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54 **Noise barrier wall.**

57 Noise barrier wall 1 comprising a plurality of horizontally adjacent wall panels 2 arranged in a zigzag pattern, wherein a right edge 6 of a first wall panel 2A of the plurality of wall panels 2 is connected to a left edge 8 of an adjacent second wall panel 2B of the plurality of wall panels 2 using a resilient connection unit 10 arranged for being resiliently compressed and/or extended in a direction substantially parallel to a connection direction A extending from the right edge 6 of the first wall panel 2A to the left edge 8 of the second wall panel 2B.

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Title: Noise barrier wall

TECHNICAL FIELD

The invention relates to a noise barrier wall useful for forming a noise barrier along the side of a roadway, highway, or railway.

5 BACKGROUND

A function of a noise barrier wall is to block and/or deflect traffic and/or road noise originating on one side of the noise barrier wall such that the audibility of the traffic and/or road noise on the other side of the noise barrier wall is reduced. Typically, a noise barrier wall is used to improve the
10 liveability of residential areas located along the side of a roadway, highway, or railway. A noise barrier wall in general may also be used to block sight form a road onto a surrounding area or vice versa.

Unfortunately, the ecological footprint of a noise barrier wall along the side of a roadway or highway can be quite large. Production of
15 such noise barrier walls generally causes large carbon dioxide emission.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a noise barrier wall with a reduced ecological footprint. More in general it is an object of the invention
20 to overcome or ameliorate at least one of the disadvantages of the prior art. Therefore, one object is to reduce carbon dioxide emissions associated with erecting a noise barrier wall. This may e.g. be done by reducing the amount of building materials required for erecting the noise barrier wall. In one solution it is desirable to construct noise barrier walls from thin concrete
25 wall panels. However, these concrete panels can be very flexible and susceptible to breakage, cracking, and/or crack forming due to varying environmental conditions. Alternatively, it is an object of the invention to at least provide the public with a useful choice.

There to, according to the invention a noise barrier wall is provided comprising a plurality of horizontally adjacent wall panels arranged in a zigzag pattern. A right edge of a first wall panel of the plurality of wall panels is connected to a left edge of an adjacent second wall panel of the plurality of wall panels using a resilient connection unit. The resilient connection unit is arranged for being resiliently compressed and/or extended in a direction substantially parallel to a connection direction extending from the right edge of the first wall panel to the left edge of the second wall panel.

The zigzag pattern provides the noise barrier wall with structural rigidity. The resilient connection unit allows for expansion and/or compression of the noise barrier wall parallel to the connection direction. The connection direction is defined as the direction from the right edge of the first wall panel to the left edge of the second wall panel. Typically, this direction is substantially parallel to the longitudinal extent of the noise barrier wall. Additionally, or alternatively, the connection direction is substantially parallel to an axial direction of the resilient connection unit. The resilient connection unit allows for the absorption of environmental forces exerted on the noise barrier wall. Environmental forces may include expansion and/or contraction due to temperature fluctuations. These forces are not limited to expansion and/or contraction in an axial direction of the wall panels. Additionally, temperature fluctuations may cause gradients in the wall panels. In this case, the deformation results in angular rotation of the vertical edges of the wall panel. The resilient connection unit can also be arranged to absorb this angular rotation at the connection area of adjacent wall panels. Noise barrier walls must be able to sustain the high temperatures of the summer and the low temperatures of the winter. Additionally, wind and/or air turbulence caused by moving vehicles may also exert forces on the wall panels of the noise barrier wall.

It will be appreciated that the solution is counter intuitive. It was thought that using thinner more flexible wall panels would require a rigid connection unit to connect and support the noise barrier wall. In fact the present invention shows that a resilient connection unit allows to absorb the forces exerted on the noise barrier wall, so that the forces do not lead to unacceptable stresses in the wall panels, potentially causing damage.

It will be clear that although the wall panels are horizontally adjacent, the wall panels of the noise barrier wall may include height differences due to unevenness of the ground. For example, it is common for noise barrier walls to follow the formation of the earth. This may include hills, mountains or undulations.

Optionally, every pair of adjacent panels is mutually connected using a resilient connection unit. Depending on the application and zigzag pattern it may be desirable that adjacent panel pairs are mutually connected using a resilient connection unit. Optionally, the two wall panels constituting a pair of adjacent panels is connected using a resilient connection unit, whereas the pairs of wall panels are mutually connected using at least one resilient or non-resilient connection unit. It will be appreciated that a non-resilient connection unit is a substantially stiff connection unit. Depending on the zigzag pattern, it may be advantageous to use the substantially stiff connection unit to connect pairs of adjacent panels extending in the same direction, and to use the resilient connection unit to connect pairs of adjacent panels forming an angle. Pairs of rigidly connected adjacent panels extending in the same direction can be seen as forming longer panels.

It will be appreciated that the noise barrier wall is standing. However it is possible that the noise barrier wall is not vertically upright. Optionally, a wall panel of the plurality of wall panels is tilted in a first direction away from vertical. Optionally, each wall panel of the plurality of wall panels is tilted in a first direction away from vertical. It has been found

that tilting the wall panels away from vertical can improve the deflection of traffic and/or road noise upwards and away from an area on the other side of the noise barrier wall where there is reduced audibility of the traffic and/or road noise, for example a residential area. It is noted that the wall panels
5 are advantageously tilted away from the road, or noise producing, side of the noise barrier wall.

Optionally, the wall panels of the noise barrier wall are precast concrete panels. Concrete panels are modular. Therefore panels may be produced at a location remote to the location of the noise barrier wall and
10 transported to the construction site. Optionally the wall panels of the noise barrier wall are monolithic precast concrete panels. Using monolithic precast concrete panels decreases the construction time of the noise barrier wall. Optionally, the wall panels are made of ferrocement, also know as microbeton. Optionally, the wall panels of the noise barrier wall include a
15 recess. The recess may extend horizontally, starting at a predetermined distance from the left edge and ending at a predetermined distance from the right edge. The recess may extend vertically, starting at a predetermined distance from a bottom edge of the panel and ending at a predetermined distance from a top edge of the panel. Herein the predetermined distance is
20 non-zero. It is also possible that the recess extends vertically all the way to the top edge of the panel. Furthermore, such recess may be present on both a first face of the wall panel and a second face of the wall panel. Including a recess in the wall panel decreases the weight of the wall panel and the raw materials necessary to produce the wall panel. Additionally, the recess aids
25 in transferring the load from the resilient connection unit at the side of the wall panel into the wall panel.

Optionally, the wall panels are made from reinforced concrete. Reinforced concrete generally includes steel reinforcement bars. However other reinforcement techniques are possible, such as reinforcing the concrete

with plastic fibers. Nevertheless, it is also conceivable that the panels are constructed from other materials such as plastics, resins, or the like.

Optionally, the resilient connection unit includes a resilient element. Optionally, a tensile stiffness of the resilient connection unit is substantially determined by a bending stiffness of the resilient element.

Then the bending stiffness of the resilient element determines the resilience of the resilient connection unit parallel to the connection direction. It is noted that the tensile stiffness of the connection unit refers to both stressing by pulling or stretching and compressing in a direction parallel to the connection direction.

Optionally, the resilient connection unit is arranged for being substantially rigid in a direction substantially perpendicular to the connection direction and substantially perpendicular to an upright direction. Herein the upright direction can be substantially parallel to at least one of the right edge of the first wall panel and the left edge of the second wall panel. It is also possible that the upright direction is substantially vertical, even if the panels are mounted slanting towards or away from the road and/or railway. In this way the resilient connection unit provides additional support to the zigzag noise barrier. Optionally, the resilient connection unit is arranged for being five times more rigid in the direction substantially perpendicular to the connection direction and substantially perpendicular to an upright direction than in the connection direction, and preferably ten times more rigid in the direction substantially perpendicular to the connection direction and substantially perpendicular to an upright direction than in the connection direction, and more preferably twenty times more rigid in the direction substantially perpendicular to the connection direction and substantially perpendicular to an upright direction than in the connection direction. It will be appreciated that the resilient connection unit may be arranged to be five times more rigid in the direction substantially perpendicular to the connection direction and substantially perpendicular to

the upright direction than in the connection direction, and preferably ten times more rigid in the direction substantially perpendicular to the connection direction and substantially perpendicular to the upright direction than in the connection direction, and more preferably twenty times more rigid in the direction substantially perpendicular to the connection direction and substantially perpendicular to an upright direction than in the connection direction.

Optionally, the resilient connection unit is arranged for being resiliently angularly expanded and/or angularly contracted about an axis substantially parallel to the upright direction. In this way the resilient connection unit can prevent damage to the noise barrier wall from angular deformations. Angular expansion is to be understood as an increase of an angle formed between two adjacent wall panels, when viewed from above along a direction parallel to the upright direction, and angular contraction is to be understood as a decrease of the angle formed between two adjacent wall panels when viewed from above along a direction parallel to the upright direction. Preferably the angle is defined as an interior angle formed between two adjacent wall panels, when viewed from above along a direction parallel to the upright direction.

Optionally, or alternatively, the resilient connection unit is arranged for being resiliently compressed and/or extended in a second direction substantially perpendicular to the connection direction and substantially parallel to the upright direction. In general the second direction can be deviating, e.g. $\pm 45^\circ$, from the upright direction. In case the resilient connection unit is arranged for being resiliently compressed and/or extended in the second direction, the resilient connection unit may be arranged to be substantially rigid in a direction substantially perpendicular to the connection direction and substantially perpendicular to the second direction. In this way the resilient connection unit is arranged for absorbing environmental stresses and/or forces exerted on the noise barrier wall in the

connection direction, and in the second direction. Environment stress substantially parallel to the second direction may arise from settling differences in the wall panel foundations. In the event that foundations are not used, it is possible these stresses arise from the settling of the ground. A resilient connection unit arranged for being resiliently compressed and/or extended in the second direction can absorb these vertical deformation differences and prevent damage to the wall panels of the noise barrier wall. At the same time, the resilient connection units provides support for the wall panels in a direction perpendicular to the connection direction and perpendicular to the second direction in order to support the wall panels and to hold the wall panels in a zigzag configuration. However, it will be appreciated that the resilient connection unit may be arranged for only being resiliently compressed and/or expanded in a direction parallel to the connection direction.

