A guard rail formed of a downwardly open channel whose interior is filled with a bonded-in-place synthetic-resin mass is formed approximately every 10 meters with a downwardly open pocket in which the upper end of a support post is received. A pivot bolt transverse to the rail passes through the rail and the post and allows pivoting of this post relative to the rail in a horizontal plane including the rail. The lower end of the post is received in an upwardly open channel so that on collision of a vehicle with the post or a similar blow being struck to the post below the rail, this post will pivot out of its socket and up into the pocket so that the rail itself will take the blow to prevent a vehicle from flipping over the guard rail.

7 Claims, 3 Drawing Figures

2,536,760 1/1951 Martin et al............................ 256/13.1

FOREIGN PATENTS OR APPLICATIONS
99,770 10/1961 Netherlands............................ 52/98

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GUARD-RAIL ASSEMBLY WITH PIVOTAL SUPPORT POSTS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to my copending application, Ser. No. 147,817 filed 28 May 1971 (now U.S. Pat. No. 3,704,861 of 5 Dec. 1972) and to application Ser. No. 814,054 filed 7 Apr. 1968 (now U.S. Pat. No. 3,603,562).

BACKGROUND OF THE PRESENT INVENTION

In my above-cited application, Ser. No. 147,817, I disclose a vehicle barrier or guard-rail structure comprising a guard rail and posts supporting same, the guard rail being formed of a downwardly open box-shaped channel of thin sheet metal, preferably unitary (i.e. in one piece) over at least three sides, the interior of which is filled from flank to flank with a foamed or cellular elastomeric synthetic resin bonded to the inner basis of the channel and in force transmitting relationship between the afore-mentioned flanks. Advantageously, the inner surface of the sheet-metal channel (as well as the outer surface thereof) is provided with a corrosion-resistant coating formed by, for example, hot galvanizing (i.e. zinc coating by hot dipping), which has been found to increase the strength of the bond formed between the sheet-metal channel and the synthetic resin. The guard rails advantageously span lengths between posts far in excess of those provided heretofore and at least about 10 meters, the foamed synthetic-resin filling (apparent density of 30 to 80 kg/m^3 within the channel serving to provide the requisite stiffness and self-supporting character. In other words, whereas the sheet-metal channel is composed of such thin sheet metal as to preclude self-supporting spans of 10 meters or more, the presence of the foam body, bonded to all of the internal surfaces of the channel and filling the latter, stiffens the guard rail without significantly increasing the tendency of vehicles to rebound therefrom and sufficiently to span such distances. Moreover, the channel is preferably non-closed, i.e. free from any rigid force transmitting member between the flanks and the free ends thereof. This is not to say that a sheet-metal enclosure member cannot be provided at the open end of the channel where the closure member does not act in inward force-transmitting relationship between the flanks of the channel. Consequently, the channel appears to have an open end and permits the synthetic-resin filler to transmit all force between the flanks of the channel.

According to a more specific feature of the invention disclosed in my prior application, the cellular elastomer entirely fills the channel whose lateral walls lie at right angles to a planar top surface, the elastomer filling being flush with the mouth of the channel. The elastomer is preferably a stiff or hard polyurethane foam of the closed-cell type which is formed in situ within the channel and thus bonds effectively to all of the interior surfaces thereof. During manufacture of the guard rail, pockets or openings may be left in the polyurethane foam filling to receive the support posts which are designed to resist torsion and preferably are generally flat with a broad surface oriented parallel to the guard rail. In other words, the bending resistance of the support post is greater in the longitudinal direction (of the guard rail) than in the transverse direction thereof. To provide a suitable mounting of the guard rail upon the post, it has been found to be advantageous to dimension the interior of the socket or pocket in which it is received to be larger than the external dimensions of the posts received therein. A torsion-free mounting of the guard rail upon the post can be realized by lining the pocket with sheet metal which is bonded (during manufacture of the guard rail) to the polyurethane foam mass and may be secured to the post by an adhesive, preferably an elastic adhesive such as polyurethane.

