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

(11) **EP 3 608 472 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.02.2020 Bulletin 2020/07

(51) Int Cl.:
E01B 3/46 *(2006.01)*

(21) Application number: **19188882.5**

(22) Date of filing: **29.07.2019**

(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:
KH MA MD TN

(30) Priority: **07.08.2018 DE 102018119150**

(71) Applicant: **Schwihag AG**
Gleis- und Weichentechnik
8274 Tägerwilen (CH)

(72) Inventors:
- **Insley, Paul**
  Nottingham, NG10 5LY (GB)
- **Sharpe, Phil**
  Derby DE21 7ED (GB)

(74) Representative: **Grosse, Wolf-Dietrich Rüdiger**
Gihske Grosse Klüppel Kross
Bürogemeinschaft von Patentanwälten
Hammerstrasse 3
57072 Siegen (DE)

(54) SELF-COMPENSATING SLEEPER AND METHOD OF MAINTAINING A RAILROAD TRACK

(57) Self-compensating sleeper (10) for supporting rails (1a) of a railroad track (1), comprising: a body (10a) having an upper surface (10b) configured for fixation of the rails (1a), each at one or more rail seat areas by means of a rail fastening system, and a base (10c) configured to contact a ballast bed (3) of granular material, wherein the body (10a) is configured to transfer the load from the rails (1a) to the ballast bed (3); and one or more cavities (11) penetrating the body (10a) between the upper surface (10b) and the base (10c) and configured to contain granular material for transfer of load to the ballast bed (3).

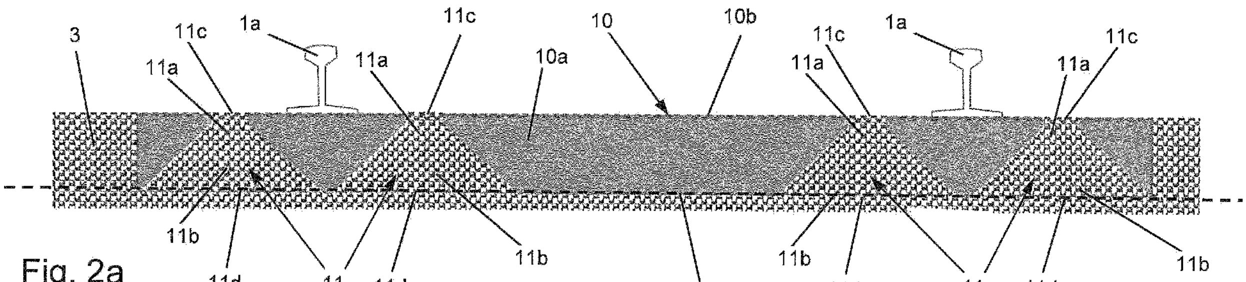

Fig. 2a

EP 3 608 472 A1

Description

Technical Field

[0001] The invention relates to sleepers, bearers or any other medium for supporting rails of a railroad track, preferably at locations that have non-uniform support and/or require additional intervention to maintain line and level. The invention further relates to a method of maintaining a railroad track.

Background

[0002] In plainline or switch and crossing (S&C) track construction, various track forms, substructures and techniques are known for supporting tracks, such as traditional track structures (flat-bottom steel rails supported on sleepers which are laid on crushed stone ballast) or ballastless tracks (which can be known as "slab track") in which the rails are fastened to and supported by a rigid construction, e.g. of concrete which is either continuous or formed of discrete slabs.

[0003] Traditional track is usually maintained by mechanical means which allows faults in line and level to be corrected efficiently. While this is suitable for long sections of track with continuous uniform support conditions, there are many discrete locations which deteriorate rapidly or are unsuitable for mechanical maintenance. An example of such a location is a transition between a ballastless track and a ballasted track, where there is a need to account for stiffness changes, settlement and uplift.

[0004] To illustrate an area of SCS application a typical slab to ballast track transition example will be used.

[0005] A slab track to ballast transition may be described in terms of three zones: a first zone relating to a slab track section comprising the end of a slab track system; a second zone relating to an initial ballast section comprising a reinforced ballasted track; and a third zone relating to a regular ballast section about which details are also required for the transition design. The second zone is sometimes absent, e.g. in the case of light loading or low speed applications.

[0006] Settlement behaviour is a critical aspect in the operation of track and specifically at track transitions. At a transition from ballast to a fixed trackform the settlement control of the ballast can be more important than balancing theoretical elasticities between the zones, although this aspect is also not to be forgotten.

[0007] A transition may be implemented in different forms: The stiffness of each zone may be changed in stages by the use of different track components and geotechnical track support treatments to match the ballast stiffness in the traditional track.

[0008] A typical example of an existing track transition is illustrated in Figure 1, in which the first zone is indicated by reference sign Z1, the second zone is indicated by reference sign Z2 and the third zone is indicated by reference sign Z3. The track 1, in the first zone Z1 supported by a bed of concrete 2, enters a ballast bed 3 of reduced depth in zone Z2. The ballast bed 3 supports sleepers 4. The ballast depth gradually increases until the track 1 enters the regular ballast section in zone Z3. In zone Z2, the ballast 3 is supported by a tapered layer of concrete 2a as an attempt at reinforcing the ballasted track 1. The regular ballast section in zone Z3 may include layers of sub-ballast and subgrade 5.

[0009] The instantaneous change between direct fastened and ballasted track, Z1 to Z2 and the stiffness discontinuity, particularly, Z2 to Z3, indicated in Figure 1 by reference sign "d1" and "d2" respectively, can both lead to a change in ballast settlement and higher dynamic loads. The reduced ballast depth in zone Z2 tends to reduce the service life of the transition. Further, a gradual decrease of the ballast depth impairs the control of settlement; tamping may not be possible. Thus, a rapid development of voids in the second zone Z2, particularly below the sleepers close to the first zone Z1, indicated in Figure 1 by reference numbers "4a", occurs under frequent loading.

