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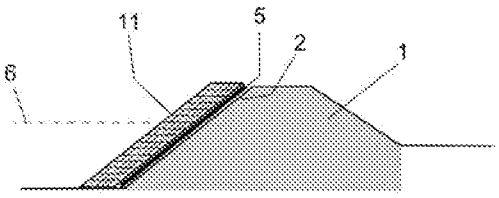
(54) **Wave/water-retarding slope**

(57) The present invention relates to a wave/water-retarding slope. The slope comprises: a slope body 1 defining a slope surface 2; a revetment 11 of revetment blocks arranged on the slope surface 2; and an intermediate layer between the slope surface 2 and the revetment 11. The revetment has a wave/water-retarding open structure The slope body 1 is made of a sediment having a grain size of at most 2 mm. The intermediate layer comprises a geo-textile 5 having a land side and water side. The land side faces to the slope body 2 and the water side contacts the revetment blocks. The geo-textile 5 separates the sediment and revetment blocks from each other and allows water to pass through the geo-textile. The geo-textile 5 has a tensile strength of at least 80 kN/m, and a strain of at most 5%, when subjected to a tensile load of 80 kN/m.



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Title: Wave/water-retarding slope

FIELD OF THE INVENTION

The invention relates to the field of wave/water-retarding slopes. In general, wave/water-retarding slopes are used in land-backed constructions (i.e. constructions with water on one side and land on the other side) extending along the shore of a sea, lake etcetera or along the bank of a river, canal etcetera.

A wave/water retarding slope retards waves and/or water. Similar a wave/water retarding construction retards waves and/or water. Wave/water-retarding slopes have an open structure designed to absorb the energy of water and/or waves

- when the water respectively waves hit the open structure of the slope,
- when the water respectively waves flow along open structure of the slope,
- when the water respectively waves flow through the open structure of the slope.

Wave/water-retarding slopes thus reduce the forces of the waves and/or water by retarding the waves and/or the flow of water. The wave/water-retarding slope according to the invention may be used with any type of water (sea, lake, river, canal, etcetera) and in any type of land-backed wave/water-retarding construction having – inherent to its wave/water-retarding function – an open structure at its slope.

BACKGROUND OF THE INVENTION

Wave/water-retarding slopes are, in general, the effective part of a land-backed wave/water-retarding construction, like a wave/water-retarding dike or wave/water-retarding bank. The wave/water-retarding slope according to the invention is provided at the water facing side of the wave/water-retarding construction. The wave/water-retarding slope according to the invention is the water facing part of a wave/water-retarding construction, i.e. the part in contact with the water and breaking the energy of the water and/or waves.

In land-backed wave/water-retarding constructions, stone-like blocks and sediments of all kinds of sizes may be used.

In general, sediments are classified by their grain size, also called particle size. Well known classifications are the Wentworth scale (or Udden-Wentworth scale) or the Krumbein *phi (Φ)* scale, which is a logarithmic scale created by Krumbein in 1934 as a modification of the Wentworth, see the below table 1 on the next page. Further elaborating on, among other

things, the scales of Wentworth and Krumbein, ISO 14688-1:2017 (E) provides 'sediment grain size ranges' in mm in relation to the classification according to the 'Wentworth grades' and 'Phi (Φ) scale', respectively, see the below table 2 on the next page, which is identical to '*table 1 in section 5.1.1 of ISO 14688-1:2017 (E)*'.

A wave/water-retarding construction – both a conventional one as well as one according to the invention - comprises a slope body which defines the gradient of the slope and has a slope surface extending, relative to the horizontal plane, at a slope surface angle corresponding to the gradient of the slope. This slope body is covered with i) a revetment of stone-like revetment blocks providing the open structure configured for wave/water-retarding and ii) one or more intermediate layers between the revetment and the slope surface. In conventional constructions the one or more intermediate layers comprise at least two intermediate layers, whilst according to the invention the one or more intermediate layers may be just one intermediate layer.

In conventional wave/water-retarding slopes, the revetment consists of large stone-like revetment blocks of natural stone or concrete, which are placed on a so called filter layer arranged between revetment and a geo-textile on the slope body, the filter layer and geo-textile both being a said intermediate layer. This filter layer in general consists of two said intermediate layers:

- a top layer of riprap (also known as rubble) - having in general a size of about 60-350 mm, i.e. in the range of Wentworth grade 'cobble' - and
- a lower layer of gravel – having in general a size of about 8-32 mm, i.e. in the range of Wentworth grades 'medium gravel' and 'coarse gravel -.

The conventional filter layer serves to protects the geotextile from being ruptured by the revetment, to keep the geotextile in place, and to slow down water hitting the wave retarding construction in order to prevent waves and water from being pressed through the geotextile.

The slope body may - conventionally as well as according to the invention - comprise any material suitable, like sand or clay.

When constructing a conventional wave/water-retarding slope this involves not only transporting multiple tons of revetment blocks to their destination, but also transporting multiply tons of riprap and gravel. This transport is quite costly and time consuming when it is not (ready) available and has to come from far.

Sediment grain sizes (mm)	Wentworth grade	Phi (F) scale
>256	boulder	< -8
>64 to 256	cobble	-6 to -8
>32 to 64	very coarse gravel	-5 to -6
>16 to 32	coarse gravel	-4 to --5
>8 to 16	medium gravel	-3 to -4
>4 to 8	fine gravel	-2 to -3
>2 to 4	very fine gravel	-1 to -2
>1 to 2	very coarse sand	0 to -1
>0.50 to 1	coarse sand	1 to 0
>0.25 to 0.50	medium sand	2 to 1
>0.125 to 0.25	fine sand	3 to 2
>0.0625 to 0.125	very fine sand	4 to 3
>0.0313 to 0.625	coarse silt	5 to 4
>0.0156 to 0.0313	medium silt	6 to 5
>0.0078 to 0.0156	fine silt	7 to 6
>0.0039 to 0.0078	very fine silt	8 to 7
<0.0039	clay	>8

Table 1:

soil group	particle size fractions [symbol]	range of particles mm
very coarse soil	large boulder [lBo]	> 630
	boulder [Bo]	> 200 to ≤ 630
	cobble [Co]	> 63 to ≤ 200
coarse soil	**gravel [gr]**	**> 2.0 to ≤ 63**
	coarse gravel [cGr]	> 20 to ≤ 63
	medium gravel [mGr]	> 6.3 to ≤ 20
	fine gravel [fGr]	> 2.0 to ≤ 6.3
	sand [Sa]	**> 0.063 to ≤ 2.0**
	coarse sand [cSa]	> 0.63 to ≤ 2.0
	medium sand [mSa]	> 0.2 to ≤ 0.63
	fine sand [fSa]	> 0.063 to ≤ 0.20
fine soil	**Silt [Si]**	**> 0.002 to ≤ 0.063**
	coarse silt [cSi]	> 0.02 to ≤ 0.063
	medium silt [mSi]	> 0.0063 to ≤ 0.02
	fine silt [fSi]	> 0.002 to ≤ 0.063
	clay [Cl]	**≤ 0.002**

Table 2:

SUMMARY OF THE INVENTION

It is an object of the invention to provide an alternative wave/water-retarding slope for a land-backed construction. A further object of the invention is providing a wave/water-retarding slope overcoming one or more of the problems associated to conventional wave/water-retarding slopes.

C1: One or more of the above objects are according to a first aspect of the invention achieved by providing a wave/water-retarding slope, comprising:

- a slope body defining a slope surface;
- a revetment of stone-like revetment blocks, such as concrete revetment blocks, arranged on the slope surface and configured to provide a wave/water-retarding open structure; and
- an intermediate layer between the slope surface and the revetment blocks;

wherein the slope body is made of a sediment having a grain size of at most 2 mm; and
wherein the intermediate layer comprises a geo-textile having a first surface side – which is further called land side face - and a second surface side – which is further called water side face -, the land side face facing to the slope body and the water side face being on the one hand exposed to openings of the open structure and on the other hand in contact with contact surfaces of the revetment blocks; and
wherein the geo-textile has a tensile strength of at least 80 kN/m, and a strain of at most 5%, such as at most 3%, when subjected to a tensile load of 80 kN/m.

In case the land-backed construction is a dike, the slope body may – according to the invention - be the so called dike body. In case the land lies substantially higher than the water, a dike may be absent and the land-backed construction may be a bank and the slope body may – according to the invention - be the part of the bank adjacent the water. This part may have an about triangular cross-section with an about vertical and an about horizontal side and a slanting side corresponding to the slope surface. According to the invention it is also possible that the slope body is a slanting layer with for example an about constant thickness in horizontal direction. For example in case a bank has already a natural or artificial slant or in case of natural or artificial dam or dike, the slope body may – according to the invention - be a slanting sediment layer arranged or already present on the bank or dike/dam.

The slope body is mainly constructed from (or built up from) a sediment having a grain size smaller than 2 mm. Such sediments are quite prone for being washed out by water. It is as such known that geo-textiles may help preventing this.

In terms of ISO 14688-1:2017, a sediment having a grain size of at most 2 mm, is a sediment smaller than 'fine gravel (fGr)'. In terms of Wentworth grade, a sediment having a grain size of at most 2 mm is a sediment having a grade smaller than 'very fine gravel', which corresponds to a Krumbein's Phi (Φ) scale of larger than '-1'.

Similar as in prior art, geo-textile is used to keep two layers on opposite sides of the geo-textile separated from each other. With the invention, these two separated layers are the sediment of small grain size ($\leq$ 2mm), on the one hand, and the revetment blocks of large dimensions, on the other hand. For dry sediment this separation works well, but under aqueous conditions when the construction according to the invention is subjected to high water and/or heavy weather this separation may not be 100%. So one may say that the geo-textile used in the invention is configured to separate the revetment blocks and sediment from each other in at least a dry condition or non-aqueous condition of the sediment (because it may not be 100% in aqueous condition).

As is known from prior art and may also be the case with the invention:

- a geo-textile in a wave-retarding slope should allow water to escape from the slope body through the geo-textile, i.e. backflow-water is allowed to pass through the geo-textile from the land side to the water side,
- backflow-water dragging along fine sediment parts from the slope body through the geo-textile may be counteracted but is difficult to prevent completely.

When water enters into the slope body then i) sediment of small grain size may tend to escape from the wave/water-retarding slope, and ii) the water entered may cause fluidisation of the sediment with small grain size. Due to this fluidizing of the sediment with small grain size, the revetment blocks may so to say sink into the slope body. In conventional wave/water-retarding slopes, this is counteracted by the filter layers between the revetment and the geo-textile. The (conventional) filter layers function as a buffer preventing the geo-textile from being exposed directly to the water/waves. Further the (conventional) filter layers reduce the flow rate of backflow-water passing from the slope body, through the geo-textile, to the revetment blocks so that this backflow-water is less-likely to drag along fine sediment parts from the slope body through the geo-textile.

As the revetment of revetment blocks puts a lots of weight on the geo-textile and consequently loads the geo-textile heavily, the geo-textile may easily damage or rupture. Such damage or rupture will result in sediment escaping from the wave/water-retarding slope and consequently weakening of the wave/water-retarding slope and possibly flooding or other

disasters. With respect to the revetment blocks loading the geo-textile, it is to be noted that in wave/water-retarding slopes the revetment blocks may also be moved by the forces of the water, which results in the geo-textile being additionally subjected to loads which may cause the geo-textile to be damaged or rupture. Conventionally, this is solved by placing gravel and riprap as an intermediate construction between the revetment blocks and the geo-textile so that the revetment blocks rest on the riprap, the riprap rests on the gravel, and the gravel rests on the geo-textile. This conventional construction prevents the revetment blocks from directly contacting the fragile geo-textile and spreads the load of the revetment blocks over the geo-textile so that the geotextile is kept well pressed against the sediment everywhere and so that local peaks in loads on and in the geo-textile are reduced. The inventor(s) surprisingly found that i) the intermediate construction of riprap and gravel may very well dispensed with provided that the geo-textile has a sufficient tensile strength in combination with a low strain when tensile loaded, and that ii) for this purpose known geo-textiles of – compared to what is known in the field of geotextiles – relatively moderate strength are already suitable. Without being bound by any scientific theory, it is believed that the low strain prevents the geo-textile from becoming permanently stretched by – amongst others – the load of revetment blocks and impact of water/waves. A permanent stretch of the geo-textile would cause the geo-textile to lengthen locally which in turn causes slackening of the geo-textile which may result in flapping of the geo-textile under influence of waves and moving water. In other words, the low strain ensures that the geo-textile is kept taut against the sediment of the slope body, which apparently counteracts fluidization of sediment of the slope body sufficiently. All in all, while the view according to the prior art is that in wave-retarding slopes one or more filter layers are necessary between the revetment blocks and the geo-textile, this appears – according to the invention - not to be necessary. When the geotextile has a tensile strength of at least 80 kN/m in combination with a strain of at most 5%, such as at most 3%, when subjected to a tensile load of 80 kN/m, then the revetment may lie directly on the geo-textile without any intermediate layer. Here, tensile strength and strain may be measured according to EN ISO 10319.

As a result of the revetment lying directly on the geo-textile, the water side face of the geo-textile – i.e. the surface side of the geo-textile which faces the revetment – is on the one hand exposed to openings of the open structure and on the other hand in contact with contact surfaces of the revetment blocks. In other words, part of the water side face is in contact with the contact surfaces of the revetment blocks – a contact surface of a revetment block being the surface of the revetment block which rests on the geo-textile -, and another part of the water side face, which part is free of contact with the revetment blocks is exposed to the

openings of the open structure. This other part of the second surface part faces so to say directly into the openings of the open structure.

Dispensing with the intermediate construction of riprap and gravel results in significant material savings, significant savings in transportation costs, significant reduction of work during construction of the wave/water-retarding slope, significant reduction of materials used, etcetera. On top of this comes that riprap and gravel are not always readily available.

C2: In order to counteract the sediment of small grain size from escaping through the geo-textile and to prevent the revetment blocks from sinking into the slope body, the geo-textile may according to a further embodiment of the first aspect be configured to keep the revetment blocks and sediment separated from each other, at least when the sediment is in dry condition. As in wave/water-retarding slopes, water may very well enter into the slope body (which may as such result in weakening of the slope body), water is allowed to pass through the geo-textile from at least its first surface facing the slope body to its water side face facing the revetment blocks in order to ensure the water can be drained off from the slope body. Optionally, the water may also be allowed to pass in the opposite direction as well, i.e. from the water side to the land side.
Surprisingly, the problem of washing out fine sediment parts by being dragged along with backflow-water through the geo-textile also does not occur, at least not nearly in the amount as expected when leaving away the filter layers which in conventional constructions serve to reduce this washing out.

C3: According to a further embodiment of the first aspect of the invention, each contact surface defines a corresponding contact area on the geo-textile, in which contact area the geo-textile contacts a revetment block. In this respect it is to be noted that not all revetment blocks have to be in contact with the geo-textile. This may for example be the case when the revetment blocks are arranged randomly with one or more revetment blocks, or even an entire layer of revetment blocks being supported on other revetment blocks and not contacting the geo-textile. Further, the part of a revetment block contacting the geo-textile – i.e. the contact surface – may be any part of the revetment block and thus does not have to be predefined part of the revetment block. In case the contact surfaces are predefined surfaces of the revetment blocks, these contact surfaces may extend about parallel to the slope surface or geo-textile.

