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Some Aspects of City Bridge Superstructure Reconstruction

Aspects de reconstruction de ponts urbains en acier

Einige Rekonstruktionsprobleme städtischer Stahlbrücken

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SUMMARY
Some rational and economically reasonable methods of reconstruction of city bridges metal superstructures are considered. Some rational methods of reconstruction of superstructures of various systems are given. The designs of reconstruction of superstructures of the Volga River Bridge in Kalinin and the Belaya River Bridge in Ufa are described.

RÉSUMÉ
Le rapport contient l'étude des techniques rationnelles et justifiées du point de vue économique de reconstruction des charpentes métalliques de ponts urbains. On considère les procédés éventuels de reconstruction des ouvrages à travées de systèmes différents; il y a également la description des projets de reconstruction des ponts sur la Volga près de la ville de Kalinine et sur la Bélaya près de la ville d'Oufa.

ZUSAMMENFASSUNG
Es werden die rationellen und ökonomisch begründeten Rekonstruktionsmassnahmen von Metalltragwerken städtischer Verkehrsbrücken betrachtet, mögliche Rekonstruktionsvarianten von Brückentragwerken verschiedener Systeme angeführt und die Rekonstruktionsprojekte der Überbrückungen der Wolga in der Stadt Kalinin und der Belaja in der Stadt Ufa beschrieben.

Recently, due to expansion of project capacities of such motor car factories, as Volzhski, Kamski and that named after Leninski Komsomol, the car fleet in our country has been greatly increased. However, the race of development of the country highway network is considerably lower than that of motor cars put in operation. Primarily, this is referred to artificial constructions on highways which do not satisfy the requirements of increased traffic, having in mind not only the road capacity, but the load carrying capacity as well, and that is an obstacle in the way of national economy development.

As of January I, 1982, the USSR has more than I million km of general-purpose highways. On the average, II.6 bridges are per each IOO km of highways. In most cases, these are short-span timber and reinforced concrete bridges. In the meantime, the bridges with metal superstructures designed, as a rule, for not very extensive traffic - constitute about IO% of the total bridges quantity and contain an enormous quantity of steel. That is why an investigation and practical use of rational and economically reasonable methods of reconstruction of metal bridges superstructures is of great importance for the national economy.

The choice of a metal superstructure reconstruction method depends on the reasons causing the necessity of reconstruction, which may be as follows:

- to increase the width of the roadway;
- to increase the superstructure load-carrying capacity;
- physical wear of metal structures and members of the superstructure roadway, as a result of a long period operation;
- various defects in the structures as a result of violation of the maintenance regulations (mainly, for bottom-road bridges);
- changing of architectural and aesthetic requirements;
- to preserve the appearance of the existing construction;
- to provide a bridge clearance.

The choice of a reconstruction method depends also on the system of the existing superstructure.

A thorough examination of the existing superstructures should be performed before selecting the method of reconstruction in order to find out the actual geometric scheme of the structure, to evaluate the condition of all members and their connections, to find out the defects, mechanical and corrosion damages, as well as to realize the necessity of further usage of old structures. Only after the analysis of the existing structures inspection results the proper method of reconstruction may be chosen.

The possible ways of solid beam superstructures reconstruction are as follows:

- installation of additional main beams for their future combined work with the existing structures;
- alteration of the working scheme of the supporting beams by means of inserting a subdiagonal under the existing structures (in case there is a free space under the superstructure), or by turning simply supported beams into continuous ones;

- installation of additional supports (where local conditions permit), reducing the design span of the existing beams.

The following methods may be used at the reconstruction of superstructures with trussed girders:

- installation of additional trusses and beams for their future combined work with the existing trusses;
- mounting of additional members of the superstructure, for example, new transverse beams, braces in the plane of chords, posts and struts;
- alteration of the existing trusses system by the method similar to that mentioned above for the superstructures with solid-web beams.

At all the methods of trusses reconstruction, it is a common practice to strengthen some members of the superstructure by increasing their cross-sections. Additional members are either welded or engaged by high-strength bolts to the structures being reinforced.

TSNIIProektstalkonstruktsiya named after Melnikov has performed some projects of reconstruction of bridges superstructures. The most interesting are the reconstruction methods used for the superstructures of the Volga River Bridge in Kalinin and the Belaya River Bridge in Ufa.

An old Volga River Bridge is an original construction with a specific solution for engineering and aesthetic problems, built by the France-Swiss Society of Electric Industry in 1898-1900.

The bridge superstructure is the so-called "Gerber's girder" - the trusses spacing 47 m with cantilevers 36 m long, hingedly supporting the suspension span 21 m long. A curved upper chord of the superstructure main trusses is of a parabolic contour, which makes it look as if a suspension bridge. Upper longitudinal and transverse braces are absent, except for the transverse three-dimensional braces in the plane of posts located above the intermediate supports. The distance between the main supports is 7 m. The roadway is wooden, 5.65 m long.

