Abstract: Modular, sintered, expanded-polystyrene element for building reinforced-concrete floors, of the type comprising a polystyrene body within which metal sections (A) are embedded (A) which impart a self-support feature to said element, and wherein said polystyrene body has any length and a substantially rectangular section from the bottom portion of which lateral, low-thickness wings (4) project. Said metal sections (A) have an overall height (h) equal to or slightly above the height of said lateral wings (4) and one or more recesses (2) are furthermore provided in said polystyrene body along a crosswise direction with respect to the one of said metal sections (A).
MODULAR ELEMENT IN SINTERED EXPANDED-POLYSTYRENE FOR BUILDING REINFORCED-CONCRETE FLOORS

DESCRIPTION

FIELD OF THE INVENTION

The present invention refers to prefabricated elements made of insulating materials to be used in the construction of floors, and in particular to a modular element made of sintered expanded-polystyrene for building reinforced-concrete floors. The invention also relates to a reinforced-concrete floor built by using a plurality of said modular elements, arranged one adjacent to the other, which remain integrated in the floor.

STATE OF THE PRIOR ART

The technique of building floors made of reinforced concrete using, for preparing the provisional casting plane, elements made of expanded plastic materials, preferably sintered expanded-polystyrene, instead of the traditional brick elements, has been known for a long time in the building industry.

The floor building technique is substantially identical in both cases and provides to form said casting plane through a plurality of self-supporting elements arranged side by side, preferably with overlap or mutual joints, and resting at their ends against perimeter walls or pillars. Before accomplishing the casting, between pairs of adjacent elements made of expanded polystyrene, and in correspondence of a longitudinal channel formed in the same, reinforcing rods are arranged in a fully conventional manner, so that, once the casting has occurred, the floor embeds within itself both the expanded-polystyrene elements and the reinforcing rods. In correspondence of the reinforcing rods, longitudinal joists are hence formed, which provide the mechanical strength of the floor once the concrete has hardened. With respect to the floors formed with brick elements, the floor with expanded-polystyrene elements has - the mechanical strength being the same - a remarkably smaller weight and a much greater thermal insulation coefficient.

WO-A-98/16703 is a representative document of the technique illustrated above which discloses a prefabricated element made...
of polystyrene wherein two Z-shaped longitudinal metal sections are embedded, upon fabrication of said elements, which metal sections provide a self-support feature thereto. The lower sides of the L-shaped sections are in view and resting on the lower face of the prefabricated element, so that they may be used to fasten a metal reinforcing mesh thereto by welding. Such mesh is meant to ease the anchoring of a lower covering such as plaster and to guarantee the overall mechanical solidity of the construction even in case of fire, in which situation the expanded-polystyrene material might melt due to the high temperatures.'

PROBLEM AND SOLUTION

The problem at the basis of the invention is to provide a prefabricated polystyrene element of the type illustrated above which allows, in addition to the reinforced-concrete longitudinal joists described above, also building crosswise joists, so that the mechanical strenght of the floor is identical in the two directions forming a so-called plate floor with remarkably better performances.

In fact the same problem has already been addressed in the known art, as shall be seen in the following, however, with solutions far from being satisfactory both due to the construction complications which sue solutions entail and due to the insufficient level of prefabrication which still requires a high degree of skilled labour during laying.

WO-A-2005/121467 has a structure fully similar to the one described above for WO-A-98/16703, of which it recalls all the essential elements. However, the metal sections which make the polystyrene element self-supporting have an L shape, wherein the upper end of the section is folded on itself, hence causing a slight thickening thereof. In a first embodiment the element is conceptually identical to the one described above and it hence allows building floors only provided with reinforced-concrete joists having a longitudinal direction. In a second embodiment, the metal sections are not provided during the manufacturing process of the polystyrene elements, but are inserted later, into respective seats formed in the polystyrene through a me-
chanical cutting process (for example by hot thread) of the element. This separate-steps fabrication method hence allows to form also a series of crosswise grooves in the polystyrene element into which reinforcing rods may then be arranged to thus finally obtain a plate floor having reinforced-concrete joists oriented in two perpendicular directions.

