# The long road to Berus: Bernard Laffaille and Eugène Freyssinet as designers of lightweight roof structures

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The names of two famous French engineers are associated with the design, the construction and the rescue of the building for hosting the radio broadcast station Europe No. 1 in Berus (Saare) in 1954: these engineers are Bernard Laffaille (1900-1955), who was the consulting engineer to the architect Jean-François Guédy (1908 - 1955), and Eugène Freyssinet (1879-1972) who designed and implemented the new roof reconstruction project after the accident of 8 September 1954. The building is covered by a huge thin concrete shell roof with double curvature prestressed with steel cables, which makes it a remarkable structure at the time of its construction and which remains exceptional today. The two French engineers are among those few pioneers who explored the potential of thin concrete shells to roof large space enclosures without intermediate supports as early as the 1920s. In addition, Freyssinet is widely considered to be the founding father of the prestressed concrete, a technique that he began to develop in 1929.

Bernard Laffaille graduated from the Ecole Centrale de Paris in 1923. From 1927 to 1932 he was technical director of a company (the CCCC) that specialized in the construction of thin concrete shell roofs (thickness 5-6cm). This was the time when he explored the constructive possibilities of conoïdal membranes: he constructed some to cover hangars or factories in Verdun (1927), Avord (1927-1929), Romilly-sur-Seine (1929-1931), Rochefort (1932-1933) etc. He also designed thin concrete shell roofs with double curvature to create barrel vault "tunnel" type aircraft hangars in Rochefort (1930), Chartres (1929-1931), Chalons-Buy (1931-1932), Reims (1931-1932), etc.
With the conoïdal shape, he also studied the possibility of building "Caquot" type aircraft hangars with overhanging canopies and built a ½ scale prototype in Dreux (1933-1934). But this very elegant type of hangar (Fig.1) was never constructed. From 1933 onwards, Laffaille became an independent consulting engineer. In addition to his research and realizations with thin concrete shells, he explored the possibilities of constructing lightweight roofs using very thin steel sheets (3-4mm thick): he was able to apply his 1935 patents to build hangars (67 m opening) in Cazaux in 1935 and in Dijon in 1936. In the "paternity" of the Berus project, it is particularly worth mentioning his contribution to the French pavilion at the 1937 Zagreb International Exhibition (with the architect R. Camelot): it is a 33m diameter rotunda, covered by a thin 2mm thick steel sheet, tensioned by the weight of a skylight ring placed in the centre of the structure. This structure, which prefigures the prestressed cable roof structures of the 1950s, still exists and has been recently renovated. Finally, before the Berus project, Laffaille proposed in 1951 to the architects appointed to build the CNIT in Paris - Camelot, de Mailly and Zehrfuss - a huge cover roof of 30000m2 (horse saddle 240m x 210m) which would have been either a thin steel sheet 4mm thick or a network of cables (Fig.2). But the steel construction industry did not support him and the roof was finally constructed concrete in reinforced concrete by the engineer Nicolas Esquillan.

When he carried out the Berus project in 1954, Laffaille was a highly experienced consulting engineer in lightweight roof structures, and well known to the architectural community. However, he had never carried out projects combining concrete and prestressing with cables.

Eugène Freyssinet graduated from the Ecole Polytechnique and the Ecole des Ponts et Chaussées in 1905. His first assignment in the Administration of "Ponts et Chaussées" led him to Moulins in the Allier department where he built many reinforced concrete bridges at a time when this technique was still in its infancy. Examining the time-dependent behaviour of the Le Veurdre bridge he had built in 1908 made him aware of the importance of the delayed deformations of concrete (shrinkage, creep). In 1913, he left the Administration and became co-manager and technical director with Claude Limousin of a construction company with which he would build remarkable concrete bridges over a period of fifteen years, many of which held span records: Villeneuve-sur-le-Lot bridge (1914-1920), Tonneins bridge (1921-1922), Saint-Pierre-du-Vauvray bridge (1922-1923), Plougastel bridge (1924-1930). But the Limousin- Freyssinet Company did not limit itself to the construction of bridges. Since 1915 Freyssinet designed and built "tunnel" type reinforced concrete aircraft hangars in Avord (1915-1916), Istres (1917-1919) and Villacoublay (1919): these were thin concrete shell barrel vaults with 45m opening. From 1921 to 1924, the Limousin Company built the famous airship hangars in Orly that attracted worldwide attention even by architects. The need to accommodate ever larger aircraft induced Freyssinet to introduce constructive innovations for the building of "tunnel" hangars in Villacoublay (1924-1925, opening 55m) and Hyères (1926, idem). Still in the register of thin concrete shell barrel vaults Freyssinet is the author, with architect E. Maigrot, of the Reims central market hall (1928). Finally, Freyssinet started at the same time as Laffaille to build thin concrete shell conoïdal vaults, but specifically to build northern light sheds, with the first examples in Bagneux in 1927.

