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CAT 360

Catastrophe Risk from Every Perspective

The CAT 360 is a quarterly newsletter that features articles developed by our Research and Development Team and covers topics that relate to Catastrophe Modeling, Natural Perils and Information Technology on a global basis. Please feel free to contact the editors if you have any questions or comments regarding any of our publications.

Eds.

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Feature Stories

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Mobile Homes — Dispelling the Myths

"How well do mobile homes perform in a Hurricane?" a catastrophe modeler was once asked.

"Mobile homes perform very well in a hurricane...it's just the landing they have problems with," he responded.

It is a fact we cannot ignore. Mobile homes are an increasingly dominant part of our landscape, serving as both part-time vacation and full-time residences. Many of these homes are located in hurricane-prone areas such as in South Florida, the Carolina coast and the Gulf shores and have a reputation of being poorly built and unsafe in a windstorm. But standards have improved and modern mobile homes can even perform better than permanent structures during a hurricane.

It is important to dispel some of the myths and to provide an insight into modern mobile homes and the issues of trying to model these structures against natural perils.

They are now referred to as "manufactured homes", since the vast majority of them are never moved once installed. There are as many as nine million mobile homes in the US according to recent estimates, making up eight percent of all housing units. Florida tops the list with the greatest number of mobile homes, followed closely by Texas and North Carolina.

Ariel view of a Manufactured Home Park in Florida

Modern Manufactured Home

Mobile homes have also played a significant role in rehousing. Seen as a more dignified alternative to the FEMA trailer, Katrina Cottages are in the classification of manufactured housing. They were developed as a semi-permanent housing solution for the thousands of people who lost their homes following Hurricanes Katrina and Rita. Although small (500 square feet or less) they have proved a good solution. They are easily towed, attractive to look at and built to modern coastal wind standards. FEMA recovery plans for future disasters include Katrina Cottages as a replacement of the trailers homes.

^ TOP

< A Brief History

The original concept of the mobile home was mobility. Mobile homes were primarily marketed to people whose transient lifestyle required movement from place to place. But beginning in the 1950s, the homes began to be sold as an inexpensive form of housing, designed to be set up and left in one location permanently. Some statistics indicate that over 98% of all mobile homes built are never moved from their original location.

Early mobile homes were typically eight feet wide and 40 feet in length or longer, roughly the same size as a studio or a small one-bedroom apartment.

Mobile Home from the 1960s

The width of a mobile home was intentionally designed to be narrow, so that it could be towed behind a large car or truck, with a low enough height to clear highway signs, bridges and underpasses. Such dimensions have subsequently been adapted, with many mobile homes now 10 to 12 feet wide, with lengths of up to 90 feet. The largest of these wider units would be comparable to a typical two-bedroom apartment. Double-width mobile homes can also be made by joining together two single-width units and have proved a popular choice. The number of double-width homes sold now exceeds the number of single-width homes. Triple-width mobile homes also exist, but are less popular due to the added complexity in design and increased costs.

^ TOP

< An Improving Structure

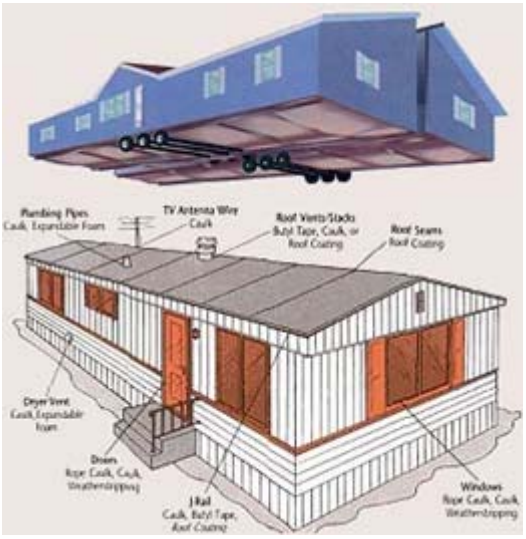
Mobile homes built prior to 1976 are highly vulnerable structures. These homes did not need to comply with any building standards, and were usually built with very light and relatively weak materials. It has been well documented that such homes perform extremely poorly, even in moderate wind conditions. Additionally, maintenance and wear significantly diminishes the strength of these structures.