C4: According to a further embodiment of the embodiment in which each contact surface defines a contact area, the distance between adjacent contact areas is at most about 90 cm, such as at most about 80 cm.

By ensuring that the distance between two adjacent contact areas is at most about 90 cm, it is further ensured that the geo-textile is kept sufficiently taut against the sediment of the slope body at the areas where the geo-textile is exposed to the openings of the open revetment structure. The smaller this distance between adjacent contact areas, the better the tautness of the of the geo-textile against the sediment will be. In embodiments this distance may be further reduced to at most about 80 cm, such as at most in the range of 70 cm to 80 cm.

C5-6: According to a further embodiment of the embodiment in which each contact surface defines a contact area, the distance between adjacent contact areas is, viewed along the slope surface and in a horizontal direction or a direction transverse to the horizontal, at least about 30 cm, such as at least about 40 cm. According to a further embodiment the distance between adjacent contact areas the may be in the range of about 40 cm to about 90 cm or in the range of about 40 cm to about 80 cm, respectively. Accordingly, the revetment blocks may be placed on the geo-textile in such manner that the contact areas of adjacent revetment blocks are spaced with respect to each other, the distance – which might be a largest distance - between each pair of adjacent contact areas being in the range of 40-90 cm or in the range of 40-80 cm. So, in first example, the revetment blocks may be placed on the geo-textile in such manner that:

- viewed parallel to the slope surface and in a horizontal direction, the contact areas of each pair of adjacent revetment blocks have a distance in the range of 40-90 cm, and
- viewed parallel to the slope surface and in a direction transverse to the horizontal, the contact areas of each pair of adjacent revetment blocks have a distance in the range of 40-90 cm;

and,

in a second example the revetment blocks may be placed on the geo-textile in such manner that:

- viewed in a horizontal direction along the slope surface, the contact areas of each pair of adjacent revetment blocks have a distance in the range of 40-80 cm, and

viewed in a direction along the slope and transverse to the horizontal the slope surface, the contact areas of each pair of adjacent revetment blocks have a distance in the range of 40-80 cm.

By ensuring that the distance between two adjacent contact areas is at most least 40 cm, it is further ensured that a sufficient backflow (which is required to allow water to escape from the slope body) is maintained and that this backflow is not too much decreased due to the parts

of the geotextile exposed to the openings of the open structure becoming small. As said above, this backflow is of importance to ensure that water is allowed to escape from the slope body.

C7-8: According to a further embodiment of the embodiment in which each contact surface defines a contact area, the sum of said contact areas is in a range of between about 5% to about 60% of the water side face of the geo-textile. In this embodiment, the rest of the water side face of the geo-textile may be exposed to openings of the open revetment structure. In other words about 5% to about 60% of the water side face of the geo-textile is a said contact area, while the rest of the water side face may be exposed. All contact surfaces together thus overlap about 5% to about 60% of the water side face of the geo-textile, and the rest of the water side face of the geo-textile may be left exposed. When too large a part of the water side face of the geotextile is contacted by contact surfaces - i.e. when the sum of all contact areas becomes too large with respect to the water side face -, the ability of the slope to dewater becomes too small and the wave/water retarding effect may decrease (too much). Lab experiments have revealed that this seems to be the case when substantially more than 55% of the second side of the geo-textile is contacted by contact surfaces. Lab experiments further revealed that flapping of the geotextile, under (simulated) normal circumstances of heavy weather, seems to be prevented very well when the sum of said contact areas is in the range of about 35% to about 60% of the water side face of the geo-textile. The sum of said contact areas may according to a further embodiment be in the range of about 40% to about 50% and may according to another further embodiment be in the range of about 45% to about 50%. When the percentage for the sum of contact areas becomes too small, then a risk of tearing of the geo-textile may be introduced. Lab experiments revealed however that when this percentage is in the range of about 5% to about 10% of the water side face of the geo-textile, the degree of tearing and the degree of flapping may, depending on requirements and circumstances, still be acceptable.

C9-10: According to a further embodiment of the first aspect of the invention, the grain size of the sediment is at most 1 mm, such as at most 0.63 mm.
In terms of Wentworth grade, a sediment with grain size of at most 1 mm is a sediment having a grade smaller than ‘very coarse sand’, which corresponds to a Krumbein’s Phi (Φ) scale of larger than ‘0’. In terms of ISO 14688-1:2017, a sediment having a grain size of at most 0.63 mm is a sediment smaller than ‘Coarse sand (cSa)’, which, in terms of Wentworth grade, is about the same as a sediment having a grade smaller than ‘coarse sand’, which corresponds to a Krumbein’s Phi (Φ) scale of larger than ‘1’. Medium and even fine sand, and

also finer sediments, like silt and clay, are sediments which in general are readily available and may very well form the basis of a slope body according to the invention.

C11-12: According to another further embodiment of the first aspect of the invention, the tensile strength of the geo-textile may be at least 90 kN/m, such as at least 100 kN/m or at least 250 kN/m or at least 500 kN/m. According to still another further embodiment of the first aspect of the invention, the strain of the geo-textile is at most 3%, such as at most 2%, when subjected to a tensile load of 90 kN/m. Applicant found for example that Polyfelt® PGM-G 100/100 of TenCate® may very well be used as geo-textile in a wave/water-retarding slope according to the invention. This Polyfelt PGN 100/100 has a tensile strength of about 100 kN/m (EN ISO 10319), a 2% strain at 90 kN/m (EN ISO 10319) and an elongation at break of 3% (EN ISO 10319).

C13-15: According to another further embodiment of the first aspect of the invention:

- the geo-textile may be a geotextile reinforced with interwoven glass fibres, such as a grid of interwoven glass fibres;

and/or

- the geo-textile may be a composite of a geo-textile layer with a reinforcement geo-grid, like for example PW4-LA of Terram®;

and/or

- the geo-textile may be a reinforced trackbed separator, for example PW4-LA of Terram®.

C16: According to another further embodiment of the first aspect of the invention, the intermediate layer may further comprise a gravel layer arranged between the geo-textile and the slope surface, the gravel layer having, transverse to the slope surface, a thickness in the range of 5-15 cm, such as about 10 cm, and having a grain size in the range of 4-32 mm. Such gravel layer further assists in preventing sand or clay sediment of the slope body from being washed out. Especially in case of steep slope surfaces, this may be useful. In this embodiment, the land side face of the geo-textile may lie on one side of the gravel layer and may contact that side, whilst the other side of the gravel layer may lie on the slope body in contact with the slope body. The gravel layer thus is provided at the backside or landside of the geo-textile.

C17: According to another further embodiment of the first aspect of the invention, the intermediate layer may consist of or be formed by the geo-textile. The geo-textile then directly lies on the slope body in contact with the slope body, without a gravel layer in between.

C18: According to another further embodiment of the first aspect of the invention, the slope body has, viewed transverse to the slope, a thickness of at least 0.5 meters (=50 cm), such as at least 1 meter or at least 1.5 meter or at least 2 meters.

C19: According to another further embodiment of the first aspect of the invention, revetment blocks according to applicant's earlier WO-2018/052292 may be used in a wave/water-retarding slope according to the invention. A revetment block according or similar to WO-2018/052292 is constituted by:

- a central part;
- a pair of wings projecting in mutually opposite directions from the central part, in horizontal direction, and parallel to the slope surface;
- a nose projecting from the central part transverse to the wings, in horizontal direction, and away from the slope surface; and
- a tail projecting from the central part transverse to the wings, in horizontal direction, and towards the slope body.

These revetment blocks may be arranged in rows with in each row the wings of the revetment blocks aligned along an about straight axis. Multiple of these rows may be stacked obliquely along the slope, with an upper row (obliquely) above an adjacent lower row. The nose of a said revetment block of the upper row may be supported on the ends of two aligned wings of adjacent said revetment blocks of the lower row, and the tail of a said revetment block of the lower row supports the ends of two aligned wings of adjacent said revetment blocks of the upper row. This manner of arranging the revetment blocks obliquely along the slope results in revetment with a regular pattern of revetment blocks, in which the upper revetment blocks press on the lower revetment blocks, resulting in turn in a solid revetment with large openings for absorbing wave/water energy.

In this further embodiment with revetment blocks according or similar to WO-2018/052292, the end of each tail forms a said contact surface, which contact surface is provided at the land facing outer end of each tail. This contact surface rests on the geo-textile and defines a corresponding contact area of the geo-textile. This contact surface may extend about parallel to the slope surface or geo-textile.

C20-22: In order to reduce or prevent flapping further:

- the contact surfaces contacting the geo-textile may be configured such that the part of the water side face of the geo-textile which is in contact or overlap with the contact surfaces forms a lattice like pattern of cross-wise lattices surrounding free parts of the water side face of the geo-textile;

and/or

- the contact surface of said revetment blocks my be configured such that all contact surfaces together overlap with at least about 5% to about 60%, such as at least about 10 % to about 60%, of the water side face of the geo-textile;

an/or

- the contact surface of said revetment blocks may be configured such that all contact surfaces together contact (or overlap with) about 35% to about 60%, such as in one embodiment about 40% to about 55% or in another embodiment about 45% to about 50%, of the water side face of the geo-textile.

C23-24: Further according to a further embodiment of the first aspect, the revetment blocks may have dimensions comparable or corresponding to a grain size of at least 300 mm, such as at least 500 mm or larger. As an alternative to or in addition to using grain size, the dimensions of the revetment blocks may according to (a further embodiment) of the invention also be expressed as having a nominal diameter in the range of 30-110 cm, such as a nominal diameter of about 45 cm or about 80cm. Here, the nominal diameter is defined as the cube root of the volume of a block,

$$\text{i.e. nominal diameter} = \sqrt[3]{(\text{volume block})}$$

C25: According to a further embodiment of the first aspect, the revetment blocks may be blocks of any material, like a natural material such as for example basalt or an artificially made material such as for example concrete. According to an example, these revetment blocks may be placed randomly on the slope body. According to another example, these revetment blocks may be placed in a regular pattern on the slope body, like for example the revetment blocks and patterns as are known from and described in applicant's earlier WO-2018/052292.

C26: According to a second aspect of the invention, one or more of the above objects are achieved by providing a stone-like revetment block for a revetment, such as a stone-like revetment block for a revetment in a wave/water retarding slope according to the first aspect of the invention. The revetment block according to the second aspect of the invention may however also be used in other constructions, for example constructions having one or more intermediate layers, like conventional layers, between the revetment and the geo-textile, or having no geotextile at all, or being not land-backed. The stone-like revetment block according to the second embodiment is constituted by:

- a central part,
- a pair of wings projecting in mutually opposite horizontal directions from the central part,

- a nose projecting from the central part transverse to the wings, in a horizontal forward direction, and
- a tail projecting from the central part transverse to the wings, in a horizontal backward direction;

wherein the end of the tail is provided with a contact surface extending at a contact surface angle with respect to a horizontal surface defined by:

i) the opposite horizontal directions in which the wings extend,

ii) the horizontal forward direction, and

iii) the horizontal backward direction;

wherein the contact surface is configured such that,

when a plurality of horizontal rows of said revetment blocks is arranged on the slope surface, with

- viewed along the slanting slope direction, an upper row of said horizontal rows of revetment blocks being arranged obliquely above an adjacent lower row of said horizontal rows of revetment blocks,
- in each row, the wings of the revetment blocks being aligned,
- the nose of a said revetment block of the upper row being supported on the ends of two aligned wings of adjacent said revetment blocks of the lower row,
- the tail of a said revetment block of the lower row supporting the ends of two aligned wings of adjacent said revetment blocks of the upper row,

the sum of the contact surfaces of the tails of the revetment blocks is in the range of 35% to about 60% of the slope surface covered by the plurality of horizontal rows arranged on the wave retarding slope.

One of the wings may extend in a right horizontal direction and the other of the wings may extend in a left horizontal direction. Per row the wings of the revetment blocks are aligned, i.e. the right wing of each block pointing to the left wing of the block adjacent on the right and the left wing of each block pointing to the right wing of the block adjacent on the left. Optionally, the free end of the right wing of each block may abut against the free end of the left wing of the block adjacent on the right and the free end of the left wing of each block may abut against the free end of the right wing of the block adjacent on the left.

The said configuration of the contact surfaces such that the sum of the contact surfaces of the tails of the revetment blocks is in the range of 35% to about 60% of the slope surface covered by the plurality of horizontal rows arranged on the wave retarding slope, may, more specifically, be a configuration of each contact surface relative to the associated block (or a configuration of the contact surfaces relative to the blocks).

Also without geo-textile or with other layers in between the revetment and the geo-textile, the contact surface being relatively large with respect to the rectangular surface provides that the layer(s) below the revetment are kept solid and in place.

C27: According to a further embodiment of the second aspect, the sum of the contact surfaces of the tails may be in the range of about 40% to about 55% of the slope surface covered by the plurality of horizontal rows arranged on the wave retarding slope.

C28: According to another further embodiment of the second aspect, the sum of the contact surfaces of the tails may be in the range of about 45% to about 50% of the slope surface covered by the plurality of horizontal rows arranged on the wave retarding slope.

C29: According to another further embodiment of the second aspect, the contact surfaces of each pair of adjacent blocks may, viewed parallel to the slope surface and in a horizontal direction, have a distance in the range of 40-90 cm, such as in the range of 40-80 cm, and the contact surfaces of each pair of adjacent blocks may, viewed parallel to the slope surface and in a direction transverse to the horizontal, have a distance in the range of 40-90 cm, such as in the range of 40-80 cm.

C30: According to another further embodiment of the second aspect, the contact surface angle may be in the range of about 18° to about 33°, such as in the range of about 20° to about 28°.

C31: According to another further embodiment of the second aspect, the slope surface defines a slope angle with respect to the horizontal plane, and contact surface angle is (about) the slope angle.

C32: According to another further embodiment of the second aspect, the revetment block may be a concrete revetment block.

C33-34: According to a third aspect of the invention, one or more of the objects of the invention are achieved by the use of a reinforced trackbed separator in a slope body as an intermediate layer between a revetment of revetment blocks with dimensions corresponding to a grain size larger than 300 mm, such as at least 500 mm, and a slope body of a sediment having a grain size of at most 2 mm, such as at most 1 mm. Alternatively to or in addition to defining the dimensions of the revetment blocks in terms of a grain size, the dimension of the revetment blocks may also be defined in terms of a nominal diameter in the range of 30-60

cm, the nominal diameter is defined as the cube root of the volume of a block, i.e. nominal diameter = $\sqrt[3]{}$(volume block). The reinforced trackbed separator may according to the second aspect have the characteristics of the geo-textile in the first aspect of the invention.

