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# Precast Continuous Span Structures for Highway and Urban Bridges Made of Completely Prefabricated Segments

Poutres continues en béton armé pour les ponts routiers et urbains en voussoirs préfabriqués

Durchlaufende Stahlbetonüberbauten für Autobahn- und Stadtbrücken aus vorfabrizierten Fertigteilen

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A now developed continuous span construction is an economical solution for multiple - span bridges and viaducts. with spans 21-63 m long. It is a precast, prestressed slab beam structure (abbr PRK) made of segments with maximum prefabrication. This construction is mounted span by span with a movable scaffold carrier.

There is a difference between slab-beam types of structure widely used abroad in continuous in-situ constructions and precast ones.

Every PRK span consists of a number of composite segments laid out in length and covering the whole carriageway in width. PRK cross-section looks like two longitudinal bulky beams with their associated slabs above. This kind of structure is simple in shape, easy in fabrication, as the bulky beams are good for winding the cables and casting the concrete. At the ends of each segment there are cross stiffeners 50-60 cm high. (See Fig. 1,2). Such a design solution increased greatly the lateral rigidity of a segment necessary for three dimensional behaviour of the structure when in service, transportation and installation. It led to modification of the scheme of three-dimensional behaviour of a carriageway slab because now it is thinner and less voluminous in comparison with slab in in-situ constructions and here it behaves like a small span. The area of segments to be glued is extended. Therefore sticking is more secure.

All technological advantages of slab-beam cross-sections are inherent in PRK. But the PRK unlike analogical solutions in the west has better characteristics than typical multiple stiffened prestressed span structures in use due to positive features mentioned above.

PRK continuous span consists of segments glued between each other and fastened by tendons running through ducts. Every span is nothing but a section, middle sections being of the same length as a span. One extreme section is shorter, the other longer than a span. Adjacent sections are coupled in-situ at a mean

distance from a pier equal to 0.2 length of the span and fixed with cables. For transportation of segments by rail ways their dimension in longitudinal plane is taken within 3 m. Their weight is to 45 t. The PRK is designed in such a way that makes it possible to fabricate segments of different width and height in one and the same formwork. But the space between main beams and the width of the middle slab are uniform. For different spans and carriageways the beam webs and slab cantilevers may differ.

The upper surface of segment slabs has a cross fall for drainage. Water-proof insulation may be laid down in shops. Under field conditions waterproofed is only glued joints. PRK types of segments are easy to apply in structures for crooked and skewed portions of highway.

All major operations as for fabricating PRK superstructure are made at works. The rate of prefabrication is about 98%.

In-situ operations comprise:

- concrete casting of section joints ;
- epoxygluing of segment joints;
- tension of high-strength cables;
- paving with bituminous concrete and
- laying down a part of water-proof insulation.

Continuous superstructure is assembled span by span from one end of a bridge. A span structure is assembled section by section on the movable scaffold carrier (Fig.3).

As a rule scaffold carriers do not occupy the space under a bridge, because span structures repose on them by their lateral stiffeners.

Thanks to segment features one can use the positive qualities of carriers, when located underneath as well as more effectively glue segment joints, prestress the reinforcement and improve the interaction between span structure and movable scaffold carrier (Fig.2).

Main peculiarity of a movable scaffold carrier lies in the fact that the heavy transshipment crane necessary for assembling segments of the next section does not stand on it (Fig. 3). The segments within the next section are transported by rail on the upper strips of the scaffold carrier. That is the main difference between this crane carrier and movable carriers widely used abroad. It has a considerably less weight of metall per 1 m<sup>2</sup> of concrete of a deck.

The movable scaffold carrier looks like two metall girders made of high-strength steel. It consist of welded sections, each 21 t. of weight. On a construction site these sections are tied into a single structure with high-strength bolts. The scope of this carrier is to mount spans from 33 to 63 m long.

There are winches here for hauling segments.

On the launching nose there is <sup>a</sup> cart (load capacity 20 t) for erecting next pier. Inside and outside the girders there are special gangways adjusted up and down. Besides that there is a suspended cart with jacks for tensioning tendons. The scaffold carrier moves along a deck on special carriages fixed to permanent piers. Camber is regulated by rails.

