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(54) A span structure such as a bridge, as well as a concrete element for use in such a structure

(57) A span structure, such as a bridge, consisting mainly of a supporting structure built up from steel sections and a road surface connected therewith and composed of concrete elements. At the location of at least part of the joints (4) between successive concrete elements (3) there are arranged pressure means (7) suitable for applying in the concrete elements (3) compression forces acting in the span direction, transmittable to the supporting structure (1) at the ends (6) of the road surface.

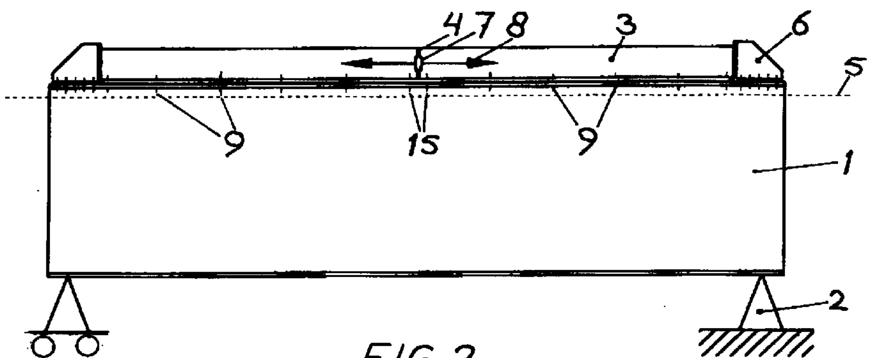

FIG. 2

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Description

This invention relates to a span structure, such as a bridge, consisting mainly of a supporting structure built up from steel sections and a road surface connected therewith and composed of concrete elements.

Such a span structure is known from practice. When the road surface is poured on the site on the supporting structure, shrinkage cracks or other cracks may occur in the course of time owing to the hardening process, resulting in damage to the road surface and symptoms of fatigue. These cracks advance the date of maintenance work and/or shorten the life of the structure.

It is known that when using a concrete road surface functioning as a monolithic whole because the concrete parts are under pressure both in transverse and in the span direction, the maintenance cost are substantially lower and the life of the span structure can be prolonged. The compressive stress in the concrete surface in the span direction is usually realized by means of a temporary support of the supporting steel structure ensuring that the supporting structure is bend in the upward direction. Subsequently, the surface is poured on the site in parts in a specific sequence or pre-fabricated concrete elements are placed to form the road surface, after which the joints between and the recesses in the concrete elements serving to connect them with the supporting structure are filled with mortar. After hardening of the road surface or of the mortar in the joints and recesses the temporary supporting structure is removed with the result that the road surface and the joints transverse to the span direction are subjected to pressure by its own weight in the span direction. The compressive stress in the concrete elements transverse to the span direction can be applied in the known manner on the site or in the factory by means of prestressed reinforcement.

The object of the invention is to provide a span structure of the above type in which the road surface can be pressurized in the span direction without requiring an auxiliary structure as a temporary support. According to the invention this object is attained by means of a span structure in which at the location of at least part of the joints between successive concrete elements there are arranged pressure means suitable for applying in the concrete elements compression forces acting in the span direction, transmittable to the supporting structure at the ends of the road surface.

The employed pressure means preferably consist of a pressure vessel to be filled with liquid under pressure, which pressure vessel can be arranged in a joint between adjacent concrete elements.

The pressure vessel preferably consists of a metal tube flattened in cross-section, deformable under internal pressure, the long axis of the pressure vessel, seen in cross-section, being parallel to the main plane of the joint.

By arranging expandable pressure vessels between the joints of the concrete elements the whole road surface can be pressurized in the span direction in such a manner that the shrinkage and creep effects otherwise occurring in the span direction are compensated from the beginning across the whole span length so that the road surface functions as a monolithic whole. The compressive stress applied in the concrete elements in the span directions produces a moment opposite to the weight load, as a result of the eccentric action on the supporting steel structure, so that this supporting structure can be made more slender. The laborious erection of an auxiliary supporting structure and the subsequent removal thereof can be left out, thus making an important saving.