C35-37: According to a fourth aspect of the invention, one or more of the objects of the invention are achieved by providing a method of making a wave/water-retarding slope, comprising the steps:

a) providing a slope body made of a sediment having a grain size of at most 2 mm, the slope body defining a slope surface;

b) applying an intermediate layer with a geo-textile along the slope surface, the geo-textile having a land side face and a water side face, the land side face facing the slope surface and optionally flush with the slope surface, the water side face facing in a direction opposite to the slope surface;

c) placing a revetment of stone-like revetment blocks, such as concrete revetment blocks, onto the water side face of the geotextile, the revetment blocks having dimensions corresponding to a grain size of at least 300 mm, such as at least 500 mm and providing wave/water-retarding open structure;

wherein, according to an optional further embodiment, the geo-textile is configured to keep the sediment and revetment blocks separated from each other whilst allowing water to pass through the geo-textile; and

wherein the geo-textile has a tensile strength of at least 80 kN/m, and a strain of at most 5% when subjected to a tensile load of 80 kN/m. Also here, the dimensions of the revetment block may in addition or alternatively also be defined in terms of a nominal diameter in the range of 30-60 cm, the nominal diameter is defined as the cube root of the volume of a block, i.e. nominal diameter = $\sqrt[3]{}$(volume block). In further embodiments of the fourth aspect of the invention, the sediment may be a sediment as defined and elucidated in relation to the first aspect of the invention; and/or the geo-textile may be a geo-textile as defined and elucidated in relation to the first aspect of the invention; and/or the intermediate layer may be an intermediate layer as defined and elucidated in relation to the first aspect of the invention; and/or the slope body may be a slope body as defined and elucidated in relation to the first aspect of the invention; and/or the revetment blocks may be revetment blocks as defined and elucidated in relation to the first and/or second aspect of the invention; and/or the step of placing the revetment may comprise placing the revetment blocks in an arrangement as defined and elucidated in relation to the first aspect of the invention; and/or the step of applying the intermediate layer comprising a first sub-step of applying a gravel layer onto the slope body, followed by a second sub-step of applying the geo-textile onto the gravel layer.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be explained further with reference to the drawings. In these drawings:

Figure 1 shows schematically, stepwise the process of constructing a wave/water-retarding slope according to the prior art, Fig. 1A showing a first step in the construction, Fig. 1B showing a second step in the construction, Fig. 1C showing a third step in the construction, Fig. 1D showing a fourth step in the construction, and Fig. 1A showing a fifth step in the construction.

Figure 2 shows schematically, stepwise the process of constructing a wave/water-retarding slope according to a first embodiment of the invention, Fig. 2A showing a first step a) in the construction, Fig. 2B showing a second step b) in the construction, and Fig. 2C showing a third step c) in the construction.

Figure 3 shows schematically, stepwise the process of constructing a wave/water-retarding slope according to a second embodiment of the invention, Fig.3A showing the initial situation, Fig. 3B showing a first step in the construction, Fig. 3C showing a second step in the construction, and Fig. 3D showing a third step in the construction.

Figure 4 shows schematically, stepwise the process of constructing a wave/water-retarding slope according to a third embodiment of the invention, Fig.4A showing a pre-existing situation, Fig. 4B showing a first step in the construction, Fig. 4C showing a second step in the construction, and Fig. 4D showing a third step in the construction.

Figure 5 shows schematically, stepwise the process of constructing a wave/water-retarding slope according to a fourth embodiment of the invention. This fourth embodiment is shown as a variant of the process of construction and embodiment shown in figure 4. This variant is however mutatis mutandis also applicable to the process of construction and associated embodiment shown in Figure 2 and Figure 3, respectively. The difference is that in figure 5, the third step of 'applying the intermediate layer' has two sub-steps and that the intermediate layer comprises a geo-textile and a gravel-layer below the geo-textile. Fig.5A is not shown, but is identical to Fig. 4A, and would show the first step in the construction. Fig. 5B is shown, is identical to figure 4B, and shows a second step in the construction. Fig. 5C-1 shows the first sub-step of the third step in the construction, which first sub-step is a step of applying a gravel layer, which takes place before applying the geo-textile. Fig. 5C-2 shows the second sub-step of the third step in the construction, which second sub-step is the step of applying the geo-textile onto the gravel layer -. Fig. 5D shows the fourth step in the construction.

Figure 6 shows a perspective view of a first stone-like revetment block which may be used in the wave/water-retarding slope according to the invention.

Figure 7 shows another perspective view of the same revetment block as in figure 6, showing in dashed lines a part of a further revetment block to illustrate how a revetment block of a higher row is supported on two revetment blocks of an adjacent lower row.

Figure 8 shows schematically a perspective view onto a wave/water-retarding slope according to the invention with a revetment of blocks as shown in figures 6 and 7.

Figure 9 shows a perspective view on the back side of the revetment of figure 8.

Figure 10 shows schematically the pattern of the contact surfaces of the revetment of figures 8 and 9.

Figure 11 shows a perspective side view of a second stone-like revetment block which may be used in the wave/water-retarding slope according to the invention.

Figure 12 shows a perspective back view of the same revetment block as in figure 10.

Figure 13 shows a perspective view on the back side of a revetment with the revetment blocks of figures 11-12.

Figure 14 shows schematically the pattern of the contact surfaces of the revetment of figure 13.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Figure 1 shows schematically, stepwise the process of constructing a wave/water-retarding slope according to the prior art.

Fig. 1A showing a first step in the construction, the first step being the step of providing a slope body. Fig. 1A shows in perspective and cross-section a slope body 1 of a land-backed dyke. The slope body 1 has a slope surface 2 on the waterside of the dike, a slanting face 3 on the landside of the dyke, and a crest face 4 on top of the dyke. The slope body comprises a sediment having a grain size of at most 2 mm, such as sand or clay.

Figs. 1B-1E all show the slope body of Fig. 1A only as a light grey-coloured cross-section. In addition to Fig. 1A, the Figs. 1B-1E schematically show the water level 6 at the waterside of the dyke.

Fig. 1B shows that, according to the prior art, in a second step, a geo-textile 5 is placed onto the slope surface 2. This geo-textile is shown as a relatively thick black line. The geo-textile has a land side face 7 facing the slope body, and has a water side face 8 facing in opposite direction, away from the slope body 1 to the water 6.

Figs. 1C-1D show that according to the prior art a so called filter layer 9, 10 is arranged on the water side face 8 of the geo-textile 5. Figure 1C shows applying – in a third step – a lower filter layer 9, shown in dark grey. This lower filter layer 9 is a layer of gravel. Figure 1D shows applying – in a fourth step – an upper filter layer 9, shown as black-rimmed white. This upper filter layer 10 is a layer of riprap.

Fig. 1E shows a fifth step in which a revetment 11 of stone-like revetment blocks is placed onto the upper filter layer 10, in which the revetment has an open structure configured for wave/water-retarding.

Figure 2 shows a first embodiment of the invention. Figure 2 shows schematically and stepwise the method – according to the fourth aspect of the invention - of constructing a wave/water-retarding slope according to the first aspect of the invention. Fig. 2A shows the first step a) of providing a slope body, Fig. 2B shows the second step b) of applying an intermediate layer, and Fig. 2C shows the third step c) of placing a revetment.

Fig. 2A and Fig. 2B are basically the same as Fig. 1A and Fig. 1B.

Fig. 2A shows in perspective and cross-section a slope body 1 of a land-backed dyke. The slope body 1 has a slope surface 2 on the waterside of the dike, a slanting face 3 on the landside of the dyke, and a crest face 4 on top of the dyke. The slope body is made of a sediment having a grain size of at most 2 mm, such as sand or clay. When building a wave/water-retarding slope structure according to the invention, a first step may be constructing a slope body, like in figure 1A. The slope body 1 may however also have been provided in other manner. It may for example also be provided by making a pre-existing, natural or artificial, dyke available or by reconstructing such a pre-existing dyke to have a slope surface at the waterside.

Figs. 2B-2C show the slope body 1 of Fig. 2A only as a light grey-coloured cross-section. In addition to Fig. 2A, the Figs. 2B-2C schematically show the water level 6 at the waterside of the dyke.

Fig. 2B shows that – in the second step of applying an intermediate layer – an intermediate layer is, according to the invention, placed directly onto the slope surface 2. As in the first embodiment, as shown in Fig. 2, the intermediate layer is only a geo-textile, the geo-textile 5 is placed directly onto the slope body 1, i.e. directly onto the sediment having a grain size of at most 2 mm. This geo-textile is shown as a relatively thick black line. The geo-textile serves

to prevent migration of sediment of the slope body, which migration is also called washing out. The geo-textile has a land side face 7 facing the slope body, and has a water side face 8 facing in opposite direction, away from the slope body 1 to the water 6.

Fig. 2C shows that, in the first embodiment, a revetment 11 of stone-like revetment blocks is placed directly onto the geo-textile 5. The revetment 11 of revetment blocks has an open structure configured for wave/water-retarding. The revetment blocks of the revetment lie – according to the invention - directly on the water side face 8 of the geo-textile. Doing, so the prior art steps of providing a filter of two layers between the revetment and the geo-textile is thus dispensed with. The inventors found that – contrary to the general teaching in this field of wave/water-retarding structures – a geo-textile having a tensile strength of at least 80-100 kN/m with a strain of at most 3-5% at a tensile load of 80 kN/m does not require a filter layer of material of smaller size than the revetment blocks to be present between the revetment blocks and the geo-textile.

Figure 3 shows a second embodiment of the invention. Figure 3 shows schematically and stepwise the method – according to the fourth aspect of the invention - of constructing a wave/water-retarding slope according to the first aspect of the invention. Fig. 3A shows a starting point, Fig. 3B shows the first step a) of providing a slope body, Fig. 3C shows the second step b) of applying an intermediate layer, and Fig. 3D shows the third step c) of placing a revetment.

In this second embodiment, the starting point is a bank 12 as schematically shown in the cross-section of Fig. 3A, which extends along the water 6.

Similar as in the first embodiment of Fig. 2, a slope body 1 having a slope surface 2 is provided in a first step, shown in Fig. 3B. Like in the embodiment of Fig. 2, the slope body is constructed from a sediment having a grain size of at most 2 mm, such as sand or clay.

Similar as in Fig. 2B in relation to the first embodiment, Fig. 3C shows that – in a second step of applying an intermediate layer – an intermediate layer is, according to the invention, placed directly onto the slope surface 2. As in this second embodiment shown in Fig. 3, the intermediate layer is only a geo-textile, the geo-textile 5 is placed directly onto the slope body 1, i.e. directly onto the sediment having a grain size of at most 2 mm. Again, the geo-textile 5 is shown as a relatively thick black line. The geo-textile serves to prevent migration of sediment of the slope body, which migration is also called washing out. The geo-textile 5 has a land side face 7 facing the slope body, and has a water side face 8 facing in opposite direction, away from the slope body 1 to the water 6.

Similar as in Fig. 2C in relation to the first embodiment, Fig. 3D shows how, in the second embodiment, a revetment 11 is placed directly onto the geo-textile 5, the revetment having an open structure of revetment blocks. The revetment blocks of the revetment 11 lie directly on the water side face 8 of the geo-textile. Doing, so the prior art steps of providing a filter of two layers between the revetment and the geo-textile is dispensed with. The inventors found that – contrary to the general teaching in this field of wave/water-retarding structures – a geo-textile having a tensile strength of at least 80-100 kN/m with a strain of at most 3-5% at a tensile load of 80 kN/m does not really require a filter layer of material of smaller size than the blocks to be present between the revetment blocks and the geo-textile.

Figure 4 shows a third embodiment of the invention. Figure 4 shows schematically and stepwise the method – according to the fourth aspect of the invention - of constructing a wave/water-retarding slope according to the first aspect of the invention. Fig. 4A shows a starting point, Fig. 4B shows the first step a) of providing a slope body, Fig. 4C shows the second step b) of applying an intermediate layer, and Fig. 4D shows the third step c) of placing a revetment.

In this third embodiment, the starting point is an already existing land-backed dyke or dam 14 as schematically shown in the cross-section of Fig. 4A. This pre-existing dyke/dam 14 extends along the water 6. This pre-exiting dyke/dam 14 may for example be made of rock-material. Depending on circumstances, the pre-existing dyke/dam 14 may have been reconstructed or reshaped before the (first) step of Fig. 4B.

Similar as in the first embodiment of Fig. 2 and in the second embodiment of Fig. 3, a slope body 1 having a slope surface 2 is provided in a first step, shown in Fig. 4B. Like in the embodiments of Fig. 2 and 3, the slope body 1 is made from a sediment having a grain size of at most 2 mm, such as sand or clay.

Similar as in Figs. 2B and 3C in relation to the first respectively second embodiment, Fig. 4C shows that – in a second step of applying an intermediate layer – an intermediate layer is, according to the invention, placed directly onto the slope surface 2. As in this third embodiment shown in Fig. 4, the intermediate layer is only a geo-textile, the geo-textile 5 is placed directly onto the slope surface 2 of the slope body 1, i.e. directly onto the sediment having a grain size of at most 2 mm. Again, the geo-textile 5 is shown as a relatively thick black line. The geo-textile serves to prevent migration of sediment of the slope body, which migration is also called washing out. The geo-textile 5 has a land side face 7 facing the slope

body, and has a water side face 8 facing in opposite direction, away from the slope body 1 to the water 6.

Similar as in Figs. 2C and 3D in relation to the first respectively second embodiment, Fig. 4D shows how, in the third embodiment, a revetment 11 of revetment blocks is placed directly onto the geo-textile 5. The revetment blocks of the revetment 11 lie directly on the water side face 8 of the geo-textile. Doing, so the prior art steps of providing a filter of two layers between the revetment and the geo-textile is dispensed with. The inventors found that – contrary to the general teaching in this field of wave/water-retarding structures – a geo-textile having a tensile strength of at least 80-100 kN/m with a strain of at most 3-5% at a tensile load of 80 kN/m does not really require a filter layer of material of smaller size than the blocks to be present between the revetment blocks and the geo-textile.

As a variant of the Fig. 4 embodiment, Fig. 5 shows a fourth embodiment of a wave/water-retarding slope according to the invention and its construction. In Fig. 5 the starting point is the same as in Fig. 4, i.e. an already existing dyke or dam 14. This starting point is not shown in Fig. 5. Fig. 5 starts therefore with Fig. 5B. The not-shown Fig. 5A is as such the same as Fig. 4A.

The difference between the fig. 4 embodiment and the Fig. 5 embodiment is in the intermediate layer and its construction, i.e. the difference starts in fact as from Fig. 4C of the third embodiment.

In the fourth embodiment of Fig. 5, the intermediate layer is constituted by an assembly of a gravel layer 15 and a geo-textile 5. The gravel layer 15 is arranged on the inner side of the geo-textile 5, i.e. on the land side face 7 of the geo-textile which faces the slope body 1. This gravel layer 15 allows the slope surface to be steeper and assists in keeping the slope body more stable.

The gravel layer 15 at the inner side of the geo-textile results in the second step of applying the intermediate layer being subdivided into a first sub-step and a second sub-step. In the first sub-step shown in Fig. 5C-1, the gravel layer is applied on the slope body. The side of the gravel layer 15 facing the slope body may – in a further embodiment – be in direct contact with the sediment of the slope body having a grain size of at most 2 mm. In the second sub-step shown in Fig. 5C-2, the geo-textile is applied on the slope body. More particular, in the second sub-step the geo-textile 5 is placed onto the gravel layer, more specifically onto the side of the gravel layer facing away from the slope body 1, towards the waterside. The land

side face 7 of the geo-textile (which faces the slope body) may – in a further embodiment – directly contact the (waterside of the) gravel layer.

