TRUSS SYSTEM INSTALLATION

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ABSTRACT

Devices, systems, and methods for securing portions of a tunnel are disclosed herein. Portions of a tunnel can be secured via attachment of a truss system to the portions of the tunnel. The truss system can include a threadbar, a bearing plate, a tie rod, a first anchor nut, a second anchor nut, and a truss eye. The threadbar can extend through both the truss eye and the bearing plate, and the truss eye and the bearing plate can be separated by the first anchor nut that can be located on the threadbar and between the bearing plate and the truss eye. The first anchor nut can hold the bearing plate against the wall of the tunnel, and the second anchor nut can hold the truss eye against the first anchor nut.
TRUSS SYSTEM INSTALLATION

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/924,590, filed Jan. 7, 2014, the entire content of which is incorporated herein by reference in its entirety and for all purposes.

BACKGROUND OF THE INVENTION

[0002] This disclosure relates in general to tunnel wall securement systems, methods, and devices including mine roof securement systems, methods, and devices.

[0003] In mining operations, bolts are often used to support the roof of the mine. In some applications, a pair of spaced-apart, inclined bar bolts, also referred to herein as threadbars, are anchored into the roof of the mine. Each inclined bar bolt is typically connected to a truss shoe, also called a truss bracket. The truss shoes, which also are spaced apart due to their connection to the inclined bar bolts, are joined together by a horizontally extending coupler, also referred to herein as a tie rod. Typically, the coupler consists of a pair of cables and/or threaded rods, each connected to a corresponding one of the truss shoes, with the cables and/or threaded rods and joined to each other by a coupler disposed between the spaced apart truss shoes.

[0004] Certain considerations may be faced when installing a mine roof truss. For example, the inclined bar bolts are typically installed, with the truss shoe already attached, using a bolting machine. In some circumstances, the operator may have to leave the bolting machine to adjust the truss shoe or otherwise reposition the truss shoe during the bolting operation. Further, some inclined bar bolts have hex-head ends, while others are threaded. Typically, a truss shoe is adapted for attachment to a particular type of inclined bar bolt. Moreover, the truss shoe typically is adapted for attachment to a particular type of horizontal cross member, such as a dead-ended, pre-seated wedge barrel attached to a threaded cable, or to a bar cross member having an anchor nut.

BRIEF SUMMARY OF THE INVENTION

[0005] Some embodiments of the present disclosure relate to a roof truss system for supporting a roof of a mine. The roof truss system includes a threadbar that can be an elongate load bearing member having a first portion proximate to a first end and a second portion proximate to a second end. The roof truss system can include a first anchor nut connecting to the threadbar at a first position, which first anchor nut can have a first end having a first contact surface and a second end located opposite the first end. The roof truss system can include a second anchor nut connecting to the threadbar at a second position. In some embodiments, the second anchor nut can have a first end that includes a second contact surface and a second end located opposite the first end. The roof truss system can include a bearing plate having a wall surface and a nut surface. The roof truss system can include a truss eye having a base with a first side and an opposed second side, a first hole extending through the first side of the base and towards the second side, and an eye portion defining an eye. In some embodiments, the threadbar can extend through the eye of the eye portion and the eye portion of the truss eye can be at an intermediate position along the threadbar between the first second anchor nuts.

[0006] In some embodiments of the roof truss system, the first portion of the threadbar is affixed within a hole in the roof of the mine and the second portion of the threadbar extends from the hole in the roof of the mine. In some embodiments, the first and second portion of the threadbar are located on the second portion of the threadbar. In some embodiments, the bearing plate is located at a position along the threadbar and between the roof of the mine and the first anchor nut. In some embodiments, the bearing plate contacts the roof of the mine and the second end of the first anchor nut. In some embodiments, the eye portion of the truss eye can form the first contact surface of the first anchor nut and the second contact surface of the second anchor nut.

[0007] In some embodiments, the roof truss system includes a tie rod that can be an elongate load bearing member having a first end and a second end. In some embodiments, the tie rod can be a cable, and in some embodiments, the tie rod can be a bar. In some embodiments, the first end of the tie rod is secured in the first hole of the truss eye. In some embodiments, the first hole of the truss eye is threaded, and in some embodiments, the first hole is tapered.

[0008] Some embodiments of the present disclosure relate to a method of installing a roof truss system. The method includes creating a first hole in a roof of a mine and attaching a first anchor nut to a threadbar at a first position. In some embodiments, the anchor nut can have opposing first and second ends and a contact surface at the first end. In some embodiments, the threadbar can be an elongate member having a first portion proximate to a first end and a second portion proximate to a second end, and in some embodiments the first position at which the first anchor nut is located can be within the second portion of the threadbar. The method can include anchoring the first portion of the threadbar within the first hole in the roof of the mine such that the second end of the first anchor nut holds a bearing plate against the roof of the mine and inserting a portion of the threadbar through an eye of a first truss eye. In some embodiments, the first truss eye can include a base having a first side and an opposed second side, a base aperture extending through the first side of the base and towards the second side, and an eye portion defining an eye. The method can include securing the threadbar to the first truss eye by attaching a second anchor nut to the threadbar at a second position. In some embodiments, the first truss eye can be located at an intermediate position between the first and second positions.

