

'El Palmeral' apartments in Aguadulce by Fernando Cassinello

José-Francisco García-Sánchez (Main and Corresponding Author)

Universidad Politécnica de Madrid. Escuela Técnica Superior de Arquitectura. Departamento de Proyectos Arquitectónicos

Avenida Juan de Herrera, 4, 28040 Madrid (Spain)

josefrancisco@coalmeria.com

Miguel Centellas-Soler

Universidad Politécnica de Cartagena. Escuela Técnica Superior de Arquitectura y Edificación. Departamento de Arquitectura y Tecnología de la Edificación

miguel.centellas@upct.es

Calle Real, 3, 30201 Cartagena (Murcia) (Spain)

Manuscript Code: 1403

Date of Acceptance/Reception: 18.03.2020/07.10.2019

DOI: 10.7764/RDLC.19.1.19-29

Abstract

'El Palmeral' apartments (1968-1970) located in Aguadulce, a tourist town in Almería, in the Andalusian region of southern Spain are the best work by the architect Fernando Cassinello (Almería, 1928-Madrid, 1975). The urban planning regulations of the development, which required the ground floor to be diaphanous, made possible the original solution of the three great reduced arches with the upper structure of porticos on each block. Hence, the apartments rest on six large arches, producing an image similar to that of an inhabited bridge. Fernando Cassinello, in his dual capacity as professor at the School of Architecture in Madrid and researcher at the Eduardo Torroja Institute of Construction Sciences (IETcc), always positioned himself in the median that unites Architecture and Engineering. In some of his works, an infrastructural derivative can be appreciated. Therein lays the interest of his architectural work. He was able to introduce singular structural aspects, even in private housing projects, both single family and collective. This could be in the way his buildings were related to the ground, or the way he dealt with stairs, which have so often been excluded from the built volume, and which served functions beyond facilitating vertical movement.

Keywords: concrete; structure; floor tiles, tourist housing, Almería.

Introduction

This paper examines one of the most important buildings by the architect Fernando Cassinello (Almería, 1928-Madrid, 1975) (Figure 1): the 32 apartments called 'El Palmeral' (1968-1970) in Aguadulce (Figure 2), a tourist town in Almería, located in the Andalusian region of southern Spain. His interest in structures led him to provide interesting solutions in this field, such as that of the dwellings in question, where the pillars of the upper floors alight on a large, lowered arch. A similar solution had been tried a few years before, in 1963, in the 'Edificio Playa' in Almería, when converting each portico made up of three pillars on the upper floors arriving to the ground floor in a singular geometrical "W".

Fernando Cassinello entered the School of Architecture in Madrid (Escuela de Arquitectura de Madrid) in 1946, and graduated in 1954. He combined professional activities with teaching in the field of Construction, as a Professor of Materials (1958-1960) and obtained the position of Professor of the School of Architecture of Madrid in 1967, a position which he held until his untimely death in 1975. In just 23 years of working in architectural practice, he built a significant number of buildings, mainly in Almería, but also in Madrid, Murcia, Pamplona and Seville.

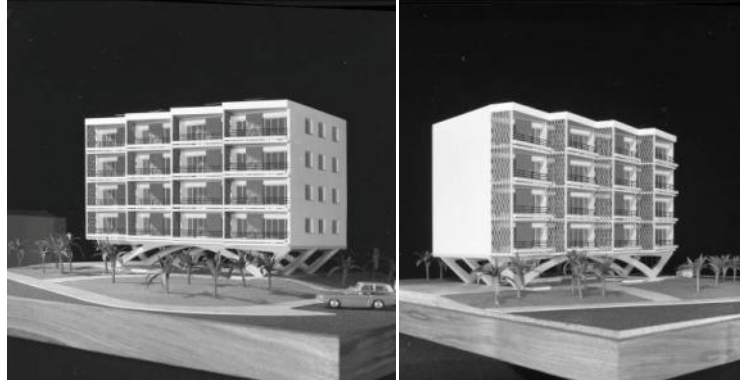
In the province of Almería, in addition to the residential buildings, he built several tourist facilities in the capital oriented towards the emerging film industry. Highlights include the 'Gran Hotel Almería' (1967), and the 'Alcazaba Gran Hotel' (1968), demolished in 2007. His architectural production is mainly found in the city itself and in two towns of the municipality of Roquetas de Mar: the developments of Aguadulce and Roquetas de Mar (Centellas-Soler & García-Sánchez, 2017).

He was a prolific author, with around 120 papers written in the journal *Informes de la Construcción*. He was a great connoisseur of brick, publishing several books on the subject. Among those that deserve to be mentioned are: *El ladrillo y sus fábricas* (1958) and *Muros de carga de fábrica de ladrillo* (1964). But his best-known book was *Construcción Hormigonera* (1974).