Similar as in Figs. 2C, 3D, and 4D in relation to the first, second, and third embodiment, respectively, Fig. 5D shows how, in the fourth embodiment, a revetment 11 is placed directly onto the geo-textile 5, the revetment having an open structure of revetment blocks. The revetment blocks of the revetment 11 lie directly on the water side face 8 of the geo-textile. Doing, so the prior art steps of providing a filter of two layers between the revetment and the geo-textile is dispensed with. The inventors found that – contrary to the general teaching in this field of wave/water-retarding structures – a geo-textile having a tensile strength of at least 80-100 kN/m with a strain of at most 3-5% at a tensile load of 80 kN/m does not really require a filter layer of material of smaller size than the blocks to be present between the revetment blocks and the geo-textile.

As will be clear, it is according to the invention, in a similar manner, also possible to construct the intermediate layer of the Fig. 2 and Fig. 3 embodiment as an assembly of a gravel layer 15 and a geo-textile 5.

Fig. 6 shows a stone-like revetment block 20 according to the earlier WO-2018/052292. For details about this revetment block 20 and its manner of laying these revetment blocks in rows on a slope, reference is made to this document WO-2018/052292, which is in this respect incorporated by reference into this application.

The revetment block 20 is made of concrete and constituted by:

- a central part 26;
- two wings 21, 22 projecting in mutually opposite directions from the central part 26 in horizontal direction, and – when arranged on a slope – parallel to the slope surface 2;
- a nose 23 projecting from the central part 26 transverse to the wings 21, 22, in a horizontal direction, and – when arranged on a slope – away from the slope surface 2;
- a tail 24 projecting from the central part 26 transverse to the wings 21, 22 in a horizontal direction opposite to the direction of projection of the nose 23, and – when arranged on a slope – towards the slope.

The revetment block 20 differs from the revetment block according to WO-2018/052292 in so far that the revetment block 20 is to say the little brother of the revetment block according to WO-2018/052292. The revetment block according to WO-2018/052292 has a horizontal wingspan WS – measured from the free end of the wing 21 to the free end of the wing 22 - of about 180 cm, whilst this horizontal wingspan WS is in the revetment block 20 as shown in

Fig. 6 about 80 cm. For revetment blocks used in the present invention, the horizontal wingspan may vary in the range of about 55 cm to about 160 cm, such as in the range of about 55 cm to about 110 cm, in the range of about 130 cm to about 150 cm, or in the range of about 70 to about 150 cm.

Referring to Fig. 8, a slope surface 2 of a slope body 1 may be covered from the toe 13 to the crest 4 with multiple of rows R, Q of revetment blocks 20. As can be seen in Fig. 8, the revetment blocks 20 lie – according to the invention - directly on a geo-textile 5 which is provided on the slope surface 2. Although Fig. 8 shows a triangular patter of revetment blocks 20 provided on the slope surface, it will be clear that this is a schematic drawing and that in practise the length of the rows of revetment blocks 20 will in general correspond with the width of the slope, and that the height over which the slope is provided with rows of revetment blocks 20 may be the full height of the slope or less.

In Fig. 8 a revetment block 20a of the row Q has been shown in dark grey. This revetment block 20a is supported on two revetment blocks 20b and 20c of the row R just below row Q. This manner of the lower revetment blocks 20b and 20c supporting the higher revetment block 20a, is further elucidated with reference to Fig. 7. In Fig. 7, the revetment block 20a is shown in solid lines, the revetment block 20b is partly shown in dashed lines, and the revetment block 20c is not shown for clarity reasons. As can be seen in Fig. 7, the right side of the nose 23 of the upper revetment block 21a is supported on the left wing 21 of the lower revetment block 20b. Similarly the left side of nose 23 of upper revetment block 21 will be supported on a right wing 22 of a left adjacent lower revetment block 20c (not shown in Fig. 7). Further, the right wing 22 of the upper revetment block 20a is supported on the left side of the tail 24 the lower revetment block 20b. Similarly the left wing 21 of the upper revetment block 20a will be supported on the right side of the tail 24 of the left adjacent lower revetment block 20c (not shown in Fig. 7). Further, the tails of the lower revetment blocks 20b and 20c (as well as the tails of the upper revetment block 20a) rest with their contact surfaces 25 (provided at the lower side of the free ends of the tails) on the geo textile 5 on the slope surface 2, resulting in that the bottom sides of the central parts 26 lie free from the geo-textile. The revetment blocks 20 of the revetment thus contact the geo-textile 5 only with the contact surfaces 25, which are shown in dark grey in Fig. 9. Each part of the geo-textile 5 where a contact surface 25 of a revetment block 20 contacts the geo-textile is called a contact area.

The arrangement of revetment blocks 20 as is shown in Figs. 7 and 8, results in a pattern of contact areas corresponding to the pattern of contact surfaces shown in Fig. 10 (and Fig. 9, the dark grey).

Although Fig. 10 only shows the contact surfaces of three rows of revetment blocks, it can be seen from Fig. 10 that each contact surface has eight adjacent contact surfaces, two horizontally adjacent contact surfaces at a distance D1, two vertically adjacent contact surfaces at a distance D2, and four diagonally adjacent contact surfaces at a distance D3. Note in this respect that 'vertically' and 'diagonally' in 'vertically adjacent' respectively 'diagonally adjacent' is not strictly vertical or diagonal respectively, as these directions are along the slope surface, which is a slanting surface.

In the embodiment of figures 6-10, the distance D1 may for example be about 69 cm, the distance D2 may for example be about 75 cm, and the distance D3 may for example be about 37 cm. The largest distance between adjacent contact areas is, in this example, thus at most about 75 cm. With such a largest distance between adjacent contact surfaces it is ensured that the geo-textile is kept sufficiently taught against the sediment at the land-side of the geo-textile, so that flapping, if not completely, is largely prevented. Defining a minimum distance between adjacent contact surfaces as a distance in horizontal direction or in a direction transverse to the horizontal and parallel to the slope surface (i.e. the above so called vertically adjacent), this minimum distance is in this example about 69 cm.

Further, in the embodiment of figures 6-10, about 5% to 10%, for example about 6.4%, of the geo-textile is contacted by all contact surfaces 25 of the revetment blocks 20 on the slope surface 2. The remaining 90% to 95% of the surface of the geo-textile is to say free from the revetment blocks 20, this remaining surface free from the revetment blocks is exposed to the openings of the open structure of the revetment, and is called the exposed .

Lab-experiments have shown that the configuration of revetment blocks 20 with the 'littler brother' dimensions, with the largest distance of about 75 cm between adjacent contact surfaces, and leaving about 90%-95% of the geo-textile free from the revetment blocks, is capable of reliably keeping the geotextile pressed against the slope body so that the slope body stays stable (and does not lose its stability due to the fine sediments becoming so to say fluidized by water entering the slope body). Further, the lab-experiments learned that this configuration also prevents the geo-textile from being damaged or rupturing by the revetment blocks.

In order to further improve the stability of the slope body, on the one hand, and the resistance of the geo-textile against being damaged or rupturing, on the other hand, the contact surfaces 25 at the tails 24 of the revetment blocks may – according to the second aspect of the invention - be enlarged to increase the total overlap of the geotextile with contact surface to a

value in the range of 35% to 60%, such as in the range of 45% to 50% or in the range of 40% to 50%. Increasing the contact surface of a revetment block, like the one of Fig. 6 may, for example, be achieved by widening the free end of the tail to provide a larger contact surface. An example of a revetment block 30 modified in this manner is shown in Figs. 11 and 12. The modified revetment block 30 has an enlarged tail 34 with an increased contact surface 35Fig. 13 shows a perspective view on the back side of a revetment of revetment blocks 30, and Fig. 14 shows the pattern of contact surfaces 35 of this revetment in plan view. As can be seen, adjacent contact surfaces 35 lie – viewed in diagonal direction – close to each other and enclose free areas 33 of geo-textile. With the revetment block 30 of figures 11-14, the contact surfaces 35 define so to speak lattices 31 and lattices 32, which are arranged crosswise to each other in a lattice like pattern with meshes 33 defining the free parts of the geo-textile which are not in contact with the revetment blocks.

In the embodiment of Figs 11-14, there is due to 'adjacent contact surfaces lying – viewed in diagonal direction – close to each other' effectively about no distance D3, which is in Fig. 10 clearly present. In a first exemplary embodiment of Figs. 11-14, the distance D1 may be about 40 cm, the distance D2 may be about 44,5 cm, the percentage of geo-textile contacted by the contact surfaces of the revetment blocks may be in the range of 45% to 50% (i.e. percentage of the geo-textile left free from contact with revetment blocks being in the range of 50 % to 55 %), and the wingspan WS of the revetment block may be about 82 cm. These dimensions may however differ. According to a second exemplary embodiment of Figs. 11-14, the distance D1 may be about 72 cm, the distance D2 may be about 79 cm, the percentage of geo-textile contacted by the contact surfaces of the revetment blocks may be in the range of 45% to 50% (i.e. percentage of the geo-textile left free from contact with revetment blocks being in the range of 50 % to 55 %), and the wingspan WS of the revetment block may be about 145 cm. Here wingspan is defined as the distance from the right end of the right wing to the left end of the left wing.

In addition to increasing the contact surface of the revetment block, the revetment block according to the second aspect of the invention also allows the revetment blocks being large sized – like is known from WO-2018/052292 – whilst keeping the distance between adjacent contact surfaces in the range of about 40 cm to about 90 cm, such as in the range of about 40 cm to about 80 cm.

CONCLUSIES

1] Golf/water-vertragend talud voor een land-backed constructie, omvattende:

- een taludlichaam dat een taludoppervlak definieert;
- een revetêment van steenachtige revetêment-blokken op het taludoppervlak, waarbij de revetêment is geconfigureerd om een golf/water-vertragende open structuur te bieden; en
- een tussenlaag tussen het taludoppervlak en de revetêment-blokken;

waarbij het taludlichaam een sediment met een korrelgrootte van ten hoogste 2 mm omvat; en

waarbij de tussenlaag een geo-textiel omvat met een landzijdig vlak en een waterzijdig vlak, waarbij het landzijdige vlak naar het taludlichaam is gericht en het waterzijdige vlak enerzijds is blootgesteld aan openingen van de open structuur en anderzijds in contact staat met contactoppervlakken van de revetêment-blokken; en

waarbij het geo-textiel een treksterkte heeft van ten minste 80 kN/m, en een rek van ten hoogste 5%, zoals ten hoogste 3%, bij een trekbelasting van 80 kN/m.

2] Golf/water-vertragend talud volgens conclusie 1, waarbij het geo-textiel zodanig is geconfigureerd dat het de revetêment-blokken en het sediment van elkaar gescheiden houdt, terwijl het water door het geo-textiel kan passeren.

3] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij elk contactoppervlak een overeenkomstig contactgebied op het geo-textiel definieert, in welk contactgebied het geo-textiel in contact is met een revetêment-blok.

4] Golf/water-vertragend talud volgens conclusie 3, waarbij een afstand tussen aangrenzende contactoppervlakken ten hoogste ongeveer 90 cm bedraagt, zoals ten hoogste ongeveer 80 cm.

5] Golf/water-vertragend talud volgens conclusie 4, waarbij de afstand tussen aangrenzende contactoppervlakken ten minste ongeveer 30 cm, zoals ten minste ongeveer 40 cm bedraagt.

6] Golf/water-vertragend talud volgens een van de conclusies 3-5, waarbij, evenwijdig aan het taludoppervlak en in horizontale richting gezien, de contactgebieden van elk paar aangrenzende revetêment-blokken een afstand van 40-90 cm hebben, en

waarbij, evenwijdig aan het taludoppervlak en in een richting dwars op de horizontaal, de contactoppervlakken van elk paar aangrenzende revetêment-blokken een afstand van 40-90 cm hebben.

7] Golf/water-vertragend talud volgens een van de conclusies 3-6, waarbij de som van de genoemde contactoppervlakken ligt tussen ongeveer 5% en ongeveer 60%, bijvoorbeeld tussen ongeveer 5% en ongeveer 55%, van het waterzijdige vlak van het geo-textiel.

8] Golf/water-vertragend talud volgens een van de conclusies 3-7, waarbij de som van de contactoppervlakken ligt tussen ongeveer 35% en ongeveer 60%, bijvoorbeeld tussen ongeveer 40% en ongeveer 55% of tussen ongeveer 45% en ongeveer 50% van het waterzijdige vlak van het geo-textiel.

9] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij de korrelgrootte van het sediment ten hoogste 1 mm bedraagt, zoals ten hoogste 0,63 mm.

10] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij het sediment omvat een of meer van: zand, slib en klei.

11] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij de treksterkte van het geo-textiel ten minste 90 kN/m bedraagt, bijvoorbeeld ten minste 100 kN/m of ten minste 250 kN/m of ten minste 500 kN/m.

12] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij de rek van het geo-textiel ten hoogste 3% bedraagt, zoals ten hoogste 2%, bij een trekbelasting van 90 kN/m.

13] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij het geo-textiel een geo-textiel is met ingeweven glasvezels, zoals een raster van ingeweven glasvezels.

14] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij het geo-textiel een composiet is van een geo-textiellaag met een geo-grid.

15] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij het geo-textiel een versterkte spoorbaanbedscheiding is.

16] Golfslag/water-vertragend talud volgens een van de voorgaande conclusies, waarbij de tussenlaag verder een grindlaag omvat die tussen het geo-textiel en het taludoppervlak is aangebracht, waarbij de grindlaag dwars op het taludoppervlak een dikte heeft van 5-15 cm, bijvoorbeeld ongeveer 10 cm, en een korrelgrootte van 4-32 mm.

17] Golf/water-vertragend talud volgens een van de conclusies 1-15, waarbij de tussenlaag bestaat uit het geo-textiel.

18] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij het taludlichaam, dwars op het talud gezien, een dikte heeft van ten minste 0,5 meter, zoals ten minste 1 meter of ten minste 2 meter.

19] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij een genoemd revetêment-blok omvat:

- een centraal deel,
- een paar vleugels die in tegengestelde richting uitsteken vanuit het centrale deel, in horizontale richting, en evenwijdig aan het taludoppervlak,
- een neus die vanaf centrale deel uitsteekt dwars op de vleugels, in horizontale richting en weg van het taludoppervlak, en
- een staart die vanaf het centrale deel uitsteekt dwars op de vleugels, in horizontale richting en in de richting van het taludoppervlak;

waarbij de revetêment-blokken in rijen zijn gerangschikt;
waarbij in elke rij de vleugels van de revetêment-blokken op één lijn liggen;
waarbij de rijen schuin langs het talud zijn gestapeld, met een bovenste rij boven een aangrenzende onderste rij;
waarbij de neus van een revetêment-blok van de bovenste rij steunt op de uiteinden van twee uitgelijnde vleugels van aangrenzende revetêment-blokken van de onderste rij;
waarbij de staart van een genoemd revetêment-blok van de onderste rij de uiteinden van twee uitgelijnde vleugels van aangrenzende genoemde revetêment-blokken van de bovenste rij ondersteunt; en
waarbij het contactoppervlak van elk revetêment-blok is voorzien aan het eind van de staart van genoemd revetêment-blok en op het geo-textiel rust.

