

Multispan Girder

The present invention relates to a concrete multispan girder, especially made of reinforced concrete or prestressed concrete according to the introductory clause of the independent claims.

Girders made among other things of reinforced concrete are produced for travel ways for railborne vehicles for high-speed traffic, such as known from DE 33 35 058. These reinforced concrete girders, which are usually precast, span the distance between two supports on which the girder rest. These so-called single-span girders have disadvantages when the extremely rapid magnetic levitation train passes over them with respect to their noise oscillation behavior. They are furthermore disadvantageous because even if the span distances are very great in the meantime, there are nevertheless frequently free joints between the individual girders and these must be designed in an extremely expensive manner because of their supports and their expansion together with the functional parts installed on the girders for the magnetic levitation train.

Girders are also known that bridge two or more spans. The disadvantage with these multispan girders known so far is that when the girder is under such a great load, especially when the clear span is long, deflection of the girder occurs. This deflection which is harmless with conventional girders used for car bridges or railroad bridges may interfere with operation under certain circumstances with modern, railborne vehicles in high speed vehicle traffic, in particular with magnetic levitation trains. Magnetic levitation trains must be guided along functional structural components installed on the girder and having to meet extremely precise positioning requirements. Reinforce concrete girders for high speed vehicle tracks with steel structural parts attached to them to guide the magnetic



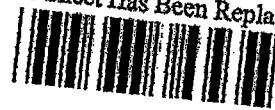
levitation trains were not realized until now, to the knowledge of the inventor, in form of multispan girders.

The present invention has therefore as its task to avoid the existing disadvantages and in particular to create a multispan girder meeting the rigorous requirements for high-speed rail roads, in particular for magnetic levitation trains, while nevertheless allowing for an extremely long clear span for economic construction of the travel way.

This object is attained through a travel way possessing the characteristics of claims 1 and 2.

The multispan girder according to the invention is made of concrete, in particular reinforced concrete or prestressed concrete and is provided with bearing spans. The bearings are located at either end of the span of the girder. Especially if the girder is made of at least one precast concrete part, e.g. a precast reinforced concrete or prestressed concrete part, an especially true-to-form and stable production of the multispan girder is made possible. The precast reinforced-concrete part can in this case be produced in a production plant under optimal climatic conditions. Retrofitting of the precast part is also possible, so that the multispan girder can be delivered in form of a precise, finished structural component at the construction site.

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If at least one prestressing element is provided on the girder, with a position, course and prestressing force that results in a true-to-form prestressing of the multispan girder, a multispan girder is created according to the invention which maintains its form extensively even under great load. Thanks to the true-to-form prestressing of the multispan girder it is possible to avoid form changes of its cross-section due to contraction or creeping. The properly prestressed girder thereby undergoes merely a change in length and no shortening in cross-section. Thereby the multispan girder can be used to special advantage when a precise positioning of the girder also during its utilization, or of attached parts on the girder is required.

The prestressing element is preferably a bracing element. Depending on the design and the applicable needs, the prestressing elements may be bracing wires imbedded in the concrete (bracing bed prestressing), they may be connected to the girder after its being concreted, they may not be connected to the girder (prestressing without interconnection) or they may be installed externally on the girder.

The multispan concrete girder according to the invention, especially a reinforced-concrete girder, is especially well suited for the installation of a travel way of a railborne vehicle in high-speed traffic, in particular a magnetic levitation train. Thanks to their construction across several spans, the multispan girders make it possible for length changes at the joints or gaps between the different girders to be mostly unproblematic for the travel of the high-speed vehicle. Due to the low number of joints subjected to length changes a multispan girder is therefore especially well suited to carry very delicate vehicles. The multispan girder according to the invention is therefore used in particular with magnetic levitation train vehicles that must be guided with extreme precision.

Also for the arrangement of a travel way of a railborne vehicle it is especially advantageous if at least one span, preferably however several spans of the multispan girder are made of a pre-cast concrete part. If the multispan girder consists of several precast concrete parts coupled to each other, the coupling is effected in such manner that the girder acts as one single girder with respect to its expansion. This means that expansion joints to adjoining multispan girders do not exist between the different spans of a single multispan girder. For an easier transportation of the multispan girder, in particular if it is a precast concrete part, it is advantageous if the multispan girder is made of several individual precast concrete parts, as thereby the precision of dimensions of the multispan girder is especially well ensured.

