

MASONRY

Association

of Florida



STRUCTURAL CONSIDERATIONS OF CONCRETE MASONRY

Reinforced Masonry vs. Hurricanes & Tornadoes

COMPONENT 3

Don Beers, PE , GC

Don Beers, PE, GC is currently the staff engineer for the Masonry Association of Florida (since 2009) and President of Adrian Engineering, Inc. Previous to 2009 Don acted as Engineering Services Manager with Rinker Materials for 29 years. He is a graduate of the University of South Florida in Civil and Structural Engineering and is a licensed engineer and general contractor in Florida. Has served as Chairman of the National Concrete Masonry Association's Codes Committee, the Florida Concrete & Products Association's Block Committee and a board member for The Masonry Society (TMS).

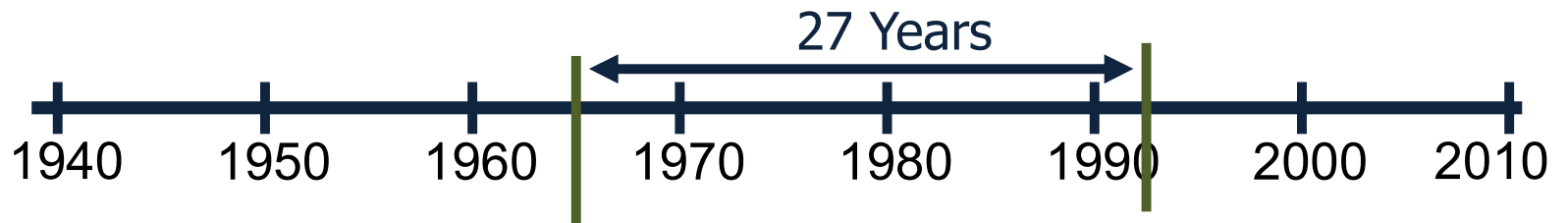
561-310-9902


don@floridamasonry.com



THE RISE OF INFERIOR BUILDING PRODUCTS

- Between 1965 and 1992 there were no significant hurricanes in South Florida.



- 
- Earlier restrictions prohibiting wood frame construction were rescinded when lumber industry threatened a lawsuit claiming discrimination against materials

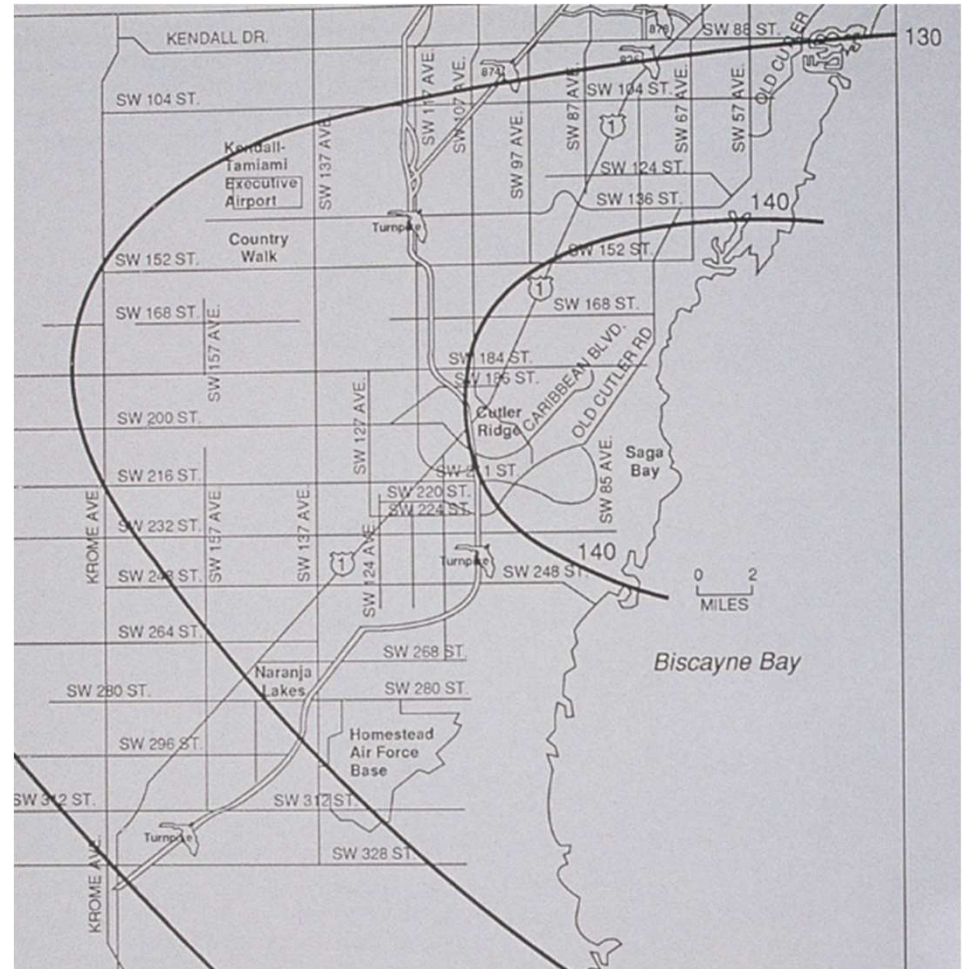
A satellite image of Hurricane Andrew over Florida. The hurricane is shown as a large, dense cloud mass with a distinct eye, appearing in shades of red and white. The Florida peninsula is outlined in yellow. The surrounding ocean is dark blue with some green and cyan patches. In the top right corner, there is a black box with yellow text.

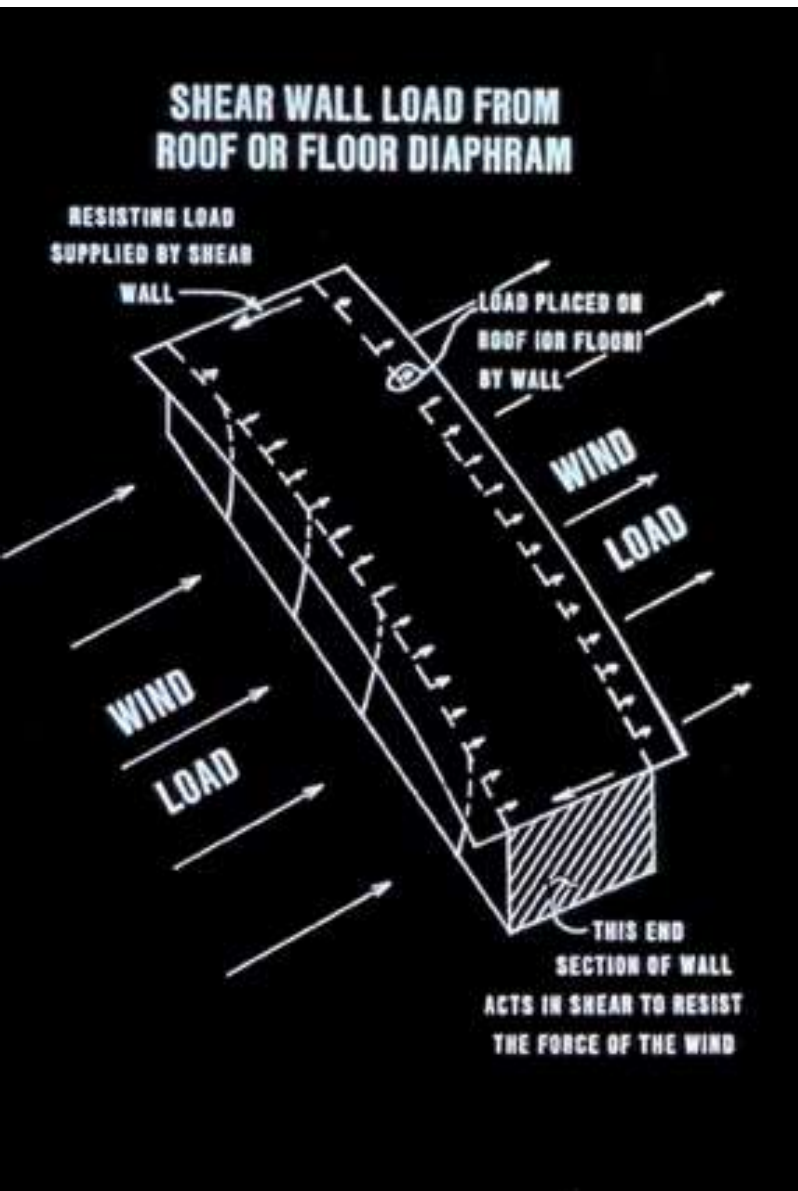
24 AUGUST 1992
5 AM EDT 926 MB

MASONRY VS. HURRICANES

Hurricane Andrew 1992

FROM TIM REINHOLD AT CLEMSON UNIVERSITY





ENGINEERING 101

Diaphragm - A roof or floor system designed to transmit lateral forces to shear walls or lateral load resisting elements.



Hurricane Andrew

An aerial photograph of a tropical coastline. The foreground shows a dark, sandy beach. The middle ground features a strip of green vegetation, possibly a road or a narrow strip of land. The background is a vast expanse of clear, bright blue ocean meeting a clear, light blue sky. A white circle with a thin black border is overlaid on the left side of the image, containing the text "Hurricane Andrew".

**Hurricane
Andrew**

A photograph showing the aftermath of Hurricane Andrew, with a severely damaged roof structure. A white circular overlay is positioned on the left side of the image, containing the text "Hurricane Andrew".

Hurricane Andrew

Hurricane Andrew



Hurricane Andrew



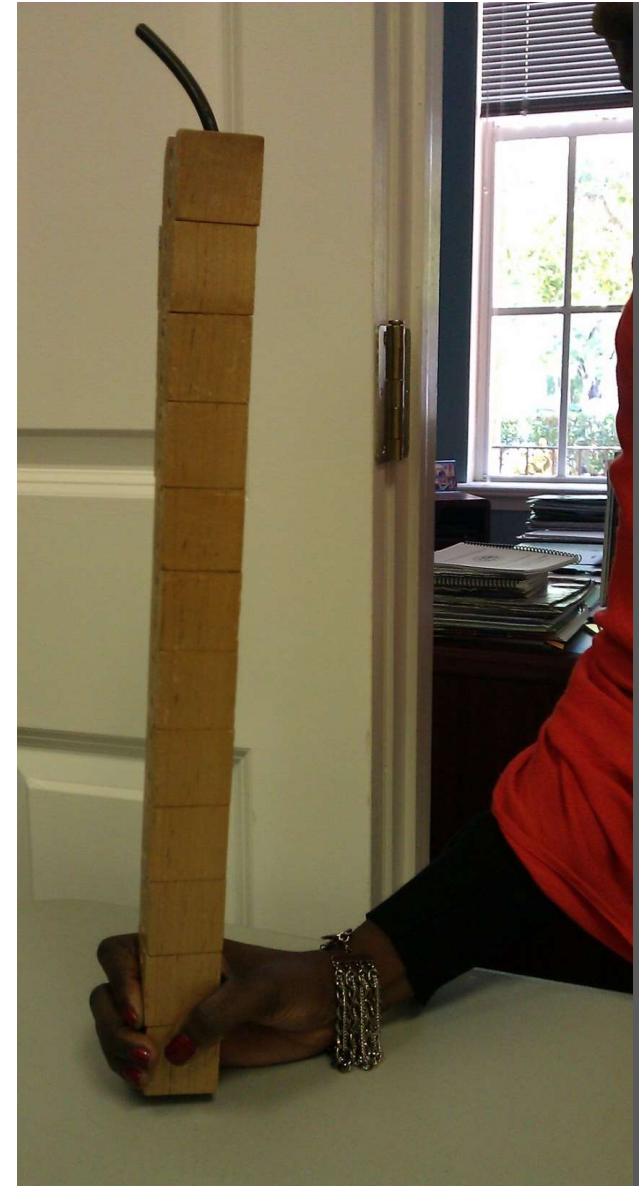


SIMPLY SUPPORTED WALL

Allowed to rotate at the ends -but kept from moving horizontally

CANTILEVERED WALL

Fixed at the base -but
allowed to both rotate
and move horizontally at
the top





TITLE OF SLIDE

- Don, please add a description here

Hurricane Andrew



Hurricane Andrew



A photograph showing the interior of a building that has been severely damaged, likely by a hurricane. The structure is in a state of collapse, with exposed metal beams and twisted rebar. Debris, including large pieces of white insulation or drywall, is scattered throughout the space. A red metal cabinet or structure is visible in the lower-left foreground. The sky is visible through the broken roof, appearing a clear blue. A white circular graphic with a thin black border is overlaid on the left side of the image, containing the text "Hurricane Andrew".

