(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 404 142 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
21.11.2018 Bulletin 2018/47

(21) Application number: **16884604.6**

(22) Date of filing: **08.04.2016**

(51) Int Cl.:
E01B 1/00 *(2006.01)* ***E01B 29/00*** *(2006.01)*

(86) International application number:
PCT/CN2016/078779

(87) International publication number:
WO 2017/121044 (20.07.2017 Gazette 2017/29)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **11.01.2016 CN 201610013534**

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(54) PRECAST SLAB RAILWAY TRACK STRUCTURAL SYSTEM FOR VIBRATION MITIGATION AND ASSOCIATED CONSTRUCTION METHOD

(57) A precast slab railway track structural system for vibration mitigation. The system consists of a steel rail (7), a fastener (5), a precast slab (6), an elastic cushion (4), a sealing sleeve (3), a longitudinal connection device (10), and a filling layer (1). The elastic cushion (4) and the precast slab (6) can be manufactured as an integrated body within a factory. The invention further discloses an associated construction method. The precast slab railway track is laid using a track laying equipment such as a slab transporting vehicle, a hoisting vehicle, and precision control vehicle. The invention has simple construction steps, rapid construction speed, high construction accuracy, good railway track levelness and smoothness, and low requirements for physical labor. The invention further addresses issues of inconvenience when replacing a railway track slab or the elastic cushion during actual operations of a railway track.

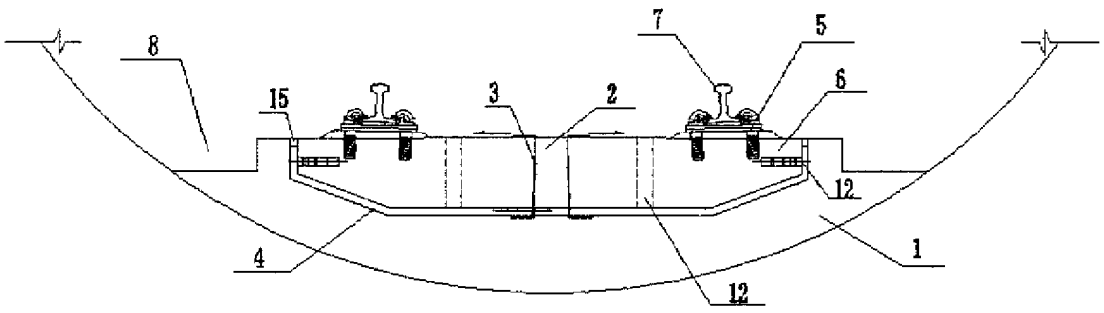

Fig. 1

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Description

BACKGROUND

[0001] The invention relates to field of damping of rail transit, in particular to a damping (vibration reduction) track structure system with prefabricated slab and a supporting construction method.

[0002] With the large-scale networking development of urban rail transit, construction time limit of the urban rail transit is becoming increasingly tense. Construction process of track structure is more close to operating time, and the pressure of construction period thereof is particularly prominent. In general, the construction period of a subway line in about nine months, which is often compressed to six months or less. Form of traditional track structure has many characteristics, such as more construction links, mainly manual work, difficult to control the construction accuracy and construction progress being slow, and so on. Under the condition that the whole construction period and the rail laying period are compressed, the construction precision and the quality of the laying rail are seriously declined, resulting in poor ride comfort of the line in operation and poor amenity of the running vehicles, frequent occurrence of rail diseases, and increasing environmental vibration and noise.

[0003] A traditional damping track structure adopts a construction method of on-site binding steel bar and cast-in-place concrete. Generally, construction speed thereof is from 25 m to 50 m per day, number of construction workers is 80 to 100. Amount of cast-in-place concrete is large, especially in the shield tunnel, because of the narrow working area and a large number of manual work links, construction precision and work efficiency is low, and safety risk is high, with cost of design, construction and maintenance increased. In addition, line diseases in cast-in-place damping track section often occur, e.g., ballast bed is likely cracking, and so on.

[0004] In view of the above defects, by diligent designing and much experiment and study, inventor proposes a damping track structure system with prefabricated slab and a fast construction method and device supporting the structure, to overcome such many defects from current damping track structure system.

SUMMARY

[0005] An object of the invention is to provide a new damping track structure system of prefabricated slab type and with adjustable damping performance for rail transit. The track structure system is suitable for all kinds of rail damping requirements, manufactured by factory and laid with highly automatic dedicated equipment, with characteristics of high construction speed, high track structure precision and good rail line smoothness, and can effectively overcome the problems existing in the existing track structure system (including damping and non-damping track structure).

[0006] To overcome above matters, the invention provides a new damping track structure system of a prefabricated slab type and supporting construction method thereof.

[0007] The damping performance of the new damping track structure system of the prefabricated slab type is adjustable, suitable for laying by manual or automatic dedicated equipment, supported by adjustable temporary vertical supporting device (supporting leg). The track structure system includes, in turn, a prefabricated high precision track slab, an elastic cushion on surface of the track slab in a special way (which can be compounded in factory or in construction site), a temporary vertical supporting with adjustable support height, a post-cast fixed pile for the track slab, and self-compacting concrete prefabricated on bottom of the track slab or rigid backfill material with good fluidity. Main construction sequence of the new damping track structure system of prefabricated slab type can be as following: producing prefabricated track slab structure in factory or on site → compounding damping cushion in factory or site → performing high precision positioning on the track slab by using dedicated planking equipment → temporarily fixing the track slab by the vertical supporting device → casting concrete filling layer under the track slab one or more times.

1. The new damping track structure system of the fabricated slab type is featured with:

1) prefabricating high precision reinforced concrete track slabs by high precision molds in factory or on site.

2) the upper surface of the track slab in the form of horizontal plane or herringbone slope surface; section of track slab being polygonal, and structure of both sides of circular tunnel section being slope surface to enhance the adaptability to tunnel section; track slab section of rectangular and horseshoe tunnel section being possible rectangular section, or same as the circular tunnel section i.e., both sides thereof being of the slope form.

3) the surface of the track slab provided with a dedicated protruding platform for supporting rail, which is equipped with fasteners for connecting steel rails.

4) steel bar spacing in the slab arranged according to certain modulus (such as integer times of 25mm or 50mm) and shape, which realizes automatic production of the steel mesh in the slab.

