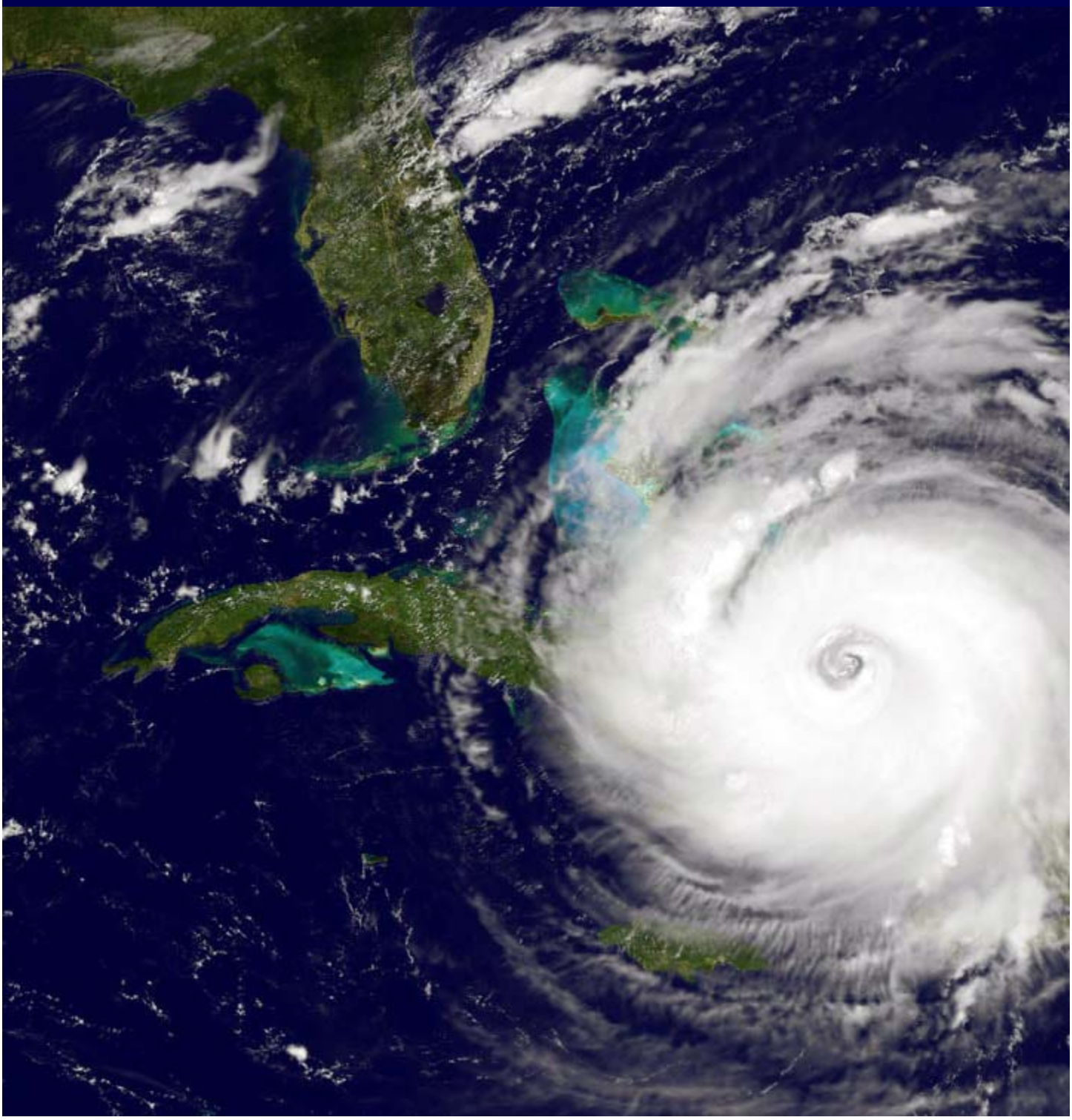
"Brick, Block & Beers" is a quarterly structural masonry Q&A hosted by Masonry Association of Florida's Don Beers, PE, GC.

BRICK, BLOCK & BEERS

MASONRY ASSOCIATION OF FLORIDA | VOLUME I, ISSUE IV DECEMBER 2017



Masonry's Greatest Strength – Don Beers, PE, GC.

Why does masonry perform so much better than other light frame products during high-wind events, such as hurricanes and tornadoes?

MASONRY'S GREATEST STRENGTH

Long time South Florida residents who have weathered a severe hurricane often express a heartfelt thankfulness that they were in a concrete masonry structure. Structures built of many lesser products have weathered hurricanes but block homes provide the secure comfort of rock solid construction. This is not just antidotal – its common sense. After reading this article perhaps you will have a better understanding of concrete masonry's built in strength.