Optionally, the resilient connection unit is secured to the right edge of the first wall panel at a first location, and the resilient connection unit is secured to the left edge of the second wall panel at a second location, wherein the first location and second location are vertically offset. As mentioned above, it is possible that difference in height may occur between adjacent panels due to the formation of the ground. Typically, the wall panels are modular and the resilient connection unit may therefore be connected to the first panel and the second panel at vertically offset locations. It is also possible that the locations are vertically offset between wall panels.

Optionally, the resilient connection unit includes a connection element extending between the first and second wall panel. Additionally, and/or alternatively, the connection element may be arranged for being resiliently compressed and/or extended in a direction substantially parallel to the connection direction.

Optionally, the connection element includes an intermediate plate. Additionally, and/or alternatively, the resilience of the connection unit may come from the material properties of the intermediate plate.

5 Additionally, and/or alternatively, the intermediate plate may provide resilience in the connection element by altering the shape of the connection unit.

Optionally, the shape of the connection element is one of an Ω -shape, a U-shape, a S-shape, a Z-shape, and a loop. These specific shapes provide a connection element including a resilient element, which is
10 resilient in a direction substantially parallel to the connection direction. It is noted that such a connection element derives its tensile stiffness in the connection direction substantially from the bending stiffness of its resilient element. For example, the U-shaped connection element includes a resilient
15 element in the valley of the U. It is the bending stiffness of this resilient element that determines the tensile stiffness of the U-shaped connection element.

Optionally, the connection element includes a rod having a diameter between 12mm and 50mm. The diameter of the connection element has an impact on its resilience. For typical noise barrier
20 applications using concrete wall panels, it has been found that connection elements ideally have a diameter between 12mm and 25mm.

Optionally, the connection element is provided with threads. In this way, the connection element can easily be secured or connected to the wall panel or resilient connection unit.

25 Optionally, the resilient connection unit includes a first wall shoe provided in the right side of the first wall panel, a second wall shoe provided in the left side of the second wall panel, and a connection element which is arranged to connect the first wall shoe to the second wall shoe thereby connecting the right side of the first wall panel to the left side of the second

wall panel. Thereto the first and second wall shoes are each provided with a connector for connecting the connection element thereto.

Wall shoes are used in tensile connections of precast concrete panels, and provide convenient connection points. Wall shoes typically include a varying number of reinforcement bars. The number of reinforcement bars depends on the specific application. Typically, the wall shoe has an open side for easy access of the connection element. Generally, prior to casting the concrete, the wall shoes are placed in the mold. Additionally, the amount of concrete covering and/or surrounding the wall shoe depends on the specific application. The wall shoes can be provided on the right and left edges of the wall panels. Furthermore, if the wall panel includes the above mentioned recess, then it is possible that the recessed area of the wall panel is thinner than the wall shoe, or the wall shoe and its enclosing panel structure. The connection element connects the first and second wall shoes and in turn the first and second wall panel.

Optionally, at least one of the first wall shoe and the second wall shoe is arranged for being resiliently compressed and/or extended in a direction substantially parallel to the connection direction. Optionally the connector of at least one of the first wall shoe and the second wall shoe is arranged to be resiliently displaceable in the connection direction, with respect to the wall panel in which the respective wall shoe is mounted. As the resilient connection unit includes a first wall shoe, a second wall shoe, and a connection element. The resilience of the resilient connection unit, may come from the first wall shoe, the second wall shoe, the connection element, or any combination thereof.

Optionally, at least one of the first wall shoe and the second wall shoe includes a flexible tongue connected to the connection element. A flexible tongue is one of many embodiments that can provide the resilience of the resilient connection unit. Furthermore, the tongue can be considered

as the resilient element whose bending stiffness substantially determines the tensile stiffness of the resilient connection unit.

Optionally, the noise barrier wall further comprises a first cover arranged for covering a gap between the first wall panel and the adjacent
5 second wall panel. Depending on the application, a gap may be formed between the adjacent first and second wall panel. A cover may be provided to cover the gap. It is possible that a first cover is placed on a first side of the noise barrier wall, and that a second cover is placed on a second side of the noise barrier wall. Optionally, the first cover and/or second cover is a
10 triangular prism. A triangular prism fits in the gap formed between the first wall panel and the adjacent second wall panel.

Optionally, a ratio of thickness to width of the wall panel is 0.05 or less, preferably 0.033 or less. A noise barrier wall constructed from a plurality of wall panels having a ratio of thickness to width of 0.05 or less
15 has been found to have an ecological footprint relatively lower than other noise barrier walls.

Optionally, an interior angle formed by the first and adjacent second wall panel, in top plan view, is between 100 degrees and 160 degrees, preferably between 110 degrees and 130 degrees, and more preferable
20 between 115 degrees and 125 degrees. The interior angle formed by the first and the adjacent second wall panel define the zigzag pattern. It has been found that the angle defined above provide a noise barrier wall with a relatively low ecological footprint and good noise reducing characteristics.

Further, according to the invention, a wall panel of the noise
25 barrier wall is provided. Further, according to the invention, a resilient connection unit of the noise barrier is provided. Further, according to the invention, a connection element of the noise barrier wall is provided.

Further, according to the invention, a use of a wall panel in the noise barrier wall is provided. Further, according to the invention, a use of a
30 resilient connection unit in the noise barrier wall is provided. Further,

according to the invention, a use of a connection element in the noise barrier wall is provided.

Additionally, according to the invention, a method of constructing a noise barrier wall is provided. The method comprises the steps of:

5 providing a plurality of wall panels; arranging the plurality of wall panels in a zigzag pattern; providing a resilient connection unit arranged for being resiliently compressed and/or extended in a direction substantially parallel to a connection direction of the resilient connection unit; and connecting a right edge of a first wall panel of the plurality of wall panels to a left edge of
10 an adjacent second wall panel of the plurality of wall panels using the resilient connection unit.

In this way, a noise barrier way may be constructed such that the resilient connection unit of the noise barrier wall allows for expansion and/or compression in a direction parallel to the connection direction.

15 Therefore, the resilient connection unit allows for the absorption of environmental forces exerted on the noise barrier. As mentioned above with regard to the noise barrier wall, environmental forces may include expansion and/or contraction due to temperature fluctuations. Noise barrier walls must be able to sustain the high temperatures in the summer and the
20 low temperatures in the winter. Additionally, air turbulences caused by moving vehicles and wind also exert forces on the wall panels of the noise barrier wall. It will be appreciated that the additional features of the noise barrier wall discussed above also apply to the method of constructing a noise barrier wall.

25 Also, according to the invention, a kit of parts for constructing a noise barrier wall is provided. The kit of parts comprises two or more wall panels; and at least one resilient connection unit arranged for being resiliently compressed and/or extended in a direction substantially parallel to a connection direction of the resilient connection unit.

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BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further elucidated by means of non-limiting examples referring to the drawings, in which

5 Figs. 1A-C are schematic views of noise barrier walls according to the invention in top plan view;

Fig. 2 is a schematic view of a noise barrier wall according to the invention including a first wall panel connected to an adjacent second wall panel using resilient connection units viewed from the side;

10 Fig. 3A is a schematic view of a noise barrier wall according to the invention including a plurality of wall panels connected using resilient connection units in top plan view;

Fig. 3B is a schematic view of the noise barrier wall of Fig. 3A including covers for gaps between adjacent wall panels;

15 Fig. 4A is a schematic view of adjacent wall panels of a noise barrier wall according to the invention connected using a resilient connection device in a first state;

Fig. 4B is a schematic view of adjacent wall panels of a noise barrier wall according to the invention connected using a resilient connection device in a second state;

20 Fig. 4C is a schematic view of adjacent wall panels of a noise barrier wall according to the invention connected using a resilient connection device in a third state;

Fig. 5 is a schematic cross sectional view of a noise barrier wall according to the invention with wall panels tilted away from vertical;

25 Fig. 6A is a schematic top plan view of a resilient connection unit connecting adjacent wall panels of a noise barrier wall;

Fig. 6B is a schematic right side view of the first wall panel;

Fig. 7A is a schematic top plan view of a resilient connection unit connecting adjacent panels of a noise barrier wall;

30 Fig. 7B is a schematic right side view of the first wall panel;

Fig. 8A is a schematic cross sectional view of a resilient connection unit connecting adjacent panels of a noise barrier wall;

Fig. 8B is a schematic right side view the first wall panel;

Fig. 9A is a schematic cross sectional view of a resilient connection unit connecting adjacent panels of a noise barrier wall;

Fig. 9B is a schematic right side view of the first wall panel;

Fig. 10A is a schematic cross sectional view of a resilient connection unit connecting adjacent panels of a noise barrier wall;

Fig. 10B is a schematic right side view of the first wall panel;

Fig. 11A is a schematic cross sectional view of a resilient connection unit connecting adjacent panels of a noise barrier wall; and

Fig. 11B is a schematic right side view of the first wall panel;

Fig. 12A is a schematic cross sectional view of a resilient connection unit connecting adjacent panels of a noise barrier wall; and

Fig. 12B is a schematic right side view of the first wall panel

DETAILED DESCRIPTION

A noise barrier wall 1 comprising a plurality of horizontally adjacent wall panels 2 is shown in Figs. 1A-1C in top plan view. In each figure, the adjacent wall panels 2 of the noise barrier wall 1 are arranged in a different zigzag pattern. The connection area between two adjacent wall panels 2 is indicated by reference numeral 4. The zigzag patterns of Figs. 1A-C are examples. Other zigzag patterns, including combinations of the zigzag patterns of Figs. 1A-C are conceivable.