The invention also relates to a concrete element for use in a span structure of the above type. Such a concrete element is characterized in that at least one edge comprises a recess of a shape corresponding to the pressure vessel.

To establish a solid connection between the concrete element and the supporting structure the concrete element is provided at the bottom with partly poured-in angle irons extending in the span direction of the supporting structure to connect the leg of the angle iron projecting from the concrete element with the supporting steel structure.

An embodiment of the span structure according to the invention and of the concrete element employed therein will be explained in more detail with reference to the accompanying drawings in which:

Fig. 1 - diagrammetically shows a known span structure;
Fig. 2 - diagrammetically shows a span structure according to the invention;
Fig. 3 - shows the shape of the pressure vessel arranged between two adjacent concrete elements;
Fig. 4 - shows the end of the span structure according to the invention;
Fig. 5 - shows the connection between concrete elements and supporting structure during mounting of the span structure;
Fig. 6 - shows another embodiment of the connection between the concrete elements; and
Fig. 7 - shows a joint between adjacent concrete elements in a ready span structure.

Fig. 1 shows the known span structure in a diagrammetic form in which a supporting structure 1 made from steel rests on two supports 2 provided at the ends. The supporting structure 1 will sag by its own weight to a greater or lesser degree, the neutral line 5, depending on the embodiment of the supporting structure, being situated more or less in the middle of the supporting structure 1. Applied to the supporting structure is a concrete road surface consisting of concrete elements 3 and a joint 4 between the concrete elements filled with mortar. The concrete elements 3 are connected with the supporting structure 1 in some way or other. To contribute to the carrying power, the concrete elements must take up pressure in the span direction, which only occurs with increasing load in the vertical direction.

Fig. 2 shows the span structure according to the invention in diagrammatic form. This structure differs from that of Fig. 1 by stops 6 provided at the ends of the road surface, which can take up the forces in the span direction, applied in the concrete elements, and transmit them to the supporting structure 1. Arranged in the joint 4 is a pressure vessel 7 consisting of a flattened metal tube, deformable under internal pressure to generate forces 8 in the span direction. When the pressure vessel 7 is pressurized, the concrete elements 3 are connected with the supporting structure 1 by means of the diagrammatically shown clamp connections 15 allowing horizontal shift. By applying the forces 8 transmitted to the stops 6 by means of the concrete elements 3, a moment opposite to the moment generated by its own weight acts on the supporting structure with the result that the carrying power of the span structure is increased or the same carrying power is obtained with a more slender supporting structure 1. A change of stress has occurred in the supporting steel structure. The forces 8 generated by the pressure vessel 7 apply a tensile stress in the span direction, while the moment produced by those forces 8 because of the eccentric action applies a tensile stress in the upper part of the supporting structure and a compressive stress in the lower part. After providing a solid connection of the concrete elements 3 with the supporting structure 1 by means of diagrammatically shown bolt connections 9, the neutral line 5 of Fig. 2 has shifted in upward direction when compared to Fig. 1.

Fig. 3 shows the shape of the pressure vessel 7 placed in the joint 4 between two adjacent concrete elements 3. The pressure vessel 7 consists of a metal tube flattened in cross-section, the long axis of which is parallel to the main plane of the joint 4. By applying in the pressure vessel 7 a pressure of, e.g., 400 bar, considerable forces are generated in the concrete elements 4 which are transmitted via the stops 6 to the supporting structure 1. After the concrete elements 3 have thus been put under compressive stress, the joint 4 is filled with mortar, after the bottom of the joint has first been sealed by means of a rubber element 11. After the mortar in the joint 4 has hardened, the pressure can be let off from the pressure vessel 7, after which the pressure vessel 7 is filled under pressure with a hardening mass which, after hardening, additionally keeps the concrete elements 3 under pressure.

