A system for protecting a building is disclosed. The building may stand on the ground surface, and may have a roof. The system comprises a mesh positionable over the roof of the building. The mesh includes a number of edge portions. A frame is secured to the edge portions of the mesh. The frame is composed of a number of elongate rigid members extending along the edge portions of the mesh. The system further includes a number of connectors. Each connector has a first end portion securable to the frame, and a second end portion removably securable to the ground surface.
FIG. 12

<table>
<thead>
<tr>
<th></th>
<th>Location1</th>
<th>Location2</th>
<th>Location3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic model</td>
<td>12.8</td>
<td>13.8</td>
<td>13.6</td>
</tr>
<tr>
<td>Cabled roof model</td>
<td>8.9</td>
<td>9.5</td>
<td>10</td>
</tr>
</tbody>
</table>
FIG. 15

Axial forces (kN)

Gable end wall studs

FIG. 16

Axial forces (kN)

Side wall studs
SYSTEM FOR PROTECTING A BUILDING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 61/327,842 filed on Apr. 26, 2010, which is incorporated by reference herein in its entirety.

FIELD

[0002] The disclosure relates to a system for protecting a building, such as a home. Particularly, the disclosure relates to a system for reinforcing a building during a hurricane or other high wind event.

INTRODUCTION

[0003] United States Patent Application Publication No. 2007/0022672 (Bachynski) discloses a hurricane protection harness apparatus for protecting homes, buildings and other assets from the destructive forces of high winds such as from hurricanes, tornadoes, cyclones and typhoons is disclosed. The disclosure presents an apparatus for mooring and securing a building roof and the underlying structure during periods of high winds, as well as a means of deflecting flying debris from windows and doors. The harness covers 40% to 90% of the home or building from the roof to the ground, covering the doors, windows and other vulnerable areas against breaking windows and damage from flying debris. The mesh material of the harness has small holes throughout for permitting the wind to pass through the mesh while blocking flying debris. The harness forms an "A" frame shaped hip roof shape, thereby preventing the wind from forming a vortex and lifting the roof from the structure. The harness helps to protect the roof from wind damage including the lifting and removing of shingles, and lifting and removal of sheathing. The mesh harness is moored to ground anchors by tensioned straps, thereby holding the building structure together and on the foundation during hurricane strength winds. The harness is removable after the threat has passed.

SUMMARY

[0004] The following summary is provided to introduce the reader to the more detailed discussion to follow. The summary is not intended to limit or define the claims.

[0005] According to one aspect, a system for protecting a building is disclosed. The building may stand on the ground surface, and may have a roof. The system comprises a mesh positionable over the roof of the building. The mesh comprises a plurality of edge portions. A frame is secured to the edge portions of the mesh. The frame comprises a plurality of elongate rigid members extending along the edge portions of the mesh. The system further comprises a plurality of connectors. Each connector has a first end portion securable to the frame, and a second end portion removably securable to the ground surface.

[0006] The system may further comprise a plurality of piles secured in the ground. The connectors may be removably secured to the piles.

[0007] The mesh may comprise steel filaments. The steel filaments may have a filament diameter of 2 mm or greater. The mesh may comprise longitudinal filaments extending in a first direction, and lateral filaments extending in a second direction transverse to the first direction. The longitudinal filaments may be spaced apart by a distance of 480 mm or less, and the lateral filaments may be spaced apart by a distance of 300 mm or less.

[0008] The rods may comprise carbon fiber. Alternately, the rods may be made from aluminum galvanized steel. The rods may each have a rod diameter of 2 inches or greater when made from carbon fiber.

[0009] The mesh may comprise a first edge portion and an opposed second edge portion, and a third edge portion and an opposed fourth edge portion. The frame may comprise a first rod and a second rod secured to the first edge portion, a third rod and a fourth rod secured to the second edge portion, a fifth rod secured to the third edge portion, and a sixth rod secured to the fourth edge portion.

[0010] The connectors may comprise cables. For example, the system may comprise ten cables. When secured to the frame and the ground, the cables may each be at an angle of approximately 45 degrees with respect to the horizontal. The cables may have a cable diameter of at least 0.75 inches. The cables may comprise steel.

[0011] The system may further comprise a tightening mechanism operatively connected to at least one of the cables for tightening the cables.