Figure 1. Fernando Cassinello and Eduardo Torroja (1961). Source: Cassinello Family archive.



Figures 2a and 2b. Model. 'El Palmeral' apartments. Photo: Cassinello Family archive.



He was a friend of the engineer Eduardo Torroja Miret (1899-1961) (Figure 1), with whom he collaborated on the construction of the Costillares Chapel in the Eduardo Torroja Institute of Construction Science (IETcc). He also collaborated with his son, José Antonio Torroja, on the construction of a rib-shaped concrete sheet that had the double function of a structural monument and the roof of an architectural space for holding various acts, located in one of the courtyards of the Institute. He was the Head of the Construction Department and Temporary Director (1968-1970) of the IETcc, where he became a German translator in 1950, and director of the journal *Informes de la Construcción*.

He was also a close friend of Felix Candela, and met Frank Lloyd Wright in Taliesin West in 1957, on the occasion of a trip made by the Spanish National Commission of Industrial Productivity. From his position in the Torroja Institute (IETcc), he established a close friendship with Richard Neutra, who was the foremost foreign collaborator to the journal *Informes de la Construcción* from 1956 to 1967. In 1968, the IETcc published the book *RJ Neutra*, edited by Fernando Cassinello, who was also the author of the prologue. Likewise, he was associated with Le Corbusier, whom he interviewed in his Parisian studio on rue de Sèvres.

He directed the *Spanish Association of Prestressed Concrete (Asociación Española del Hormigón Pretensado [AEHP])*, and was President of the *Spanish Technical Association of Prestressing (Asociación Técnica Española de Pretensado [ATEP])*. He was also Full Member of the *International Association for Shell Structures (IASS)* founded by Eduardo Torroja in 1958.

He served on various committees of the *Conseil International du Bâtiment (CIB)* in the W-23 commissions (*Wall Structures*) at their meetings in Paris (1962), London (1963), Oslo (1965), and Kiev (1967). He attended the *VII International Congress of the International Prestressing Federation (VII Congreso Internacional de la Federación Internacional del Pretensado [FIP])* held in New York in 1974, as a delegate of the Spanish group, where he presented the paper "Prestressed Concrete in Spanish Building".

Figure 3a. Perspective. 'El Palmeral' apartments. Source: Archivo del Ayuntamiento de Roquetas de Mar, Almería (Spain).
Figure 3b. Arch detail. 'El Palmeral' apartments. Source: Archivo del Ayuntamiento de Roquetas de Mar, Almería (Spain).

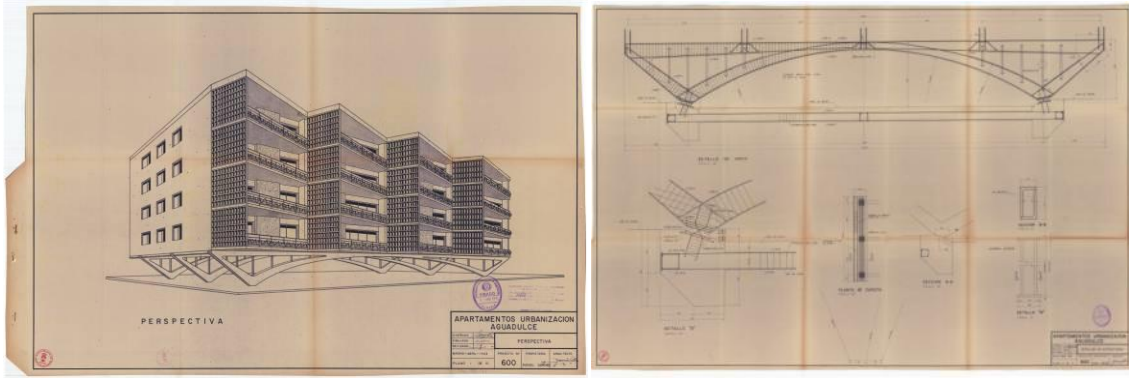


Figure 4a. Three Archs. 'El Palmeral' apartments. Photo: Cassinello Family archive.
Figures 4b and 4c. Arch detail. 'El Palmeral' apartments. Photo: Cassinello Family archive.



Figure 5a. Arch during construction. 'El Palmeral' apartments. Photo: Cassinello Family archive.
Figure 5b. Arch finished. 'El Palmeral' apartments. Photo: Cassinello Family archive.



Figures 6a, 6b and 6c. Final image. 'El Palmeral' apartments. Photo: Cassinello Family archive.



