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(54) Shearhead reinforcement.

(57) A shearhead assembly supporting a laterally extending concrete slab (18) on a column (14), has a shearhead comprising two pairs of beams (2,4) with juxtaposed vertical surfaces (10,12) which define therebetween an area substantially corresponding to the cross-section of the column (14). The juxtaposed vertical surfaces thus enclose the bulk of the column cross-section. During installation, the shearhead is located at the top of a partly constructed column, and concrete is cast around the shearhead and between the pairs of beams including the portion between the juxtaposed vertical surfaces thereof, to form the laterally extending slab (18) and simultaneously extend the column (14) therethrough. There is no need for any element of the shearhead itself to traverse the cross-section of the column between the juxtaposed vertical surfaces (10,12).

SHEARHEAD REINFORCEMENT

This invention relates to the design of shearheads in the reinforcement of junctions between for example, vertical columns and horizontal floors, where at least the floor is formed in reinforced concrete. A shearhead is a separately definable structure embodied in the concrete at the junction which serves to spread the load of the floor on the respective column and thereby reduce the effect of the vertical forces; ie, reduce the stress in the slab concrete by increasing the critical shear perimeter around the column.

It has long been recognised that supporting an horizontally extending body or slab on one or more vertical columns imposes bending and shear forces on the slab at the junctions with the columns which must be withstood by the structure of the slab or resisted by specific design features at the respective junction. Traditionally, the cross-section of the columns has been enlarged at least at the junction either wholly or locally at the junction by the introduction of flared column heads. Alternatively or additionally, the depth of the slab has been increased in the vicinity of the column to reduce the stresses arising particularly from the local shear forces. However, in modern building design it has become desirable to eliminate such obstructions or modifications to the slab, and provide clear substantially perpendicular junctions between each column and the lower uniform surface of the slab. It is also desirable to be able to use columns of smaller cross-section for a given slab loading or to increase the span of the slab for a given column size or cross-section. A number of shearhead designs have been proposed to these ends, and examples of such proposals are disclosed in European Patent Specification Nos. 0079413 and 0128994. This subject has also been considered in the following papers published by the American Concrete Institute:

1. Corley, W.G., and Hawkins, N.M., "Shearhead Reinforcement for Slabs," ACI Journal, Proceedings V.65, No. 10, October 1968, pp. 811-824.
2. Hawkins, N.M., and Corley, W.G., "Moment Transfer to Columns in Slabs with Shearhead Reinforcement", Shear in Reinforced Concrete , Special Publication SP-42, American Concrete Institute, Detroit, 1974, pp. 847-879. Also, Research and Development Bulletin RD 037.01D, Portland Cement Association.

Research into shearhead design is based essentially on the premise that shear failure of the laterally extending slab occurs along a shear failure plane on a perimeter around the head of the respective column. If this shear perimeter can be enlarged; ie, spaced from the column axis, then the shear forces acting on the slab at a particular point on the perimeter will be reduced.

Research into the above problem has followed two distinct paths. In the first, shearheads have been designed as reinforcing structures which are placed directly on a column and extend laterally outward therefrom to define a shear perimeter significantly spaced from the column axis. In the second, elements are introduced into the slab to provide more local shear reinforcement, effectively to a radius from the column at which the slab can be sufficiently self-supporting. Such local reinforcement can be interconnected to form a linked unit. The present invention is directed at the first of these options.

