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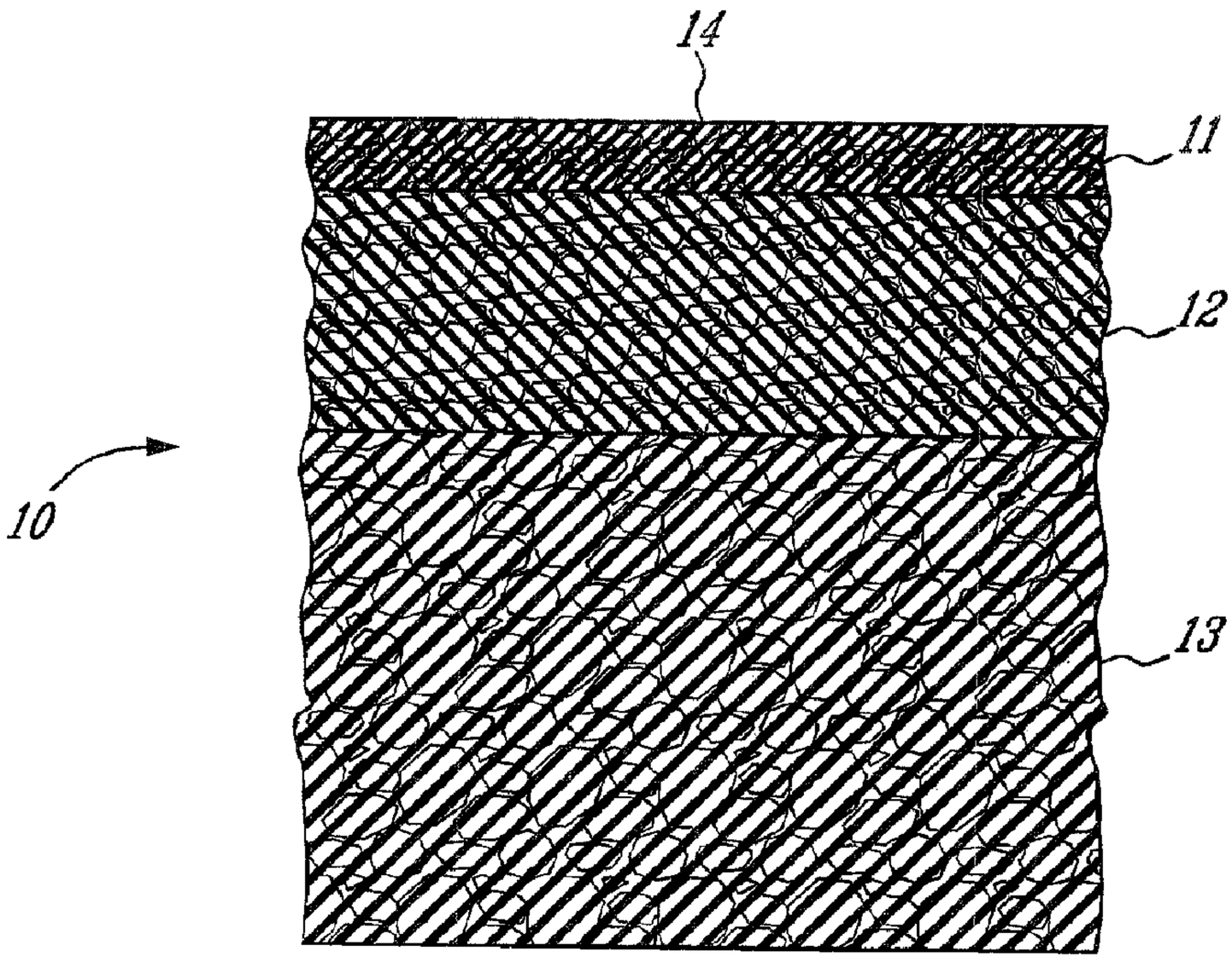
(54) Titre : REVETEMENT DE SECURITE MULTICOUCHE POUR SURFACE DE TERRAIN DE JEUX
(54) Title: MULTI-LAYER SECURITY MAT FOR PLAYGROUND SURFACE



(57) Abrégé/Abstract:
The present invention relates to a multi-layer security mat for covering a playground surface, comprising a top abrasion layer, an intermediate charge-distributing layer and a bottom shock-absorbing layer. The intermediate charge-distributing layer is interposed between the top abrasion layer and the bottom shock-absorbing layer for distributing charges applied to the top surface of the top abrasion layer on the bottom shock-absorbing layer. The bottom layer absorbs shocks applied to the top surface of the top abrasion layer. The top abrasion layer, the intermediate charge-distributing layer, and the bottom shock-absorbing layer increase in thickness while they reduce in density. To manufacture the multi-layer security mat, a prefabricated panel of expanded polypropylene is disposed generally horizontally to form the bottom shock-absorbing layer. A first mixture of (a) granules of rubber material and (b) polyurethane is poured on the top surface of the prefabricated panel of expanded polypropylene and, then, is cured to form the intermediate charge-distributing layer. A second mixture of (a) granules of rubber material and (b) polyurethane is finally poured on the top surface of the intermediate charge-distributing layer and then cured to form the top abrasion layer.

ABSTRACT OF THE DISCLOSURE

The present invention relates to a multi-layer security mat for covering a playground surface, comprising a top abrasion layer, an intermediate charge-distributing layer and a bottom shock-absorbing layer. The intermediate charge-distributing layer is interposed between the top abrasion layer and the bottom shock-absorbing layer for distributing charges applied to the top surface of the top abrasion layer on the bottom shock-absorbing layer. The bottom layer absorbs shocks applied to the top surface of the top abrasion layer. The top abrasion layer, the intermediate charge-distributing layer, and the bottom shock-absorbing layer increase in thickness while they reduce in density. To manufacture the multi-layer security mat, a prefabricated panel of expanded polypropylene is disposed generally horizontally to form the bottom shock-absorbing layer. A first mixture of (a) granules of rubber material and (b) polyurethane is poured on the top surface of the prefabricated panel of expanded polypropylene and, then, is cured to form the intermediate charge-distributing layer. A second mixture of (a) granules of rubber material and (b) polyurethane is finally poured on the top surface of the intermediate charge-distributing layer and then cured to form the top abrasion layer.

