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(54) **Drainage system providing damping properties**

(57) The present invention relates to a drainage mat system with built-in damping and anti-fatigue properties and improved drainage behaviour, the process for manufacturing of such system and the use of such system.

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Description

[0001] The present invention relates to a drainage mat system with built-in damping and anti-fatigue properties and improved drainage behaviour, the process for preparation of such system and the use of such system.

[0002] Drainage systems for mainly outdoor application in sports and leisure (e.g. turf, artificial turf, sports tracks, athletic grounds, slopes, playgrounds etc.) and building and construction (flat and green roofing, draining counterpart to irrigation, such as in greenhouses etc.) have been improved over the last decades, but mainly still are designed and applied in a classical or traditional manner, i.e. by constructions using pin holes in the upper construction and/or the support (CA 1150958), mostly in combination with pipe and/or ditch systems (DE 3911690, JP 58207412, KR 102007112286, US 20070137017).

[0003] These systems are mainly supported by underlay or infill consisting of granulated matter, such as gravel, draining asphalt concrete (JP 2009257055, JP 4203002, KR 102008095553, KR 100903808, KR 100869292), or combinations thereof (JP 62178602US 20060115328). Some attempts have been made to improve the draining properties e.g. by creating a mat-like material out of fibres (JP 9164617, JP 5148827; combined with classic pipe systems in JP 7331640), or by applying thermoplastic resin based materials (mainly PE, as in JP 8135157, KR 102008019194; with drain holes in JP 5272110, JP 59072302, KR102005011423; with ripples in JP 59059120; from PVC with drain holes in JP 2195910).

[0004] However, all those solutions only have influence on the draining behaviour and will not provide any additional effect possibly being desired in the final application. By using special constructions some elastic properties are said to be achieved by combining thermoplastics with stabilizing layers (KR 102008075350, using EVA, PE, PP), or by trying to apply PE foam as a layer providing some damping, but drainage again is achieved by additional efforts (US 7166340). Rubber has only found limited use in the field of application despite of its potential for damping: one document mentions the respective use of -solid, not expanded-rubber mat, but together with separate ditches providing the drainage (JP 5163705). Another document (DE 2065209) uses rubber bitumen granules in combination with gravel and resin, and DE 19521944 and US 20030177799 claim the use of waste rubber in a way that water can permeate through. The main purpose of rubber, however, was considered to be infill, as in US 20070137017, US 7147401, CA 2247484 and WO 2001037657, where the drainage is provided by combination of the ground rubber infill and a classic underlay system. Alternatively, as in US 20050048225, rubber infill is combined with an impact layer also containing rubber particles. Those solutions are able to provide at least some damping effect in addition to an acceptable drainage function. However, they all lack of both outstanding anti-fatigue and draining properties as well as of easy application and use as they are based on particles, and as those particles being made from solid, thus rather rigid, rubber.

[0005] A major object of the present invention thus is to provide a system or material not showing the above mentioned deficiencies but exhibiting easy, i.e. economic and ecologic, manufacturing and handling/mounting/application, showing excellent drainage effect and a high level of built-in damping ability leading to anti-stress and anti-fatigue properties.

[0006] Surprisingly, it is found that such system or material not showing the above mentioned disadvantages can be obtained as a whole underlay mat directly from elastomeric and/or thermoplastic elastomer and/or sufficiently elastic thermoplastic and/or thermoset compounds by expanding and crosslinking the compound and applying well-matched pin hole patterns and surface structures on the mat.

[0007] The claimed material comprises at least one layer (A), which is made from an expanded elastomer and/or thermoplastic elastomer and/or thermoplastic and/or thermoset based polymer mixture, or combinations thereof, which is preferably crosslinked to improve mechanical and wear properties. The polymer mixture is expanded by physical and/or chemical expansion agents to an open cell sponge or closed cell foam, depending on the required damping and drainage properties. The polymer mixture may contain fillers, such as oxides, carbonates, hydroxides, carbon blacks, recycled (ground) rubber, other recycled polymer based materials, fibers etc., and additives, such as flame retardants, biocides, plasticizers, stabilizers, colors etc., of any kind in any ratio. The polymer mixture may be crosslinked by any applicable mean of crosslinking, such as sulphur, peroxide, radiation, bisphenolics, metal oxides etc. (A) can show low densities if applied as underlay mat, but also can be compounded and expanded to densities higher than water to prevent floating if applied without covering, support or loading. It is found that (A) provides damping already if an elastic modulus (E-modulus) below 5 is achieved, allowing to use various combinations of polymer based compounds and various combinations of layers (A) made thereof.

