Nov. 10, 1964 U. FINSTERWALDER 3,156,169

CONCRETE ROADWAY

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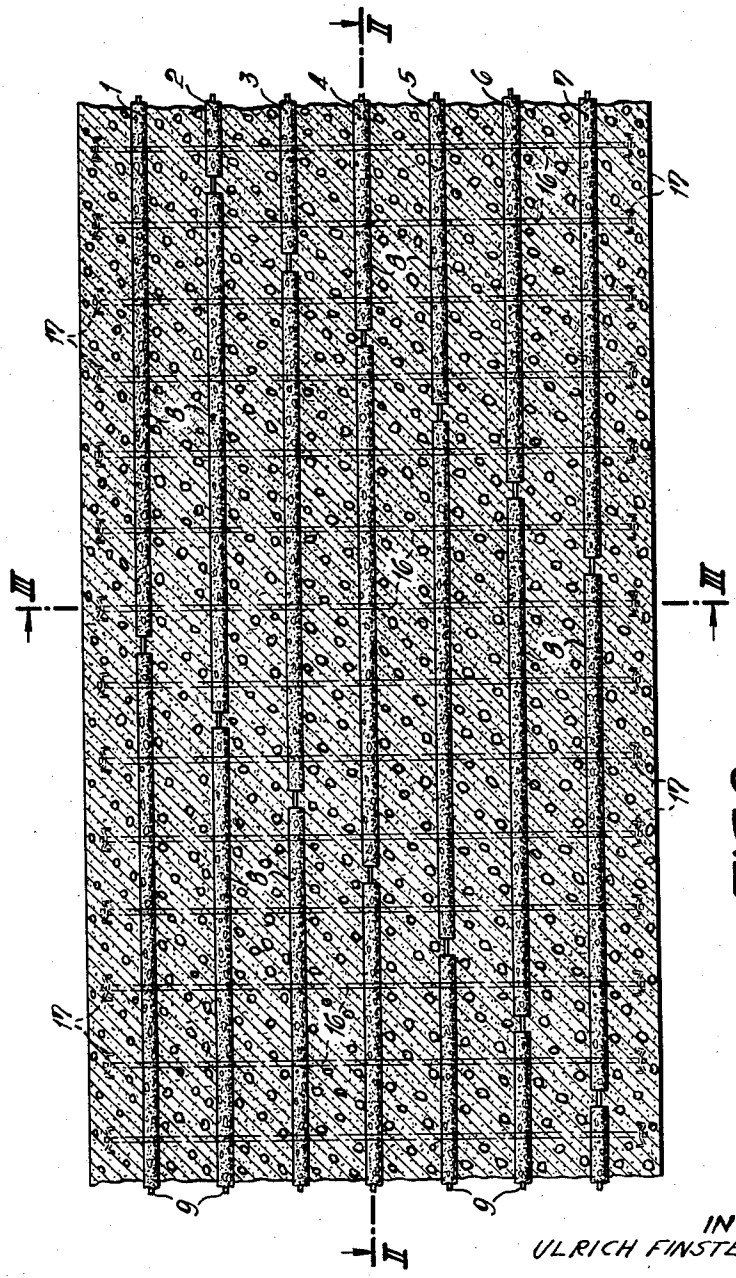


FIG. 1



FIG. 2

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FIG. 3

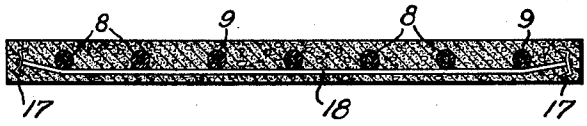
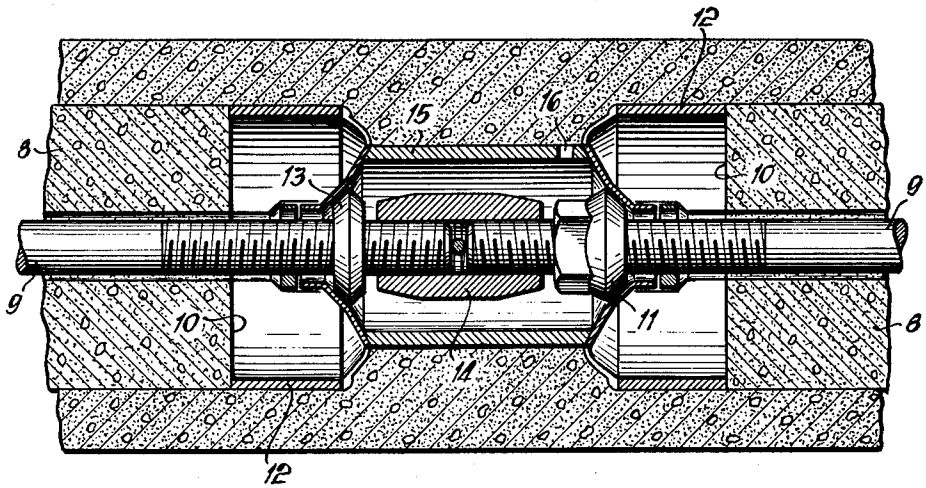


