typically connected into a flat grid on the ground, and then gradually erected into shape by pushing in the supporting edges on site. This requires space and supporting ground, setting constraints on where such structures can be built. The continuity of the members further restricts the kinds of line networks that can be used in this method. For example, the method is not suitable for line networks composed of irregular n-gons. There are also important constraints in the erection of such gridshells.

In another method as shown in FIG. 17, the gridshell curvature is achieved through the use of curved structural beams with uniquely cut edges for joining with other curved structural beams. In this method, the curved structural beams typically require 3D fabrication, which can be costly and restrictive.

A need therefore exists to provide a grid structure which will overcome at least some of the limitations of the above conventional methods.

SUMMARY

According to one aspect, there is provided a grid structure formed from a plurality of building blocks, the grid structure comprising: a plurality of flat panels, wherein two of the plurality of flat panels are paired in parallel to have one of the two parallel flat panels provide an inner surface to one building block from the plurality of building blocks and the other of the two parallel flat panels provide an inner surface to another building block from the plurality of building blocks, wherein within each of the plurality of building blocks, inner surfaces of the building block provided by any two adjacent panels lie on planes that intersect along a straight line, defined by edges of the two adjacent panels, that passes through an inner corner of the building block, wherein at a location where corners of two or more of the plurality of building blocks meet, the straight lines that pass through the inner corners of adjacent building blocks each lie on axes that have different angles to one another, wherein within at least two of the plurality of flat panels that are paired, the edges of the paired flat panels which are closest each lie on axes that have different angles to one another.

According to another aspect, there is provided a method for determining geometry of a flat panel, wherein two of a plurality of flat panels are paired in parallel to have one of the two parallel flat panels provide an inner surface to one building block from a plurality of building blocks of a grid structure and the other of the two parallel flat panels provide an inner surface to another building block

from the plurality of building blocks of the grid structure, the method comprising: obtaining a line network representation of the grid structure, the line network comprising a plurality of nodes where adjacent nodes are connected by an edge, wherein a line representation of each of the building blocks is formed by three or more edges connected in a loop; determining a normal for each of the edges; constructing a plane for each of the edges, wherein the normal of the edge and the edge lie on the plane; offsetting the plane inward of the loop, the offset being along an axis that is perpendicular to the plane, wherein the offset plane is used to construct the inner surface of the flat panel, the inner surface facing inward of the loop; and determining a straight line along which the offset planes intersect, wherein two of the inner surfaces of two of the adjacent flat panels from the same loop lie on the offset planes, wherein the straight line passes through an inner corner of each of the plurality of building blocks, wherein at a location where the corners of two or more of the plurality of building blocks meet, the straight lines that pass through the inner corners of adjacent building blocks each lie on axes that have different angles to one another.

According to yet another aspect, there is provided a method for constructing a grid structure formed from a plurality of building blocks, the method comprising: forming the plurality of building blocks by having, within each of the plurality of building blocks, two inner surfaces of any two adjacent panels lie on planes intersecting along a straight line that passes through an inner corner of the building block; and joining the plurality of building blocks by pairing two of a plurality of flat panels, each from a different building block, in parallel, to have one of the two parallel flat panels provide an inner surface to one building block from the plurality of building blocks and the other of the two parallel flat panels provide an inner surface to another building block from the plurality of building blocks, wherein at a location where the corners of two or more of the plurality of building blocks meet, the straight lines defined by edges of the two adjacent panels that pass through the inner corners of adjacent building blocks each lie on axes that have different angles to one another, wherein within at least two of the plurality of flat panels that are paired, adjacent edges of the flat panels each lie on axes that have different angles to one another, and wherein within at least two of the plurality of flat panels that are paired, the edges of the paired flat panels which are closest each lie on axes that have different angles to one another.

Herein disclosed is a grid structure formed from a plurality of building blocks, the grid structure comprising: a plurality of flat panels, wherein two of the plurality of flat panels are paired in parallel to have one of the two parallel flat panels provide an inner surface to one building block from the plurality of building blocks and the other of the two parallel flat panels provide an inner surface to another building block from the plurality of building blocks, wherein within each of the plurality of building blocks, the inner surfaces of any two adjacent panels lie on planes intersecting along a straight line that passes through an inner corner of the building block.

BRIEF DESCRIPTION OF THE DRAWINGS

Example embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention, in which:

FIGs 1A and 1B respectively show a perspective view and a top view of a grid structure 100 according to a first embodiment.

CLAIMS

1. A grid structure formed from a plurality of building blocks, the grid structure comprising:

a plurality of flat panels, wherein two of the plurality of flat panels are paired in parallel to have one of the two parallel flat panels provide an inner surface to one building block from the plurality of building blocks and the other of the two parallel flat panels provide an inner surface to another building block from the plurality of building blocks,

wherein within each of the plurality of building blocks, inner surfaces of the building block provided by any two adjacent panels lie on planes that intersect along a straight line, defined by edges of the two adjacent panels, that passes through an inner corner of the building block,

wherein at a location where corners of two or more of the plurality of building blocks meet, the straight lines that pass through the inner corners of adjacent building blocks each lie on axes that have different angles to one another,

wherein within at least two of the plurality of flat panels that are paired, the edges of the paired flat panels which are closest each lie on axes that have different angles to one another.

2. The grid structure of claim 1, wherein the plurality of building blocks comprises different polygonal structures.

3. The grid structure of claim 2, wherein the polygonal structures comprises any one or more of the following shapes: triangular, quadrilateral, pentagonal and hexagonal.

