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(54) **ROAD SAFETY BARRIERS**

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EP 1 664 442 B1

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Description

[0001] This invention relates to road safety barriers for use at the sides or central reservations of roads and motorways, and in particular these including a plurality of wire ropes interwoven and maintained under tension between supporting posts.

[0002] A known wire rope road safety barrier, described in EP 0 369 659 A1, includes two pairs of wire ropes, one pair of upper ropes supported in slots provided in a number of posts and lying generally parallel to one another, and a lower pair of ropes held in tension against and in contact with opposite side edge surfaces of posts. Each lower cable follows a sinuous path and passes to a different one of the two side surfaces of the same post. Although this safety barrier design added substantially to the containment capability over an earlier two wire rope barrier, it is now recognised that there are disadvantages associated with the parallel arrangement of the upper ropes because they have very little connectivity/cohesion with the posts. Consequently the upper ropes behave less stiffly and have less energy absorption capability than the (interwoven) lower ropes. Also because of the vertical rigidity of the posts there is a possibility of an errant vehicle straddling the safety barrier and receiving an upward thrust leading to overturning of the vehicle, if the posts fail to collapse in time.

[0003] It is desirable to achieve a degree of pre-tensioning of the interwoven wire ropes such that the integrity of the barrier is maintained during the immediate post-crash period. However, a consequence of the pre-tensioning is a tendency for the interwoven ropes to grip the posts so tightly that their combined frictional grip in the direction of the line of the barrier exceeds the elastic bending strength of the posts in that direction. This can lead to posts located some distance away from the vehicle impact zone being pulled over by the ropes towards the vehicle to the extent that they are permanently deformed.

[0004] It is an aim of the present invention to provide a road safety barrier which alleviates the aforementioned problems.

[0005] According to the present invention, there is provided a road safety barrier comprising four or more ropes supported by posts rigidly mounted on or in the ground, each rope being held in tension against the posts and following a sinuous path between the posts.

[0006] In embodiments of the invention, the tensioning of the ropes against the posts gives rise to a combined frictional resistance to displacement of the ropes relative to each post or at least some of the posts along the length of the safety barrier. The structure of each post and/or its/their mounting with respect to the ground defines a minimum bending yield strength in a direction along the length of the barrier. This minimum bending yield strength is advantageously greater than the bending moment resulting from the combined frictional resistance forces acting on the post.

[0007] Notwithstanding the above requirement all (or most) of the posts exhibit a preferential mode of collapse in a direction along the length of the safety barrier, relative to a transverse direction, so that they do not project from the line of the fence after an accident.

[0008] Embodiments of the present invention may provide an enhanced vehicle restraint capability relative to the four-wire rope fence described in EP 0 369 659 A1 particularly in cases involving larger and heavier vehicles. Further ropes may be interwoven between the posts to create a multi-rope barrier in order to achieve an increased containment capability although additional ropes to the minimum four are preferably added in pairs so the total number of ropes is even. This is so that the barrier has a more consistent resistance to vehicle penetration along its length. The ropes may be arranged in pairs at different heights on the posts or alternatively each rope may be at a different height from the others. In the latter case, the dispersion of the ropes allows the barrier to better accommodate a wide variety of vehicle types/heights and reduces the risk of rope redundancy in terms of vehicle capture.

[0009] Rope supports may be provided on the posts for vertically locating the ropes thereon while permitting longitudinal movement in the direction of the plane of the barrier. The rope supports may be formed integrally in the posts, possibly by way of longitudinally disposed notches. Alternatively the ropes may be supported on frangible supports such as rollers mounted on the posts.

[0010] The posts may have an asymmetrical cross-sectional profile such that the post presents the same profile to oncoming traffic on both sides of the barrier. This is, when the post is installed in the ground, rounded corners of the post are presented to oncoming traffic travelling in opposite directions on either side of the barrier. For example, the cross-sectional profile of the post may be of "S" or "Z", preferably with rounded corners on the line of the bend so that a rounded corner is presented to oncoming traffic. The S-post is therefore to be preferred in the central reservation of dual carriageways where vehicles drive on the left-hand side of the road, whereas the Z-post is preferable in the near-side verges. The opposite choice would naturally prevail in right-hand drive countries.

[0011] Embodiments of the present invention are advantageous in that when a vehicle impacts the barrier, there is an enhanced vehicle containment/retardation capability and a reduced risk of post collapse or damage in the regions of the barrier up and downstream of the impact area.

[0012] The invention will now be further described by way of example with reference to the accompanying drawings, in which like reference numerals designate like elements, and in which:

Figure 1 shows part of a road safety barrier described in EP 0 369 659 A1;

Figure 2 shows a section of a road safety barrier according to a first embodiment of the present invention;

5 Figure 3 shows a section of a road safety barrier according to a second embodiment of the present invention;

Figures 4a to 4c show a rope support which may be adopted in embodiments of the present invention;

10 Figure 4d shows an alternative rope support which may be adopted in embodiments of the present invention;

Figure 5 is a graph showing frictional resistance between ropes and posts due to interweaving; and

Figure 6 is a graph showing tension fall-off due to rope interweaving.

15 **[0013]** In the arrangement shown in figure 1, posts 1, 2 and 3 are inserted into the ground (not shown) and support two pairs of wire ropes 4,5 and 6,7. The posts may be inserted into the ground either into recesses in pre-cast footings or by any other suitable means. The posts may be made from steel pressings having, for example, and "S" or "Z" cross-section such that a rounded corner of the line of the bend is offered to the direction of the traffic instead of a sharp edge. In addition the post shape will preferably present a smooth conforming surface to the ropes, and a smooth radiused surface to any other impacting bodies so as to minimise the damage thereto under collision conditions.

20 **[0014]** The ropes 4, 5 of one pair are lying parallel to one another and supported within notches 8, 9 and 10 provided within respective posts 1, 2 and 3. The ropes 6,7 of the other pair are interwoven between the posts in the manner illustrated and supported in a vertical direction on the side of the posts by way of supports 11, 12 and 13. Each rope is maintained under tension so that the barrier provides an effective restraint to errant vehicles.