FIG. 4



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CONCRETE ROADWAY

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1 Claim. (Cl. 94—8)

The invention relates to a concrete roadway surface, without joints, and non-slidably connected to the bed on which it is built. This prevents the development of areas where the ground is subjected to higher stresses from the effect of the traffic load, for example joints between adjacent concrete slabs. These local higher stresses represent one of the main disadvantages of the known types of road surfaces made of concrete, such as those for streets, motorways, runways for aerodromes, and the like.

It is the aim of the invention to overcome this disadvantage, and the problem is solved by making the armouring of the roadway surface from concrete parts placed on a bed in the longitudinal direction, one next to the other, but with space between them, where the cross-section of the concrete parts, after they have been placed on this bed, does not exceed the thickness of the roadway surface, so that in each of these concrete parts one or several highly stressed steel inserts are arranged, and the concrete parts forming a road are positively connected together to form a continuous chain of reinforcing elements, and the space between the individual reinforcement chains is filled with concrete poured on the site.

In a preferred embodiment of the invention, the individual reinforcement element consists of a piece of prestressed concrete of circular or polygonal cross-section, prefabricated, of transportable length, and is armoured with a highly prestressed steel rod along its longitudinal centerline, and equipped at both ends with means for making a positive connection with the preceding and following elements of the appropriate reinforcement chain.

According to a further feature of the invention, the consecutive reinforcement elements of a longitudinal reinforcement chain are connected together in such a way that the threaded ends of the prestressing bars of two consecutive reinforcement parts, projecting beyond the concrete of the individual elements, are connected together by means of a sleeve tapped at both ends.

The subject matter of the invention is also formed by a procedure for the production of a jointless roadway surface of concrete by means of reinforcement parts of the aforementioned kind, this procedure having additional advantages. The new features consist in the fact that in the production of the reinforcement elements, made as prefabricated prestressed concrete parts, the prestressing insert consisting of a prestressing bar carries only a part, such as one half, of the final prestressing force, and is anchored on one side of the reinforcement element, while the anchorage on the other side is effected by an auxiliary anchoring nut, for preliminary anchoring, so that the individual reinforcement elements prepared in this way can be placed on the bed, and the residual part of the full prestressing force is applied in the reinforcement element in question only subsequently, when the aforementioned auxiliary nut is naturally destroyed by shear.

Further features of the invention and details of the advantages achieved by way of this invention are found from the following description of an example of an embodiment, of a jointless roadway surface according to the invention, illustrated in the appended drawings.

FIG. 1 is a plan view of a section of a finished jointless roadway surface with the features of the invention,

FIG. 2 is a longitudinal section along the line II—II in FIG. 1,

FIG. 3 is a cross-section along the line III—III of FIG. 1.

FIG. 4 shows a section through the sleeved joint of two consecutive reinforcing parts of a reinforcing chain, on a larger scale.

FIG. 1 shows a finished section of the roadway surface according to the invention. The broken boundary lines running transversely of the highway section in FIG. 1 are to indicate that the section shown here can be extended to the left and to the right without joints to any desired length.

The roadway surface rests on a bed, prepared in the usual and well-known way, this bed is not shown further in the drawings. The thickness of the concrete of the roadway surface normally amounts to between 15 and 18 cm. The roadway surface is reinforced as follows:

In the example of an embodiment shown here, seven chains of reinforcement parts made of concrete extend in the longitudinal direction of the roadway surface. These chains are denoted in the drawing by the numbers 1–7. They are distributed uniformly and with equal spacing over the width of the roadway surface. Naturally, the distances between the various chains of reinforcement parts can also be varied in special vases. The reinforcement chains 1–7 extend over the entire length of the roadway surface to be constructed.

Each of the seven reinforcement chains consists of directly consecutive concrete bodies 8, arranged in line, resting on the aforementioned bed, and having a cross-section that after positioning they do not project at any point from the cross-section of the roadway surface.

