

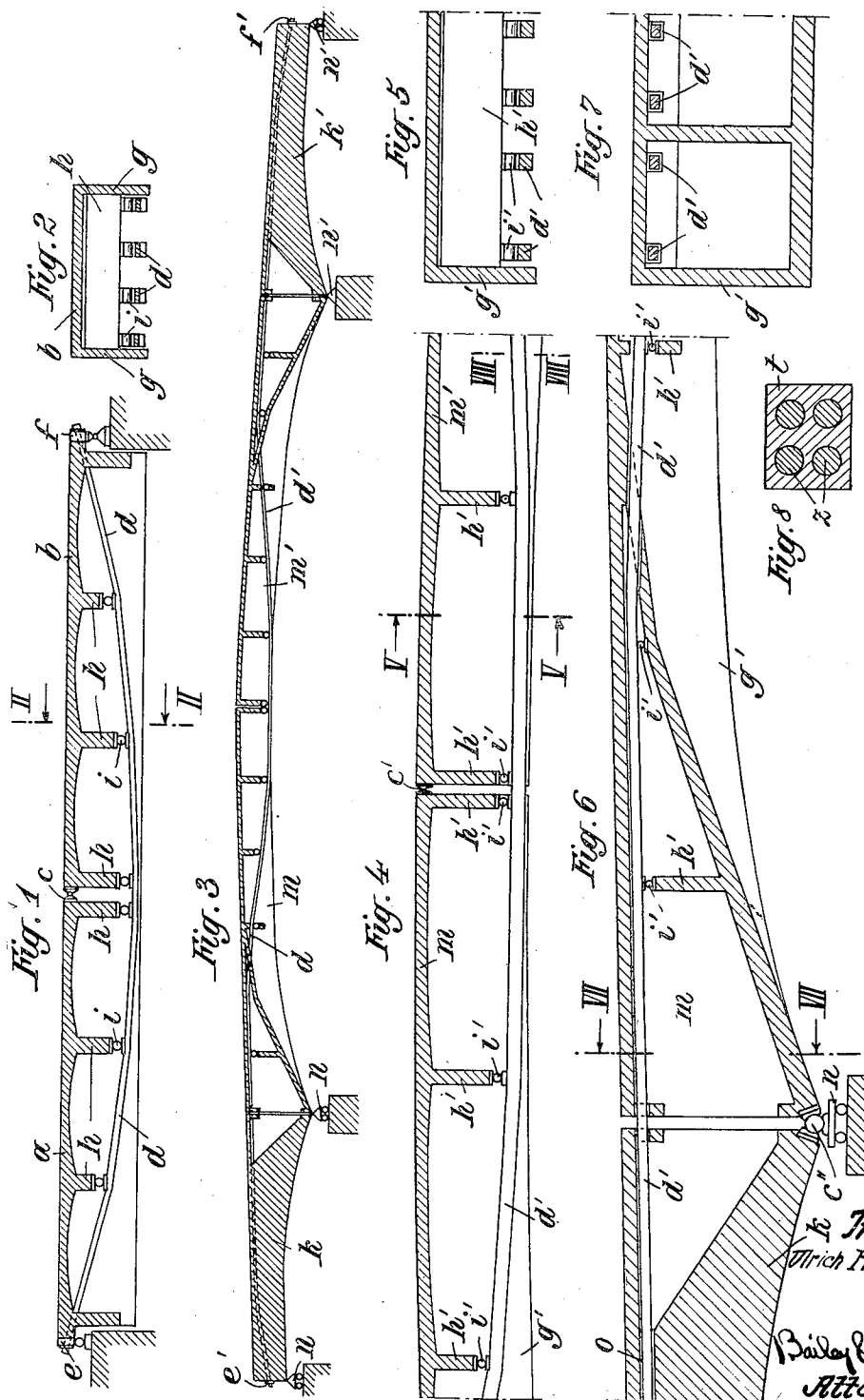
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U. FINSTERWALDER

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FERRO-CONCRETE BEAM

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Inventor:
Ulrich Finsterwalder
Bailey & Carson
Attorneys

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FERRO-CONCRETE BEAM

Ulrich Finsterwalder, Berlin-Wilmersdorf,
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The use of ferro-concrete beams for structures of wide-span, especially for bridges, is limited as regards width of span. The structure is generally manufactured as a plate beam with depending longitudinal webs spaced about 3 metres apart. For manufacturing reasons the webs have a minimum breadth of about 25 centimetres, while the thickness of the plate is determined by the loading.

With increasing width of span of the beam and constant relation of the depth of the structure to the span-width the bending stress increases and thus the quantity of iron necessary with uniform weight per metre of the structure increases linearly. Even with very small span widths of about 13 metres the web-breadth of 25 centimetres no longer suffices for the disposal of the necessary tension irons. Therefore the webs must be broadened, whereby the weight of the structure, calculated on the area of surface, is substantially increased, so that with a freely supported beam the limit is reached with a span width of about 25 metres.

