July 19, 1966 J. M. STEVENS 3,261,737

METHOD OF MAKING BRIDGE BEAM BEARING

Filed April 11, 1961

Fig. 1.

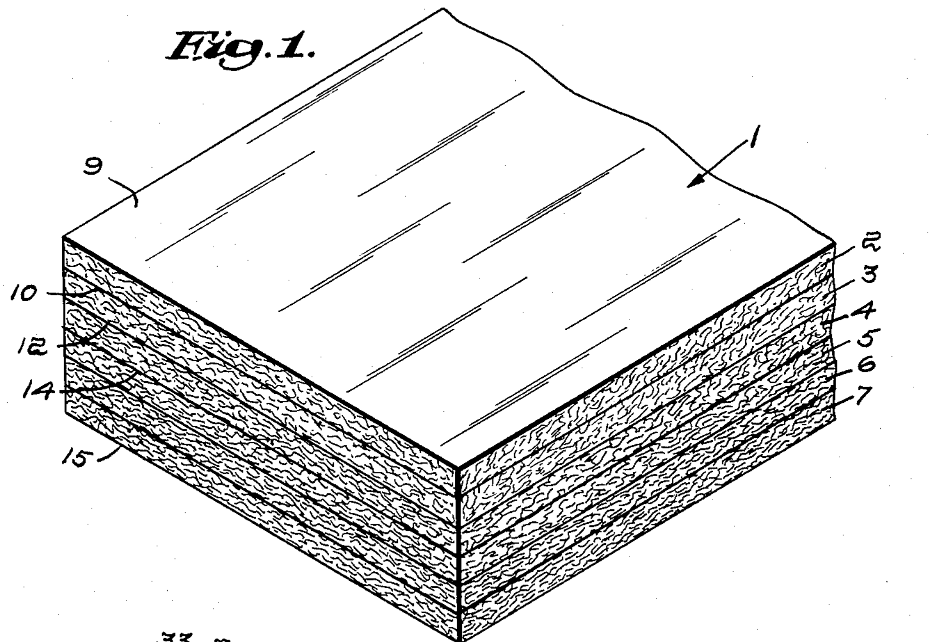



Fig. 2.

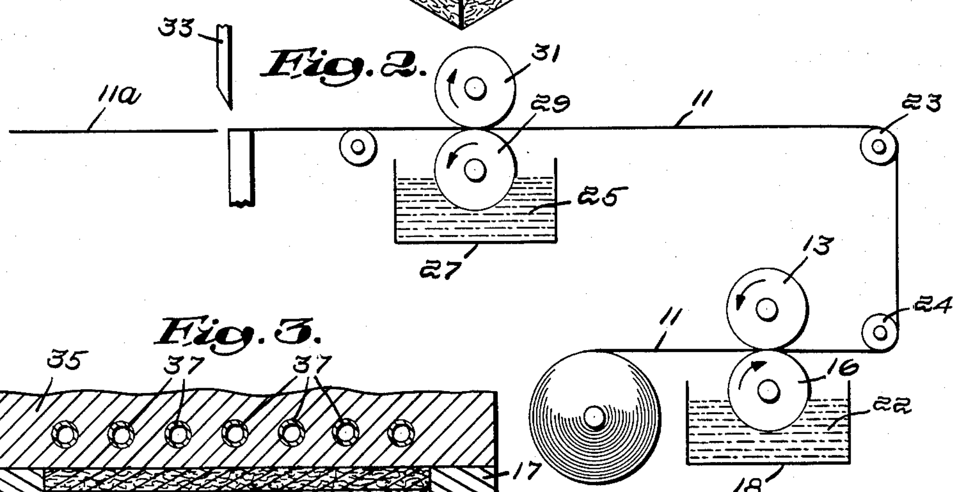
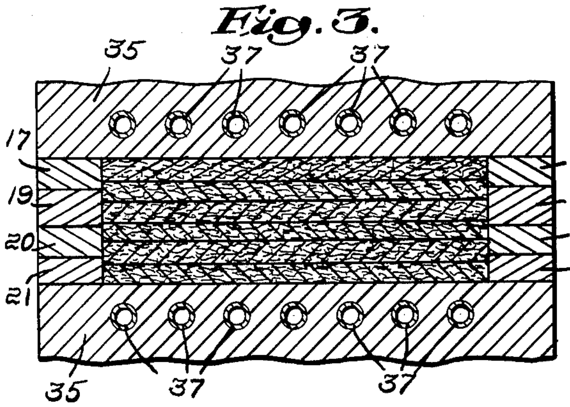



Fig. 3.

