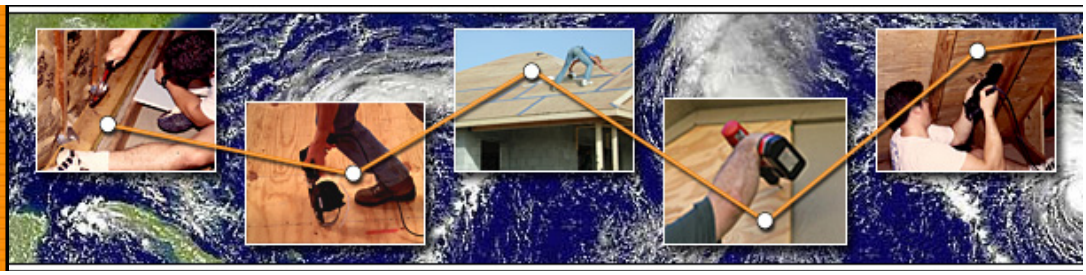


Equipment & Loose Objects

Outdoor equipment such as air conditioner compressors, satellite dishes, solar water heater elements and other roof-top equipment can be blown off their pads or supports. Also remember that mobile homes, outbuildings, barns, fences, and storage sheds can fail. Both the parts of these structures and their contents can produce wind-borne debris that can break windows and sometimes tear openings into your house; letting in damaging rain and wind.

HVAC Equipment

A couple of angle brackets could have kept this compressor in place

(click image for larger version)

It would be nice to attach the equipment to the shelf

(click image for larger version)

Equipment outdoors or in a carport such as air conditioning compressors, water conditioners, water heaters, pool equipment, washing machines, and the like may well get blown around in a hurricane. While they may not get blown very far, it may be far enough to cause a lot of damage to the equipment. Damage, to electrical hookup and condenser lines, that can be hard to get repaired after a hurricane. People who have had their air conditioners damaged and had to wait first for restoration of electricity and then for a repairman in mid summer heat can testify you don't want this to happen to you. Luckily it is easy to anchor such equipment. A very few manufacturers make kits for anchoring their equipment. If yours doesn't, you may be able to make your own and use the manufacturers own cover screw attachment points to anchor the equipment. All it may take is a few right angle brackets to connect the equipment to a concrete slab, a wood porch,

or a wall. There need to be enough brackets to resist wind forces from all directions. The brackets need to be able to restrain about 50 pounds for each square foot of the largest face of equipment so for example a 3' x 3' air condition compressor would need to be well enough secured to resist about 450 pounds. Large generators, those installed on slabs, may well be heavy enough to stay in place.

If you plan it right, you may be able to use the screws from the cover to attach an angle bracket to the equipment.
(click image for larger version)

In some cases you can use a standard small bracket and anchor the bottom pan of the compressor
(click image for larger version)

Yard Structures

(Storage Sheds, Dog Houses, Play Houses, Playground Equipment, Etc.)

The Risk:
Storage sheds pose a real threat to houses by contributing wind borne debris to a neighborhood (and the house whose yard it is in) because, typically, they are not built to the same standards as regular buildings. Further they usually have a large doorway that consumes nearly all of the face of one of the walls. This means that one wall has almost no strength to resist wind and that same wall can allow air to flow into the building. In addition sheds are usually not nearly well enough anchored to the ground or a foundation.

Storage shed blown apart by Hurricane Charley - note the tools still hanging on what is left of the wall
(click image for larger version)

Forces on a shed: The horizontal force applied by a 130 mph wind to a shed that is 8' wide by 8' high is about 2,100 pounds. That is the weight of a small sports car.

Inspecting your shed: Is it strong enough? The answer to the question is your shed strong enough is easy, because most likely the answer is a resounding `No!'. It would be an exception if it were strong enough.

[ ] Can you push on any corner of the shed and make it wiggle? Try all four corners pushing in both directions.

[ ] Can you lift a corner of the building up off the ground, even a little bit? Answer this question assuming the building has no contents to weight it down.

[ ] Is the shed rated, designed and properly anchored for the wind zone where it is located?

The answers to these questions will most likely lead you to know that something has to be done. The question is what.

Corrective Measures For Sheds:
For most metal sheds, adding strength to the building itself would mean essentially starting over again. However anchoring the building to a concrete slab would help it act more like a structural box. If a slab is not an option, one could install screw anchors into the ground near the corners and use ratchet straps crisscrossed over the top and pulled tight to anchor the shed to the ground. The light capacity anchors and ratchet straps are available at many home supply stores; but, you may have to go to a mobile home dealer or supplier if you want more robust anchors. Securing only the floor of a shed may well hold the floor down, but unless the walls are well attached to the floor, the building may still come apart. However, connecting the walls to a well anchored floor can make a difference. Tying the straps off with a rope that is wrapped around the building at mid-height would help create a net-like system for restraining the shed and would help hold the door shut.