[0009] In some embodiments, the method of installing a roof truss system can include inserting the threadbar through a hole in the bearing plate. In some embodiments, the threadbar can be affixed within the first hole in the roof of the mine via the mixing and the hardening of resin within the first hole.

[0010] In some embodiments, the method includes affixing a first end of a tie rod to the base aperture of the first truss eye. In some embodiments, a second end of the tie rod is connected to a second base aperture of a second truss eye, and the second truss eye is connected to a second threadbar that is affixed within a second hole in the roof of the mine.

[0011] In some embodiments, the method includes creating a desired tension within the tie rod. In some embodiments, creating the desired tension within the tie rod can include moving the second anchor nut to a third position to thereby increase the relative proximity between the first and second anchor nuts. In some embodiments, the tension in the tie rod increases when the second anchor nut is moved from the second position to the third position. In some embodiments,
creating the desired tension within the tie rod can include applying a force to the tie rod equal to the desired tension. Further areas of applicability of the present disclosure will become apparent from the detailed description provided hereinbefore. It should be understood that the detailed description and specific examples, while indicating various embodiments, are intended for purposes of illustration only and are not intended to necessarily limit the scope of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of one embodiment of a truss eye.
FIG. 2 is a front view of one embodiment of a truss eye.
FIG. 3A is a top view of one embodiment of a truss eye.
FIG. 3B is a bottom view of one embodiment of a truss eye.
FIG. 4 is a perspective view of one embodiment of a wedge.
FIG. 5 is a perspective view of one embodiment of a wedge clip.
FIG. 6A-6C depict embodiments of an integrated truss system.
FIGS. 7 through 9 illustrate one embodiment of a process for creating an integrated truss system.

In the appended figures, similar components and/or features may have the same reference label. Where the reference label is used in the specification, the description is applicable to any one of the similar components having the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

DETAILED DESCRIPTION OF THE INVENTION

In some embodiments, the present disclosure relates to a truss eye that can be used as a component of an integrated truss system to secure some or all of one or several walls, including a roof of a tunnel, including a mine. Advantageously, the truss eye can be used with a wide variety of threadbars and with threadbars having a variety of angular positions relative to the truss eye.

With reference now to FIG. 1, a perspective view of one embodiment of a truss eye 100 is shown. The truss eye 100 can comprise a variety of shapes and sizes and can be made from a variety of materials, the details of several of which are discussed below. In some embodiments, the truss eye 100 can be sized and shaped, and made from materials so as to hold at least 1 ton, 5 tons, 10 tons, 20 tons, 30 tons, 50 tons, 100 tons, or any other or intermediate load. In some embodiments, for example, the truss eye 100 can comprise ductile iron.

As depicted in FIG. 1, the truss eye 100 can comprise a base portion 102. The base portion 102 can comprise a variety of shapes and sizes and can be made from a variety of materials. In some embodiments, the base portion 102 comprises an integral portion of the truss eye 100 and is made of the same material as the other portions of the truss eye 100. The base portion 102 can have a bottom 104 located at a proximal end of the truss eye 100 and the base top 106 located at the distal boundary of the base portion 102 and sides 107 extending between the bottom 104 and the base top 106. In the embodiment depicted in FIG. 1, the base portion 102 is cylindrically shaped, and specifically approximates the shape of a right circular cylinder. In some embodiments, the distance between the bottom 104 and base top 106 can be, for example, 0.25 inches, 0.35 inches, 0.45 inches, 0.5 inches, 0.75 inches, 1 inch, 1.5 inches, 1.75 inches, 2 inches, 3 inches, 5 inches, 10 inches, or any other or intermediate distance, and the distance between the sides 107, and/or the diameter of the base portion can be, for example, 0.5 inches, 0.75 inches, 1 inch, 1.5 inches, 1.75 inches, 2 inches, 3 inches, 5 inches, 10 inches, or any other or intermediate distance.

As seen in FIG. 1, base portion 102 can include a base aperture 108 that can extend from the bottom 104 towards the base top 106. In the embodiment depicted in FIG. 1, the base aperture 108 extends from the bottom 104 to the base top 106. As further seen in FIG. 1, the base aperture 108 defines an aperture axis 110 that extends along the centerline of the base aperture 108. In some embodiments, the aperture axis 110 can be collinear with the centerline of the base portion 102 extending between the bottom 104 and the base top 106, and in some embodiments, the aperture axis 110 can be non-collinear with the centerline of the base portion 102 extending between the bottom 104 and the base top 106.

