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Test Data for POS-I-TIE™ Brick Veneer Anchoring System

Tests were conducted at the Phil Ferguson Structural Engineering Laboratory at the University of Texas at Austin under the supervision of Dr. Richard Klingner Spring/Summer 2005.

2 ½" Pos-I-Tie™ Self-Drilling Screw In Steel Studs
Tension Test
5 specimens were tested. Each consisted of a 16 gage steel stud with 1/2" Denz-glass, 2" Styrofoam, 2" airspace, and a standard modular clay-masonry veneer. The 2-1/2" long Pos-I-Tie self-drilling screw was drilled through the Styrofoam and denz-glass into the steel stud. A 3/16" x 4" long Hot Dipped Wire Tie was connected to the Barrel-Screw and mortared in the bed joint of the veneer.
Also given, in inches, are the "plateau displacements" at which the approximate maximum load level was first reached. This plateau displacement is a general index of the deformation capacity of the tie system.

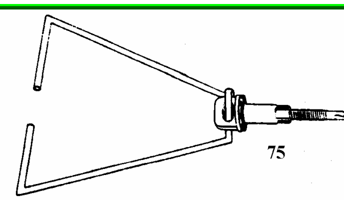
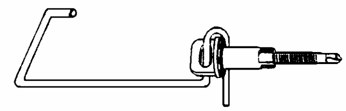
Table 1	**Tension Test – With TRIANGLE WIRE TIE**		
sample	failure	failure load , lbs	Plateau Displacement, inches
1	screw pulled out of steel stud	679	1.2
2	triangle tie pulled out of bed joint	605	1.2
3	eye of screw fractured	709	1.3
4	eye of screw fractured	756	1.4
5	triangle tie pulled out of bed joint	644	1.5
	AVERAGE	679	
	COV	0.086	

Table 2	**Tension Test – With SINGLE WIRE TIE**		
sample	failure	failure load , lbs	Plateau Displacement, inches
1	Single-leg tie pulled out of bed joint	350	1.8
2	Single-leg tie pulled out of bed joint	610	0.6
3	Masonry unit cracked, single-leg pulled out of bed joint	415	0.2
4	Eye of screw "walked" to end of single-wire tie, tie straightened out	270	0.4
5	Eye of screw "walked" to end of single-wire tie, tie straightened out	547	0.3
	AVERAGE	438	
	COV	0.32	

Tension Tests – Self-Drilling Screw to Steel Studs

- Specimens with triangle ties are about 1.5 times as strong as the single-wire ties, and are also much more consistent in strength.
- These ties are "adjustable two-piece anchors" under the definition of MSJC Code Section 6.2.2.5.6, which requires that one such anchor be provided for every 2.67 ft^2 of wall area. Put simply, each tie must be responsible for 2.67 sq ft of wall. A typical high design wind pressure (components and cladding) is 50 lb/ft^2. Typical design loads per anchor, assuming a load factor of 1.6, are therefore about 215 lb. **Even the weaker of the two types of tie has strength about twice this**.
- Specimens with triangle ties sometimes failed by pullout of the tie from the bed joint, and sometimes by fracture of the eye of the screw. In contrast, the specimens with single-wire ties sometimes failed by pullout of the tie from the bed joint, and sometimes by straightening out of the tie. This straightening out ultimately limited the capacity of the single-wire ties to loads less than what would probably have been required to fracture the eye of the screw.
- Because the specimens were loaded so that the stud could rotate, loads were directed along the axis of the tie, and the closed eyes at the ends of the Pos-I-Tie® screws were subjected to concentric loads only, with essentially no shear or bending. As a result, the capacities corresponding to eye fracture are quite high, about 700 lb (triangle ties). This is in contrast to loads corresponding to the Tapcon Pos-I-Tie tests, and is discussed in the section dealing the CMU tests.
- Specimens with triangle ties have plateau displacements much larger than the specimens with single-wire ties. This is because the triangle ties are closed, and the eye cannot slip off. In contrast, specimens with single-wire ties are limited in displacement capacity by straightening out of the tie or slipping of the eye of the screw along the bent end of the tie. Triangle ties are initially stiffer than single-wire ties, because they have two wires rather than one.
- Examination of some specimens shows that the female-threaded portion of the Pos-I-Tie™ can turn with respect to the embedded portion of the screw. This does not seem to affect capacity, however. Capacity is much more affected by the movement under load of the screw-eye of specimens with single-wire ties, toward the free end of the tie.

