The present invention relates generally to overhead cranes and to an improved girder therefor.

Crane girders of the type to which the present invention relates must be capable of supporting a load which is highly concentrated at one location of the girder cross section, and these girders are subjected to three basic types of loading: vertical, lateral, and torsional. Heretofore, such girders have necessarily been of considerable weight and cross-sectional size in order to safely support the loads imposed on them. As a result, these girders were not only expensive and required a considerable amount of space for their installation, but also required the trolley, which was supported between two of these girders, to be of considerable spread.

In accordance with the present invention, a crane girder has been provided which is considerably lighter in weight and smaller in size than a conventional prior art girder of comparable stiffness and strength.

More specifically, the present invention provides a girder of the above type in which the section shear center is controlled by proportioning the section so that the twisting due to asymmetrical bending is kept to a minimum. Preferably, the load application plane passes through the shear center of the girder section.

The invention provides a girder of the above type which is comprised of a combination of a beam, of modified C cross-sectional shape, and a box beam of rectangular shape in cross section. The result is a girder which is economical to produce, has adequate lateral stiffness, and has a shear center which is close to the action lines of the load vectors. The use of a box beam of relatively small size is possible for providing sufficient torsional stiffness.

The invention provides a bridge member girder for an overhead crane which has section properties that incorporate the light weight of the conventional "I" or "W" beams, combined with the torsional stiffness of a conventional box-type girder. The girder includes a wide top flange which assures lateral stiffness to resist loads due to acceleration, deceleration, and side pull which are found in structures utilizing the present invention.

The present invention generally provides an improved overhead crane having a minimum amount of spread and good economy of design.

These and other objects and advantages of the present invention will appear hereinafter as this disclosure progresses, references being had to the accompanying drawings, in which:

FIGURE 1 is a side view of a crane girder made in accordance with the present invention; FIGURE 2 is a sectional view taken along line 2—2 in FIGURE 1; FIGURE 3 is an enlarged sectional view of one of the girders shown in FIGURE 2; FIGURE 4 is a fragmentary, perspective, exploded view showing the connection between the girder and end truck; FIGURES 5 to 9 are schematic, cross-sectional views of various types of beams, the beams of FIGURES 5 and 6 being conventional; FIGURES 10 to 14 are diagrams showing the distribution of normal stresses in the beams of FIGURES 5 to 9, respectively.

Referring in greater detail to the drawings, the crane C in general is mounted on suitable rails 1, 2 supported on any suitable overhead structure, indicated partially at 3 and 4. The crane includes two girders G which are arranged in spaced apart, parallel relationship and are rigidly secured together at their ends by end trucks 5 and 6. These trucks each have a pair of wheels 7 and 8 so that one wheel is located generally at each corner of the crane and which ride on and are guided by the rails 1 and 2. As shown in FIGURES 1, 2, and 3, the ends of the girders are of reduced height, and the girders and end trucks have abutting surfaces 12 and 13, respectively, which may be rigidly held together in any suitable manner as by welding or by bolt means 14. Drive motors 11 are provided for at least some of the wheels to furnish the driving power for propelling the crane along the rails, and if a more complete description of these motors is deemed to be either necessary or desirable, reference may be had to our co-pending U.S. patent application, Ser. No. 426,863, filed Jan. 21, 1965, which issued on May 24, 1966 as Patent No. 3,252,586 and entitled "Integral and Coaxial Drive Assembly for Crane Wheels."

As shown in FIGURES 1 and 2, a conventional trolley T is mounted on and driven along the crane C on other rails 15, one located on and rigidly fixed to the top side of each of the girders G. For this purpose, the trolley has four wheels 16 and its own power source in the form of the electric motor 20. A power hose including a hook 21, cable 22, and its drum 23 also forms part of the trolley.

In general, these cranes C may be of considerable length; more specifically, the girders G may be of considerable length and must be capable of supporting loads of many tons. Accordingly, the strength and the weight of the girders themselves are of utmost importance.

