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(54) **Precast structural concrete slab for slab track and process for installing the same**

(57) A structural precast concrete slab (3) and the process for installing the same, of the type supporting the rails on which railway cars circulate and comprising

on its face or lower surface an elastomer layer (4) fixed in a discontinuous manner which in turn bonds to the substrate for supporting the precast slab.

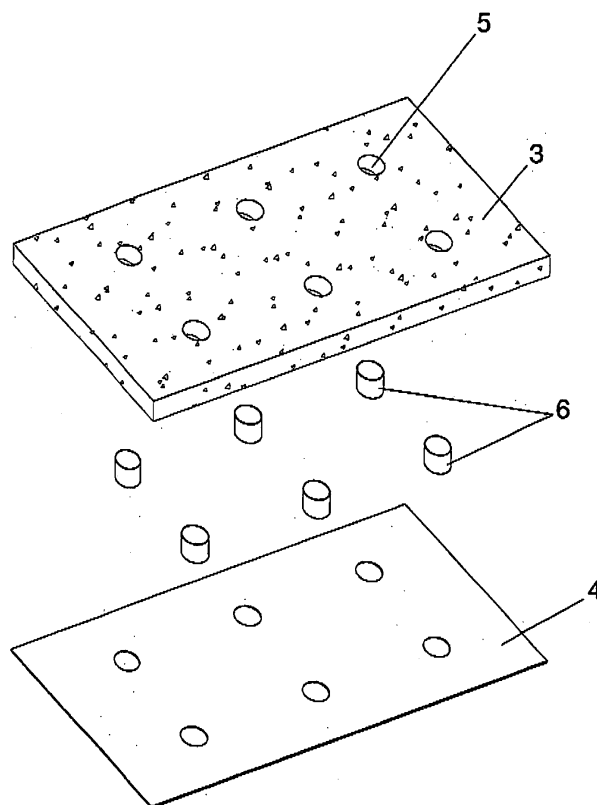


FIG. 1

Description

Field of the Art

[0001] The present invention relates to a precast structural concrete slab and the process for installing same, said slab being of the type supporting the rails on which railway cars circulate and having on its face or lower surface an elastomer layer, preferably rubber agglomerate, which is fixed in a discontinuous manner to the slab, and the elastomer layer bonds to the substrate for supporting the slab, creating independent slabs.

Prior State of the Art

[0002] Slab track systems are commonly formed by a reinforced or prestressed concrete slab on which the systems for fixing the rail on which railway cars circulate is arranged.

[0003] In the state of the art there are different precast slab track systems known which have a precast slab independent from the adjacent slabs with a considerably prismatic shape and made from reinforced or prestressed concrete and a layer of material having low rigidity or an elastic layer (of elastomer, asphalt cement, etc.) located between the precast slab and the substrate of the track (normally concrete). Anchoring elements integral with the substrate and housed in geometrically identical cavities made in the slab are used for anchoring between the substrate and the precast slab.

[0004] The purpose of the elastic layer is mainly to reduce the vertical rigidity of the assembly formed by the track, the fastening of the track slab and the substrate compared to the traditional track with sleepers and ballast. Another purpose is also to reduce the wear due to friction of the contact surface existing between the substrate, when it is made of concrete, and the precast concrete slab. Said wear is due to the transmission of forces to the substrate due to braking, longitudinal and centrifugal accelerations.

[0005] The most important horizontal longitudinal forces or actions in these systems originate from, in addition to the previously indicated railway traffic, time-dependent deformations of the concrete (shrinkage and creep) as well as from the thermal changes overtime. Said deformations are different in the substrate and in the precast slab which causes stresses capable of cracking the concrete of the slab if, due to bonding, the substrate restricts the free shortening of the precast slab.

[0006] There are two main solutions to prevent or limit this restriction.

- The first solution consists of placing by injection a layer of several centimeters of cement and asphalt mortar, or another type of flexible mortar, between the precast slab (already placed) and the substrate already set prior to placing the track slabs. This solution has considerable horizontal and vertical flexi-

bility as well as a bonding limited to the two concretes which have been hardened long before their application, therefore the restriction of the horizontal deformation differences of both concretes is very small.

- The second solution, normally associated to using reinforced precast concrete slabs, uses a thin elastomer layer of around 5 mm adhered to a surface of the precast slab by one of the faces of the elastomer layer and the opposite face of said layer is put into contact with a concrete used for leveling-up that of the substrate, said face being provided with an anti-tack agent (wax or paraffin). This anti-tack agent cancels the bond which would otherwise occur between the elastomer and the leveling-up concrete which is incorporated on site and which, in the event that the anti-tack agent is not used, would set in contact with the elastomer. The latter is accentuated when elastic layers of rubber agglomerate with a coarse grain (2 to 4 mm) surface are used, for which purpose an anti-tack layer of paraffin with an impalpable aggregate is used further providing the property of smoothing the contact surface.

[0007] In both solutions, especially in the second solution, there is virtually no bonding between the elastic layer and the concrete or lower mortar on which it is supported, concrete stoppers therefore being necessary which will be responsible for absorbing the horizontal forces due to the circulation of the trains on the slabs.

[0008] In the first solution two cylindrical shaped stoppers are used and located outwardly from the longitudinal ends of the track slab, whereas in the second solution the stoppers are normally two in number and are located inwardly and have a rectangular shape, being internally lined by the elastomer which is a prolongation of the lower elastomer of the slab. The plan dimensions of these stoppers are always considerable (greater than 600 mm) and other boreholes with a small diameter are required for the installation, the function of which boreholes is to allow the injection of the asphalt cement or of the filler concrete in order to complete the access of these materials to the entire base of the slab.