Where the sheet metal of the channel is extremely thin (preferably of a thickness of 2mm), the guard rail filled with the polyurethane foam is found to be light compared to equal lengths of conventional guard rails. However, the bonding of the polyurethane foam to all of the interior surfaces provides resistance to torsion and bending within the guard rail and enables the latter to span distances of, say, 10 to 20 meters between support posts, some 4 to 6 times greater distances than the conventional post spacing. Furthermore, the mounting of the guard rail upon the posts, the manufacture of post and guard rail, and the low cost of both the guard rail and the posts represent major advantages.

A further advantage of the system of application, Ser. No. 147,817 can be found in the manner in which the guard rail absorbs the energy of impact of heavy vehicles, such as trucks. Heretofore, a collision between the truck and the roadside barrier has resulted in breakage of the barrier unless the latter was dimensioned to resist such breakage. In these cases, a large number of posts were provided to distribute the force of the collision and, where resistance to impact was high, there was always the danger that the truck would roll over or jump the barrier. Not only was this a disadvantage, but a close spacing of the supports invariably increased the cost of the barrier many times. The system of the present invention provides a crushable rail designed to take up the energy of impact and limit rolling-over or rebound at low cost. Unless the force of collision is sufficient to break the barrier, the usual permanent distortion of the guard rail is avoided in the case of the present system because of the self-restoring quality of a filling bonded to the sheet-metal walls.

The barrier of my prior invention, although composed of metal sheet as previously described, is characterized by a membrane-like engagement with the vehicle. Hence, a vehicle colliding with the barrier will deflect the latter into an S-curve or undulation which will ride along the barrier together with the vehicle, thereby precluding rebounding of the latter onto the roadway. The barrier may have the vehicle-guide surface located significantly above the height of present barriers and, consequently, a barrier height of 70cm has been found to be advantageous. This height is capable of preventing rollover of heavy vehicles.

The system has been found to be particularly advantageous in corrosive environments, i.e. in locations in which the application of salt or other chemicals to the road is common as an ice-melting measure. A particular problem with prior-art sheet-metal barriers has been the rapid deterioration of the sheet metal due to corrosion. According to an essential feature of my earlier invention, the hot-dipped or hot-galvanized sheet-metal channel is provided to reduce corrosive attack. With closed-cell foams, as described earlier, moisture penetration into the channel is precluded, even when the
lower end thereof is uncovered or open. Furthermore, the zinc coating has been found to augment the bond between the sheet metal and the polyurethane foam.

According to yet another feature of my prior invention, the lengths of guard rail are formed at opposite ends with plug-and-socket formations. For example, the plug end may be filled with the polyurethane foam and may be of a cross-section reduced by the thickness of the sheet-metal channel. The socket end may have an equal length free from the synthetic-resin foam and designed to receive the plug end of a longitudinally contiguous guard rail. When the two guard rail lengths are joined in this manner, the surface exposed to the vehicles is substantially continuous. Alternatively, the junction between two guard rails may be formed by providing a connecting socket arrangement of sheet steel which covers the upper surface and walls of each channel and is bonded thereto with an adhesive. The junction may also be filled with an elastomeric material, e.g. a foam polyurethane, capable of bonding to the zinc-coated sheet-metal surface. This filler maintains the corrosion resistance, strength and impact characteristics of the rail even at the junctions.

A common problem with guard rails, even to a certain extent with those of my prior applications, is that the post presents a danger to a motor vehicle colliding with the rail. Particularly in locations where the rail is arranged at a height of 750–750 mm rather than the customary height of 550–600 mm it is a common occurrence that a vehicle striking the guard rail catches on a post and flips over into the opposing lane of traffic. An attempt has been made to cure this difficulty by means of break-away posts which fracture easily when the corresponding rail section is struck. Such an arrangement has a limited degree of efficacy since the necessary fragile posts often snap due to normal tensions caused by expansions and contractions resulting from changes in temperature, or, alternatively, they are made so strong that they do not break when they are supposed to.

OBJECTS OF THE PRESENT INVENTION

It is therefore an object of the present invention to provide an improved guard-rail assembly for a roadway.

A more specific object is the provision of such an assembly whose support posts present no danger to vehicles colliding with the rail.

