1.- Introduction.

In the age of classicism, the technical and architectural aspects of bridge-building were developing in close unity. A notable example is the activity of the École des ponts et chaussées, established in France and the work of its director, Jean-Rodolphe Perronet. His bridges always conformed to the Vitruvius three principles: “usefulness, strength, beauty”. To put this point precisely, at that time bridges were considered to be the most important aspects of the architectural cityscape and its overall appearance. These qualities determined the method of bridge design. One of the most impressive examples of Perronet’s work is the Pont Louis XVI (today Pont de la Concorde) in Paris, an important and integral element of the splendid ensemble which is the Place de la Concorde.

Less attention has been given to how and to what extent this problem was being solved during the construction of bridges and highways. On this topic, I should like to share some of my thoughts and the observations I have made during my research studies of the history of bridge building on the main highway which, in the 18th century, linked the two Russian capitals – Saint-Petersburg and Moscow.

By the end of the 18th century in the West European part of Russia, there was already a quite well developed network of waterways, begun during the period of the reforms of Peter the Great. The story was not the same where land communications were concerned. Cargo was mostly transported by riv-
ers and canals, much less so by road. The vastness of the Russian territory made road building one of the country’s main difficulties.

During the 18th century Russian bridges were built from wood, since forests abounded. Bridges built on pile-piers were used along with the ancient methods of bridge construction – on crib-piers (“ryazh” in Russian), wooden blocks with stones used for filling (fig. 1). Bridges of this type, as well as wooden bridges on piles, can still be seen in remote parts of Russia, rich in forests.

During the reign of Catherine II (1762-1796) more attention was given to the improvement of the main highway network. For this purpose, a special “Commission for the building of roads at the State” has been created in 1786. One of its principal tasks was to plan properly engineered roads, including bridges of various types.

The new Petersburg school of bridge-building began to be established during those decades. With the help of Russian specialists to improve and strengthen the structures, energetic building activity developed, firstly in St. Petersburg and then in the whole North-Eastern area of the country.

Figure 1. The bridge on crib-piers across the river Kena, in the village Peliugino (Archangelskaya province). Built at late XVIII century. Photography of 1960s.
The grand scale of stone structures produced, during those years, in St Petersburg, causes some delight even today. According to 18\textsuperscript{th} century town planning practices, the new long granite embankments of St. Petersburg, built in the 1760s-1830s, are unequalled in their architectural qualities and length. Together with embankments, stone bridges were built, including unusual bridges with draw-spans and towers, containing the mechanisms for raising the wooden wings of the bridges.

In the first third of the 19\textsuperscript{th} century, a new type of bridge construction began. Magnificent bridges with spans overlapped by arches of cast iron blocks can still be seen today. The first of these appeared in 1806 at the intersection of Nevski Prospect and the Moika. It was designed by Vasilij Geste (William Hastie), a St. Petersburg architect and engineer. Later, in the 1820s, some cast-iron bridges were designed and built by the engineers Egor Adam (pupil of A. Betancourt) and Wilhelm (Guillaume) Traiteur (a colleague of Betancourt). The magnificent railings and lightings of these cast-iron bridges are remarkable examples of the then prevailing empire style (fig. 2).

Figure 2. Koniushenny bridge across the Moika-river. Engineer E. A. Adam.
Suspension chain bridges, initiated by Traitteur, were also built. Some of them still stand, for example, the Lions Bridge (fig. 3, 4). Its chains are held by cast-iron systems concealed inside these hollow cast iron sculptures of

Figures 3, 4. The suspension Lions bridge over the Griboyedov-kanal in Saint-Petersburg. 1825-1826. Engineer W. Traitteur, sculptor P. Sokolov.
lions, the work of the Russian sculptor, Pavel Sokolov. The Lions Bridge is an interesting example of the integration of engineering and sculpture.

Thus, the technical innovations of the period of industrial revolution found striking embodiments in the bridges of St. Petersburg, built when the engineer Agustin Betancourt was working in the city. His influence on the development of Russian bridge building remains undisputed.

The really important merit of the St. Petersburg bridge-building school was its meticulous attention to town-planning and the architectural aspect of bridge-building. This quality made the school one of the leading bridge-building schools of Europe. It can be claimed that the advanced ideas of an integrated ensemble were so consistently applied in the St. Petersburg bridges of the classical period, that the art of bridge-building in this capital can be considered as a unique achievement.

2.- St. Petersburg-Moscow highway: beginnings.

In the final decades of the 18th century, the building of durable stone bridges took place, according to the “model” (standard) designs of St. Petersburg engineers in the 1780s. Some of them remained till today—for example one-flight bridges on the outskirts of Tver, the ancient Russian town.