**Hurricane
Andrew**







**Connection
?**



**Hurricane
Andrew**







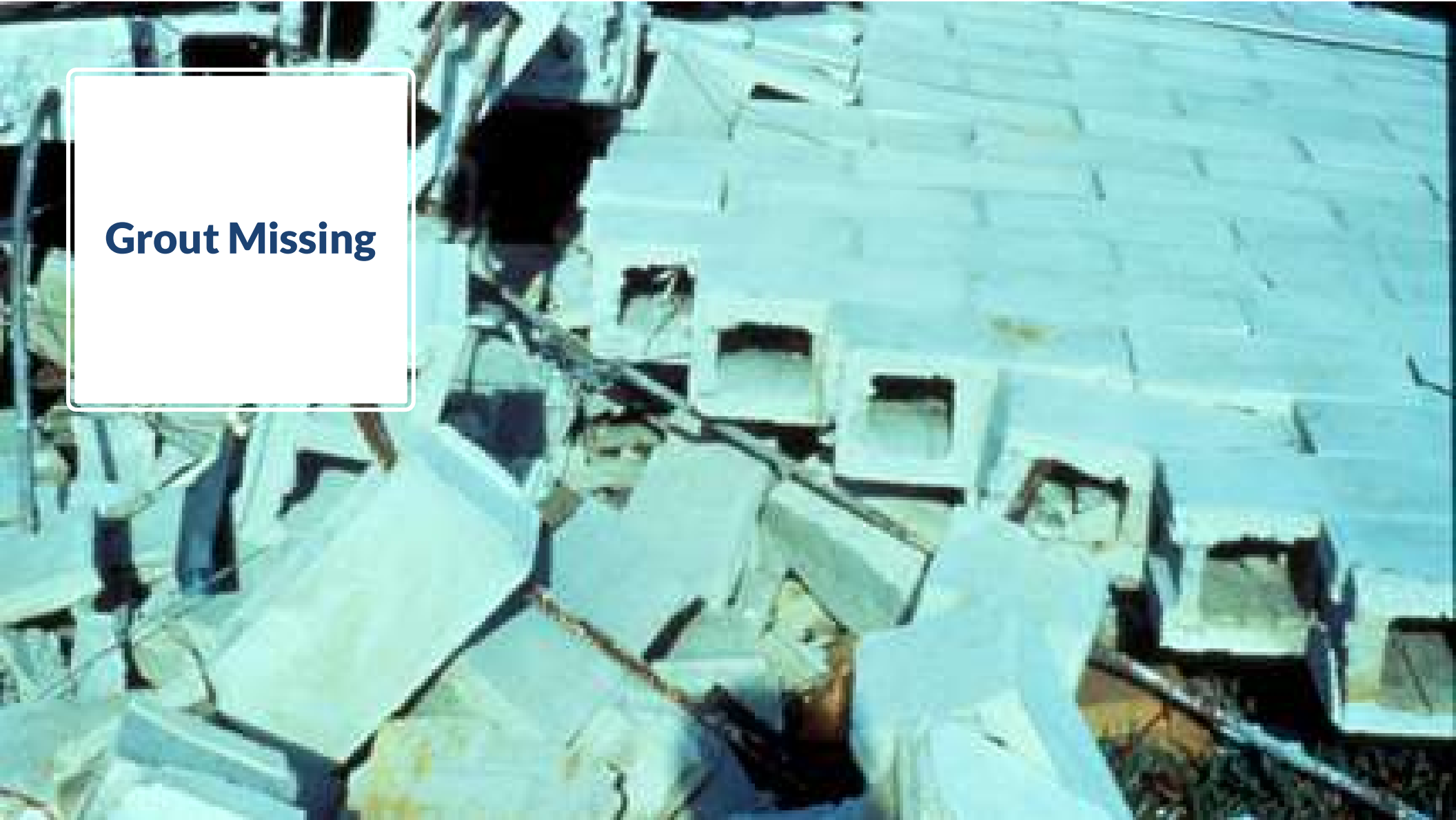
**No connection
to the
prestressed
roof**



The image shows the interior of a building that has been severely damaged by a hurricane. The structure is in a state of collapse, with wooden beams and metal supports exposed and leaning precariously. Debris is scattered throughout the space. A large, white, rectangular object, possibly a piece of furniture or a wall section, is in the foreground. The overall scene is one of destruction and chaos.

Hurricane Andrew

Grout Missing





**Where's the
grout ?**



Hurricane Andrew



A photograph showing the aftermath of a hurricane. In the foreground, a white, textured wall stands amidst a chaotic scene of exposed wooden beams and debris. The background shows a clear, bright blue sky. The overall image conveys the scale of destruction.

Hurricane Andrew



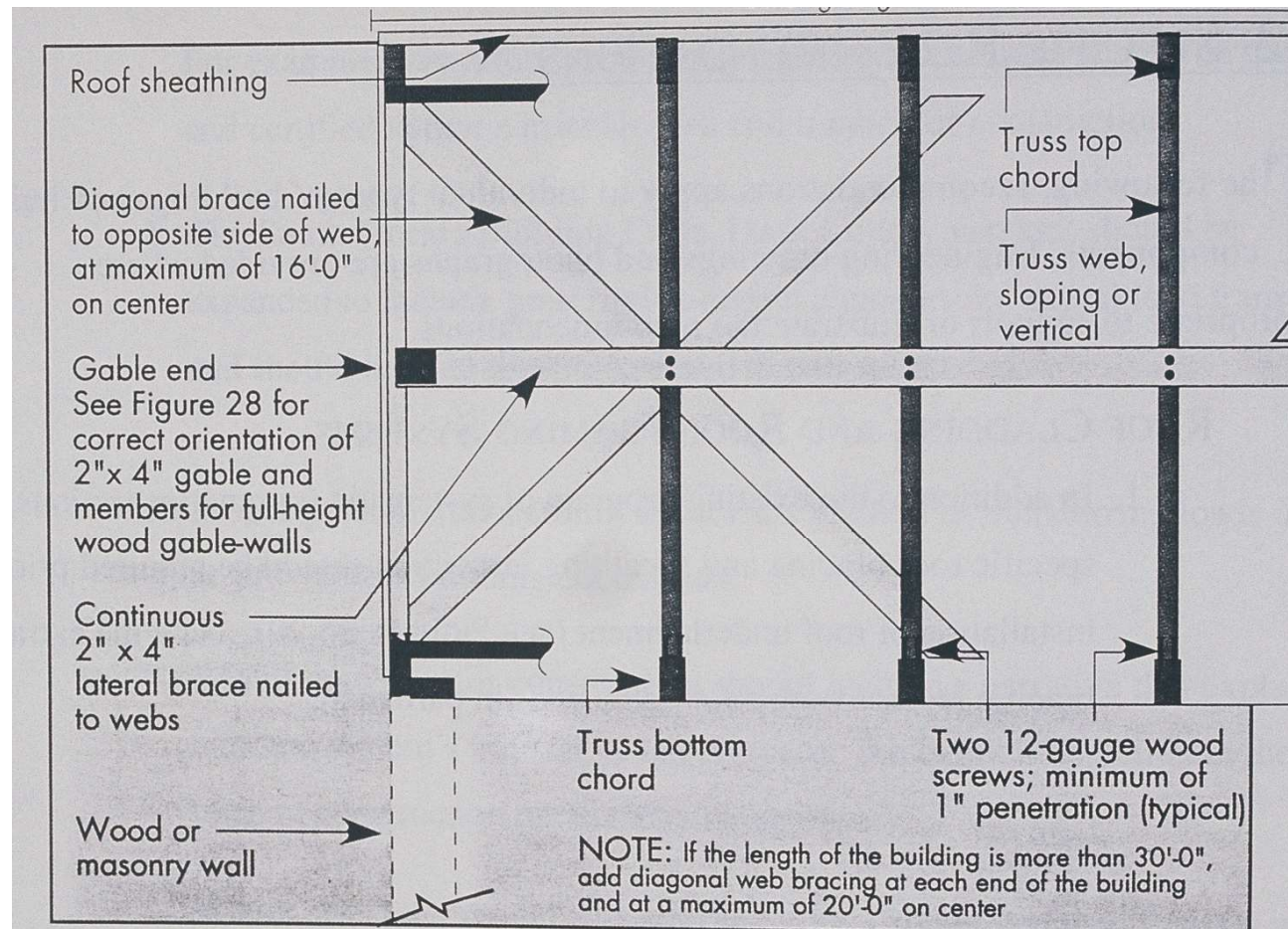
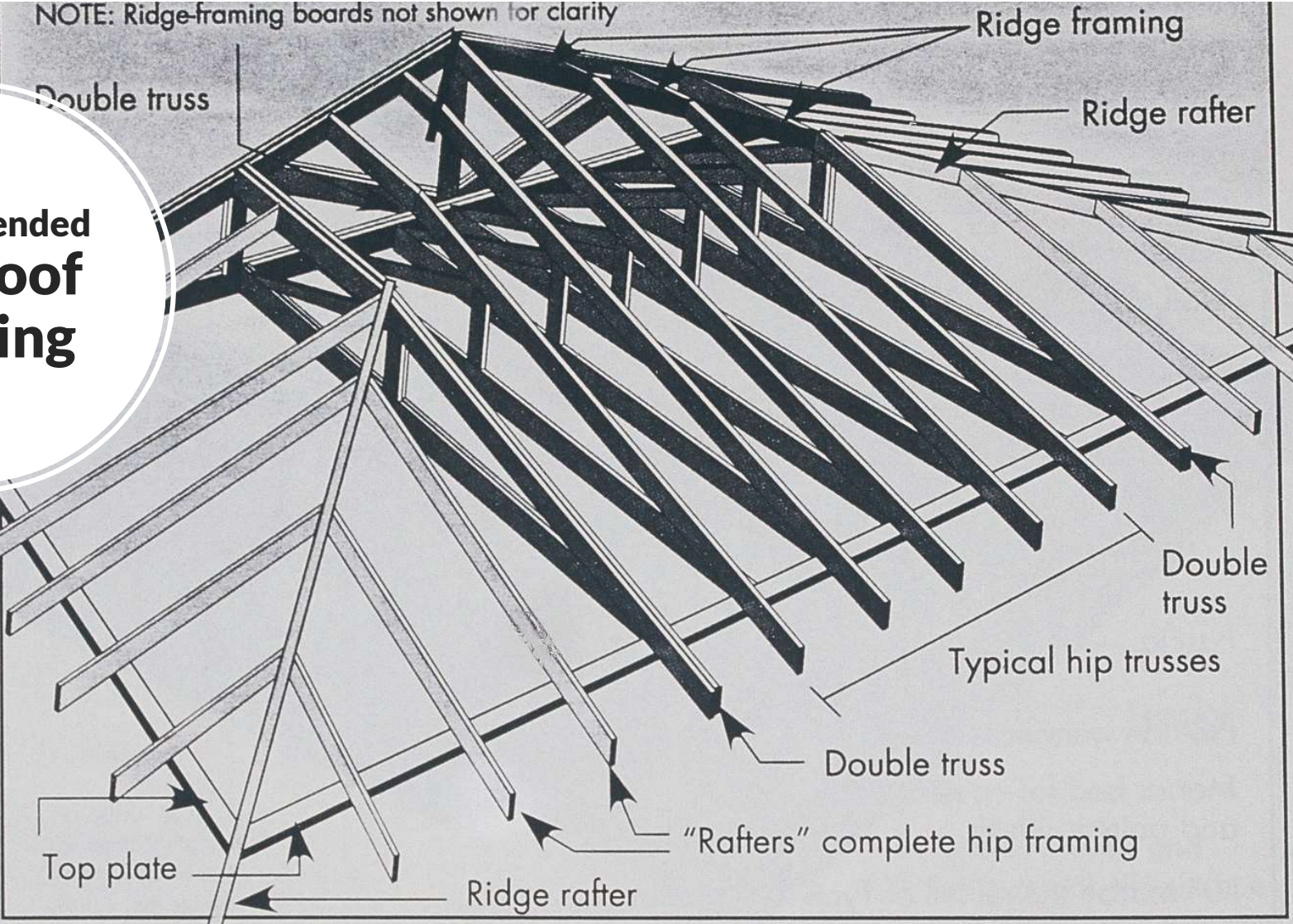


