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To cite this article: Ignacio Sanfeliu and Estefania Martin 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **471** 082038

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Design and Building of New Softball Sports Equipment in Barcelona: The Last Intervention in The Olympic Area of Historical Mountain of Montjuic

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Abstract. After the designation of Barcelona as an Olympic city in 1992, a process of fervent reconstruction and transformation of the city began. For the development of the games, four strategic zones of the city were chosen, destined to the achievement of sporting events. One of these places was the historic mountain of Montjuïc that hosted the largest sports complex in the city in an architectural and urban macro-project called "*Anella Olímpica*". After 25 years, Barcelona continues to rebuild the mountain, adapting it to the new requirements with regard to sports facilities and this is how the Softball Barcelona project came about. The design criteria of this equipment have been: The use of the site's characteristics, the easy communication with the current Baseball, the proper visibility of the field by the public, essentially familiar, the introduction of innovative elements that add value to the installation, and a certain visibility and quality of the installation that does not disregard the magnificent environment, in the most important concentration of sports facilities throughout the country. Other criteria have been: The use of land as a consequence of the construction of the field, the possibility of organizing future events of a certain magnitude, the economy of the media, this new softball field is located next to the current Baseball Olympic Field to the east, under the Olympic Ring, in Montjuïc. The main element is a Marquee, based on six inclined metallic "pillars" that support a structure and also allow the placement of another horizontal network, which serves as security as to configure an awning, very convenient due to the orientation to south. These porticos that form the same curvature on the ground that the track, will support the vertical protection network, and will also be able to accommodate the access lighting and will serve as support for the awning-net. This structure configures the image of the field since it will be seen from the street Pierre de Coubertin.

1. Montjuïc before the Olympic games

The mountain of Montjuïc is a characteristic enclave of Barcelona that predominates the city from south-west. Historically it has been the prominently important place. Prior to the demolition of the medieval walls that surrounding the city at the end of the 19th century, *Montjuïc* was a bastion of control of the city that in its skirt hosted a remote and marginal settlement of the most vulnerable population. With the arrival of the new century the mountain, then full of self-built homes, is undergoing an urban redevelopment that modernizes it and makes it part of the city with the International Exhibition of 1929. For the event the *Estadi Olímpic Lluís Companys* built in 1927, it was renovated in 1989 to be the main stadium for the 1992 Summer Olympics.



With the adaptation of the mountain for public and sports-type uses, all self-built houses were demolished and buried under tons of anthropic land. With the 1992 Olympic Games, the area was radically transformed (figure 2) with the construction of the Olympic stadium by Margarit and Gregotti architects, Sant Jordi Sports Pavilion by Arata Isozaki architect, INEFC Sports Pavilion by Bofill architect, Bernat Picornell swimming pools by Gallego and Fernández i Eduardo architects, the iconic Telephoe communications tower by Calatrava, the Parc del migdia by Galí and Quintana architects, and finally the Baseball field Carlos Pérez de Rozas built at 1989.



Figure 1. Photographs of the *Estadi Olímpic Lluís Companys* the day of its inauguration at 1929 and posterior view. Images by Gaspar i Serra, Josep through the *Institut Cartogràfic de Catalunya*

The baseball track is located next to the botanical garden and is currently in use, however it does not have all the features required for the sports facility. With the modification of the metropolitan general plan, "*Modificació del Pla General Metropolità a l'Àmbit de la Muntanya de Montjuïc*", a new zone was assigned for softball equipment (field for training and competition of children and women's categories). This land is south to the baseball field, in the Pierre de Coubertín street nº 9-11. Previously it was a green area and had an area of 1.2 Ha.