5) the corresponding holes and embedded parts are reserved on the track slab to meet particular needs of construction and use, which mainly includes the following aspects (which can be selected according to specific needs):

(1) installing embedded parts for steel rail

fasteners (nylon sleeves, etc.);
(2) 1-3 holes running through the thickness direction of track slab (for casting of filled layer under the slab, position reservation of fixed pile, observation of casting of filled layer under the slab, etc.);
(3) reservation of installation conditions for installation of temporary positioning vertical supporting devices wherein the vertical supporting device may be installed in a position close to the slab or to the side of the slab.
(4) pre-embedding installation parts for automatic measurement and positioning marks, which can be realized by pre-embedding pipe in the slab or directly using pipe for mounting fastener and so on;
(5) setting centering marks for positioning in laying track slabs;
(6) pre-embedding parts for composite connection of the elastic cushion, wherein the pre-embedded parts for connection can be done by bolt sleeve, fixed end of expansion bolt, simple expansion bolt or even wooden embedded pile, etc, and compounding of prefabricated slab and the elastic cushion can be realized by means of reserved slot or embedded channel, etc;
(7) pre-embedding 3 to 4 dedicated hoisting nails for hoisting;
(8) preserving prefabricated parts for longitudinal connection of track slabs;
(9) pre-embedding parts for the installation of contact rails, etc (if necessary).

2. the damping cushion is compounded in the bottom and side of the prefabricated track slab in the factory or the construction site to realize the integration of the slab and the cushion, with key points are as following:

1) the damping cushion being made of elastic materials, including damping film with different structure and form, polyurethane sheet and other materials with similar elastic and damping performance.
2) in order to meet requirement of different damping levels, three laying methods, such as full laying, strip laying and point laying at the bottom of the track slab can be used to lay the damping cushion. When the elastic cushion is of surface supporting, the lower surface of the track slab is tiled on the whole upper surface of the elastic cushion. When the elastic cushion is of strip supporting, the elastic cushion comprises at least two parallel elastic supporting strips, and the lower surface of the track slab is laid on the top surface of the two elastic support strips. When the elastic cushion is of point supporting, it comprises a plurality of cuboids, cylindrical, circular or ridge-shaped elastic cushion arranged at intervals, and the lower surface of the track slab is laid on the support of the plurality of elastic points;
3) the connection between the damping cushion and the track slab adopts a special connection method which does not affect the performance of the damping cushion;
4) in order to prevent elastic loss or even failure of the damping cushion caused by the filling concrete at the bottom into gap of the cushion, a special elastic sealing sleeve with "cap brim" at bottom is set in hole position of the track slab, wherein the "cap brim" at the bottom of the sealing sleeve is effectively and tightly connected with the bottom surface of the damping cushion. The sealed sleeve also has the functions of isolating the track slab from the fixed position pile, avoiding direct hard contact, allowing up and down free deformation of the track slab without constraint from the positioning pile, so as to realize the elastic positioning of the track slab, avoid the stress concentration, and ensure that the elasticity of the track slab will not be lost.
5) compounding damping cushion at the bottom of the track slab is integrated with the end and sides of the track slab. After integrated forming, the damping cushion is of sleeve shoe(casing) form, and the bottom and the side of the damping cushion are formed as a whole. Main function of the side cushion is to realize elastic isolation between the track slab and the surrounding concrete, in order to avoid concrete pouring into the joint layer between the damping cushion and the track slab during construction and to ensure up and down free deformation of the track slab without constraint, avoid situation of damping "short circuit". Main function of the bottom cushion is to provide the elasticity of the track slab and realize the damping function of the track structure system.
6) sealing measures may be set in the exposed part of the elastic cushion to prevent dust, dirt or groundwater from entering the compounding layer during construction and operation.

3. After the damping cushion is compounded on the prefabricated track slab in the factory or the construction site, the slab is transported to the rail laying site, with main construction procedures as follows:

1) slab conveyer vehicle (with function of hoisting and unloading slab) carrying the slabs to the site;
2) placing the track slab on the precision trolley.
3) according to the instruction for adjusting slab, the precision adjustment trolley can adjust the

track slab with multiple degrees of freedom (longitudinal, transverse, rotation and elevation, etc.), and finish the fine adjustment and positioning of the track slab, which includes steps of: slab adjustment control system directing the total station to automatically measure the marks placed on the track slab; according to measurement results, deviations of position and space attitude from the design position of the track slab being calculated; the slab adjustment command being issued to a fine adjustment trolley; the fine adjustment trolley completing adjustment action; repeating the above procedures as required, until the track slab adjustment being in place.

3) using the vertical supporting device for the track slab with adjustable height, the space shape and position of the track slab after fine adjustment are maintained and fixed; each track slab is provided with a number of support points according to needs, and the vertical support device can be arranged in the slab or on the side of the slab; in order to adapt to the structure slope which may exist in the tunnel structure at the bottom, a universal adjustable movable ball head pad which can adapt to the slope angle independently is installed at the bottom of the vertical supporting device; the vertical supporting device is designed with disassembly and reuse capacity; the vertical supporting device should be able to ensure the absolute stability of the track slab at all times so that the position accuracy of the track slab can always meet the error limit requirements of fine adjustment when pouring the filling layer under the slab later.

4) pouring concrete filling layer under the slab, which is carried out through a pouring hole preserved for filling in the track slab; in order to avoid the track slab precision affected by the track slab floating in the filling layer filling process, filling layer pouring can be done by 2 and 3 times of pouring processes.

5) when the filling layer is poured and reaches a certain strength, the vertical supporting device is taken out, and the movable ball head cushion at the bottom thereof is automatically separated from the supporting device and left in the concrete; in order to ensure that the supporting device can be removed smoothly, the part of the supporting body structure in the concrete is in the form of a cone, and is provided with a central exhaust hole.

6) installation of fasteners. After the filling layer reaches certain strength, the upper buckle components of the track slab arc installed, and the buckle components are transported to the working surface by the track slab transporter, the order thereof is of the elastic cushion under the slab → the iron plate → the elastic cushion under the rail.

7) Steel rail installation. Steel rails will be moved to working surface by a rail transporter, and through the transporter, the steel rails is unloaded to installation point and spread out, through the manual way, the steel rail will be put into the rail groove of the iron plate, and the gauge block, connecting bolts and elastic bars will be installed.