[0012] According to another aspect, a system for protecting a building with a roof and standing on a surface is disclosed. The system includes a mesh positionable over the roof of the building, where the mesh comprises a plurality of loops along an edge of the mesh. The system also includes a frame positioned along the edge of the mesh, where the frame is secured within the loops of the mesh. The frame comprises a plurality of elongate rigid members. The system also includes a plurality of anchors securable to the surface, as well as a plurality of cables. Each cable comprises a first end and an opposing second end, where each cable is removably securable to the frame at the first end and to one of the anchors at the second end. The system also includes a tightening mechanism connected to at least one of the cables. The tightening mechanism controls the tautness of the cable.

[0013] Preferably, the elongate rigid members are rods and the tightening mechanism is a turnbuckle.

DRAWINGS

[0014] Reference is made in the detailed description to the accompanying drawings, in which:

[0015] FIG. 1 is a perspective illustration of an exemplary system for reinforcing a home;

[0016] FIG. 2 is an elevation view of the system and home of FIG. 1;

[0017] FIG. 3 is a top plan view of the system and home of FIG. 1;

[0018] FIG. 4 is an enlarged view of the region shown in box 4 in FIG. 3;

[0019] FIG. 5 is an illustration showing a cross section taken along line 5-5 in FIG. 1 showing the tie of FIG. 1, and also showing a side plan view of a connector of FIG. 1;

[0020] FIG. 6 is a top plan view of the tie shown in FIG. 5;

[0021] FIG. 7 is a side view of the turnbuckle shown in FIG. 5;

[0022] FIG. 8 is a perspective illustration of a test home used to model the system of FIG. 1;

[0023] FIG. 9 is a graph showing the average deflection curve for a toe-nail connection;
FIG. 10 is a schematic diagram showing the double node concept as applied at the connections between the cable elements simulating the mesh and the shell elements simulating the sheathing:

FIG. 11 is a schematic diagram showing the studied locations for sheathing deformation;

FIG. 12 is a graph showing the effect of the system of FIG. 1 on plywood sheathing deformation;

FIG. 13 is a graph showing axial tension distribution on link elements of a standard house model;

FIG. 14 is a graph showing axial tension distribution on link elements of a house model using the system of FIG. 1;

FIG. 15 is a graph showing axial tension distribution on gable end wall studs of a standard house model;

FIG. 16 is a graph showing axial tension distribution on side wall studs of the standard house model;

FIG. 17 is a graph showing axial tension distribution on gable end wall studs of a house model using the system of FIG. 1;

FIG. 18 is a graph showing axial tension distribution on side wall studs of a house model using the system of FIG. 1;

FIG. 19 is a plot showing bending moments on the rods of the system of FIG. 1; and

FIG. 20 is a plot showing axial forces on the rods of the system of FIG. 1.

DETAILED DESCRIPTION

Hurricanes and other strong wind-events can cause significant damage, both to the structure and to the contents of a building through a breach in the building envelope. During a high wind event, uplift pressures are applied to the roof of a building, causing a net uplift force on the building. An exemplary system is described herein for reinforcing a building during a high wind event. As used herein, “building” means any structure that could be susceptible to wind damage. It is believed that the system described herein may prevent or reduce damage to the building, preferably by providing the uplift forces with a vertical load path from the roof of the building to the foundation.

Referring to FIG. 1, an exemplary system 100 for protecting a building 102 is shown. The system 100 may be removably assembleable to the building 102, or permanently secured to the building 102, and may be used to protect the building 102 during a hurricane or other high wind event such as a typhoon, a tornado, or a tropical storm.

In the example shown, the building 102 is a single story home 104, which has a generally rectangular footprint, and which includes a gabled roof 106. In alternate examples, the system 100 may be used with any other suitable type of building, such as a home of an alternate configuration, a garage, a storage shed, or an office building, for example.

Continuing to refer to FIG. 1, the system includes a mesh 108 which is positionable over the roof 106 such that it rests on the roof 106, a frame 130 for the mesh, and a plurality of connectors 136 for securing the frame 130 to the ground 105.

Continuing to refer to FIG. 1, in the example shown, the mesh is made up of filaments 110. For simplicity, all of the filaments 110 of the mesh 108 are not shown in FIG. 1. The filaments 110 may be steel, such as FY50 steel having a diameter of 2 mm or greater. In alternate examples, an alternate grade of steel, such as a higher grade of steel, may be used.

