A grout pack is provided comprising a grout bag and a restraining envelope encircling the grout bag. The restraining envelope includes multiple elongate tension elements made of a multitude of fibres twisted, braided or woven to form confinement tension elements for operatively supporting the grout bag. The restraining envelope may include an inner mesh layer positioned on the inside of the elongate tension elements which may assume the form of containment rings encircling the grout bag at spaced positions up the height of the grout pack. Alternatively, or in addition, at least some elongate tension elements may extend in generally helical directions of opposite hand in the installed condition of the grout pack. The tension element may assume the form of a rope or a length of webbing. The ends of the rope or webbing may be joined in a manner providing for controlled slipping of overlapping ends thereof.
MINE SUPPORT GROUT PACKS

FIELD OF THE INVENTION

[0001] This invention relates to mine support grout packs of the type having a grout bag that, in use, is filled with a cementitious or other settable mix, typically, but not necessarily, including pulverised ore or backfill of processed or barren mined material.

[0002] The term grout bag as used herein is intended to mean a generally permeable bag that is used to contain slurry pumped into it under pressure and to retain the solids whilst allowing excess moisture to permeate through the grout bag wall that is typically made of a suitable textile material such as a geotextile material.

[0003] The term grout pack as used herein is intended to mean a grout bag that is used in combination with a restraining envelope encircling the generally upright walls of the grout bag, the restraining envelope including either or both of a reinforcing mesh and a series of elongate tension elements typically in the form of confinement rings or bands encircling the grout bag.

BACKGROUND TO THE INVENTION

[0004] Depending on the type and quality of rock being supported, the depth of mining, the prevalent field stresses, seismicity, stoping width and a number of other factors, stope support can utilise a vast range of materials, configurations and systems, including, gun poles, timber and composite packs, steel props, unmined ore pillars, rock anchors and granular (tailings) type supports.

[0005] Among the granular support media, cemented grout packs are increasingly being utilised as combination support products, consisting essentially of a support column formed by cured cemented backfill or a similar cured cementitious grout, contained within a geotextile bag and stiffened against lateral deformation under axial load with an external restraining envelope of either or both of a reinforcing mesh and a series of tension rings or bands encircling the grout bag, typically both.

[0006] In a conventional configuration, a non-yielding type of grout pack consists of a grout bag surrounded by a restraining envelope including some form of mesh reinforcement and a plurality of confinement rings encircling the mesh and bag. In the instance of yielding grout packs, the construction is similar except that the confinement rings or ring assemblies are able to yield under load thereby maintaining a measure of restraining force before their eventual failure. The mesh is typically a reinforcement of wire or polymer netting and the confinement rings are usually made of steel wire.

[0007] Also, due to its relative rigidity, steel wire requires relatively complex production facilities for making the confinement rings. Also, the yielding characteristics of steel wire may not be appropriate as regards the yielding behaviour of the confinement rings.

OBJECT OF THE INVENTION

[0008] It is an object of this invention to provide a grout pack having an alternative restraining envelope that is suit-

able for ease of production and to provide for controlled collapse of an installed grout pack in use.

SUMMARY OF THE INVENTION

[0009] In accordance with one aspect of this invention there is provided a grout pack comprising a grout bag and a restraining envelope encircling the grout bag, the grout bag having flexible side walls and two ends defining, in use, a top, and a bottom and a cavity for receiving settable granular material or grout, the grout bag further having an inlet for slurry to be introduced into the interior of the grout bag and wherein the flexible side walls are adapted to retain solids within the grout bag and the grout bag has an axis in the general direction of which a filled and set grout pack is adapted to yield, the grout pack being characterised in that the restraining envelope includes multiple elongate tension elements each of which is made of a multitude of fibres twisted, braided or woven or any combination thereof to form confinement tension elements for operatively supporting the grout bag.

[0010] Further features of the invention provide for the fibres to be polymer fibres including but not limited to one or more of polypropylene, nylon, polyesters, polyethylene especially high molecular weight polyethylene, and aromatic polymides, for the restraining envelope to include an inner mesh layer positioned on the inside of the elongate tension elements, for the elongate tension elements to assume the form of containment rings encircling the grout bag at spaced positions up the height of the grout pack in the installed condition; or, alternatively, for the elongate tension elements to extend in generally helical directions of opposite hand in the installed condition of the grout pack; and for the restraining envelope to include terminal rigid confinement rings at each of its two ends, the rigid confinement rings conveniently being of steel wire or similar relatively rigid material.

[0011] In one variation of the invention each tension element assumes the form of a rope that may be of a twisted construction or a braided construction. In such variation the ends of a length of rope are preferably spliced together to form an endless loop. The splice may be either configured to be a non-slip type of splice or it may be configured to slip under predetemined loads in order to provide for controlled yielding of an installed grout pack.

