FIG. 1.

FIG. 2.

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FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

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ABSTRACT OF THE DISCLOSURE

An elongated structural unit is formed by two parallel longitudinal chord members and separate web elements located between the chord members and having marginal edges which are secured to the chord members, the web elements consisting of rectangular sheet metal plates with reinforcing flanges extending between and bracing opposite facing surfaces of the chord members, the web elements being staggered to provide discontinuous side walls which alternate from side to side along the unit.

This invention relates to elongated structural units, such as, for example, beams, girders, joists, pillars and like load-bearing members, and building structures fabricated therefrom. More particularly, the invention is concerned with an improved composite construction of such structural units which are especially suitable for forming the components of building frameworks.

According to the invention, an elongated structural unit consists of a pair of parallel, spaced-apart, longitudinal chord members interconnected by a plurality of separate independent web elements forming opposite side walls which alternate from side to side along the length of the unit, each web element being composed of a plate of which the opposite longitudinal marginal edge portions engage, and are secured to, surfaces of said chord members, said web element plates also having offset reinforcing strut parts which extend between and brace opposite facing surfaces of said chord members.

Preferably, the opposite longitudinal marginal edge portions of the web element plates engage, and are secured to, exterior side faces of the chord members so that said web elements can each be placed in position between the correctly located chord members, during assembly, by a lateral displacement.

In the accompanying drawings,

FIGURE 1 is an exploded isometric view of a beam representing one exemplary embodiment of the invention;
FIGURE 2 is an isometric view of the beam of FIGURE 1 after assembly;
FIGURE 3 is a side view of the beam shown in FIGURE 2;
FIGURE 4 is a vertical section on line IV-IV of FIGURE 3;
FIGURE 5 is a horizontal section on line V-V of FIGURE 3;
FIGURE 6 is an exploded view illustrating the manner of assembly of one corner section of a building framework fabricated from beams and pillar or stranchion units in accordance with this invention;
FIGURES 7a, 7b, and 7c are diagrammatic plan views of the ends of different forms of pillar or stranchion units;
FIGURES 8 and 9 are diagrammatic views of complete two-story building frameworks assembled in the manner illustrated in FIGURE 6 from beams and pillar or stranchion units in accordance with the invention; and
FIGURE 10 is a perspective view of a modified beam in accordance with the invention.

Referring to the drawings, the beam illustrated in FIGURES 1 to 5 has a composite construction, being made up of a pair of metal channel chord members 1, 1, and a plurality of separate web elements 2.

Each web element 2 is composed of a substantially square sheet steel plate 3 having longitudinal marginal edges 4, 4, and a pair of integral inwardly projecting perpendicular flanges 6, 6, along the opposite end edges. As shown, these flanges 6, 6 do not extend for the full depth of the plates 3 but terminate at each end short of the adjacent longitudinal marginal edge 4 leaving short side lugs or ears 5 at the ends of the latter. Furthermore, each plate 3 is advantageously embossed as by swaging for example, with a substantially triangular patterning, as indicated, in order to improve the mechanical strength.

On assembly of the beam, the channel chord members 1, 1, are positioned in parallel, spaced-apart relation with the bases 7, 7, of the channels 1, 1, presented towards each other, and with the side flanges 8, 8, extending outwardly, whilst the web elements 2 are fitted between the chord members with their longitudinal marginal portions 10, 10, in face-to-face engagement with the exterior surfaces of the flanges 8, 8, to which they are secured by spot-welding, and the flanges 6, 6, fit between the two chord members with their ends in engagement with opposite facing surfaces of the bases 7, 7.

Successive web elements 2 are arranged alternately along the two sides of the beam to give a "wandering web" type of construction in which they form the opposite side walls, and in this first embodiment they are also slightly spaced apart in the longitudinal axial direction of the beam to provide relatively narrow gaps 11 (see FIGURE 3) which can serve for the transverse passage of service facilities, such as pipes and electrical wiring or for the fitting of the ends of joists or other structural members when the beams are used in the construction of building frameworks as hereinafter described.

The flanges 6, 6, of the web elements 2 are important in that they form reinforcing strut parts between the chord members 1, 1, laterally offset from the planes of the plates 3, so that the rigidity and load-bearing strength of the structure is greatly increased. Instead of being perpendicular to the plates 3, however, they may be slightly inclined outwardly, if desired, so that stacking of the separate web elements during storage and transport would be facilitated.