The connection area 4 of noise barrier wall 1 is shown in side view in Fig. 2. In this example the plurality of wall panels 2 are thin rectangular precast concrete panels. In Fig. 2 the panels 2 include a recess 5 on a first face 7 of the wall panel, in the view of Fig. 2 the rear face. In other examples, a similar, second, recess may be provided in a second (front) face of the wall panel. In this example, the recess 7 extends horizontally, starting

at a predetermined distance from the left edge 8 and ending at a predetermined distance from the right edge 6. In this example, the recess also extends vertically, starting at a predetermined distance from a bottom edge of the panel and at the top edge of the panel. Herein the predetermined distance is non-zero. Precast concrete panels can withstand high compression forces, but can crack and/or break when subjected to tensile or bending forces.

Typically, the wall panels 2 are approximately 3 m wide, and between 4m and 6m tall. However, in certain application the wall panels 2 may be as tall as 8m or even taller. The wall panels may be reinforced with steel reinforcement bars. When using steel reinforced concrete panels, typically the wall panels 2 are approximately 7-15 cm thick, thereby having a thickness to width ratio of 0.05 or less, preferably 0.033 or less. In the example of Fig. 2 the recess 7 extends over the larger part of the face surface of the panel 2, hence the thickness can be measured at the recess 7. When using, for example, plastic fiber reinforced concrete panels, typically the wall panels are approximately 3-15 cm thick, thereby having a thickness to width ratio of 0.05 or less, preferably 0.01 or less. It is noted that when using reinforced concrete panels, the resilient connection unit is used predominantly for preventing cracking and/or crack forming in the wall panels. The risk of breaking of the reinforced concrete panels is already limited by the reinforcement material. On the other hand when using non-reinforced concrete wall panels the resilient connection unit is used predominantly for preventing breaking of the wall panels. Additionally, due to the resilient connection unit it may be possible to reduced the amount of reinforcement material used to reinforce the concrete wall panels while still reducing the risk of breaking.

Here a right edge 6 of a left first wall panel 2A of the plurality of wall panels 2 is connected to a left edge 8 of an adjacent right second wall panel 2B of the plurality of wall panels 2 using a resilient connection unit

10. In this example three resilient connection units 10 are used. The resilient connection unit 10 is arranged for being resiliently compressed and/or extended in a direction substantially parallel to a connection direction A extending from the right edge 6 of the first wall panel 2A to the left edge 8 of the second wall panel 2B.

Fig. 3A shows a schematic top plan view of a portion of noise barrier wall 1. In Fig. 3A, four wall panels 2 are shown, including three connection areas 4. In this example, the wall panels 2 are not provided with the recess 7, although it is of course possible to provide the panels with such recess 7. The connection direction at each connection area is indicated by arrow A. In this example the connection direction A is the same for each of the three connection areas 4. Adjacent wall panels 2 are connected using a resilient connection unit 10. Although in Fig. 3A only one resilient connection unit 10 is pictured, this does not exclude the possibility of using more than one resilient connection unit 10 between adjacent panels. The number of resilient connection units 10 used between two adjacent panels 2 is determined by the application. Taller wall panels may require more resilient connection units 10 than shorter wall panels. It is noted that due to the relativeness of first/second wall panel and right/left edge, wall panels 2A and 2B have only been indicated in Fig. 3A once.

In Fig. 3A, a resilient connection unit 10 is used at each connection area 4. Depending on the application, this may not be strictly required. For example, the zigzag pattern shown in Fig. 1C includes connection areas 4 where adjacent panels extend in the same direction. It may be advantageous to use a substantially rigid connection unit to connect adjacent panels at a connection area 4' where the respective panels extend in the same direction, and to use a resilient connection unit 10 to connect adjacent panels at a connection area 4 where the respective panels are connected at an angle. Depending on the application, it is also conceivable

that some adjacent panels are connected using a resilient connection unit 10 and that others are connected using a stiff connection unit.

In Fig. 3B, the noise barrier 1 is provided with a first cover 12A and a second cover 12B. In this example, both covers 12A and 12B are
5 triangular prisms, and the length of the covers 12A and 12B is substantially equal to the height of the wall panels 2. In this example the triangular cross section of 12B is larger than 12A, although it is possible that the covers 12A and 12B are substantially identical. The cover 12A is designed to cover a
10 gap 14 at the connection area 4 on the side where the adjacent wall panels form an angle smaller than 180 degrees. In practice this angle is preferably an obtuse angle between 100 degrees and 160 degrees, more preferably between 110 degrees and 130 degrees, and most preferably between 115 degrees and 125 degrees. In this example the angle is 120 degrees. Similarly, the cover 12B is designed to cover the connection area 4 on the
15 side where the adjacent wall panels form a reflex angle, i.e. an angle greater than or equal to 180 degrees. In this example this angle is 240 degrees. The second cover 12B may also be used to cover a gap formed between adjacent panels extending in the same direction.

The effects of forces on the adjacent panels 2A and 2B, and the
20 resilient connection unit 10 are shown in Figs. 4A-C. In Fig. 4A the adjacent panels 2A and 2B, and the resilient connection unit 10 are shown in a first state, schematically representing the connection unit in a neutral state.

Environmental forces may include expansion and/or contraction
due to temperature fluctuations. These forces are not limited to expansion
25 and/or contraction in an in-plane direction of the wall panels. Additionally, temperature fluctuations may cause gradients in the wall panels. In this case, the deformation results in angular rotation of the vertical edges of the wall panels. This angular rotation at the connection area of adjacent wall panels is absorbed by the resilient connection unit. Furthermore,
30 environmental stress may arise from settling differences in the wall panel

foundations and/or ground. The forces acting on the adjacent wall panels may also be caused by wind and/or air turbulences from moving vehicles.

In Figs. 4A-C, deformation primarily due to in-plane contraction and expansion is shown. Due to environmental changes, the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B may be forced together. The environmental change may e.g. cause thermal expansion of the panels 2A, 2B. The noise barrier wall 1 is exposed to large temperature fluctuations between seasons as well as nighttime and daytime temperature differences.

As the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B approach each other, the resilient connection unit 10 is resiliently compressed in a direction substantially parallel to the connection direction A. Thus the force of the adjacent wall panels 2A and 2B moving together is absorbed by the resilient connection unit 10, and damage to the adjacent wall panels 2A and 2B is prevented. This situation is illustrated in Fig. 4B, in which the resilient connection unit 10 is shown in a compressed state.

In Fig. 4C, environmental changes force the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B apart. Again, different environmental conditions could cause this to occur. For example, the wall panels 2 may contract due to a drop in temperature. Additionally the contraction may be caused by the setting/shrinking of the concrete. As the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B move away from each other, the resilient connection unit 10 is resiliently extended in a direction substantially parallel to the connection direction A, thus absorbing the force of the adjacent wall panels 2A and 2B. This situation is illustrated in Fig. 4C, in which the resilient connection unit 10 is shown in an extended state. As concrete can be easily damaged when exposed to tensile forces, the resilient connection unit 10 prevents the concrete from breaking, cracking, and/or

crack forming due to tensile forces acting at the connection area 4. As noted above, when using reinforced concrete panels, the resilient connection unit is used predominantly for preventing cracking and/or crack forming in the wall panels. Breaking of the reinforced concrete panels is already limited by the reinforcement material. On the other hand, when using non-reinforced panels, the resilient connection unit is used to predominantly prevent breaking of the wall panels. wall panels.

It is noted that the change in relative position between the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B may be caused by the first wall panel 2A, the second wall panel 2B, or the combination of the first wall panel 2A and the second wall panel 2B.

The wall panels 2 of the noise barrier wall 1, depicted in Fig. 5, are tilted in a first direction away from vertical. In this example, the wall panels are tilted in a direction away from a road 16. As shown in Fig. 5, the tilted wall panels help deflect the traffic noise indicated by arrow B and the road noise indicated by arrow C. The traffic noise originates from a vehicle 18. The road noise originates from the tires 20 of the vehicle 18 rolling on the road 16. The traffic and road noise, arrows B and C, are deflected upwards and away from an area on the other side of the noise barrier wall 1. This helps improve the noise reducing capabilities of the noise barrier 1. If a residential area is located on the other side of the noise barrier wall 1, this also improves living conditions in the residential area. It will be appreciated that one or more of the wall panels of the noise barrier walls shown in Figs. 1-4 may be tilted as described with respect to Fig. 5.

Additionally, a foundation 17 is shown in Fig. 5. The wall panels 2 of the noise barrier wall 1 are secured to the foundation 17 using a securing unit 19. Depending on the specific application, the foundation 17 may or may not be necessary. Furthermore, if the foundation 17 is necessary the application determines the type of foundation needed. The foundation 17 may be a shallow foundation or a deep foundation. The foundation 17 may

be formed of poured concrete and reinforcement bars. Additional, or alternatively, the foundation 17 may include a plurality of piles.

In the remaining figures, different examples of the resilient connection unit 10 are shown. As mentioned above, the right side 6 of the first wall panel 2A is connected to the left side 8 of the second wall panel 2B using the resilient connection unit 10. A top plan view of an example of a resilient connection unit 10 is shown schematically in Fig. 6A. In Fig. 6B, a schematic right side view of the first wall panel 2B is shown. The resilient connection unit includes a connection element 22 extending between the first wall panel 2A and the second wall panel 2B. In Fig. 6A the connection element 22 is shown to extend in a plane that is substantially perpendicular to the upright edges 6, 8 of the panels 2A, 2B. Thus, the connection element 22 extends in a plane substantially perpendicular to the upright direction. The connection element 22 can extend substantially in the horizontal plane, e.g. if the wall panels are mounted vertically. Both wall panels 2A and 2B are provided with a recess 5 on a first face 7 of the wall panel. The resilient connection unit further includes a first wall shoe 26 provided in the right edge 6 of the first wall panel 2A and a second wall shoe 28 provided in the left edge 8 of the second wall panel 2B. In this example the first wall shoe 26 and the second wall shoe 28 are identical. In this example, the wall shoes 26 and 28 do not include reinforcement bars. Depending on the specific application reinforcement bars may or may not be necessary. Wall shoes are typically arranged in a mold prior to casting the slab of precast concrete forming the panel. In this example the connection element 22 is provided with threads 24 for connecting the connection element 22 to the wall shoes 26,28.