It has proved possible (partly as a result of my own activity) to preserve this three-flight bridge near Novgorod. The new highway was taken past it, so that the bridge was preserved as an architectural monument of the 18th century.

In those days, floating bridges on barges “plashkoats” were put across broad rivers. New standard projects were developed especially for the construction of such bridges.

The beginning of Alexander I’s reign, in 1801, saw a regularizing of the organization of architecture and building in Russia. A Building Committee, with broad powers, was established in 1806 by the Ministry of Internal Affairs. However, it soon became clear that the question of planning, build-

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3 Pavel Sokolov was a permanent collaborator of Betancourt and of the engineers of his circle.
5 Dorogi Tverskoj oblasti (2001), St. Petersburg, 42-65.
ing and the development of water and land communications demanded the establishment of an independent system of administration. Thus, in 1809, the General Direction of the Waterways and Land Transports (Glavnoe upravlenie vodânymi i suhoputnymi soobšeniâmi; since 1810, General Direction of the Ways of Communication = Glavnoe upravlenie putej soobšeniâ) was established. For three years, its main director was Prince Georg Oldenburg (fig. 5), followed, in 1812-1818, by Franz Dewollant (fig. 6). After his death, the directorship passed to A. Betancourt.

In 1809, the St. Petersburg Institute of Ways of Communication Engineers was created, with A. Betancourt as its principal. The institute began to train qualified engineers for Russia\(^6\). The system of preparation equipped bridge-builders to solve problems. Though technical disciplines prevailed, attention was given to the architectural and artistic aspects of professional education.

\(^6\) For the details, see the text of V. Pavlov in the same volume.
The methodological principle expounded by Betancourt continued to dominate in Russian bridge-building in the first half of the 19th century and was reflected in the architecture of bridges on the improved main highway linking the two capitals – Moscow and St. Petersburg.

3.- The large scale works.

Large scale work on the improvement of the highway took place at the end of 1810, continued in the 1820s, and was completed in 1834 under the reign of Nicolas I (fig. 7). The way was made straighter and better.

Station houses with stables for changing horses and rest lodgings for travellers were built along the highway. These buildings were highly esteemed by contemporaries, even by such as the ironic Marquis de Custine, who went to Russia in 1839 and travelled along the newly constructed highway from St. Petersburg to Moscow. He praised the skill and courage of the Russian coachmen7 (fig. 8).

Figure 7. Emperor Nicolas I. Engraving after J. Dow’s portrait, 1826.

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7 CUSTINE Astolphe, Marquis de (1990) La Russie en 1839, Paris, Solin, 2 t. On the Moscow-St. Petersburg highway, see the following quotation (p. 38-39): “Voyager en poste sur la route de Pétersbourg à Moscou, c’est se donner pendant des jours entiers la sensation qu’on éprouvait lorsqu’on descendait les montagnes russes à Paris. On fait bien d’apporter une voiture anglaise à Pétersbourg, uniquement pour avoir le plaisir de parcourir sur des ressorts réellement élastiques [...] cette fameuse route, la plus belle chaussée de l’Europe, au dire des Russes, et je crois des étrangers. Il faut convenir qu’elle est bien soignée, mais dure, à cause de la nature des matériaux [...]. d’où il arrive qu’on perd au relai le temps qu’on a gagné sur la route, où l’on tourbillonne dans la poussière avec l’étourdissante rapidité d’un ouragan chassant les nuages [...]. Les garde-fous des ponts sont en belles grilles de fer ornées d’écussons aux armes impériales, et les poteaux qui soutiennent ces élégantes balustrades sont des piliers de granit équarris avec luxe; toutes ces choses ne font qu’apparaître aux yeux du voyageur absconsi, le monde fuit derrière lui comme les rêves d’un malade”. On the Russian coachmen, see t. 1, 283; t. 2, 45-47, 57-58. For the hypothesis dealing with the fact that this systematic and excessive interest of Custine towards the representatives of this profession was linked with his particular sexual orientation, see the comment in the Russian version: KÜSTIN, Astol’f de (1996) Rossiâ v 1839 godu: V 2 t. / Komment. Very Mil’činoj i Aleksandra Osipovata. M.: Izd-vo im. Sabašnikovyh, t.1, 492. – Note from the Editors.
The famous poet Alexander Pushkin approved of this smooth highway, along which he was travelling comfortably in “a calm carriage”\(^8\). In those days, it took more than three days (including day stops and night rests) to go from Moscow to St. Petersburg.

In the first half of the 19\textsuperscript{th} century, many new bridges were built along the highway. Among them were the newest constructions, with wooden arches made from curved bars. The arches were supported by stone piers. Wilhelm (Guillaume) Traitteur (a colleague of Betancourt) built several bridges of this kind at the beginning of the 1820s (fig. 9-11).