References. Inhabited bridges

The most characteristic elements of the 'El Palmeral' apartments are the three large arches on the ground floor on which the upper levels rest (Figures 3, 4 and 5) (Cassinello, 1974, p. 202). The following references are inevitable: *Casa Puente* (1945), built by Argentine architect Amancio Williams (1913-1989) for his father in Mar del Plata, or *Casa Chávez Peón* (1951), in the Pedregal Gardens in Mexico City, a work by the architect Francisco Artigas, although in this case, the structural solution is totally different. In *Casa Puente* (1945), a work by the architect Amancio Williams, to save the Las Chacras stream, the architect projects a slab supported by edged girders that constitute the lledge of the house. These elements transmit the strength of the transversal walls that rest on a recessed cylindrical vault, supported by its ends. It is, structurally, a very different solution to that of 'El Palmeral', but in both cases, you can see the interest in leaving the center of the ground floor free.

Other examples exemplify the idea of building 'inhabited bridges', such as the *Warner House* (1956), by the architect John Johansen on the Rippowam River in New Canaan, United States, or the *Weekend House* (1967), in San Luis Obispo, California, a work by the architect Craig Ellwood. Two large arches support the three floors of the *Administrative Building* (1971), in Stade, Germany, by architect Gustav Gullmer, with the intention of freeing up the ground floor (Gullmer, 1971). And in the history of construction, we also recognize some bridges with the intention of being inhabited: such as the *Pont Notre-Dame* (1576), on the River Seine in Paris, a work by the architect Androuet du Cerceau, or the *Gallery of the Château de Chenonceaux* (16th century, on the Cher river, also in France, a work by the architect Jean Bullant. The castle is by Philibert Delorme. There are also projects which have never been built, such as the '*bridge-skyscraper*' (1928) by Chicago architect C.L. Morgan. He proposed a great structure of arches that crossed the whole city, with habitable piles used for diverse purposes. They would be accessible both from the lower floors and the upper part of the bridge.

Bibliographic references

Reference to 'El Palmeral' Apartments (Figure 6) was first published in the 1971 (*Anuario*) *Yearbook*, edited by the Official Association of Architects of Catalonia and the Balearic Islands (Colegio Oficial de Arquitectos de Catalunya y las Islas Baleares) (Cassinello, 1971, p. 47), occupying only one page and including a short text, two photographs and a typical floor plan. The publication collected the constructions that architects from all over Spain had sent, although they were mainly works by Catalan architects. On a single page, a short text, a typical floor plan, a photograph with an external arch and a whole one are shown.

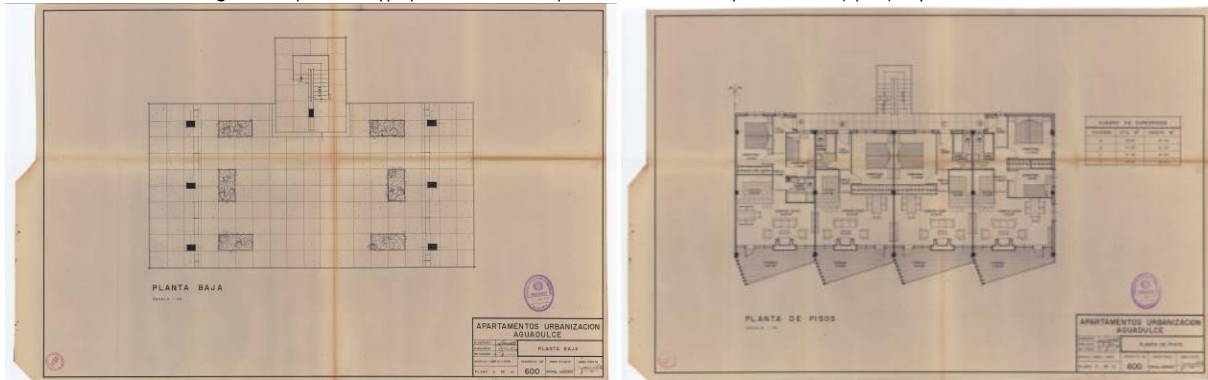
The following brief reference is found in the year 2012, in a book about architecture linked to tourism in the Mediterranean, entitled *La arquitectura del sol_Sunland architecture* (Villanueva, Orejudo & Santiago, 2002), where it is possible to see two photographs of the facade and a perspective of the original project by Cassinello.

The architect and Pritzker prize winner Rafael Moneo, during his tenure as professor of the subject 'Elements of Composition' in the School of Architecture of Barcelona (Escuela de Arquitectura de Barcelona), proposed studying the plan of 'El Palmeral' and its relationship to orientation, as a second exercise, in the course 1973-1974, in addition to the project of a new façade (Moneo-Vallés, 2017, p. 159). Rafael Moneo omits the original location of the building by Cassinello, as well as its author, and states in the exercise that the apartments are located on the Costa Brava —in Barcelona—, also changing the orientation towards the north. This is a veiled criticism of this work, whose layout of the lattices of the terraces, although helping to provide independence from neighbors, does not orient them well in relation to solar radiation, since they are facing north, when they should logically be placed to protect the terraces from the harsh Mediterranean sunlight.

