THE ESPLANADE OF THE OLYMPIC RING IN BARCELONA: ARCHITECTONIC COUNTERPOINT OF THE MONTJUIC PARK

F. Correa (1) A. Mild (1) J. Puig-Pey (1) A. Josa (2) C. Jofrd (3)

(1) Architect, Barcelona, Spain

(2) Civil Engineer, IECA-TUC (*), Barcelona, Spain

(3) Civil Engineer, IECA (*), Madrid, Spain

SUMMARY

The Olympic Ring, situated in the Park of Montjure, is one of the areas that the city of Barcelona is dedicating to the Olympic Activities in 1992. Here is a large Esplanade of over 60,000 m^2, paved with concrete blocks. In this paper a summary is given of the project criteria used for the architectonic planning of the Ring complex and for the Esplanade, as well as the solutions originally envisaged for its paving, the studies and tests carried out, the reasons that led to the use of concrete blocks and a description of the pavement as finally constructed.

Introduction

The Olympic Ring is one of the areas that the city of Barcelona is dedicating to the Olympic Activities and in which the major sports events of the 1992 Olympic Games will be held (Figures 1 and 2). The Olympic Stadium (A), and the Sports Pavilion (B) are the most remarkable installations which, due to their dimensions and seating capacity, represent the fundamental components of the complex. The Olympic swimming pool (C), the National Physical Education Institute of Catalonia (INEFC) Building (D), the baseball field (E), hockey field (F) and an athletics training track (G) comprise the rest of the facilities in this area.

Situated on a plateau on the mountain of Montjure, open towards the Mediterranean Sea, the Olympic Ring is set within a large urban park almost completely surrounded by the city of Barcelona. The most outstanding enterprise in the interventions carried out on the Montjure mountain was the creation of the area where the International Exhibition of 1929 was held. As a consequence, part of the mountain was subjected to urbanization, and a series of relevant buildings was constructed. From then until the 1980's, no global enterprises were undertaken on the mountain.

(*) IECA: Spanish Institute of Cement and its Aplications
TUC: Technical University of Catalonia

The Olympic Ring project

The project of the Olympic Ring was the fruit of a restricted contest held in 1983 to which, amongst others, the Spanish architects Federico Correa, Alfonso Mila and Ricardo Lofill were invited along with the Italian architect Vittorio Gregotti, the Englishman James Sterling and the Japanese Arata Isozaki. The contest was judged in January 1984, with the Federico Correa and Alfonso MilS team being entrusted with the global planning of the Ring, and the other teams of architects being assigned the various surrounding buildings. Federico Correa and Alfonso Mila developed this planning in collaboration with the other Spanish architects Joan Margarit and Carles Buxade.

The people in charge of the planning of the Ring tried to take into account the historical guidelines of Montjuic's previous projects. The Ring's setting is to be found on a plateau of 1,000 metres long by 600 metres wide, gently sloping down from east to west, presided over by the Stadium building. As it descends, the flanks form a tree-lined hill in the northern section (an old park dating back to 1915) with a deep depression of the land to the south and west. Inside the Olympic Ring we encounter the Olympic Esplanade (Figure 2, H) terraced in three levels (H1, H2, H3) on the perpendicular axis of the Stadium's facade, that provide access to the buildings of the Ring. It was possible to preserve the facade of the Olympic Stadium, dating back to 1929 and currently regarded as a monumental building in Barcelona, due to complete interior remodelling to adapt it to current Olympic requirements and considerably increase its seating capacity. The three major terraces are large paved plazas, each confined above and below by transversal accesses to the Ring.

The first terrace corresponds to the Sports Pavilion, work of the Japanese architect, Isozaki, confined by wide steps and cascades. The second also forms a plaza with architectonic and decorative elements analogous to the first. Access is gained to the Olympic swimming pool from this plaza via a large archway situated at one end. The third and final level, circular and separated from the second by a waterfall and large staircase, is the lower end of the Olympic Esplanade. This plaza's center is formed by a circular lawn which surrounds an also circular pond. From this plaza, and through another large curved gateway, access is gained to the building of the INEFC, work of the architect Ricardo Bofill. Finally, a perimeter ramp descends to the municipal baseball field, situated in the heart of a forest. The Olympic Esplanade, determined by its features and terraces, links the different buildings, each with its own style. The asymmetrical final planning, in accordance with the natural slopes of the land and with the facade of the Olympic Stadium, allowed a more complex architectonic composition of the Ring.

