

[54] REINFORCED MATTRESS FOR  
PROTECTING SHORELINES AND THE  
LIKE

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3,696,623 10/1972 Heine et al. .... 61/38

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[57] ABSTRACT

[21] Appl. No.: 296,348

A pair of sheets of flexible material are interconnected at a plurality of spaced points by a cord system comprising elongated flexible intersecting cord means with the cord means extending between the two sheets and with means interconnecting at least some of the intersecting portions of the cord means whereby a form constructed in this manner may be injected with a cementitious slurry which will inflate the form with the cord means permitting separation of the two sheets for a substantial but controlled amount.

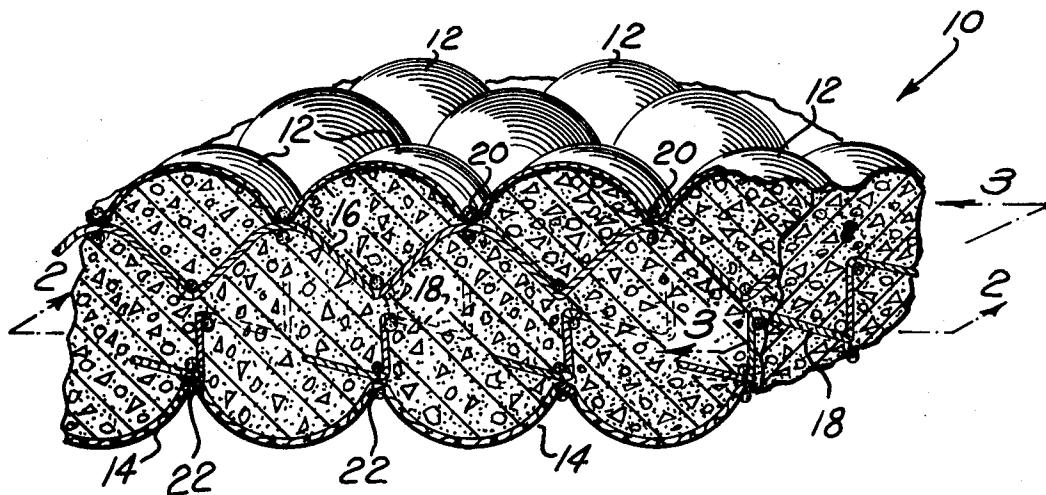
[52] U.S. Cl. .... 61/38, 5/349  
[51] Int. Cl. .... E02b 3/12  
[58] Field of Search ..... 61/37, 38, 35; 5/345 R,  
5/349, 350