In 2014, the authors of this paper made a study of the work by Fernando Cassinello by publishing different texts about the architect, which very briefly include the 'El Palmeral' apartments. Among the published texts, the following two can be highlighted:

- a) A study on the staircases of his buildings can be seen in «Fernando Cassinello: La construcción del paseo vertical» published in 2014, which highlights in a special way the stairs flowing from two sections, which starts in the apartments' El Palmeral 'and is repeated in' Las Chumberas' in 1971 (García-Sánchez & Centellas-Soler, 2014).
- b) A more extensive article on the professional, teaching and research activity of our subject: «Fernando Cassinello Pérez, polyhedral architect» was published in the year 2017, in which a general vision is given to the work of the architect, in which his most important buildings stand out, among them, 'El Palmeral' (Centellas-Soler & García-Sánchez, 2017).

Figure 7a. Ground floor plan. 'El Palmeral' apartments. Source: Roquetas de Mar (Spain) City hall archive.
Figure 7b. Apartment type plan. 'El Palmeral' apartments. Source: Roquetas de Mar (Spain) City hall archive.



Project and distribution

'El Palmeral' apartments by the architect Fernando Cassinello, located on plot 15 of the Avenida de El Palmeral in the Aguadulce development —the planning was designed by the architect Diego Méndez González in 1964— were built by Rafael Sánchez-Bretones and are made up of two identical, but not symmetrical blocks, linked at one of the front walls. Each one has four levels of apartments, 4 per level, with the total group consisting of 32 apartments. An independent project was carried out for each block, with the one located to the south the first to be built (Figure 5b). Of the two buildings, the one located to the north corresponds to file 120/68 of the College of Architects of Almería (Colegio Oficial de Arquitectos de Almería). It was visited on February 19, 1968 —corresponding to the number 479 of the file of Fernando Cassinello— and the Final Certificate of Work (CFO) was issued on January 13, 1969. The second block, further south, has the number 600 in the architect's file and the date of design on the cover of the plans of April 1968. There is no more documentary evidence in the Association of Architects of Almería (Colegio Oficial de Arquitectos de Almería).

The architect explains the building in the report of the project as follows:

«In the new Aguadulce development, the construction of a block of apartments has been designed whose conditions of order and volume respond to the development project approved in the declaration of The National Tourist Interest Center (Centro de Interés Turístico Nacional).

The ground floor, due to ordinance requirements, has been planned to be totally diaphanous, a circumstance that has permitted the creation of an original solution of great structural audacity, consisting of three large arches on which the whole building rests.

In accordance with the structuralist conception, the stairway of exposed concrete, floating on the rear façade and with steps floating from the central line of the stringer, has also been projected» (Cassinello, 1968).

On the ground floor there is no monotonous repetition of the floor tiles, but rather, it is a reference plan to which the rest of the elements are subjected, something that we also find in many of Mies van der Rohe's works (Figure 7a). Thus, the width and length of the plan coincides with the modulation of the pieces and the size and position of the planters obeys the traces of the flooring. Also, the beginnings of the three arches are supported on the grid of the tiles, the two outer arches being aligned on their outer side to one of the longitudinal joints, and the central arch supports its axis on another of the joints of the tiles (Figures 2, 3, 4, 5 and 6). This also occurs in the area of the staircase, whose width and length coincide with the module that the floor dictates, as well as the width of the stringer that measures exactly two modules.

There are two types of apartments, of one or two bedrooms, depending on whether they are central or at the ends of each block. In the houses that have a double bedroom located at the ends, they open through the lateral side in one of the houses; however, in the house that adjoins the neighboring block, the two bedrooms open towards the rear. The two central apartments of each block have a single bedroom that exclusively opens through the gallery-access corridor (Figures 8 and 9).

In all the apartments, the living-dining room is oriented towards the main façade, leaving the kitchen open to the living room; except in the extreme apartments of the group which have a window that can be seen in the side façades.

The living-dining terraces extend out from the façade and the structural line that marks the concrete arch. They have a layout similar to a 'saw tooth', generating terraces at right angle triangles, with the longer side facing south —to the sea— and the shorter side formed by a lattice of ceramic material. On the hypotenuse rests the glass enclosure of the living-dining room, which is interrupted by a chimney that is seen from the exterior, covered with exposed ceramic brick. The chimney takes up 1/4 of the total width of the terrace, and a French window on one side occupies 2/4, and 1/4 of fixed glass is on the other side (Figure 7b).