Previously known designs of shearheads have included essential elements that traverse the cross-section of the respective column in order to achieve the requisite transfer of loading to the column. Inevitably, this interferes with the integrity of the column itself, and in a concrete column disrupts the homogeneity of the concrete thereof, and restricts the size, amount or spacing of the reinforcement in the column. We have found that this can be avoided. According to the invention, a shearhead assembly supporting a laterally extending concrete slab on a column, has a shearhead comprising two pairs of beams with juxtaposed vertical surfaces which define therebetween an area substantially corresponding to the cross-section of the column. The juxtaposed vertical surfaces thus enclose the bulk of the column cross-section. During installation, the shearhead is located at the top of a partly constructed column, and concrete is cast around the shearhead between the pairs of beams including the portion between the juxtaposed vertical surfaces thereof, to form the laterally extending slab and simultaneously extend the column therethrough. A concrete column will typically be reinforced by vertically extending rods, and these rods will extend between the juxtaposed vertical surfaces of the shearhead beams when the shearhead is located at the top of the column. Because the shearhead extends around and not between such reinforcing rods, the installation of the reinforcing rods can be conducted independently of the construction and location of the shearhead at the top of the column. While the column is usually concrete, it may be of another material such as steel.

Normally, the beams of the shear head will be interconnected, typically by welding, to form an integral structure. Such a structure provides some reinforcement for the slab itself against bending out of its lateral plane which permits the internal reinforcement in the slab to be reduced in the region of the shearhead in the eventual assembly. However, in one form of assembly embodying the invention, the shearhead is not in the form of an integral structure, and comprises four separate beams converging in a horizontal plane towards the column. Each beam has two parallel sections connected by bridges substantially at the periphery of the column. The four bridges present juxtaposed surfaces which define the area substantially corresponding to the cross-section of the column. Each beam section and bridge is normally of C-shaped or channel cross-section, with a vertical web and flanges directed inwardly on each respective beam. The beams may be quite separate; i.e., no interconnection is required, and in this form the shearhead provides minimal reinforcement to the slab against bending. Thus, the slab must be fully reinforced against bending independantly of the shearhead which is designed predominantly to resist the shear forces generated at the junction. Although this arrangement is structurally less efficient, it has the advantage of simplifying the shearhead assembly design. In this case the slab bending and shear reinforcement must be considered separately. This arrangement can be moddified by introducing a substantially contunuous hoop bar which passes through each beam and effectively encircles the column. Since the hoop bar confines the encircled slab concrete, cracking is further inhibited and the performance of the assembly is enhanced.

The cross-section of the column in a shearhead assembly of the invention is normally square or rectangular, and the juxtaposed vertical surfaces of the beams of the shearhead are substantially aligned with the sides of the column. However, other column cross-sections can be used such as circular and elliptical. In these variants, the vertical surfaces of the shearhead beams may form tangents to or chords across the column cross-section, but in all cases will usually surround the reinforcement in the column.

In some embodiments of the invention, the juxtaposed vertical surfaces of the beams can be built up to project slightly inwardly into the cross-section of the column. While we have found this is usually unnecessary, it can improve the resistance to shear forces at or adjacent the column periphery. Preferably, such building up is accomplished by means of bodies secured to the respective juxtaposed surfaces, and eaoh body will normally define a substantially planar vertical surface spaced a short distance from the beam upon which it is mounted. A body of uniform thickness is normally used in this embodiment of the invention, but it may be broken up into smaller sections. However, a specifically roughened or undulating surface is not required. In other embodiments, the juxtaposed surfaces can be outside the periphery of the column cross-section; i.e., away from the adjacent face of the column. This spacing should normally be no more than one half the depth of the slab, and will preferably be much closer.

In all embodiments of the invention, it is recommended that the lower edges of the juxtaposed surfaces are disposed as close as possible to and preferably at the line of conveyance between the lower surface of the slab and the side surface of the column. This is particularly desirable when a flange extends outwardly from each lower edge of the juxtaposed surfaces. Because high compression forces are generated along this line of conveyance, there is a correspondingly high risk of crushing which can initiate cracks and breakdown the concrete at and around the column. The location of the shearhead with components thereof in this region provides reinforcement in an important section of the junction and can improve the transfer of these forces from the slab to the column.