Fig. 4 shows the end of the span structure. The supporting structure 1 can be provided at the end with a strengthened flange 12. The concrete elements 3 are provided with poured-in angle irons 13 of which the leg extending into the concrete element 3 is preferably connected with the transverse reinforcement (perpendicular to the plane of the drawing) of the concrete element 3. The leg of the poured-in angle iron 13 projecting from the concrete element is connected by means of a welded or bolt connection 10 with the strengthened flange 12 of the supporting structure 1 to form the stop 6 for transmitting the forces 8 in the span direction, generated in the concrete elements 3, to the supporting structure 1.

The steps of mounting the concrete elements 3 and connecting them with the supporting structure 1 will be explained hereinbelow with reference to Fig. 5.

Fig. 5 shows a concrete element 3 provided at the bottom with poured-in angle irons 13 resting on the upper flange of the supporting structure 1. Arranged between adjacent concrete elements 3 are pressure vessels 7 filled with a liquid capable of being put under a high pressure of, e.g., 400 bar by means of appropriate means. In the middle between the pressure vessels the concrete element 3 is firmly connected with the supporting structure 1, preferably by means of a bolt connection 14. At the joints 4 the poured-in angle irons 13 are connected with the suporting structure 1 by means of a plate 15 which is fixed in such a manner that shifting of the poured-in angle iron 13 with respect to the supporting structure 1 is possible. By pressurizing the pressure vessel 7 the concrete to the left and the right of the pressure vessels will be put under compressive stress so that the concrete elements are shortened. This compressive stress is transmitted at the ends of the span structure to the supporting steel structure, as a result of which mainly in the upper part thereof a tensile force is generated so that this upper part is lengthened. In view of the described shortening of the concrete 3 and the lengthening of the upper part of the supporting structure 1 the angle irons 13 poured in the concrete shift with respect to the supporting structure 1 (except at the location of the solid fastening bolts 14), after which in the final condition the angle irons 13 are connected with the supporting structure 1 by means of bolts 9.

A connection between the concrete elements 3 and the supporting structure 1 may also be effected in a manner different from the one shown in Fig. 5 and described above. This other manner of connecting is shown in Fig. 6. Instead of angle irons 13 extending throughout the length of the concrete element 3, there are only arranged short pieces of angle iron, namely at both ends of the concrete element 3 at the plates 15 allowing shifting and in the middle of the concrete element 3 at the connecting bolts 14. The short angle irons 13 mainly have the function of supporting legs.

After fixing the concrete element 3 by connecting the middle angle-iron shaped portions 13 with the upper flange of the supporting structure 1, pressurizing the concrete element by means of the pressure vessels 7, filling the joints 4 with mortar and hardening them, the connection between concrete element 3 and supporting structure 1 is effected by filling the groove 19, arranged on the upper flange of the supporting structure 1, with concrete mortar. The axial confinement between concrete element 3 and supporting structure 1 is obtained by providing the concrete element 3 at the bottom with straps 16 at regular intervals, while dowels 17 projecting into the plane through the horizontal legs of the straps 16 are welded to the upper flange of the supporting structure.

Fig. 7 shows a joint between adjacent concrete elements 3 in the final condition. After the liquid in the pressure vessel 7 has been pressurized, the joint 4 is filled with mortar. After hardening of the mortar the pressure in the pressure vessel 7 is let off and the pressure vessel 7 is filled with a mass hardening under pressure for additionally keeping the adjacent concrete elements 3 under compressive stress.

Instead of the pressure vessels as described above, hydraulic jacks may also be arranged between adjacent concrete elements 3 and/or at the ends of the supporting steel structure in appropriate recesses. After the concrete elements 3 have been definitively connected with the supporting structure 1 in some way or other, the jacks are removed. As indicated above, the pressure vessels are first filled with a liquid to be pressurized, e.g. hydraulic oil or water and then with a hardening mass. It is also possible to bring that hardening mass directly into the pressure vessels on condition that the hardening of that mass occurs more slowly than the hardening of that mass takes place more slowly than the hardening of the mortar to be applied to the joint 4.