[0009] A numeric analysis of the stresses due to the shrinkage and creep of the concrete of the precast slab restricted with the concrete substrate, justifies the need to prevent the bonding between both concretes through the mentioned non-bonded elastomer layer. The obtained values indicate excessive cracking with normal amounts of reinforcement, and in the case of prestressed slabs, the loss over time of the total prestressing force in the case of bonding.

[0010] The contrast is the obligation of arranging considerable concrete elements or stoppers, normally surrounded by an elastic layer, connecting the precast track slab and the concrete of the substrate, allowing the absorption of the horizontal forces of breaking, acceleration, continuity of the rail, etc.

Explanation of the Invention

[0011] The present invention consists of a precast structural concrete slab and a process for installing same, of the type supporting the rails on which railway cars circulate and having on its face or lower surface an elastomer layer, preferably rubber agglomerate, fixed to the slab without any intermediate adhering layer or admixture. Said structural concrete can be reinforced, prestressed or reinforced with fibers.

[0012] By means of the present slab, loads are transmitted to the substrate formed by compacted improved ground or concrete through a self-compacting rigid mortar or Portland cement mortar, and naturally joined together without any intermediate anti-tack material, both to the substrate and to the elastic layer. The precast slab has several roughly cylindrical shaped boreholes, preferably two every two meters, with a diameter of between 10% and 16% of the width of the slab, which are internally lined or encased by an elastomer having a thickness greater than that of the elastomer or elastomeric layer arranged below the slab and which are filled by the self-compacting mortar in the final assembly situation. The reduced diameter of the boreholes allows the distribution of the prestressing of the slab to be even and therefore provides a solution for a structurally correct slab.

[0013] A first object of the present invention is a slab according to claim 1, i.e. a structural precast concrete slab, i.e. reinforced or prestressed and with a rectangular section. Said slab is preferably used in a slab track system on which train rails are fixed and has an elastomeric layer which is supported on a substrate through a mortar poured after placing the slab on the substrate, said slab having vertical holes or boreholes. The elastomeric layer is fixed in a discontinuous manner by one of its faces to the lower surface of the precast slab, only through certain points or areas partially covering said lower surface, and which never extend along the entire contact surface with the slab. Said elastomeric layer likewise bonds in a continuous manner to the subsequently poured mortar due to the natural bond existing between the mortar and the elastomer. The slab has at least four vertical holes for pouring the self-compacting mortar, and with an elastomeric layer independent from the lower elastomeric layer, arranged therein by way of an inner lining.

[0014] The process for installing the mentioned slab track system comprises the following steps:

1 Precasting the structural concrete slabs, preferably comprising inserts on the upper surface for fixing the rails, known as spikes or screws, for subsequently fixing the rail, preferably cylindrical boreholes with their elastomer lining or sleeve, an elastomer layer weakly and/or provisionally fixed at a series of specific points to the lower surface of the slab, but not fully adhered or bonded to all of said surface of the slab. Said elastomer layer is placed on the lower surface of the slab once the concrete thereof has set.

2 After transporting the slab to its location, the on site positioning and vertical and horizontal plotting of the slabs in relation to the substrate is carried out. Metal frames or other provisional elements with hydraulic and mechanical elements can be used for this operation, which will allow the geometric adjustment of the slab and which will be supported in the substrate and be provisionally integral with the slab, the slab being in its definitive position and supported by the mentioned frames.

3 Subsequently injecting the self-compacting bonding mortar, leveling and filling, carried out without vibration and which mortar is distributed through the preferably cylindrical boreholes or holes existing in the slab and evenly distributed in the base for allowing complete filling with said self-compacting mortar of the space existing between the slab and the substrate. As has been mentioned, this operation is carried out without any vibration as a result of using self-compacting mortars and concretes and of the pressure on the assembly produced by filling said boreholes.

4 The last step of the installation process consists of the setting of the mortar, removal of the provisional fixings or pedestals and making the final geometric adjustments of the rail to be installed on the slab.

[0015] In addition to the previous steps, the rail would be installed on the structural precast concrete slab, said installation being able to be carried out previously or subsequently to pouring the concrete, i.e. before or after the previously described third step.

[0016] Therefore a second object of the present invention is a process for installing a concrete slab according to claim 13.

[0017] Both the slab and the installation process object of the present invention thus allow there to be no cohesion in the contact surface between the precast slab and the elastomer layer since there is no bonding agent, but there is friction between the concrete and the elastomer. There is likewise considerable bonding and friction in the contact surface between the elastomer layer and the self-compacting mortar upon the setting of the mortar in direct contact with said elastomer.

[0018] The performance of the installed precast slab given different stresses is detailed below:

- Given time-dependent deformations (shrinkage and creep) and thermal deformations of the precast slab. These deformations occur over time without the presence of the weight of the trains, there being no restriction of the deformation by the elastomer layer in these conditions since the cohesion is virtually null and void and considerable vertical stresses do not exist in elastomer-slab contact; friction therefore does not act. This prevents cracking in reinforced slabs and the almost complete time-dependent losses of prestressing force in prestressed slabs.