The cross-section of the concrete bodies 8, forming the longitudinal reinforcement of the roadway surface is round in the example of an embodiment shown here. It may also be oval, square, rectangular, or polygonal.

In a preferred embodiment of the invention, the reinforcement bodies 8 are prefabricated prestressed concrete parts, reinforced with a steel bar 9 along their longitudinal centerline, which steel bar is capable of absorbing high prestressing forces. A steel bar suitable for this purpose may have a diameter of 10 mm. and may be made of a steel of type 80/105.

The steel bars 9 are made sufficiently long so that they project beyond the concrete at both face ends of each reinforcement body 8. This enables the prestressing bars 9 of two consecutive reinforcement bodies 8 in each row or chain to be positively connected together in a suitable way, such as by means of sleeves.

The prestressing force applied to the prestressing bar is made comparatively high, and should amount to 150 kg./cm.^{2}, after the shrinkage and creepage of the concrete is completed. It is anchored on the stressing side by means of a nut 11, and a bell-shaped anchorage piece 12.

The length of the individual reinforcement bodies 8, made as prefabricated prestressed concrete elements, is a matter of no substantial importance as far as the present invention is concerned. The longitudinal dimension is subject to certain practical limits only inasmuch as it is desirable to enable the reinforcement bodies 8 to be made in an efficient manner in a concrete works equipped with the necessary machinery, and that they can be transported to the site when using conventional transportation means. This in general will only be possible if the length of the individual reinforcement elements, made as a prefabricated prestressed concrete body, does not exceed 10 meters, or at least does not exceed this length to any appreciable extent. It is convenient to make the individual reinforcement bodies in what is known as a prestressing bed, the longitudinal mobility of the steel bar 9 being maintained

by coating it with bitumen or by arranging it in tubes, so that later the prestressing force can be applied to the steel rod.

For the production of the individual reinforcement bodies 8 in the concrete works, only a part, normally about half, of the final prestressing force is applied to the steel bar 9. This prestressing force is permanently anchored at one end of the reinforcement body 8 by means of the nut 11, while on the other it is anchored temporarily by means of an auxiliary nut 13. This auxiliary nut 13 is later automatically destroyed by shearing, when the residual part of the full prestressing force is applied, the nut shearing when three-quarters of the full prestressing force has been applied to the prestressing bar 9 of the reinfrcement body 8.

The reinforcement bodies 8 described here are placed after transportation to the site on the aforementioned bed in such a way that the reinforcement parts follow each other consecutively in the longitudinal direction of the roadway surface to be made. In order to make the chains 1–7 which extend over the entire length of the roadway surface, from a corresponding number of consecutively arranged reinforcement bodies 8, the latter are positively connected together. In the example of an embodiment shown here, this is accomplished as shown in FIG. 4, in that the threaded ends of steel bars 9 projecting from the end faces 10 of two longitudinally consecutive concrete elements are engaged by the tapped sleeve 14, so that the facing ends of the two steel bars 9 are clamped together.

At the two face ends 10 of each reinforcement body 8, bell-shaped anchoring members 12 are provided. The ends of a steel tube 15 rest against these anchoring members, the steel tube being pushed over the tapped sleeve 14. The two ends of the steel tube 15 are bevelled to suit the slope of the bottom part of the anchoring members 12.

Force is imparted to the steel tube 15 in such a way that the auxiliary anchoring nut 13 arranged at the end of the bar to be connected to the chain is automatically sheared off by means of a clamping press (not shown). This ensures the flow of force from the concrete of any given reinforcement part 8 through the steel tube 15 to the next following or preceding reinforcement body 8.

It should be noted that nut 13 is considerably smaller in height than nut 11 and has less than half the number of threads. Consequently an increase in tension beyond that applied in the shop for prestressing will permit the threads of nut 13 to be sheared off while the threads on nut 11 remain intact.

In one practical method of connecting the prestressing bars 9 of the reinforcing bodies 8 to each other, the nut 14 is first mounted on the threaded end of the bar 9 of the preceding body 8. The sleeve 15 is positioned around the nut and then the threaded end of bar 9 of the body 8 to be connected is entered into the open end of the nut 14 and the entire body or reinforcing element 8 is rotated until the sleeve 15 is in contact with the ends of sleeves 12 which match the ends of sleeve 15. This requires, of course, that the succeeding body 8 is first exactly aligned with the preceding body 8 to which it must be joined and this operation is suitably performed by more than one man.

