A crash cushion system (1) for road use, comprising: a frame (2) fixable to a road surface; a deformable body (3) configured such as to deform along a longitudinal axis thereof consequent to an impact of a vehicle against the deformable body (3), the deformable body (3) being fixable to the frame (2) such to identify, by means of the longitudinal axis, a deforming direction (A) of the deformable body (3); first rolling means (4) rotatably couplable to the deformable body (3) such as to support the deformable body (3) and such as to guide the deformable body (3) along the deforming direction (A) when a vehicle impacts against the deformable body (3).
A CRASH CUSHION SYSTEM

FIELD OF THE INVENTION

The present invention relates to the technical sector of crash cushion systems for road use.

DESCRIPTION OF THE PRIOR ART

Crash cushions are provided along roads to screen fixed obstacles, such as spikes (constituted by guardrails) or bridge abutments, which can seriously endanger the safety of the occupants of a vehicle in a case of impact against them.

Crash cushions in particular have the function of damping the impact of a vehicle: they absorb the kinetic energy of the vehicle by deforming on the impact.

Crash cushions are usually used together with road safety barriers, i.e. guardrails. For example, a crash cushion can be provided at an exit lane from a motorway, where the guardrail is a spike.

A crash cushion can comprise: a frame fixed to the road surface, comprising a single rail having a longitudinal development; a peripheral edge formed by lateral strips made of sheet metal and a frontal mask made of a plastic material; a plurality of membranes that are arranged in the peripheral edge and which each have a central slide for sliding along the single rail and two lateral skates for dragging on the road surface; dissipator elements fixed to the membranes and interposed between them. The membranes, the dissipator elements and the peripheral edge, which embraces the membranes and the dissipator elements, form the deformable body of the crash cushion.

The deformable body usually has a longitudinal plane of symmetry; the axis of the monorail lies on this longitudinal plane.

In a case of an impact of a vehicle against the cushion, then, the deformable body will tend to deform in a parallel direction to the axis of the monorail,
which can be indicated as the "deforming direction".

If the vehicle impacts the cushion frontally, it can be said that the overall impact force of the vehicle has a parallel direction to the axis of the monorail; there are therefore no components of the impact force that are transversal to the axis of the monorail. As a consequence, the deforming body will tend to deform an crush progressively along the axis of the monorail by effect of the dragging of the skates on the road surface and the sliding of the slides on the monorail. The behaviour of the cushion in this case will be regular and will enable the kinetic energy of the vehicle to be absorbed.

If on the other hand the vehicle impacts laterally against the cushion, in the sense that the axis of the vehicle is inclined by an angle with respect to the axis of the monorail, the overall impact force of the vehicle will exhibit a longitudinal component that is parallel to the axis of the monorail. The longitudinal component of the impact force will tend to cause the deforming body to deform and crush progressively along the axis of the monorail, as specified above in the case of frontal impact.

Differently, the transversal component of the impact force will cause the slide of each membrane to press against the sliding seatings of the monorail, producing a strong dragging friction force which will oppose the retreating of the deformable body along the axis of the monorail during the crushing of the deformable body.

In this way limit situations can occur wherein the cushion is partially or entirely ineffective: the cushion for example can jam and not retreat correctly along the axis of the monorail, with consequences that might even be lethal for the occupants of the vehicle, as a preponderant quantity of the kinetic energy of the vehicle would not be absorbed by the cushion in the form of deforming energy.

This unpredictable behaviour of the cushion depends on many factors, such as the assembly mode of the cushion itself, the speed of the vehicle which impacts against the cushion, as well as the inclination of the vehicle with
respect to the monorail.

It is very important to guarantee crushing of the deformable body by retreating thereof along the deforming direction, such as to guarantee a progressive deformation of the deformable body and a cushioning of the impact, thus safeguarding the safety of the occupants of the vehicle.

Document US 2,000,974 discloses the characteristics which form the preamble of claim 1 of the present application; this teaching however does not obviate the drawbacks mentioned above, in particular in the event of a vehicle impacting laterally against the crash cushion.

SUMMARY OF THE INVENTION

The aim of the present invention consists in obviating the above-mentioned drawbacks, by providing a road crush cushion which is reliable and effective.

The above aims are obtained by means of a road crush cushion according to claim 1.

