Claims

1. A rope of a lifting device for a transport elevator,
- the rope extending in a longitudinal direction and the rope having a width and a thickness in a transverse direction that is perpendicular to the longitudinal direction, wherein the width is greater than the thickness,
- the rope comprising a load-bearing part extending in the longitudinal direction, which load-bearing part comprises a reinforced composite material having a number of reinforcing fibers enclosed in a polymer matrix, and
- the rope comprising one or more optical fibers
characterized in that
the reinforcing fibers are aligned in the longitudinal direction and are distributed homogeneously in the polymer matrix, and
the one or more optical fibers are enclosed together with the load-bearing part by the polymer matrix, wherein the optical fibers are aligned in the longitudinal direction.

2. A rope according to the preceding claim, **characterized** in that the rope has a uniform structure along its whole length, and in that the load-bearing part comprises prepreg reinforcement layers laminated together, wherein the one or more optical fibers are laminated between and/or on a surface of the prepreg reinforcement layers.

3. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers are distributed within the reinforcing fibers laminated into the polymer matrix.

4. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers have a length being equal or greater than a length of the load-bearing part, and travel continuously in the longitudinal direction along the length of the load-bearing part.

5. A rope according to claim 4, characterized in that the one or more optical fibers travel along the length of the load-bearing part more than once.

6. A rope according to any one of the preceding claims, **characterized** in that a light pulse is input into and received from the one or more optical fibers at the same end of the rope or at opposite ends of the rope.

7. A rope according to the preceding claim 6, **characterized** in that the one or more optical fibers comprise single-mode or multimode fibers and the light pulse is generated with a laser transmitter or with a LED light source.

8. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers comprise a Fabry-Pérot-type sensor fiber.

9. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers comprises a Bragg grating structure.

10. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers function as a Brilloun distributed fiber sensor.

11. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers comprise a fiber, in which time-of-flight of a light pulse is measured.

12. A rope according to any one of the preceding claims, **characterized** in that the reinforcing fibers comprise one or more of a carbon-fiber, an aramid-fiber and a glass-fiber.

13. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers comprise one or more optical fiber bundles.

14. A rope arrangement of a lifting device for a transport elevator, which rope arrangement comprises a plurality of ropes, at least one of which comprise a rope according to any one of the preceding claims 1-13.

15. An elevator having an elevator car, a traction sheave, and a power source for rotating the traction sheave, **characterized** in that the elevator car is arranged to be moved by a rope according to any one of claims 1-13 and/or rope arrangement according to claim 14.

16. An elevator according to claim 15, **characterized** in that the rope and/or the rope arrangement is arranged to move the elevator car and a counterweight.

17. An elevator according to any one of the preceding claims 15-16, **characterized** in that the rope is arranged to operate as an overspeed governor rope and/or a compensating rope.

18. An elevator according to any one of the preceding claims 15-17, **characterized** in that the elevator comprises means for monitoring a condition of the one or more optical fibers, which means monitor a change in the condition of each optical fiber.

19. An elevator according to claims 18, **characterized** in that the condition comprises a strain and/or a displacement of the or each optical fiber.

20. A condition monitoring method for a rope of a lifting device for a transport elevator, **characterized** in that in the condition of a rope according to any one of the preceding claims 1-13 and/or a rope arrangement according to claim 14 is monitored by monitoring a condition of the or each optical fiber and if it is detected that the condition of the optical fiber has changed over a certain pre-defined limit value, a need to replace or overhaul the rope or ropes is diagnosed and rope replacement work or rope maintenance work is started.

21. A method according to the preceding claim 20, **characterized** in that the condition comprises a strain and/or a displacement of the or each optical fiber.

22. A method according to any one of the preceding claims 20-21, **characterized** in that the or each optical fiber comprises a single-mode or multimode fiber and a light pulse is input into the optical fiber, wherein the light pulse is generated with a laser transmitteror with a LED light source.

23. A method according to any of the preceding claims 20-22, **characterized** in that the or each optical fiber comprises a sensor fiber and a reference fiber arragned to eliminate common mode errors.

24. A method according to any one of the preceding claims 20-23, **characterized** in that the or each optical fiber comprises a Fabry-Pérot-type sensor fiber, with which the condition is monitored.

25. A method according to any one of the preceding claims 20-23, **characterized** in that the or each optical fiber comprises a Bragg grating structure, with which the condition is monitored.

26. A method according to any one of the preceding claims 20-23, **characterized** in that the or each optical fiber functions as a Brilloun distributed fiber sensor, with which the condition is monitored.

27. A method according to any one of the preceding claims 20-23, **characterized** in that the or each optical fiber comprises a fiber, in which time-of-flight of a light pulse is measured, and with which the condition is monitored..

