Inherently strong multiplicity of unique, planar, triangular roof truss frames or panels assemble into a replete, self-supporting roof system usable on a wide variety of building shapes and roof slopes. Compound angles on edges of truss panels facilitate connecting panels directly to each other either face-up and/or faced-down. Combinations of triangular trusses create domed, even-sided hipped roof structures, and also form ridges, eaves, valleys, dormers and overhangs. Compound angles used to construct triangular roof trusses are unique to the shape (number of sides) of the building and the roof slope (pitch) desired but can be used to design and build a diverse collection of building styles. Half trusses create gable ends on roofs; special trusses connect different geometric shapes; roof pitch can be changed part way up many roofs.
TRIANGULAR ROOF TRUSS SYSTEM

BACKGROUND

1. Field of Invention

This invention relates to prefabricated roof trusses used to enclose buildings, specifically to a new and improved series of roof trusses applicable to a multitude of building shapes and styles.

2. Discussion of Prior Art

Conventional prefabricated roof trusses are widely used for enclosing buildings using square and rectangular floor plans, where they also help tie the outside walls together. Their greatest weakness is in their parallel installation, like the other framing in most buildings. Conventional trusses do not work with most non-traditional building shapes.

Ceiling joists and collar ties also serve the purpose of helping hold rafters and exterior walls of buildings together, so that weight loads transferred by roof rafters would not push the walls out, and cause the ridge pole to sag. However, when building designs include geometric shapes outside square and rectangular floor plans, neither of the above solutions can typically be used to retain the walls.

As a result, numerous inventors have patented approaches to building multi-sided buildings, many offering alternative approaches to this problem of supporting the walls. It is among these non-traditional building designs that the use of triangular panels in the roof is most widely encountered.

Raemer (U.S. Pat. No. 2,440,449) uses triangles in his roof system, but illustrates a retaining cable installed around the perimeter of a ten-sided structure. Reidelberger, et al., (U.S. Pat. No. 3,710,528) shows a clustered hexagon comprised of an open beam skeletal frame with specialized connector brackets. Cole (U.S. Pat. No. 3,807,101) uses rigid corner connectors and a center retaining system to support curved roof panel panels. Walters (U.S. Pat. No. 3,908,329) 12-sided polygon has a cable threaded through the wall sections and rafters. Raptoloss (U.S. Pat. No. 4,173,855) uses triangular roof panels mounted on top of a 3-sided collar that stabilizes his octagonal gazebo. Porter (U.S. Pat. No. 4,275,534) includes prefabricated (triangular) sandwich-type panels on his roof over a steel frame that includes a tension ring, threaded fasteners, etc., for strength. Buchanan’s (U.S. Pat. No. 4,332,116) roof is comprised of substantially similar triangle shaped components that are held up by a permanently installed center column in the middle of this multi-sided polygon. Greenblatt’s (U.S. Pat. No. 4,733,508) hexagonal gazebo has triangularey configured roof panels that use a center hub and foot brackets to support roof panels. Hoehn (U.S. Pat. No. 6,843,026) introduces a variation on conventional roof trusses that span from the walls to a center column, supporting triangular pieces of metal roofing.

Some inventors with very futuristic structures have also envisioned using triangular roof panels in some of their structures. Mangan (U.S. Pat. No. 3,685,221) illustrates large tetrahedrons as building structures, some of which appear to include triangular panels, but no discussion is provided of how they are made structural. Pearce (U.S. Pat. No. 3,974,600) uses a framework system to support interstitial triangular panels. Levy (U.S. Pat. No. 5,440,840) uses a triangulated framework to cover stadiums and arenas using a roof system that includes cables, tensioning elements and compression rings, and is ultimately covered in fabric. Richter (U.S. Pat. No. 5,704,169) uses a framework and a sub-framework to support the triangular panels in his round dome cover. Knight (U.S. Pat. No. 6,647,672) refers to triangular panels and trusses but never mentions whether unique edge angles or 3-dimensionality is important to the various panel shapes comprising his domed structures. Kerney (U.S. Pat. No. 6,568,134) appears to include 3-dimensional triangular components among his prefabricated items, but shows building the trusses, and all the other shapes he uses, in the manner of conventional trusses using top and bottom chords interconnected by shorter framing members.