During assembly of beams and like members having the construction described, after positioning of the chord members 1, 1, the individual web elements 2 can be brought into position and fitted by lateral displacement from opposite sides of the structure, and this feature greatly facilitates the assembly operation and provides scope for arranging a satisfactory automated manufacturing process and mass-production methods.

Although sheet-metal, particularly steel, will often be a preferred material, the use of other materials may be advantageous in some cases and it may be possible, for example, to utilize satisfactorily a plastics material. Also, in some cases, the chord members 1, 1, may advantageously be composed of solid wooden bars having regard to the ease with which other parts may then be attached by nails, screws and like fixing means. To enable other parts to be attached by such fixing means, however, without having to rely upon wood as a main load-bearing material, chord members composed basically of metal may be fitted with wood inserts. Projecting wood inserts may also be fitted into metal chord members primarily for the purpose of providing a cushioning or seating material for transferring compression loading forces between the structural units and other underlying or overlying parts.
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Other, more complex cross-sectional forms of channel chord members may be used if desired, and in particular, subsidiary smaller channels or pockets may be provided for receiving inserts as referred to above. Apart from simple beams, the present invention may also be applied to the construction of more complex structural units. For example, beam-like structures of substantially greater depth may be built up by providing a series of parallel spaced-apart superposed chord members. For example, adjacent pairs of separate web elements as hereinbefore described. Also, pillar or stanchion units may be constructed in a manner similar to that described in my copending British patent application No. 45,866, by connecting together in angular relationship, two or more vertically-positioned beam-like structures which each comprise a pair of chord members and interconnecting separate web elements formed and assembled in accordance with the basic structure of this invention hereinbefore described and which form angularly disposed limbs of the pillar or stanchion unit.

Structural units in accordance with this invention may be especially useful in the fabrication of building frameworks, especially building frameworks adapted to carry substantially the whole structural load of a building as, for example, in frameworks constructed according to my co-pending British patent applications Nos. 6,547 and 15,983.

Thus, by way of example, the manner of assembly of two beams a, a, and an L-section pillar or stanchion unit b, each constructed in accordance with this invention, so as to build up a corner section of a building framework, is illustrated in FIGURE 6. Each beam a and limb c of the pillar or stanchion unit b has a construction similar to that of the beam of FIGURES 1 to 5 and, although not shown in the drawing for the sake of clarity, the web plates are preferably similarly embossed. The end portions, however, are slightly modified, terminating in end channel parts 20 extending across the ends of the chord members, and in the case of the beams a, a, the end two web plates are placed directly opposite to one another adjacent an intermediate stiffening channel part 21 which is similar to the end channel part 20 and which is spaced from the latter by a distance substantially equal to the length of one web plate.

The two limbs c of the L-section pillar or stanchion unit b are connected together at right angles to one another through an intermediate coupling bracket 22 and L-shaped end plates 23, 24, which are predrilled with bolt holes corresponding with bolt holes in the lower channel parts 20 of the separate limbs. In the assembled framework, the lower end of the first-story corner pillar or stanchion unit b of each corner section is secured to a concrete foundation or footing d by holding-down bolts which register with the bolt-holes of the lower end plate 23 and of the lower end channel parts 20 of the separate limbs, and the end portions of the adjacent beams a, a, are seated upon the upper end of the pillar or stanchion unit b to which they are directly secured in located position by bolts passing through aligned holes in the base of the lower chord members and in the web plates extending between the bolts-holes of the upper end plate 24 and of the upper end channel parts 20 of the pillar or stanchion unit limbs c.

The frameworks are built up according to a rectangular plan with a first set or pillar or stanchion units erected at the corners of one or more rectangles and a set of horizontal rafters assembled to form walls and seats upon the top of adjacent pillar or stanchion units. Higher stories may then be built up in a similar manner from units with the upper story pillar or stanchion units seated upon the end portions of the underlying horizontal beams which in turn are seated on the lower pillar or stanchion units so that at each corner of each rectangle, the pillar or stanchion units are all in vertical alignment and transmit the whole loading of the framework to the foundations. At each joint, the ends of the beams are preferably connected independently to each adjacent pillar or stanchion unit in the manner indicated in FIGURE 6 to above.

