A dragline excavator system has a support assembly, a hoist coupler assembly suspended from the support assembly, a bucket assembly suspended from the hoist coupler assembly, a sheave assembly supported by the hoist coupler assembly, a drag coupler assembly, and at least one dump rope operatively connected to the drag coupler assembly and the bucket assembly. The at least one dump rope extends through the sheave assembly. The at least one dump rope is formed of at least one fiber made from at least one high modulus polyethylene (HMPE), poly-p-phenylenebenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (Aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass.
DUMP ROPE FOR A DRAGLINE EXCAVATOR

TECHNICAL FIELD

[0001] This application relates to dragline excavators and, more specifically to tension lines used as part of a system for maneuvering a bucket of a dragline excavator.

BACKGROUND

[0002] A dragline excavator is a piece of heavy equipment used in surface mining and other civil engineering operations. A dragline excavator employs a movable base from which extends a boom. A bucket is suspended by hoist cables from the boom. A pair of draglines typically is connected between the base and the bucket. A single rope (tension line) or pair of ropes (tension lines) typically referred to as “dump lines” or “dump ropes” is connected between the dragline and the bucket. Each dump rope is typically arranged over a sheave between the dragline and the bucket. The dump ropes are conventionally steel wire ropes.

[0003] All functional movements of the bucket are controlled using a combination of a position of the boom and by controlling effective lengths of the hoist cables, draglines, and dump ropes. In particular, a vertical relationship of the bucket relative to the base is controlled by the hoist cables. The draglines are used to pull the bucket towards the base during excavation. The dump ropes extend between an intermediate point on the dragline and an upper lead point on the bucket to control an angle of the bucket.

[0004] The dump ropes wear out quickly and need to be replaced regularly. The change out time for a conventional dump rope can be significant due to the size and weight of the steel wire rope used to form the dump rope. The dragline excavator is not functional when the dump rope is changed out, so the change out time required to replace dump ropes can result in significant, costly delays in excavation operations using the dragline excavator.

[0005] The need exists for dump lines for dragline excavators that reduce change out times and allow increased digging capability and thus increase the efficiency of the dragline excavator.

SUMMARY

[0006] A dragline excavator system comprising a support assembly, a hoist coupler assembly suspended from the support assembly, a bucket assembly suspended from the hoist coupler assembly, a sheave assembly supported by the hoist coupler assembly, a drag coupler assembly, and a dump rope operatively connected to the drag coupler assembly and the bucket assembly. The dump rope extends through the sheave assembly and is made of synthetic fibers. An elongation of the dump rope is within a first range of less than approximately 4 percent.

[0008] The present invention may also be embodied as a dump rope for a dragline excavator system comprising a first loop, a second loop, and a central portion. The dump rope is formed of at least one fiber made from at least one of high modulus polyethylene (HMPE), poly-p-phenylenebenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (Aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass. An elongation of the dump rope is within a first range of less than approximately 4 percent.

DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 illustrates an example dragline excavator system of the present invention with a bucket thereof in a first configuration.

[0010] FIG. 2 depicts a portion of the example dragline excavator as depicted in FIG. 1 illustrating a dump rope of the present invention.

[0011] FIG. 3 illustrates the example dragline excavator system depicted in FIG. 1 with the bucket thereof in a second configuration.

[0012] FIG. 4 is similar to FIG. 2 but illustrates the dump rope of the present invention with the bucket in the second configuration.

[0013] FIG. 5 depicts in further detail the example dump rope used by the example dragline excavator depicted in FIGS. 1-4.

DETAILED DESCRIPTION

[0014] FIGS. 1-4 of the drawing illustrate a dragline excavator system 20 constructed in accordance with, and embodying, the principles of the present invention. As illustrated in FIGS. 1, 2, and 4, the example dragline excavator system 20 is removing material from a surface 22 of the earth.

[0015] The example dragline excavator system 20 comprises a support assembly 30, a bucket assembly 32, at least one hoist coupler assembly 34, at least one drag coupler assembly 36, and a line system 38. The term “line” is used herein to refer to steel rope, synthetic rope, steel cable, chain, and/or other flexible elongate member cable of bearing the anticipated tension loads.

[0016] The example line system 38 comprises at least one hoist cable 40, at least one dragline 42, at least one dump rope 44, at least one first coupler line 46, and at least one second coupler line 48. In the example dragline excavator system 20, two hoist coupler assemblies 34, two drag coupler assemblies 36, two hoist lines 40, two draglines 42, two dump ropes 44, two first coupler lines 46, and two second coupler lines 48 are provided, but only one of each of these components 34, 36, 40, 42, 44, 46, and 48 is illustrated in FIGS. 1-4 for purposes of clarity. Each drag coupler assembly 36 is connected to one of the draglines 42. As is conventional, the example dump lines 44 are connected at one end to the one of the drag coupler assemblies 36 and at another end to opposite atrial ends of the bucket assembly 32 to facilitate control of the bucket assembly 32.

