Timbrel Construction and Reinforced Concrete in Madrid Rationalism (1925-1939)

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ABSTRACT: In the period between 1925 and 1936, within a national and international context marked by the search for a new architectural idiom and the use of new materials, a series of important buildings were constructed using reinforced concrete in Spain, as a result of the fruitful collaboration between the group of Madrid-based architects known as the Generation of 25 and civil engineer Eduardo Torroja. Several of the most brilliant contributions of modern Spanish architecture to the European scene were made in little over 10 years. In this context, timbrel construction, with its long and deep-rooted tradition in Spain, continues to be used throughout the entire country. In Madrid, it survives and exists alongside new techniques totally naturally in a significant number of new buildings built by the best architects, who are at the same time working on the spectacular reinforced concrete projects.

INTRODUCTION AND CONTEXT. THE MODERN MOVEMENT IN SPAIN

The special characteristics of Spain's history between 1925 and 1939 determines the development and subsequent progress of the architecture of our Modern Movement and succeeds in differentiating it, following the Civil War, from that of the rest of the countries in Europe with which it should, culturally speaking, have continued to correspond.

The Spanish Modern Movement is less well-known than others not because it is less valuable or interesting, but because of the coming together of a series of circumstances and, especially, the consolidation of the Franco Regime after the war enveloped it in a *cloak of silence*.

Throughout these years Spanish architects remained abreast of what was going on elsewhere in Europe, with two major centres of activity in Madrid and Barcelona and relevant figures across the rest of the country with two important Modern groups being formed: *G.A.T.E.P.A.C (Grupo de Arquitectos y Técnicos Españoles para el Progreso de la Arquitectura Contemporánea / Group of Spanish Architects and Technicians for the Progress of Contemporary Architecture)* and the *Movimiento Racionalista (Rationalist Movement)*.

The dramatic nature of the Spanish Civil War (1936-1939) also has tragic repercussions on architectural circles with the deaths of a number of young and brilliant architects such as Aizpurúa in 1936 and Torres Clavé in 1939, the latter a friend and partner of Josep Lluis Sert.

However, the great intellectual catastrophe only occurred with the end of the war and the defeat of the Second Republic, during the first years of the Franco Regime. This not only brought the final curtain down upon the Modernist Movement as far as architecture within Spain was concerned, but also halted the intellectual and professional development of several complete generations of architects and prevented any chance of the pre-war movement from continuing.

Those architects who remained in Spain were the victims of purges and restrictions, which were brought to bear, some for life and even on pain of death, and any possibility of continuing with the Modern ideas and idioms that had developed before the war was simply swept aside.

Another large group saw out their lives in exile in Argentina, Colombia, Cuba, Chile, the United States, France, Mexico, Poland, Santo Domingo, Venezuela, etc.

Of these, perhaps the most noteworthy are Manuel Sánchez Arcas in Poland, Martín Domínguez, initially in Cuba and then in the United States, and the most internationally recognised of all, Josep Lluís Sert, also in the United States.

THE RATIONALIST MOVEMENT IN MADRID: MADRID RATIONALISM

In Madrid a group of architects whose members embarked on their professional careers between 1918 and 1923 worked alongside, and in coexistence with GATEPAC, to which some of them actually belonged.
Rafael Bergamín (1891-1970), Luis Blanco Soler (1894-1988), Regino Borobio (1895-1976), Casto Fernández-Shaw (1896-1978), Miguel de los Santos (1896-1991), Agustín Aguirre (1896-1985), Manuel Sánchez Arcas (1895-1970), Luis Lacasa (1896-1966), Fernando García Mercadal (1896-1985), Carlos Arniches (1897-1955), Martín Domínguez (1897-1970) y Luis Gutierrez Soto (1900-1977). They are referred to by Carlos Flores as the Generation of 25, due to the influence a journey they made, as recent graduates, to the Decorative Arts Exhibition in Paris in 1925 had on them, where regionalist historicisms together with the most modern and radical proposals of the time were exhibited simultaneously.
This group, together with the somewhat older, Secundino Zuazo (1887-1970), the most influential architect in Spain at that time, developed a rationalist architecture with a variety of responses but with a common attempt to eliminate ornament, and search for new solutions more in line with the vanguard currents prevalent in Europe and in contrast to the regionalism so prominent in the country during this first quarter of the century.
Although as a group, the Generation of 25 did not attain the radicalism apparent in the more developed G.A.T.E.P.A.C. proposals in Barcelona, it is in Madrid where the first truly modern buildings in Spain were designed and built: *El Rincón de Goya* in Zaragoza in 1928 by *García Mercadal*, the *Porto-Pi Petrol Service Station* in Madrid's Calle Alberto Aguilera, with its reinforced concrete structure, by *Casto Fernández-Shaw* and the *House for the Marquis de Villoria* in Calle Serrano 130, Madrid, by *Rafael Bergamín*, which saw a return to the brickwork that had made such an impression on him in the Netherlands.