However, the solution proposed in WO-A-2005/121467, in addition to the evident complication and to the greater costs of the two-steps manufacturing, also has two remarkable technical disadvantages. A first disadvantage is due to the fact that the metal sections are no longer securely anchored to the expanded material - as occurs instead in the simultaneous manufacturing process in which said material penetrates, in the fluid state, in the holes existing on the wings of said sections - but are simply inserted in the same. That close connection between sections and expanded material is hence lacking, which connection being the only feature apt to cause an even and correct distribution of the mutual loads both during the transport and laying operations and during the floor-building step. A second remarkable operational disadvantage is furthermore connected to the fact that the operation of laying the reinforcing rods in the crosswise channels may of course be accomplished only after the metal sections have been positioned, thus creating a plurality of barriers within said channels. It is hence not possible to arrange the rods in said channels from above, according to the standard building site procedure, but the rods must instead be inserted laterally introducing them one by one into the holes provided on the wings of the different metal sections which interrupt the continuity of said channels. Hence an operation which is not always possible to be performed, due to the evident need for a free space next to the floor under construction having a size at least corresponding to that of the floor itself, and in any case an extremely long, difficult and labour-intensive operation.

WO-A-2006/040624 addresses the same problem, however, offering a solution of a different type, in which the polystyrene
elements are divided into two separate layers which are mounted only during the installation on-site. A first base layer forms a low-thickness continuous plane and embeds the metal sections which provide a self-support feature thereto. A second layer consists instead of individual parallelepiped elements which are positioned one-by-one according to a grid-like pattern on the base layer, forcedly inserting them on a portion of the metal sections protruding from the base layer, so as to leave between them both longitudinal channels and crosswise channels in which the reinforcing rods are then arranged. Although this solution removes the drawback shown above in connection with patent WO-A-2005/121467, i.e. the lateral insertion of the reinforcing rods, it still has instead the drawback of an insufficient anchoring of the upper polystyrene layer to the metal sections and of a remarkable installation complexity of such layer, the individual parallelepiped elements of which must be accurately positioned in a longitudinal direction, possibly using suitable templates, to guarantee that the crosswise channels formed thereby have constant width and perfect alignment.

The object of the present invention is hence that of providing a prefabricated polystyrene element of the self-supporting type which solves the above-described problem of allowing building a plate floor comprising reinforced-concrete joists in two orthogonal directions, however, without being affected by the above-described drawbacks of the prior art.

In particular it is hence a first object of the present invention to provide a prefabricated polystyrene element of the type described above in which the reinforcing metal sections are perfectly embedded in the expanded material during the prefabrication procedure.

A second object of the present invention is to provide a prefabricated polystyrene element of the type described above, already perfectly complete and available in modules extending in a longitudinal direction at a desired length, so that such element may be directly installed side by side to other similar elements, without requiring any other further mounting or fin-
ishing operation or insertion of additional bodies, despite allowing the desired creation of said crosswise channels.

Such objects are achieved through a modular expanded-polystyrene element having the features defined in the main claim herewith enclosed. The dependent claims describe other preferred features of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the invention will in any case be more evident from the following detailed description of a preferred embodiment thereof, given purely as a non-limiting example and illustrated in the attached drawings, wherein:

fig. 1 is a schematic perspective view of a modular polystyrene element according to the present invention:

fig. 2 is a crosswise section view in an enlarged scale of the modular element of fig. 1; and

fig. 3 is a schematic perspective view of a plurality of modular elements laid side by side to provide a casting plane for the construction of a floor.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

As clearly illustrated in figs. 1 and 2, each modular element E of the present invention consists of a single sintered, expanded-polystyrene body, within which two metal sections A are embedded which impart a self-support feature to the element, in a fully similar way to the reference known art consisting of above-described patent WO-A-98/16703, the full contents of which are here considered included by reference. In particular the polystyrene body has any length and a substantially rectangular section from which lateral wings 4 project below, said wings 4 having a reduced thickness compared to the one of the main inner portion 1 of said body.

The modular element of the present invention, however, is characterised - compared to the prior art - by the fact that metal sections A have an Ω-shaped section, preferably comprising edge-connected planar sides, as well as by the fact that the overall height h of such sections is substantially equal to, or
slightly greater than, the thickness of the wings 4 of element E. Due to this particular construction it is possible to provide within each element E a series of crosswise recesses 2 being so depth as to extend up to the upper part of the metal sections Δ. Recesses 2 can thus have a fully equivalent size, both in width and in depth, to the longitudinal cavities 3 which are formed in the junction area between two adjacent elements E, according to the teachings of the prior art, said recesses 2 and cavities 3 thereby defining the inner portions 1 of modular element E which have a square or rectangular shape depending on whether the pitch of recesses 2 is equal to or different from the width of portions 1.

