TECHNICAL BULLETIN No. 3

In April 2011, more than 500 tornadoes were recorded across 16 states taking more than 300 lives and leaving over 10 billion dollars in property damage.

So far, more than 1600 tornadoes and 7 hurricanes have recorded for 2011 costing more than 20 billion dollars in property damage.

Source: http://www.nssl.noaa.gov/news/2011/

Hurricanes and tornadoes have progressively caused more damage to property, personal injury and loss of life than any other natural disaster in the United States. In fact, 2011 is proving to be a record year for tornadoes costing billions in property damage, and hundreds of lives lost.

As we continue to rebuild in the paths of hurricanes and tornadoes, stronger and more durable building materials than traditional framed or masonry wall construction needs to be considered. Basically, these buildings need to be more resistant to extreme wind events than what is currently required by building codes.

Element is a new ICF product that is quickly gaining popularity in the building industry as an alternative to traditional framed or masonry construction. Despite its recent introduction, Element has already proven to be quick and easy to install, offering built-in insulation and a vapor barrier. The thick rigid foam insulation combined with the concrete core creates a highly energy-efficient wall system.

The added benefit of a solid reinforced concrete core protected by a layer of rigid foam makes Element one of the strongest, most durable wall systems available, and ideal for buildings and safe rooms in high wind-prone regions.

This document discusses the use of Element in the design and construction of buildings and safe rooms in high wind-prone regions. In addition, engineered wind load tables and FEMA compliant ready-to-use safe room construction plans are noted as a design aid specific for Element.

BUILDINGS CONSTRUCTED TO MODEL BUILDING CODES

Depending on the geographic location of the building, the model building codes require the design and construction of buildings in high wind regions to be based on basic wind speeds that may be up to 170 mph (200 mph in the Florida Building Code). Statistically, this covers approximately 90% of all wind speeds experienced in the US including those generated by hurricanes and weaker tornadoes.

The main model building codes in the United States include the International Residential Code and the International Building Code.

TECHNICAL BULLETIN No. 3

ICF home left standing and surrounded by rubble in the aftermath of Hurricane Katrina. Source: Insulating Concrete Blocks Association, "ICFs Stand Up to Storms"

Buildings in compliance to the model building codes are designed and constructed with adequate wall to roof, and wall to footing connections, so that a continuous load path is provided to transfer wind loads from the framing members to the foundation. *However, with the exception of window openings, model building codes have no requirements for the protection of exterior walls and roofs from wind-borne debris*. As a result, buildings hit from flying debris during high wind events can experience a breach in the building envelope through the exterior walls, even within wind speeds the building was designed for.

A breach in the building envelope during high wind events can greatly increase the pressure experienced by the building, which can lead to possible structural damage and potential harm to building occupants. *For the most part, minimum requirements of model building codes are meant to protect the loss of property rather than the loss of life*.

Generally, the costs associated to design and construct a debris resistant home, or larger building, with the intent to fully protect its building occupants, make it impractical to build. Which is likely the reason there are no wind-borne debris impact protection requirements for exterior walls and roofs in model building codes.

However, with exterior walls being the main structural support for buildings, stronger, more durable walls offer more protection to building occupants against debris impacts, and can reduce the costs of maintenance and repairs compared to framed and masonry construction.

Without further enhancements, traditional framed buildings offer little resistance to debris impacts[1]. In addition, air infiltrating through framed walls during extreme wind events can increase the stress on the building. Masonry construction requires full grouting and reinforcement. In comparison, Element walls are naturally strong, durable and airtight structures that resist high wind loads, and debris impacts without the need to further strengthen the wall.

History has shown that reinforced concrete structures, like those built with Element, are often the only buildings left standing in the aftermath of a hurricane or tornado.

> *"There are no reports of any cast-in-place concrete buildings experiencing a significant structural problem during wind events, including the strongest hurricanes (Category V) and tornadoes (F5)."*
>
> *Source: Whole Building Design Guide, http://www.wbdg.org/resources/env_wind.php, "Wind Safety of the Building Envelope"*

TECHNICAL BULLETIN No. 3

Since 1980, more than 30,000 storm shelters or safe rooms have been built saving more than 10,000 lives every year.

FEMA grant programs have provided over 260 million dollars in funds to building nearly 20,000 residential and 500 community safe rooms.

There are federal and local initiatives to aide in the cost of FEMA compliant safe rooms. Contact your local government or visit www.fema.gov/plan/prevent/saferoom/srfunding.shtm or contact FEMA at 1-800-621-3362

Despite the lack of wind-borne debris protection in the model building codes for walls and roofs, using Element can help ensure buildings stay intact and provide a higher level of safety, during extreme wind events.

Element is recognized by the Florida State and Miami-Dade County as an approved building product for use in High Velocity Hurricane Zones.

For more information contact your local Element representative or visit the Element Technical Library at www.elementicf.com for the Element Florida State and Miami-Dade evaluation report.

