The private house of engineer Jean-Marie Huberty and its hypar roof. A unique experiment in concrete construction in Belgium in the 1960s

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Introduction

In 1961-64, Jean-Marie Huberty (1932-2014) built a modest house for himself and his family, somewhat concealed on a plot in La Hulpe, located a few kilometres south-east of Brussels (Fig.1). Fair-faced concrete was used extensively. The unique character of this house is further enhanced by the experimental nature of the roof: it was constructed as a thin shell in reinforced concrete only 5 centimetres thick, composed of two adjacent hyperbolic paraboloid surfaces, spanning roughly 10 by 20 metres. For the design of this unusual, daring roof structure, Huberty called in the help of engineer André Paduart (1914-85), Belgium’s key figure when it comes to thin shells in reinforced concrete. It was carried out by a local contractor, who had little experience in reinforced concrete construction, in an almost archaic way.

Fig. 1. Front façade of the house (S. Van de Voorde, Feb. 2007).
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The analysis of the house is mainly based on interviews with Jean-Marie Huberty and documents from his private archive [1]. The highly experimental design and construction of the house captures one’s imagination, yet it is almost completely absent from the history of concrete architecture in Belgium. In this paper, we will analyse the construction history of this one-off experiment, including the contribution of each of the actors involved, the relationship between them and their motivations, in order to (re)position this unique building in the history of concrete architecture.

Introducing the key actors: Huberty and Paduart

The history of this house reads much like a script with two lead actors, finding each other at just the right time, under the right circumstances, to undertake a unique experiment together. The two men, Jean-Marie Huberty and André Paduart, were both engineers, sharing a penchant for concrete and for deviating from the beaten track. Yet, their engineering profiles and background were quite different, as well as their motivation and their respective input in the experiment.

Huberty graduated in 1956 as Ingénieur civil des constructions at the university of Liège. Having worked two years at an engineering firm in Liège, he continued his career at the federation of the Belgian cement industry Febelcem, in particular the federation’s documentation department Centre d'information de l'industrie cimentière belge. This Centre, founded in 1952, held a diverse collection of publications on cement and concrete, but also published books and periodicals on the topic [2]. From 1958 to 1996, Huberty was responsible for many of such publications edited by the federation, including manuals and theoretical literature, but also more popular publications such as Betonologie (an introduction to concrete technology with cartoon-like drawings by Huberty himself [3]) and the ABC van cement en beton (an alphabetical overview of the main concepts of concrete construction technology [4]). Most of these publications were oriented towards readers who did not have a huge technical background, yet they were based on thorough theoretical and scientific knowledge.

Another example of the somewhat popularising publications are the ‘monthly announcements' of the Centre d'information, published in a French and Dutch edition between September 1952 and April 1963. Every month, one aspect related to the composition, properties or technology of cement and concrete was presented in a mere six pages. The collection of these folded sheets gives a good idea of the common practice of concrete construction at that time in Belgium. From upon his appointment at the Centre d'information in 1958, Huberty became responsible for this publication. As such he was able to include personal preferences, as for example when it came to the illustrations. In one of his first issues, discussing how concrete was to be poured, a picture of the so-called ‘Civil Engineering Arrow’ was included (Fig. 2) [5]. He had discovered the Arrow during one of his first assignments at the Centre d’Information, an exploratory study into the innovative use of concrete at the 1958 World’s Fair in Brussels. The Arrow, part of the Civil Engineering Pavilion, designed by engineer André Paduart, architect Jean Van Doosselaere (1919-2000) and sculptor Jacques Moeschal (1913-2004), was one of those structures at the Fair that left a particularly strong impression on Huberty. The Arrow was a daring cantilevered beam in the shape of an inverted capital A, spanning 78.8 metres and weighing 405 tonnes (Fig. 3). The section of this inverted A decreased from 10 metres at the support to only a few centimetres at the utter end, while the thickness decreased from 12 to 4 centimetres. The Arrow was balanced by a large exhibition hall, cantilevering to the other side of the support, which was covered with a thin shell in reinforced concrete, 6 centimetres thick. The sole function of the Arrow - besides ‘représenter la Victoire du Génie Civil belge sur la Nature’ [6] - was to support a hanging footbridge that gave a bird’s eye view on a large relief map of Belgium with scale models of
recent and planned civil engineering structures. The pavilion was a collaborative work of three men, but the structural design of the Arrow was unquestionably the work of Paduart [7].