MULTI-LAYER SECURITY MAT FOR PLAYGROUND SURFACE

FIELD OF THE INVENTION

The present invention relates to a multi-layer security mat for covering a playground surface.

BACKGROUND OF THE INVENTION

U.S. Patent No. 5,916,034 granted to Steven A. Lancia on June 29, 1999 discloses a miniature golf hole system including an expanded polystyrene foam base. A porous rubberized material is applied to an upper exposed side of the expanded polystyrene base, and a porous outdoor carpeting is finally applied to the exposed surface of the rubber material.

A drawback of expanded polystyrene foam for this kind of application is that its resiliency deteriorates with every shock absorbed by the polystyrene material.

International patent application published under number WO 02/055299 A1 (Lemieux et al.) on July 18, 2002 describes a resilient floor surface that can be used for indoor and outdoor sporting applications. This floor surface includes a resilient underpad of expanded polypropylene suitable for being laid down directly on the ground or other subfloor surface in a floating arrangement. A floor covering material is finally applied upon this resilient underpad. This floor covering may comprise synthetic rubber tiles and panels, rubber flooring tiles

and panels, residential and commercial carpets, crumb rubber surface coatings, polyurethance surface coatings, etc.

The resilient floor surface of international patent application WO 02/055299 A1 does not comprise, over the resilient expanded polypropylene underpad, a proper arrangement of layers for optimal performance, in a playground surface application, of a multi-layer security mat.

SUMMARY OF THE INVENTION

According to the present invention, there is provided, to overcome the above-discussed drawbacks, a multi-layer security mat for covering a playground surface, comprising a top abrasion layer, an intermediate charge-distributing layer, and a bottom shock-absorbing layer. The top abrasion layer has a top surface and a first thickness, this top abrasion layer being made of a resilient material having a first density. The bottom layer absorbs shocks applied to the top surface of the top abrasion layer, this bottom shock-absorbing layer having a second thickness greater than the first thickness and being made of a resilient material having a second density lower than the first density. The intermediate layer is interposed between the top abrasion layer and the bottom shock-absorbing layer for distributing charges applied to the top surface of the top abrasion layer on the bottom shock-absorbing layer, this intermediate charge-distributing layer having a third thickness intermediate the first and second thicknesses and being made of a resilient material having a third density intermediate the first and second densities.

The present invention also relates to a method of manufacturing a multi-layer security mat for covering a playground surface, comprising lying a prefabricated panel of expanded polypropylene generally horizontally to form a bottom shock-absorbing layer having a first thickness and a first density, the

prefabricated panel of expanded polypropylene having a top surface. A first mixture of (a) granules of rubber material and (b) polyurethane is poured on the top surface of the prefabricated panel of expanded polypropylene, and is cured to form an intermediate charge-distributing layer having a top surface, a second thickness smaller than the first thickness, and a second density higher than the first density. A second mixture of (a) granules of rubber material and (b) polyurethane is poured on the top surface of the intermediate charge-distributing layer, and is cured to form a top abrasion layer having a third thickness smaller than the second thickness, and a third density higher than the second density.

The foregoing and other objects, advantages and features of the present invention will become more apparent upon reading of the following non restrictive description of an illustrative embodiment thereof, given by way of example only with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the appended drawings:

Figure 1 is a partial, cross sectional elevation view of the non-restrictive, illustrative embodiment of the multi-layer security mat according to the present invention;

Figure 2a is a graph of the dynamic cushioning performance of beads of expanded polypropylene, this graph showing curves of the deceleration (G-value) as a function of the static load (PSI) for expanded polypropylene beads having a density of 20 g/l for a first impact and for different H/t (Drop Height/Cushion Thickness) ratios;

Figure 2b is a graph of the dynamic cushioning performance of beads of expanded polypropylene, this graph showing curves of the deceleration (G-value) as a function of the static load (PSI) for expanded polypropylene beads having a density of 20 g/l for the subsequent 2-5 impacts and for different H/t (Drop Height/Cushion Thickness) ratios;

Figure 3a is a graph of the dynamic cushioning performance of beads of expanded polypropylene, this graph showing curves of the deceleration (G-value) as a function of the static load (PSI) for expanded polypropylene beads having a density of 30 g/l for a first impact and for different H/t (Drop Height/Cushion Thickness) ratios; and

Figure 3b is a graph of the dynamic cushioning performance of beads of expanded polypropylene, this graph showing curves of the deceleration (G-value) as a function of the static load (PSI) for expanded polypropylene beads having a density of 30 g/l for the subsequent 2-5 impacts and for different H/t (Drop Height/Cushion Thickness) ratios.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENT

The non-restrictive, illustrative embodiment of the multi-layer security mat according to the present invention will now be described with reference to the accompanying drawings.

Although the non-restrictive, illustrative embodiment of the multi-layer security mat will be described in the following description with reference to covering of a playground surface, it should be kept in mind that the present invention applies as well to other types of surface, for example a sport-playing surface.

As illustrated in Figure 1, the multi-layer security mat for covering a playground surface, generally identified by the reference 10, comprises a top abrasion layer 11, an intermediate charge-distributing layer 12, and a bottom shock-absorbing layer 13.

Top abrasion layer

The top abrasion layer 11 is the denser layer of the non-restrictive, illustrative embodiment of the multi-layer security mat 10 according to the present invention. Its main function is to form an aesthetic, abrasion and attrition-resistant layer.

The top abrasion layer 11 is made of a mixture of (a) granules of rubber materials and (b) polyurethane. According to the non-restrictive, illustrative embodiment of the multi-layer security mat, the granules of the top abrasion layer 11 are made of synthetic rubber material (E.P.D.M.) for presenting better abrasion and resistance to attrition.