Entirely aside therefrom, in known constructions, even with span widths below those given, the consumption of material is very great, resulting in high cost of production and low efficiency.

According to the invention, which eliminates the aforesaid drawbacks, the beam is formed of jointed concrete sections which have none of the usual reinforcing rods passing therethrough and are connected by an external tension bar which replaces the internal reinforcing rods. The beam is subdivided preferably at the mid-point, and comprises two similar jointed sections.

It is particularly advantageous to support the tension bar on roller bearings arranged at the lower ends of integral cross-ribs which depend from the concrete sections so that the stresses in the tension bar and in the concrete are substantially independent of alterations of form of these structural members.

Hereby without any pre-stressing of the tension bar and irrespective of alteration of form of the concrete there is obtained a constantly uniform tensile condition in the bar and in the beam. By suitable choice of the level of the tension bar the tensile condition can be controlled at will. It is thus possible, for example, so to choose the level of the deflecting points for the tension bar, that balanced marginal stresses are set up in the ferro-concrete beam under the most unfavourable loading conditions.

With the invention further advantages are realised.

In contrast with other constructions, with the invention the depth of the structure available at the mid-point can be fully utilised. Above all, it is possible by the invention, with the concrete stresses permissible today, with the aid of freely supported bridge beams with structural depth, to span up to 70 metres, and with girder beams to span up to 120 metres. The structures provided can also be manufactured economically as their weight per square metre is only slightly greater than that of bridges of smaller width of span.

Two embodiments of the invention are illustrated in the accompanying drawing.

Fig. 1 is a longitudinal section of a freely supported ferro-concrete beam according to the invention.

Fig. 2 is a cross-section on the line I—I of Fig. 1.

Fig. 3 shows in longitudinal section a second embodiment of the invention in the form of a ferro-concrete bridge structure incorporating four concrete sections.

Fig. 4 shows also in longitudinal section but to a larger scale than Fig. 3 the middle section of the structure shown in Fig. 3.

Fig. 5 is a transverse section on the line V—V of Fig. 4.

Fig. 6 reproduces to a larger scale a fragment of the structure according to Fig. 3.

Fig. 7 is a transverse section on the line I—I of Fig. 6.

Fig. 8 shows in section a tension bar sheathed in ferro-concrete.

As appears from Fig. 1, the beam comprises two sections *a* and *b*, which are articulated to one another by means of a joint designated *c*.

The joint may be devised in different ways, following known teachings. In certain circumstances the simple severance of the beam and the interposition of lead interlays in the gap is sufficient.

The subdivision of the beam is effected, in this embodiment, at the mid-point. If required, it may be effected at another point.

For joining the beam sections there serves also a tension bar *d*, hereinafter particularly described, which is anchored at one end in the beam section *a* and at the other end in the beam section *b*.

The beam sections *a* and *b* comprise a continuous upper compression plate with depending longitudinal webs *g* and transverse ribs *h*. The

compression plate is arched on its under face between successive transverse ribs *h*.

In the embodiment illustrated the tension bar *d* is led from the anchorage points over the lower ends of the several transverse ribs *h*, but the invention is not confined to the course of the tension bars represented in this example.

The transverse ribs *h* form deflecting points for the tension bar *d* and are provided at their lower ends with roller bearings *i* over which the tension bar is led. The roller bearings are equipped in usual manner with horizontal races and are also vertically adjustable.

The rollers need not be vertically adjustable at all the deflecting points. The arrangement may be such that only selected rollers are adjustable in vertical direction. In certain circumstances also vertical adjustment may be dispensed with, especially if the tension bar *d* is adapted for after-adjustment at the anchorage points *e, f*.

As will be apparent, the bending moment of the beam at the mid-point is taken up by the compression stress at the joint *c* and the tensile stress in the tension bar *d*.

In consequence of the rollers *i* being mounted for horizontal movement, the horizontal stress in the tension bar *d* is constant throughout. Thus, at any point of the beam, from the moment and from the known horizontal stress of the tension bar the leverage of the internal stresses can be determined, and by choice of the level of the deflecting points the level of the compression stress acting on the ferro-concrete beam can be freely chosen.

With unilateral loads the amount and the level of the compression stress are altered to a small extent. It is a matter of practical design, having regard to the circumstances of the particular case, so to fix the level of the deflecting points that with the most unfavourable loading conditions marginal stresses balanced as far as possible may be obtained. Depression due to plastic deformations of the beam does not occasion stresses, as the leverage of the tension bar in the beam and the leverage of the internal stresses are not altered. In case for any reason the beam is lifted too high or sags, it is immediately possible to effect a correction, for example by adjusting the level of the deflecting points. The tension bars *d* consist either of normal iron of suitable cross-section or of composite iron construction.

It is, however, desirable to form the tension bars of ferro-concrete, so that they may be well protected against the influences of the weather.

In the embodiments according to Figs. 1 to 7 it is assumed that the tension bars are formed of round iron sheathed with concrete.

In the example shown in section in Fig. 8, the tension bar consists of four round iron rods *z* enveloped by a sheath *t* of concrete of rectangular form and section.