The invention will now be described by way of example and with reference to the accompanying schematic drawings wherein:

Figure 1 is a plan view of a shearhead assembly embodying the invention:

Figure 2 is a sectional elevation taken on line II-II of Figure 1;

Figure 3 is an enlarged detailed plan view of an alternative shearhead according to the invention;

Figure 4 and 5 illustrate the location of a shearhead according to the invention on a column of circular cross-section;

Figure 6 is a perspective view of another shearhead assembly according to the invention;

Figure 7 shows an assembly broadly similar to that shown in Figures 1 and 2, but including an auxiliary shearhead incorporated therewith; and

Figure 8 shows a side view of a part of the assembly of Figure 6.

The shearhead shown in Figure 1 comprises two pairs of parallel steel beams, 2, 4 of 'C' or channel section with flanges 6,8. The beams 2, 4, which will usually be of steel, are cut and welded together to form the cruciform shape shown. The webs of the beams are vertical and define two pairs of juxtaposed surfaces 10, 12. The upper and lower flanges 6, 8 of the beams 2, 4 lie in the same two horizontal planes, such that the juxtaposed surfaces 10 and 12 define at the intersection of the beams a volume enclosed by a substantially continuous surface defined thereby. At the point of installation, this volume corresponds to a length of the column 14 with the juxtaposed surfaces 10 and 12 at the intersection of the beams defining the peripheral surface of the column. As shown in Figure 1, a column 14 has vertically extending reinforcement rods which extend wholly within the volume defined by the juxtaposed surfaces 10 and 12.

When installing a shearhead of the kind shown in Figure 1, the shearhead is raised or lowered to the top of a column 14, generally as shown in Figure 2. The shearhead is supported on suitable shuttering which will define the lower surface of the eventually cast lateral slab 18, and the requisite reinforcement for the slab is also laid at this time. Concrete is then cast against the shuttering, around the shearhead and within the central volume defined by the juxtaposed surfaces 10 and 12 to simultaneously form the slab 18 and continue the column upwards through the shearhead. The slab 18 around the shearhead will normally be cast in a single pour, but it might be accomplished in stages if required. Similarly, the extent to which concrete is cast to extend the column 14 can be varied, although normally both the slab 18 and the column 14 will be cast to the same height.

The absence of any essential elements to the shearhead within the central volume defined by the juxtaposed surfaces 10 and 12 enables the use of this space for the passage of column reinforcement. If desired, and although strictly unnecessary, this shearhead itself may be reinforced by reinforcing elements within this volume. However, the provision of any such reinforcement such as steel plates or dowels can be determined for a particular installation and can even be fitted in situ to accommodate other components already decided upon. Generally though, the incorporation of additional reinforcement of the shearhead within this volume is unnecessary as it will interfere with the integrity of the column and with the column reinforcement.

In the detailed view shown in Figure 3, a modification of the shearhead of Figure 1 is shown. As shown in Figure 3, the juxtaposed surfaces 10 and 12 are built up around the central volume by means of bodies 20 secured thereon. It will be seen that the bodies 20 project only slightly from the surfaces 10 and 12, and remain well spaced from the reinforcement rods 16. Typically, each body 20 defines a substantially planar vertical surface spaced from the respective surface 10 or 12 by up to 5cm for a column of square cross-section, 50cm x 50cm. Each body 20 can be a single continuous body, or may be broken up into discrete smaller bodies. The overall effect though, should be to define a substantially planar surface spaced from and parallel to the base surface 10 and 12 respectively.

As is apparent from Figure 1, the shearhead described defines a shear perimeter 22 extending around the distal ends of the beams 2 and 4. The extent of the shear perimeter is then determined by the lengths of the beams, which may be set according to the requirements of a particular design. Additionally, it will be noted that because the beams extend against the external surface of the column 14, the beams of each pair are wider spaced from each other than they would be if they passed through the body of the column. This enables the shearhead of the invention to define a larger shear perimeter than would be possible for more closely spaced beams of the same length. It also reduces the variations in the radius of the shear perimeter with respect to the column axis. The more widely spaced beams also provide additional space for the installation of utilities and service ducts. In larger constructions for example a service duct might be disposed between a pair of beams 2 or 4. This is of course in addition to the space available between each beam 2 and its adjacent beam 4.