It's all about the "safety factor". Simply stated the "safety factor" is the difference between what engineers expect will be the largest wind load a structure will ever be exposed to --- and the wind load that they calculate would rip the structure apart. Structural engineers always like a good safety factor – usually around 3 times or 300%. Poor construction and material deficiencies erode safety factors but if you have sufficient safety factor there is some room for error.

Understanding Wood Frame Connection Problems

Wood frame residential structures have performed poorly in every wind event I have had the opportunity to do wind damage assessment on. The problem is not in the wood itself but in the connectors. A tree branch can be very strong – but if you saw it off you will have a real problem on your hands to nail it back on to its original strength.

The lumber industry is extremely sophisticated in their design procedures. Nails and connections are assigned industry accepted load carrying capacities and safety factors based on extensive testing. All of this is proper engineering. There is, however, a number of factors which explain why Hurricane Irma left dozens of modern wood structures in ruins and zero concrete masonry structures in ruins. These are:

- Product Weight and Stability
- Natural Safety Factors in Design
- Complexity in Design
- Complexity in Connections
- Complexity of Proper Installation

Product Weight and Stability

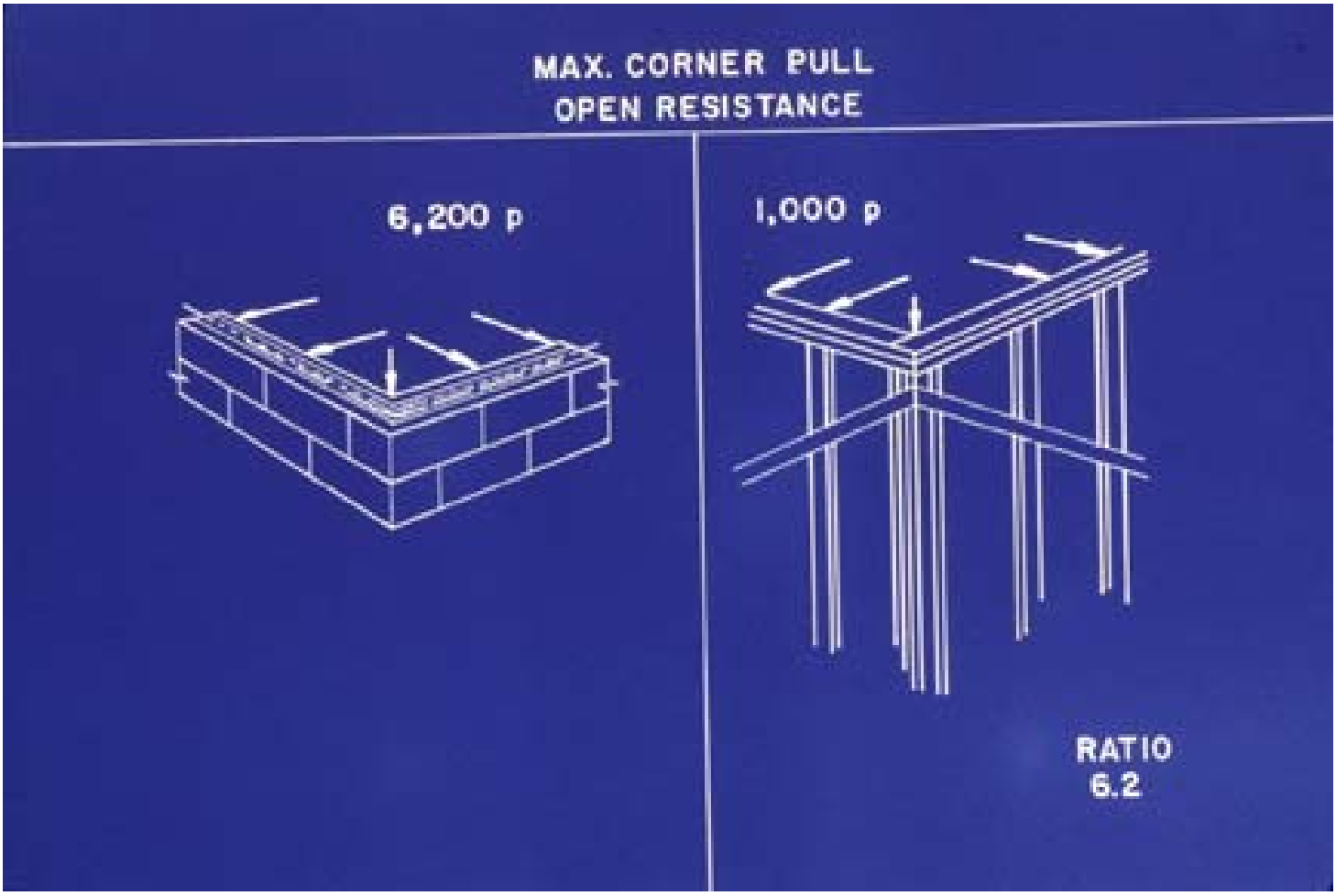
This is simple but true. Things that weigh more are harder to blow over. The wind, particularly in gusting, has to overcome the inertia of a much higher mass. A home made of 8" concrete masonry weighs 7 to 10 times as much as a home built of wood frame. In seismic loading where you have ground accelerations which care nothing about the weight of your wall this can work against you. But in wind loading the wind has to get the structure moving before it can blow it apart. In this case mass works in your favor.