If some or all the prestressing elements provided in the girder run along curved courses in vertical direction, a true-to-form prestressing of the multispan girder must be maintained. The curved courses are locally similar to a parabola or are wave-shaped, with the peaks of the curve being in the vicinity of the rest point and the low points being essentially in the center of each span. Especially if the course of at least some prestressing elements is essentially as the course of the girder moments, the true-to-form prestressing of the girder is especially advantageous.

If provisions are made for the prestressing force to be adjustable in order to provide and/or to correct the required true-to-form prestressing of the girder, the force can be adjusted in such manner if necessary, after the installation of the girder or of the prestressing elements in the girder, so that it results in an individual true-to-form prestressing of the individual girder. Even if the most important parameters of the true-to-form prestressing change in course of utilization, it can be corrected.

It is advantageous if the prestressing element is permanently interconnected with the precast concrete part by being cast into it at the same time during the manufacture of the precast concrete part. In this manner a precise course of the prestressing element can be achieved within the precast concrete part.

Furthermore the anchoring of the prestressing element within the precast concrete part is especially well maintained in this manner. It must however be possible for the prestressing element to move within the precast concrete part in the longitudinal sense so that an appropriate prestressing force may be applied to the precast concrete part.

If the prestressing element is interconnected with the precast concrete part so that it can be replaced, it can be built in especially after the manufacture of the precast concrete part or can be replaced in case of damage to the prestressing element. This replaceability ensures long use of the precast concrete part because it is especially maintenance friendly.

If the girder has at least one ridge, an especially advantageous cross-section of the girder is selected with respect to its deflection. The ridge gives the girder an essentially T-shaped cross-section so that it is eminently suited to serve as base of the travel way for high-speed vehicle traffic due to the deflection and the true-to-form prestressing of the girder. The girder can in this case be designed with a full cross-section or with a caisson cross-section. A caisson cross-section girder has especially good stability and its length changes are advantageously true to form.

If the prestressing elements are located in the ridge or ridges, this results a combination of the girder's cross-sectional form and the prestressing of the girder considered today as being optimal while its cross-sectional form is maintained during length changes.

The course of the prestressing elements is curved in vertical direction, in spots similar to a parabola or a sinus curve, or is wave-shaped. The peaks of the curve are in the vicinity of the rest point and the low points are essentially in the center of each span. Thereby a pre-bending of each span of the girder can be achieved in an advantageous manner. With a double span girder it is here especially advantageous if the curve starts essentially in a peak and reaches at least one low point within the span, showing a further peak in the vicinity of the rest point. Following this, at least one low point will be again present for the second span, and finally a last peak towards the end bearing. Thanks to this curved course of the prestressing element a curvature is achieved that is oriented in opposition to the conventional sag of the girder. The stress in the prestressing element causes it to attempt to assume a straight line and thus causes a bending of the reinforced-concrete girder in opposition to the line of the prestressing element course. In this manner a target dimension of the girder that is optimal for the operation of the vehicle is maintained by the addition of the functional parts on the reinforced-concrete girder as well as when the vehicle passes over it.

In order to achieve good bracing of the prestressing element, the two ridges of the girder are connected to a plate that is transversal to the longitudinal direction of the girder and serves as a counter-bearing at each end of the girder, preferably near each bearing rest point. This plate which serves as a counter-bearing ensures stability of the girder with respect to its torsion and in addition is a sufficient attachment of the prestressing elements as well as for the joining of hydraulic presses for the bracing of the prestressing elements.

In order to achieve especially good bracing of the prestressing elements, i.e. in order to make it possible for the prestressing element to glide against the girder, the prestressing element is installed in an jacket tube. The jacket tube is

preferably imbedded in the concrete of the ridge in form of an empty pipe. In order to achieve bracing, the prestressing element is introduced through the empty pipe and is attached at the bearing points. The jacket tube is here imbedded in a linear course within the concrete of the ridges, following the subsequent course of the prestressing elements. In order to avoid corrosion and condensation in the jacket tube, a ventilation of the jacket tube is provided at the peak.

With a span length of approximately 31 m, 4 mm pre-bending upwards per span has proven to be especially advantageous. For a magnetic levitation train actually in existence this provides a pre-bending making safe and trouble-free travel possible.

To be able to apply the hydraulic presses correctly, the ends of the prestressing element are drawn out horizontally. Thereby a large supporting surface is provided serving as a counter-bearing for the presses. Furthermore, in case of a certain overlap of several prestressing elements, this ensures that a through-going load and therefore a correct pre-bending is present in the girders.

For the support of the girder one fixed bearing and two loose bearings are provided. Alternatively it is also possible to provide three loose bearings to attach the girder on the supports, as unacceptable shifting of the long girders need not be feared because of the extremely high weight of such multispan girders.

