Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 64 (1991)

Artikel: Unification of steel highway bridge superstructures
Autor: Streletsky, N.N. / Dankov, V.S. / Tarnarutsky, V.A.
DOI: https://doi.org/10.5169/seals-49290

Unification of Steel Highway Bridge Superstructures

Standardisation des structures métalliques de ponts-routes

Typisierte stählerne Tragwerke von Autobahnbrücken

N.N. STRELETSKY
Prof. Dr.
Melnikov Inst.
Moscow, USSR

N.N. Streletsky, born 1921, graduated from the Moscow Civil Eng. Inst. He specialized in metal structures, composite and temporary bridges. Currently he is a main research scientist at the Melnikov Central Res. and Design Inst. of Steel Structures.

V.S. DANKOV
Cand. Sc. (Eng.)
Melnikov Inst.
Moscow, USSR

V.S. Dankov, born 1944, gratuated from the Moscow Highway and Road Inst. A specialist on metal bridges and structures. Currently a leading research scientist at the Melnikov Central Res. and Design Inst. of Steel Structures.

V.A. TARNARUTSKY
Engineer
Melnikov Inst.
Moscow, USSR

V.A. Tarnarutsky, born 1944, graduated from the Moscow Highway and Road Inst. He is a specialist in bridge engineering. Now a head of department on bridges design at the Melnikov Central Res. and Design Inst. of Steel Structures.

SUMMARY

The problem of unification of main girders and bracing of highway composite and steel superstructures with covering plates of the deck is considered. Efficient unified composite superstructures spanning from 42 to 105 m having a built-up deck with an increased life have been developed.

RESUME

L'article traite de la standardisation des poutres principales et des contreventements des ouvrages autoroutiers mixtes et en acier, et des travées métalliques des dalles du tablier. Des ouvrages mixtes standardisés, avec des travées de 42 à 105 m et un tablier préfabriqué économiques et de durabilité élevée, ont été créés.

ZUSAMMENFASSUNG

Es wird das Problem einer Typisierung der Hauptträger und Verbände bei stählernen Brückentragwerken mit aufgelegten Fahrbahnplatten betrachtet. Es wurden wirtschaftliche Stahlbetontragwerke mit Spannweiten von 42 m bis 105 m und eine vorgefertigte Brückenfahrbahn von grosser Lebensdauer geschafft.

A high level of unification is one of the specific features of metal bridges in the USSR, "GIPROTRANSMOST" has completely unificated the superstructures of the railway bottom-road bridges used in the USSR. "LENGIPROTRANSMOST" in cooperation with some other firms has unificated the superstructures of highway and city bridges with one-piece-transportable blocks of box-shaped main girders.

The Melnikov Central Research and Design Institute of Steel Structures in cooperation with some other firms is engaged in scientific work on the unification of highway composite and steel superstructures with welded plate I-girders. The superstructure consists of two braced main girders in the cross-section. The deck widths are 8 m, 10 m, 11,5 m. Irrespective of the deck width the distance between the main girders in the top-road bridge superstructures is taken equal to 7,6 m.

The bridge spans have multiple equal 21 m modules. The unificated steel girders have 2,48 m; 3,16 m; 3,60 m depths. A set of blocks has been designed for each web depth, which may be used for making up the main girder for any spans required as well as their combinations. The most blocks are formed with unsymmetrical crosssections with an upper chord of a reduced area and with a heavy lower chord. As a rule, the superstructures consist of continuous beams. Simply supported beams are used for short spans and for long span superstructures beams reinforced with stay cables or with some other means are used (Fig.1).