The concrete sheath *t* is preferably formed after the erection of the bridge, in order to avoid the setting up of tension stresses in the concrete. Thus, before the sheathing of the bars a load may be applied to the bridge to the extent of the traffic load to be expected, and the tension bars sheathed with concrete under the conditions thus set up. This method offers the advantage that the concrete of the ferro-concrete tension bar is normally under compression, whereby elastic deformations of the tension bar are reduced.

In the embodiment according to Figs. 3 to 7 the ferro-concrete beam consists of four concrete sec-

tions, namely, two similar outer sections *k, k'* which are separated by gaps from the adjacent inner sections *m, m'*. The two inner sections *m, m'* are in turn separated from one another by a gap shown in Fig. 4 and connected by a joint *c'*. The formation of the junction of the inner and outer sections *k, m* and *k', m'* is shown in Fig. 6. Also in this case a gap is interposed between the adjacent concrete sections and an articulated joint is provided. In this case, however, the joint is located on the underside of the sections. As appears from Fig. 3 three supports indicated at *n* are formed as roller bearings and that indicated at *n'* as a tilting bearing.

The round iron rods indicated at *d'* extend in this embodiment of the invention in a continuous course from the anchorage point *d'* on the left-hand outer section *k* to the anchorage point *f'* on the right-hand outer section *k'*. In both outer sections *k, k'* the tension bars are guided in suitable channels. In the region of the inner sections *m, m'* they run over rollers *i, i'* as in the embodiment of Fig. 1, the said rollers *i, i'* being disposed at the lower ends of the transverse ribs *h'*.

In other respects the construction of the inner sections *m, m'* is similar to that of the beam sections *a* and *b* in Fig. 1. Also the inner sections *m, m'* each comprise a continuous upper compression plate with depending longitudinal webs *g* and transverse ribs *h'*.

In the last described construction static determinativeness of the system is obtained, so that both the tensile stress in the tension bar and also the compression stress at the joint can be calculated without regard to alterations of form. The cross-sectional formation of the ferro-concrete beam altered as compared with the freely supported beam of Fig. 1 at the junction points according to Figs. 3 to 7 results from the stressing of the structure by negative moments.

In both embodiments the axes of the ferro-concrete beam and of the tension bar are at such an angle to one another that the actual transverse stress is substantially taken up. Thereby thrust stresses in the ferro-concrete beam are almost entirely avoided. Also tensile stresses in the concrete due to bending and to thrust are entirely or almost entirely avoided.

With regard to the form of the joint, the invention is not restricted to the arrangement of corporeal joints in the narrow sense. In certain circumstances, besides the forms described, also weakening of the cross-section at a determined point of the beam or crossed reinforcing irons or other means will suffice for forming in the beam a part which for the purposes of the invention will act practically like a joint.

I claim:—

1. A ferro-concrete beam comprising a compression plate formed by a pair of elongated members in end-to-end relationship, said members being adapted and arranged to be supported substantially at their outside ends, a plurality of transverse ribs attached beneath said members, said members and ribs being concrete, roller bearings on the lower ends of said transverse ribs, and an iron tension band engaged beneath said bearings, the ends of said bar being anchored in said members substantially at the outside ends thereof.

2. A ferro-concrete beam as claimed in claim 1, and extensible means between said roller bearings and the lower ends of said trans-

verse ribs, and means for adjusting the length of said extension means.

3. A ferro-concrete beam as claimed in claim 1, and means for adjusting the length of said bar.

4. A ferro-concrete beam as claimed in claim 1, and extensible means between said roller bearings and the lower ends of said transverse ribs, and means for adjusting the length of said extension means, and means for adjusting the length of said bar.

5. A ferro-concrete beam, comprising a compression plate formed by a pair of elongated concrete members hinged together at their inner ends each of said members having at least one downwardly extending portion, and at least one tension band, the ends of said band being secured to said members substantially at the outside ends thereof, respectively, said band being engaged beneath said downwardly extending portions.

6. A ferro-concrete beam, comprising a compression plate formed by a pair of elongated concrete members hinged together at their inner ends, each of said members having a plurality of downwardly extending portions, the portion nearest the inside end on each member

being substantially longer than at least one of the other portions on each of said members, and at least one tension band, the ends of said band being secured to said members substantially at the outside ends thereof, respectively, said band being engaged beneath said portions.

7. A ferro-concrete beam as claimed in claim 5, and pivoted supports for said members at their outside ends.

8. A ferro-concrete beam, comprising concrete sections joined in end to end relation, and devoid of internal reinforcing rods passing through said sections, and at least one tension band disposing externally of and connecting said sections and extending lengthwise of the beam, said sections being formed with integral cross-ribs depending therefrom, roller bearings at the free ends of said cross-ribs, said tension band being engaged with said roller bearings.

9. A ferro-concrete beam as claimed in claim 5, the axis of said tension band extending at an inclination to the axes of the concrete members.

10. A ferro-concrete beam as claimed in claim 5, said members being arched on the underside.

ULRICH FINSTERWALDER.