The bridge is an integral part of the silhouette and the town-building composition of the centre of Kalinin and is an architectural monument. That's why, alongside with the increasing of a load-carrying capacity and a traffic-carrying capacity the design assignment for the bridge reconstruction involved also the preservation of its architectural appearance.

For the period of operation the bridge was often subjected to inspecting and testing. The last inspection of the bridge was undertaken in summer of 1980 with the aim to evaluate the real condition of the elements of the main trusses, to find out the defects and damages. The inspections showed that the bridge is in a wreckling condition. The most typical defects of the structural members are metal corrosion due to improper water, mud and debris drainage from the inner parts of the structures, as well as due to deformation of overhangs of horizontal plates which are, as a rule, of a mechanical nature. The analysis of the structures inspection results, checking up of mechanical properties and chemical composition of metal showed that the old trusses could not be reused as supporting members of a rehabilitated superstructure. In order to maintain the appearance of the existing bridge, old trusses may be reused only after their cleaning and only as members of architectural trimming of the construction.

The reconstructed bridge has two lanes 9 m wide and two side-walks 2.25 m wide each. The bridge carries two heat pipelines of 720x8 mm diameter and some service lines of a total proof linear load I.8 tf/m.

The main idea of reconstruction lies in placing along the bridge axis a continuous steel-and-reinforced concrete superstructure with spans 47+93+47 m over the existing supports and erecting the old trusses along the front of the new superstructure on the cantilevers spacing I.5 m. The distance between the axes of the old trusses increases up to IO.6 m and that provides the required roadway width. The bearing structures of the steel-and-reinforced concrete superstructure are four solid-web welded main girders with a constant web depth 2.48 m, which are combined in pairs by latticed transverse braces into three-dimensional blocks 2 m wide, spacing 3.6 m. A solid reinforced concrete slab of the roadway is placed onto upper chords of the main girders. This slab is included into a combined work with the main girders by means of rigid buffer stops. The horizontal longitudinal braces of a triangular form are located only inside the three-dimensional blocks and engaged at a distance 250 mm from the lower chords of the main girders. Between the three-dimensional blocks there are struts spaced at 6 m, which carry the heat pipelines. The side-walks are placed onto the cantilevers spacing 6 m. The stability of the old structures is ensured by the horizontal stiffening truss, mounted at the level of the upper members of side-walks carrying cantilevers and also by a rigid connection of the truss lower chord to the supporting plates of the overhanging cantilevers of the new superstructure. The design precludes the combined work of the lattice trusses with supporting structures of the new superstructure, by providing plate hinges in the trusses lower chords, as well as by providing the possibilities of free movement of some struts in the trusses assemblies. An erection method of the new superstructure proposed by the authors of the reconstruction project, is of a certain interest. The sequence of erection operations is shown in Fig. I. The cost of reconstruction was estimated as 3.98 mln. rubles.

The method of reconstruction of metal superstructure of the Belaya River Bridge in Ufa greatly differs from the above mentioned method. The existing bridge built in I956 has ten spans, seven constructions span the flood-lands part as continuous steel-reinforced concrete superstructures and three constructions span the river-bed as a superstructure of a combined type made as a system of beams strengthened by a flexible arch. In the middle span the arch projects over the roadway, so that the scheme of a half-through bridge is obtained and two side spans carry semi-arches, one end of them is connected to the beams and the other rests on the lowered supporting arch assembly of the middle span. The roadway is 9 m wide and includes 2 lanes for traffic. The design load was taken equal to I3 t. The reconstructed bridge should include 6 lanes and two side-walks, each 2.25 m wide and two lanes would be carried by the existing superstructure. The design load from motor transport is supposed to be up to 30 t and from pedestrians - 400 kgf/m^2.

