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ICC-ES Evaluation Report

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ESR-3381

Reissued 03/2018
This report is subject to renewal 03/2019.

DIVISION: 03 00 00—CONCRETE
SECTION: 03 16 00—CONCRETE ANCHORS
SECTION: 03 41 00—PRECAST STRUCTURAL CONCRETE
SECTION: 03 47 00—SITE-CAST CONCRETE

REPORT HOLDER:

HK COMPOSITES, INC.

851 EAST 675 SOUTH
LEHI, UTAH 84043

EVALUATION SUBJECT:

HK™ ST THERMOPOLYMER WYTHE CONNECTORS FOR INTEGRALLY INSULATED WALL PANELS

"2014 Recipient of Prestigious Western States Seismic Policy Council (WSSPC) Award in Excellence"

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Section: 03 47 00—Site-Cast Concrete

REPORT HOLDER:

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EVALUATION SUBJECT:

HK™ ST THERMOPOLYMER WYTHE CONNECTORS FOR INTEGRALLY INSULATED WALL PANELS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015 and 2012 *International Building Code*® (IBC)
- 1997 *Uniform Building Code*™ (UBC)

Properties evaluated

- Structural
- Environmental
- Physical and Mechanical

2.0 USES

The HK ST standard ties (ST50, ST75 and ST100) are used for multiple installations and function by anchorage into concrete and resistance of the connector body for integrally insulated concrete walls (commonly known as sandwich walls). The ST standard connectors spaced apart nonrigid material and formed a connection to resist static and transient tension and shear loads in uncracked, normal-weight concrete on both sides. The connectors are alternatives to cast-in-place steel anchors described in Section 1901.3 of the 2015 IBC or Section 1908 of the 2012 IBC, or Section 1923 of the UBC.

3.0 DESCRIPTION

3.1 Connectors:

HK ST standard ties (ST50, ST75 and ST100) are engineered thermopolymer connectors with a double key section at the pointed end and a head at the other end for anchorage into wet concrete. The connectors are illustrated in Figures 1, 2 and 3. The connectors are produced from polyphenylsulfone by injection molding.

3.2 Concrete:

Normal-weight concrete must conform to Section 1903 of the IBC or UBC, as applicable and comply with the compressive strength requirements in Table 2.

4.0 DESIGN AND INSTALLATION

4.1 Physical and Material Properties of the Connectors:

Design must be based on the physical and mechanical properties described in Tables 1 and 2.

4.2 Design for Tension and Shear:

Design must be performed using the applicable sections of the applicable codes with the allowable loads as noted in Table 2. Allowable loads for ST connectors subjected to combined shear and tension forces must be determined by the following equation:

$$(P_s/P_t) + (V_s/V_t) \leq 1$$

where:

P_s = Applied service tension load (lbf or N).

P_t = Allowable service tension load (lbf or N).

V_s = Applied service shear load (lbf or N).

V_t = Allowable service shear load (lbf or N).

4.3 Displacement of the Connector:

The ST standard connectors are used to resist shear loads in bending rather than pure shear. Therefore, a limiting displacement value of 0.1 inch (2.54 mm) due to gravity loads is placed on the connector. When the connector displacement exceeds the limiting value of 0.1 inch (2.54 mm) due to gravity loads, the free end of the connector must be supported to maintain fixity by other means. The displacement must be calculated as follows (neglecting any contribution from the insulation in the intended application):

$$\Delta_g = \frac{Q_g . d_A^3}{12 E_{Ab} . I_A}$$

where:

Δ_g = Displacement due to gravity load (inch or mm).

Q_g = Gravity load on the connector, typically the weight of the fascia layer of the tributary area for the connector (lbf or kN), $Q_g = t \cdot a \cdot b \cdot \gamma$

where:

t = thickness of the fascia layer (feet or m).

a = horizontal spacing of the connector (feet or m).

b = vertical spacing of the connector (feet or m).

γ = density of concrete (lb /ft^3 or kg/m^3).

$$d_A = d_d + \frac{2h_v}{3}\left[1 - \frac{1}{1 + \frac{h_v}{d_d}}\right]$$

where:

d_A = Connector bending length, a function of insulation thickness and embedment (inch or mm).

d_d = Insulation thickness (inch or mm).

h_v = Embedment length of the connector in the concrete (inch or mm).

E_{Ab} = Flexural modulus of elasticity as given in Table 1 (psi or MPa).

I_A = Moment of inertia of the connector as given in Table 1 (in^4 or mm^4).

The deflection of the connector may be reduced by decreasing the connector spacing, with a minimum spacing of 8 inches (203 mm) on center each way.

4.4 Installation:

Connector orientations and locations must comply with the plans and specifications approved by the code official. ST connectors must be installed in accordance with the instructions provided by HK Composites Incorporated (HKC). The instructions are provided with each shipment of connectors. The minimum embedment, critical edge distance, and critical spacing must comply with Table 3 of this report.