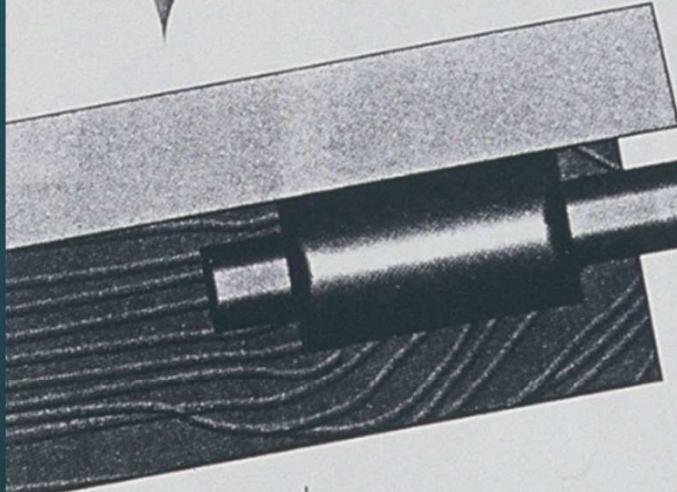
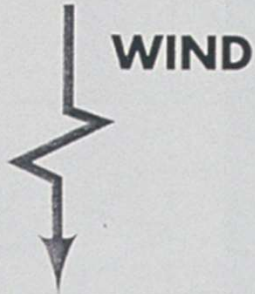
FIGURE 27. *Detail A — Typical truss web bracing. Diagonal web bracing as shown, at each gable end of building.*

**Recommended
Hip Roof
Framing**





Deflection of garage door edge assembly



Displaced glider wheel

Bent and torqued bracket

Bent and torqued glider track

Door deflection ↓

Glider pulls out of track due to deflection
NOTE: Failure may also occur due to pin pullout from wheels

Exterior wall: Reinforced masonry or tie-column (See Figure 64)

Expansion anchor: Establish size and embedment for pullout resistance

Garage door

Edge mullion

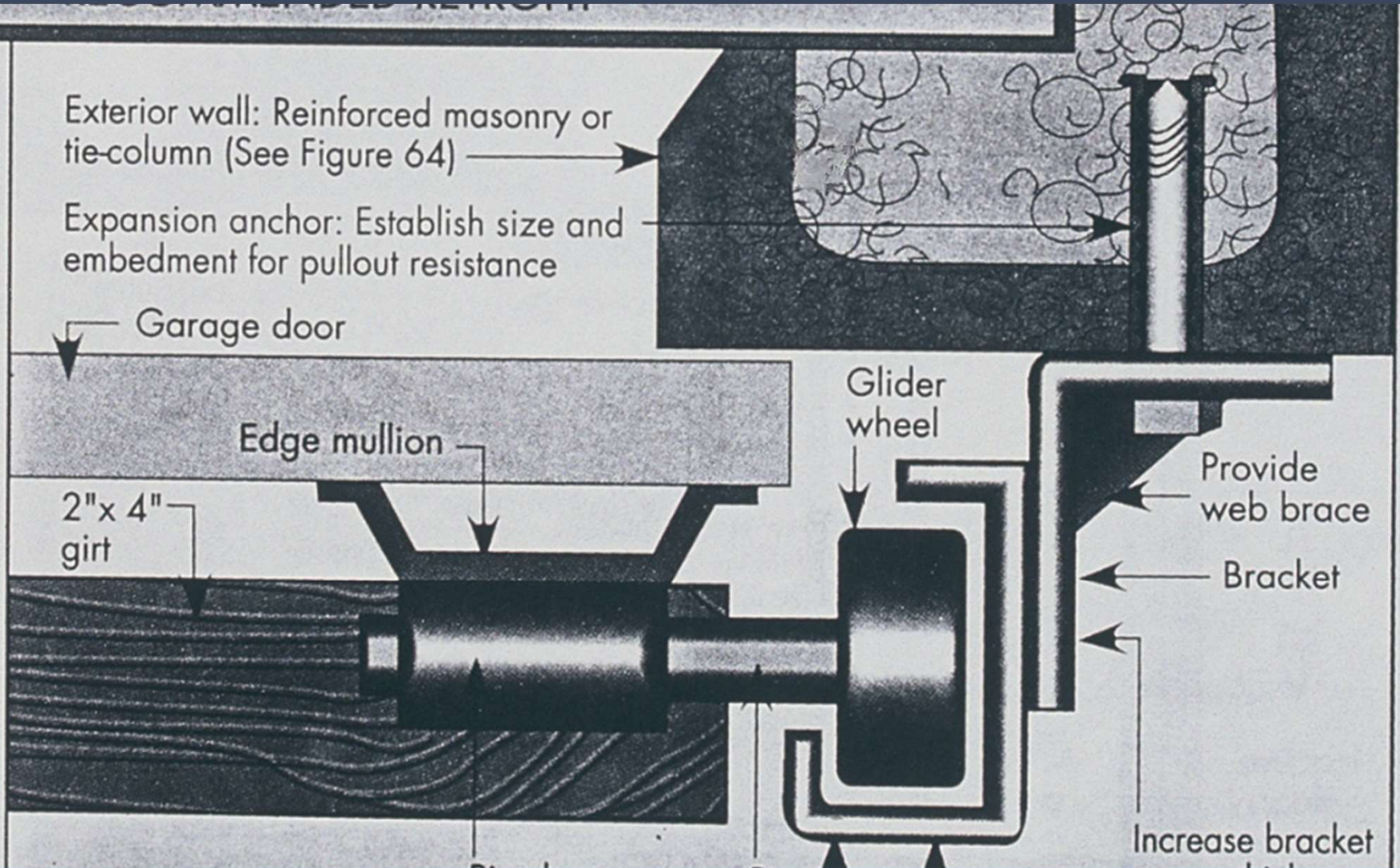
2"x 4" girt

Glider wheel

Provide web brace

Bracket

Increase bracket



DESIGNING MASONRY FOR WIND LOADS

Lessons from Hurricane Andrew

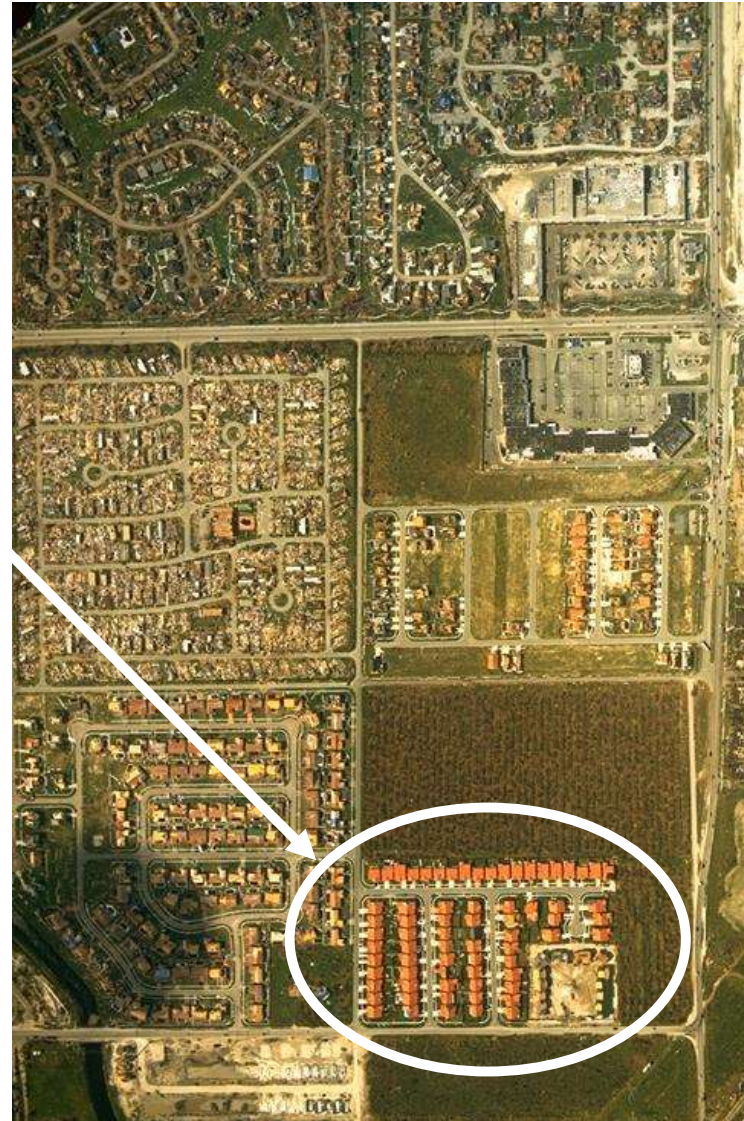
- **DESIGN FAILURES**

- Bond beam design for uplift
- Roof connection at top of
 - wall for lateral wall stability
- Proper bar laps and embedment

- **CONSTRUCTION FAILURES**

- Roof connection at top of
 - wall for lateral wall stability
- Proper steel placement and bar lapping
- Proper grouting of cells

Surrounded by flattened subdivisions this area was virtually undamaged. The damage varied wildly by builder and material type.





Moore, Oklahoma

May 20th, 2013















ANDREW PERFORMANCE!



