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3,140,764

PRESTRESSED GIRDER MEMBER

Filed March 17, 1960

Figure 1

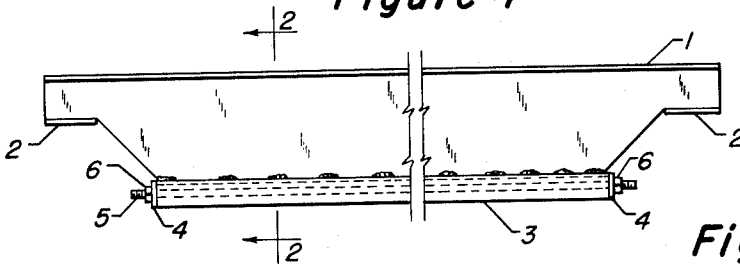


Figure 2

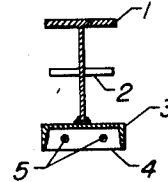


Figure 3

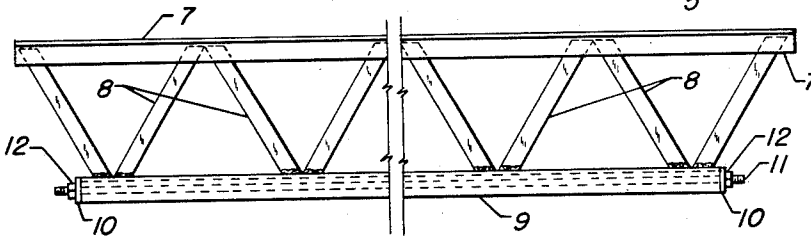


Figure 4

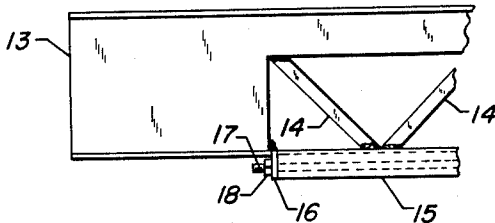


Figure 5

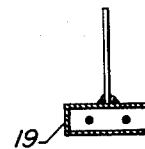


Figure 6

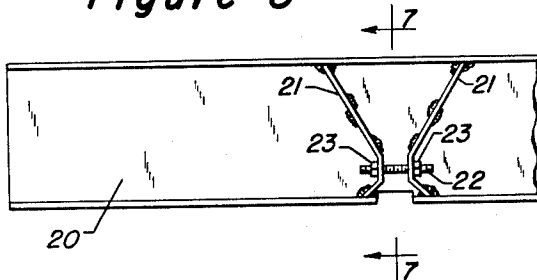
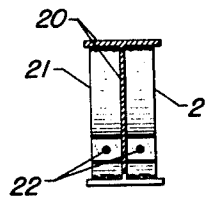


Figure 7



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PRESTRESSED GIRDER MEMBER

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3 Claims. (Cl. 189-37)

This invention relates to a special type of prestressed girder design and arrangement. More specifically, the improved design provides for relatively light-weight, low cross-sectional area, steel girder members which have pretensioning and camber so as to accommodate high loadings.

The usual pretensioned steel beam and girder arrangements have cables or rods as tensile members that are connected below standard rolled sections or standard built-up designs by suitable brackets. Also, modified king-post arrangements have been provided below a beam section, such that the tensioned cables or rod members are not in a straight line position.

A principal object of the present invention is to provide a pretensioned girder or beam design having a low cross-sectional area and which is fabricated or assembled to obtain maximum stability about a vertical axis.

A further object is to provide means for combining new high tensile strength steels with beam sections so as to effect internal stressing and loading in the assembly whereby to provide camber and loading which will act opposite to the loads to be applied.

Broadly, the improved pretensioned girder arrangement of this invention comprises in combination an upper flange section, a web section, and a lower section having a large radius of gyration about its central vertical axis, tensile means having adjustable tensioning means connecting therewith, and with said tensile means being attached to and paralleling the lower section.

The beam or girder section need not be limited to any one type or arrangement. The main upper body portion may comprise a conventional portion of a rolled section or may be built-up from standard structural members, in which case the top chord member and web members may be formed from angles in the manner of a truss or trussed-girder. Also, contours may vary, with the top and bottom chords, being straight, sloped, arched, etc., as may be required for conditions of use.

In all cases, it is a feature of the present invention to provide a design which substantially eliminates a heavy conventional lower flange section. In some cases, however, the lower flange of a standard section may be merely notched or eliminated for a portion of the beam span so as to permit the desired pretensioning arrangement. The term "lower section" as used in connection with, or in reference to, the various embodiments of the pretensioned girder design of this invention will have, in turn, various forms and shapes. The lower section may, in one embodiment, comprise a channel shaped member of light-weight design and construction which provides good lateral stability and in turn provides a channel or pathway for cables or other tensile members. Such lower section may be straight and parallel a normal lower flange position, or alternatively, such section which will be subjected to compression by tensioning of the tensile portion thereof, may be curved with the central portion being convex downwardly with respect to upwardly turned end portions. In another embodiment, the lower section may comprise a rod or cable tensioning means which is positioned just above a normal lower flange position for a girder or truss. It should also be pointed out that the tensioning means and lower section means, as used in this improved pretensioned design, need only extend over a middle portion of beam or girder and does not have to extend over the entire length of the girder or beam span.

