ABSTRACT: A rail fastener device for directly affixing rapid transit system rail apparatus to a rigid support structure. The device includes a rail plate and a baseplate which are separated by a layer of elastomeric material which is bonded to the adjacent sides of each plate. Means are provided for fastening the rail directly to the rail plate, and means are provided for fastening the baseplate directly to the support structure. The rail plate, however, is free to float on the elastomeric material with respect to said baseplate so as to provide vibrational damping as well as electrical isolation therebetween.
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DIREC: FIXATION RAIL FASTENER APPARATUS

BACKGROUND OF THE INVENTION

The present invention is related generally to rail fastening devices and, more particularly, to a novel rail fastener for directly affixing rapid transit rail apparatus to a rigid support structure.

Because of new transportation techniques and apparatus being used in modern rail-type rapid transit systems, it has become necessary to provide new methods and apparatus for supporting and tying down the carrier rails. In the past, all rails in the United States have either been mounted on wood or concrete ties on ballast, or on wood ties embedded in concrete.

The tie on ballast arrangement has been favored in the past for on-grade applications because it readily permits alignment adjustment and provides a certain amount of vibration absorption. However, for elevated systems, the tie on ballast method is unsuitable because of the additional deadweight load produced by the ballast and ties. The tie-on-ballast method is likewise unsuitable for subsurface systems because of the additional space required in the structure used to form the required tunnels.

In order to eliminate the ballast and thus reduce to some extent the tunnel size required for a given type of transit vehicle, the rails of some subway systems have been mounted on short sections of wood ties embedded in concrete. In these systems the rails are fastened to a steel tie plate which is in turn secured to the wooden ties by spikes. This method, however, suffers from several important disadvantages. One is that the wooden ties eventually have to be replaced and since they were initially embedded in soft concrete, they must now be dug out before replacement can be made. The problems of replacing an article previously embedded in concrete are quite well known.

Another disadvantage of the embedded tie arrangement is that because of the thickness of the tie, the tunnel must be at least a foot higher than is otherwise necessary in order to accommodate the thickness of the wood tie. This is a particularly undesirable feature since the larger the required tunnel size, the more costly the tunnel.

In order to circumvent these disadvantages, it has now been decided that the rails used in tunnels and aerial structures of modern rapid transit systems should be mounted directly onto the concrete supporting structures. However, because of the stress conditions placed on the rail and supporting structure by the transit apparatus as well as by changing environmental conditions, such as temperature, moisture, etc., direct fixation of a rail to concrete is not a simple matter. Furthermore, without having the ballast as an energy absorbing medium, means must be provided to dampen the vibration induced between the rails and the supportive structures. Direct fixation methods are still further complicated by the fact that many of the transit systems are electrically energized and use the rails as the return path for the energizing electric current, and as a result the rails must also be electrically isolated from the support structure.

As a rail mounted vehicle moves along a track, a differential pressure wave is caused to build up in the track in front of the vehicle because of the leverage action which results from the localized vertical forces applied to the rails by the wheels of the vehicle. Thus, a given portion of the track is subjected to first an upward force as the vehicle approaches and then a downward force as the wheels roll thereover. Where the track is directly affixed to the rail, this wavellite track motion will produce a pounding action between the rail and the supporting concrete which will tend to disintegrate the concrete unless some means is provided between the rail and the concrete to absorb the impact therebetween.

In addition to the deleterious effects on the concrete produced by the pounding action, undesirable sonic vibrations will be introduced into the surrounding structures. Thus, suitable means must be incorporated into the rail fastening device to absorb the shock and dissipate some of the energy in order to attenuate the noise which would otherwise be transmitted into surrounding buildings, etc.

Another problem which must be overcome in attaching a rail directly to a concrete structure is that normal workmanship is not capable of providing 100 percent accuracy between the alignment of the rails and supporting structures. This is especially true in areas where the supporting structures will be subjected to sinking, earthquakes and other uncontrollable phenomena. Thus, means must be provided in the rail fastener itself which will permit the rails to be adjusted laterally within reasonable limits. As an example, one current set of design specifications requires that lateral adjustment be at least plus or minus 1 inch, although in most cases the contractor is able to achieve an alignment which is within plus or minus one-half inch of the design alignment.