Objects and Advantages: Essentially, of these many inventors envisioning multi-sided, improved or futuristic structures and using triangular roof panels, none has referenced incorporating specific edge angles onto the two sides and base of a roof triangle, thus creating self-supporting planar trusses that can be interconnected without the need for external connecting devices. Further, the creation of panels that interconnected face-up led to discovering the opportunities of connecting face-up to panels to reversed panels thus creating a multitude of roof panels shapes and sizes, attractive variations on existing home designs, as well as many striking, new and unique building designs.

Triangular roof trusses overcome the following shortcomings. Our triangular trusses accommodate numerous non-traditional home designs, and also square and rectangular floor plans. Sets of triangular frames or panels are structural, self-supporting trusses, eliminating the need for a separate supporting frame. Matching panels connect flawlessly to each other, eliminating the need for connective hardware in most cases. After installation, all edge surfaces are vertical, and the triangular roof structure effectively transfers roof loads to a vertical pressure on the tops of the perimeter walls, eliminating the need for retaining rings, cross-cables or turnbuckles to prevent the walls pushing out.

Unique sets of triangular trusses can be used to design and build a vast array of different styles of homes, using components that can be mass-produced.

DESCRIPTION OF DRAWINGS

12. Triangular roof trusses for specific geometric shapes are made with angles unique to the shape they enclose, but share the characteristics shown in FIGS. 1 through 12.

13. FIG. 1 includes overall views of a single triangular roof truss panel. In FIG. 1-A truss is face up. You can see the planar top surface and the angled edges and sides. FIG. 1-B is a side view of 1-A. In FIG. 1-C the same truss is shown flipped over, in a reversed position. You can see the planar bottom surface, which is the same size and shape as the planar top surface. FIG. 1-D is a side view of 1-C. The side view of the face up truss 1-B appears identical to the side view of the same truss flipped over in 1-D, which helps in comprehending the trusses ability to connect efficiently to each other.

14. FIGS. 2 through 5 illustrate the components that make up a single triangular roof truss frame. In FIG. 2-A
truss is face up. FIG. 2-B is a side view of 2-A. In FIG. 2-C the same truss is flipped over, in a reversed position. FIG. 2-D is a side view of 2-C.

[0015] FIG. 3 details a left side frame component also shown in FIG. 2. With frame component standing on a flat surface, FIG. 3-A is an end view; FIG. 3-B an inside view; and FIG. 3-C a top view. As illustrated in 2-A and 2-C, left frame component extends from outside of base to apex of triangular truss.

[0016] FIG. 4 details a right side frame component also shown in FIG. 2. Standing this frame component on a flat surface, FIG. 4-A is an end view; FIG. 4-B an inside view; and FIG. 4-C a top view. FIGS. 2-A and 2-C show how right frame component extends from outside of base to inside edge of left frame member at their intersecting point inside of triangular frame.

[0017] FIG. 5 shows details of base frame component also shown in FIG. 2. With frame component standing on a flat surface, FIG. 5-A is an end view; FIG. 5-B an inside view; and FIG. 5-C a top view. Base frame component extends from inside of left frame component to inside of right frame component as shown in FIGS. 2-A and 2-B.

[0018] To simplify illustrations, remaining drawings feature triangular truss panels 1-A and 1-C although similar principles apply equally to truss frames 2-A and 2-B.

[0019] FIGS. 6 through FIG. 9 show plan view examples of how complete face up truss panels 1-A adjoin reversed truss panels 1-C to form a multitude of roof truss panel shapes.