2 ½" Pos-I-Tie™ Self-Drilling Screw In Steel Studs
Compression Test
5 specimens were tested. Each consisted of two 16 gage steel studs with 1/2" Denz-glass, 2" Styrofoam, 2" airspace, and standard modular clay masonry veneer. Two 2-1/2" long Pos-I-Tie self-drilling screws were drilled into each stud. 3/16" x 4" long Hot Dipped Pos-I-Tie Triangle ties were connected to the Barrel-Screws and mortared in the bed joints of the veneer. (Entire wall was 3 masonry units wide x 9 high).

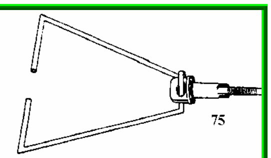
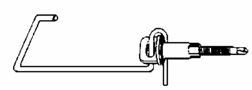
Table 3	**Compression Test – With TRIANGLE WIRE TIE**			
sample	failure	failure load, lbs	Plateau Displacement, (total) inches	Plateau Displacement, (gap) inches
1	buckling of ties	1503	0.6	--
2	buckling of ties	1359	0.4	0.1
3	buckling of ties	1254	0.4	0.1
4	buckling of ties	1398	0.4	0.2
5	buckling of ties	1458	0.4	0.2
	AVERAGE	1394		
	COV	0.069		

Table 4	**Compression Test – With SINGLE WIRE TIE**			
sample	failure	failure load, lbs	Plateau Displacement, (total) inches	Plateau Displacement, (gap) inches
1	buckling of ties	1286	1.5	1.5
2	buckling of ties	743	0.8	0.8
3	buckling of ties	1015	0.4	0.4
4	buckling of ties	1026	0.4	0.2
5	buckling of ties	936	0.6	0.4
	AVERAGE	1002		
	COV	0.20		

- All specimens failed by buckling of the ties. Failure loads are higher for triangle ties than for single-leg ties, because triangle ties have two legs rather than one.
- These ties are "adjustable two-piece anchors" under the definition of MSJC Code Section 6.2.2.5.6, which requires that one such anchor be provided for every 2.67 ft^2 of wall area. Put simply, each tie must be responsible for 2.67 ft^2 of wall. A typical high design wind pressure (components and cladding) is 50 lb/ft^2. Typical design loads per anchor, assuming a load factor of 1.6, are therefore about 215 lb. For four anchors, the typical design loads would be 4 times this, or 860 lb**. Even the weaker of the two types of tie has a strength exceeding this.**

- In specimens with triangle ties, the total plateau displacement is due primarily to deformation of the studs, with only slight contributions from the flexibility of the ties. In contrast, in specimens with single-wire ties, almost the entire total plateau displacement is due to closing of the gap. This is due to the relatively high flexibility of the single-wire ties compared to that of the triangle ties.

5/8” Pos-I-Tie™ Tapcon® Screw In CMU
Tension Test
Each specimen consisted of an 8 x 8 x 16-in.lightweight CMU conforming to ASTM C90, with a 5/8-in. long Tapcon Pos-I-Tie® screw placed in the face shell of the unit. Using a 2-in. airspace, the eye of the screw was attached to a 3/16-in. diameter, 4-in. long tie that was mortared in the bed joint of veneer made of standard modular clay masonry units.

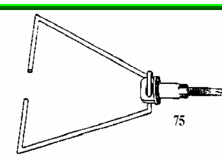
Table 5	**Tension Test – With TRIANGLE WIRE TIE CMU Positie Tapcon® screw in face shell aligned with the cross-web**		
sample	failure	failure load, lbs	Plateau Displacement, (total) inches
1	Fracture of eye	489	0.2
2	Fracture of eye	344	0.1
3	Fracture of eye	454	0.3
4	Fracture of eye	405	0.3
5	Fracture of eye	404	0.4
	AVERAGE	419	
	COV	0.13	