As shown in Fig. 6B, the wall shoe may be flush with a face of the wall panel. In this example, the wall shoes 26 and 28 are both provided with a side opening 32. This allows access to an interior 34 of the wall shoes 26 and 28. Additionally, in Fig. 6B an connection opening 36 in the wall shoe

26 is provided on the side of the wall shoe flush with the right side face of the wall panel 2A. A similar connection opening is provided in wall shoe 28 in wall panel 2B.

On the construction site where the noise barrier wall is being erected, the resilient connection unit 10 is assembled. The connection element 22 is placed in the connection opening 36 and nuts 38 are used to secure the connection element 22 to the wall shoes 26 and 28. Access to the threads 24 of the connection element 22 located in the interior 34 of the wall shoe 26 and 28, is realized through the side opening 32, located on a front or rear face side of the wall panel 2A,2B. As mentioned above the resilient connection unit 10 includes the connection element 22 and the wall shoes 26 and 28. The resilient connection unit 10 connects the right edge 6 of the first wall panel 2A to the left edge 8 of the second wall panel 2B.

In this example, the resilient connection unit 10 includes a resilient element, in this example the connection element 22, and a tensile stiffness of the resilient connection unit 10 is substantially determined by the bending stiffness of the resilient element, in this example the connection element 22. The required bending stiffness is dependent on the specific application. An easy way to select a connection element 22 having the correct tensile stiffness is to select a connection element having an appropriate diameter, and/or an appropriate transverse length L. In practice it has been found that the desired diameter of the connection element 22 is in the range of 12mm to 25mm.

The resilient connection unit 10 is arranged for being compressed and extended in a direction parallel to the connection direction indicated by arrow A. Due to the substantially horizontal orientation of the U-shaped resilient connection unit 10, in this example, the resilient connection unit 10 is also arranged for being compressed and extended in a direction in a second direction substantially perpendicular to the connection direction A and substantially parallel to the upright direction. In this example the

upright direction is substantially vertical and parallel with the right and left edges 6 and 8 of the wall panels 2A and 2B. In general the second direction can be deviating, e.g. $\pm 45^\circ$, from the upright direction. It is noted that the second direction is determined by the orientation of the resilient connection unit 10 and more specifically the orientation of the U-shaped connection element 22. Furthermore, due to the shape of the connection element 22, the resilient connection unit 10 is substantially rigid in the direction D perpendicular to the connection direction indicated by arrow A and perpendicular to the second direction.

10 In this example, the resilient connection unit 10 includes wall shoes 26 and 28, and the connection element 22. It is however conceivable that the connection element 22 is secured to the right and left edges 6 and 8 in a different manor, for example, by adhesives or plugs.

15 In Figs. 7A and 7B another example of a resilient connection unit 10 is shown. Fig. 7A is a schematic top plan view. In this example the resilient connection unit 10 includes the wall shoe 26 provided in the right edge 6 of the first wall panel 2A, the wall shoe 28 provided in the left edge 8 of the second wall panel 2B, and the connection element 22. In this example, the connection element 22 is in the shape of a freestanding loop. This loop shape provides the desired resilience in both a direction parallel to the connection direction A, and in a second direction substantially perpendicular to the connection direction and, in this example, substantially parallel to both the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B. Again, the resilience of the resilient connection unit 10 comes from the resilient element, here formed by connection element 22.

25 Due to the substantially horizontal orientation of the freestanding loop, the resilient connection unit 10, in this example, is also arranged for being compressed and extended in a direction in a second direction
30 substantially perpendicular to the connection direction A and substantially

parallel to the upright direction. In this example the upright direction is substantially vertical and parallel with the right and left edges 6 and 8 of the wall panels 2A and 2B. In general the second direction can be deviating, e.g. $\pm 45^\circ$, from the upright direction. It is noted that the second direction is
5 determined by the orientation of the resilient connection unit 10 and more specifically the orientation of the connection element 22, in this example a freestanding loop. Furthermore, due to the shape of the connection element 22, the resilient connection unit 10 is substantially rigid in the direction D perpendicular to the connection direction indicated by arrow A and
10 perpendicular to the second direction.

In Figs. 8A and 8B another example of a resilient connection unit 10 is shown. In this example, two reinforcement bars 30 are used. The specific application determines the number of reinforcement bars 30 needed. It is also possible that reinforcement bars 30 are not needed at all. It is also
15 possible that additional reinforcement bars 30 are necessary, and/or that at least one reinforcement bar is in a direction perpendicular to the connection direction, indicated by arrow A. In this example the reinforcement bars 30 are both parallel to the connection direction indicated by arrow A. In this example, the resilient connection unit 10 is secured to the right edge 6 of the
20 first wall panel 2A at a first location 40, and the resilient connection unit 10 is secured to the left edge 8 of the second wall panel 2B at a second location 42. The first location 40 is vertically offset from the second location 42. This vertical offset may arise from a difference in height between adjacent panels due to the formation of the ground. It may also arise from wall panels 2
25 having wall shoes 26 and 26 at mismatched/misaligned locations 40 and 42.

In this example the resilient connection unit 10 includes the wall shoe 26 provided in the right edge 6 of the first wall panel 2A, the wall shoe 28 provided in the left edge 8 of the second wall panel 2B, and the connection element 22. In this example the connection element 22 is S-
30 shaped. The S-shape allows the connection to occur at offset locations 40 and

42, and provides the desired resilience in a direction parallel to the connection direction A. Again, the resilience of the resilient connection unit 10 comes from the resilient element, here formed by connection element 22. The resilient connection unit 10 in Fig. 8A and 8B is arranged for being
5 resiliently compressed and extended in a direction parallel to the connection direction, indicated by arrow A. An easy way to select a connection element 22 having the correct tensile stiffness is to select a connection element having an appropriate diameter, and/or an appropriate transverse length L.

Another example of a resilient connection unit 10 is shown in
10 Figs. 9A and 9B. In this example, the resilient connection unit 10 is secured to the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B at vertically offset locations 40 and 42. Furthermore, the resilient connection unit 10 includes wall shoes 26 and 28 and connection element 22. In this example the connection element 22 includes an
15 intermediate plate 44 and connection sections 46 and 48. The connection sections 46 and 48 are welded to the intermediate plate 44. The connection sections 46 and 48 are secured to the wall shoes 26 and 28 using nuts 38. It will be appreciated that other securing means for securing the connection sections to the intermediate plate, such as a bolted connection, e.g. using
20 nuts, are possible.

In this example, the intermediate plate 44 is made from metal. The resilient connection unit is arranged for being resiliently compressed and extended in a direction parallel to the connection direction, indicated by arrow A. In this example, the resilience of the resilient connection unit 10
25 comes from the shape of the connection element 22 formed by the connection sections 46 and 48, and the intermediate plate 44. An easy way to select a resilient connection unit 10 having the correct tensile stiffness is to select connection sections 46 and 48 having an appropriate diameter, and/or an intermediate plate 44 having an appropriate transverse length L. It is also
30 conceivable that the material of the intermediate plate 44 contributes to the

resilience of the resilient connection unit 10. Furthermore, it is also conceivable that the connection element 22 including an intermediate plate is used in a resilient connection unit 10 secured to the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B at
5 locations which are substantially horizontal, in other words not vertically offset.

The connection opening 36 of wall shoe 26 and 28 is L-shaped in this example and has an opening towards the side opening 32. The L-shape facilitates the insertion of the connection element 22 into the wall shoe.

10 Additionally, or alternatively, the resilience of the resilient connection unit 10 need not come from the connection element 22. It may also arise from other elements included in the resilient connection unit 10. For example, in Figs. 10A and 10B the resilience of the resilient connection unit 10 comes from the wall shoes 26 and 28. Specifically, in this example
15 one, or both of the wall shoes 26 and 28 are provided with a tongue 50. The tongue 50 is shaped like a tab, and has a connection opening 36 for receiving the connection element 22. The tongue 50 is resilient and is arranged for resiliently deflecting in a direction parallel to the connection direction, indicated by arrow A. Thus, the wall shoe 26,28 comprising the tongue 50
20 can be compressed or extended in the connection direction A. Therefore, the tongue 50 allows that the resilient connection unit 10 is compressed or extended in the connection direction A. Furthermore, the tongue 50 can be considered as the resilient element whose bending stiffness substantially determines the tensile stiffness of the resilient connection unit 10. The
25 material, shape and dimensions of the tongue 50 can be chosen in accordance with the application. It is conceivable that in some applications a tongue 50 provided in only one of the wall shoes 26,28 would be sufficient.

The connection element 22 shown in Fig. 10A is provided with threads 24 and has been inserted in to the connection opening 36 of the
30 tongue 50 provided in both wall shoes 26 and 28. The connection element 22

is secured using nuts 38. Nevertheless, other ways of connecting the connecting element 22 to the tongue 50, such as welding, gluing, clicking, crimping, etc. are conceivable.