In order to facilitate the transportation and/or the production of the multispan girder, the girder may be subdivided according to the invention and to special advantage into segments. The segments then come in a preferably integral number of fractions of the overall length of the girder. The individual segments are finally combined with each other into the multispan girder. The connection is such, in that case, that the forces and oscillations in the girder occur as in a continuous

multispan girder. In this way the advantages of the multispan girder are maintained without limiting the production and transportation possibilities any more than for conventional single-span girders.

A construction in segments whereby one segment per span of the multispan girder is provided has proven to be especially advantageous. A two-span girder for example, then consists of two segments, each of which has the length of one span.

In the segmented design it has proven to be advantageous if the prestressing elements take their courses separately per segment. Each prestressing element has its own jacket tube in that case. The prestressing element then starts at the free end of the multispan girder and reaches into the following span. It therefore reaches from one peak to the next peak. The prestressing element of the subsequent segment begins in the previous segment and takes its course through the second segment for example. If this second segment is already the last segment, and this is therefore a two-span girder, this prestressing element ends at the end of the second segment. With a multispan girder with more than two spans, the prestressing element of the second segment reaches into the third segment. Here too an overlapping of the prestressing element is produced. In the vicinity of the central bearing span or inside bearing span, an overlap of prestressing elements therefore takes place. As a result the multispan girder, although it is composed of several individual segments, acts as a multispan girder made of one piece with respect to its noise, oscillation and expansion behavior. In this way a multispan girder with all the advantages of a multispan girder is obtained in an especially advantageous manner, without its disadvantages, i.e. the transportation from the place of manufacture to the place of utilization as well as the precise positioning at the place of utilization causing problems, because

the individual segments can be handled with considerable greater ease with conventional production and transportation means.

In order to produce a multispan girder functionally in spite of the segmented construction, a joint is provided at each segment end that corresponds to another segment. This segment has special equipment and configuration to achieve a good connection with the adjoining segment.

It is especially advantageous if the joint is cast in concrete. An especially high-quality concrete especially well suited for the casting of the joint without hollows being created is used for this.

The joint is filled at least in part with foamed material. As a result the surface pressure is sufficiently high on the areas of the joint not filled with foamed material, and this makes good pre-stressing of the joint possible. The entry of water that could destroy the joint concrete is thereby reliably prevented. If the joint is produced in such manner that the two segments are placed against each other at the place of production extensively in a target state, and that the joint is poured at that location, it is especially advantageous if a separating layer is provided on the side of the joint filling material. The separating layer ensures that as the two segments are taken apart for transportation to the utilization site, the form of the joint is preserved and a fitting together of the two segments on location can take place without any problem. The separating layer separates the joint filling material from the one side of the segment. On the other hand the joint has then the shape corresponding to the end of the segment, so that a simple assembly of the segments at the building site is possible.

While the one side of the joint filling material is provided with the separating layer, it is important on the other side of the joint filling material to ensure a good contact

with the other segment. IN order to create good contact here between the segment and the joint filling material, the segment is roughened up at the joint face. As a result a very good connection between the joint filling material and the segment of the girder is obtained.

In order to achieve an even better connection between the two segments, an interlocking connection between the joint filling material and the faces of the segments is provided. For this a kind of tooth arrangement has proven to be especially advantageous. In addition to the roughening up, the joint filling material on the one face of the segment can also be provided with these teeth in order to create a good and permanent connection between the joint filling material and the segment. Of the separating layer is installed on the other side of the joint filling material, the teeth ensure a true-to-form positioning between the two segments as they are put together at the building side. Thereby the precisely measured and positioned connection of the two segments already effected at the place of manufacture is restored again by the teeth meshing between the joint filling material and the segment.

In order to achieve an interlocking connection in different directions and thus to absorb the forces acting from different directions on the different segments, teeth are provided at the front of the girder segment. In addition the positioning of the different segments in x, y and z axes is thereby determined exactly.

For a correctly positioned connection one or more guide bolts could be imbedded in the concrete at one end of a segment, in addition to the teeth of the joint. The guide bolts extend in that case slightly beyond the end of the segment and into the joint. By concreting the joint, a corresponding form is created towards the end of the guide bolt. When separating and joining against the different segments together, the guide bolt serves to position the segments exactly in the position

existing before the filling of the joint. In order to achieve especially good guidance of these guide bolts in the guide, it is advantageous to imbed a sleeve corresponding to the guide bolts into the joint. For this the sleeve is placed on the guide bolt while the joint is being filled. As the different segments are taken apart and joined together the sleeve remains in the joint filling material while the guide bolts moves out of the sleeve. By inserting the guide bolts again into the sleeves, precise positioning of the segments is achieved. It is especially advantageous if the sleeve or the corresponding end of the guide bolt is conical. Thereby the introduction of the guide bolt into the sleeve when joining the individual segments together is facilitated.