Crane girders of the above type are subjected to several basic loading components. For example, they are subjected to vertical loading due to live loads such as the hook load, trolley weight, and impact. Vertical loading also results from dead loads such as the weight of the girders themselves, machinery, and other items. These girders are also subjected to lateral loading due to acceleration, deceleration, side pull, and swinging loads. In addition, these girders are subjected to torsional moments or twisting resulting from an eccentric application of either the vertical or lateral loading.

Referring to FIGURES 5 to 9, the maximum torsional loading results when the various torsional components act in the same direction: Maximum M = aL + bV where a and b are the moment arms of the lateral and vertical load vectors L and V, respectively, with respect to the shear center SC. The center of gravity (commonly referred to as the centroid) of the section has been labeled CG.

In FIGURES 10 to 14, tensile stresses have been indicated with a positive sign, and compressive stresses have been indicated with a negative sign.

FIGURES 5 to 9 represent different types of crane girders. FIGURES 5 and 6 represent conventional beams, namely a box beam and an I beam, respectively. FIGURES 7 and 8 show a C beam and a modified C beam, which are shown and described in order to illustrate the present invention, which invention is shown in FIGURE 9 where there is shown a beam made in accordance with the present invention.

Referring more specifically to the girder represented by FIGURES 5 and 10, it will be noted that this box section has a very large torsional stiffness. Disadvantages of this form of girder, however, are poor utilization of material (two web plates are necessary), high dead weight to capacity ratio (especially on short spans), and it requires a large number of internal diaphragms because the vertical loading is not applied at the web plates.
The I girder represented by FIGURES 6 and 11 has relatively good utilization of material and is therefore of comparatively light weight. It has limited lateral stiffness, however, and poor torsional stiffness. In girders of this type, the torsional and auxiliary trusses are required to obtain sufficient stability.

The C beam form of FIGURES 7 and 12 results in good utilization of material and sufficient lateral stiffness. Because of extremely poor torsional stiffness (note location of shear center), these beams cannot be used in most cases for main girders.

The modified C beam of FIGURES 8 and 13 has better utilization of material when compared to the regular C beam type, and the location of the shear center is also better. The torsional stiffness, however, is still insufficient which precludes this type from being used in general applications as a crane girder.

The design shown in FIGURES 9 and 14 is made in accordance with the present invention and is a combination of the box and modified C designs. It has been found that this new design results in very efficient utilization of material, adequate lateral stiffness, and the shear center is close to the action lines of the load vectors. With this new combination design, a small box section is capable of providing sufficient torsional stiffness, and the compressive load can be distributed over a number of rigid plate elements 26, 26a and 26b. Gusses 35 are welded to and within the modified C portion of the girder as shown in FIGURE 3, and these gusses have a reinforcing flange 25a normal thereto and along their inclined outer edge.

These gusses prevent buckling of wall 29 and flange 26.

The new design provides a considerable weight reduction compared to the conventional girder design. The section properties of the new design incorporate the lightness of the conventional 1 or WF beams combined with the torsional stiffness of a conventional box-type girder.

The wide top flange 26 assures the necessary lateral stiffness which is essential in the crane girder design to resist the loads due to acceleration, deceleration, and side pull. Flange 26 has an upturned reinforcing flange 26a on its outer edge. The new design also includes the narrow, lower flange 27 and a relatively small rectangle or box section 28 secured to the vertical wall 29 at the top thereof and adjacent the wide top flange 26. The box 28 is located on the inner side of the girder (FIGURE 3) and the top flange extends outwardly, with respect to the trolley. Stated otherwise, the box 28 is located on the side of wall 29 which is opposite to the side from which flanges 26 and 27 extend. The rail 15 is located in vertical alignment with the vertical wall 29.