The base aperture 108 can comprise a variety of shapes and sizes. In some embodiments, the base aperture 108 is a cylindrical aperture having a constant radius with respect to the aperture axis 110 along the length of the base aperture 108. In some embodiments in which the base aperture 108 has a constant radius with respect to the aperture axis 110 along the length of the base aperture 108, the radius can be, for example, 0.1 inches, 0.25 inches, 0.35 inches, 0.5 inches, 0.75 inches, 1 inch, 2 inches, or any other or intermediate measure.

In some embodiments, the base aperture 108 can have a varying radius with respect to the aperture axis 110 along the length of the base aperture 108. In some embodiments, for example, the base aperture 108 can have a first radius measured with respect to the aperture axis 110 at the base top 106 that is larger than a second radius measured with respect to the aperture axis 110 at the bottom 104. In such an embodiment, the base aperture 108 can comprise a frustum such as, for example, a conical frustum. In one embodiment in which the base aperture 108 comprises a conical frustum, the first radius of the base aperture 108 can be 0.25 inches, 0.5 inches, 0.75 inches, 0.855 inches, 1 inch, 2 inches, or any other or intermediate measure and the second radius of the base aperture 108 can be 0.1 inches, 0.25 inches, 0.35 inches, 0.355 inches, 0.5 inches, 0.75 inches, 1 inch, 1.9 inches, or any other or intermediate measure.

The base aperture 108 can, in some embodiments, include features configured to allow mechanical connection with other components of an integrated truss system. In one embodiment, these features can include the above discussed frustum shape of the base aperture 108, and in one embodiment, these features can include threads on all or portions of the base aperture 108. In one embodiment, access to the threads can be facilitated by a chamfer located at the intersection of the base aperture 108 and the bottom 104 which chamfer can be, for example, a 10 degree chamfer, a 20 degree chamfer, a 30 degree chamfer, a 40 degree chamfer, a 50
degree chamfer, a 60 degree chamfer, a 70 degree chamfer, an 80 degree chamfer, or any other or intermediate chamfer.

[0029] The truss eye 100 can include an eye portion 112 extending from a portion of the base portion 102, and specifically as depicted in FIG. 1, the eye portion 112 extends from the sides 107 of the base portion 102 of the truss eye 100. The eye portion 112 can include a first member 114 and a second member 118. As seen in FIG. 1, the first member 114 and the second member 118 attach to the sides 107 of the base portion 102 and extend distally from the bottom 104. As further seen FIG. 1, the distally extending centerlines of the first and second members 114, 116 are coplanar with each other and with the aperture axis 110.

[0030] As further seen in FIG. 1, the first and second members 114, 116 are connected by connecting member 118 which is located at a distal end of the truss eye 100. In some embodiments, the connecting member 118 can be a variety of shapes and sizes. In the embodiment depicted in FIG. 1, the connecting member 118 has a circular cross-section and forms a half annulus with the first end of the connecting member 118 extending tangentially from the distal end of the first member 114 and the second end of the connecting member 118 extending tangentially from the distal end of the second member 116.

[0031] In some embodiments, the base top 106 of the base portion 102, the first member 114, the second member 116, and the connecting member 118 together define an eye 120. The eye 120 has a length measured along the aperture axis 110 that extends from the base top 106 to the most distal interior edge of the connecting member 118. In some embodiments, the length of the eye 120 can be, for example, 1 inch, 1.5 inches, 2 inches, 2.5 inches, 2.6 inches, 3 inches, 5 inches, 10 inches, or any other or intermediate length. In some embodiments, the eye 120 has a width measured perpendicular to the aperture axis 110 and across the shortest distance between the interior edges of the first and second members 114, 116. In one embodiment, the width of the eye 120 is the shortest distance between the interior edges of the first and second members 114, 116 that connect with portions of the connecting member 118. The width of the eye can be 0.5 inches, 0.75 inches, 1 inch, 1.25 inches, 1.35 inches, 1.5 inches, 2 inches, 3 inches, 5 inches, 10 inches, or any other or intermediate width. In some embodiments, the length of the eye 120 can be the same as the width of the eye 120. In some embodiments, the length of the eye 120 can be greater than the width of the eye 120. In some embodiments, for example, the length of the eye 120 can be 1.1 times, 1.2 times, 1.3 times, 1.4 times, 1.5 times, 1.75 times, 2 times, 3 times, 5 times, or any other or intermediate factor larger than the width of the eye 120.

