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PROCESS OF MANUFACTURING COMPOSITE AND PRESTRESSED STEEL-CONCRETE BEAMS

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Fig. 1

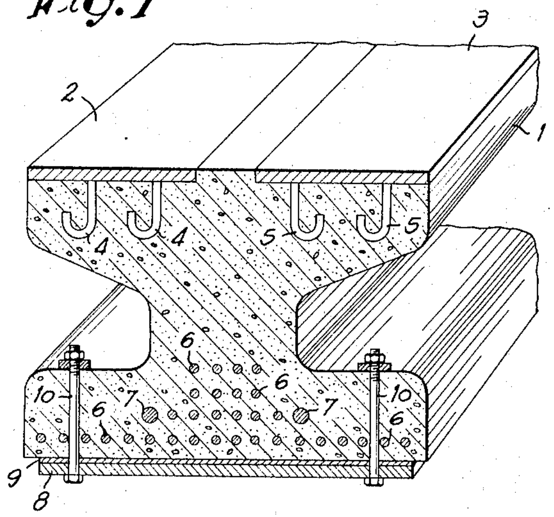
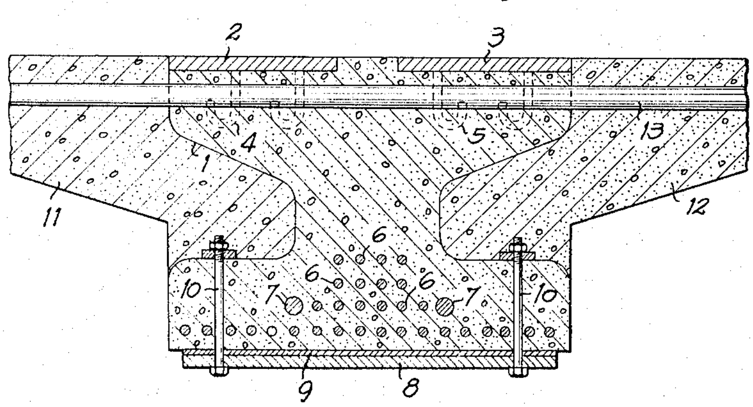


Fig. 2



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PROCESS OF MANUFACTURING COMPOSITE AND PRESTRESSED STEEL-CONCRETE BEAMS

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ABSTRACT OF THE DISCLOSURE

A composite steel-concrete beam has a zone adapted to be subjected to a compressive stress, and another zone adapted to be subjected to a tensive stress. The process of making the beam includes subjecting it to one prestress by means of wires located in the second-mentioned zone, then attaching metal flats, whereby at least one flat is attached by bolts of high tensile strength, applying a layer of mortar between this flat and the underlying flange and then subjecting the beam to another prestress by means of wires located in the second-mentioned zone.

In the erection of buildings and bridges, cases are sometimes encountered in which, over a considerable span of the construction, the height of the beam must be reduced to a minimum.

Armoured and prestressed concrete elements cannot solve this problem, on account of the fact that their l/h ratio (in which l and h are respectively the span and the height of the beam) is limited. An object of the present invention is the provision of a beam which will make it possible to reach limiting values of l/h of the order of twice as much as is possible with prestressed concrete, under the same conditions.

In the appended drawing, FIGURE 1 is a cross section, partially in perspective, of a beam of the present invention.

FIGURE 2 is a section through a similar beam provided with additional elements.

For this purpose, the process for making such beam substantially consists in starting with a prefabricated concrete beam **1** (FIG. 1) which may comprise in its zone intended to be compressed by outside stresses, at least one unstressed metal element; in applying to this beam a first prestress by means of wires **6**; in fastening to the beam in question, in the zone thereof intended for being subjected to outside tensile stresses, at least one nonstressed element **8** by means of fastening elements **10** of high tensile strength and in inserting, between the metal and the concrete, a layer of mortar **9** and, finally, in applying onto the composite material which has thus been realized by means of wires **7**, a second prestress.

In one form of embodiment of the present invention, the composite and prestressed steel-concrete beam consists of a prefabricated concrete beam **1** onto which is fastened a nonstressed metal flat **8** on the side where the flange will be compressed by outside stresses. This flat may be fastened to the hard concrete by means of bolts **10** of high elastic limit and by inserting a layer **9** of cement-mortar or other material between the metal flat and the concrete flange. These bolts must be able to withstand the skimming stresses existing between the metal flat and the remainder of the section (the skimming or grazing stress being the effort which tends to separate the concrete from the steel). On the other hand, these bolts must prevent buckling of the flat in the zone where the latter is strongly compressed; it is for this reason, although the skimming effort may be negligible at this point, that the bolts must, after all, not be spaced too far apart.

The bolts of high elastic limit subject the contact surface between the steel and the concrete to a prestress which provides the connection by friction. The presence of the layer of cement-mortar provides a coefficient of friction which is considerably higher than that which would be obtained without this layer of mortar.