The shear perimeter may in all embodiments of the invention, be more clearly defined if desired. The distal ends of the beams 2 and 4 may be linked by suitable additional structure, to which utilities and surface passages can also be secured.

Shearheads according to the invention are suitable where relatively heavy loads must be borne. As noted above, a typical column might be 50cm square, to support a slab of say 30cm depth. Once installed, and with the concrete cast therearound, the shearhead itself is wholly covered, and a substantially perpendicular junction. is formed between the lower surface of the slab and each side of the column.

Figures 4 and 5 show how a shearhead according to the invention can be used on circular columns. In Figure 4 the column 24 has four vertical reinforcement rods 26. The juxtaposed faces 10 and 12 are aligned tangentially to the cylindrical external surface of the column 24. In Figure 5 the faces 10 and 12 form chords across the cross-section of the column 24, and the distal edges of the flanges 6,8 of the beams 2,4 run tangentially to the column surface. It will be noted though, that the reinforcement rods 26 remain within the space enclosed between the juxtaposed faces 10 and 12 of the beams 2,4.

Figure 6 shows an alternative embodiment of the invention in which the shearhead comprises four separate beams 28, each comprising parallel side sections 30 and a bridge 32, in which the bridge 32 forms the juxtaposed surfaces 12. Each of the sections 30 and bridges 32 is of C-shaped or channel cross-section comprising a web (30) and flanges 34 directed inwardly relative to the respective beams. The beams 28 are quite separate, and do not therefore contribute to the reinforcement in the slab itself against bending about the junction with the column out of the lateral or horizontal plane in which it is cast. This shearhead is thus designed solely to resist shear forces generated by the weight of the slab and the load thereon acting on the column.

In Figure 7 a shearhead assembly of the type described with reference to Figures 1 and 2 is illustrated in which an additional shearhead of the linked unit type referred to above is incorporated. The unit shown comprises a hoop bar 36 with a plurality of shear legs 38 depending therefrom. Such a unit type shearhead can structurally strengthen the junction between the slab and column with respect to shear forces, and assist in defining the shear perimeter as discussed above with reference to Figures 1 and 2. The reason is that the hoop bar 36 effectively confines a mass of concrete within it and serves to inhibit radial cracking. This effect can be enhanced by the provision of an additional hoop bar (not shown) below the shearhead, but the primary benefit is achieved by the use of the upper hoop bar 36 alone. It is also possible to omit the shear legs 38, but these are preferably retained as they act directly to reinforce the slab against shear forces. Shearheads of the unit linked type are considered in greater detail in our co-pending Application filed today under our Agents' reference EH 34199, and to which reference is directed. That Application discusses the use of a plurality of such shearheads around one column, and such a plurality can also be used in conjection with the shearheads described herein.

As shown in Figure 8, the hoop bar 36 extends over the beams 2, 4 of the shearhead. The shear legs 38 depend therefrom around the column 14 both in the quadrants between orthogonal beams 2 and 4 and between parallel beams 2 or 4. The bases of the shear legs are at or just below the lower flanges 8 to preserve the depth of shear reinforcement around the shear perimeter.

Combining shearhead types in the same assembly as described above also facilitates the formation of service openings in the slab adjacent the column. Such openings can be formed within or between the beams of the shearheads with their outer periphery reinforced by a section of the hoop bar of the linked unit type shearhead in a structurally sound manner.

While the shearheads of the present invention are described primarily for use on reinforced concrete columns, they can also be used welded or otherwise mounted on steel columns, but again supporting a reinforced concrete slab. This can be alone or in combination with one or more linked unit type shearheads as described.