16 Claims, 10 Drawing Figures

[56] References Cited

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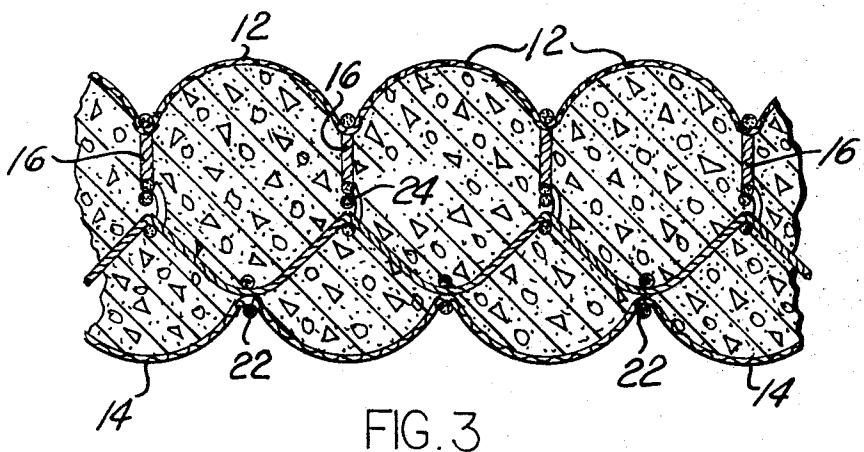
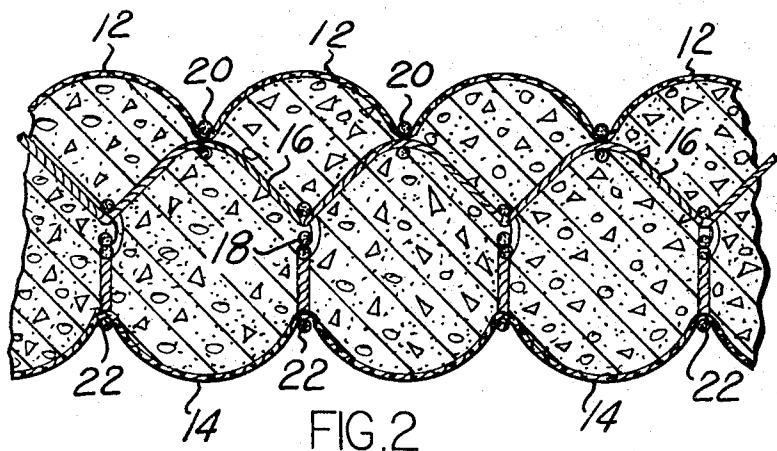
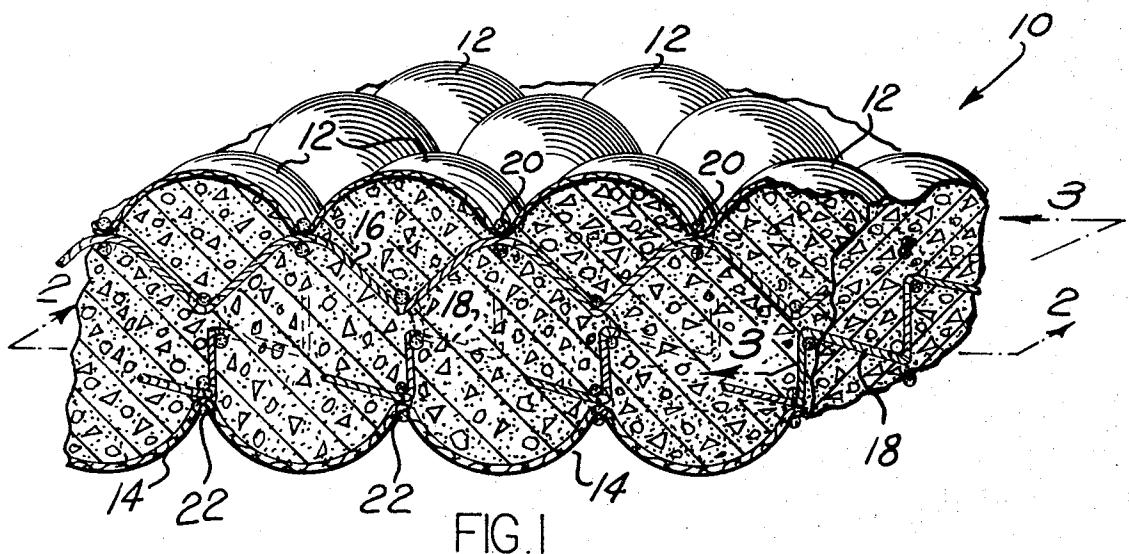
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PATENTED SEP 24 1974

