ICC EVALUATION SERVICE
In Cooperation with Innovation RESEARCH LABS

Most Widely Accepted and Trusted

ICC-ES Report

ESR-2953

ICC-ES | (800) 423-6587 | (562) 699-0543 | www.icc-es.org

Reissued 02/2017
This report is subject to renewal 02/2019.

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

REPORT HOLDER:

ALTUS GROUP, INC.

POST OFFICE BOX 1449
BETHLEHEM, PENNSYLVANIA 18018

EVALUATION SUBJECT:

C-GRID® SHEAR CONNECTORS

Look for the trusted marks of Conformity!

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

A Subsidiary of INTERNATIONAL CODE COUNCIL®

ICC-ES Evaluation Report

ESR-2953

Reissued February 2017

This report is subject to renewal February 2019.

www.icc-es.org | (800) 423-6587 | (562) 699-0543 *A Subsidiary of the International Code Council®*

DIVISION: 03 00 00—CONCRETE
Section: 03 41 00—Precast Structural Concrete
Section: 03 47 00—Site-cast Concrete

REPORT HOLDER:

ALTUS GROUP, INC.
POST OFFICE BOX 1449
BETHLEHEM, PENNSYLVANIA 18018
(864) 328-1700
www.altusgroup.com

ADDITIONAL LISTEE:

CHOMARAT NORTH AMERICA, LLC
2901 NEW POND ROAD
ANDERSON, SOUTH CAROLINA 29624
www.chomarat.com
kyle.barton@chomaratna.com

EVALUATION SUBJECT:

C-GRID® SHEAR CONNECTORS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012 and 2009 *International Building Code*® (IBC)
- 2015, 2012 and 2009 *International Residential Code*® (IRC)
- 2013 *Abu Dhabi International Building Code* (ADIBC)†

†The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.

Properties evaluated:

- Physical
- Environmental
- Structural

2.0 USES

The C-GRID® connectors are used in integrally insulated concrete walls to resist static and transient tension and shear loads in uncracked, normal-weight concrete.

3.0 DESCRIPTION

3.1 Connectors:

C-GRID® connectors are fiber-reinforced composite grid material cut on a 45-degree bias. The connectors are illustrated in Figure 1. The connectors are produced in a continuous high-speed nonwoven cross-laid composite manufacturing process using carbon fibers and epoxy resin.

The grid pattern of C-GRID® connectors measures 1.8 inches (46 mm) long by 1.6 inches (41 mm) wide and comes in a sheet length of 67.5 inches (1.7 m). The height of the C-GRID® connector is based on embedment requirements and insulation thickness. Heights range from 3.5 inches (89 mm) to 10 inches (254 mm). Dimensions are shown in Figure 1.

3.2 Concrete:

Normal-weight concrete must conform to Sections 1903 and 1905 of the IBC, as applicable, and comply with the compressive strength requirements in Table 2.

3.3 Insulation:

All insulation must be Type I rigid EPS complying with ICC-ES report ESR-1006, ESR-1946 or ESR-1788.

4.0 DESIGN AND INSTALLATION

4.1 Physical and Material Properties of the Connectors:

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

4.2 Shear Flow of the Connector:

The nominal shear flow (lbs/inch) of the C-GRID® connector parallel to the length of the connector depends on insulation thickness and connector spacing. The nominal shear flow values of the C-GRID® connectors are shown in Table 2.

4.3 Shear Modulus of the Connector:

The nominal shear modulus (lbs/inch) of the C-GRID® connector parallel to the length of the connector depends on insulation thickness and connector spacing. The nominal shear modulus values of the C-GRID® connectors are shown in Table 2.

4.4 Strength Reduction Factors:

The following strength reduction factors are applicable for the design of the insulated concrete panel construction with grids:

- A strength reduction factor of 0.75 must be used to determine the nominal design shear flow strength. An additional strength reduction factor of 0.85 must also be applied to improve the reliability of the strength prediction.

- For the design of the insulated concrete panels for sustained loads, a strength reduction factor of 0.15 must be used to determine the nominal design shear flow strength.

4.5 Stiffness:

Designing the deflections of insulated concrete panels using the construction method under consideration must be based on a combination of flexural deformation and shear deformation. The total deformation is the sum of the long-term flexural deformation and the long-term shear deformation. The total deformation must be based on the following:

$$\left(\delta_F \lambda_\Delta + \delta_S \xi\right) = \delta_{LongTerm}$$

where

δ_F = the flexural deflection of the panel due to moment applied to the panels by sustained gravity loads

λ_Δ = long-term load flexural deformation creep factor due to sustained loads as defined in Section 4.5.1.

δ_S = the shear deflection of the panel due to shear in the panel due to the sustained gravity loads

ξ = the shear deformation creep factor due to sustained loads as defined in Section 4.5.2.