IBHS

IBHS

COMMON

STRONGER





Insurance
Institute for
Business &
Home
Safety

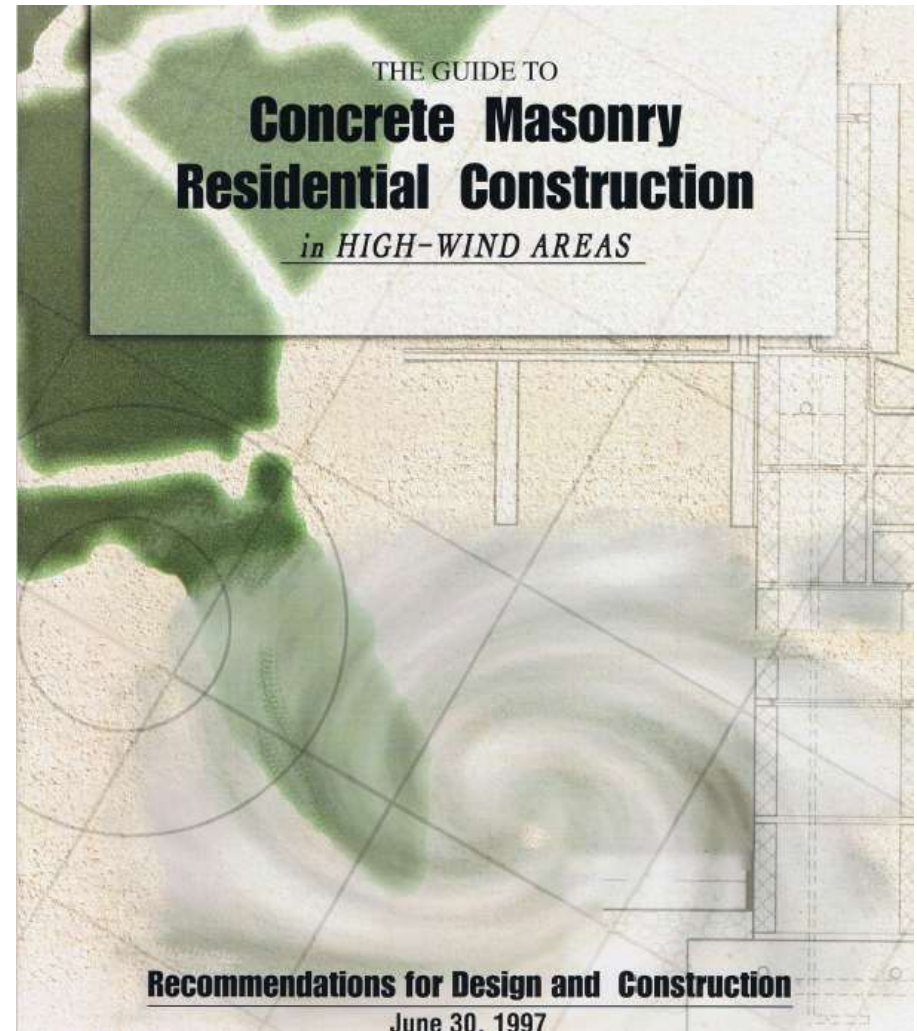
**STANDARD FOR
HURRICANE
RESISTENT
RESIDENTIAL
CONSTRUCTION
SSTD 10-93**

1993

**Standard
For
Hurricane Resistant
Residential Construction
SSTD 10-93**

SBCCI®

**Still a Referenced
Document in the
7th Ed. FBC -
Residential**



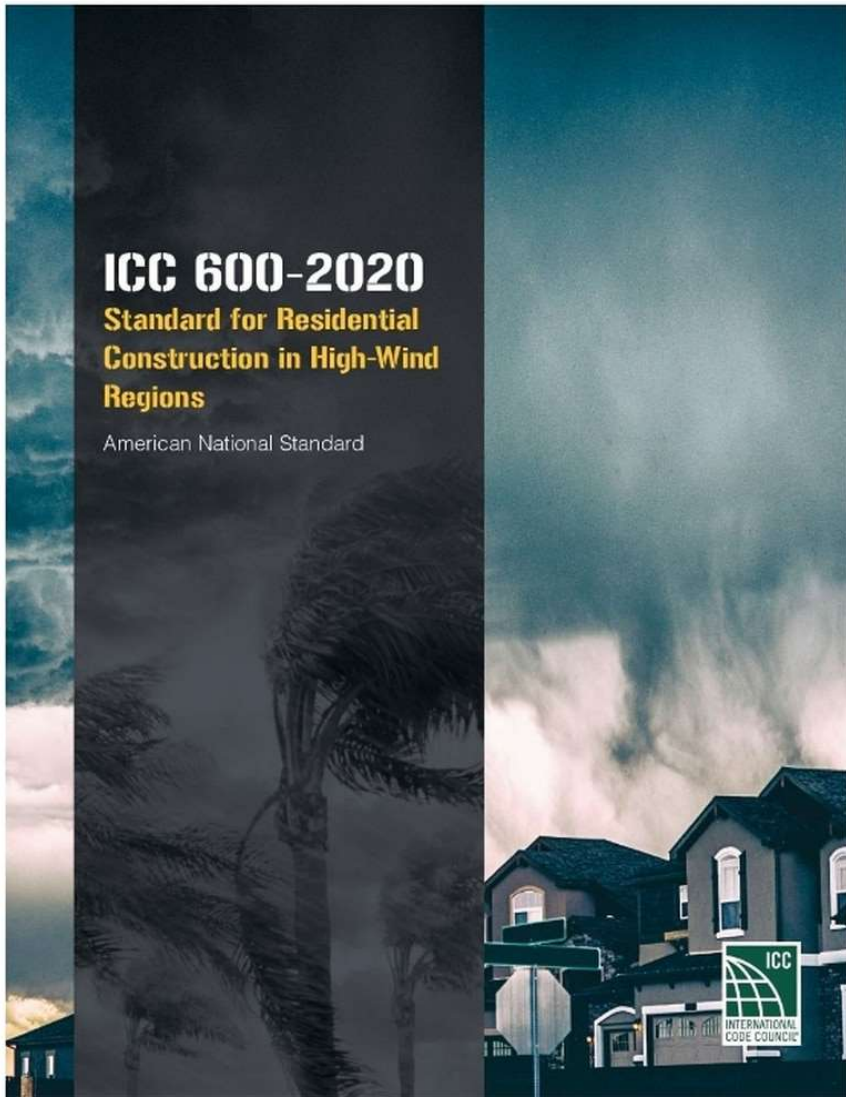
**STANDARD FOR
HURRICANE
RESISTANT
RESIDENTIAL
CONSTRUCTION
SSTD 10-99**

1999

**STANDARD
FOR
HURRICANE
RESISTANT
RESIDENTIAL CONSTRUCTION**

SSTD 10-99

SBCCI®



ICC 600-2020

Update Version
Completed And
Available Online

Current (Older) Version
Referenced in 7th Ed.
FBC

SSTD 10-99

		8" Concrete or Masonry									
8"	8'	12	8	8 ²	6 ²	6 ²	8	8 ²	6 ²	6 ³	6 ³
	10'	10	8	8 ²	6 ²	6 ³	8	6 ²	6 ²	6 ³	4 ³
	12'	8	8 ²	6 ²	6 ²	6 ²	6 ^{a,2}	6 ²	6 ³	6 ³	4 ³
	16'	4 ^{a,3}	4 ^{a,3}	4 ^{a,3}	4 ^{a,3}	4 ^{a,3}	4 ^{a,2}	4 ^{a,3}	4 ^{a,3}	4 ³	4 ³
	20'	4 ²	4 ²	4 ³	4 ³	NP	NP	NP	NP	NP	NP
12" & 16"	8'	32 ^g	18 ^g	18 ^{g,2}	18 ^{g,2}	16 ^{g,2}	18 ^h	16 ^h	14 ^{h,2}	14 ^{h,2}	12 ^{h,2}
	10'	12 ^f	10 ^c	10 ^{c,2}	10 ^{c,2}	10 ^{c,2}	8 ^d	8 ^{c,2}	8 ^{c,2}	8 ^{c,2}	8 ^{c,3}
	12'	8 ^{a,d}	8 ^{a,d,2}	8 ^{a,d,2}	8 ^{a,d,2}	8 ^{a,d,3}	6 ^{a,d}	6 ^{a,d,2}	6 ^{a,d,2}	6 ^{a,d,3}	6 ^{a,d,3}
	16'	4 ^a	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,3}	4 ³
	20'	4 ^{e,2}	4 ^{e,2}	4 ^{e,3}	4 ^{e,3}	4 ^{e,3}	NP	NP	NP	NP	NP

ICC 600

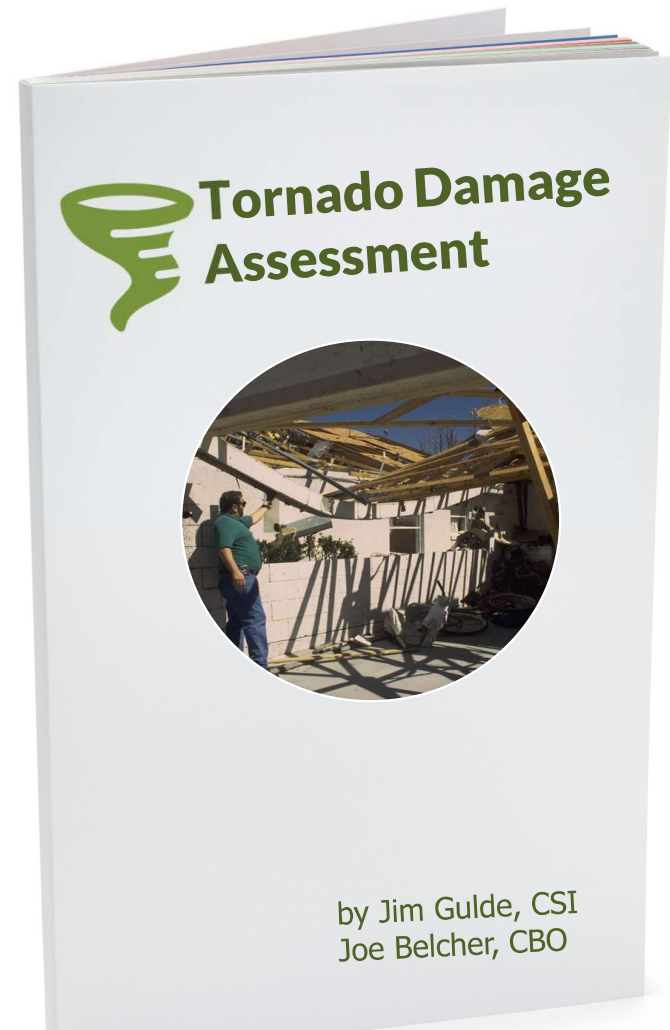
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8"	8'	12	8	8 ²	6 ²	6 ²	8	8 ²	6 ²	6 ³	6 ³
	10'	10	8	8 ²	6 ²	6 ³	8	6 ²	6 ²	6 ³	4 ³
	12'	8	8 ²	6 ²	6 ²	6 ²	6 ^{a,2}	6 ²	6 ³	6 ³	4 ³
	16'	4 ^{a,3}	4 ^{a,3}	4 ^{a,3}	4 ^{a,3}	4 ^{a,3}	4 ^{a,2}	4 ^{a,3}	4 ^{a,3}	4 ³	4 ³
	20'	4 ²	4 ²	4 ³	4 ³	NP	NP	NP	NP	NP	NP
12" & 16"	8'	10 ^g	10 ^g	10 ^{g,2}	10 ^{g,2}	10 ^{g,2}	10 ^h	10 ^h	10 ^{h,2}	10 ^{h,2}	10 ^{h,2}
	10'	10 ^f	10 ^c	10 ^{c,2}	10 ^{c,2}	10 ^{c,2}	8 ^d	8 ^{c,2}	8 ^{c,2}	8 ^{c,2}	8 ^{c,3}
	12'	8 ^{a,d}	8 ^{a,d,2}	8 ^{a,d,2}	8 ^{a,d,2}	8 ^{a,d,3}	6 ^{a,d}	6 ^{a,d,2}	6 ^{a,d,2}	6 ^{a,d,3}	6 ^{a,d,3}
	16'	4 ^a	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,2}	4 ^{a,3}	4 ³
	20'	4 ^{e,2}	4 ^{e,2}	4 ^{e,3}	4 ^{e,3}	4 ^{e,3}	NP	NP	NP	NP	NP



1998 FLORIDA TORNADOES

Central Florida – February 22, 1998

1998 Florida Tornadoes



1998 FLORIDA TORNADOES

On the night of February 22, 1998 powerful tornadoes ripped through Central Florida killing 42 people.