Claims

1. A shearhead assembly supporting a laterally extending concrete slab on a concrete column, having a shearhead comprising two pairs of beams with juxtaposed vertical surfaces which define therebetween an area substantially corresponding to the cross-section of the column, wherein the shearhead is located at the top of the column, and concrete is cast around the shearhead and between the pairs of beams to form the laterally extending slab and extend the column therethrough.

2. A shearhead assembly according to Claim 1 wherein the column is reinforced by rods extending vertically through the space between the beams.

3. A shearhead assembly according to Claim 1 or Claim 2 including reinforcement in the column and between the pairs of beams.

4. A shearhead assembly according to any preceding Claim wherein the juxtaposed vertical surfaces of the beams are built up.

5. A shearhead assembly according to Claim 4 wherein said surfaces are built up by means of a body secured thereto and projecting towards the respective juxtaposed surface.

6. A shearhead assembly according to Claim 5 wherein each body defines a substantially planar vertical surface spaced from the respective beam.

7. A shearhead assembly according to any preceding Claim wherein the shearhead comprises steel beams welded together to form an integral structure.

8. A shearhead assembly according to any preceding Claim wherein the beams are of 'C' section with flanges extending outwardly from the space between the beams.

9. A shearhead assembly according to any of Claims 1 to 6 wherein the shearhead comprises a plurality of convergant beams with the proximal ends thereof defining the juxtaposed surfaces, the beams being unconnected to each other and independantly supported in the assembly.

10. A shearhead assembly substantially as described herein with reference to the accompanying drawings.

Fig. 1.

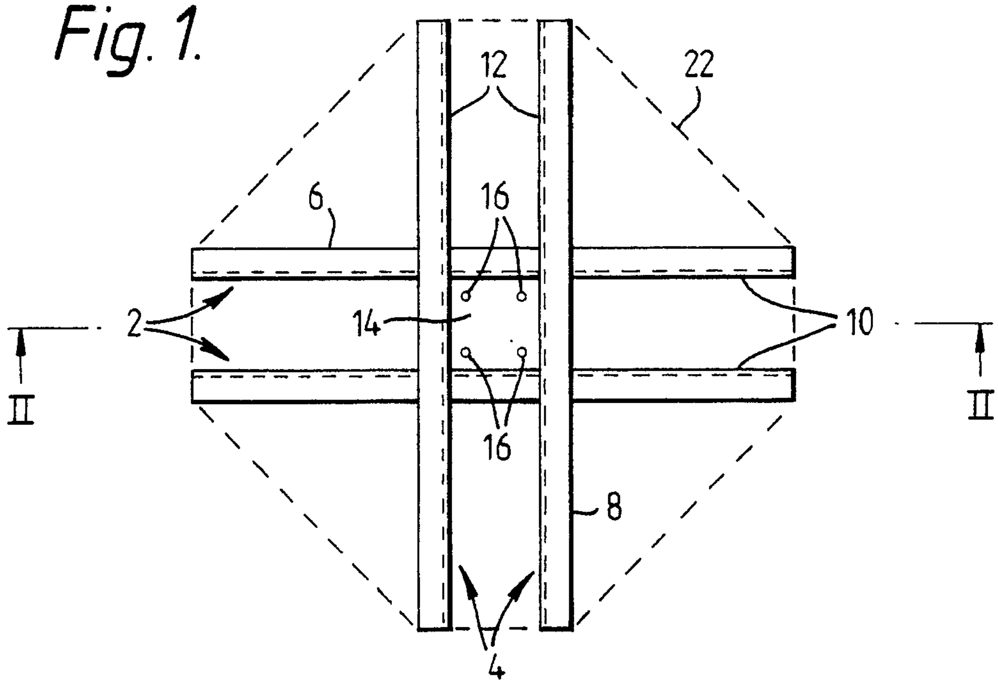


Fig. 2.