Post 1976, all mobile homes were required to

The HUD standards remained in place until 1994, when new wind zone design standards were developed in the wake of 1992's Hurricane Andrew. Andrew was particularly hard on the manufactured home community. Data shows that 97% of manufactured homes directly affected by the storm were destroyed. This compares to 11% of single family homes destroyed and 43% incurring major damage.

Many of the destroyed manufactured homes

pass very strict HUD [US Department of Housing and Urban Development] standards for safety and quality. These structures were a vast improvement over the pre-1976 designs and were much less vulnerable to moderate wind conditions. In 1980 the name was officially changed to "manufactured homes" however "mobile homes" has stuck fast and continues to be used (we will be referring to these structures as manufactured homes for the rest of this article).



Double Width Construction of a Manufactured Home

were of 1975 or earlier vintage, which would have had no chance of surviving the Category 5 hurricane.

The HUD Wind Load Standards that were introduced in 1994 use the following general guidelines:

Wind Zone I – Same as 1976 HUD standard;
Wind Zone II – Built to withstand 100 mph peak gusts – sheet rock construction, wood sheathing on the corners; and
Wind Zone III – Built to withstand 130 mph peak gusts – wood sheathing around the home.

The four hurricanes of 2004 – Charley, Frances, Ivan and Jeanne – which hit Florida in quick succession, were defining events to test the strength of modern manufactured homes. The newest homes passed the test, with the vast majority of post-1994 homes performing very well. Manufactured home parks containing homes with a Wind Zone III Rating actually performed better than many of the permanent homes in the surrounding area, according to one damage survey carried out after Hurricane Ivan. The permanent site-built homes incurred damage to their sidings and partial losses to their roof shingles, while the manufactured homes suffered little wind-driven damage.

^ TOP

< Ongoing Issues

Tie-downs versus permanent foundations: The largest driver in deciding to purchase a manufactured home is the cost of ownership. Manufactured homes usually cost a fraction of the price of a site-built home in a similar area. However, given a choice between retrofitting a manufactured home to have greater resistance to wind (the cost of retrofitting a permanent foundation can be as high as $25,000) or using the same funds to do anything else (like vacationing), the retrofit will almost always lose out.

The most effective retrofit available is modern tie-down systems. While a full permanent foundation would be the ideal situation, the cost of such systems is outside of the budget of a typical manufactured homeowner. Modern tie-down systems are anchored using concrete footings, and are attached to a manufactured home using a series of straps spaced every four to five feet. When properly installed, the tie-down systems create a much stronger structure, resistant to moderate hurricane winds.

Nevertheless, such added structures remain popular for manufactured home owners. In Florida, a state with one of the toughest standards for all inhabitable structures, car ports and patio covers are commonplace. Since they are not sheltering lives, they can legally be built to a lower wind standard than the home they are attached to. But despite the danger attached to these sub-standard structures, they remain a popular choice for manufactured home owners as they add living space to a limited sized home.

Density: The fact that many manufactured homes are installed in mobile home parks can actually help protect the structures from forceful winds. Packed like sardines, the home density of a typical park would rival that of a busy apartment complex. Each mobile home lot has just enough room for the unit (single- or double-width) and a single car parking space. Because they are packed so tightly together, the homes can

There is no arguing that a manufactured home installed on a permanent foundation is a far more secure and safe structure than one with tie-downs, but permanent foundations remain a less popular option. In addition to price there are building code implications. In some jurisdictions, a permanent foundation would change the building classification for the structure, making it subject to all local building codes. In most jurisdictions, manufactured homes with tie-downs are regulated by the department of motor vehicles and are not required to comply with the stricter codes for permanent structures.

Added structures: Probably the largest source of damage to the modern manufactured home is the addition of covered patios or car ports to the structure.

During a storm, car ports and patio covers can rip apart and damage the home they are attached to or adjacent homes as strong wind turns them into destructive projectiles.

protect each other from high winds and wind-driven debris.

Two is better than one: Double-width manufactured homes stand up better to strong winds than single-width homes. The larger footprint of the double-wide homes provide a base with much greater stability, and have proven to be much less damageable in a hurricane.