[0032] With reference now to FIG. 2, a front view of one embodiment of the truss eye 100 is shown. The truss eye 100 depicted in FIG. 2 depicts the base portion 102, including the bottom 104, the base top 106, the base aperture (not shown), the centerline of which base aperture defines the aperture axis 110, and the eye portion 112 that includes first and second members 114, 116 and the connecting member 118. The first and second members 114, 116 and the connecting member 118 together with the base top 106 define the eye 120. As seen in FIG. 2, the first member 114 includes a first extension portion 202 and a first root 204. The first root 204 connects with the sides 107 of the base portion 102 and distally extends from the base portion 102 until it connects with the first extension portion 202 of the first member 114. Similarly, the second member 116 includes a second extension portion 206 and a second root 208. The second root 208 connects with the sides 107 of the base portion 102 and distally extends from the base portion 102 until it connects with the second extension portion 206 of the second member 116. As seen in FIG. 2, each of first and second roots 204, 208 angularly extends from the base portion 102 of the truss eye 100. In some embodiments, this angle can be 5 degrees, 10 degrees, 15 degrees, 20 degrees, 30 degrees, 45 degrees, 60 degrees, or any other or intermediate angle.

[0033] In some embodiments, the first and second root portions 204, 208 have constant cross sections, and in some embodiments, the first and second root portions 204, 208 have variable cross-sections. Thus, in one embodiment, the first and second root portions 204, 208 comprise a circular cross-section at the point at which the first and second root portions 204, 208 respectively intersect with the first and second extension portions 202, 206, and a non-circular cross-section at other points along the first and second root portions 204, 208. In one embodiment, the first and second root portions 204, 208 include a taper 209 that starts at the bottom 104 of the first and second root portions 204, 208, decreases along the length of the first and second root portions 204, 208, and terminates before the intersection of the first and second root portions 204, 208 with the first and second extension portions 202, 206.

[0034] In some embodiments, the first and second extension portions 202, 206 can comprise a circular cross-section and can extend parallel to the aperture axis 110. In some embodiments, the diameter of the first and second extension portions 202, 206 and of the connecting member 118 can be 0.25 inches, 0.5 inches, 0.75 inches, 1 inch, 1.15 inches, 1.25 inches, 1.5 inches, 2 inches, 3 inches, 5 inches, or any other or intermediate diameter. In some embodiments, dimensions of the first and second members 114, 116 including of the first and second extension portions 202, 206 and the first and second roots 204, 208, as well as of the connecting member 118, can be selected in connection with the material of the truss eye 100 to withstand desired loads.

[0035] In some embodiments, and as seen in FIG. 2, the truss eye 100 can include wedge 210. In some embodiments, the wedge 210 can be configured to be received and retained within the base aperture 108 so as to allow engagement of the tie rod with the truss eye 100 via the wedge 210 and the base aperture 108. The wedge 210 can, in some embodiments, be a single piece wedge, a two piece wedge, a three piece wedge, a four piece wedge, a five piece wedge, or have any other desired number of pieces. In some embodiments, the retention of the wedge 210 within the base aperture 108 can be facilitated by the wedge clip 212. Both the wedge 210 and the wedge clip 212 will be discussed in greater detail below.

[0036] With reference now to FIGS. 3A and 3B, top and bottom views of the truss eye 100 are shown. As seen in the top view shown in FIG. 3A, the truss eye 100 includes base portion 102 having base top 106 and sides 107 and connecting member 118. As further seen in FIG. 3A, the wedge clip 212 extends across a portion of the base top 106 of the base portion 102 and is retained between first and second retention features 302, 304 each protruding from two positions on the sides 107 of the base portion 102. In some embodiments, the first and second retention features can be configured to hold
the wedge clip 212 in a position to retain the wedge 210 within the base aperture 108. In one embodiment, and as seen in FIG. 2, the wedge clip 212 can retain the wedge 210 within the base aperture 108 when the wedge clip 212 is distally positioned with respect to a portion of the wedge 210. As seen in the bottom view shown in FIG. 3B, the wedge 210 can be located in base aperture 108 and can extend around and within the perimeter of the base aperture 108.

[0037] With reference now to FIG. 4, a perspective view of one embodiment of the wedge 210 is shown. The wedge 210 depicted in FIG. 4 is a three-piece wedge. The wedge 210 can include a wedge top 400, a wedge bottom 402, and wedge sides 403 extending between the wedge top 400 and the wedge bottom 402. As seen in FIG. 4, in some embodiments, the diameter of the wedge varies along the longitudinal axis extending between the wedge top 400 and the wedge bottom 402. In some embodiments, the rate of change of the wedge diameter corresponds to the rate of change of the radius and/or diameter of the base aperture 108 so that the wedge sides 403 mate with the walls of the base aperture 108 when the wedge 210 is positioned within the base aperture 108.