The same type of staircase was constructed in the three blocks adjacent to 'El Palmeral', called 'Las Yuccas' (1971). It is also similar to the staircase of another block that was built nearby called 'El Pitaco' (1972). In the development in Roquetas de Mar, Cassinello built 'Las Chumberas' (1971), a group of buildings made up of two independent blocks, which have one more apartment per floor than those of 'El Palmeral' in Aguadulce. In other respects, however, they are very similar. Here, he built a staircase, also with a stepped stringer, but resting on a lattice wall formed of square pieces. In an attempt to unify the work, they were also used in the division of the terraces, in a 'saw tooth' pattern, on the main elevation, similar to the Palmeral buildings.

Figure 8a. Cross section. Structure detail. 'El Palmeral' apartments. Source: Roquetas de Mar (Spain) City hall archive.

Figure 8b. Stairs detail. 'El Palmeral' apartments. Source: Roquetas de Mar (Spain) City hall archive.

Figure 8c. Stairs detail. 'El Palmeral' apartments. Photo: Cassinello Family archive.

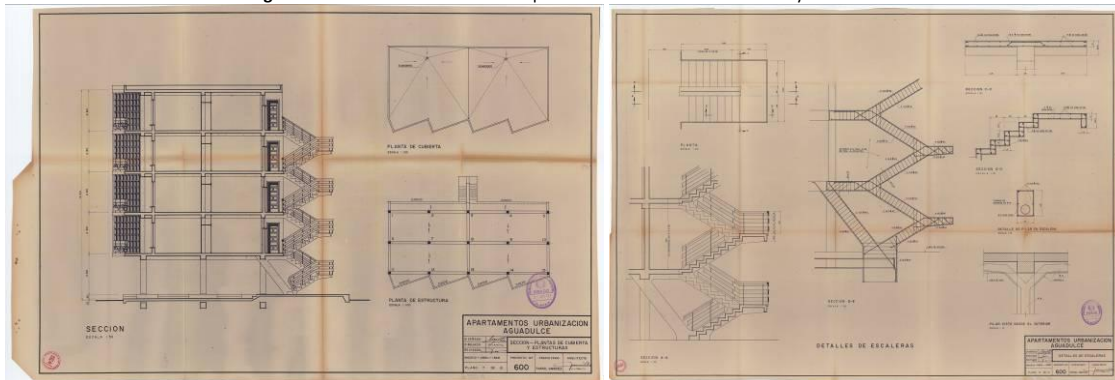


Figure 9a. Stairs during construction, where it is possible to see his daughter Pepa Cassinello on the stringer and staircase finished. 'El Palmeral' apartments. Photo: Cassinello Family archive.

Figure 9b. Stairs details during construction. 'El Palmeral' apartments. Photo: Cassinello Family archive.

Figure 9c. Stairs during finished. 'El Palmeral' apartments. Photo: Cassinello Family archive.



Fernando Cassinello, in his famous book *Construction Hormigonería* (1974), developed during his time as Professor of Construction of the School of Architecture of Madrid (*Escuela de Arquitectura de Madrid*), explains of the use and methods of concrete construction, occasionally illustrated with photographs of his own works (Cassinello, 1974). In chapter 17, entitled 'Linear elements, generalities, supports, beams, arches and trusses', we can see some photographs taken during the construction of the arches of the 'El Palmeral' apartments, as well as a sectional outline of the arch, the bi-articulated supports and the five pillars that rest on it. He refers to this type of structure in this way: «*The bi-articulated arch is used when it is not interesting to send a moment of force. It is somewhat stiffer than the tri-articulated arch and is used almost exclusively for cable-stayed arches*» (Cassinello, 1974, pp. 405-407).

In chapter 19, entitled 'Stairs and ramps', two photographs appear under the heading 'flying slabs'. This is a element widely developed by Cassinello in different works (García-Sánchez, J.F. & Centellas-Soler, M., 2014), and research papers (Cassinello, 1958). One of them was taken during construction, where it is possible to see his daughter Pepa Cassinello (Figure 9a) on the stringer, and the other was taken when the staircase was finished, with the railings in place (Cassinello, 1974, p. 441). In chapter 10, entitled 'Formwork', the stairs appear during the construction process, emphasizing the formwork of the stringers and steps, as well as a detail of the section of the stairs (Cassinello, 1974, pp. 216-217).

