Using FRP profiles to construct terraces at a residential complex in Malta

As a result of the technical documents that serve to support engineers during the design phase of structures made with FRP profiles (CNR-DT 205/2007 **"Instructions for the Design, Execution and Control of Structures made with Pultruded Fibreglass-Reinforced Plastic Profiles (FRP)"**, in addition to the advantages offered by FRP itself (lightness, high mechanical strength-to-weight ratio, resistance to chemical and atmospheric agents, dielectricity, anti-magnetism, high workability), an increased use of this material in the Civil Engineering and Architecture sector has been observed.

One example of an FRP profile application is the "Laguna Porto Maso" residential complex in Saint Julian's, Malta. M.M. S.r.l. - a Friulan company established in 1977 that produces its own FRP gratings and metalwork - both designed and manufactured the FRP profiles **to construct the terrace decks**.

The project

A residential complex that encircles **a large private seawater pool**; the ground-floor apartments boast very large terraces that extend above the pool itself and provide direct pool access.

The modern architectural design, the desire to use innovative materials alongside the traditional ones of the island, the high mechanical performance and chemical resistance required for a highly-corrosive environment due to the presence of sea water, in addition to the possibility of reducing structure maintenance costs, led the client to choose FRP profiles to create the terraces' load-bearing structures.

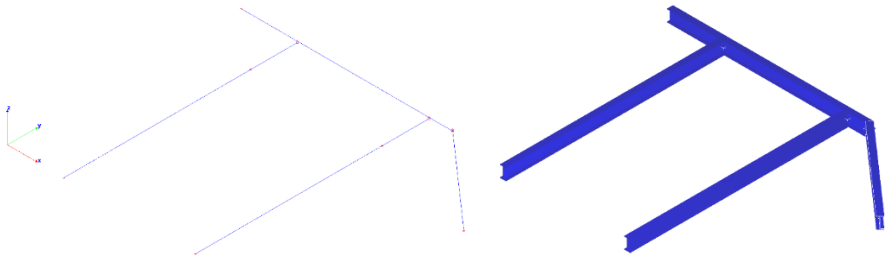
In total, 15 various-sized and shaped terraces, all different from each other, were designed for the Laguna Porto Maso complex by M.M S.r.l.'s in-house Technical Department. Thanks to the teamwork with the architects involved in the project, the Company was able to develop the simplest and most effective design solutions.

Each terrace is enclosed on two or three sides by concrete walls or slabs, whilst the pool-facing side is open, in order to allow the water to flow below the terraces themselves and even be visible at certain points through the apartments' internal flooring. There are only one or two concrete pillars on the fourth side to support the main FRP beams.