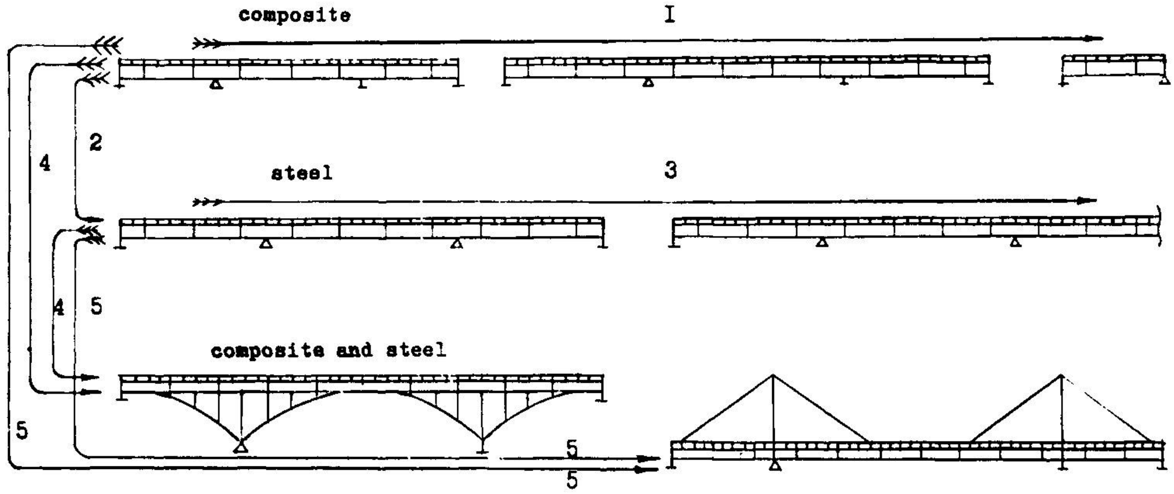


Fig.1 Unification of highway bridge superstructures with I-beams.

In composite superstructures (1) all blocks of the main girders, the bracing system, the r.c. blocks of the built-up deck are unificated. The specific feature of the superstructures is securing of steel orthotropic deck plate on the upper chord of the I-girders by means of longitudinal diaphragms ensuring the increase of the design height of the superstructure by means of the chords "moving" apart and unification (2) of the blocks of the main girders and the bracing system of steel and composite superstructures.

Inside the set of steel girder superstructures (3) all the blocks of the main girders, their bracing system, all the blocks of the steel orthotropic deck plates are unificated. Combined steel-reinforced concrete and steel superstructures are also subjected to unification (4,5), in this case, the blocks of the main girders are to be partially unificated; as to the members of the bracing system and the deck the following positions are due to unification: in the deck-type bridges the above shall be completely unificated (4) and in the bottom-road bridges (in cable-stayed constructions) - partially unificated (5). The unificated composite superstructures spans are in the range of 42 m to 105 m, the unificated steel girder superstructures cover the spans from 63 m to 147 m. The combined composite and steel superstructures may cover even larger spans.

The unification ensures great advantages to the manufacturers of steel (and r.c.) bridge superstructures: simplification of the production process organization and the technical control, reduction and increasing of the shop auxiliaries, stability in metal supply, at mis-deliveries of the ordered products and disruption of the manufacture schedule - there exists a possibility of production of modular blocks members and their storage at the stock-room.

The unificated composite superstructures have been already developed. They are fabricated at the manufacturing plants in conformity with the design of the Melnikov Institute and have been installed at various bridges.

At the development of the unificated composite bridge superstructures the defects of the so-called "purlin-type" composite superstructures with a prefabricated flat slab, combined with the girders by cast-in-situ concrete around the rigid shear legs and the junctions over the steel purlin to support the slab in the midpoint of its span have been eliminated. The r.c. slab in such a structure begins to deteriorate after 10-12 years of maintenance and in about 15-20 years it may fail as a result of cracks development and deterioration of the cast-in-situ concrete used for the shear legs and the longitudinal junction. A large volume of the cast-in-situ concrete and an additional expense of steel for the purlin and the bracing system may be also referred to the negative features of such a structure.

Nowadays the unificated superstructures have been designed without a purlin but with a ribbed r.c. prefabricated slab without any "windows" for the shear legs and a longitudinal junction. Steel structures are fabricated of steel 15ХСНД (for the northern variant "B" - from steel of grade 10ХСНД). Shop connections are welded, field joints are bolted, bolts M-22 are used. Range of steel products is completely unificated; joints, stiffeners and structural members are also unificated. The places of alteration of main girders chords cross-sections have been computer-aid optimizated. For 17 unificated composite continuous superstructures (from 2 to 7 spans) and simply supported ones spanning from 42 m to 105 m, about 60 types of main girder blocks with the above mentioned web depths were required. The lateral braces spaced at 5,25 m, are arranged as flat triangular-lattice trusses. The lower longitudinal braces are arranged as a cross system with additional cross-bars.