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## METHOD OF MAKING BRIDGE BEAM BEARING

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1 Claim. (Cl. 156—310)

This invention relates to bearings of the type known as expansion plates or shoes, used in many structures and equipment subject to expansion and contraction, and particularly between the beams or girders of bridges and other structures and the piers, abutments, or other emplacements on which the beams rest. These bearings support the ends of the beams or girders with capacity for longitudinal movement relatively to the supports as required to permit expansion and contraction of the bridge members under change in temperature without thrust against the piers. An example of such a bearing in wide use in bridge construction is that disclosed in U.S. Patent No. 2,187,626,

This bearing has proved very satisfactory, but its cost has restricted its use to bridges of major importance. The bearing being mounted on the masonry pier or abutment which supports the bridge beam, a rigid metal base plate is provided to afford a true flat surface for the support of the bearing's expansion plate, so that the latter's lubricated working or friction-receiving surface will in turn remain flat and undistorted in its engagement with the sole plate moving with the beam and transmitting the load to the expansion plate and the pier. The expansion plate is made of bronze or other corrosion-resistant metal and provided with trepanned lubricant-filled recesses throughout its working surface, and when as heretofore in prior structures it must be made an inch or more thick, and fixedly supported on a base plate of carbon steel made two inches or so in thickness to avoid distortion, and must have an area of from five to ten square feet, with the machining of a recess or provision of lugs or other means to hold the expansion plate from moving on the base plate, the cost is high.

The need for heavy construction of the expansion plate and its base plate arises from the presence of unavoidable inequalities in the surface of the supporting pier or abutment—high and low spots, pebbles, and such. There will be corresponding supported and unsupported spots on the base plate under load, as a result of these irregularities in the concrete top surface of the pier. Unless these plates are very rigid, the excess loading of the expansion plate thus concentrated on the localities overlying the high spots on the pier will shorten materially the life of the bearing. Hence the resort to massive components to attain rigidity so as to insure a true surface for the support of the sliding sole plate that is fixed on the beam, and thus uniform distribution of the load over the relatively moving surfaces.

I have found that such heavy-gauge construction of the bearing members is not needed if the expansion plate is supported on the pier by a pad of sheet material possessing the seemingly contradictory characteristics of compressibility so as to yield at the high spots, pebbles, or other protrusions of the concrete without a corresponding elevation of the opposite surface of the sheet, and also to level the depressions, and at the same time avoid overall vertical deflection, under compression, beyond 10% of its initial thickness under its maximum loading. When such material is used under the expansion plate to provide a flat supporting surface therefor, not only can the base plate be omitted, but the expansion plate itself can be greatly reduced in thickness. Thus a very important saving in the cost of such bridge bearings is attained, with



consequent widening of the field of their use to include projects where economies are compelled.

A material capable of performing as just described is the aim of the present invention, and in the preferred form of the invention comprises an elastomeric sheet or pad made of synthetic plastic material, preferably a plastisol of polyvinyl chloride resin combined with plasticisers and reinforced with glass fiber, the latter preferably needled into a bat or woven into a sheet, the plastisol having been fused and with the fibers embedded therein. A characteristic feature is that the hardness of the pad is different at different parts of its thickness, preferably being hardest at one surface and softest at the other surface, with the hardness gradually increasing from soft to hard throughout the intervening material. One way of attaining this variation is by composing the pad of laminations of fiber impregnated or coated with plastisols having different ratios of resin to plasticiser, or of plastisol to fiber, or otherwise differing in composition.

A pad thus made according to the invention has one surface hard as desired for firm adhesive attachment to the metal of the expansion plate while the other surface is soft and thus able to conform to rough or irregular surfaces such as concrete and to include and surround pebbles lying thereon to attain a perfect seat on the abutment or support while maintaining its upper surface flat, and to have a high coefficient of friction, cling, preventing relative slip of the bearing on the support. Further, the novel pad is capable of enduring loads up to 1000 p.s.i. with a deflection under compression not exceeding 10%, and without internal stresses which induce creep and weather-cracking of the exposed edges. Additionally, the different layers or parts of the thickness of the pad have different vibration periods and tend to arrest the transmission of all but their own frequency, thus making the pad absorb practically all the vibrations of the beam under traffic and keep them from reaching the abutment.