20] Golf/water-vertragend talud volgens conclusie 19, waarbij de contactoppervlakken die in contact komen met het geo-textiel zodanig zijn geconfigureerd dat het gedeelte van het waterzijdig vlak van het geo-textiel dat in overlap is met de contactoppervlakken een

rasterachtig patroon van kruislings geplaatste rasters vormt dat vrije gedeeltes van het waterzijdig vlak van het geo-textiel omgeeft.

21] Golf/water-vertragend talud volgens een van de conclusies 19-20, waarbij het contactoppervlak van de revetêment-blokken zodanig is geconfigureerd dat alle contactoppervlakken tesamen ongeveer 5% tot ongeveer 60%, zoals ongeveer 10% tot ongeveer 60%, van het waterzijdig vlak van het geo-textiel overlappen.

22] Golf/water-vertragend talud volgens een van de conclusies 19-21, waarbij het contactoppervlak van de revetêment-blokken zodanig is geconfigureerd dat alle contactoppervlakken tesamen ongeveer 35% tot ongeveer 60%, zoals ongeveer 40% tot ongeveer 55% of ongeveer 45% tot ongeveer 50%, van het waterzijdig vlak van het geo-textiel overlappen.

23] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij de revetêment-blokken afmetingen hebben die overeenkomen met een korrelgrootte groter dan 300 mm, zoals ten minste 500 mm.

24] Golf- en waterkerende talud volgens een van de voorgaande conclusies, waarbij de revetêment-blokken een nominale diameter hebben van 30 tot 110 cm, bijvoorbeeld ongeveer 45 cm of ongeveer 80 cm, waarbij de nominale diameter wordt gedefinieerd als de derdemachtswortel van het volume van het revetêment-blok.

25] Golf/water-vertragend talud volgens een van de voorgaande conclusies, waarbij de revetêment-blokken betonnen revetêment-blokken zijn.

26] Steenachtig revetêment-blok voor een revetêment van een golf/water-vertragend talud, zoals een steenachtig revetêment-blok geschikt voor een revetêment van een golf/water-vertragend talud volgens een van de conclusies 1-25,
waarbij het golf/water-vertragend talud, indien voorzien van een veelheid van genoemde revetêment-blokken, een taludoppervlak heeft dat bedekt is met de veelheid van genoemde revetêment-blokken, waarbij het taludoppervlak een schuine taludrichting heeft die loodrecht staat op de horizontaal;
waarbij het revetêment-blok omvat:

- een centraal gedeelte,
- een paar vleugels die in onderling tegengestelde horizontale richtingen vanaf het centrale deel uitsteken,

- een neus die, dwars op de vleugels, vanaf het centrale deel uitsteekt in horizontale voorwaartse richting, en
- een staart die, dwars op de vleugels, vanaf het centrale deel in horizontale achterwaartse richting uitsteekt;

waarbij het uiteinde van de staart is voorzien van een contactoppervlak dat zich uitstrekt onder een contactoppervlak-hoek ten opzichte van een horizontaal oppervlak gedefinieerd door i) de tegenovergestelde horizontale richtingen waarin de vleugels zich uitstrekken, door ii) de horizontale voorwaartse richting, en door iii) de horizontale achterwaartse richting;

waarbij het contactoppervlak zodanig is geconfigureerd dat,

wanneer een aantal horizontale rijen van genoemde revetêment-blokken op het taludoppervlak is geplaatst, met

- gezien langs de schuine taludrichting, een bovenste rij van genoemde horizontale rijen van revetêment-blokken geplaatst schuin boven een aangrenzende onderste rij van genoemde horizontale rijen van revetêment-blokken,
- in elke rij de vleugels van de revetêment-blokken uitgelijnd,
- de neus van een genoemd revêtment-blok van de bovenste rij steunend op de einden van twee uitgelijnde vleugels van aangrenzende revêtment-blokken van de onderste rij,
- de staart van een genoemd revêtment-blok van de onderste rij de einden van twee uitgelijnde vleugels van aangrenzende blokken van de bovenste rij ondersteunend,

de som van de contactoppervlakken van de staarten van de revetêment-blokken een waarde heeft in het bereik van 35% tot ongeveer 60% van het taludoppervlak dat door de veelheid horizontale rijen op het golfvertragend talud wordt bestreken.

27] Revetêment-blok volgens conclusie 26,

waarbij de som van de contactoppervlakken van de staarten ligt tussen ongeveer 40% en ongeveer 55% van de grootte van het taludoppervlak dat wordt bedekt door de veelheid horizontale rijen op de golf/water-vertragend talud.

28] Revetêment-blok volgens een van de conclusies 26-27,

waarbij de som van de contactoppervlakken van de staarten ligt tussen ongeveer 45% en ongeveer 50% van de grootte van het taludoppervlak dat wordt bedekt door de veelheid horizontale rijen op de golfvertragend talud.

29] Revetêment-blok volgens een van de conclusies 26-28,

waarbij, evenwijdig aan het taludoppervlak en in horizontale richting gezien, de contactoppervlakken van elk paar aangrenzende revetêment-blokken een afstand hebben van 40-90 cm, bijvoorbeeld 40-80 cm, en
waarbij, evenwijdifg aan het taludoppervlak en in een richting dwars op de horizontaal gezien, de contactoppervlakken van elk paar aangrenzende revetêment-blokken een afstand hebben van 40-90 cm, zoals 40-80 cm.

30] Revetêment-blok volgens een van de conclusies 26-29,
waarbij de contactoppervlak-hoek ligt tussen ongeveer 18° en ongeveer 33°, bijvoorbeeld tussen ongeveer 20° en ongeveer 28°.

31] Revetêment-blok volgens een van de conclusies 26-30,
waarbij het taludoppervlak een taludhoek ten opzichte van een horizontaal vlak bepaalt, en
waarbij de contactoppervlakhoek ongeveer de taludhoek is.

32] Revetêment-blok volgens een van de conclusies 26-31,
waarbij het revetêment-blok een betonnen revetêment-blok is.

33] Gebruik van een versterkte spoorbaanbedscheiding in een taludlichaam als tussenlaag tussen een revetêment van revetêment-blokken met afmetingen die overeenkomen met een korrelgrootte groter dan 300 mm, zoals ten minste 500 mm, en een taludlichaam van een sediment met een korrelgrootte van ten hoogste 2 mm, zoals ten hoogste 1 mm.

34] Gebruik volgens conclusie 20, waarbij de versterkte spoorbaanbedafscheiding een geo-textiel omvat met de kenmerken van het geo-textiel van een of meer van de conclusies 1, 2, 11, 12, 13, 14, 15.

35] Werkwijze voor het maken van een golf/water-vertragend talud, bestaande uit de stappen:

a) het verschaffen van een taludlichaam met een sediment met een korrelgrootte van ten hoogste 2 mm, waarbij het taludlichaam een taludoppervlak definieert;
b) het aanbrengen van een tussenlaag met een geo-textiel langs het taludoppervlak, waarbij het geo-textiel een landzijdig vlak en waterzijdig vlak heeft, waarbij het landzijdige vlak is gekeerd naar het taludoppervlak en eventueel gelijkligt met het taludoppervlak, en het waterzijdig vlak is gejeerd in een richting tegenovergesteld aan het taludoppervlak;

c) het op het waterzijdige vlak van het geo-textiel plaatsen van een revetêment van steenachtige revetêment-blokken, zoals betonnen revetêment-blokken, waarvan de afmetingen overeenkomen met een korrelgrootte van ten minste 300 mm, bijvoorbeeld ten minste 500 mm; en

waarbij het geo-textiel een treksterkte heeft van ten minste 80 kN/m, en een rek van ten hoogste 5% bij een trekbelasting van 80 kN/m.

36] Werkwijze volgens conclusie 35, waarbij het geo-textiel zodanig is geconfigureerd dat het sediment en de revetêment-blokken van elkaar gescheiden blijven, terwijl het water door het geo-textiel kan passeren.

37] Werkwijze volgens conclusie 35 of 36, verder gekenmerkt door een of meer van de volgende maatregelen:

- elk contactoppervlak definieert een contactgebied definieert, en de contactgebieden zijn zoals gedefinieerd in een of meer van de conclusies 4-8;

en/of

- het sediment is een sediment als gedefinieerd in een of meer van de conclusies 9-10;

en/of

- het geo-textiel is een geo-textiel als gedefinieerd in een of meer van de conclusies 11-15;

en/of

- de tussenlaag is een tussenlaag als gedefinieerd in een of meer van de conclusies 16-17;

en/of

- het hellend lichaam is een hellend lichaam als gedefinieersd in conclusie 18;

en/of

- de revetêment-blokken zijn revetêment-blokken als gedefinieerd in de eerste "waarbij" van conclusie 19 en/of als gedefinieerd in een of meer van de conclusies 20-25;

en/of

- de revêtment-blokken zijn revêtment-blokken volgens een van de conclusies 26-32;

en/of

- de stap van het plaatsen van de revetêment omvat het plaatsen de revetêment-blokken in een opstelling als gedefinieerd in de tweede "waarbij" tot en met de laatste "waarbij" van conclusie 19;

en/of

- de stap van het aanbrengen van de tussenlaag omvat een eerste sub-stap van het aanbrengen van een grindlaag op het taludlichaam, gevolgd door een tweede sub-stap van het aanbrengen van het geo-textiel op de grindlaag.