- Given longitudinal horizontal acceleration and braking actions and transverse actions.
These actions occur with the presence of the trains, causing the subsequent normal vertical stresses bringing about or activating friction between the slab and the upper face of the lower elastic layer. A large part of the horizontal forces, usually greater than 50% in normal cases, is transmitted to the substrate through this elastomer layer in a widely distributed manner and with very minor creep or displacements. This behavior together with the forces considerably less than 50% transmitted to the boreholes filled with mortar acting for this purpose as connectors, represent a clear advantage in displacements and stresses compared to other systems in which upon having an anti-tack substance on the contact surface between the elastomer and the filling concrete of the substrate, all the horizontal forces are transmitted in a concentrated manner through the rectangular connection or anchoring elements the dimensions of which must be considerable.
- Given vertical loads as a composite section.
Friction causes the integral behavior of the slab and the elastomer layer upon the passage of vehicles, which together with the permanent bonding of the self-compacting mortar with the elastomer and with the substrate causes continuous deformations throughout the assembly and stresses in the materials, mainly in the slab, which are much lower than those corresponding to a behavior with sliding on the contact surfaces between different materials appearing in the solutions used in the state of the art using an anti-tack layer.

[0019] Another feature object of the present invention and consequence of the simple geometry of the slab, of the boreholes with small diameter and of the possibility of varying the thicknesses of the elastic layer is the module character of the system, since it allows adapting to that end the amount of the prestressing tendons, which is geometrically easily achieved.

[0020] This modular adaptation quality has two important practical consequences:

1 Using the system with substrates or with lower surfaces within a wide range of rigidities. To that end, the rigidity and thickness of the elastic layer is adapted, which allows responding to the range of corresponding bending moments and also to the amount of active reinforcement of the prestressing.

2 Obtaining typical frequencies of the precast slab-non-cushioned mass assembly of the rolling stock, i.e. the train assembly sliding on the rails, within a predetermined range, particularly applicable for demanding environmental conditions with precise control of the vibrations transmitted to the supporting ground or structure, such as bridges for example. To that end considerable thicknesses (several cms of

elastic layer) are necessary and obtaining greater flexibility further forces reducing the surface of the elastic layer

[0021] In order to solve the foregoing or for the purpose of saving in costs, it is possible to substitute the continuous elastomer layer with a peripheral elastomer band covering the boreholes and a central area made of a material with very low rigidity, such as polyspan, and a thickness greater than the peripheral band.

[0022] This solution maintains the behavioral philosophy of the previously detailed embodiment with a continuous elastomer layer as regards the behavior under horizontal loads and the implementation simplicity with the joint injection of the rigid self-compacting Portland cement mortar layer.

[0023] This alternative support form involves a modification of the stresses to which the system and particularly the slab is subjected and is solved by means of adapting the prestressing amount.

[0024] The prestressed slab condition allows the modular nature of the solution, adapting the prestressing level in each case, due to the reversible character of this technology, i.e. the capacity of closing the cracks (remaining crack width less than 0.05 mm, implying an acceptable value in an aggressive environment) when overloads do not act, and due to the concrete element being compressed in the permanent weight situation. This prestressing property further involves a considerable strength capacity reserve in the case of localized cavities and settings of the supporting ground and high performance against fatigue and durability.

[0025] In the two proposed solutions, the contiguous slabs are independent of one another, i.e. one slab is independent of the contiguous slab or slabs in the transmission of bending, even though the space existing between the precast slabs is filled or not filled by the self-compacting mortar, which does not transmit the bending moments between slabs.

Description of the Drawings

[0026] Reference has been made below to the following figures attached to the description in a non-limiting manner for the purpose of facilitating the understanding of the invention.

Figure 1 shows an exploded view of the components of the precast slab.

Figure 2 shows an upper plan view of the slab track system object of the present invention.

Figure 3 shows a cross-sectional view according to the AB plane of Figure 2.

Figure 4 shows a section of a second solution of the slab track system.

Figure 5 shows a partial lower view of the base of the slab track system of Figure 4.

Figure 6 shows a plan view of the precast slab ac-

cording to the present invention in which an arrangement of the prestressing tendons can be observed therein.

Figure 7 shows an upper plan view of the precast slab with the rails installed.

Description of a Preferred Embodiment

[0027] In the first solution of the precast slab 3 object of the present invention, which is observed in figures 1, 2, 3 and 6, the slab 3 is prestressed both longitudinally and transversally with centered prestressing force provided preferably by two symmetrical layers of tendons. Said slab has planar and parallel faces, with dimensions between 5 and 6 meters in length, preferably 5.1m or 5.75m; between 2 and 2.8 meters in width, preferably 2.5 m; and between 0.15 and 0.25 meters thick, preferably 0.20 m; including at least four through boreholes 5, preferably six in number, evenly distributed in the base, two rows of three boreholes and with a considerably cylindrical longitudinal section and with a circular horizontal section with an average diameter of 0.3 m. The longitudinal section can also be frustum-conical and the horizontal section elliptical. This distribution of boreholes 5 and the reduced diameter thereof allows an optimized arrangement of the prestressing tendons inside the slab 3 in addition to enabling a reliable injection of the self-compacting mortar 2. The situation, dimensions and the use of either material for designing the slab have evidently been object of complex calculations and tests.

[0028] The elastomer layer 4 is preferably formed by fine grain rubber agglomerate normally bonded or cemented with polyurethane and with a thickness of greater than 3 mm. The elastomer 6 coating the inside of the boreholes 5 useful as a lining therefor, has a thickness greater than that of the lower layer to regulate the horizontal rigidity of the lined stopper, which stopper results from the setting of the self-compacting mortar poured inside said boreholes, such that the horizontal stresses due to the trains are absorbed in large part by the lower surface of the slab supported on the elastomer layer 4 and in addition the restriction of the stoppers due to shrinkage, creep and thermal effects is very small. It is also appropriate for the self-compacting mortar layer 2, resulting from the pouring thereof through the boreholes 5 made in the slab 3, to have, due to construction conditions, an average thickness greater than 4 cm in order to thus absorb the irregularities of the substrate 1.

