

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.

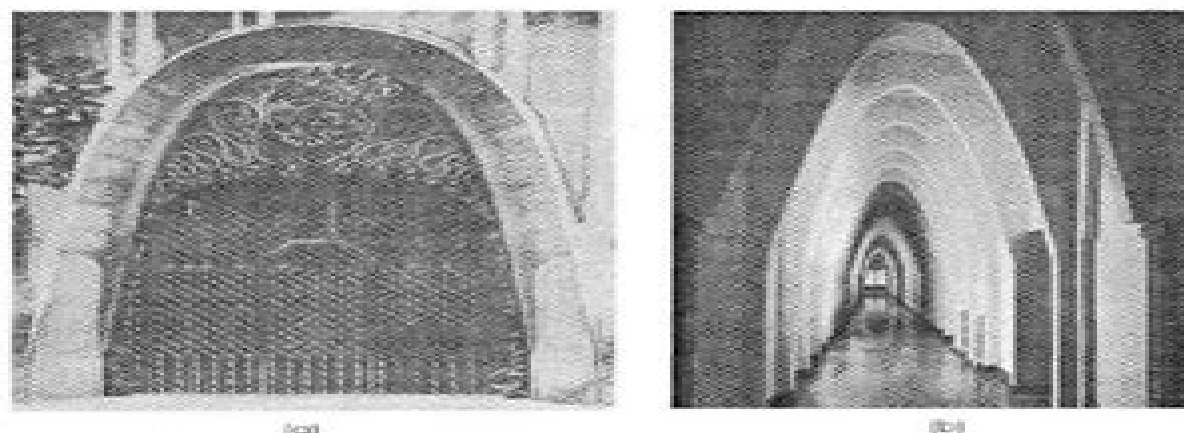


Figure 1. Catenary arches: (a) Entrance to the Palaciu Güell (Rafel 1929); (b) corridor in the School of the Teresianas (Tarragó 1991).

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A Century of Excellence in Measurements, Standards, and Technology David R. Lide, 2018-02-06 Established by Congress in 1901 the National Bureau of Standards NBS now the National Institute of Standards and Technology NIST has a long and distinguished history as the custodian and disseminator of the United States standards of physical measurement

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Extreme Man-Made and Natural Hazards in Dynamics of Structures Adnan Ibrahimbegovic, Ivica Kozar, 2007-05-16 This book provides a critical assessment of current knowledge and indicates new challenges which are brought about at present times by fighting man made and natural hazards in transient analysis of structures The latter concerns both permanently fixed structures such as those built to protect people and or sensitive storage material or special structures like bridges and tunnels and moving structures such as trains planes ships or cars

Natural Disasters P. A. Merriman, C. W. A. Browitt, 1993 It has been estimated that as a result of natural disasters during the 1970s and 1980s three million lives were lost worldwide the number of disasters increased threefold the economic losses per decade almost doubled and the insurance losses quadrupled In the light of these figures the United Nations proclaimed the 1990s as the International Decade for Natural Disaster Reduction and this book focuses on the British contribution to the Decade and is supplemented by papers from America Asia Europe and Africa

Safety at Natural-gasoline Plants G. B. Shea, 1929

Human-Computer Interaction. Multimodal and Natural Interaction Masaaki Kurosu, 2020-07-10 The three volume set LNCS 12181 12182 and 12183 constitutes the refereed proceedings of the Human Computer Interaction thematic area of the 22nd International Conference on Human Computer Interaction HCII 2020 which took place in Copenhagen Denmark in July 2020 A total of 1439 papers and 238 posters have been accepted for publication in the HCII 2020 proceedings from a total of 6326 submissions The 145 papers included in these HCI 2020 proceedings were organized in topical sections as follows Part I design theory methods and practice in HCI understanding users usability user experience and quality and images visualization and aesthetics in HCI Part II gesture based interaction speech voice conversation and emotions multimodal interaction and human robot interaction Part III HCI for well being and

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Natural Shelter Construction Laura Anderson, AI, 2025-02-19 Natural Shelter Construction explores how to build sustainable shelters using only natural materials This book bridges architectural design with practical survival skills focusing on thermal efficiency structural integrity and smart site selection Discover how different natural materials like earth and timber have unique thermal properties that can be optimized for comfortable shelter Learn the principles of load bearing structures and jointing methods to ensure your shelter withstands environmental stressors The book starts with design fundamentals and material properties progressing to construction techniques for various climates It emphasizes the importance of understanding engineering principles and respecting natural materials to create effective shelters in diverse environments This approach demonstrates that building with nature is a practical skill applicable to emergency preparedness and sustainable living enhancing resilience and self sufficiency

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