[0010] Many transitions, including the transition illustrated in Figure 1, are designed with the objective of providing a smooth change of the track stiffness. However, since the elastic displacement is relatively small compared to the plastic displacement, permanent maintenance is required. What complicates matters is that due to the proximity of a fixed track, a tamper cannot be used regularly at the interface between the ballasted region and the fixed track. If used, the tamper has to work away from the fixed track end and the lift facility cannot be used in the last section due to the risk of damaging the fixed track components. Thus, lifting and packing normally requires manual work in those areas, i.e. techniques such as jacking the track to the level before packing utilising manual tamping or stone-blowing may be required.

[0011] If no measures are taken as to improve the transition design, experience shows that re-packing to restore the level and ballast support in the initial ballast zone, i.e. second zone, is frequently necessary, and measurements have shown that voids can re-establish within a day if no strengthening or control measures are taken. For many years the industry has looked at solutions for these problems and developed techniques such as multistage gluing of the ballast (utilising epoxy glues or mixtures based on polyurethane), auxiliary rails, providing an extended cemented layer under the ballast, ballast mats, sleeper pads or combinations thereof.

Summary of the Invention

[0012] It is an object of the present invention to improve railroad track structures and substructures, particularly at discrete locations where maintenance of line and/or level is difficult to achieve, such as at transition zones, preferably in order to reduce and/or simplify maintenance work at track transitions.

[0013] The object is solved by a self-compensating sleeper as defined in claim 1 as well as a transition of a railroad track as defined in claim 9. Preferred embodiments are defined in the dependent claims, the general description of the invention as well as the description of specific embodiments and the drawings.

[0014] Hereinafter, the sleeper according to the invention is denoted as a "self-compensating sleeper", also abbreviated as "SCS". The SCS is adapted for supporting rails of a railroad track. Normally, the track comprises two rails; however, the sleeper may as well support only one or more rails, such as auxiliary rails.

[0015] For this purpose, the SCS comprises a body having an upper surface configured for fixation of the rails, each at a rail seat area by means of a rail fastening system, and a base configured to contact a ballast bed of granular material, typically but not restricted to crushed stone. The body is configured to transfer the load from the rails to the ballast bed. The rail fastening system may be any suitable means for fixing the rails at the respective rail seat areas to the SCS, such as a system utilising tension clamps. The SCS may comprise one or more rail seat areas for each rail, e.g. in the case of track slab.

[0016] According to the invention, the SCS comprises one or more cavities, preferably customized, penetrating the body between the upper surface and the base. In other words, each cavity can have an upper opening in the upper surface, hereinafter referred to as the "opening", and a lower opening in the base, hereinafter referred to as the "base area". Thus, each cavity is or comprises a through hole penetrating the body substantially in the direction of gravity, provided that the SCS is correctly seated on the ballast bed. The cavities are configured to accommodate or contain granular material, preferably well specified for instance by having similar stone properties to those of conventional rail ballast, but graded to provide the desirable flow characteristics for self-compensation behavior while transferring loads to the existing track bed. The document hereinafter refers to this well specified granular material simply as ballast, i.e. for linguistic simplicity there is no distinction between conventional rail ballast and well specified material contained within and/or used to fill up the cavities.

[0017] We would like to note that also for linguistic simplification, the singular form "cavity" is frequently used. However, the features, effects, advantages etc. also apply to the preferred embodiment of multiple, such as four, cavities per SCS. Further, positional relations such as "above", "under" etc. refer to the situation in which the SCS is properly mounted or seated.

[0018] In case of a conventional track, corrections to the line and level of the sleeper(s) may be made periodically by repacking the ballast, which is normally carried out by tamping, for which a minimum thickness of the ballast, usually at least 200 mm, is required. In contrast, the SCS transfers the load to the ballast contained within the cavities. When the SCS is lifted, for instance by lifting the track, the ballast contained in the cavities is transferred downwards, i.e. new ballast accumulates in lower portions of the cavities and also underneath the base of the SCS. The cavities may be filled up occasionally via the opening in the upper surface.

[0019] Since the lower portions of the cavities are automatically filled simply by lifting the SCS, no ballast needs to be repacked by tamping in order to correct the line and level of the SCS. Any plastic displacement of the track is compensated only by lifting the SCS. In the case of voids compensation may occur automatically as sleepers are lifted by the rails following the passage of a train. Compaction of the ballast is achieved as needed without requiring access of maintenance equipment to the ballast underlying the SCS, which is normally performed via the sides of the sleeper to either repack the ballast or insert new material to raise the track.

[0020] In summary, the SCS provides for an automatic repacking: When the SCS is positioned at a location where voids would normally form under a conventional sleeper, the SCS can effectively pack itself; thus, compensating for any void created beneath the SCS. Further, the SCS shows an increase of lateral and longitudinal resistance: Lateral and longitudinal loads are transferred to the ballast bed by interlock of ballast particles, rather than frictional resistance on a flat concrete base which is a surface of reduced friction. Further, applying the SCS allows for a reduction of the minimum depth of ballast, since there is no necessity for large thicknesses of ballast to permit tamping.

[0021] In its simplest form the cavity preferably has a conical shape, at least partially, so that the cavity widens from the upper surface towards the base. In this case, the cavity or at least parts of the cavity effectively transfer the load of the rails to the ballast. In other words, the surface area which transfers the load to the ballast, conventionally the base only, is increased and partially located within the body. Thus, the self-compensating effect as well as the stability of the sleeper is further increased.