[0012] In another variation of the invention each tension element assumes the form of a length of webbing. In such an instance the free ends of a length of webbing may be stitched together to form an endless loop. Alternatively, the free ends of a thing of webbing may be associated with a buckle that may be arranged to provide for yielding under predetemined loads. In the event that the webbing is arranged in a criss-cross arrangement, the overlapping zones of the webbing can be stitched together.

[0013] The invention also provides a restraining envelope adapted to receive a grout bag in order to form a grout pack as defined above.

[0014] As a general rule, the grout packs defined above are preassembled at a factory level for transport, storage and conveyance to a site of installation in a collapsed condition with the grout pack being ready for installation and erection by securing the upper portion of the assembly against the stope hanging wall and filling the grout bag with a settable material that is typically a cementitious material introduced in the form of a slurry.
In order that the above and other features of the invention may be more fully understood, various embodiments of the invention will now be described with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 is a schematic elevation of one embodiment of grout pack according to the invention in an operative position between a hanging wall and a footwall;

Fig. 2 is a schematic plan view thereof; and,

Figs. 3, 4, 5, 6, 7, 8 and 9 are each a schematic elevation of a second, third, fourth, fifth, sixth, seventh and eighth embodiment of grout pack according to the invention.

DETAILED DESCRIPTION WITH REFERENCE TO THE DRAWINGS

In the embodiment of the invention illustrated in Figs. 1 and 2, a grout bag (1) has, in an operative inflated condition, generally cylindrical flexible side walls (2), and two end walls that form a top (3), and a bottom (4) so as to define a cavity for receiving settle granular material or grout as shown in the cut-away part of Fig. 1 and as indicated by numeral (5). A non-return inlet valve (6) is provided for the introduction of granular material or grout in the form of slurry that is to be introduced into the cavity of the grout bag, in the usual way.

The grout bag may be manufactured from a series of panels stitched together or it may be made from a tubular textile material having end panels secured thereto of the required shape defining the top and bottom.

The fabric from which the grout bag is manufactured may be any suitable fabric and, in particular, a geotextile is considered to be particularly suitable, at least for the flexible side walls that are adapted to retain solids within the grout bag and allow water to permeate through it as may be required. A similar result can be achieved in numerous different ways and utilizing numerous different designs.

In this particular embodiment of the invention a grout pack is formed utilising the grout bag described above together with a restraining envelope comprising both an inner peripheral supporting mesh (7) conforming generally to the outer shape of the grout bag in the open condition and a series of operatively axially spaced circumferential confinement rings (8), the axis being indicated by line A-A in Fig. 1.

In keeping with this invention, each of the confinement rings (8) is formed from a synthetic polymer rope made of a multitude of polymer fibres twisted or braided together to form the rope. The free ends of a suitable cut length of rope are joined together by means of a splice indicated by numeral (9) to form an endless loop. The splice can be configured in one of two different ways.

In a first way the splice is made to be non-sliping and a permanent connection between the two ends. In such an event yielding is dependent on the stretch available in the rope and the rope will eventually break at some point that will generally not be the splice.

In a second way the splice is configured such that when a predetermined tension is exerted on the splice in consequence of the grout pack yielding, the splice slips to allow the containment ring to increase in size whilst still retaining effective containment of the collapsing grout pack.

In such an event the confinement ring will eventually fail once the splice has slipped sufficiently to cause the splice to effectively open.

In the embodiment of the invention illustrated in Fig. 1 the confinement rings are spaced equally up the height of the grout pack in the installed condition and are arranged to extend substantially circumferentially around the grout pack.

In the second embodiment of the invention that is illustrated in Fig. 3, the restraining envelope is devoid of any conventional mesh and comprises multiple elongate tension elements in the form of helically wound synthetic polymer ropes (10) extending in generally helical directions of opposite hand in the installed condition of the grout pack. In this embodiment of the invention the ropes extend at about 45° to the horizontal and are themselves interlaced to form a coarse mesh with diamond shaped apertures, as illustrated in Fig. 3.

The ropes are attached at each end to a steel wire ring (11) of generally conventional configuration at the top and bottom of the grout pack. The individual ropes may include splice joints (12) made in either of the first and second ways described above.

In the embodiment of the invention illustrated in Fig. 4, the rope is replaced by tension elements in the form of interlaced helically wound webbing (15) and the steel wire rings are replaced by circumferential rings (16) of webbing to which the ends of the helically wound webbing are secured by stitching (17) at the angle of 45°. Once more the restraining envelope is devoid of any conventional restraining mesh.