The improved pad is equally useful as a backing or bed for the steel sole plate, affixed to the beam's under surface for engagement with the lubricated expansion plate, and moving with the beam and relative to the expansion plate as the beam's length changes. Here it serves likewise to level out any irregularities in the beam's surface, effecting economies through enabling a reduction in the thickness of the sole plate while maintaining the required true flat surface thereof needed to go against the expansion plate. The pad in this location also aids in the absorption of vibration and shock from the beam.

The novel pad also serves as a substitute for a rocker bearing, being used when a bridge beam is subject to flexing under traffic loads. Through its compressibility, it lets the expansion plate and sole plate remain in parallel relation and continuous contact over their common areas though the beam end's under surface becomes slightly oblique to the surface of the pier beneath it, thus also avoiding undesired localized concentration of the load on reduced areas of the bearing surfaces.

Other objects of the invention and the manner of their attainment are as set forth hereinafter.

An illustrative embodiment of the invention is shown in the accompanying drawings, in which:

FIG. 1 is a perspective view of a portion of a bridge pad of laminated construction;

FIG. 2 is a schematic showing of a machine for applying different consistencies of plastisol to the opposite surfaces of a needled bat of glass fiber, and cutting the bat into lengths; and

FIG. 3 is a detail of a press for making the pad by combining and curing the bats of FIG. 2 under heat and pressure.

The pad 1 of FIG. 1 is of the preferred form comprising a plurality of layers 2, 3, 4, 5, 6, 7 initially composed of glass fiber needled into sheet form and sized, i.e., surface-coated, with a vinyl chloride resin plastisol, and fused or "cured" under heat and pressure, as in the press of FIG. 3. In this case, in layer 2 the glass fiber bat has been sized on its upper surface 9 with a plastisol having a high resin content and adapted to create a relatively very hard and dense surface on the bat when cured, while the other surface 10 was sized with a plastisol having a lesser resin content and adapted to produce a surface thereon of a lesser degree of hardness when cured, with the intervening material being of an intermediate degree of density, increasing in hardness as the upper surface is approached, when the processing of the pad is completed.

Layer 3 is of corresponding nature, the upper surface contiguous with surface 10 of layer 2 having been coated with a lesser ratio of resin to plasticiser than either face of layer 2 so as to produce a softer surface and underlying portions than either face of layer 2, while the lower surface 12 of layer 3 is made even softer than the upper face by reducing the resin content of the plastisol, or otherwise.

In analogous manner the third layer 4 has its upper surface softer than the contiguous surface 12 of the overlying layer 3, while the under surface 14 of layer 4 is made softer still, the consistency of the interior portions of layers 3 and 4 as before being mainly intermediate in hardness between the densities of each layer's two surfaces, as stated of layer 2. This same progressive increase in the softness of the layers as between the successive layers, and as between the top and the bottom portions of each layer, is similarly obtained in layers 5, 6, and 7, the surface portion 15 of layer 7 being softest of all.

As indicated, the hard upper surface 9 of layer 2 is to be adhesively attached to the flat back surface of the expansion plate (not shown), while the exposed or bottom surface 15 of layer 7 is merely laid on the abutment or pier (not shown) upholding the beam. By reason of the relatively soft under surface 15 of layer 7, the pad will conform to any irregularities in the contiguous surface of the beam or pier and settle over and around any pebbles or protrusions that may be present, leveling minor hollows, and distributing the load applied to the expansion plate uniformly and avoiding localized strains of destructively high intensity. Thus the extra effort and expense previously needed in trying to trowel the concrete upper surface of the pier to a smooth and flat seat for the base plates is obviated. The same softness and conformability of the bottom surface gives it a high coefficient of friction against the surface of the rough concrete, precluding slip. Yet the top surface 9 and its underlying material provide rigid support for the now reduced thickness of metal in the expansion plate.

When used between the beam and the steel sole plate, the pad is adhesively or mechanically affixed to the plate with its hard surface 9 against the sole plate and adhesively or mechanically affixed to the beam and with its soft surface 15 against the beam.