Another example of a resilient connection unit 10 is shown in Figs. 11A and 11B. In this example, the connection element 22 of the resilient connection unit 10 includes connection sections 46 and 48, and a guide 52 having a channel 54. The sections 46 and 48 are received in the guide 52 and biased by a resilient element, here formed by a spring 56. The resilience of the resilient connection unit 10 is provided substantially by the spring 56. The guide 52 and channel 54 are arranged for guiding the resiliently compressing and expanding movement of the connection sections 46 and 48 of the connection element 22 in a direction parallel to the connection direction, indicated by arrow A. In this example the connection sections 46 and 48 are provided with threads 24 for securing the connection element 22 with nuts 38 to the wall shoes 26 and 28 of the right edge 6 of the first wall panel 2A and the left edge 8 of the second wall panel 2B.

In Fig. 12A and Fig. 12B another example of a resilient connection unit 10 is shown. In this example, the resilient connection unit 10 is arranged for being resiliently compressed and extended in a direction parallel to the connection direction, indicated by arrow A. In this example, the resilient connection unit 10 is arranged for being substantially linearly compressed and extended, Further in this example, the resilient connection unit 10 is arranged for being resiliently angularly expanded and angularly contracted about an axis substantially parallel to the upright direction.. In this example, the upright direction, indicated by arrow E, is substantially parallel to the left edge 8 of the second wall panel 2B.

In Figs. 12A and 12B, the resilient connection unit 10 includes the wall shoe 26 provided in the right edge 6 of the first wall panel 2A, the wall shoe 28 provided in the left edge 8 of the second wall panel 2B, the connection element 22, nuts 38, rigid elements 62, and resilient elements 60.

In this example, the resilient elements are elastomer rings 60. The connection element 22 is provided with threads 24 and is manufactured from a rigid material, for example steel.

The elastomer rings 60 provide the resilience of the resilient connection unit in this example. In Figs. 12A and 12B, the elastomer rings 60 are placed in pairs around the connection openings 36 of the wall shoes 26 and 28. The pair of elastomer rings 60 around connection opening 36 are placed such that one ring is in the interior 34 of the wall shoe 26, 28, and one ring is exterior to the wall shoe 26, 28. It is conceivable that, e.g. with proper material choice, the elastomer rings 60 may only be necessary on one wall shoe of the resilient connection unit 10. The elastomer rings 60 are sandwiched around the wall element of the wall shoe 26, 28 containing the connection opening 36 by rigid elements 62, here of approximately the same diameter as the elastomer rings 60. This ensures that the entire elastomer ring 60 contributes to the resilience of the resilient connection unit 10. In this example, the rigid elements 62 are steel washers. The rigid elements 62 are in turn held in place by nuts 38.

The elastomer rings 60 provide resilience for the resilient connection unit 10 for being resiliently compressed and extended in a direction parallel to the connection direction, arrow A, yet at the same time the connection element 22, in this example a steel rod, provides the desired rigidity in a direction substantially perpendicular to the connection direction.

In this example, the connection element 22 is an M20 threaded steel rod. The steel washers 62 have a diameter of 60 mm and a width of 0.60 mm. The elastomer rings 60 have a diameter of 50 mm, and a width of 15 mm. Furthermore, in this example, the elastomer rings 60 have a Young's module of 0.01-0.1 GP.

It will be appreciated that the resilient connection units 10 of the previous embodiments are also arranged to be resiliently angularly

expanded and/or angularly contracted about an axis substantially parallel to an upright direction.

It will be appreciated that the features of the examples of the resilient connection unit 10 discussed above may be combined to form other examples of resilient connection units. For instance, it is possible to use a resilient connection element in conjunction with one or two resilient wall shoes. It will be clear that the combination of the features, for example the resilient tongue 50 and the U-shaped connection element 22, fall within the scope of the invention.

10 The above examples involved traffic and road noise. The noise barrier wall according to the invention may also have other uses such as reducing noises around airports, along railroad track, or other noisy facilities. Also, the noise barrier wall may be used to block sight.

In the examples shown, each panel is directly connected to the adjacent panel using the resilient connection unit. In the examples, no substantially upright post forming a support structure is interposed between the adjacent panels. It has been found that the noise barrier wall comprising the plurality of horizontally adjacent wall panels arranged in a zigzag pattern, wherein a right edge of a first wall panel of the plurality of wall panels is connected to a left edge of an adjacent second wall panel of the plurality of wall panels using a resilient connection unit arranged for being resiliently compressed and/or extended in a direction substantially parallel to a connection direction extending from the right edge of the first wall panel to the left edge of the second wall panel can be provided free from substantially upright posts forming a support structure interposed between the right edge of the first wall panel and the left edge of the second wall panel.

In the foregoing specification, the invention has been described with reference to specific examples of embodiments of the invention. It will, however, be evident that various modifications and changes may be made

therein without departing from the broader spirit and scope of the invention as set forth in the appended claims. However, other modifications, variations, and alternatives are also possible. The specifications, drawings and examples are, accordingly, to be regarded in an illustrative rather than
5 in a restrictive sense.

In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word 'comprising' does not exclude the presence of other features or steps than those listed in a claim. Furthermore, the words 'a' and 'an' shall not be construed as limited to 'only
10 one', but instead are used to mean 'at least one', and do not exclude a plurality. The mere fact that certain measures are recited in mutually different claims does not indicate that a combination of these measures cannot be used to advantage.

Conclusies

1. Geluidsschermwand voorzien van een veelvoud van horizontaal aangrenzende wandpanelen opgesteld in een zigzag patroon, waarbij een rechter rand van een eerste wandpaneel van het veelvoud van wandpanelen verbonden is aan een linker rand van een aangrenzend tweede wandpaneel van het veelvoud van wandpanelen met gebruik van een veerkrachtige verbindingseenheid, waarbij de veerkrachtige verbindingseenheid ingericht is om verende samengedrukt en/of uitgerekt te worden in een richting die in hoofdzaak parallel is aan een verbindingsrichting die zich uitstrekt van de rechter rand van het eerste wandpaneel naar de linker rand van het tweede wandpaneel.
2. Geluidsschermwand volgens conclusie 1, waarbij het veelvoud van wandpanelen prefabbetonpanelen zijn.
3. Geluidsschermwand volgens conclusie 1 of 2, waarbij de veerkrachtige verbindingseenheid een veerkrachtig element omvat, en waarbij een trekstijfheid van de veerkrachtige verbindingseenheid in hoofdzaak bepaald wordt door een buigstijfheid van de veerkrachtige element.
4. Geluidsschermwand volgens conclusie 1, 2, of 3, waarbij de veerkrachtige verbindingseenheid verder ingericht is om in hoofdzaak stijf te zijn in een richting die in hoofdzaak loodrecht is op de verbindingsrichting en in hoofdzaak loodrecht is op een rechtopstaande richting.
5. Geluidsschermwand volgens een der conclusies 1-4, waarbij de veerkrachtige verbindingseenheid ingericht is om veerkrachtig qua hoek uitgezet en/of qua hoek samengetrokken te worden rond een as die in hoofdzaak parallel is aan de rechtopstaande richting.

6. Geluidsschermwand volgens een der conclusies 1-5, waarbij de veerkrachtige verbindingseenheid verder ingericht is om veerkrachtig samengedrukt en/of uitgerekt te worden in een tweede richting die in hoofdzaak loodrecht is op de verbindingsrichting en in hoofdzaak parallel is aan de rechtopstaande richting.
7. Geluidsschermwand volgens een der conclusies 1-6, waarbij de veerkrachtige verbindingseenheid vastgemaakt is aan de rechter rand van het eerste wandpaneel op een eerste plaats, en waarbij de veerkrachtige verbindingseenheid vastgemaakt is aan de linker rand van het tweede wandpaneel op een tweede plaats, waarbij de eerste plaats en tweede plaats verticaal op afstand zijn.
8. Geluidsschermwand volgens een der conclusies 1-7, waarbij de veerkrachtige verbindingseenheid een verbindingselement omvat dat zich tussen het eerste en tweede wandpaneel uitstrekt.
9. Geluidsschermwand volgens conclusie 8, waarbij het verbindingselement een tussenplaat omvat.
10. Geluidsschermwand volgens conclusie 8 of 9, waarbij een vorm van het verbindingselement een is van een Ω -vorm, een U-vorm, een S-vorm, een Z-vorm, en een lus.
11. Geluidsschermwand volgens conclusie 8, 9, of 10, waarbij de veerkrachtige verbindingseenheid verder voorzien is van een in de rechter rand van het eerste wandpaneel verschafte eerste wandschoen, een in de linker rand van het tweede wandpaneel verschafte tweede wandschoen, en waarbij de verbindingselement ingericht is om de eerste wandschoen aan de tweede

wandschoen te verbinden en daardoor de rechter rand van het eerste wandpaneel aan de linker rand van het tweede wandpaneel te verbinden.

12. Geluidsschermwand volgens conclusie 11, waarbij ten minste een van de eerste wandschoen en de tweede wandschoen ingericht is om veerkrachtig samengedrukt en/of uitgerekt te worden in een richting die in hoofdzaak parallel is aan de verbindingsrichting.

13. Geluidsschermwand volgens conclusie 12, waarbij ten minste een van de eerste wandschoen en de tweede wandschoen een aan het verbindingselement verbonden flexibele tong omvat.

14. Geluidsschermwand volgens een der conclusies 1-13, waarbij de geluidsschermwand verder voorzien is van een bedekking, waarbij de bedekking ingericht is om een ruimte tussen het eerste wandpaneel en het aangrenzende tweede wandpaneel te bedekken.

15. Geluidsschermwand volgens een der conclusies 1-14, waarbij een verhouding tussen dikte en breedte van het wandpaneel 0,05 is of minder, bij voorkeur 0,033 is of minder.

16. Geluidsschermwand volgens een der conclusies 1-15, waarbij een door het eerste en het aangrenzende tweede wandpaneel gevormde binnenhoek tussen 100 graden en 160 graden is, bij voorkeur tussen 110 graden en 130 graden is, en meer bij voorkeur tussen 115 graden en 125 graden is.

