

Invited Paper

Structural Design in the Work of Gaudí

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Abstract: The work of Gaudí embraces all the facets of architectural design. The present paper studies the analysis and design of masonry arches, vaults and buildings. It is well known that Gaudí used hanging models and graphical methods as design tools. These methods can be traced back to the end of the 17th Century. In addition, it was not original the use of equilibrated, catenarian forms. What was completely original was the idea of basing all the structural design in considerations of equilibrium. Gaudí also employed unusual geometrical forms for some of his vaults and ruled surfaces, showing a deep structural insight. Finally, he designed tree-forms of equilibrium for the supports of the vaults in the Sagrada Família. In the present paper Gaudí's equilibrium methods are studied with some detail, stressing their validity within the frame of Limit Analysis.

Keywords: Structural design; Gaudí; Masonry arches; Vaults; Catenarian forms; Equilibrium methods; Limit analysis

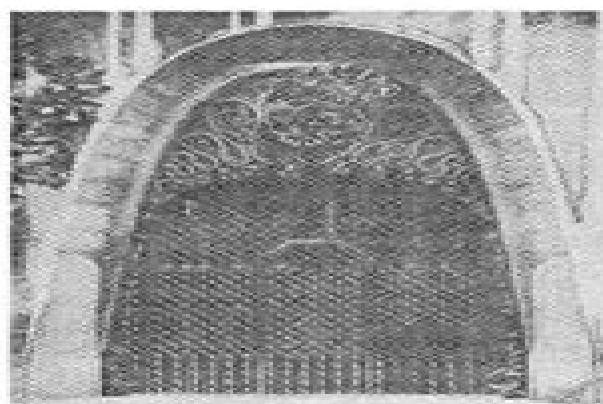
Introduction

Antoni Gaudí (1852–1926) was a Master Builder. His work covers all aspects of architecture: layout, ornamentation and stability. He also incorporates other arts: sculpture (particularly), painting, and photography. Any study of Gaudí's work must embrace this global concept of the project. This article considers only one of the aspects of Gaudí's work: the design and calculation of structures. For Gaudí, structural design was an integral part of architectural design from its initial stages. It was not restricted, as was the usual case in those days, to a mere stability check. This paper will go through the different structural elements, studying the detail of Gaudí's design and calculation process and attempt to place his activity in a historical context.

Catenary Arches

From his first projects, Gaudí showed his originality and independence. In particular, he began to use systematically a type of arch not common in the western architectural tradition. Instead of using arches with a shape derived from

the circle (roman, pointed, basket-handle, etc.), he used arches with non-circular shapes: parabolic or "catenary." These arches are already present in Gaudí's first buildings, seen in Figures 1 and 2.



(a)



(b)

Figure 1. Catenary arches: (a) Entrance to the Palaciu Güell (Rafel 1929); (b) corridor in the School of the Teresianas (Tarragó 1991).

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