Diamond Snap-Form®
Insulated Concrete Form

Tech Bulletin

DSF No. 7001

Subject: **Diamond Snap-Form ICF Code Considerations**

Date: **February 2011**

With the multitude of lightweight concrete forming systems in the construction market, building officials are raising questions about code compliance and/or code evaluation reports for these systems. The two basic types of lightweight concrete forming systems are foam blocks and the plank and tie systems. Block-type systems reduce the area of concrete in the wall and may be required to have evaluation reports to address their design. The plank and tie forms, generally, do not reduce the volume of concrete in the wall; therefore, separate evaluation reports for the capacity of the finished concrete wall are not required for plank and tie systems.

The Diamond Snap-Form (DSF) ICF System is a plank and tie system which does not change the physical properties or the configuration of the concrete wall. It functions identically to a plywood or metal form system. That is to say, the form holds the wet concrete in place until the concrete has sufficient strength to support itself. The design requirements for the concrete formed with the DSF ICF System are the same as with any other concrete wall. Rebar is still required in the horizontal and vertical directions as designed by the structural engineer or stipulated by code minimums.

Various sections of the codes that deal with concrete formwork state that the design of the formwork shall include consideration of rate and method of placing concrete and construction loading. Pursuant to these codes, building officials have requested to see structural information on the validity of the DSF ICF System.

Calculations for the spacing of the Diamond Snap-Ties and the capacity of the EPS are included with this technical bulletin. DSF has conducted field and laboratory testing which determined tension values for the Diamond Snap-Ties (6”, 8”, and 10”) at 450 - 650 pounds.

Based on this data, DSF recommends that a pour rate of three to four feet per hour is appropriate. This, as well as the minimum bracing needed to assure plumb and true walls, is shown in our technical data.

The Foam-Control EPS with Perform Guard used in the DSF ICF System is produced under a third party quality control program and is UL listed with flame spread and smoke development ratings that meet major model building codes.

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Tech Bulletin

DSF No. 7002

Subject: **Diamond Snap-Form ICF Screw Withdrawl Capacities**

Date: **February 2011**

The DSF ICF System is used in applications where finish materials such as drywall and sheet sidings are desired. The attachment of these types of finishes is accomplished by installing screws through the finishing material and into the tie face of the Diamond Snap®-Tie (reference the DSF ICF Construction Manual). As support for these types of applications, DSF conducted numerous screw withdrawal tests. In these tests, screws of various sizes and thread design were evaluated for resistance to withdrawal when pulled out of the face of Diamond Snap-Ties. Tests showed only slight variation in the force required to remove a variety of screw fastener types from the tie, irrespective of screw diameter, thread design, or penetration depth.

DSF recommendation for the ultimate withdrawal value of #6 through #14 screw fasteners placed in Diamond Snap-Ties is 210 pounds per fastener.

In all cases: the screw fastener must penetrate the full thickness of the Diamond Snap-Tie face. The finishing materials manufacturers' recommendations for fastener frequency should be followed. Applications exposed to weather conditions should utilize corrosion resistant fasteners.

The data in this bulletin is an average ultimate withdrawal value. No factor of safety has been applied. An appropriate factor of safety must be used in design calculations.

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TECH BULLETIN

DSF No. 7003

Subject: **Concrete - Wood Wall Strength Comparison**

Date: **February 2011**

Diamond Snap-Form has prepared a guide for strength comparison of concrete construction versus wood construction. Specific conditions for comparison of each wall type are presented in this bulletin. The variables are spelled out for each material and the results follow.

The wall comparisons are based on bending strengths only. The deflection limitations of the various materials are not considered. In designing a specific project, the serviceability of the wall (i.e., the deflection requirements) must also be considered.

** NOTE: Comparisons given here are not to be used for any project designs. They are strictly for information only. DSF recommends that the applicable code requirements and the services of a registered professional structural engineer be used for the design of specific projects.

Situation: Exterior wall, 10' tall, wind loading only (i.e. no gravity load).