[0017] The example support assembly 30 comprises a vehicle 50, a dragline boom 52, an intermediate boom 54, and a gantry structure 56. Boom lines 58 extend between the gantry and the dragline boom 52 to allow the angle of the
dragline boom 52 relative to vertical to be altered. The example dragline boom 52 rotatably extends upwardly and outwardly from a front portion of the vehicle 50. The example gantry structure 56 rigidly extends upwardly from a central portion of the vehicle 50. The example intermediate boom 54 is supported between the gantry structure 56 and the dragline boom 52. The vehicle 50 may be mounted on trucks or, for larger dragline excavator systems, may be provided with a drum base and feet to allow movement yet provide a more stable base for the support assembly 30 during the excavation process.

[0018] The hoist cables 40 are connected between the support assembly 30 and the hoist coupler assembly 34 and are supported by the dragline boom 52. The first coupler lines 46 are connected between the hoist coupler assembly 34 and the bucket assembly 32 such that the bucket assembly is suspended from the dragline boom 52. The draglines 42 are connected between the support assembly 30 and the drag coupler assembly 36. The second coupler lines 48 are connected between the drag coupler assembly 36 and the bucket assembly 32 such that tension loads applied on the draglines 42 are capable of displacing the bucket assembly 32 towards the support assembly 30.

[0019] The details of the support assembly 30 are provided by way of example only, and the present invention may be embodied with a support assembly that differs from the example support assembly 30. For example, certain support assembly designs eliminate the need for an intermediate boom 54. And instead of using pairs of the cables, one or more than two of these cables 40, 42, 44, 46, and 48 may be used depending on the specifications of a particular dragline excavator system.

[0020] In any event, winches (not shown) mounted on the vehicle 50 displace the lines 40 and 42 relative to the support assembly 30 to alter a location of the bucket assembly 32 relative to the support assembly 30 and an angle of bucket axis A. The bucket assembly 32 relative to horizontal. The dragline boom 52 may also be moved to affect the location of the bucket assembly 32 relative to the support assembly 30.

[0021] Referring now to FIGS. 2 and 4, it can be seen that the example bucket assembly 32 comprises a bucket member 60, a first bucket coupler member 62, a second bucket coupler member 64, and a bucket pin 66. A bucket coupler projection 68 extends from the example bucket member 60. FIGS. 2 and 4 further illustrate that each example hoist coupler assembly 34 comprises a hoist coupler member 70, a first hoist link assembly 72, a second hoist link assembly 74, and a sheave assembly 76. The example sheave assembly 76 comprises a sheave wheel 80 and a sheave link assembly 82. FIGS. 2 and 4 further show that the example drag coupler assembly 36 comprises a drag coupler member 90, a first drag link assembly 92, a second drag link assembly 94, and a drag pin 96.

[0022] The first hoist link assembly 72 pivotably connects the hoist cable 40 to the hoist coupler member 70. The second hoist link assembly 74 pivotably connects the first coupler line 46 to the hoist coupler member 70. The first bucket coupler member 62 pivotably connects the first coupler line 46 to the bucket member 60. The second bucket coupler member 64 pivotably connects the second coupler line 48 to the bucket member 60. The sheave link assembly 82 pivotably supports the sheave wheel 80 relative to the hoist coupler member 70. The first drag link assembly 92 rotatably attaches the dragline 44 to the drag coupler member 90. The second drag link assembly 94 rotatably attaches the second coupler line 48 to the drag coupler member 90.

[0023] Referring now to FIG. 5 of the drawing, it can be seen that the example dump rope 44 comprises a rope structure 120 configured to define a central portion 122, a first loop 124, and a second loop 126. The first and second loops 124 and 126 are formed by splicing the ends of the rope structure 120 back into the central portion 122. In particular, splice regions 130 and 132 are formed adjacent to the first and second loops 124 and 126 where the ends of the rope structure 120 have been spliced to form the loops 124 and 126.

[0024] The first loop 124 of the dump rope 44 is connected to the bucket coupler projection 68 by the bucket pin 66. The second loop 124 of the dump rope 44 is connected to the drag coupler member 90 by the drag pin 96. The central portion 122 of the dump rope 44 extends over the sheave wheel 80.

[0025] The example rope structure 120 is a braided rope structure. The example braided rope structure 120 has a nominal diameter of approximately 3” but in any event is typically in a range for approximately 2”-5”. Other rope structures and sizes may be used depending upon the nature of the particular dragline excavator system on which the dump rope 44 is used. The example rope structure 120 is made of at least one synthetic fiber or a blend of synthetic fibers combined to form yarns. The yarns are in turn combined to form strands. The example rope structure 120 is formed of 12 such strands, but fewer or more strands may be used.

[0026] The example rope structure 120 is formed of at least one synthetic fiber or a blend of synthetic fibers. The example rope structure 120 is made from any one or more of the following materials: high modulus polyethylene (HMPE), poly-p-phenylenenbenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass. The example dump rope 44 thus comprises at least one fiber made from at least one material from the following list of materials: high modulus polyethylene (HMPE), poly-p-phenylenenbenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass. The example dump rope 44 is formed of high modulus polyethylene (HMPE).