The first rolling means are configured such as to support the deforming body and guide it along the deforming direction. In the event of an impact of a vehicle against the cushion of the invention, the friction that develops with the rolling is much lower than the dragging friction which would develop with the cushions of the prior art as discussed above: advantageously, also in a case of a lateral impact, the deformable body crushes regularly and deforms progressively along the deforming direction, absorbing the kinetic energy of the vehicle.

The behaviour of the cushion is predictable and the above-cited limit cases are no longer created with reference to the prior art.

The cushion thus-obtained is therefore effective and reliable in cases of frontal or lateral impacts, and safeguards the occupants of the vehicle impacting the cushion from injury.

The low friction between the rolling means and the surface on which they roll
further means that the resistant force associated with the rolling that is exerted by the cushion in opposition to the impact force generated by the vehicle impacting against the cushion can be ignored; in the known cushions, on the other hand, the resistant force exerted by the deformable body (in the prior art example described above the resistant force is exerted by the slides and skates of the membranes) took on significant and unpredictable values. The fact of being able to ignore this resistant force due to the rolling advantageously enables optimal and precise dimensioning of the deformable body in accordance with the kinetic energy which it has to absorb, and thus the dimensioning can be calculated as a function of the maximum speed at which the vehicle can impact the cushion (this maximum speed is established as a function of the type of road on which the cushion is to be installed). Computer simulations of the behaviour of the deformable body (and therefore the crush cushion in its entirety) in a case of impact thus become more realistic and predictable and enable more accurate, simpler and more precise design of the crash cushion itself.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages of the invention will emerge from the description that follows of specific embodiments of the invention, with the aid of the accompanying tables of drawings, in which:

figure 1 is a perspective view of the crash cushion of the present invention;

figures 2A, 2B, 2C, 2D, 2E respectively illustrate a view from above, from the front, from the side, perspective and exploded, of some significant parts of the crash cushion of figure 1;

figures 3A, 3B, 3C, 3D are the same views as in figures 2A, 2B, 2C, 2D but indicate parts that are not in view with broken lines.

DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to the accompanying tables of drawings, reference number 1 denotes in its entirety the crash cushion of the present invention, comprising: a
frame (2) fixable to a road surface (not shown); a deformable body (3) configured such as to deform along a longitudinal axis thereof consequent to an impact of a vehicle (not shown) against the deformable body (3), the deformable body (3) being fixable to the frame (2) in order to identify, by means of the longitudinal axis, a deforming direction (A) of the deformable body (3); first rolling means (4) rotatably coupleable to the deformable body (3) such as to support the deformable body (3) and such as to guide the deformable body (3) along the deforming direction (A) when a vehicle impacts against the deformable body (3).

The deformable body (3) can comprise: a peripheral edge, which in turn can comprise a plurality of lateral strips (5) made of sheet metal and a front mask (6) made of a plastic material; a plurality of membranes (7) that are arranged within the peripheral edge and which can be fixed to the lateral strips (5) or to a lower wall of the deformable body (3) (not shown); groups of dissipator elements fixed for example to the membranes (7), each group being interposed between two adjacent membranes and being constituted by a structure having hexagonal cells (30) with axes thereof arranged vertically.

A first part of the frame (2) can comprise bars which form a box structure (8) arranged posteriorly with respect to the deformable body (3); the rear part of the deformable body (3) is fixed to the first part of the frame (2) (see figure 1).

The frame (2) can further comprise a rolling plate (9) fixable to the road surface; the first wheel (11) and the second wheel (12) can be rotatably coupleable to the deformable body (3) such as to roll on the rolling plate (9).

The rolling plate (9) can be made of a sheet metal.

The rolling plate (9) can be arranged below the deformable body (3) and exhibit a flat and regular surface on which the first rolling means (4) can roll.

In a case of impact, the rolling means can roll, still on a smooth and regular surface, which makes the behaviour of the deformable body (3) even more predictable in the event of an impact with a vehicle; the revolving friction associated to the first rolling means (4) is further reduced.
The first rolling means (4) can comprise a first wheel (11) and a second wheel (12) rotatably couplable to the deformable body (3) and positionable respectively on opposite sides of the longitudinal halfway plane of the deformable body (3) in order to compensate torque forces acting with respect to the longitudinal direction of the deformable body (3), which torque might arise in a case of an impact of the vehicle in arrival in an inclined direction with respect to the deforming direction (A).