At the end of 1928, Freyssinet, at the pinnacle of his career as a builder of reinforced concrete structures, left the Limousin Company to devote himself to the development of the prestressed concrete technology. He first developed the pre-tensioning technique for prefabrication, but commercial success was not forthcoming. However, he received the reward for his work by being able to apply the techniques he had developed and his ideas to "save" the threatened ruined Le Havre ferry terminal in 1933. This attracted the attention of the contractor E. Campenon, who offered Freyssinet the opportunity to use all kinds of prestressed concrete techniques on large equipment projects in Algeria on a grand scale. The first bridge with prestressed concrete girders was built in Oelde (Germany) in 1935 by Wayss und Freytag, the German patent agent for Freyssinet. In 1939, Freyssinet invented the anchorage and tendon system with multiple 5mm diameter high strength steel wires that would allow, after the war, the rise of prestressing by post-tensioning. But before and during the Second World War, the applications of prestressed concrete remained exceptional. It was the economic conditions of the post-war years, as well as the enormous needs for reconstruction - particularly of bridges - that made it possible, after 1945, to expand the use of prestressed concrete. In 1943, the contracting company chaired by E. Campenon had ceased its activities, and Freyssinet had created then the STUP Company to promote the applications of its patents relating to prestressing.

When he was called upon to resume the works at Berus after the accident of September 1954, Freyssinet was probably the most famous and respected construction engineer in France. He had not built thin shell concrete roofs for 25 years, but he was rightly considered, not only in France but also abroad, as the most prominent authority on prestressed concrete.

Translated with www.DeepL.com/Translator, enhanced by B. Espion

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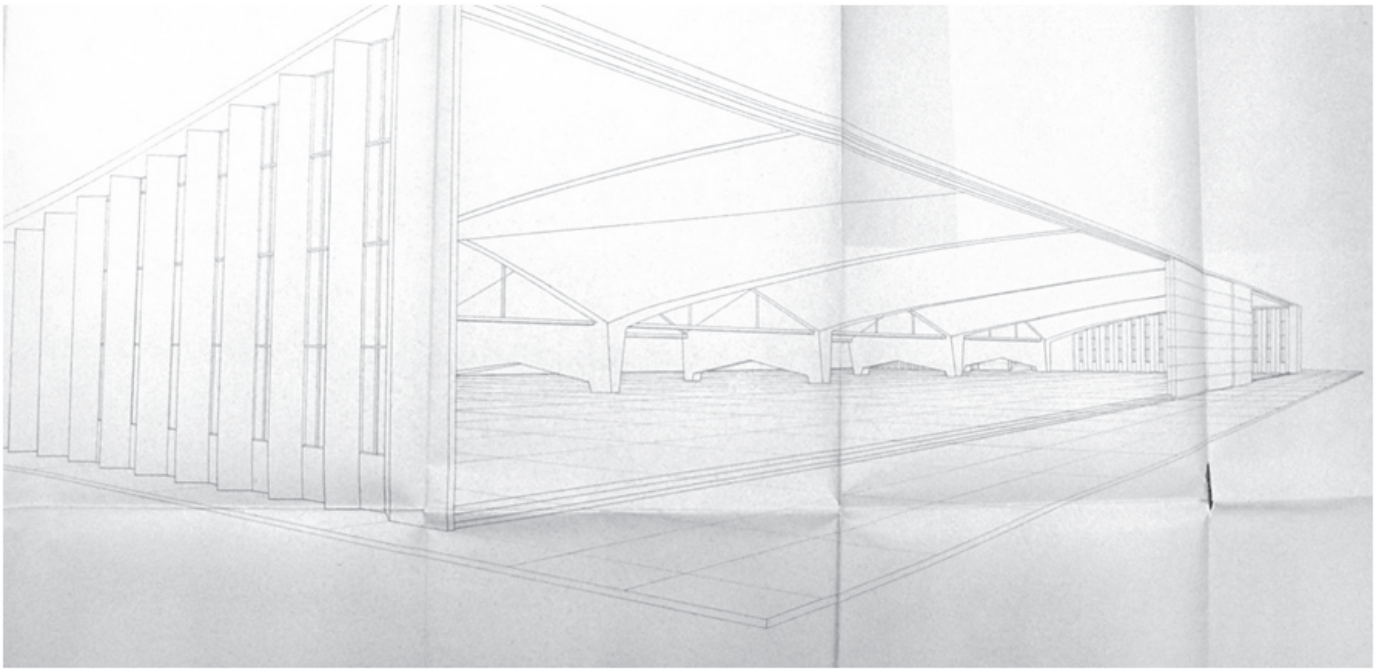