The architectonic design of the Esplanade

The overall layout of the Ring is based on the six following fundamental elements (Figure 3) that appear throughout, creating unity and an identity for it.

1. Water. Water appears in the Olympic Esplanade in two different ways. First of all there is still water, restful and specular (M). Two narrow ponds measuring 85 m x 3.6 m placed in the geometrical centre of the plazas subtly emphasize the complex's longitudinal axis; a third circular one with a 25 m diameter situated in the round plaza, closes the perspective of the Esplanade. The second way in which water appears is totally in contrast to the above, comprising live and noisy waters in the cascades (J) separating the three terraces. The two closest to the Stadium are straight and 80 m long, and the third is curved, with an arch of 120 m.

2. Light (Q). The light on the three terraces comes from columns 1.5 m in diameter by 18 m high which serve as a counterpoint to the flatness of the plazas. At the same time, both the cascades and the still ponds incorporate their own points of light. A third source of light is the large glass rings with a diameter of 2 m which hang from the Olympic gateways (see point 4).

3. Staircases and steps. The levels of the Esplanade are connected by extremely wide helicoidal steps (I). Meanwhile, other flights of steps and stairs (N), much smaller, link the different terrace levels. A third type of access between the different levels is the extremely wide steps, like grandstands, constituting the base of both the gateways and the cascades. Finally a ramp communicates the various terraces of the Olympic Esplanade, thus making its use and access easy for handicapped people.

4. The Olympic Gateways (K). These are made up by pillars and beams, forming a cube, and are fundamental elements of the complex as they are successively associated to the different buildings that comprise the Ring, even forming an integral part of the architecture itself in the case of the Sports Pavilion. Their importance is even more accentuated upon considering that with the Olympic luminaries, these are the elements that confer the vertical scale to the large esplanades.

5. Vegetation. In contrast to the natural green outside the Ring, the vegetation introduced into the different plazas have a remarkably geometric and rational tone. Following this idea there are two large green parterres (O), lightly sunken, which surround the linear ponds of still waters. In the round plaza, a similarly round parterre surrounds the central pond. Additionally, 64 bitter orange trees in large concrete flower pots (P) and with their tops trimmed, lie in line with the extremes of the two linear ponds.

6. Paving. The paving of the complex in the Olympic Ring was subjected to a meticulous study. In the Olympic Ring we can perceive two differentiated areas: the large Esplanade with its terraces, and the surrounding park. The former is paved, whereas the latter is fully natural and based on grass and trees (pine, oak and olive trees and cypresses) forming a typical Mediterranean forest. The paved esplanade is juxtaposed to the buildings, and being surrounded by vegetation on all sides, it appears as a clearance in the woods in the most literal sense. The shape of the perimeter of the complex, based on very simple lines (straight lines and