Where intermediate walls are required to be incorporated in the framework, as in a semi-detached house for example, adjacent pairs of separate web elements may be used which are built up in the same manner as the L-shaped corner units b and are composed of either two or three limbs similar to the limbs c, the limbs being connected together in correct relative positions by appropriate predrilled end plates of T-form. By way of illustration, of these different forms of pillar or stanchion units, FIGURES 7a, 7b and 7c show diagrammatically plan views of the ends of an L-shaped two-limb corner unit, a T-shaped two-limb intermediate unit and a T-shaped three-limb intermediate unit respectively.

Typical completed basic frameworks composed of beam or pillar or stanchion structural units, a and b respectively, of the form herein described are illustrated diagrammatically in FIGURES 8 and 9, the framework of FIGURE 8 being intended for a semi-detached two-story house and that of FIGURE 9 being intended for a single detached two-story house. As indicated, the framework is supported on concrete foundations or footings d and, in a preferred method of building construction, they are used to carry the other major structural parts of the building, such as the walls, roof and at least upper story flooring, all load being ultimately transmitted by the lower pillar or stanchion units to the foundations. Structural units constructed as described in accordance with the invention have important advantages in providing high strength lightweight structures which are very economical in their use of structural material, which have good handling properties and which can be readily manufactured with low production costs. Also the spacing of the web elements at opposite sides of the chord members, as in the embodiment herebefore described, conveniently provides a central space extending along the whole length of the unit for the passage of service facilities, such as pipes and electrical wiring, which forms an additional advantageous feature in applications within the building field.

Building frameworks fabricated as described from beam and pillar or stanchion units in accordance with the invention and with inherent strength and rigidity which, together with the ease of erection, versatility of layout, and low cost of production, renders them highly suitable for use in industrialised building projects for the efficient construction of dwelling houses and other building structures of one or more stories.

It will be understood that numerous modifications may be made in the detailed construction of the structural units within the scope of this invention, and by way of further example, there is illustrated in FIGURE 10 one form of modified beam in which a pair of metal channel chord members 1, 1', are interconnected by a plurality of separate web elements 2 which are similar to the web elements of the first described embodiment and which are similarly arranged alternately along the two sides of the beam with inwardly projecting side flanges 6, 6', fitted between the two chord members with their ends in engagement with opposite facing surfaces thereof. In this modified beam, each extends both horizontally, has an embossed pattern and they are arranged in substantially end-to-end relationship with respect to the longitudinal axial direction of the beam so that viewed in side elevation there is, in effect a continuous web without any transverse gaps or apertures.

I claim:

1. An elongated structural steel beam unit, comprising a pair of parallel spaced-apart longitudinal thin-walled
chord members of narrow open channel form with base portions presented toward each other and outwardly extending side wall flanges, and a plurality of separate independent web elements interconnecting said chord members, said web elements being spaced one from the other and extending in the longitudinal direction of said chord members, each of said web elements consisting of a substantially rectangular thin-walled plate having longitudinal marginal edges along two opposite sides, the two marginal edges of one of said web elements being firmly fixed to aligned wall flanges located upon one side of the two chord members, the two marginal edges of the following web element being firmly connected to aligned wall flanges located upon the opposite side of the two chord members, whereby said web elements are disposed in staggered spaced apart relationship to provide discontinuous side walls having front surfaces which alternate from side to side, each of said web elements also having narrow reinforcing flanges extending toward and terminating short of the side of the chord members which is opposite the side to which that web element is fixed, said reinforcing flanges having opposed edges engaging the base portions of the chord members, said flanges terminating short of said longitudinal marginal edges, whereby ears aligned with the front surface of the web element are located between said edges of the reinforcing flanges and said longitudinal marginal edges.

2. A structural unit in accordance with claim 1, wherein each web element has embossed diagonal bracing ribs, said ears extending substantially in the direction of said ribs.

3. A building framework adapted to carry substantially the whole structural load of a building upon concrete footings or foundations, said framework being composed of column units at the corners which comprise vertically-extending elongated structural units as claimed in claim 1, assembled and welded together into a right-angular cross-sectional form, and horizontal beams which also comprise elongated structural units as claimed in claim 1, and which have their ends seated upon and connected to the tops of the adjacent lower column units to form a series of interconnected rectangles extending throughout the whole structure in both vertical and horizontal planes.

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