May 7, 1963 G. THIMAN 3,088,246

BRIDGE AMD METHOD OF BUILDING THE SAME

Filed Oct. 20, 1958

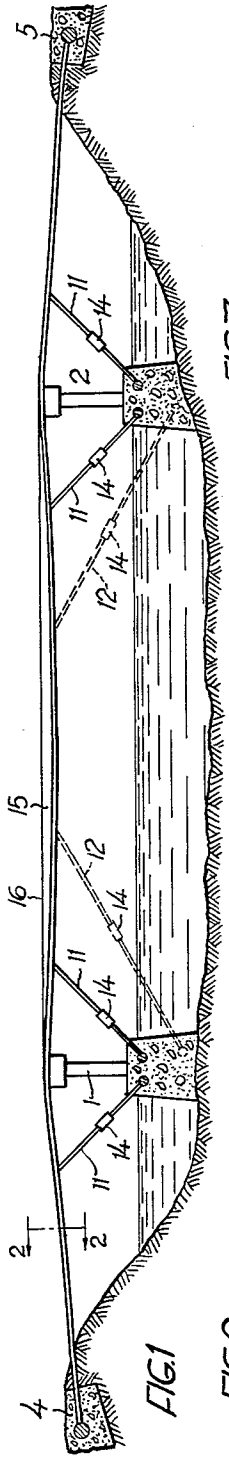


FIG.1

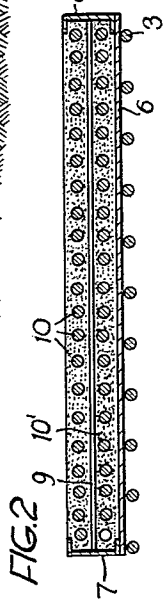


FIG.2

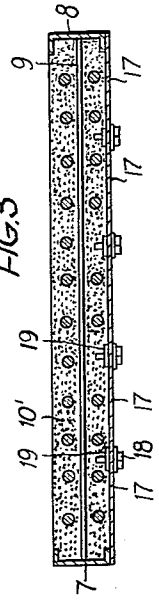


FIG.3

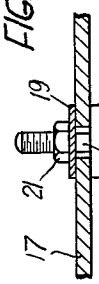


FIG.4



FIG.5

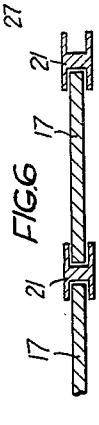


FIG.6

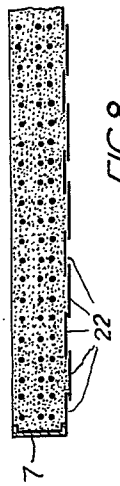


FIG.7

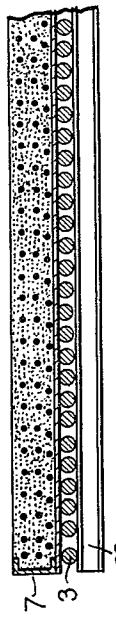


FIG.8

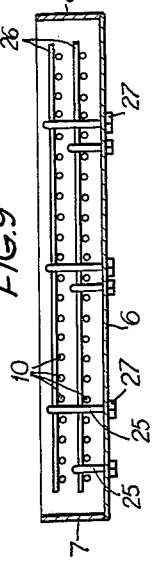


FIG.9

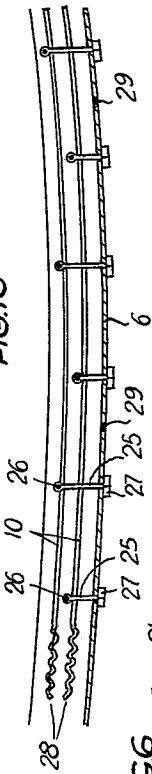


FIG.10

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3,088,246

Patented May 7, 1963

3,088,246

BRIDGE AND METHOD OF BUILDING THE SAME

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Filed Oct. 20, 1958, Ser. No. 768,146
Claims priority, application Sweden July 22, 1958
1 Claim. (Cl. 50—148)

The present invention relates to bridges, and particularly to the type of bridges in which a roadway is carried on or by cables or wires.

The main object of the invention is to provide a bridge of reinforced concrete which can be built more rapidly and at a lower cost than prior bridges comprising roadways of concrete.

A further main object of the invention is to provide a method for building bridges of the type referred to in a simple and efficient manner at a relatively low cost.

The bridge, according to the invention, comprises suspension cables or wires and means for anchoring the ends thereof at the ends of the bridge and, further, a roadway of concrete in which the cables or wires are embedded as reinforcements. Supporting cables may be extended between the anchoring places of the bridge prior to the moulding of the roadway, whereby said cables can be utilized for supporting the mould in which the roadway is moulded. Not only the suspension cables may be utilized as reinforcements for the concrete, but also the mould itself, since the latter may remain in the moulded roadway as a structural element receiving the stresses and strains applied to the bridge in use.