Graduated in 1936 as a structural engineer, André Paduart developed a twofold career as consulting engineer and professor at the Université Libre de Bruxelles. He is mostly recognized both at home and internationally for his work related to thin shells [8]. Although the Arrow marked Paduart’s breakthrough as a consulting engineer, it
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cannot be considered as truly structurally innovative at an international level. In 2006 Bernard Espion rightly noted that the Arrow illustrates the popularity and knowledge of thin concrete shells at the end of the 1950s but that it was not structurally innovative or ground breaking [9]. Nevertheless, the structure aroused astonishment and admiration. The Arrow was described as “the dramatic element in the Belgian Civil Engineering exhibit” and even “the very apotheosis of concrete” [10]. The Arrow was also the first of two decisive factors leading to the collaboration between Huberty and Paduart.

The other event was the publication of the first handbook on thin shells in Belgium in 1961, written by Paduart: Introduction au calcul et à l’exécution des voiles minces en béton armé [11]. The book was commissioned by the Centre d’information, Huberty’s employer at the time. A few years before, in 1957, Paduart had already written a manual for the calculation of reinforced concrete at their request [12]. In 1961, Paduart had carried out only five thin shells (although five is actually not so few in a Belgian context), yet he had set up the first course on concrete shells in Belgium in 1959 and proved to master the field. Particularly clearly written, in the handbook Paduart elaborated on, among other things, the calculation of single and double curved shells and cable roofs, including phenomena such as instability and preloading. While explaining different theories and calculation methods (by Wilhelm Flügge, Franz Dischinger, Ulrich Finsterwalder and Fernand Aïmond among others), he clearly demonstrated a preference for simplified, approximate methods, if they were used wisely. He ended the book by expressing the wish that engineers and architects would collaborate closely on the design of large thin shells, in order to let this interesting and new technique come to full bloom. The book quickly became a reference work and was also internationally acclaimed, with an English edition in 1966 [13]. The revised and extended 1969 French edition, Voiles minces en béton armé, illustrates the exponential development of the field and its expertise [14].

A one-off collaboration resulting in a unique experiment

When Huberty decided to design his own house in 1961, he choose to deviate from the common housing practice in Belgium at that time, which still mostly consisted of red brick walls and a pitched roof covered with clay tiles. Huberty, conversely, had an image of a tent in mind and wanted to explore the versatility of reinforced concrete. Prompted by the audacity and creativity that Paduart had demonstrated with the Arrow, together with the scientific knowledge and authority displayed in the book on thin shells, Huberty called upon Paduart to assist him in the design of an experimental, tent-like roof structure. Huberty was responsible for the overall design of the house but he also called in the help of architect Jacques Gillet (°1931-) as advising architect for the design of the side façade. Huberty, Paduart, Gillet and the contractor formed the perfect team to create this unique house.

The house, designed in 1961-62 and constructed in 1963-64, has a rectangular floor plan of 9.3 by 19 metre (Fig. 4). The living room is the most important room of the house, in both size and layout: all the other rooms are situated around it, in a U-shaped configuration. The central position of the living room is marked in the front façade by means of a small setback. Almost the entire house is constructed in reinforced concrete: floors, walls, cellar (including a garage and atelier for Huberty’s sculptural work in concrete, bronze and wood) and the roof. Even more unusual is the shape of the roof: a thin shell, barely 5 centimetres thick, consisting of two adjacent hyperbolic paraboloids, or hypars. This particular type of double curved thin shell, presents particular structural and technical advantages [15]. It can be considered as a quadratic, antilastic surface, in which a convex parabola is translated over a concave parabola, resulting in a saddle surface. This negative Gaussian surface results in an increased stiffness and easy calculations (when relying on simplified membrane theory at least): the directions of the two generating parabolas correspond to the main directions of the compression and tensile stresses. On the
other hand, by changing the axis, a hypar can also be considered as a doubly-ruled surface, generated by translating two series of parallel straight lines. This means that a hypar is not only relatively easy to calculate but also easy to build, as it can be constructed with straight wooden boards. In addition to the structural and technical properties, the architectural versatility contributed to the popularity of this particular type of thin shells. Both Bernard Lafaille (1900-55) and Fernand Aimond (1902-84), two French engineers, had already applied themselves to the design and calculation of hypars in the 1930s [16], but it was especially in the post-WWII era that hypars became relatively widely used in modern architecture, thanks to the work of Felix Candela (1910-97) among others. Paduart used hypars in (at least) five structures during the 1960s and 1970s, including a car dealership, a canopy, a swimming pool, a school and -the only residential application- the house for Huberty [17].