Figure 1: Porto-Pi Petrol Service Station in Madrid; (Fernández-Shaw 1927, pp. 302, 303)

Another key figure in this generation is civil engineer *Eduardo Torroja* (1889-1961), who introduced reinforced concrete to Spain and was a major collaborator of the Madrid-based architects.
As a result of this collaboration, three extremely important projects were carried out that showed both the development of and the possibilities offered by the new material: *The Algeciras Market* in 1935 with *Manuel Sanchez Arcas*, *the Recoletos Pelota Court* with *Secundino Zuazo* the same year, and the *Madrid Hippodrome* in 1936 with *Carlos Arniches* and *Martín Dominguez.*

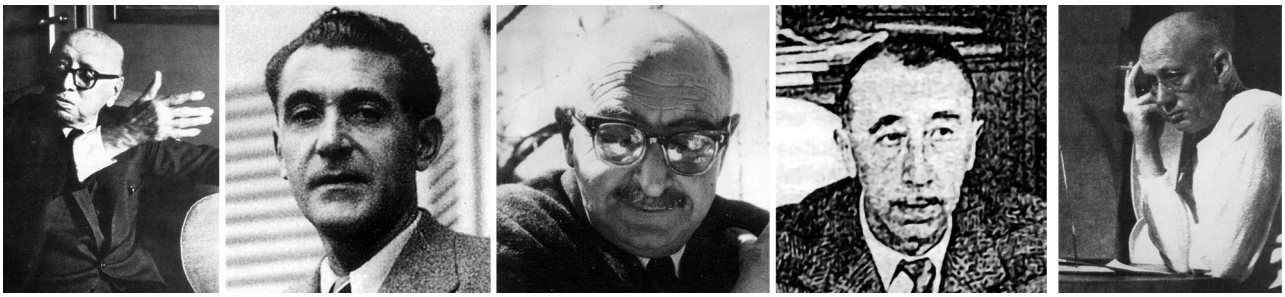

Figure 2: Secundino Zuazo, Manuel Sánchez Arcas, Martín Domínguez, Carlos Arniches and Eduardo Torroja

THE BEGINNINGS OF REINFORCED CONCRETE IN MADRID

The application of the new materials, modern steel and concrete, was initially developed more rapidly with respect to civil engineering projects such as the construction of stations, greenhouses and bridges. Due to the

enormous social, formal and intellectual weight of tradition within architecture, architects find themselves torn between their respect for history, admiration for technique and fear of destroying art.
The search for another architectural idiom as a result of the new possibilities offered by these materials was an ever-present part of the architectural debate both internationally and in Spain as of the turn of the 20th century and would manifest itself in the architectural Modern Movement.
A significant example of this debate is the *IV International Architects' Congress* held in Madrid in April 1904. Among those taking part in the 4th topic, namely the *"Influence des procedes modernes de construction dans la forme artistique"*, were *H.P. Berlage*, and *Guastavino*. The position of the former as regards the importance of concrete was of special relevance together with the need shown by the architects to familiarise themselves with this theme given that "there is a lack of architectural development regarding the new materials".
In addition to this congress, and also in Madrid, these years saw a series of circumstances occur and a number of relevant characters appear in relation with the development of reinforced concrete.
José Eugenio Ribera, (1864-1936) was one of the first researchers into reinforced concrete in Spain. A key figure in its diffusion and application, in 1901 he patented his own construction system using this material. Not only was he a practising engineer and successful businessman, but he also found time to teach, most notably on the subject of *Masonry and Reinforced Concrete Bridge* at the *Escuela de Caminos de Madrid* (Madrid School of Civil Engineering). Here he influenced several generations of Spanish civil engineers and trained them in the use of reinforced concrete, among them *Eduardo Torroja,* his main disciple.
Eduardo Torroja finished his civil engineering studies in 1923 and went to work for the *Compañía de Construcciones Hidráulicas Civiles (Civil Hydraulic Constructions Company)* of which *Ribera* happened to be Managing Director until 1927, the year in which he opened his own projects office in Madrid which functioned until the outbreak of the Civil War in the middle of 1936.
From amongst the different possibilities offered by reinforced and pre-stressed concrete, the one that most interested Torroja, and to which he dedicated most of his time and effort, was the construction of wide-span roofs with reinforced concrete laminar surfaces. This was mainly because of the formal freedom that the malleability and plasticity of the material provides. (Torroja was perfectly familiar with the studies by the German engineers Franz Dischinger and Ulrich Finsterwalder, the theoretician who established the basis to calculate cylindrical shells in 1930).
An expert in this type of structures, which require complex mathematical calculations, he opted for and developed empirical procedures for checking these structures by an experimental analysis using scale models, which represented a significant innovation not only regarding the construction of the model, but also with respect to the measuring techniques he employed.
In light of the total lack of suitable laboratories, Torroja set about creating a company capable of carrying out construction-related experimental research. With the help of a group of technicians and friends he founded *ICON* (Investigaciones de la Construcción), an organisation dedicated to undertaking research projects for the building sector.

