Ignasi Bosch Reitg and the Construction of "Timbrel" Vaults during the Post-War Period in Girona, Catalonia

Miquel Àngel Chamorro and Beatriu Cuenca

INTRODUCTION

Ignasi Bosch Reitg was born in Girona on 31 March 1910. He began his architectural career in 1933 after obtaining his degree from the School of Architecture in Barcelona. Once he had finished his studies, Ignasi Bosch returned to Girona and began his professional activity in the office of his father, Isidre Bosch. He was initially interested in any and all aspects of rationalistic architecture, and worked together with his father on this shortly before the Spanish Civil War. This was the case of both the "Reglà House" (1936) and the "Cadenes House" (1934) in Girona where he combined elements of "Noucentism" with rationalism.

Ignasi Bosch Reitg distinguished himself as an architect during the period beginning immediately after the end of the Spanish Civil War until the mid 1950s, doing interesting works within the local architectural scene. After 1939 his work changed and as he began to follow the guidelines of the new regime which promoted a style inspired by monumental classicism. This new opportunity allowed him to put into practice a new type of architecture, definitively distinct from rationalism – at least formally – and rooted in "noucentism" with elements from the classical and local traditions. For the new regime it was important that official and public buildings be representative, and it was therefore necessary that they express the idea of monumentality, with an abundance of ornamental elements.

This monumentality is reflected in such representative works as the Trade Union Building of Girona, the project for the Trade Union Building of Figueres and especially the "Ultònia Hotel and Cinema" in 1940 **(fig. 1)**. In this building Ignasi Bosch Reitg emphasised the design of the first façade with a chamfered edge in the city of Girona, undoubtedly one of his important career landmarks, although he never managed to add the ornamental finishing touches on the last floor.

He produced numerous residential projects such as the "Riera Perpiñan House" (1940) in Girona, which still had rationalist references and a façade designed in collaboration with the artist Orihuel. From his position as architect to the "Trade Union and Housing Works" he did some very interesting projects for new urban developments in the region. His position responded to the new regime's interest in direct intervention in social housing as a result of the "Protected Housing Law" of 1939. Given this situation, in the 1940s he started to built such ambitious projects as the neighbourhood of Sant Narcís in Girona (1944), where he would apply with rigor his in-depth

knowledge of traditional construction techniques (timbrel vaults), and which he would also use in other projects. Other works from this period are: the "Poeta Marquina" houses, built in 1954 in Figueres; the "Sant Pere Martir" houses, carried out with Joaquim Masramon in Olot in 1951; the "Santa María de Banyoles" houses in 1956; and others built in Palamós, Palafrugell, Salt, and Sant Feliu de Guíxols.

Figure 1. Hotel and Cinema Ultonia, Girona (Cormenzana and Sebé 2003, p.8)

It must also be remembered that during the early- 1970s, Ignasi Bosch was the president of the Girona "College of Architects". At that time the "Pia Almoina" building was acquired for their social headquarters and they began offering services following the example of Barcelona. His great interest in town planning legislation led him to attempt to repeal the 1971 General Plan of the City of Girona. He won the case and the Plan was repealed because, according to him, it promoted negative city planning projects. As a city planner his participation on the team that worked on the "General Plan" of the town of La Bisbal and its surroundings is also worthy of mention. Although it became very impersonal in the process leading to its final approval, it was nevertheless considered to be a model plan because it attempted to preserve the landscape of that area.

Ignasi Bosch Reitg died on 29 May 1985 in Girona.

HISTORICAL CONTEXT

We will focus on the post-war period (Spanish Civil War, 1936-1939) when Ignasi Bosch Reitg would develop his most interesting projects applying traditional construction techniques.

In this period – from 1936, when the Civil War started, until 1955 - Catalonia suffered through the worst economic period in its history. From the end of the war until the year 1951, Spain and consequently Catalonia were subjected to the economic and cultural autarchy imposed by the new regime based on a totalitarian and corporalist government with a single party (The Movement) and a single trade union (Vertical Union). The exaltation of the commander, General Franco, was especially relevant in the political climate of the time. The Catholic Church participated in the government and National-Catholicism began promoting social hierarchies, paternalism, anticommunism, antiliberalism, the antimasonry and antimodernism.

