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Желѣзнодорожное Дѣло

ЖУРНАЛЪ

The topic considered in the preceding article is continued by two publications first published in the journal 110 years ago. Both articles (they had been in turn reproduced and translated from French editions) are dedicated to engineering solutions that allowed construction of a railway in mountain region and that were unique for that time.
To the maximum extent possible the vocabulary of the period of publication has been kept intact.

Keywords: mountain railway, viaduct, Pyrenees, transport history, bridge structures.

For the original Russian text of the publication please see p. 304

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RAILWAY IN THE FRENCH PYRENEES

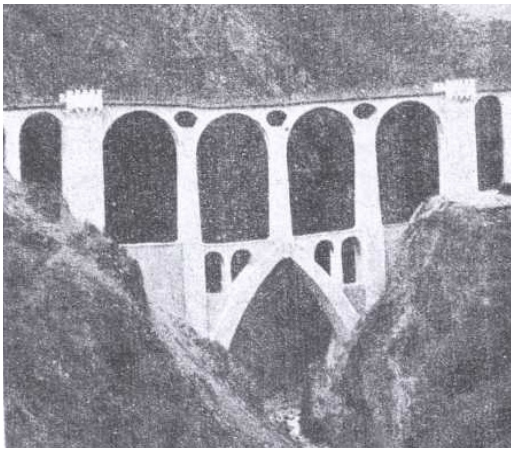
In the presence of the Minister of Public Works, Millerand, the opening of a new railway linking Villefranche-de-Conflent with Bourg-Madame will soon be inaugurated in the French-Eastern Pyrenees. This railway, on which, due to steep inclines, it was decided to use electric traction, serves as an extension of the existing line from Perpignan to Villefranche.

Passing through unexplored, inaccessible terrain, the new railway line is remarkable not only for the variety of beautiful views, but also for the originality of some manmade structures, for the construction of which new calculation formulas and bold methods were used in the work itself.

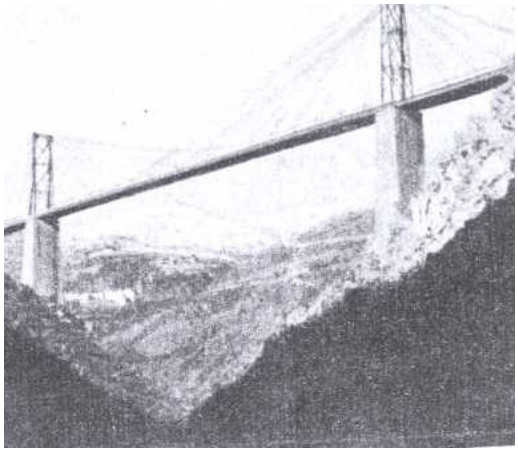
From Villefranche, the train runs along the valley of the Têt River and then crosses the French Pyrenees all the way to Bourg-Madame.

At first, running at an average height of 549 meters above sea level, the railway rises along a mountain gorge, crosses the ridge of the Pyrenees chain at an altitude of 1580 meters and then again descends at the border, holding at an altitude of 1138 m.

Without touching the railways of a purely mountainous nature, this railway line should be considered, in general, very elevated in terms of the absolute height of its points (La Mur – 925 meters, St. Gotthard – 1154 meters, Arlberg – 1311 meters and Brenner – 1370 meters); on any other road there are no separate points that differ so much in height above sea level and in climate on clear summer days, during three hours of travel along the railway line, the temperature at different points varies up to 20°. Between the dense vineyards that cover the Roussillon Plain and the uninhabited pastures, over which the fortress of Mont Louis rises, a provincial city, the most elevated and coldest in France in terms of climate, there are valleys where tamarind, scarlet and cacti grow: but if from here, having risen along the Perche Gorge, to descend again to Burg-Madame (towards Spain), then you will find yourself on the high plateau Cerdagne, and although this



Pic. 1. Arched bridge Séjourné over the avalanche of the river Têt.



Pic. 2. General view of the suspension bridge of the Gisclard system.

plateau is still at an altitude of 1100 meters, its luxurious fertility and vegetation can be compared with the best orchards of Touraine. Winding in all directions, narrow valleys diverge, where they huddle, now in the bushes of dense greenery, now clinging to the bare rock, various climatic stations, and hydropathic establishments; their modest size, limited by compressed gorges, lends an even more imposing appearance to the distant Pyrenees, whose peaks loom at their entire colossal height along the entire length of the railway track. As it approaches the Spanish border, this new railway line represents a real pass through the Pyrenees, it crosses the border to a point where both slopes, by virtue of the treatise, belong to France. Under this agreement, 33 villages in Cerdagne were ceded to the possession of France, while the town of Llivia, then considered a city, remained with Spain. Currently, in this place, a settlement of 10 sq. km appeared, with a population of 1000 people, connected by a neutral strip (road) with the border near the small town of Puigcerda, built only two kilometers from the French territory. The pass over the ridge is made by an open-air notch; instead of a large tunnel for the railway line, numerous artificial structures had to be erected, between which the following two bridges are of exceptional interest.