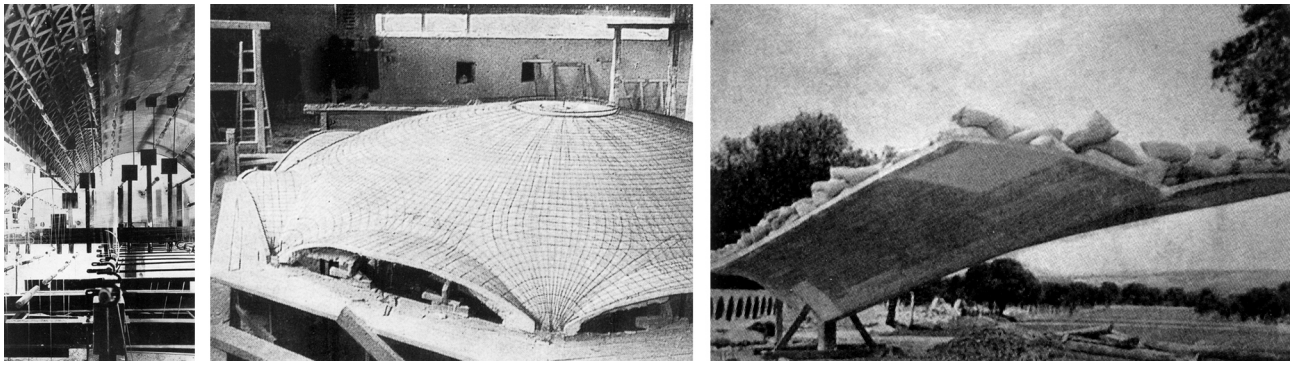

Figure 3: From left to right, Recoletos Pelota Court and Algeciras Market scale models, both of them built in ICON, and Madrid Hippodrome module bearing load; (Fernández 1999, pp.139, 75, 125)

Manuel Sánchez Arcas and Eduardo Torroja. The Algeciras Market.

In 1933, the architect *Manuel Sánchez Arcas* designed and project managed, together with *Eduardo Torroja*, the construction of the *Algeciras Market*.
The market was covered using a hemisphere of reinforced concrete supported by eight pillars and achieved a free span of 47.62 metres in which the maximum thickness of the concrete used was a mere 9 centimetres. A 10-metre diameter lantern was placed in the centre of the dome made from a series of triangular concrete frames prefabricated in a workshop. In this dome the horizontal pressures are withstood using an exterior octagonal steel tie beam.
Apart from the extreme thinness of the roof covering and the fact that its edge was made rigid by way of a fold, this structure included another important innovation: the bracing of the octagonal tie beam, which enables the concrete hemisphere to be load bearing and which, as a result of this operation, could be lifted into the key, thereby managing to separate the concrete covering from the falsework that has supported it during

construction. In this way the task of removing the falsework, an operation that was normally extremely risky as far as the construction of extra thin roof coverings was concerned, was simplified.
In addition to these technical advances, the solution employed to roof the *Algeciras Market* became the widest and thinnest reinforced concrete hemisphere ever built, exceeding that of *Jena* which, at 40 metres, had held the record for more than 10 years.