In the example shown, the filaments 110 are woven together. More specifically, the mesh includes longitudinal filaments 112, and lateral filaments 114. The longitudinal filaments 112 may be spaced apart by a longitudinal spacing 116, which may be, for example, 300 mm or less. The lateral filaments 114 may be spaced apart by a lateral spacing 118, which may be, for example, 480 mm or less. In one specific example, the longitudinal spacing 116 is 100 mm, and the lateral spacing 114 is 480 mm.

Preferably, the mesh filaments 110 are made from steel. In alternate examples, the mesh 108 may be made from another suitable material having another suitable configuration.

Referring to FIG. 2, in the example shown, when the mesh 108 rests on the roof 106 (shown in FIG. 1), the mesh includes two portions. A first portion 172 sits on the roof 106. A second portion 174 overhangs the roof. For example, the second portion may overhang the roof by 200 mm or greater.

In alternate examples, when the mesh 108 rests on the roof 106, the mesh 108 may include only a first portion 172.

Referring to FIG. 3, the mesh includes a plurality of edge portions 120. Specifically, in the example shown, the mesh 108 is generally rectangular when viewed in top plan view, and includes a first edge portion 120a and an opposed second edge portion 120b, and a third edge portion 120c, and an opposed fourth edge portion 120d. As the roof 106 of the home is gabled, when the mesh 108 rests on the roof 106, the mesh folds along a fold-line 122 (seen in FIG. 1) preferably aligned with the peak 124 of the roof 106. The first edge portion 120a is folded into a first portion 120a and a second portion 120a. The second edge portion 120b is folded into a first portion 120b and a second portion 120b.

Referring to FIGS. 1 and 3, the frame 130 is secured to the edge portions 120 of the mesh 108. The frame 130 includes a plurality of elongate members, such as rods 132, which extend along the edge portions 120 of the mesh. Specifically, in the example shown, the frame 130 includes a first rod 132a secured to the first portion 120a of the first edge portion 120a, a second rod 132b secured to the second portion 120a of the first edge portion 120a, a third rod 132c secured to the first portion 120b of the second edge portion 120b, a fourth rod 132d secured to the second portion 120b of the second edge portion 120b, a fifth rod 132e secured to the third edge portion 120c, and a sixth rod 132f secured to the fourth edge portion 120d.

The rods 132 are preferably rigid, and more specifically, are rigid in bending. Further, the rods 132 are preferably relatively lightweight. Without being limited by the following theory, it is believed that during a high wind event, such as a hurricane, uplift forces act on the home. The uplift forces may cause the mesh 108 to stretch, developing tensile forces. It is believed that by using rigid rods 132, the mesh 108 will stretch more uniformly, and the tensile forces will be transferred from the mesh 108 to the rods 132, and from the rods 132 to the ground via the connectors 136. This will provide the uplift forces with a load transfer path that is an alternative to the frame of the home.

One specific material suitable for rods 132 is carbon fiber, which has a modulus of elasticity similar to that of steel, but has a specific weight that is approximately one-fifth of that of steel. In an alternate example, the rods 132 may be aluminum galvanized steel. In further alternate examples, the rods may be another suitable material.
Rods 132 made from carbon fiber may have a circular cross section with a diameter of 2 inches or less. In another example, the carbon fiber rods may be a hollow bar having a 3" by 3" square cross-sectional shape. Alternatively, the rods may be aluminum bars having a hollow rectangular cross-section of 2" by 4" with a thickness of 3/46.

The rods 132 may be secured to the edge portions 120 of the mesh 108 in any suitable fashion. For example, as shown in FIG. 4, the filaments 110 of the mesh 108 may include the first ties 148. A second cable 138b is secured to the frame 130 at a second junction 144b between the first rod 132a and the fifth rod 132c. A second cable 138c is secured to the frame 130 at a second junction 144b between the first rod 132a and the second rod 132b. A third cable 138d is secured to the frame 130 at a junction 144c between the second rod 132b and the sixth rod 132d. A fourth cable 138e is secured to the frame 130 at a junction 144d between the sixth rod 132d and the fourth rod 132d. A fifth cable 138f is secured to the frame 130 at a junction 144c between the third rod 132c and the fourth rod 132d.

