CURTAIN WALL ANCHOR

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ABSTRACT

The panels and mullions of a curtain wall are attached to the frame of the building enclosed by the curtain wall with anchors which permit the frame to shift horizontally and vertically relative to the curtain wall so that the frame and the curtain wall can experience different degrees of racking. Each anchor includes a base member and a displaceable member located in front of the base member. Both members have keyways and are coupled together with a horizontal key that engages the members at their keyways, allowing the displaceable member to shift horizontally relative to the building frame, but preventing it from pulling away from the base member. Each anchor also has a mullion clamp which is attached firmly to one of the mullions. It has a vertical keyway where it is engaged by a key on the displaceable member, thus permitting vertical displacement of the mullion relative to the building frame.
FIG. 6
CURTAIN WALL ANCHOR

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

BACKGROUND OF THE INVENTION

[0003] This invention relates in general to building cladding materials, such as curtain walls, and more particularly to anchors for curtain walls.

[0004] Many buildings of current construction, particularly commercial buildings, derive no structural support from their exterior walls. These walls simply isolate the interiors of the buildings from the environment outside the buildings and as such are called "curtain walls". The typical curtain wall comprises a multitude of panels arranged side-by-side and in tiers, and mullions separating the side-by-side panels. Indeed, the panels are attached to the mullions with fastening devices which may assume a variety of configurations. To a measure the configuration of a fastening device depends on the nature of the panel that itfastens, and the panels may be formed glass, metal, or even stone, such as granite, and in some cases cast concrete. In addition, the typical curtain wall has anchors which secure the mullions to structural components of the building, whether they be steel girders or columns or cast concrete decks or columns, which components form the frame of building.

[0005] Modern building codes require a measure of flexibility in buildings, and this holds particularly true for the codes in seismic zones such as California. These buildings must be capable of undergoing a swaying motion, called "racking", of as much as 5 inches from floor to floor. In many buildings the frame can withstand more racking than the curtain wall which encloses it, and this holds particularly true for buildings having glazed curtain walls. Indeed, it is not unusual for the frame to rack as much as three or more inches from floor to floor, while the curtain wall has the capacity to rack only one inch from floor to floor. Thus, when the frame shifts, as for example during a seismic event, the curtain wall moves with it until the curtain wall can rack no more. At this point, the continued racking of the frame will damage the curtain wall. The problem is particularly acute for buildings having glazed curtain walls. Building codes require that the glass in such curtain walls remain in place and not crack during racking.

[0006] To be sure, anchors exist for attaching the mullions and panels of a curtain wall to the frame of a building while accommodating differential racking between the frame and the curtain wall, but these anchors tolerate only small differences in racking.

[0007] The typical anchor relies on slotted bolt holes and bolts loosely fitted through such holes to accommodate displacement between the mullions and the building frame. Aside from tolerating only a limited differential in the racking, the bolts tend to bind in the slotted holes, and when this occurs the anchors tolerate even less differential racking. Moreover, the anchors are usually custom designed and fabricated specifically for the buildings on which they are installed.

SUMMARY OF THE INVENTION

[0008] The present invention resides in a curtain wall anchor that includes a base member adapted to be attached to the frame of a building, a displaceable member coupled to the base member such that it can shift along a first axis relative to the base member, and an attachment member coupled to the displaceable member such that it can shift along a second axis relative to the displaceable member. The invention also resides in the anchor mounted on a building frame at its base member and coupled to curtain wall components at its attachment member. The invention further resides in an anchor having a base member mounted on a building frame and a displaceable member coupled to the base member through a key and keyway such that the displaceable member can shift horizontally relative to the base member, and wherein the displaceable member is coupled to a mullion in a curtain wall.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0009] FIG. 1 is a fragmentary elevational of a building provided with a curtain wall attached to the frame of the building with anchors constructed in accordance with an embodying the present invention, with the curtain wall being broken away to show the frame of the building;

[0010] FIG. 2 is a fragmentary sectional view of a building provided with a curtain wall attached with anchors constructed in accordance with an embodying the present invention;

[0011] FIG. 3 is a plan view of an anchor taken along line 3-3 of FIG. 2;