These granules of synthetic rubber material are mixed, according to the non-restrictive, illustrative embodiment of the multi-layer security mat 10, with liquid hydro-reactive, mono-component clear polyurethane. Of course, the polyurethane constitutes a binder for the granules of synthetic rubber material.

The top abrasion layer 11 may contain 18% to 22% (by weight) of polyurethane, and the granules of synthetic rubber material may have a diameter of 1-3 mm. It should be kept in mind that the present invention is not restricted to these values and the resulting density.

The synthetic rubber material of the granules of the top abrasion layer 11 can be colored as desired, for example depending on the intended use of the multi-layer security mat 10.

A suitable thickness of the top abrasion layer 11 of the non-restrictive, illustrative embodiment of the multi-layer security mat 10 is of the order of 8-10 mm, but the present invention is not restricted to this particular thickness.

Intermediate charge-distributing layer

The intermediate layer 12 is interposed between the top abrasion layer 11 and the bottom shock-absorbing layer 13 for distributing charges applied to the top surface 14 of the top abrasion layer 11 on the bottom shock-absorbing layer 13. Accordingly, the intermediate charge-distributing layer 12 constitutes a support layer for the top abrasion layer 11 and helps this top abrasion layer 11 to resist to extreme conditions, for example a person wearing high-heel shoes. This intermediate charge-distributing layer 12 has a thickness intermediate the thicknesses of the layers 11 and 13, and is made of a resilient material having a density intermediate the densities of these layers 11 and 13.

According to the non-restrictive, illustrative embodiment of the multi-layer security mat 10, the intermediate charge-distributing layer 12 is made of a mixture of (a) granules of rubber material and (b) polyurethane. According to this illustrative embodiment, the granules of the intermediate layer 12 are made of black recycled rubber material (S.B.R.) and are mixed with liquid hydro-reactive, mono-component clear polyurethane. Of course, the polyurethane constitutes a binder for the granules of recycled rubber material.

The charge-distributing intermediate layer 12 may contain 12% to 16% (by weight) of polyurethane, and the granules of recycled rubber material may have a diameter of 1-5 mm. It should be kept in mind that the present invention is not restricted to these values and the resulting density.

A suitable thickness of the intermediate charge-distributing layer 12 of the non-restrictive, illustrative embodiment of the multi-layer security mat 10 is of the

order of 20-30 mm, but the present invention is not restricted to this particular thickness.

Bottom shock-absorbing layer

The bottom layer 13 absorbs shocks applied to the top surface 14 of the top abrasion layer 11. More specifically, the bottom layer 13 is made of resilient material capable of absorbing mechanical energy in order to damp, for example, a child's fall on the multi-layer security mat 10.

The bottom shock-absorbing layer 13 is the thicker but less dense layer.

According to the non-restrictive, illustrative embodiment of the multi-layer security mat 10, the resilient material of the bottom shock-absorbing layer 13 comprises a prefabricated panel of expanded polypropylene having a thickness of the order of 25-50 mm and having a density of 0.7-1.0 PCP (Pounds per Cubic Feet).

According to an alternative, the resilient material of the bottom shock-absorbing layer 13 comprises a mixture of (a) granules and buffing (filaments) of rubber material and (b) polyurethane. According to this alternative, the granules of the bottom layer 13 are made of black recycled rubber material (S.B.R.), and these granules and the buffing are mixed with liquid hydro-reactive, mono-component clear polyurethane. Again, the polyurethane constitutes a binder for the granules of recycled rubber material and the buffing. The buffing (filaments of rubber material) also contributes to bind the granules together.

Also in accordance with this alternative, the density of the bottom shock-absorbing layer 13 is lower than that of the intermediate charge-distributing layer 12 and the thickness of this bottom shock-absorbing layer 13 is greater than 50 mm.

Manufacture of the illustrative embodiment of the multi-layer security mat

To manufacture the non-restrictive, illustrative embodiment of the multi-layer security mat 10 on the site of the installation, the following operations can be performed:

- lying one or many prefabricated panels of expanded polypropylene generally horizontally and adjacent to each other over the whole surface to be covered by the mat 10 to form the bottom shock-absorbing layer 13, wherein the prefabricated panel(s) of expanded polypropylene can be perforated to improve drainage;

- preparing a mixture of the granules of black recycled rubber material (S.B.R.) and the liquid hydro-reactive, mono-component clear polyurethane, pouring this mixture on the top surface of the prefabricated panel(s) of expanded polypropylene, eventually pressing and finally curing this mixture to form the intermediate charge-distributing layer 12; and

- preparing a mixture of the granules of synthetic rubber material (E.P.D.M.) with the liquid hydro-reactive, mono-component clear polyurethane, pouring this mixture on the top surface of the charge-distributing layer 12, eventually pressing and finally curing this mixture to form the top abrasion layer 10.

Governmental regulations require that playground security mats meet with a parameter *Gmax*<200 and a parameter *HIC(Head Injury Criteria)*<1000.

Gmax<200

Gmax is a parameter representative of the resiliency of the multi-layer security mat 10. Parameter *Gmax* is in fact representative of the capability of the

multi-layer security mat 10 to keep its initial properties notwithstanding the number of shocks on the top surface 14 (Figure 1). Governmental regulations require a *Gmax*<200 no matter the height.

In this respect, reference is made to Figures 2a and 2b showing the dynamic cushioning performance of beads of expanded polypropylene, these graphs showing curves of the deceleration (G-value) as a function of the static load (PSI) for expanded polypropylene beads having a density of 20 g/l for different H/t (Drop Height/Cushion Thickness) ratios and for:

- a first impact (Figure 2a);
- the subsequent 2-5 impacts (Figure 2b).

Reference is also made to Figures 3a and 3b showing the dynamic cushioning performance of beads of expanded polypropylene, these graphs showing curves of the deceleration (G-value) as a function of the static load (PSI) for expanded polypropylene beads having a density of 30 g/l for different H/t (Drop Height/Cushion Thickness) ratios and for:

- a first impact (Figure 3a);
- the subsequent 2-5 impacts (Figure 3b).