[0008] According to the structure and the supporting construction method, the damping track structure system with prefabricated slab and a supporting construction method of the invention can make the track structure system have damping function by adopting the prefabricated track slab and the damping cushion, and can solve the vibration problem caused by rail transit. By reserving preembedded parts or installation condition for hoisting, slab cushion compound, track slab measurement, filling layer pouring under the track slab, laying and positioning of the slab, fixing of the slab, etc., in the slab, and by using rail laying equipment such as slab carrier, crane and fine adjustment trolley and the like, the hoisting, laying and precise positioning of the slab is realized, which solves the problems of rapid and high-precision construction and the replacement of track slab and elastic cushion in later period. The invention has the advantages of simple construction procedure, fast construction speed, high construction precision, good rail smoothness and low labor intensity, etc.

[0009] Detailed contents of the invention may be obtained by means of the later description and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 shows a structural schematic diagram of a damping track structure system with prefabricated slab of the present invention.

Fig. 2 shows a top view of the surface support of the invention.

Fig. 3 shows a top view of the point support of the invention.

Fig. 4 shows a top view of the stripe support of the invention.

Fig. 5 shows a schematic diagram of the invention when the slab is fixed by the adjusting rod after the slab is adjusted in place.

Fig. 6 shows a schematic diagram of the structure of the slab transporter of the present invention.

Fig. 7 shows a schematic diagram of the structure of the crane of the invention.

Fig. 8 shows a schematic diagram of the structure of a crane of the present invention with fine adjustment function.

Fig. 9 shows a schematic diagram of the structure

of the fine adjustment trolley of the present invention.

DETAILED DESCRIPTION

[0011] Referring to Fig. 1, the invention relates to a damping track structure system with prefabricated slab, which is of a multi-layer design, comprising a filling layer 1, an elastic cushion 4 and a track slab 6, from the bottom to the top.

[0012] The filling layer 1 is the lowest layer, and the elastic cushion 4 is laid on the filling layer 1. Preferably, the filling layer is made of self-compacting concrete, thereby providing good fluidity during pouring and providing good supporting effect. End of the elastic cushion 4 is made of sealing material (polyurethane seaming adhesive and the like) 15 to ensure that dust, sundries, water, and so on will not enter the gap between the elastic cushion 4 and the rail 6 or the elastic cushion 4 and the filled layer 1.

[0013] The elastic cushion 4 is arranged on the filling layer 1 to provide elastic cushioning to the filling layer 1 to avoid rapid damage thereof. Alternatively, the elastic cushion 4 is made of elastic material such as rubber or polyurethane, which can provide good damping effect.

[0014] The track slab 6 is arranged on the elastic cushion 4 for damping, and the track slab 6 is provided with two parallel steel rails 7, each of which being respectively fixed on the track slab 6 by a plurality of fasteners 5.

[0015] Alternatively, the elastic cushion 4 may be of surface supporting (see Fig. 2), point supporting (see Fig. 3), and strip supporting (see Fig. 4).

[0016] In the surface supporting shown in Fig. 2, the lower surface of the track slab 6 is laid flat on the entire upper surface of the elastic cushion 4 which is integrally coated on the bottom and side parts on both sides of the track slab 6

[0017] In the point supporting shown in Fig. 3, the elastic cushion 4 includes a plurality of rectangular, cylindrical, circular or ridge-shaped elastic cushion 4 arranged at intervals, the lower surface of the track slab 6 being laid on the plurality of elastic cushions.

[0018] In the strip supporting shown in Fig. 4, the elastic cushion 4 includes at least two parallel elastic supporting strips and the lower surface of the track slab 6 is laid on the top surface of the two elastic supporting strips.

[0019] Alternatively, section of the track slab 6 is a symmetrically set polygon, with a beveled structure on both sides to enhance adaptability to the tunnel section.

[0020] The upper surface of the track slab 6 is a horizontal plane or with a slope, and can be provided with a convex platform, surface of which is a horizontal plane or a slope.

[0021] The upper surface of track slab 6 is reserved with four lifting points 11 for hoisting and laying, mark 14 for centering, preserved hole 12 for fixing and adjusting slab, and holes for setting prism can be realized by using nylon pipe for setting fastener or by pre-embedding nylon pipe in the slab particularly.

[0022] Both sides of the track slab 6 can be provided with longitudinal connection device 10, by which the track slabs 6 can be connected each other, so as to better avoid mutual dislocation between the slabs, wherein, the longitudinal connecting device 10 may comprise a plurality of mounting holes on the track slab 6 and connecting bars secured to the mounting holes by bolts so as to longitudinally connect the two prefabricated slabs.

[0023] Middle part of the track slab 6 is provided with two holes 2, the hole 2 penetrates the track slab 6 and the elastic cushion 4, and after pouring the filling layer through the hole 2, a limit pile of the slab is formed.

[0024] A sealing sleeve 3 is installed in the hole 2, and is of a cylinder structure made of elastic material, which ensures that when the filling layer is poured from inner of the hole, the filling material is prevented from entering between the slab and the elastic cushion and resulting in damping failure. Also, buffering is formed between the slab and the limit pile.

[0025] The track slab 6 is of industrialized production, and the elastic cushion and the track slab are integrated in the factory (the elastic cushion can also be laid on the site under special circumstances). After being transported to the site by a slab carrier, the slab can be laid and finely adjusted by the fine adjustment trolley and fixed by the adjusting rod 14, then is poured into the filling layer, and the seamless line is laid.

[0026] The two sides of the track slab 6 may be provided with a drain 8, and the lower part of the elastic cushion 4 may be provided with a ditch (at this time, the drain 8 is not necessary) or without a ditch.

[0027] In order to provide the damping track structure system with prefabricated slab of the invention, effective compounding should be carried out when prefabricating, wherein the compounding method of the rail damping structure comprises the following steps:

Step 1: track slab prefabrication.

[0028] Steel bar binding within track slab, concrete pouring in track slab and track slab maintenance after prefabrication is conducted in factory, which can be realized by using maintenance measures such as covering, water retaining, film moisturizing, spraying or painting curing agent and other.

Step 2: compounding of slab and cushion.

[0029] After the maintenance of the track slab, the bottom face, the inclined plane and the side surface of the track slab are covered with a damping cushion, which is formed as a whole of the slab end, the slab underside and the slab side to avoid cutting and second connecting. The compounding of damping cushion and track slab adopts a unique compounding method without affecting the performance of the damping cushion.

[0030] The supporting construction method of the invention mainly comprises the following steps:

Step 1: transport of track slabs.