As an illustrative example, the generally useful pad of FIG. 1, adapted to support loads of the order of 1000 p.s.i., is made of six needled bats of glass fiber each weighing 2 oz. per square foot. The plastic used, as well as its reinforcing fiber, must be able to stand extremes of temperature, also weathering and exposure to acids and other chemicals, and to withstand heavy pressure without bleeding of the plasticiser. Therefore polyvinyl chloride is the preferred resin, and glass fiber the chosen reinforcing material. The surface 9 of layer 2 is sized with a mixture of 3.2 parts resin to 1 part plasticiser by weight, while the opposite surface 10 is sized with 3 parts resin to 1 part plasticiser. The surface of the next layer 3 adjacent surface 10 of layer 2 is sized with 2.8 parts of resin to 1 part of plasticiser, while the bottom surface 12 is sized with 2.6 parts of resin to 1 of plasticiser. The top surface of layer 4 is sized with 2.4 parts resin to 1 of plasticiser, while the bottom 14 of layer 4 is sized with 2.2 parts of resin to 1 of plasticiser. By the same gradients, the top and bottom surfaces of the layers 5, 6 and 7 are sized with .2 part less of resin to each part of plasticiser than the surface next above, so that the bottom surface, softest of all, has 1 part resin to 1 part plasticiser.

There is no factor restricting the number of layers to 6, as more or less may be used, as to give a greater or more gradual range of hardness variation, in which case thinner bats of 1½ oz. per square foot will be used if more layers are wanted.

As shown diagrammatically in FIG. 2, conventional types of coating machines are suitable for applying the sizing of plastisol to the bats of the several layers 2 to 7. The bat or fabric 11 if glass fiber is run in continuous form between driven rolls 13, 16 of which the lower roll 16 dips into a tank 18 partly filled with plastisol 22 of one of the several consistencies used to get the different degrees of hardness in the respective layers, and transfers it to the under side of the bat 11. The bat then is turned over as by running over rolls 23, 24 and its other surface is sized with plastisol 25 of different consistency from tank 27 by a similar pair of driven rolls 29, 31, of which the lower roll 29 dips into the plastisol 25 and rolls it onto the adjacent surface of bat or fabric 11. Thereafter the bat is cut up into the desired lengths 11[a] by reciprocating knife 33 and carried forward in suitable manner. Like treatment is given to the bats which provide the other 5 or more layers of the pad, using plastisols of different consistencies.

After sizing with the respective plastisols of graduated degrees of eventual hardness, the 6 or more layers are superposed in order of hardness to be, and subjected to heat and pressure to fuse or "cure" the plastisol into elastomeric condition. FIG. 3 shows a suitable press for making up large sheets one batch at a time, and which may be cut up into a number of pads. As shown, the laminated raw sheet is pressed between parallel platens 35 heated by electrical resistance heaters 37.

The curing of the sheet thus formed of the assembled sized layers is done in stages. Between the heated platens 35 and at each side of the stack of layers 2–7, now several inches thick, a series of rigid spacers 17, 19, 20 and 21 are stacked up to limit the closing of the platens upon the assembled layers to predetermined intervals. In the first stage, the top platen is brought down into contact with the top layer 2 and stops short of the top spacers 17, exerting no material pressure upon the stack beyond that needed to bring both platens into good heat-transmitting contact with the exposed surfaces 9 and 15 of outside layers 2 and 7. This pressure and the heat are maintained for a period and to a degree sufficient to cure only the plastisols applied to such surfaces. During this curing, the layers 2 and 7 of dry and unimpregnated glass fiber are uncompressed and filled with air-pockets so that they act as barriers preventing or impeding the flow of heat from the platens and the outside coatings of plastisols to the next coatings of plastisols covering the meeting faces of layers 2 and 3 and of layers 6 and 7.

While the polymerized plastisols on surfaces 9 and 15 are still soft and plastic, the press is tightened until the top platen rests on the uppermost spacer 17 at each side of the assemblage. This increased pressure and compacting of the top and bottom layers 2, 7, expels the air from layers 2 and 7 and permits the heat from the platens 35 and the cured outer portions of plastisol to pass through the glass fiber of layers 2 and 7 into the plastisols coating the under surface 10 of layer 2 and the contiguous upper surface of layer 3, but only after the fusion of the plastisols at the outer surfaces of layers 2 and 7 has occurred. This prevents the unlike plastisols of the upper and lower surfaces of layer 2 from intermixing and blending to an extent which might give this layer a uniform density. The result is the same with layer 7, and is the method by which the desired unequal degrees of hardness are attained, first in each outer layer, and finally throughout the pad.