In addition or alternatively, screws and plugs can be used to join the different segments together. While the plugs are installed in one segment, the other segment is provided with a passage bore, e.g. in the plate of the girder, to receive the screws. By combining the screw with the plug, the two segments or the joint filling material are clamped together.

Alternatively or in addition, a prestressing element e.g. reaching through the two plates of the segment girders can be used instead of a screw and plug connection. At the protruding ends of the prestressing elements the latter can be fastened with nuts so that again a clamping together of the segments is achieved.

In order to allow for thermal expansion of the multispan girder, it is especially advantageous to provide a free joint towards the subsequent multispan girder. The free joint serves to compensate for the thermal expansion of the multispan girders without jamming or upsetting deformation of the different multispan girders occurring due to extreme temperature differences.

If a girder is designed in form of a caisson girder, it is especially advantageous if the caisson serves as a wire path, i.e. for the attachment of girder elements for wires. Such wires may be provided e.g. for power supply or data transmission.

For the inspection or installation of the wires within the caisson girder it is especially advantageous if the caisson girder is provided with access opening. Thereby maintenance or inspection personnel can enter the caisson girder and carry out all necessary inspections or work within.

Additional advantages of the invention are described in the following figures:

- Fig. 1 shows a one-part two-span girder
- Fig. 2 shows a two-span girder consisting of two segments
- Fig. 3 shows a section III-III from Fig. 2
- Fig. 4 shows a section IV-IV from Fig. 2
- Fig. 5 shows a connection interface between two segments
- Fig. 6 shows the face of a segment
- Fig. 7 shows a joint

In the following examples of embodiments multispan girders are described that are suitable e.g. for the installation of components suitable for magnetic levitation trains. The girders are shown as caisson girders, but could also be girders with

one single or several ridges with full cross-section. Bracing elements 5 are shown as the prestressing elements.

Fig. 1 shows a multispan girder 1. This is a girder bridging two spans, i.e. a two-span girder. The girder 1 has three bearing spans 2.1, 2.2, 2.3 supporting the girder on supports that are not shown here. The girder 1 is a reinforced-concrete part with two hollow spaces 3. If sufficient strength exists, the separation between the two hollow spaces 3 near bearing span 2.2 can also be omitted. Each hollow space 3 is provided with an access hole 4 for the inspection of the hollow space 3. The access hole 4 is large enough to enable a maintenance worker to enter the hollow space 3 and to carry out inspection of the structural condition of the girder 1.

Inside the girder 1 a wave-shaped bracing element 5 in the form of a sinus curve and in places in form of a parabola is installed. In the areas of each of the bearing spans 2.1, 2.2, 2.3 the bracing element 5 has a peak in its linear extension. The low points of the curve are approximately in the center of each span. The bracing element 5 is attached at the end of the girder 1. In this case plates 8 act as counter-bearings so that the bracing element 5 may be sufficiently braced. The bracing of the bracing element 5 causes a prestressing of the girder 1 so that a flexion of the girder 1 takes place in the opposite sense of the course of the curve. This means that the girder 1 flexes upward between the bearing spans 2.1 and 2.2 as well as between the bearing spans 2.2 and 2.3, as required or in function of the stress of the bracing element. The advantageous result is that the girder 1 can be brought to a given target dimension due to its own weight as well as due to the weight applied by added components located on a flange 6 of the girder 1. Due to this prestressing of the girder 1 extremely long bearing distances of the girder 1 are achieved. Thus it is possible with such a design of the girder 1 according to the invention to obtain bearing distances of more than 30 meters between the

bearing spans 2.1 and 2.2 or 2.2 and 2.3 without disturbing the high-speed trains such as magnetic levitation trains in their operation. This ensures most economic construction of the travel way in addition to extremely favorable travel comfort for the high-speed vehicle.

Thanks to the arrangement shown of the prestressing elements in the girder 1 a true-to-form prestressing of the precast concrete art in form of a multispan girder can be achieved. In this case the cross-sectional form of the girder 1 is not changed by a change in length of the girder 1 in the course of time, so that any warping of the girder 1 is avoided.