[0020] FIGS. 10 through FIG. 12 illustrate completed trusses connecting into 3-dimensional roof shapes, as they are used in actual construction. Trusses shown here exhibit vertical faces on all edges, which occurs when they are connected to each other, in the position of their actual use. FIG. 10 shows two face up truss panels 1-A that are are connected left side 3 to right side 4. FIG. 11 shows two reversed truss panels 1-C connected left side 3 to right side 4. In FIG. 12 two reversed trusses are shown connected base 5 to base 5.

[0021] FIGS. 13 through FIG. 16 illustrate square and rectangular buildings and variations thereof made with the same "square" triangular trusses.

[0022] FIG. 17 shows a building made with "hexagon" triangular trusses.

[0023] In FIG. 18 you can see a building made with "octagon" triangular trusses.

[0024] FIG. 19 illustrates one of many hexagonal cluster building we have designed and can build using "hexagon" trusses also used in 17.

SUMMARY

[0025] Triangles used in roof systems of the past have not addressed the value of adding predetermined angles to the edges of the triangles, making them structural interconnecting trusses, that simplify installing roofs on a wide variety of buildings.

[0026] The adding of predetermined angles to create easy to assemble roofs for geometric shapes led to discovering the many design alternatives inherent in connecting matching triangles face up, reversed, and in a combination of the two.

OPERATION OF INVENTION

[0027] Using an elongated piece of solid or sandwiched material, whether 3 feet or 3 inches wide, anyone skilled in the art can mass-produce identical triangular truss panels. The multiple views of a typical triangular roof truss panel shown in FIG. 1 should help to understand how one is made. Side views 1-B and 1-D show that the point and the base of each truss panel are sharply angled. In fact, both the point and base are angled to match the desired roof pitch. To prepare material for this panel, start by cutting parallel bevels onto both edges of material used. To create roof trusses for buildings with a 45° roof slope, cut a 45° bevel on the two edges.

[0028] Triangular roof truss panels should be cut to exacting specifications to fit together well. Use a compound saw or some other tool that will cut precise compound angles. Use stops on the saw or some other type of cutting jig to make sure width of panels is consistent and to produce matching triangles. The following variations use material prepared for a 45° slope, as explained above.

[0029] One embodiment of this invention is a truss panel that builds roofs for square and rectangular buildings and variations thereof. On your cutting device, set the bevel at 30.1° and the miter at 35.3°. After making your first cut, flip material front to back and make your second cut. That second cut produces your first triangular roof panel. Flip material and cut another panel loose; continue to flip and cut until material is exhausted.

[0030] Another embodiment of this invention is a triangular panel that builds octagonal buildings and variations thereon. Just set the bevel to 16.25° and the miter to 15.75°, and follow the cutting and flipping directions above.

[0031] A unique embodiment of this invention is created when both the bevel and the miter is set to 18.2°. Panels resulting from these cuts form into a domed roof for a seven-sided building.

[0032] A bevel of 12° and a miter of 9° will form a roof to a twelve-sided building. A popular embodiment of this invention includes hexagon shaped buildings, and hexagonal clusters. Set the bevel to 21° and the miter at 22° for hexagon forming panels with a 45° slope.

[0033] To make roof truss panels that change the roof slope on the above hexagon (or any other shape roof) to 30°, start by preparing material with a 30° bevel cut on both edges, as explained above when creating 45° slopes. Once material is prepared, change the bevel to 15.5° and the miter to 26.5°, and cut panels.

[0034] To make roof truss panels that change the roof slope to 60°, start by preparing material with a 60° bevel on each edge. A bevel of 26.5° and a miter of 16.5° will produce panels that form octagon roofs with a 60° slope.

[0035] By now it should be obvious that the number of sides to the building and the slope of the roof each truss panel fits are determined by precise cutting of specific bevels and miters to generate the necessary compound angles. In many cases, triangular truss panels created to build a basic
shape, like squares, can be reconfigured to build rectangles, ell shaped houses, and numerous other variations on the basic floor plan.

[0036] The size of the individual trusses can be scaled up and down, without impacting their ability to combine into roof systems. We have build prototypes only one inch wide at the base, and individual triangles sixteen feet tall. When truss size is changed, all dimensions change in relationship to each other, but the various angles stay the same, regardless of size.