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SHEET 1 OF 2



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SHEET 2 OF 2

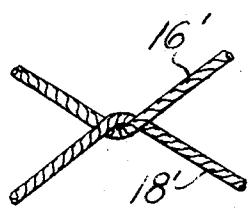


FIG. 4

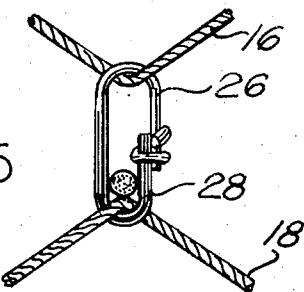


FIG. 5

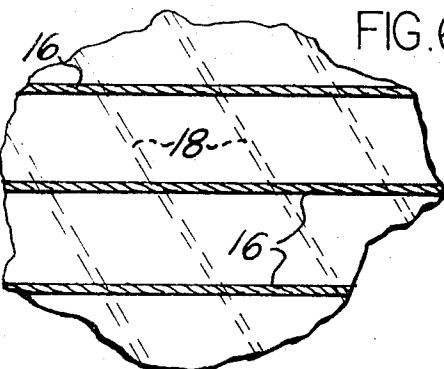


FIG. 6

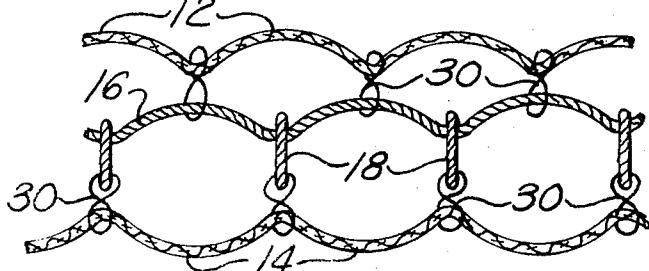
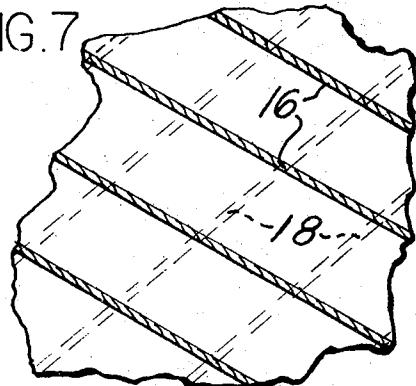


FIG. 8

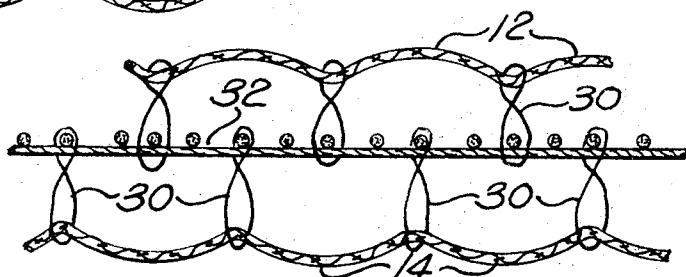


FIG. 9

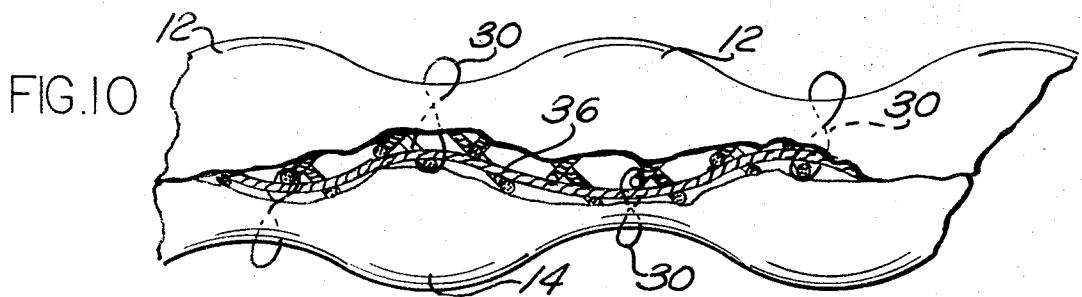


FIG. 10

## REINFORCED MATTRESS FOR PROTECTING SHORELINES AND THE LIKE

This invention broadly relates to the construction arts and, more particularly, to an improved form of flexible material from which concrete structures, such as erosion control mats, may be constructed.

### BACKGROUND OF THE INVENTION

There is disclosed in prior U.S. Pat. No. 3,396,542 a means and a method for protecting surfaces of the earth against erosive action by pumping a cementitious slurry into a form of water permeable fabric. The form comprises two sheets or layers of fabric joined together at a plurality of spaced points so that when the slurry is injected to inflate the form, the sheets separate a substantial but limited amount to form a monolithic concrete body of a controlled thickness.

It has been recognized that in the use of mats constructed in this manner, particularly where such mats are subjected to severe wave action, they may commence to crack. Should this occur, the encasing fabric normally restrains separation of the cracked pieces, but if the fabric itself deteriorates, the cracked pieces of the mat may wash away thereby exposing the underlying soil to erosive forces.