Seventh to tenth ties 148 may be used to connect the seventh to tenth cables (138g to 138i) to the frame 130. The seventh to tenth ties 148 may be similar to the to the first tie 148a. However, rather including a tube 150 that is bent to form a first portion 152 and a second portion 154, the seventh to tenth ties 148 may include a straight tube.

As mentioned above, the second end portion 142 of each cable 138 is removably secured to the ground 105 using any suitable type of anchor. In one example, a plurality of wires 160 may be permanently installed in the ground adjacent the home 104, and secured in the ground. The cables 138 may be removable secured to the piles 160. Specifically, referring to FIG. 5, the piles 160 may each include an upwardly extending hook 162. The second end portion 142 of each cable 138 is connected to a turnbuckle 170, which includes a second loop 164. The hook 162 is inserted into the second loop 164 to removably secure the second end portion 142 of each cable 138 to the ground.

A turnbuckle 170 is shown in more detail in FIG. 7. Turnbuckles 170 may be used in order to maintain tautness in the cables 138 when secured between the frame 130 and the piles 160. In alternate examples, alternate tightening devices may be used to maintain tautness in the cables 138. In further alternate examples, the second end portion 142 of the cables may be connected directly to the piles 160.

Referring again to FIG. 2, the piles 160 are preferably installed in the ground such that when the system 100 is assembled to the home 104, the cables 138 are at an angle of approximately 45 degrees with respect to the horizontal.

In use, the system 100 may be assembled to the home 104 in response to a weather warning, such as a hurricane warning. In order to assemble the system 100 to the home, the mesh 108 may be draped over the roof 106, and oriented such that the rods 132 generally align with the edges of the roof 106. The second end 140 of each cable 138 may then each be secured to a hook 162 of one of the piles 160. The turnbuckle 170 of each cable 138 may then be tightened.

Alternately, the system 100 may be permanently or semi-permanently secured to the roof 106.

Various apparatuses or methods are described above to provide an example of each claimed invention. No example described above limits any claimed invention and any claimed invention may cover processes or apparatuses that are not described above. The claimed inventions are not limited to apparatuses or processes having all of the features of any one apparatus or process described above or to features common to multiple or all of the apparatuses described above. It is possible that an apparatus or process described above is not an embodiment of any claimed invention. Applicant reserves the right to claim such apparatuses or processes in other applications.

Examples

Introduction

The system 100 was modeled numerically using the Finite Element Method. Referring to FIG. 8, a test home 800 used in the modeling is shown. The test home is 9 meters long by 9 meters wide. The test home includes a frame 802. The frame 802 includes 2 inch by 4 inch wall studs 804 that are spaced apart by 24 inches.

Referring still to FIG. 8, the frame 802 includes a roof 806 that includes trusses 808 that are spaced 24 inches apart. The trusses 808 include 2 inch by 3 inch boards and 2
inch by 4 inch boards. The trusses 808 are joined to the wall studs 804 by top plates 810. The top plates 810 include 2 inch by 4 inch boards. The trusses 808 are joined to the top plates using 16d toe-nails. The roof further includes a ridge beam 814, and connecting beams 816.

[0065] The test home further includes a sheathing (not shown) mounted to the trusses 808. The sheathing includes spruce plywood having a thickness of 0.5 inches. The sheathing has a slope of approximately 30 degrees.

[0066] The system 100 that was modeled included a mesh 108, rods 132, and connectors 136, described above. Specifically, the mesh 108 included FY50 steel filaments having a diameter of 2 mm. The longitudinal filaments 112 were spaced apart by a longitudinal spacing 116 of 300 mm, and lateral filaments 114 were spaced apart by a lateral spacing 118 of 480 mm. The frame 130 included eight carbon fiber rods 132, which were circular in cross section, and had diameter of 2 inches. The rods were arranged as shown in FIG. 3. The connectors 136 included ten cables 138 which were made from FY50 steel having a modulus of elasticity of 200,000 MPa and having a cable diameter of 0.75 inches. The cables were arranged as shown in FIG. 3, and had an inclination of 45 degrees with respect to the horizontal.

[0067] Two models were developed for the test home, one with the system 100, and one without the system 100. Material properties were modified for both models to account for the adopted Spruce-Pine-Fir (SPF) wood used in the home construction. Trusses 808, wall studs 804 and connecting beams 816 were modeled using three-dimensional “frame” elements to account for the effects of biaxial bending, torsion, axial and biaxial shear deformations. A total number of 720 Shell elements were used to model the sheathing. Shell elements have membrane and bending capabilities allowing them to deflect in and out-of-plane simulating the realistic behavior of the sheathing.