When multiple elements E are arranged one adjacent to the other, a network of orthogonal channels 2 or 3 is thus formed, within which it is easy and immediate to arrange, from above, reinforcing rods F while, where desirable, a metal reinforcement mesh R may simply be rested above the inner portions 1 of elements E. At this point a concrete cast C, above the casting plane consisting of elements E positioned side by side, builds the desired plate floor provided with reinforced-concrete joists both in a longitudinal direction and in a crosswise direction, thus reaching the object of the invention.

As stated above, metal sections A have an Ω-shaped section, to be precise consisting of five edge-connected planar sides. The two terminal sides and the central one of the section are parallel to the lower face of element E while the two intermediate sides are perpendicular or moderately inclined with respect to such face. Moreover, one of said terminal sides is positioned adjacent to and outside the expanded-polystyrene body, so as to be able to be used for the anchoring of a metal reinforcing mesh, in a manner known per se, while the other terminal side is embedded in the expanded-polystyrene body.

As will be clear from the preceding description, the modular, expanded-polystyrene element E of the present invention has fully achieved the set objects. As a matter of fact it is an element which is completely prefabricated in all its details in
the desired length and which may hence be installed in a fast and easily automatable way. In such element E, the metal sections A which provide the self-support feature thereof are entirely embedded in the expanded-polystyrene body and hence perfectly integral with the same. The arrangement of multiple adjacent elements E hence allows to obtain - with no further operations but the simple laying, from above, of reinforcing rods F in a conventional manner - a casting plane already prepared with orthogonal channels for building a plate floor with bidirectional reinforced joists.

However, it is understood that the invention must not be considered limited to the particular arrangement illustrated above, which represents only an exemplifying embodiment thereof, but that a number of variants are possible, all within the reach of a person skilled in the field, without departing from the scope of protection of the invention, which is defined by the attached claims.
CLAIMS

1. Modular, sintered, expanded-polystyrene element for building reinforced-concrete floors, of the type comprising a polystyrene body within which metal sections (A) are embedded which impart a self-support feature to said element, and wherein said polystyrene body has any length and a substantially rectangular section from the bottom portion of which lateral, low-thickness wings (4) project, characterised in that said metal sections (A) have an overall height (h) equal to or slightly above the height of said lateral wings (4) and in that one or more recesses (2) are furthermore provided in said polystyrene body in a crosswise direction with respect to the one of said metal sections (A).

2. Modular, sintered, expanded-polystyrene element as claimed in claim 1, wherein said metal sections (A) have an Ω-shaped section with edge-connected planar sides.

3. Modular, sintered, expanded-polystyrene element as claimed in claim 1 or 2, wherein said crosswise recesses (2) have substantially the same size of the cavities (3) which are formed, above said lateral wings (4), in correspondence of the junction area of two adjacent elements (E).

4. Modular, sintered, expanded-polystyrene element as claimed in claim 3, wherein said crosswise recesses (2) have a direction perpendicular to said metal sections (A).

5. Modular, sintered, expanded-polystyrene element as claimed in claim 4, wherein the distance between two adjacent, crosswise recesses (2) is equal to the width of the inner portions (1) of said elements (E).

6. Modular, sintered, expanded-polystyrene element as claimed in anyone of the preceding claims, wherein said metal sections (A) having an Ω-shaped section with edge-connected planar sides have the two terminal sides parallel to the bottom surface of said element (E), said sides being positioned, adjacent to and outside and inside, respectively, the expanded-polystyrene body.

7. Reinforced-concrete floor comprising: a casting plane
consisting of a plurality of modular, expanded-polystyrene elements as claimed in any one of claims 1 to 6, arranged mutually adjacent; reinforcing rods (F) arranged within said longitudinal recesses (3) and said crosswise recesses (2); and, possibly, reinforcing meshes (R) arranged above the inner portions (1) of the polystyrene body of said elements (E).
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. E04B5/19  
EQ4B5/21  
E04B5/36  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

EQ4B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<tr>
<td>X</td>
<td>US 2008/041004 AI (GIBBAR JAMES H [US] ET AL) 21 February 2008 (2008-02-21) figures 5, 6</td>
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</tr>
<tr>
<td>Y</td>
<td>US 5 893 248 A (BELIVEAU JEAN-LOUIS [CA]) 13 April 1 1999 (1999-04-13) figure 2b</td>
<td>2,6</td>
</tr>
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Date of the actual completion of the international search: 11 November 2013

Date of mailing of the international search report: 18/11/2013

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<tr>
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<tr>
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<td>21-02-2008</td>
<td>NON E</td>
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<td>13-04-1999</td>
<td>NON E</td>
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<td>us 2007039266</td>
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<td>RU 23461.18 C2</td>
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<td>US 2007039266 Al</td>
<td>22-02-2007</td>
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