Other objects and features of the invention will more clearly hereinafter appear by reference to the accompanying drawing forming a part of the specification and wherein like characters of reference designate corresponding parts throughout the several views, in which

FIG. 1 is a vertical elevation showing the bridge from one side thereof,

FIG. 2 is a transverse section on an enlarged scale, taken on lines 2—2 of FIG. 1,

FIG. 3 is a transverse section similar to that shown in FIG. 2 but relating to a modified embodiment of the invention,

FIG. 4 is a detail of FIG. 3 shown on an enlarged scale,

FIG. 5 is a bottom view of a detail of FIG. 4,

FIG. 6 is a fragmentary section of a detail which is a modification of the detail shown in FIG. 4,

FIG. 7 is a transverse section similar to that shown in FIG. 2 but relating to a further embodiment of the invention.

FIG. 8 is also a transverse section similar to that shown in FIG. 2 but relating to a still further embodiment of the invention,

FIG. 9 is a transverse section of the roadway during moulding, and

FIG. 10 is a fragment of a longitudinal section corresponding to FIG. 9.

The invention would be most easily understood by a description of the method for building the bridge. First, it should be noted that FIG. 1 illustrates a bridge comprising two piers 1 and 2 as supports for the roadway or top structure but that such supports can be omitted. Alternatively, any other suitable number of piers could be used, the number being dependent upon the length of the bridge.

Suitably, the pier structures 1 and 2 are first built, for example, from reinforced concrete. A layer of steel cables or wires 3 are then mounted to extend from one shore anchorage 4 over the piers 1, 2 and to the other shore anchorage 5, the ends of the cables or solid wires being embedded into concrete anchorages or secured to

the anchorages in any other suitable manner. The cables or wires 3 are referred to hereinafter as supporting means or supporting cables.

A roadway is now built on the supporting cables by mounting a mould on the top of the cable layer, said mould being then used for the manufacture of a roadway of reinforced concrete. As shown in FIG. 2, the bottom of the mould may consist of sheet metal pieces 6 extending over the entire breadth of the bridge. A plurality of steel sheets may be welded together to form an integral web extending from one end of the bridge to the other. Lateral members 7 and 8 in the form of U-shaped girders or bent sheet metal strips are mounted on the longitudinal marginal portions of the bottom web to form the sides of the mould. The lateral members 7, 8 are connected by transverse truss rods 9. Steel cables or wires 10 are mounted in the mould to form reinforcements. These cables or wires may extend from one anchorage 4 to the other 5 and be secured to these anchorages, or each individual cable may extend only for a part of the length of the bridge. They may consist of wires that are corrugated or undulated at their end portions or along their entire length. Concrete mass 10' is now poured into the mould so that the cables or wires 10 will become embedded into the concrete as reinforcements.

The mould may advantageously remain to form a part of the carrying structure of the bridge. In such case, the mould and the concrete form an integral unit in the roadway adapted to receive the stresses and strains caused by the weight of the roadway itself and by the load thereon, as well as by lateral wind forces.

Since it would be diffiicult to effect the moulding of the bridge in one single operation within the period of setting of the concrete, there would be a risk of uneven deflection of the roadway during the moulding operation so that it could deviate from the catenary form. This may be avoided by mounting additional truss cables or rods 11 and 12 between the bases of the piers 1, 2 and the roadway, as shown in FIG. 1. The truss rods may contain turnbuckles such as 14 allowing reduction of their length to apply downward tension on the roadway mould. Torsional deflection of the mould may also be counteracted by performing the casting operation successively in steps, each step comprising the moulding of a longitudinal strip or section of substantially the same length as the bridge but corresponding to only a portion of the breadth thereof. The concrete may be applied by blowing the concrete through longitudinal tube lines along the entire length of the bridge. After one longitudinal concrete section has been cast, the tube lines may be moved to blow out concrete for a further section laterally of the first section and so forth.

The truss rods or cables 11 and 12 may be mounted so as to allow downward pull on the suspension reinforcements or cables 10, whereby the cables 10 may be prestressed during the moulding operation substantially like the reinforcements in prestressed concrete. After the moulding operation has come to an end, the truss rods should be tightened further, for example, by the turnbuckles 14. The truss rods 12 which are attached to the roadway relatively near the central portion thereof may be removed after the concrete has set. The truss members 11 located nearer the piers should be maintained under their own tension with a view to eliminating oscillations of the bridge.