Figures 2a, 2b, 3a and 3b show that the dynamic cushioning performance does not significantly deteriorate from one impact to the other.

HIC<1000

HIC is a parameter representative of the energy absorbed by a child's head upon a fall on the multi-layer security mat 10. Parameter *HIC* is in fact representative of the capability of the multi-layer security mat 10 to absorb and dissipate energy when a child's head hits the top surface 14 (Figure 1). Governmental regulations require a *HIC*<1000 for all heights.

Advantages of the non-restrictive, illustrative embodiment of the multi-layer security mat 10

A bottom shock-absorbing layer 13 made of expanded polypropylene is very resilient and resistant to repeated shocks without significant damage, and efficiently absorbs and dissipates the energy of shocks for reducing as much as possible the energy absorbed by a child's head upon falling on the multi-layer security mat 10. In this manner, the parameters *Gmax*<200 and *HIC*<1000 are easily met by a multi-layer security mat 10 having a bottom shock-absorbing layer made of expanded polypropylene.

A bottom shock-absorbing layer 13 made of expanded polypropylene absorbs almost no water and constitutes an isolating material whereby a bottom shock-absorbing layer 13 made of expanded polypropylene will not freeze when the multi-layer security mat 10 is used outdoors to render the playground surface more comfortable all year long.

Although the present invention has been described in the foregoing specification by means of an illustrative embodiment, this illustrative embodiment can be modified as will, within the scope of the appended claims without departing from the nature and spirit of the subject invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A multi-layer security mat for covering a playground surface, comprising:

a top abrasion layer having a top surface and a first thickness, the top abrasion layer being made of a resilient material having a first density;

a bottom layer for absorbing shocks applied to the top surface of the top abrasion layer, the bottom shock-absorbing layer having a second thickness greater than the first thickness and being made of a resilient material having a second density lower than the first density; and

an intermediate layer interposed between the top abrasion layer and the bottom shock-absorbing layer for distributing charges applied to the top surface of the top abrasion layer on the bottom shock-absorbing layer, the intermediate charge-distributing layer having a third thickness intermediate the first and second thicknesses and being made of a resilient material having a third density intermediate the first and second densities.

2. A multi-layer security mat as defined in claim 1, wherein the resilient material of the bottom shock-absorbing layer comprises expanded polypropylene.

3. A multi-layer security mat as defined in claim 1, wherein the bottom shock-absorbing layer is made of a prefabricated panel of expanded polypropylene.

4. A multi-layer security mat as defined in claim 2, wherein the second thickness is of the order of 25-50 mm.

5. A multi-layer security mat as defined in claim 2, wherein the density of the resilient material of the bottom shock-absorbing layer is of the order of 0.7-1.0 PCF.

6. A multi-layer security mat as defined in claim 1, wherein the resilient material of the intermediate charge-distributing layer comprises a mixture of (a) granules of rubber material and (b) polyurethane, wherein the granules of rubber material are bound to each other through the polyurethane.

7. A multi-layer security mat as defined in claim 6, wherein the granules are made of recycled rubber material.

8. A multi-layer security mat as defined in claim 6, wherein the third thickness is about 20-30 mm.

9. A multi-layer security mat as defined in claim 6, wherein the polyurethane comprises hydro-reactive mono-component clear polyurethane.

10. A multi-layer security mat as defined in claim 6, wherein the intermediate charge-distributing layer contains 12% to 16% of polyurethane, and wherein the granules of rubber material have a diameter of 1-5 mm.

11. A multi-layer security mat as defined in claim 1, wherein the top abrasion layer comprises a mixture of (a) granules of rubber material and (b) polyurethane, wherein the granules of rubber material are bound to each other through the polyurethane.

12. A multi-layer security mat as defined in claim 11, wherein the granules are made of synthetic rubber material.

13. A multi-layer security mat as defined in claim 12, wherein the synthetic rubber material comprises a colored synthetic rubber material.

14. A multi-layer security mat as defined in claim 11, wherein the first thickness is about 8-10 mm.

15. A multi-layer security mat as defined in claim 11, wherein the polyurethane comprises hydro-reactive mono-component clear polyurethane.

16. A multi-layer security mat as defined in claim 11, wherein the top abrasion layer contains 18% to 22% of polyurethane, and wherein the granules of rubber material have a diameter of 1-3 mm.

17. A method of manufacturing a multi-layer security mat for covering a playground surface, comprising:

lying a prefabricated panel of expanded polypropylene generally horizontally to form a bottom shock-absorbing layer having a first thickness and a first density, the prefabricated panel of expanded polypropylene having a top surface;

pouring on the top surface of the prefabricated panel of expanded polypropylene a first mixture of (a) granules of rubber material and (b) polyurethane;

curing the first mixture of (a) granules of rubber material and (b) polyurethane to form an intermediate charge-distributing layer having a top surface, a second thickness smaller than the first thickness, and a second density higher than the first density;

pouring on the top surface of the intermediate charge-distributing layer a second mixture of (a) granules of rubber material and (b) polyurethane; and

curing the second mixture of (a) granules of rubber material and (b) polyurethane to form a top abrasion layer having a third thickness smaller than the second thickness, and a third density higher than the second density.

18. A method of manufacturing a multi-layer security mat as defined in claim 17, further comprising perforating the prefabricated panel of expanded polypropylene.

19. A method of manufacturing a multi-layer security mat as defined in claim 17, wherein pouring on the top surface of the prefabricated panel of expanded polypropylene a mixture of (a) granules of rubber material and (b) polyurethane comprises pouring a mixture of (a) granules made of recycled rubber material and (b) hydro-reactive mono-component clear polyurethane.

20. A method of manufacturing a multi-layer security mat as defined in claim 17, wherein pouring on the top surface of the charge-distributing layer a mixture of (a) granules of rubber material and (b) polyurethane comprises pouring a mixture of (a) granules made of synthetic rubber material and (b) hydro-reactive mono-component clear polyurethane.