The bracing element 5 is attached in the plate 8. By applying conventional hydraulic presses (not shown), the bracing element 5 is stressed and is anchored in the plate 8 which serves as a counter-bearing for the bracing element 5. As a result permanent prestressing of the bracing element 5 is achieved.

To avoid corrosion of the bracing element 5 a ventilation opening 9 is provided near the peak at the bearing span 2.2. Thereby it is possible to remove the condensation moisture deposited in the area of the bracing element 5 or, if the bracing element 5 is placed in an empty pipe, in the empty pipe, so that the need for inspection and maintenance is reduced.

Fig. 2 also shows a lateral view of a two-span girder 1 consisting of two segments 10.1 and 10.2, contrary to the embodiment shown in Fig. 1. The segment 10.1 is supported with bearing spans 2.1 and 2.2 on supports that are not shown. The bearing span 2.2 is divided in two, with one part of the bearing span 2.2 assigned to the girder 10.1 and the other part to the girder segment 10.2. The girder segments 10.1 and 10.2 as well as the bearing span 2.2 are connected to each other by means of a joint 12. The joint 12 shall be described in greater detail

further below. Each one of the girder segments 10.1 and 10.2 has a hollow space 3 that is closed in part by a plate 8 or 8.1 or 8.2. Each girder element may be provided with an access hole 4 as shown in Fig. 1, to perform maintenance and assembly work inside the hollow space 3.

The bracing element is subdivided also into two segments, i.e. the bracing elements 5.1 and 5.2. The bracing elements 5.1 and 5.2 overlap each other in the vicinity of the central bearing span 2.2 inside the plates 8.1 and 8.2. Each one of the bracing elements 5.1 and 5.2 has its peak in the plate 8 or 8.1 and 8.2. The lowest point is approximately in the center of the girder segment 10.1 or 10.2. Each of the bracing elements 5.1 and 5.2 is attached in the area of the plates 8 or 8.1 or 8.2 and is stressed by means of the not shown hydraulic presses. As a result prestressing of the segments 10.1 or 10.2 results. Due to the overlapping of the bracing elements 5.1 and 5.2 near the bearing span 2.2, a very strong connection is obtained between the girder segments 10.1 and 10.2. Oscillation, flexion and noise behavior is here similar to that of a one-part multispan girder 1. The bracing element 5.2 is anchored from the hollow space 3 of the girder segment 10.2. The bracing element 5.1 is anchored from the hollow space 3 of the girder segment 10.1. Thereby a very strong connection is established between the girder segments 10.1 and 10.2. In addition, the joint 12 is also influenced by means of several bracing elements 13 located in the bearing spans 2.2 as well as in areas of the plates 8.1 and 8.2 that are not shown. The bracing elements 13, in addition to the bracing elements 5.1 and 5.2 press the segments 10.1 and 10.2 towards the joint 12 together and thus produce a solidly connected multispan girder 1.

Fig. 3 shows a section III-III from Fig. 2. The girder segment 10.1 is accordingly a hollow profile with upper and lower flanges 6 as well as with lateral ridges 7. For better load acceptance the cross-section is given an essentially trapezoid

configuration. The upper flange 6 is provided with arms extending away from the profile that are used to attach consoles 33 and or built-on components for the guidance of a magnetic levitation train. A wire path 25 is provided inside the hollow space 3. Supply wires for the transmission of current or data or other wires are installed in the conduit path 25. The conduit path 25 can of course also be installed in other areas of the hollow space 3 that facilitate in particular maintenance work in the hollow space 3.

In the lower area of the ridge 7 a jacket tube 14 is imbedded in the concrete. The bracing elements 5.2 or 5.4 extend inside the jacket tube 14. The bracing elements 5.2 or 5.4 are inserted into the jacket tube 14 after the completion of the girder segment 10.1 and are brought to a required prestressed condition after the assembly with the other segment or in case of a one-part multispan girder upon its completion. The jacket tube 14 is then imbedded in the concrete of the girder 10.1 in a position corresponding to the path of the bracing element 5 in order to ensure prestressing of the girder 10.1.