[0029] Another preferred embodiment consists of substituting the mentioned continuous elastomer layer 4 with a peripheral elastomer band 8 covering the boreholes 5 and a central area made of a material having very low rigidity 9, such as polyspan, and a thickness greater than the outer band 8.

[0030] The precast slabs 3 are longitudinally and transversally stressed by means of prestressing tendons 11, the layout of said tendons 11 being geometrically compatible with the cylindrical holes or boreholes 5 crossing

the slabs 3.

[0031] In the two proposed solutions, the contiguous slabs 3 are independent of one another 10 as can be observed in Figure 2, i.e. slab 3 is independent of contiguous slab or slabs 3 in the transmission of bending, even though the space existing between the precast slabs 3 is filled or not filled by the self-compacting mortar which does not transmit the bending moments between slabs.

[0032] Recently available materials such as 'self-compacting mortar, which allows using reduced thicknesses, as well as injecting without vibration through the preferably six boreholes 5, the transversally non-bonding post-stressing and recently developed rubber agglomerates, which allow using very fine grains, self-cementing and obtaining custom-made superficial and elastic qualities, have been used for installing the precast slab.

[0033] The completely planar geometry of the upper surface allows using SFC type fasteners by RAILTECH 12, in which the metal plate for supporting the fastener, providing the inclination of the rail 13, is fixed in the precast slab 3 by means of two threaded inserts, such that a multipurpose slab track is obtaining, arranging four inserts for support and forming pairs separated by a distance of 116.5 mm, and fixing the metal plate in either pair of inserts. This solution has the advantage of being able to use a normal, tested fastener, which has already been successfully used "in situ" concrete slab track, whereas this new application in the case of the precast slab involves considerable improvements both in construction and in final precision and reliability. As is known, a track is "multipurpose" if the fixing has two positions, one for international gauge (UIC) and the other for local gauge, for example Iberian gauge, such that it can initially work in this gauge and subsequently in an international gauge (UIC) by changing the position of the rails to this second position of the fastener.

[0034] The process for installing the previously described precast slabs is carried out on a substrate and comprises the following steps:

- Precasting of the structural concrete slabs with a rectangular section with at least four boreholes, an elastomer layer fixed at a series of specific points, or not fully bonded by fitting the elastic layer to the partially settled concrete precast slab without any bonding agent, to the lower surface of the slab,
- Transporting to the slab location site,
- On site positioning and vertical and horizontal plotting of the slabs in relation to the substrate by means of provisional fixings,
- Injecting the self-compacting bonding; leveling and filling mortar, which mortar is distributed through the boreholes or holes existing in the slab for allowing a complete filling of the space existing between the slab and the substrate with said self-compacting mortar without the need of vibration,
- Setting of the mortar, and

- Removing the provisional fixings for plotting.

[0035] It is also possible to install the rail fasteners in the slab either before injecting the mortar or after the setting thereof, said self-compacting mortar preferably being rigid.

[0036] The slabs are installed separately from one another, being joined together only by the mortar poured inside each of the slabs.

Claims

1. A reinforced or prestressed precast structural concrete slab having a rectangular section, to be used in a slab track system on which rails are fixed, with an elastomeric material layer which is supported on a substrate through a mortar and which has vertical holes or boreholes, **characterized in that:**

- said first elastomeric layer is fixed in a discontinuous manner by one of its faces to the lower surface of the precast slab and only through certain points or areas partially covering said lower surface, never being extended along the entire contact surface with the slab,
- said first elastomeric layer bonds in a continuous manner to the self-compacting bonding mortar with the substrate due to the natural bonding existing between said mortar and the elastomer after pouring said mortar, and
- it has at least four vertical holes with a second elastomeric layer, independent from the previous layer, arranged therein by way of an inner lining.

2. A slab according to claim 1, **characterized in that** said first elastomeric layer is arranged along the entire lower surface of the slab.
3. A slab according to claim 1, **characterized in that** said first elastomeric layer is arranged in the periphery of the lower surface of the slab, covering the central surface of said lower surface with a central layer of a highly deformable material different than that of the first elastomeric layer.
4. A slab according to claim 1, **characterized in that** the vertical holes or boreholes have a diameter of between 10% and 16% of the width of the slab.
5. A slab according to the previous claims, **characterized in that** it is longitudinally and transversely prestressed by means of prestressing tendons, the layout of said tendons being geometrically compatible with the cylindrical holes or boreholes crossing the slab.

6. A slab according to claim 5, **characterized in that** said prestressing tendons provide a centered prestressing force formed in two layers of tendons.

7. A slab according to claim 1, **characterized in that** in its upper surface it simultaneously has inserts or threaded spikes for fixing the rails separated from one another according to the gauge determined by the Iberian railway gauge and inserts separated from one another according to the gauge determined by the international railway gauge (UIC).

8. A slab according to claim 1, **characterized in that** its upper surface and its lower surface are planar and parallel.

9. A slab according to claim 1, **characterized in that** the elastic layer has different contact surfaces on its two faces.

10. A slab according to claim 1, **characterized in that** the holes or boreholes have a frustum-conical or cylindrical longitudinal section.

11. A slab according to claim 1, **characterized in that** the holes or boreholes have an elliptical or circular horizontal section.

12. A slab according to claim 1, **characterized in that** the points or areas for fixing the elastomeric layer to the lower surface of the slab are provisional and weak.

13. A slab according to claim 1, **characterized in that** the elastomeric layer is not fully bonded to the lower surface of the slab by fitting said layer to the partially settled concrete precast slab without any bonding agent.