25 **[0015]** In the first embodiment of the present invention, as illustrated in figure 2, the ropes of both pairs 4, 5 and 6, 7 are interwoven about the posts 1, 2 and 3 instead of only the lower pair 6, 7. Each of the ropes is supported in a vertical direction on the side of the posts by way of supports 11, 12 and 13. The ropes of the first pair 4, 5 are at substantially the same height above the ground as one another and the ropes of the second pair 6, 7 are also at substantially the same height above the ground as one another but lower than first pair. In the second embodiment, illustrated in figure 30 3, all of the ropes 4 to 7 are interwoven but instead of being arranged in two pairs vertically spaced apart from one another, all of the ropes are vertically spaced apart with respect to one another at different heights above the ground. The first and second embodiments have the advantage, relative to the prior art arrangement illustrated in figure 1, that the containment capability of the barrier is improved and the risk of an impacting vehicle overturning is reduced for a wider range of vehicle weights and sizes. It is noted that figures 2 and 3 illustrate a preferred method of interweaving in that each of the ropes passes from one side of the first post to the alternate side of the next one and so on progressively along the length of the barrier. It is preferred for the interweaving of half of the ropes to be arranged out of phase with the other half and in a manner which balances the potential bending moments on the respective posts, to ensure a consistent resistance to penetration (by vehicles) along the length of the barrier.

35 **[0016]** Figures 4a to 4c show rope supports which maybe advantageously adopted in the posts of the embodiments of figures 2 and 3. Figure 4a shows a keyhole slot 15 formed in the wall of the post 1. A support roller 16 is mounted within the keyhole slot 15 and held therein by spigot 17. The roller 16 supports the wire rope 4 so that it is free to slide in the longitudinal direction of the safety barrier and free to move upwardly in the event of a vehicle impact. The roller supports are preferably frangible so that, in the event of a vehicle impact in which the posts fail to collapse towards the ground, the ropes are able to become detached from the posts more easily. Instead of supporting the ropes by way of the support roller 16 illustrated in figures 4a to 4c, the ropes could be supported by a simple protuberance formed in the surface of the post.

45 **[0017]** Alternatively, as illustrated in figure 4d which shows a part view of the post 1, the rope 4 may be located within shallow and longitudinally orientated grooves/depressions or notches 20 provided in flanges of the post section. This enables smooth supporting of the ropes as well as simple and accurate positioning thereof at predetermined heights on the one hand while allowing the ropes to be released from the notch if a significant vertical force is exerted on the rope. The release of the rope from the post 1 when subjected to an upward or downward force avoids them applying any upthrust to the vehicle and the possibility of the post 1 being pulled out of the ground.

50 **[0018]** Each of the ropes 4 to 7 is pre-tensioned by means of ground anchors at suitable intervals along the highway. The tension may be applied, for example, by temporary jacking means and adjustable rope anchorages, or by threaded end connectors and bottle screws (not shown). Intermediate tensioning means may be introduced to permit the end anchorages to be more widely separated.

55 **[0019]** During installation of the safety barrier, steps should be taken to ensure that the pre-tensioning of the wire ropes 4 to 7 is such that the tension is uniformly distributed along the barrier between the anchorage points.

[0020] In the present invention, the yield strength of the posts in the longitudinal direction of the safety barrier exceeds the combined bending moments due to the normal frictional forces of the ropes on the posts under the expected tensions in the system. The significance of the post-rope frictional resistance and its bearing on the performance of the safety barrier will be explained in more detail below under the heading "Safety Barrier Crash Performance".

[0021] The posts should be designed to be secured in the ground in a manner capable of resisting the (longitudinal and transverse) bending moments on the post prior to and during its collapse under vehicle impact conditions, having regard to the prevailing ground conditions.

[0022] The post cross-section may be of any size and shape which satisfies the above criteria, and may vary in dimensions along the length of the barrier to reflect differing requirements, e.g. curves in the highway and/or changing post spacing.

Examples of possible Z-post sections:-

[0023]

Superficial dimensions of post cross-section mm			2 nd Moment of Inertia mm ⁴	
Depth	Width	Thickness	In plane of barrier	Normal to barrier
100	32	5.0	59,000	914,000
100	32	6.0	66,700	1,064,000
100	40	6.0	125,000	1,280,000
110	40	6.0	130,000	1,625,000
110	50	6.0	242,000	1,960,000
120	40	6.0	135,000	2,016,000
120	50	6.0	245,000	2,420,000
120	50	8.0	307,000	3,070,000

It may also vary in flexural stiffness along the length of the post to take account of the varying bending moment. The type of section will therefore preferably lend itself to being manufactured by processes which can readily accommodate changes in size and shape without incurring prohibitive costs for tooling and the like.

[0024] The posts shall be of such a cross-section that they not only provide the barrier with adequate resistance to vehicle penetration (transverse to the line of the barrier) but also have a preferential mode of collapse in the direction of the line of the barrier. This is achieved by making the second moment of area of the posts in the longitudinal direction (in the plane of the barrier) significantly less than its second moment of area in the transverse direction (normal to the barrier) as illustrated in the above table. In order to comply safely with this requirement it is expected that the depth of the post cross-section is preferably in the region of 2-3 times the width thereof.

[0025] The constructional design detail of the rope tendons is believed non-critical to the initial functionality of the barrier so long as the ultimate strength and axial stiffness of the ropes are correctly specified, in keeping with the expected (crash) performance of the barrier. However the 19mm diameter 3x7(6/1) rope is commonly used at present in this application and is a suitable rope for use in barriers embodying the present invention. This type of rope is favoured both for ease of manufacture/handling, and for its structural integrity when subjected to mechanical abrasion/abuse. In addition it is substantially torque balanced under load which facilitates pre-tensioning and avoids undesirable rotational displacements in service.

[0026] However to optimise the functionality of the barrier in the immediate post-crash period steps should be taken to minimise the loss in rope tension when the barrier is impacted by a vehicle. In addition to ensuring that the barrier is uniformly pre-tensioned along its length, the ropes should be pre-stretched at a tension equivalent to 50% of their breaking strength, to remove initial stretch and elevate the elastic limit of the wire rope. Typically such ropes will have a minimum breaking strength of 174 kN and an axial stiffness of at least 23 MN.

[0027] The level of pre-tension applied to the wire ropes during installation of the barrier may be regarded as an important variable in determining the crash performance of the barrier, with particular regard to vehicle deceleration rates and the permissible level of penetration beyond the line of the barrier. Normally for effective containment the ropes will be pre-tensioned to a tension equal to at least 10% of their breaking strength, and preferably to a tension equivalent to about 15% of their breaking strength and even to a level equivalent to about 20% of their breaking strength where other design and practical considerations allow.

Safety Barrier Crash Performance

[0028] The use of parallel top ropes in the prior art barrier illustrated in figure 1 is advantageous in that it is easy to apply and maintain tension in those elements of the system. Specifically, the frictional resistance between the ropes and the post slots (in which they are a loose fit) is so low that that tension is readily transmitted over long lengths simply by tightening up the bottle screws at the anchorage points. This has the added benefit that in the event of a vehicle collision with the fence, there is little loss in tension in the top ropes and their functionality is largely maintained, thus preserving the integrity of the barrier until repairs can be effected. On the other hand, the use of interwoven top ropes increases the dynamic stiffness of the barrier and its energy absorption capability, thus improving the primary safety of the barrier.