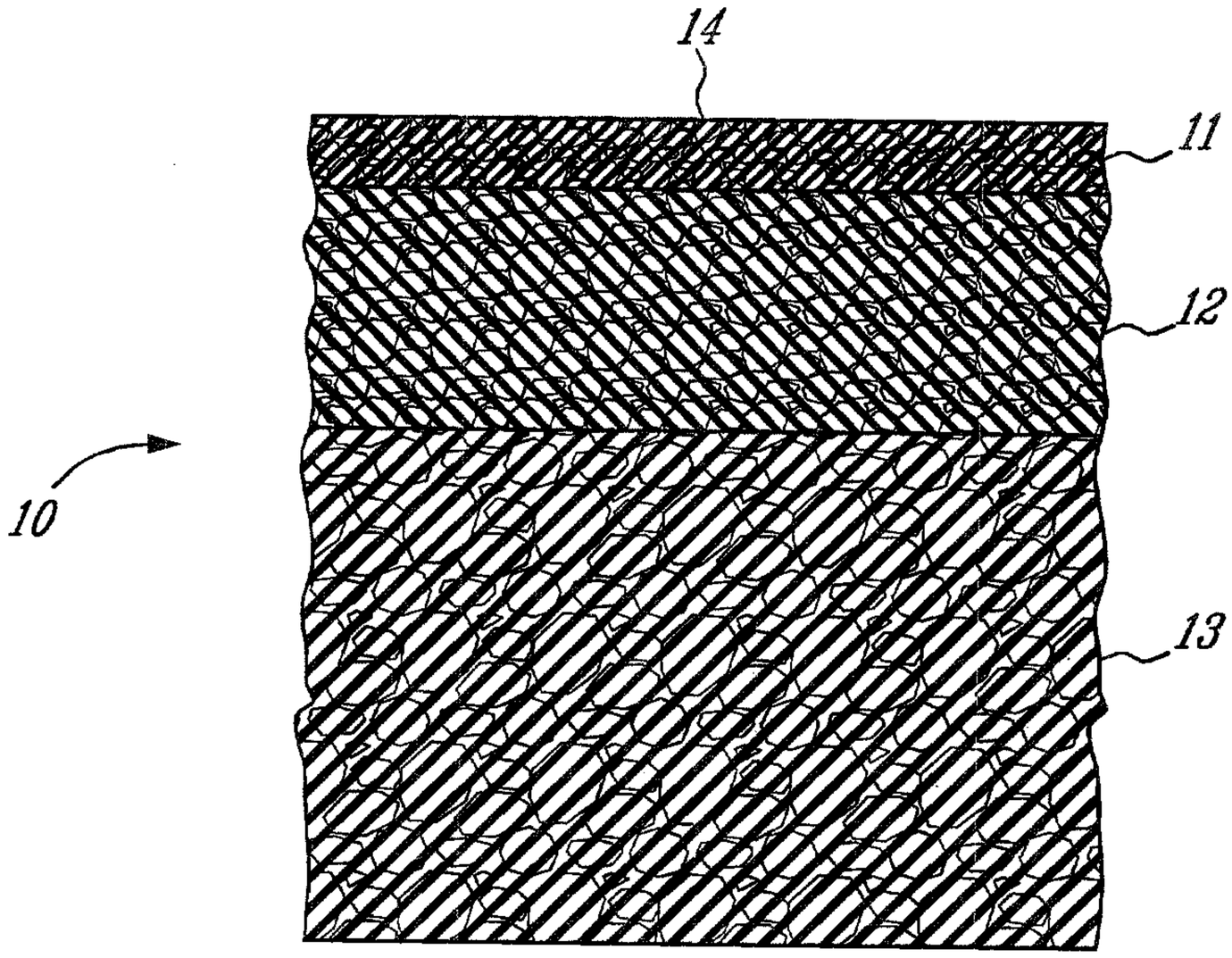
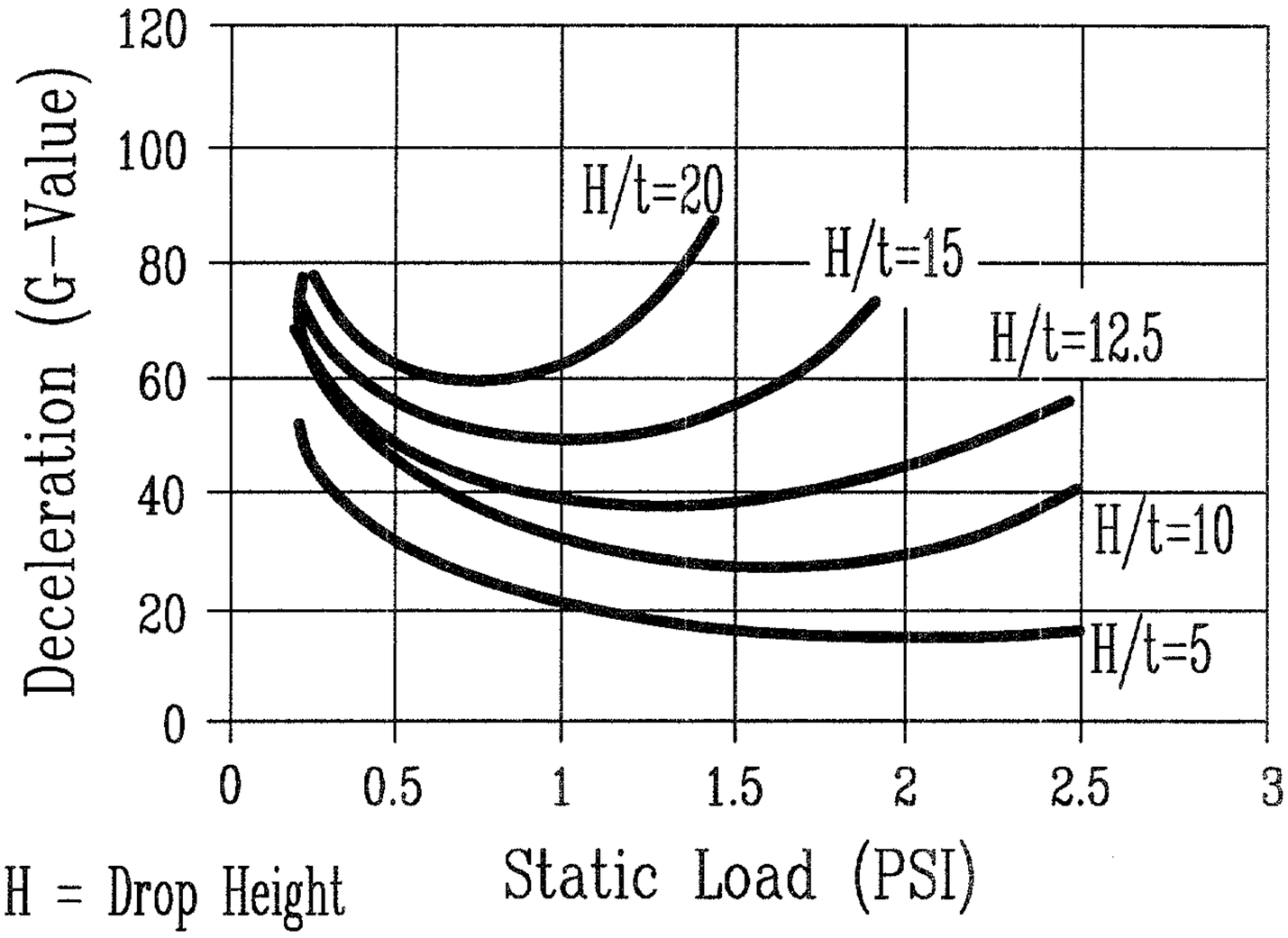


