing. This type of threaded connection later avoids the need for welding during the installation in Marseille, which would require the control of an adequate protocol and specialized welders.

It is these small details that show the excellence of Sendin in dealing with the materials that they work, and that have made them a benchmark for the processing of stainless steel reinforcements in this Project.

référence quant au process du rond à béton en acier inoxydable.

ASSEMBLY WORKS IN PORT OF MARSELLE (SENDIN FRANCE)

In the offices of Marseille, Sendin works with the different engineering drawings where the locations for the stainless steel reinforcements in the caissons are indicated. Of the total 18 caissons of the project, 15 of them are denominated “big type”, and 2 of them are “small type”. Both types of caissons have internal hollow areas through which sea-water penetrates and freely flows inside those boxes, allowing those holes connected between them to serve as an ecosystem in which a different and varied marine biodiversity is located and developed.

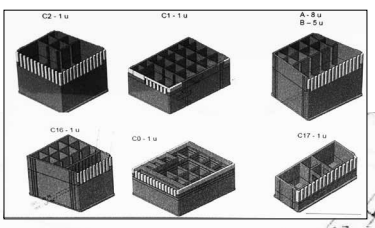
The caisson No. 0 is different, having a swimming pool inside, as it can be seen in the infographics.

These Jarlan-type caissons, are in the case of the small type, composed of two vertical walls parallel to each other, the first one perforated and the second solid so that the action of the waves on the perforated wall is reduced, absorbing and dissipating the incident wave energy. The water enters and passes freely between the different windows of the first wall until reaching the hollow of greater dimensions. In the case of the large caissons, the difference lies in the number of existing walls that goes from 2 to 4.

The reinforcement of stainless steel is located in the external zone of the pillars that face sea- water and between the walls of the first hollow part of the caissons, through which the sea water enters and circulates freely.

The project has a total and absolute respect for the environment, acting on the smallest details. As an example, it is worth highlighting the rough concrete surface inside the caissons where the sea water will flow. This roughness will favour the formation of marine life such as molluscs or mussels, offering a new habitat for the fauna and flora of the project, which is included in the vicinity of an important natural reserve.

The concrete covers the most external stainless steel reinforcements, close to the surface in contact with seawater, with a guarantee of 100 year durability in the project.



***SECOND PHASE**

Once constructed, the caissons are covered by a concrete slab on the top. Since they are partially filled with sea water, the lower part of the mentioned slab is also reinforced with stainless steel reinforcement.

To carry out this project, multiple training courses have been followed at all levels, in order to expose the best work and storage practices of a material such as stainless steel.

The construction of the caissons destined for the extension of Monaco is being carried out in the port of Marseille. The manufacturing process has 3 phases:

- The first one corresponds to the preparation of the caisson in the floating dock Marco Polo.
- The second phase corresponds to the concreting of the Jarlan pillars. It is made with a very special and high strength grey colour concrete on all seen sides of the project, for aesthetic reasons.
- The third part corresponds to the manufacture of the interior walls, where the sea water circulates. This phase was initially going to be built in Monaco, but finally for operational reasons, it is being carried out in Marseille

For the first phase, carried out inside the Marco Polo, the estimated time of manufacture of the caissons depends on the size that is 2 days for the small ones and 8 for the large ones. The elaboration of the concrete slab is carried out at a rate of about 12 cm/h working uninterrupted. More than 100 people work in several shifts

The final height of the caissons is 24 meters. The floating dock has a hydraulic system that varies its height, depending on the progress of construction operations in the interior.

The work is subject to rigorous and extensive quality controls by all the companies involved (Sendin Bouygues, Cemex, TÜV, Monaco authorities, among others).

Different work and storage areas have been established for both stainless steel and other materials, avoiding contact contamination between materials of different galvanic potential.

One of the main problems that the project has had to face has been the wind. Due to the location of the works at the seafront, the incidence of this has been important, limiting or eliminating in some cases, the possibility of working with cranes. Since the works cannot stop at any time, being subject to multiple penalties, this inclement weather has forced to work at a slower pace and in much more complex conditions. There is a continuous contact between Meteofrance and the work to mitigate this type of impacts on the project.

For the joints between stainless steel rebars two methods are used. One of them consists, for the most demanding connections, in the union of threaded rods in Sendin-Teruel, with the previously mentioned connectors of the company Bartec. The rest of the bars are joined with stainless steel binding wire produced by

Inoxfil, also a company of the Acerinox group.

Once the work was completed in Marseille, the caissons were again stored until they were towed by boat to Monaco. The crossing lasts 3 days. These caissons were washed in the open sea with clean water, in order to remove all waste from the port of Marseille, which, due to its more industrial conditions, may contain dirt and pollutants that could affect, in some way, the environment in Monaco bay.

It is important to emphasize again that the use of stainless steel in this important Project, due to its great durability and sustainability, makes it a valuable ally in the important target of maximum care and protection of the environment and marine fauna of this city, avoiding also expensive maintenance for this important infrastructure in the future.

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***THIRD PHASE**

MATERIAL:
Duplex stainless steel
Manufactured by Roldan S.A.
Stainless steel wire manufactured by Inoxfil, S.A.

***SOURCE*:**
Bouygues Travaux Publics
www.sendin.com
Photos Bouygues and Cedinox