[0012] FIG. 4 is a sectional view of the anchor taken along line 4-4 of FIG. 3;

[0013] FIG. 5 is a perspective view of the anchor attached to a mullion; and

[0014] FIG. 6 is a fragmentary perspective view of the anchor showing its back face.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring now to the drawings, a building has a structural frame A (FIGS. 1 & 2) and a cladding system, called a curtain wall B, which encloses the frame A to isolate the interior of the building. Typically, the building has multiple stories, and the frame A extends through all of the stories. During seismic events, the frame A will move or rack in the sense that its upper regions will displace horizontally relative to its lower regions. The side-to-side displacement could amount to as much as 2% of the vertical height of the frame A. The curtain wall B follows this movement and undergoes racking itself, but its capacity to rack is not as great as that of the frame A.

[0016] Structural steel better withstands flexures that poured concrete, so preferably the frame A, where seismic events are expected, is fabricated from structural steel. The frame A includes (FIGS. 1 & 2) steel columns 2 and girders...
4 spanning the spaces between the columns 2. It also has brackets 6 which are welded to the columns 2 and girders 4 to provide vertical mounting surfaces to which the curtain wall B is attached. Even so, the curtain wall B is well-suited for use on frames of other construction, such as poured concrete. Such frames likewise have columns and also have decks supported by the columns. Both can be fitted with the brackets 6 or otherwise provided with vertical surfaces for attachment of the curtain wall B.

[0017] The curtain wall B includes (FIG. 1) panels 12, which actually enclose the sides of the exterior of the building, and mullions 14 which extend vertically between adjacent panels 12. The panels 12 may be glass or formed from a sheet metal such as aluminum. They may also be slabs of stone, such as granite, or even a thin slabs of cast concrete. Whatever, their composition, they are attached to the mullions 14 which hold them in place, there being a variety of fastening devices available for making the attachments. The mullions 14 are standard and are typically aluminum extensions of tubular configuration. Each has (FIGS. 3 & 5) a flat back wall 16, flat parallel side walls 18, and a front wall 20 configured to cooperate with the fastening devices that secures the panels to the mullions 14. Being formed from aluminum, the mullions 14 expand and contract at a greater rate than the steel columns 2 and girders 4 which lie behind them. In other words, the coefficients of thermal expansion differ.

[0018] Finally, the curtain wall B includes (FIGS. 1 & 2) anchors 26 and 28 which hold the mullions 14 along the frame 2 and, of course, the panels 12 as well since the panels 12 are attached to the mullions 14. The anchors 26 actually provide support for the mullions 14 and the array of panels 12 attached to them and are known as “dead load anchors”. While they can accommodate horizontal displacement between the mullions 14 and the frame 2, they do not permit vertical displacement. As such the anchors 26 are located at the lower ends of the mullions 14. In this regard, a succession of mullions 14 may align along the frame 2 and give the appearance of a single mullion, but each mullion 14 in the succession, at its lower end, is attached to the frame 2 with a dead load anchor 26. The remaining anchors 28, which are sometimes referred to as “wind load anchors”, attach the mullions 14 to the frame 2 above the dead load anchors 26, that is to say, for each mullion 14, a dead load anchor 26 secures that mullion 14 to the frame 2 at its lower end and one, or more likely more, wind load anchors 28 secure the mullion to the frame 2 elsewhere. They accommodate both horizontal and vertical displacement between the mullions 14 and the frame 2 and in that sense are universal anchors. Moreover, as their name implies, the transfer wind loads to the frame 2.

[0019] Each wind load anchor 28 includes (FIGS. 3-5) a base member 32 which is attached, preferably by bolts 30 to one of the brackets 6 on the frame 2 of the building where it extends horizontally, it being about 6 to 8 inches long. The base member 32, has a web 34 and stiffening flanges 36 along the upper and lower margins of the web 34. Between the flanges 36 the base member 32 has a pair of rails 38, each of which projects outwards from the exposed face of the web 34 and then turns vertically in the provision of a retaining flange 40. Indeed, the flanges 40 from the two rails 38 project toward each other, but do not meet, there being a horizontally directed gap between the two retaining flanges 40. The rails 38 together with the region of the web 34 that lies between them forms a keyway 42 that opens away from the frame 2 and establishes a horizontal axis X1. The bolts 30 pass through the region of the web 34 between the stiffening flange 36 and the rails 38 and also through the bracket 6, and are secured with nuts.