[0031] The track slab is transported to the working site by a dedicated slab conveyer vehicle, wherein the track slab is hoisted on the slab conveyer vehicle, which is provided with a self-locking device, which automatically fixes the track slab and automatically aligns the center of the track slab with the center of baseboard of the vehicle to control the position of the track slab during transportation. When the slab conveyer vehicle runs to the working surface, the track slab is automatically unloaded to the working surface by the associated slab unloading mechanism. The slab conveyer vehicle in the tunnel adopts rail-less transportation mode. Referring to Fig. 6 the slab conveyer vehicle in the tunnel comprises a vehicle body 16 carrying a plurality of track slabs, a plurality of running parts 18 located at the lower end of the vehicle body. A belt conveyor 17 and a slab automatic unloading mechanism 19 for unloading track slab are set at one end of the transport slab, wherein, the slab conveyer vehicle in the tunnel is also provided with a driver control room at front and rear thereof, and the running mechanism can be adjusted according to the different sections of the tunnel structure to adapt to the running requirements of different structural forms (on plane or curved surface basis).

Step 2. Lifting of track slabs.

[0032] The dedicated crane can hoist the track slab on the working surface and run on the circular shield wall in the tunnel. It can also run on the horizontal plane to adapt to different types of structural planes (that is, on a plane and curved surface basis). Referring to Figs. 7 and 8, the crane has frame structure 20, running mechanism 21 that can walk on curved surface and plane, lifting mechanism 22 that controls the track slab up and down, control system 23, hydraulic system 25, positioning system 24 and so on.

Step 3. Fine adjustment of track slab.

[0033] There are two solutions for fine adjustment of the track slab, namely:

1. Solution 1

[0034] Fine adjustment mechanism and precise control system are provided in the dedicated crane. Referring to Fig. 8, it mainly includes frame structure 20 and front and backward running mechanism 21. The frame structure 20 is provided with a regulating oil cylinder 22, the regulating oil cylinder 22 can comprise two longitudinal adjusting oil cylinders and two transverse regulating oil cylinders, which can adjust the track slab by a adjusting rod connected to the track slab, and can feedback data to control system of the fine adjustment trolley by measure equipment. Slab adjustment vehicle can automatically adjust the elevation, the positioning of the central line and the superelevation of the track slab, to make position of the track slab reach the precision required by fine adjustment. The running mechanism 21 adopts a precision control system 23, feeds back to the hydraulic system 25 through the measurement of the total station, and realizes the accurate positioning of the crane through the measurement positioning system 24 of the total station, and accomplishes the fine adjustment of the track slab. After the fine adjustment, a track slab supporter 13 is installed on the track slab to fix the track slab position, so as to ensure that the position accuracy of the track slab in the following pouring of the lower filling layer 1 always meets the error limits.

2. Solution 2

[0035] After the dedicated crane unloads the track slab to the fine adjustment trolley developed by the inventor, the track slab can be precisely adjusted and located through the fine adjustment trolley.

[0036] Referring to Fig.9, the fine adjustment trolley mainly comprises a tractor 27, a fine adjustment frame 26, a rotary tray 29, vertical and horizontal guide rails 28 and 30, a height adjustment cylinder 31, and so on. By feeding back data from measuring equipment to control system of the fine adjustment trolley, the attitude of the track slab can be adjusted automatically. The axis of the track slab is parallel to the central line of the line by rotating the rotation tray 29 for core rotation, then the degree of freedom of rotation is locked. The position of the tray moving along and perpendicular to the line direction is adjusted by using the longitudinal 28 and the transverse guide rail 30, and the projection position (horizontal position) of the track slab on the moving tray is adjusted in place. The height of the track slab is adjusted by vertical adjustment Jack 31 located above moving mechanism. Finally, the position of the track slab reaches the precision required by fine adjustment. After the fine adjustment, the track slab supporter 13 is installed on the track slab to fix position of the track slab, so as to ensure that the position accuracy of the track slab in following pouring of the lower filling layer 1 always meets the error limit.

Step 2: concrete pouring.

[0037] The concrete can be poured after checking the compound condition of the damping cushion and the track slab as well as the sealing condition around the damping cushion. The filling layer in the lower part of the track slab is made of self-compacting concrete.

[0038] The self-compacting concrete is poured in the field mixing method. The self-compacting concrete should be bagged. After being transported to the site, the concrete should be mixed with mixing equipment. After mixed evenly, the self-compacting concrete should be poured through the filling hole reserved in the track slab (and also as a convex platform for limit).

[0039] In order to achieve smooth surface and increase compactness during pouring of the self-compacting concrete, a small vibrator can be inserted to assist vibration and stirring.

[0040] After pouring, concrete settlement may be caused by bubble overflow during the standing process, the concrete shall be added to the specified elevation before the initial setting of the concrete. In order to avoid the track slab precision affected by the track slab floating in pouring the filling the layer, the filling layer can be poured in place by pouring two times as following: the filling layer being poured to 50mm above the bottom of the slab for the first time, and then further poured after the concrete is finally set.

Step 3: buckle components laying.

[0041] After the self-compacting concrete reaches certain strength, the assembly of the buckle components on top of the track slab is carried out, wherein the buckle components are transported to the working surface by the track slab transporter, and the order of installation is: rubber pad plate under the slab → iron plate → rubber plate under the rail.

Step 4: rail laying.

[0042] The rail is transported to the working surface by the track slab transport vehicle, and the steel rail is discharged to the installation point by the transport vehicle, and the steel rail is manually allocated to the rail groove of the iron plate bearing plate, and the gauge block, connecting bolts and elastic bars are installed and welded together.

[0043] The invention has the following advantages:

1. the form of structure can adapt to the size of subway shield tunnel and reduce the influence of civil construction error on rail laying.
2. by adopting the prefabricated slab structure, the laying schedule and construction quality are improved, the reliability of the track structure system is enhanced, and the appearance is more beautiful.
3. by adopting the factory compound way of prefabricated slab and elastic cushion, it can realize the protection of the slab when hoisting and upper bearing, and because of canceling the link of laying elastic cushion on the site, the construction progress has been accelerated.
4. many measures such as reserved lifting point, center mark, adjusting rod hole and measuring prism hole are adopted on the slab, which realizes the rapid and accurate construction of the track slab and improves the exchangeability of the damping track structure system.
5. self-compacting concrete being adopted to enhance the fluidity of concrete and ensure the compactness of concrete under track slab.
6. the limit device and the bottom concrete are molded at the same time.
7. by using the fine adjustment trolley system developed by the inventor to carry on the planking construction, the construction procedure is simple, the construction progress speeds up greatly, the laying precision is high, the labor intensity is reduced by a large margin.