[0027] In any event, the elongation of the example dump rope 44 should be within a first example range of less than approximately 4 percent and in any event should be within a second range of approximately 5 percent.

[0028] The example dump rope 44 is of comparable strength to steel wire rope but has only a fraction of the weight of steel wire rope of similar dimensions. The example dump rope 44 may thus be replaced and released with fewer personnel and in a fraction (approximately 1/3) of the time of a conventional dump line made of steel wire rope. An additional advantage of the example dump rope 44 is that the lower weight of the example dump rope 44 allows for an increased bucket payload, thereby allowing for more efficient use of the bucket and more efficient operation of the dragline excavator.

[0029] The embodiments described herein may be embodied in other specific forms without departing from their spirit
or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

We claim:

1. A dragline excavator system comprising:
   a support assembly;
   a hoist coupler assembly suspended from the support assembly;
   a bucket assembly suspended from the hoist coupler assembly;
   a sheave assembly supported by the hoist coupler assembly;
   a drag coupler assembly; and
   at least one dump rope operatively connected to the drag coupler assembly, the bucket assembly, where the dump rope extends through the sheave assembly; wherein
   the at least one dump rope is formed of at least one fiber made from at least one of high modulus polyethylene (HMPE), poly-p-phenylenebenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (Aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass.

2. The dragline excavator system of claim 1, in which the at least one dump rope is formed of a blend of at least two fibers made from at least two of high modulus polyethylene (HMPE), poly-p-phenylenebenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (Aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass.

3. The dragline excavator system of claim 1, in which each dump rope comprises a first loop and a second loop, where the first loop is connected to the bucket assembly and the second loop is connected to the drag coupler assembly.

4. The dragline excavator system of claim 1, in which each dump rope is formed from a rope structure in which first and second ends of the rope structure are spliced to the rope structure to form the first and second loops.

5. The dragline excavator of claim 4, in which each dump rope defines a first splice region and a second splice region.

6. The dragline excavator system of claim 1, in which an elongation of the dump rope is within a first range of less than approximately 4 percent.

7. The dragline excavator system of claim 1, in which an elongation of the dump rope is within a first range of less than approximately 5 percent.

8. The dragline excavator system as recited in claim 1, in which the at least one dump rope comprises first and second dump ropes.

9. A dragline excavator system comprising:
   a support assembly;
   a hoist coupler assembly suspended from the support assembly;
   a bucket assembly suspended from the hoist coupler assembly;
   a sheave assembly supported by the hoist coupler assembly;
   a drag coupler assembly; and
   at least one dump rope operatively connected to the drag coupler assembly, the bucket assembly, where the dump rope extends through the sheave assembly; wherein
   the at least one dump rope is made of synthetic fibers; and
   an elongation of the at least one dump rope is within a first range of less than approximately 4 percent.

10. The dragline excavator system of claim 9, in which an elongation of the at least one dump rope is within a first range of less than approximately 5 percent.

11. The dragline excavator system of claim 9, in which the at least one dump rope is formed from at least one fiber made from at least one of high modulus polyethylene (HMPE), poly-p-phenylenebenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (Aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass.

12. The dragline excavator system of claim 9, in which the at least one dump rope is formed of a blend of at least two fibers made from at least two of high modulus polyethylene (HMPE), poly-p-phenylenebenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (Aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass.

13. The dragline excavator system of claim 9, in which each dump rope comprises a first loop and a second loop, where the first loop is connected to the bucket assembly and the second loop is connected to the drag coupler assembly.

14. The dragline excavator system of claim 9, in which each dump rope is formed from a rope structure in which first and second ends of the rope structure are spliced to the rope structure to form the first and second loops.

15. The dragline excavator system of claim 14, in which each dump rope defines a first splice region and a second splice region.

16. The dragline excavator system as recited in claim 9, in which the at least one dump rope comprises first and second dump ropes.

17. A dump rope for a dragline excavator system comprising:
   a first loop;
   a second loop; and
   a central portion; wherein the dump rope is formed of at least one fiber made from at least one of high modulus polyethylene (HMPE), poly-p-phenylenebenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (Aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass; and
   an elongation of the dump rope is within a first range of less than approximately 4 percent.

18. The dump rope of claim 17, in which the dump rope is formed of a blend of at least two fibers made from at least two of high modulus polyethylene (HMPE), poly-p-phenylenebenzobisoxazole (PBO), liquid crystal polymer (LCP), aromatic polyamide (Aramid), polyester, nylon, polyolefin, polypropylene (PP), carbon, and glass.

19. The dump rope of claim 17, in which the dump rope is formed from a rope structure in which first and second ends of the rope structure are spliced to the rope structure to form the first and second loops.

20. The dump rope of claim 17, in which the dump rope defines a first splice region and a second splice region.

21. The dump rope of claim 17, in which an elongation of the dump rope is within a first range of less than approximately 5 percent.

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