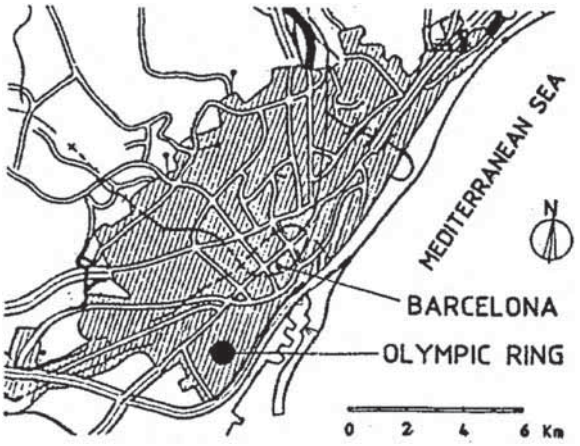


Figure 1. Situation of the Olympic Ring in Barcelona

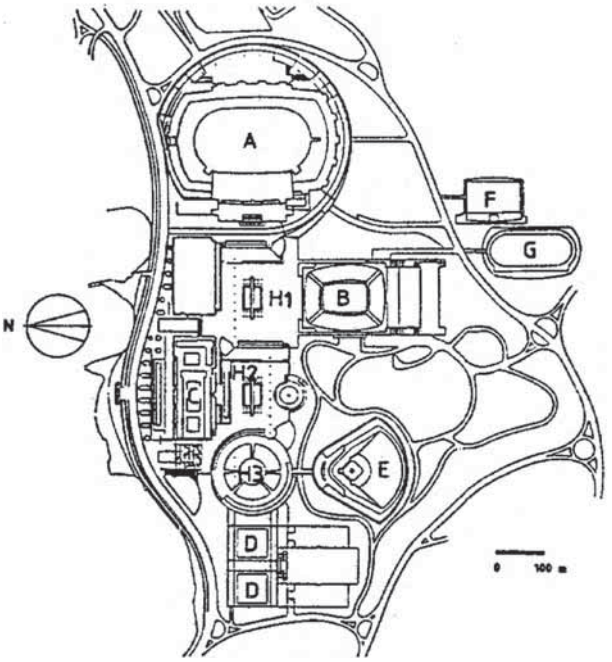


Figure 2. Olympic Ring

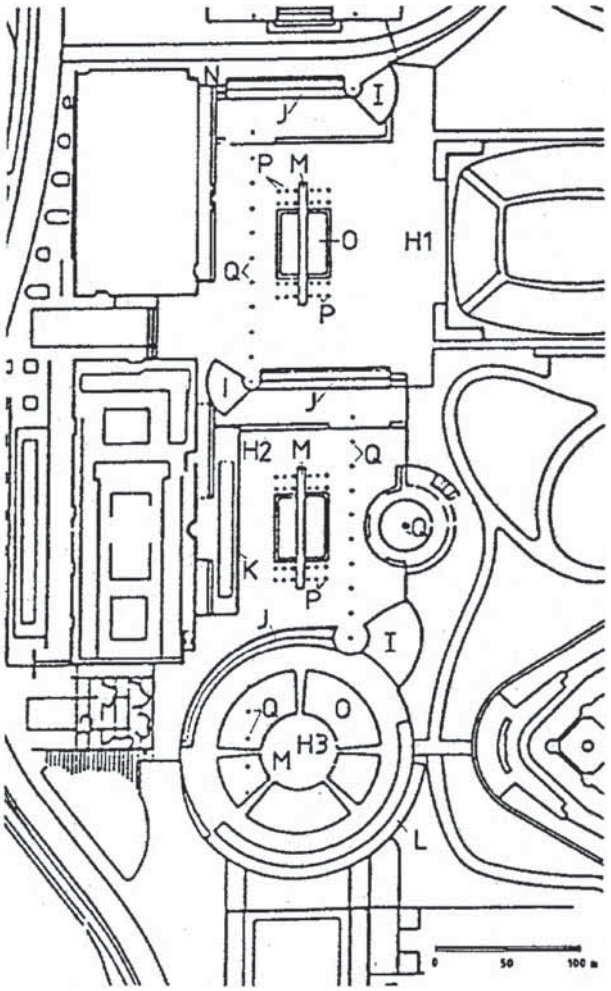


Figure 3. Esplanade of the Olympic Ring

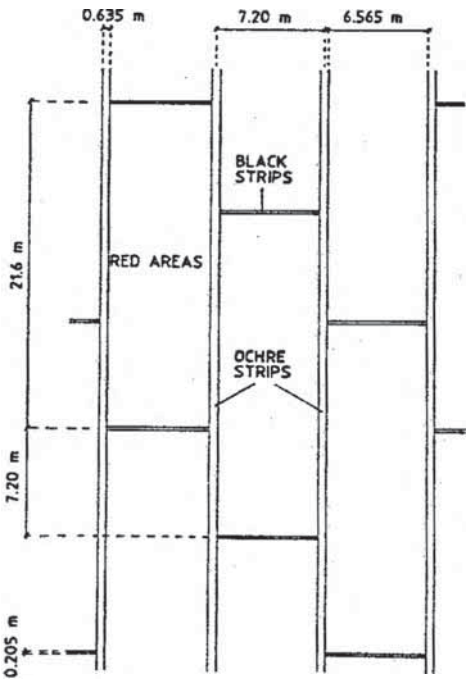


Figure 4. Basic layout of the pavement of the Esplanade

circumference arches) rationally cuts the adjacent park, subtly accentuating the contrast with nature.