Still another feature which must be provided for by the rail fastener is that of electrically isolating the rails from the supporting structure. Although it is most difficult to provide complete isolation of the rails, leakage must be limited to a reasonable value throughout the track, or signalling equipment will not operate properly and adequate power cannot be transferred to the vehicle.

Still another capability which the fastener must have is that it must be able to securely fasten the rail relative to the support structure and limit movement thereof to within acceptable tolerances in the vertical, lateral, and longitudinal directions. As was mentioned above, the track is subject to both an upward and backward force and the fastener must be capable of accommodating these forces in both directions. In addition, on curved track sections, the rails may be subject to lateral loads in the neighborhood of 5,000 pounds or more and the fastener must be capable of preventing the rails from twisting or being displaced laterally in excess of an allowable small deflection. However, accelerating forces, decelerating forces and expansion and contraction forces due to temperature variations will tend to cause the rail to move in the longitudinal direction and the fastener must be capable of clamping the rail tightly enough to prevent such movement.

OBJECTS OF THE INVENTION

It is therefore a principal object of the present invention to provide a novel rail fastening apparatus for use in securing rapid transit rails directly to a rigid support structure.

Another object of the present invention is to provide a novel direct fixation rail fastening apparatus having shock absorbing properties for dampening rail vibration so as to reduce the transmission thereof from rail to support.

Still another object of the present invention is to provide a novel direct fixation rail fastening apparatus which is capable of electrically isolating the rail from the support structure.

Still another object of the present invention is to provide a novel direct fixation rail fastening apparatus having means for allowing rail alignment adjustment.

Still another object of the present invention is to provide a novel rail fastener apparatus for securely affixing a rail directly to a rigid support structure and preventing relative movement therebetween in any direction in excess of predetermined limits.

Still another object of the present invention is to provide a novel rail fastener apparatus for direct fixation of a steel rail to a concrete or steel support structure, said fastener apparatus having each of the above characteristics.

SUMMARY OF THE PRESENT INVENTION

The rail fastener of the present invention is in a preferred embodiment essentially comprised of a pair of steel plates bonded together by a layer of elastomeric material which is capable of electrically isolating the plates one from the other while, at the same time, securing the plates against excessive relative movement. The elastomeric material must be firm enough to withstand high compressive loads yet resilient
enough to dampen certain rail vibrations. A rail is secured to the upper steel plate of the fastener by means of a pair of adjustable clamping devices which permit the selective positioning of the rail relative to the upper plate within a predetermined tolerance. The lower plate of the fastener is secured to a rigid rail support structure by means of a pair of sleeved bolts which pass through apertures in the upper plate and are electrically isolated therefrom by said elastomeric material.

A principal advantage of the present invention is that it provides a means for directly affixing a rail to a rigid structure while, at the same time, damping vibrations transmitted therewith and electrically isolating the rail from the support structure. This is accomplished by means of the "free floating," nonmetallic relationship provided between the respective plates by the elastomeric bonding material.

Another advantage of the present invention is that it is compact in construction and can be installed by one man using ordinary manual tools.

Still another advantage of the present invention is that because of its rugged construction the fastener will have a useful life which is at least as long as the design life of the rail which it secures.

Still another advantage of the present invention is that it requires less than 2 inches of the space between the bottom of the rail and the top of the support structure.

Still other advantages of the present invention will become apparent to those skilled in the art after having read the following detailed disclosure of a preferred embodiment which is illustrated in the several FIGS. of the drawing.

IN THE DRAWING

FIG. 1 is a perspective illustration of a section of track and support structure showing the manner in which the present invention may be utilized.

FIG. 2 is a schematic illustration of a direct fixation rail fastening device in accordance with the present invention.

FIG. 3 is a cross section taken along the lines 3-3 of the rail fastening device illustrated in FIG. 2.