In the embodiment of the invention illustrated in Fig. 5, the elongate tension elements (18) are, once more, webbing. The webbing is wound in more horizontal helices that make an angle of about 22.5° with the horizontal or 67.5° with the direction of the axis of the grout pack. This flatter direction in which the webbing is wound translates into tension elements that carry a higher tensile load than in the instance of the embodiment illustrated in Fig. 4 with the result that the grout pack will show a stiffer response under compressive load, in use.

In the embodiment of the invention illustrated in Fig. 6, the restraining envelope has both an inner peripheral supporting mesh (20) of generally conventional design conforming to the outer shape of the grout bag in the open condition and a series of operatively axially spaced elongate tension elements in the form of spaced circumferential confinement rings (21) that in this instance are made of webbing. The ends of the webbing can be stitched together as indicated by numeral (22) and at least selected confinement rings can be provided with buckles (23) that are configured to allow controlled slippage of overlapped end regions of the webbing to enable the circumference thereof to increase and provide a yielding characteristic. The top and bottom rings (24) can conveniently be generally conventional steel rings, as described with reference to Fig. 3. The ends of both the mesh and bag are secured to the steel rings.

In the embodiment of the invention illustrated in Fig. 7, the arrangement is the same as that described with reference to Fig. 6 apart from the fact that additional longitudinally extending tension elements in the form of lengths of webbing (26) extend in a direction parallel to the axis of the grout pack between the upper and lower steel rings (27).

In the embodiment of the invention illustrated in Fig. 8 the arrangement is substantially the same as that described reference to Fig. 4 except that selected lengths of the helically wound webbing tension elements (30) are pro-
vided with buckles (31) that are configured to allow controlled slippage of overlapped end regions of the webbing to enable the length thereof to increase and provide a yielding characteristic under load. Also, FIG. 8 illustrates the fact that two layers of webbing can be stitched together at selected points at which lengths of webbing cross each other, as indicated by numeral (32). In the embodiment of the invention described with reference to FIG. 8, the ends of the restraining envelope are once more steel rings (33).

[0034] In the embodiment of the invention illustrated in FIG. 9, the arrangement is substantially the same apart from the fact that the webbing tension elements (35) extend at a flatter angle to the horizontal as in the case of the embodiment described with reference to FIG. 5.

[0035] Numerous variations may be made to the embodiments of the invention described above without departing from the scope hereof. In particular, it should be noted that the construction of the elongate tension members can be varied widely and is not limited to any of those described above. Also, wherever a steel ring is used, this may be a double steel ring to facilitate attachment of any mesh that may be used and any elongate tension members to it. Also, any other type of fastening of the elongate tension members to each other or to an end confinement ring may be employed.

[0036] Numerous other arrangements are possible within the scope of the invention.

1. A grout pack comprising a grout bag and a restraining envelope encircling the grout bag, the grout bag having flexible side walls and two ends defining, in use, a top, and a bottom and a cavity for receiving settable granular material or grout, the grout bag further having an inlet for slurry to be introduced into the interior of the grout bag and wherein the flexible side walls are adapted to retain solids within the grout bag and the grout bag has an axis in the general direction of which a filled and set grout pack is adapted to yield, wherein the restraining envelope includes multiple elongate tension elements each of which is made of a multitude of fibres twisted, braided or woven or any combination thereof to form confinement tension elements for operatively supporting the grout bag.

2. A grout pack as claimed in claim 1 in which the fibres are polymer fibres selected from one or more of polypropylene, nylon, polyesters, polyethylene and aromatic polyamides.

3. A grout pack as claimed in claim 1 in which the restraining envelope includes an inner mesh layer positioned on the inside of the elongate tension elements.

4. A grout pack as claimed in claim 1 in which at least some elongate tension elements assume the form of containment rings encircling the grout bag at spaced positions up the height of the grout pack in the installed condition.

5. A grout pack as claimed in claim 1 in which at least some elongate tension elements extend in generally helical directions of opposite hand in the installed condition of the grout pack.

6. A grout pack as claimed in claim 1 in which the restraining envelope includes terminal rigid confinement rings at each of its two ends.

7. A grout pack as claimed in claim 1 in which a tension element assumes the form of a rope (8, 10).

8. A grout pack as claimed in claim 7 in which the ends of a length of rope are spliced together to form an endless loop.

9. A grout pack as claimed in claim 8 in which the splice is configured to be either a non-slip type of splice or a splice configured to slip under predetermined loads in order to provide for controlled yielding of an installed grout pack.

10. A grout pack as claimed in claim 1 in which a tension element assumes the form of a length of webbing.

11. A grout pack as claimed in claim 10 in which the free ends of a length of webbing are associated with a buckle that is arranged to provide for yielding under predetermined loads.

12. A grout pack as claimed in claim 10 in which selected overlapping zones of the webbing are stitched together.

13. A restraining envelope adapted to receive a grout bag in order to form a grout pack as claimed in claim 1.

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