EARTHQUAKE RESISTANT HOUSE

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ABSTRACT

An earthquake resistant structure includes a structure base assembly and a building structure positioned on the structure base assembly. The earthquake resistant structure includes a base isolation assembly which carries the building structure and structure base assembly, wherein the base isolation assembly includes a movement member and horizontal dampening member which allow the building structure and structure base assembly to move in response to an applied force, such as from an earthquake.
FIG. 1b
FIG. 2a
FIG. 2b
FIG. 5

130

113

134a

134b

134c

134d

136
EARTHQUAKE RESISTANT HOUSE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 60/949,613 filed on Jul. 13, 2007, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] This invention relates generally to buildings and, more particularly, to buildings designed to be resistant to earthquakes.
[0004] 2. Description of the Related Art
[0005] Particular geographical areas are known to suffer from earthquakes. Generally, earthquake-prone areas are near a geological fault on the earth’s tectonic plates. For example, in the United States, California is prone to earthquakes because it runs along the San Andreas fault. The damage to buildings from earthquakes is costly and it is inconvenient and time consuming to rebuild. Additionally, people are often injured from total or partial collapse of a building and from falling pieces of the building during an earthquake.

[0006] To reduce earthquake injuries and building damage, people have used many different types of earthquake-resistant structures and construction techniques. For example, passive damping construction techniques may be used to absorb shaking energy within a building during an earthquake. Passive damping includes using building materials that deform, but will not break during an earthquake. Diagonal bracing is used to resist the shearing forces from the sway of a building. However, these techniques may limit the materials and designs used for a building structure. For example, it is difficult to determine the amount of deformation that can be allowed in a building material, because using a material with too much deformation can affect the strength of a building’s structure. Additionally, a building design with too much diagonal bracing may not be aesthetically appealing to a building owner, or may limit the use of other standard materials during the building construction. Thus, there is a need for an earthquake-resistant building structure that absorbs the shaking from an earthquake while allowing the use of standard building materials and designs.

BRIEF SUMMARY OF THE INVENTION

[0007] The present invention provides an earthquake resistant structure, which includes a structure base assembly and a building structure positioned on the structure base assembly. The earthquake resistant structure includes a base isolation assembly, which carries the building structure and structure base assembly, wherein the base isolation assembly includes a movement member and horizontal dampening member which allow the building structure and structure base assembly to move in response to applied force. In some embodiments, the movement member is a spherical ball and in some embodiments, the horizontal dampening member is a spring. The spring is compressed and decompressed in response to movement of the movement member. The base isolation assembly can include a cell which contains the movement member.

[0008] The present invention provides an earthquake resistant structure, which includes a structure base assembly having a plurality of interior and exterior walls connected together to form a plurality of volumes and a building structure positioned on the structure base assembly. The earthquake resistant structure includes a base isolation assembly, which carries the building structure and structure base assembly. The base isolation assembly includes a plurality of movement assemblies positioned in a corresponding volume, each movement assembly including a support grid and a plurality of movement members and a plurality of dampening assemblies, each dampening assembly including a plate which carries a plurality of vertical dampening members.

[0009] Further features and advantages of the invention will be apparent to those skilled in the art from the following detailed description, taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1a is a top perspective view of an earthquake-resistant structure, in accordance with the invention.
[0011] FIG. 1b is a top perspective view of a structure base assembly and base isolation assembly, in accordance with the invention, included in the earthquake resistant structure of FIG. 1a.
[0012] FIGS. 2a and 2b are a top perspective view and a bottom view of a structure base assembly, in accordance with the invention, included in the earthquake resistant structure of FIG. 1a.
[0013] FIGS. 3a and 3b are top perspective views of a dampening assembly and a movement assembly, respectively, in accordance with the invention.
[0014] FIG. 3c is a sectional top view of movement assembly 111, in accordance with the invention.
[0015] FIG. 3d is a cutout view of movement assembly, taken along line 117 in FIG. 3c, in accordance with the invention.
[0016] FIGS. 4a and 4b are a top perspective view and a bottom view of a middle plate assembly, in accordance with the invention, included in the base isolation assembly of FIGS. 1a and 1b.
[0017] FIG. 5 is a top perspective view of a bottom plate assembly, in accordance with the invention, included in the base isolation assembly of FIGS. 1a and 1b.
[0018] FIGS. 6a and 6b are a sectional side view and an exploded sectional side view, respectively, of structure base assembly and base isolation assembly, as viewed from line on FIG. 1a, in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] FIG. 1a is a top front perspective view of an earthquake resistant structure 100, in accordance with the invention. Earthquake resistant structure 100 includes a building structure 101 positioned on a structure base assembly 102, wherein building structure 101 and the structure base assembly 102 are both carried by a base isolation assembly 103. Base isolation assembly 103 is positioned on the ground or another stationary object. In accordance with the invention, the building structure 101 and structure base assembly 102 are moveable in relation to base isolation assembly 103, as described in more detail below. In this way, building structure 101 and structure base assembly 102 are moveable relative to base isolation assembly 103 in response to an earthquake. Hence, building structure 101 and structure base assembly 102 are moveable relative to the ground.
[0020] During an earthquake, the forces and movement from the shaking of the earth are transmitted to base isolation assembly 103. Hence, base isolation assembly 103 will shake and transmit forces and movement to building structure 101 and base 102. These forces and movement can damage building structure 101 and cause harm to the people and valuables contained therein. In accordance with the invention, base isolation assembly 103 includes movement members to allow movement of base isolation assembly 103 relative to base 102 and building structure 101. Isolation assembly 103 also includes dampening members to reduce the forces transmitted from base isolation assembly 103 to base 102 and building structure 101. By allowing base isolation assembly 103 to move relative to and by reducing the forces transmitted to base 102 and building structure 101, this reduces the likelihood that building structure 101 will be damaged by the earthquake and provides better protection for the people and valuables in structure 101. This feature will be discussed in more detail below.