The paved area of the Olympic Ring is much in excess of 60,000 m^2. To assist in the design of such a vast area, the idea of modulation emerged. A standard measurement of 7.20 m was chosen as it was easy to divide, and its sub-multiples could be perfectly adapted to commercial block sizes in the event of their use (15, 30, 45, 60 cm, etc.). Once the pattern module was established, the Esplanade was divided into 66 modules, a measurement reaching from the facade of the stadium to the INEFC building. An abstract drawing of 66 straight lines intercepted by varying elements (cascades, ponds, flight of steps, gateways, etc.) was defined. The formal and tonal composition was getting closer to a free interpretation of the pictorial experiences of Kandinsky, Klee or Mondrian. The tones chosen for the different elements were from the warm range of ochre and reddish colours, as well as black.

The major part of the Esplanade would be in a reddish tone, alluding to the tone of clay. This even tone would be intersected by innumerable parallel lines in an ochre colour, evenly separated, without beginning or end. These straight ochre lines coincide with the work modules in the final design, as they are 7.20 m apart. At the same time, transversal black strips were inserted between the modules but well set apart (every 21.6 m), and with a step pattern (Figure 4). Thus a non-ending paving design was achieved, a paving that could start or end wherever convenient, and which was perfectly suited to the conditions of the edges of the different terraces.

Finally the texture of the paving was defined. The main deciding factor arose from its use, which meant that it had to be slightly rough so as to guarantee adherence even when wet. This was completely in line with the idea of the project as it was wished to give the same effect as that given by bricks.

With the modulation perfectly designed, the exact dimension of the lines that would sketch the modules was determined, as well as the dimensions of the pieces that fill the gaps between the modules and the transversal black strips and their joints. Similarly, all the different elements of the composition susceptible to taking on specific dimensions were adapted to the module pattern, with the multiples and sub-multiples thereof.

Preliminary studies

For the execution of the formal design as expressed in the previous section, different solutions were brought forward with regards to the materials and structural sections to be used. The preliminary deciding factors considered in all cases were as follows:

a) Obtaining the colours and textures intended in the design, with an adequate guarantee of evenness.

b) Durability of the solution adopted (colours, textures and structural sections).

c) Possibility of reproducing colours and textures if repair or maintenance tasks were needed in the future.

d) Sufficient output during construction, bearing in mind the large extension to be paved.

With regards to the parameters of the project, the following were considered in accordance with the specific conditions of the situation of the pavement and its use:

a) Traffic: fundamentally for pedestrians, although it was possible that both during construction and later on, heavy service vehicles might have to pass.

b) Subgrade: the subgrade was divided into two different sections, one in cut and the other in fill. In the cut sections, the existing soil corresponded to a subgrade with a CBR between 5 and 10, whereas in the fill sections it was planned to compact the soil in order to obtain at least a similar CBR.

The above considerations and the previously established design led to the following considerations of a general nature on the materials and structural sections to be adopted:

a) The disposition of the areas with different colours and textures made it essential to distinguish the central reddish rectangles from the narrow strips surrounding them. The latter, due to their width, had to be designed by means of a discontinuous paving with blocks. The central areas, however, could be designed with this same solution or with a continuous pavement. In the discontinuous solutions, first of all the possibility of using blocks of natural stone, clay or concrete was contemplated. However, the blocks of natural stone were discarded due to the difficulties in obtaining the desired colours and textures as well as cost factors; the bricks were also rejected due to their durability. As to the continuous solutions, first of all the use of selected granular materials, asphalt or concrete was considered. However, the granular materials were decided against due to the possible generation of dust by pedestrians moving around. Asphalt materials were also discarded as they weren't considered suitable for paving with the existing factors in this case (colour, texture and the geometry of the pavement). Therefore the options of concrete blocks in the narrow strips and cast-in-site concrete slabs or concrete blocks in the central rectangles were initially acepted.

b) With regards to the structural sections, it was decided to use materials that could assure a good distribution of loads in order to avoid local settlements of the subgrade. Therefore solutions based on concrete slabs were chosen.