[0037] Sometimes it is better to build the trusses as wooden frameworks, attaching plywood sheathing and/or drywall after the truss frames are connected into geometric shapes and installed on the building. Making the trusses as frames shown in FIG. 2 involves some of the angles used in the truss panels above, and some new compound angles. 1x6 inch wood is our preferred material for making side frames of trusses by hand.

[0038] To make side framing members 3-A to 3-C and 4-A to 4-C, start by cutting parallel bevels onto each edge as shown in end views 3-A and 4-A. Bevel varies based on shape of building and roof slope desired. To create roof truss side frames for squares and rectangles with a 45° slope, use a 30.1° bevel. To create truss side frames for octagonal buildings with a 45° slope, use 16.25° for bevel.

[0039] For roof truss frames that form hexagons and hexagonal clusters with a 45° roof slope, use a 21° bevel on truss side frame components. For hexagon truss frames with a 30° slope, use 15.5° bevel on side frame components. For hexagon truss frames with a 30° slope, use 26.5° on side pieces. You may notice that these bevels correspond to one portion of the compound angles used to cut roof truss panels detailed above.

[0040] Once material is properly beveled, use a compound miter saw or other precision cutting tool to cut compound angles. For trusses for square and rectangles with a 45° slope, set the bevel at 90° and the miter at 30° for the top end; change the bevel to 45° and leave the miter at 30° for the base end. For trusses that form octagons and variations thereof with a 45° slope, set the bevel and miter at 45° for the top end but change the bevel to 21° for the base end.

[0041] For trusses for hexagons and hexagonal clusters with a 45° slope, set the bevel to 45° and the miter to 30° for both top and base cuts. To change hexagon roof slope to 30°, set the bevel at 30° and the miter at 25.3°. Remember to use material with the correct edge bevels precut, if you change roof slope.

[0042] Now that material is prepared and compound angles are set to desired settings, set individual stops to maintain consistent lengths in your two side frame components. Cut 1st end of piece one; flip piece over and slide to stop. Make 2nd cut; flip piece over again and slide to stop for other framing member. Repeat this process until material is exhausted. As you can see, end cut of one framing piece is beginning cut of other piece, on so on.

[0043] To make base framing member 5, cut parallel bevels onto both edges of material to match roof slope desired as shown in end view 5-A. 45° slope equals 45° bevel; 30° slope equals 30° bevel. Base frame members 5 must have the same vertical height as side framing members 3 and 4, when all frame components are standing on their beveled edges. Since the bevel is much greater on base members 5, it is wise to start with wider material than that used in the side framing members 3 and 4. 1x8 lumber is our preferred material for making base frame members 5.

[0044] Miter cut on both ends of base 5 changes only if number of sides in polygon is changed. Miter both ends of base framing members 5, using a miter saw or miter box. To make base of truss frames 5 for octagons for any roof slope set miter to 45°. (No compound angle is needed on the ends of these base framing members.) To make base of truss frames for squares and rectangles at any slope, set miter to 22.5°. To make base of truss frames for hexagons and hexagonal clusters, set miter to 30°.

[0045] It is possible to create special truss frames for use along the eaves of the building. On framed trusses it is possible to cut a “bird’s mouth” into side framing components facilitating instulling and attaching the lower trusses onto the wall plates. On steep roof pitches, the face of the base material may be too wide for esthetic appeal. An easy cut can be made to reduce the eave “face” and precut a soffit at the same time.

[0046] Now that the frame components are built, it is necessary to assemble them on a flat surface. As shown in FIG. 2, edge 3 extends from outside the left edge of base member 5 to the apex of the truss. Edge 4 extends from outside the right edge of base member 5 to the inside top of edge 3. Base member 5 fits inside of the two side frame members 3 and 4. Glue and screws are commonly used to connect frame components. One-inch material used in framing members now becomes equivalent to two-inch stock when trusses are joined together along common edges.

