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(54) **BRIDGE STRUCTURE**

BRÜCKENAUFBAU

STRUCTURE DE PONT

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Description

Technical field

A bridge, small, average or great, is usually composed of two parallel main girders, made of steel or concrete, extended from one abutment to another, directly or via a number of intermediate supports. The girders carry a bridge deck for the relevant traffic, its load being transmitted to ground via the girders and the bridge supports. The bridge deck, connected to the bridge girders, consists of structures made of timber, steel or concrete or a combination of these materials, and it is usually covered by a surfacing of bitumen or concrete. The bridge girders are also connected to each other by means of cross beams or other transverse connections, spaced accordingly.

State of the art

One traditional way of making girder bridges is to design the bridge slab with reinforcement that rigidly connects the slab to massive concrete girders. Another common way is to use steel girders, e.g. I-girders where the top flange is connected to a flexible web below. The former construction is complicated and cost consuming to build. The latter leads to extensive temperature movements at non-consistent weather conditions, and requires bracing and care at execution.

A concrete slab on top of main steel girders is usually made on a scaffolding, which is put directly on to the girders. It may be prefabricated or made in situ. Usually traditional scaffolding is used for small and average bridges, and prefabricated scaffoldings for large bridges. The scaffolding may either extend along the entire bridge, or be built for every new section of the bridge slab that should be made. Before the casting reinforcement has to be fixed accurately to the bottom and the top of the mould, and around the welded studs on the girders as well. Hence the concrete slab can bear bending moments, which in some cases generate tension and a risk of cracking at the bottom or top of the slab, contributing to the later detoriation of the concrete and the reinforcing bars. The slab is terminated on both sides of the bridge by reinforced edge beams with a complicated formwork, into which balusters are to be cast. This design makes production steps cost consuming, time consuming, and dangerous, and makes the construction sensible to deficiencies in material and execution.

A concrete slab on concrete main girders is usually made in a similar way, except for the fact that scaffolding is required for the girders as well. In order to prevent the slab from separating in cracking from the torsion-resistant girders, when load is applied to the bridge, the girders and the slab are connected with moment- and shear resistant reinforcement. Working with scaffolding, formwork, reinforcement, and removal of the formwork are time consuming and dangerous construction steps.

It is also well known that the slab may be depressed between the main girders, making the bridge through-shaped. A bridge construction of the kind referred to is disclosed in DE-C- 914 258. In the known construction, however the main girders and the bridge deck form a rigidly connected unit as the connections between the girders and the bridge deck will transfer restrain moments between the bridge deck and the girders. In order to prevent the bottom from falling down, the slab is rigidly connected to the girders, e.g. by reinforcement. Even in this case there is a risk of cracking of the slab, both at the top and at the bottom, and a consequent risk of deterioration of the concrete and the reinforcement.

The traditional way of carrying the load to the main girders is to let reinforcing bars in the concrete slab carry the tensile forces of the bending moment. The slab is generally too thin to allow shear reinforcement to be used. In order to carry transverse forces from wheel loads and other loads, it must therefore be made extensively thick. An alternative way of carrying tensile forces from bending moments is to use lost scaffolding made of corrugated steel sheet, with intrusions or extrusions supposed to grip to the bottom surface of the concrete slab. This method is not generally accepted, and is not used for road bridges.

The aim and most important characteristics of the invention

The aim of the invention is to provide an overall solution to the actual problem. The invention is a new way to combine known structural elements with purely new designed elements in order to avoid the disadvantages mentioned above. With the invention, speed, economy, and safety in execution of the job are achieved.

The bridge is composed of preferably two main girders with a closed cross section and a depth greater than the width, preferably filled with plain concrete. A self-supporting and remaining steel deck extends from one girder to the other, and carries the load of a concrete slab which is cast on top of it. The deck preferably consists of steel case profiles in composite action with the concrete, and with crossbars placed in notches in the case profiles, according to WO-A-94 10 385.

At its bottom the deck is connected to each girder, to the bottom flange, and the slab is cast against the girder side, in order to generate neglible restraint moments from the girders when loading the slab, whereas moments of the opposite sign can be transmitted from one girder to the other by bending of the slab. Transverse force from the deck is transmitted to the girders by the steel deck without need for reinforcing bars. Hence both cracking at the top of the slab and damage to the deck-to-girder connectors are avoided. The bottom of the slab is protected by the remaining steel deck, which is preferably hot dip galvanized. Possible cracking is concentrated to the surface between deck con-

struction and girder. Leakage at this point is preferably prevented by making the edge of the deck construction elevated and closed by an elastic sealant. The capacity of the deck construction to transfer bending moment from one girder to another reduces the torsion in the girders at the supports.