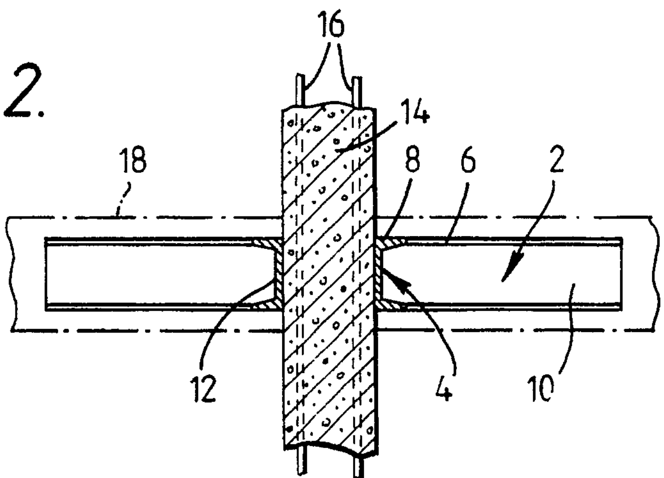


Fig. 3.

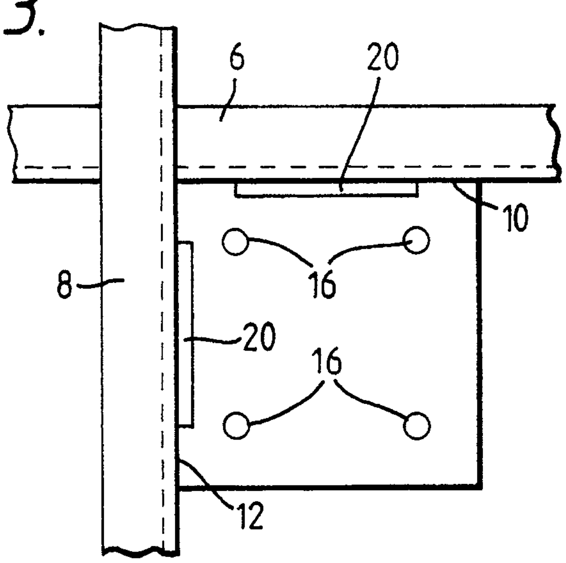


Fig. 4.

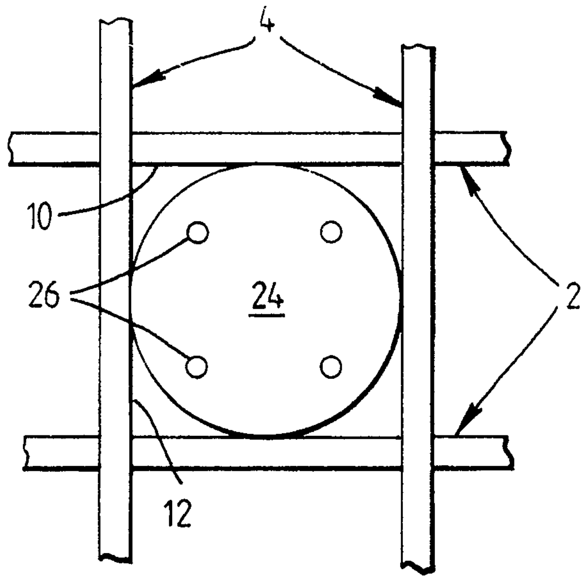


Fig. 5.

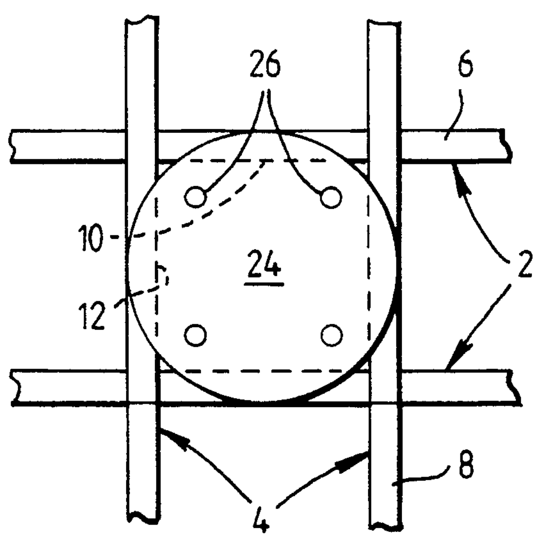


Fig. 6.