[0022] The following principles may be taken as objectives for optimising sizes and shapes of the cavities: The settlement behaviour of the cone, after the contained ballast has undergone initial consolidation, shall be similar to the settlement behaviour of a conventional ballast bed. Lateral pressures developed in the underlying ballast shall not be higher than under conventional sleeper loading. When a small lift is applied after a substantial period of cyclic loading, there is a useful amount of residual lift after initial settlement.

[0023] Taking these principles into account, the cavity may be divided or partitioned into several portions, such as a reservoir portion and a load transfer portion, wherein the reservoir portion is located above the load transfer portion and is configured to be filled up with ballast from above via the opening in the upper surface. Preferably, the load transfer portion has a conical shape, wherein the cone angle to the horizontal plane may be in the range of 30° to 75°, more preferably about 60°. Preferably, also the reservoir portion has a conical shape, wherein the cone may be in the range of 70° to 90°. In general, if the cavity comprises or can be partitioned into a reservoir portion and a load transfer portion, the cone angle of the reservoir portion should be smaller than the cone angle of the load transfer portion.

[0024] Preferably, the body comprises two or more, for instance four, cavities in order to improve the support. In case of two rails, the body preferably comprises four cavities respectively located on each side of the rail seat areas. According to a preferred embodiment, four conical cavities are present, centered on the longitudinal axis of the SCS with a cavity being located on each side of the rail seat area to provide optimum support.

[0025] Further, the above-mentioned object is solved by a transition of a railroad track, which comprises a first zone including a slab track section, a second zone and preferably a third zone including a regular ballast section. Here, the ballast may be a bed of granular material, preferably comprising crushed stones. The second zone, preferably an intermediate section comprises at least one, preferably three or more, self-compensating sleepers as previously described.

[0026] Primarily, the SCS is intended for use in locations where maintenance is difficult due to the formation of voids beneath the sleepers, such as at transitions between directly fastened and ballasted trackforms. However, the SCS may also be applied to other trackforms and applications such as plain line, switches and crossings, checked curves, jointed tracks, irregular track support spacings, framed systems and any other tracks which may benefit from the technical contributions of the SCS.

[0027] The SCS may also be applied to areas where it is important to increase either lateral or longitudinal track stability of track. In order to accommodate the particular requirements at a given location the shapes and configurations of each cavity may vary as appropriate.

[0028] The invention also concerns a new maintenance concept that allows track to be repositioned without having either to disturb the underlying trackbed or pack with new stone, while improving longitudinal, lateral and vertical geometry retention. This is achived by a method of maintaining a railroad track comprising at least one self-compensating sleeper, wherein the method comprises lifting the body such that granular material within the cavities is transferred downwards, thus repositioning the self-compensating sleeper.

[0029] Thus, the maintenance concept according to the invention allows for rail(s) to be repositioned while providing more durable longitudinal, lateral and vertical support. Further, the SCS facilitates maintenance without the need to access the underside of the body and is therefore particularly suitable for direct placement on substrates such as asphalt.

Brief Description of the Drawings

[0030] Preferred embodiments of the invention will be explained in the following, having regard to the drawings.

Figure 1 is a cross-sectional view, schematically illustrating an example of a conventional transition comprising a first zone relating to a slab track section, a second zone relating to an initial ballast section and a third zone relating to a regular ballast section.

Figures 2a and 2b illustrate a self-compensating sleeper, wherein Figure 2b is a plan view thereof and Figure 2a shows the cross-section A-A as indicated in Figure 2b.

Figures 3a and 3b schematically illustrate the operation of the self-compensating sleeper.

Figure 4 is a cross-sectional view, schematically illustrating a transition comprising an initial ballast section equipped with self-compensating sleepers.

Figure 5 illustrates an example of different shapes of cavities which may be utilised by the self-compensating sleeper.

Detailed Description of Embodiments

[0031] In the following, preferred embodiments of the invention will be described with reference to the drawings. Here, elements that are identical, similar or have an identical or similar effect are provided with the same reference numerals in the figures. Repeating the description of such elements may be omitted in order to prevent redundant descriptions.

[0032] Figures 2a and 2b illustrate a possible configuration of a self-compensating sleeper 10 (herein also referred to as "SCS"). Figure 2b is a plan view thereof and Figure 2a shows the cross-section A-A as indicated in Figure 2b.

[0033] The SCS 10 comprises a body 10a of substantially cuboid shape. The body 10a serves to support rails 1a of a running railway track 1 and transfer the load from the rails 1a to the ballast bed 3. For this purpose, the body 10a comprises an upper surface 10b which is adapted for fixation of the rails 1a by means of a suitable rail fastening system. The rail fastening system, which is not illustrated in the Figures, may be any suitable means for fixing the rails 1a to the body 10a, such as systems of tension clamp fastening, and will not be discussed in further detail.

[0034] The SCS 10 is configured to contain well specified granular material within specifically shaped, hollow spaces provided in the body 10a. For this purpose, the SCS 10 comprises one or more, preferably four, cavities 11 which extend from the lower surface or base 10c of the body 10a to the upper surface 10b of the body 10a, thereby allowing granular material to enter and be added at a later stage from the upper surface 10b. In other words, each cavity 11 is arranged as a through hole penetrating the body 10a, which has an upper opening in the upper surface 10b, denoted as opening 11c, and a lower opening in the base 10c, denoted as the base area 11d.

[0035] In case of a conventional track, corrections to the line and level of the sleeper(s) are made periodically by repacking the ballast, which is normally carried out by tamping, for which a minimum thickness of ballast, usually at least 200 mm, is required.

[0036] In contrast, the SCS 10 transfers the load to the ballast 3 partially contained within the cavities 11 as illustrated in Figure 2a. When the SCS 10 is lifted, for instance by lifting the track, the ballast contained in the cavities 11 is transferred downwards, i.e. new ballast accumulates in lower portions of the cavities 11 and also underneath the base 10c of the SCS 10, as illustrated in Figures 3a and 3b.