Both the design and construction of the house, especially the roof, can be characterized as rather experimental. Huberty designed and calculated most of the concrete structure himself but called in the help of Paduart for the roof. Huberty has no recollection whether or how Paduart calculated the hypar roof. Yet as Paduart had just published his book on the calculation of thin shells in 1961, it is likely that he used the simplified calculation methods he proposed in this book to calculate this roof structure [18].

The two hypars span the entire house without intermediate supports. The tensile and compressive stresses follow the direction of the upward and downward parabolas, respectively (Fig. 5). Rebars transfer these forces to the outside walls, then to a ring beam at ground level and finally to the foundation. In the corners, where the forces reach their highest value, Paduart added additional reinforcement in the walls in order to create (virtual) tensile and compressive columns. At the intersection of the two hypars, the compression and tensile forces of both surfaces are added up and transferred by a beam whose height varies from 4 to 20 centimetres. At the rear wall, the central beam transfers the compression force to a large, inclined reinforced concrete buttress measuring 30 by
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40 centimetres, absorbing about half of the total roof load (Fig. 6). In his original design, Huberty had not included this buttress, yet it was seen to be necessary once the roof structure was modeled.

Fig. 5. Schematic view of the compression and tension forces in the roof, by J.M. Huberty (Private Collection J.M. Huberty).

Fig. 6. Section through the roof and buttress, drawn by A. Paduart (Private Collection J.M. Huberty, A. Paduart, Projet de toiture. Dos. 143 Plan n° 1A).

In addition to the structural concept of the roof, there are some other structural features in the house, for instance the chimney piercing through the roof and the cantilevering rear corner of the floor slab preserving a rare old tree (Fig. 7). Another feature are the oblique and triangular buttress elements of the façade. These buttresses give increased stiffness to the façade and support the eaves, yet sometimes they have a mere aesthetic function, for instance at the south-western point where they do not even touch the overhanging roof (Fig. 8).
To reduce the cost, Huberty hired a befriended local contractor [19]. Although this contractor had little experience with concrete construction, his limited knowhow was amply compensated by the knowledge and
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experience of Paduart and Huberty. The composition of the concrete mixture for instance was defined by Huberty, who also gave advice during the mixing. On the other hand, one of the contractor’s labourers had worked at a shipbuilding yard in the port of Antwerp: he thus had experience in woodworking and also knew how to construct bent surfaces with wooden boards. These skills were particularly useful for Huberty’s house, as constructing the formwork was almost half the work to be done.

The entire construction was carried out using traditional techniques, in an almost archaic way (Fig. 9). For example, the concrete was made on site with a small concrete mixer and transported with a wheelbarrow along an improvised, shaky ramp of wooden boards. The outer walls were built in fair-faced concrete, 7 centimetres thick, reinforced with a wired mesh in the middle (with 6-millimetre bars at every other 20 centimetres). The southern wall, designed by Gillet, had irregular window openings scattered seemingly at random over the entire wall: this wall was reinforced with individual rods instead of a mesh. The window frames were attached to the rough timber boards of the formwork before the concrete was poured. They consisted of U-shaped metal bars, made by a metal-working artist from a nearby village, in which the glass was placed directly. When the concrete walls were poured and the formwork was removed, thermal insulation was applied on the inside off the walls, finished with a cement plaster. The inner walls were constructed with prefabricated concrete blocks.

Fig. 9. Pictures of the building site. ‘Den Bolle’ is standing on top of the ladder in the first picture (Private Collection J.M. Huberty).