The hollow space surrounded by the steel tube 15 is subsequently filled with grouting, through the bore denoted by the number 16.

After placing the chains 1–7, which extend with uniform spacing therebetween over the entire width of the roadway surface to be constructed, the chains being made from interconnected reinforcing bodies 8, which are prefabricated prestressed concrete elements, the transverse armoring is laid out, in such a way that the longitudinal movability of the transverse bars 18 is maintained, by arranging them either in tubes, or by coating, for instance, with bitumen. The end anchorages of the transverse bar 18 are shown diagramatically at 17.

After the longitudinal and transverse reinforcements have been laid, the open spaces remaining between the individual reinforcement chains 1–7 are filled with concrete poured on the site. The concreting of the roadway surface takes place continuously over long sections. It is therefore not necessary to make the working sections coincide with the joints of the reinforcement bodies 8 in the individual reinforcement chains 1–7, and the working sections can be selected arbitrarily. The example of an embodiment shown in FIG. 1 indicates a uniform arrangement of these joints.

If one assumes, what in general will be quite permissible, that the chains 1–7 of reinforcement parts are concreted in at approximately the average temperature over the year, they retain their stress at this temperature, and the roadway surface concrete is not under any appreciable stress. If the temperature rises by, say, 20° C., the stress in the reinforcement bodies 8 embodied in the roadway surface will rise by 60 kg./cm.^{2}, due to the prevention of thermal expansion, if the modulus of elasticity of the concrete is taken as 300,000 kg./cm.^{2}, so that the stress in the individual reinforcement bodies reaches 210 kg./cm.^{2}, and the surrounding poured concrete reaches 60 kg./cm.^{2}. When the temperature drops by 20° C., the stress in the reinforcement bodies will drop from 150 kg./cm.^{2} to 90 kg./cm.^{2}, while the surrounding poured concrete of the roadway surface will expand by 0.2 millimetre per metre.

Experiments have shown that the poured concrete of the roadway, which is very effectively bonded to the prefabricated prestressed reinforcement parts, owing to the large contact faces, can follow this strain without danger of cracking, while in the roadway reinforced in the conventional manner with simple steel reinforcements, cracks would be formed at a strain of this magnitude. This roadway would not stand up to the load formed by the traffic owing to its inadequate resistance to shear forces. According to the invention even a crack would not destroy the roadway surface because the reinforcement part, still prestressed to 90 kg./cm.^{2}, is able to absorb the transverse forces.

Recently a type of road surface has come into use, particularly for motorways, which is called a black surface. This is a surface made of asphalt with suitable additives, or the surface is made of asphalt concrete. The reinforcement bodies shaped according to the invention and connected together can be used with the same advantage also in conjunction with road surfaces of the latter type. In this case, it will be convenient (in order to improve the transfer of the shear forces) to reduce the distances between the individual chains of reinforcement parts in the transverse direction.

I claim:

A jointless roadway surface of concrete comprising reinforced concrete bodies extending longitudinally of the roadway disposed over a bed alongside one another in spaced apart relationship and concrete filling the spaces between and above said bodies and presenting an exposed face of overfill and forming the roadway surface, the cross section of said bodies being smaller than the thickness of said roadway surface, each of said bodies including at least one highly prestressed steel reinforcing element and the elements of sequential said bodies being connected at their adjacent ends to form a prestressed continuous chain of reinforcing bodies, said elements being steel rods or the like having threaded ends projecting beyond the concrete of the bodies and a threaded sleeve being mounted on said threaded ends to connect adjacent said bodies, a bell shaped anchoring member being mounted proximate the ends of each said steel rod and a hollow cylindrical supporting body of steel or the like being received over said threaded sleeve intermediate proximate said bell shaped members and being supported against said

bell shaped members to transmit the forces from the concrete of one body to the concrete of the other.

References Cited in the file of this patent

UNITED STATES PATENTS

2,134,941	Guignon	Nov. 1, 1938
2,590,685	Coff	Mar. 25, 1952
2,611,262	Dodson et al.	Sept. 23, 1952
2,660,049	Maney	Nov. 24, 1953
2,702,424	Bakker	Feb. 22, 1955
2,737,802	Bakker	Mar. 13, 1956
2,950,576	Rubenstein	Aug. 30, 1960
2,961,803	Shapiro et al.	Nov. 29, 1960

FOREIGN PATENTS

711,449	Great Britain	June 30, 1954
871,681	France	Jan. 19, 1942
1,167,385	France	Nov. 24, 1958