14. A process for installing the precast slab on a substrate, of the type used for slab track construction, **characterized in that** it comprises the following steps:

- Precasting of the structural concrete slabs with a rectangular section with at least four boreholes, an elastomer layer fixed at a series of specific points to the lower surface of the slab,
- Transporting to the slab location site,
- On site positioning and vertical and horizontal plotting of the slabs in relation to the substrate by means of provisional fixings,
- Injecting the self-compacting bonding, leveling and filling mortar, which mortar is distributed through the boreholes or holes existing in the slab for allowing a complete filling of the space existing between the slab and the substrate with said self-compacting mortar, without the need

- of vibration,
- Setting of the mortar, and
- Removing the provisional fixings for plotting.

15. A process according to claim 14, **characterized in that** the rail fasteners are installed before transporting the slab. 5
16. A process according to claim 15, **characterized in that** it has an additional step to be carried out before the step of injecting the mortar or after the setting thereof consisting of fixing the rail to the fasteners thereof. 10
17. A process according to claim 14, **characterized in that** the poured mortar is rigid self-compacting mortar. 15
18. A process according to claim 14, **characterized in that** the slabs are installed separated from one another and are joined together only by the poured mortar inside the slabs. 20
19. A process according to claim 14, **characterized in that** the elastomer layer is not fully bonded to the lower surface of the slab by fitting said layer to the partially settled concrete precast slab without any bonding agent. 25

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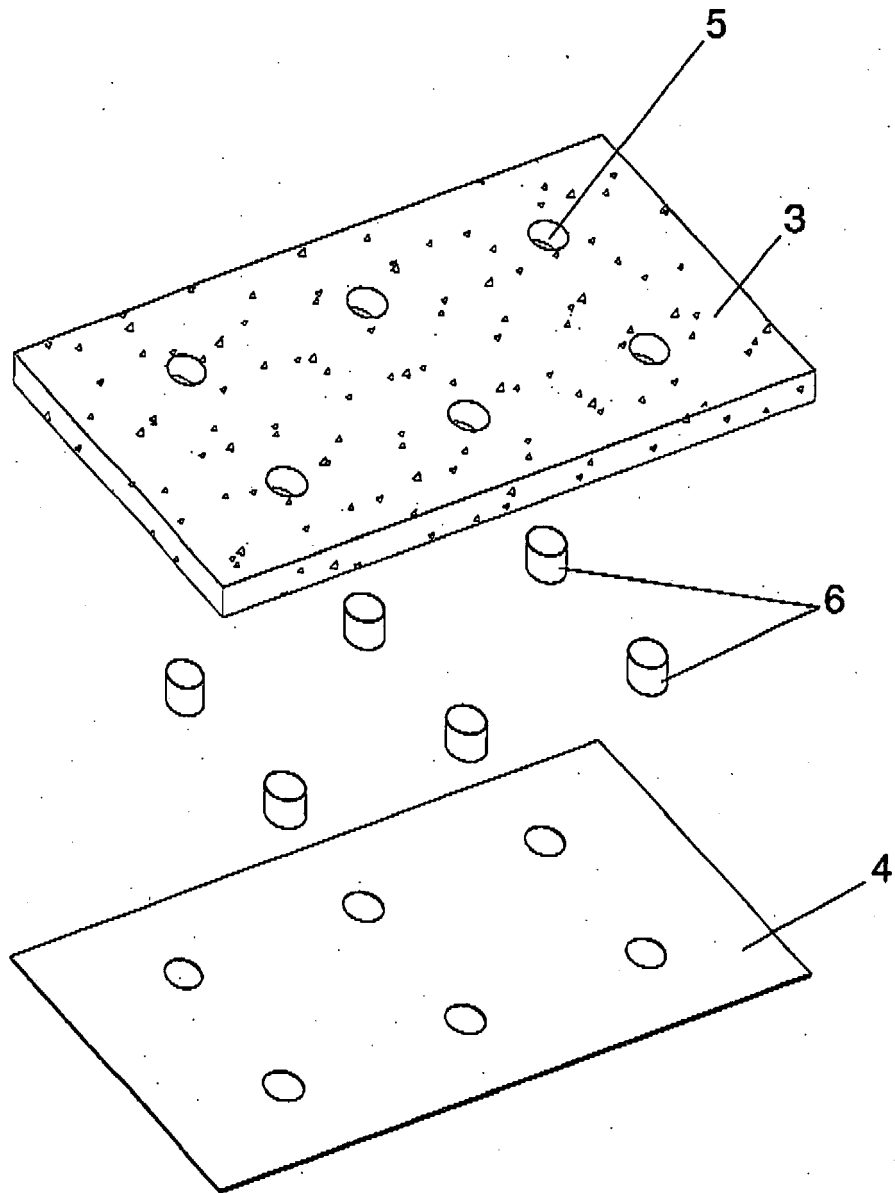


