

Callan

HOW TO MAKE YOUR BUILDING WITHSTAND STRONG WINDS

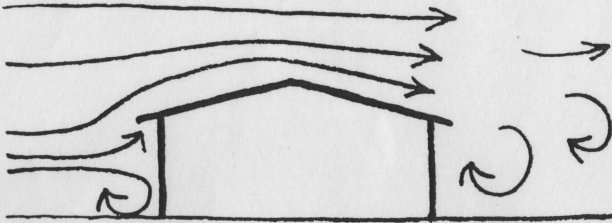
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Overseas Division, Building Research Establishment, UK

Paper presented at BRE Seminar on Low-income Housing, St Vincent, 26-27 March 1980

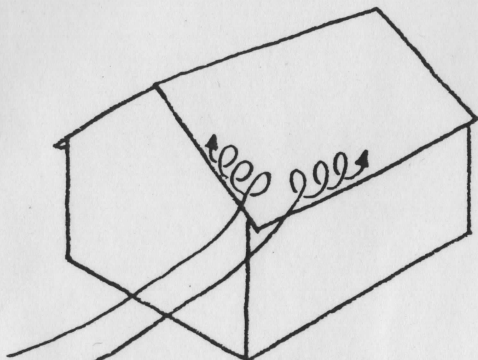
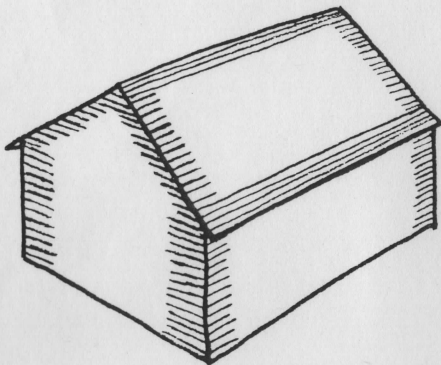
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PATTERNS OF AIRFLOW AND DISTRIBUTION OF PRESSURES

When the wind blows more or less square-on to a building, it is slowed down against the front face with a consequent build-up of pressure against that face. At the same time it is deflected and accelerated around the end walls and over the roof with a consequent reduction in pressure, ie suction, exerted on these areas. The greater the speeding up of the wind, the greater will be the suction. Behind the building, a large turbulent area is created exerting a small suction on the rear face.



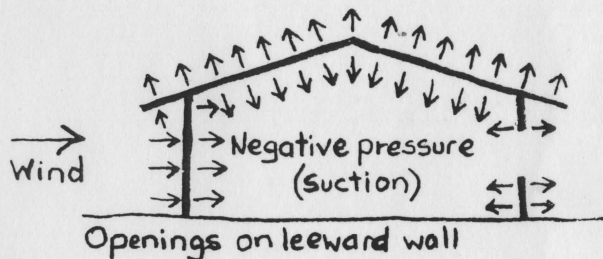
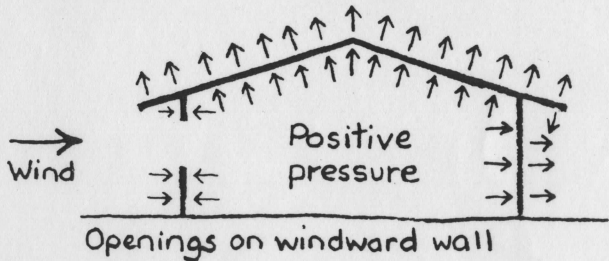
The distribution of pressure or suction over a wall or roof surface is far from uniform. High suction occurs at the corners of walls and along the edges of roofs, and these are areas where careful attention has to be paid to cladding details.



Vortices produced along edge of roof when wind blows on to a corner

An important factor contributing to the loads on a roof is the roof pitch. When this is low, the windward slope will be subject to severe suction, particularly at angles less than 15°. Roofs steeper than 35° generally present a sufficient obstruction to the wind for a positive pressure to be developed.

The load across any roof or wall surface depends on the net effect of the internal and external pressures or suction. The internal pressure is controlled by the relative amounts of openings on the various surfaces. For example, if a window on the windward wall is broken by flying debris in a hurricane, positive pressure will be admitted inside the building and this will act in conjunction with the external suction (particularly on the roof) and greatly increase the loads. This situation frequently occurs as can be seen during any wind storm; most damage occurs to roofs.