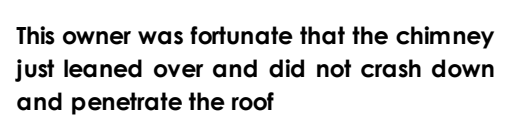
If you have a plastic shed, attaching it to a concrete slab or installing four screw anchors in the ground and strapping the shed down as described above may be the only realistic options for trying to keep the shed from flying around in the storm.

If you have a pretty well made wood shed, then you can do two things to help it survive. Anchoring it to the ground would make a big difference especially it is anchored to a concrete slab. A good connection to a slab would help hold the building down and help it act more as structural box. You can strengthen the building itself much like one would a house by the use of metal straps. If a slab is not an option, using screw anchors and strapping it down may be the only other option. Be sure that walls are well connected to the floor and the roof to the tops of the walls.

Chimneys

The Risk of Chimneys:
We tend to forget about how much chimneys expose our houses to damage. Because chimneys stick up in the air they are particularly vulnerable to wind. Adding to their vulnerability is the fact that they stick up above the roof where the wind can pick up speed as it whips around and over the house. Unfortunately, they frequently are simply not built well enough to resist hurricane winds. Chimney types include those that are factory made of galvanized or

stainless steel sheet metal piping (frequently encased in a sheathed wood frame with vinyl siding and those made at the site using wood framing, masonry (concrete blocks), or stone. Chimneys are made for different purposes, some to exhaust combustion fumes from a gas water heater or gas fireplace, some conventional chimneys for wood burning fireplaces, and some are simply decorative. Sizes can range from 4" diameter galvanized pipe that may stick up beyond the roof 3' to much more massive and decorative chimneys. On frame houses fireplace chimneys tend to be about 2' by 4' wide and stick up at least 3', and some much more than that height. The two things you want to consider when evaluating your chimney are:



This owner was fortunate that the chimney just leaned over and did not crash down and penetrate the roof

(click image for larger version)

- Can it survive the wind forces?
- Will it let water into the house?

The wind forces acting on chimneys are much greater than one might think. A site built fireplace chimney 2' wide by 4' wide extending up 4' above the roof will present a face to the wind that can be subject to a force of over 700 pounds in a 150 mph wind. Imagine having three 230 lb men hanging from the tip of the chimney, with the chimney turned sideways.

Metal Chimneys:

The Risks: Metal chimneys have two major risks: rust and excessive height compared to strength and width. Secondary risks are a lack of a sufficient number of screws to keep the parts together and their vulnerability (inability) to withstand being hits by debris such as tree branches, shingles, roof tiles, or other debris from your house or nearby ones. Gas water heat chimneys tend to be rather spindly compared to their height above the roof. In fact, you may have seen ones bent off to an angle even without a hurricane.

Warning:

If you have a gas water heat with an exhaust chimney that exits through the roof, you should definitely turn the gas off if the wind or debris crumples it or breaks it off. That will prevent hot gasses from being discharged into the attic or just above the roof.

Evaluating Metal Chimneys: Use the checklist below to assess the strength of your metal chimney.

Metal Chimney Checklist

[ ] By pushing on the chimney can you cause it to wiggle? This is somewhat subjective, but if you can cause it to wiggle (not simply just budge), then hurricane winds will beat on the chimney and loosen it. Push or pull from all four sides.

[ ] Are screws that hold sections of pipe missing or severely rusted? Are there screws on all four sides of any joints?

[ ] If the chimney has guy wires or struts to help support it, are they in good condition? Are they rusted? Are connections to the chimney and the house sound and in good condition?

[ ] Is the chimney cap or spark arrestor so rusted that it could come off the roof in high wind?

Corrective Measures For Metal Chimneys: If you find any of the above conditions or others that cause you concern, then you probably need to call a professional to make repairs. If the metal chimney is for a gas appliance such as water heater, then call the gas company to see who they recommend. If the metal chimney is for a metal fireplace, then call the local representative for the manufacturer of your fireplace. You can probably find a label that indicates the manufacturer of the fireplace on the face of the fireplace just behind the doors or behind the spark arresting screen. The reason for calling the local representative for the fireplace is to potentially save a service call because some fireplace manufacturers have their own specially sized chimney pipes.

Wood Framed Chimneys:

The Risks: Some wood frame chimneys are simply attached to the roof surface. Unless they are well connected to the roof structure below, they are extremely vulnerable to being pushed over by wind. Others, as picture farther below, are attached to the sides of houses. In this case the chimney was not well attached.

Chimney cap or shroud
(click image for larger version)

Spark arrestor showing minor rust
(click image for larger version)

Evaluation Of Wood Framed Chimneys: Use the checklist below to assess the strength of your wood chimney.