[0047] We now turn to combining the trusses to form roof systems. FIGS. 6 through 9 illustrate in plan view some of the 2-dimensional combinations of trusses that are commonly used in our roof systems. Each of the shapes shown becomes a truss panel, when assembled. To combine trusses, start by placing several trusses in front of you with points facing away from you, as shown in FIG. 1-A. These are face up trusses. Flip some trusses over so that some point toward you, as shown in FIG. 1-C. These are reversed trusses.

[0048] The shapes in FIG. 6 show alternate ways one face up truss and one reversed truss fit together. As illustrated in 6, a left edge 3 always connects to a right edge 4; and base 5 always connects to another base 5. Glue and screws are our preferred means to connect wooden truss frames one to another.

[0049] FIG. 7 shows geometric shapes formed by combining three trusses and FIG. 8 illustrates shapes formed out of four trusses. Included in FIG. 8 is shown a “triangle within a triangle” one of the strongest embodiments of this truss system. Note that large triangle in FIG. 8 is identical, except in size, to the smaller triangles. Then, in FIG. 9, note the even larger triangle, still identical except in size. This is how small trusses form into bigger and bigger truss panels. The other geometric shapes illustrated in FIGS. 6 through 9 also get larger by adding rows or columns of trusses.

[0050] FIGS. 10 through 12 illustrate 3-dimensional combinations of two trusses. In FIG. 10, two face up trusses 1-A
are combined left side 3 to right side 4. This creates a roof section with a peak 20; eaves 21; and a hip roof 22.

In FIG. 11 two reversed trusses 1-C are connected left side 3 to right side 4. This creates a roof section with two ridgepoles 23; eaves 21; and a valley 24.

FIG. 12 shows two reversed trusses connected base 5 to base 5. This creates a roof section with both sides of a ridgepole 23. All 3-dimensional illustrations of FIGS. 10 through 12 include facets on surfaces on each panel that extend vertically, enabling triangular roof trusses to distribute load axially to the top of the walls, where it exerts a vertical load. This is important, as these triangular based roof systems do not push the walls outward.

FIGS. 13 through 16 show how plan view geometrically shaped truss panels shown in FIGS. 6 through 9 combine with 3-dimensional shapes shown in FIGS. 10 through 12 to create complete roof systems for square and rectangular buildings, and variations thereon.

Combine four face up trusses designed for square buildings left side 3 to right side 4 to create a standing square hip roof shown in FIG. 13. Trusses form a roof replete with peak, eaves, and hips. FIG. 13-A is an overhead view; FIG. 13-B is the square building.

To form a rectangular roof from the square hip roof in FIG. 13, remove one triangular truss. Replace the missing truss with two reversed trusses as introduced in FIG. 12, joined base 5 to base 5. Add three more face up trusses to complete the hip roof and you get the rectangular building shown in FIG. 14. FIG. 14-A is an overhead view; FIG. 14-B a 3-dimensional illustration of the rectangular building.

To create the building in FIG. 15, remove one side truss from the rectangular roof in FIG. 14 and replace it with two more reversed trusses from FIG. 12, joined base to base. This forms a valley. Add three more face up trusses to complete the ell shaped building. In FIG. 15-A, the overhead view shows the twelve trusses that configure the roof; FIG. 15-B illustrates the ell shaped home.

FIG. 16 illustrates using two of the large triangular truss panels of FIG. 8 and two of the large oblong truss panels of FIG. 9, and combining them to create a roof out of four large truss panels. FIG. 16-A shows the twenty-four trusses that combine to make up this roof; FIG. 16-B illustrates the resulting large rectangular home. "Square" trusses shown in FIGS. 13 through 16 can be formed in numerous additional square and rectangular building variations.

In FIG. 17, we combined six "hexagon trusses" left side 3 to right side 4 and they create a domed roof to a single hexagon. FIG. 17-A is an overhead view; FIG. 17-B shows the hexagonal building. It is possible to remove two adjacent trusses from a hexagon; reinstall those trusses reversed as in FIG. 12, and you extend the length of the hexagon. Add additional pairs of reversed trusses and a whole realm of design possibilities starts to open up.