[0029] Embodiments of the invention adopt interwoven ropes in place of the prior art parallel top rope arrangement. However, interwoven ropes are more difficult to pre-tension, because the angular deflection of the ropes creates a proportional increase in the frictional resistance to movement between them and the posts. Typically the ropes are deflected from the line of the barrier by 2-3 degrees, but at shorter post spacing the angular deflection increases rapidly and may reach 5 degrees or more. The effect of this on the frictional resistance between the ropes and the posts is illustrated in Figure 5 below. This figure takes the example of a 19mm (3/4") dia. rope on 100mm (4") deep posts, and assumes a coefficient of friction = 0.20.

[0030] This tensioning difficulty can be overcome by adopting an iterative tensioning procedure. The ropes may be tensioned up to or slightly beyond the desired level at the anchorage or tensioning points, and then the intervening posts (in the direction of the line of the fence) may be disturbed so as to promote rope slip and the redistribution of the tension. This procedure is repeated to effect a progressive tensioning of the whole fence stage, up to the desired level.

[0031] Notwithstanding the effectiveness of this technique, the interwoven ropes suffer a significant loss in local tension when posts are collapsed by an impacting vehicle, as the angular (zigzag) deflection of the ropes is removed in the area of the collision. Figure 6 (below) illustrates this effect graphically by considering one (or more) post bays in isolation from the rest of the fence and assuming that the ropes are initially pre-tensioned to 20% of the breaking strength (B/S) of the ropes.

[0032] This is admittedly a worst case scenario and in practice a considerable amount of these tension losses will be taken up by the undisturbed rope in the adjoining fence bays. Nevertheless the residual tension in the ropes will be significantly less than if they had not been interwoven. This emphasises the need for effective pre-tensioning of the ropes to the recommended level, if a degree of barrier integrity is to be maintained in the immediate post-crash period.

[0033] A consequence of these effects is that the interwoven ropes will tend to grip the posts tightly such that their combined frictional grip in the direction of the line of the fence exceeds the elastic bending strength of the posts in that direction. When interwoven upper ropes are introduced, there is therefore the prospect of posts being pulled over by the ropes in positions not directly affected by an impacting vehicle. This pre-supposes that the rope displacements are sufficiently large to induce flexural yielding of the posts. Significantly the direction of this movement will be towards the colliding vehicle. Therefore, in accordance with a preferred aspect of the present invention, the posts are constructed and/or their attachment to the ground is such that the yield strength in bending of the posts (in the direction of the line of the fence) exceeds the combined bending moment of the rope frictional forces.

[0034] The move to a fully interwoven barrier system in accordance with the present invention further alleviates this problem. Embodiments may be provided with means for supporting the ropes, which are frangible at the posts. In the embodiment illustrated with reference to figures 4a to 4c, the (roller) supports are mounted on spigots which readily shear in the event of substantial downward forces being applied.

Worked Example: -

[0035] Consider the case of a 4-rope interwoven barrier in which the ropes have a mean height above ground level of 550mm and posts at 2.4m spacing, each having a depth of 100mm. The resulting angular deviation of the ropes (in plan view relative to the line of the barrier) will be 2.38 degrees. If we assume for design purposes that each rope will see a tension of 50kN, then it can be shown that the four ropes will generate a frictional grip on a post of 3.33kN (taking the coefficient of friction to be 0.20). The effect of this force is to create a bending moment in the post which will reach a maximum of 1832 Nm (at the base of the post) before the ropes slip. The result of this bending moment in terms of maximum bending stress will vary with the strength and stiffness of the type of post selected, as illustrated in the table below:-

Comparison of maximum bending stresses in Z-posts at 2.4m centres:

[0036]

Post dimensions mm D x W x Thickness.	In-line moment of inertia mm ⁴	Combined bending moment Nm	Maximum bending stress N/mm ²
100x32x6.0	66,700	1832	439
100 x 40 x 6.0	125,000	1832	293
120 x 50 x 6.0	245,000	2197	224

[assumes 50kN rope tension and 550mm mean rope height]

[0037] With the Standard (100x32x6mm) post it was found that the maximum bending stress greatly exceeded the yield strength of the post, which is 275 MPa [for Fe430A grade material]. The use of a larger (100x40x6.0mm) post was therefore considered but the maximum bending stress still marginally exceeded the Fe430A yield strength. In this instance the problem could be solved by using a higher grade of steel post, e.g. Grade Fe510A which offers a yield strength of 355 MPa. A possible alternative solution would be to use a yet larger post such as the 120x50x6mm section. Whilst this increases the angular deviation of the ropes and the bending moment slightly, the maximum bending stress falls to 224 MPa, well below the normal yield strength of 275 MPa.

[0038] Although intuition would suggest that post failure would be caused by direct impact of a colliding vehicle on the post, it appears that (for a pre-tensioned wire rope safety barrier) the mode of collapse of the posts is more generally attributable to the longitudinal components of the tensions in the ropes, as they are deflected by the ingress of the vehicle beyond the line of the barrier. The angular deflection of the ropes increases rapidly as the vehicle approaches the (first) post, up to the point at which the yield point of the post is reached, whereupon the ropes are released from the first post, to apply a similar progressive force (and bending moment) to the next post in line.

[0039] In an interwoven barrier, only the ropes that are on the upstream side of the post in question (i.e. lie between it and the oncoming vehicle) can act to pull it down. Hence, provision of an even number of ropes would render the barrier to a more consistent resistance to vehicle penetration along its length. Similar considerations apply to the selection of an optimum interweaving pattern for the ropes, if the ropes are not being paired at the same height.

[0040] It is noted that in embodiments of the present invention, the aforementioned problem of posts being pulled over is less apparent in the regions of the barrier close to the ends where the ropes are anchored to the ground. This is because at posts close to the barrier ends, the effective stiffness of the ropes increases due to the relatively short length thereof between the post in question and the anchorage point. Consequently, the ropes near the end positions of the barrier tend to deflect less under crash conditions relative to positions further away from the ends. As a result the frictional resistance of the ropes against the posts in these positions is less likely to deflect the post sufficient to cause yielding in bending. Therefore, posts near the anchorage ends of the barrier need not necessarily comply with the minimum bending yield strength of the present invention.