Fig 3 illustrates schematic erection of a span structure. The scaffold carrier is assembled on the approaches to the bridge on one of its slopes and pushed forward into the first span.

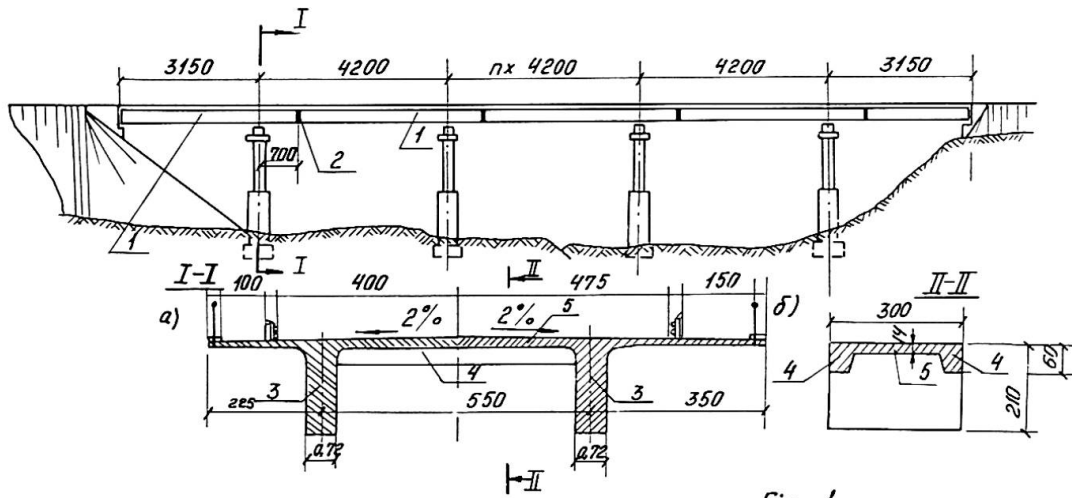


Fig 1

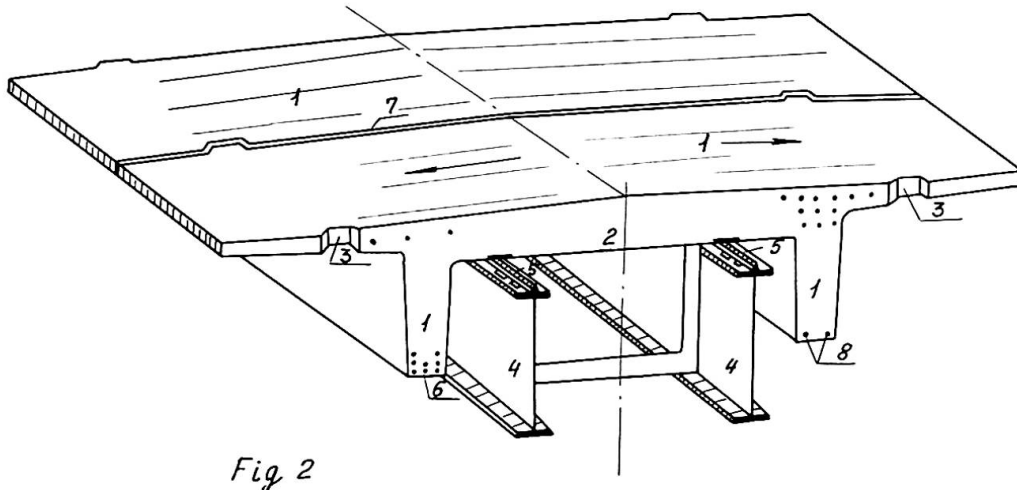


Fig 2

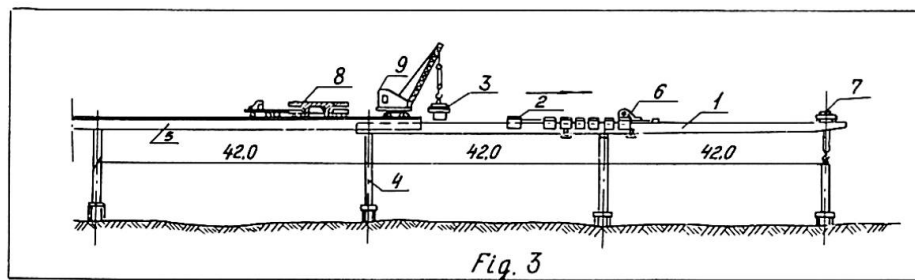


Fig. 3

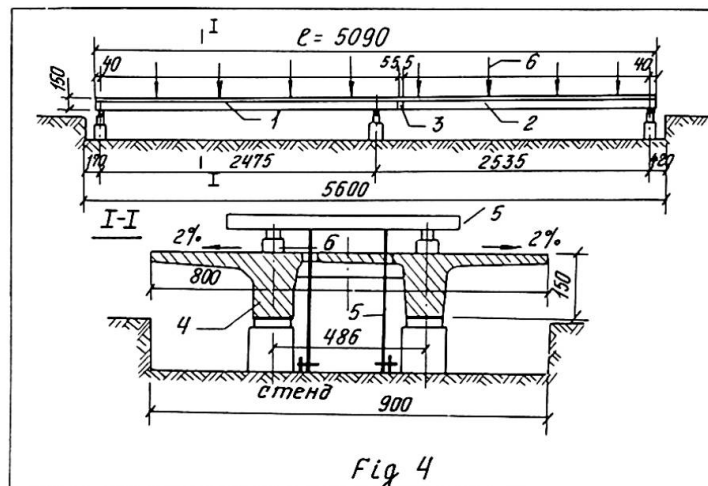


Fig 4

The scaffold carrier being in such position, the crane for hauling segments is installed at its front over the breast wall. The first available segment of span structure is transported on a trailer under a transshipment crane which then hauls it on the rails. This done, the block is pulled along rail with the help of a winch in its design position. When all the segments of a span are assembled together on the carrier they are coupled and prestressed.

The section being completed, the scaffold carrier is descended and removed to the next span with hoisting jacks fixed on the piers. Next spans are assembled in the same way with the only difference that the transshipment crane in this case is installed on the outside panels of the assembled span.

A superstructure with spans  $2 \times 25$  m was assembled on the special power test stand with the purpose of investigating and developing fabrication technology, transportation and assembly of continuous construction of PRK type. Experimental slab-beam spans were made of segments of natural dimensions: length 2m, width 8 m, height 1.5 m. Weight of each block is 18.5 m.

Experimental deck was composed of two sections: 1st section of 15 blocks, 2nd section of 10. Blocks were fabricated by printing method and their production technology turned out to be very effective.