[0021] FIGS. 2a and 2b are front perspective and bottom views, respectively, of structure base assembly 102. Structure base assembly 102 includes a house plate 105 that supports and is connected to structure 101. House plate 105 can be of many types, but here it is a single flat surface and rectangular. Structure base assembly 102 includes upper carrier 108 positioned on the bottom of plate 105. Upper carrier 108 includes exterior walls 107a, 107b, 107c, 107d, and interior walls 107e, 107f, 107g, 107h, and 107i. Walls 107a-i are positioned to define bottom surfaces 105a, 105b, 105c, 105d, 105e, and 105f of plate 105. Surfaces 105a-f can be of many types. In this embodiment, they consist of four substantially square surfaces (105a, c, d, and f) and two rectangular surfaces (105b and 105e). Volumes 106a, 106b, 106c, 106d, 106e, and 106f are bounded by walls 107a-i and bottom surfaces 105a-f, as shown in FIG. 2a. For example, volume 106a is bounded by walls 107a, 107e, 107i, and 107j, and surface 105a. Upper carrier 108 also includes a dampening assemblies 110a-f and a movement assemblies 111a-f (see FIGS. 1a, 1b, and 1c). Volumes 106a-f of upper carrier 108 are provided to contain the dampening assemblies 110a-f and movement assemblies 111a-f, as will be discussed presently.

[0022] FIG. 3a is a perspective view of a dampening assembly 110 in accordance with the invention. Dampening assembly 110 includes dampening members 113a-d connected to plate 112, in accordance with the invention. Dampening members 113a-d can be of many types, such as a plurality of oil shocks, but here they are springs vertically positioned on the corners of plate 112. Dampening assembly 110 can be of many sizes and shapes, such as those embodied as dampening assemblies 110a-110f (FIG. 1b). In this embodiment, dampening assemblies 110a, 110c, 110d, and 110f are substantially square and are dimensioned to be contained within volumes 106a, 106c, 106d, and 106f, respectively, and dampening assemblies 110b and 110e are rectangular and are sized to be contained within volumes 106b and 106e, respectively.

[0023] FIG. 3b is a perspective view of a movement assembly 111, respectively, in accordance with the invention. Movement assembly 111 includes a plurality of movement members 114 contained by a support grid 115. Movement members 114 are contained by grid 115 through a plurality of cells 116. Movement members 114 can be positioned in cells 116 in many different ways. In this embodiment, movement members 114 are positioned within every other cell 116 of grid 115 and are offset between rows, as shown in FIG. 3b. The width W of cells 116 is greater than the diameter D of movement members 114, as shown in the sectional top view of movement assembly 111 in FIG. 3c. The width W of cells 116 and diameter D of movement members 114 are sized to allow movement members 114 to rotate while being contained within cells 116. Further, the height H of cells 116 and grid 115 is less than the diameter of movement members 114 as viewed along line 117 and shown in cross sectional side view FIG. 3d. The height H of cells 116 and grid 115 is less than the diameter of movement members 114 to allow the movement members 114 to roll freely when movement assembly 111 is positioned between dampening assembly 110 and middle plate assembly 120 or between middle plate assembly 120 and bottom plate assembly 130, as discussed in more detail below.