[0068] To simulate the true behavior of the roof 806 to wall stud 808 connection, link elements were used at the connection locations. These elements allow describing a nonlinear generalized force-deflection relation simulating the characteristics of the nails. A typical average load-deflection curve for a toe-nail connection consisting of three common nails utilized in the analysis is shown in FIG. 9.

[0069] In the model, the cables 138 as well as the mesh 108 were simulated using nonlinear cable elements, which can describe the catenary behavior of slender cables under their own self-weight and strain loading. Similar to the home components, the rods 132 were modeled using three-dimensional linear frame elements. The rods were assumed to the same orientation as the roof edge portions, and to overhang from the home by 200 mm.

[0070] The double node concept was applied at the connections between the cable elements simulating the mesh 108 and the shell elements simulating the sheathing as shown in FIG. 10. This means that two nodes simulating each one of these two components exist at the same location with different and independent degrees of freedom. However, the degrees of freedom at similar locations are constrained in order to achieve compatibility of the displacements in the direction perpendicular to the roof for both the sheathing and the mesh 108. No compatibility in the displacements along the two perpendicular in-plane axes of the roof is assumed. In reality, such compatibility will be governed by the friction that develops between the mesh 108 and the sheathing. Such an assumption is conservative, since the in-plane compatibility between the mesh 108 and the sheathing will tend to increase the in-plane stiffness of the sheathing, which can decrease their deflections.

[0071] The modeled roof 806 was analyzed under the effect of a static uniform pressure having an intensity of 2 kPa acting perpendicular to the roof 806 in the upward direction. A uniform wind pressure was applied, despite the spatial variation of the uplift wind pressure observed during wind storms. This is justifiable since the purpose of the test was to assess the uplift performance of the roof 806 with and without the system 100.

Results

[0072] Deformation of the roof sheathing in the direction of the load is observed at the three different points of the roof. A plan view of the roof 806 is provided in FIG. 11 showing the x and y axes used to define the coordinates of these points. The z-axis is along the vertical direction. The three points are labelled as 1, 2 and 3 in FIG. 12. The coordinates of points 1, 2 and 3 are (−3.15 m, 7.44 m, 0.45 m), (−3.15 m, 5.03 m, 0.45 m) and (−1.35 m, 5.03 m, 1.05 m), respectively. The three points are located in between the trusses 808. None of the three points is in close proximity to a cable 138 to avoid the stress concentration confusion.

[0073] FIG. 12 shows a comparison between the deflections of the three points with and without the system 100. In this figure, basic model and cable roof model refer to the home 800 without the system 100, and the home 800 with the system 100, respectively. Despite being located almost halfway between two cables 138, a significant decrease in the roof deformation values at the three locations is reached in case of the cable roof model compared to the basic model. The decrease in the deformation values at locations away from the cables 138 gives an indication that the entire mesh 108 has been stressed during the application of the uplift pressure. This will tend to limit the upward deformations of the mesh 108 and the sheathing panels. In general, the analysis shows an average reduction of 40% in the structure’s deflection due to the addition of the system 100.

[0074] FIG. 13 shows the distribution of the tensile axial forces acting on all the link elements simulating the roof to wall connections for the case of the home 800 without the system 100. As shown in FIG. 9, the connection starts to behave in a nonlinear manner and loses its stiffness significantly at a critical axial force. The maximum value of such a critical axial force obtained from various test did not exceed 2.5 kN. As such, the capacity of the connection can be set as 2.5 kN. The results shown in FIG. 13 indicate that many of the connections are subjected to axial loads that exceed this capacity. In fact, about 68% of the links are subjected to an axial tension value exceeding 2.5 kN. Also, 42% of the links experiences an axial tension value of more than 3 kN.

[0075] The corresponding distribution of axial forces associated with the home 800 with the system 100 is shown in FIG. 14, and shows significantly lower axial tension forces on the roof to wall connections. The stretched mesh 108 decreases the average tension force to a value of 0.88 kN. The maximum tension force does not exceed 1.32 kN, which is almost half the designated capacity of the used connection. About 65% of the links are even subjected to an axial tension value less than 1.0 kN as shown in FIG. 15.