No deaths occurred in masonry homes - All those killed were in light frame manufactured homes or trailers.

1998 FLORIDA TORNADOES

FLAMINGO LAKES

*Pre-Hurricane Andrew
.....Appendix D era*

Typical Failure:

- *Envelope is breached,*
- *Sheathing lifts off,*
- *Bond beam deflects upward and wall falls out.*
- *Bond beam deflects downward.*

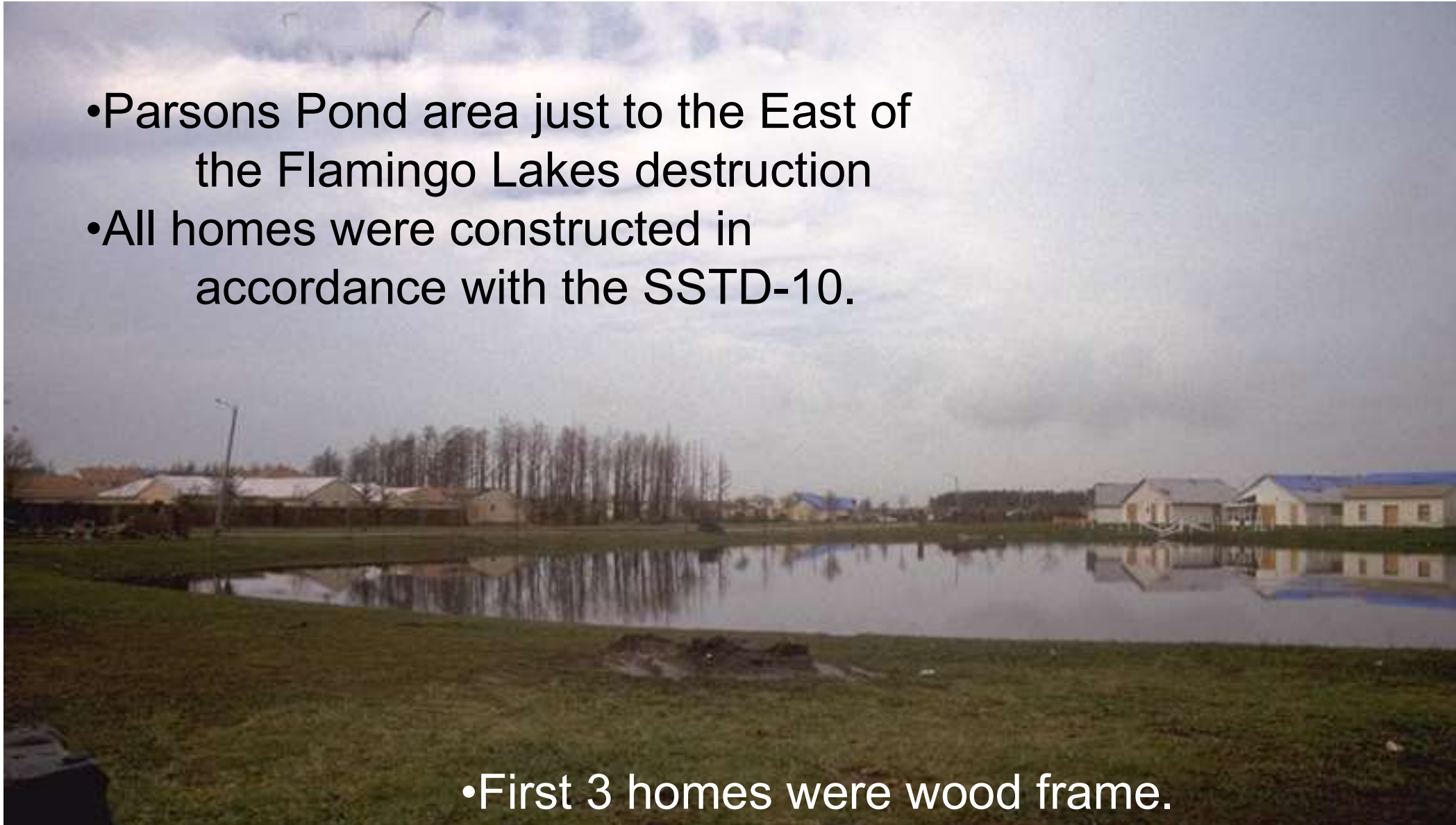


CG6-11
Photograph
of the Felt
Grout Stop



- Parsons Pond area just to the East of the Flamingo Lakes destruction
- All homes were constructed in accordance with the SSTD-10.

•First 3 homes were wood frame.



JB-53-0005:Frame Home No. 1 Complete collapse !

**Both front and back ends completely separated
from the side walls.**



JB3-57-0009: Foreground-Frame Home No. 1

The back wall, gable end intact lying on the grass. The corner connection failed. The connection of the gable end at the roof failed.



CG4-19: Frame Home No. 3 – Block home with blue tarp is in the background.







CG3-34: Results of missile (automobile) impact: Belcher, CBO, is viewing the displacement of the masonry in the area of the impact.

1998 FLORIDA TORNADOES

Seminole County.
** Same Scenario **



Robert McIntosh Home
855 Myrtle
Seminole County

DESIGNING MASONRY FOR WIND LOADS



Lessons from 1998 Florida Tornadoes (Build with BLOCK)

- Masonry Design Failures in Post Andrew structures (Built to SSTD 10-93)
 - None



FLORIDA TORNADOES 2007

Central Florida - February 2, 2007

2007 FLORIDA TORNADOES

Between 3 and 4 am on February 2, 2007 tornadoes ripped through Central Florida killing 21 people.



Again, nearly all those killed were in light frame manufactured homes or trailers.

2007 FLORIDA TORNADOES

- Villages of Lady Lake
- All Post-Hurricane Andrew Construction

CE MIONA

Village of S
Jarr

nado entered
villages between
d 3:20 a.m.

PATH OF
ORNADO

Village of
Liberty Park

Old Camp Rd.

Canal St.

Village of
Caroline

Village of
Mallory Square

Stillwater Trail

Coconut Grove
Recreation Center

Hill
Club

Odell Gr.

Village of Mallory Square
Gayle Mill Drive

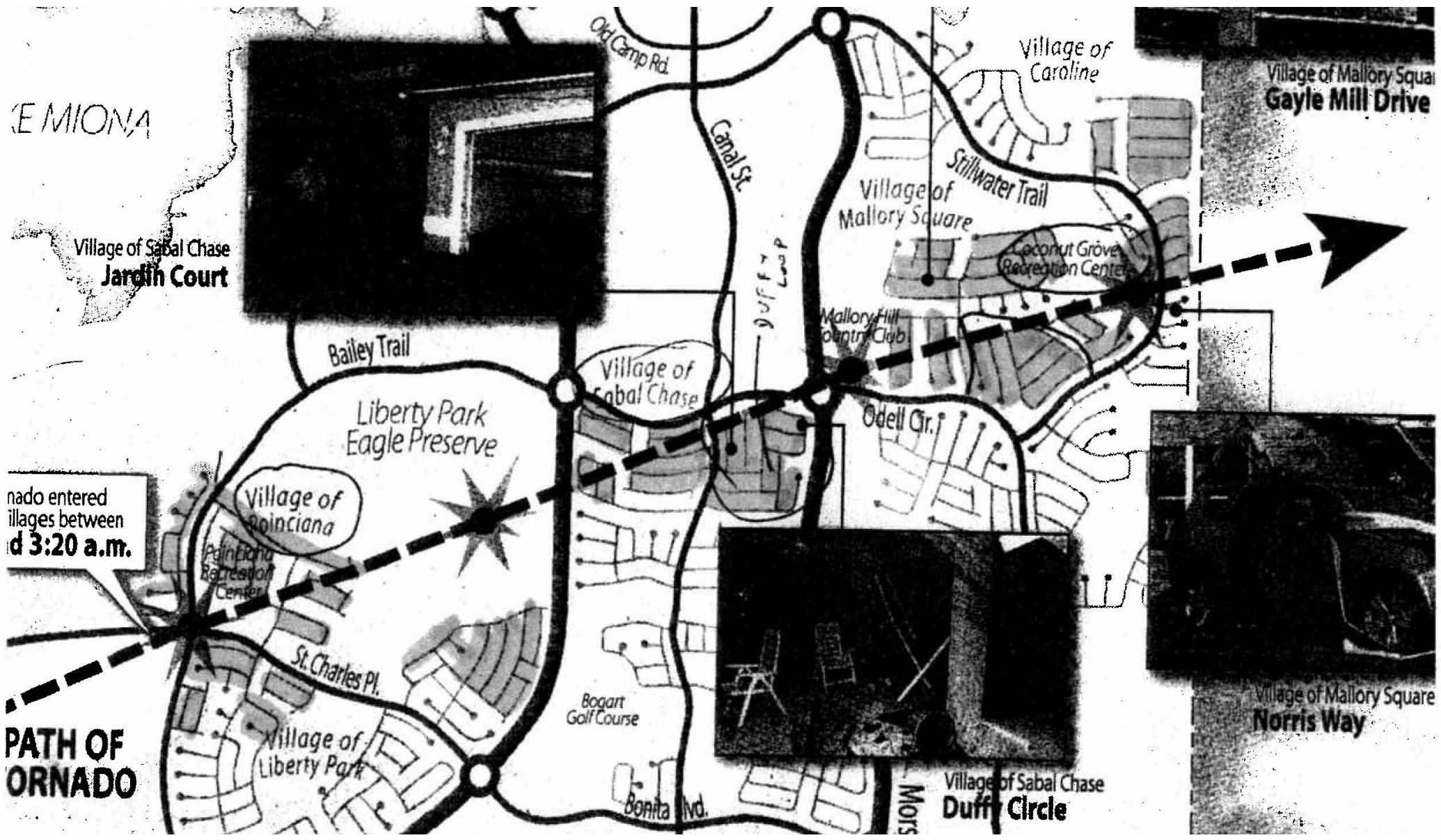


Bonita Blvd.

Village of Sabal Chase
Duff Circle

Village of Mallory Square
Norris Way

MEMORANDUM



Village of Sabal Chase
Jardin Court

Storm entered
villages between
11:30 p.m. and
3:20 a.m.