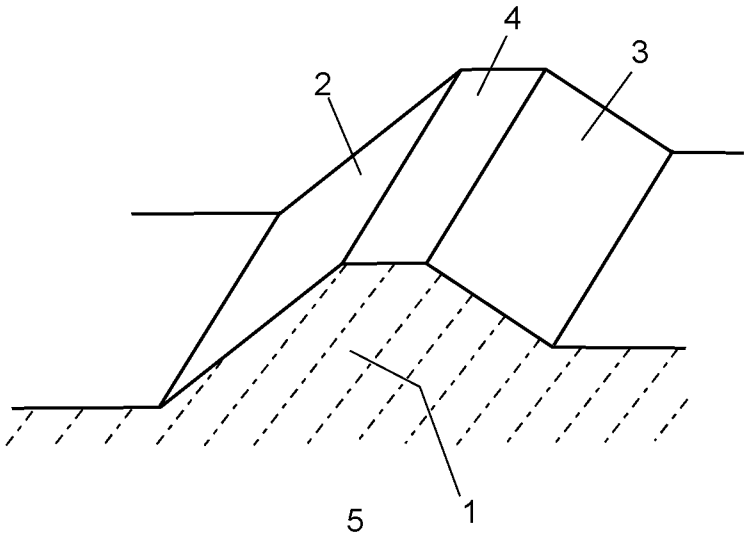

Fig. 1A

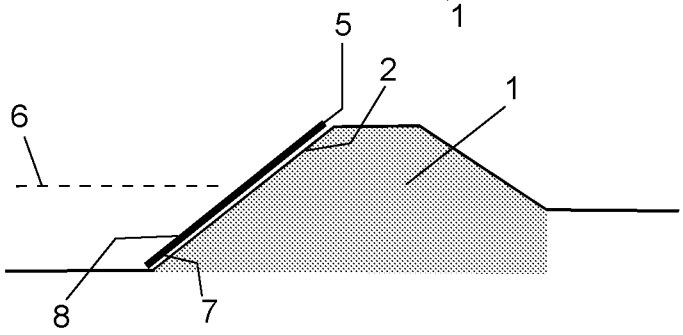

Fig. 1B

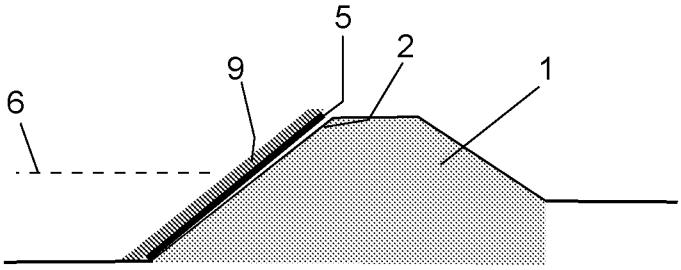

Fig. 1C

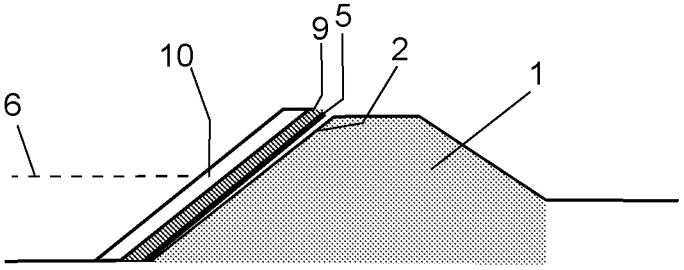

Fig. 1D

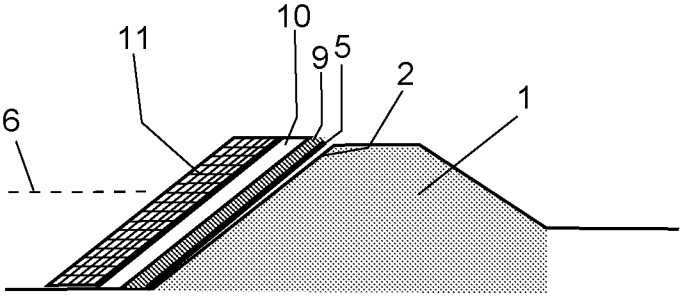

Fig. 1E

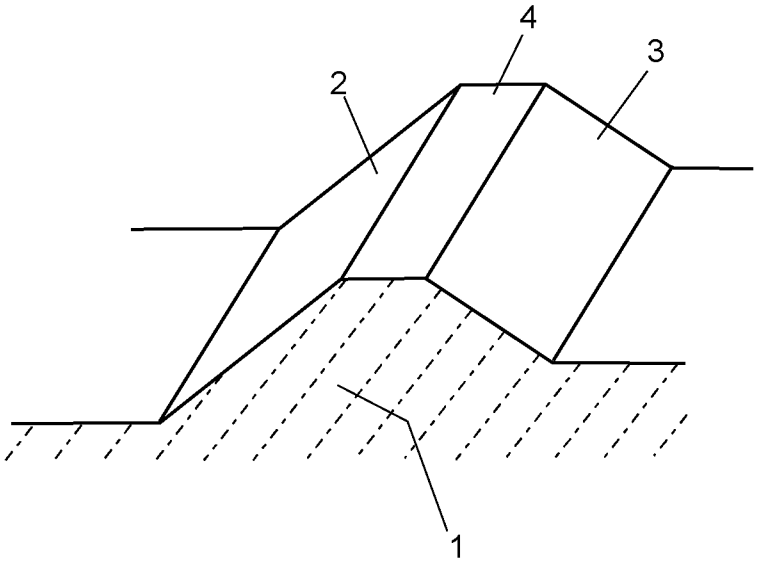

Fig. 2A

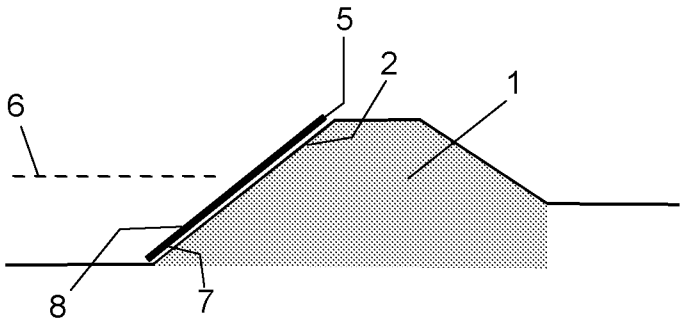

Fig. 2B

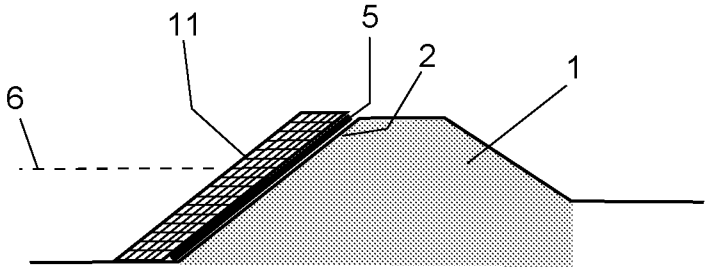

Fig. 2C

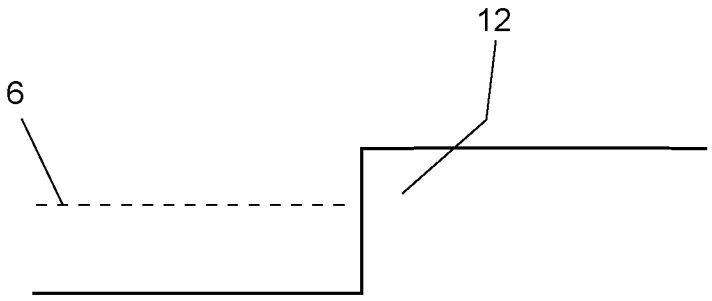

Fig. 3A

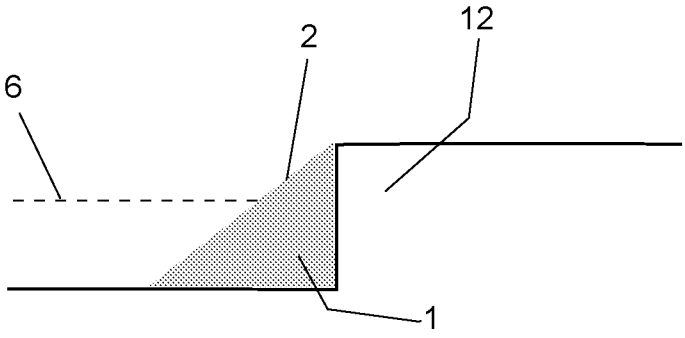

Fig. 3B

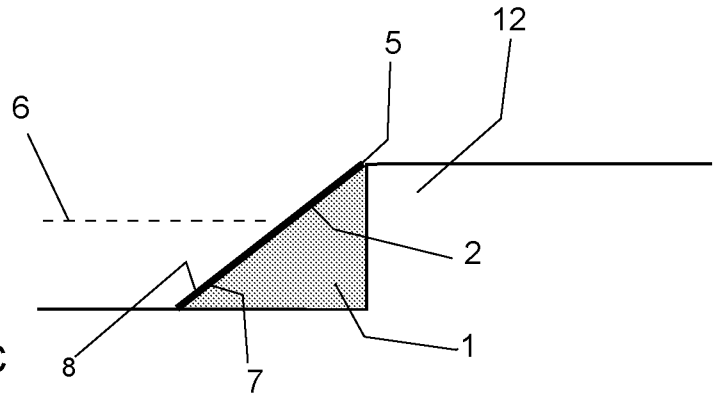

Fig. 3C

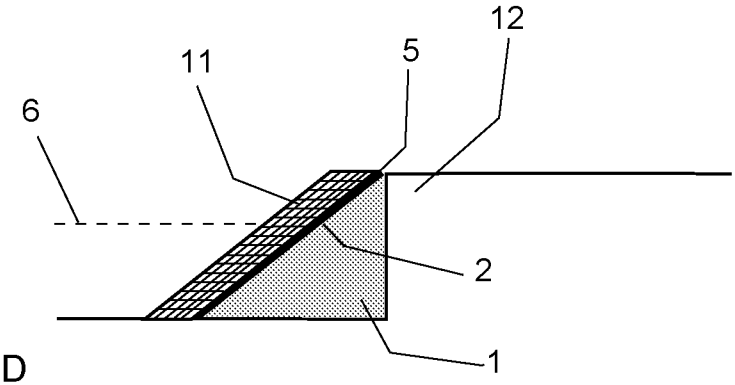

Fig. 3D

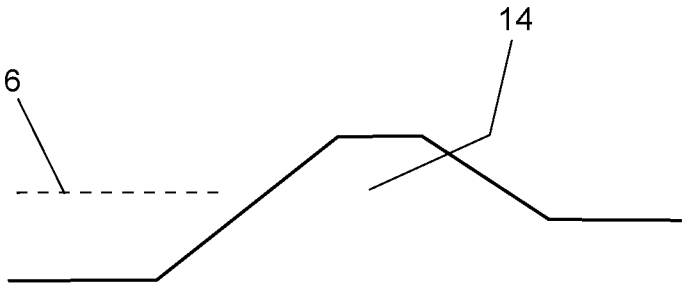

Fig. 4A

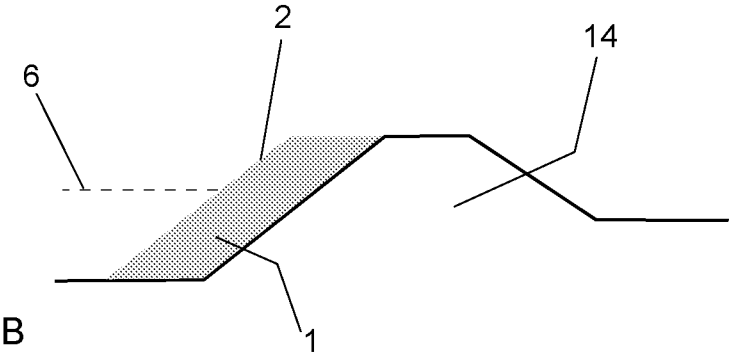

Fig. 4B

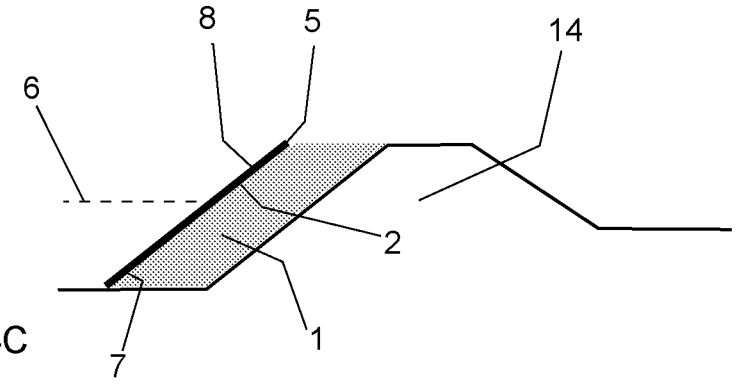

Fig. 4C

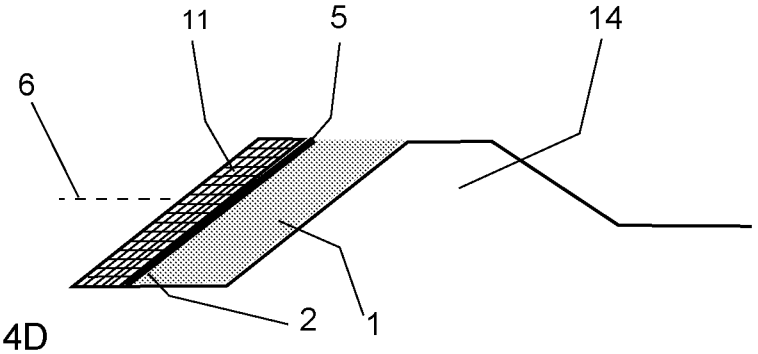

Fig. 4D

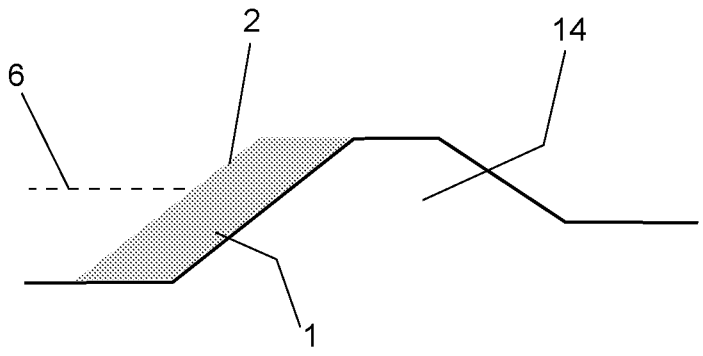

Fig. 5B

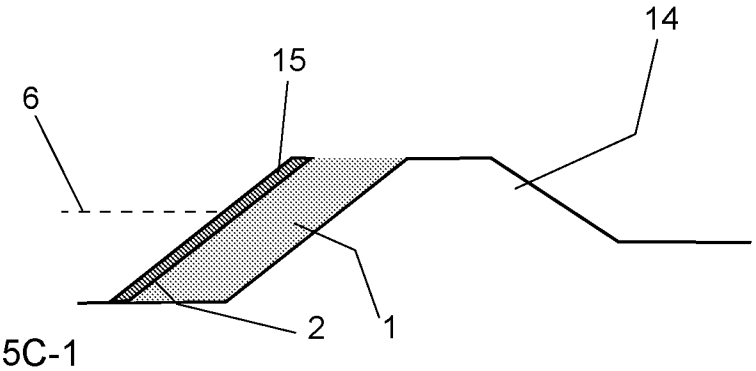

Fig. 5C-1

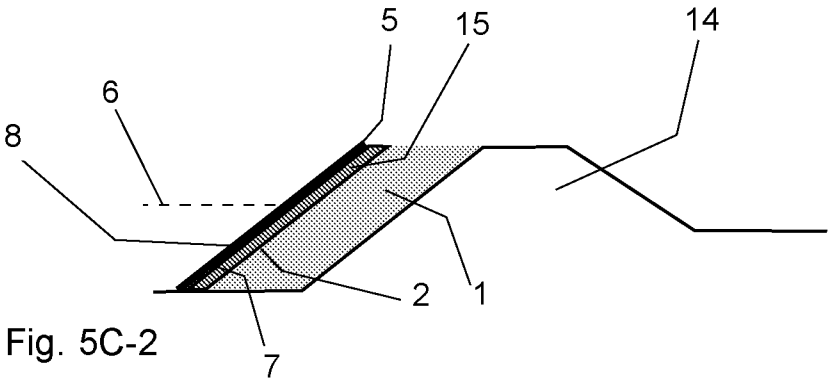

Fig. 5C-2

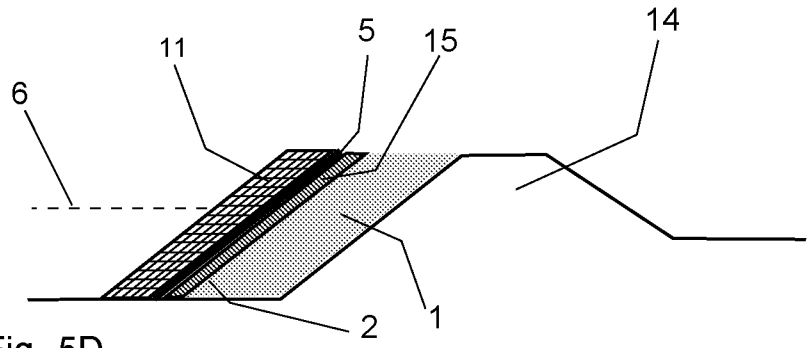

Fig. 5D

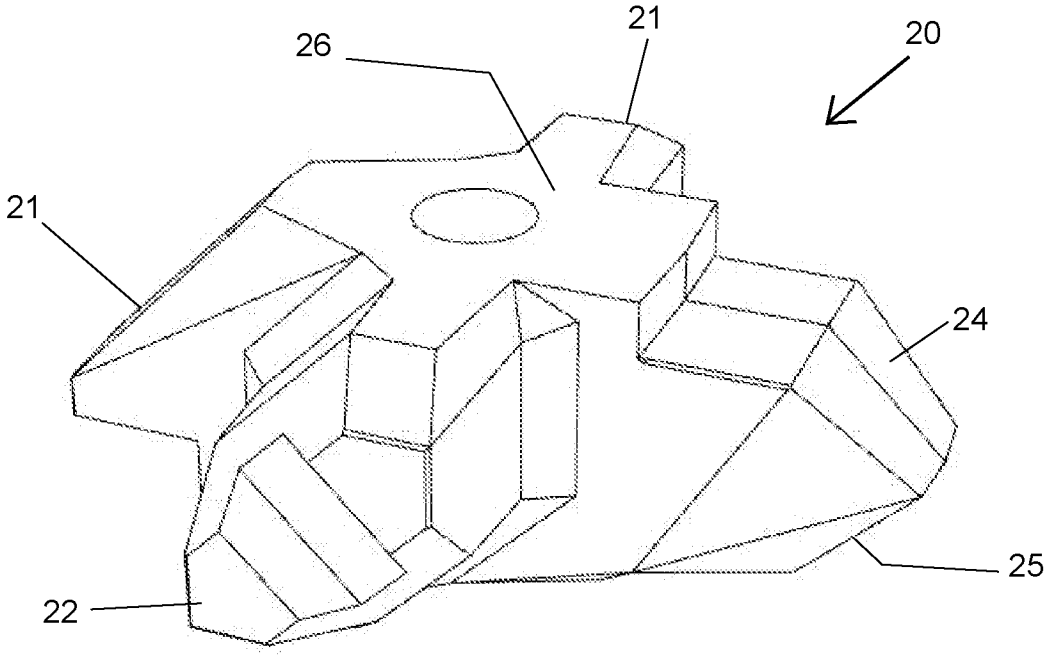

Fig. 6

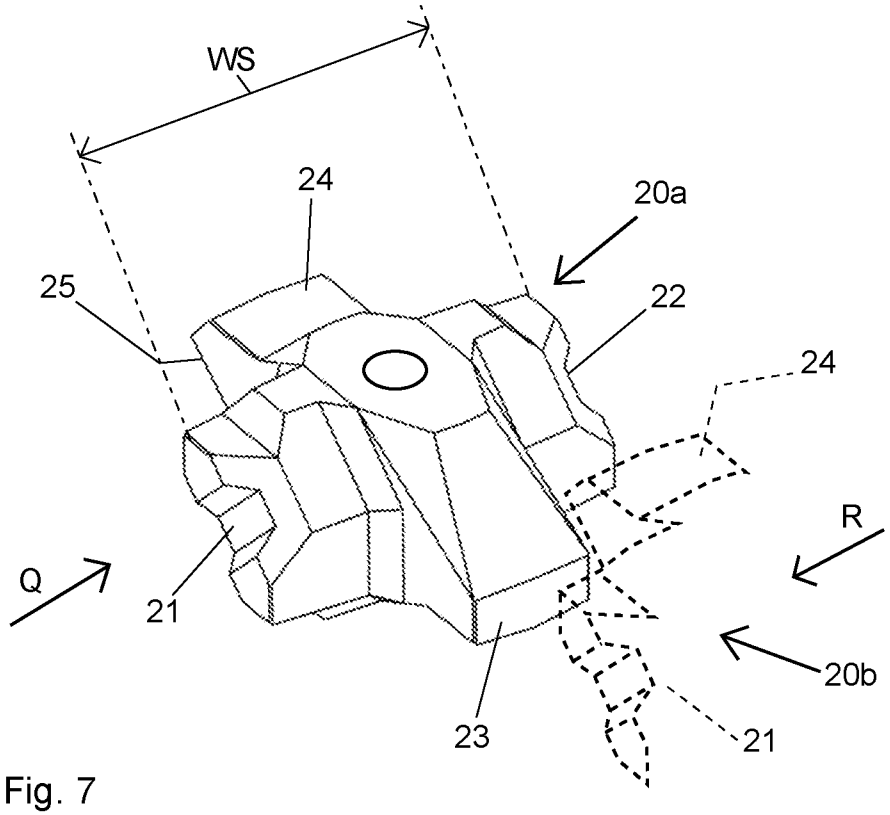

Fig. 7

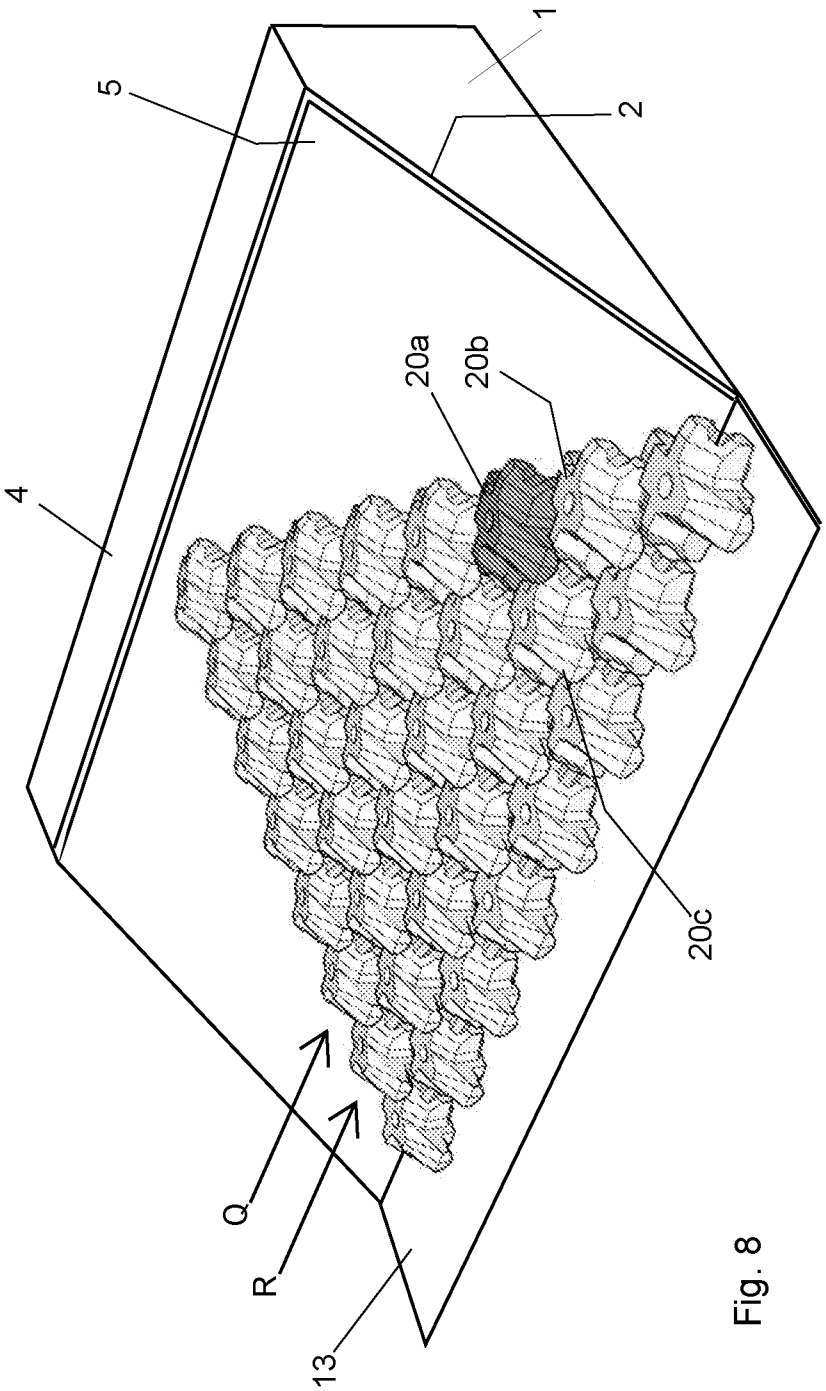

Fig. 8

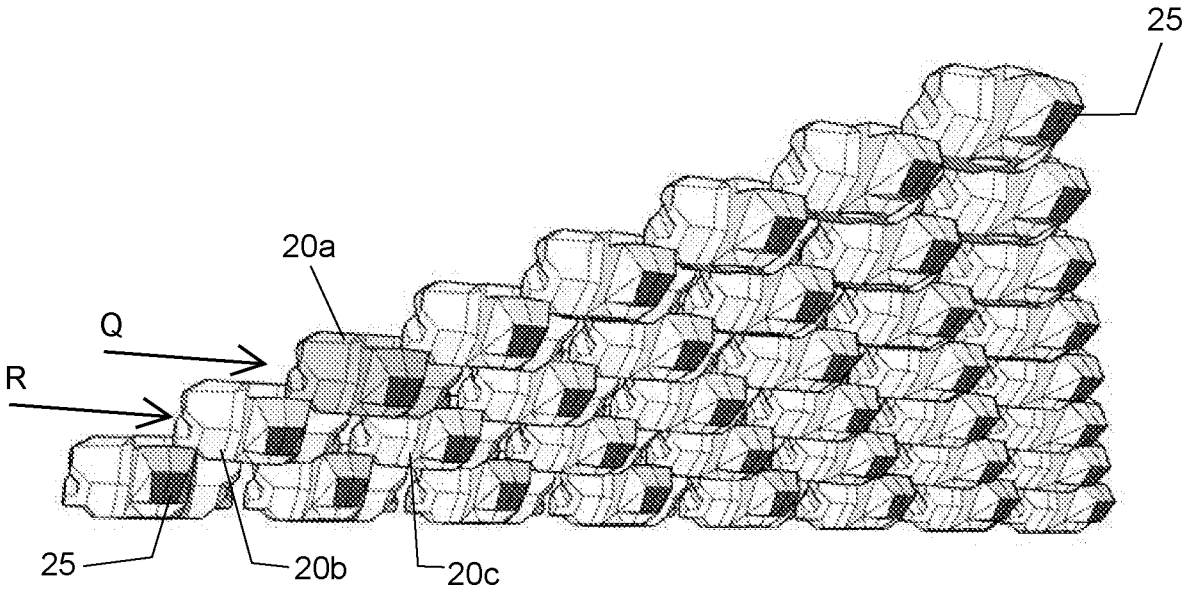

Fig. 9

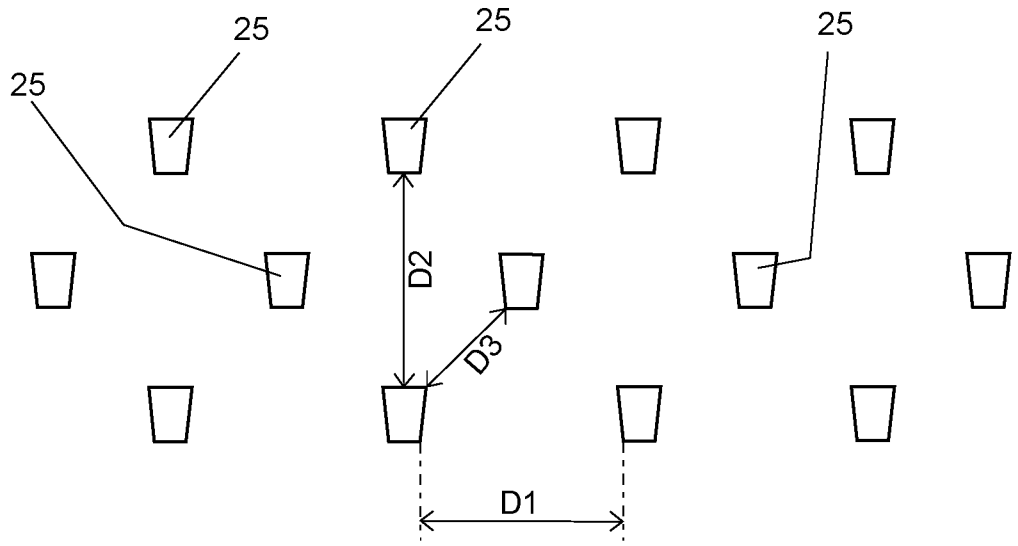

Fig. 10

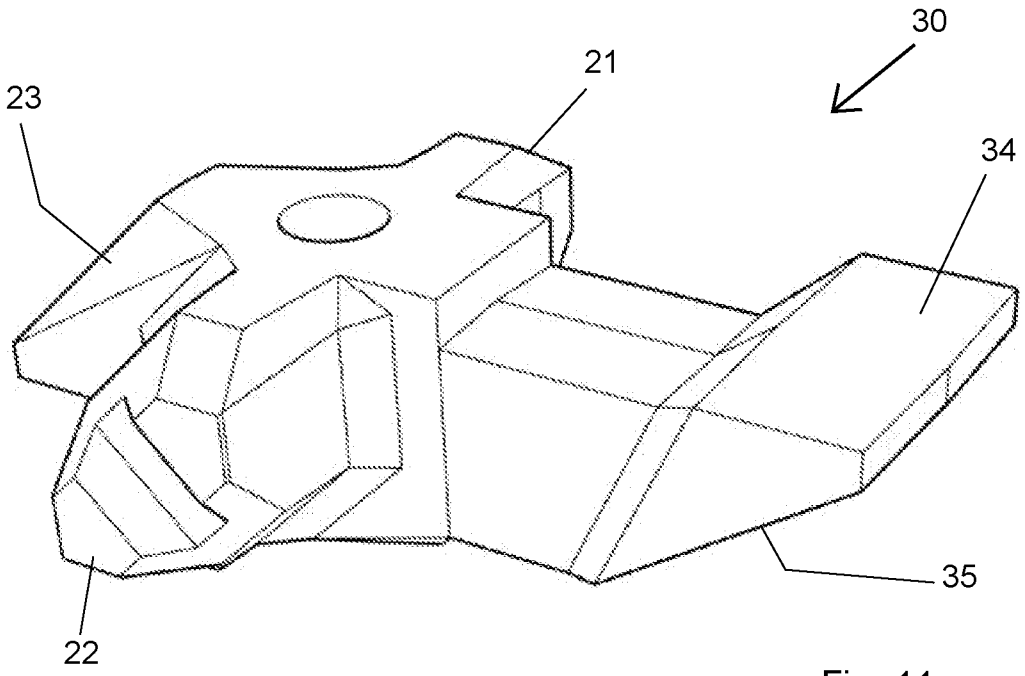

Fig. 11

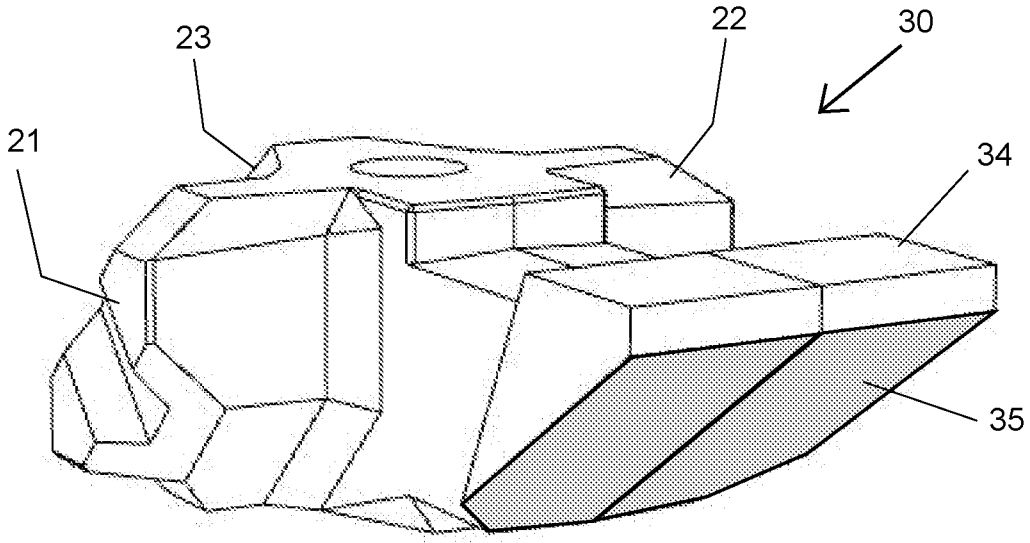

Fig. 12

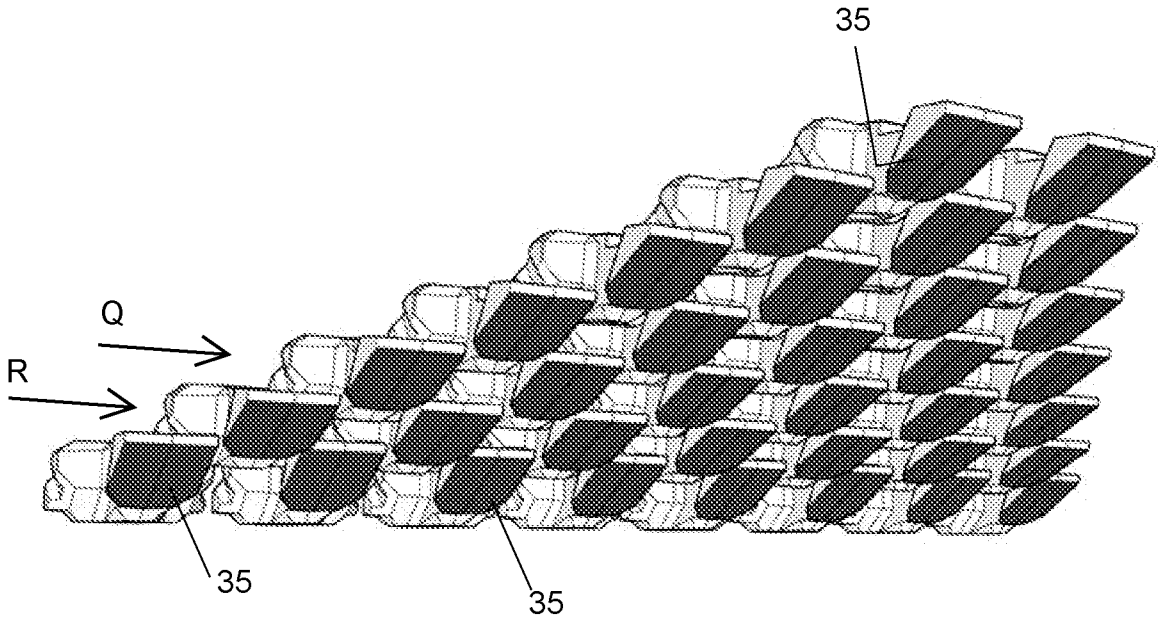

Fig. 13

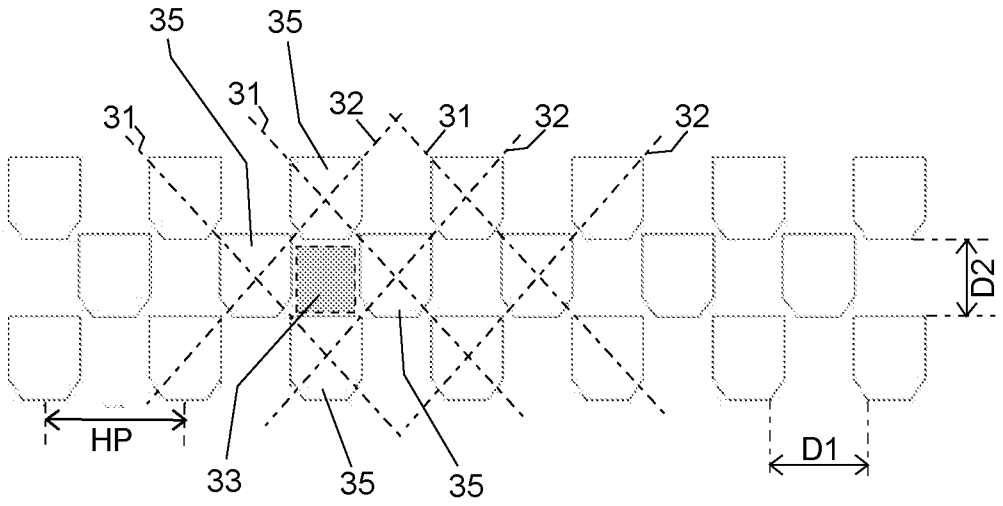

Fig. 14

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
Nederlands aanvraag nr. **2034112**	Indieningsdatum **08-02-2023**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Koninklijke BAM Groep N.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **25-03-2023**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN83508**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

Zie onderzoeksrapport

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**Zie onderzoeksrapport**

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

III.		**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	**X**	**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 2034112

A. CLASSIFICATIE VAN HET ONDERWERP
INV. E02B3/10 E02B3/12 E02B3/14
ADD.

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

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
E02B E01B E02D

Onderzochte andere documentatie dan de mimimum 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

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
	EENHEID VAN UITVINDING ONTBREEKT **zie aanvullingsblad B** **-----**	
X	**DE 24 33 031 A1 (KOENIG HINRICH)** **22 januari 1976 (1976-01-22)** *** bladzijde 3, regel 13 - bladzijde 5,** **laatste regel; figuren 1-4 *** **-----**	**1-25,** **35-37**
A	**EP 1 464 760 A2 (GRAUL NIKLAS-SIMON** **DIPL-MED [DE]) 6 oktober 2004 (2004-10-06)** *** alineas [0015], [0017]; figuren 1-4 *** **-----**	**1,13**
	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie 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 octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), 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 octrooiaanvrage, 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

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
4 augustus 2023	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	**Zuurveld, Gerben**

1

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 2034112

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	CN 111 962 471 A (CCCC WATER RESOURCES AND HYDROPOWER CONSTRUCTION CO LTD) 20 november 2020 (2020-11-20) * See: "The installation steps of precast concrete blocks should be implemented after the settlement and deformation of the embankment body have reached a basic stability. In the construction method of the artificial lake enclosure, the geotextile at the bottom of the embankment is 120 kN/m woven geotextile; the slope protection geotextile is 60 kN/m woven geotextile."; figuren 1-3b *	1-25, 35-37

GEBREK AAN EENHEID VAN UITVINDING

Octrooiaanvrage Nr.:
SN 83508
NL 2034112

AANVULLINGSBLAD B

De Instantie belast met het uitvoeren van het onderzoek naar de stand van de techniek heeft vastgesteld dat deze aanvrage meerdere uitvindingen bevat, te weten:

1. conclusies: 1-25, 35-37

   Golf/water-vertragend talud en werkwijze voor het maken van een golf/water-vertragend talud

   ---

2. conclusies: 26-32

   Steenachtig revetêment-blok

   ---

3. conclusies: 33, 34

   Gebruik van een versterkte spoorbaanbedscheiding in een taludlichaam

   ---

Het vooronderzoek werd tot het eerste onderwerp beperkt.

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 2034112

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
DE 2433031 A1	22-01-1976	GEEN	
EP 1464760 A2	06-10-2004	DE 10313974 A1	14-10-2004
		EP 1464760 A2	06-10-2004
CN 111962471 A	20-11-2020	GEEN	

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN83508	08.02.2023		NL2034112

International Patent Classification (IPC)
INV. E02B3/10 E02B3/12 E02B3/14

Applicant
Koninklijke BAM Groep N.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
	Zuurveld, Gerben

Application number

WRITTEN OPINION

NL2034112

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, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the application as filed.

   b. ☐ furnished subsequent to the filing date for the purposes of search,

      ☐ accompanied by a statement to the effect that the sequence listing does not go beyond the disclosure in the application as filed.

3. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the application, this opinion has been established to the extent that a meaningful opinion could be formed without a WIPO Standard ST.26 compliant sequence listing.

4. Additional comments:

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step, or to be industrially applicable have not been examined in respect of

☐ the entire application

☒ claims Nos. 26-34

because:

☐ the said application, or the said claims Nos. relate to the following subject matter which does not require a search *(specify)*:

☐ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. are so unclear that no meaningful opinion could be formed *(specify)*:

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed *(specify)*:

☒ no search report has been established for the whole application or for said claims Nos. 26-34

☐ a meaningful opinion could not be formed without the sequence listing; the applicant did not furnish a sequence listing complying with WIPO Standard ST.26.

☐ See Supplemental Box for further details.

WRITTEN OPINION

Box No. IV Lack of unity of invention

1. The requirement of unity of invention is not complied with for the following reasons:

   see separate sheet

2. This report has been established in respect of the following parts of the application:

   ☐ all parts.

   ☒ the parts relating to claims Nos. (see Search Report)

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	1-25, 35-37
	No:	Claims	
Inventive step	Yes:	Claims	
	No:	Claims	1-25, 35-37
Industrial applicability	Yes:	Claims	1-25, 35-37
	No:	Claims	

2. Citations and explanations

   see separate sheet

Box No. VII Certain defects in the application

see separate sheet

Re Item IV

Lack of unity of invention

1 It is considered that there are three (potential) inventions covered by the claims indicated as follows:

I: claims 1 to 25, and 35 to 37, directed to a "golf/water-vertragend talud en werkwijze voor het maken van een golf/water-vertragend talud";

II: claims 26 to 32, directed to a “steenachtig revetêment-blok"; and

III: claims 33 and 34, directed to a “gebruik van een versterkte spoorbaanbedscheiding in een taludlichaam”.

2 The reasons for which the (potential) inventions are not so linked as to form a single general inventive concept, are as follows.

2.1 There appears to be no common concept linking together these separate (potential) inventions, as they have no features in common:

- independent claim 1 defines a “golf/water-vertragend talud voor een land-backed constructive” with its particular features;

- independent claim 26 defines a “steenachtig revetêment-blok” with its particular features, the “blok” being suitable for a “revetêment van een golf/ water-vertragend talud”, but it does not define the “talud” of claim 1 itself; and

- independent claim 33 defines “gebruik van een versterkte spoorbaanbedscheiding in een taludlichaam als tussenlaag” in combination with particular features of the “revetêment” and the “taludlichaam”.

2.2 However, a feature which is mentioned in these three independent claims is a “talud” or “taludlichaam”. This feature is therefore considered to form the common concept.

2.3 Of course a “talud” or “taludlichaam” is known from the prior art, see for instance document WO2018052292, which is cited in the application.

3 Starting from the common concept, (potential) invention I comprises the features of claim 1, being (see claim 1):

“Golf/water-vertragend talud voor een land-backed constructie, omvattende:

- een taludlichaam dat een taludoppervlak definieert;

- een revetêment van steenachtige revetêment-blokken op het taludoppervlak, waarbij de revetêment is geconfigureerd om een golf/ water-vertragende open structuur te bieden; en

- een tussenlaag tussen het taludoppervlak en de revetêment-blokken; waarbij het taludlichaam een sediment met een korrelgrootte van ten hoogste 2 mm omvat;

en waarbij de tussenlaag een geo-textiel omvat met een landzijdig vlak en een waterzijdig vlak, waarbij het landzijdige vlak naar het taludlichaam is gericht en het waterzijdige vlak enerzijds is blootgesteld aan openingen van de open structuur en anderzijds in contact staat met contactoppervlakken van de revetêment-blokken;

en waarbij het geo-textiel een treksterkte heeft van ten minste 80 kN/m, en een rek van ten hoogste 5%, zoals ten hoogste 3%, bij een trekbelasting van 80 kN/m."

3.1 These features are related to the solution of the problem of how to build a "golf/water-vertragend talud" with "een taludlichaam", "een revetêment van steenachtige revetêment-blokken", and "een tussenlaag tussen het taludoppervlak en de revetêment-blokken".

4 (Potential) invention II comprises the following (additional) features of independent claim 26, being (see claim 26):

"Steenachtig revetêment-blok voor een revetêment van een golf/water-vertragend talud, zoals een steenachtig revetêment-blok geschikt voor een revetêment van een golf/water-vertragend talud volgens een van de conclusies 1-25, waarbij het golf/water-vertragend talud… …de staart van een genoemd revêtment-blok van de onderste rij de einden van twee uitgelijnde vleugels van aangrenzende blokken van de bovenste rij ondersteunend, de som van de contactoppervlakken van de staarten van de revetêment-blokken een waarde heeft in het bereik van 35% tot ongeveer 60% van het taludoppervlak dat door de veelheid horizontale rijen op het golfvertragend talud wordt bestreken."

4.1 These features are related to the solution of the problem of how to build a "revetêment-blok" with particular features.