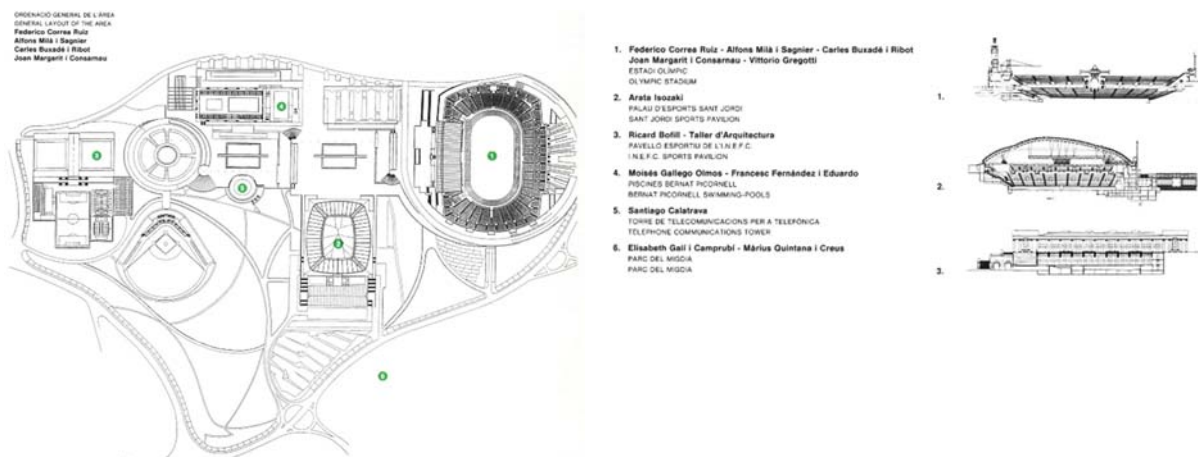


Figure 2. Plan and sections of the main buildings of the Montjuïc Olympic Ring. Source: magazine "*Quaderns d'Arquitectura i Urbanisme*" Barcelona 1993, nº187, page 33

The commissioning of this new sports equipment in the Olympic Anella arrived at the office in the year 2012 and in 2015 the first phase of the construction could be completed. On a general level, the plot devoted to the project had a group of trees that consisted of oaks, oaks, pine trees, olive trees, cypresses and palm trees that were tried to keep as much as possible or were transplanted. As for the lighting enclosures and bays, they were discarded and moved to a warehouse, in addition to making the pertinent land movements to execute access roads and the embankment that would level the stands of the project with the access of the old baseball field.

2. Antecedents, affectations and foundations

The subsoil represented one of the greatest concerns at the same time as the development of the project. The entire area had been, once exhausted the Montjuïc quarry “*Pedrera del Mussol*” at 1955, a garbage dump until the 1970s. The landfill once closed had been rebuilt with lands, with an important layer of refurbishment and under a layer of urban waste. The existing baseball field is located in a field of the same characteristics.

The geotechnical study was carried out by the Geo-log area of applied geology of the Catalan company “*ARDA, Gestió i Estudis Ambientals, SLL*” that made a historical study of the geography of the site and proposed the recognition of the land with non-destructive tests and finally with perforations. In figure 3 we can observe the plan that collects the historical study of the site with flights made between 1926 and 1966. It is interesting to distinguish, in aerial photography from 1947, that the quarry is being exploited and that the future location of the softball field It is between the two valleys of the exploitation zone.

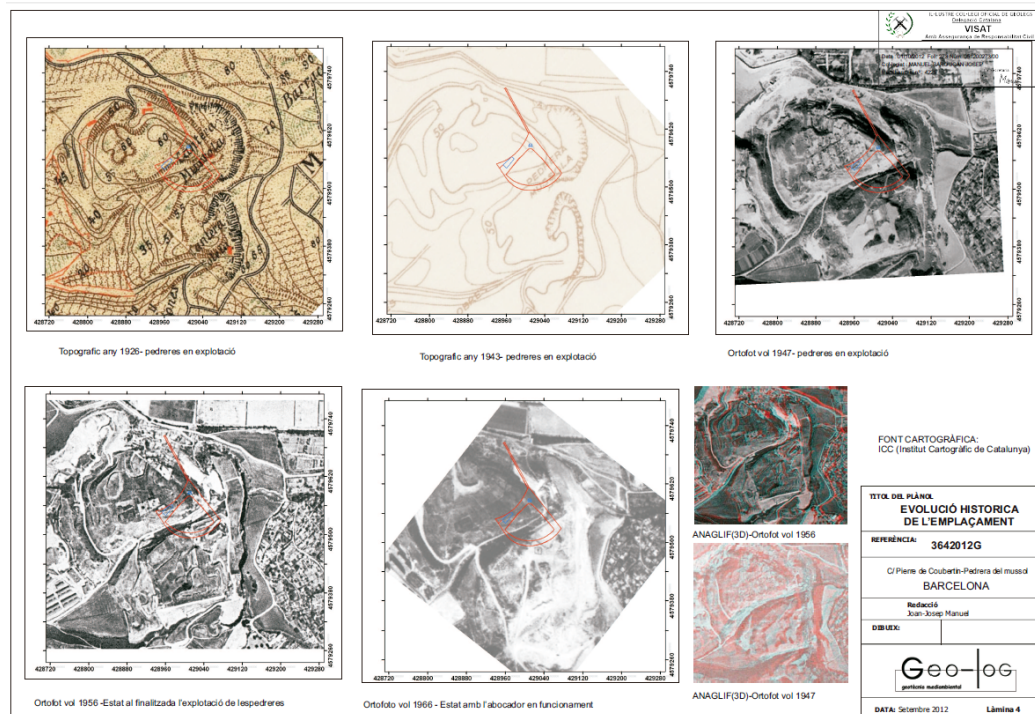


Figure 3. Plan of the geological study that shows the historical evolution of the site