FIG. 4 is a cross section taken along the lines 4-4 of the rail fastening device illustrated in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 of the drawing, there is shown a section of a concrete structure 10 which may be of the type utilized in tunnels or aerial structures to support a rapid transit trackway. In accordance with usual construction techniques, the structure 10, which may be either a preformed member or a member formed in place, is installed in place and left unloaded for a predetermined period of time in order to account for normal structural settling. Subsequently, the slabs 12 are poured to design grade and the rails 14 are affixed directly thereto by means of the fasteners 16 are provided in accordance with the present invention. It will also be noted that a third rail 18 is mounted to the side of the structure 10 for supplying high voltage electricity to the electrically operated vehicles used in the rapid transit system.

FIGS. 2, 3, and 4 of the drawing, a preferred embodiment of a rail fastener in accordance with the present invention will be described in detail. The fastener 16 includes a steel rail plate 20 having two circular holes 22 passing therethrough at opposite corners and two elongated slots 24 cut therein in the remaining opposite corners. The rail plate 20 is typically made of high strength steel of a nominal one-half inch thickness. The baseplate 26, which may be made of one-fourth inch high strength steel, for example, is secured to the rail plate 20 by a layer of elastomeric material 28 which is bonded to both plates. The elastomeric material 28 must be rigid enough to withstand a predetermined range of tensile and compressive forces while at the same time being capable of providing the required vibrational isolation as well as electrical isolation between the rail plate 20 and the baseplate 26. In the preferred embodiment, the elastomeric layer is three-eighths inch thick.

Although the elastomeric layer 28 is illustrated as being of a homogeneous solid mass it is to be understood that the material comprising the layer 28 could just as well be cellular, corrugated, or of any other suitable form capable of providing the desired load bearing, vibrational dampening and electrical isolating characteristics.

The ends 30 of the baseplate 26 are turned upwardly and extend to the top of the plate 20 so as to resist excessive displacement of the plate 20 in the lateral direction relative to the baseplate 26 in response to high lateral loads. By so turning the ends 30, the amount of permitted movement between the rail plate 20 and the baseplate 26 in the lateral direction is not determined by the sheer strength of the elastomer 28 alone. This feature provides an additional resistance to lateral movement in the form of tensile and compressive forces applied between the ends 32 of the plate 20 and the ends 30 of the plate 26 via the layers of elastomer 34 which separate the two plates. Although this feature is desirable where lateral load conditions are excessive, as in tight curves in the trackway for example, tests have shown that a device without the upturned ends 30 is capable of restraining railroad deflections to within an acceptable range under moderate-to-heavy lateral load conditions.

The slots 24 in the rail plate 20 include elongated portions 36 through which the heads 38 of the bolts 40 may be inserted. After insertion the bolts 40 may be slidable positioned anywhere along the slots 24 so that the heads 38 bear against the lower side of the rail plate 20 when an upward force is applied to the bolts 40. It will be noted that in order to accommodate the heads 38 of the bolts 40, portions of the elastomer 28 have been removed in the vicinities of the slots 24. It is, however, preferable to leave a thin layer of the elastomer over the top of the baseplate 26 to insure against accidental shorting between the bolt head 38 and the plate 26 because of water, oil or foreign objects which may become trapped within the passageway 42.

The fastener 16 is typically mounted to the concrete slab 12 over a polyethylene gasket or pad 44 and is rigidly secured to the slab 12 by means of a pair of bolts 46 which are threaded into inserts 48 provided in the concrete bed. The pad 44 is merely a shimming means to accommodate vertical alignment of the rail 14 and is not a part of the fastener 16. The pad 44 may be of any suitable shimming material and is only shown as polyethylene for purposes of illustration. Since it is desirable that the rail plate 20 "float" with respect to the baseplate 26, and have no rigid metallic interconnection therebetween, the bolts 46 do not apply any compressive force to the rail plate 20, but only engage the baseplate 26 via the cylindrical spacers or sleeves 50 which extends slightly above the upper surface of the elastomeric areas 52 which are raised around the bolt holes 22. The flat washers 53 are slightly separated from the raised elastomeric areas 52 and do not intentionally transmit any force to the top of the rail plate 20, but merely facilitate tightening of the bolts 46. They do, however, provide an incidental function of preventing the entry of foreign matter into the boltways between the bolts 46 and the sleeves 50.