5 (Potential) invention III comprises the following (additional) features of independent claim 33, being (see claim 33):

"Gebruik van een versterkte spoorbaanbedscheiding in een taludlichaam als tussenlaag tussen een revetêment van revetêment-blokken met afmetingen die overeenkomen met een korrelgrootte groter dan 300 mm, zoals ten minste 500 mm, en een taludlichaam van een sediment met een korrelgrootte van ten hoogste 2 mm, zoals ten hoogste 1 mm."

5.1 These features are related to the solution of the problem of how to use a "versterkte spoorbaanbedscheiding in een taludlichaam als tussenlaag".

6 Consequently, the features of (potential) inventions I, II, and III, which make a technical contribution over the common concept are different.

As the problems they solve are also different, these features are not corresponding either.

7 Claims 2 to 25, and 35 to 37 are considered to be part of (potential) invention I, as they are (directly or indirectly) dependent on independent claim 1, and/or related to the same problem.

Claims 27 to 32 are considered to be part of (potential) invention II, as they are (directly or indirectly) dependent on independent claim 26, and/or related to the same problem.

Claim 34 is seen as part of (potential) invention III, as it is considered dependent on independent claim 33, although it refers (erroneously) to claim 20.

Re Item V

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

1 **Cited prior art**

1.1 Reference is made to the following documents:

D1	DE 24 33 031 A1 (KOENIG HINRICH) 22 januari 1976 (1976-01-22)
D2	EP 1 464 760 A2 (GRAUL NIKLAS-SIMON DIPL-MED [DE]) 6 oktober 2004 (2004-10-06)
D3	CN 111 962 471 A (CCCC WATER RESOURCES AND HYDROPOWER CONSTRUCTION CO LTD) 20 november 2020 (2020-11-20)

2 **Novelty and inventive step**

2.1 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 does not involve an inventive step.

2.2 Document D1 may be regarded as being the prior art closest to the subject-matter of claim 1, and discloses, see the cited passages in the search report:

een golf/water-vertragend talud voor een land-backed constructie, omvattende:
- een taludlichaam dat een taludoppervlak definieert (see figure 1 and page 4, point a): "Boschungsneigung");

- een revetêment van steenachtige revetêment-blokken (7) op het taludoppervlak, waarbij de revetément is geconfigureerd om een golf/ water-vertragende open structuur te bieden; en

- een tussenlaag (4) tussen het taludoppervlak en de revetêment-blokken; waarbij het taludlichaam een sediment met een korrelgrootte van ten hoogste 2 mm omvat (see page 4, point c): "bindige Böden", this is equivalent to a maximum diameter of 0,63 mm, see also claim 9 of the application);

en waarbij de tussenlaag een geo-textiel omvat met een landzijdig vlak en een waterzijdig vlak (see page 4, point c): "Kunststoff-Filtervlies"), waarbij het landzijdige vlak naar het taludlichaam is gericht en het waterzijdige vlak enerzijds is blootgesteld aan openingen van de open structuur en anderzijds in contact staat met contactoppervlakken van de revetêment-blokken (see figure 1).

2.3 The subject-matter of claim1 therefore differs from this known "talud" in that

"waarbij het geo-textiel een treksterkte heeft van ten minste 80 kN/m, en een rek van ten hoogste 5%, zoals ten hoogste 3%, bij een trekbelasting van 80 kN/m."

The subject-matter of claim 1 is therefore novel.

2.4 The problem to be solved by the present invention may therefore be regarded as providing a more resistant "geo-textiel".

2.5 The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step, because the skilled person, looking for an appropriate geo-textile for a given location, will always choose the properties of the geo-textile such that they will fit the requirements according to circumstances.

Therefore, if need be, the skilled person would choose a stronger geo-textile than the one disclosed in D1 with parameters falling into the claimed ranges.

Such geo-textiles are commonly known, see in particular the description of the application, see page 5, lines 17 to 19:

"ii) for this purpose known geo-textiles of - compared to what is known in the field of geotextiles - relatively moderate strength are already suitable."

See also document D3, and in particular the cited passage in the annexed machine translation into English, which discloses already the use of a geo-textile with a tensile strength falling into the claimed range:

"In the construction method of the artificial lake enclosure, the geotextile at the bottom of the embankment is 120 kN/m woven geotextile; the slope protection geotextile is 60 kN/m woven geotextile."

2.6 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent method claim 35, which therefore is also considered not involving an inventive step

2.7 In view of documents D1 to D3, the features of dependent claims 2 to 25, 36, and 37 form merely some of several straightforward and/or already known possibilities from which the skilled person would select, in accordance with circumstances, without the exercise of inventive skill.

Consequently, the subject-matter of dependent claims 2 to 25, 36, and 37 does not involve an inventive step.

Re Item VII

Certain defects in the application

1 The features of all the claims should have been provided with reference signs placed in parentheses.

2 The relevant background art disclosed in the cited prior art documents is not mentioned in the description, nor are these documents identified therein.