FIG. 18 shows combining eight "octagon" trusses left side 3 to right side 4, and they create a domed roof to an octagon. FIG. 18-A is an overhead view; FIG. 18-B is an illustration of the building resulting. If you were to remove three adjacent trusses, then to reinstall two of them in the reversed fashion of FIG. 12, it becomes possible to extend the length of the octagon. Add additional pairs of reversed trusses, and octagons can be designed with flowing bends and corners.

FIG. 19 is a simple example of some of the expansions of which the hexagon in FIG. 17 is capable. FIG. 19-A is an overhead view; FIG. 19-B illustrates a two-story version of the resulting building. We have designed numerous variations of hexagon clusters, using miniatures of our "hexagon" truss panels.

We can create roofs for buildings of almost any geometric shape or size. If we created a ten-sided building, we could extend its length by removing four adjacent trusses and installing a pair of reversed trusses as shown in FIG. 12.

If we wanted to extend a twelve-sided building, we would remove five adjacent trusses, and so on. This capability also allows for easy installation of dormers and overhangs that fit together like the parts of a jigsaw puzzle. We can even produce specialized triangular trusses, that allow for gable ends on square and rectangular buildings; or that serve to transition roofs of different geometric shapes. In other words, we can connect the roofs on square buildings to hexagonal buildings, octagons to hexagons, octagons to squares, and many others.

CONCLUSION, RAMIFICATIONS, AND SCOPE OF INVENTION

Throughout these examples we have used sawn lumber as the construction material, as it was readily available for experimentation and development. Wooden triangular roof trusses would be made most efficiently out of engineered wood. Another version is creating 3-dimensional triangular structural insulated panels. Triangular roof trusses can also be made by cutting flat sheet metal to correct angles, folding and welding some. Miniature trusses have already been made out of plastic, and they make a great design tool and toy.

Alternative connection systems are also important to this product. The sawn lumber examples referenced are connected to each other using construction adhesive and screws. Tongue and groove connectors work well, because of the consistent way the panels interconnect. Panels manufactured as SIPs need some type of wooden or hardware connectors, to make up for lack of access to the trusses’ framework in this embodiment. Our miniature panels that we may market as design tools or toys are connected with embedded magnets.

Summary: Triangular roof trusses may be used on many building designs, including but not limited to squares, rectangles, hexagons, octagons, and even seven-sided buildings. Trusses can be built to whatever scale and roof slope is needed. Many materials can be used for prefabricating trusses. Geometric shapes formed by combining individual truss panels are truss panels themselves.

Each of the truss panels created for even-sided geometric shapes can also construct other variations on the original shape. Truss panels in assorted combinations create flat (planar) panels, domed roofs, hips, valleys, eaves, ridgepoles, dormers and overhangs.

Builders should be able to enclose homes faster, create stronger, more damage-resistant structures, and efficiently incorporate a multitude of new designs into day-to-day construction.
Our vertical triangle-based framing should transfer roof loads axially to the top of walls, exerting a primarily vertical force on load bearing walls, and eliminating the need for retaining rings, perimeter cables, and other structural support elements needed for previous triangle based roof systems.

I claim:

1. A scaleable 3-dimensional triangular roof truss panel comprising:
   a. planar top and bottom surfaces of a matching size,
   b. two sides, cut at predetermined angles on ends and edges, the face of whose edges are vertical when installed,
   c. a base, cut at predetermined angles on ends and edges, whereby stronger roofs can be installed more quickly on houses.

2. A scaleable 3-dimensional triangular roof truss frame comprising:
   a. two side frame members, cut at predetermined angles, the face of whose edges are vertical when installed,
   b. a base frame member, cut at predetermined angles means for attaching said frame members to each other, whereby stronger roof frames can be installed more quickly on houses.

3. A multiplicity of 3-dimensional roof truss, comprising:
   a. two or more triangular roof truss triangles,
   b. means to connect said trusses to each other, whereby entire roofs can be installed quickly in large sections.