[0037] The cavities 11 may be filled up occasionally via the opening 11c in the upper surface 10b. Since the lower portions of the cavities 11 are automatically filled simply by lifting the SCS 10, no ballast 3 needs to be repacked by tamping in order to correct the line and level of the SCS 10.

[0038] In order to improve these effects, each cavity 11 according to the present embodiment comprises a reservoir portion 11a including material of the ballast 3, i.e. preferably crushed stones, and a load transfer portion 11b which is configured to transfer the load of the rails 1a to the ballast 3.

[0039] The reservoir portion 11a is located above the load transfer portion 11b and, preferably, can be filled up with granular material of the ballast bed 3 from above via the opening 11c. Preferably, the load transfer portion 11b is conically shaped, whereas the reservoir portion 11a is or includes a cylindrical portion.

[0040] The load transfer portion 11b has a base area 11d which is open to the stratum below the SCS 10; thus, the ballast material 3 inside the load transfer portion 11b contacts and is connected to the ballast material 3 below the SCS 10.

[0041] Please note that the reservoir portion 11a and the load transfer portion 11b are not necessarily separate and/or differently shaped portions of the cavity 11, even though this would be preferred in order to optimize the operation thereof. Possible shapes of the cavities 11 are also discussed and illustrated further below with reference to Figure 5.

[0042] With reference to Figures 3a and 3b, when the SCS 10 is lifted, for instance by lifting the track 1, lower portions of ballast 3 leave the cavity 11 at the base 10c and additional ballast 3 is added to the load transfer portion 11b via the reservoir portion 11a above the load transfer portion 11b. The load transfer portion 11b may require to be filled up occasionally via the opening 11c.

[0043] Since the load transfer portion 11b is automatically filled by lifting the SCS 10, no ballast 3 needs to be repacked by tamping in order to correct the line and level of the track portion supported by the SCS 10. Any plastic displacement of the track 1, for instance due to the generation of voids within the ballast 3, is compensated only by lifting the SCS 10. Compaction of the ballast 3 is achieved as needed without requiring access of maintenance equipment to the ballast 3 underlying the SCS 10, which is normally performed via the sides of the sleeper to either repack the ballast 3 or insert new material to raise the track 1.

[0044] Figure 4 illustrates a transition comprising a first zone Z1 relating to a slab track section, a second zone Z2 relating to an initial ballast section comprising plural, for instance six, self-compensating sleepers 10 and a third zone Z3 relating to a regular ballast section.

[0045] The SCS 10 provides for an automatic repacking: When the SCS 10 is positioned at a location where voids would normally form under a conventional sleeper, the SCS 10 can effectively pack itself, thereby compensating for any voids created below the SCS 10.

[0046] The SCS 10 shows an increase in lateral and longitudinal resistance: Lateral and longitudinal loads are transferred to the ballast bed 3 by interlock of ballast particles, rather than frictional resistance on a flat concrete base which rather is a surface of reduced friction.

[0047] Further, applying the SCS 10 allows for reducing the minimum depth of ballast 3 since there is no necessity for large thicknesses of ballast 3 to permit tamping.

[0048] According to the preferred embodiment illustrated in the Figures 2a and 2b, four conical cavities 11 are present, centered on the longitudinal axis of the SCS 10 with a cavity 11 being located on each side of the rail seat area to provide optimum support. However, any other shape(s) and/or location(s) of the cavities 11 suitable to make the SCS 10 more efficient may be applied, for example by resisting settlement, improving lateral resistance, encouraging self-compaction and/or self-compensation.

[0049] Further, the technique of self-compensation, based on the principle of addition of new material and compaction from the surface, applies to any sleeper, bearer or support medium dimensions and track panels, for instance containing multiple rail fastenings.

[0050] The SCS 10 provides a high degree of both lateral and vertical restraint for rails 1a, while allowing improved adjustability of the position compared to conventional sleepers/bearers of a ballasted track.

[0051] Preferably, each cavity 11 has a large base area 11d to allow track loads to be transferred to the underlying stratum, i.e. ballast 3, while the upper part of the cavity 11 is smaller to prevent granular material being squeezed upwards.

[0052] Primarily, the SCS 10 is intended for use in locations where maintenance is difficult due to the formation of voids beneath the sleepers, such as at transitions between direct fastened and ballasted trackforms. However, the SCS 10 may also be applied to other trackforms and applications such as plain lines, switches and crossings, checked curves, jointed tracks, irregular track support spacings, framed systems and any other tracks which may benefit from the technical contributions of the SCS 10.

[0053] The body 10a of the SCS 10 may be formed of steel, concrete, plastic, timber or composites containing the aforementioned. The dimensions of the SCS 10 may be similar to conventional sleepers.

[0054] By virtue of the method of maintenance, there is no requirement for a conventional ballast layer, which means that while the SCS 10 is suitable for laying on a conventional ballasted trackbed, it can also be founded on a variety of substrata, including reduced thickness of ballast, existing (partially life expired) ballast layer or other appropriate substratum such as asphalt.

[0055] The cavities 11 may be lined with suitable material either to alter the track stiffness properties or to alter the internal stress/strain behaviour of the well specified granular fill.

[0056] The granular fill may be of any size and consist of any solid material as to give the desired wear characteristics and/or frictional resistance to plastic and elastic deformation.

[0057] In order to identify suitable shapes of the cavities 11, several tests have been conducted utilising a large-scale test machine, which is designed specifically for assessing the settlement of railway ballast. For initial design purposes, it was assumed that the bearing pressure at the base of the conical cavity 11 should be the same as the typical bearing pressure beneath a conventional sleeper.