Fig. 1

1st Impact

Density = 1.3 PCF (20 g/l)



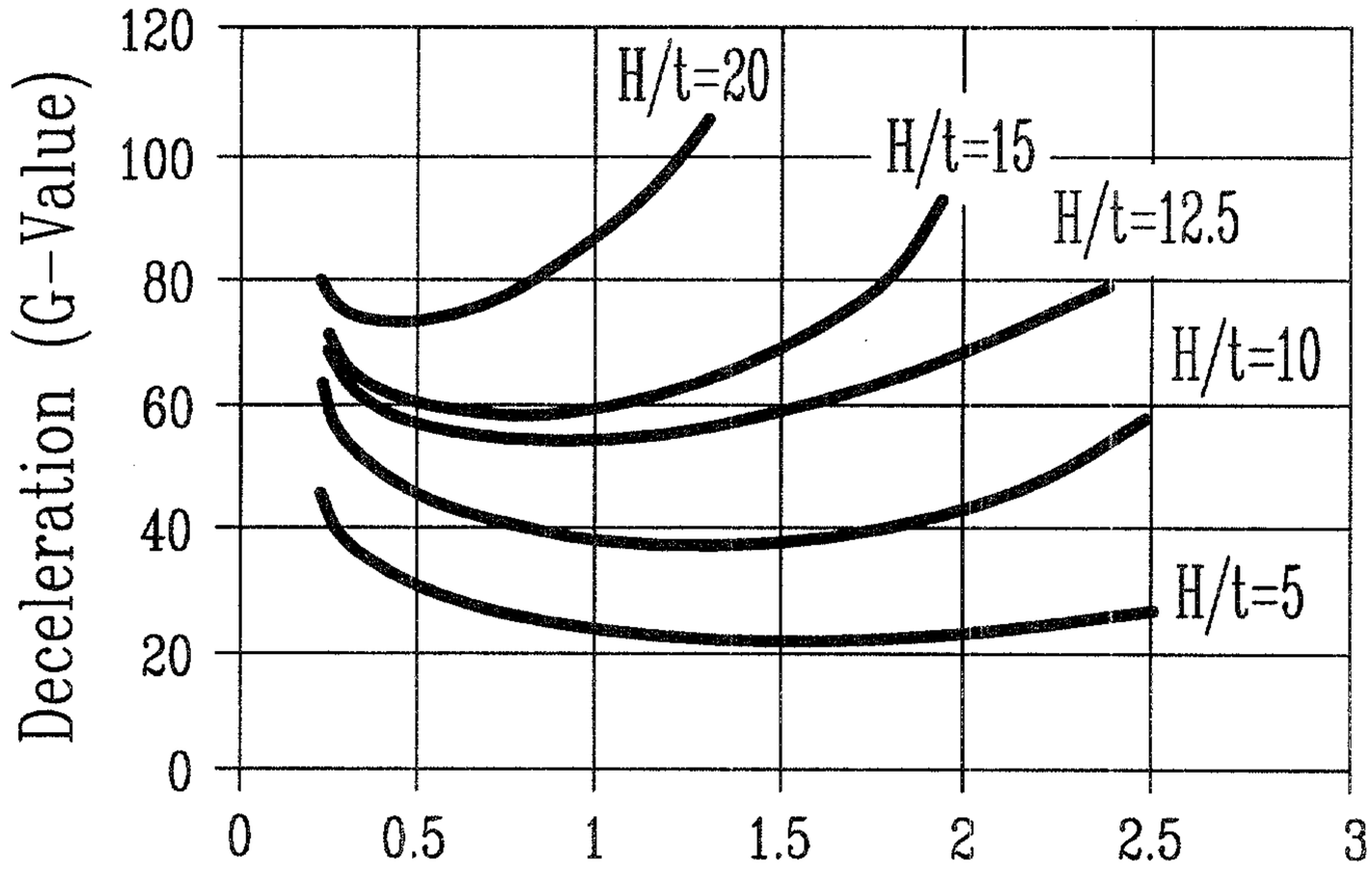
H = Drop Height

t = Cushion Thickness

Fig. 2A

2-5 Impacts

Density = 1.3 PCF (20 g/l)