The geophysical prospecting with the electrical tomography method consisted in the realization of three profiles of 195m in length, with a separation between electrodes of 5m, to reach a depth of up to 40m in order to detect the existing morphology and paleorelief. From the comparison between the tomographic profiles and the extracted probes, the geological section number 2 was the most representative when clearly showing the peak where Softball would be located (figure 4).

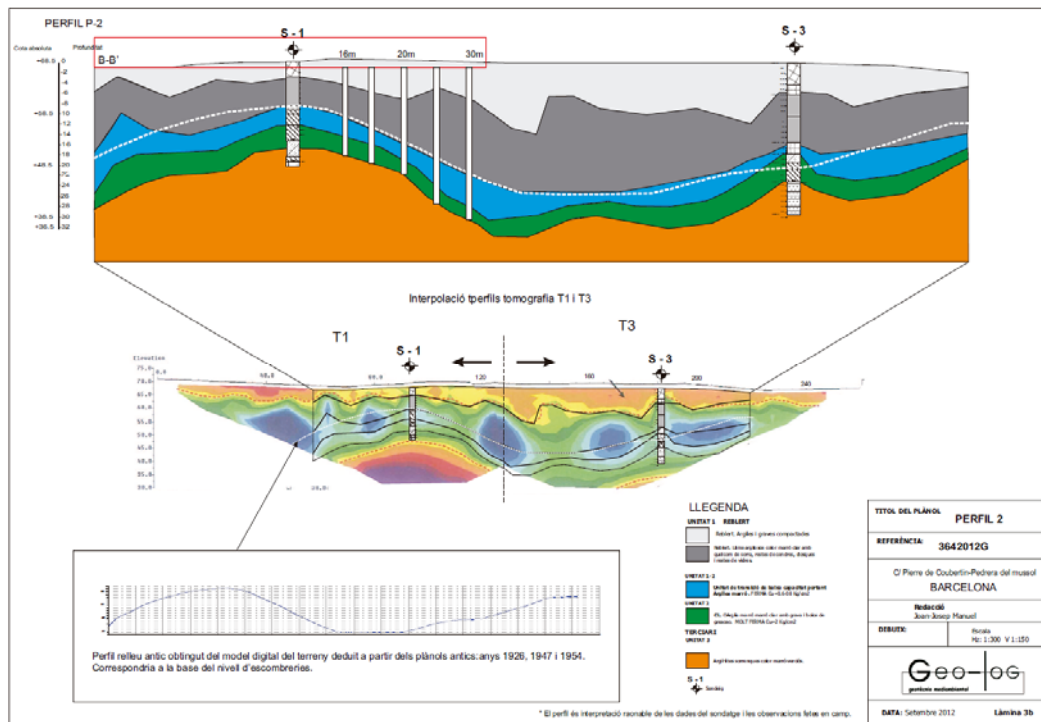


Figure 4. Section number two of the geological study that compares the two land survey techniques used

As for the drilling tests, three rotary drillings were made with continuous testimony extraction of 101 mm diameter, to depths between 20 and 30 meters. In figure 5 you can see the testimonies extracted and placed in the relevant boxes. In the same location, the materials of the samples were identified and characterized, SPT's tests were carried out and the cut resistance was tested with a manual penetrometer. The water table was not found, but in the geological study the surface runoff due to the existing slopes was indicated. Once in the laboratory, the granulometry, the resistance, the deformability and the chemical content of the samples were tested.

With the surveys, the lithological units of the land could be determined. The first was the filling of clayey materials and clayey gravels with different degree of compaction in a layer of 3 to 10m. In this same stratum, urban solid waste from the 60s and 70s is found, mainly plastics, metals and wood, from 6 to 25m deep (testimonies of black color in figure 5). Finally, silty clays with gravel under the garbage. The second unit (quaternary) are clays with different levels of cohesion. The third stratigraphic unit (tertiary) consists of a firm soil.

