Claims

1. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a host mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane; and

wherein the elastomeric load compensator is mounted to the boom, and a dead end of the hoist rope is attached to the elastomeric load compensator.

2. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a host mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane; and

which includes a sheave movably mounted to the boom and the hoist rope is carried by the sheave, and the elastomeric load compensator is mounted to the boom and coupled to the sheave to compensate motion of the sheave with respect to the boom.

3. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a host mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane; and

wherein the elastomeric load compensator mounts the hoist mechanism to said at least one of the base and the boom.

4. The crane as claimed in claim 3, wherein the hoist mechanism includes a winch hoist movably mounted to at least one of the base and boom, and the elastomeric load compensator is mounted to said at least one of the base and boom and coupled to the winch hoist to compensate motion of the winch hoist with respect to said at least one of the base and boom.

5. The crane as claimed in claim 3, wherein the elastomeric load compensator is mounted to the base and coupled to the boom to compensate pivoting of the boom with respect to the base.

6. The crane as claimed in claim 3, wherein the elastomeric load compensator includes a stack of elastomeric plates fastened together and disposed between the hoist mechanism and said at least one of the base and the boom.

7. The crane as claimed in claim 6, wherein the elastomeric load compensator includes a pair of metal or composite mounting plates, and the elastomeric plates are disposed between the pair of metal or composite mounting plates and fastened to the metal or composite mounting plates.

8. The crane as claimed in claim 6, which further includes a metal or composite plate disposed between a pair of neighboring elastomeric plates in the stack of elastomeric sheets.

9. The crane as claimed in claim 6, which further includes peripheral retaining brackets mounted to said one of the base and the boom and disposed around the stack of elastomeric plates for retaining the elastomeric load compensator in the event of separation of the elastomeric plates from each other.

10. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a host mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane;

wherein the tension applied to the hoist rope places elastomer of the elastomeric load compensator in tension and causes elongation of elastomer of the elastomeric load compensator; and

wherein the elastomeric load compensator is color-coded to indicate elongation of the elastomer to persons near the crane.

11. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a host mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane;

wherein the tension applied to the hoist rope places elastomer of the elastomeric load compensator in tension and causes elongation of elastomer of the elastomeric load compensator; and

wherein the elastomeric load compensator has a housing comprised of telescoping components.

12. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a host mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane; and

wherein the tension applied to the hoist rope causes shear deformation of elastomer of the elastomeric load compensator.

13. The crane as claimed in claim 12, wherein the elastomer is comprised of a multiplicity of co-axial elastomer disks.

14. The crane as claimed in claim 13, wherein the elastomeric load compensator includes a real-out sheave co-axial with and coupled to the elastomer disks, and the sheave is coupled to the hoist rope so that tension applied to the hoist rope causes the sheave to rotate.

15. The crane as claimed in claim 14, wherein the elastomeric load compensator further includes a mechanical stop for stopping rotation of the real-out sheave once the tension applied to the hoist rope reaches a limit value.

16. The crane as claimed in claim 12, wherein the elastomeric load compensator includes:

first and second rigid plates and a stack of elastomeric layers disposed between and bonded to the first and second rigid plates; and

a pair of parallel-spaced retaining brackets, wherein the stack of elastomeric layers is disposed between the retaining brackets so that the retaining brackets retain the pair of rigid plates and the stack of elastomeric layers against separation of the first and second rigid plates from the stack of elastomeric layers.

17. The crane as claimed in claim 16, which further includes a respective plastic wear strip fastened to each of the retaining brackets and disposed between said each of the retaining brackets and one of the rigid plates to contact said one of the rigid plates and facilitate sliding of said one of the rigid plates against the respective wear strip.

18. The crane as claimed in claim 17, wherein the plastic wear strip is made of nylon plastic loaded with molybdenum disulfide powder.

19. An elastomeric load compensator comprising:

elongated elastomeric tension elements, each of the elongated elastomeric tension elements including an elastomer body and a pair of end caps made of a rigid material and bonded to ends of the elastomer body, and

a pair of end plates made of rigid material for applying tension to the elongated elastomeric tension elements, the pair of end plates mechanically connecting the elongated elastomeric tension elements in parallel with respect to the applied tension.

20. The elastomeric load compensator as claimed in claim 19, further including an eyelet secured to one of the end plates for applying the tension to the elastomeric load compensator.

21. The elastomeric load compensator as claimed in claim 19, further including a flange secured to one of the end plates for applying the tension to the elastomeric load compensator.

22. The elastomeric load compensator as claimed in claim 19, further including a telescoping housing enclosing the elongated elastomeric tension elements.