ELEMENT WIND LOAD TABLES

Since reinforced concrete is the structural component of Element, buildings constructed with Element can be designed for higher wind loads than what is required by code.

To aide designers and builders, Table 3B in the Element US Prescriptive Engineering Manual offers a wind load table for above-grade walls where the design wind speed is greater than 150 mph. The table includes wind speeds of 200, 250, 275 and 300 mph for Element walls of varying thicknesses and wall heights. Table 3B can be found at the end of this document.

The use of Table 3B creates Element walls capable of withstanding wind speeds greater than what is require by code, and will offer more safety than framed or masonry walls. However, it is important to note that special attention should be paid to the connection details for wind loads not covered in building codes. Connection details between the wall to footing, and wall to roof, will depend on a number of factors such as wind load, height and shape of building. A local licensed engineer should be consulted if the design of the building is outside the scope of the model building codes.

SAFE ROOMS

Typically buildings are not designed to fully withstand wind-borne debris impacts generated by hurricanes and tornadoes.

Wind driven debris presents the greatest hazard to building occupants and to building structures during a tornado or hurricane. In cases of extreme wind events, building occupants should evacuate to safe rooms designed to protect building occupants.

Every component of a safe room, from the roof to the foundation, is designed to withstand missile impacts and associated wind loads up to 250 mph. This represents more than 99% of all tornadoes known to have occurred in the United States, and higher than Category 5 hurricanes.

TECHNICAL BULLETIN No. 3

The intent of FEMA 361 and 320 is to aide builders and designers in the design and construction of safe rooms. FEMA does not enforce or certify safe rooms.

For the first time, the International Building Code 2009 and the International Residential Code 2009, now references ICC-500, 2008 Standard for The Design and Construction of Storm Shelters. ICC-500 covers requirements for storm shelters. Using ICFs to build FEMA compliant safe rooms will meet or exceed the ICC-500 requirements.

Research has shown that for strength and resistance to debris impacts, ICFs out perform other wall assemblies making them ideal for Safe Rooms. Traditional framed construction requires considerable improvements to match the strength and resistance of ICFs. CMUs require full grouting and reinforcing. Only traditional reinforced concrete and tilt-up panels were comparable to ICFs. However, ICFs were the only wall system that showed no signs of damage to the structural component of the wall assembly - no visible damage to the concrete core of the ICFs tested[1].

It is worth noting, that the tested ICF walls consisted of a 4 inch reinforced concrete core, and performed better than tested 6 inch thick traditional reinforced concrete walls. This is likely due to the layer of rigid foam insulation that blankets the concrete core absorbing energy from debris impacts. Hence, reducing the impact load to the concrete core (analogous to rigid foam used in helmets to absorb impacts).

Element block panels feature some of the thickest foam insulation in the ICF industry, starting at a minimum thickness of 2.75 inches and increasing incrementally by 2 inches with Element XRV™ panels. This makes Element one of the most debris impact-resistant ICFs available.

BUILDING SAFE ROOMS WITH ELEMENT

Based on numerous case studies and research, the Federal Emergency Management Agency (FEMA) has developed two best practice guides for the design and construction of safe rooms. FEMA 361 covers community safe rooms intended to accommodate more than 16 persons, and FEMA 320 covers residential and small business safe rooms intended to accommodate 16 persons or less.

Residential and Small Business Safe Rooms

FEMA 320, Taking Shelter from The Storm, offers a prescriptive guide to the design and construction of safe rooms specifically for residential and small businesses. These safe rooms are intended to hold no more than 16 persons, and include the use of ICFs for the construction of safe rooms.

As an aid to home owners, builders and designers, Logix Brands has developed a set of construction plans for the construction of residential and small business safe rooms using Element. The Element construction plans are FEMA compliant and include plans for
in-ground, basement, crawl space and detached safe rooms. For reference, the Element Safe Room plans can be found at the end of this document.

The Element Safe Room plans for residential and small businesses are available for download in the Element Technical Library, or contact your local Element representative.

TECHNICAL BULLETIN No. 3

The FEMA Safe Room guides are largely based on debris impact testing conducted by the Texas Tech University (TTU), and Florida A & M University. The tests involved wall assemblies representing typical wall sections which included CMU, wood and steel frame, tilt-up, reinforced concrete with removable blocks and ICFs. The walls had a variety of typical cladding and finishes applied for the test.

The TTU tests showed that traditional wall assemblies that meet minimum building codes cannot resist debris impacts during extreme wind events.

For worst case scenario, a 15 lb-2x4 launched from an air compressed cannon and hitting the test walls at 100 mph represented wind-borne debris during a tornado with 250 mph wind speeds, which is greater than a Category 5 hurricane.

Tests showed that reinforced concrete, tilt-up panels, and ICFs are able to resist impacts during a 250 mph wind event. However, reinforced concrete and tilt-up showed signs of spalling and surface damage, whereas ICFs showed no signs of structural damage or even spalling of the concrete core.