Wall Type - Stud Wall:

2 x 4 Stud Wall

SPF #2 & better;

2 x 4 @ 16" o.c.;

F_b = 850 psi;

Capacity = 13 psf

2 x 6 Stud Wall

SPF #2 & better;

2 x 6 @ 16" o.c.;

F_b = 850 psi;

Capacity = 32 psf

2 x 8 Stud Wall

SPF #2 & better;

2 x 8 @ 16" o.c.;

F_b = 850 psi;

Capacity = 56 psf

2 x 10 Stud Wall

SPF #2 & better;

2 x 10 @ 16" o.c.;

F_b = 850 psi;

Capacity = 90 psf

Wall Type - Reinforced Concrete:

4" Concrete Wall

f'_c = 3000 psi;

A_s = #4's @ 24" o.c.;

F_y = 60 ksi;

Reinforcing centered in 4" wall.

Capacity = 59 psf

6" Concrete Wall

f'_c = 3000 psi;

A_s = #4's @ 24" o.c.;

F_y = 60 ksi;

Reinforcing centered in 6" wall.

Capacity = 89 psf

8" Concrete Wall

f'_c = 1350 psi;

A_s = #4's @ 24" o.c.;

F_y = 60 ksi;

Reinforcing centered in 8" wall.

Capacity = 120 psf

10" Concrete Wall

f'_c = 1350 psi;

A_s = #4's @ 24" o.c.;

F_y = 60 ksi;

Reinforcing centered in 10" wall.

Capacity = 150 psf

Wall Type - Unreinforced Concrete:

4" Concrete Wall

f'_c = 3000 psi;

A_s = None;

Capacity = 29 psf

6" Concrete Wall

f'_c = 3000 psi;

A_s = None;

Capacity = 66 psf

8" Concrete Wall

f'_c = 1350 psi;

A_s = None;

Capacity = 117 psf

10" Concrete Wall

f'_c = 1350 psi;

A_s = None;

Capacity = 183 psf

Key:
F_b - bending stress strength level of the wood (SPF #2 usually rates 850 psi)
Capacity refers to the wind load wall strength in pounds per square foot (psf)
f'_c - compressive strength of the concrete used (usually at 28 days cure time)
A_s - size of rebar in the wall (#4 = 1/2 inch diameter) and the spacing (24 inch O/C)
F_y - yield strength of the steel rebar - in this case 60,000 pounds per square inch

Diamond Snap-Form is manufactured by Big Sky Insulations, Inc.

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Tech Bulletin

DSF No. 7004

Subject: **Diamond Snap-Form ICF Corner Room Test Results**

Date: **February 2011**

The International Building Code (IBC) has specific requirements when it comes to the application of foam plastics.

The codes require the use of a thermal barrier covering the foam plastic, when the foam plastic is placed toward the interior of habitable space.

This code requirement does not include attics with limited access, crawl spaces, or mechanical rooms, all of which have alternate provisions within the codes.

A recognized building product used to meet these thermal barrier code requirements is 1/2" gypsum board (other materials may qualify under the code). In applications where the DSF ICF System is utilized to create a full basement or the main structure above grade, it is required that the Diamond Snap-Form ICF interior be covered with a thermal barrier.

DSF ICF was subjected to a "Corner Room Burn" (UL 1715, UBC 26-3) test at a third party laboratory to demonstrate that the application of gypsum over the DSF ICF System meets code requirements for a thermal barrier. This test showed that the code-required thermal barrier remained in place through the fire test.

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Tech Bulletin

DSF No. 7005

Subject: **Real Time Aging of Diamond Snap-Form Ties**

Date: **February 2011**

Construction projects may take weeks or even months to complete. During this time, the components used in the construction are exposed to the elements. To demonstrate that the DSF ICF System is not negatively effected by long term exterior exposure, DSF conducted field exposure tests on Diamond Snap-Ties.

Diamond Snap-Form subjected DSF Ties to the elements for an extended period of time - five months. During this time, the ties were mounted in both horizontal and vertical positions facing due south. At the conclusion of the exposure, the DSF Ties were tested for color retention, screw holding power, and tensile strength.