23. The elastomeric load compensator as claimed in claim 22, wherein the telescoping housing includes housing members having contrasting colors so that one of the contrasting colors becomes visible when tension is applied to the elongated tension members.

24. The elastomeric load compensator as claimed in claim 19, wherein each of the end plates is slotted to receive one of the metal caps of each of the elongated elastomeric tension elements.

25. The elastomeric load compensator as claimed in claim 24, wherein the end plates are circular, and the elastomeric tension members are parallel to each other and arranged in a circular array.

26. The elastomeric load compensator as claimed in claim 25, further including another circular array of elongated elastomeric tension elements so that the elastomeric load compensator includes two circular arrays of elastomeric tension elements, and the two circular arrays of elastomeric tension elements are mechanically connected in series with each other respect to a load applied to the elastomeric load compensator.

27. The elastomeric load compensator as claimed in claim 26, wherein one of the two circular arrays of elastomeric tension elements is nested within another of the two circular arrays of elastomeric tension elements.

28. An elastomeric load compensator comprising:

a frame;

a shaft mounted to the frame;

a sheave mounted to the shaft for rotation about the shaft to dispense and retract a rope; and

a stack of elastomeric torsion elements mechanically connected in series between the sheave and the frame to resist the dispensing of the rope and to enhance the retraction of the rope.

29. The elastomeric load compensator as claimed in claim 28 wherein the stack of elastomeric torsion elements includes rigid members between neighboring pairs of the elastomeric torsion elements, and each of the rigid members is bonded to a respective one of the neighboring pairs of the elastomeric torsion elements.

30. The elastomeric load compensator as claimed in claim 28, which further includes a padeye bar mounted to the sheave, and the sheave is split into two parts and the padeye bar is disposed between the two parts of the sheave to mount the padeye bar to the sheave.

31. The elastomeric load compensator as claimed in claim 28, which further includes a bar mounted to the sheave, and a stop secured to the frame for contacting the bar to stop rotation of the sheave when torsion upon the torsion elements reaches a limit value.

32. The elastomeric load compensator as claimed in claim 28, wherein the elastomeric torsion elements are annular and the shaft passes through each of the elastomeric torsion elements.

33. The elastomeric load compensator as claimed in claim 32, further including another stack of annular elastomeric torsion elements mechanically connected in series between the sheave and the housing to resist the dispensing of the rope and to enhance the retraction of the rope, so that the elastomeric load compensator includes two stacks of annular elastomeric torsion elements mechanically connected in parallel with respect to the housing and the sheave, and the shaft passes through each of the two stacks of annular elastomeric torsion elements, and the sheave is disposed between the two stacks of annular elastomeric torsion elements.

34. An elastomeric load compensator comprising first and second rigid plates and a stack of elastomeric layers disposed between and bonded to the first and second rigid plates; and

a pair of parallel-spaced retaining brackets, wherein the stack of elastomeric layers is disposed between the retaining brackets so that the retaining brackets retain the pair of rigid plates and the stack of elastomeric layers against separation of the first and second rigid plates from the stack of elastomeric layers;

wherein the stack of elastomeric layers includes at least one pair of neighboring elastomeric plates, and the elastomeric load compensator further includes a rigid reinforcing shim disposed between the elastomeric layers in the pair of neighboring elastomeric layers and bonded to the elastomeric layers in the pair of neighboring elastomeric layers.

35. An elastomeric load compensator comprising first and second rigid plates and a stack of elastomeric layers disposed between and bonded to the first and second rigid plates;

a pair of parallel-spaced retaining brackets, wherein the stack of elastomeric layers is disposed between the retaining brackets so that the retaining brackets retain the pair of rigid plates and the stack of elastomeric layers against separation of the first and second rigid plates from the stack of elastomeric layers; and

a third rigid plate and another stack of elastomeric layers disposed between the retaining brackets and disposed between the second rigid plate and the third rigid plate and bonded to the second rigid plate and the third rigid plate, and the third rigid plate is co-planar with the first rigid plate, so that the elastomeric load compensator includes two stacks of elastomeric layers mechanically connected in series to resist tension applied to the first rigid plate and the third rigid plate.

Claims

1. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a hoist mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane; and

wherein the elastomeric load compensator is mounted to the boom, and a dead end of the hoist rope is attached to the elastomeric load compensator.

2. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a hoist mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane; and

which includes a sheave movably mounted to the boom and the hoist rope is carried by the sheave, and the elastomeric load compensator is mounted to the boom and coupled to the sheave to compensate motion of the sheave with respect to the boom.

3. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a hoist mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane; and

wherein the elastomeric load compensator mounts the hoist mechanism to said at least one of the base and the boom.