A cross-section of the 42 m superstructure is shown in Fig.2, a fragment of a prefabricated r.c. slab and of this slab in assembly with the main girders are shown in Fig.3. The ribbed blocks

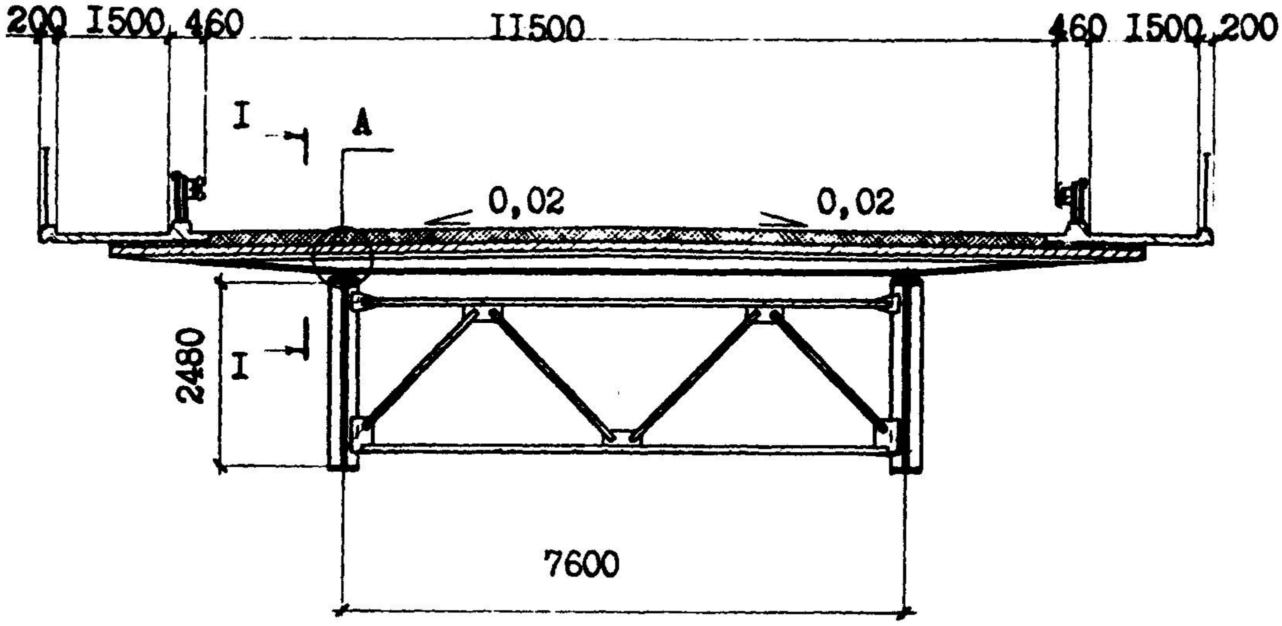
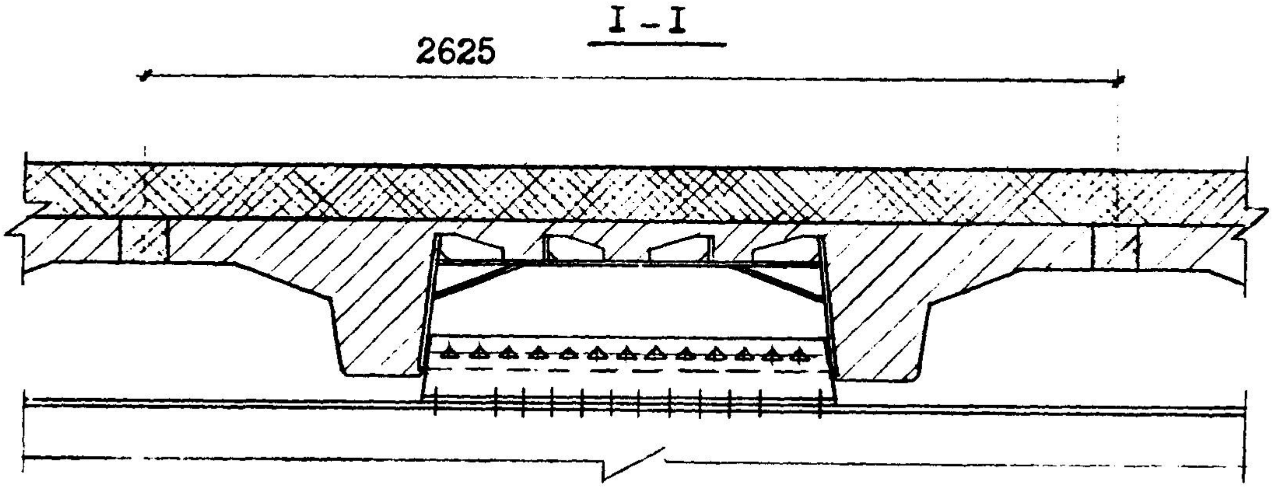


Fig.2 Cross-section of the unificated composite superstructure of 42m span.



