

**Eduardo Torroja:
Works and Projects**
A review of the book by
Pilar Chías Navarro
and Tomás Abad Balboa[†]

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This is a wonderful new book on the designs of Eduardo Torroja, the brilliant Spanish engineer and the founder of the IASS. To call it a paperback does not do justice to this fine publication of very high quality. The pages are of thick weighty stock and the text and illustrations are very well organized. Spanish and English appear side-by-side throughout,

avoiding the need to create two separate publications. A feature not usually present in such books and much appreciated by this reviewer is the excellent translation into English by Margaret Clark.

The text contains a thorough introduction by Torroja's son, Jose Antonio Torroja, who is an engineer in his own right. He starts with a brief history of the development of reinforced concrete, a subject of my own explorative efforts. It was, of course, enjoyable to gain from his insights and observations about his father's career and about his own memories from childhood forward, "...the (huge) room in the semi-basement (full of employees), which no longer seemed so large...." Jose Antonio describes his father's family background, as he was born in 1899 to a family of mathematicians, engineers, and physicists. He describes his father's education and the faith placed in him by his first employers, some very prominent engineers of the day. He recounts his father's practice at its peak in the 1930s, the many innovative designs, the experimental construction techniques, and the drive for aesthetic results, and goes into some detail to explain his father's role in the early developments of prestressing, and the establishment of his own firm, "Eduardo Torroja, Engineering Bureau." However, he seems frustrated in attempting to explain Torroja's sudden downsizing of his thriving practice in the middle of World War II. On the other hand, he proudly draws attention to a letter that his famous father sent to him when he first enrolled in the School of Engineering, "...And far more than the technical results, I value the experience in its human, social and professional dimension ... to create organizations where the different professions, the upper and lower echelons, could work together in perfect harmony; where everyone has grown accustomed to living a life on the highest rung of humanity, where courtesy, mutual respect and support, and maximum personal dignity reign."

Torroja's son continues emphasizing a distinguishing characteristic of his father's practice, that of always looking first for a new way to accomplish the design requirements. And when the results of his innovation brought about less than desirable results (in his discerning opinion), how quick he was, with signature modesty, to honestly admit his judgmental error.

[†] Pilar Chías Navarro and Tomás Abad Balboa, *Eduardo Torroja: Obras y proyectos*, Eduardo Torroja Foundation and the Association of Members of the Eduardo Torroja Institute, 2005, ISBN 84-7292-362-2, Depósito Legal: M-51.203-2005, 32 x 29 cm paperback.

Jose Antonio proceeds to describe a second “career.” While still maintaining a smaller design practice, Torroja became increasingly involved in the establishment of organizations devoted to research, education, and the development of codes and standards. As described in the book, they are too numerous to name, but it is clear to me that Torroja at least equaled the French contractor, Hennebique, in this field, and that’s quite an achievement!

The majority of this excellent document consists of detailed studies of ten or so built designs highlighting Torroja’s brilliance as a structural artist. One of my favorite structures is the 1933 Market Hall at Algeciras (See Figure 1.) It is a thin shell (Torroja’s favorite type of reinforced concrete construction) with a tension ring of 16 continuous rods around the edge to pick up the horizontal thrust. The central skylight is an elegant tracery of thin concrete mullions supporting the glazing. But the most distinctive feature is the presence of folded “eyebrows” over each of the eight entrances. The author correctly calls attention to the fact that the fold stiffens the edge of the shell while acting as an arch to direct the radial compression forces to the columns. I have recommended this edge condition (always crediting Torroja, of course) to many of my students over the years. In 1999, on the 100th anniversary of Torroja’s birth, the Spanish government authorized an extensive restoration of this structure under the direction of Jose Antonio Torroja. That work was completed in 2003, and the Market is set to last another 70 or more years.



Figure 1. Martek Hall at Algeciras



Figure 2. La Zarzuela Racetrack

All of the featured designs are presented in the book with construction photographs and drawings. These are seldom found in less thorough treatments of the master’s works and are most informative.

Among the featured building structures is the Fronton Recoletos (jai-alai court) destroyed in the Spanish civil war. (I must confess that I had no idea how big the space really was, 52 by 32 meters!) Thorough treatment is also accorded the famous racetrack grandstand at Zarzuela. (See Figure 2.) This 1935 ingenious shell roof cantilevers an impressive 13 meters. The cantilever is supported and uniquely counterbalanced by the structure of the betting hall below.