Inspections showed the possibility of reusing metal structures of

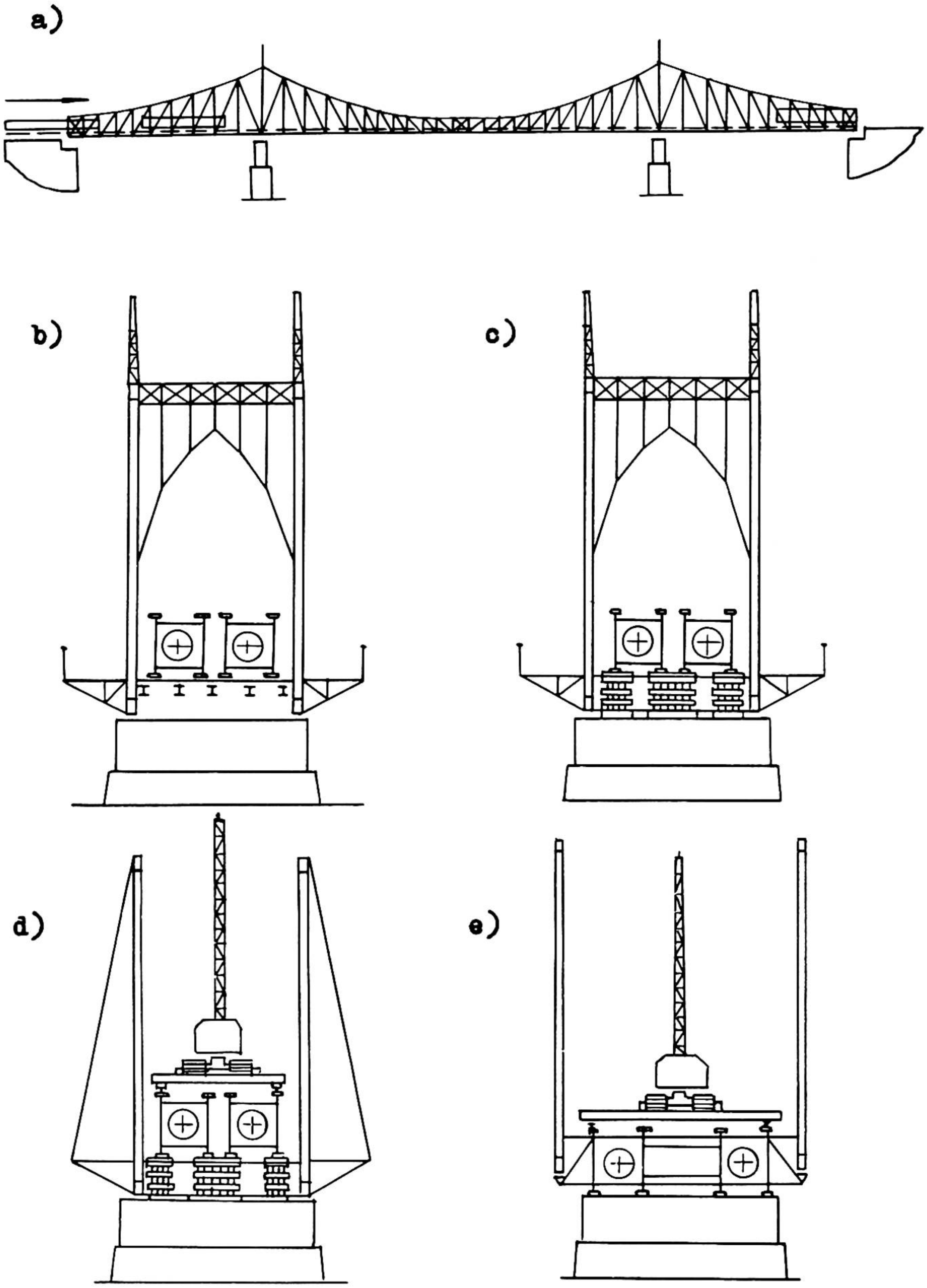

Fig.I The method of reconstruction of the metal superstructure of the Volga River Bridge in Kalinin: a,b- moving on blocks of the new superstructure; c- lowering of the moved on blocks onto the cades disposed on the permanent supports; d- cuttind of lattice trusses into blocks and dismountind them; e- moving apart the blocks of the new superstructure and erection of lattice truss assemblies along the front of the new superstructure and their egaging.

the existing superstructure as bearing ones. The increasing of the width of the roadway is obtained by means of additional superstructure from the bottom side of the existing superstructure installation. The new superstructure of the flood-lands part consists of eight solid-web welded H-beams with a constant web depth 2.48 m with spans 40+3x48+3x56 m. The beams are spaced at 3 m. The roadway is a reinforced concrete slab, working together with the main girders. The new superstructure of the river-bed part is a combined system consisting of a system of beams strengthened by the comparatively flexible arches on the middle supports. The spans preserved their former size 68+I48+68 m. The superstructure consists of eight longitudinal solid welded H-beams 2.48 m deep, spaced at 3 m. The arch members are distributed between the beams with one end engaged to the beam and the other one to the supporting assembly on the support. The distance between the arches axes is 6 m. The arches are circumferentially arranged, which helps in levelling their erection members length and in maintaining an equal distance between the posts. The arches are connected to the beams by a special structure providing the transfer of horizontal and vertical forces to the beams.

At working out the method of reconstruction of the Belaya River Bridge an alternative of two new similar superstructures, each consisting of four main beams, simmetrically to the existing superstructure, was considered. However, the new superstructure erected only from one side of the existing bridge reduces the area of the construction site, extends the life of the old bridge for the period of reconstruction and in the transient period the change to the new superstructure of the traffic and pedestrians is painless. That's why the recommendation to use the method of reconstruction with the one-side arrangement of the new superstructure was adopted.

The above described examples of bridges with metal superstructures reconstruction do not cover all possible methods of reconstruction, which greatly depend on local conditions (architectural value of the existing construction, physical wear, etc.).

The importance and actuality of the problems of rehabilitation of the existing bridges instead of new ones construction under the changed conditions of their maintenance requires the necessity of accumulation, systematization and generalization of the native and foreign experience in performance of such type of operations, as well as working out of suggestions on the most economically efficient methods of their realization.

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