Full geotechnical studies were carried out, with electrical tomography profiles and probes to determine the most suitable areas or layers to achieve the foundation of softball elements. The morphology of the land with the valley filled with waste and a layer of clay materials in a variable thickness is very heterogeneous. Another important factor was that the land has a high content of ammonia and an acidic Ph and therefore the foundations have a special concrete to avoid chemical attack. In summary; the variability of the layers of the terrain (3 to 5 meters of clays), the situation of the stratum resistant to great depth, the deformability and irregularity, the presence of garbage and the chemical aggressiveness of the terrain caused that a type of suitable foundation was chosen.

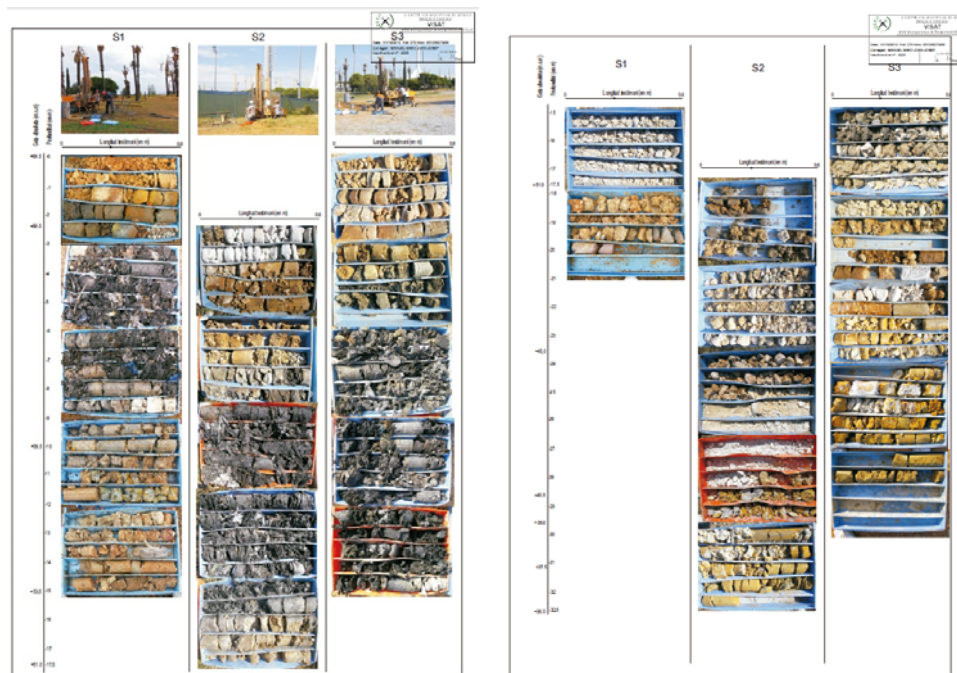


Figure 5. Testimonies extracted from the surveys

The geotechnical study recommended the implementation of prefabricated pile to the foundations of structures. This meant an increase in the amount of the project and due to this, its construction was planned in stages. To go on insurance, the worst scenario was defined in the project, that is, the foundation by pile driven up to 30 meters, after consulting the architects of the old Olympic Baseball at the coast that piloted until an approximate depth of 30 meters. Finally, due to the fact that the field is located on this landfill (filled with an exhausted quarry), the geological study requires the use of depth foundations except for the construction elements of the enclosure, such as a perimeter wall of reinforced earth. This retaining wall has a characteristic weight that does not entail danger to build it on the surface.

The final solution will be prefabricated piles that will be "repelled" and each will have a different depth according to the resistant stratum. These pilots were calculated to work properly in compression. In the marquee of the project two and three piles for their pile caps of pillars will be used, in the building of the marker four pile caps of three piles. The weight of these metallic structures is minimal but the anthropic terrain requires deep foundations.



Figure 6. Photographs of the execution of the foundation

3. From the project to the construction

The new softball field will be located next to the current Baseball Field to the east, under the Olympic Ring, in Montjuïc. Suggested by the address, it will have exactly the same orientation as the one the current Baseball Field of Baseball, towards the west, aware that it is not the best orientation, is advisable for the existing available space and the contact with the current installation. The softball as we said before will share facilities with the Baseball Field. In this place, there is a free zone, consisting of pine trees and palm trees, recovered, some in poor condition. It is a sensibly flat area, forming a kind of small hill, that separates the current field of the future.