[0008] The claimed material comprises a set of pin holes (B) in layer (A). The pin holes can be applied in a wide variety of size and pattern, however, it is found that the pin holes are preferably applied in a size not smaller than 0.1" (0.25 cm), especially preferred in a size bigger than 0.2" (0.5 cm); it is also found that the preferred distance of the pin holes is at least 1" (2.5 cm), especially preferred at least 2.5" (6.35 cm). The pin holes (B) can be brought into (A) directly when manufacturing in a molding process by fixing pins in the mold accordingly, or by perforating them into (A) e.g. after extrusion by pins or round knives or the like. The pin holes (B) not only do provide good drainage effect, but also will contribute to the damping properties by slightly "softening" the mat (see table 1).

[0009] The claimed material furthermore comprises a surface structure (C) on either one or both sides of (A) which is

characterized by ripples or ridges or grooves. The structure can be of round (sinus like) and/or triangular and/or trapezoidal and/or rectangular shape. It can be integrated into the material (A) by applying the structure (C) e.g. in a mold when manufactured by molding, or by using a respective die shape when manufacturing by extrusion, or by embossing the respective structure (C) into (A). The surface structure (C) will ensure that water will be rapidly transported to the pin holes (B) if the structure can be found on the top side of (A), or structure (C) will ensure that water will be drained away from the pin holes when being applied on the bottom side of (A), or both effects may be combined. Table 2 shows the significantly better drainage properties of pin hole/ridge systems in comparison to pin hole only systems. The surface structure will also slightly contribute to the damping properties.

[0010] The claimed material furthermore may comprise additional layers (D) providing additional drainage and/or damping and/or other properties, such as reinforcement, impact resistance etc. The layers (D) can e.g. comprise fibres or nonwoven, wire mesh, resin sheet etc. of any kind. Layers (D) can be fixed to (A) by mechanical or chemical means or being in contact only. If (D) is applied as directly connected surface layer the composite may be used not only as underlay mat, but in direct exposure, means, as e.g. a playground or sports or roof mat without turf or soil covering.

[0011] It is a prominent advantage of the claimed material that it is providing excellent draining effect due to its composition and structure and that it additionally provides anti-fatigue and protection properties due to its composition.

[0012] Another basic advantage of the claimed material is the fact that its drainage and damping properties are very constant over a wide temperature range leading to the fact that its playability and "feel" remain unchanged no matter if it is used in summer or winter.

[0013] It is a further advantage of the claimed material that its composition will allow to add any desired additives beneficial for the intended application, such as UV stabilizers, biocides (e.g. for preventing mold growth), absorbers (e.g. scavengers for odor, harmful substances etc. to protect the environment) etc.

[0014] It is another advantage of the claimed material that it is environmental friendly itself as it does not comprise or release harmful substances, does not affect water or soil and as it is recyclable by grinding and then can be used as infill or filler for another mat.

[0015] A resulting advantage of the material is the fact that it can be blended or filled with or can contain scrapped or recycled material of the same kind to a very high extent not losing relevant properties significantly.

[0016] It is another advantage of the claimed material that its expanded structure provides insulation properties, thus, it is beneficial for insulating turf or other substrates from the cold or warm soil or by supporting turf heating systems by insulating them against the ground, too.

[0017] A basic advantage of the claimed material is the fact that it is free of fibres and can be produced also free of PVC if required, both of them being under survey and being discussed for environmental and health issues.

[0018] A further advantage of the claimed material is that phthalates are not needed as plasticizers, which are partially under discussion and partially prohibited already for the same reason.

[0019] A further advantage of the claimed material is the possibility to adapt its properties to the desired property profile (concerning mechanics, damping, water intake, porosity etc.) by expanding it to an appropriate foam cell structure from totally open-cell to totally closed-cell. This can be achieved by modifying the crosslinking system(s), the expansion agent(s) and the base matrix, as well as the density. The material thus can be modified from water repellent to water absorbing; it can be altered to damp from high to low frequencies or frequency bands, and good playability is always ensured.

[0020] It is a prominent advantage of the claimed material that it can be produced in an economic way in a one-step mixing and a one-step shaping process, e.g. by moulding, extrusion and other shaping methods. It shows versatility in possibilities of manufacturing and application. It can be extruded, co-extruded, laminated, moulded, co-moulded etc. as single item or multilayer and thus it can be applied in unrestricted shaping.

[0021] It is a further advantage of the claimed material that it can be transformed and given shape by standard methods being widespread in the industry and that it does not require specialized equipment.

[0022] A further advantage of the claimed material is the fact that it is easily colourable to match to the application, e.g. green for turf, brown for soil, etc.