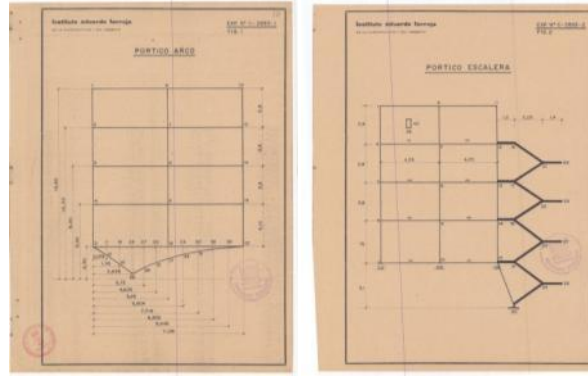
The staircase of 'El Palmeral', which is really two, has a longitudinally flying stringer and platform. However, having a stepped stringer of constant thickness of 10 cm, requires a beam to be located in the center of the staircase that joins both slabs and whose layout runs parallel to the angle that the stringer forms. This beam is responsible for absorbing the greatest force; and since it is located in the center of the staircase, its visual presence is minimized by the shadow cast by the slab itself. Thus, a true effect of lightness in the staircase is provoked, with only the width of the thin stepped shank presented. The railing is formed of a light steel substructure, and on it, three wooden bands which leave a distance similar to the width of the piece of wood between them (Figure 8 and Figure 9).

The rung is constructed of reinforced concrete executed in-situ, and it also flies in its transversal and centrifugal direction with respect to the beam. According to Cassinello in his book *Construcción Hormigonería* (1974): «*... the stepped staircase offers advantages over the continuous uniform thickness, because in the successive steps the vertical side of the step is the one that works more favorably in the absorption of moment, for its greater edge, while the horizontal surface of the steps, while playing the role of compression and tensile heads of the resulting Z-beams, require the longitudinal armature of distribution, which is, at the same time, responsible for the longitudinal continuity of the stringer*» (Cassinello, 1974, pp. 440-441).

Figure 10. Structure calculation report. Eduardo Torroja Institute of Construction Science (IETcc). Instituto Eduardo Torroja de la Construcción y del Cemento (IETcc). 'El Palmeral' apartments. Source: Roquetas de Mar (Spain) City hall archive.



Figure 11. File. Exp. C-2893-1 & C-2893-2. Structure calculation report. Instituto Eduardo Torroja de la Construcción y del Cemento (IETcc). 'El Palmeral' apartments. Source: Roquetas de Mar (Spain) City hall archive.



Structure. Computer calculation

In January 1964, the 'Electronic Calculation Section' (*Sección de cálculo electrónico*), belonging to the 'Calculation Division of the Studies Department' (*División de cálculo del Departamento de Estudios*), was created in the Eduardo Torroja Institute of Construction Science (IETcc). That same month, a new computer, an NCR-Elliott 803 B, was received and installed. It was one of the most powerful machines for scientific calculation in the country at a time when computers were beginning to be installed in banks and large companies and were mainly devoted to administration and accounting tasks (Morán, 2008).

For the calculation of the structure of 'El Palmeral', the services of the 'Electronic Calculation Service' of the IETcc were required (Figure 10). It was the first building in the province, and perhaps Andalusia, whose structure was calculated with the help of a computer.

The urban regulations of the Aguadulce development (Almería), which required that the ground floor be diaphanous, resulted in the original solution of three arches on which a structure of porticos is situated. With the date of February 9th, 1968 and file number C-2893, Fernando Cassinello carried out the formal request for the computer calculation of two of the structure's elements: a) The portico of the arch (C-2893- 1), which had 32 nodes, 48 bars and 1 load hypothesis (48 bars); and b) The stair gantry (C-2893-2), which had 28 nodes and 1 load hypothesis (39 bars) (Figure 11).

In (Figure 11), the structural data and the assumed loads are provided, as well as the calculation of: a) The shifts and rotation of the nodes, b) The axial and cutting forces and c) The bending moments.

A year later, Fernando Cassinello was invited by the School of Architecture of Seville (*Escuela de Arquitectura de Sevilla*) to participate in the Symposium on Teaching Structures, on April 29th, 1969. He gave a lecture entitled «The Architect and Structure» (*El arquitecto y la estructura*). A few months later, on October 28th, 1969, the Official Association of Architects of Madrid (Colegio de Arquitectos de Madrid) proposed that he give that same conference, but updated, in the *III International Fair of Construction and Public Works* (FICOP), in the Pabellón de Cristal of the Casa de Campo in Madrid. These two lectures gave rise to the monograph (Cassinello, 1970) of the same name that the IETcc published in March 1970. In it, an example is given of the calculation made by the computer, of the portico of the arch of the apartments of 'El Palmeral'. He develops it following three phases in the calculation:

First step: Pascal

In this step, only the balance of forces is taken into account, in order to conceive the structural scheme and test the sizing of its various elements. The structural layout, given the shape and dimensions of the building, responds to the double-bay scheme, with longitudinal porches, four open spans of 5.50 m, with pillars located on the walls, extreme pinions, and separation lines between the four apartments on each floor. Once the structural scheme of the houses was decided, which allowed 4 apartments per floor and block, the original possibility of the diaphanous structure on the ground floor was raised, which did not make the construction of the upper floors more expensive. The nature of the ground played an important role in the acceptance of the definitive solution, since it would be able to absorb tension on the order of 2.5 kp/cm². The arch solution was tested, but the embedding of the support would have

produced uneven pressure on the ground, and would also have been a very unfavorable solution due to the temperature, which varies from + 10°C to + 50°C, given the effect of direct sunlight on the exposed structure.