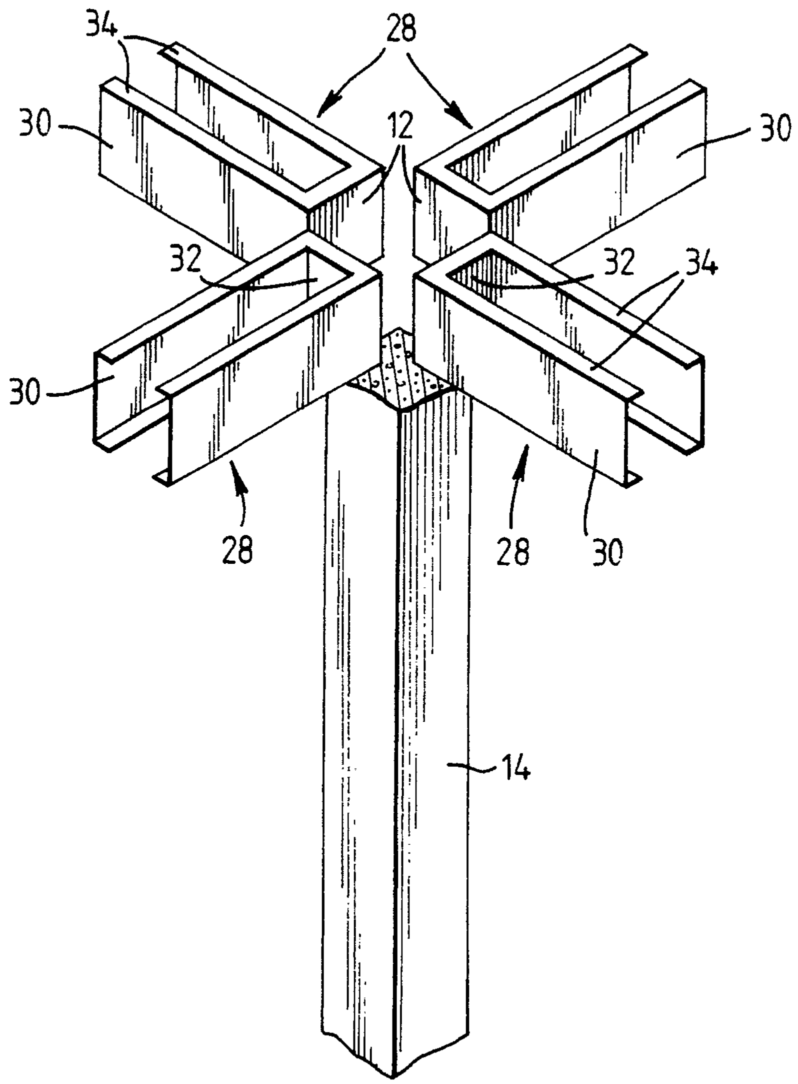


Fig. 7.