3.1. Project criteria

The design criteria have been the use of the site's characteristics, easy communication with the current Baseball, due to the dependence that the new equipment will have of the services that this offers us. Also, the proper visibility of the field by the public, essentially familiar, the introduction of innovative elements that add value to the installation and the coherence of the phases have been very present in the writing of the project. Each phase is a defined project. Until the third phase will be used, the existing changing rooms in Baseball and there will be a single Bullpen. With regard to baptism tunnels, existing ones will be used in the current field.

Other criteria have been: The use of land because of the construction of the field, resizing them to adapt the space and avoid its transfer, the possibility of organizing future events of a certain magnitude. The economy of means and finally a certain visibility and quality of the installation that does not disdain the magnificent environment, in the most important concentration of sports facilities throughout the country.

The idea is to access it from the same entrance of the current baseball field and gently lower parallel to the new field. To avoid mixing players and spectators, there will be two levels: the players that come from the current installation and will always be at the level 67.30; and the public that will run for quota 70, which is the level of the entrance esplanade. This will be 2.70m above the playground located at level 67.30, slightly higher than the current Baseball field.



Figure 7. Photograph and plan of the situation

This ramp access is delimited by the existing torsion steel mesh tanks. A door with direct access from the public, from the outside without access from the baseball field is also foreseen. The lands will be used to adapt existing roads, from the Pierre de Coubertin street to the proper access to the installation. The definitive access from the existing baseball field is foreseen in the third phase. They will be located in the public area; two doors with three sheets of 1 meter each, for a quick and emergency evacuation. In the symmetry axis, there will be located toilets and the zone called markers, and on both sides will be placed a single row of stands that disappear at the ends. Some ramps facilitate access to these. Also, in the same area 69.55 cm, the control and marking zones are located. The use of stands for 100pax and a maximum capacity of 463 people is expected, see annex PCI 13.1. and they will be of the same concrete of the access pavement. Its special configuration is to facilitate its flexibility of use. They will be accessible through the two existing ramps on both sides and by stairs.

The front railings will be of laminated glass with structure of steel handrails. The final track network has been studied in detail, in order to avoid the elements of vertical support that make it difficult for the game and the judges. This system is based on later metallic "pillars" that support a structure of a pair of round tubes, which receive the vertical network and also allow the placement of another horizontal network, which serves as security as to configure an awning, very convenient due to the orientation to the south. In any case, the need to base it with piloting at a high cost requires doing this structure in two phases.

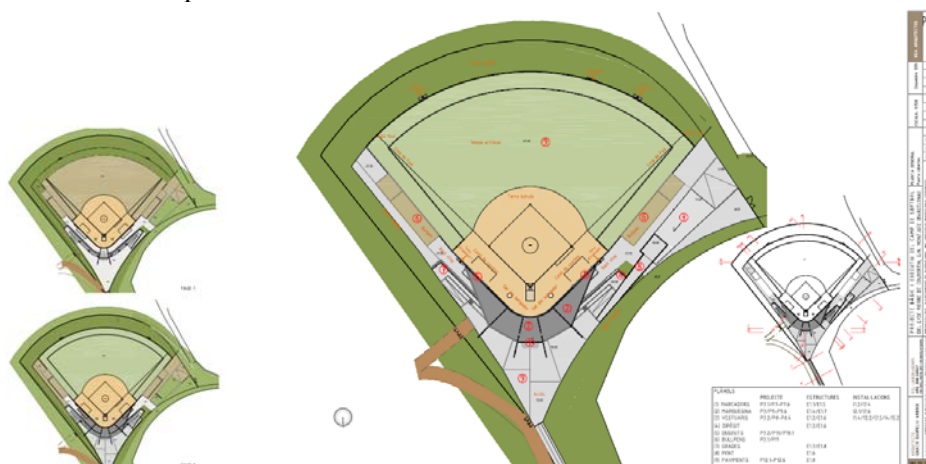


Figure 8. Phases of the project

The field has been designed with regulatory sizes, according to the regulations of the "Spanish Federation of Baseball and Softball", for women, that is, a Field of 67.10 meters deep from the "man", until the closure. It will have different paved areas: artificial grass, *sauló* and *terra batuda*, according to the phases. Concrete paving will have retraction joints with prefabricated parts and continuous drainage grilles.

3.1.1. Structure of the marquee and facilities

The Marquee, which name does not reflect the true meaning of this structure. This is how we will now see: awning, network support and everything else in one element. Element that configures the field image. The design of the marquee tries to solve four problems at the same time:

- The protection of the public regarding the game's volumes, compulsory according to regulation, with a vertical network, which in this case will also have horizontal continuity. The planned solution allows a double use as an awning and decrease the height of the vertical network to the field at 7.50 m.
- Avoid loss of vision of the public due to the vertical support posts of this network, which are usually placed every 4 meters.
- Give shade on a part of the stands, which is located to the south, using a network. Dense month, which will make of awning.
- Provide support for a minimum lighting system in the public area and access to the installation.