Claims

1. A road safety barrier comprising:

a plurality of posts (1, 2, 3) rigidly mounted on or in the ground, the barrier having a length in a direction from one post to another; and

four or more ropes (4, 5, 6, 7) supported by the posts, each rope being held in tension against the posts; wherein the arrangement of the ropes and the posts gives rise to a combined frictional resistance to displacement of the ropes relative to each post along the length of the safety barrier, the combined frictional resistance imparting a bending moment to each post;

wherein the cross section of at least most of the posts is such that the second moment of area of the posts in the plane of the barrier is significantly less than the second moment of area of the posts normal to the barrier, **characterised in that** each rope follows a sinuous path between the posts, said cross section and the arrangement of said posts relative to the ground provide a bending yield strength in a direction along the length of the barrier greater than the bending moment resulting from the combined frictional resistance forces acting on the posts; and

whereby in the event of an impact on the barrier by a vehicle, the posts outside the immediate collision zone tend to remain upright to maintain the overall integrity of the barrier and the risk of post collapse towards the impacting vehicle is minimised.

2. A road safety barrier according to claim 1, wherein the depth of the post cross-section is substantially 2 to 3 times the width thereof.
3. A road safety barrier according to claim 1 or claim 2, wherein all or most of the posts (1, 2, 3) are configured such that they exhibit a preferential mode of collapse in a direction along the length of the safety barrier, relative to the transverse direction.
4. A road safety barrier according to any preceding claim, comprising an even number of ropes (4, 5, 6, 7) arranged in pairs (4, 5; 6, 7).
5. A road safety barrier according to any of claims 1 to 3, wherein the ropes (4, 5, 6, 7) are arranged at different heights.
6. A road safety barrier according to any preceding claim, further comprising rope supports (11, 12, 13) provided on the posts (1, 2, 3) for vertically locating the ropes (4, 5, 6, 7) thereon while permitting longitudinal movement in the direction of the plane of the barrier.
7. A road safety barrier according to claim 6, wherein the rope supports (11, 12, 13) are formed integrally in the posts (1, 2, 3).
8. A road safety barrier according to claim 7, wherein the rope supports (11, 12, 13) are longitudinally disposed notches (20).
9. A road safety barrier according to claim 6, wherein the ropes (4, 5, 6, 7) are supported on rollers (16) mounted on the posts (1, 2, 3).
10. A road safety barrier according to claim 9, wherein the rollers (16) are mounted in keyhole slots (15) formed in the posts (1, 2, 3).
11. A road safety barrier according to any of claims 6 to 10, wherein the rope supports (11, 12, 13) are frangible.
12. A road safety barrier according to any preceding claim, wherein the posts (1, 2, 3) are of asymmetric cross-section such as to have rounded corners whereby a rounded corner can be presented to oncoming traffic travelling in opposite directions either side of the barrier.
13. A road safety barrier according to claim 12, wherein the posts (1, 2, 3) are of "S" or "Z" cross-section.
14. A road safety barrier according to any preceding claim, wherein the ropes (4, 5, 6, 7) are pre-tensioned to a level of at least 10% of their breaking strength.
15. A road safety barrier according to any of claims 1 to 13, wherein the ropes (4, 5, 6, 7) are pre-tensioned to a level of at least 15% of their breaking strength.
16. A road safety barrier according to claim 1, wherein chosen post cross-section satisfies the criteria that:
the second moment of inertia in the plane of the barrier is substantially within the range 59,000 to 307,000 mm⁴; and
the second moment of inertia normal to the barrier is substantially within the range 914,000 to 3,070,000 mm⁴; and
wherein most or all of the posts (1, 2, 3) are configured such that they provide the barrier with resistance to vehicle penetration transverse to the line of the barrier.

Patentansprüche

1. Straßenleitplanke, die aufweist:

eine Vielzahl von Pfosten (1, 2, 3), die starr auf oder im Boden montiert sind, wobei die Barriere eine Länge in einer Richtung von einem Pfosten zum anderen aufweist; und
vier oder mehr Seile (4, 5, 6, 7), die von den Pfosten getragen werden, wobei ein jedes Seil gegen die Pfosten

unter Spannung gehalten wird;

wobei die Anordnung der Seile und der Pfosten einen kombinierten Reibungswiderstand gegen eine Verschiebung der Seile relativ zu jedem Pfosten entlang der Länge der Sicherheitsbarriere bewirken, wobei der kombinierte Reibungswiderstand einem jedem Pfosten ein Biegemoment erteilt;

wobei der Querschnitt von mindestens den meisten der Pfosten so ist, dass das zweite Flächenmoment der Pfosten in der Ebene der Barriere bedeutend geringer ist als das zweite Flächenmoment der Pfosten senkrecht zur Barriere, **dadurch gekennzeichnet, dass** ein jedes Seil einem gewundenen Weg zwischen den Pfosten folgt, wobei der Querschnitt und die Anordnung der Pfosten relativ zum Boden eine Biegebiegefestigkeit in einer Richtung entlang der Länge der Barriere größer als das Biegemoment liefern, das sich aus den kombinierten Reibungswiderstandskräften ergibt, die auf die Pfosten wirken; und

wobei im Fall eines Stoßes auf die Barriere durch ein Fahrzeug die Pfosten außerhalb der unmittelbaren Kollisionszone dazu neigen, aufrecht zu bleiben, um die gesamte Integrität der Barriere aufrechtzuerhalten, und die Gefahr eines Knickens eines Pfostens in Richtung des auftreffenden Fahrzeuges wird minimiert.

