Why Do We Invite Disasters?

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With the disasters the US has experienced within the past several weeks (fires in Montana & Oregon, Harvey in Texas and Louisiana, and Irma in Florida, Maria coming), they did not need to be the disasters that they turned out to be. We as a nation created disasters from the earth going through its normal cycles.

Whether Climate Change contributed to the disasters is not an issue. We the people have had a greater contribution based on decisions we and our leaders have made.

This document addresses single-family homes and similar structures. It does not address high-rise buildings, etc.

This is just a brief overview of a very complex group of subjects. Most people who push different management practices understand only part of the complex subject, and as a result, often contribute to the problems we face. Example: The new energy code mandates an air barrier to make the insulation more effective, but it can trap moisture that leads to mold growth.

This is not an engineering report which provides designs to follow for building disaster-resistant homes; instead, it is a crude road map to get people to start asking the correct questions.

Lest you think you are innocent, consider this: if you buy a home along the Gulf or Atlantic coast and you want it to have curb appeal, you will probably select a roof with gables, long eaves, and dormers. Each of them is waiting for a wind to either tear them off or to create a leak which will lead to mold growth.

Forest Fires

Forest fires usually move through an area rapidly enough so any given structure is not exposed to the fire for more than an hour. Forest fires generate their own windstorms. They are most prevalent and hardest to control when weather conditions are warm and dry. Usually there is up to a day's time to evacuate from the path of a major fire.

Prior to modern forest management, every few years a fire would pass through the understory of many of our forests. It cleared the burnable material off the forest floor and seldom got up into the tops of the trees. Seldom did it kill the

trees. When we learned to control these small fires, the amount of fuel on the forest floor increased, so the fires became hotter. This resulted in trees being killed and in the fires getting into the upper stories of the trees. Protecting the spotted owl increased this fuel on the forest floor, even though the spotted owl originally lived well in forests which periodically had understory burns.

So that homes would not burn in a forest fire, codes have been written so the walls and the roofs meet a one-hour fire-resistant standard. This is wonderful, because most homes are not exposed to a forest fire for over an hour. A problem is that when a home has an attic, the attic needs to be vented. Often the soffit vents are sized so they will not plug up when various plant materials blow onto them. Home owners love this decision, but embers from forest fires can pass through the soffit vents as well. When the embers from the fire are sucked through the soffit vents land on the lumber used to construct the attic, problems develop. This lumber has been exposed to high temperatures for months, and as a result, the moisture content is low. With most wood, the kindling point is substantially reduced as the moisture content of that wood is decreased.

Tornadoes

Tornadoes usually travel through an area with a narrowly focused path, with high & twisting winds and with rain. Usually there is not time to evacuate from the path of a tornado, and one must shelter in place.

Tornadoes have two characteristics that cause problems. There are high winds, and they love to pick objects up and insert them into their high winds.

If a home has curb appeal, chances are that the high winds will be able to latch onto a roof overhang, a gable end, or a dormer. These items become flying debris, which become projectiles which attack other structures. A hip roof or a Dutch hip roof (with minimal overhangs) will not prevent the attack, but it will reduce the amount of roofing material which becomes airborne. Also, if the roof remains in place, there is less water damage and less mold growth later.

There are building methods which are inherently resistant to tornado attacks if they are built to rigid specifications. They are discussed under the section Disaster-Resistant Housing.

Hurricanes

Hurricanes move through much slower than tornadoes, cover a much broader path, and normally are accompanied by more rain and less wind. Normally, there are 4 days up to more than a week to prepare for a hurricane; but since a precise path is never known, 90% of the people in the potential path are missed, so there is a tendency to delay evacuation until it is too late to evacuate. Most hurricane damage is caused by winds and things carried by the winds,

rainfall and the resulting flooding, and storm surges.

Hurricanes can be small in diameter, or be over 700 miles in diameter. They may have winds of just over 75 mph or sustained winds approaching 200 mph.

This website lists historic hurricanes over the last several hundred years. http://www.hurricaneville.com/historic.html

Wind damage to homes can be prevented by building with the same technologies listed under tornadoes. See the section Disaster-Resistant Housing for information on construction technology which can be built to withstand major hurricanes.

Storm surge which in some areas can be 15 to 20 feet or more, can be eliminated by leaving the barrier islands and critical low lands undeveloped. After Hurricane Ike in Galveston and the Bolivar Peninsula, the setback from the beach was increased, but not far enough. Homes were rebuilt in the anticipated storm surge area.

Flooding can be minimized by taking a realistic approach to flood plains. Why would anyone build in a flood plain, even with flood insurance? Designation of all flood plains needs to consider the imperious terrain (roofs, roads, highways) that currently exist and that are anticipated in the next 50 years. It does not need to consider where developers and politicians own land.

An additional problem is that current farming methods have reduced the amount of organic matter in the soil. When the organic matter in the soil is high, it can hold more water, and it can absorb water faster. As a result, the amount of runoff is reduced, and that reduces flooding. At a recent conference, we were informed that the average thickness of topsoil when Columbus made his first voyage was 8 feet and now it is 8 inches. Those numbers may be exaggeration, but there has been considerable erosion of the topsoil. The same speaker stated that the 8 feet of topsoil was high in organic matter, but now, with the current farming methods, it is about 8 inches thick and has little or no organic matter. It went from a lot of soil which conserved water to a little bit of dirt that was always on the verge of drought.