Claims

1. A span structure, such as a bridge, consisting mainly of a supporting structure built up from steel sections and a road surface connected therewith and composed of concrete elements, characterized in that at the location of at least part of the joints (4) between successive concrete elements (3) there are arranged pressure means (7) suitable for applying in the concrete elements (3) compression forces acting in the span direction, transmittable to the supporting structure (1) at the ends (6) of the road surface.

2. A span structure according to claim 1, characterized in that the pressure means (7) consist of a pressure vessel to be filled with liquid under pressure, which can be arranged in a joint (4) between adjacent concrete elements (3).

3. A span structure according to claims 1-2, characterized in that the pressure vessel (7) consists of a metal tube flattened in cross-section, deformable under internal pressure, the long axis of the pressure vessel, seen in cross-section, being parallel to the main plane of the joint (4).

4. A span structure according to claims 1-3, characterized in that the long axis of the pressure vessel (7), seen in cross-section, is approximately 1/3 to 2/3 of the thickness of a concrete element (3).

5. A concrete element for use in a span structure according to any of claims 1-4, characterized in that at least one edge of the concrete element (3) comprises a recess of a shape corresponding to the pressure vessel (7).

6. A concrete element according to claim 5, characterized in that the concrete element (3) is provided at the bottom with partly poured-in angle irons (13) extending in the span direction to connect the leg of the angle iron (13) projecting from the concrete element (3) with the supporting steel structure (1).

7. A concrete element according to claims 5-6, characterized in that the angle irons (13) have a small length in the longitudinal direction and are only arranged in the middle and at both ends of the concrete element (3), while straps (16) are provided between the angle irons (13), seen in the longitudinal direction, in the bottom face of the concrete element (3) at regular intervals, which straps (16) can cooperate with dowels (17) arranged on the supporting structure (1) to confine the concrete element (3) being under compressive stress in the longitudinal direction.