Their labour capacity happen<sup>ed</sup> to be lower than that of box beams. Transportation and mounting of experimental span structure. were made very successfully and with little labour expenditure.

The precast experimental span structures are supposed to be continued with static and pulse loads. Their stress-strain states at that are investigated at different stages until they are collapsed. (Fig.4).

Nowadays with the help of this method a bridge with spans  $42 \times 2 \times 63 + 42$  m is under construction and a number of other structures are scheduled to be erected.

SUMMARY - A new structure of a continuous span (abbr. PRK) is assembled on a movable scaffold carrier of original construction. An experimental continuous span with dimensions  $2 \times 25$  m is tested under movable load on a specially designed test stand in order to examine the technology of fabrication and assembly and also to investigate the stress-strain state of the new construction.

RESUME - La structure nouvelle d'une poutre continue de pont (en abrégé PRK) est exécutée à l'aide d'un chariot d'étaiyage mobile de conception originale. Le poutre de  $2 \times 25$  m de portée est sollicitée par une charge mobile en laboratoire, en vue d'élaborer une technologie de montage et d'étudier l'état contrainte-déformation de la structure nouvelle.

ZUSAMMENFASSUNG - Eine neue Methode, durchlaufende Ueberbauten von Brücken herzustellen, besteht in der Montage von Fertigteilen auf einen speziell entwickelten Gerüstwagen. Ein speziell hergestellter Versuchswagen dient dazu, Fertigungs- und Montagethoden zu prüfen und den Spannungs-Verformungs-Zustand eines Versuchsträgers von  $2 \times 25$  m Spannweite unter beweglichen Lasten zu ermitteln.