The deformable body (3) can be configured such as to have a longitudinal plane which is also a plane of symmetry.

Additionally, the first rolling means (4) can comprise at least a pair of additional wheels (13) which are arranged straddling the deforming direction (A) and thus straddle the longitudinal halfway plane of the deformable body (3). In the illustrated example two pairs of additional wheels (13) are provided.

In this way the stability of the deformable body (3) improves, and at least a part of the weight thereof is better distributed on the first rolling means (4); a part of the weight of the deformable body (3) is supported by the box structure (8) of the frame (2) on which the deformable body (3) is fixed.

In the example illustrated in the figures, the deformable body (3) comprises an axle (14) having: two lateral stalks (15) which respectively rotatably bear the first wheel (11) and the second wheel (12); and a central stalk (16) which rotatably bears the pair of additional wheels (13).

Further, the cushion (1) can comprise a third wheel (17) and a fourth wheel (18) rotatably couplable to the deformable body (3), while the frame (2) can comprise a first longitudinal wall (19) and a second longitudinal wall (20) which are positionable such as to be: facing one another, vertical and parallel to the deforming direction (A); the first longitudinal wall (19), the second longitudinal wall (20), the third wheel (17) and the fourth wheel (18) further being positionable such that the third wheel (17) can roll along a first surface (21) of the first longitudinal wall (19) and the fourth wheel (18) can roll along a second surface (22) of the second longitudinal wall (20) which faces the first surface.
(21) of the first longitudinal wall (19).

The first longitudinal wall (19) and the second longitudinal wall (20) preferably have an elongate development; the longitudinal development axes thereof are parallel to the deforming direction (A) defined above.

The first longitudinal wall (19) and the second longitudinal wall (20) are preferably arranged such as to be on opposite sides with respect to the longitudinal halfway plane of the deformable body (3). In a case of lateral impact of the vehicle against the cushion (1), the deformable body (3) will be subject to a slight transversal displacement with respect to the deforming direction (A) up until the third wheel (17) or the fourth wheel (18) (depending on which direction the vehicle impacts against the cushion) presses respectively against the first surface (21) or the second surface (22), due to the presence of a transversal component of the impact force of the vehicle which is perpendicular to the deforming direction (A).

This transversal displacement depends on the play existing between the third wheel (17) and the first surface (21) of the first longitudinal wall (19) and the play between the fourth wheel (18) and the second surface (22) of the second longitudinal wall (20).

The transversal displacement of the deformable body (3) will determine a dragging of the first wheel (11) and the second wheel (12) along the rolling plate (9); the dragging is insignificant thanks to the small friction between the first wheel (11) and the rolling plate (9) and between the second wheel (12) and the rolling plate (9).

The longitudinal component of the impact force of the vehicle which is parallel to the deforming direction (A) will cause the progressive deforming of the deformable body (3) and the relative retreating thereof along the deforming direction (A): as a consequence, the third wheel (17) or the fourth wheel (18) will roll respectively either along the first surface (21) of the first longitudinal wall (19) or along the second surface (22) of the second longitudinal wall (20).

The first longitudinal wall (19) and the second longitudinal wall (20)
advantageously function as guides to guarantee a retreating of the deformable body (3) along the deforming direction (A); even very violent lateral impacts (with high impact energy) will thus guarantee a retreating of the deformable body (3), again along the deforming direction (A). The friction that is generated when the third wheel (17) or the fourth wheel (18) rolls along the first surface (21) or the second surface (22) is of minimal entity, which is extremely advantageous as it makes a jamming or not-perfect functioning of the cushion (1) extremely improbable in a case of lateral impact of a vehicle travelling at high velocity.

The first longitudinal wall (19) and the second longitudinal wall (20) are arranged above the rolling plate (9).

The first longitudinal wall (19) and the second longitudinal wall (20) can be incorporated respectively in metal C-profiled members (24).

The third wheel (17) and the fourth wheel (18) can be borne rotatably by a T-shaped structural element (23) which is fixed to the central stalk (16) of the axle (14).