2. Straßenleitplanke nach Anspruch 1, bei der die Tiefe des Pfostenquerschnittes im Wesentlichen das 2- bis 3-fache von dessen Breite beträgt.
3. Straßenleitplanke nach Anspruch 1 oder Anspruch 2, bei der alle oder die meisten der Pfosten (1, 2, 3) so ausgebildet sind, dass sie eine bevorzugte Art und Weise des Knickens in einer Richtung entlang der Länge der Sicherheitsbarriere relativ zur Querrichtung zeigen.
4. Straßenleitplanke nach einem der vorhergehenden Ansprüche, die eine gerade Anzahl von Seilen (4, 5, 6, 7) aufweist, die in Paaren (4, 5; 6, 7) angeordnet sind.
5. Straßenleitplanke nach einem der Ansprüche 1 bis 3, bei der die Seile (4, 5, 6, 7) in unterschiedlichen Höhen angeordnet sind.
6. Straßenleitplanke nach einem der vorhergehenden Ansprüche, die außerdem Seilhalterungen (11, 12, 13) aufweist, die an den Pfosten (1, 2, 3) für das vertikale Anordnen der Seile (4, 5, 6, 7) daran vorhanden sind, während eine Längsbewegung in der Richtung der Ebene der Barriere gestattet wird.
7. Straßenleitplanke nach Anspruch 6, bei der die Seilhalterungen (11, 12, 13) zusammenhängend mit den Pfosten (1, 2, 3) ausgebildet sind.
8. Straßenleitplanke nach Anspruch 7, bei der die Seilhalterungen (11, 12, 13) in Längsrichtung angeordnete Kerben (20) sind.
9. Straßenleitplanke nach Anspruch 6, bei der die Seile (4, 5, 6, 7) auf Rollen (16) getragen werden, die an den Pfosten (1, 2, 3) montiert sind.
10. Straßenleitplanke nach Anspruch 9, bei der die Rollen (16) in Befestigungslöchern (15) montiert sind, die in den Pfosten (1, 2, 3) ausgebildet sind.
11. Straßenleitplanke nach einem der Ansprüche 6 bis 10, bei der die Seilhalterungen (11, 12, 13) zerbrechlich sind.
12. Straßenleitplanke nach einem der vorhergehenden Ansprüche, bei der die Pfosten (1, 2, 3) einen asymmetrischen Querschnitt aufweisen, so dass sie abgerundete Ecken aufweisen, wodurch eine abgerundete Ecke dem Gegenverkehr präsentiert werden kann, der sich in den entgegengesetzten Richtungen auf beiden Seiten der Barriere bewegt.
13. Straßenleitplanke nach Anspruch 12, bei der die Pfosten (1, 2, 3) einen "S"- oder "Z"-Querschnitt aufweisen.
14. Straßenleitplanke nach einem der vorhergehenden Ansprüche, bei der die Seile (4, 5, 6, 7) bis zu einem Niveau von mindestens 10 % ihrer Reißfestigkeit vorgespannt sind.
15. Straßenleitplanke nach einem der Ansprüche 1 bis 13, bei der die Seile (4, 5, 6, 7) bis zu einem Niveau von mindestens 15 % ihrer Reißfestigkeit vorgespannt sind.

16. Straßenleitplanke nach Anspruch 1, bei der ein ausgewählter Pfostenquerschnitt die folgenden Kriterien erfüllt:

das Flächenträgheitsmoment in der Ebene der Barriere im Wesentlichen innerhalb des Bereiches von 59000 bis 307000 mm⁴ liegt; und

das Flächenträgheitsmoment senkrecht zur Barriere im Wesentlichen innerhalb des Bereiches von 914000 bis 3070000 mm⁴ liegt; und

wobei die meisten oder alle Pfosten (1, 2, 3) so ausgebildet sind, dass sie die Barriere mit einem Widerstand gegen ein Eindringen des Fahrzeuges quer zum Verlauf der Barriere versehen.

Revendications

1. Glissière de sécurité routière, comprenant :

plusieurs montants (1, 2, 3), montés de manière rigide dans le sol, la glissière ayant une longueur dans une direction allant d'un montant à l'autre ; et

quatre cordes ou plus (4, 5, 6, 7), supportées par les montants, chaque corde étant maintenue en tension contre les montants ;

dans laquelle l'agencement des cordes et des montants entraîne une résistance de frottement combinée au déplacement des cordes par rapport à chaque montant le long de la longueur de la glissière de sécurité, la résistance de frottement combinée conférant un moment de flexion à chaque montant ;

dans laquelle la section transversale d'au moins la majeure partie des montants est telle que le deuxième moment d'inertie des montants dans le plan de la glissière est notablement inférieur au deuxième moment d'inertie des montants dans une direction perpendiculaire à la glissière, **caractérisée en ce que** chaque corde suit une trajectoire sinueuse entre les montants, ladite section transversale et l'agencement des montants par rapport au sol entraînant une limite élastique de flexion dans une direction le long de la longueur de la glissière supérieure au moment de flexion résultant des forces de résistance de frottement combinées agissant sur les montants ; et

en cas d'un impact d'un véhicule sur la glissière, les montants situés hors de la zone de collision immédiate tendant ainsi à rester droits en vue de maintenir l'intégrité globale de la glissière, le risque d'un affaissement des montants en direction du véhicule sujet de l'impact étant ainsi réduit au minimum.

2. Glissière de sécurité routière selon la revendication 1, dans laquelle la profondeur de la section transversale du montant représente sensiblement 2 à 3 fois la largeur de celle-ci.

3. Glissière de sécurité routière selon les revendications 1 ou 2, dans laquelle tous les poteaux ou la majeure partie des poteaux (1, 2, 3) sont configurés de sorte à présenter un mode d'affaissement préférentiel dans une direction le long de la longueur de la glissière de sécurité, par rapport à la direction transversale.

4. Glissière de sécurité routière selon l'une quelconque des revendications précédentes, comprenant un nombre pair de cordes (4, 5, 6, 7) agencées par paires (4, 5, 6, 7).

5. Glissière de sécurité routière selon l'une quelconque des revendications 1 à 3, dans laquelle les cordes (4, 5, 6, 7) sont agencées au niveau de hauteurs différentes.

6. Glissière de sécurité routière selon l'une quelconque des revendications précédentes, comprenant en outre des supports des cordes (11, 12, 13) agencés sur les montants (1, 2, 3) en vue d'y positionner verticalement les cordes (4, 5, 6, 7), tout en permettant un déplacement longitudinal dans la direction du plan de la glissière.

7. Glissière de sécurité routière selon la revendication 6, dans laquelle les supports des cordes (11, 12, 13) sont formés d'un seul tenant dans les montants (1, 2, 3).

8. Glissière de sécurité routière selon la revendication 7, dans laquelle les supports des cordes (11, 12, 13) sont constitués par des encoches à agencement longitudinal (20).

9. Glissière de sécurité routière selon la revendication 6, dans laquelle les cordes (4, 5, 6, 7) sont supportées sur des rouleaux (16) montés sur les montants (1, 2, 3).

EP 1 664 442 B1

10. Glissière de sécurité routière selon la revendication 9, dans laquelle les rouleaux (16) sont montés dans des fentes en forme de trou de serrure (15) formées dans les montants (1, 2, 3).

11. Glissière de sécurité routière selon l'une quelconque des revendications 6 à 10, dans laquelle les supports des cordes (11, 12, 13) sont frangibles.

12. Glissière de sécurité routière selon l'une quelconque des revendications précédentes, dans laquelle les montants (1, 2, 3) ont une section transversale asymétrique, de sorte à avoir des coins arrondis, un coin arrondi pouvant ainsi être présenté au trafic arrivant, roulant dans des directions opposées de chaque côté de la glissière.

13. Glissière de sécurité routière selon la revendication 12, dans laquelle les montants (1, 2, 3) ont une section transversale en « S » ou en « Z ».

14. Glissière de sécurité routière selon l'une quelconque des revendications précédentes, dans laquelle les cordes (4, 5, 6, 7) sont prétendues à un niveau représentant au moins 10% de leur résistance à la rupture.