The first bridge (Pic. 1) crosses the Têt River just below Fontpédrouse. In this place, the valley of the river Têt takes on a funnel shape, reaching a width of only 35 meters. At fifty meters above the river, meanwhile, at the level of the railway bed, which rises 75 meters above the river, the valley, expanding, reaches over 200 meters in width.

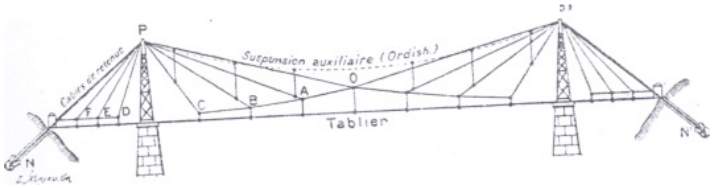
The construction of a stone pipe (bridge arch) in the usual way would cost a lot of money. The engineer Séjourné came up with the idea of throwing a lancet vault over this avalanche, at the top of which he grounded the columns, the height corresponding to the depth of the river Têt crossed by the thalweg; thus, an arched bridge was built, built in an original and economical way.

Another bridge (Pic. 2), built upstream (along the river) of the previous bridge, is a large bridge, a suspension system, on steel ropes. This is one of the rare cases in European practice when they decided to build a bridge of this kind under the railway track.

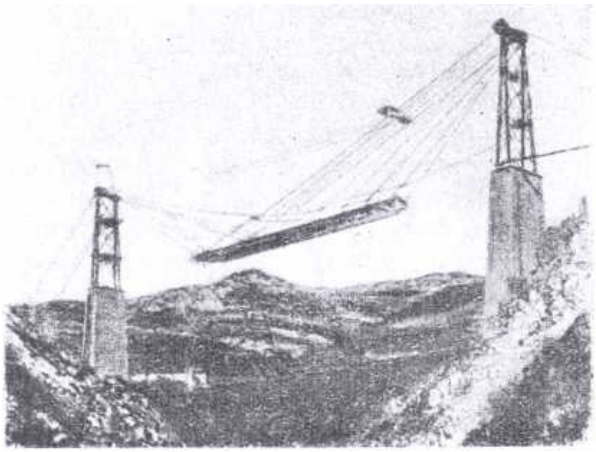
In this respect, experience has previously been done in the United States (North America), but the bridge in question is significantly different from American bridges; designed by military engineer Gisclard. This bridge should be noted as an important step in improvement of metal bridges.

Suspension bridges are usually arranged using chains or steel ropes stretched through two supports (pylons), and ropes are suspended along the length of the ropes to support the bridge deck. When a moving load passes, the curvature of these ropes (parabola) undergoes gradual changes, which cause harmful vibrations in the bridge deck and additional stresses in individual component parts of the structure.

To reduce the swinging of suspension bridges, the Americans use the system adopted during the construction of the Brooklyn Bridge.



Pic. 3. Diagram of the method of suspension of the bridge. Trusses PO, PA, PB, etc. connected to the main rope in such a way that they form triangles, to the tops of which rods supporting the bridge deck are attached. These trusses, moreover, are suspended from an auxiliary rope stretched through both supports P and P′. At points N and N′, underground anchors are shown holding the tensioned ropes.



Pic. 4. Execution of works on the assembly of the Gisclard bridge.

For this purpose, high lattice trusses are arranged on both sides of the bridge, thereby creating an intermediate type between suspension bridges of the previous type, with a flexible bridge deck and bridges of an ordinary rigid system of lattice trusses. The Gisclard bridge is based on the principle of an immutable triangular system; the bridge leaf is suspended by means of triangular trusses formed, as shown in the diagram, Pic. 3, with ropes fastened both at the meeting points and at the points adjacent to the rods supporting the bridge deck; the rigidity of the latter is enhanced by means of auxiliary suspensions of the Ordish type, consisting of special ropes thrown from one support to another; to these auxiliary ropes, at certain intervals, the main tension ropes of the trusses are attached using vertical ties. Thus, a geometrically unchanging system is obtained, and the metal parts undergo only very small deformations, depending on the elasticity of the metal, as is the case in structures made of rolled and riveted iron.

The Gisclard bridge, erected in the town of Cassagne, between the stations of Sauto and Planès, is located about 80 meters above the level of the Têt River; the total length of the bridge is 253 meters, of which 234 meters are the bridge deck, suspended from two supports located at a distance of 156 meters, and the remaining 19 meters constitute the span fixed part of the bridge related to the coastal abutments (Pic. 4).

The construction work was carried out with remarkable art by the specialist engineer Arnodin, well known for the construction of Châteauneuf-sur-Loire.

The very execution of the work on the assembly of the bridge was distinguished by boldness and grace.