Fig. 4 shows a section IV-IV from Fig. 2. It shows a section through the girder segment 10.1 immediately before the bearing span 2.2. The jacket tube 14 or the bracing elements 5.2 and 5.4 are in this case close to the peak of their curve. The start of the overlapping of the bracing elements 5.1 and 5.2 or 5.3 and 5.4 can also be seen. While the elements 5.2 or 5.4 still extend in the area of the ridge 7, the bracing elements 5.1 and 5.3 are warped out laterally. bracing elements 5.1 and 5.3. This lateral pull of the makes the overlapping with the bracing elements 5.2 and 5.4 becomes possible. Furthermore the application of fastening elements and hydraulic presses for the stressing of the bracing elements 5.1 and 5.3 is made possible. The counter-bearing of the bracing elements 5.1 and 5.3 is located in the area of the plate 8.1 and thereby bears reliably upon the girder segment 10.1. Within the plate 8.1 as well as in the bearing spans 2.2 are bracing

elements 13. The bracing elements 13 are threaded rods that firmly connect the halves of the bearing span 2.2 and the plate 8.1 and the plate 8.2 which is not shown to each other and thereby press the segments 10.1 and 10.2 against the flange (not shown). The bracing elements 13 are only indicated here. They can of course be located at other or additional locations within the cross-section.

Fig. 5 shows a sketch of a longitudinal section in top view of the central bearing span 2.2. The girder segments 10.1 and 10.2 are firmly connected to each other in the area of this central bearing span 2.2. The connection is made by means of the bracing elements 13 that extend through the bearing span halves 2.2 through a joint 12 as well as through the plates 8.1 and 8.2 into the hollow space 3. The bracing elements 13 are preferably threaded rods with nuts which put tension on the joint 12 by bracing the girder segments 10.1 and 10.2. The bracing elements 5.1 to 5.4 extend in the ridges 7 or in the plates 8.1 and 8.2. The ends of the bracing elements 5.1 to 5.4 are warped out horizontally in the direction of the hollow space 3. Thereby an overlapping of the bracing elements 5.1 to 5.4 is achieved and makes in addition the bracing of the respective bracing elements possible since the ends of the bracing elements 5.1 to 5.4 end in the hollow space 3.

In order to obtain good surface pressing in the area of the joint 12, part of the stope faces of the girder segments 10.1 and 10.2 are provided with elastic inserts 15. The elastic insert causes the surfaces of the ends of the girder segments 10.1 and 10.2 instrumental in pressing together the girder segments 10.1 and 10.2 to be reduced. As a result a high surface pressure exerted by the bracing elements 13 as well as by the bracing elements 5.1 to 5.4 at the joint 12 is achieved and ensures permanent and trouble-free interconnection of the girder segments 10.1 and 10.2, while in addition maintaining the positive properties of one-piece

construction of a multispan girder in spite of the segmented construction method used.

Fig. 6 shows a view of a face of the girder segment 10.1. Part of the face is provided with the elastic insert 15 in order to reduce the surface of the face active in the pressing the segments together. In order to combine the girder segment 10.1 with the girder segment 10.2 which is not shown, several bracing elements 13 are provided. Jacket tubes 14 in which the bracing elements 5 extend are imbedded in the ridges 7. A plurality of teeth 18 are distributed over the entire cross-section of the face. The teeth engage the joint 12 (not shown) and thus achieve shift-proof and precise positioning of the girder segments 10.1 and 10.2 with respect to each other. The teeth 18 are here oriented in different directions in order to absorb forces in all lateral directions of the girder.

The bearing span 2.2 is seated on two bearings 19 that are attached to a support.30. The bearing 19 is made in such manner that concrete is injected through injection hoses 20 located in the bearing span 2.2 into a casing (not shown) and fills out the casing. Once the concrete has hardened, the casing is removed so that the bearing 19 is produced. During casting and until the concrete is cured, the girder segment 10.1 is supported temporarily on hydraulic presses on the support 30. In this way the bearing 19 can be extensively precast and merely a compensation layer can be added as required for the exact alignment of the girder segment 10.1. Other production methods such as are used in bridge construction can also be used..

Fig. 7 is a detailed sectional view of a joint 12. The girder segments 10.1 and 10.2 abut on joint 12. To be able to separate the girder segments 10.1 and 10.2 from each other again after making the joint 12, one face of the girder segments 10.1 or 10.2 is roughened up. As a result the joint 12, which is made of an especially

high-quality concrete, is firmly connected to the face of the corresponding girder segments 10.1 and 10.2. The opposite face of the girder segments 10.2 or 10.1 is provided with a release agent so that the concrete of the joint 12 does not combine with the face of the corresponding girder segments 10.2 or 10.1. Once the concrete of the joint 12 is set, the girder segments 10.1 and 10.2 can thus be separated again from each other while the concrete of the joint 12 adheres to the face that was previously roughened up. Thanks to the teeth 18 provided in both faces, a strong connection between the concrete of the joint 12 and the face of the girder segments 10.1 or 10.2 is obtained on the one hand. On the other hand, a true-to-form fitting together is ensured when the girder segments 10.1 and 10.2 are joined together once more. Furthermore an interlocking connection of the girder segments 10.1 and 10.2 is obtained in this manner, capable of absorbing certain forces that act laterally on the girder segments 10.1 and 10.2.