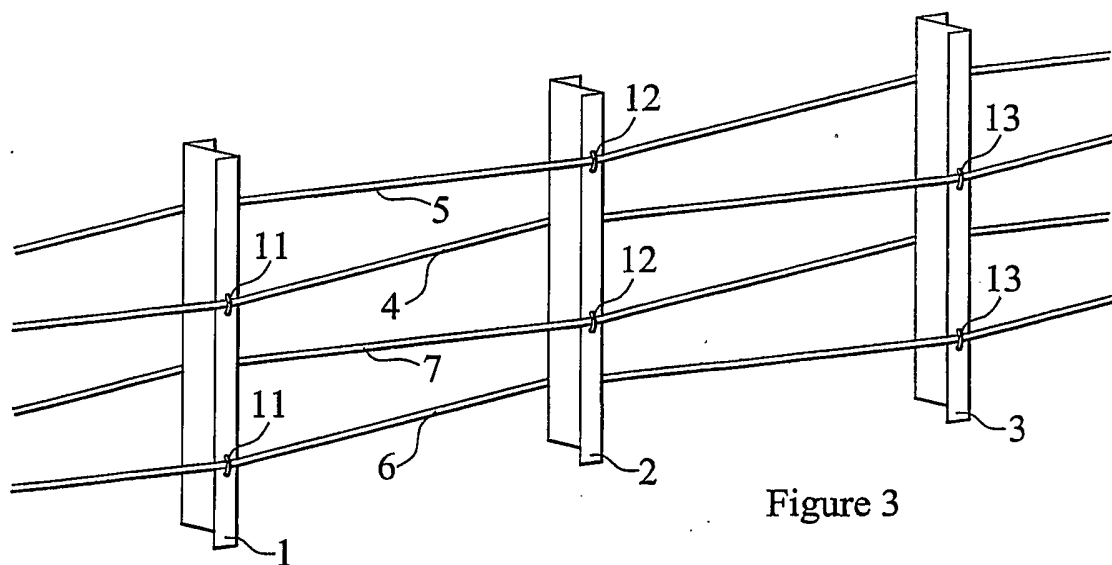
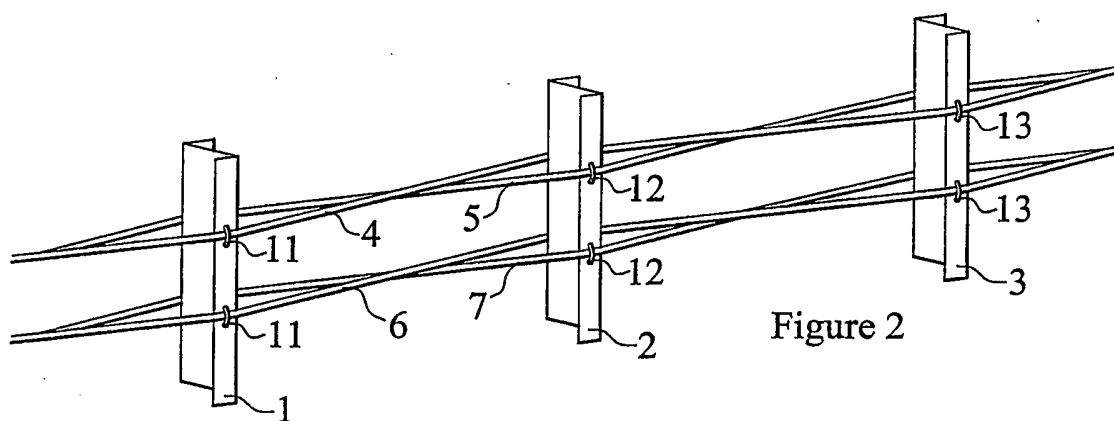
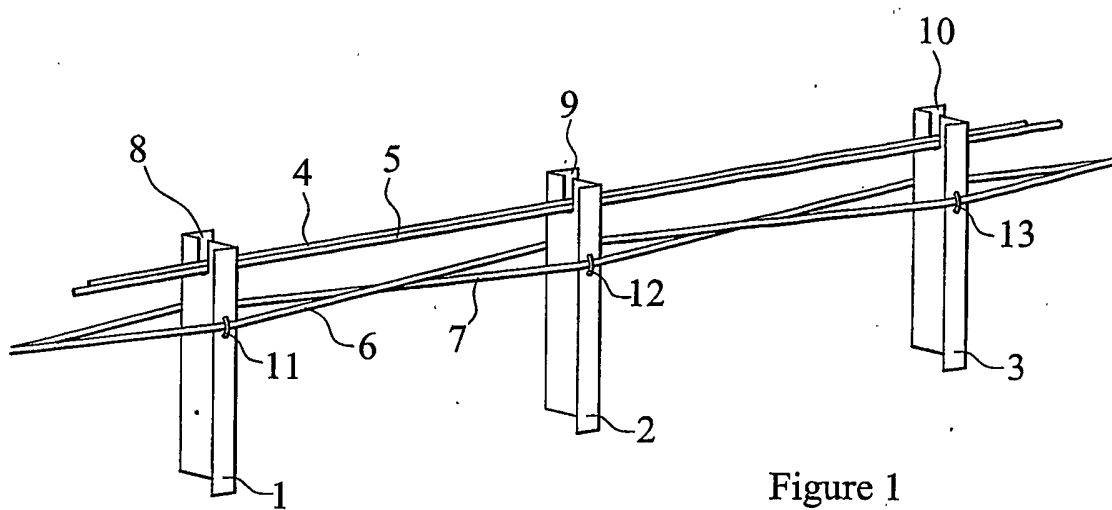
15. Glissière de sécurité routière selon l'une quelconque des revendications 1 à 13, dans laquelle les cordes (4, 5, 6, 7) sont prétendues à un niveau représentant au moins 15% de leur résistance à la rupture.

16. Glissière de sécurité routière selon la revendication 1, dans laquelle la section transversale choisie des montants satisfait les critères ci-dessous :

le deuxième moment d'inertie dans le plan de la glissière est sensiblement compris dans l'intervalle allant de 59.000 à 307.000 mm⁴ ; et

le deuxième moment d'inertie perpendiculaire à la glissière est sensiblement compris dans l'intervalle allant de 914.000 à 3.070.000 mm⁴ ; et

dans laquelle la majeure partie des montants ou tous les montants (1, 2, 3) sont configurés de sorte qu'ils confèrent à la glissière une résistance à une pénétration d'un véhicule dans une direction transversale à la ligne de la glissière.