To give greater stability to the behaviour of the deformable body (3) in a case of a lateral impact, a first pair formed by a third wheel (17) and a fourth wheel (18) can be provided, arranged frontally with respect to the central stalk (16), and a second pair formed by a third wheel (17) and a fourth wheel (18), arranged posteriorly with respect to the central stalk (16).

The above has been described by way of non-limiting example, and any eventual constructional variants are understood to fall within the scope of protection of the present technical solution, as claimed in the following.
CLAIMS

1) A crash cushion system (1) for road use, comprising:

a frame (2) fixable to a road surface;

a deformable body (3) configured such as to deform along a longitudinal axis thereof consequent to an impact of a vehicle against the deformable body (3), the deformable body (3) being fixable to the frame (2) such as to identify, with the longitudinal axis, a deforming direction (A) of the deformable body (3);

first rolling means (4) rotatably couplable to the deformable body (3) such as to support the deformable body (3) and such as to guide the deformable body (3) along the deforming direction (A) when a vehicle impacts against the deformable body (3), the first rolling means (4) comprising a first wheel (11) and a second wheel (12) rotatably couplable to the deformable body (3) and positionable respectively on opposite sides of the longitudinal halfway plane of the deformable body (3) in order to compensate torque forces acting with respect to the longitudinal direction of the deformable body (3) which might arise in an event of an impact of the vehicle in arrival in an inclined direction with respect to the deforming direction (A);

a third wheel (17) and a fourth wheel (18) rotatably couplable to the deformable body (3);

a first longitudinal wall (19) and a second longitudinal wall (20) which are positionable such as to be: facing one another and vertical; the first longitudinal wall (19), the second longitudinal wall (20), the third wheel (17) and the fourth wheel (18) further being positionable such that the third wheel (17) can roll along a first surface (21) of the first longitudinal wall (19) and the fourth wheel (18) can roll along a second surface (22) of the second longitudinal wall (20) which faces the first surface (21) of the first longitudinal wall (19);

characterised in that:

the frame (2) comprises a rolling plate (9) fixable to the road surface and
wherein the first wheel (11) and the second wheel (12) are rotatably couplable to the deformable body (3) such as to roll on the rolling plate (9);

the first longitudinal wall (19) and the second longitudinal wall (20) being fixed and integral parts of the frame (2), and positionable such as to be parallel to the deforming direction (A).
International application No
PCT/IB2012/053816

A. CLASSIFICATION OF SUBJECT MATTER
INV. E01F15/14
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
E01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search
6 December 2012

Date of mailing of the international search report
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<tr>
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<th>Publication date</th>
<th>Patent family member(s)</th>
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<tr>
<td>US 2000974 A</td>
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<td>NONE</td>
<td></td>
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<tr>
<td>KR 100869344 B1</td>
<td>19-11-2008</td>
<td>NONE</td>
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</tr>
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<td>US 2005036832 A1</td>
<td>17-02-2005</td>
<td>AU 2004267412 A1</td>
<td>03-03-2005</td>
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<td></td>
<td>BR PIQ413520 A</td>
<td>10-10-2006</td>
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<td>CA 2477166 A1</td>
<td>12-02-2005</td>
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<td>CN 1849427 A1</td>
<td>18-10-2006</td>
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<td></td>
<td>EP 1668187 A2</td>
<td>14-06-2006</td>
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<tr>
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<td>HK 1092510 A1</td>
<td>14-01-2011</td>
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<td></td>
<td>JP 2007502390 A</td>
<td>08-02-2007</td>
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<td>KR 20060057610 A</td>
<td>26-05-2006</td>
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<td></td>
<td>MX PA04007757 A</td>
<td>21-04-2005</td>
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<tr>
<td></td>
<td></td>
<td>NZ 545732 A</td>
<td>26-06-2009</td>
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<td></td>
<td>US 2005036832 A1</td>
<td>17-02-2005</td>
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<td>US 2005047862 A1</td>
<td>03-03-2005</td>
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<td></td>
<td>US 2005063777 A1</td>
<td>24-03-2005</td>
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<td></td>
<td>US 2005244224 A1</td>
<td>03-11-2005</td>
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<td></td>
<td>WO 2005019680 A2</td>
<td>03-03-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZA 200601325 A</td>
<td>27-06-2007</td>
</tr>
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<td>DE 19525243 A1</td>
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