



## The Portuguese River Douro Bridges - the Designer and the Aesthetics

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### Summary

Prof. Edgar Cardoso (1913-2000) was a skilled structural engineer with a special aptitude on the design of bridges and the aesthetics. He considered that every site had an adequate bridge design solution. He was deeply committed to his concepts and will, and he would carry on with his ideas until the bridge was constructed. A native of Oporto where he graduated, he did some of his best original designs over the River Douro. The purpose of this study is to present several different designs, from this unique Portuguese bridge designer, spanning over this stormy river. The early 1955 Barca d'Alva multi-span arch, the 1957 Foz-do-Sousa arch, the 1963 Arrábida arch, the 1973 Mosteirô continuous truss girder, and the 1991 São João portal frame bridges, are few unique structural concrete examples of a prodigious creative mind, with more than 500 bridge studies.

**Keywords:** bridge; structural concrete; arch; design; aesthetics;

### 1. Introduction

The river Douro has a total length of approximately 900 km, from the springs in the Spanish Sierra de Urbión (Soria) until it meets the Atlantic Ocean, in the Portuguese city of Oporto. Only after the city of Zamora, the river Douro goes to very old granite rock masses, deeply carved by erosion. Prof. Edgar Cardoso (b. Oporto 1913 – d. Lisbon 2000), one of the foremost Portuguese bridge designers, developed several bridge structural concrete design solutions along the 214 km length, from the Spanish border to the City of Oporto.

The Barca d'Alva (1955) reinforced concrete (RC) multi-arch bridge with 232,00m represents a great achievement considering the post-WW II economic conditions and the difficult hinterland access. The 1957 Rio Sousa RC bridge is a shallow single arch and it was considered to be a “reduced”-scale test to the incoming Oporto Arrábida RC arch bridge completed in 1963. This last bridge has one of the longest spans in the world (1963) with 270,00m, and a total length of nearly 614,40m.

However, the Mosteirô structural concrete (SC) bridge (1968), with 110,00m central span and two 42,00m side spans, is considered to be a unique solution considering the site, the existing conditions, and the original design. The strong aesthetic impression caused on the observer is long lasting. Finally, the Oporto São João railway bridge (1991), with a total length of 1028,6m and a 250,00m central span, represents the ultimate achievement of this designer.

In the footsteps of last century major European bridge designers - Spain (E. Torroja), Italy (P.L. Nervi, R. Morandi), France (E. Freyssinet; Y. Guyon), Prof. Edgar Cardoso with more than 500 bridge studies still represents a learning experience to every young structural engineer. This study purpose is to present along the river Douro, his SC designs from an early phase (1955) until a more mature level (1991). The different shapes – arch, continuous girder, portal frame, show an excellent command on geometry, material science and structural behavior.