Eminent Structural Engineer: Eugène Freyssinet (1879–1962)

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Introduction

"My fortune, my great good fortune, has been to be seized, since a child, by a vehement vocation. I have loved this art of construction which I conceived, as did my artisan forbears, as a means of reducing to the extreme the human labour needed to achieve a useful object".

"I was born a builder. It was for me both an overriding need and also an endless source of joy imposing upon the crude material those shapes and forms which sprang from my imagination" (Eugène Freyssinet) (*Fig. 1,* [1]).

Brief CV

1879	Born at Objat (Corrèze)
1899	Ecole Polytechnique Paris
1905–1914	Junior Engineer to the local office of the "Ponts et Chaussées" at Moulins
1914–1928	Technical Director and Partner of Entreprise Mercier - Limousin
1920	First Patent on Prestressing
1928–1933	Prestressed concrete piles manufacturer
1934	Solves the problem of the disastrous settlement of the Gare Maritime at Le Havre
1943	Prestressing takes off. Creation of the enterprise STUP "Société Technique pour l'utilisation de la précontrainte" which became Freyssinet International in 1970.

Early Years

At Moulins, his job was to advise a number of local rural mayors. He loved it. He knew their needs and had total freedom to satisfy them with structures of his own design in reinforced concrete, built with their own direct labour.

Fig. 1: Eugène Freyssinet

All this led to three identical bridges over the River Allier. They were bridges comprising three 72,5 m span three-hinged arches, very flat, built by direct labour. He made a test arch, using prestressed concrete as a foundation tie and discovered the existence of creep in concrete.

Today, close to Vichy, Boutiron bridge, the Veurdre's twin brother (*Figs. 2, 3*), still stands after two world wars as a clear piece of evidence. Jose Fernandes Ordonez wrote in 1978 [1]: "It is for me the most beautiful of all man made concrete bridges still remaining on the face of the earth!".

Fig. 3: Boutiron bridge

Master of Concrete Construction

This period included the construction of between 7 and 8 ha of concrete shell roofs for industrial buildings, including the steelworks at Caen and an assembly shop at Le Creusot; extensive bridge reconstruction and a number of seagoing cargo ships as well as numerous more specifically military works.

At the end of the war, he was a master of concrete construction. He was a pioneer in shell roof construction. By putting stiffening ribs on the top surface, leaving the lower surface smooth, he simplified barrel vault, mitred vault and conoid north-light roofs. His ingenuity and economy in timber formwork was remarkable; he adopted sliding formwork widely. In his private laboratories of pre-war days, he had obtained a profound knowledge of cement and concrete: in his war-time ships, he had compacted the concrete in the hulls using vibrators borrowed from foundries where they were used on sand moulds.

He continued to build shell roofs (his final total came to about 1 km square) culminating in the airship hangars at Orly. His bridges progressively established records for spans with

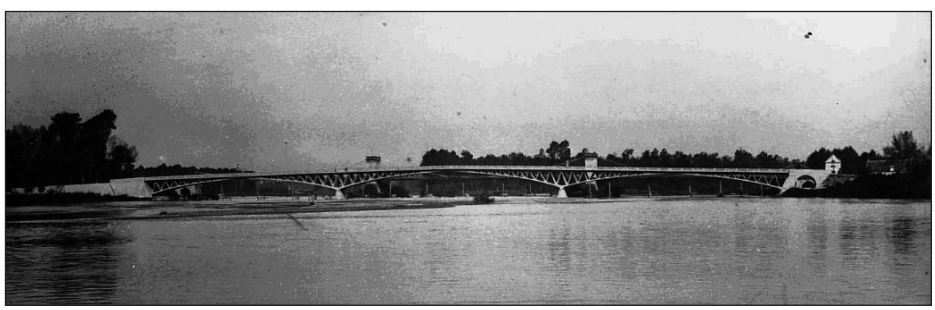

Fig. 2: Veurdre bridge

concrete – not forgetting the 100 m span arch at Villeneuve-sur-Lot with no reinforcement at all. The triumph – and the conclusion – was Plougastel bridge, comprising three 180 m span arches [2].

Prestressing Breakthrough

The story started with the Havre Gare Maritime which had been founded on piles bearing on a 10 m thick layer of gravel: the old quay wall and platform were founded on gravel at a depth of 30 m: between them was mud. The quay held firm, the Gare Maritime squeezed out the mud and was sinking rapidly: cracks abounded.

Eugène Freyssinet (by then well known – indeed famous) raised some money and was accepted even though he proposed techniques that he had never used before. First, using three long and massive beams, he prestressed together the pile heads of the existing foundations. Then, through holes in these beams, he jacked down concrete tubular piles that were cast, steam-cured and prestressed in 2 m lengths.

As soon as the first piles reached the deeper layer of gravel, subsidence slowed down; eventually he used the piling jacks to restore the building to its intended level. In 1944, bombing

Fig. 4: Luzancy bridge

demolished the Gare Maritime; but its replacement was built on those same three beams and supporting piles.

Prestressing was now launched: thanks to the confidence of Mr. Campenon, who backed him for the rest of his life, Eugène Freyssinet built caissons at Brest, dams in North Africa, pressure pipes and road bridge beams developed with licensees.

After the war, with a huge need for bridges (*Fig. 4*), harbours and hydroelectric energy, and given the existence of numerous post-tensioning systems, prestressed concrete was soon used worldwide. But Freyssinet continued to produce major works bearing his own unmistakable mark up to within a year of his death in 1962.

Conclusion

Jose Antonio Fernandez Ordonez wrote in 1978 [1] what could be considered as the summary of this amazing engineering life:

"Prestressing, his legacy to history, is now familiar the world over to architects, engineers, industrialists, workers in the building trade and students in appropriate disciplines. The tools Eugène Freyssinet used and his methods of calculation are today the birthright of builders everywhere. There is not a shadow of doubt that Eugène Freyssinet's brilliant solutions to problems and methodology, which showed such economy in the use of materials and such elegance have not been surpassed even today, nor has anything fundamental been discovered or added to his creative output. Reinforced concrete has always been an irrational, paradoxical, deceptive material but Eugène Freyssinet was able to master it; with prestressing he raised concrete to the level of a noble material, and from then on it stood on an equal footing with steel in civil engineering structures throughout the world."

Reference

[1] JOSE A. FERNANDEZ ORDONEZ, *Eugene Freyssinet,* ISBN 9788485434008, Jan, 1978.

[2] Un siècle de Génie Civil, Paris, *AFGC Conference Proceedings,* 12 Dec., 2000.

Correction: The complete affiliation of the Author of the article **"Strengthening Coalport Bridge"** published in SEI May, 2007, Pg. 178 issue is "Julian De Voy, BSc PhD CEng MICE, Technical Manager, Grontmij, Solihull, UK **(formerly Associate, Gifford, Southampton, UK)"**