4. The grid structure of claim 1, wherein two opposite edges of each of the plurality of building blocks that connect two corners of each of the plurality of building blocks are parallel.

5. The grid structure of claim 1, wherein each of two opposite edges of each of the plurality of building blocks that connect two corners of each of the plurality of building blocks are curved or straight.

6. The grid structure of claim 1, wherein the perimeter of each of the plurality of flat panels is derived from a perpendicular cut.

7. The grid structure of claim 1, wherein the two parallel flat panels are connected by a spacer disposed between the two parallel flat panels.

8. The grid structure of claim 1, wherein the two parallel flat panels are directly connected.

9. The grid structure of claim 1, wherein the grid structure is a gridshell.

10. The grid structure of claim 1, wherein the two flat panels, providing the two inner surfaces that lie on planes intersecting along a straight line that passes through the inner corner of the building block, are coupled together by a linear joint selected from a group comprising a hinge, a weld, a fold, an adhesive, and a fastener.

11. A method for determining geometry of a flat panel, wherein two of a plurality of flat panels are paired in parallel to have one of the two parallel flat panels provide an inner surface to one building block from a plurality of building blocks of a grid structure and the other of the two parallel flat panels provide an inner surface to another building block from the plurality of building blocks of the grid structure, the method comprising:

obtaining a line network representation of the grid structure, the line network comprising a plurality of nodes where adjacent nodes are connected by an edge, wherein a line representation of each of the building blocks is formed by three or more edges connected in a loop;

determining a normal for each of the edges;

constructing a plane for each of the edges, wherein the normal of the edge and the edge lie on the plane;

offsetting the plane inward of the loop, the offset being along an axis that is perpendicular to the plane, wherein the offset plane is used to construct the inner surface of the flat panel, the inner surface facing inward of the loop; and

determining a straight line along which the offset planes intersect, wherein two of the inner surfaces of two of the adjacent flat panels from the same loop lie

on the offset planes, wherein the straight line passes through an inner corner of each of the plurality of building blocks,

wherein at a location where the corners of two or more of the plurality of building blocks meet, the straight lines that pass through the inner corners of adjacent building blocks each lie on axes that have different angles to one another.

12. The method of claim 11, wherein the step of offsetting the plane further comprises determining an amount to offset by taking into consideration the thickness of the flat panel and the gap between the two parallel flat panels.

13. The method of claim 11, wherein the step of determining a normal for each of the edges further comprises the step of:

determining node normals on both ends of each of the edges based on a surface curvature of the grid structure; and

obtaining the edge normal by averaging the node normal on both ends of each of the edges.

14. The method of claim 11, further comprising the step of extruding the surface of the flat panel in a direction outward of the loop by the desired thickness of the flat panel to obtain a three dimensional geometry representation of the flat panel.

15. A method for constructing a grid structure formed from a plurality of building blocks, the method comprising:

forming the plurality of building blocks by having, within each of the plurality of building blocks, two inner surfaces of any two adjacent panels lie on planes intersecting along a straight line that passes through an inner corner of the building block; and

joining the plurality of building blocks by pairing two of a plurality of flat panels, each from a different building block, in parallel, to have one of the two parallel flat panels provide an inner surface to one building block from the plurality of building blocks and the other of the two parallel flat panels provide an inner surface to another building block from the plurality of building blocks,

wherein at a location where the corners of two or more of the plurality of building blocks meet, the straight lines defined by edges of the two adjacent

panels that pass through the inner corners of adjacent building blocks each lie on axes that have different angles to one another,

wherein within at least two of the plurality of flat panels that are paired, adjacent edges of the flat panels each lie on axes that have different angles to one another, and

wherein within at least two of the plurality of flat panels that are paired, the edges of the paired flat panels which are closest each lie on axes that have different angles to one another.

16. The method of claim 15 further comprising:

determining the geometry of each of the plurality of the flat panels; and

cutting sheet material perpendicularly to obtain the flat panels.

17. The method of claim 16, wherein the step of determining the geometry of the flat panel further comprises

obtaining a line network representation of the grid structure, the line network comprising a plurality of nodes where adjacent nodes are connected by an edge, wherein a line representation of each of the building blocks is formed by three or more edges connected in a loop;

determining a normal for each of the edges;

constructing a plane for each of the edges, wherein the normal of the edge and the edge lie on the plane; and

offsetting the plane inward of the loop, the offset being along an axis that is perpendicular to the plane, wherein the offset plane is used to construct the inner surface of the flat panel, the inner surface facing inward of the loop,

wherein each of the straight lines that pass through the inner corners of adjacent building blocks is formed by determining, within two of the inner surfaces of two of the adjacent flat panels from the same loop that lie on the offset planes, a straight line along which the offset planes intersect.

18. The method of claim 15, wherein the step of forming the plurality of building blocks by having, within each of the plurality of building blocks, two of the inner surfaces of any two adjacent panels lie on planes intersecting along the straight line that passes through the inner corner of the building block further comprises coupling the two flat panels, that provide the two inner surfaces, using

a joint selected from a group comprising a hinge, a weld, a fold, an adhesive, and a fastener.

19. The method of claim 15, wherein the step of joining the plurality of building blocks by pairing two of the plurality of flat panels in parallel further comprises disposing a spacer between the two parallel flat panels.

20. The method of claim 15, wherein the step of joining the plurality of building blocks by pairing two of the plurality of flat panels in parallel further comprises directly connecting the two parallel flat panels.