[0044] Therefore, the supporting construction method of the slab-type rail damping structure machine can be used in the field of rail transit, and not only the damping performance can be designed according to the demand, but also the characteristics of simple construction procedure, fast construction speed, high construction precision, good rail smoothness and low labor intensity can be realized. It accords with the current direction of rail transit environmental protection, high efficiency and disease reduction, and has great social benefit. It can effectively reduce the vibration and secondary structure noise caused by the operation of urban rail transit vehicles.

[0045] It is obvious that the above descriptions and records are merely illustrations and are not intended to limit the disclosure application or use of the present invention. Although embodiments have been described in the embodiments and embodiments have been described in the drawings, the present invention will not be limited by the specific examples described in the accompanying drawings and embodiments as currently considered the best mode to implement the teachings of the present invention. The scope of the invention will include any embodiments that fall into the preceding specification and the accompanying claims.

Claims

1. A damping track structure system with prefabricated slab, **characterized in that** the damping track structure system with prefabricated slab comprises a filling layer , an elastic cushion and a track slab, from the bottom to the top,
wherein the elastic cushion is laid on the filling layer, the filling layer is made of self-compacting concrete etc. with good fluidity, thereby providing good fluidity during pouring and providing good supporting effect, the elastic cushion and the prefabricated slab are compounded as a whole, the track slab is arranged on the elastic cushion for damping, the track slab is provided with two parallel steel rails, each of which being respectively fixed on the track slab by a plurality of fasteners.

2. The damping track structure system as in claim 1, **characterized in that** the elastic cushion is of surface supporting, point supporting, or strip supporting, in the surface supporting, the lower surface of the

track slab is laid flat on the entire upper surface of the elastic cushion,
in the point supporting, the elastic cushion includes a plurality of rectangular, cylindrical, circular or ridge-shaped elastic cushions arranged at intervals, the lower surface of the track slab 6 being laid on the plurality of elastic cushions,
in the strip supporting, the elastic cushion includes at least two parallel elastic supporting strips and the lower surface of the track slab is laid on the top surface of the two elastic supporting strips.

3. The damping track structure system as in claim 1, **characterized in that** upper surface of the track slab is in the form of horizontal plane or herringbone slope surface, section of the track slab is polygonal, and structures of both sides of circular tunnel section are slope surface to enhance the adaptability to tunnel section.

4. The damping track structure system as in claim 1, **characterized in that** there are provided 1 to 3 holes running through the thickness direction of the track slab on the track slab, for casting of filled layer under the slab, position reservation of fixed pile, and observation of casting of filled layer under the slab.

5. The damping track structure system as in claim 1, **characterized in that** installation structure for installing supporting legs for temporary positioning is set on the track slab, wherein the supporting legs is fixed and adjusted, by threads within the slab or on the side of the slab for installing a mounting sleeve device and the supporting legs, clenching with threads within the sleeve device.

6. The damping track structure system as in claim 1, **characterized in that** there is provided pre-embedding structure for automatic measurement and positioning marks on the track slab, which includes pre-embedding pipe within the slab or pipe for mounting fastener.

7. The damping track structure system as in claim 1, **characterized in that** there are provided centering marks for positioning in laying slabs on the track slab.

8. The damping track structure system as in claim 1, **characterized in that** there are provided pre-embedding 3 to 4 dedicated hoisting nails for hoisting on the track slab.

9. The damping track structure system as in claim 1, **characterized in that** preserving prefabricated parts for longitudinal connection are set at end of the track slab.

10. The damping track structure system as in claim 1, **characterized in that** pre-embedding parts for the installation of contact rails are set on the track slab.

11. The damping track structure system as in claim 1, **characterized in that** spacing between steel bars within the slab is arranged according to certain modulus, so as to realize automatic production of the steel mesh.

12. The damping track structure system as in claim 1, **characterized in that** pre-embedding parts for composite connection are set in the elastic cushion, wherein pre-embedding parts is bolt sleeve, fixed end of expansion bolt, simple expansion bolt or wooden embedded pile, and compounding of prefabricated slab and the elastic cushion can be realized by means of reserved slot or embedded channel, etc.

13. The damping track structure system as in claim 1, **characterized in that** connection between the damping cushion and the track slab adopts a dedicated connection manner which does not affect the performance of the damping cushion.

14. The damping track structure system as in claim 1, **characterized in that** compounding damping cushion at the bottom of the track slab and cushion at side are designed as separated with each other, as a whole, or with different stiffness.

15. A supporting construction method for the damping track structure system as described in any one of claims 1 to 14, including the following steps:

Step 1: transporting and laying the track slab;
Step 2: pouring concrete;
wherein concrete construction is carried out after cleaning the water in the foundation of the tunnel, checking compound situation of the damping cushion and track slab and sealing condition around the damping cushion, concrete material with good fluidity such as self-compacting concrete, etc. is used in the lower part of the track slab;
Step 3: concrete maintaining;
Step 4: laying buckle components;
Step 5: laying steel rail.

16. The supporting construction method as described in claim 6, **characterized in that** said Step 1 comprises:

1) the slabs being carried to site by a slab conveyer vehicle, running mechanism of which can be adjusted according to different sections of the tunnel structure to adapt to running requirements of different structural forms;

2) dedicated crane hoisting the track slab on the working surface, and run on a circular shield wall in the tunnel, and can also run on the horizontal plane to adapt to different types of structural planes;

3) finely adjusting the track slab with two manners, that is, running on a dedicated fine adjustment trolley or a crane with function of fine adjustment, according to instruction for adjusting slab, adjusting the track slab thereon with multiple degrees of freedom (longitudinal, transverse, rotation and elevation, etc.), and finishing the fine adjustment and positioning of the track slab, which includes steps of: slab adjustment control system directing the total station to automatically measure the marks placed on the track slab; according to measurement results, calculating deviations of position and space attitude from the design position of the track slab; sending slab adjustment instruction to a fine adjustment mechanism; the fine adjustment mechanism completing adjustment action and repeating the above procedures as required, until the track slab adjustment being in place.

4) after completing fine adjustment, using adjustable supporting legs for fixing the finely adjusted prefabricated slab, wherein the supporting legs can be set closed to center of the slab or on the side of the slab, wherein the supporting leg is able to ensure absolute stability of the track slab at all times so that position accuracy of the track slab can always meet the error limit requirements for the fine adjustment when pouring the filling layer under the slab later.