To overcome this problem, it was proposed in my U.S. Pat. No. 3,425,228 to embed a layer of fabric in the concrete mat with the embedded layer of fabric providing a means for interconnecting the cracked pieces of the mat and retaining them in position even though the outer coverings of the fabric may be destroyed. The arrangement disclosed in that patent also contemplated interconnecting the two sheets or layers of fabric at a plurality of spaced points, which points of interconnection served to control the extent to which the sheets were separated when the form was inflated and, thereby, the thickness of the mat.

In both of the aforementioned patents, the two sheets of fabric were placed in contact with each other at their points of connection for the purpose of providing filter points through which hydrostatic forces could be relieved. Another technique for controlling the separation of a pair of sheets of a fabric form when inflated by a slurry is disclosed in my prior patent 3,396,545 and wherein straps extend across the outer surfaces of the two sheets with ties extending between the straps. With this arrangement, the ties limit the amount of separation of the sheets to provide the desired cross sectional thickness of the formed concrete body. A similar arrangement is disclosed in U.S. Pat. No. 3,486,341.

Another mattress construction which has achieved considerable commercial success uses a pair of fabric sheets in which internal fiber reinforcing consisting of drop stitches connects the two sheets with these drop stitches being woven into the fabric of the two sheets. These drop stitches both serve the function of the tie elements in my aforementioned U.S. Pat. No. 3,396,545 in that they control the amount of separation of the two sheets and also serve the function of the layer of fabric in my prior U.S. Pat. No. 3,425,228 in that they serve to retain cracked pieces of the mat in position even though the outer sheets of fabric may have deteriorated.

Although this latter construction has been used with considerable success, some problems have been incurred. For example, since drop stitches extending be-

tween the two sheets are woven into the fabric, it is necessary that the threads comprising the drop stitches be of essentially the same size and character as the threads from which the outer walls are woven. As a result, relatively fine threads have had to be used. For these drop stitches to have sufficient strength to retain cracked pieces in position, it has been necessary to utilize a relatively high density of the drop stitches, with the result that injection of slurry into the interior of the fabric form is sometimes impeded. Another problem is that the drop stitch weaving process is a relatively complex technique requiring special setup of the weaving looms. Accordingly, it is economical to produce only when substantial runs of a particular size are to be made. However, one particular application may require a mattress four inches thick, while in another application a six inch mattress or a three inch mattress may be required. Moreover, in some circumstances it may be desirable to have a mattress which is four inches thick over part of its area and a different thickness over another part. Since it has not been economical to set up the looms for relatively short runs, the use of drop stitch mattresses has been largely limited to one standard size.

### SUMMARY OF THE INVENTION

It is the object of this invention to provide a form for concrete structures which has the advantages of prior arrangements but overcomes the foregoing problems, which is economical to produce in any desired size and which has enhanced strength characteristics.

In accordance with this invention, there is provided a form for use in construction of erosion control mattresses or the like comprising two sheets of flexible material with a plurality of flexible cords having diameters substantially greater than the thickness of the sheets arranged to extend between the interior surfaces of the two sheets at a plurality of spaced points with portions of the cords intersecting other portions and a plurality of individual connecting means with the connecting means connecting the cords to the sheets and interconnecting at least some of the intersecting portions of the cords whereby the cords permit separation of the two sheets for a substantial but limited amount to produce mats of a controlled thickness.

In one form of the invention, the cords comprise an upper and a lower cord system with each system having a plurality of sinusoidally arranged cords and wherein alternating loops of the cords in the upper system are connected to the upper sheet and alternating loops of the cords in the lower system being connected to the lower sheet with the cords of the two system being interconnected at their points of intersection.

In a modified form of the invention, the cords may be arranged in the form of a network, similar to a cargo net, with the cord network being fastened at a plurality of spaced points to the upper and lower sheets by long staples which cooperate to control the thickness of the mat.

These features and aspects of the invention, as well as others, will be more apparent from the following description which, together with the attached drawings, discloses only certain forms of the preferred embodiment.

### BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings wherein like reference numerals indicate like parts in the various views:

FIG. 1 is a perspective view of a portion of an erosion control mattress constructed in accordance with this invention;

FIG. 2 is a sectional view along line 2—2 of FIG. 1;

FIG. 3 is a sectional view along line 3—3 of FIG. 1; 10

FIG. 4 is a fragmentary view of one form of intersection of the reinforcing cords used in the mattress of FIG. 1;

FIG. 5 is a modified form of interconnection of the cords;

FIGS. 6 and 7 illustrate various layouts of the cords to form a mat in accordance with this invention;

FIGS. 8—10 are views similar to FIG. 2 showing modified forms of the invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more in detail to the drawings and particularly FIGS. 1 through 3, there is illustrated a fragmentary portion 10 of a concrete mattress which may be positioned along the shoreline of a water body in a manner similar to that described in U.S. Pat. No. 3,396,542.

The mattress is installed in situ by providing a form comprised of a pair of large sheets 12, 14 of flexible sheet material. These two sheets are arranged in overlying relationship with the peripheral edges of the sheets being closed by any suitable means to form a closed interior space into which a cementitious slurry may be injected. The sheets may be of a porous fabric material of the type disclosed in U.S. Pat. No. 3,396,542. However, the sheets, if desired, may be impervious or only portions of one or both sheets may be porous.

Extending between the two sheets 12, 14 is a cord system comprising a plurality of upper and lower reinforcing cords 16, 18. As shown in FIGS. 1 and 2, the cords 16, are each arranged in a generally sinusoidal configuration with every other loop being connected by a suitable fastener such as a staple 20 to the upper sheet 12. The staples 20 pass through the sheet 12 and around the cord to connect the cords firmly in engagement with the interior surface of the sheet 12.

The lower cords 18 are each arranged in a similar sinusoidal configuration with all of the cords 18 extending generally perpendicular to the cords 16. Alternate loops of the cords 18 are secured by fasteners such as staples 22 to the lower sheet 14 in the same manner as cords 16 are secured to sheet 12.

With this arrangement, alternate unsecured loops of each of the upper cords 16 extend downward toward the lower sheet 14 while the alternate unsecured loops of the cord 18 extend upward toward the upper sheet 12. This results in each unsecured loop of each upper cord being adjacent to an unsecured loop of one of the lower cords 18. In accordance with this invention, the adjacent loops of the cords 16, 18 are secured together by suitable fasteners such as a ring or staple 24. The ring or staple 24 only loosely interconnects the loops of the cords 16, 18 so that relative movement between the two cords is permitted. Contrasted with this is the connection between the staples 20, 22 and their respective

cords and sheets wherein movement of each cord relative to its associated sheet is not permitted.

A form constructed as described and illustrated is used for erosion control by positioning the form on the surface to be protected. Thereafter, a cementitious slurry is injected into the interior space of the form in a manner described in U.S. Pat. No. 3,396,542. Reference may be had to that patent for a disclosure of one suitable cementitious slurry. The slurry is injected under pressure so that it fills the interior space and inflates the form. It will be noted that the cords 16, 18 are embedded in the slurry and the slurry causes the sheets 12, 14 to bulge outwardly to form upper and lower surfaces of a generally bulbous configuration. Thereafter, the slurry is allowed to harden to form a monolithic concrete mat encased by the sheets 12, 14 with the cords 16, 18 embedded in the concrete.

The thickness of the inflated mat is controlled by the cords 16, 18 which cooperate, through the interconnections defined by the fasteners 24, to permit separation of the sheets 12, 14 a substantial but limited amount.

It will be appreciated that the described construction readily lends itself to variations in the thickness of the mats. This may be accomplished simply by varying the size of the loops formed in the cords 16, 18. With relatively shallow loops, a thin mat will be produced while with loops of larger size, a thicker mat will be produced.

