Manta Bay, the pool in textile architecture

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Abstract

Everyone knows the above-ground pools like concrete wall or steel frames which have the aim to contain a volume of water. This is the first and ancient meaning of pools and over time it is developed. The pool is a form of architecture and it can follow new ways like contemporary architecture and where people can to enjoy of the wellness. The new challenge is to do an above-ground pools in according to the architectural textile concept, the project had to follow several criteria: 1. maintain the main structure at the minimum size and increase the value of the membrane; 2. maintain the water always light and clean; 3. find a shape typical of the textile structure never seen in the pools; 4. to be installed and dismantle easily; 5. modular textile structure, always at the service of simplicity of set-up, use and maintenance. In these ways it was born the project Manta Bay.

The textile pool is composed of tensioned membrane (PVC thermo-sealed) stabilized from self-weight of water and thin steel bracket that it doesn’t touch membrane. It is laid on composed matchboard floor (Eco-Friendly composite material, made with rice husk and virgin polymers)

The challenges of this project is the formfinding of the membrane that it should have a deformation against typical behavior of membrane under permanent load (convex shape). It is looking for an concave shape.

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The production of the membrane accessories and steel structure needed of suitable characteristics for working with water plus chlorine, pipes for circulation of water, a little waterfall (solution needed to have an infinity pool).

**Keywords**: Lightweight structures, design pool, textile architecture, form finding, idrostatic load, softening, temporary structure, membrane stress, above-ground pool, quick installation

### 1. Design development

Manta Bay become from an architectural approach to pools.

Traditionally the pool has been considered just a commodity that has more to do with structure and systems. As it is a status symbol the only architectural requirement at first is it to be as wide as possible.

During the ages the basic concept has been evolved, as the building technics have. Pools became not mere technical equipmet anymore. The aesthetic approach has introduced for pools specifically designed for wellness, and not only for agonistic sport.

The task is to considering the pool a “volume”, rather than a “hole in the ground”; a “room to live in” rather than a simple “water tank”.

Manta Bay is a step ahead. This concept introduces a brand new point of view: unlikely traditional pools, the volume is designed to be enjoyed from both into and outside the basin. In addition to that, water is not presents as its still surface, but it has an active role in the landscape thanks to the vibrant lamination infinity waterfall.

To keep such concept and to overcomes the traditional limits a modern and versatile building technic is needed.
2. Tensostucture building technology

Tensioned textile architecture is the answer. It allows a way to create basins in many shapes and sizes. Following criteria had been adopted:

- to design the supporting frame at its minimum size, so to henphatize the membrane
- to keep the membrane as much intact as possible, since every flange is a possible leak. This brings to infinity for lamination.
- To set the most organic shape and synclastic form typical for tensostructures, but not common for traditional pools.

Once the technic was defined, we realized that the lightness of tensostructures technology to provide several advantages compared to average pools.

First, such item can be easily set up. This allows to get a pool in sites otherwise not suitable, because of logistic or building permit.

Second, setting up and uninstalling are quick (about 3 hours), so to make Manta Bay a temporary choice. Seasonal use is a topic for reducing pool costs. The possibility to take off the equipment during non bathing season represents a remarkable saving.

Third, as tensostructures does not need heavy supports, Manta Bay does not need further finishin work but the basic kit. Sides and stairs are not needed, that saves a lot of money.
3. Supporting frame and decking

In short time the initial concept gained the traits of an industrial product, according to a specific niche, not yet occupied: high-ended above-ground design pools.

Steel struts as part of a linear frame, mechanical links, make it to be delivered in kit, easy to assemble. More components are adopted for decking and water system, according to a “modular” mind, easy to maintaining and to replace, just in case.

The modular approach allows to design several different models, whose the traits are: longness of struts, membrane surface and number of rthe decking modules.

This fit to the delivery: Manta Bay can be easly exported, where pool is part of local culture or the heat makes it a must to have. Mainteniance is easy from far away as well: every components is easy to be sent and install by unskilled persons. Optional systems like whirlpool, heater or spotlights may be added beyond the first season.