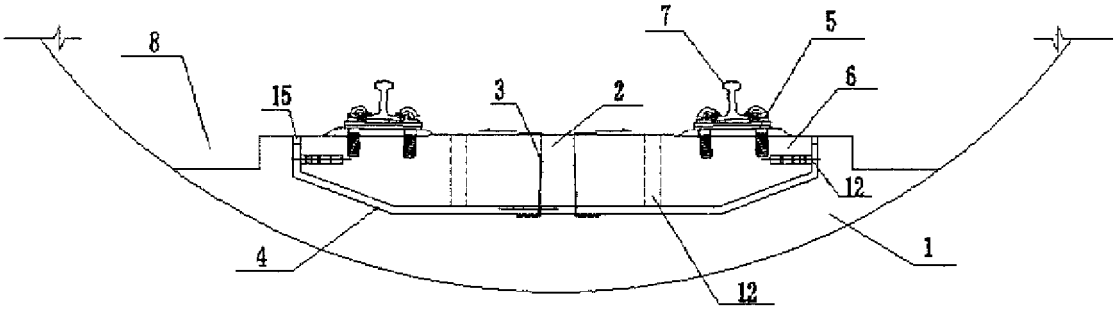

Fig.1

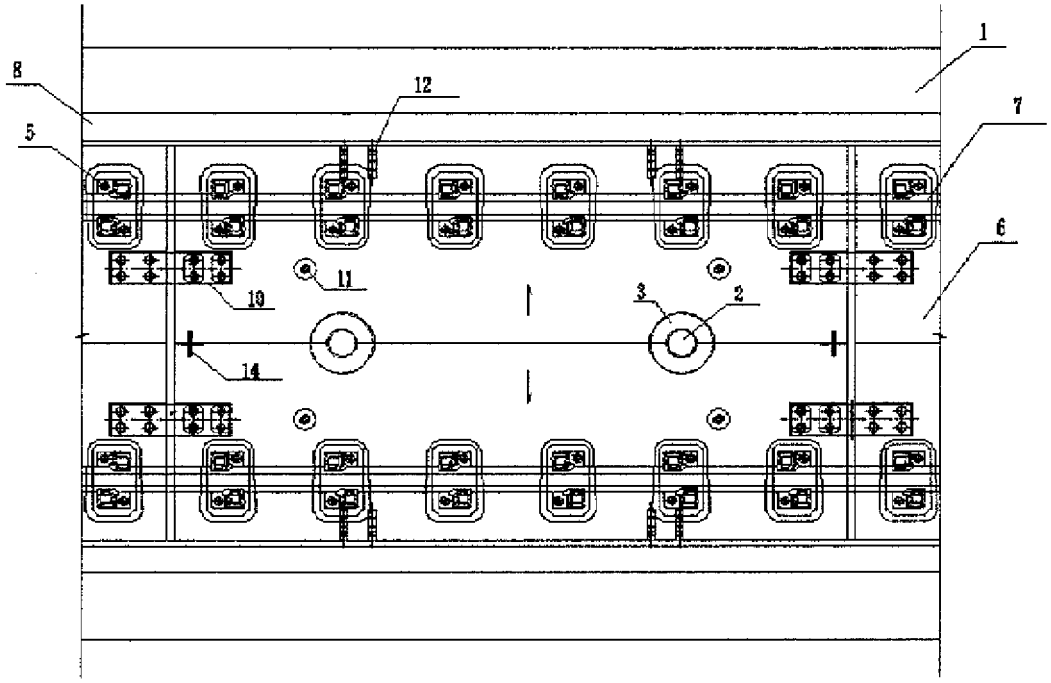

Fig.2

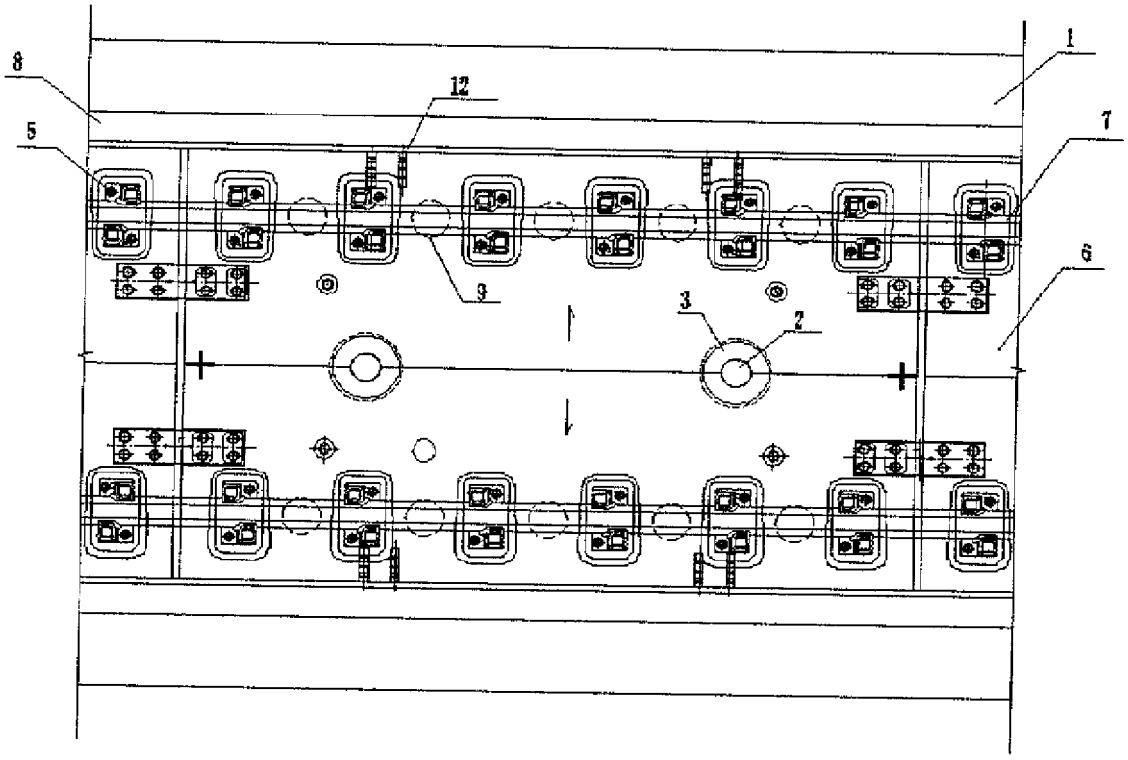

Fig.3

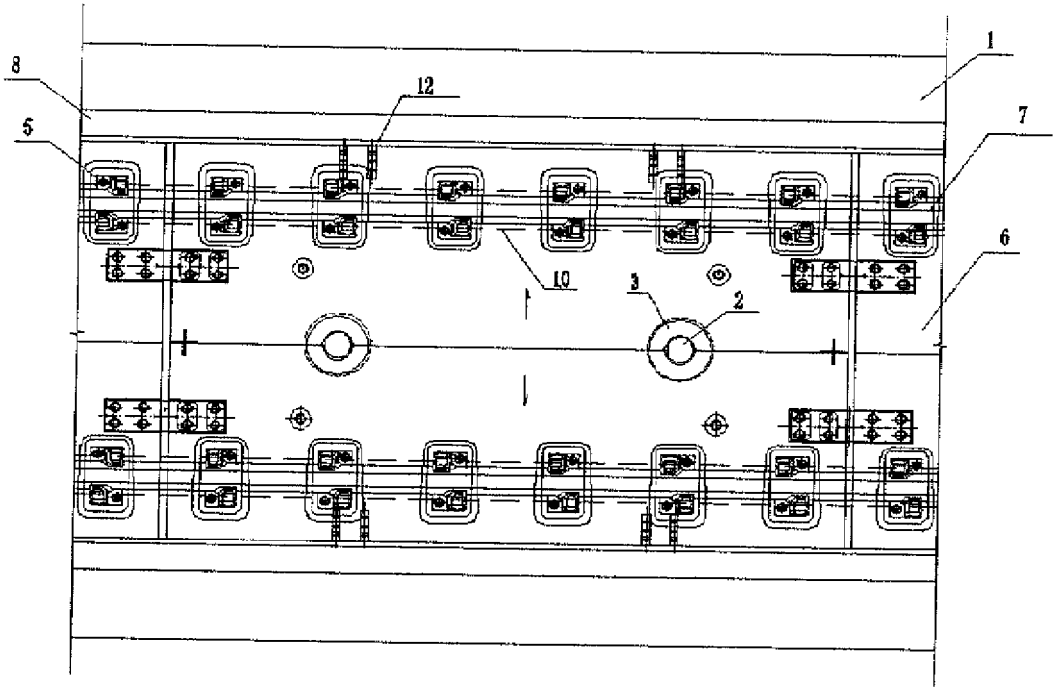

Fig.4

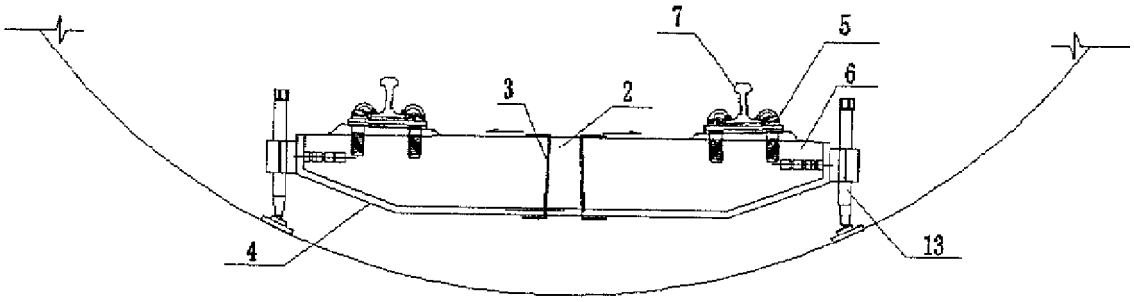

Fig.5

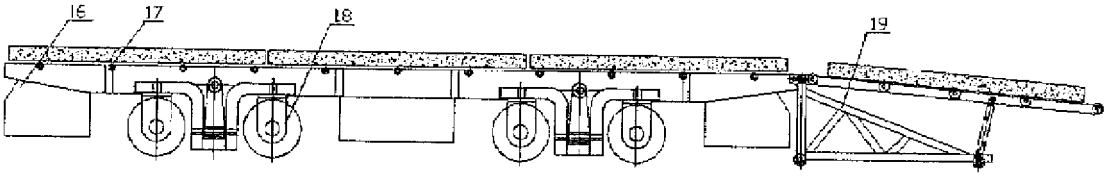

Fig.6

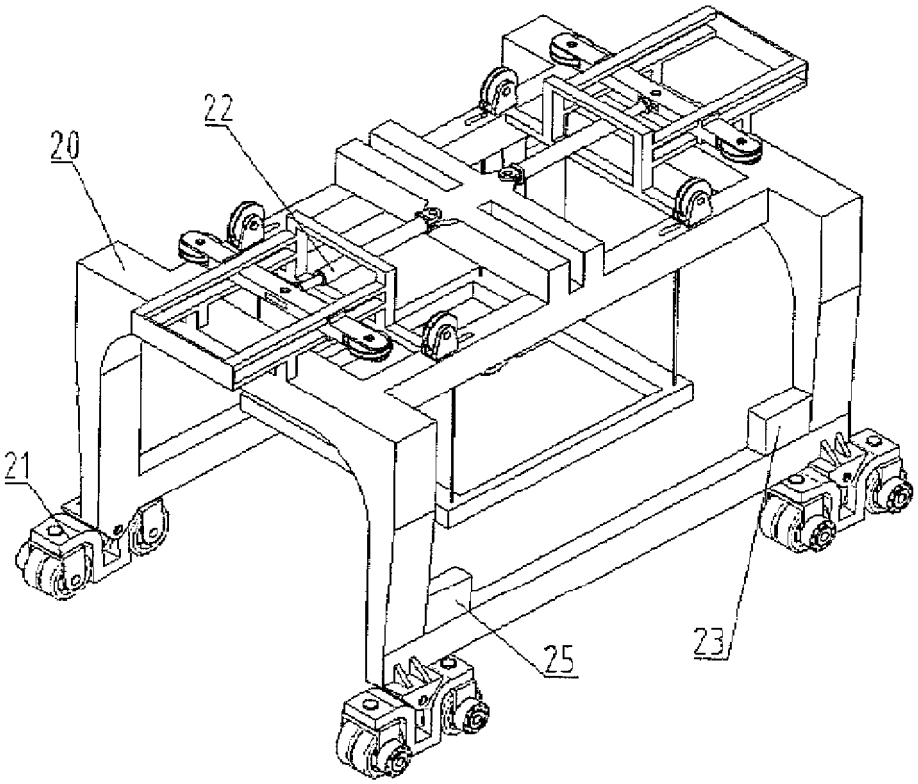

Fig.7

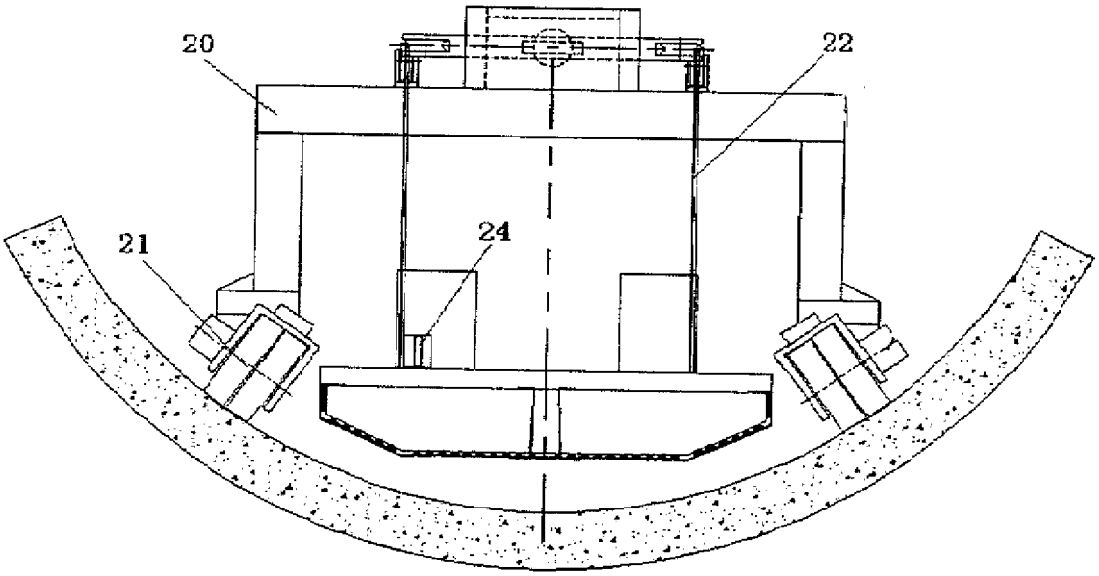

Fig.8

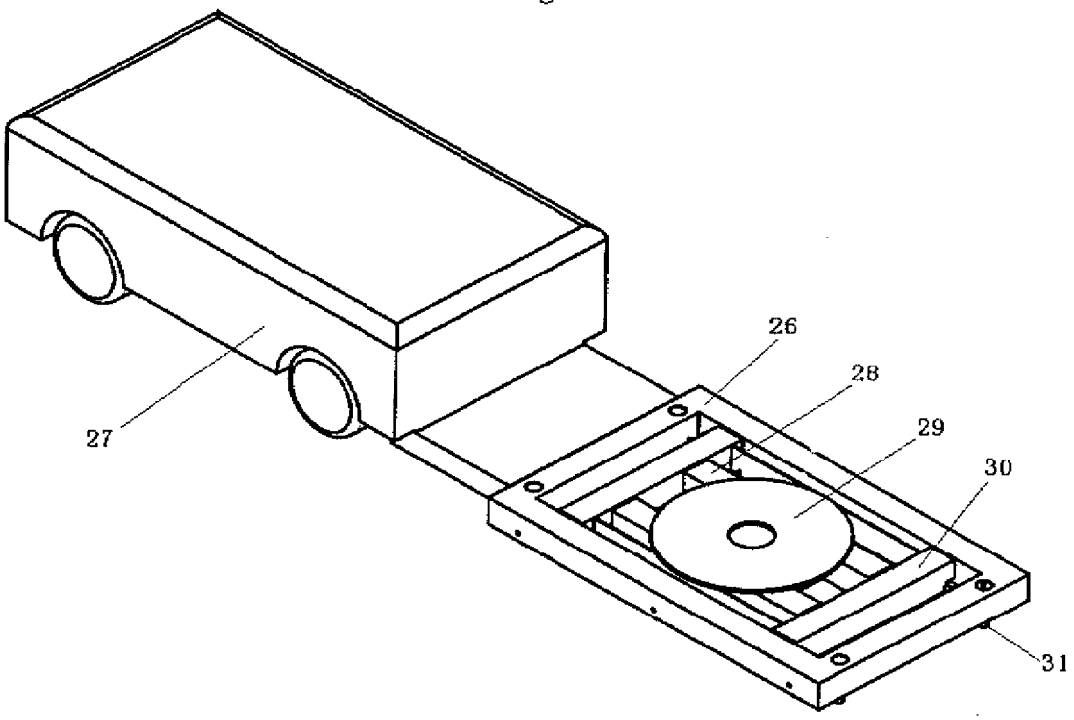

Fig.9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/078779

A. CLASSIFICATION OF SUBJECT MATTER

E01B 1/00 (2006.01) i; E01B 29/00 (2006.01) i

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)

E01B

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)

CNABS, CNTXT, CNKI, DWPI, SIPOABS: E01B1/002/CPC, prefabricate, vibration reduction, track plate, track bed, vibrate, elastic, resilient