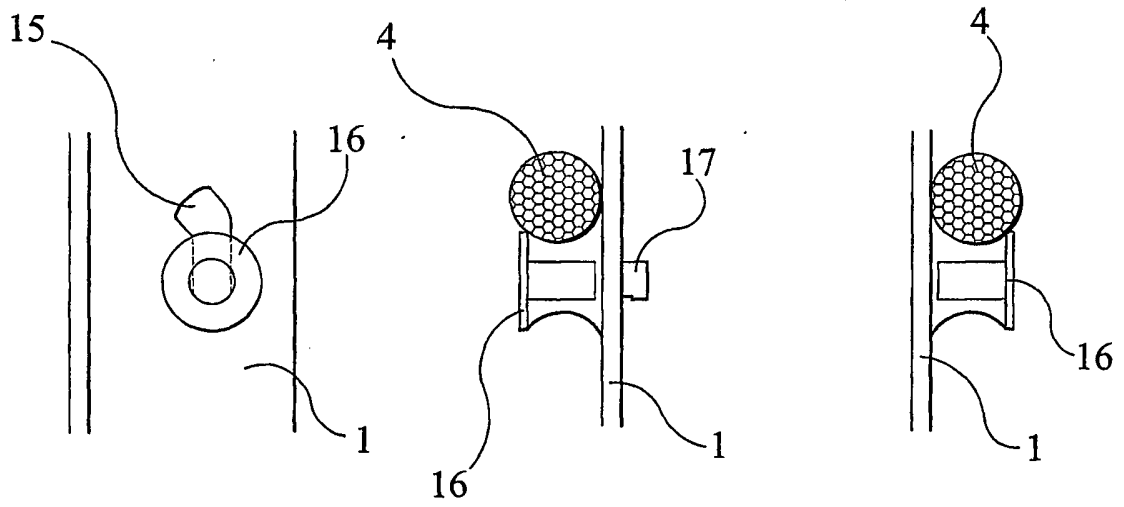


Figure 4a

Figure 4b

Figure 4c

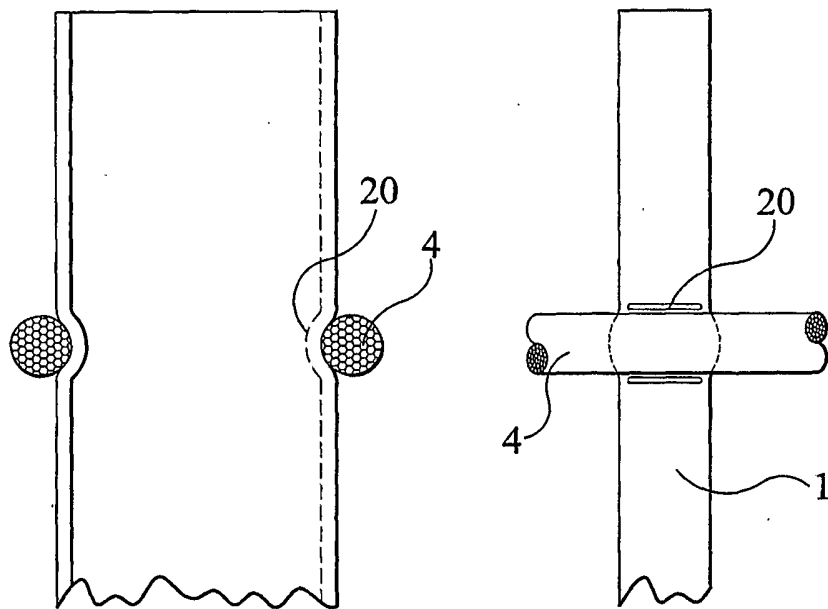


Figure 4d

Friction Resistance Between Ropes and Posts
Due to Interweaving

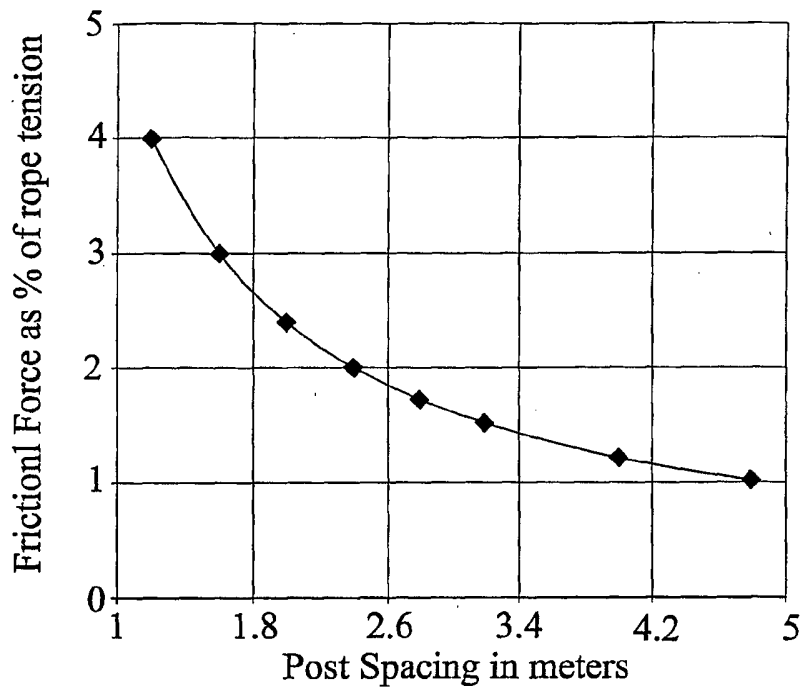


Figure 5

Tension Fall-Off Due To Interweaving of Ropes
(assuming initial pre-tension = 20% of rope B/S)