The flat can also be attached to the concrete flange by means of studs fastened into said metal flat. These studs should be provided with a head or hook in order to ensure a mutual grip between the flat and the concrete.

These studs must also withstand the skimming or grazing stresses and avoid buckling of the metal flat under compression. The latter must be placed on the concrete flange immediately after the flange has been cast, in order that the studs should readily penetrate into the concrete.

There is a third system for fastening this metal flat. The latter is then replaced by two or several parts into which the studs are fastened, and they are placed on the shuttering in order that the concrete might be cast between the various flats. This process also has the further advantage of making it possible to tie some prestressing cables between two or several flats.

It may be possible to replace aforesaid metal flats by heavy nonstressed bars embedded into the concrete flange, but in most cases there will hardly be enough space for lodging the number of bars which would be required to replace an outside flat.

The first prestress is applied by the wires **6**, either to the concrete only, when the metal flat is fastened by means of studs of high tensile strength, or on the compound section formed by the concrete section and the steel section fastened to the flange which is to be compressed by outside stresses. The nonstressed metal flat is then fastened to the concrete flange which will be drawn by action of the outside stresses by means of bolts **10** of high tensile strength, by a layer of cement-mortar inserted between this flat and the concrete flange, or by other means which will make it possible to carry out this system of connection with or without mortar layer. These bolts **10** must only withstand the skimming effort existing between the flat and the remainder of the section, considering that in this case the metal flat is being drawn. Any suitable means may be used for inserting the bolts **10** in the manner shown in FIG. 1.

The second prestress is then applied on the complete section with upper and lower flats by wires **7**.

After the first prestress, the concrete flange which will be drawn under the effect of outside stresses is strongly compressed. After the fastening of the flat, the loss of stress in the concrete by creep is recovered in the steel, which fact is quite important, considering that this flat will subsequently be subjected to heavy tensile stresses.

The beam is ready; it has either protruding bars for the upper slab, or holes through which prestressing cables can be passed for the latter.

Compared to concrete beams which are merely prestressed, this beam offers an additional safety against the formation of cracks, on account of the presence of the drawn metal flat. Under the action of creep, there will be no increase of stress therein. In fact, at this point, the concrete is only very weakly stressed and there is no need to seek release on the steel.

On the other hand, the compressed metal flat will undergo a considerable increase of stresses because at this point the concrete undergoes a very strong compression and will seek release by transferring part thereof to the steel.

This phenomenon results from tests which have been made on a prestressed steel-concrete compound beam at the Magnel laboratory of the Ghent University.

Experience has shown that the creep ceases much faster than for a concrete beam which has simply been prestressed, and also that the creep is much weaker.

In FIGURE 1, **1** is a prefabricated concrete beam; **2** and **3** are the metal flats fastened by means of their studs **4–5** to the flange of the beam, before hardening; **6** are the elements of first prestress; **7** are the elements of second prestress; **8** is the metal flat; **9** is the layer of cement-mortar inserted between flat **8** and the face of beam **1**; **10** are the bolts of high tensile strength for fastening the flat **8** to the flange of the concrete beam.

All these elements are again illustrated in the embodiment of FIGURE 2 which is moreover completed by concrete fillings **11–12** and by cross-bars or cross-cables **13** for subsequent application of a transversal prestress. Any suitable means are used for inserting the cable in the manner shown in FIG. 2.

It is evident that the process according to the present invention can be applied to beams or similar elements of various shapes and dimensions, together with any appropriate additional feature.

What I claim is:

1. A process of making a composite steel-concrete beam, comprising in combination the steps of casting a concrete beam having a first zone and a second zone, at least said second zone having a flange, said first zone being adapted to be subjected to a compressive stress and said second zone being adapted to be subjected to a tensile stress, securing at least one metal flat to said first zone, locating wires in said second zone and causing said wires to produce a prestress in said beam, securing a metal flat to said second zone by bolts of high tensile strength extending through said flange while inserting a layer of mortar between said last mentioned metal flat and said second zone, locating wires in said second zone and causing the last-mentioned wires to produce another prestress in said beam.

2. A process of making a composite steel-concrete beam in accordance with claim **1**, wherein said one metal flat is

secured to said first zone by studs inserted during said casting.

3. A process of making a composite steel-concrete beam in accordance with claim **2**, wherein two spaced metal flats are secured to said first zone and wherein the space between them is filled with concrete.

4. A process of making a composite steel-concrete beam, comprising in combination the steps of casting a concrete beam having a first zone and a second zone, said zones having separate flanges, said first zone being adapted to be subjected to a compressive stress and said second zone being adapted to be subjected to a tensile stress, locating wires in said second zone and causing said wires to produce a prestress in said beam, securing separate metal flats to said zones at least partly by bolts of high tensile strength extending through at least one of said flanges while inserting a layer of mortar between at least one of said flats and at least one of said zones, locating wires in said second zone and causing the last-mentioned wires to produce another prestress in said beam.

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