The minimum concrete thickness must comply with the applicable code requirements or 1.5 times the connector effective embedment, whichever is greater. Within 20 minutes after the bottom layer of concrete is placed, code complying rigid insulation board with dots or predrilled holes to indicate connector locations must be placed over the concrete while it is in the plastic state. The connectors, sized to match the insulation board thickness, are inserted through the insulation board into the layer of concrete, until the prescribed embedment is reached. Concrete consolidation around the connectors must be conducted in accordance with the applicable code and HKC's published instructions. The top layer of concrete is then placed over the insulation board and concrete is consolidated around the connectors. Panels must be cured in accordance with the applicable code.

4.5 4.5 Special Inspection:

Installations must be made under special inspection in accordance with Section 1705.1.1 of the IBC, or Section 1701.5.2 of the UBC. The special inspector must be on the jobsite continuously during connector installation to verify connector type, connector dimensions, and cleanliness, embedment depth, concrete type, concrete compressive strength, edge distance(s), connector spacing(s), concrete thickness, concrete consolidation and concrete curing.

5.0 CONDITIONS OF USE

The HK ST connectors described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Connector sizes, dimensions, and installation must comply with the information in this report and HKC's published installation instructions. In case of a conflict, this report governs.

5.2 Allowable tension and shear loads must be used as noted in Table 2.

5.3 Calculations and details demonstrating compliance with this report must be submitted to the code official for approval. The calculation and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.4 Design and installation of concrete wall panels, except as specifically noted in this report, is outside the scope of this report and must comply with the applicable code.

5.5 Connectors may be recognized for interior exposure, exterior exposure or damp environments.

5.6 Connectors must not be permitted in contact with preservative-treated and fire-retardant-treated wood.

5.7 Special inspection must be provided in accordance with Section 4.5 of this report.

5.8 Since ICC-ES acceptance criteria for evaluating data to determine the performance of connectors subjected to fatigue or shock loading is unavailable at this time, the use of these connectors under these conditions is beyond the scope of this statement.

5.9 Since ICC-ES acceptance criteria for evaluating data to determine the performance of thermoplastic connectors in cracked concrete is unavailable at this time, the use of these connectors must be limited to normal-weight uncracked concrete. Cracking occurs when ft > fr due to service loads or deformations.

5.10 Connectors must not be permitted for use in conjunction with fire-resistant-rated construction, except when connectors resist wind loading only, or for other than wind loading, special consideration is given to fire exposure conditions.

5.11 Seismic or wind load under the IBC: Use of the connectors to resist seismic loads is beyond the present scope of compliance. When using the basic load combinations in accordance with IBC Section 1605.3.1.1, allowable loads are not permitted to be increased for wind loading. When using the alternate basic load combinations in IBC Section 1605.3.2 that include wind loads, the allowable shear and tension loads for connectors may be increased.

5.12 Seismic or wind load under the UBC: When using the basic load combinations in accordance with UBC Section 1612.3.1, allowable loads are not

permitted to be increased for wind or seismic loading. When using the alternate basic load combinations in IBC Section 1612.3.2 that include wind or seismic loads for connectors are permitted to be increased by $33^1/_3$ percent.

5.13 Connectors are manufactured by HK Composites, Incorporated, under a quality control program with inspections conducted by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Fiber-reinforced Composite Connectors Anchored in Concrete (AC320), dated October 2015, including seismic tests and creep tests.

7.0 IDENTIFICATION

The connectors must be identified in the field by dimensional characteristics and packaging. The packaging label indicates HK Composites Incorporated name and address, the type of connector, the name of the inspection agency (ICC-ES), identification number and ICC-ES ESR report number (ESR-3381). The lot number is molded into each connector.

TABLE 1—PHYSICAL AND MECHANICAL PROPERTIES

DESCRIPTION	ST50 CONNECTOR		ST75 & ST100 CONNECTORS	
	Customary Units	SI Units	Customary Units	SI Units
Cross-sectional area	0.196 in^2	126.5 mm^2	0.257 in^2	165.80 mm^2
Moment of inertia	0.0031 in^4	1277 mm^4	0.0053 in^4	2187 mm^4
Embedment depth (headed end)	1.50 inches	38 mm	1.50 inches	38 mm
Embedment depth (pointed end)	1.81 inches	46 mm	1.73 inches	44 mm
Bending elastic modulus (flexural modulus)	347,000 psi	2379 MPa	347,000 psi	2379 MPa

TABLE 2—ALLOWABLE TENSION AND SHEAR VALUES IN NORMAL-WEIGHT CONCRETE[1] (in pounds)

DESCRIPTION	ST50 CONNECTOR	ST75 CONNECTOR	ST100 CONNECTOR
	f'_C = 3,000 psi^2	f'c = 3,000 psi^2	f'c = 3,000 psi^2
Static tension	315	414	414
Static shear	162	231	195
Seismic tension[3]	314	418	418
Seismic shear[3]	140	-	-

For SI: 1 psi = 6.9 kPa, 1 pound = 4.45 N

[1] Allowable loads have been determined by applying a factor of safety of 4 to the test results.