4. The crane as claimed in claim 3, wherein the hoist mechanism includes a winch hoist movably mounted to at least one of the base and boom, and the elastomeric load compensator is mounted to said at least one of the base and boom and coupled to the winch hoist to compensate motion of the winch hoist with respect to said at least one of the base and boom.

5. The crane as claimed in claim 3, wherein the elastomeric load compensator is mounted to the base and coupled to the boom to compensate pivoting of the boom with respect to the base.

6. The crane as claimed in claim 3, wherein the elastomeric load compensator includes a stack of elastomeric plates fastened together and disposed between the hoist mechanism and said at least one of the base and the boom.

7. The crane as claimed in claim 6, wherein the elastomeric load compensator includes a pair of metal or composite mounting plates, and the elastomeric plates are disposed between the pair of metal or composite mounting plates and fastened to the metal or composite mounting plates.

8. The crane as claimed in claim 6, which further includes a metal or composite plate disposed between a pair of neighboring elastomeric plates in the stack of elastomeric sheets.

9. The crane as claimed in claim 6, which further includes peripheral retaining brackets mounted to said one of the base and the boom and disposed around the stack of elastomeric plates for retaining the elastomeric load compensator in the event of separation of the elastomeric plates from each other.

10. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a hoist mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane;

wherein the tension applied to the hoist rope places elastomer of the elastomeric load compensator in tension and causes elongation of elastomer of the elastomeric load compensator; and

wherein the elastomeric load compensator is color-coded to indicate elongation of the elastomer to persons near the crane.

11. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a hoist mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane;

wherein the tension applied to the hoist rope places elastomer of the elastomeric load compensator in tension and causes elongation of elastomer of the elastomeric load compensator; and

wherein the elastomeric load compensator has a housing comprised of telescoping components.

12. A crane comprising:

a base;

a boom mounted to the base;

a hoist rope descending from the boom for attachment to a payload; and

a hoist mechanism mounted to at least one of the base and the boom for applying tension to the hoist rope to lift the payload;

wherein the crane has a stiffness from the payload to the base;

wherein the crane further includes an elastomeric load compensator coupled between the payload and the base for reducing the stiffness of the crane; and

wherein the tension applied to the hoist rope causes shear deformation of elastomer of the elastomeric load compensator.

13. The crane as claimed in claim 12, wherein the elastomer is comprised of a multiplicity of co-axial elastomer disks.

14. The crane as claimed in claim 13, wherein the elastomeric load compensator includes a real-out sheave co-axial with and coupled to the elastomer disks, and the sheave is coupled to the hoist rope so that tension applied to the hoist rope causes the sheave to rotate.

15. The crane as claimed in claim 14, wherein the elastomeric load compensator further includes a mechanical stop for stopping rotation of the real-out sheave once the tension applied to the hoist rope reaches a limit value.

16. The crane as claimed in claim 12, wherein the elastomeric load compensator includes:

first and second rigid plates and a stack of elastomeric layers disposed between and bonded to the first and second rigid plates; and

a pair of parallel-spaced retaining brackets, wherein the stack of elastomeric layers is disposed between the retaining brackets so that the retaining brackets retain the pair of rigid plates and the stack of elastomeric layers against separation of the first and second rigid plates from the stack of elastomeric layers.

17. The crane as claimed in claim 16, which further includes a respective plastic wear strip fastened to each of the retaining brackets and disposed between said each of the retaining brackets and one of the rigid plates to contact said one of the rigid plates and facilitate sliding of said one of the rigid plates against the respective wear strip.

18. The crane as claimed in claim 17, wherein the plastic wear strip is made of nylon plastic loaded with molybdenum disulfide powder.

19. An elastomeric load compensator comprising:

elongated elastomeric tension elements, each of the elongated elastomeric tension elements including an elastomer body and a pair of end caps made of a rigid material and bonded to ends of the elastomer body, and

a pair of end plates made of rigid material for applying tension to the elongated elastomeric tension elements, the pair of end plates mechanically connecting the elongated elastomeric tension elements in parallel with respect to the applied tension.

20. The elastomeric load compensator as claimed in claim 19, further including an eyelet secured to one of the end plates for applying the tension to the elastomeric load compensator.

21. The elastomeric load compensator as claimed in claim 19, further including a flange secured to one of the end plates for applying the tension to the elastomeric load compensator.

22. The elastomeric load compensator as claimed in claim 19, further including a telescoping housing enclosing the elongated elastomeric tension elements.

23. The elastomeric load compensator as claimed in claim 22, wherein the telescoping housing includes housing members having contrasting colors so that one of the contrasting colors becomes visible when tension is applied to the elongated tension members.

24. The elastomeric load compensator as claimed in claim 19, wherein each of the end plates is slotted to receive one of the metal caps of each of the elongated elastomeric tension elements.