[0058] The following principles have been taken as objectives for optimising sizes and shapes of the cavities 11: The settlement behaviour of the cone, after the contained ballast has undergone initial consolidation, shall be similar to the settlement behaviour of a conventional ballast bed. When a small lift is applied after a substantial period of cyclic loading, there is a useful amount of residual lift after initial settlement.

[0059] Figure 5 illustrates two different shapes, as an example of how the self-compensation may be improved by modification of the cavity shape. A simple cone-shaped cavity 11 is shown with a vertical sided reservoir portion 11a indicated by solid lines; together with a more complex cone-shaped cavity 11' with a conical reservoir portion 11a' indicated by dashed lines. The size and shape of the openings 11c, 11 c' as well as the base area 11d, 11d' are identical.

[0060] It is likely that the more complex shaped cavity 11' is advantageous over the simple cone-shaped cavity 11. A lower high-pressure load transfer portion 11b' may have an angle of 50° or less, which would support the sleeper loads. The reservoir portion 11a', which in this case is an upper low-pressure cone with a steeper angle, appears to be more sensitive to collapse but is less likely to compact. The improved reservoir portion 11a' acts like a ratchet mechanism, so the slightest void created above the load transfer portion 11b', when unloaded, would allow more ballast to be forced downwards from the reservoir portion 11a', thus repacking the load transfer portion 11b' as necessary to prevent formation of large voids.

[0061] The invention is not restricted by the description of embodiments. Rather, the invention comprises any new feature and also any combination of features, including in particular any combination of features in the patent claims, even if this feature or combination itself is not explicitly specified in the patent claims or exemplary embodiments.

List of Reference Numerals

[0062]

1	Track
1a	Rail
2	Bed of concrete
2a	Tapered concrete
3	Ballast
4, 4a	Sleeper
5	Subgrade
10	Self-compensating sleeper (SCS)
10a	Body
10b	Upper surface
10c	Base
11, 11'	Cavity
11a, 11a'	Reservoir portion
11b, 11b'	Load transfer portion
11c, 11c'	Opening
11d, 11d'	Base area

Z1	First zone
Z2	Second zone
Z3	Third zone
d1	Discontinuity Z1 to Z2
d2	Discontinuity Z2 to Z3

Claims

1. Self-compensating sleeper (10) for supporting rails (1a) of a railroad track (1), comprising:

    a body (10a) having an upper surface (10b) configured for fixation of the rails (1a), each at one or more rail seat areas by means of a rail fastening system, and a base (10c) configured to contact a ballast bed (3) of granular material, wherein the body (10a) is configured to transfer the load from the rails (1a) to the ballast bed (3); and
    one or more cavities (11) penetrating the body (10a) between the upper surface (10b) and the base (10c) and configured to contain granular material for transfer of load to the ballast bed (3).

2. Self-compensating sleeper (10) according to claim 1, **characterised in that** the cavity (11) has a conical shape such that the cavity (11) widens from the upper surface (10b) towards the base (10c).

3. Self-compensating sleeper (10) according to claim 1 or 2, **characterised in that** the cavity (11) comprises a reservoir portion (11a) and a load transfer portion (11b), wherein the reservoir portion (11a) is located above the load transfer portion (11b) and is configured to be filled up with granular material from above via an opening (11c) in the upper surface (10b).

4. Self-compensating sleeper (10) according to claim 3, **characterised in that** the load transfer portion (11b) has a conical shape, preferably having a cone angle in the range of 30° to 75°, more preferably about 60°.

5. Self-compensating sleeper (10) according to claim 3 or 4, **characterised in that** the reservoir portion (11a) has a shape designed to encourage self-compensation.

6. Self-compensating sleeper (10) according to any one of the preceding claims, **characterised in that** the body (10a) comprises one or more cavities (11).

7. Transition of a railroad track (1), comprising a first zone (Z1) including a slab track section and a second zone (Z2) including an initial ballast section comprising at least one self-compensating sleeper (10) according to any one of the preceding claims.

8. Transition according to claim 7, **characterised in that** the transition further comprises a third zone (Z3) including a regular ballast section.

9. Transition according to claim 7 or 8, **characterised in that** the ballast is a ballast bed (3) of granular material, preferably comprising crushed stones.

10. Transition according to any one of the claims 7 to 9, **characterised in that** the slab track section of the first zone (Z1) comprises a bed of concrete (2) for supporting the rails (1a) of the track (1).

11. Method of maintaining a railroad track (1) comprising at least one self-compensating sleeper (10) according to any one of claims 1 to 6, wherein the method comprises lifting the body (10a) such that granular material within the cavities (11) is transferred downwards, thus repositioning the self-compensating sleeper (10).