To avoid significant costs for arrangement of the scaffold, the work was carried out on the weight, using conveyors; starting the assembly from the middle panel of the bridge deck, as shown in Pic. 4, were moved step by step from each side to the supports. The work was carried out so accurately and was entrusted to such a skilled staff that the business went without any accidents.

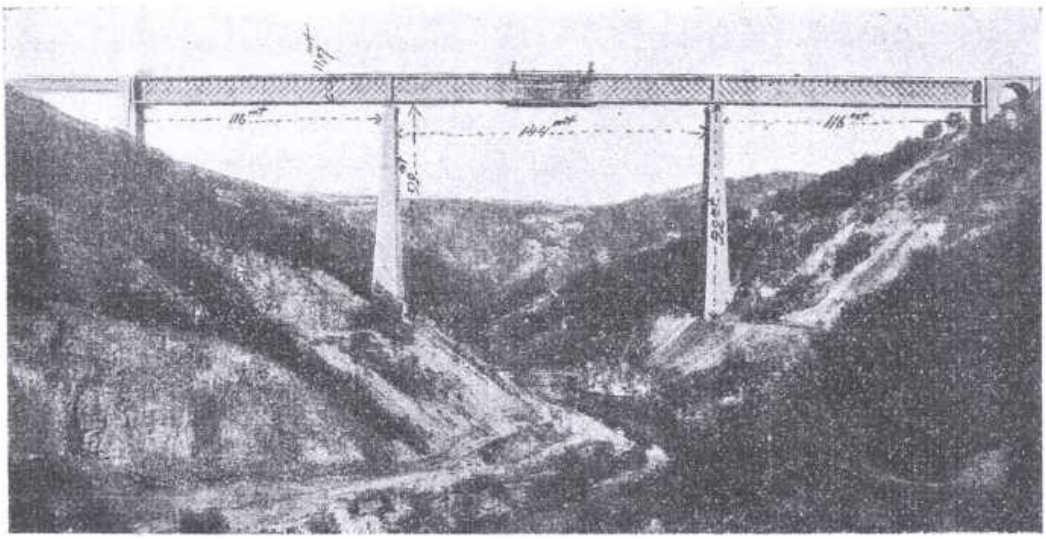
The underground anchors N and N' (Pic. 3), holding the tension of the rope chains, are arranged according to a new highly improved method by the engineer Nouailhac-Pioch. They allow at any time to inspect the ropes along their entire length and replace any of them without the slightest harm to the strength of the structure.

The railway line from Villefranche to Bourg-Madame, ceded by contract to the

community of the Southern Railways network, was built by the government. Started in 1904, the line was finally completed in 5 years; this speed was the record for the government over private companies. The merit in this respect belongs to M. Lax, Chief Inspector of Bridges and Roads (former Director of the Railways Department of the Ministry of Public Works), who was entrusted with the main management of both this line and all the Pyrenean Mountain railways. And, indeed, it took such a strong authority as engineer Lax to finally bring through the ministry a new type of this wonderful suspension bridge, the project of Colonel Gisclard, whose merits were recognised after only thirty years (L'Illustration, 1909).

Engineer Aleksey Zholkevich
(Zheleznodorozhnoe delo [Railway Business], 1910, No. 6–7, pp. 36–38) ●

FADE VIADUCT ON THE ORLEANS RAILWAY (FRANCE)



In Auvergne, near Clermont-Ferrand, the viaduct of Fade, which is under construction, is soon to be opened, one of the most notable buildings on the French railways.

This engineering structure, erected by the engineer Chatelier, crosses the valley and the Sioule River (a tributary of the Allier River) at a height of 132,5 meters, in three spans, with the opening of the middle span – 144 meters, and the lateral ones –116 meters each. The iron bridge itself, a lattice system, with a height of the posts of 11,17 meters, is located with the lower belts on stone supports (pylons), with a height of the middle supports of 92 meters. In general, this structure seems to be outstanding among modern railway buildings in terms of the height of the supports and the boldness of the concept.

This viaduct bridge aims to shorten the railway route between Montlucon and Clermont-Ferrand stations, passing through the town of Saint-Eloy.

Before the construction of the viaduct, the distance from Montlucon to Clermont-Ferrand was considered to be 108 kilometers (of which 67 kilometers from Montlucon to Hann – along the Orleans railway and 41 km from Hann to Clermont-Ferrand along Paris–Lyon–Mediterranean line). In the new direction, bypassing the network of roads of the Society P. L. M. the distance between these points has become of 96 kilometres only.

The viaduct, built with mechanical structures, was accepted by the Orleans Railway in its final form, after proper strength tests by loading and passing heavy loaded trains through it.

Passengers travelling along this line will enjoy the scenic view from a height of 132 meters above the luxurious Sioule Valley (From «Le Monde Illustré»).

Engineer Aleksey Zholkevich
(Zheleznodorozhnoe delo [Railway Business], 1910, No. 3–4, p. 22) ●