At first, for the central reddish rectangles, the continuous solution of cast-in-site concrete was adopted in an attempt to increase the output during construction, a highly critical aspect considering the more than 60,000 m^2 to be paved. However there were several issues that would first have to be resolved:

a) Concrete pigmentation. Surface pigmentation was rejected as it made impossible to obtain the textures defined in the project. Therefore, pigmentation would have to be used in the concrete mass. Due to reasons of cost, it was decided to pigment only the top part of the section (5 cm) which have to be bonded to the rest of the slab in order to assure correct structural performance.

b) Colour and texture. Specific colours and textures had to be obtained. Thus a series of tests was carried out in order to define the necessary gradings, mixtures and construction methods to obtain each colour and texture with sufficient mechanical strengths. The laboratory tests carried out were as follows:

1. 80 specimens of different colours or tones (red, violet, yellow, ochre and black); in order to do so, synthetic inorganic pigments which assured resistance to climatological agents were used, plus aggregates with the closest possible colour to that being sought (red, yellow and grey). These samples also allowed the final definition of the colour and tone of other elements of the pavement.

2. 40 small slabs (50 cm x 50 cm) on which different methods of obtaining the texture were tested (grooving, treatment with acid, sand chute). Additionally, different gradings of aggregates were used. As above, these slabs allowed the final definition of the texture of the different elements of the pavement.

c) Structural sections. In accordance with the above, the solution of using concrete slabs with a pigmented upper layer of 5 cm was considered. The thickness of the slabs was 15 cm in all, and the characteristic flexural strength of the concrete was 3.5 MPa.

d) Construction. To achieve the required results from the pigmented layer it was necessary to find a good method for bonding it to the lower concrete layer. Therefore and adhesion with resins could be used once the latter had set, which made the cost too high, or else the two layers could be laid successively wet on wet. In both cases it was difficult to achieve a high output during construction due to the shape of the paving itself, and particularly with regards to the latter proposal. This problem could only be resolved by means of a manual execution, slab by slab, which could mean renouncing the specific advantages of this solution.

e) Evenness of colour and texture. To check the result that could be obtained, a slab was constructed (7.2 in x 3.6 m) whose thickness was 10 cm of conventional concrete and 5 cm of pigmented concrete. Both layers were laid consecutively to assure an adequate bonding between them. In this slab, the difficulty of achieving even colouring and texture with cast-in-site concrete was noted, unless extreme precautions were taken in the regularity of concrete (above all workability) and construction (compaction, curing). Moreover, efflorescences appeared on the paving’s surface.



Figure 5. Part of the Esplanade and Olympic Stadium



Figure 6. Access to the Olympic Stadium



Figure 7. Part of the Esplanade and Sports Palace



Figure 8. Detail of the pavement

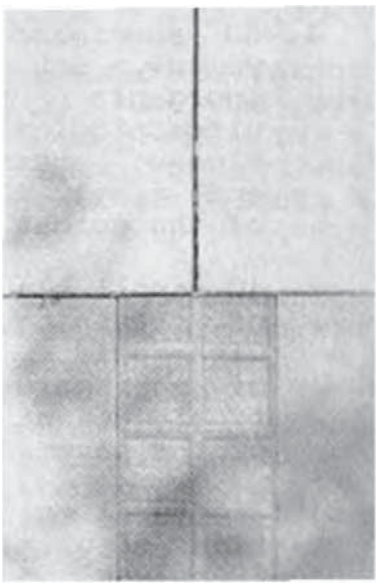


Figure 9. Detail of the pavement

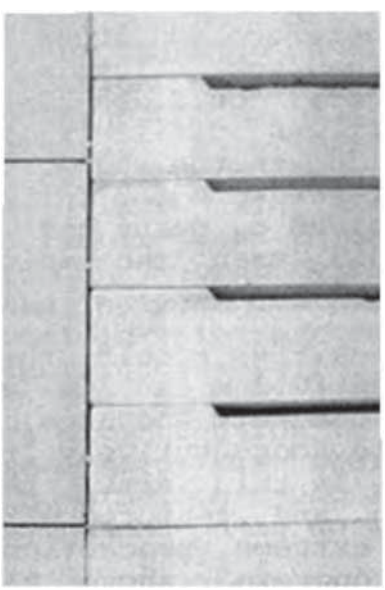


Figure 10. Drainage blocks



Figure 11. Additional pavement of the Ring



Figure 12. Additional pavement of the Ring

f) Long term performance. In addition to the above, a test pavement of 1,000 m^2 was constructed to check on the long-term performance of the chosen solution. The project included not only the rectangular reddish slabs but also the surrounding blocks, using the same design as in the Olympic Ring plaza. The difficulties observed were similar to those in the first slab, although somewhat less intense due to the precautions that had now been taken.