The roof was constructed on a permanent formwork of planed wooden boards and 4 centimetres of expanded polyurethane as thermal insulation. According to Paduart’s instructions, the concrete had to be 4 centimetres thick almost throughout, and locally increased to 7 centimetres in the south-west corner of the house, near the large eave. The 6-millimetre rebars, which run parallel to the walls, are spaced 15 centimetres apart. No vertical spacers
were used during the execution, so the rebars are probably not everywhere exactly in the middle of the roof section. Although no rapid-hardening cement was used, the formwork was removed after only 15 days, because the contractor needed the wooden boards for another project. Yet the foreman feared a collapse and was not present during the removal of the formwork. The removal was supervised by Paduart, who gave instructions on which parts were to be removed first. During the removal, a few minor flaws became clear. The overhang of the front façade sagged about 1 to 1.5 centimetres, yet this deflection is hardly visible as this edge does not run parallel to the façade surface and is thus already curved because of the geometrical properties of a hypar (Fig. 10). In addition, a number of small cracks occurred at the two places with the highest tensile stresses: where the virtual roof beam meets the front façade and in the north-eastern corner. These cracks caused moisture ingress during very heavy rainfall. In 1986, expanded polyurethane was applied on top of the roof, decreasing from 4 to 0 centimetres near the edges in order to maintain the slim lines and elegance of the roof. This insulation was replaced in 2018; during the renovation no new cracks in the roof were detected, confirming the good quality of the original concrete mixture.

![Fig. 10. Exterior of the house, shortly after removal of the formwork (Private Collection J.M. Huberty).](image)

**Balancing between simple and sophisticated**

The history of the house is one of exceptional harmonies and well-balanced contrasts. Inspired by his work at the Centre d’information, Huberty took the construction of his own house as a one-time opportunity to explore the structural and aesthetic aspects of concrete. Hiring a contractor with little experience in concrete construction to build a house entirely in reinforced concrete might seem strange in that respect, but was fully justified considering the shared knowledge of the entire team. The building yard was not equipped with high-tech tools or machinery, but a simple wheel barrow, a small concrete mixer and a gigantic pile of wooden boards. The traditional, low-tech way of building stands in contrast to the daring and explicitly modern character of thin shell structures, yet the choice for a hypar shell solved many issues. In addition, while the design and calculation of a thin shell required thorough knowledge of the subject, the only paper trail of Paduart’s contribution is a drawing...
of the roof, showing the thickness and position of the rebars [20]. Paduart proposed a minimum thickness of 4 centimetres yet Huberty feared that the minimum cover of the concrete could not be guaranteed and the minimum thickness was increased to 5 centimetres, which is still very little given the workers’ lack of experience with thin concrete shells.

The minimal material use and the possibility of covering large spans were important assets for thin shells, especially for their increasingly popular application in large, mainly public buildings during the 1960s. Yet in small-scale buildings, these structural and economic advantages were often lost. Also in the case of Huberty’s house, which is indeed an exceptional example of thin shells in private housing, there was no important structural advantage or reason to construct a thin shell [21]. Moreover, it was in fact not structurally necessary to span the entire house at once as the internal walls would reach up to the roof. To ensure enough daylight in all the rooms, approx. 60 glass bricks were included in the roof during the casting process [22]. Yet at the suggestion of Paduart, the upper parts of most of the internal walls were not constructed with prefabricated blocks as planned but in glass, while other rooms were given a lower, horizontal ceiling creating “maisons dans la maison” [23]. In the living room, as well as in the kitchen and the office, the unbroken sweep of the hypar roof is clearly visible (Fig. 11). In an unpublished note, written by Huberty a few years after the house had been completed, it became clear that the structural benefits were indeed not his main motivation to build a thin shell: “Contestable sur bien des points, et à raison d’ailleurs, ... cette maison témoigne cependant de certaines options de vie dont la principale est, sans conteste, la créativité pour elle-même” [24].

Fig. 11. Interior of the house, showing the unbroken sweep of the hypar in the living room (Private Collection J.M. Huberty).