Many buildings have been saved from damage during a hurricane by the occupants deliberately controlling the internal pressure. A suction can easily be achieved by creating an opening in an area away from the windward wall. If this action is taken, careful checks should be made for changes in the mean wind direction during the passage of the storm.

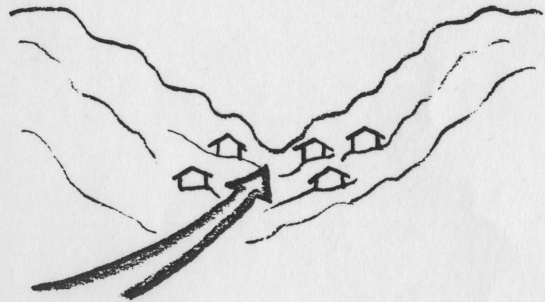
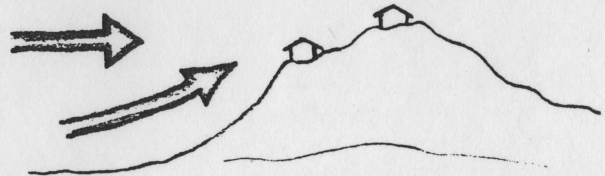
GUIDELINES FOR DESIGN AND CONSTRUCTION

The following 25 points should be incorporated where possible when new buildings are being designed and constructed in hurricane areas, or when damaged

buildings are being repaired. These guidelines either help to reduce the forces exerted on the building whilst strong winds are blowing, or help to increase the resistance of the structure to the forces.

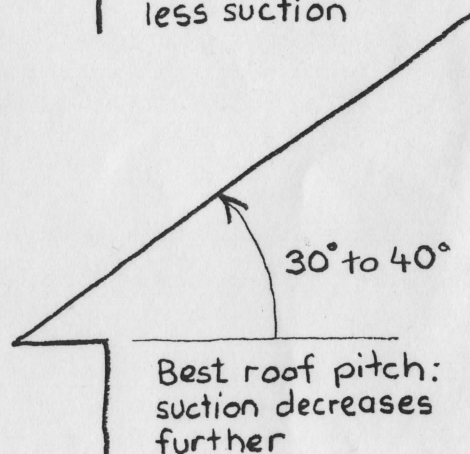
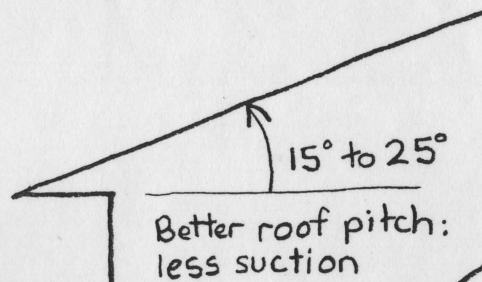
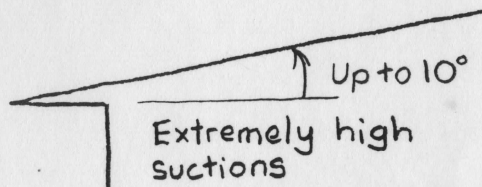
Location:

- 1 Take advantage of natural windbreaks such as trees or hedges when locating a building. Such a site can reduce the impact of prevailing winds.
- 2 Be careful of sites on hills or near tops of hills. Windspeeds can be much higher.
- 3 Valleys funnel winds and can create higher wind speeds.

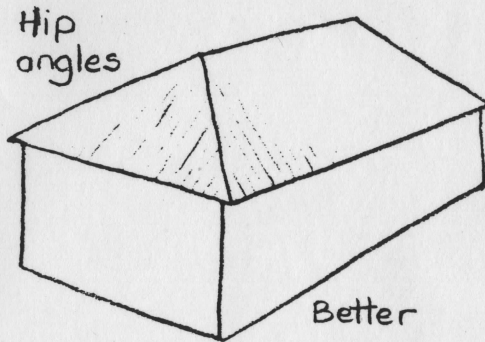
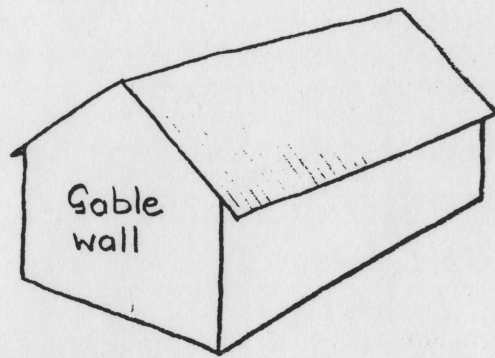


Shape of building:

- 4 Carefully consider the pitch of the roof.