[0020] The anchor 28 also includes a displaceable member 44 which possess the same cross-sectional configuration as the base member 32 and therefore has a web 34, stiffening flanges 36, rails 38, including retaining flanges 40, and a keyway 42. It too is an aluminum extrusion, typically 6 to 8 inches long, but may be longer, inasmuch as the length can vary by applications. Indeed, it may be extruded from the same die as the base member 32.

[0021] The base and displaceable members 32 and 44 are coupled by a horizontal key 50 (FIGS. 4 & 5) which is likewise preferably an aluminum extrusion. It prevents the members 32 and 44 from separating, yet allows the displaceable member 44 to shift horizontally with respect to the base member 32 along the axis X1. The key 50 possess an H-shaped cross section, it having a connecting segment 52 and flanges 54 projecting both upwardly and downwardly at both sides of the connecting segment 52. The flanges 54 on the key 50 fit into the keyway 42 of the base and displaceable members 32 and 44 where they lie behind the retaining flanges 40 on the rails 38. The connecting segment 52 fits into the spaces between the opposed retaining flanges 40 of the rails 38 and spans the space between the rails 38 on the base member 32 and the rails 38 on the displaceable member 44. The key 50, in effect, engages the two members 32 and 44 at their keyways 42 such that the members 32 and 44 cannot be separated, yet the displaceable member 44 can shift relative to the base member 32 along the horizontal axis X1. The sides of the key 50 lie close to, if not against, the webs 34 on the two members 32 and 44, so the key 50 prevents the members 32 and 44 from approaching as well. Nevertheless, the key 50 fits somewhat loosely into the keyways 42 on the two members 32 and 44, so that the key 50 may slide easily in the keyways 42. This permits the displaceable member 44 to shift horizontally in either direction along the axis X1 over the base member 32. To prevent the key 42 from leaving keyway 42 of the base member 32, the base member 32 in its web 34, between the two rails 38, contains (FIG. 6) a slot 56, the longitudinal axis of which lies parallel to the axis X1. The key 50, on the other hand, is fitted with a pin 58 which projects from it into the slot 56. Thus, the pin 58 confines the displacement of the key 50 in the keyway 42 of the base member 32 to essentially the length of the slot 56. The displaceable member 44 may of course shift still farther on the key 50.

[0022] In addition to the base and displaceable members 32 and 44, and the horizontal key 50 that is between them, the wind load anchor 28 has a vertical key 64 which is fastened firmly to the displaceable member 44. The vertical key 64 includes a center segment 66 and two flanges 68 at the outer end of the center segment 66 where they project laterally from the center segment 66, giving the vertical key 64 a T-shaped cross-sectional configuration. The vertical key 64 is attached to the displaceable member 44 at the inner end of its center segment 66 where it is secured against the web 34 of the member 44, preferably with cap screws 70 which pass through the web 66 above and below its rails 38 and
thread into the center segment 66. The vertical key 64, like the horizontal key 50, may be an aluminum extension.

[0023] Lastly, the anchor 28 includes a mullion clamp 76 that is fitted to the vertical key 64 and receives the mullion 14 to which it is firmly fastened. As such, the mullion clamp 76 serves as the attachment member for the anchor 28. It too may be an aluminum extrusion. More specifically, the mullion clamp 76 includes parallel side walls 78 which are spaced far enough apart to receive the mullion 14 loosely between them, with the side walls 18 of the mullion 14 lying along the inside surfaces of the side walls 78 on the clamp 76. The side walls 78 of the clamp 76 terminate short of the front wall 20 on the mullion 14, so that they do not interfere with the panels 12. The two side walls 78 are connected by a cross wall 80 (FIG. 3) from which vertical rails 82 project rearwardly. Each rail 82 terminates at an inwardly directed retaining flange 84. The spacing between the opposed flanges 84 slightly exceeds the width of the center section 66 on the vertical key 64, whereas the spacing between the flanges 84 and the cross wall 80 slightly exceeds the thickness of the flanges 84. In other words, the vertical rails 82 together with the cross wall 80 creates, on the back of the mullion clamp 76, a keyway 86 having a vertical axis X2, and that keyway 86 receives the vertical key 64 that is attached to the replaceable member 44. Indeed, the key 64 fits loosely enough in the keyway 86 to enable the mullion clamp 76 to slide upwardly and downwardly on the key 64 without pulling away from the outer member 44. The mullion clamp 76 is secured firmly to the mullion 14 with machine bolts 88 which pass through the side walls 78 of the clamp 76 as well as through the side walls 18 of the mullion 14.