30 The fasteners 20, 22, which define the points of connection between the cords 16, 18 and the sheets 12, 14 are, as shown in FIG. 1, offset one from the other so that each indentation in one surface of the mat, representing a connection point, is opposed by a bulbous portion in the other surface. If desired, other arrangements of the cords and their connection points may be employed. For example, the upper cord and lower cord systems may be arranged such that their points of attachment to their respective sheets oppose each other, 35 in which case the indentations in the upper and lower surfaces would be in alignment.

While the cords 16, 18 are shown as being mutually perpendicular, other angular relationships between the cords may be employed as shown for example in FIG. 45 6. Also, the cords may be laid out on the sheets at angles other than perpendicular to the edges of the sheets, as shown schematically in FIG. 7.

Although fasteners in the form of rings or staples 24 have been shown, other forms of interconnection between the upper and lower cord systems may be employed. For example, FIG. 4 illustrates an arrangement in which the cords 16', 18' are merely looped through each other thereby obviating the need for fasteners while FIG. 5 illustrates the use of cords 26 connecting the upper and lower cords 16, 18. With the arrangement of FIG. 5, the cords 26 may be used to position reinforcing rods 28.

60 The cords 16, 18 may be of any suitable material such as common clothes line. However, a wide range of other materials such as webbing, slit heavy fabric, wire, bonding, or fiber reinforced tape may be employed and the term "cord" is used herein without limitation as to the material from which it is made. It is contemplated that the thickness of the cords will be between 1/16 inch and 1/4 inch so that undue bulkiness is avoided but substantial strength is obtained for reinforcing the mat. In any event, the thickness of the cords is significantly

greater than the thickness of the sheet material 12, 14.

Referring to FIG. 8, a modified form of the invention is illustrated wherein, in lieu of connecting the upper and lower cord systems against the sheets 12, 14, long staples or wires 30 are used. The staples 30 pass through the sheets 12 or 14 and extend around the associated cord to support the cord spaced from the adjacent sheet. It is contemplated that each staple will frictionally grip its associated cord to restrain movement 10 of the cord through the staple; however, some swinging movement of the cord relative to the sheets will be permitted.

The arrangement of FIG. 8 has the advantage that the thickness of the mat may readily be varied simply by 15 selection of the length of staples used in assembling the form.

FIG. 9 illustrated an embodiment in which the thickness of the mat is entirely a function of the length of the 20 staples 30. In this embodiment, a rigid meshwork 32 of, for example, reinforcing steel, is positioned between sheets 12, 14 with staples 30 suspending the meshwork between the two sheets.

Referring to FIG. 10, a further modification is illustrated in which a network comprising a plurality of interconnected cords 36 is interposed between the two sheets with some of the cords being connected to the upper layer 12 and other cords connected to the lower sheets 14 by long staples 30. Still other cords of the 25 layer 36 remain unconnected to either sheet. The layer 30 may consist of a conventional cargo net which is of a relatively heavy construction.

This construction has the advantage that almost any 35 configuration of connection points can be obtained. Moreover, by varying either the spacing between the points of connection to the upper and lower sheets 12, 14 or the length of staples 30, the thickness of the mat can be readily varied. Still further, a mat varying cross 40 sectional thickness can be readily produced with this arrangement.

In all of the described embodiments, it is contemplated that the cords will be restrained from any substantial movement relative to the sheets 12, 14 so that the thickness of the mat can be controlled. However, 45 to allow the form to accommodate itself to the surface and to facilitate inflation, the interconnection between the cords where a network of individual cords is used, is such that each cord can shift relative to the other. In the embodiments where a preformed network of interconnected cords is used, such as FIGS. 9 and 10, it is less important that the fasteners securely connect the network to the sheets since the network can only shift a distance equal to the spacing between adjacent cords 50 in any event so there can be a relatively loose relationship between the network and the fasteners in these embodiments.

While the invention has been described with reference to certain specific embodiments, neither the embodiments illustrated nor the terminology employed in 60 describing them is intended to be limiting; rather, it is intended to be limited only by the scope of the appended claims.