During the first years of the dictatorship, the Spanish State constantly intervened in the city-building process to compensate for the lack of investments from the private sector. The lack of housing had become a social problem which endangered the stability of the system, so the State invested in construction to guarantee its continuity. In that period the organisations in charge of putting urban policies into practice were: the National Institute of Housing (I.N.V.) – dependent on the Ministry of Labour - and the Trade Union Housing Organization (O.S.H.) – dependent on the National Trade Union Organization.

The Spanish State was characterized (during the years of the dictatorship) by a lack of coherent urban policies: little housing, faulty materials, deficient infrastructures and almost nonexistent municipal facilities. This situation made it very difficult for new neighbourhoods to be built following orderly planning. In Girona, as in so many other Spanish cities, its activities were based on the search for solutions to the lack of affordable rented housing. Through funding the new government tried to stabilize and integrate certain social classes into society by providing access to property. Faithful to their “Trade Union Nationalistic” ideology with paternalistic tendencies, the O.S.H. was aware that the key to victory consisted in empowering home and family life.

The O.S.H. has generally been characterized by low quality housing construction. A lack of facilities and housing development, with conservation problems caused by little or no maintenance led to accelerated physical deterioration and a rapid degradation of living conditions. As a member of the O.S.H., Ignasi Bosch worked on subsidized housing projects following regulations of the "National Housing Institute". Very specific measures dictated this type of housing under the previously existing regulations: “The Regulations for the law of 19 April 1939 on protected housing, rules and official ordinances for construction” as well as “The Rules and Ordinances of the National Housing Institute."

Regarding the materials that should be used, it was stipulated that the brick walls should be 30 centimetre thick when load bearing, and 15 centimetres for the rest. In the load bearing walls of mass or reinforced concrete, whether made of clay, lime and clay, lime, lime and cement, or cement, the minimum thickness for one-story houses will be 40 centimetres, except in those made with Portland cement where it could be 30 centimetres. The horizontal wrought ironwork was divided into two groups. Group A: "Metal Beams and small made-up vaults", "Metal Beams and bricks", "Metal Beams and concrete board", "Reinforced Concrete in reinforced slab", "Reinforced Concrete in ribbed slabs", "Reinforced Concrete with chunk of plaster or other forms" and "Timbrel Vaults" (covering areas smaller than 16 m².). Group B has "Wrought iron of any type of beam or flat element like boards or light slabs".

THE "TIMBREL" VAULT

Ignasi Bosch like other architects of his time studied vaulted structural systems. Soon after these studies, he wrote the "Tratado sobre la bóveda vaída tabicada" which was published in "La Revista Nacional de Arquitectura" under the title "La bóveda vaída tabicada" (see references at the end). This study was driven by the search for solutions which were solid, quick and economic, necessary features at the time because of the lack of Portland cement and iron.

Based on the system of Catalan vaults, he designed his own solution, which he called "timbrel" vault. The concept of the "timbrel" vault is simple; it is formed by bricks-on flat placed next to the one another in concentric rows over the entire vault in a single layer, fixed with plaster or Portland cement. Bosch called them "thin arched walls". Doing without a double layer, Bosh attained a lighter and therefore more economical structure, minimizing the loads by reducing the size of sections of pillars, walls and foundations.

The wrought iron of floors and support beams, while able to support loads from 150 to 250 kg/m^2, weigh from 250 to 300 kg/m^2 themselves. On the other hand, vaults supporting the same loads only weigh between 50 and 60 kg/m^2. In this way he tried to demonstrate that the most solid constructions were not always the heaviest ones. In addition, Bosch provided the vaulted structure with material homogeneity by using only one layer and as a result was able to obtain more precise calculations of deformations and elastic modules.