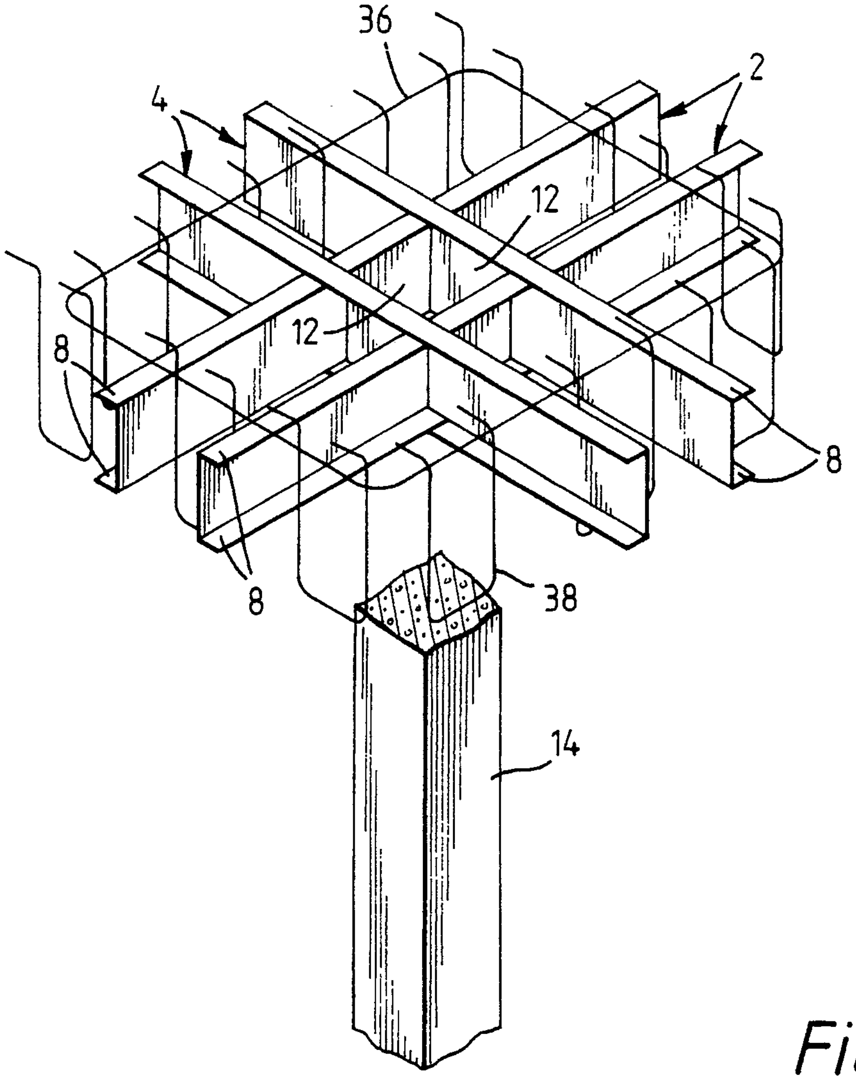
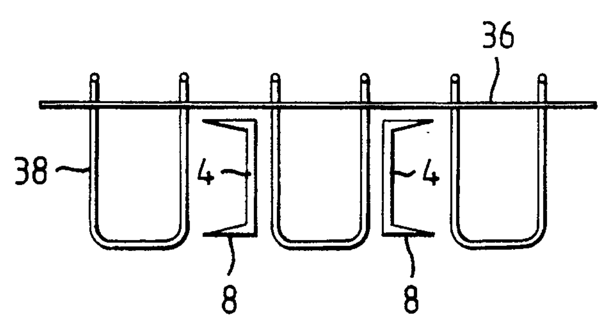


Fig. 8.



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EUROPEAN SEARCH REPORT

Application Number

EP 90 30 9137

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	CH-A-1 569 64 (B. BAUER) * Page 3, column 1, paragraph 7; page 3, column 2, paragraph 3 - page 4, column 1, paragraph 1; figures 1-5,25 * - - -	1-8,10	E 04 B 1/16
A	WO-A-8 707 318 (J. CULICA et al.) * Page 3, paragraph 11 - page 4, paragraph 4; figures 1-3 * - - -	1-3,7,8	
A,D	EP-A-0 128 994 (GEILINGER AG) - - -		
A	EP-A-0 184 995 (U.C. ASCHWANDEN) - - - - -		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 04 B

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	26 November 90	KAPPOS A.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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