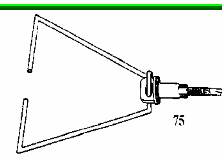
Table 6	**Tension Test – With TRIANGLE WIRE TIE CMU Positie Tapcon® screw in face shell aligned with the empty cell**		
sample	failure	failure load, lbs	Plateau Displacement, (total) inches
1	Fracture of eye	410	0.4
2	Fracture of eye	549	0.7
3	Pullout of tie from bed joint	785	1.0
4	Fracture of eye	572	0.3
5	Fracture of eye	404	0.6
	AVERAGE	544	
	COV	0.29	

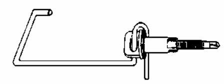
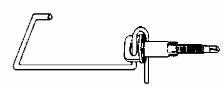
Table 7	**Tension Test – With SINGLE WIRE TIE CMU Positie Tapcon® screw in face shell aligned with the cross-web**		
sample	failure	failure load, lbs	Plateau Displacement, (total) inches
1	Pullout of tie from bed joint	364	0.4
2	Fracture of eye	599	0.2
3	Fracture of eye	419	0.3
4	Fracture of eye	613	0.4
5	Fracture of eye	517	0.3
	AVERAGE	502	
	COV	0.22	

Table 8	**Tension Test – With SINGLE WIRE TIE CMU Positie Tapcon® screw in face shell aligned with the empty cell**		
sample	failure	failure load, lbs	Plateau Displacement, (total) inches
1	Fracture of eye	574	0.2
2	Fracture of eye	325	0.3
3	Fracture of eye	621	0.2
4	Fracture of eye	427	0.2
5	Fracture of eye	487	0.4
	AVERAGE	487	
	COV	0.24	

- Practically all specimens failed by fracture of the closed eye at the end of the Pos-I-Tie™ screw. This failure mode is essentially independent of the type of tie or whether the tie is attached to the face shell of the CMU or the web. It is therefore essentially the same for all four types of specimens tested in this series.
- These ties are “adjustable two-piece anchors” under the definition of MSJC Code Section 6.2.2.5.6, which requires that one such anchor be provided for every 2.67 ft^2 of wall area. Put simply, each tie must be responsible for 2.67 ft^2 of wall. A typical high design wind pressure (components and cladding) is 50 lb/ft^2. Typical design loads per anchor, assuming a load factor of 1.6, are therefore about 215 lb. **Even the weakest of the four types of specimen has strength about twice this.**

- Examination of close-up photos of different specimens of this series during testing suggests that in most cases, the screw eyes were subjected to a combination of direct tension parallel to the axis of the screw, shear perpendicular to the axis of the screw, and local bending due to the orientation of the tie through the eye. Shear perpendicular to the axis of the screw arises when the axis of screw is not perpendicular to the face of the CMU, and therefore not exactly parallel with the direction of loading.
- Because the specimens in this series were loaded so that the CMU and the veneer could not rotate freely, if the anchor were not perpendicular to the surface of the masonry, shears could exist perpendicular to the axis of the anchor, and would account for the lower capacity of the ties in CMU compared with the ties in Steel Studs. For example, in Table 5 and Table 6, which show failures for triangle ties by fracture of the eye, capacities are uniformly about 60% of the capacities corresponding to eye fracture for the same type of triangle tie in Table 1. Although the anchors and the failure modes are identical, the presence of shear in the CMU series makes the capacities in that series less than those in the Steel Stud test. It also makes the ties in the CMU fail almost invariably by fracture of the screw eye, rather than by the other failure modes noted for Steel Studs.
- It might be thought that because local bending decreases the fracture load of the eye, and because local bending depends on the angle of the upright portion of the tie, that control of that angle in production is important. This is not the case, however. No matter what the initial angle is, the tie straightens out and the angle changes as the load increases.
- Specimens with triangle ties have plateau displacements larger than the specimens with single-wire ties. This is because the triangle ties are closed, and the eye cannot slip off. The difference is less for the CMU tests than the Steel Stud tests, because the ties in the CMU are prevented from rotating by the manner in which the CMU and veneer are loaded. In contrast, specimens with single-wire ties are limited in displacement capacity by straightening out of the tie or slipping of the hook of the screw along the bent end of the tie. Triangle ties are initially stiffer than single-wire ties, because they have two wires rather than one.