17. Geluidsschermwand volgens een der conclusies 1-16, waarbij een wandpaneel van het veelvoud van wandpanelen geneigd is in een eerste richting weg van verticaal.

18. Wandpaneel van de geluidsschermwand volgens een der conclusies 1-17.
19. Veerkrachtige verbindingseenheid van de geluidsschermwand volgens een der conclusies 1-17.
- 5
20. Verbindingselement van de geluidsschermwand volgens een der conclusies 8-13.
21. Gebruik van een wandpaneel in de geluidsschermwand volgens een der
- 10 conclusies 1-17.
22. Gebruik van een veerkrachtige verbindingseenheid in de geluidsschermwand volgens een der conclusies 1-17.
- 15 23. Gebruik van een verbindingselement in de geluidsschermwand volgens een der conclusies 8-13.
24. Werkwijze voor het bouwen van een geluidsschermwand welke de stappen omvat van:
- 20 - het verschaffen van een veelvoud van wandpanelen;
- het opstellen van het veelvoud van wandpanelen in een zigzag patroon;
- het verschaffen van een veerkrachtige verbindingseenheid, waarbij de veerkrachtige verbindingseenheid ingericht is om verend samengedrukt en/of uitgerekt te worden in een richting die in hoofdzaak parallel is aan een
- 25 verbindingsrichting van de veerkrachtige verbindingseenheid; en
- het verbinden van een rechter rand van een eerste wandpaneel van het veelvoud van wandpanelen aan een linker rand van een aangrenzend tweede wandpaneel van het veelvoud van wandpanelen met gebruik van de
- veerkrachtige verbindingseenheid.

25. Set van onderdelen voor het bouwen van een geluidsschermwand
voorzien van:

- een veelvoud van wandpanelen; en
 - ten minste een veerkrachtige verbindingseenheid, waarbij de ten minste
- 5 ene verbindingseenheid ingericht is om verend samengedrukt en/of uitgerekt te worden in een richting die in hoofdzaak parallel is aan een verbindingsrichting van de verende verbindingseenheid.