The invention also includes a method to produce permanent compressive stress at the top of the slab, for increased protection against water penetration. The steel bottom is simultaneously exposed to tension; in this area however the concrete is protected by the preferably hot dip galvanized case profiles. The state of strain is achieved by pressing the case profiles, which are connected to the main girders, upwards before casting by means of a temporary beam, intermediate and parallel to the girders. The latter is, in its turn, connected to cross beams, preferably connected to the outside of the girders, which will consequently twist slightly outwards when applying the press power. As the beams are released after casting and hardening the girders will twist back and the slab will descend slightly in the centre of the bay and get the desired state of strain with compression in the entire top area. The method is particularly suitable for road bridges with a great width, since the steel deck is continuously supported by the temporary beam during casting.

The bridge may be cable stayed where spans are greater. In this case the girders are preferably designed with an inclined exterior side, onto which exterior plates are directly welded, suitable for connection of the cables. Hence the attachment plates and the cables form a plan, substancially parallel to and eccentric to the torsion centre line of the girder.

The girders are, at least at some points, supported by columns or cross beams, capable to resist the residual torsion from load on the slab or eccentric cables. The columns are preferably made of prepainted steel tubes, inclined in pairs with a foundation in common, from that extending upwards and outwards in such a way that they directly carry their own girders. By this means an aesthetic aspect is obtained, and disturbing drainage pipes from the slab may be hidden in the columns. The columns and part of the slab or a cross beam form a closed V-shape, suitable to carry relevant forces. The columns are preferably filled with pure concrete in order to resist collision.

The invention, with or without concrete filling, is also suitable for temporary bridges or fly-overs. The permanent slab is then substituted by a number of deck elements, locked up between the girders and fixings at the bridge ends. The main girders are connected rigidly by at least two cross beams, which need not to be located at the ends of the bridge. The advantage with this construction is that the bridge deck is situated at the ground level, making both excavation and embankment up to the level of the deck unnecessary. The girders form natural collision barriers, which makes temporary safety fences excessive as well. Transverse force between the deck elements may be transmitted by support plates welded to the bottom of the elements with a specific gap, and arranged in such a way that the support plates on one element is active when loading the adjacent ones.

The load carrying function of the safety fence is with the invention substituted by the concrete-filled girders. The finishing railing may therefore be designed unspliced and aesthetic.

Due to the absence of edge beams and the fact that concrete and fasteners in the slab are protected by the hermetical bottom and the impermeable sealing layer on top of the slab, the concrete, steel, and reinforcement are well protected from all sides against thawing salt, soaking, carbonating and corrosion.

Where concrete-filled girders with two adjacent webs, according to the invention, are being used, the advantage of the concrete-beam-bridge to compensate temperature changes is obtained, which often leads to simpler and cheaper abutments, bearings and joints. At the same time a construction with good torsion resistance and stability is obtained, especially with concrete filling. The advantages of the steel-girder-bridge; low weight and a high level of prefabrication are also obtained, further improved since the girders are separate complete units including railing that needs not to be spliced and since all scaffolding and demolition of the formwork is substituted by permanent structures.

Description of applications

In a bridge according to an embodiment of the invention the bridge girders are put on steel columns filled with concrete, and the columns are rigidly connected to the ground. The steel columns and the steel deck or a separate tension member form a closed V-shape. Drainage pipes are hidden in the steel columns.

Without restrictions, a few suggestions concerning material and dimensions should also be mentioned. The case profile of the deck is made of steel plate in the thickness range 4 to 7 mm. The case profile is hot dip galvanized. The girders are 700 to 1500 mm deep. The column section is circular with a diameter of 500 mm. Girders, railings, and columns are painted in matching colors.

A method to produce permanent compression in the entire top area of the slab may be as follows. The steel deck, connected to the bottom flanges of the girders, is before casting pressed upwards by means of a temporary longitudinal beam, which is supported by temporary cross beams, which are being raised by turning nuts on threaded bars. When the concrete is hardened the threaded bars are loosened and the slab will deflect elastically to a level of equilibrium, characterized by a slightly excessed bottom of the slab and a top with compression in the concrete.

With the invention used as a temporary bridge the main girders are connected rigidly to cross beams. Between the girders, and on top of their bottom flanges,

deck elements are put, the deck elements being furnished with support plates, welded to the bottom of the elements with a specific gap.

Claims

1. Permanent bridge structure including main girders and a deck construction connected to the girders at the lower edge thereof, **characterized in that** the deck construction includes a steel deck connected to the girder lower flanges by connections withstanding tensile forces and a concrete body slab cast upon the deck inside the and abutting the girders, the abutment between the side faces of the cast slab and the girder insides transferring compression forces between the girders and the cast slab.