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It is also a feature of the present design arrangement to utilize and combine in the prestressed sections various of the high tensile strength alloy steels, such as the steels containing chromium, nickel, manganese and the like, as the tensile members. The high strength steels may be stressed to effect the compression in the lower section of the girder and the tensioning in the upper portion of the girder prior to loadings, then after loading there will still be residual tensile ability left in the tensioned members for withstanding girder loadings and substantially no stresses put into other portions of the girder or beam. It may be further pointed out that the desired result may be obtained by having the tensile members of higher elastic limit or of higher modulus of elasticity than the prestressed members of the combination.

The accompanying drawing and the following description thereof will serve to more clearly set forth the improved designs and arrangements covered by the present invention.

FIGURE 1 of the drawing is a diagrammatic elevational view of a structural girder with the lower section thereof having means to effect prestressing of the girder member.

FIGURE 2 of the drawing is a sectional elevational view through FIGURE 1 of the drawing as indicated by the line 2-2 in FIGURE 1.

FIGURE 3 of the drawing is a diagrammatic elevational view of built-up girder section having means for effecting prestressing and having the upper and lower sections tied together and spaced by lattice type web members.

FIGURE 4 is a partial elevational view of another modified form of beam or girder section having a special lower flange arrangement for providing prestressing.

FIGURE 5 is a sectional view through a lower flange section of a prestressed girder showing the use of tubular shaped members therein.

FIGURE 6 shows a partial elevational view of a girder section formed from a standard structural member, with the lower flange notched, and means provided above the lower flange for effecting the prestressing of the girder.

FIGURE 7 is a sectional view through the girder section illustrated in the embodiment of FIGURE 6, as shown by the line 7-7.

Referring now more specifically to FIGURES 1 and 2 of the drawing, there is shown a girder or beam section 1 having the lower end portions thereof cut away and provided with support plates 2. The lower portion or section of the girder illustrates one embodiment of the present invention which provides a light-weight, or low cross-sectional area lower section, in lieu of the usual heavy flange member, and at the same time provides means for holding and accommodating tensile members. A light-weight member 3, in the form of a channel is welded or otherwise attached to the lower portion in the vertical web of girder 1 and is in turn provided with end plates or stop-members 4. The end members 4 in turn provide for holding and spacing suitable high tensile strength cables or rods 5 which can be pretensioned and serve to compress the lower section of the girder and pretension the upper portion of the girder. The light-weight member 3, or the entire assembly, with the exception of the high tensile strength members 5, may be of materials having a low modulus of elasticity, such as aluminium and magnesium alloys, and the like. In the present embodiment, the tensile members 5 are indicated as having threaded end portions whereby suitable adjustment nuts 6 may be placed at each end thereof. As previously pointed out, it is a preferred construction arrangement to provide high tensile strength alloy members 5 such that they may be initially pretensioned to utilize only a portion of their ultimate strength, staying well

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within the elastic limit thereof, and effecting the desired pretensioning, and perhaps cambering, of the upper portion of the girder section 1 such that, as live loads and dead loads are applied to the girder section in use, the girder will have substantially no stress therein. This, of course, provides the desired beneficial effects of a prestressed girder construction in turn permitting the design of smaller or less heavy beam and girder sections for the particular structure involved.

The channel shaped member 3 may be a standard light-weight section or built-up from a light-weight plate in order that it might have low cross-sectional area and minimum use of metal. The member is, however, designed to have substantial width and lateral stability, which may be measured in terms of having a relatively high I/r ratio, such that as the tensile members 5 are placed under tension, the lower section can properly withstand the compressive action thereon, as well as provide overall lateral stiffness to the girder member itself.

In FIGURE 3 of the drawing, there is indicated diagrammatically a trussed-girder type of construction with the upper portion thereof being fabricated from structural angles 7 placed back to back each side of a plurality of diagonally positioned web members 8, or alternatively, the top flange portion may be constructed from a structural T member welded or otherwise attached to the plurality of diagonally positioned web members. The lower section 9 of the girder may be welded or otherwise attached to the plurality of web members 8 and is indicated to have a channel-shaped cross section, similar to the arrangement provided in FIGURES 1 and 2. Thus, the channel 9 is constructed and arranged to have lateral stability and low cross-sectional area and again is in turn provided with end plates 10 which in turn accommodate spaced tensile members 11. The latter are provided with threaded end portions and suitable adjustment nuts 12 which may, of course, be adjusted to effect the desired pretensioning of the members 11 and the prestressing of the girder whereby there is resulting compression in the lower portion thereof, and tension and camber in the upper portion thereof, so as to resist the loadings that will subsequently be placed upon the girder after it is in use.