Earthquakes

Earthquakes normally occur along fault zones. The shock waves radiate out from the fault zone. While scientists can predict that an earthquake is coming in a specific area, they may be years off in their prediction.

Earthquakes are normally caused by the earth on one side of a fault line shifting in relationship to the earth on the other side of the fault line. This can be a gradual movement over time (earth tremors), or it can be a major adjustment.

Obviously, homes should not be built directly over the fault/fault zone.

Earthquake damage to homes can be prevented by building with the same

technologies listed under tornadoes.

In California 30 homes were built with SCIP technology in the 1970s. 30-some years later all of them remained in excellent condition, except for one which slid down the hillside during a mud slide. The windows and doors remained operable.

Flooding

Besides major rain events from hurricanes, flooding can be caused by major rainfall events over an extended area. The more impervious the surface and the more over-grazed an area is, the more likely that the rate of rainfall will lead to flooding. Flood plain maps need to be developed which take these items into account. Flood insurance can be sold to those homes already in the flood-prone areas, but all further construction should be eliminated.

A two-inch rainfall even over one square mile will produce up to 34 million gallons of water if the surface is impervious or saturated. That same area often will not have any runoff if the topsoil is maintained with high organic matter.

Disaster-Resistant Housing

There are several housing technologies which will resist disasters if they are built appropriately. If shortcuts are taken, or if they are "enhanced" with curb appeal, they will not remain disaster-resistant.

They include:

A Concrete Box: A six-sided (walls, roof, floor) concrete box of not less than 4 inches of reinforced concrete where all sides are firmly anchored to each other. These can be built with poured-in-place concrete or with tilt wall technology. These structures are very hard to insulate.

Confined Masonry (CF): Masonry walls are laid up and columns are placed at corners, on both sides of windows and doors and at least every 4.5 meters. Beams are needed below the windows and as a ring beam at each floor level. This is an indigenous method of construction in many areas, but often it is not built to disaster-resistant standards. A flat concrete roof is preferred, but Dutch or Dutch hip roof can be substituted. These structures are very hard to insulate.

Structural Concrete Insulated Panels (SCIP): These are wire mesh panels which are separated by Warren trusses or similar devices. Between the trusses, Expanded Polystyrene (EPS) is placed. When the panels are assembled, they are plastered on each side. Since the mesh is thinner than the rebar in poured-in-place concrete, the mesh does not need to be buried as deep in the stucco, so 1.5" of stucco on each side of a wall with 5 inches of EPS in the middle will react like an 8-inch-thick reinforced concrete wall. A SCIP roof is preferred,

but Dutch or Dutch hip roof can be substituted. These are some of the most energy-efficient homes which can be built.

Insulated Concrete Forms (ICF): A sheet of EPS or similar product is the inner form, and another sheet is the outer form. There are dozens of ways to brace the two sheets of EPS. Horizontal and vertical rebar is inserted, and then concrete is pumped into the cavity. If done right, they provide disaster-resistance. The problems include:

- the concrete needs to be vibrated to ensure there are no voids in the wall,
- if the concrete is over-vibrated, the aggregate can separate or a hole can be blown in the EPS forms,
- the EPS needs to be coated to limit fire danger,
- the thermal mass of the concrete is separated from the inside of the home by a layer of EPS, so the thermal mass loses its effectiveness, and the air conditioner or heater must cycle often.

Concrete domes (not geodesic domes): There are basically two types of concrete domes. There are the insulated variety (such as the Monolithic Dome) and the non-insulated variety (such as the EcoShell). The Monolithic Dome is probably the most energy-efficient home which can be built and is very competitive with conventional stud and crud construction. With the corners eliminated, there are no "handles" for tornados, hurricanes, and earthquakes to latch onto, so they are very resistant to these forces. The EcoShells are much cheaper to build but do not have insulation.

Roofs

All the listed construction technologies except the concrete domes can be built with conventional roofs to give curb appeal, but that can negate their disaster-resistance. A well-designed flat concrete roof braces the walls so they are more resistant to lateral loads. If a concrete roof is replaced with a "conventional" roof, an engineer should determine how many concrete beams or concrete walls are needed and their placement, to carry the loads on the walls. A carefully designed and constructed hip roof or a Dutch hip roof with minimal overhangs can be used and still achieve disaster-resistance. Most roofs with curb appeal substantially reduce disaster-resistance.

Avoid

Wood frame homes, brick veneer homes, and most of the common methods of construction are not reinforced to resist the winds of a tornado or hurricane, the movement of an earthquake, or the heat of a fire. Yes, some do; but there is risk.

Homes with overhanging porches and long wings also give the disasters an

opportunity to attack.

A masonry house with 13-inch-thick brick walls or the equivalent can be built disaster-resistant, but most of us cannot afford the expense.

Summary

Each of the sections in this report could be expanded into several books; but if the politicians and the people who elect them prefer homes with curb appeal in disaster-prone areas, we will continue to talk about how much worse disasters are now than they used to be, and the people at FEMA will have permanent jobs.