[0038] In some embodiments, and as further depicted in FIG. 4, the wedge 210 can include a wedge aperture 404 that can extend through all or portions of the wedge between the wedge top 400 and the wedge bottom 402. In some embodiments, the wedge aperture 404 can have a constant diameter along its longitudinal axis, and in some embodiments, the diameter of the wedge aperture 404 can vary along its longitudinal axis. In some embodiments, the wedge aperture 404 can include features configured to mechanically engage with and retain a tie rod, which features can include, in some embodiments, threads on all or portions of the wedge aperture 404.

[0039] The wedge 210 can, in some embodiments, include retention recess 406. The retention recess 406 can be sized, shaped, and located on the wedge 210 to allow interaction with the wedge clip 212 to thereby retain the wedge 210 within the base aperture 108 of the truss eye 100. In the embodiment depicted in FIG. 4, the wedge recess 406 is a channel extending circumferentially around the outer perimeter of the wedge 210.

[0040] With respect now to FIG. 5, a perspective view of one embodiment of the wedge clip 212 shown. As discussed above, wedge clip 212 is a component of the truss eye 100 that can retain the wedge 210 within the base aperture 108 of the truss eye 100. The wedge clip 212 can be a variety of shapes and sizes and can be made from a variety of materials. In the embodiment depicted in FIG. 5, the wedge clip 212 comprises a retainer 500. The retainer 500 can be configured to interact with the wedge 210 to retain the wedge 210 within the base aperture in the embodiment depicted in FIG. 5. The retainer 500 is configured to extend across the base top 106 of the base portion and across portions of the wedge top 400 of the wedge 210.

[0041] As further depicted in FIG. 5, the wedge clip 212 comprises connectors 502. The connectors 502 are configured for insertion into portions of the truss eye 100 to thereby connect wedge clip 212 to the truss eye 100. In the embodiment depicted in FIG. 5, the connectors 502 are further configured to allow movement of the wedge clip 212 between a first position in which the wedge 210 is retained within the base aperture 108 of the truss eye 100 by the wedge clip 212 and a second position in which the wedge 210 is not retained within the base aperture 108 of the truss eye 100 by the wedge clip 212. In the embodiments depicted in FIGS. 3A and 3B, the wedge clip 212 can be retained in the first position by the first and second retention features 302, 304.

[0042] FIGS. 6A-6C depict different embodiments of an integrated truss system. With reference now to FIG. 6A, one embodiment of an integrated truss system 600 is shown. The integrated truss system 600 can be used to secure all or portions of one or several walls 602, including roofs within a tunnel, including in a mine. As seen in FIG. 6A, holes 604 have been made in the walls 602. In some embodiments, the holes 604 can receive components of the truss system 600 to thereby create the integrated truss system 600. In the embodiment depicted in FIG. 6A, the truss system 606 includes a truss eye 100, and specifically two truss eyes 100. The truss eyes 100 have received, and are affixed to tie rods 608 via the base apertures 108 of the truss eyes 100. The tie rods, which can be any elongate load-bearing members having a first end and a second end can comprise a cable, a rod, a bar, or any other member. In some embodiments, the tie rod 608 can comprise a plurality of connected members, and in some embodiments, the tie rod 608 can comprise a single member. As specifically seen in FIG. 6A, the tie rod 608 comprises, a first member that is attached to a first truss eye and a second member that is attached to a second truss eye. The first and second members of the tie rod 608 are connected via connector 610 which can be any desired connector.

[0043] The truss system 606 further includes a threaded bar 612 that is inserted into the holes 604 of the walls 602 of the tunnel. The threaded bar 612 can be configured for affixation to the walls 602 of the tunnel using any of a variety of known techniques including, for example, via mechanical features on the threaded bar 612, via mechanical features associated with the threaded bar 612, or via use of adhesive, resin, epoxy, or the like. The threaded bar 612 can comprise an elongate member that can include features to allow affixation, either directly or indirectly to the truss eye 100. In some embodiments, these features can comprise one or several threads. As seen in FIG. 6A, the threaded bar 612 has a first portion 612-A that is proximate to a first end 612-B and a second portion 612-C that is proximate to a second end 612-D. As further seen in FIG. 6A, in some embodiments, the first portion 612-A of the threaded bar 612 can be inserted into the one of the holes 604 in the wall 602 of the tunnel.

[0044] As depicted in FIG. 6A, the threaded bar 612 passes through the eye 120 of the truss eye 100 and is secured by the anchor nut 614. The anchor nut 614 can be configured to allow attachment of the truss eye 100 to the threaded bar 612. In some embodiments, the anchor nut 614 can be separate from the threaded bar 612, and in some embodiments, such as with a headed threaded bar or headed rebar, the anchor nut 612 can be an integral piece of the threaded bar 612.