After five months of exposure to ambient outdoor conditions, the weathered DSF Ties showed:

- No color change
- Maintained their excellent screw holding capabilities (see ICF Tech. Bulletin #7002)
- Retained their complete tensile strength

In addition to the controlled experiment described, DSF also tested DSF Ties on a 1-1/2 year old concrete filled field exposed test wall. DSF monitored the appearance and tested the screw holding capacity of the exposed ties. The field exposed wall was located in Denver, Colorado. It was subjected to the harsh ultraviolet light exposure and temperature fluctuations that Denver is known to experience.

After this severe 1-1/2 year exposure to the elements, the weathered DSF Ties showed:

- Excellent color retention.
- Screw holding capacities in excess of recommended values (see ICF Tech Bulletin #7002).
- Retained their complete tensile strength

DSF testing demonstrates that projects utilizing the DSF ICF System will maintain the necessary attachment strength characteristics under general construction time exposure.

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TECH BULLETIN

DSF No. 7006

Subject: **Concrete Consolidation in the Diamond Snap-Form ICF System**

Date: **February 2011**

Concrete form applications that use rigid wood, steel or hard board require that concrete placed within the form be consolidated by vibration. The vibration requirement for these type of form materials is necessary to ensure that no voids or pockets are created in the concrete. Voids can be caused by the lack of flow around obstacles such as ties, rebar and blockouts within these rigid form types. Air also may be trapped during the pour.

DSF ICF does not require vibration when you follow DSF recommended application procedures. The Diamond Snap-Tie is designed to allow 4" - 6" slump concrete, with 3/4" or smaller aggregate to readily flow around and through the tie. The Diamond Snap-Tie design, along with the natural vibration that takes place in the form system during the concrete placement, eliminates the need for additional vibration. The natural vibration caused by the concrete placement eliminates voids and honey-combing in the DSF ICF System wall.

Diamond Snap-Form has evaluated in-place DSF ICF walls to prove that consolidation does occur. Block-outs have been removed and the Foam-Control EPS with Perform Guard® stripped from the projects. Each of these applications showed excellent consolidation of the concrete.

To further demonstrate that complete consolidation occurs around the Diamond Snap-Ties, a concrete saw was used to cut through a typical 8" DSF wall. The cut was made directly in line with a row of Snap-Ties. It was found that concrete had flowed through and completely around the Diamond Snap-Ties. Consolidation was so complete that the printing found on the web of the tie was embossed into the concrete and legible.

Diamond Snap-Form®
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Tech Bulletin

DSF No. 7007

Subject: **ICF Diamond Snap-Tie Alkalinity Resistance**

Date: **February 2011**

Any time products are used in conjunction with concrete, the product is subjected to an alkaline environment. This alkaline environment has a tendency to slowly deteriorate many materials over time. Diamond Snap-Ties are encased in concrete, and these ties must continue to withstand potential alkalie exposure.

DSF ICF polymer is resistant to many chemicals, including alkalies. The Diamond Snap-Tie is manufactured from polypropylene homopolymer and produced under a strict quality control program. Through utilization of this high quality, alkalie resistant polymer, DSF knows that its Diamond Snap-Ties will perform unaffected in concrete.

Diamond Snap-Form®
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Tech Bulletin

DSF No. 7008

Subject: **Rebar Requirements and Diamond Snap-Form ICF System**

Date: **February 2011**

Concrete walls can be classified as either plain concrete or reinforced concrete. The American Concrete Institute (ACI) defines plain concrete as concrete that is either unreinforced or contains less reinforcement that the minimum amount specified in the code for reinforced concrete. Reinforced concrete is defined as concrete reinforced with no less than the minimum amount required by the code, and designed on the same assumption that the two materials act together in resisting force. ACI also states that reinforcement shall be accurately placed, adequately supported and be secured against displacement at the time of the concrete pour, within tolerances of the code.

In typical reinforced concrete walls, the horizontal and vertical rebar is secured against displacement by wire tying the rebar and by the use of spacers. When building with the DSF ICF System these methods of securing the rebar are not necessary. The Diamond Snap-Tie has a rebar cradle into which the horizontal reinforcement is placed. This secures the rebar in place. The positioning of the rebar cradle also ensures that the concrete cover is a minimum of 1 1/2 inches. Vertical rebar is captured between the webs of several Diamond Snap-Ties. The friction developed from placement of the vertical rebar keeps it in place when the concrete is poured.