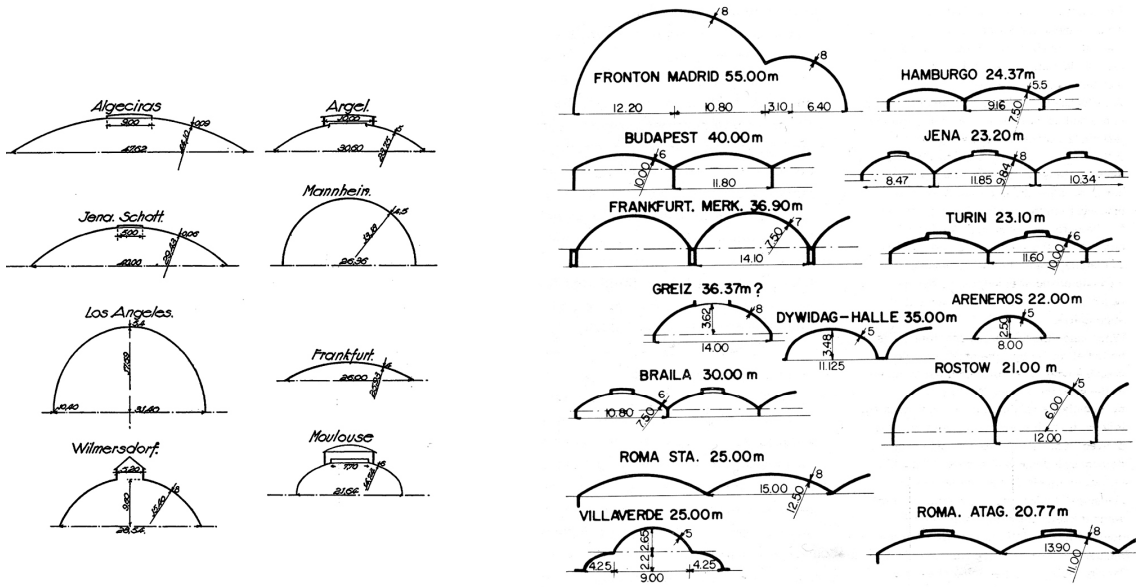

Figure 4: Comparative diagramas of reinforced concrete shells, built until 1936. The roof of Algeciras Market (left) took the world record for spans of this kind of shells of revolution, and The Fronton Recoletos in Madrid (right) held the world record for cylindrical shells; (Torroja 1936, p.143; Arredondo 1977, p.205)

Secundino Zuazo and Eduardo Torroja. The Frontón Recoletos.

In 1935, Eduardo Torroja joined architect Secundino Zuazo in designing and managing the construction of the *Fronton Recoletos* (*Recoletos Pelota Court)*.
Standing next to the National Library in Madrid's Calle Villanueva, it meets the needs of the Basque game of pelota, be it of the hand/short bat or long bat/basket variant, by providing a large rectangular space with one side open where the stands housing the spectators are located, the court and the out-of-bounds area. This introduced innovative and spectacular improvements as regards the conditions for playing the game simply by building a large roof that protected a unitary and continuous indoor space, namely the area in which the game is both played and watched, from the rain without having to sacrifice natural daylight.
The roof was built using an 8-centimeter thick sheet of reinforced concrete covering a floor space measuring 55 x 32.5 metres without any intermediate supports. The shape of the roofline is that of two circumferential arches which meet at right angles to form an asymmetric *gull wing* in line with the floor of the building, namely the pelota court. Natural light is brought into the building through the roof itself by way of two large north facing skylights cut into the concrete roofing sections which were, in turn, structurally achieved using a number of reinforced concrete ribs forming 140-centimetre sided equilateral triangles.
The Pelota Court took a mere 5 months to build despite the complexity of the shuttering and was opened to the public on February 29, 1936. Architecturally speaking, it represented a huge conceptual and formal change in the approach to building pelota courts, becoming one of the finest indoor sports arenas anywhere in Europe and one of the most important projects of modern Spanish architecture.