Under this increased pressure the plastisols of the outside coatings of layers **2** and **7** while still viscous are pressed into and impregnate the adjacent portions of the thickness of the glass fiber of these two layers, and the transmitted heat fuses the two coatings on the meeting faces of layers **2** and **3**. The same result occurs at the meeting faces of layers **6** and **7**. Though some intermingling occurs of the two slightly different consistencies of plastisols at all these meeting surfaces, and permanently unites these surfaces, for the most part each retains its intended different degree of density. The as yet uncompressed fibers of layers **3** and **6** bar the inward passage of the heat, at this stage.

When the fusion of these four sizings of plastisols on the meeting faces of layers **2, 3, 6** and **7** has been effected, the second spacer **19** at each side of the stack of layers is removed, and the press again tightened to bear upon the top of the third spacers **20**. This causes the still viscous plastisols on the bottom of layer **2** and the top of layer **7** to permeate the glass fiber of these respective layers until they meet the plastisols which entered the fibers from outside surfaces **1** and **15**, and the plastisols sizing the surfaces of layers **3** and **6** respectively contiguous to layers **2** and **4** are caused likewise to permeate the adjacent portions of layers **3** and **6**.

At the same time, the heat passing through the now compressed layers **3** and **6** reaches and polymerizes the coatings on the under surfaces of layers **3** and **5** and the upper surfaces of layers **4** and **6**, but does not pass through layers **4** and **5**.

When the curing of the plastisols at these surfaces is completed, the spacers **20** are removed, and the press is again tightened, forcing the fibers at the contiguous surfaces of each of these layers **3, 4, 5** and **6** into its respective plastisol coating and causing the heat to pass through the now compressed layers **4** and **5** to fuse the plastisols at their meeting surfaces, the pressure remaining on until the remainder, substantially half, of the thickness of each of these layers is embedded in the viscous plastisol of its respective co-engaging surface.

The heat and the accompanying pressure, which is a most substantial amount, ordinarily of the order of 500 lbs. per square inch, thus complete the curing of the pad and the impregnation of all the fibers and determine its final thickness, as established by spacers **21**. When the curing of layers **4** and **5** is completed, cooling of the sheet is effected by chilling the platens **35** with maintenance of the high pressure until the sheet is cool enough to handle, whereupon it is removed from the presses completed and ready for use or to be cut up into pads of any desired size.

As already indicated, the harder surface of a pad made according to the invention is adhesively or mechanically affixed to the non-lubricated surface of the expansion plate and together they are merely laid in place on the bridge pier or abutment where the beam end is to rest, needing no attachment because of the pad's high coefficient of friction.

Thus all need for providing recesses, lugs, or bolting means is obviated. The usual bed plate is not needed, and the expansion plate itself is made thinner, reducing materially the cost of the bearing. A pad can of course be applied to the underside of the bed plate if one is to be used, enabling this part also to be of reduced thickness.

In cases where the under side of the bridge beam is irregular, another pad is interposed between such surface and the underlying sole plate and held in place by the fastenings which secure the plate to the beam in position to rest upon the expansion plate. Here also it compensates for unevenness of the beam's surface, effects economy through permitting reduction of the thickness of the steel sole plate, and increases the absorption of vibration and shock from traffic over the bridge.

As is obvious, the novel pad is adapted for use in many other instances where expansion plates are used to provide bearings for expansible structural and functional elements subjected to changes of temperature which produce relative motion.

In cases where a coarser gradation of the successive degrees of hardness is sufficient, the sizings of plastisols of varying consistency will be applied to only one surface of each fiber layer save one, which latter will have both surfaces appropriately coated.

While I have illustrated and described a certain form in which the invention may be embodied, I am aware that many modifications may be made therein by any person skilled in the art, without departing from the scope of the invention as expressed in the claim. Therefore, I do not wish to be limited to the particular form shown, or to the details of construction thereof.

I claim:

The method of making elastomeric sheet material which includes the steps of sizing a plurality of component plies of glass fiber on each side thereof with plastisols of differing degrees of hardness when fused, assembling the plies in superposed relation in the order of their eventual hardness, applying heat to the outside plies only, applying pressure to the outside plies to transmit such heat throughout the outer plies in quantity to fuse the plastisol in such outer plies alone, and thereafter increasing the pressure to transmit heat through the fused outer plies to the inner plies in quantity sufficient to fuse the plastisol therein.

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