The mounting of the wires or cables 10 in the mould may be facilitated by using a wooden mounting table 15, the top surface 16 of which is substantially straight and horizontal as indicated in FIG. 1. This mounting table rests on the bottom of the mould while the wires 10 are laid out on the top of the mounting table. The wires 10

are suitably stretched between the anchorages **4**, **5** but only to a certain relatively little extent. The ends thereof are secured to the anchorages. The ends of the wires or the entire wires may be of sinuous shape (cf. FIG. 10), or there may be anchoring means such as rings or sleeves secured to the ends of the wires which are embedded into the anchorages **4** and **5**. The mounting table is removed, after the wires have been mounted and, as a result, the wires will sag and be stretched longitudinally due to their own weight. If desired, suitable tensioning members may be attached to the wires and secured to the transverse truss rods **9** or the bottom of the mould to allow further stretching of the wires **10** by pulling them towards the bottom of the mould to a suitable distance therefrom, as will be further described with reference to FIGS. 9 and 10. Concrete mass is then poured into the mould and allowed to set, the tensioning members being embedded into the concrete in their stretched state.

Since the mould is cast permanently to the concrete to form an integral structure and remains in the roadway as a structural element taking up load, no particular costs for additional mould means are required. This results in a considerable saving of cost and material.

The supporting cable **3** may be omitted, if the bottom of the mould is composed of flat steel strips extending adjacent one another from one anchorage **4** to the other **5**. A transverse section of a bridge of this construction is illustrated in FIG. 3, wherein the bottom strips are designated by reference numeral **17**. The strips are held on the same level by bolts **18** located between the adjacent edges of the strips **17** and carried through holes in sealing strips **19** overlapping the space between the edges of the strips **17**. The heads **20** of the bolts may be of a special elongated shape, as shown in FIGS. 4 and 5, whereby the bolts may be easily inserted between the strips **17** from above after the strips have been adjusted into their correct position. The bolts are tightened from above by nuts **21** which also will press the sealing strips **19** firmly on the bottom strips **17**. The strips **17** and **19** are intended to remain in the roadway after the concrete has set, thus the strips contribute to the strength of the bridge.

A modified arrangement for keeping the bottom strips **17** in correct mutual position and for obtaining seal between the longitudinal edges thereof is shown in FIG. 6, according to which the connection and sealing means consist of shallow strips **21** of I-section, having their web between the strips **17** and their flanges at the top and the bottom of the strips **17**, respectively.

FIG. 7 illustrates a still further form of the bottom of the mould which, in this case, is composed of a plurality of overlapping steel bands **22**, all of them suitably having equal breadth.

FIG. 8 illustrates a cross section of a further embodiment of roadway which is similar to that shown in FIG. 2 but in which transverse beams **23** are mounted below the supporting cables **3**. By way of example, it could be mentioned that sixteen beams **23** may be mounted in spaced relation and distributed along the length of the

bridge, the span of which may amount to about 330 yards and total length to 545 yards.

In FIGS. 9 and 10, tensioning members in the form of ear bolts **25** are provided to enable stretching of the longitudinal wires **10** in the mould **6**, **7**, **8** before pouring concrete mass into the latter. Transverse rods **26** extend through the ears of the bolts **25** and rest on the wires which are located in two superimposed layers. The bolts are carried through smooth holes in the bottom pieces **6** of the mould, and are adapted to be pulled downwards by turning nuts **27** on the lower ends of the bolts, whereby the wires **10** may be stretched and adjusted to take their correct position relatively to the bottom of the mould. FIG. 10 also illustrates undulated portions **28** of the wires **10** as well as weld joints **29** between the transverse edges of the bottom steel pieces **6** referred to hereinbefore.

Since I have described hereinbefore various forms which the roadway of the bridge may take and various modifications of the details, it will be understood that I do not intend to limit myself to the specific forms of the invention shown herein but intend to claim the invention as broadly as may be permitted by the state of the prior art and the scope of the following claims.

What is claimed is:

A bridge comprising shore anchorage means, a plurality of steel bands connected together along their adjacent edges to form a continuous bottom, means for coupling said bottom at its opposite ends to said shore anchorage means, at least two piers positioned between the shore anchorage means and supporting intermediate portions of said bottom, the bottom being suspended along a catenary curve from said piers, a concrete roadway carried and reinforced by said steel band bottom, truss rods each connected at one end to one of the piers and at the opposite end to said bottom to apply downward tension to the latter, reinforcing cables having their ends coupled to said anchorage means and embedded in the concrete roadway to further reinforce the roadway, and a plurality of tensioning means each connected from an intermediate part of a reinforcing cable to the adjacent underlying point on the bottom for applying tension to the reinforcing cables.

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