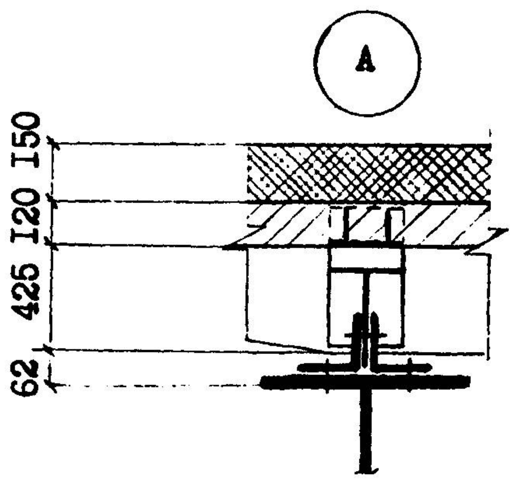


Fig.3 A r.c. slab with a steel top chord assembly.

of the r.c. slab of a П-shape with overhangs are fabricated from concrete B30 in steel formworks, the transverse ribs of the slab are spaced at 2,625 m. The longitudinal reinforcement is butt-connected by means of welding of the free length of the reinforcement bars. The block mass is about 17 tn. The conjunction of a r.c. slab with steel girders is carried out without any "wet" operations, discretely, in conformity with Fig.2 and 3, by means of insert members provided with shear legs and anchors, twin-angles and high-strength bolts M22 in holes of 28 mm diameter.

Metal consumption for the main structures of the composite superstructures is shown in Fig.4.

Steel girder superstructures with I-shaped main girders and an orthotropic deck plate almost completely unificated for the spans