[0045] The anchor nut 614 has a first end 618 (labeled in FIG. 6B) including a contact surface 620 (labeled in FIG. 6B) and a second end 622 (labeled in FIG. 6B), and in some embodiments, the anchor nut 614 has a threaded aperture extending between the first and second ends. In some embodiments, the contact surface has a dimension, and specifically a diameter that allows the contact surface to engage the first and second members 114, 116 of the truss eye 100. The anchor nut 614 can be tightened on the threaded bar 612 against the truss eye 100 to thereby compress a portion of the truss eye 100 against the wall 602 of the tunnel and to tension the threaded bar 612. In some embodiments, the anchor nut 614 can be tightened to compress a portion of the truss eye 100 by applying a
torque to the anchor nut 614, and in some embodiments, the anchor nut 614 can be tightened to compress a portion of the truss eye 100 by increasing the depth to which the first portion 612-A extends into the hole 614 in the wall 602 of the tunnel.

With reference now to FIGS. 63 and 6C, a second embodiment of the integrated truss system 600 is shown. The integrated truss system 600 shown in FIGS. 63 and 6C is used to secure all or portions of one or several walls 602, including roofs within a tunnel, including within a mine. As seen in FIGS. 63 and 6C, holes 604 have been created in the walls 602, which holes 604 can receive components of the truss system 606. The truss system 606 can include truss eye 100, a tie rod 608 (which can include first and second members mechanically linked by connector 610), threadbar 612, and anchor nuts 614. In some embodiments, and specifically as depicted in FIGS. 63 and 6C, the truss system 606 includes two truss eyes 100, two threadbars 612, a tie rod 608, and four anchor nuts 614.

In some embodiments, the truss system 606 can further include bearing plate 616. The bearing plate 616 can comprise a variety of shapes and sizes and be made from a variety of materials. In some embodiments, the bearing plate 616 can be any available bearing plate having desired material and mechanical properties. The bearing plate 616 can include a mating surface 616-A configured to mate and apply a force to an object such as, for example, the wall 602 of the tunnel, and an affixation surface 616-B configured to mate with a portion of the anchor nut 614 to secure the position of the bearing plate 616 relative to the threadbar 612. As seen, the threadbar 612 can extend through a portion of the bearing plate 616 such as, for example, through an aperture in the bearing plate 616. In the embodiments depicted in FIGS. 63 and 6C, the threadbar 612 extends through the bearing plate 616 and the bearing plate is positioned along the threadbar 612 and in the second portion 612-C of the threadbar 612. In some embodiments, the bearing plate 616 can be positioned so that the mating surface 616-A abuts the wall 602 of the tunnel.

In the embodiments depicted in FIGS. 63 and 6C, the truss system 606 includes first anchor nuts 614-A located at first positions on the threadbars 612, and second anchor nuts 614-B located at second positions on the threadbars 612. The anchor nuts 614 can be placed on the threadbar 612 in any desired orientation. In some embodiments, the anchor nuts 614 can be placed on the threadbar 612 such that the contact surfaces 904 of the first and second anchor nuts 614-A, 614-B face in the same direction, and in some embodiments, the anchor nuts 614 can be placed on the threadbar 612 such that the contact surfaces 904 of the first and second anchor nuts 614-A, 614-B face in opposite directions. As seen in FIGS. 63 and 6C, the orientation of the first and second anchor nuts 614-A, 614-B is such that the contact surfaces 904 of the first and second anchor nuts 614-A, 614-B face in opposite directions and face each other.

As further seen in FIGS. 6B and 6C, the truss eye 100 is immediately positioned along the threadbar 612 at a position between the first and second positions of the first and second anchor nuts 614-A, 614-B. In some embodiments, when the first and second anchor nuts 614-A, 614-B are in the first and second positions respectively, portions of the truss eye 100 contact portions of both of the first and second anchor nuts 614-A, 614-B, and in some embodiments, when the first and second anchor nuts 614-A, 614-B are in the first and second positions respectively, portions of the truss eye 100 contact portions of one of the first and second anchor nuts 614-A, 614-B. In the embodiment depicted in FIG. 63, when the second anchor nut 614-B is in the second position, the truss eye 100 does not contact both the first anchor nut 614-A and the second anchor nut 614-B, but rather contacts portions of the second anchor nut 614-B. However, as seen in FIG. 6C, when the second anchor nut 614-B is moved to a third position, the truss eye 100 contacts portions of both of the first anchor nut 614-A and the second anchor nut 614-B. In some embodiments, advantageously, tension within the tie rod 608 can be changed by moving the position of the truss eye 100 along the threadbar 612 by moving the second anchor nut 614-B from the second position to the third position.