SUMMARY OF THE INVENTION

I attain these in a guard-rail assembly of the above-described general type wherein the post is pivoted at its upper end to the rail and is received at its lower end in the ground in a socket in the form of a channel extending parallel to the rail. In such a system a vehicle coming into contact with the post will merely swing the post out of its socket about a pivot axis transverse to the rail, with the post pivoting in a horizontal plane including the guard rail. Thus the post, while serving to support the rail adequately, offers little resistance to a blow substantially parallel to the rail so that the rail itself absorbs the shock, as is intended with my guard rail.

According to other features of my present invention the rail is formed generally as described in my prior applications, with a pair of central longitudinally extending grooves on its sides. The pivot extends through the center of the rail at these grooves, midway in its height. Also the socket receiving the upper end of the post is made of sufficient longitudinal length to receive the post should it be pivoted to a horizontal position.

DESCRIPTION OF THE DRAWING

The above and other objects, features, and advantages will become apparent from the following, reference being made to the accompanying drawing in which:

FIG. 1 is a side sectional view of the assembly according to the present invention;

FIG. 2 is a section along line II—II of FIG. 1; and

FIG. 3 is a vertical section through an alternative embodiment of the post socket.

SPECIFIC DESCRIPTION

In FIG. 1 I have shown a guard-rail structure comprising a three-sided channel 10 of sheet metal, preferably steel, which is coated on its internal surface and external surface with corrosion-resistant layers. Preferably the channel 10 is hot-galvanized, i.e. coated with zinc internally and externally by hot-dipping. Prior to galvanizing the sheet metal has a thickness between 0.2mm and 2.5mm, here about 1.2mm. The channel 10 is generally box-shaped, i.e. provided with an upper wall 12 and a pair of parallel flanks 14 and 15 lying at right angles to the upper wall 12. This upper wall 12 is planar and horizontal whereas the flanks 14 and 15 are profiled or corrugated, as described in the aforementioned applications. More specifically a generally trapezoidal recess or groove 16 is formed in the center of each of the flanks 14 and 15 and extends the full longitudinal length of each rail 10. In addition each flank 14, 15 goes over into the top 12 and bottom 13 of the channel 10 by means of an angled region 17.

The channel 10 has a length of 10–20 meters, usually about 16 meters. The interior of the channel is filled completely with a foamed synthetic resin, preferably a closed-cell compression-resistant polyurethane foam which is foamed and cured in situ within the channel and in contact with the galvanized walls of the sheet-metal channel. Surprisingly, such a firm bond is formed between the foam filling 18 and the galvanized walls that the foam not only acts as a packing for the transfer of transverse forces between the parallel walls of the channel 10, but also as a bending resistance for the rail structure as a whole. More specifically, the elimination of any slip or relative movement between the foam-rubber body and the walls of the channel at the interface between them rigidifies the structure and increases its bending moment so that, in spite of the small thickness of the sheet metal, the guard rail is self-supporting. This surprising result is underlined by the fact that rubber surfaces generally have not been bonded successfully heretofore to galvanized sheet metal.

While the modulus of elasticity, resistance, compression, strength, density and apparent density of the foam will be established in accordance with the desired resistance to bending and strength of the guard rail and, therefore, in accordance with the transverse dimensions of the box-like rail structure, it has been found that certain parameters should be observed. Preferably, the transverse width of the rail should be about 300mm while its height is about 500mm. When such a system is used as a medium separator between two lanes of oppositely moving traffic, it is desirable as mentioned
above to employ a channel 10 having a sheet metal thickness of 1.2mm and a polyurethane hard foam with an apparent density of 50 kg/m³. The polyurethane foam is produced by casting, immediately after formation, a mixture of 41 percent polyester resin containing alcoholic or hydroxyl functional groups, 53 percent of a di-isocyanate and about 6 percent of a fluorinated hydrocarbon such as that marketed under the name FREON or FRIGAN. Since the art describes many polyurethane foam compositions of similar hardness, substantially any of these can be substituted, provided that approximately equivalent compressive characteristics are obtained. In fact, practically any of the di- or polyisocyanates hitherto used for the production of polyurethane foam and practically any of the polyfunctional alcohols which have been provided in connection therewith, may be used in accordance with the present invention as well. I prefer to use the foam designated commercially as MOLTRENE.