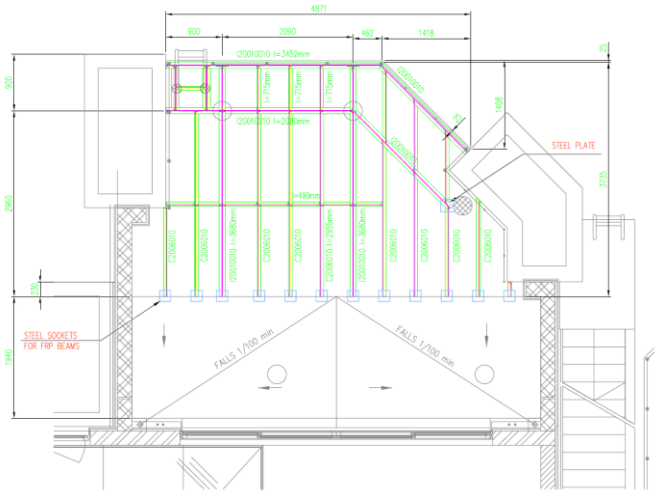
The project's challenges

The main challenge during the development stage of this project, was the thickness constraint of the terraces; this had to coincide with the finished thickness of the slab and decking, i.e. 36 cm in total. The first solution devised was to create a primary load-bearing structure that would involve the few pillars available as supports and the surrounding walls as potential end supports; a secondary supporting frame would be laid on top of the primary one, which would create the terrace's overhang and also secure the decking. The clear span and the loads involved would have required beam sections with a minimum height of 20 cm, whilst also taking into account the fact that the deformability of the beams had to be minimized in order to ensure living comfort. This first structural scheme resulted in an overall terrace thickness higher than the limit allowed by the client; as a consequence, it was necessary to design a solution involving coplanar primary and secondary frames. The few columns and their unusual shapes in the central section of the terraces resulted in the development of **structural solutions "ad hoc" for each terrace**. It was decided to place the primary load-bearing beams on the concrete slab at one end and on the pillar, in order to create the overhang of the projecting part of the terrace. As the two main beams overhang, a third beam is allowed to be secured orthogonally at their ends providing support for the secondary supporting frame. The same principle repeated for the other terraces, where the number and direction of the beams is varied in order to adapt to the irregular-shapes.

The terraces with only two concrete walls presented the most difficulties, and as a consequence, more complex structures were designed with longer beams. In some cases, part of the pre-installed concrete pillars passed through the terraces themselves and therefore could not be used as a direct support; as a result, it was decided to produce steel plates to be connected to the aforementioned, in order to recreate the supports required to keep the structure as thin and streamlined as possible.

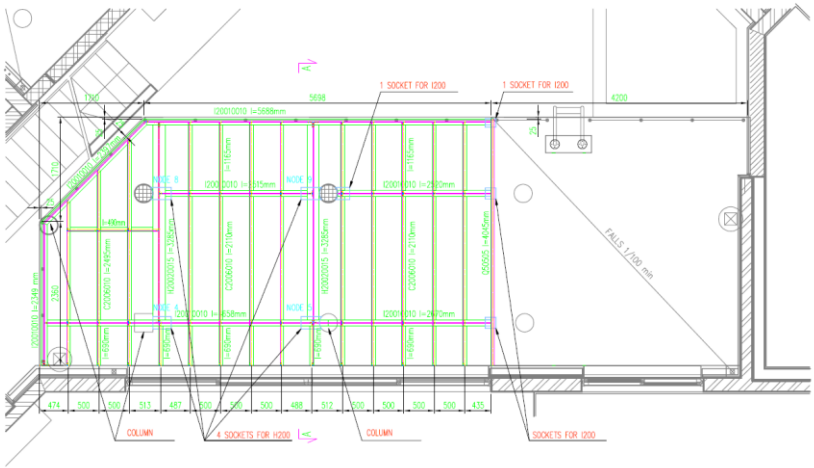


FEM model of the main supporting frame used for Apt. 112's terrace



Structural plan of Apt. 112's terrace

Image of Apt. 112's terrace



Structural plan of Apt. 111's terrace with through columns

During the design phase, thermal load was also taken into consideration, since this can reach high values, and the thermal expansion of the profiles might not have been negligible.

The various shapes of the terraces and their big clear span, the scarcity of the pillars to be used as supports and the necessity of complying with the architectural concept of wide free spaces, led to the development of different, customized solutions that share the principle of the most regular geometry possible to allow the placing of the decking.

In some areas at the edge of the terrace on the side closest to the pool, the spacing between the beams is modified in order to allow the ladders - which provide access to and from the pool itself - to be firmly and securely mounted.

The advantages of using FRP profiles

In this project M.M.'s type-C200, I200 and H200 fibreglass-reinforced plastic beams were used, whilst the joints between the beams and concrete walls, in addition to those between the beams themselves, were realized by means of stainless steel angle brackets and plates.

The lightness of the profiles, the material's remarkable workability and the simplicity of the bolted joints, allowed **an easy prefabrication of the structures** and a fast completion of the works at the construction site. From both an architectural and engineering point of view, the excellent end result underlines just how well FRP holds its own against the more commonly-used traditional materials; this is just another step towards the future, as highlighted by its evidently increasing application in the civil sector. Contact us here for more information.