Wood Framed Chimney Checklist

[ ] By pushing on the chimney can you cause it to wiggle? This is somewhat subjective, but if you can cause it to wiggle (not just budge), then hurricane winds will beat on the chimney and loosen it. Push or pull from all four sides.

[ ] Does there appear to be water damage to wood to such an extent that nails cannot do their job to hold the structure and siding together?

[ ] Has the plywood siding delaminated to such an extent that its ability to provide rigidity is compromised?

[ ] Have decorative boards deteriorated because of exposure to rain and sunlight to the point where they are not effective at holding the wood underneath them together?

[ ] Have decorative boards deteriorated because of exposure to rain and sunlight to the point where they are not effective at holding the wood underneath them together?

[ ] Does the shroud have secure nails at least every 12" to hold it to the framing? By secure we mean; are the nails snug and not apt to fall out?

[ ] Are the nails that hold the shroud at least 2 1/2" long?

[ ] Are nails driven into good solid (undeteriorated) wood? If nails have pulled out replacing them with long screws of slightly larger diameter should solve that problem forever.

[ ] Is the wood that the shroud is nailed to well secured to the rest of chimney structure?

[ ] Is the shroud rusted to the point that it structural integrity should be questioned?

[ ] Can you tell what the chimney uses for sheathing? Is it plywood, OSB, or Thermoply type sheathing as a structural member?

Corrective Measures For Wood Framed Chimneys: It is essential that a chimney be well anchored to a roof because if it gets blown off or over it can leave a huge hole in your roof to let wind and water enter your home.

If the chimney extends vertically as an outside attachment to the house as shown in the photo to the right, then you will want to make sure that it is well anchored to the roof framing using straps on each side of the chimney where it passes by the roof structure. If wall sheathing on the gable end blocks access to inspect and secure this type of chimney, access can be made by cutting holes in the sheathing directly behind the chimney. If access is practical then straps can be run from the vertical framing members of the chimney back to the rafters or trusses.

This chimney box was only attached with a couple of toe-nails near the roof
(click image for larger version)

For chimneys attached to the top of the roof sheathing, one possible access is from the attic. But, this will depend on where the chimney is located. If it is near one of the eaves of the house, it is likely that the attic space is so limited that access is not practical. For chimneys sitting on top of the roof surface, straps should be run down from every corner of the chimney box and from each intermediate stud. There might not be rafter or truss members where these corners or studs are located. If that is the case, the way to provide anchorage for the chimney is to add framing members in the attic that will provide good tie down locations for the straps. To be effective straps should be tight so that the structure cannot start moving in response to the wind and begin to shake apart. In addition to strapping the framing there are likely nails that the original carpenters used to hold the framing to the roof sheathing. These nails could be clinched where they protrude through the bottom face of the sheathing. However, this will be only as strong as the sheathing which in this application is not terribly strong.

To further strengthen the attachment of a plywood chimney box sitting on a roof surface, one could add deadwood (e.g. 2x4's flat) between rafters or trusses that would be held in place by nails or screws through the sides of rafters or trusses. Then

lag bolts could be screwed vertically up through the deadwood and into the bottom plates of the fireplace chimney box.

Another possible way to get at framing is to disassemble part of one face of the chimney by removing some trim boards and either all or part of a piece of plywood siding. Once the access is made you may be able to worm enough of your body in to attach straps as suggest above. If care is used in removing the siding, trim boards, or sheathing, it may be possible to reuse them.

Another way to gain access for strengthening a chimney is to remove the shroud. Removing the shroud should be easy to do, but still most likely won't give you good bodily access. However, it will give you access for a two step process. In the first step, feed coil strap material from above down into the attic and nail it as well as possible to as much chimney structure as you can. In the second step, go into the attic where you can fasten the straps to roof framing members. Unless straps are very tight, they are not likely to be effective because any movement facilitates vibration that can pull nails and ultimately lead to failure. By feeding strap material from the top, the strap will of necessity be long. A way to minimize this disadvantage is once the straps have been nailed at each end they can be tightened by adding blocking, more nails or similar methods to get the straps tight. At least one strap should be installed along framing members at each of the four corners of the chimney box. Do what you can.

For some reason, it seems that termites like chimneys. Consequently you should look for evidence of termites. Chimneys need all the strength they can get and being compromised by termite damage could lead to a spectacular failure.

If you are concerned about a chimney but simply can't get adequate access to make it stronger, then you need to have a remodeling contractor evaluate the situation. Another possibility is to add guy wires or struts to a chimney. Guy wires would have to be added so that support was provided in all directions. Struts tend to be unsightly, but they can be effective. However, both guy wires and struts could probably be made in such a way that they could be deployed just before a hurricane.