The advantages of such a system are manifold. For example, the polyurethane-foam filling 18 transfers force from one flank of the rail to the other with some dissipation and absorption of energy, although the overall configuration need not be significantly distorted. As a consequence, the composite body retains its strength during impact of a vehicle therewith and the vehicle encounters a guard rail with significantly greater strength than guard rails of thicker sheet metal. The rebounding effect is nil. The system need not be used with strong posts. Finally, kinking of the guard-rail structure is avoided since the mass within the guard rail resists local penetration, and endeavors to re-establish its original configuration immediately upon release of any applied force.

It has been already been pointed out that the bottom 13 channel 10 can remain open. By this I mean that no special measures are required to close the mouth of the channel to gain additional strength. For example, I may provide the lower ends of the walls 14 and 15 with inwardly extending flanges or lips, 14a and 15a adapted to underlie the body of foam polyurethane within the channel. Alternatively, I may taper the walls 14 and 15 downwardly and inwardly to provide a narrow slot through which the post may be inserted. Also it is possible to cover the mouth of the channel with a plate which may bridge the two walls, but need not be disposed in force-transmitting relationship between them insofar as inward forces are concerned.

The closed-cell polyurethane foam utilized in accordance with the present invention has the advantage that it is impermeable to moisture. The body 18 of foam polyurethane thus seals the interior of the channel against corrosion resulting from contact with moisture, constitutes a weather-resistant filler and provides structural support for the thin sheet-metal walls. Since the guard rails of the present invention can span exceptionally long distances, they are able to follow bends in the roads more successfully and to be deformed in accordance with road curvatures without special machinery or preparation.

The polyurethane foam is polymerized and cured within the channel at the time of its manufacture and any conventional method of molding polyurethane may be used to this end. Generally the components are mixed together and poured or injected into the channel while the latter is held in an inverted, upwardly open state, the ends of the channel being provided with walls of any desired configuration.

A smooth surface for the eventual underside of the guard rail and for the upper surface at the time the guard rail is produced by the use of a strike board or by providing a temporary cover for the channel mouth. The cover is coated with a parting material to which the polyurethane foam is not adherent.

The recesses or corrugations 16 formed in the sidewalls 14 and 15 of the channel increase the resistance to compression on collision with the vehicle and also form guides restricting the tendency of an impacting vehicle to ride up along the rail. After forming and galvanization, the channel is advantageously degreased prior to the casting of the forming mixture therein. In some cases it has been found to be advantageous to apply a wash-primer or some other binding coating, preferably of the volatile-solvent type, to increase adhesion between the foam polyurethane and the walls of the channel. A suitable primer is the solvent containing adhesive EC 1357 marketed by the 3M Company.

The rail 10 is provided with a downwardly open sheet metal pocket 11 having planar end walls 11a, side walls 11b, and a top wall 11c, this last-named wall being adhesively fixed to the top wall 12 of the channel 10. Thus the pocket 11 has the shape of a downwardly open rectangular box of a transverse width equal to the space between the lips 14a and 15a of the flanks 14 and 15. In case no such lips 14a and 15a are provided, the sides 11b are also adhesively attached to the insides of the flanks 14 and 15 at the groove 16. The area between the side walls 11b and the flanks 14 and 15 is filled with a much more dense foam body 19 of the above-described general type but having a density of about 250 kg/m³. This filling is formed as described above, and serves to impart the same rigidity to the rail in the region of the pocket as elsewhere along its length.

The rails 10 are formed so that they can be fitted together end-to-end. This is achieved by forming one end with a recess by eliminating the foam filling for about 500mm. The other end is correspondingly formed of reduced cross sectional size to fit exactly into such an empty end.

Posts 20 support the rails 10 at a height of 650mm–750mm from the ground level G. Each post is made of a steel shell 23 of closed rectangular section filled like the channel 10 with a polyurethane mass 22. A round, oval, or variously polygonal post 20 is also usable equally well. The upper end region of the post 20 is thicker than the lower region and is received with slight clearance in the pocket 11. The very upper end 24 of the post 20 and the lower end 25 are rounded and the end 24 engages the top wall 11c of the pocket 11.