Referring now to FIGURE 4 of the drawing, there is shown a special girder design which may be readily fabricated from standard heavy structural members or built-up from plate. The girder or beam section 13 has the middle lower portion thereof lightened by the elimination of the middle lower flange section and the lower portion of the web section. Suitable diagonal members 14 are used to connect with and tie to a lower section 15. The lower section 15 in the present embodiment extends over only a middle portion of the length of the girder in as much as it is not necessary to have the prestressed compression section and the tensile members extend over the full length of the beam or girder sections. The present embodiment again provides the lower section 15 with end plates 16 which accommodate the passage of suitable tensile members 17 and also means for providing stops or backing for adjustment nuts 18 on the threaded ends of tensile members 17.

In each of the embodiments described, a channel shaped lower section has been provided for the prestressed girders, however, other shaped members may well be used. For example, one or more hollow tubular members can be placed along the lower portion of the girders and provide means for the passage of one or more tensile members therein. A wide flat tubular section such as member 19 in FIGURE 5 of the drawing, may accommodate a plurality of tensile members, or alternatively, a series of small diameter, or small width, tubular members may be arranged in a side by side manner along the bottom of the girder, with each tubular member being designed merely to hold one tensile member. Suitable end plates may be attached to the tubular members to provide a

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backing plate for adjustment nuts on the ends of the tensile members in the manner shown in the previously described embodiments. It may also be pointed out that suitable mechanical or hydraulic jacking means may be used to tension the members, such as members 5, 11 and 17. Then, after they are tensioned and the girder sections prestressed, they may be permanently clamped, welded or otherwise held in place within the lower section of the girder to maintain the desired prestressing therein.

Referring now to FIGURES 6 and 7 of the drawing, there is shown a girder member 20 which may be a standard rolled structural member, or alternatively, may be built up from plate members. The middle lower flange portion of the section is notched out or is eliminated in the fabrication thereof, while thereabove, within the web portion of the girder there are provided spaced apart opposing diagonally positioned reinforcing members 21. The members 21 are provided on both sides of the web member and oppose one another in a symmetrical relationship. It is a particular feature of this prestressing arrangement to have holes, notches, or other means in connection with the reinforcing members 21 at a point just above the lower flange, to accommodate tensile members 22. Each of the tensile members 22 have threaded ends and suitable adjustment nuts 23 in order that proper tensioning may be effected therein and resulting compression provided within the lower portion of the girder section 20.

It is not intended to limit the design of the embodiment of FIGURES 6 and 7 to any one type of reinforcing member 21 or to any set types of bracket and tensile members, for it is obvious that members such as 21 may take varying shapes and may be positioned at varying angles along the web of the girder 20 and between the upper and lower flange portions thereof. It is necessary, however, to have the tensile members 22 placed within the mid portion of the girder span and positioned substantially parallel with and along the lower portion or bottom of the girder member such that there may be effected the desired compression forces in the lower portion of the girder and tension within the upper portion thereof. The elimination of a short length of lower flange permits the girder to readily accommodate itself to compressive stresses within the lower portion of the girder without exerting unduly high tensioning within members 22. There is also thus provided low effective cross-sectional area within the lower flange portion of the girder while at the same time there is maintained the desired substantially high I/r ratio within the girder member. In other words, by keeping the notched-out or eliminated flange portion to a minimum amount, say one inch or less, the radius of gyration of the lower portion of the web itself with respect to the length of the notched portion still obtains a high I/r ratio.

The foregoing embodiments illustrate various constructions and designs which embody simplified prestressed girder arrangements, which in turn permit the use of less metal and material within members that can accommodate longer spans and heavier loadings than would ordinarily be structurally possible. The designs also permit the use of high tensile strength alloy tensile members in combination with the more common forms of structural steel and other metals and materials, and thus obtain substantially no stresses or at least very low stresses within the body of the girder member even though the loadings be normal or unusually heavy building loadings. The tensioning operation within the prestressed girder sections may be accomplished prior to the erection of the girders to their normal places within the structure, or if desired, may be erected into their proper positions and subsequently tensioned and prestressed to the desired level, as long as such tension takes place prior to subjecting the girder members to loading.

As previously pointed out, the drawing is diagrammatic and still other shapes and designs may be provided within the concept of the present invention.

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I claim as my invention:

1. A non-arch form prestressed girder member comprising in combination, an upper flange section, a web section, a continuous lower section of relatively low cross-sectional area having an extended width and providing a larger radius of gyration about a central vertical axis than said upper flange section, tensile means having a greater elastic limit than any of the other sections of said girder member having adjustable tensioning means connecting therewith, and means attaching said tensile means to the ends of said lower extended width section while extending parallel therewith across at least a mid-portion of the length of said girder member.

2. The non-arch form prestressed member of claim 1 further characterized in that said tensile means comprises high tensile strength cable means having threaded adjustment means at the ends thereof and abutting means connecting with said lower section whereby tensioning of the tensile means effects camber in the upper section of said

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girder and compression within said lower section of said girder member.

3. The non-arched prestressed girder member of claim 1 further characterized in that said lower section is a channel member with downwardly projecting flanges.

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