Such item needs a brand representing its “organic” design, ligthness and its relationship with water element: therefore Manta Bay.
4. Design of membrane

The first point to consider for the design of membrane is the behaviour of the idrostatic force. As usually is knew, the hydrostatic thrust is the product between the pression by the surface where it is applied, as following equation:

\[ S = \frac{1}{2} \gamma_{\text{acqua}} \cdot h \cdot a \cdot l \]  

\[(1)\]

![Figure 4: Scheme of hydrostatic force](image)

The situation for textile pool is the following:

![Figure 5: Loads applied in the membrane](image)

<table>
<thead>
<tr>
<th>Forces involved</th>
<th>Description</th>
<th>Applied</th>
<th>Membrane issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Vertical forces for the water weight</td>
<td>On membrane in the bottom of pool.</td>
<td>It works in contact with the floor (friction)</td>
</tr>
<tr>
<td>F2</td>
<td>Inclined forces with horizontal and vertical component</td>
<td>On membrane between bottom of pool and steel bracket in the corner</td>
<td>It works with high permanent load and the membrane have to transfer the tension maintaining shape designed</td>
</tr>
</tbody>
</table>

Before formfinding phase it needs to take in account forces named “F1” and it his behavior and distribution. The forces named “F2” is important for the stability of entire textile structure where it is involved membrane, steel structure and ropes, but it has less influence in the Formfinding.
4.1. Form-finding

The challenge to win, at least parcial, it is the shape of membrane that it doesn’t follow the typical deformation of fabric under a permanent load. In fact, when it is in that situation (permanent load as snow, water ponding, etc..) the membrane has following trade:

![Deformation typical of membrane](image)

In the pool, it means to have a shape with concavity towards the inside of the pool (convex), as shown in the Figure 6.

At the contrary, the formfinding should allow an membrane deformation with concavity towards the outside of the pool (concave) as shown in Figure 6 over black arrow.

4.1.1 Form-finding with software Easy (Technet GmbH)

Without water load, the result of the input geometry into software for formfinding (as Easy, Technet GmbH) has the shape how it seeks for:

![Deformation typical of membrane](image)
Into the software Easy there is a program named Auftr, which creates the external loads caused by water. In order to get correct results it has to define the triangles which are in the hydrostatic force.

![Deformation typical of membrane](image1)

**Figure 8: Deformation typical of membrane**

### 4.1.2 Statik analysis with software Easy (Technet GmbH)

Under this water load the software calculate the stress of membrane, but the first observation is that the shape is not like seeked, because the membrane has deformation typical as mentioned before. To reach the final shape, it has to increase the force density along horizontal link and the result is the membrane works with concentric rings and it permits to get convex surface in almost of surface.

![Stress analysis of membrane under water load](image2)

**Figure 9: Stress analysis of membrane under water load**
At the end, the membrane is made with high compensation along horizontal line and the warp has to be horizontal too. It should to accept the concave shape in the side where there is the water overflow because the membrane is very inclined and the water weight can not be countered by the compensation or the increasing of the force density.

It is due to limit of the membrane, in fact if it increases the stiffness of the horizontal link (concentric rings) the result is high stress of membrane (not existing on the market)

4.2. Characteristic of material designed

The statik analysis of membrane and its accessories takes to defined a fabric type 2 with low deformation. In the first time the textile pool has been made with standard fabric as “Sioen T2101E” 100% PES and then it has been replaced with pre-stressed fabric as Serge Ferrari Precontraint type 2 because it has a better behavior.

In the edge of membrane there is stainless steel rope with thread swage terminal and turnbuckle. The forces in the rope are transmitted to machined fork-swage turnbuckle (shown in the Figure 11) with round stainless steel plates and bolts for clamping the membrane.
4.3. Develop of membrane suitable

The membranes used in the construction of above ground pools are simple PVC fabric. This kind of membrane can be negative affected if subjected to continuous contact with water, but the textile pool designed is temporary and into water there is chlorine.

As an alternative, the market offers membrane solutions used in the field of inflatable boats or in-ground pools, such as the membrane of Renolit (Alkorplan3000) or Mehler (Valmex Boat).

5. Steel structure design

The steel structure to support the membrane has been designed as light as possible, to avoid heavy look. The weight of load is the main contrast to balance the tipping forces and to reduce the arm of the typical force in the cantilever.

![Figure 12: Main steel structure](image)

6. Conclusion

Textile structures can have outlets also in those sectors where at first glance there seems to be no possibility of application. The textile architectural pool shown would open other doors in the pool and wellness sector where the concrete and the steel are the masters.