2. Bridge structure according to claim 1, **characterized in that** the girders are filled with plain concrete.

3. Temporary bridge structure including main girders and a deck construction connected to the main girders at the lower edge thereof, **characterized in that** the girders are rigidly connected to at least two cross beams and that the deck construction consists of temporary elements locked up between the girders (1) and fixings at the bridge ends, and that the temporary elements have support plates welded to the bottoms of the elements, said support plates arranged to mutually support adjoining elements.

4. Method for producing permanent pressure in the entire top of the slab of the bridge structure according to claim 1 or 2, **characterized in that** the steel deck, which is connected to the bottom flanges of the girders, before casting is pressed upwards by means of a longitudinal beam connected to cross beams, which are eccentrically connected to the exterior side of the main girders, and that the press power is released after hardening of the concrete.

Patentansprüche

1. Dauerhafter Brückenaufbau, enthaltend Hauptträger und eine mit den Trägern an ihrer Unterkante verbundene Deckenkonstruktion, **dadurch gekennzeichnet,** daß die Deckenkonstruktion eine Stahldecke, die mit den unteren Trägerflanschen über Verbindungen, die den Zugkräften widerstehen, verbunden ist, und eine auf die Decke gegossene Betonplatte innerhalb der und anstoßend an die Träger enthält, wobei die Endauflager zwischen den Seitenflächen der gegossenen Platte und den Trägerinnenseiten Druckkräfte zwischen den Trägern und der gegossenen Platte übertragen.

2. Brückenaufbau nach Anspruch 1, **dadurch gekennzeichnet,** daß die Träger mit unbewehrtem Beton gefüllt sind.

3. Temporärer Brückenaufbau, enthaltend Hauptträger und eine mit den Hauptträgem an ihrer Unterkante verbundene Deckenkonstruktion, **dadurch gekennzeichnet,** daß die Träger mit mindestens an zwei Querträgern starr verbunden sind und daß die Deckenkonstruktion aus temporären Elementen besteht, die zwischen den Trägern (1) und Befestigungen an den Brückenenden eingeschlossen sind, und daß die temporären Elemente über Auflagerplatten verfügen, die auf den Unterseiten der Elemente angeschweißt sind, wobei die Auflagerplatten so angeordnet sind, daß sie die angrenzenden Elemente gegenseitig tragen.

4. Verfahren zur Erzeugung eines dauerhaften Drucks auf der gesamten Oberseite der Platte des Brükkenaufbaus nach Anspruch 1 oder 2, **dadurch gekennzeichnet,** daß die mit den unteren Flanschen der Träger verbundene Stahldecke vor dem Gießen mit Hilfe eines Längsbalkens, der mit exzentrisch mit der Außenseite der Hauptträger verbundenen Querträgern verbunden ist, nach oben gedrückt wird und daß die Druckkraft nach Härtung des Betons gelöst wird.

Revendications

1. Structure de pont fixe comprenant des poutres principales et une construction de tablier supérieur liée aux poutres à son bord inférieur, **caractérisée par** le fait que la construction de tablier supérieur comprend un tablier supérieur d'acier lié aux brides inférieures des poutres par des connexions résistant aux fortes de traction et un corps de béton à fini rainuré sur le tablier supérieur à l'intérieur et jointif aux poutres, la jointure entre les faces latérales du fini rainuré et les intérieurs des poutres, effectuant un transfert des forces de compression entre les poutres et le fini rainuré.

2. La structure de pont conforme à l'exigence No. 1 est **caractérisée par** le fait que les poutres sont remplies de béton non armé.

3. Une structure de pont temporaire comprenant des poutres principales et une construction de tablier supérieur liée aux poutres à son bord inférieur, **caractérisée par** le fait que les poutres sont liées rigidement à au moins deux poutrelles croisées et que la construction de tablier supérieur consiste en éléments temporaires verrouillés entre les poutres (1) et les fixations aux extrémités du pont et que les éléments temporaires ont des plaques de soutien

soudées aux fonds des éléments, les dites plaques de soutien étant placées de manière à soutenir mutuellement les éléments adjacents.

4. Une méthode pour produire une pression permanente dans toute la partie supérieure du fini de la structure du pont conformément aux exigences 1 ou 2, **caractérisée par** le fait que le tablier supérieur d'acier, qui est lié aux semelles inférieures des poutres, est pressé vers le haut avant le coulage à l'aide d'une poutrelle longitudinale liée aux poutrelles croisées, qui sont liées de manière excentrique à la face extérieure des poutres principale et que la pression est relâchée après le durcissement du béton.