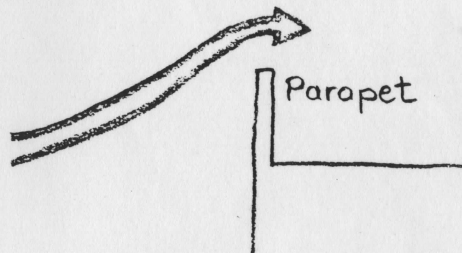
- 5 Consider having a hip-angle roof instead of gable ends. Roof suctions can be reduced.



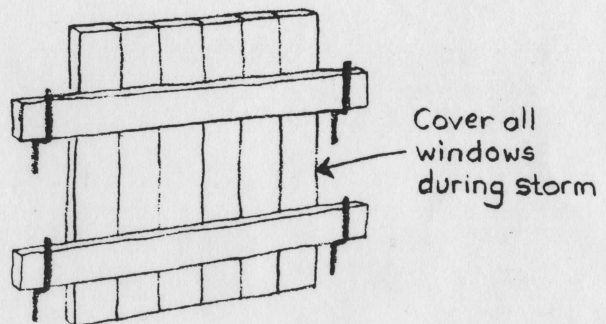
- 6 Avoid large roof overhangs, even if they are supported at the edge by columns. If necessary, use vents to relieve the pressure.



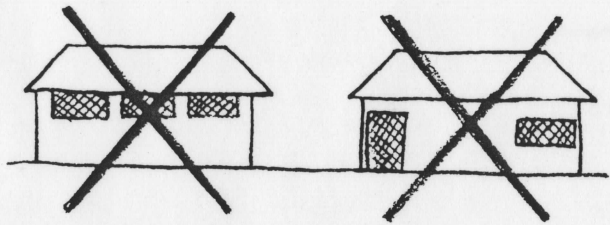
- 7 A parapet around a roof can help to reduce the high suctions along the roof edges.



- 8 Try to have shutters that can be placed over all windows during hurricanes. These will help prevent missiles breaking windows and creating high internal pressures.

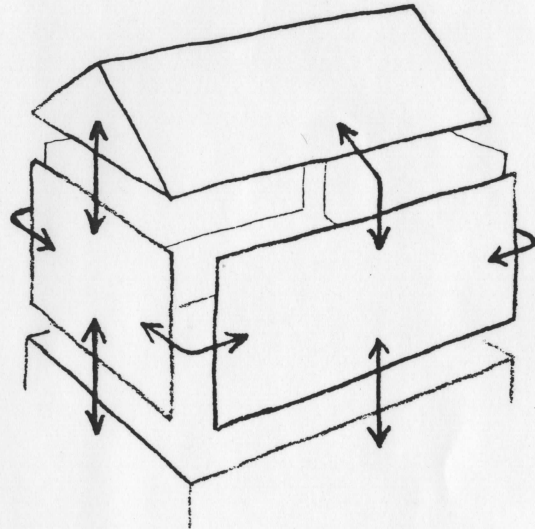


- 9 Avoid large openings near roof lines or near corners of walls. These tend to weaken the structure, and are located in areas of greatest loading.

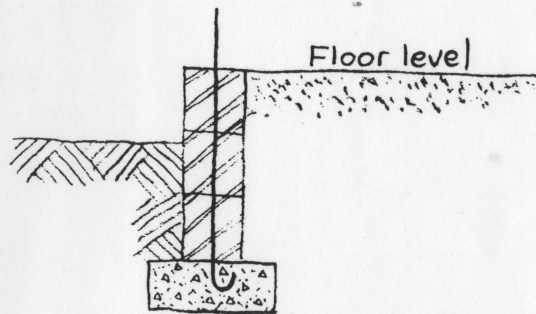


Construction details:

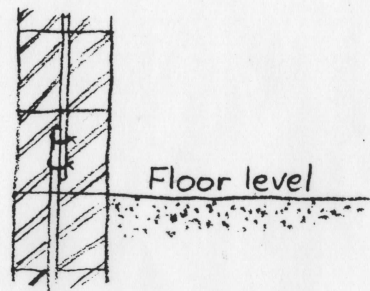
- 10 Make sure that every part of the building is securely tied together; all roof elements, roof to walls, walls to walls, walls to floor, floor to foundations.