25. The elastomeric load compensator as claimed in claim 24, wherein the end plates are circular, and the elastomeric tension members are parallel to each other and arranged in a circular array.

26. The elastomeric load compensator as claimed in claim 25, further including another circular array of elongated elastomeric tension elements so that the elastomeric load compensator includes two circular arrays of elastomeric tension elements, and the two circular arrays of elastomeric tension elements are mechanically connected in series with each other respect to a load applied to the elastomeric load compensator.

27. The elastomeric load compensator as claimed in claim 26, wherein one of the two circular arrays of elastomeric tension elements is nested within another of the two circular arrays of elastomeric tension elements.

28. An elastomeric load compensator comprising:

a frame;

a shaft mounted to the frame;

a sheave mounted to the shaft for rotation about the shaft to dispense and retract a rope;

a stack of elastomeric torsion elements mechanically connected in series between the sheave and the frame to resist the dispensing of the rope and to enhance the retraction of the rope, wherein the stack of elastomeric torsion elements includes rigid members between neighboring pairs of the elastomeric torsion elements, and each of the rigid members is bonded to a respective one of the neighboring pairs of the elastomeric torsion elements; and

a padeye bar mounted to the sheave, and the sheave is split into two parts and the padeye bar is disposed between the two parts of the sheave to mount the padeye bar to the sheave.

29. An elastomeric load compensator comprising:

a frame;

a shaft mounted to the frame;

a sheave mounted to the shaft for rotation about the shaft to dispense and retract a rope;

a stack of elastomeric torsion elements mechanically connected in series between the sheave and the frame to resist the dispensing of the rope and to enhance the retraction of the rope, wherein the stack of elastomeric torsion elements includes rigid members between neighboring pairs of the elastomeric torsion elements, and each of the rigid members is bonded to a respective one of the neighboring pairs of the elastomeric torsion elements; and

a bar mounted to the sheave, and a stop secured to the frame for contacting the bar to stop rotation of the sheave when torsion upon the torsion elements reaches a limit value.

30. An elastomeric load compensator comprising:

a frame;

a shaft mounted to the frame;

a sheave mounted to the shaft for rotation about the shaft to dispense and retract a rope;

a stack of elastomeric torsion elements mechanically connected in series between the sheave and the frame to resist the dispensing of the rope and to enhance the retraction of the rope, wherein the stack of elastomeric torsion elements includes rigid members between neighboring pairs of the elastomeric torsion elements, and each of the rigid members is bonded to a respective one of the neighboring pairs of the elastomeric torsion elements; and

wherein the elastomeric torsion elements are annular and the shaft passes through each of the elastomeric torsion elements.

31. The elastomeric load compensator as claimed in claim 32, further including another stack of annular elastomeric torsion elements mechanically connected in series between the sheave and the housing to resist the dispensing of the rope and to enhance the retraction of the rope, so that the elastomeric load compensator includes two stacks of annular elastomeric torsion elements mechanically connected in parallel with respect to the housing and the sheave, and the shaft passes through each of the two stacks of annular elastomeric torsion elements, and the sheave is disposed between the two stacks of annular elastomeric torsion elements.

32. An elastomeric load compensator comprising first and second rigid plates and a stack of elastomeric layers disposed between and bonded to the first and second rigid plates; and

a pair of parallel-spaced retaining brackets, wherein the stack of elastomeric layers is disposed between the retaining brackets so that the retaining brackets retain the pair of rigid plates and the stack of elastomeric layers against separation of the first and second rigid plates from the stack of elastomeric layers;

wherein the stack of elastomeric layers includes at least one pair of neighboring elastomeric plates, and the elastomeric load compensator further includes a rigid reinforcing shim disposed between the elastomeric layers in the pair of neighboring elastomeric layers and bonded to the elastomeric layers in the pair of neighboring elastomeric layers.

33. An elastomeric load compensator comprising first and second rigid plates and a stack of elastomeric layers disposed between and bonded to the first and second rigid plates;

a pair of parallel-spaced retaining brackets, wherein the stack of elastomeric layers is disposed between the retaining brackets so that the retaining brackets retain the pair of rigid plates and the stack of elastomeric layers against separation of the first and second rigid plates from the stack of elastomeric layers; and

a third rigid plate and another stack of elastomeric layers disposed between the retaining brackets and disposed between the second rigid plate and the third rigid plate and bonded to the second rigid plate and the third rigid plate, and the third rigid plate is co-planar with the first rigid plate, so that the elastomeric load compensator includes two stacks of elastomeric layers mechanically connected in series to resist tension applied to the first rigid plate and the third rigid plate.