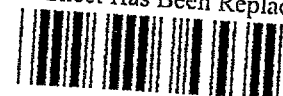
An additional positioning aide and reinforced concrete of the connection of the girder segments 10.1 and 10.2 with each other is achieved by means of a guide bolt 21. The guide bolt 21 is imbedded in the concrete of the girder segment 10.1 and protrudes with its conical end into the joint 12. Before concreting the joint 12, a corresponding sleeve 22 is placed on the conical end of the guide bolt 21 and is imbedded in the concrete of the joint 12. When the girder segments 10.1 and 10.2 are separated from each other, the sleeve 22 is pulled off the conical end of the guide bolt 21. To join the girder segments 10.1 and 10.2 the conical end of the guide bolt 21 is again introduced into the sleeve 22, so that positioning of the girder segments 10.1 and 10.2 relative to each other is restored as it was during the casting of the joint 12.

Instead of or in addition to the guide bolts 21 and the sleeve 22, as well as the teeth 18, screw connections with plugs can be inserted. For this screws or threaded rods are provided in one girder segment while corresponding plugs are imbedded in the other girder segment. Proper pressing together or interlocking can also be achieved in this way.

The present invention is not limited to the shown examples of embodiments. In particular, several spans can be combined with each other by using the shown segment construction method. Also in the one-part configuration of the invention the guiding of the bracing element can be arranged as required in order to achieve suitable prestressing. The arrangement of the bracing elements 5 in particular, although considered especially advantageous at this time, need not necessarily be located in the ridges of the hollow girder profile. While in case of a one-piece design the prestressing of the construction component can take place immediately after manufacture or during the manufacture of the girder, or only at the building site after setting it down on the appropriate supports, it is a particularity of the multi-part construction method that the bracing of the individual girder segments takes place after positioning them on the supports.

Of course other embodiments than those shown here are covered by the invention. In particular combinations of the individual embodiments is possible. For example, several one-part two-span girders can be combined into a multispan girder by using the interconnection of the different segments according to the invention. Thus for example, a four-span girder is created from two one-part two-span girders. Furthermore it is possible, through appropriate configuration and casting of the joint, to create a connection that cannot be separated without destroying the joint connection. In this way the multispan girder is produced without the

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possibility of disassembling and reassembling it. This is sufficient in some cases. In addition to the kind of pre-bracing described in the embodiment examples, prestressing with or without interconnection, an external prestressing or a combination thereof can be realized.

CLAIMS

1. Multispan girder consisting of concrete, especially reinforced concrete or prestressed concrete, whereby the multispan girder (1) is provided with bearing spans located on either end of a span of the girder (1), characterized in that the girder (1) is made in particular of at least one precast concrete part, and in that at least one prestressing element is provided on the girder (1) whose position, course and/or prestressing force results in a true-to-form prestressing of the multispan girder (1).
2. Multispan girder consisting of concrete, especially reinforced concrete or prestressed concrete, whereby the multispan girder (1) is provided with bearing spans located on either end of a span of the girder (1), in particular as in claim 1, characterized in that the multispan girder (1) is provided for the installation of a travel way of a railborne vehicle for high-speed transportation, in particular a magnetic levitation train.
3. Multispan girder as in one of the preceding claims, characterized in that in that the prestressing element is a bracing element (5)
4. Multispan girder as in one of the preceding claims, characterized in that the prestressing element consists of bracing wires under tension imbedded in the concrete (bracing bed prestressing).
5. Multispan girder as in one of the preceding claims, characterized in that the prestressing element is connected to the girder (1) after the casting of the girder (1).

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6. Multispan girder as in one of the preceding claims, characterized in that the prestressing element is not combined with the girder (1) (prestressing without combination)
7. Multispan girder as in one of the preceding claims, characterized in that the prestressing element is installed outside the girder (1).
8. Multispan girder as in one of the preceding claims, characterized in that at least one span, preferably several spans of the multispan girder (1) are made of a concrete, in particular reinforced concrete or precast prestressed concrete part.
9. Multispan girder as in one of the preceding claims, characterized in that individual or all prestressing elements (5) installed in the girder (1) take curved courses in vertical direction, in places similar to a parabola, and with peaks in the area of the bearing spans (2), their low point being essentially in the center of each span.
10. Multispan girder as in one of the preceding claims characterized in that the prestressing element (5) follows a straight and/or curved course in the girder (1).
11. Multispan girder as in one of the preceding claims characterized in that the course taken by at least some of the prestressing elements (5) is essentially the same as the course of the moments of the girder 1.
12. Multispan girder as in one of the preceding claims characterized in that the prestressing force for the creation or the correction of the true-to-form prestressing of the girder 1 is adjustable.