28. A method according to any one of the preceding claims 20-27, **characterized** in that in the condition is monitored in a number of ropes and when the condition in different ropes differ sufficiently from each other, a need to

replace or overhaul the rope or ropes is diagnosed and rope replacement work or rope maintenance work is started.

Claims

1. A rope of a lifting device for a transport elevator,
- the rope extending in a longitudinal direction and the rope having a width and a thickness in a transverse direction that is perpendicular to the longitudinal direction, wherein the width is greater than the thickness,
- the rope comprising a load-bearing part extending in the longitudinal direction, which load-bearing part comprises a reinforced composite material having a number of reinforcing fibers enclosed in a polymer matrix, and
- the rope comprising one or more optical fibers
characterized in that
the one or more optical fibers are enclosed together with the load-bearing part by the polymer matrix,
wherein the reinforcing fibers are aligned in the longitudinal direction and are distributed homogeneously in the polymer matrix.

2. A rope according to the preceding claim, **characterized** in that the rope has a uniform structure along its whole length, and in that the load-bearing part comprises prepreg reinforcement layers laminated together, wherein the one or more optical fibers are laminated between and/or on a surface of the prepreg reinforcement layers.

3. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers are distributed within the reinforcing fibers laminated into the polymer matrix.

4. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers have a length being equal or greater than a length of the load-bearing part, and travel continuously in the longitudinal direction along the length of the load-bearing part.

5. A rope according to claim 4, characterized in that the one or more optical fibers travel along the length of the load-bearing part more than once.

6. A rope according to any one of the preceding claims, **characterized** in that a light pulse is input into and received from the one or more optical fibers at the same end of the rope or at opposite ends of the rope.

7. A rope according to the preceding claim 6, **characterized** in that the one or more optical fibers comprise single-mode or multimode fibers and the light pulse is generated with a laser transmitter or with a LED light source.

8. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers comprise a Fabry-Pérot-type sensor fiber.

9. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers comprises a Bragg grating structure.

10. A rope according to any one of the preceding claims, **characterized** in that the one or more optical fibers function as a Brilloun distributed fiber sensor.

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13. A rope according to any one of the preceding claims, **characterized** in that the one or more fibers comprise one or more fiber bundles.

14. A rope arrangement of a lifting device for a transport elevator, which rope arrangement comprises a plurality of ropes, at least one of which comprise a rope according to any one of the preceding claims 1-13.

15. An elevator having an elevator car, a traction sheave, and a power source for rotating the traction sheave, **characterized** in that the elevator car is arranged to be moved by a rope according to any one of claims 1-13 and/or rope arrangement according to claim 14.

16. An elevator according to claim 15, **characterized** in that the rope and/or the rope arrangement is arranged to move the elevator car and a counterweight.

17. An elevator according to any one of the preceding claims 15-16, **characterized** in that the rope is arranged to operate as an overspeed governor rope and/or a compensating rope.

18. An elevator according to any one of the preceding claims 15-17, **characterized** in that the elevator comprises means for monitoring a condition of the one or more optical fibers, which means monitor a change in the condition of each optical fiber.

19. An elevator according to claims 18, **characterized** in that the condition comprises a strain and/or a displacement of the or each optical fiber.

20. A condition monitoring method for a rope of a lifting device for a transport elevator, **characterized** in that in the condition of a rope according to any one of the preceding claims 1-13 and/or a rope arrangement according to claim 14 is monitored by monitoring a condition of the or each optical fiber and if it is detected that the condition of the optical fiber has changed over a certain pre-defined limit value, a need to replace or overhaul the rope or ropes is diagnosed and rope replacement work or rope maintenance work is started.

21. A method according to the preceding claim 20, **characterized** in that the condition comprises a strain and/or a displacement of the or each optical fiber.

22. A method according to any one of the preceding claims 20-21, **characterized** in that the or each optical fiber comprises a single-mode or multimode fiber and a light pulse is input into the optical fiber, wherein the light pulse is generated with a laser transmitteror with a LED light source.

23. A method according to any of the preceding claims 20-22, **characterized** in that the or each optical fiber comprises a sensor fiber and a reference fiber arragned to eliminate common mode errors.

24. A method according to any one of the preceding claims 20-23, **characterized** in that the or each optical fiber comprises a Fabry-Pérot-type sensor fiber, with which the condition is monitored.

25. A method according to any one of the preceding claims 20-23, **characterized** in that the or each optical fiber comprises a Bragg grating structure, with which the condition is monitored.

26. A method according to any one of the preceding claims 20-23, **characterized** in that the or each optical fiber functions as a Brilloun distributed fiber sensor, with which the condition is monitored.

27. A method according to any one of the preceding claims 20-23, **characterized** in that the or each optical fiber comprises a fiber, in which time-of-flight of a light pulse is measured, and with which the condition is monitored..

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