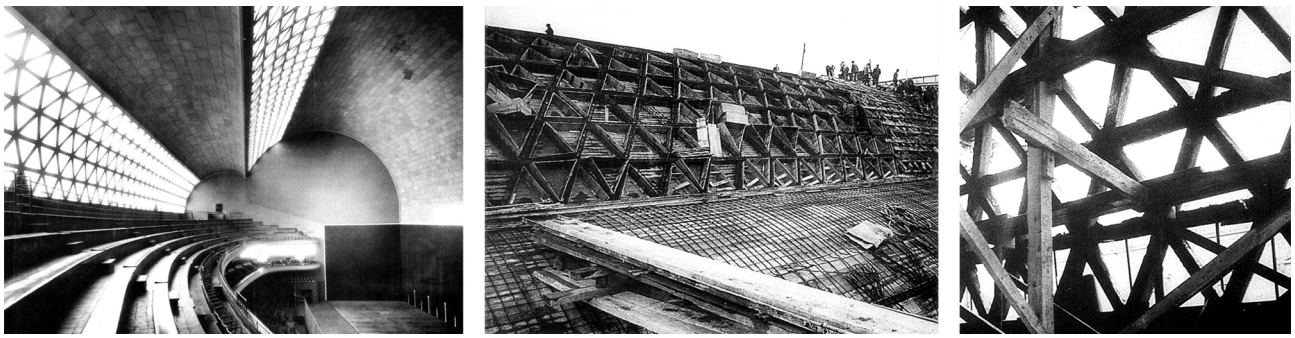

Figure 5: The Frontón Recoletos. Photo inside and construction of the skyligths; (Fernández 1999, pp. 80, 87)

Carlos Arniches, Martín Domínguez and Eduardo Torroja. The Zarzuela Hippodrome in Madrid.

Construction work began on the *Zarzuela Hippodrome* in 1935, but it was not opened until May 1941 due to the Civil War, although it was practically finished by July 18, 1936, the day on which the war started.
The old La Castellana Hippodrome needed replacing and in the contest held in 1934 nine designs were submitted, with the winner being the one presented by the architects *Carlos Arniches* and *Martín Domínguez* in collaboration with the civil engineer *Eduardo Torroja*.
It is possibly the most internationally well-known work of its authors. Totally innovative for its time, it remains an object of study to this day, especially the laminar concrete system used to form the roofs of the stands which projects almost 13 metres out from the springing.

> The roof is made up of single-leaf hyperboloid structures whose axes are noticeably horizontal and parallel. Positioned 5 metres apart, their colarin sits on the springing, thereby resulting in the surface losing curvature the further out it projects until the end is reached 12.80 metres away from the springing. The effect is that of a series of shallow circular arches whose ends are one tenth lower than the radius of the circumference. The thickness of the concrete skin, which includes no reinforcements or ribs whatsoever, starts off at 15 centimetres where it leaves the springing and thins to 5 centimetres at the outer edge.
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> Lengthways, the structure works like a cantilever, with stresses in the upper part and compressions in the lower, but crosswise it does not work in the way an arch would - as might appear at first glance - given the fact that there is no normal or vertical thrust in the springing. The study into the shear stresses, both vertical and horizontal, along the whole of the section, comes from checking the existence of compressions in accordance with the guideline in the central or key part, compressions that gradually diminish towards the flanks before becoming stresses next to the vertex. This is characteristic of this type of structures – which have been given the name of "gull wing" due to the similarity between the two branches or segments of vault springing from an intersection point and the wings of a bird whose body would be in the vertex and which would remain hanging from these wings under tension - which goes a long way towards understanding why this type of structure is so strong. (Torroja 1936, pp.147, 148).

As well as an elegant shape, the resulting structure has an especially stable geometry that withstood up to 26 direct bomb strikes during the Civil War without the stability of the overall construction being compromised. Lengthways, a unitary solution is provided by a number of elements, and the cross section of the stands clearly shows the total interrelation between the structural and the functional layout.
In Torroja's own words, "The best type of structure is that which remains standing thanks to its shape and not to the hidden strength of the materials used to build it" (CICCP 1979, p.91).