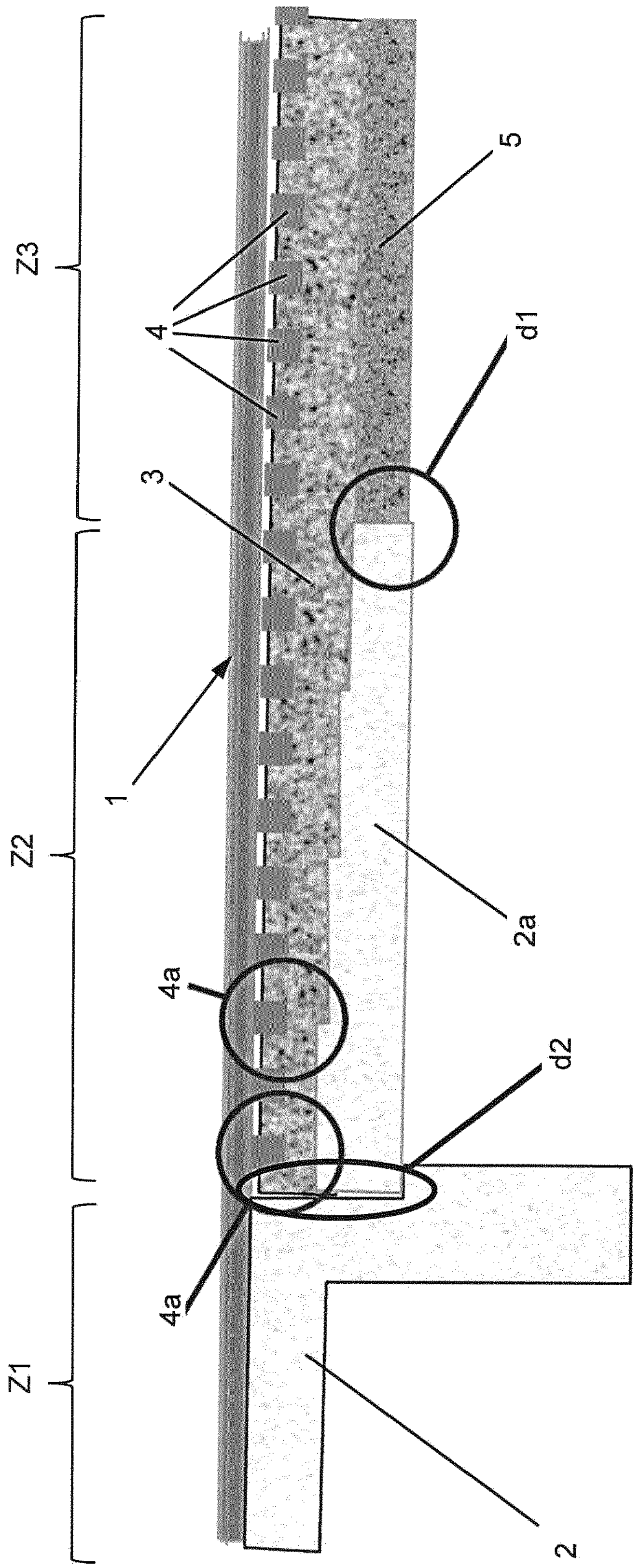

Fig. 1

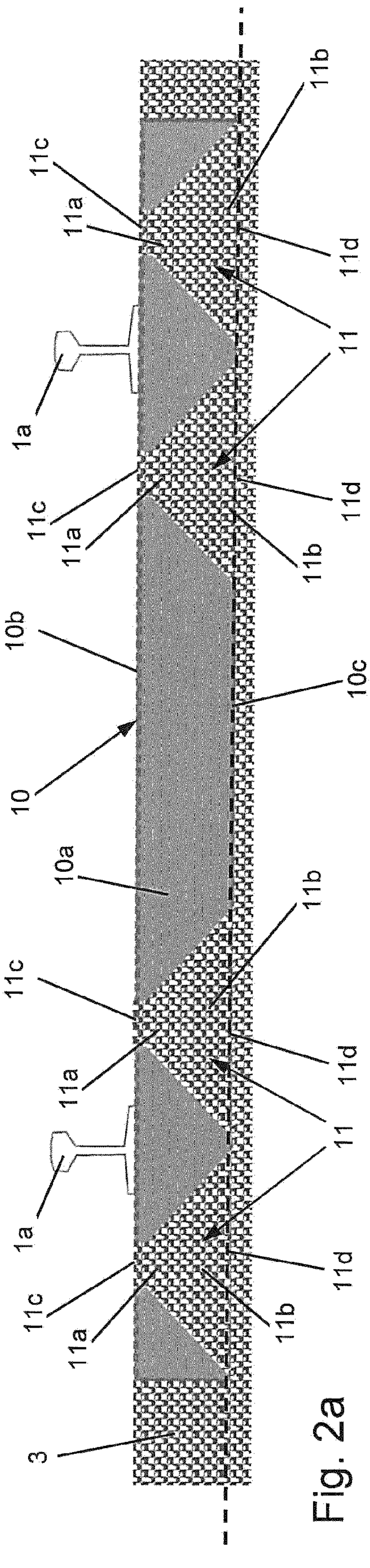

Fig. 2a

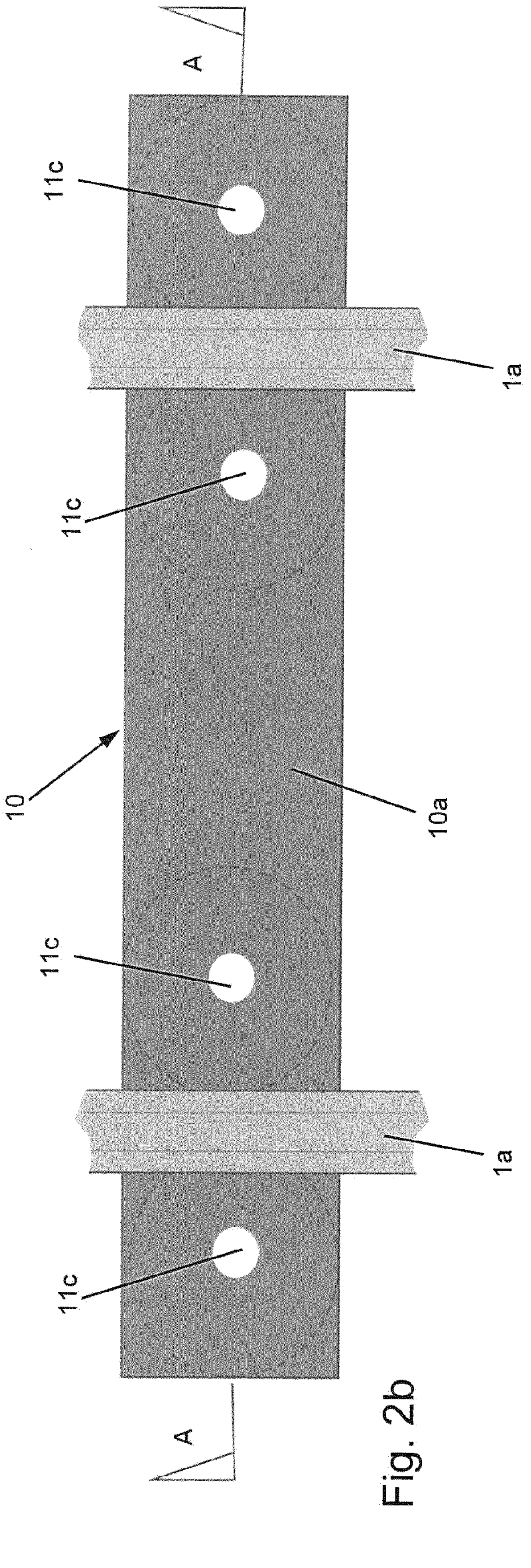

Fig. 2b

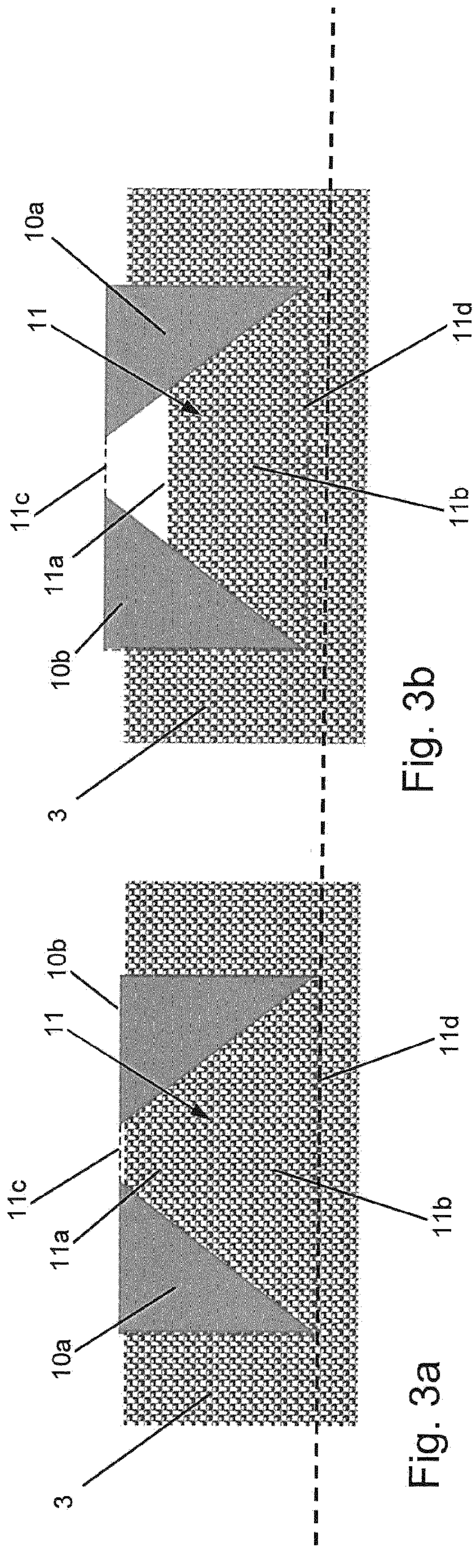

Fig. 3a

Fig. 3b

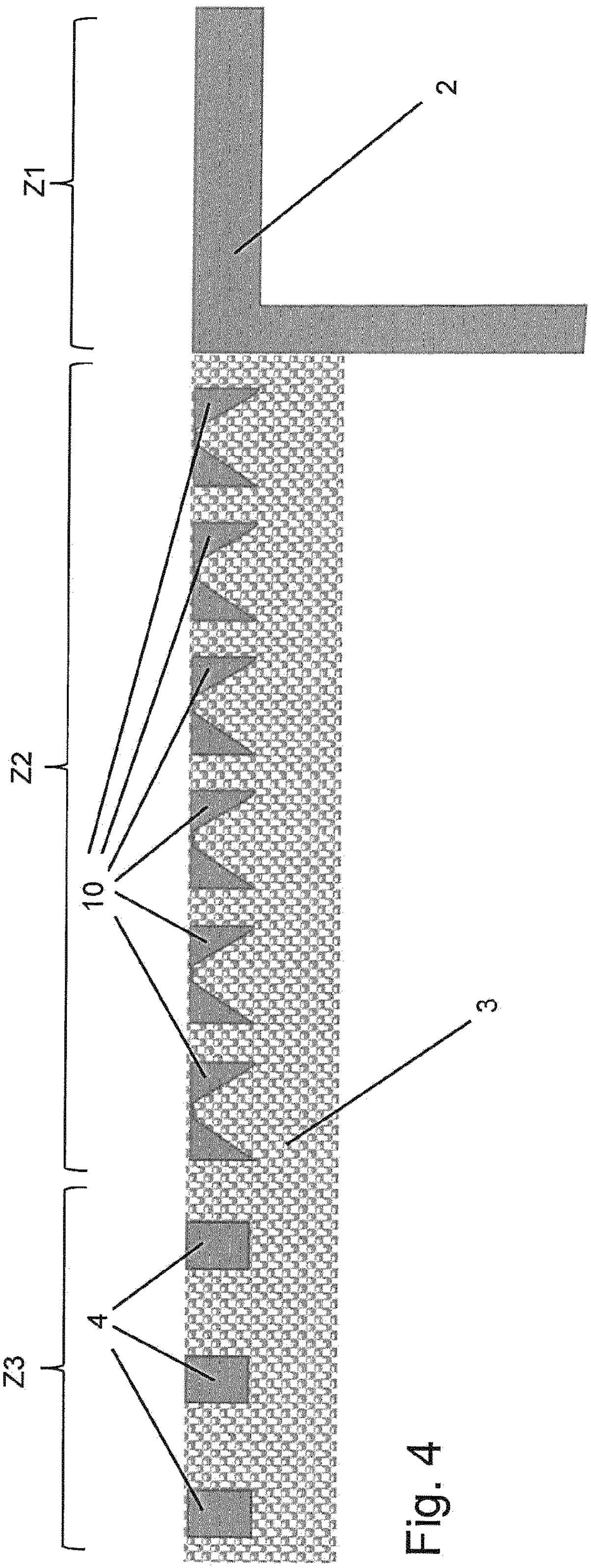

Fig. 4

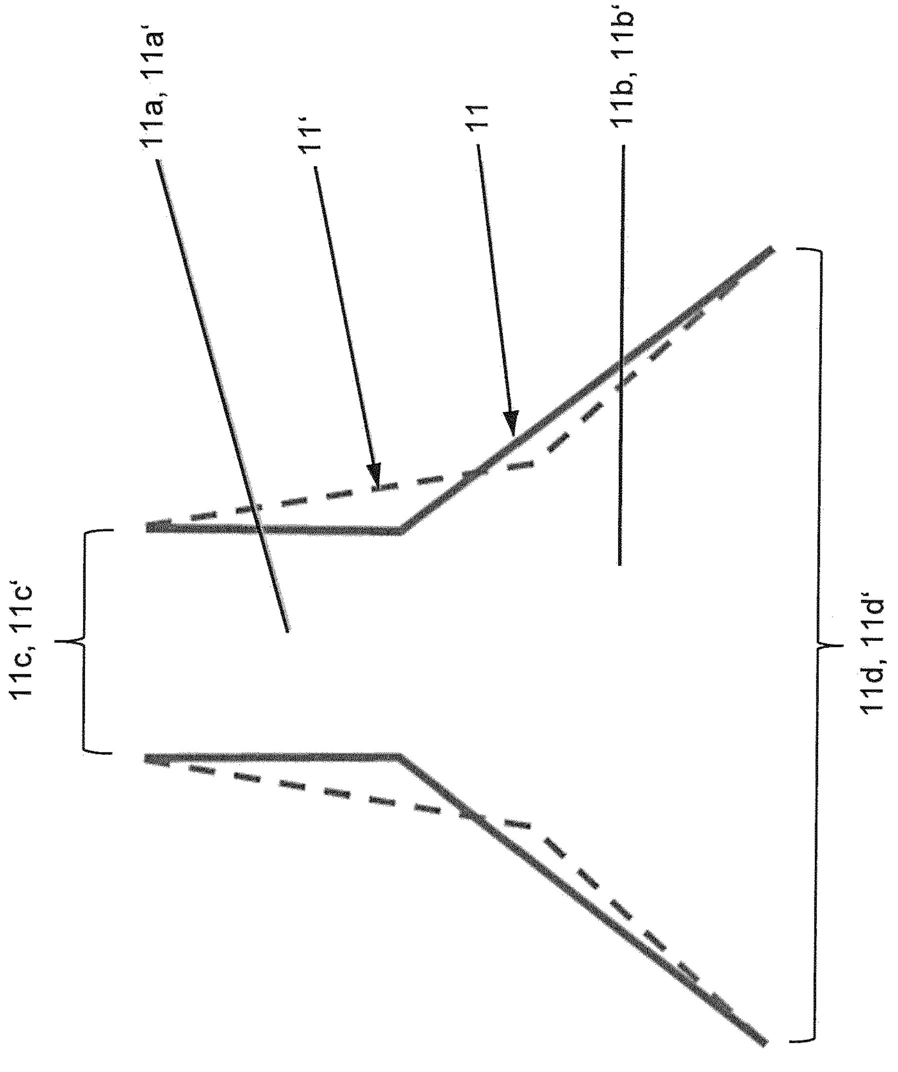

Fig. 5

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 18 8882

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	GB 2 448 500 A (SPECIALIST INNOVATIONS LTD [GB]) 22 October 2008 (2008-10-22) * page 1, lines 24-28; figures 1,3,4 * * page 4, lines 23-26 * * page 7, lines 2-25 * * page 9, lines 19-20 * -----	1,3,5-11 2,4	INV. E01B3/46