FIG. 1

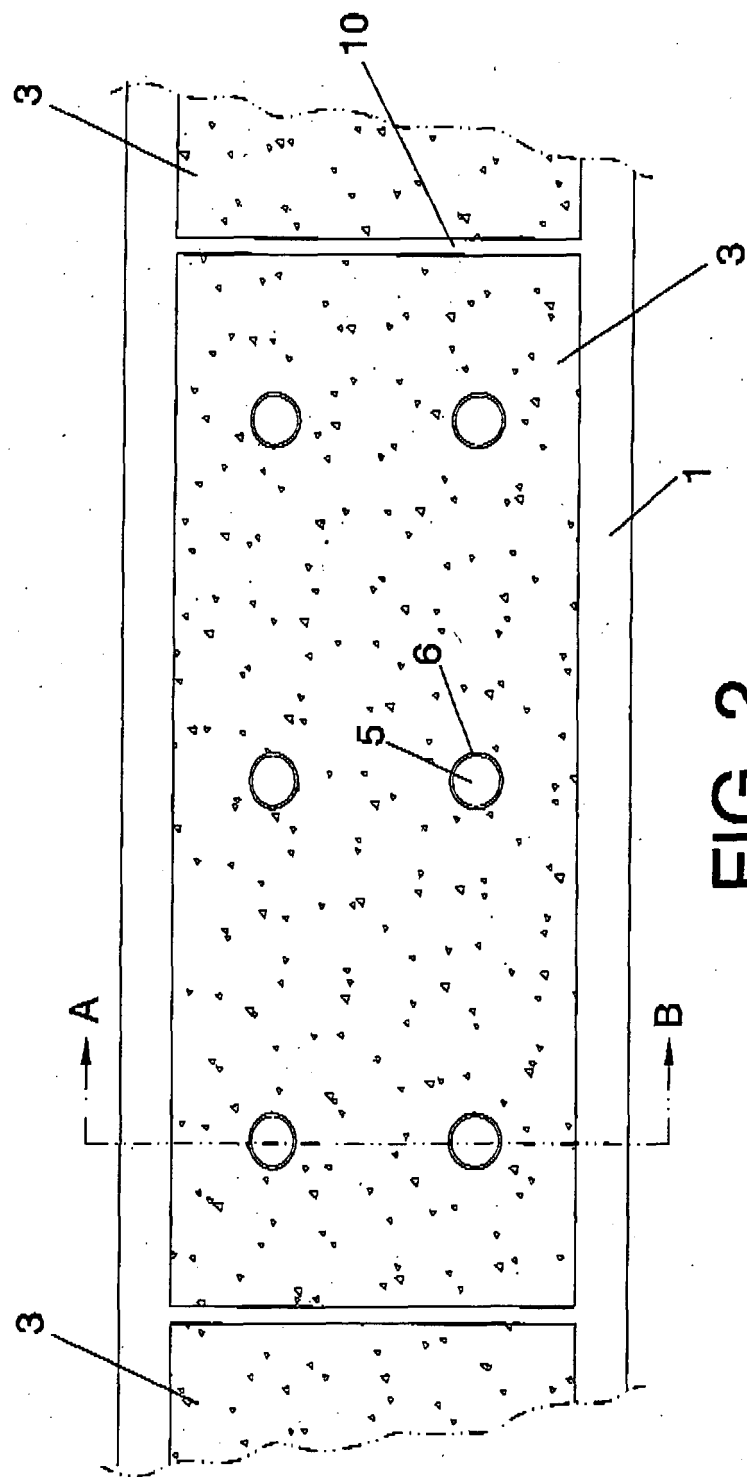
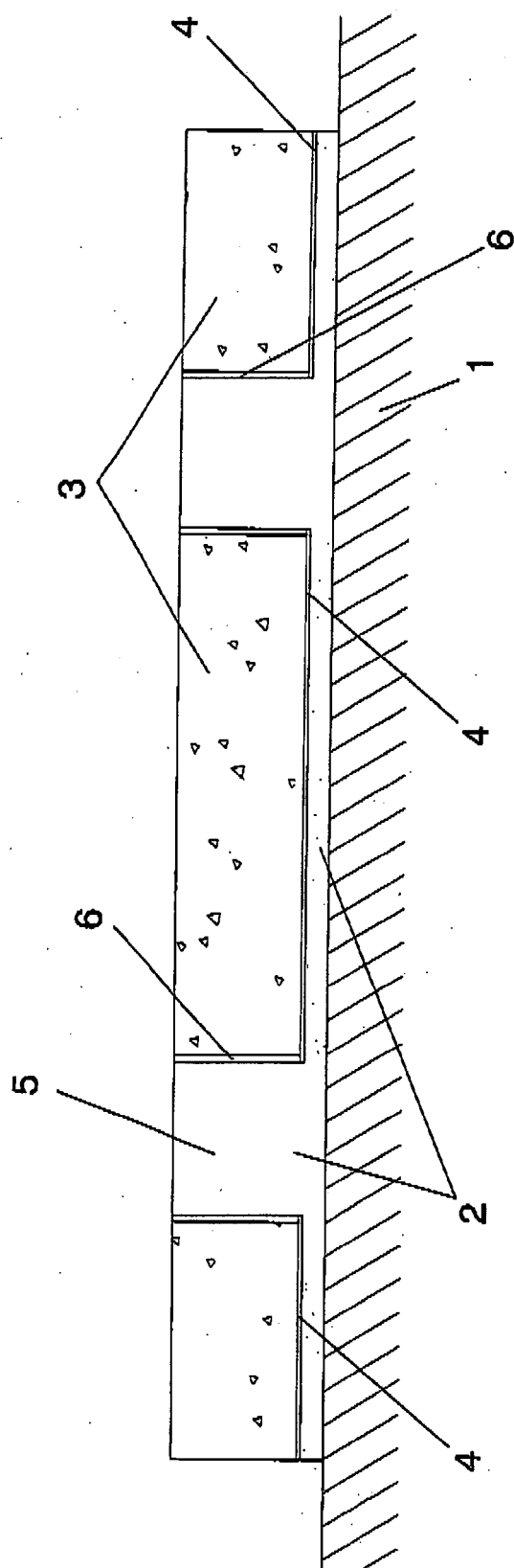