Therefore, the bi-articulated arch solution was chosen. A simple isostatic calculation permitted the measurement of the dimensions of the structural elements: pillars: 0.30 x 0.30 m, beams: 0.30 x 0.40 m (edge $L/10 > h > L/15$). Dimensions of the arch: light = 16.60 m, arrow: 2.90 m ($F/L = 1/6$, reduced arch). Edge in the key: $hc=0.40$ m ($L/40 > hc > L/50$). Edge: $ha = 0.70$ m ($2hc > ha > 1.5hc$).

Second step: HOOKE

Once the longitudinal and transversal dimensions of each of the pieces were fixed, as well as the isostatic loads and reactions, the next step was to deal with the elastic calculation of the structure, with the help of the NCR-Elliott 803 B electronic computer. The data provided were the following: the coordinates of each of the nodes considered and the rigidity of each of the pieces, as well as the actions.

Due to the symmetry of the structure, it was decided to consider only half a portico (C-2893-1) in the arch, with 32 nodes. Being a reticulated structure, with movable and rotating nodes, the equilibrium conditions in each node were proposed: the balance of horizontal forces, the balance of vertical forces and the balance of moments. Thus, three equations were produced per node: $3 \times 32 = 96$. That is, the problem was reduced to the resolution of a system of 96 equations with 96 unknowns. The primitive computer solved the problem by means of a matrix calculation, whose matrix is defined by bands, in which the main diagonal has the rigidity of the pieces as a coefficient. In the lines parallel to this diagonal, the transmission coefficients appear, and the rest is formed of zeros, the independent terms being the loads and moments of embedding. The problem was solved by the computer in 15 minutes. Using the same procedure, and with a little less time, the transversal type of the staircase (C-2893-2) was calculated. It performs two fundamental missions: creating the oblique point that guarantees transversal stability to wind and housing downspouts, water supply, electricity and telephone lines; and cantilevering the structure of the access staircase.

All this is collected in a file full of numbers, since in each node there are turns, horizontal and vertical displacements, bending moments, and shear and normal forces. The computer was equipped with a printer and the corresponding graphics were drawn.

Figure 12. Uniqueness of the joints at the ends of the arch during construction. 'El Palmeral' apartments. Photo: Cassinello Family archive.



Third step: TORROJA

Given the uniqueness of the joints at the ends of the arch, it is worth commenting on its constructive organization (Figure 12 and Figure 13). In reinforced concrete, it was usual, at that time, to achieve an articulated effect by means of simple notches, whose structure produces bi-compression stress on the ball joint, which facilitated the possibility of turning by plasticizing the material. Therefore, the first concern was that the section of limitation would be able to absorb the total value of the reaction, admitting that in said section, and by its type of bias compression, a working voltage of $0.8R_k$ could be accepted. The second problem arose as a result of the appearance of strong transversal traction in the vicinity of the ball joint, forcing the tension to converge in the smaller thickness of that area. The value of this traction can easily be determined to be $0.18N$ in the longitudinal direction and $0.06N$ in the orthogonal sense. Constructively, strongly spiked cross-armored reinforcements were placed in equal lengths to the edge, to absorb the transversal traction.

Figure 13a. Concrete sculpture located at the entrance of the plot. 'El Palmeral' apartments. Photo: Cassinello Family archive.

Figure 13b. Ground floor. 'El Palmeral' apartments. Photo: Cassinello Family archive.

Figure 13c. Final image. 'El Palmeral' apartments. Photo: Cassinello Family archive.



Conclusions

In 'El Palmeral' Apartments (Figure 2, Figure 4, Figure 6 and Figure 13), we can appreciate the peculiarities that Fernando Cassinello introduced in these tourist apartments, built mainly in the developments of Aguadulce and Roquetas de Mar in Almería. The access through the corridor in the rear façade, the terraces placed facing the sea, the use of ceramics in its constructive definition as an enclosure or as a lattice, and the concrete stairway seen from two sections flying in the rear façade.

The urban planning regulations of the development, which required that the ground floor be diaphanous, resulted in the original solution of the three great reduced arches on which the upper structure of porticos of each block was placed. It is really possible that there were other possibilities, but Cassinello decided on the one that he considered most suggestive from the plastic point of view, without considering the economic costs.

Undoubtedly, it would have been more rational and cheaper if the ground floor had been resolved with the same structural frames as the upper floors, but the architect considered that the one with the arches was the best option. Cassinello did not carry out this uniqueness of the arches in any of the buildings that he later projected.