X	GB 2 030 621 A (OHNO I) 10 April 1980 (1980-04-10) * page 1, lines 43-51; figures 1,2,3, * -----	1,3,5-9,11	
X	WO 2016/134747 A1 (SUSTAINABLE RAILWAY COMPONENTS GMBH [AT]) 1 September 2016 (2016-09-01) * page 1, lines 3-5 * * page 20, lines 3-30; figure 14 * -----	1,3,5-9,11	
X	GB 00942 A A.D. 1910 (GEARON JOHN [US]) 8 December 1910 (1910-12-08) * page 3, lines 47-49; figure 2 * -----	1,6-9,11	TECHNICAL FIELDS SEARCHED (IPC)
X	DE 18 53 647 U (PAUL MUELLER HOLZWAREN FABRIK [DE]) 20 June 1962 (1962-06-20) * page 4, paragraph 5 - page 5, paragraph 2; figure 1 * -----	1,6-9,11	E01B

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	2 December 2019	Stern, Claudio

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 18 8882

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-12-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2448500 A	22-10-2008	NONE	
GB 2030621 A	10-04-1980	DE 2935149 A1	13-03-1980
		FR 2434895 A1	28-03-1980
		GB 2030621 A	10-04-1980
		JP S5532856 A	07-03-1980
WO 2016134747 A1	01-09-2016	NONE	
GB 191000942 A	08-12-1910	NONE	
DE 1853647 U	20-06-1962	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82