Chimney caps or shrouds made of sheet metal are usually made by sheet metal shops. If you give a sheet metal shop the size of the chimney that it needs to slip over, the location of the chimney coming up through it, the diameter of the chimney, and give them a photograph of your cap, they can make you another one. The safest bet is to take the cap off to show the sheet metal shop fabricator, and then return the cap to its perch. Pick a day when rain is not a threat. Calling the shop ahead of time will spare you a wasted effort and trip. You should fasten it with nails or screws that penetrated into the framing (not just the trim, but all the way to the framing). The fasteners should penetrate at least 1-½" into the framing and be spaced no farther than 12" apart on all four sides. Number 8 screws 3" long will work in most cases. The use of screws has the advantage of ease of installation and removal. If a shroud is 4' by 2', it can easily have 200 pounds of pressure applied to it.

Masonry Chimneys:

The Risks: Masonry fireplaces can be made of concrete, concrete block, stone, or brick. They may be faced. That is, have a façade of brick or stone. If they are very

narrow compared to their width, they can be at risk because the narrow side cannot resist the force that wind applies to the wide side. Because masonry chimneys are made of masonry which is a brittle material, they can have cracks that greatly weaken them.

Evaluation Of Masonry Chimneys: Use the checklist below to assess the strength of your masonry chimney.

Wood Framed Chimney Checklist

[ ] Are there cracks between concrete block that are wide enough to cause concern that settling has taken place to such an extent that the mortar between blocks are so weakened that a strong vibrating wind might cause the chimney to come apart? Bear in mind the forces that are applied, 700 pounds to just a 4' by 4' section in a 150 mph wind. A masonry fireplace may have much more surface area exposed to wind depending on the design.

[ ] Does there appear to be water damage to wood to such an extent that nails cannot do their job to hold the structure and siding together?

[ ] Does the shroud have secure screws at least every 12" to hold it to the block or concrete? By secure we mean screws that are snug and not apt to fall out. Screws installed in concrete blocks can easily work their way loose.

[ ] Is the shroud rusted to the point that it structural integrity should be questioned?

Corrective Measures For Masonry Chimneys: If your masonry chimney is falling apart, you should get a mason to evaluate it and help you decide what to do. If it has a single crack line or weak area, it may be possible to brace it with a splint made from steel or aluminum angles at the corners that is fastened together with metal bands that wrap around the chimney. These angles could be used as attachment points for guy wires to brace the chimney from all directions. You are advised to seek professional help before making these fixes lest they not be as effective as you hope.

Antennas and Satellite Dishes

The Risks of Antennas And Satellite Dishes:
Though the examples shown in the photos below may be extreme, every antenna on a roof should to be evaluated for the risk it imposes. Some of the risks to consider include:

1. What happens if an antenna or satellite dish is torn off a roof?
2. What happens to the roof surface or fascia if it is torn off?
3. If an antenna has guy wires, what happens when extra force is applied to them? Might they pull off a chimney?
4. What does an antenna or satellite dish do when it is torn off? Does it tumble down the roof tearing off roof covering? Might it blow into a window or door?

If the satellite dish in the photograph is 5' in diameter, it can easily have 1,000 pounds of wind pressure applied to it. This makes it clear that the concrete blocks

that only weigh about 40 pounds each will simply be flipped off to roll down this shingle roof knocking shingles off as it goes. Satellite dishes should only be installed using code approved support systems. They should be removed when a hurricane threatens.

Photovoltaic & Solar Collector Panels

The Risks:
Anything on a roof is subject to being blown off or torn apart by winds in a hurricane. Especially risky are photovoltaic and solar panels where they are pitched at an angle that is different from the roof slope. This is usually done in order to improve their efficiency during the winter when the sun will be lower on the horizon. When these panels experience high wind loads, they can impose loads that most roofs are not designed to withstand and the connections themselves are unable to handle. The industry is currently struggling to better define these loads and develop robust support systems. It is not just the panels themselves that are at risk. In addition, the roof covering membrane may be damaged as panels tumble across a roof, holes may be created in the roof covering, and holes maybe left in the roof where the panels were pulled up by their roots from the roof structure. The safest installations are those where the panels are installed at least 3' to 4' away from any roof edge and the panels are installed parallel to and a few inches above the roof surface. Wind pressures will tend to equalize very quickly on the top and bottom surfaces of these panels so forces will be lower. The riskiest installations are ones where the panels are installed at a different angle than the roof slope and near an edge of the roof where they can be exposed to increased winds as the flow spills and accelerates around the corners and edges of the roof.

Retrofit Measures:
Check to make sure that your installation has building code approval for use in your area. If you have a system that is installed at a different angle than your roof slope, check to see if it would work well enough if the angle were changed to match that of your roof or whether the angle could be temporarily changed when a hurricane is threatening. If it is close to the edge of the roof, see if it is practical to move it away from the edge.

PDF Version

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Questions