4.5.1 Flexural Deformations: Long-term load flexural deformation calculations must follow a rational method. The long-term load flexural deformation creep factor is defined as λ_Δ and can be determined in accordance with Section 24.2 of ACI 318-14 (2015 IBC) or Section 9.5 of ACI 318-11 (2012 IBC) or ACI 318-08 (2009 IBC) .

4.5.2 Shear Deformations: Long-term load shear deformation calculations must follow a rational method. The long-term load shear deformation creep factor is defined as ξ and can be determined in accordance with Section 24.2 of ACI 318-14 (2015 IBC) or Section 9.5 of ACI 318-11 (2012 IBC) or ACI 318-08 (2009 IBC).

5.0 INSTALLATION

5.1 General:

Connector orientations and locations must comply with this report and the plans and specifications approved by the code official. C-GRID® connectors must be installed in accordance with the instructions provided by AltusGroup Inc.

The minimum embedment, critical edge distance, critical spacing and minimum concrete thickness must comply with Table 3 of this report.

Within 20 minutes after the bottom layer of concrete is placed, code-compliant strips of rigid insulation board in widths equal to grid spacing requirements are placed over the concrete while the concrete is in a plastic state. The connectors are inserted between the strips of insulation in lengths per design requirements into the bottom layer of concrete until the prescribed embedment is reached. Concrete consolidation around the connectors must be conducted in accordance with the manufacturer's installation instructions. The top layer of concrete is then placed and consolidated over the insulation board, engaging the connectors. Panels must be cured in accordance with the manufacturer's installation instructions.

The longitudinal gap of the C-GRID®, as shown in Figure 2, may vary from zero to 6 inches (152 mm) in the row of grid.

5.2 Special Inspection:

Installations must be made under special inspection in accordance with Section 1705 of the IBC. The special inspector must be in the manufacturing facility continuously during connector installation to verify connector type, connector dimensions, cleanliness, embedment depth, concrete type, concrete compressive strength, edge distances, connector spacings, concrete thickness, concrete consolidation and concrete curing.

6.0 CONDITIONS OF USE

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

6.1 Connector sizes, dimensions, and installation must comply with this report and the AltusGroup Inc. published installation instructions. In case of a conflict between this report and other documentation, this report governs.

6.2 Nominal shear flow and shear modulus must be as noted in the Table 2, adjusted in accordance with Section 4.4 of this report. The values may be interpolated for intermediate insulation sizes and grid spacings not shown.

6.3 Calculations and details demonstrating compliance with this report must be submitted to the code official for approval. The calculations 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.

6.4 Connectors are for use in insulated concrete panels recognized in a current ICC-ES evaluation report.

6.5 Qualification testing, as described in Section 4.4 of AC422, is needed for each insulated concrete panel manufacturing facility. The testing must justify that the nominal shear flow capacity and shear modulus of the grid connectors is applicable to the insulated concrete panels manufactured at that panel manufacturing facility.

6.6 Special inspection must be provided in accordance with Section 5.2 of this report.

6.7 Short-term loads due to product manufacturing, transportation, and handling is outside the scope of this evaluation report.

6.8 Since an 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 the connectors under these conditions is beyond the scope of this report.

6.9 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of connectors in cracked concrete is unavailable at this time, the use of the connectors in cracked concrete is beyond the scope of this report. Cracking occurs when $f_t > f_r$ due to service loads or deformations.

6.10 Lap splicing of connectors is outside the scope of this evaluation report.

6.11 Use of grid connectors in conjunction with fire-resistance-rated construction is outside the scope of this report.

6.12 Use of the connectors to resist seismic loads is beyond the scope of this report.

6.13 The minimum span of panels with grid connectors is limited to 7 feet (2.1 m).

6.14 Connectors are manufactured by Chomarat North America under a quality control program with inspections by ICC-ES.

7.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Semicontinuous Fiber-Reinforced Grid Connectors Used in Combination with Rigid Insulation in Insulated Concrete Panel Construction (AC422), dated October 2010 (editorially revised July 2016).

8.0 IDENTIFICATION

The connectors are identified in the field by dimensional characteristics and packaging. The packaging label indicates the Chomarat North America name and address, the type of connector, and the ICC-ES report number (ESR-2953). Each connector box is stamped with the lot number.