One of the few criticisms I have of the book is that while Torroja’s use of physical models is highlighted several times, no mention is made as to how these models were used for other than form studies. From personal experience with structural models, I would be most interested in how various problems such as similitude and strain measurement were overcome in the 1930s. When discussing the structure of the Canellas Dam, for example, the authors call attention to a model made of a “mouldable material” but never identify the material or provide any specifics. Another

flaw, so easy for the authors to have addressed, is the failure to convert kg/cm^2 to both kPa and psi for the readers not accustomed to working in kilogram-force. I would also have appreciated more recognition of the architects involved with most of his buildings. They are mentioned, for the most part, only on the credits page.

In addition to Torroja's buildings, the book covers the many aqueducts designed by him including his most recognized one at Alloz spanning the Salado River. (See Figure 3.) Acknowledging that concrete was Torroja's material of choice, the book also addresses the many trussed-arch bridges designed by him, thus illustrating that steel was also part of his structural vocabulary. In addition, for the first time, I learned that he used brick, both structurally and as formwork, most notably in hyperboloid cooling towers. The writers also included a section on the University of Madrid, with which Torroja was involved from the early planning stages. They call attention to the many innovative campus structures, which have been sadly covered over or hidden by newer and usually mediocre additions.

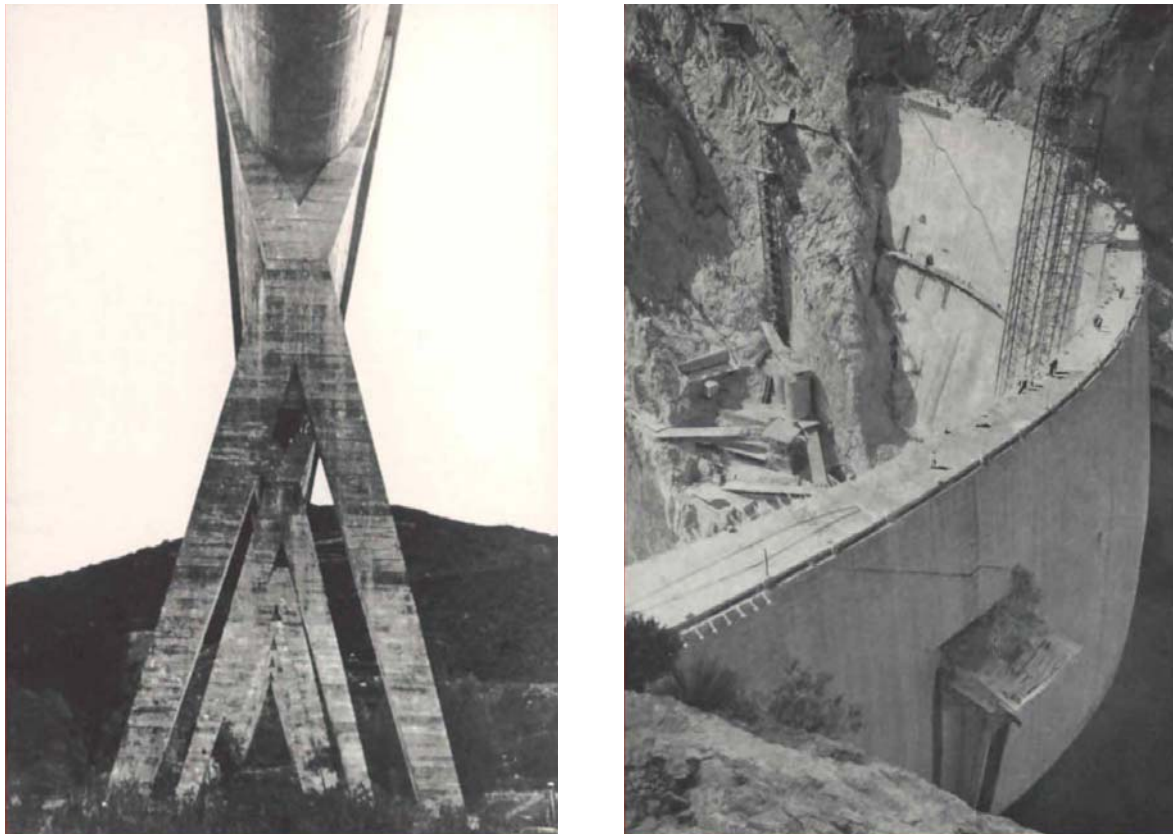


Figure 3. Aqueduct at Alloz

Throughout their descriptions the authors rightly point out that Torroja, in addition to being perhaps the pre-eminent structural designer of the 20th Century, was also a master at developing new construction techniques. This message comes through with almost every structure. In conclusion, this is a book that should be owned by every architect and engineer in practice today. It is an educational joy!