Hence, the apartments rest on six large arches, producing an image similar to that of an inhabited bridge. In this way, the boundaries between the public space of the street, the garden of the plot, and the private covered, but open space that literally crossed the building on its lower level, produced a cool, shady, genuinely Mediterranean space.

He was able to introduce singular structural aspects, even in private housing projects, both single family and collective. This could be in the way his buildings were related to the ground, or because of the way he built the stairs, which have often been excluded from the built volume, and which served functions beyond facilitating vertical movement. In the case of 'El Palmeral', they were cantilevered stairs whose energetic expression made them part of the urban landscape and were located in the back, allowing access to homes through a gallery open to the outside. This structural solution of the staircase is very interesting when it reaches the ground floor. The pillar on the upper floor leans outwards to pick up the start of the central stringer on which the ladder rests (Figure 8).

Fernando Cassinello always positioned himself in the median that unites Architecture and Engineering. In some of his works, an infrastructural derivation can be appreciated, a timeless condition that allowed the wear produced by the passage of time to be incorporated naturally into the creative process. The use of reinforced concrete, a material on which he was an expert, favored that his surfaces were tattooed as a consequence of the construction process (Figure 13). Therein lay the interest of his architectural work.

- Burmester, G. (1971). Edificio administrativo suspendido en Stade-Alemania. *Informes de la Construcción*, 23(228). <http://dx.doi.org/10.3989/ic.1971.v23.i228.3398>.
- Cassinello-Pérez, F. (1958). Escaleras helicoidales. *Informes de la Construcción*, 10(100). <http://dx.doi.org/10.3989/ic.1958.v10.i100.5569>
- Cassinello-Pérez, F. (1968). *Memoria descriptiva del Proyecto de los Apartamentos 'El Palmeral' de Almería. Proyecto 479 y 600 (febrero y abril de 1968)*. Almería: Archivo Municipal del Ayuntamiento de Roquetas de Mar.
- Cassinello-Pérez, F. (1970). *El arquitecto y la estructura*. Monografía del Instituto Eduardo Torroja de la Construcción y del Cemento, IETcc. Número 285. Madrid: Patronato de investigación y técnica «Juan de la Cierva» del CSIC, Consejo Superior de Investigaciones Científicas.
- Cassinello-Pérez, F. (1971). Edificio para apartamentos 'El Palmeral'. *Cuadernos de Arquitectura y Urbanismo. Anuario I*, 84, p. 47. Barcelona: Colegio Oficial de Arquitectos de Cataluña y Baleares.
- Cassinello-Pérez, F. (1974). *Construcción Hormigonera*. Madrid: Editorial Rueda e Instituto Juan de Herrera.
- Centellas-Soler, M. & García-Sánchez, J.F. (2017). Fernando Cassinello Pérez, arquitecto poliédrico / Fernando Cassinello Pérez, polyhedral architect. *Informes de la Construcción*, 69(545): e174. Madrid: Consejo Superior de Investigaciones Científicas. <http://dx.doi.org/10.3989/ic.16.083>.
- García-Sánchez, J.F. & Centellas-Soler, M. (2014). Fernando Cassinello: la construcción del paseo vertical. In: Barbero-Barrera, M.M., Olivieri, F. & Pinilla-Melo, J. (eds.), *Miradas a la investigación arquitectónicas: construcción, gestión, tecnología (Architectural research findings: building construction, management, technology)*, pp. 478-483. Congreso Internacional sobre investigación en Construcción y Tecnología Arquitectónicas, 11-13 de junio de 2014. Madrid: Escuela Técnica Superior de Arquitectura, Universidad Politécnica de Madrid.
- Moneo-Vallés, R. (2017). Segundo ejercicio. 14 de noviembre de 1973. Cátedra de Elementos de Composición. Curso 1973-1974. In: García-Estévez, C. (ed.), *Rafael Moneo. Una manera de enseñar arquitectura. Lecciones desde Barcelona, 1971-1976. Clásicos del siglo XX*, 4, p. 159. Barcelona: Escuela Técnica Superior de Arquitectura de Barcelona, Universitat Politècnica de Catalunya.
- Morán-Cabré, F. (2008). La revista Informes y el servicio de cálculo electrónico del Instituto Eduardo Torroja / The journal Informes and the Eduardo Torroja Institute's computerized structural analysis service. In: Cassinello-Plaza, P. (ed.), *El espíritu impreso de una idea / The spirit of an idea in print*, pp. 274-287. Madrid: Instituto de Ciencias de la Construcción Eduardo Torroja, CSIC.
- Villanueva-Pleguezuelo, E., Orejudo-Utrilla, A. & Santiago-Lardón, J.Á. (2002). AND: Almería, Granada y Málaga. Desengaño veraniego. In: VV.AA. *La arquitectura del sol_Sunland Architecture*. Barcelona: VV. Colegios de Arquitectos.