When designing reinforcement for the DSF ICF System, it is most efficient to keep the spacing of the horizontal and vertical reinforcing to multiples of 12 inches, since the Diamond Snap-Ties are spaced at 12 inches on center in each direction. This spacing of reinforcing will allow the Diamond Snap-Ties to secure the rebar against any displacement and not require any time consuming wire tying of the rebar.

Diamond Snap-Form®
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Tech Bulletin

DSF No. 7009

Subject: **Sound Transmission of Concrete Walls**

Date: **February 2011**

The Diamond Snap-Form ICF System is often used in above grade applications. Many of these applications, including exterior and partition walls of commercial structures, require that specific sound transmission standards be met. These requirements are usually called out for in a specification as a STC value. STC (sound transmission class) is determined by testing full scale wall assemblies for the amount of sound which transmits through the assembly at various frequencies.

The following are STC Values for concrete wall assemblies which consist of plain concrete (no insulation attached):

Concrete wall thickness	STC*
6”	57
8”	58

* STC values extracted from Portland Cement Association paper, “Sound Loss Through Concrete and Masonry Walls”, by Albert Litvin and Harold Belliston.

These STC values typically will meet or exceed specific sound transmission requirements found in most structures. STC values will also be enhanced when additional finishes, such as drywall and/or cementitious coatings, are added to the final wall assembly. Please consult with the Portland Cement Association, as well as other appropriate resources, regarding concrete design.

DSF ICF wall applications provide excellent sound resistance and will meet most specifications found in commercial and common wall structures. Design of final application to meet STC requirements is the responsibility of the building designer.

Diamond Snap-Form®
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Tech Bulletin

DSF No. 7010

Subject: **12” & Greater Diamond Snap-Form ICF Applications**

Date: **February 2011**

The DSF ICF System is available with ties that create 6”, 8” and 10” concrete wall assemblies. In a small percentage of applications a greater thickness of concrete may be desired. Diamond Snap-Form has developed a cost effective means for creating a form system that will allow for walls of 16” and greater.

The following chart shows tie combinations and the resulting concrete thickness of the wall.

Tie combination	=	Wall Thickness
6”+ 6”		16”
6”+ 8”		18”
6”+ 10”		20”
8”+ 8”		20”
8”+ 10”		22”
10”+ 10”		24”

When ties are combined to fabricate ties for these larger wall sections, it is necessary to attach the ties to each other with four # 6 course threaded drywall screws. Care must be taken not to over torque the screws. Thick wall sections, such as those listed above, are not to be poured in lifts greater than two feet per pass.

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Tech Bulletin

DSF No. 7011

Subject: **Concrete Placement Diamond Snap-Form ICF**

Date: **February 2011**

The following recommendations are intended to help you successfully pour your DSF ICF wall.

• First and foremost, schedule the concrete to arrive only after your DSF ICF system is completely in place and you have time to double check your details.

• Be sure to plan ahead when ordering pump trucks and concrete. Allow time for the equipment and concrete suppliers to schedule your delivery.

• Concrete trucks hold at most 10 cubic yards of concrete and most suppliers allow 5 to 7 minutes per yard of concrete to unload.

• Ask the ready mix supplier to space the concrete trucks out appropriately for your project.

• Normal concrete mix for a DSF ICF wall is 5" slump with maximum 3/4" cut aggregate. However, design and/or code requirements could possibly dictate a different concrete mix.

• When ordering concrete explain to the ready mix supplier and pump truck contractor that you are pouring an ICF system.

• Tell the pump truck supplier that you want two 90 degree elbows or an "S" attachment for the end of the pump hose. Elbows and "S" attachments help control the discharge of the concrete from the delivery hose.

• If you can get a pump truck that is a newer model with an accumulator on it, request this from the pump truck supplier.