TABLE 1—TESTED MECHANICAL PROPERTIES

PROPERTY	TESTED MACHINE DIRECTION PROPERTIES
Grid tensile strength per unit width	9,513 lbs/ft (139 kN/m)
Tensile modulus of elasticity	32,900 ksi (226,800 MPa)
Elongation at break	1.5% (15,160 microstrain)
Individual strand cross-sectional area	0.002860 in^2 (1.85 mm^2)
Average number of strands per unit width	6.67 strands/ft (21.87 strands/m)
Area of strands per unit width	0.019067 in^2/ft (40.36 mm^2/m)
Strand tensile strength	1427 lbs (6.3 kN)

TABLE 2—NOMINAL SHEAR FLOW VALUES AND NOMINAL SHEAR MODULUS VALUES[1]

INSULATION[2], inch (mm)	GRID SPACING, inch (mm)	NOMINAL SHEAR FLOW lbs./in. (N/mm)	NOMINAL SHEAR MODULUS (lbs./in) (N/mm)
2 (51)	12 (305)	170 (29.8)	975 (170.7)
2 (51)	24 (610)	330 (57.8)	214 (37.5)
6 (152)	12 (305)	151 (26.4)	334 (58.5)
6 (152)	24 (610)	216 (37.8)	410 (71.8)

For **SI:** 1 inch = 25.4 mm.

[1] Concrete compressive strength ($f'c$) must be a minimum of 5,000 psi (3447 kPa).

[2] Values for intermediate insulation thicknesses may be interpolated.

TABLE 3—MINIMUM EMBEDMENT, CRITICAL EDGE DISTANCE, AND CRITICAL SPACING

PARAMETER	VALUE
Grid embedment	No less than ¾ inch (19 mm)
Distance from edge of panel to grid	Must exceed 2 inches (51 mm)
Grid spacing	Must exceed 12 inches (305 mm)
Concrete thickness	At least 1.5 times grid embedment

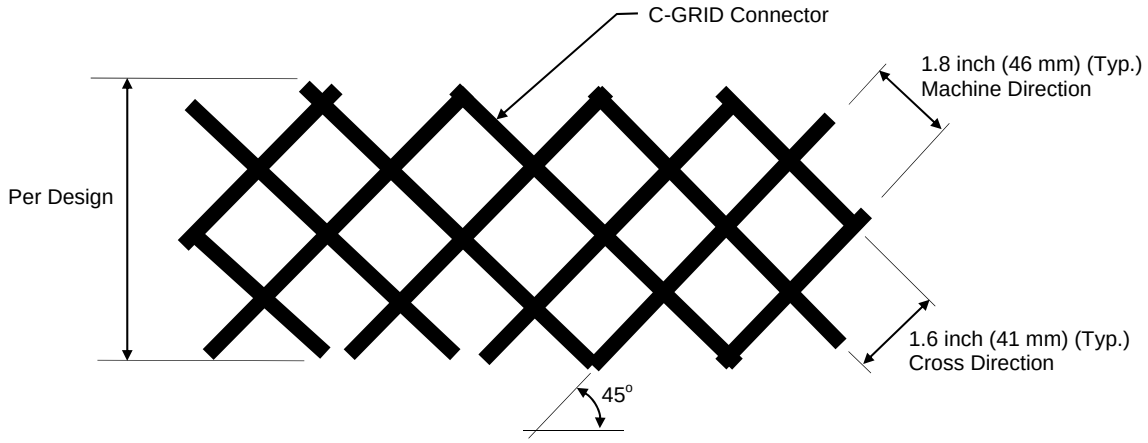

FIGURE 1—C-GRID DIMENSIONS

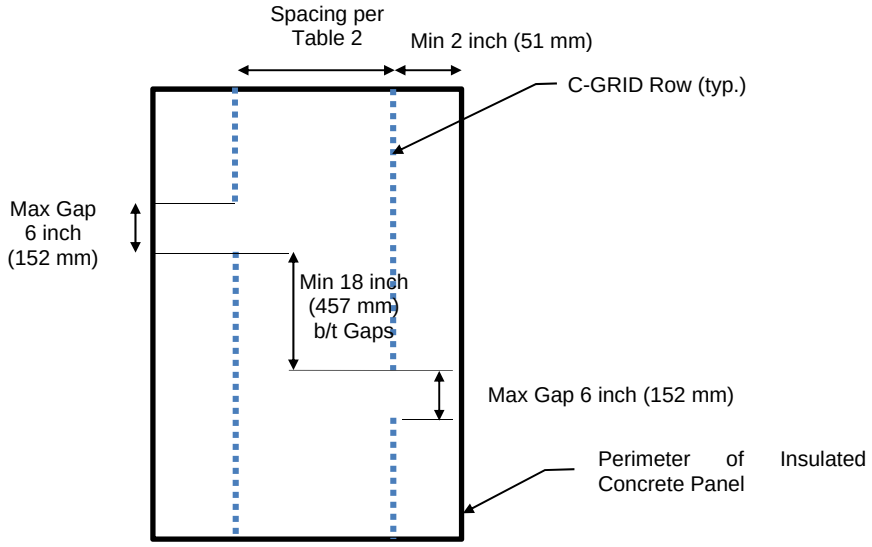

FIGURE 2—C-GRID PLACEMENT