When designing his own house, Huberty’s main desire was to create something architecturally and visually attractive and to experiment with the aesthetics of reinforced concrete. This material determination is of course related to his professional background as an employee of the federation of the cement industry. In that sense, the
house might be considered as an architect’s house. When an architect builds a house for himself, the stakes are often not the same as when designing for clients: he can seize the opportunity to create a statement, a manifesto, or a full-scale business card, demonstrating his expertise to future clients [25]. Yet assessing this house as a public statement or manifesto of reinforced concrete would not be correct, as it was a truly personal, private matter for Hubert. This is also demonstrated by the fact that Hubert did not want to use it to publicly showcase the richness of reinforced concrete, although he was continuously looking for appealing graphics to enliven the publications of the Centre d’information [26]. Also Paduart never referred to the house in his publications, in contrast to most other, and mostly larger projects in which he was involved. The fact that Paduart’s collaboration is hardly documented on paper, suggests that he did not tackle Hubert’s house in the same way as other projects. This hypothesis is supported by the fact that in the catalogue of Paduart’s oeuvre only a picture of the house is included, without any details or explanation: not even the oldest and closest colleagues of Paduart knew much about the project, as it was overshadowed by more famous projects such as the Arrow (Fig. 12) [27].

Although the house can thus not be considered as a business card, there is however one important characteristic that relates to the understanding and significance of architects’ houses. When the designer is also the client, the relationship and the interplay between the various actors involved changes. Whereas a regular client is not always fully aware of the implications of decisions taken during the design and construction process and is usually not inclined to take risks, a client/designer with a professional background has sufficient knowledge to better assess or calculate such risks. When embarking on such an experiment, he can rely on his network to choose the right
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partners with the necessary capacities and a similar mindset because a close collaboration and complete trust in each other and each other’s knowledge is essential. In the case of Huberty’s house, a number of risks were taken, for instance in relation to technical and structural aspects, finances or safety, yet these were minimized due to the mutual understanding and complementary partnership. The similarities between this house and other architects’ houses such as the private house of architect Lucien-Jacques Baucher (°1929), built in Uccle in 1965-66 in collaboration with engineer René Sarger (1917-88), are striking, e.g. the collaboration with local, befriended craftsmen, the lack of paper traces, calculation notes or bills, and the changes made during the design and construction process [28].

Conclusion

However unobtrusive, the house of Jean-Marie Huberty is exemplary for many small-scale and modest projects where unique things happen, but which seem to be easily forgotten or disappear in the historiography of architecture and construction. Telling in this case is the very short but apt comment in one of the very few articles that refer to the house, published in Concrete Quarterly in the spring of 1964. The article gave an overview of new, mostly large offices, housing schemes and public buildings in Belgium, yet also devoted two short paragraphs to this “modest private house … which should not pass without mention” [29]. Counterbalancing the history of the largest, tallest, first and longest, the history of this house shows how temptingly bold and versatile reinforced concrete can be: both archaic and pioneering, simple yet sophisticated. It also demonstrates how particular, seemingly unimportant details become important, and vice versa, for instance the lack of expertise that would be dangerous in any other case. Moreover, as this was his own house, Huberty was able to fully control the entire design and construction. This added value is tangible and also appreciated by Huberty’s son, who inhabits the house since his father’s death [30]. Steeped in knowledge and passion, the house tells a unique story that brings together some of the key actors, organisations and technological developments in the history of reinforced concrete in Belgium.

Acknowledgements

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References


[18] Computer simulations by Robby Caspeele, Pieter Desnerck and Luc Taerwe (Department of Structural Engineering and Building Materials, Ghent University) in fact showed that the difference between the two calculation methods is negligible. The re-calculation also showed that the structure would not meet current standards.
[19] Returning the favour, Huberty designed a house for the contractor’s daughter a few years later, yet this house was rather traditional and very different from Huberty’s house.
[21] Other exceptions of private houses with hypars are the Saier House by Marcel Breuer (Glanville-Calvados, France, 1972-78). Before that, Breuer had designed two other houses with hypars, but these were not executed (Ustinov House, Vevey, Switzerland, 1959 and Soriano House, Greenwich, Connecticut, 1968-72).
[22] These glass bricks became apparent -and were removed- during the recent renovation of the roof. At the same time, the minimum thickness of the roof of 5 centimetres was confirmed. Communication with Jean-Damien Huberty, January 2020.
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[25] Ongoing PhD research by Linsy Raaffels on architects’ houses in Brussels, see architectshousesbrussels.be (Consulted on 7 January 2020).
[26] In a publication on fair-faced concrete, Huberty used two close-ups of the house, yet without mentioning the designer, location, etc. so the house cannot be recognized without background knowledge. J.M. Huberty, Duurzaamheid van het uitzicht van dagvlakbeton: Het verouderen van gevels, Brussels: WTCB/FeBe/VCN, 1980.