This is not a large factor in why masonry performs better than wood frame, but it is a factor to some extent so I have included it.

Natural Safety Factors in Design

I use the word "natural" to denote something built into a product. Consider it the minimum reasonable design of a product. An example of this is 8" masonry. In many cases your design might call for 3" or 4" or 5" masonry, but those products aren't available. We use 8" masonry as a "natural" minimum in the design. Another example would be the ever-present #5 bar (5/8th inch in diameter). Often a 3/8" bar or even a ¼" wire would supply the needed strength but those products are not the norm so we simply make it a #5 bar for convenience of installation.

The drawing below is an example of how easy this is to understand. Making sure the corners of a home stay closed to the wind is extremely important. A single #4 bar wrapped around a masonry corner provides over 6000# of closure force and it is done as a routine minimum at every masonry corner. Rarely do you see a detail for even 1000# of closure in a wood frame home and it is not routinely done.



Complexity in Design

A typical wood frame home has well over 2000 connection pieces. Each of those must carry a significant load during a design event. Making sure each one of those connection points is designed correctly takes time and attention to detail. This is true in designing any building but it is particularly true when designing a wood frame home. The failure of any individual connection point runs the risk of over-stressing the adjacent connectors and allowing the structure to "unzip" and completely disintegrate. Often what you see is either an intact light frame structure – or – a light frame structure that has completely come apart with not enough left to identify what came apart first (See picture of destroyed homes along W Indies Dr on Ramrod Key).

Unfortunately, there is no financial margin in wood frame home design. Much of the time these designs are actually done by marginally trained technicians, not structural engineers. The importance of good wood frame design and the lack of same further reduces the safety factor for wood frame houses.

Complexity in Connections

While visiting a large contractor constructing wood homes I came upon an interesting connection. An important connection which had the job of keeping the central portion of the house from becoming airborne debris. I offer it to you as a study in "wood frame connection complexity". I am convinced that this connection was neither detailed completely nor adequately understood by the installer. I have my doubts that the designer took the time to understand it either. It contains 9 nail plate connectors, 4 straps and over 100 nails. Keep in mind that during a design windstorm event <u>every</u> nail and connector is expected to carry its prescribed load. A strap nailed to the wrong member, or several nails not carrying their load because they split the wood or are too close to the edge, could render the connection utterly useless in resisting wind loads.

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Complexity in Proper Installation

The last problem involved with wood frame construction is one well known to everyone in the construction industry today – availability of trained, qualified and competent construction workers. Every phase of the construction industry has this same problem but an unskilled worker faced with properly assembling the connection shown in Picture 52 is certainly a danger to future inhabitants of the structure during a design wind event. Unfortunately, it is a well-known fact that residential framing contractors are some of the poorest trained in the industry. Again, all trades, including masonry, have this problem but where your safety factor has already been degraded by lack of mass, lack of "natural" safety factor, poor design and complex and important connections you have a true receipt for disaster.

Summary

It is a legitimate question to ask if higher safety factors – beyond minimum code requirements – make a difference in hurricane and tornado damage levels. The answer is a resounding yes. All structural types incur damage during major storm events. But the percentage of damaged structures of a particular construction type and the severity of that damage is clearly related to safety factor. This fact is being recognized in the current push for resilient structures. Code officials and community governments across the Country are recognizing the value of a little extra safety factor in reducing catastrophic storm damage. Many Florida residents have learned that lesson well and insist on concrete masonry for added piece of mind.

Destroyed Wood Frame Homes on Either Side of a masonry home along W Indies Drive on Ramrod Key

DON BEERS, PE, GC
MAF Staff Engineer
don@floridamasonry.com
561-310-9902