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102767123 A (ZHEJIANG TIANTIE INDUSTRY CO., LTD.), 07 November 2012 (07.11.2012), description, pages 2-3, and figures 1-4	1-16
X	CN 202055116 U (CHINA RAILWAY SIYUAN SURVEY AND DESIGN GROUP CO., LTD.), 30 November 2011 (30.11.2011), description, pages 4-5, and figures 3, 4 and 6	1
X	CN 103741561 A (BEIJING JIUZHOUYIGUI SHOCK AND VIBRATION CO., LTD.), 23 April 2014 (23.04.2014), description, page 1, and figure 1	1
X	WO 2009121323 A1 (RAIL ONE GMBH) 08 October 2009 (08.10.2009), description, pages 5-7, and figure 1	1
X	US 4303199 A (EISSES, J.A.), 01 December 1981 (01.12.1981), description, columns 2-4, and figures 1-3	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 September 2016 (30.09.2016)	**18 October 2016 (18.10.2016)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **KANG, Hongyan** Telephone No.: (86-10) **62085293**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/078779

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102767123 A	07 November 2012	None	
CN 202055116 U	30 November 2011	None	
CN 103741561 A	23 April 2014	CN 103741561 B	25 November 2015
WO 2009121323 A1	08 October 2009	DE 102008016953 A1	08 October 2009
US 4303199 A	01 December 1981	ES 483577 A1	01 September 1980
		AU 5016379 A	28 February 1980
		CA 1125719 A	15 June 1982
		AU 526556 B2	20 January 1983
		EP 0008743 B1	10 February 1982
		DE 2962093 D1	18 March 1982
		EP 0008743 A1	19 March 1980

Form PCT/ISA/210 (patent family annex) (July 2009)