[0076] As the wall studs 804 are spaced at 16 inches (0.4 m), while the roof trusses 808 are spaced at 24 inches (0.6 m), axial tension forces acting on the link elements are expected
to be greater than those on the wall studs 804 under the applied wind loading. The distributions of axial tensile forces acting on the wall studs 804 located along the end gable and along the sides of the home 800 are shown in FIG. 15 and FIG. 16, respectively. The analysis shows that for the basic model, the average axial tension value on all studs is 1.711 kN with almost 75% of the values below 2 kN. However, the two middle wall studs at both gable ends experience very high tension value that exceed 11 kN as shown in FIG. 15.

[0077] The corresponding distributions of axial forces resulting from the analysis of the cable model are provided in FIG. 17 and FIG. 18. The figures show that the effect of the system 100 on the wall studs 804 is also noticeable. By comparing the results with those of the basic model, it is found that the average axial tension value on the wall studs 804 decreases by 26% after using the system 100, as it reaches 1.31 kN.

[0078] It is also noticeable that the large tension force experienced by the two middle wall studs has decreased from 11 kN to 5.5 kN as shown in FIG. 17.

[0079] The analysis indicates that the cables 138b, g, d, e, i, and f experience axial tensile forces that are significantly higher than those experienced by cables 138a, c, g, and h. The axial tension forces on cables 138b, g, d, e, i, and f reach values of 7 kN and 6.2 kN, respectively. Cables 138a, c, g, and h experience a maximum axial tensile force of only 1.4 kN. Based on the geometric and material properties of the cables 138, the ultimate strength capacity of each cable 138 is 99.75 kN. The above capacity is significantly higher than the resulting strain actions, which may allow decreasing the cable diameter of the cables 138.

[0080] The mesh 108 was considered to consist of two portions 172, and 174, as described hereinabove. The first portion 172 is sits on the roof. The second portion 174 overhangs the roof and is directly connected to the rods 132. The analysis shows that the first portion 172 is subjected to axial forces that are less than those acting on the second portion 174. The largest tension force in the first portion 172 is 0.75 kN, while it reaches 2.5 kN in the second portion 174.

[0081] The mesh 108 was assumed to have an ultimate strength capacity of 1.1 kN. The results indicate that the assumed configuration of 2 mm diameter steel filaments 110 having a longitudinal spacing of 300 mm may not be adequate in certain conditions. This can be solved by either increasing the diameter of the filaments 110, reducing the spacing 116 or using higher strength steel. A reduction of the longitudinal spacing 116 by a factor of 3, to 100 mm, will reduce the maximum forces in the individual filament by the same factor and will satisfy the strength capacity requirement.

[0082] FIG. 19 and FIG. 20 show the distribution of the bending moments and axial forces along the rods 132. The high negative bending moment values shown in FIG. 14, occur at the vicinity of the cables 138d, e, i, and j. The analysis shows that the maximum values for the bending moment and axial forces are 0.46 kN-m and 9 kN, respectively. The stresses associated with the combined effects of bending moment and axial forces are calculated. This leads to maximum compression and maximum tension stresses of 41 MPa and 36 MPa, respectively, which are significantly less than the ultimate strength of carbon fiber.

CONCLUSIONS

[0083] The use of the exemplary system 100 resulted in significant improvement in the behavior of the home 800. Comparing the results of a home 800 without the system 100 and a home 800 with the system 100 show that:

[0084] Deformation of the roof sheathing at three different critical locations is reduced by 42%. The average axial tension force on the roof to wall connections decreases from 2.7 to 0.88 kN with a peak value of 1.325 kN which is almost half the designated capacity of the used connection.

[0086] Average axial tension on the wall studs 804 decreases by 26% after using the system 100. Also, axial tension on the two middle wall studs at each gable end decreases from 11 to 5.5 kN.

[0087] Based on the experimental results set out above, the exemplary system 100 of the model reduced bending and axial stresses on the rods 132. Resulting axial tension forces on the cables 138d, e, i, and j as well as on the first portion 172 of the mesh 108 were reasonably below the section capacity. Higher axial forces are noticed on the second portion 174 of the mesh 108. However, this may be overcome by increasing the diameter of the filaments 110, reducing the spacing 116, or using higher strength steel.