**PATH OF
ORNADO**

Village of Mallory Square
Gayle Mill Drive

Village of Mallory Square
Norris Way

Village of Sabal Chase
Duff Circle



2007 Florida Tornadoes



2007 Florida Tornadoes



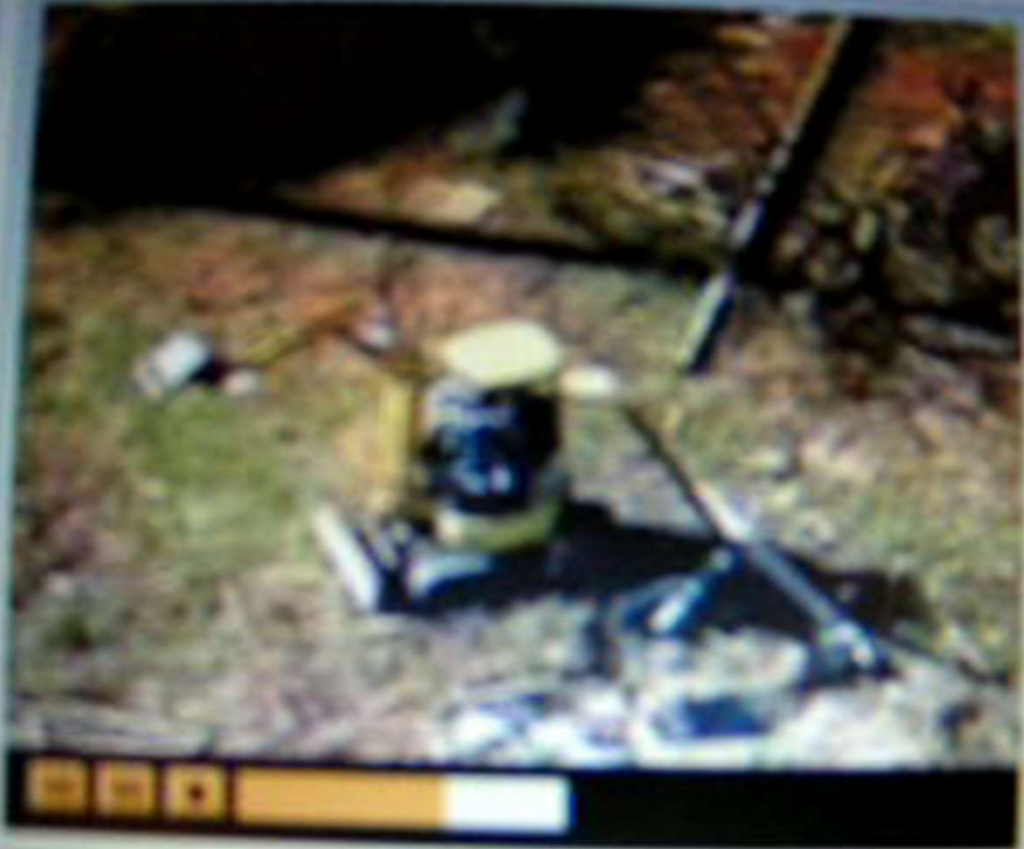


Exhibit Stations

National
tree farm
villages
and other
scenic spots



PLAYLIST

2007 Florida Tornadoes



2007 Florida Tornadoes





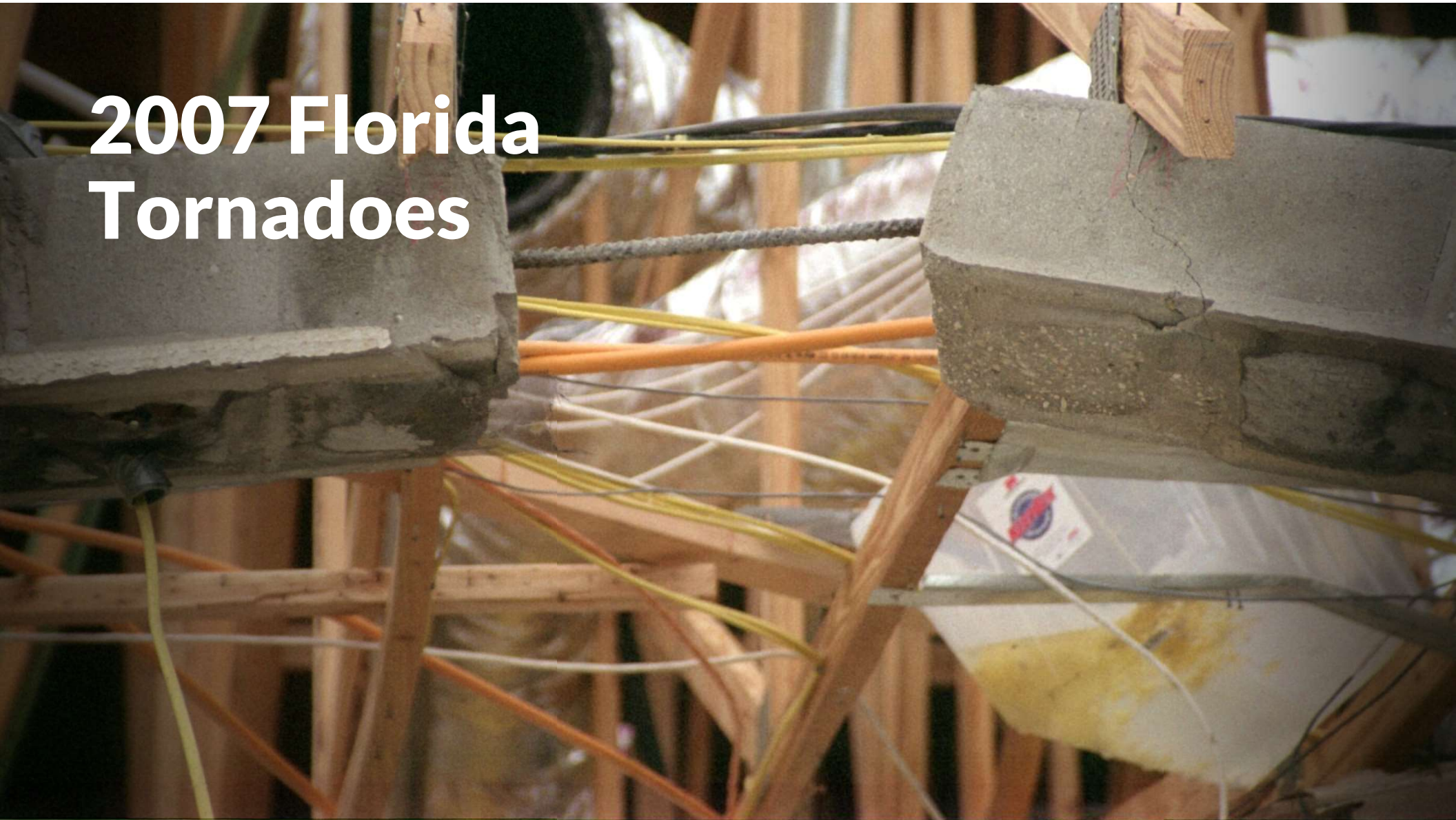
2007 Florida Tornadoes



2007 Florida Tornadoes



2007 Florida Tornadoes



2007 Florida Tornadoes



**2007
Florida
Tornadoes**

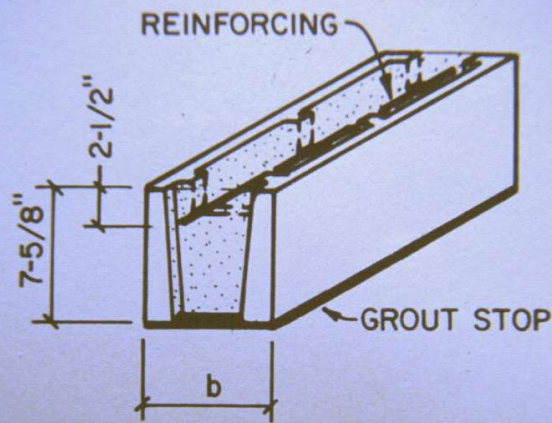


2007 Florida Tornadoes

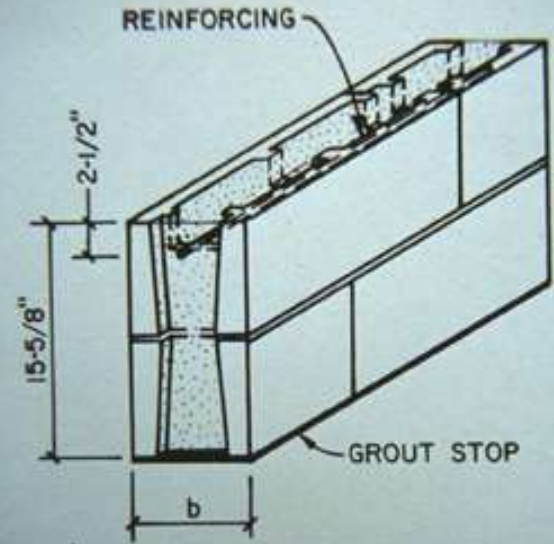


A photograph showing the aftermath of a tornado. The image features a large pile of broken concrete blocks and debris. A single, thick, grey metal rebar (reinforcing bar) is bent and protrudes from the center of the rubble. The concrete is light grey with visible aggregate. In the foreground, there is green grass and some dry pine needles. A white circular graphic with a black border is overlaid on the left side of the image, containing the text "2007 Florida Tornadoes".

**2007
Florida
Tornadoes**



MASONRY BOND BEAM TYPE "K"



MASONRY BOND BEAM TYPE "B"