With reference now to FIGS. 7 through 9, one embodiment of a process for creating an integrated truss system 600 is shown. The process begins with the selection of a portion of the walls 602 of the tunnel for securement via the truss system 606. After the portion of the wall 602 has been selected, one or several holes 604 are created in the selected wall portion. These holes 604 can be created using any desired technique including, for example, drilling or cutting.

After the holes 604 have been created in the walls 602 of the tunnel, the process proceeds as indicated in FIG. 7 wherein the tie rod 608 is connected to the truss eye 100. In the embodiment depicted in FIG. 7, the tie rod 608 is connected to the truss eye 100 via the base aperture 108 of the truss eye 100, and specifically, the tie rod 608 is connected to the wedge 210 which is retained within the base aperture 108 by the wedge clip 212.

The process proceeds as indicated in FIG. 8 wherein the threadbar 612 is connected to the truss eye 100. Specifically, the threadbar 612 is inserted into the hole 604 in the wall 602 of the tunnel and is affixed within the hole 604 in the wall 602 of the tunnel. In some embodiments, the threadbar 612 is inserted through the eye 120 of the truss eye 100. The threadbar 612 is tensioned as the anchor nut 614 is threaded onto the threadbar 612 and the contact portions of the anchor nut 614 interact with the first and second members 114, 116 to thereby force a portion of the truss eye 100 against the wall 602 of the tunnel. The anchor nut 614 is torqued to a desired torque level to achieve a desired tension in the threadbar 612.

In one embodiment, for example, the anchor nut 614 is attached to, and specifically is threaded on to the threadbar 612, and the threadbar 612 is passed through the eye 120 of the truss eye 100. The threadbar 612 is then inserted into the hole 604 in the wall 602 of the tunnel, which hole 604 can include resin or resin packets which can be, in some embodiments, mixed or unmixed resin or resin packets. In some embodiments, a bar spinner can be used to engage the threadbar 612 and to rotate the threadbar 612 to thereby mix the resin and/or resin packets. After the resin and/or resin packets have been mixed, the threadbar 612, and thereby also the attached anchor nut 614 and truss eye 100 can be held in a desired position until the resin hardens. In one embodiment, for example, the threadbar 612 can be held in the hole 604 such that a portion of the truss eye 100 engages a portion of the wall 602 of the tunnel.

In one embodiment for example, the first anchor nut 614-A is attached to, and specifically is threaded onto the threadbar 612 and the threadbar 612 is passed through a portion of the bearing plate 616 such as, for example, the aperture of the bearing plate 616. The threadbar is then inserted into the hole 604 in the wall 602 of the tunnel, which
hole 604 can include resin or resin packets which can be, in some embodiments, mixed or unmixed resin or resin packets. In some embodiments, a bar spinner can be used to engage the threadbar 612 and to rotate the threadbar 612 to thereby mix the resin and/or resin packets. After the resin and/or resin packets have been mixed, the threadbar 612, and thereby also the attached anchor nut 614 and bearing plate 616 can be held in a desired position until the resin hardens. In one embodiment, for example, the threadbar 612 can be held in the hole 604 such that a portion of the bearing plate 616, and specifically the mating surface 616-A, engages a portion of the wall 602 of the tunnel. In such an embodiment, the threadbar 612 can be additionally passed through the eye 120 of the truss eye 100 either before or after the threadbar 612 is inserted into, and affixed within the hole 604 in the wall 602 of the tunnel. In some such embodiments, after the threadbar has been passed through the eye 120 of the truss eye 100, the second anchor nut 614-B can be positioned in the second position on the threadbar 612.

[0055] After the threadbar 612 has been connected to the truss eye 100, the process proceeds as indicated in FIG. 9 wherein the tie rod 608 is tightened to a desired tension. In some embodiments, the tie rod 608 can be tightened to the desired tension by a tensioner that can apply a desired tension to the tie rod 608. In some embodiments, the connector 610 can be configured to engage with the tensioned tie rod 608 to secure the position of the tie rod 608 with respect to the connector 610.

[0056] In some embodiments, the tie rod 608 can be tensioned by a combination of removing the slack in the tie rod 608 and thereby bringing the tie rod 608 to a first tension and then adjusting the tension in the tie rod 608 to a second tension. In such an embodiment, after the tension in the tie rod 608 has reached the first tension, the second anchor nut 614-B can be moved from the second position to the third position. This movement can, when the threadbar 612 angles away from the tie rod 608 as depicted in FIGS. 6A-6C, increase the tension within the tie rod 608. In some embodiments, the second anchor nut 614-B reaches the third position when the tension within the tie rod 608 reaches a desired level, which desired level can be manifest, for example, by a torque applied to the second anchor nut 614-B, or when the truss eye 100 contacts both the first and second anchor nuts 614-A, 614-B.