[0024] The wind load anchor 28 may be easily converted into a dead load anchor 26 simply by securing the mullion clamp 76 to the vertical key 64, such as by extending the cap screws 70 into the cross wall 80 of the mullion clamp 76. This prevents the mullion 14 from shifting vertically with respect to the anchor 28 and frame A.

[0025] The wind load anchors 28 accommodate both vertical and horizontal displacement of the section of the mullion 14 that lies in front of the bracket 6 to which the anchor 28 is fastened. Should the frame A of the building rack, perhaps as the result of a seismic event, the bracket 6 for a wind load anchor 28 will undergo a horizontal displacement and perhaps a slight vertical displacement as well. The curtain wall B, may follow the frame A and undergo racking as well, but not to the extent that the frame A experiences, particularly if some of the panels 12 in the curtain wall are glazed. The anchors 28, accommodate the difference in the amount of racking experienced by the frame A and the curtain wall B, allowing the frame A to, in effect, undergo displacement behind the curtain wall B.

[0026] In this regard, as the bracket 6 on which an anchor 28 is mounted shifts horizontally the base member 32 of the anchor 28 moves with it. However, the replaceable member 44 remains in the same lateral position as the mullion 16 which the anchor 28 secures and the mullion 16 remains essentially with the panels 12 on either side of it, and while the curtain wall B may and probably does move horizontally, it displaces a lesser amount. In short, the base member 32 moves horizontally behind the replaceable member 44 which is replaceable in the sense that it moves relative to the base member 32. More specifically, the horizontal key 50 slides in the keyway 42 of the base member 32 or the keyway 42 of the replaceable member 44 or in both keyways 42, thereby accommodating the horizontal displacement. The horizontal displacement caused by the racking could be accompanied by a vertical displacement of the frame bracket 6 relative to the portion of the mullion 16 that lies behind it. In that event the vertical key 64 moves vertically in the keyway 86 of the mullion clamp 76. The vertical keyway 86 also accommodates vertical displacement of the mullion 14 caused by differential thermal expansion. Notwithstanding the freedom to shift both horizontally and vertically relative to the frame A, the mullion 14 cannot pull away from or move toward the building frame A. It remains in place in this respect.

[0027] Variations are possible. For example, only one keyway 42 will accommodate horizontal displacement, so the horizontal key 50 may be fixed firmly to or extruded integral with either the base member 32 or the replaceable member 44. Also, the vertical key 64 may be on the mullion clamp 76 and the vertical keyway 86 on the web 34 of the replaceable member 44. Moreover, the key 50 and keyways 42 can be oriented vertically to accommodate the vertical displacement, while the key 64 and keyway 86 can be oriented horizontally to accommodate horizontal displacement. Furthermore, the mounting surfaces to which the anchors 26 and 28 are attached need not be on brackets 6 and need not be oriented vertically.

What is claimed is:

1. An anchor for attaching curtain wall panels to the frame of a building, said anchor comprising: a base member adapted to be attached to the frame of the building; a replaceable member located in front of the base member and being coupled to the base member such that it can shift relative to the base member along a first axis, yet cannot pull away from the base member, an attachment member configured to be attached to a component of a curtain wall and being coupled to the outside member such that it can shift relative to the outside member along a second axis which is located at an angle to the first axis, yet cannot pull away from the replaceable member.