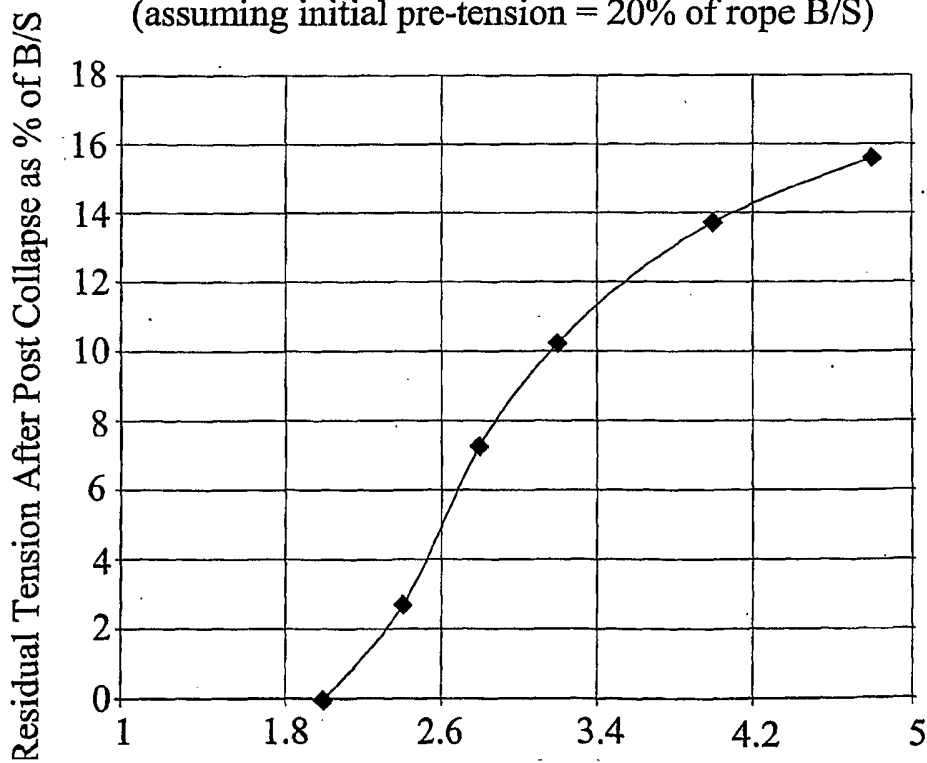


Figure 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0369659 A1 [0002] [0008] [0012]

Szabadalmi igénypontok

1. Biztonsági útkorlát, amely tartalmaz:

több oszlopot (1, 2, 3), amely mereven van szerelve a talajon vagy talajban, a korlátnak van hossza, amelynek iránya egyik oszloptól a másikig mutat; és

5 négy vagy több kötelet (4, 5, 6, 7), amelyeket az oszlopok tartanak, mindegyik kötél feszültség alatt van tartva az oszlopok által; ahol a kötelek és az oszlopok elrendezése emeli a kombinált surlódási ellenállást a kötelek mindegyik oszlophoz képesti viszonylagos elmozdulásával szemben a biztonsági korlát mentén, a kombinált surlódási ellenállás mindegyik oszloppal hajlítónyomatékok közül;

10 ahol az oszlopok legalább többségének keresztmetszete olyan, hogy az oszlopok inerciányomatéka a korlát síkjában lényegesen kisebb, mint az oszlopok keresztmetszetének korlátra merőleges inerciányomatéka, azzal jellemezve, hogy mindegyik kötél kanyargós utat követ az oszlopok között, az oszlopoknak a keresztmetszete és elrendezése a talajhoz viszonyítva nagyobb hajlítószilárdsággal bír a korlát hossza mentén, mint a az oszlopokon működő kombinált surlódási ellenállási erőkből származó hajlítónyomaték, és

15 ahol a korláton egy jármű általi ütés esetében az oszlopok a közvetlen ütközési zónán kívül tendenciájában állva maradnak, hogy a korlát teljes integritását fenntartsák és az oszlop összeomlása az ütköző jármű irányában minimalizálva van.

2. Az 1. igénypont szerinti biztonsági útkorlát, ahol az oszlop keresztmetszet mélysége lényegében 2-3-szorosa a szélességének.

20 3. Az 1. vagy 2. igénypont szerinti biztonsági útkorlát, ahol az oszlopok (1, 2, 3) mindegyike vagy többsége úgy van kialakítva, hogy az összeomlás előnyös módjával rendelkeznek a biztonsági korlát hossza mentén a keresztirányhoz képest.

4. Az előző igénypontok bármelyike szerinti biztonsági útkorlát, amely páros számú kötelet (4, 5, 6, 7) tartalmaz párokban elrendezve (4, 5; 6, 7).

25 5. Az 1-3. igénypontok bármelyike szerinti biztonsági útkorlát, ahol a kötelek (4, 5, 6, 7) különböző magasságokban vannak elrendezve.

6. Az előző igénypontok bármelyike szerinti biztonsági útkorlát, amely továbbá tartalmaz kötéltartókat (11, 12, 13) az oszlopokon (1, 2, 3) a kötelek (4, 5, 6, 7) azon történő függőleges elhelyezésére, míg megengedi a hosszanti mozgást a korlát síkjában.

30 7. A 6. igénypont szerinti biztonsági útkorlát, ahol a kötéltartók (11, 12, 13) össze vannak építve az oszlopokkal.

8. A 7. igénypont szerinti biztonsági útkorlát, ahol a kötél támaszok (11, 12, 13) hosszirányban elhelyezett vágatok (20).

35 9. A 6. igénypont szerinti biztonsági útkorlát, ahol a kötelek (4, 5, 6, 7) görbőkön (16) vannak támasztva, amelyek az oszlopokon (1, 2, 3) vannak szerelve.

10. A 9. igénypont szerinti biztonsági útkorlát, ahol a görbők (16) rögzítési lyukakban (15) vannak szerelve, amelyek az oszlopokban (1, 2, 3) vannak kialakítva.

11. A 6-10. igénypontok bármelyike szerinti biztonsági útkorlát, ahol a kötél támaszok (11, 12, 13) törékenyek.

12. Az előző igénypontok bármelyike szerinti biztonsági útkorlát, ahol az oszlopok (1, 2, 3) aszimmetrikus keresztmetszetűek, úgy hogy lekerekített sarkai vannak, amelyeket az ellenirányú forgalom számára lehet mutatni, amely ellenkező irányban mozog a korlát mindkét oldalán.
13. A 12. igénypont szerinti biztonsági útkorlát, ahol az oszlopok (1, 2, 3) "S" vagy "Z" keresztmetszetűek.
14. Az előző igénypontok bármelyike szerinti biztonsági útkorlát, ahol a kötelek (4, 5, 6, 7) elő vannak feszítve legalább a szakítószilárdságuk 10%-ára.
15. A 1-13. igénypontok bármelyike szerinti biztonsági útkorlát, ahol a kötelek (4, 5, 6, 7) elő vannak feszítve legalább a szakítószilárdságuk 15%-ára.
- 10 16. Az 1. igénypont szerinti biztonsági útkorlát, ahol a választott oszlopkeresztmetszet kielégíti a kritériumokat, hogy:
- az inercianyomaték a korlát síkjában lényegében a $59,000 - 307,000 \text{ mm}^4$ tartományban van; és
- az inercianyomaték a korlátra merőlegesen lényegében a $914,000 - 3,070,000 \text{ mm}^4$ tartományban van; és
- 15 ahol az oszlopok (1, 2, 3) mindegyike vagy többsége úgy van kialakítva, hogy a korlátnak ellenállást adnak járműbehatolással szemben keresztben a korlátra.