ABSTRACT
A roofing method and system in which sensors are placed on the roof substrate, and a water impermeable membrane is placed over the sensors. This can be accomplished by applying the sensors and membrane separately, or by applying a membrane which incorporates the sensors. The sensors may be selected so as to provide strain and temperature information. A system monitoring this information may provide an alert if a roof leak or excessive strain is detected.
ROOFING SYSTEM WITH SENSORS

CLAIM OF PRIORITY TO PRIOR APPLICATION


FIELD OF THE INVENTION

[0002] The present invention relates to roofing systems.

BACKGROUND OF THE INVENTION

[0003] Rain, heavy snow and roof gardens can place a great strain on many roofing structures. Over time, even a small leak can lead to catastrophic failure if not discovered and fixed. A roofing failure cannot only lead to damage and loss of property, it can also be very dangerous.

SUMMARY OF THE INVENTION

[0004] The present invention comprises a roofing method and system in which sensors are placed on the roof substrate, and a water impermeable membrane is placed over the sensors. This can be accomplished by applying the sensors and membrane separately, or by applying a membrane which incorporates the sensors. The sensors may be selected so as to provide strain and temperature information. A system monitoring this information may provide an alert if a roof leak or excessive strain is detected.

[0005] These and other objects, advantages, purposes and features of the present invention will become more apparent upon review of the following specification in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a perspective view of a building showing roofing membrane in accordance with a preferred embodiment of the present invention;

[0007] FIG. 2 is a perspective view of a building for which sensors have been placed on the roof substrate, and membrane is being applied over the sensors;

[0008] FIG. 3 is a plan view of a scrim incorporating sensors;

[0009] FIG. 4 is a sectional view of the roofing membrane of FIG. 1;

[0010] FIG. 5 is an exploded view of the roofing membrane of FIGS. 1 and 4;

[0011] FIG. 6 is a sectional view of an alternative embodiment sensor membrane;

[0012] FIG. 7 is a sectional view of a second alternative embodiment sensor membrane;

[0013] FIG. 8 is a sectional view of a third alternative embodiment sensor membrane;

[0014] FIG. 9 is a sectional view of a fourth alternative embodiment sensor membrane; and

[0015] FIG. 10 is a schematic of a roof monitoring and reporting system of the preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] In the preferred embodiments, the roofing system of the present invention may comprise a roofing membrane 20 incorporating sensors as shown in FIGS. 1, 3, 4 and 6-9, or may comprise sensors applied directly to the roof substrate, and then covered with a membrane 20A as shown in FIG. 2. In either of those alternatives, the sensors can be incorporated into a scrim layer 40 as shown in FIG. 5, which is then either laid on the roof substrate 12 and covered with a separate water impervious membrane 20A, or which is adhered directly onto a water impervious membrane layer 30, as shown in FIG. 4. Alternatively, sensors 50 may be incorporated directly into the water impervious membrane layer 30 as shown in FIGS. 6-9. Preferably sensors 50 are elongated sensor strands, most preferably fiber-optic strands. Fiber-optic strands can identify water leaks by identifying temperature changes which affect the optical signal, and can identify roof strain due to deflection of the fibers, which affect the optical signal.

[0017] Referring now to the drawings and the illustrative embodiments depicted therein, a roofing membrane or sheet 20 used for covering a rooftop 12 on a building 10 comprises a sensor or sensing layer 40 and a water impervious cover or coating layer or membrane 30. Sensing layer 40 includes a plurality of fiber-optic sensors 50 adhered, sewn or woven into a geotextile fabric or other scrim 46. Sensors 50 are configured to measure changes in temperature and/or strain. Membrane layer 30 covers a top surface 42 of sensing layer 40. One or more sheets 20 can be installed on rooftop substrate 12 and seemlessly fused together with an additional layer of coating, providing a water tight seal over rooftop 12. A monitoring system 60 monitors the output of sensors 50 and issues an alert to a receiving device 70 in the event of a leak in sheet 20 or excessive strain on rooftop 12 or the like.

[0018] Each roofing membrane layer can come in varying sizes. Widths typically vary from 5 to 15 feet, and can be conveniently supplied in rolls as long as 300 feet. When membrane units 20 are butted endwise, the sensors 50 are connected using conventional coupling methods. The spacing within a membrane layer 20 can vary, but a spacing of one sensor 50 every 2 to 4 feet is exemplary.

[0019] In the FIG. 2 embodiment, sensors 50 are laid onto roof substrate 12, either as individual strands, or incorporated into sensor scrim 40 as described above. Roofing membrane 20A which does not incorporate sensors is then applied over the layer of sensors 50. At their ends, sensors 50 are connected to a communication strand 51 and 52, which connect them to monitor 62 via communication links 66 (FIG. 10).