In previous fastening apparatus of this type wherein a resilient material was utilized as the shock absorbing medium between rail and support structure, it has been found that if the bolt which secures the fastening apparatus either to the rail or to the support structure is subjected to the forces which result from the repeated flexures of the elastomeric material of the support or track, such resilient material may be subjected to excessive fatigue and bolt failure will likely result. It will be noted that in the illustrated embodiment of the present invention the baseplate 26 is directly fastened to the slab 12 by the bolts 46, and the force applications therebetween are separated only by the gasket 44 which is not intended to act as a resilient element but only as a means providing vertical alignment. Similarly, the rail 14 is secured directly to the rail plate 20 by the clips 54. Thus, neither the bolts 40 nor 46 are subject to fatigue due to flexure of the elastomeric layer 28.
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The clips 54 have one side adapted to engage the lower flanges 56 of rail 14, and include a chisellike projection 58 on the other side thereof for frictionally engaging the upper surface of the rail plate 20. Once the rail 14 is properly aligned, the clips 54 are spaced adjacent the heads 38 of the bolts 40 into the enlarged apertures 36 of the slots 24, and then sliding the bolts 40 and clips 54 into engagement with the lower flange 56 of the rail 14. Once the clips 54 are suitably positioned adjacent the rail 14, the nuts 62 are tightened down upon the bolts 40 to a predetermined torque suitable for causing the desired frictional engagement between the rail 14 and clip edge 60 on the rail and the clip edges 58 and the upper surface of the rail plate 20 on the other. The amount of torque required is that necessary to resist the maximum anticipated forces which might be applied to the rail 14.

In the illustrated embodiment, a plurality of serrations 64 are provided in the upper surface of the rail plate 20 in the area over which clip 54 might be positioned, i.e., the rail adjustment range in the lateral direction. The serrations 64 provide for an increased frictional engagement between the clip 58 and the upper surface of the rail plate 20. Although preferable, the serrations 64 are not absolutely necessary in most instances since the frictional engagement obtained between the edges 58 of the clips 54 are the upper surface of the plate 20 by tightening the nuts 62 is sufficient to lock the rail.

In order to insure that the nuts 62 do not become loosened as a result of vibration imparted to the fastener from the rail 14, lock washers 66 are provided between the nuts 62 and the top of the clips 54 so that once the nuts 62 have been properly torqued, the edges 68 of the washers 66 can be bent up against one of the faces of the nuts 62 so as to prevent the unintentional loosening thereof. A similar means could likewise be provided for the bolts 46 where deemed necessary.

The utility and advantages of the present invention will be readily apparent to those of skill in the art. For example, once the grade slabs 12 have been laid, with the inserts 48 provided at appropriate points along the intended track alignment, the fastener devices 16 of the present invention can be mounted to the slab 12 by merely inserting the bolts 46 through the appropriate apertures in the fastener device, and then bolting the device directly to the slab 12. The rails 14 can then be positioned over the rail plates 20 and aligned with the required degree of precision. Once the rails 14 have been suitably aligned, the rail clips 54 can be inserted into the slots 24 and positioned to engage the flange 56 of the rail 14. With the clips 54 so positioned, the nuts 62 are tightened to the desired torque, the locking clip 68 is bent into engagement with the nut 62, and the operation is complete.

It should be noted that there are no unirrigated pockets in the fastener device 16 in which corrosive fluids can become trapped to cause deterioration of the various components. Furthermore, should the cavities 42 below the slots 24 become clogged with dirt, grease or other foreign matter so as to interfere with the insertion or removal of the clip bolts 40, such foreign matter can easily be removed by inserting an appropriate projection into the slide openings.

After having read the above disclosure, it is contemplated that certain alterations and modifications of the above described embodiment will become apparent to those skilled in the art. It is therefore understood that this description of a preferred embodiment is for purposes of illustration only and is in no manner intended to be limiting in any way. Accordingly, I intend that the appended claims be interpreted as covering all modifications which fall within the true spirit and scope of my invention.