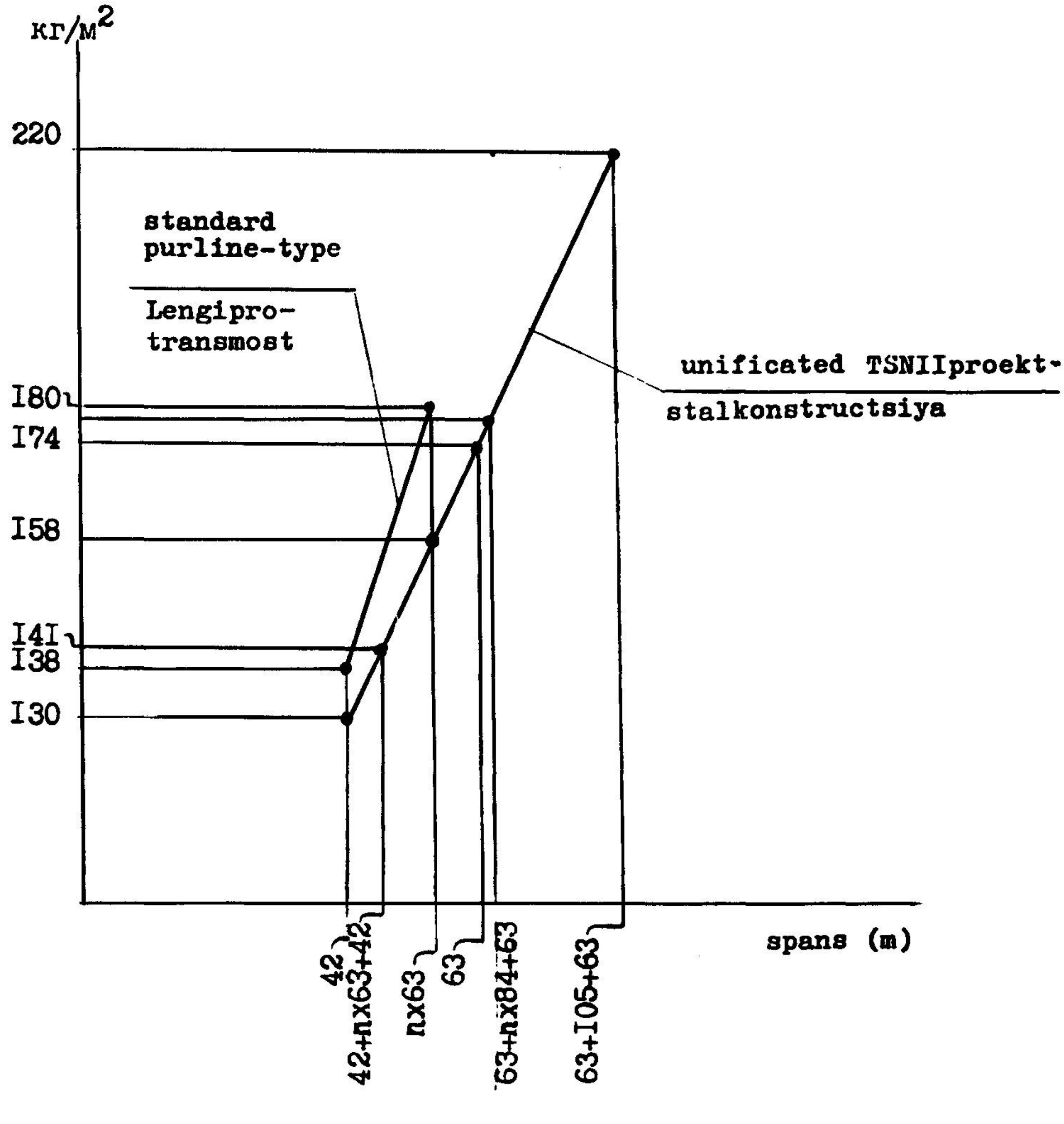


Fig.4 Metal consumption for composite superstructures.

within the range 63 to 147 m and unificated with the composite superstructures, are being worked out. The variant of the cross-section of such a superstructure is shown in Fig.5. Steel orthotrop-

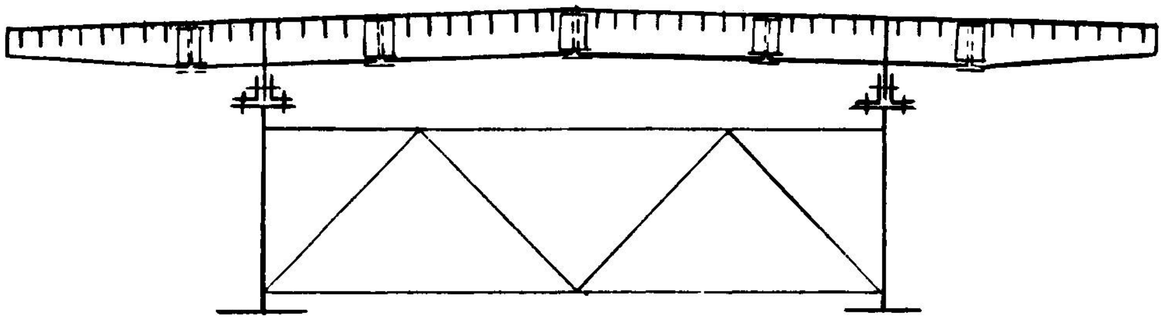


Fig.5 Cross-section of unificated steel superstructure with a covering orthotropic plate.

ic deck plates discretely attached to the main girders by means of longitudinal diaphragms secured to the upper chords of I-girders with bolts or field welding. The orthotropic deck plate significantly increases the design height of the steel superstructure and also increases the span length in comparison with usual steel structures with web depths 2,48; 3,16 and 3,60 m, respectively.

In order to increase the life of the bridge deck surfacing, investigations showed, that it is proper to apply a layer of cement-concrete 8-10 sm high over the steel plate. In this case a number of longitudinal ribs of the orthotropic deck plate may be twice reduced which makes up for the steel consumption and greatly decreases the scope of shop welding. Thus, it is possible to use a new bridge deck bearing surfacing over the orthotropic deck for the designed unificated steel superstructures.

After the development of unificated superstructures with ribbed r.c. and steel orthotropic plates used as "covering slabs" there appears an opportunity of a considerable simplification for those used abroad and in our country continuous superstructures with an advantageous alternation of r.c. and steel plates all along the superstructure length.