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13. Multispan girder as in one of the preceding claims characterized in that the prestressing element (5) is intimately combined with the precast concrete part by being imbedded when the precast concrete part is being made.
14. Multispan girder as in one of the preceding claims characterized in that the prestressing element (5) is connected to the precast concrete part in such manner as to be replaceable and in that it is installed in particular after completion of the precast concrete part.
15. Multispan girder as in one of the preceding claims characterized in that the bearing span (2) rests on supports (30).
16. Multispan girder as in one of the preceding claims characterized in that the girder 1 is provided with at least one ridge (7).
17. Multispan girder as in one of the preceding claims characterized in that the girder 1 is a girder with full cross-section.
18. Multispan girder as in one of the preceding claims characterized in that the girder 1 is a caisson girder.
19. Multispan girder as in one of the preceding claims characterized in that the prestressing elements (5) are installed in the ridge or ridges (7).
20. Multispan girder as in one of the preceding claims characterized in that the ridges (7) are connected to a plate (8) provided at a right angle to the longitudinal orientation of the girder 1 at least at the ends of the girder 1, preferably near each bearing span (2).

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21. Multispan girder as in one of the preceding claims characterized in that the prestressing elements (5) are supported in the plate (8) to brace the girder 1.
22. Multispan girder as in one of the preceding claims characterized in that the prestressing element (5) is installed in a jacket tube (14).
23. Multispan girder as in one of the preceding claims characterized in that the jacket tube (14) is ventilated at the peak.
24. characterized in that each span of the girder 1 is pre-bent.
25. Multispan girder as in one of the preceding claims characterized in that the pre-bent curve fore each span bends upward by about 4 mm for a span length of 31 meters.
26. Multispan girder as in one of the preceding claims characterized in that the ends of the prestressing element (5) are warped out horizontally.
27. Multispan girder as in one of the preceding claims characterized in that the girder 1 is supported in one fixed bearing and/or in two or three loose bearings.
28. Multispan girder as in one of the preceding claims characterized in that the multispan girder (1) is subdivided into segments (10)
29. Multispan girder as in one of the preceding claims characterized in that one segment (10) is provided per field of the multispan girder (1).



30. Multispan girder as in one of the preceding claims characterized in that if the girder (1) is made in segments, the prestressing elements (5) are provided separately for each segment (10)
31. Multispan girder as in one of the preceding claims characterized in that the prestressing elements (5) overlap in proximity of the central bearing span (2.2).
32. Multispan girder as in one of the preceding claims characterized in that a joint (12) is provided at the end of the segment.
33. Multispan girder as in one of the preceding claims characterized in that that the joint (12) is made in concrete.
34. Multispan girder as in one of the preceding claims characterized in that the joint (12) is provided with an elastic insert (15) .
35. Multispan girder as in one of the preceding claims characterized in that a release agent layer is applied to one segment end near the joint (12).
36. Multispan girder as in one of the preceding claims characterized in that one segment end near the joint (12) at the central bearing span (2.2) is roughened up for better contact with the joint filling material.
37. Multispan girder as in one of the preceding claims characterized in that teeth (18) are provided at the end of the segment (10) near the central bearing span (2.2).

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38. Multispan girder as in one of the preceding claims characterized in that the teeth (18) take effect in different directions.
39. Multispan girder as in one of the preceding claims characterized in that a guide bolt (21) is imbedded in the concrete in one end of a segment (10).
40. Multispan girder as in one of the preceding claims characterized in that a conical sleeve (22) is imbedded in the concrete in the joint (12).
41. Multispan girder as in one of the preceding claims characterized in that the connection between the segments (10) is effected by means of screws and plugs.
42. Multispan girder as in one of the preceding claims characterized in that the connection between the segments (10) is effected by means of a bracing element (13)
43. Multispan girder as in one of the preceding claims characterized in that a free joint is provided to the next multispan girder (1) of the travel way.
44. Multispan girder as in one of the preceding claims characterized in that a wire path (25) is provided in the caisson girder (1)
45. Multispan girder as in one of the preceding claims characterized in that an access opening (4) into the hollow space (3) is provided on the girder (1).

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