FIG. 2



A-B
FIG. 3

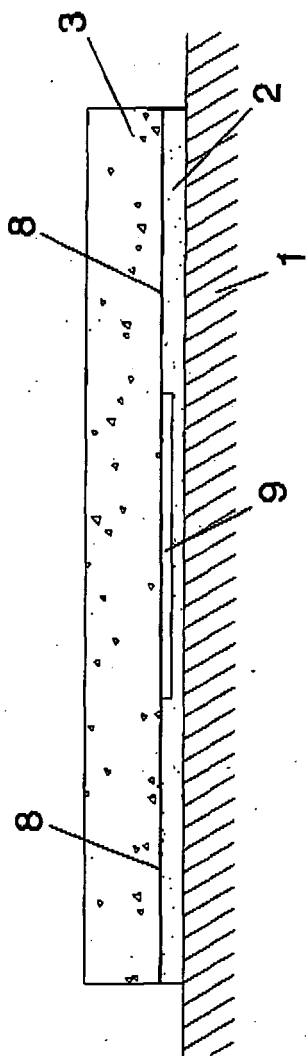


FIG. 4

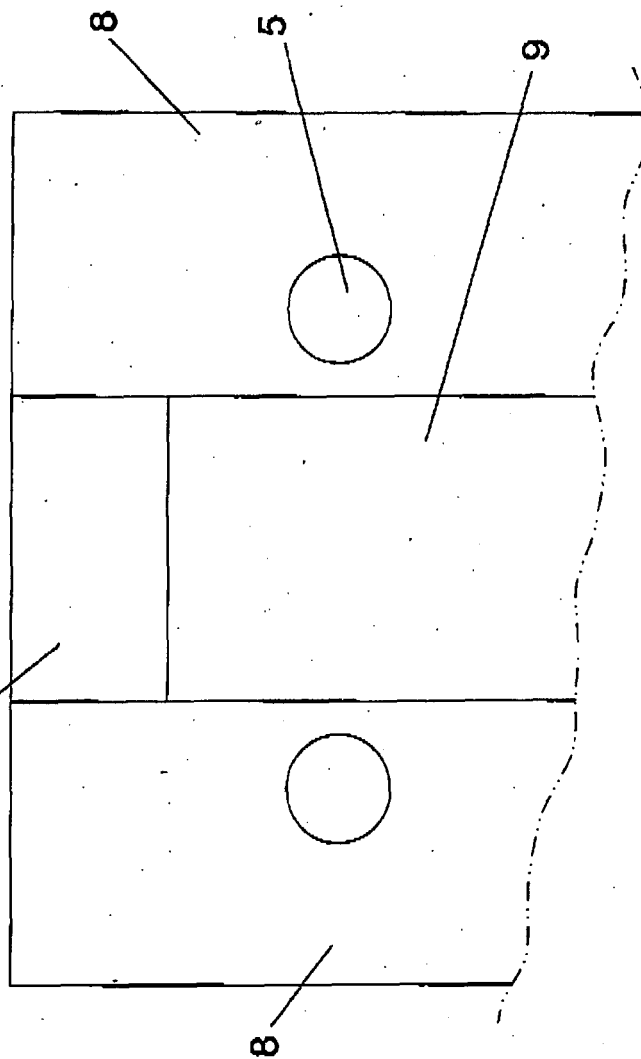


FIG. 5

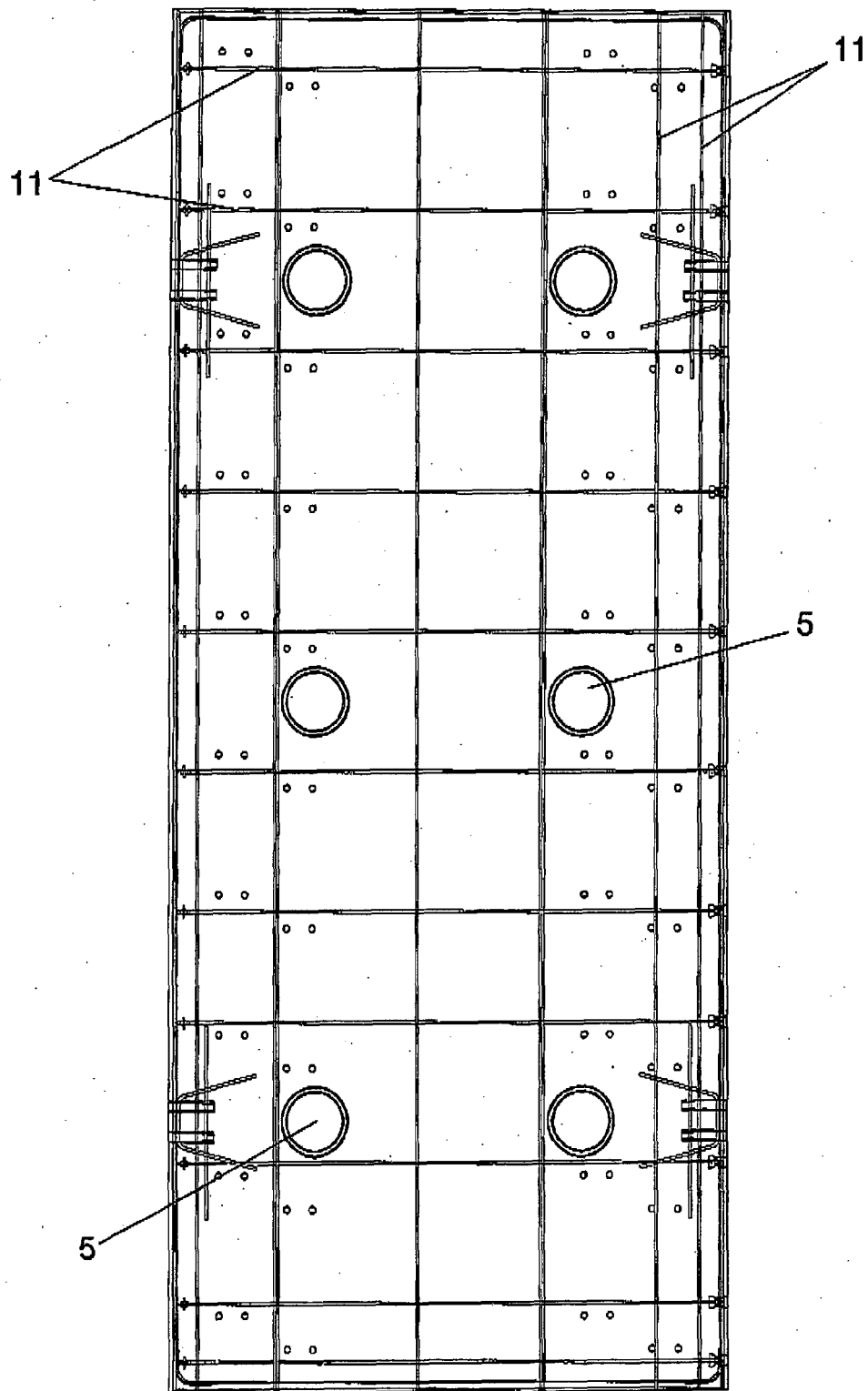


FIG. 6

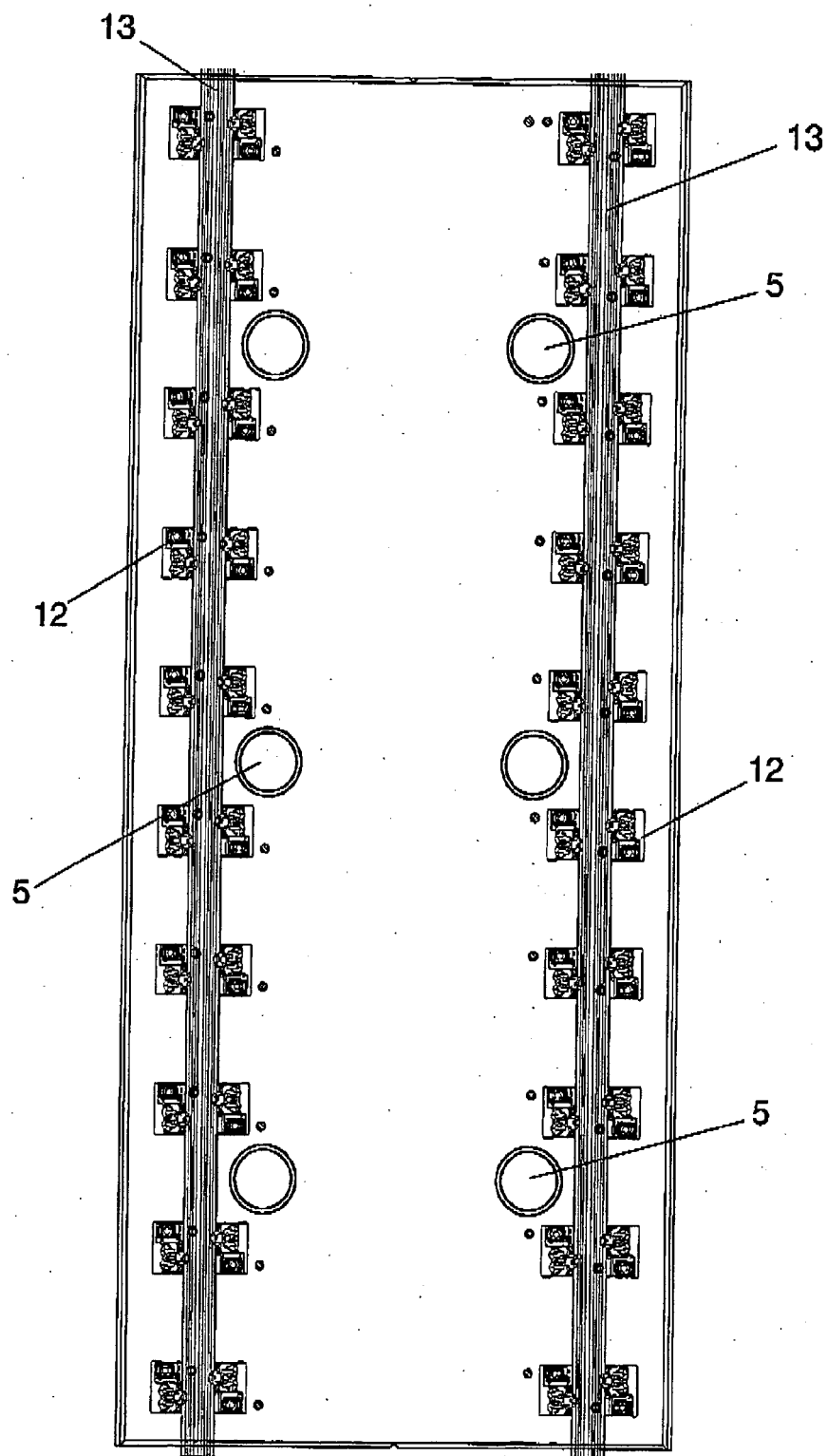


FIG. 7



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 00 5317

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC) E01B
Place of search Munich		Date of completion of the search 8 July 2008	Examiner Fernandez, Eva
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 08 00 5317

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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