Having thus described the invention what is claimed 65 is:

1. A form for use in construction of an erosion control mattress or the like, comprising:

a pair of sheets of flexible material having mutually facing interior surfaces, upper and lower cord systems, each comprising a plurality of intersecting flexible cords, a plurality of individual fastener means securing said upper cord system to one of said sheets, and the lower cord system to the other of said sheets, with the fastener means securing said upper cord system being off-set from the fastener means securing the lower cord system, and means intermediate said sheets interconnecting said upper and lower cord systems, whereby said fastener means cooperate with said upper and lower cord systems to permit separation of said sheets a substantial but limited amount.

2. The form of claim 1 wherein said interconnecting means comprises the cords of said upper and lower systems being interlooped.

3. A form for use in construction of erosion control mattresses or the like comprising:

two sheets of flexible material having mutually facing interior surfaces, a cord system comprising a plurality of elongated flexible cords with at least some of said cords intersecting other of said cords, said cords having a thickness substantially greater than the thickness of said sheets of flexible material, said cord system being positioned between said sheets of flexible material and extending generally coplanarly with the interior surfaces of said two sheets, and

a plurality of individual connecting means loosely engaging and connecting intersecting cords forming said system to one or the other of said two sheets, with each of said connecting means extending through its associated sheet of flexible material at the point of connection, the individual connecting means extending through one of said sheets being off-set with respect to the individual connecting means extending through the other of said sheets, whereby said cord system is loosely secured to said two sheets at a plurality of spaced, off-set points, thereby permitting separation of said two sheets for a substantial but limited amount, while allowing some shifting between the cord system and the sheets.

4. The form of claim 3 wherein said fasteners secure said cord system against the interior surfaces of said sheets.

5. A form for use in construction of an erosion control mattress or the like comprising:

a pair of sheets of flexible material having mutually facing interior surfaces, upper and lower cord systems each comprising a plurality of flexible cords, means securing the cords of said upper system to one of said sheets and the cords of said lower system to the other of said sheets, and means intermediate said sheets interconnecting the cords of said upper and lower systems whereby said sheets may separate a substantial but limited amount.

6. The form of claim 5 wherein said interconnecting means comprises the cords of said upper and lower systems being interlooped.

7. The form of claim 5 wherein said interconnecting means comprises fastener means extending around said cords.

8. The form of claim 7 and further including reinforcing rods positioned between said sheets and connected to said cord systems by said fastener means.

9. The form of claim 5 wherein the cords of said upper system are secured to said one sheet at points offset from the points of securement of the cords of said lower system to said other sheet.

10. The form of claim 5 wherein the cords of said systems are secured against the interior surfaces of said sheets.

11. The form of claim 5 wherein said securing means comprises elongated tie means extending through said sheets and connected to said cords intermediate said sheets.

12. A form for use and construction of erosion control mattresses or the like comprising:

two sheets of flexible material having mutually facing 20 interior surfaces,  
upper and lower cord systems with each of said systems having a plurality of flexible cords arranged in generally parallel rows, with the rows of one system intersecting the rows of the other system, said 25 cords having a thickness substantially greater than the thickness of said sheets of flexible material, said upper and lower cord systems being positioned between said sheets of flexible material and arranged to extend between the interior surfaces of 30 said two sheets at a plurality of spaced points,

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means interconnecting each cord of said cord systems to cords of the other of said cord systems, and

a plurality of individual connecting means with said connecting means securing some of the cords of one of said systems to one of said sheets, and some of said cords of the other of said systems to the other of said two sheets, with each of said connecting means extending through its associated sheet of flexible material at the point of connection, whereby said upper and lower cord systems are secured to said two sheets at a plurality of spaced points, thereby permitting separation of said two sheets for a substantial but limited amount.

13. The form of claim 2 wherein said interconnecting means comprises

the cords of said systems being intertwined.

14. The form of claim 2 wherein said interconnecting means comprises

fastener means for restraining movement of the interconnected cords away from each other while permitting relative movement of the cords.

15. The form of claim 2 wherein each cord is arranged in a generally sinusoidal configuration with some of the loops of each cord being secured to one of said sheets and other of the loops being connected to the cords of the other system.

16. The form of claim 2 wherein the rows of cords of said system are mutually perpendicular.

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