Ignasi Bosch defended the idea of a single layer using the example of the resistance of an egg shell to uniform loads and its vulnerability to isolated asymmetric forces. In this way he explained the importance of the moment of inertia in structures, demonstrating that in order for the vault to support asymmetric loads, a greater moment of inertia must be found, not a greater weight and section size. The solution contributing to a larger moment of inertia was the use of mortars with greater resistance than the pieces making them up. Studying asymmetric loads and the problems

resulting from them, Bosch noticed that in vaults of double curvature the flexion moments and the warping caused by them were cancelled out.

That is how he came to adopt the vault of double curvature, in particular the basket-handle arch with only one layer, since it was easily carried out and it did not require skilled labour. It was built with the help of an arched frame which was moved along the entire vault. He also studied the points of support of the "timbrel" vaults found in the vault angles. He solved the problem by totally eliminating the walls and replacing them with four pillars supporting the vault. The construction of the structure was established through a system of "timbrel" vaults with only one layer and without the need for any beams. So, in two- or three-storied houses, it was possible to build a vault for each room and to support them on the L or T intersections formed by the interior walls of the house. Where the loads are very heavy or in rooms with great spans, the support angles could be reinforced by a chamfer, creating triangular supports of great strength. Adopting this system eliminated the need for false ceilings by using the empty spaces between the vault and the superior vault levelling for the installation of services.

As these structures of double curvature are resistant to asymmetric or isolated loads, it is possible to design them for the first floor independently of their location on the ground floor. Bosch investigated the thrusts of the vaults deducing that there were four of them and that they appeared at the support points following the direction of the diagonal lines. To shore up these points he placed some iron crosspieces following the perimeter of the vault, counteracting the thrust components following the direction of the four sides of the vault and thereby hiding the brace in the partition. He used crosspieces for the levelling above or he built a flat ceiling of hollow tiles resting on small, 5 centimetre thick partition walls. This ceiling reached the highest level of the vault. If the top was covered, a partition with small bricks separated by 80 cm. followed the slope of the roof.

A PATENT TO BUILD VAULTS OF DOUBLE CURVATURE (TIMBREL VAULTS)

Ignasi Bosch Reitg applied for a 20-year patent (A.C.A.G. not catalogued). According to the architect, the application for this patent (which remained undated) was the result of the rising price of construction materials, primarily metal elements, which in turn led to the adoption of lighter construction techniques needing careful calculations. In this patent he proposed the construction of vaults of double curvature with prefabricated pieces – of any material and measurements – placed in a single layer with a quick-setting mortar.

The geometry of the vault would be obtained by means of two curved guides supporting an arched generatrix which was used as guide or support until the mortar had set. In order to accomplish this, the prefabricated pieces would be placed in lines parallel to the generatrix starting from the guides. Each line would act like a vault exerting lateral thrusts, requiring reinforcement elements to be placed at these points. Once the mortar had set. these reinforcements were removed and the vault

would settle elastically and the trusts would shift to its vertices. Resistant elements (pillars, columns, etc.) were to be located in places to absorb these thrusts. In order not to overstress these support elements, a number of crosspieces were placed among them to counteract the thrusts and allow pillars only to receive compression loads. These vaults would allow the construction of floors over the light material with which they were to be covered.

This system allows wide spaces to be covered with very elementary materials and, being a pillared structure, it allows the floor distribution to be changed. Such a solution would reduce the weight and volume of materials used because neither support walls nor false ceilings are required. It also decreases the load on the foundations allowing savings on material in these. In this kind of simple construction specialized labour is not necessary. Filling the vault would improve thermal and acoustic insulation and since it is an element of great elasticity of holes could be cut without reducing its overall strength.

We do not know the application date for this patent, but we do know the requirements for the construction of such vaults.

PARALLELS WITH THE VAULT OF THE HOTEL CAP SA SAL AND OTHER VAULTS BUILT IN CATALONIA

The brick vault that was used to resolve the structure of the central block of the old "Great Hotel Cap Sa Sal" in the town of Begur, is a timbrel vault formed by four layers of bricks. An entire net of iron reinforcements were implanted to secure it.