MASONRY

BOND BEAMS

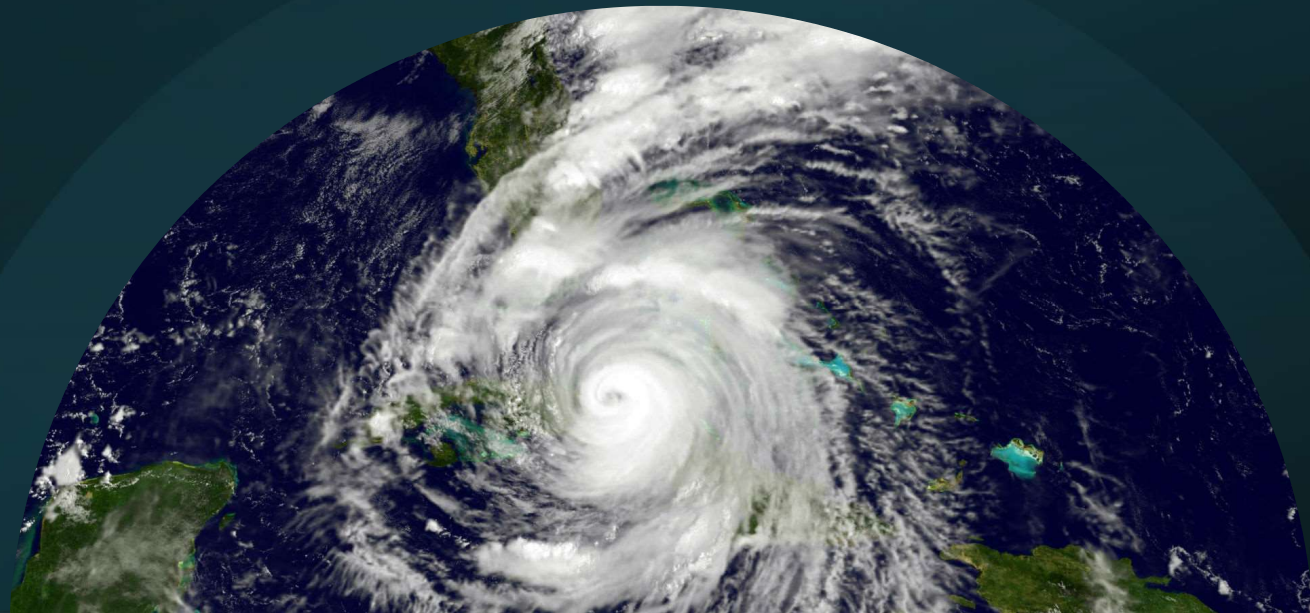


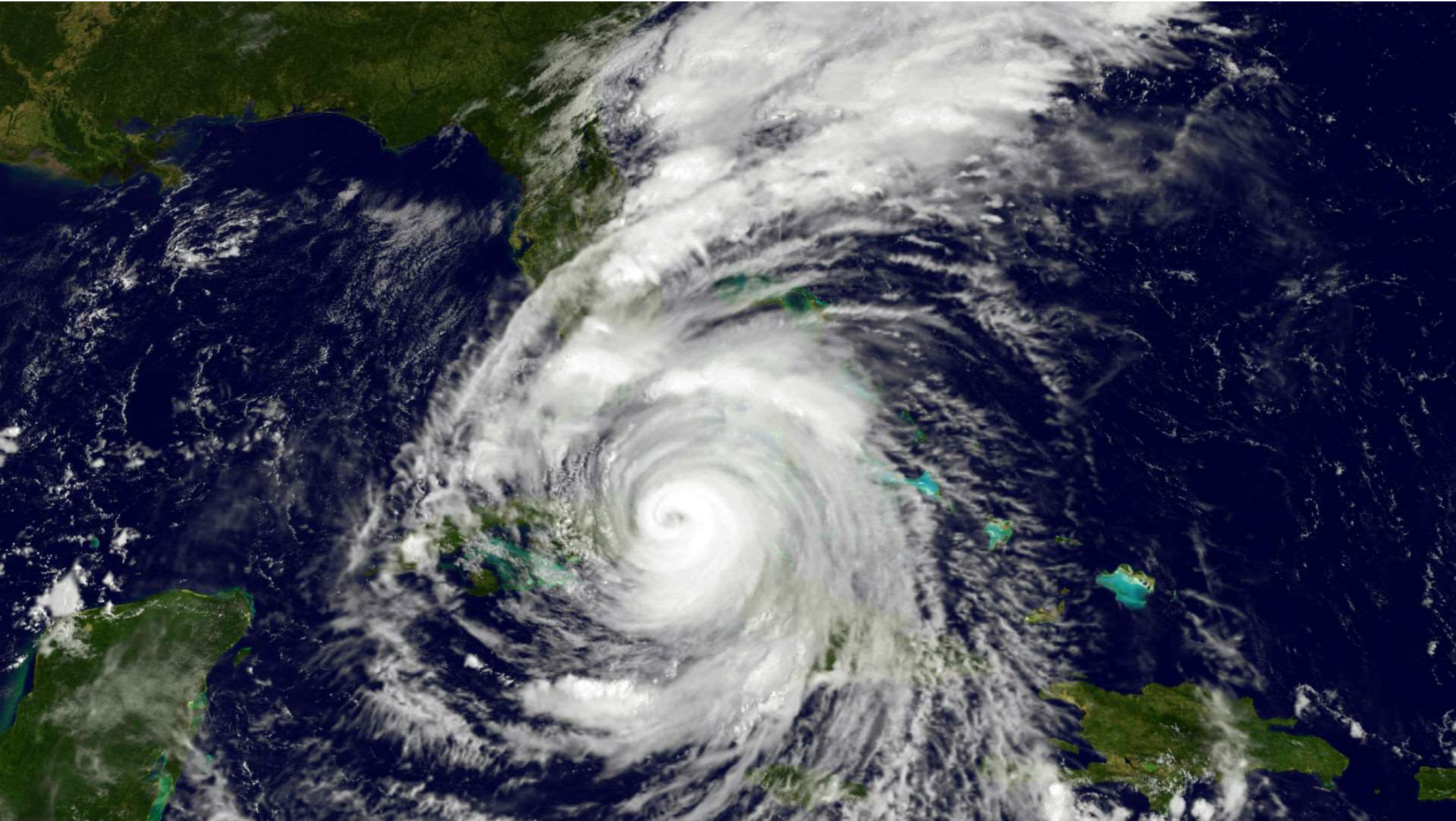
DESIGNING MASONRY FOR WIND LOADS

LESSONS FROM 2007 TORNADOES (BUILD WITH BLOCK)

- Masonry Design Failures
 - 8" Bond beam
 - Embedment of Verticals into Bond Beam (use 16" bond Beam)

2017 HURRICANE IRMA





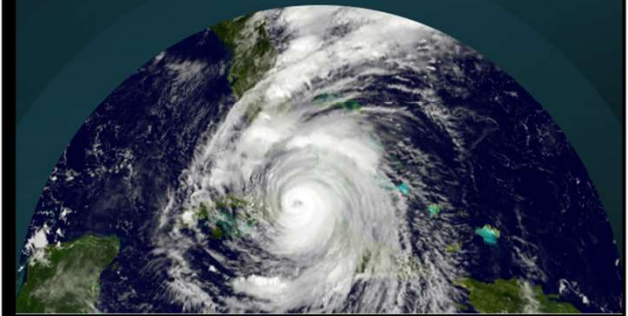
2017 HURRICANE IRMA



Hurricane Irma Damage Report A Structural Damage Perspective

Don Beers, Adrian Engineering, Inc.
Joe Belcher, JDB Code Services, Inc.
Pat McLaughlin
McLaughlin Management Assoc., Inc

2017 HURRICANE IRMA



2017 Hurricane Irma

- During our review of damage from Hurricane Irma, both up in Jacksonville and throughout SW Florida and the Keys, we found only two instances of failed masonry – regardless of age.
 - An old unreinforced wall fell over in Naples
 - An old unreinforced masonry home got washed away by storm surge (1811 Long Beach Drive, Big Pine Key)



2017 Hurricane Irma

2017 Hurricane Irma

Other than this damage we found not a block out of place. Perfect performance for every concrete masonry wall impacted by Irma.

The performance of masonry was regardless of real or imagined “tornado” or “micro-burst” wind action. In many cases nothing was left of the former structure except the concrete masonry.



Damage to Competitive Products

Civil Air Patrol Bldg., 2003 Mainsail Drive, Naples



Damage to Competitive Products

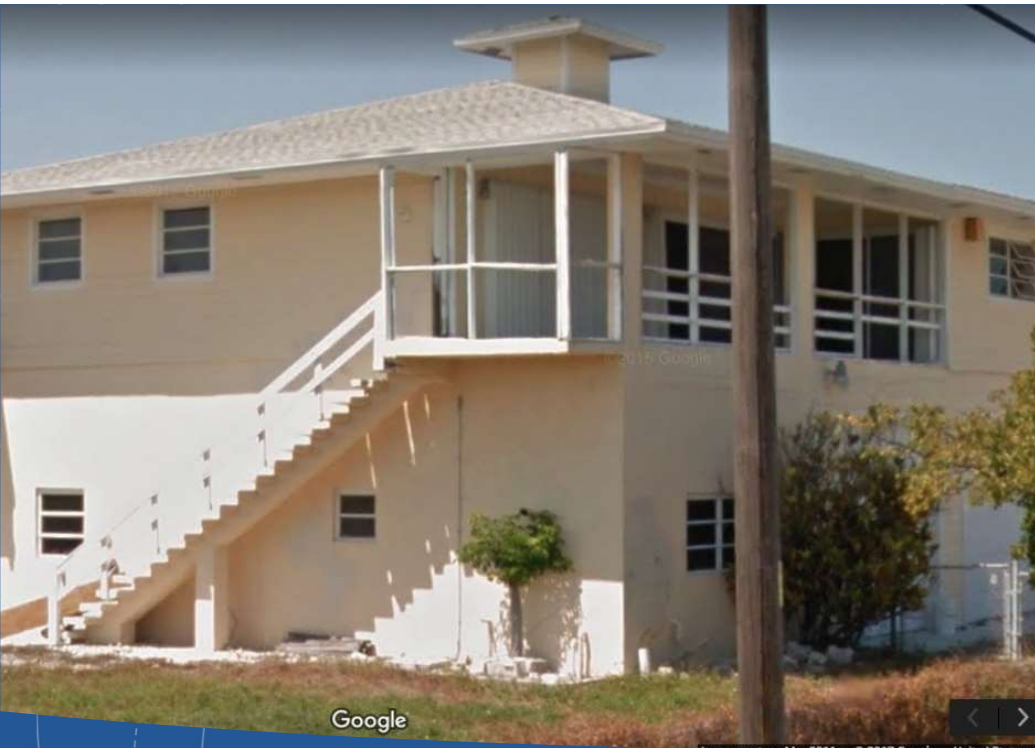
31153 and 31221 Hollerich Drive – Big Pine Key



**Damage to
Competitive
Products**



**561 Blackbeard Road
Little Torch Key**



**Damage to
Competitive
Products**

**530 Blackbeard Road
Little Torch Key**

2017 Hurricane Irma



The area highlighted within the panel extends from 491 to 711 W Indies Drive on Ramrod Key. Within that area 8 wood frame homes were totally destroyed. There was no damage to any concrete masonry home along W Indies Drive other than minor roof damage.



2017 Hurricane Irma



2017 Hurricane Irma



2017 Hurricane Irma



2017 Hurricane Irma



2017 Hurricane Irma



2017 Hurricane Irma



2017 Hurricane Irma

2017 Hurricane Irma

Total # of Homes Surveyed – 51

- # of All Concrete Masonry Homes – 13
- # of Concrete Homes with Wood 2nd Floors – 3 (none of these were destroyed)
- # of Wood Frame Homes – 33 + 3 second floor wood = 36
- # of Homes with Unidentified Const Type - 2
- # of Destroyed Wood Homes – 9
- % of All Wood or 2nd Floor Wood Homes Destroyed – 25%
- % of All Wood or 2nd Floor Wood Built After 1992 Destroyed – 12.5% (1 out of 8)(491 built 2002)