1/7

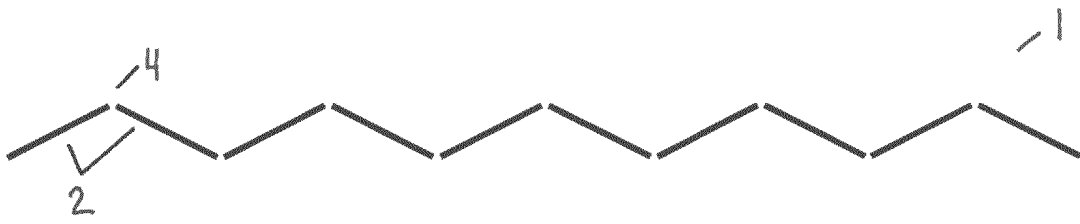


Figure 1A

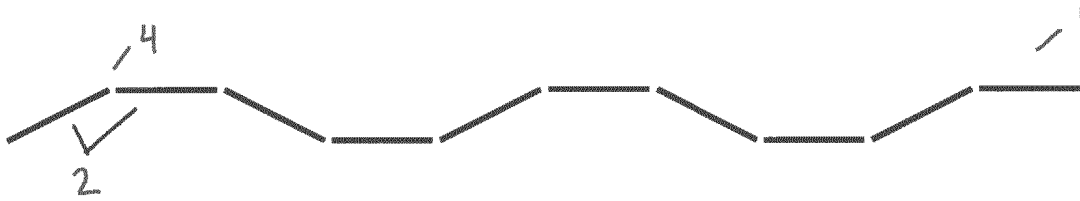


Figure 1B

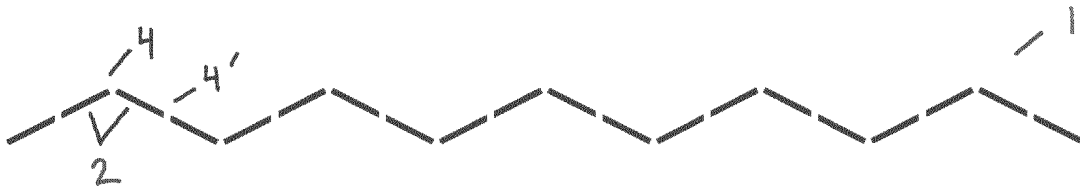


Figure 1C

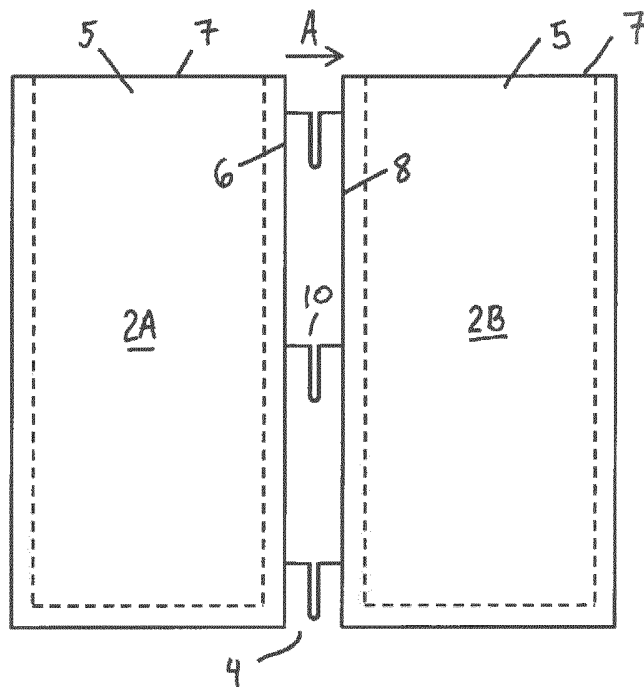


Figure 2

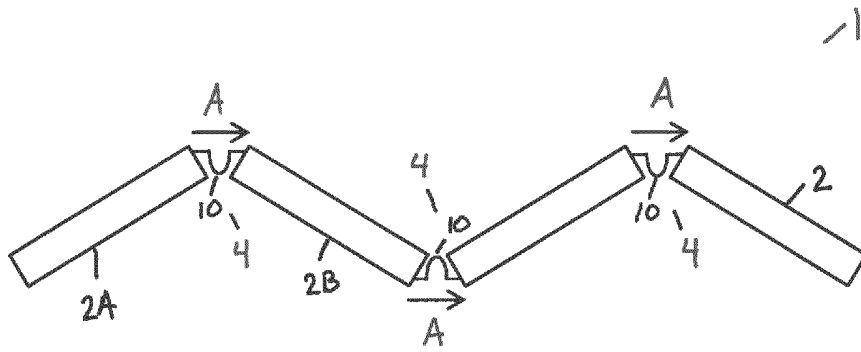


Figure 3A

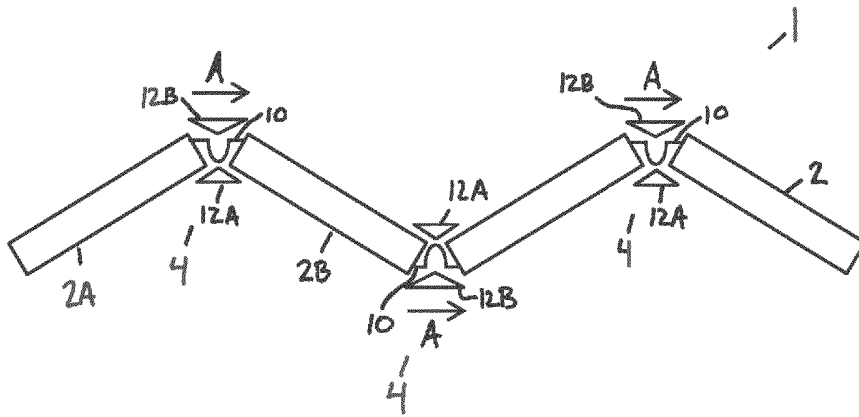


Figure 3B

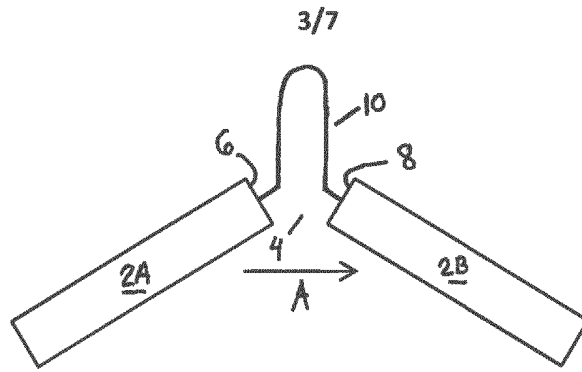


Figure 4A

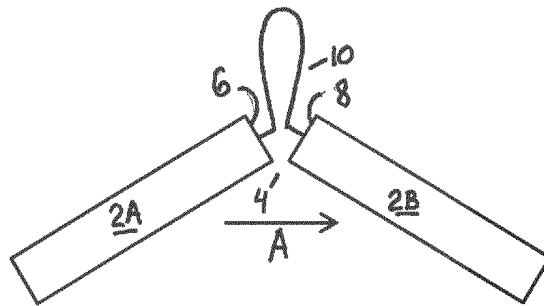


Figure 4B

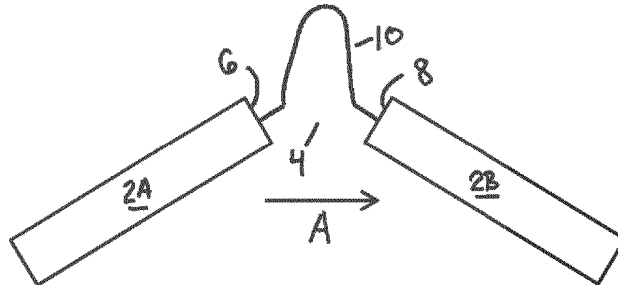


Figure 4C

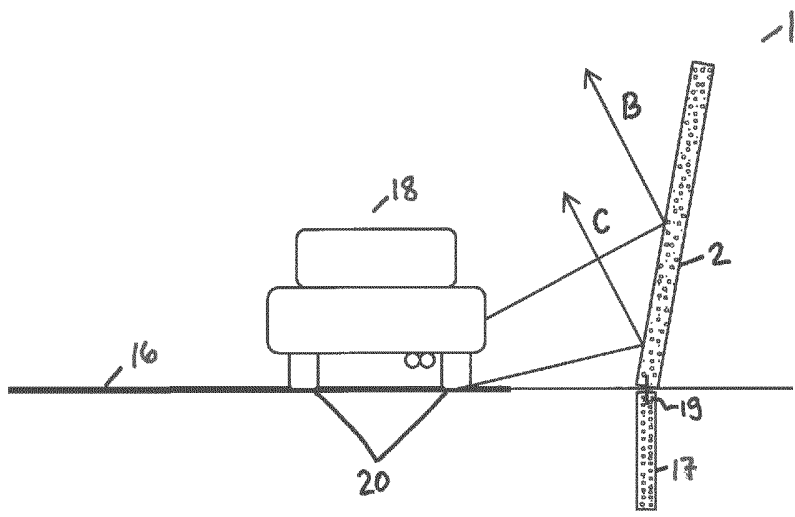


Figure 5

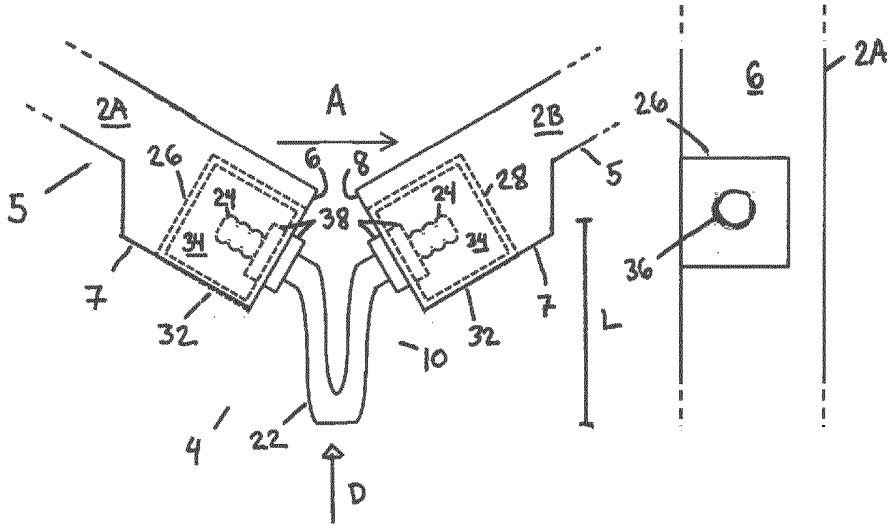


Figure 6A

Figure 6B

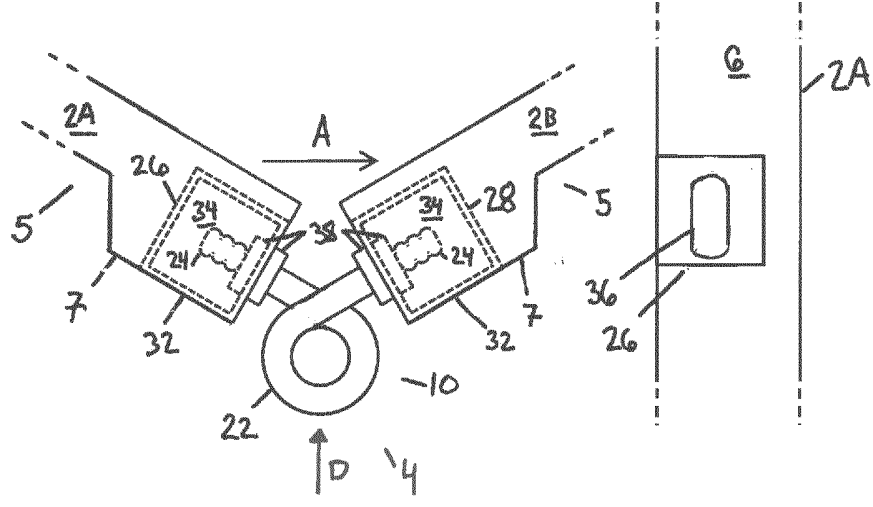


Figure 7A

Figure 7B

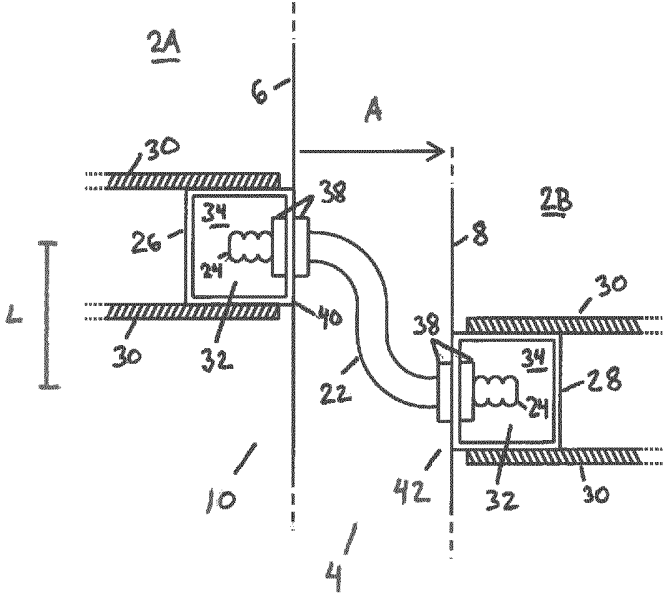
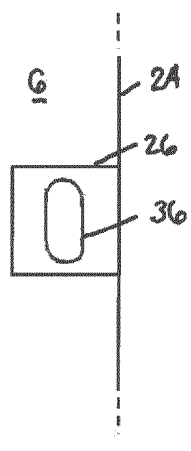