[0023] An important advantage of the claimed material is the fact that it is low gassing, means, there is no odor irritation.

[0024] An important advantage of the claimed material for its application is the fact that it can be surface treated, e.g. coated, welded, braided etc. with various agents and by various means, and glued, laminated etc. and thus can be easily integrated into other systems.

[0025] It is a prominent advantage of the claimed material that it can easily be applied, e.g. laid without facing troubles with wind, warping etc. The material can be supplied in big mats when manufactured by molding, and in huge mats or even rolls when being done by extrusion, which will tremendously facilitate mounting. Sports tracks e.g. can be equipped with one piece instead of using multiple parts creating undesired seams.

[0026] It is another prominent advantage of the claimed material that it is very versatile in application leading to the fact that it can be used as underlay or overlay for sports grounds and tracks, playgrounds, slopes, roofing and other applications where good drainage and/or damping and/or wear properties are required, such as asphalt underlay etc.

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[0027] It is a prominent advantage of the claimed material resulting from its elastic nature that it can be bent easily and thus will adapt itself to various surface and substrate structures, such as slopes, curves, steps etc.

[0028] It is a further advantage of the claimed material for the application in turf and artificial turf that infill can be reduced as the claimed material will take over some of the infill's performance.

Examples

[0029] For the following examples a mat of 5/8" (1.56 cm) thickness and 3 feet (91 cm) width had been produced by extruding, expanding and crosslinking a rubber compound (Armoprene® TU, Armacell GmbH, Münster/Armacell LLC., Conover NC). The mat then was cut into pieces of 3 feet (91 cm) length. One part of the pieces was furnished with pin holes of 0.25" (0.64 cm) diameter in an average distance of 3" (7.6 cm). A second part was embossed on one side by heated embossing rollers or structured hot plates, respectively, and then furnished with pin holes. A third part was used for comparative testing and left without embossing or applying pin holes.

Example 1; Test of mats according to ASTM F355-01: Standard Test Methods for Shock-Adsorbing Properties of Playing Surface Systems and Materials.

[0030] Data obtained from this test method are indicative of cushioning properties of the playing surface system and materials under the specific conditions selected. The playing system is impacted at a specified velocity with a missile of given mass and geometry to determine the maximum value of G encountered during impact.

[0031] A turf system (the turf material used for all tests was a standard 42 Oz -2.25" PH-monofilament synthetic turf) was positioned over the sub base (crushed rock) with a clear view bumper (G max test equipment) placed over the entire playing surface system. The missile was released, so as to impact the center of the assembly at a velocity of 3.43 m/s at a drop height of 24" (61 cm).

[0032] Three drops were made at 3 second intervals. The first drop was for assembly conditioning and was not included in the average.

Table 1: Damping properties of expanded elastomeric material for underlay mats

Turf infill	Pad	Innovative example	Comparative example	average G max
3.3 lbs/ft ² Rubber mixed with 3.0 lbs/ft ² Sand*	5/8" Perforated Pad	X		58
1.7 lbs/ft ² Rubber mixed with 1.5 lbs/ft ² Sand**	5/8" Perforated Pad	X		66
None	5/8" Perforated Pad	X		87
3.3 lbs/ft ² Rubber mixed with 3.0 lbs/ft ² Sand*	5/8" Non perforated Pad		X	70
1.7 lbs/ft ² Rubber mixed with 1.5 lbs/ft ² Sand**	5/8" Non perforated Pad		X	84
None	5/8" Non perforated Pad		X	99
* "recommended standard infill practice"				
** "half infill"				

Example 2: Test according to British Standard 7044 Method 4: Determination of Infiltration Rate - Buffered Ponding-Type Infiltrometer

[0033] The test conducted determines the rate at which water enters the turf surface under defined constant head conditions and reflects the permeability of the surface tested. The turf material used for all tests was a standard 42 Oz (2.25" PH) monofilament synthetic turf.

Table 2: Drainage properties of elastomeric mats (all innovative examples)

Infill	Pad type	Infiltration rate [inches/ hour]	Infiltration rate [centimeters/hour]
3.3 lbs/ft ² Rubber mixed with 3.0 lbs/ft ² Sand	5/8" Perforated Pad	25	45
3.3 lbs/ft ² Rubber mixed with 3.0 lbs/ft ² Sand	5/8" Perforated Pad with Ridges	31	79