2018 Hurricane Michael



**The Secret
of
Masonry
Resilience**

Product Weight and Stability

Natural Safety Factors

Simplicity of Design

Simplicity of Connections

Ease of Proper Installation



Does Weight Make a Difference – Experience Says YES



**The Secret
of
Masonry
Resilience**

Product Weight and Stability

Natural Safety Factors

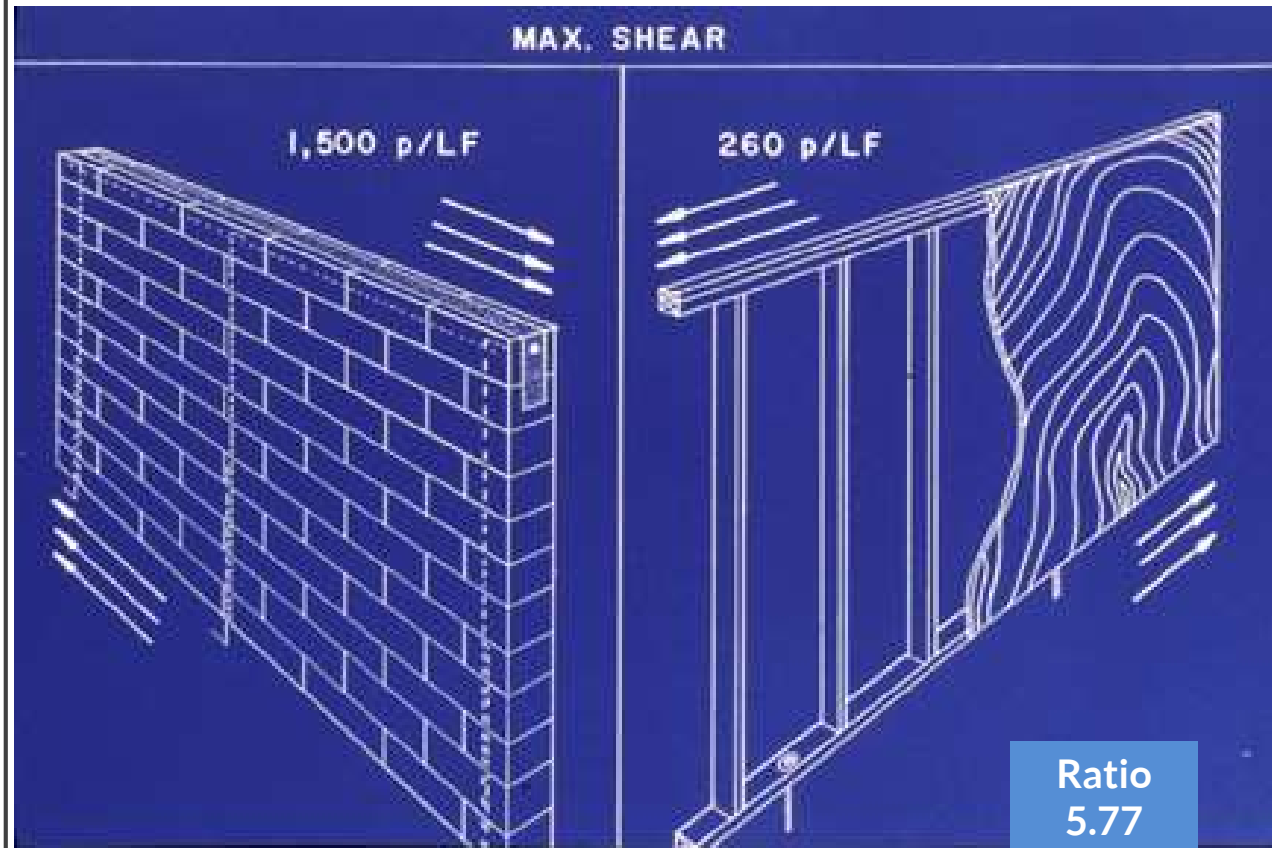
Simplicity of Design

Simplicity of Connections

Ease of Proper Installation

**NATURAL
SAFETY
FACTORS
SHEAR
CAPACITY**

**MASONRY 5.77 TIMES AS
STRONG AS WOOD**



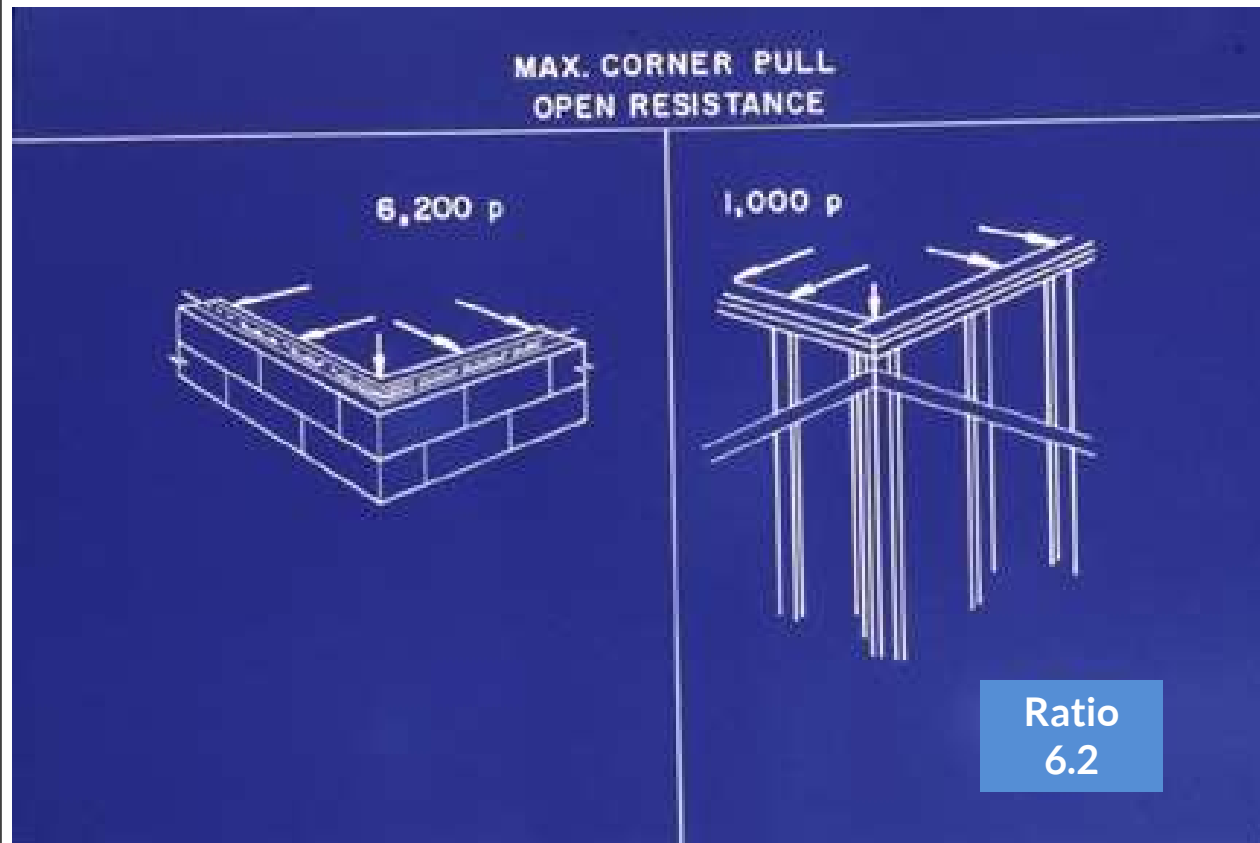


**Hurricane
Andrew**

**Does the shear
strength of the
wall make a
difference –
experience
says YES**

**NATURAL
SAFETY
FACTORS
CORNER
OPENING
RESTRAINT**

**MASONRY 6.2 TIMES AS
STRONG AS WOOD**





1998 FLORIDA TORNADOES

**Does the
strength of the
corner
connection make
a difference –
experience says
YES**



**The Secret
of
Masonry
Resilience**

Product Weight and Stability

Natural Safety Factors

Simplicity of Design

Simplicity of Connections

Ease of Proper Installation



Does the Simplicity of Design Make a Difference – Experience Says YES



2017 Hurricane Irma



**The Secret
of
Masonry
Resilience**

Product Weight and Stability

Natural Safety Factors

Simplicity of Design

Simplicity of Connections

Ease of Proper Installation

Thousands of Connections to Install



Hurricane Andrew - 2002



Masonry 1st Floor



**530 Blackbeard Road
Little Torch Key**



Hurricane Irma - 2017



The Secret of Masonry Resilience

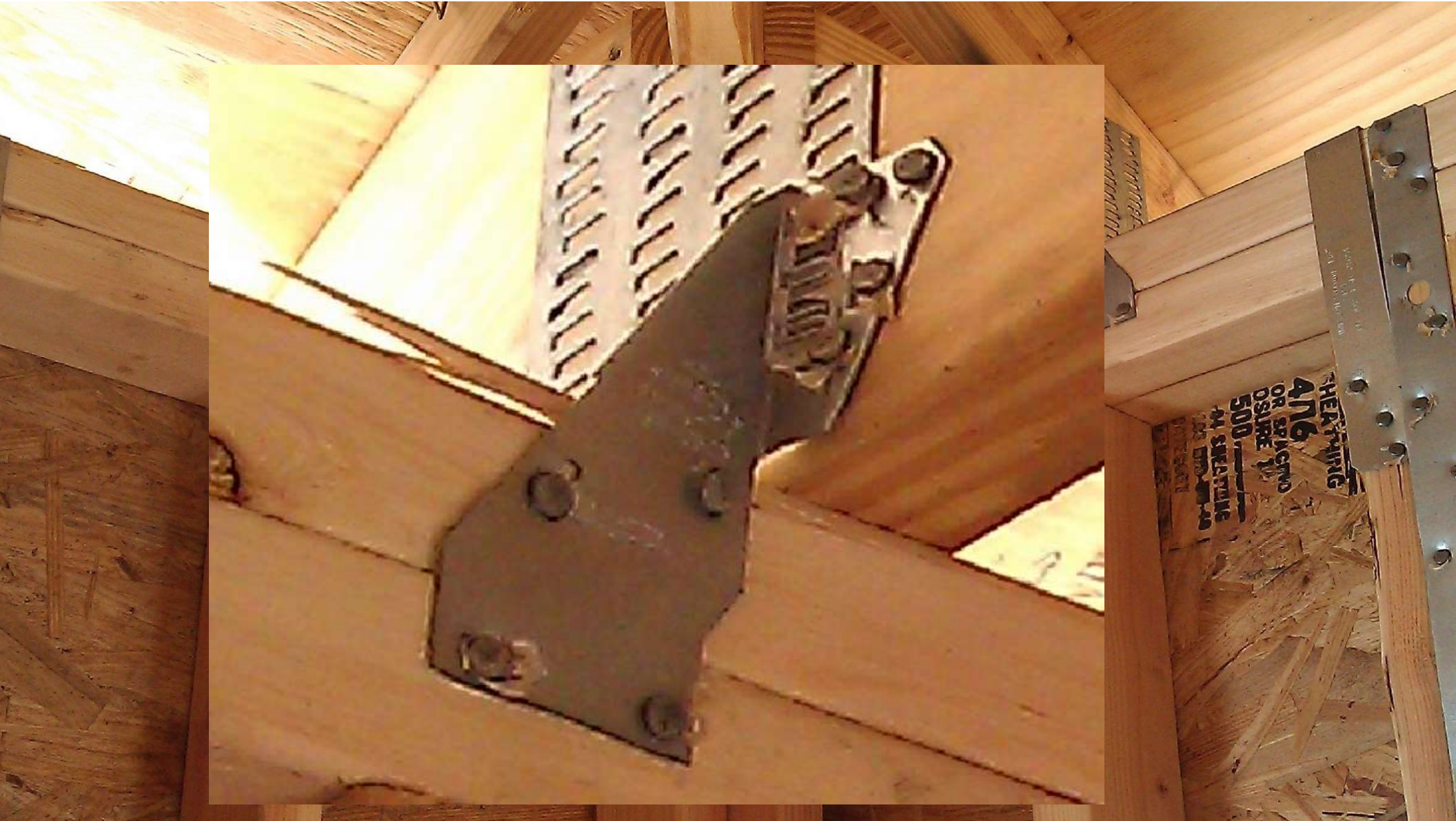
Product Weight and Stability

Natural Safety Factors

Simplicity of Design

Simplicity of Connections

Ease of Proper Installation





Summary

Light-frame wood construction did not perform as expected. Heavy-frame masonry construction performed.

All structural connections in coastal environments need to convert from galvanized to stainless steel connections.

Light gauge metal cladding and exterior insulation and finishing systems (EIFS) had failed with Irma wind speeds.

Irma was not a code event – did not test the code. Winds < 125 mph

Tornado / Microbursts occurred pushing winds gust over 130 mph.

Codes need to adopt ICC 600-2014 (Hurricane Resistant Residential Construction methods)

Codes need to adopt more parity between heavy and light frame materials.

We need to prepare now for the inevitable.

The Future

Maintaining strong codes governing the construction of all types of wall systems.

A photograph of a modern, multi-story white building on a beach. The building has a minimalist design with large windows and a prominent white staircase leading to an upper level. The building is situated on a sandy beach with palm trees and a cloudy sky in the background. The word "QUESTIONS?" is overlaid in large, bold, white text in the center of the image. The entire image is framed by a white, hand-drawn style border.

QUESTIONS?