[2] Concrete must achieve this compressive strength before anchors are loaded.

[3] For use under the UBC only.

TABLE 3—INSTALLATION PARAMETERS

DESCRIPTION	STANDARD 2-in CONNECTOR (ST50) (inches)	STANDARD 3-in & 4-in CONNECTORS (ST75, ST100) (inches)
Embedment Headed End	1.50	1.50
Embedment Pointed End	1.81	1.73
Critical edge distance	5.25	5.25
Critical spacing	8	8

For SI: 1 inch = 25.4 mm.

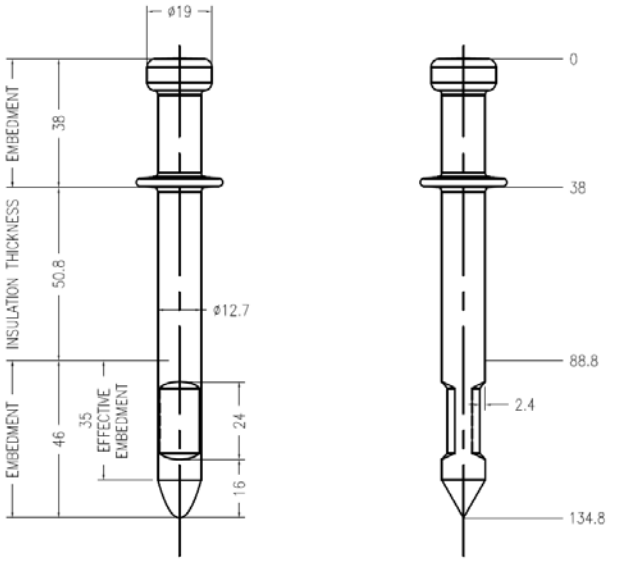

FIGURE 1—HK ST-50 CONNECTOR PROFILE
(All dimensions are in mm; 1 mm = 0.0394 in.)

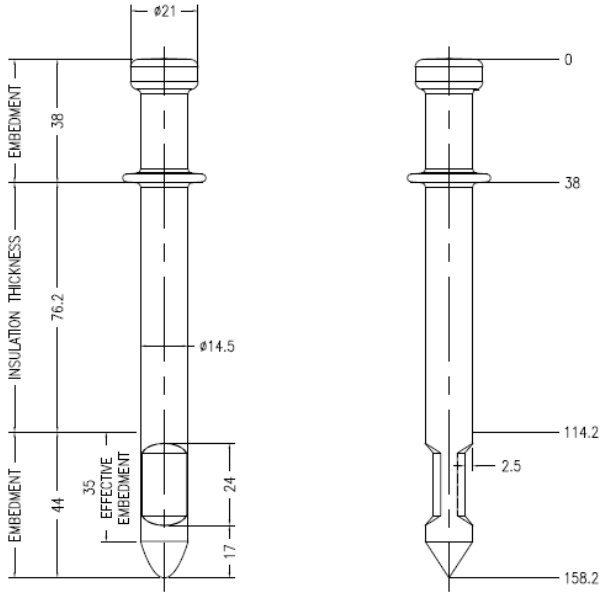

FIGURE 2—HK ST-75 CONNECTOR PROFILE
(All dimensions are in mm; 1 mm = 0.0394 in.)

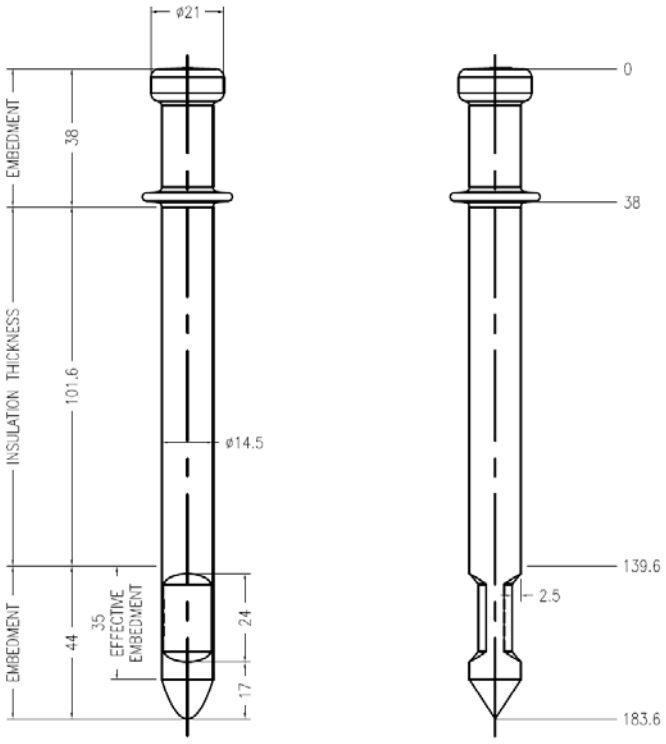

FIGURE 3—HK ST-100 CONNECTOR PROFILE
(All dimensions are in mm; 1 mm = 0.0394 in.)