Figure 8A

Figure 8B



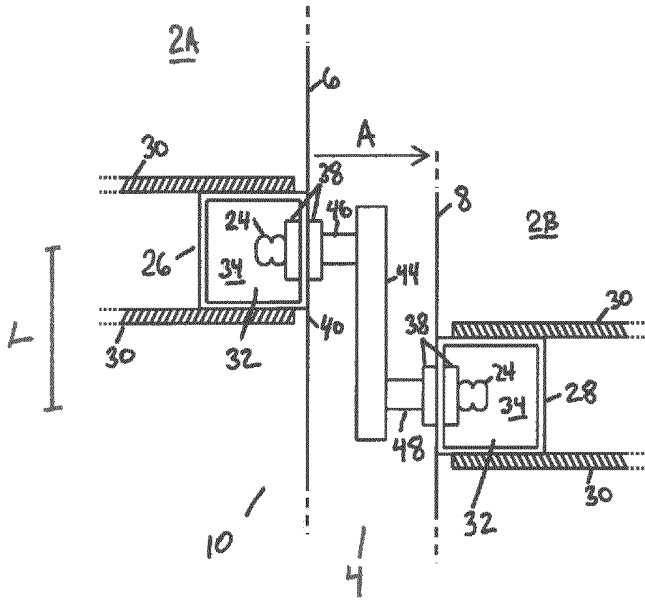


Figure 9A

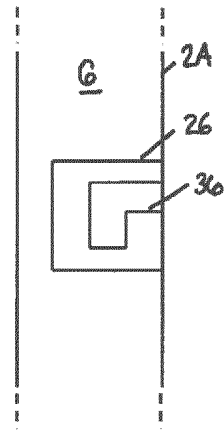


Figure 9B

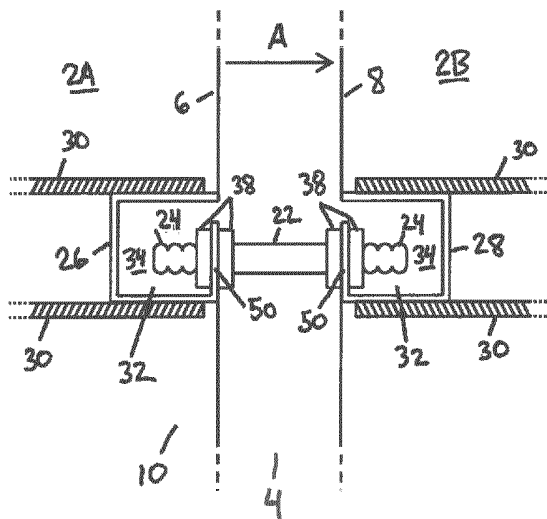


Figure 10A

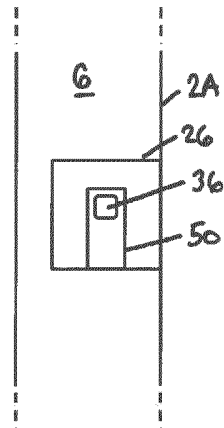


Figure 10B

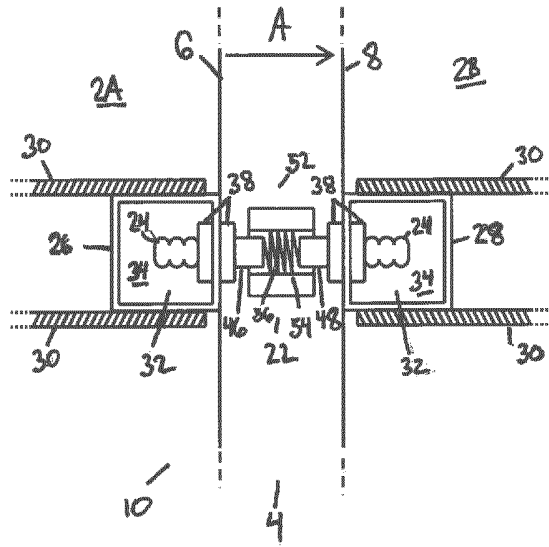


Figure 11A

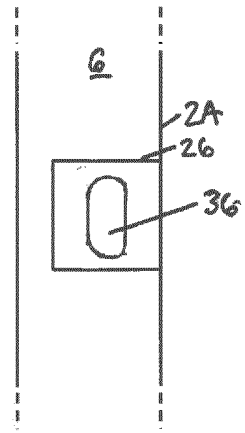


Figure 11B

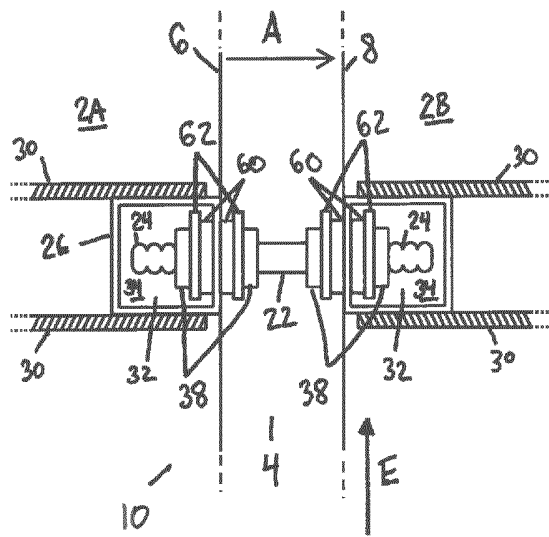


Figure 12A

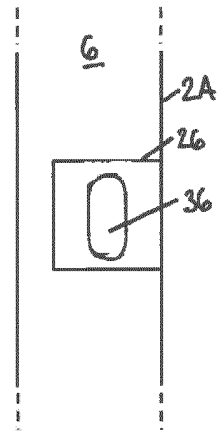


Figure 12B

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE P100276NL00
Nederlands aanvraag nr. 2010500	Indieningsdatum 21-03-2013
	Ingeroepen voorrangdatum
Aanvrager (Naam) Grontmij Nederland B.V.	
Datum van het verzoek voor een onderzoek van internationaal type 24-08-2013	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. SN 60530
I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)	
Volgens de internationale classificatie (IPC) E01F8/00	
II. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK	
Onderzochte minimumdocumentatie	
Classificatiesysteem	Classificatiesymbolen
IPC	E01F
Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen	
III. <input type="checkbox"/>	GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES (opmerkingen op aanvullingsblad)
IV. <input type="checkbox"/>	GEBREK AAN EENHEID VAN UITVINDING (opmerkingen op aanvullingsblad)

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
de stand van de techniek
NL 2010500

A. CLASSIFICATIE VAN HET ONDERWERP
INV. E01F8/00
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
E01F

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	DE 27 23 726 A1 (VKI RHEINHOLD & MAHLA AG) 7 december 1978 (1978-12-07) * het gehele document *	1,2, 18-25
A	US 3 732 653 A (PICKETT W) 15 mei 1973 (1973-05-15) * kolom 5, regel 64 - kolom 6, regel 68; figuren 1-16 *	1,24,25
A	US 4 111 401 A (PICKETT WILLIAM HAYDEN) 5 september 1978 (1978-09-05) * kolom 3, regel 33 - kolom 6, regel 63; figuren 1-14 *	1,24,25
A	US 5 428 926 A (MELFI NICHOLAS W [US]) 4 juli 1995 (1995-07-04) * kolom 2, regel 28 - kolom 3, regel 48; figuren 1-5 *	1,24,25

Verdere documenten worden vermeld in het vervolg van vak C.

Leden van dezelfde octroofamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

A niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

D in de octrooiaanvraag vermeld

E eerdere octrooi(aanvraag), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

L om andere redenen vermelde literatuur

O niet-schriftelijke stand van de techniek

P tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

T na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

X de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

Y de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

Z lid van dezelfde octroofamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

8 januari 2014

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie

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De bevoegde ambtenaar

Flores Hokkanen, P

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 2010500

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
DE 2723726	A1	07-12-1978	AT 355079 B 11-02-1980 BE 857889 A2 16-12-1977 CH 621169 A5 15-01-1981 DE 2723726 A1 07-12-1978 FR 2392171 A1 22-12-1978 NL 7708775 A 28-11-1978
US 3732653	A	15-05-1973	GEEN
US 4111401	A	05-09-1978	CA 1077316 A1 13-05-1980 DE 2731898 A1 19-01-1978 FR 2358511 A1 10-02-1978 JP S609611 B2 12-03-1985 JP S5310531 A 31-01-1978 US 4111401 A 05-09-1978
US 5428926	A	04-07-1995	GEEN



WRITTEN OPINION

File No. SN60530	Filing date (day/month/year) 21.03.2013	Priority date (day/month/year)	Application No. NL2010500
International Patent Classification (IPC) INV. E01F8/00			
Applicant Grontmij Nederland B.V.			

This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the application
- Box No. VIII Certain observations on the application

	Examiner Flores Hokkanen, P
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WRITTEN OPINION

Application number
NL2010500

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - a sequence listing
 - table(s) related to the sequence listing
 - b. format of material:
 - on paper
 - in electronic form
 - c. time of filing/furnishing:
 - contained in the application as filed.
 - filed together with the application in electronic form.
 - furnished subsequently for the purposes of search.
3. In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes: Claims	3-17
	No: Claims	1, 2, 18-25
Inventive step	Yes: Claims	3-17
	No: Claims	1, 2, 18-25
Industrial applicability	Yes: Claims	1-25
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

- 1 Reference is made to the following documents:
D1: DE 27 23 726 A1
D2: US 5 428 926 A
D3: US 3 732 653 A
D4: US 4 111 401 A

- 2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

D1 discloses (see in particular page 4, lines 3-9; page 7, line 18 to page 9, line 27 and figures):

Geluidsschermwand ("Lärmschutzwand") voorzien van een veelvoud van horizontaal aangrenzende wandpanelen 1 opgesteld in een zigzag patroon (see in particular page 8, line 24), waarbij een rechter rand 6 van een eerste wandpaneel van het veelvoud van wandpanelen verbonden is aan een linker rand 6 van een aangrenzend tweede wandpaneel van het veelvoud van wandpanelen (see in particular figure 4) met gebruik van een veerkrachtige verbindingseenheid 10-15, waarbij de veerkrachtige verbindingseenheid ingericht is om verende samengedrukt en/of uitgerekt te worden in een richting die in hoofdzaak parallel is aan een verbindingsrichting die zich uitstrekt van de rechter rand van het eerste wandpaneel naar de linker rand van het tweede wandpaneel.

- 2.1 In fact, the term "wandpaneel" in the claim is considered as broad and does not necessarily imply that the panel should have a particular shape. Furthermore, the expression "rand" is also considered as broad, so that it may encompass any particular region near the edge of a panel.

In D1, the wall panel 1 comprises side panels 2,3 ("Seitenwände") with corresponding edges 4,6. The connection unit 10-15 includes resilient elements 10 of rubber or foamed plastic material (page 9, last two lines; figure 4) which are necessarily compressed by the remaining elements of the connection unit. Furthermore, a connection direction between the edges 6 in figure 4 can be defined along the longitudinal axis of the bolt 13, which is also the direction of the compression of the resilient elements 10. In consequence, D1 discloses a resilient connection unit as defined in claim 1.

- 3 The present application does not meet the criteria of patentability, because the subject-matter of claim 24 is not new.

In fact, claim 24 defines a method of constructing a noise barrier by providing wall panels and a resilient connection unit with the same features as the ones of claim 1, but being formulated as method steps. In consequence, the subject matter of claim 24 is also disclosed by document D1.

- 4 The present application does not meet the criteria of patentability, because the subject-matter of claim 25 is not new.

In fact, claim 25 defines a kit of parts for constructing a noise barrier comprising two or more wall panels and at least a resilient connection unit with the same features as the ones of the noise barrier defined in claim 1. In consequence, the subject matter of claim 25 is also disclosed by document D1.

- 5 Dependent claims 2, 18-23 do not contain any features which, in combination with the features of any claim to which it refers, meet the requirements of novelty.

- Regarding claim 2, D1 discloses "prefab betonpanelen" (precast concrete panels see page 7, line 19).

- Regarding claims 18, 19, 21, 22, D1 also discloses a wall panel 1, a connection unit 10-15, the use of the wall panels and the use of the connection unit in a noise barrier as claimed in claim 1, already anticipated by the same document D1.

- Regarding claims 20, 23, D1 (figure 4) discloses a connection unit 10-15 and its corresponding use in a noise barrier as claimed, whereas the unit extends between the wall panels.

- 6 The combination of the features of dependent claim 3 is neither known from, nor rendered obvious by, the available prior art.

There are no indications for the skilled person to modify the connection unit in the noise barrier of D1 so to comprise a resilient element with a bending stiffness determining the tensile stiffness of the connection unit.

In fact, in D1, the tensile stiffness of the connection unit is determined by a tensile stiffness of the resilient elements 10, without any bending action being possible or intended.

D2 (figure 4) discloses a connection unit 35 between wall elements of a noise barrier, the unit including a connector plate 36. Although the plate 36 as such has a given bending stiffness, the connection unit is not arranged for being resiliently compressed or extended as claimed.

D3 (figure 3) and D4 (figure 5) disclose barriers with wall elements connected by connection units allowing a rotational movement for compensating thermal expansion and contraction (see D3, col. 6 and D4, col. 5) without therefore allowing a compression or extension as claimed.

- 7 Claims 4-17 are dependent of claim 3 and fulfill the requirements of novelty and inventive step.