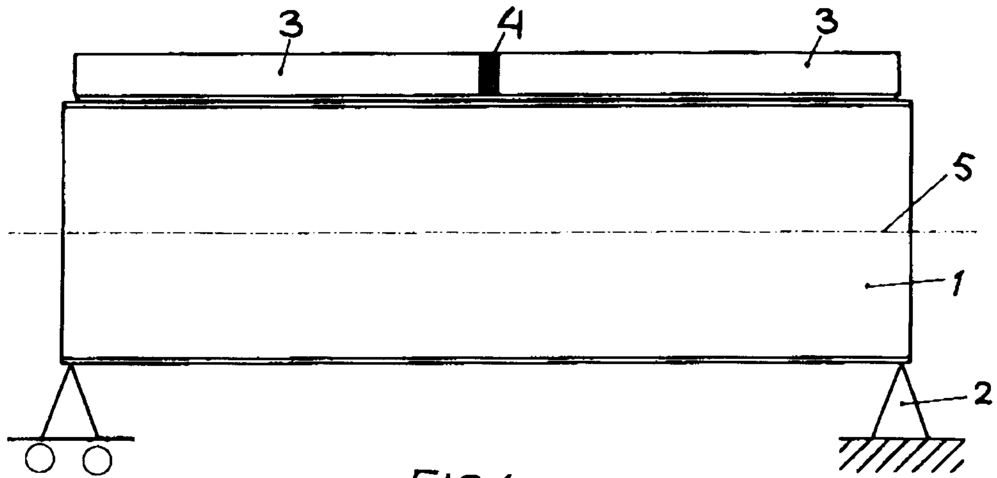

FIG.1

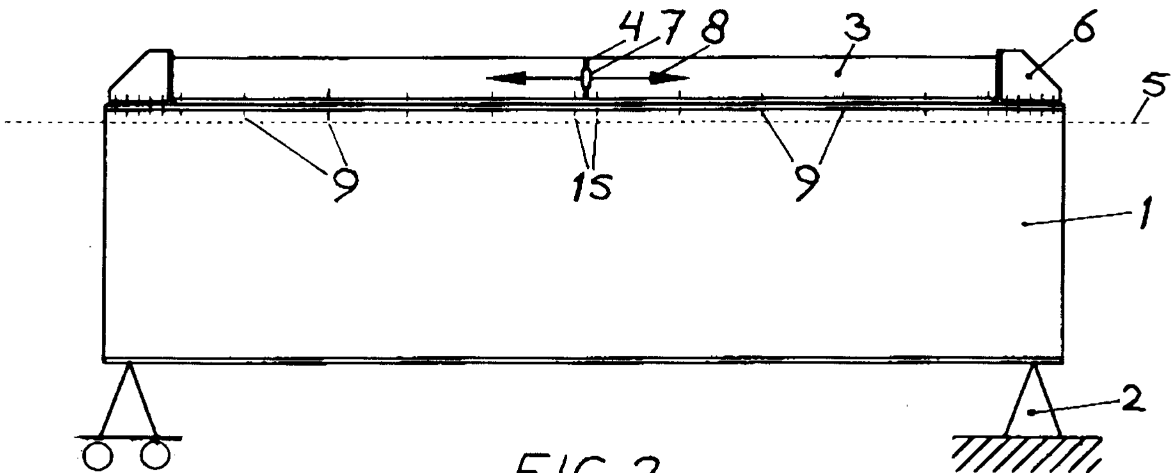

FIG.2

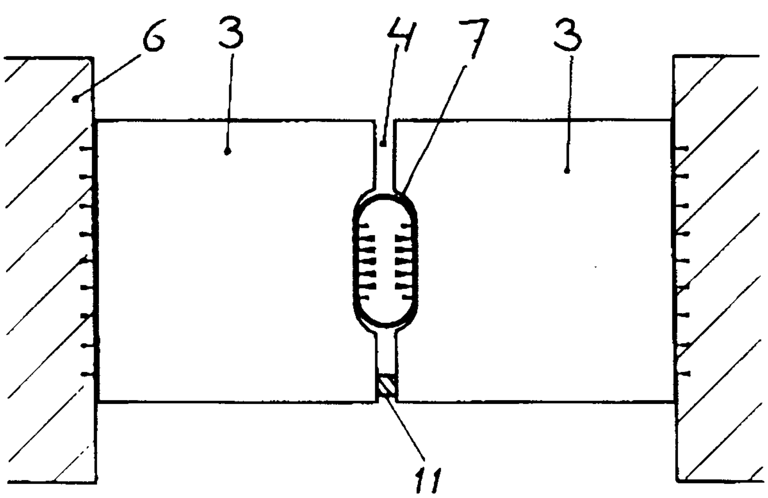

FIG. 3

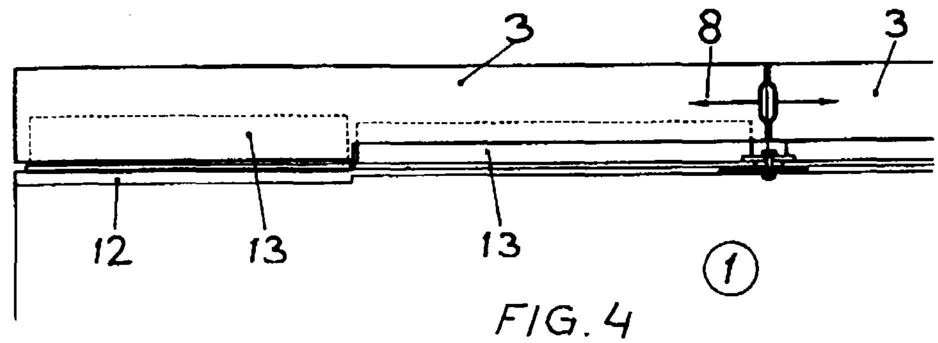

FIG. 4

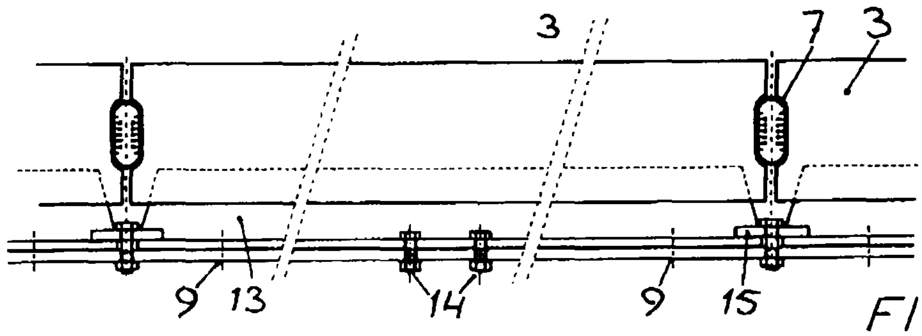

FIG. 5

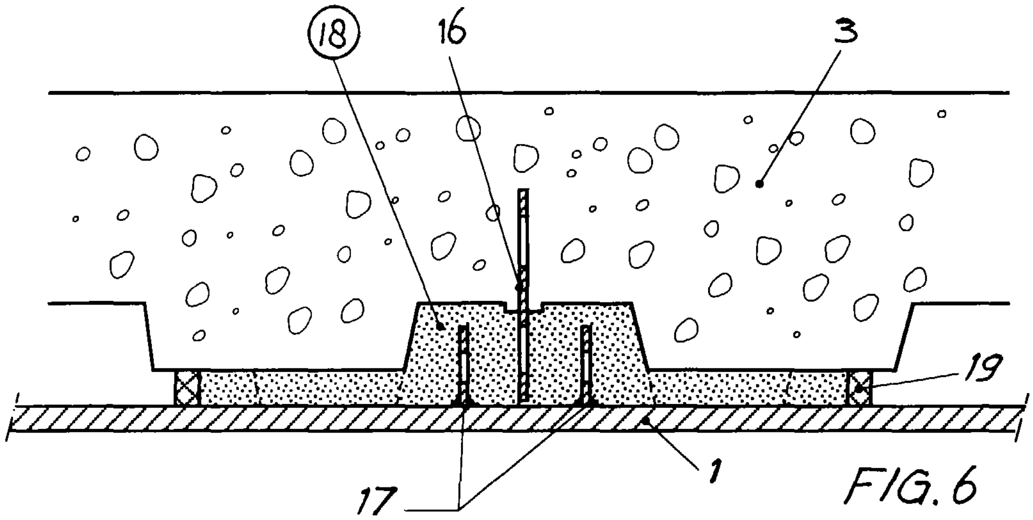

FIG. 6

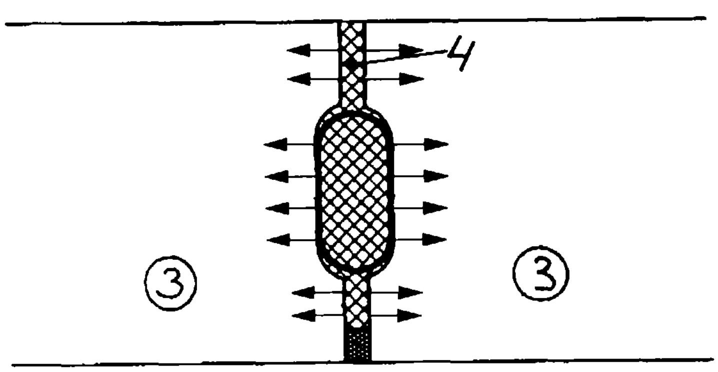

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 97 20 1832

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 4 343 123 A (SOERJOHADIKUSUMO ROOSSENO) 10 August 1982 * the whole document *	1-5	E01D2/02
X	FR 2 218 434 A (LORIN PAUL) 13 September 1974	1-3	
A	* the whole document *	4,5	
A	DE 16 09 322 A (GUTEHOFFNUNGSHÜTTE STERKRADE) 3 September 1970 * the whole document *	6	
A	FR 2 698 111 A (RAZEL FRERES ENTR) 20 May 1994 * figures *	7	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
E01D
E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 August 1997	Dijkstra, G

CATEGORY OF CITED DOCUMENTS

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