[0088] In the light of these findings, it can be concluded that using the exemplary system 100 can significantly enhance the behavior of a home in high wind events.

1. A system for protecting a building standing on a ground surface, the building having a roof, the system comprising:
   a) a mesh positionable over the roof of the building, the mesh comprising a plurality of edge portions;
   b) a frame secured to the edge portions of the mesh, the frame comprising a plurality of elongate rigid members extending along the edge portions;
   c) a plurality of connectors, each connector having a first end portion securable to the frame, and a second end portion removably securable to the ground.

2. The system of claim 1, further comprising a plurality of piles secured in the ground, wherein the connectors are removably securable to the piles.

3. The system of claim 1, wherein the mesh comprises steel filaments.

4. The system of claim 3, wherein the steel filaments have a filament diameter of 2 mm of greater.

5. The system of claim 3, wherein the mesh comprises longitudinal filaments extending in a first direction, and lateral filaments extending in a second direction transverse to the first direction; wherein the longitudinal filaments are spaced apart by a distance of 300 mm or less; wherein the lateral filaments are spaced apart by a distance of 480 mm or less.

6. The system of claim 1, wherein at least a portion of the elongate rigid members are rods.

7. The system of claim 6, wherein the rods are made from carbon fiber.

8. The system of claim 6, wherein the plurality of rods have a rod diameter of 2 inches or greater.

9. The system of claim 1, wherein the rods are made from aluminum galvanized steel.

10. The system of claim 1, wherein:
   a) the mesh comprises a first edge portion and an opposed second edge, and a third edge portion and an opposed fourth edge portion; and
   b) the frame comprises a first rod and a second rod secured to the first edge portion, a third rod and a fourth rod...
secured to the second edge portion, a fifth rod secured to the third edge portion, and a sixth rod secured to the fourth edge portion.

11. The system of claim 1, wherein the mesh comprises a plurality of mesh loops connected to at least one edge of the mesh, wherein at least a portion of the elongate members are received within the plurality of mesh loops.

12. The system of claim 1, wherein the connectors comprise cables.

13. The system of claim 12, wherein the system comprises ten cables.

14. The system of claim 12, wherein when secured to the frame and the ground, the cables are each at an angle of approximately 45 degrees with respect to the horizontal.

15. The system of claim 12, wherein the cables have a cable diameter of 0.75 inches or less.

16. The system of claim 12, wherein the cables comprise steel.

17. The system of claim 11, further comprising a tightening mechanism operatively connected to at least one of the cables for tightening the cable.

18. The system of claim 11, further comprising:
   a) at least one tie secured to a pair of adjacent elongate members, and
   b) a ring secured to the tie, wherein a first end portion of at least one of the connectors comprises a first loop threaded to the ring, thereby securing the connector to the frame.

19. The system of claim 18, wherein the tie defines a passage therethrough, wherein an end of each of the pair of elongate members is received within the passage.

20. The system of claim 19, wherein the tie has an angled shape, wherein the pair of elongate members are positioned at an angle to each other.

21. The system of claim 18, further comprising a pile secured within the ground surface, the pile comprising a hook projecting from an upper end of the pile, wherein a second end portion of the connector comprises a second loop removably secureable to the hook.

22. The system of claim 21, wherein the connector comprises a tightening mechanism.

23. The system of claim 22, wherein the connector comprises a cable, wherein the tightening mechanism comprises a turnbuckle.

24. The system of claim 1, wherein the mesh comprises a first portion and a second portion, wherein the second portion overhangs the roof.

25. A system for protecting a building standing on a surface, the building having a roof, the system comprising:
   a) a mesh positionable over the roof of the building, the mesh comprising a plurality of loops along an edge of the mesh;
   b) a frame positioned along the edge of the mesh, the frame being secured within the loops of the mesh, the frame comprising a plurality of elongate rigid members;
   c) a plurality of anchors secureable to the surface;
   d) a plurality of cables, each cable comprising a first end and an opposing second end, wherein the first end of each cable is secureable to the frame, and the second end of each cable is removably secureable to one of the anchors; and
   e) a tightening mechanism connected to at least one of the cables, the tightening mechanism being adapted to control tautness of the cable.

26. The system of claim 25, wherein the rigid members are rods.

27. The system of claim 26, wherein the tightening mechanism is a turnbuckle.

* * * * *