From all these tests, it was concluded that it was too risky to attempt a solution with cast-in-site pigmented concrete, and that this solution did not in fact have any of the construction advantages initially considered due to the geometric design of the pavement. Amongst the factors that made up the decision, the following are mentionable:

- high sensitivity of the final result (colour and texture) with variations in concrete mixtures (above all the cement/water ratio) or laying (compaction, curing).
- difficulty in avoiding efflorescences.
- high cost of pigments, and of the aggregates in the event of choosing them specifically for the suitable colour.
- difficulty in constructing two bonded layers
- difficulty in the future of reproducing the colours or the textures in the event of repairs or service maintenance.
- possibility of breakage of slabs due to soil settlements.

Due to all that goes above, a concrete block pavement set on concrete slabs was finally chosen, as shown in the following section.

Description of the solution adopted

To design the structural section of the pavement, recommendations from IECA (1,2) were followed. As per these, the structural section constructed was as follows:

- Concrete blocks 4 cm thick with a characteristic flexural strength of 4.0 MPa, a maximum absorption of water of 5.5 % and a maximum polishing of 4 mm. Joints of 5 mm were disposed between blocks, and 2 cm of mortar was placed below them.
-15 cm of concrete with a characteristic flexural strength of 3 MPa.
-15 cm of granular subbase in the areas in which the subgrade were of the worst quality.

Colours and textures defined as from the tests described in the previous section were reproduced by the manufacturers supplying the varying types of blocks. Regularity of these features was checked visually in each batch received against previously selected specimens. The dimensions of each one of the types of blocks were as follows:

- rectangular reddish areas: 50 cm x 50 cm x 4cm
- longitudinal ochre strips: 63 cm x 63 cm x 4cm
- transversal black strips: 20 cm x 20 cm x 4cm

The geometric tolerance of these measurements was 2 mm. Blocks with other dimensions were also used in some additional paved areas of the Olympic Ring. Part of these blocks were specially designed in order to adapt them to specific functions as for instance drainage (Figure 8) or for the steps. Figures 5 to 10 show general views and details of the Esplanade pavement, and Figures 11 and 12 are of other block pavements of the Ring.

Construction and costs

The pavement was constructed between January, 1989 and March, 1992. The subgrade was compacted to obtain 98 % of the maximum modified Proctor density. Both concrete slabs and blocks were laid by manual methods. Indicated herein is some of the data on the construction outputs obtained, as well as on the corresponding materials and execution costs (the exchange rate of 1 $ = 100 Pta was taken).

- reddish blocks	3 m^2 per hour/person:	39.82 $/m^2
- ochre blocks	3 m^2 per hour/person:	38.80 $/m^2
- black blocks	4 m^2 per hour/person:	35.00 $/m^2
- concrete slabs	200 m^2/day:	18.60 $/m^2
- granular sub-base	400 m^2/day:	6.59 $/m^2

Conclusions

In conclusion it can be said that the solution with concrete blocks proved to be the optimum one, as a combination of the following factors of the project:

- execution of a general geometric design.
- obtaining of relatively arbitrary colours and textures.
- good regularity of characteristics due to the industrial manufacture of the blocks.
- suitable surface behaviour against polishing.
- adaptation to subgrade settlements and reconstruction in the same initial conditions in the event of having to repair the pavement itself or the services installed below.
- sufficiently fast construction with complex shapes.
- cost.

With regards to the alternative solutions, the disadvantages were the following:

- stone blocks: cost and difficulty in obtaining specific colours and textures.
- bricks: lack of durability.
- extension of selected granular material: generation of dust.
- continuous paving (concrete, asphalt): difficulty in obtaining good evenness of colours and textures and in reconstructing in the future the same features on the surface, poor performance against subgrade settlements and low construction outputs with complex shapes.

References

(1) "Manual of concrete pavements for low volume roads". IECA. Madrid, 1988.
(2) "Manual of concrete block pavements". IECA/ITEC. Madrid, 1989.