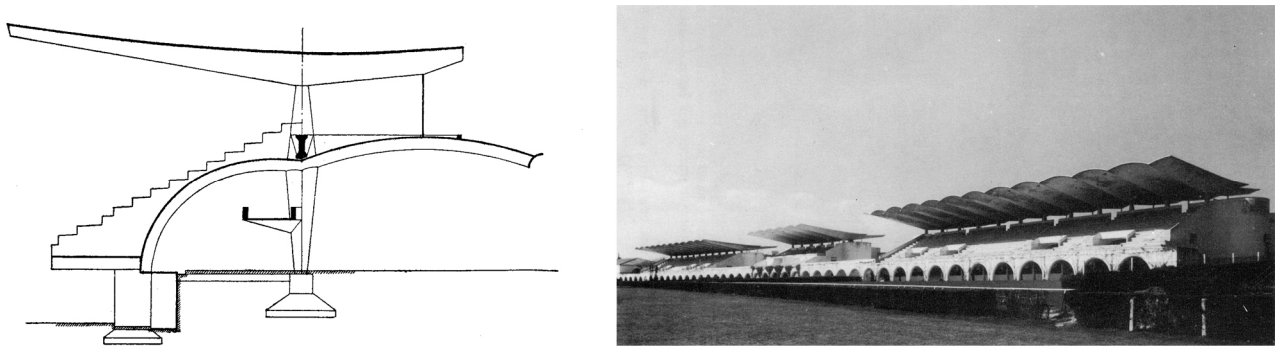

Figure 6: The Madrid Hippodrome; (Torroja 1936, pp.152; Arredondo 1977, p.215)

TIMBREL CONSTRUCTION IN MADRID RATIONALISM.

The timbrel vault, fundamentally Mediterranean, has its roots in Mesopotamia and Egypt.
It is the only masonry vault that, although limited, continued into the 20th century with some truly spectacular examples in the work of Guastavino.
The well known temporary boom in timbrel vault construction that took place after the Spanish Civil War owes its recovery to the work of architects such as Luis Moya, Asís Cabrero and Rafael Aburto.
Its renaissance was not only due to the scarcity of materials at the time, but also because of the new political regime that extolled the virtues of a more traditional vision of architecture due to the distrust it felt for modern architecture, ideologically represented by the work of GATEPAC and the Rationalist Movement, during the Second Republic period.
As part of its general search for truthful architecture, the Spanish Modern Movement made frequent use of the timbrel vault in all parts of the country, with outstanding examples to be found in both Barcelona and Madrid.
It is not that the use of timbrel construction systems is generally representative, or even the most widely used, but it survives and coexists naturally with new techniques in an important number of buildings, with some magnificent examples in the construction of stairways.

This fact, quite possibly little mentioned due to the widely held belief about modern architecture's disinterest in all aspects that are not strictly to do with form, is no doubt due to the values of honesty, simplicity, local tradition and climate, cost effectiveness and sobriety, so admired of popular architecture by the Spanish Modern Movement, and so well represented by timbrel construction. In fact, it is the only type of masonry vaulted construction that the Modern Movement accepts as its own.
The two most important Spanish architectural publications of this period are the magazines *AC Documentos de Actividad Contemporánea*, the official mouthpiece of *GATEPAC*, and *Arquitectura*, published by the *Colegio Oficial de Arquitectos de Madrid*. Both were related to the European avantgarde of the time and alongside international current affairs, they published articles about the CIAM (International Congresses of Modern Architecture), the Werkbund, the work being done by Le Corbusier and Gropius and foreign collaborations (Theo van Doesburg became a regular feature in the *Revista Arquitectura)*, and resulted in many articles referring to modern projects implemented in Spain using timbrel construction. (Rodriguez 2007, pp.765, 770)
The importance of timbrel construction in Spain, as a technique deeply rooted in and characteristic of our building culture is also reflected in the works of Eduardo Torroja and of the aforementioned architects as examples of the modern nature and development of reinforced concrete and who, in accordance with the type of project in question, also used timbrel vaults.
Torroja worked with timbrel vaults throughout his professional life, and in his own words: "...reinforced concrete and hollow brick are the ideal materials for laminar, plate and membrane structures".
He refers to these as:

> ...that efficient constructional invention that is the timbrel vault; because, with hollow bricks and plaster or quick-drying cement, a proficient bricklayer can, in a few hours, create a huge variety of strong shapes using no other tools than a hod and trowel. (Torroja 1957, p.243)
>
> The Catalonian vault, as much a part of that region as the carob trees of its landscapes, and such a marvellously thought out and executed structure that even today's theoretical knowledge struggles to explain and gauge its phenomenal strength, was invented by builders who were laid beneath the ground from which they made their bricks centuries ago. (Torroja 1957, p.235)