Fig. 1: Unrealised project (1932) by Laffaille for a « Caquot » type aircraft hangar with thin concrete shells (Fonds Laffaille, file 206 ifa 59/2 –SIAF/cité de l'architecture et du patrimoine/Archives d'architecture du XXe siècle).

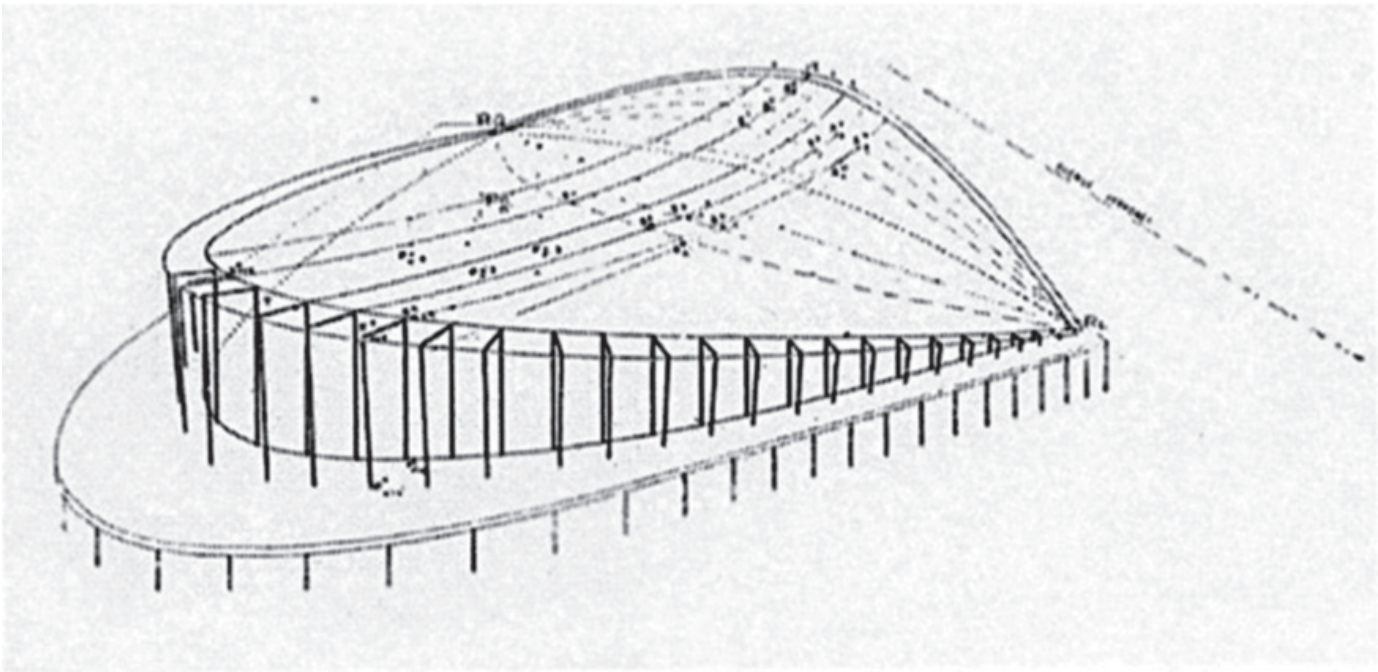

Fig. 2: Unrealised project (1951) by Laffaille for roofing the CIM (Centre of the Mechanical Industries) with a steel membrane or steel cables (Nogue, 2004, 195).