Figure 2. Hotel Cap Sa Sal, Begur (J. Planas)

A number of examples of brick vault constructions dating from before and after the construction of Cap Sa Sal survived, usually these served singular and functional purposes. Brick vaults of this kind have occupied an important place in the history of Catalan architecture. This is the case for the structural and ornamental stairway vaults built in the province of Girona which were stuck together with plaster and built by expert architects trained in traditional construction techniques of the country. One good example is the vault built by Ignasi Bosch in the "Parc de la Devesa" in the city

of Girona. However, we find very few vaults like the one in Cap Sa Sal in terms of its span and the arrangement of the bricks. The only one geographically close is located in the region of Maresme (Barcelona). Currently part of the "La Massa" Theatre of Vilassar de Dalt (Dilmé and Fabré 2002), it was designed by the Valencian architect Rafael Guastavino and inaugurated on 13 March 1881 (renovated between 2000 and 2002).

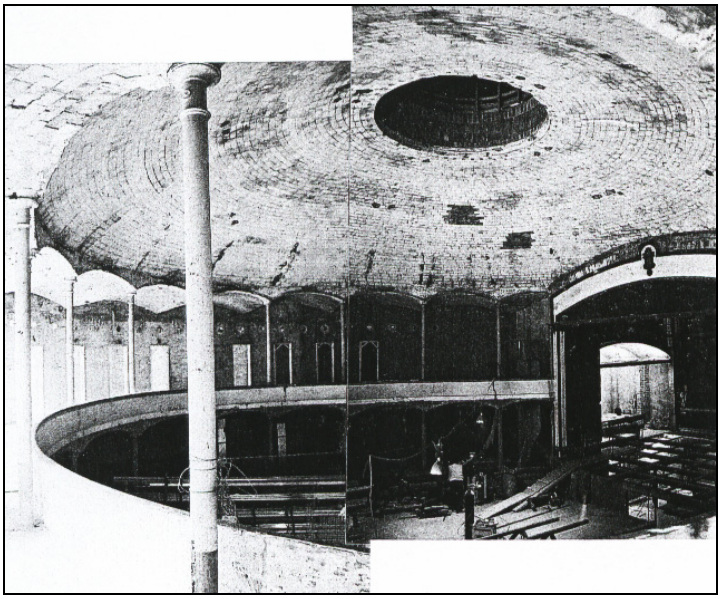

Figure 3. “La Massa” Theatre (Dilmé and Fabré, 2002)

This theatre, one of the last projects by Guastavino, is representative of his work before he emigrated and established himself in New York where he would spend the rest of his professional career and create the firm Guastavino Fireproof Company, specialising in large fireproof brick vaults of quick construction(Garcia Gutiérrez 2003, pp. 959-961).

The central vault that covers the great stalls of the old “La Massa” Theatre of Vilassar de Dalt, follows Guastavino’s “cohesive” construction idea. This idea consists of the construction of layered bricks fixed with modern mortars forming a whole of great resistance despite being thin. In this case, the first brick layer fixed with quick setting, low resistant plaster facilitated its construction without the need to use the frameworks that served for the construction of the upper layer with abundant Portland cement mortar. Unlike the central vault at Cap Sa Sal (Begur), the first layer initially had a lining of Portland cement mortar hiding the brick pattern of the vault. That pattern, as can be seen in the picture, is identical to the one used in Cap Sa Sal. During the renovation carried out on the theatre, I removed this plaster (that was in an advanced state of degradation) and the bricks were uncovered.

If we compare the two vaults, we observe that there are slight differences in their dimensions, the way the rows of bricks are placed, forms of discharge and functional elements, like the central rose lantern. Therefore, the two vaults present differentiated profiles translated into similar forms, but of different magnitudes. The flatter profile in Cap Sa Sal supposes a state of loads and a more critical spreading of forces, trusting in the resistance of the brick construction and the reinforcement of steel bars. The configuration of the vault supports is also different in the two buildings. Steel columns and load bearing walls are used at Vilassar of Dalt and reinforced concrete is used at Begur.