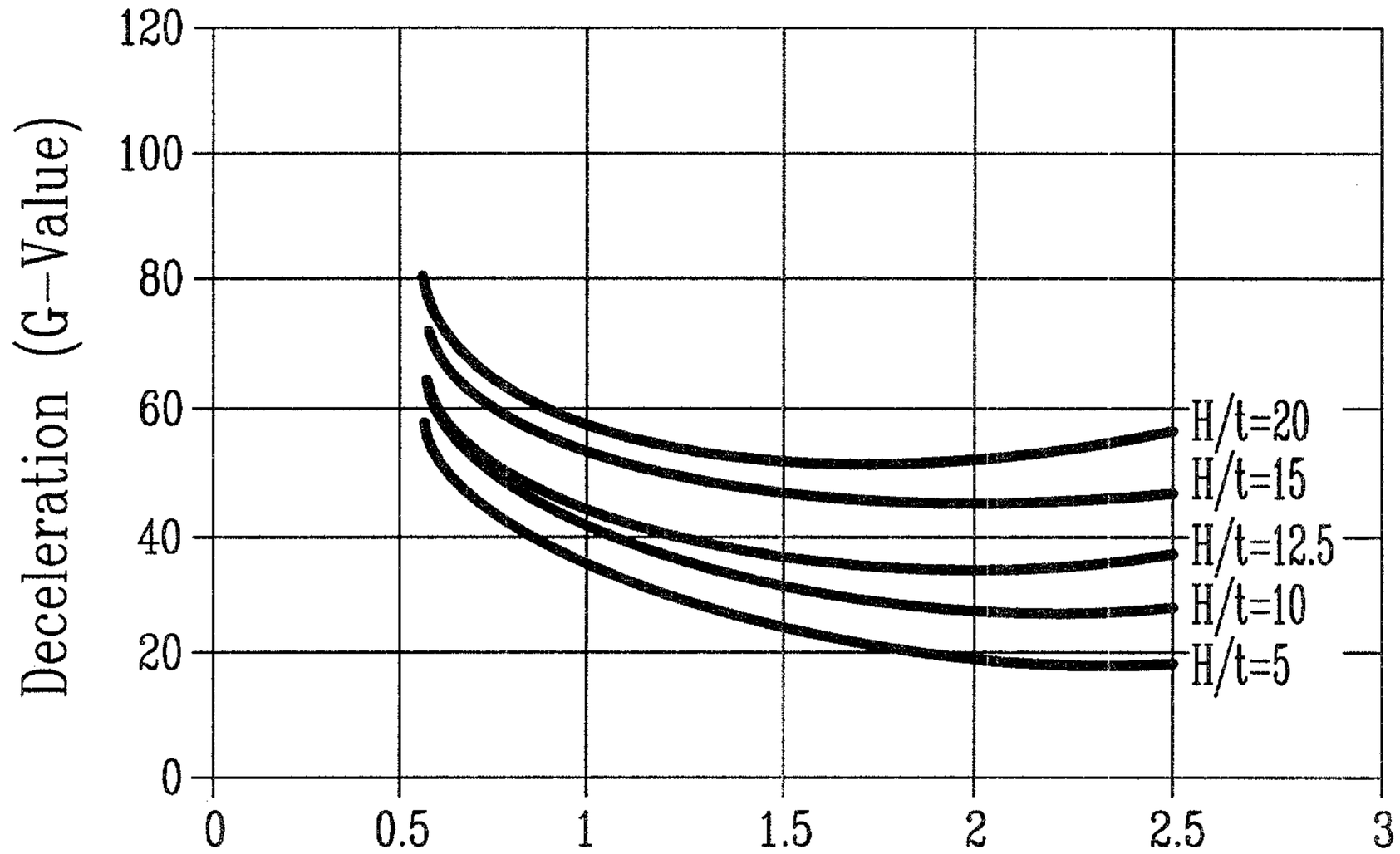


H = Drop Height

t = Cushion Thickness

Fig. 2B

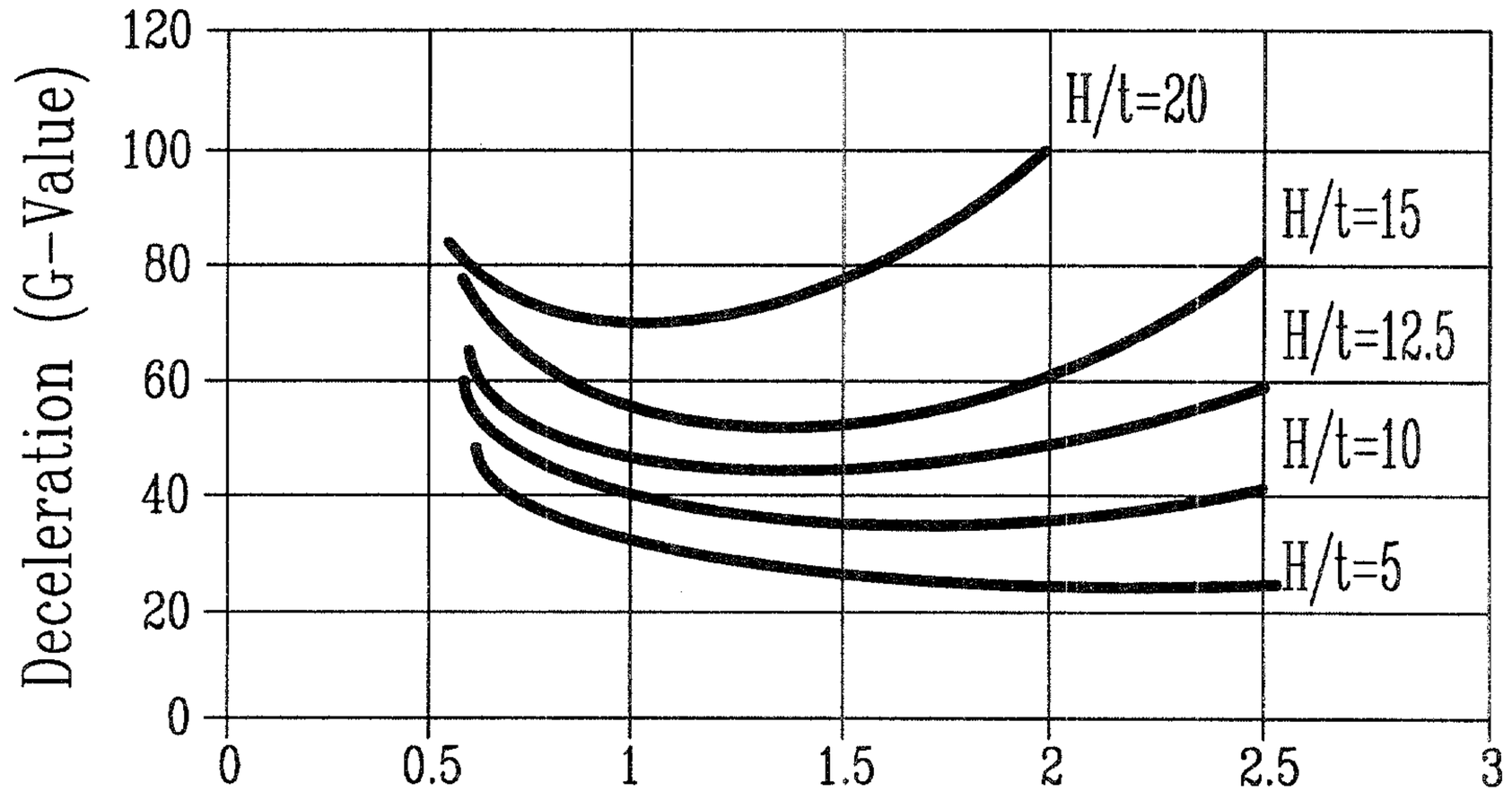
1st Impact
Density = 1.9 PCF (30 g/l)