It could be said that his interest in the study and development of laminated reinforced concrete surfaces goes back to timbrel vaults, given the fact that although they involve the disadvantage of shuttering, they do enable the formal limitation of traditional vaults. The aspect of this shuttering technique was the one that interested Torroja the least, but needed to be overcome.
Two extraordinary buildings featuring very differently conceived timbrel vaulted stairways serve to show the variety of form and the deep-rooted nature of this technique in Spain and its survival in modern pre-Civil War Spanish architecture and, in this particular case, in that of Madrid Rationalism. Both examples interpret timbrel construction from a modern point of view, using it for the formal possibilities and material economies it offers and not as a throwback to the past or as a manifestation of local folklore.
The Casa de las Flores by Secundino Zuazo, the architect with whom Torroja collaborated on a number of reinforced concrete projects during the same period, including the impressive Recoletos Pelota Court. This has 10 three-flight staircases repeated in two types, with six of the stairwells incorporating non-traditional elements such as the specific thin steel-support for improving the spatial conditions of the landings giving access to the dwellings. In contrast, there is the unusual nature of the important two-flight staircase, built exclusively using timbrel vaulting, of the New Pavilion for the Residencia de Señoritas Estudiantes (Female Student Halls of Residence) by Carlos Arniches. Arniches, together with his partner Martín Domínguez, was at the same time working on the spectacular reinforced concrete project of the Madrid Hippodrome with Eduardo Torroja.

La Casa de las Flores 1930-1932 by Secundino Zuazo.

In 1928, Secundino Zuazo was commissioned by the Compañía Inmobiliaria Española (Spanish Real Estate Company), of which he was Chairman of the Board, to design an apartment building to house multi-family dwellings for rent in the Argüelles district of Madrid. In his role as both architect and developer, he was assigned a complete city block within the Ensanche Oeste del Plan Castro (Westward Urban Expansion Phase of the Castro Plan) demarcated by the following streets: Hilarión Eslava, Meléndez Valdés, Gaztambide and Rodríguez San Pedro. The idea behind the project was to provide a sample building that could then be duplicated in other blocks of the urban expansion project as yet undeveloped, but in the end this was the only building constructed. Known as the Casa de las Flores (House of Flowers), it was designed to house 1,475 residents in 248 apartments above 17 business premises. Keeping the same basic layout throughout with respect to living and sleeping areas, these either look out over the interior garden or the street, with the bathrooms and services areas giving onto interior light wells. The building contains twenty-one different sizes of apartment with floor areas of between 88 m² and 170 m².
This magnificent residential complex, embodying many of the contemporary European Rationalist ideas and experiences as regards collective dwelling and one of the most important representations of Spanish and European rationalist architecture of the time, was built using a steel structural framework enclosed with meticulously worked facing brickwork, with maximum expression and rationalism being put into the use of each material. In line with this philosophy, Zuazo built the ten staircases of the complex using the timbrel vault, given

that the use of this technique is practically unbeatable where the quality, formal result and price of materials and labour is concerned. Each staircase has three flights between floors, which run around the lift shaft, with different intersections in accordance with their supports, one of which is a specific thin steel-support in six of the staircases, proof that the this technique was used for reasons of constructional rationalism and not in an attempt to be traditionalist.

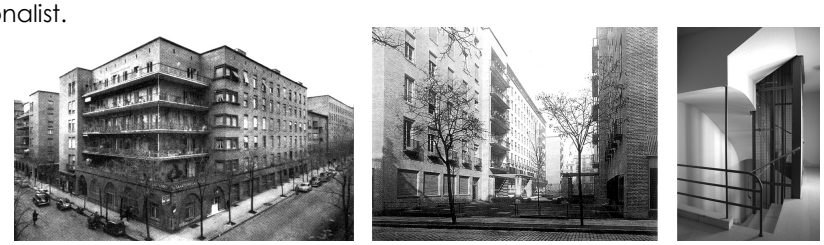

Figure 7: La Casa de las Flores. General views (Maure 1987, pp.72, 79) and timbrel vault stair; (Photo authors)

The New Pavilion for the Residencia de Señoritas Estudiantes 1933 by Carlos Arniches

The main purpose of the building was that of accommodation, with the most important requirement of the new pavilion being that of providing the greatest number of new bedrooms with all the communal areas being in the central building with which the new pavilion would share the garden. The building had four floors of bedrooms plus a basement in which there was a large assembly room and the general installations.
It is a small building in which the bedrooms are laid out in lines along the southern and eastern façades and with a gallery to the north to provide access and light for the corridors.
The staircase, with two flights between floors and a semicircular ground plan, is located at one end of the building, and is its most important and outstanding element. As there are no lounges or other communal spaces, the intention behind the staircase was for it to become the focal point of each floor. From the outside, its volume characterises the new pavilion.
The brick construction of this pavilion is simple and intrinsic and its external rendered finish lends it a powerful and clearly modern image.
It is the sheer size of the timbrel vaulted staircase that is most eye-catching. With its design of smooth curved surfaces and continuous finishes, it represents the new idiom of the Modern Movement and at the same time shows the structural shapes of its timbrel construction. Here, the way the traditional and the modern intermingle is completely relevant.