We claim:

1. A fastener device for fastening a rail means to a supporting structure and providing vibrational dampening and electrical isolation between the rail means and the supporting structure comprising:
   - a rigid first plate means and a rigid second plate means disposed in overlying relationship and including apertures in registry with each other;
   - a layer of electrically nonconductive elastomeric material, said first and second plate means being separated by said layer of elastomeric material, said elastomeric material being securely bonded to the adjacent faces of said first and second plate means, at least one edge of said first plate means being bent upwardly and outside of the overlying edge of said second plate means and extending upwardly at least as far as the lower surface of said second plate means, the proximate extremities of said first and second plate means being separated by a portion of said elastomeric material which acts as a space therebetween whereby said one edges do not limit lateral motion of said first plate means relative to said second plate means; and
   - securing means for securing said second plate means to the rail means, said securing means including bolt means which extend through the apertures in both of said first and second plate means and corresponding apertures in said separating layer of elastomERIC material, and metalic sleeve means extending through the apertures in said second plate means and engaging the upper surface of said first plate means to transmit the force applied to said bolt means directly to said first plate means, said bolt means and sleeve means being electrically insulated from said second plate means by said elastomeric material.

2. A fastener device as recited in claim 1 wherein said means for securing said second plate means to said rail means is a clip means having a first portion adapted for engaging the lower flange of said rail means as it rests upon the top of said second plate means and a second portion for frictionally engaging the upper surface of said second plate means, said clip means being secured to said second plate means by a suitable mechanical force applying means.

3. A fastener device as recited in claim 1 wherein the portion of the upper surface of said second plate means engaged by said clip means is irregular so as to increase the frictional engagement between said clip means and said second plate means.

4. Rail fastener apparatus for directly affixing a rail to a rigid support structure comprising:
   - upper plate means having a pair of parallel side edges, said upper plate means including means for securing the rail to the upper side thereof with the longitudinal axis of the rail lying parallel to said parallel side edges;
   - a layer of elastomeric material bonded to the underside and said parallel side edges of said upper plate means;
   - lower plate means having its upper side bonded to said layer of elastomeric material, said lower plate means having upturned side portions extending outside of said parallel side edges and terminating substantially flush with said upper side of said upper plate means, said side edges being separated from said side portions by a separating portion of said layer of elastomeric material whereby lateral motion of said upper plate means relative to said lower plate means is restrained to within predetermined limits; and
   - means electrically insulated from said upper plate means for securing said lower plate means to said support structure.

5. Rail fastener apparatus as recited in claim 4 wherein said attachment means is adjustable so as to provide for lateral adjustment of said rail with respect to said fastener apparatus.

6. Rail fastener apparatus as recited in claim 5 wherein said elastomeric material is of sufficient thickness to electrically isolate said upper plate means from said lower plate means when said fastener apparatus is subjected to normal operating load conditions.

7. Rail fastener apparatus as recited in claim 6 wherein the thickness of said elastomeric material which separates said upper plate means from said lower plate means is firm enough to prevent substantial reduction in the stiffness of said upper and lower plate means under normal load conditions yet is resilient enough to absorb a substantial amount of the vibrational energy which would otherwise be transmitted from said rail to said support structure.
8. Rail fastener apparatus as recited in claim 7 wherein said upper plate means includes slot means for accommodating said adjustable attachment means.

9. Rail fastener apparatus as recited in claim 8 wherein said attachment means is a bolted clip means, the bolt portion of which is operatively received by said slot means, and said clip means is adapted to frictionally engage said rail and said upper plate means in response to a tightening of said bolt means.

10. Rail fastener apparatus as recited in claim 9 wherein said means for securing said lower plate means to said support structure is a bolt means which extends upwardly through an aperture in said upper plate means so that access is provided to said securing means.

11. Rail fastener apparatus as recited in claim 8 wherein an opening is provided in the side of said apparatus leading to said slot means for providing drainage thereof.