The compressive stress in the vertical wall 29 increases from zero from a point 30 (FIGURE 14) about midway of its height to a maximum stress at the upper end of the wall. The location of the new girder section shear center is controlled by proportioning the section in such a manner that the twisting due to asymmetrical bending is kept to a minimum. In the ideal case, the load application plane passes through the shear center of the girder section.

An additional advantage of the new girder is its asymmetrical section with the top flange extending outwardly of the crane in general, which minimizes the necessary distance between the trolley rails. This consequently results in a crane of minimum spread, as shown in FIGURE 2, thus offering maximum economy in design.

The integral, cross-sectional shape of the new, elongated, steel girder sections of the present invention may be produced by bending, welding, or using extruded sections for the girder component parts, or by utilizing combinations of the above manufacturing methods.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:
1. An elongated, steel overhead crane girder having a transverse and integral cross-sectional shape comprising: a modified C shape including a vertical wall, a wide top flange extending from the upper edge of said wall and to one side thereof, a narrower lower flange extending from the bottom edge of said wall and to said one side thereof; and a relatively small rectangle shape at the upper end of said wall and forming a continuation of said wide top flange and located on the side of said vertical wall which is opposite to said flanges.
2. A girder as defined in claim 1 further characterized in that said rectangular shape is formed in part by said vertical wall.
3. A girder as defined in claim 1 further characterized in that said vertical wall is of a vertical height approximately five times that of the height of said rectangle shape.
4. An overhead crane comprising a pair of spaced apart girders arranged in substantial parallelism and rigidly secured together, a rail mounted longitudinally on each girder and along the top side thereof, said rails adapted to support a load carrying trolley for movement therealong, each of said girders being fabricated from steel and having a cross-sectional shape comprising: a modified C shape including a vertical wall, a wide top flange extending from the upper edge of said wall and to one side thereof, a narrower lower flange extending from the bottom edge of said wall and to said one side thereof; and a relatively small rectangle shape at the upper end of said wall and forming a continuation of said wide top flange and located on the side of said vertical wall which is opposite to said flanges.
5. A girder as defined in claim 4 further characterized in that said rectangular shape is formed in part by said vertical wall.
6. A crane as set forth in claim 4 wherein said vertical wall is of a height approximately five times that of the height of said rectangular shape.
7. An overhead crane comprising a pair of spaced apart girders arranged in substantial parallelism, transversely arranged end trucks rigidly secured between corresponding ends of said girders so as to form a crane of generally rectangular shape when viewed in plan, each of said girders being fabricated from metal and having a cross-sectional shape comprising: a modified C shape including a vertical wall, a wide top flange extending from the upper edge of said wall and to one side thereof which is outwardly of said crane, a narrower lower flange extending from the bottom edge of said wall and to said one side thereof; and a relatively small rectangle shape at the upper end of said wall and forming a continuation of said wide top flange and located on the inner side of said vertical wall which is opposite to said flanges.
8. A crane as set forth in claim 7 wherein said vertical wall is of a height approximately five times that of the height of said rectangular shape.
9. An overhead crane comprising a pair of spaced apart girders arranged in substantial parallelism, transversely arranged end trucks rigidly secured between corresponding ends of said girders so as to form a crane of generally rectangular shape when viewed in plan, a rail mounted longitudinally on each girder and along the top side thereof, said rails adapted to support a load carrying trolley for movement therealong, each of said girders being fabricated from metal and having a cross-sectional shape comprising: a modified C shape including a vertical wall, a wide top flange extending from the upper edge of said wall and to one side thereof, a narrower lower flange extending from the bottom edge of said wall and to said one side thereof; and a relatively small rectangle shape.
at the upper end of said wall and forming a continuation of said wide top flange and located on the side of said vertical wall which is opposite to said flanges; said girders being arranged relative to one another with their rectangular shapes positioned inwardly adjacent to one another to thereby minimize the distance between said rails; said rails being located substantially in vertical alignment with said vertical walls.

10. A crane as defined in claim 9 further characterized in that said girders have reduced end portions and said end trucks are detachably secured to said portions.

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