2. An anchor according to claim 1 wherein one of the axes is horizontal, and the other axis is vertical.

3. An anchor according to claim 1 wherein the first axis is horizontal and the second axis is vertical.

4. An anchor according to claim 3 wherein the replaceable member slides relative to the base member along the first axis, and the attachment member slides relative to the replaceable member along the second axis.

5. An anchor according to claim 3 wherein one of the base or replaceable members has a keyway and the other member carries a key which engages said one member at the keyway such that the other member can shift along the first axis, but cannot be displaced laterally with respect to the first axis, whereby the replaceable member can shift horizontally, but cannot be withdrawn from or drift toward the base member.

6. An anchor according to claim 5 wherein each of the base and replaceable members has a keyway, and the key engages both members at their keyways such that the key can slide in the keyways along the first axis, but cannot be displaced laterally with respect to the keyways.
7. An anchor according to claim 5 wherein the attachment member has a keyway and the displaceable member carries another key which engages the attachment member at its keyway such that the attachment member can slide along the second axis but cannot be displaced laterally with respect to the second axis.

8. An anchor according to claim 7 wherein the attachment member has spaced apart walls to receive a mullion between them.

9. The anchor of claim 1 in combination with a building having a frame provided with mounting surface; and wherein the base member of the anchor is attached securely to the mounting surface on the frame.

10. In combination with a building having a frame provided with a mounting surface, a curtain wall comprising: side-by-side panels located outwardly from the frame; a mullion located between the side-by-side panels; and an anchor located between the mounting surface on the building frame and the mullion to position the panels beyond the frame, the anchor including a base member attached securely to the frame against the mounting surface, a displaceable member coupled to the base member such that it can slide relative to the base member along a first axis but cannot pull away from the base member, and a mullion clamp attached to the mullion and coupled to the displaceable member such that it can slide relative to the displaceable member along the second axis, but cannot pull away from the displaceable member, one of the axes being oriented vertically and the other of the axes being oriented horizontally.

11. The combination according to claim 10 wherein one of the base or displaceable members has a keyway and the other member carries a key which engages said one member at the keyway, with the keyway and key being configured such that the other member can shift relative to said one member along the first axis but cannot be displaced laterally with respect to the first axis.

12. The combination according to claim 11 wherein the mullion clamp has a keyway and the displaceable member carries another key which engages the mullion clamp at the keyway on the mullion clamp, with the other key and the keyway of the mullion clamp being configured such that the mullion clamp can slide relative to the displaceable member along the second axis, but cannot be displaced laterally with respect to the second axis.

13. The combination according to claim 10 wherein both the base and displaceable members have keyways and the key engages both members at their keyways, with the keyways and key being configured such that the displaceable member can slide relative to the base member, but cannot be displaced laterally with respect to the first axis.

14. The combination according to claim 13 wherein the mullion clamp has a keyway and the displaceable member carries another key which engages the mullion clamp at the keyway on the mullion clamp, with the other key and the keyway of the mullion clamp being configured such that the mullion clamp can slide relative to the displaceable member along the second axis, but cannot be displaced laterally with respect to the second axis.

15. The combination according to claim 10 wherein one of the axes is horizontal and the other axis is vertical.

16. The combination according to claim 10 wherein the first axis is horizontal and the second axis is vertical.

17. In combination with a building having a frame provided with a mounting surface, a curtain wall comprising: side-by-side panels located outwardly from the frame; a mullion located between the side-by-side panels, and an anchor located between the mounting surface on the building frame and the mullion to position the panels beyond the frame, the anchor including a base attached to the building frame at the mounting surface on the frame, a displaceable member located in front of the base member, one of the base or displaceable members having a keyway and the other member carrying a key which engages said one member at the keyway, with the keyway and key being configured such that the other member can shift horizontally relative to said one member along a horizontal axis but cannot be displaced laterally from the axis, the displaceable member also being connected to one of the mullions.

18. The combination according to claim 17 wherein both the base and displaceable members have a keyway and the key engages both members at their keyways, with the keyways and key being configured such that the displaceable member can slide relative to the base member, but cannot be displaced laterally from the axis.

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