Figure 8: The New Pavilion general view (Arniches 1935, p.3) and timbrel vault stair; (Photo authors)

CONCLUSIONS

In the period between 1925 and 1936 a series of important buildings were constructed using reinforced concrete as a result of the fruitful collaboration between the group of Madrid-based architects known as the Generation of 25 and civil engineer Eduardo Torroja. In little over 10 years, several of the most brilliant contributions of modern Spanish, not to say European, architecture were made within a context marked by the search for a new architectural idiom and the use of new materials, above all reinforced concrete, within the development of modern architecture.
It is important to stress that although it was Eduardo Torroja's know-how that made the realisation of some of these projects possible (such as the Algeciras Market, the Recoletos Pelota Court and the Zarzuela Hippodrome, all of which were built using laminar surfaces of reinforced concrete bridging significant spans), it was precisely when he was collaborating with architects the likes of Zuazo, Sánchez Arcas, Arniches and Martín Domínguez that Torroja did his best work.
Against this backdrop of the development of the Modern Movement and the use of reinforced concrete in architecture, timbrel construction, with its long and deep-rooted tradition in Spain, continues to be used throughout the entire country. It survives and exists alongside new techniques totally naturally in a significant number of new buildings, where it truly comes into its own in the construction of magnificent staircases. This is, in part, due to the fact that although modern architecture seeks standardised industrial systems in order to be able to mass-produce multi-family dwellings, generally speaking urban construction has continued to be carried out manually far longer than civil engineering projects.
However, this is also due to those values of constructional sincerity, simplicity, local and climatic tradition, economy of means and sobriety that are such highly admired aspects of the architectural vernacular, aspects

that are also well represented by timbrel construction. In fact, it is the only one of the masonry vault construction techniques that the Modern Movement claims as its own in its quest for a true architectural style.
Its use as a spatial configurator is closely associated with domestic scale projects and the best examples of these are to be found in single-family dwellings and educational facilities. It is also frequently associated with the concept of repetition, both during the period we are dealing with and later, as shown in examples by Bonet Castellana, Sert and Le Corbusier. In apartment buildings, timbrel vaulted staircases were habitually used in Madrid, even as late as the sixties.
However, when an unusual design calls for large sizes, the timbrel technique cannot compete with how the development of and possibilities offered by reinforced concrete cater for the modern train of thought, especially as regards the formal freedom it provides in comparison with traditional domes and vaults.
Timbrel vaults and reinforced concrete laminar surfaces share a number of similarities, but it is precisely their differences that favour an increased development of the latter within modern architecture. Using the two techniques, large spans can be covered and light, delicate and highly fire-resistant structures can be attained. Both practically disappeared in the sixties due to the increase in the cost of labour and the development of prestressed concrete.
The great advantage of timbrel vaults is that they do not need great expanses of arched falsework, although this does limit their formal possibilities. And, while the reinforced concrete sheets need a great deal of shuttering to form them, being a plastic material that adapts to the mould when it is fresh is precisely the quality that enables the freedom of an almost unlimited number of shapes as against the traditional domes and vaults, this is the aspect of maximum interest to modern architecture, as it was to Torroja.
Furthermore, concrete enables the creation of large cantilevers such as those protecting the spectators at the Madrid Hippodrome, and openings and perforations can be incorporated for natural overhead lighting, such as the central roundel of the Algeciras Market or the longitudinal slats of the roof of the Recoletos Pelota Court. It also enables the possibility of constructing all of the elements of the building out of the same material, such as is the case of the Porto-Pí Petrol Service Station by Casto Fernández-Shaw, something that proved fascinating to Berlage at the Municipal Museum of The Hague.
The choice of the examples described above is not only due to their architectural quality, but also to the fact that they provide an especially relevant representation of the possibilities of both techniques.

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