[0024] Movement assembly 111 can be of many sizes and shapes, such as those embodied as 111a-f (discussed above) and 111g (discussed further below). In this embodiment, movement assemblies 111a, 111c, 111d, and 111f are substantially square and are contained within volumes 106a, 106c, 106d, and 106f, respectively, and movement assemblies 111b and 111e are rectangular and are contained within volumes 106b and 106e, respectively. Movement assembly 111g is contained within bottom container 123 of middle plate assembly 120, as will be discussed presently.

[0025] FIGS. 4a and 4b are perspective and bottom views of a middle plate assembly 120, respectively, in accordance with the invention. Middle plate assembly 120 includes upper container walls 124a-d positioned on the top of a middle plate 122. Upper container walls 124a-d are positioned to contain a middle plate top surface 126 on the top of plate 122. Middle plate assembly also includes dampening members 128 connected to upper container walls 124a-d. Dampening members 128 can be of many types and can be connected to upper container walls 124a-d in many ways. In this embodiment, dampening members 128 are four springs with one end connected to and extending along the interior side of each of opposing walls 124a and 124e; and three springs with one end connected to and extending along the interior side of each of opposing walls 124b and 124d. In this way, dampening members 128 are connected along the length and interior side of walls 124a-d and are positioned to extend roughly perpendicularly from the interior surface of the walls. Middle plate assembly 120 also includes an upper container volume 121 bounded by upper container walls 124a-d and middle plate top surface 126. Volume 121 and dampening members 128 are dimensioned to contain upper carrier 108 within volume 121, as discussed further below (FIGS. 6a and 6b).

[0026] Middle plate assembly 120 also includes a lower carrier 129. Lower carrier 129 includes a lower container walls 125a-d, a middle plate bottom surface 127, and a lower container volume 123. Lower container walls 125a-d are positioned on the bottom of middle plate 122 to contain bottom surface 127 on the bottom of plate 122. Lower container volume 123 is bounded by lower container walls 125a-d and bottom surface 127. Lower carrier 129 also includes movement assembly 111g (not shown), which is contained within volume 123 (FIGS. 6a and 6b).

[0027] FIG. 5 is a perspective view of a bottom plate assembly 130, in accordance with the invention. Bottom plate assembly 130 includes container walls 134a-d positioned on the top of a bottom plate 132. Plate 132 can be of many shapes, but in this embodiment, it is rectangular and extends beyond container walls 134a-d. Container walls 134a-d are
positioned to contain a plate surface 136 on the top of plate 132. Bottom plate assembly 130 includes a container volume 131 bounded by upper container walls 134a-d and plate surface 136. Middle plate assembly also includes dampening members 128 connected to upper container walls 134a-d. Dampering members 128 can be of many types and can be connected to upper container walls 134a-d in many ways. In this embodiment, dampening members 128 are connected to and positioned along walls 134a-d similarly to the position of members 128 along walls 124a-d in middle plate assembly 120 discussed above.

[0028] FIGS. 6a and 6b are a sectional side view and an exploded sectional side view, respectively, of structure base assembly 102 and base isolation assembly 103, as viewed from line 140 on FIG. 1a, in accordance with the invention. In operation, damping assembly 110a and movement assembly 111a are contained within volume 106a of upper carrier 108, and upper carrier 108 is contained within volume 121 of middle plate assembly 120. The distal ends of dampening members 113a-d are in contact with surface 105a. In some embodiments, dampening members 113a-d are connected to surface 105a.

[0029] In accordance with the invention, movement members 114 of movement assembly 111a are in rolling contact with and positioned between the bottom surface of plate 112 on damping assembly 110a and the surface of middle plate assembly 120. Damping assembly 110a and movement assembly 111a are dimensioned to allow their movement within volume 106a in direction 160. Damping assembly 110a and movement assembly 111a are dimensioned to restrict and allow their movement, respectively, within volume 106a in direction 150 (as shown), and in direction 170 (FIG. 1b). It should be noted that damping assemblies 110b-f and movement assemblies 111b-f operate similarly within volumes 106b-f, respectively, of upper carrier 108.

[0030] Upper carrier 108 of structure base assembly 102 is contained within volume 121 of middle plate assembly 120, with horizontal dampening members 128 positioned therebetween. For example, damping member 128 is positioned between the exterior portion of wall 107a-d and the interior portion of wall 124a-d as shown. Similarly, damping members 128 are positioned between the exterior of walls 107a-c and the interior of walls 124a-c, respectively (not shown). In addition to one end of dampening member 118 being attached to the interior of walls 124a-d (discussed above), in some embodiments, the opposing ends of dampening members 128 are connected to the exterior of walls 107a-d of upper carrier 108.