[0020] Referring now to FIG. 3, sensing layer 40 is a sensor enabled geotextile, available from sources such as TenCate, a division of Royal Ten Cate of the Netherlands, under the brand name GEODETECT. Sensing layer 40 comprises a scrim or fabric 46 made from a composite geotextile material and a plurality of fiber-optic sensors 50. Preferably, scrim 46 is porous, especially when the fiber-optic sensors are located between scrim 46 and water impervious layer 30 (FIG. 4). This allows water leakage to gain access to fiber-optic sensors 50. Alternatively, scrim 46 can be sufficiently thin that temperature variations caused by water leakage can be sensed at the fiber-optic sensors 50. In the illustrated embodiment, sensing layer 40 is essentially rectangular in shape with four edges 48a, 48b, 48c, and 48d. Sensing layer 40 has a top surface 42 and a bottom surface 44. Sensors 50 run lengthwise across top surface 42 and are adhered, sewn or interwoven into fabric 46.

[0021] As illustrated in FIGS. 4 and 5 membrane 30 is applied to sensing layer 40 covering at least top surface 42. Membrane 30 is formed from a spray coating that when applied to sensing layer 40 creates a waterproof layer having a top surface 32 and a bottom surface 34. In the illustrated
embodiment, membrane 30 is generally rectangular in shape with four edges 36a, 36b, 36c, and 36d corresponding to edges 48a-48d of sensing layer 40, respectively. While membrane 30 may be any number of water resistant coatings and thicknesses, the illustrated embodiment uses an 80 ml spray coating of polyurea. Polyurea spray coatings can provide fast curing, even at very low temperatures, and water resistance, along with high hardness, flexibility, and tear strength. Although sensor layer 40 and membrane layer 30 shown in the illustrated embodiment as generally rectangular, it should be appreciated that alternative shapes, styles and configurations may be utilized. Optionally, interrogator 62 may be capable of analyzing the data for warning conditions. In this case, interrogator 62 can issue the alert directly to receiving device 70 without the need the computing unit 64.

Changes and modifications to the specifically described embodiments may be carried out without departing from the principles of the present invention, which is intended to be limited only by the scope of the appended claims as interpreted according to the principles of patent law including the doctrine of equivalents.

1. A roof covering system comprising:
   a waterproof membrane having integrally joined therewith a plurality of sensors for sensing roof conditions.

2. The roof covering system of claim 1 comprising:
   said plurality of sensors being secured to a scrim;
   said waterproof membrane being affixed to and overlying said scrim.

3. The roof covering system of claim 2 wherein said sensors comprise fiber-optic sensors.

4. The roof covering system of claim 3 in which said scrim includes a top and a bottom surface, said fiber-optic sensors being located on said top surface of said scrim, and said waterproof membrane being secured to said top of said scrim, with said fiber-optic sensors located between said scrim and said waterproof membrane layer.

5. The roof covering system of claim 4 in which said scrim is porous, such that water seeping beneath said scrim will make contact with said fiber-optic sensors.

6. The roof covering system of claim 3 in which said scrim includes a top and a bottom surface, said fiber-optic sensors being located on said bottom surface of said scrim, and said waterproof membrane being secured to said top of said scrim.

7. The roof covering system of claim 3 in which said waterproof membrane layer is affixed to said scrim by coating said scrim.

8. The roof covering system of claim 7 in which said membrane is made of polyurea.

9. The roof covering system of claim 1 comprising: said sensors being joined directly with said waterproof membrane.

10. The roof system of claim 9 in which said sensors are fiber-optic sensors.

11. The roof covering system of claim 9 comprising: said sensors being encapsulated in said waterproof membrane.

12. The roof system of claim 11 in which said sensors are fiber-optic sensors.

13. The roof covering system of claim 9 comprising: said sensors being adhered to the undersurface of said waterproof membrane.

14. The roof system of claim 13 in which said sensors are fiber-optic sensors.

15. The roof covering system of claim 9 comprising: said sensors being embedded in said waterproof membrane.

16. The roof system of claim 15 in which said sensors are fiber-optic sensors.

17. The roof covering system of claim 9, further comprising said sensors being operably connected to a computer for interpreting the information provided by said sensors.

18. The roof covering system of claims 17 in which said operable connection of said sensors to said computer comprises a transceiver for wirelessly communicating information provided by said sensor to said computer.
19. The roof covering system of claim 3, further comprising said sensors being operably connected to a computer for interpreting the information provided by said sensors.

20. The roof covering system of claims 19 in which said operable connection of said sensors to said computer comprises a transmitter for wirelessly communicating information provided by said sensor to said computer.

21. The roof covering system of claim 1, further comprising said sensors being operably connected to a computer for interpreting the information provided by said sensors.

22. The roof covering system of claims 21 in which said operable connection of said sensors to said computer comprises a transmitter for wirelessly communicating information provided by said sensor to said computer.

23. A roofing system comprising: a plurality of sensors placed on a roof substrate, and a water impermeable membrane placed over said sensors.

24. A method of monitoring roof conditions comprising: placing a plurality of sensors on roof substrate, and placing a water impermeable membrane placed over said sensors.

25. The method of claim 24 in which said placing steps are accomplished in a single step by placing on said roof substrate a waterproof membrane having integrally joined therewith a plurality of sensors for sensing roof conditions.

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