On many bridges, there were fine iron railings, cast according to “standard” projects developed in St. Petersburg\(^9\) (fig. 12, 13). In accordance with late classical traditions, the empire style, stylised images of military symbols

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9. Rossijskij Gosudarstvennyj Istoricheskij Arhiv (RGIA). F. 199, op. 1, d. 268, f. 72; F. 208, op. 1, d. 47, 51; F. 1487, op. 46, d. 626, 627, 648, 653, 739, 785, 1066; F. 1487, op. 47, d. 71.
Figure 9. The wooden arched bridge in the village Babino on the highway St. Petersburg – Moscow. The beginning of 1820s. Engineer W. Traitteur. Lithograph of 1820s.

Figure 10. The wooden arched bridge in the village Liuban on the highway St. Petersburg-Moscow. The beginning of 1820s. Engineer W. Traitteur. Lithograph of 1820s. Under the façade of the arched bridge is shown the façade of the old wooden bridge on crib-piers.
were added to the composition of the railings. Travellers, especially foreigners, marvelled at the elegant decoration of the bridges. Evidence of this can be found in Lady Londonderry’s diary; she travelled in Russia in 1836-1837. She noted the good quality of the road and its excellent state of upkeep: “This is the most beautiful road I’ve ever seen. The railings of the little bridges are all of cast iron decorated with Imperial eagles”\(^\text{10}\). Unfortunately, in subsequent times, as a result of military operations and road service neglect, these magnificent empire style railings disappeared.

The bridge across the Volga river at Tver remained a floating structure (fig. 14). Two more bridges with unique structures of wooden spans were built on the Moscow-St. Petersburg highway. One was a single span bridge with a compound, combined structure. It spanned the Tver Canal in the town of Vishny Volotchok\(^\text{11}\).

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\(^{11}\) RGIA. F. 156, op. 2, d. 33; F. 218, op. 1, d. 3437, 3575.
The first variant of this bridge was constructed between the 18th and 19th centuries. Its structure was considered an innovation in those days of Russian bridge-building: a wooden girder supported by the stone piers of the bridge. The girder (in case of bad weather) was covered with a gabled roof and planked with slabs at its sides. The bridge thus looked like a house and was even used as a place for business dealings. In 1845-1846, this bridge was rebuilt. Its span was covered by wooden girders, but without planking. A contemporary pointed out that the solid slab plank of the former bridge “in
no way enhanced the decoration of the bridge”, and that the new structure, built without planking “enhances the beauty of the city and the view, open from the bridge on all sides, is one of the best in the city”\textsuperscript{12}.

The most grandiose structure on the Moscow-St. Petersburg highway was the five-span bridge over the Msta river, near the village of Bronnitsky\textsuperscript{13} (fig. 15). It was erected in 1837-1842, after the design produced under the guidance of the engineer K.Y. Reichel. The engineer Y.I. Afanassiev directed the construction of the bridge. Both engineers had graduated from the St. Petersburg Institute of Ways of Communication Engineers, and were pupils of A. Betancourt and his colleagues. The five spans of the bridge, each of 48 metres, straddled the river.

The piers were made of stone with granite facing. Wooden span structures were of a combined type, interesting and unique to those days of Russian bridge-building. It had elements of curved bar arches, strut systems and girders with a diagonal strut support. To protect them against the effects of the weather, the span structures were covered by a roof.

The architectural appearance of the bridge was of great importance to the designers. Both ends of the bridge were garnished with entry pavilions. Memorial plates with inscriptions were included in their design. Even the col-

\textsuperscript{12} RGIA. F. 218, op. 1, d. 3575, f. 26.
\textsuperscript{13} RGIA. F. 1487, op. 47, d. 341, 516, 548.
our of the bridge was considered, as we know from a special plan, confirmed in 1842. By this design, entry pavilions were painted yellow, span structures light grey, the pilasters of the facades, white, with their capitals and bases in imitation bronze.

The Bronnitsky Bridge was highly praised by its contemporaries, who considered it to be one of the first constructions of its kind newly arrived in Russia and equal to the best European structures. Its exterior was described as beautiful and grand.

These reports suggest that in the classical period areas of the major Russian road network were seen as an object for creative architectural work, a natural consequence of the entire system of the aesthetics of the Enlightenment. The aims for “aesthetisation” of the road area environment was not only connected with a brand new understanding and concern for travellers, but pursued precise aims for prestige, in line with efforts of state politics in the architectural sphere and organization of the building process.

There is no doubt that the afore mentioned fine technical and aesthetic qualities of the bridges on the Moscow-St. Petersburg highway were the
result of the educational system for engineers and bridge builders established by A. Betancourt, the principal of the St. Petersburg Institute of Ways of Communication Engineers. This system was, unquestionably, the achievement of Betancourt-engineer, teacher and man of outstanding and distinguished culture.