H = Drop Height
t = Cushion Thickness

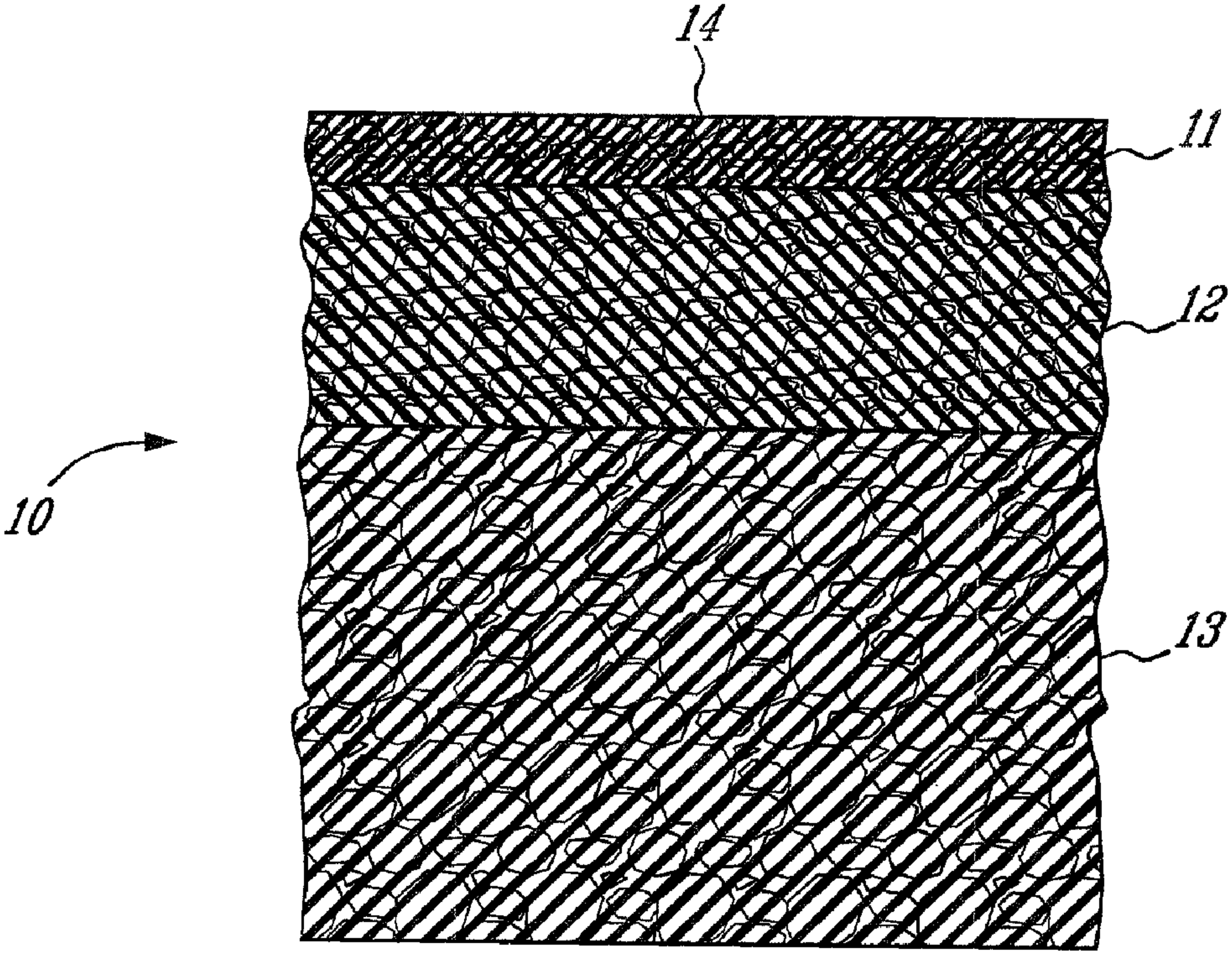
FIG_3A

2-5 Impacts
Density = 1.9 PCF (30 g/l)



H = Drop Height
t = Cushion Thickness

FIG_3B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