Storm surge: Because of the limited elevation that a manufactured home can have they are highly susceptible to storm surge and flood. Even a moderate storm surge of two to four feet can lift a manufactured home from its parked position and smash it into adjacent buildings, severely damaging the structures involved. Because of this threat, the vast majority of manufactured home parks are built inland, away from any potential storm surge threat.

^ TOP

< Modeling Challenges

Analyzing manufactured homes using today's catastrophe modeling tools can be a challenge. While modern, post-1994 homes have proven to be relatively strong structures, they make up a small minority of all manufactured homes in existence. At the other end of the scale, pre-1976 manufactured homes are highly vulnerable to moderate wind conditions. As previously discussed, the year of construction is the key factor for determining vulnerability and is broken down into the following categories:

Pre-1976: These structures are highly vulnerable; 1977-1993: These structures perform much better than pre-1976 structures, but only in Category 1 or lower events; and Post-1994: These structures have proven to perform very well in recent hurricane events. In some cases post-1994 manufactured homes performed better than site-built homes in the same area.

Having the right year of build is the most critical data item, followed closely by having the right Wind Zone Rating for post-1994 homes. A post-1994 home without a Wind Zone 3 designation should be coded to pre-1994 since the construction standard would closely resemble the earlier guidelines.

From a modeling perspective, it is assumed that all mobile homes are not installed on a permanent foundation. Certain states, such as

However, 1994 and newer homes can perform well if they are built to Wind Zone III standards and are properly anchored. The Katrina Cottage is a good example of this. Classified as manufactured homes, they are designed to the IBS (international building code) hurricane code, and built out of hurricane resistant materials. However, it is also possible for a Wind Zone I or II specification manufactured home to be placed in a coastal location. Unless individually inspected, these homes would be placed in the same category as the Katrina Cottage, but in reality are far more vulnerable. From a catastrophe modeling perspective both homes would be modeled the same way, but would perform very differently in a real event.

A Katrina Cottage

Added Structures: As previously discussed, added structures (car ports and patio covers) can cause damage to a structure that would have otherwise not happened. Chances are remote that information on the structures

Florida, now require that all manufactured homes are tied down. However, tie-downs are optional or unregulated in other wind exposed states. In any case, pre-1994 homes have limits of performance irrespective of the use of tie-downs due to the strength of the building envelop.

General Data Quality: The quality of a manufactured home can vary greatly, which is critical in understanding the vulnerability of a home. As stated previously, pre-1976 manufactured homes are highly vulnerable in a wind event. Homes from 1976-1994 are much stronger, but they start to fail during a Category 2 event.

would be captured for a manufactured home, but these are commonly added items in a community. Loads for these structures should be added if there is a potential of their existence. Conversely, a credit is due if the structures are banned from a community.

Double-width homes: Post-1994 Double-width manufactured homes have proven to be less vulnerable in wind events. The added mass and foot print, coupled with a modern tie-down system, creates a structure that would more closely resemble a modern site-built home. Additionally, the low roof pitch with minimal overhangs, common to a double-width home, are an ideal design in minimizing resistance to wind. Since most models do not include a classification for double-width manufactured homes, one technique that can be used is to classify these homes as site built. However, this classification would only be appropriate for homes that are built post-1994 with a Wind Zone III rating.

^ TOP

< Summary

Manufactured homes have come a long way since the 1950s and are likely to remain a popular choice for holidaymakers and permanent residents alike. They have gone up-market and evolved from uninspiring and vulnerable structures into solid, attractive and much safer homes. Today, most are built to withstand hurricane-force winds. Tie-downs and retrofitting can provide additional strength, while care surrounding additional structures, such as patio roofs, can help avoid secondary damage. Double-width homes built to Wind Zone III standards are robust enough to be considered site-built from a modeling perspective.

But there are still plenty of manufactured homes in existence that were not built to such high specifications. Older homes, particularly those built before 1976 but even pre-1994 homes, are at high risk of being damaged by a Category 1 storm or above. Such homes continue to dominate the landscape. While there are ways of improving the fortitude of older homes, owners are put off by the additional cost. Until this situation changes, such structures will remain highly vulnerable to hurricanes and the catastrophe modeler's joke about flying mobile homes will continue to be tragically fitting.

Acknowledgments:
IBHS (The Institute for Business and Home Safety) - http://www.disastersafety.org/
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