A bolt 21 orthogonal to the longitudinal direction of the rail 10 and passing completely through it at the base of the grooves 16, therefore midway up its height, also passes through a corresponding hole in the post 20 so that this post may pivot about an axis A defined by this bolt 21. The dot-dash line position shown in FIG. 1 shows how the length L of the post, here 750mm from its end 25 to the pivot 21 is slightly less than half the longitudinal length of the pocket 11, so that this post can swing up entirely into the pocket 11. As a matter of fact the posts can be attached to the rails at the factory and shipped in in this swung-up position. The pocket has an overall length of at least 1,000mm as will be described below.
The lower end 25 of the post 20 is received in a socket generally designated 30 made of cast iron or steel and mounted on a fixed base 31 of, for example, concrete. The socket 30 is a channel having flanks 32 and 33 which extend upwardly and parallel to each other and to the rail 10, only confining movement of the end 25 transverse to the rail 10. Thus the only obstacle to swinging of the post 20 about its axis A is whatever dirt or sand lies to either of the open ends of the channel 30. Indeed the slight resistance of such dirt, since the end 25 is only 100 mm - 200 mm below ground level G, is advantageous in that it prevents the post from pivoting except when such pivoting is strictly necessary. The channel 30 may be coated with, for example, synthetic resin in order to prevent the post end from rusting fast to it. The lower end portion of the post 20 is smaller in cross-section than the upper portion so that if the post 20 is pushed slightly to the side, it is still able to swing up into the pocket 11. It is possible to taper the post 20 gradually rather than just step it to make the lower region slimmer.

The arrangement shown in FIGS. 1 and 2 is intended to be used between opposite lanes of traffic. To this end the pocket has a length of 2L and the channel 30 is open on both ends. In the case of the assembly being used at the outside edge of a highway, where it is only likely to be hit by cars in one direction, it is only necessary to have the channel 30 open on one end and it is only necessary that the pocket 11 be extended widely to one side of the pivot 21 since the post 20 is only likely to be pushed in this direction. Thus, the pocket 11 can end at one end at the location shown in FIG. 1 by dot-dash line B and the corresponding end of the channel 30 can be closed, as shown at 35 in FIG. 3.

As shown in FIG. 1 the base 34 of the channel 30 is upwardly concave and has the same radius of curvature, equal to R, as the lower end of the post 20. FIG. 3 shows a channel 30' whose base 34' is planar. Thus when a vehicle strikes the guard rail with a sufficient component of force parallel to the rail 10, the post 20 will simply swing up, pivoting about the axis A. In this manner the rail itself will act to absorb the energy of the impact, as described at length in my prior applications, so that rather than rebounding or going over the rail, the vehicle will be brought to a stop at the edge of the roadway.

1 claim:

1. A guard-rail assembly comprising: a horizontal rail formed with at least one downwardly open pocket elongated in the longitudinal direction of said rail; a vertical post having an upper end received in said pocket; a pivot between said upper end and said rail and defining for said post relative to said rail a pivot axis extending transverse to the longitudinal direction of said rail; and an upwardly open socket in the ground receiving the lower end of said post, said socket being an upwardly open channel extending parallel to the longitudinal direction of said rail, said post being pivotal about said axis to swing said lower end upwardly free from said channel in said direction.

2. The assembly defined in claim 1 wherein said pocket is sufficiently elongated in the longitudinal direction of said rail that said post may pivot about said axis into a position parallel to said rail.

3. The assembly defined in claim 1 wherein said axis is spaced from the top edge and from the bottom edge of said rail.

4. The assembly defined in claim 3 wherein said rail is formed on both sides with a groove, said axis passing through said grooves.

5. The assembly defined in claim 1 wherein said rail is formed of a downwardly open sheet metal shell, a downwardly open sheet metal lining defining said pocket, and a synthetic-resin mass substantially filling said shell and adhering to the interior of said shell and the exterior of said lining.

6. The assembly defined in claim 1 wherein said channel has a pair of upwardly extending flanks laterally embracing said lower end.

7. The assembly defined in claim 6 wherein said flanks are between 100 mm and 200 mm in height and have upper edges substantially flush with the ground level.