[0031] In this way, movement assembly 111a and dampening assembly 110a allow middle plate assembly 120 to move in directions 150, 160 and 170 relative to structure base assembly 102. When middle plate assembly 120 moves relative to structure base assembly 102 in direction 160, dampening members 113a-d extend or compress, and thus reduce the forces and movement transferred from middle plate assembly 120 to structure base assembly 102 in direction 170.

[0032] In accordance with the invention, movement assembly 111g is contained within volume 123 of lower carrier 129, and lower carrier 129 is contained within volume 131 of bottom plate assembly 130. In this way, movement members 114 of movement assembly 111g are in rolling contact with and positioned between surface 127 of lower carrier 129 on middle plate assembly 120 and the surface 136 of bottom plate assembly 130. Movement assembly 111g is dimensioned to allow its movement within volume 131 in directions 170 (FIG. 1b) and 150.

[0033] Lower carrier 129 of middle plate assembly 120 is contained within volume 131 of bottom plate assembly 130, with horizontal dampening members 128 positioned therebetween. For example, damping member 128 is positioned between the exterior portion of wall 125a-d and the interior portion of wall 134a-d as shown. Similarly, damping members 128 are positioned between the exterior of walls 125a-c and the interior of walls 134a-c, respectively (not shown). In addition to one end of dampening member 118 being attached to the interior of walls 134a-d (discussed above), in some embodiments, the opposing ends of dampening members 128 are connected to the exterior of walls 125a-d of lower carrier 129.

[0034] In this way, movement assembly 111g allows bottom plate assembly 130 to move in directions 150, 160 and 170 relative to middle plate assembly 120. When bottom plate assembly 130 moves relative to middle plate assembly 120 in direction 150, dampening members 128 extend or compress, and thus reduce the forces and movement transferred from bottom plate assembly 130 to middle plate assembly 120 in direction 150. Additionally, when bottom plate assembly 130 moves relative to middle plate assembly 120 in direction 170, dampening members 128 extend or compress, and thus reduce the forces and movement transferred from bottom plate assembly 130 to middle plate assembly 120 in direction 170.

[0035] The embodiments and examples set forth herein were presented in order to best explain the present invention and its practical application and to thereby enable those of ordinary skill in the art to make and use the invention. However, those of ordinary skill in the art will recognize that the foregoing description and examples have been presented for the purposes of illustration and example only. The description as set forth is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the teachings above without departing from the spirit and scope of the forthcoming claims.

1. An earthquake resistant structure, comprising:
   a structure base assembly;
   a building structure positioned on the structure base assembly;
   and
   a base isolation assembly, which carries the building structure and structure base assembly, wherein the base isolation assembly includes a movement member and horizontal dampening member which allow the building structure and structure base assembly to move in response to an applied force.

2. The structure of claim 1, wherein the movement member is a spherical ball.
3. The structure of claim 1, wherein the base isolation assembly includes a cell which contains the movement member.

4. The structure of claim 2, wherein the horizontal dampening member is a spring.

5. The structure of claim 4, wherein the spring is compressed and decompressed in response to movement of the movement member.

6. The structure of claim 1, further including a dampening assembly which includes a plate and vertical dampening member.

7. An earthquake resistant structure, comprising:
a structure base assembly which includes a plurality of interior and exterior walls connected together to form a plurality of volumes;
a building structure positioned on the structure base assembly; and

a base isolation assembly, which carries the building structure and structure base assembly, wherein the base isolation assembly includes

a plurality of movement assemblies positioned in a corresponding volume, each movement assembly including a support grid and a plurality of movement members; and

a plurality of dampening assemblies, each dampening assembly including a plate which carries a plurality of vertical dampening members.

8. The structure of claim 7, wherein the movement members are spherical balls.

9. The structure of claim 7, wherein the dampening members are springs.

10. The structure of claim 7, wherein the horizontal dampening member is a spring.

11. The structure of claim 7, further including a middle plate assembly which includes a middle plate and upwardly and downwardly extending walls, and a horizontal spring extending from the upwardly extending wall.

12. The structure of claim 11, wherein the middle plate assembly carries a movement assembly, wherein the movement assembly is engaged with the spring of the middle plate assembly.

13. The structure of claim 7, further including a bottom plate assembly which includes a bottom plate and an upwardly extending wall and a horizontal spring extending from the upwardly extending wall.

14. The structure of claim 13, wherein the bottom plate assembly carries a movement assembly, wherein the movement assembly is engaged with the spring of the bottom plate assembly.

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