The 2 x 4 projectile penetrated the wood and steel framed walls well below the 250 mph wind speed. Tests also showed that wood and steel frame walls require extensive strengthening in order to resist debris impacts during a 250 mph wind event.

While the Element safe room construction plans are comprehensive, consulting with a local engineer is recommended to review the plans and identify any additional local hazards that should be considered before construction.

Safe rooms should not be constructed in flood prone areas. A local engineer can recommend the safest place to locate your safe room.

Community Safe Rooms

The construction of a safe room designed to hold a large number of people dictates a larger building than that required for residential or small business safe rooms. Hence, a structural engineer is required for the design of a community safe room.

FEMA 361, Design and Construction Guidance for Community Safe Rooms, offers design and construction guidelines for community safe rooms, and notes 4 inch ICFs as a wall system capable of providing sufficient protection against extreme wind events and debris impacts.

Depending on the size of the community safe room, designers can use the wind load table, Table 3B, in Section 6 of the Element Design Manual to aide in design of the safe room.

Improving occupant safety means constructing stronger, more durable buildings capable of withstanding large wind loads, including debris impacts, than typical framed and masonry structures. Well recognized for their inherent resistance to large wind loads, and debris impacts, ICFs are the perfect choice for constructing buildings in high wind prone regions. And choosing Element makes it easier for builders and designers to create a building, or safe room, by providing detailed engineered high wind load tables, and FEMA compliant ready-to-build safe room construction plans.

For more information contact Logix Brands at info@logixbrands.com.

[1]Texas Tech University Test Reports, "Construction Materials Threshold Testing", Florida A & M University Test Report, "Large Wind Missile Impact Perblock-ance of Public and Commercial Building Assemblies, National Institute of Science and Technology, "A Summary Report on Debris Impact Resistance of Building Assemblies."

TECHNICAL BULLETIN No. 3

ELEMENT ABOVE-GRADE WALL TABLE

The table below, taken from the Element Design Manual, provides reinforcement for Element walls in areas of high wind-prone regions not covered by model building codes. This table should be used in conjunction with the notes and design parameters detailed in Section 6 of the Element Design Manual.

(WIND SPEEDS GREATER THAN 150 MPH)

TE: Logix Bands recommends builders, owners and /or designers using these tables confirm that on-site building conditions are within the scope of the tables being us

GROUND FLOOR LOGIX SUPPORTING ROOF ONLY

Height of Basement Wall, ft	4" Element				6" Element				8" Element				10" Element				12" Element			
	Unfactored Wind Load (psf)				Unfactored Wind Load (psf)				Unfactored Wind Load (psf)				Unfactored Wind Load (psf)				Unfactored Wind Load (psf)			
	200	250	275	300	200	250	275	300	200	250	275	300	200	250	275	300	200	250	275	300
8	12	8	6	-	16	12	8	8	24	16	12	8	32	16	16	12	42	24	16	16
9	8	6	-	-	16	8	8	6	16	12	8	8	24	16	12	8	32	16	16	12
10	8	-	-	-	12	8	6	-	16	8	8	6	16	12	8	8	24	16	12	8
12	-	-	-	-	8	-	-	-	8	6	6	-	12	8	6	6	16	8	8	6
14	-	-	-	-	6	-	-	-	8	-	-	-	8	6	-	-	12	8	6	-
16	-	-	-	-	-	-	-	-	6	-	-	-	8	-	-	-	8	6	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	6	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-

GROUND FLOOR LOGIX SUPPORTING 2nd STORY LOGIX (OR 2nd STORY WOOD FRAME) & ROOF ONLY

Height of Basement Wall, ft	4" Element				6" Element				8" Element				10" Element				12" Element			
	Unfactored Wind Load (psf)				Unfactored Wind Load (psf)				Unfactored Wind Load (psf)				Unfactored Wind Load (psf)				Unfactored Wind Load (psf)			
	200	250	275	300	200	250	275	300	200	250	275	300	200	250	275	300	200	250	275	300
8	12	8	6	-	16	12	8	8	24	16	12	12	32	16	16	12	42	24	16	16
9	8	6	-	-	16	8	8	6	16	12	8	8	24	16	12	12	32	16	16	12
10	8	-	-	-	12	8	6	-	16	8	8	6	16	12	8	8	24	16	12	8
12	-	-	-	-	8	-	-	-	12	6	6	-	12	8	6	6	16	8	8	6
14	-	-	-	-	6	-	-	-	8	-	-	-	8	6	-	-	12	8	6	-
16	-	-	-	-	-	-	-	-	6	-	-	-	8	-	-	-	8	6	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	6	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-

NOTES:
1. Table 3B shall be read in conjunction with the notes listed under "NOTES FOR ABOVE-GRADE WALL TABLES."
2. Vertical bar spacing is for #4 rebar. #5 rebar can be substituted provided the spacing is multiplied by 1.5. Spacing shall be no more than 48 inches on center.
3. Steel yield strength = 60 ksi, 28 day concrete compressive strength = 3 ksi.
4. Where cells show "-" engineering is required.