• A pump truck will retain about 1 cubic yard of concrete in its hopper and line. If you cannot hand haul this to the ICF wall, it will be dumped in cleanup. To be sure you have an adequate quantity of concrete ordered, it is best to give your ready mix company your wall dimensions, and let them tell you how much concrete you should order. In this way, any wastage factor becomes their responsibility and should be taken into a account by them.

• When you are pouring concrete into the DSF ICF system, direct the concrete stream between the Diamond Snap-Ties as you move down the wall. Always pour concrete at a controlled rate.

• Pouring should be done in 4 foot maximum lifts in a continuous pour around the DSF ICF wall.

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TECH BULLETIN

DSF No. 7012

Subject: **Use of EIFS Type Systems over Diamond Snap-Form ICF**

Date: **February 2011**

The DSF ICF System consists of a uniquely designed plastic tension tie and high density Foam-Control EPS with Perform Guard® insulation. These components are used to create a lightweight rigid form, into which concrete is poured, resulting in a high strength insulated concrete wall system.

The DSF ICF System has been used widely in building foundations, above grade walls, retaining walls and other similar structures. DSF feels that EIFS products are an exceptional finish for the DSF ICF System. We have developed details which show the application of EIFS systems. We are providing these to users of the DSF ICF System, so that they have a basic understanding of the methods for applying EIFS Systems and One Coat Stucco products.

Complete installation guidelines for EIFS Systems should be obtained from the EIFS company. The recommended guidelines, as warranted by the EIFS manufacturer, are recognized as the primary source of installation information for the EIFS System. Our recommendations are general and show the two basic approaches for the application of EIFS and One Coat Stucco Systems over the DSF ICF System:

- **Polymer Based Systems** - DSF suggests that a minimum layer of 3/4" EPS be applied over the ICF System. Attachment can be made by EPS foam to EPS foam adhesive bonding methods that are recommended by the EIFS manufacturer. Attachment can also be made by screw fasteners into the Diamond Snap-Tie face, as recommended by the EIFS manufacturer. The finish system can then be applied per the EIFS manufacturer's guidelines. Expansion joints should be installed where substrate changes occur, or at a frequency recommended by the Polymer Based EIFS manufacturer.

- **Polymer Modified Systems** - DSF suggests that these systems can be applied directly to the ICF System, provided that the DSF ICF substrate has been rasped to a level plane, and that a reinforcing mesh recommended by the EIFS manufacturer is used. The reinforcing mesh should be screw applied to the face of the Diamond Snap-Tie, with the polymer modified reinforced coating then applied at a level fully embedding the mesh and covering the face of the Diamond Snap-Tie plate at a minimum thickness recommended by the Polymer Modified EIFS manufacturer. Finish coloring, when required, should be applied per the EIFS manufacturer's guidelines. Expansion joints should be installed where substrate changes occur or at a frequency recommended by the Polymer Modified EIFS manufacturer.

- **One Coat Stucco Systems** - DSF suggests that these systems can be directly applied to the DSF System provided that the DSF substrate has been rasped to a level plane, and that a reinforcing wire recommended by the one coat stucco manufacturer is used. The reinforcing wire should be screw applied to the face of the Diamond Snap-Tie with the one coat stucco then applied at a level fully embedding the wire reinforcement and covering the face of the Diamond Snap-Tie plate at a minimum thickness recommended by the one coat stucco manufacturer. Finish coloring, when required, should be applied per the one coat stucco manufacturer's guidelines. Expansion joints should be installed at a frequency recommended by the one coat stucco manufacturer.

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TECH BULLETIN

DSF No. 7013

Subject: **Windspeed versus Pressure - Diamond Snap-Form ICF**

Date: **February 2011**

Diamond Snap-Form (DSF) ICF recommends the following formula be used in order to calculate the approximate load that will be imposed on a DSF formed concrete wall for a specific windspeed:

The following formula and graph are based upon atmospheric pressure of 14.7, a temperature of 60°F and a velocity pressure based on air which is 0.0764 lbs/ft^3. Actual values will vary with elevation, atmospheric conditions and geographic location. The formula for approximating velocity pressure is $p=0.00256w^2$ or the constant of 0.00256 X the windspeed squared. A qualified engineer should be consulted to ensure adequate design of the concrete wall.