In addition, it is important to mention the acoustic problems which are common to the two vaults. The technical reports produced for the rehabilitation work at the old theatre revealed the extend of the acoustical problems: the propagation of sound, the resonance and the reverberation. These problems were checked during restoration work and solved with acoustic absorption elements. The introduction of the quick-drying cement mortar as a binding material in the vault of Cap Sa Sal is attributed to the introduction of new mortars and industrial cements in the construction of the "La Massa" Theatre.

Finally, we must point out that it was the removal of the plastering of the vault in the "La Massa" Theatre that enabled us to compare the brick patterns, a fact that revealed the parallels in the construction process of the two vaults and the absence of supporting framework during their construction.

Figure 4. Vault Hotel Cap Sa Sal (X. Borda)

Figure 5. Pattern of the brick vault, Hotel Cap Sa Sal (J. Carreras)

ACKNOWLEDGEMENTS

Many thanks are due to Carme Gafarot, the English teacher who translated this article, and to Miquel Llorens, professor of structures at the University of Girona. Many thanks, too, to the Lingusitic Support Unit of the Modern Language Service of the University of Girona.

REFERENCES

A.C.A.G. Archive of the Architects' Association of Girona.

Birulés, J. M., 1996. *Guia d'arquitectura – Girona ciutat : Segles XI-XX*, Girona: Demarcació de Girona del Col·legi d'Arquitectes de Catalunya.

Bohigas, O., 1998. *Modernidad en la arquitectura de la España Republicana*, Barcelona: Tusquets Editores.

Borda, X., Planas, R. and Rodríguez, M., 2003. "Edifici Cap Sa Sal – Begur – Antic Gran Hotel Cap Sa Sal. Anàlisi constructiu i estructural de les voltes del bloc central", unpublished P.F.C. (final degree project), Girona University.

Bosch, I., 1949. "La bóveda vaída tabicada", *Revista Nacional de Arquitectura*, 89, pp. 185-199.

Castells, R., 2000. “Modernisme, noucentisme, racionalisme i electicisme”, *Revista de Girona*, 200**,** pp. 295-310.

Comenzana, L. and Sebé, J., 2003. “Recerca arxivística sobre Ignasi Bosch”, unpublished P.F.C. (final degree project), Girona University.

Dilmé, Ll. and Fabré, X., 2002. *Teatre la Massa de Guastavino*, Vilassar de dalt 1881-2002. Barcelona: Universitat Politècnica de Catalunya, S.L.

Falgueras, J., 1995. *La tradició moderna 30’, 40’, 50’ : Catàleg d’arquitectura de l’any 1930 al 1960 a la Demarcació de Girona*, Girona: Demarcació de Girona del Col·legi d’Arquitectes de Catalunya.

Fortea, M. and López, V., 2001. *Bóvedas de ladrillo*, Madrid: Editorial de los Oficios S.L.

Fraguell, R. M., 1988. *La ciutat-jardí i l’Obra Sindical del Hogar a l’època franquista*, Girona: Quaderns del Cercle – Cercle d’estudis històrics i socials.

Garcia-Gutiérrez, J., 2003. “The adventure of the Guastavino vaults”, *Proccedings of the First International Congress on Construction History*, volume II, pp. 957-964.

Gil, R. M., Gallart, J. and Bonal, Ll., 1995. *Girona itineraris – El moviment modern a Girona (1930-1960), L’arquitectura racionalista*, Girona: Ajuntament de Girona, Demarcació de Girona del Col·legi d’Arquitectes de Catalunya, 1995.

Moreno, F., 1992. *Arcos y Bóvedas*, Barcelona: Edicions CEAC.

Moya, L., 1947. *Bóvedas tabicadas*, Madrid: Ministerio de Fomento.

Pareta, M. M., 2004. *Construir Girona: l’arquitectura com a reflex de la societat (1936-1955)*, Girona: Col·legi Oficial d’Aparelladors i Arquitectes Tècnics de Girona i CECAM.

Truñó, A., 2004. “Construcción de Bóvedas tabicadas” in Huerta, S. and González, J. L. (eds.) in *Textos sobre Teoría e Historia de las Construcciones*, Madrid: Instituto Juan de Herrera: Escuela Técnica Superior de Arquitectura de Madrid.