The solution is specified in a structure consisting of 4 semi-arches with inclined 6.65m high pillars and beams, composed of pairs of round steel tubes. of diameters of 219.1 mm and different thicknesses of 10mm and 12mm; depending on your situation. There will be 2 pillars plus verticals of 7.00m, next to the "dugouts".

The fact of the existence of two tubes is justified by the independent link of the network in one of the two. However, the inertia of two tubes combined with platinum is much larger and avoids the excessive diameters that would be needed in the event that it was fitted with a sun, in this case they could reach 40-50cm. In the case of a single tube. This structure configures the image of the field, since it will be seen from the street Pierre de Coubertin. It will be painted white. In the central porches there will be two centres that will illuminate the access area and the public area and focus on each of the remaining two.

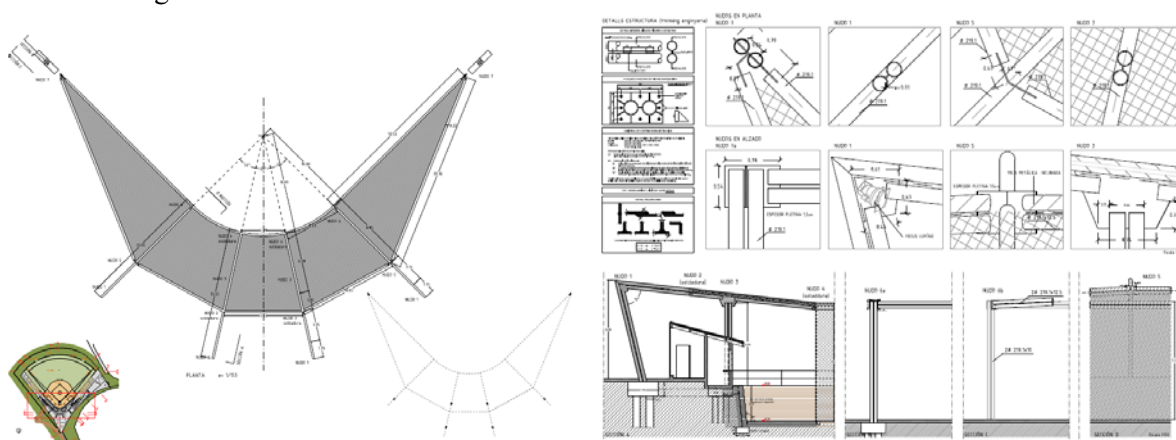


Figure 9. Marquee's structure

The structure is configured with six sloping posts and four beams, with pairs of solidary tubes, 193.7mm in diameter and 10 to 12.5mm in thickness. The porticos that form the same curvature on the ground that the track will support the vertical protection network will also be able to accommodate the access lighting and will serve as support for the awning-net. However, in some cases the support structure of this network will be used as pillars of the volume of markers and toilets.

3.2. Execution of works

During the execution of the first phase it was possible to adapt the terrain with platforms and ramps, it was possible to complete the stands, the different enclosures and railings, also the referees' building or the scoreboard, as well as the dogouts and the bullpen. The field of play was paved with dirt and the place was lit with lighting, electronic scoreboard and foul sticks. The landscaping of the subsequent slopes adapted. Regarding the structure of pergola or marquee, it was possible to carry out the first phase consisting of the six main pillars and the joists, pending the execution of the two pillars and final beams to be able to place the upper tarpaulin. The construction of the pergola required an exhaustive monitoring since the tubular profiles had to be welded to the plates. The structure was painted to homogenize the esthetic, and in this way, it is perfectly integrated into the "*Olympic Anella*". In the next phase, pending start, artificial turf will also be placed in the field and the building of the changing rooms and the store will be built.



Figure 10. Photographs finally works on phase 1

4. Conclusions

The construction of this new facility in the historic mountain of Montjuïc, right in the Olympic area, makes it an important building that dialogues with the great works built for the 1992 event. Its lightness and organic character makes it perfectly integrated into the site without disturbing the general image of the area. This update or implementation in sports facilities tells us that the mountain is still alive, growing and adapting to the new urban and social requirements, and with each performance that takes place in the mountain its past comes to light, its previous buildings, its original quarry, his story.

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