[0057] In some embodiments, additional portions of the walls 602 can be selected for placement of additional truss systems 606, and the above outlined steps can be repeated.

[0058] A number of variations and modifications of the disclosed embodiments can also be used. Specific details are given in the above description to provide a thorough understanding of the embodiments. However, it is understood that the embodiments may be practiced without these specific details. For example, well-known components may be shown without unnecessary detail in order to avoid obscuring the embodiments.

[0059] Also, it is noted that the embodiments may be described as a process which is depicted in FIGS. 7-9. Although a depiction may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed, but could have additional steps not included in the figure.

[0060] The above description of embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form described, and many modifications and variations are possible in light of the teaching above. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. Thus, it will be appreciated that the invention is intended to cover all modifications and equivalents within the scope of the following claims.

What is claimed is:

1. A roof truss system for supporting a roof of a mine, the roof truss system comprising:
   a threadbar comprising an elongate load bearing member having a first portion proximate to a first end and a second portion proximate to a second end;
   a first anchor nut connecting to the threadbar at a first position, the first anchor nut comprising:
   a first end, wherein the first end comprises a first contact surface; and
   a second end located opposite the first end;
   a second anchor nut connecting to the threadbar at a second position, the second anchor nut comprising:
   a first end, wherein the first end comprises a second contact surface; and
   a second end located opposite the first end;
   a bearing plate comprising:
   a wall surface; and
   a nut surface;
   a truss eye comprising:
   a base having a first side and an opposed second side,
   a first hole extending through the first side of the base and towards the second side;
   an eye portion defining an eye, wherein the threadbar extends through the eye of the eye portion and the eye portion of the truss eye is at an intermediate position between the first and second anchor nuts.

2. The system of claim 1, wherein the first portion of the threadbar is affixed within a hole in the roof of the mine and wherein the second portion of the threadbar extends from the hole in the roof of the mine.

3. The system of claim 2, wherein the first and second anchor nuts are located on the second portion of the threadbar.

4. The system of claim 2, wherein the bearing plate is located at a position along the threadbar between the roof of the mine and the first anchor nut.

5. The system of claim 4, wherein the bearing plate contacts the roof of the mine and the second end of the first anchor nut.

6. The system of claim 5, wherein the eye portion of the truss eye contacts the first contact surface of the first anchor nut and the second contact surface of the second anchor nut.

7. The system of claim 1, further comprising a tie rod comprising an elongate load bearing member having a first end and a second end.

8. The system of claim 7, wherein the tie rod comprises a cable.

9. The system of claim 7, wherein the tie rod comprises a bar.

10. The system of claim 7, wherein the first end of the tie rod is secured in the first hole of the truss eye.
11. The system of claim 1, wherein the first hole of the truss eye is threaded.

12. The system of claim 1, wherein the first hole is tapered.

13. A method of installing a roof truss system, the method comprising:
creating a first hole in a roof of a mine;
attaching a first anchor nut to a threadbar at a first position, wherein the anchor nut comprises opposing first and second ends and a contact surface at the first end, wherein the threadbar comprises an elongate member having a first portion proximate to a first end and a second portion proximate to a second end, wherein the first position is located within the second portion of the threadbar;
anchoring the first portion of the threadbar within the first hole in the roof of the mine such that the second end of the first anchor nut holds a bearing plate against the roof of the mine;
inserting a portion of the threadbar through an eye of a first truss eye, the first truss eye comprising:
a base having a first side and an opposite second side; a base aperture extending through the first side of the base and towards the second side; and an eye portion defining an eye;
securing the threadbar to the first truss eye by attaching a second anchor nut to the threadbar at a second position, wherein the first truss eye is located at an intermediate position between the first and second positions.

14. The method of claim 13, further comprising inserting the threadbar through a hole in the bearing plate.

15. The method of claim 14, wherein the threadbar is affixed within the first hole in the roof of the mine via the mixing and the hardening of resin within the first hole.

16. The method of claim 13 further comprising affixing a first end of a tie rod to the base aperture of the first truss eye.

17. The method of claim 16, wherein a second end of the tie rod is connected to a second base aperture of a second truss eye, and wherein the second truss eye is connected to a second threadbar that is affixed within a second hole in the roof of the mine.

18. The method of claim 17, further comprising creating a desired tension within the tie rod.

19. The method of claim 18, wherein creating the desired tension within the tie rod comprises moving the second anchor nut to a third position and thereby increasing the relative proximity between the first and second anchor nuts, wherein the tension in the tie rod increases when the second anchor nut is moved from the second position to the third position.

20. The method of claim 18, wherein creating the desired tension within the tie rod comprises applying a force to the tie rod equal to the desired tension.

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