Claims

1. A drainage and damping mat obtained from expanded elastomer and/or thermoplastic elastomer and/or thermoplastic and/or thermoset, and/or combinations thereof, preferably crosslinked, which provides elastic properties by showing an elastic modulus smaller than 5 and which is perforated to provide drainage properties.
2. The material according to claim 1 wherein the perforation comprises pin holes.
3. The material according to claim 2 wherein the pin holes are applied in a size not smaller than 0.1" (0.25 cm), especially preferred in a size bigger than 0.2" (0.5 cm), and wherein the preferred distance of the pin holes is at least 1" (2.5 cm), especially preferred at least 2.5" (6.35 cm).
4. The material according to anyone of claims 1-3 wherein the mat is equipped with a ridge structure on one or both sides to further improve drainage properties and damping.
5. The material according to anyone of claims 1-4 which shows a density of 1.8 pound/foot³ (29 kg/m³) to 30 pound/foot³ (480 kg/m³), preferably from 3.5 pound/foot³ (56 kg/m³) to 15 pound/foot³ (240 kg/m³) for drainage purposes without load, or a density bigger than 63 pound/foot³ (1009 kg/m³) for use without support or fixture to prevent flotation.
6. A process for preparation the material according to anyone of claims 1-5 in a molding or continuous extrusion process followed by applying the desired structures and/or perforation patterns.
7. The use of a material according to anyone of claims 1-5 for applications requiring drainage properties and/or playability, preferably in combination with protection against impact and/or anti-fatigue properties and/or damping properties, such as for turf or artificial turf underlay, for plant underlay in general, for sports tracks and athletic grounds, playgrounds etc., for roofing, for indoor and/or outdoor purposes.



EUROPEAN SEARCH REPORT

Application Number
EP 10 16 2925

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 2 693 751 A1 (ZINK WALTER [DE]) 21 January 1994 (1994-01-21) * page 2, lines 4-9 * * page 1, lines 20-25 * * page 3, lines 17-24 * * page 4, lines 33-35 * * page 6, lines 1-14; figures 1-4 *	1,2,4-7	INV. E01C13/02 E01C13/04 E01C13/08
X	EP 1 900 874 A2 (PREFORMATI B M C S R L [IT]) 19 March 2008 (2008-03-19) * paragraphs [0014], [0015], [0017] - [0019], [0022], [0026]; figures 2-3 *	1-3,5,7	
X	WO 2009/045516 A1 (FIELDTURF TARKETT INC [CA]; FIELDTURF USA INC [US]; MURPHY STEPHEN [CA]) 9 April 2009 (2009-04-09) * paragraphs [0014], [0034], [0036], [0037]; figures 1-3 *	1,2,4-7	
A	US 4 505 960 A (LEFFINGWELL JAMES W [US]) 19 March 1985 (1985-03-19) * column 1, lines 5-12 * * column 4, lines 15--63 *	1,5	TECHNICAL FIELDS SEARCHED (IPC) E01C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 26 October 2010	Examiner Gallego, Adoración
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-10-2010

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
FR 2693751	A1	21-01-1994	DE 9209520 U1	10-09-1992
EP 1900874	A2	19-03-2008	NONE	
WO 2009045516	A1	09-04-2009	CA 2701654 A1	09-04-2009
			EP 2209368 A1	28-07-2010
			US 2009208674 A1	20-08-2009
US 4505960	A	19-03-1985	AU 564195 B2	06-08-1987
			AU 3181284 A	14-02-1985
			CA 1229854 A1	01-12-1987
			DE 3480220 D1	23-11-1989
			EP 0168545 A1	22-01-1986
			JP 1731938 C	17-02-1993
			JP 4021582 B	10-04-1992
			JP 60071246 A	23-04-1985

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CA 1150958 [0002]
- DE 3911690 [0002]
- JP 58207412 B [0002]
- KR 102007112286 [0002]
- US 20070137017 A [0002] [0004]
- JP 2009257055 B [0003]
- JP 4203002 B [0003]
- KR 102008095553 [0003]
- KR 100903808 [0003]
- KR 100869292 [0003]
- JP 62178602 B [0003]
- US 20060115328 A [0003]
- JP 9164617 B [0003]
- JP 5148827 B [0003]
- JP 7331640 B [0003]
- JP 8135157 B [0003]
- KR 102008019194 [0003]
- JP 5272110 B [0003]
- JP 59072302 B [0003]
- KR 102005011423 [0003]
- JP 59059120 B [0003]
- JP 2195910 A [0003]
- KR 102008075350 [0004]
- US 7166340 B [0004]
- JP 5163705 B [0004]
- DE 2065209 [0004]
- DE 19521944 [0004]
- US 20030177799 A [0004]
- US 7147401 B [0004]
- CA 2247484 [0004]
- WO 2001037657 A [0004]
- US 20050048225 A [0004]