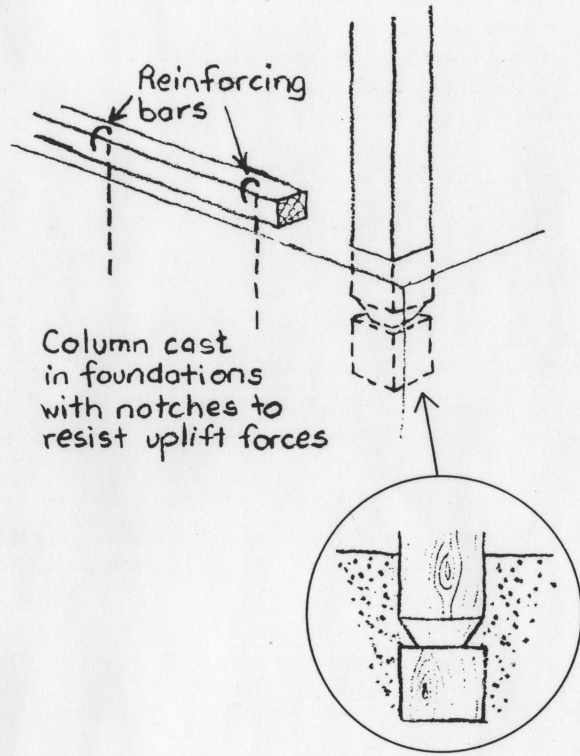
- 11 Have good foundations, well constructed to a uniform depth all round the building. Place a continuous concrete footing in a trench. Have reinforcing bars out of the concrete footing and through hollow masonry blocks filled with concrete.



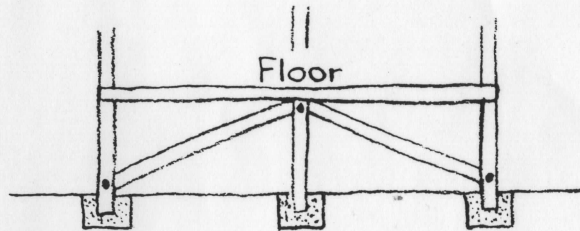
- 12 Use the foundation reinforcement to anchor the subsequent house construction. If masonry construction is used, lap and continue the reinforcement in the walls.



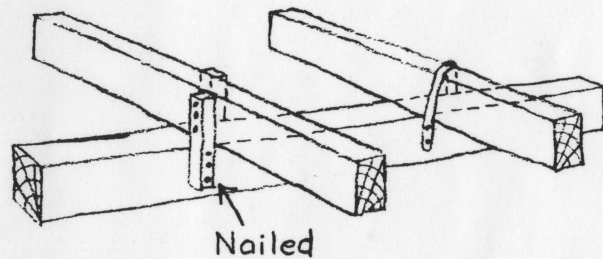
- 13 If timber walls are used ensure a positive connection and tie-down to the foundations, either by using reinforcement from the footings, or by casting columns in-situ in the foundations. In this case 'notch' the columns to resist uplift forces.



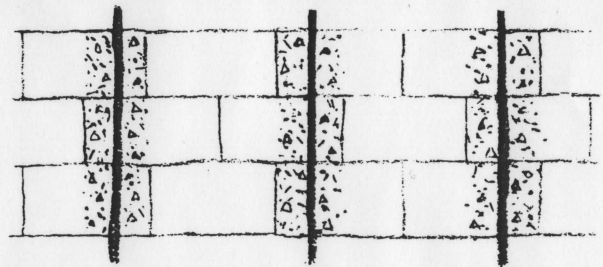
- 14 If a suspended floor construction is used, ensure that the entire sub-structure is braced and positively anchored to the foundations.



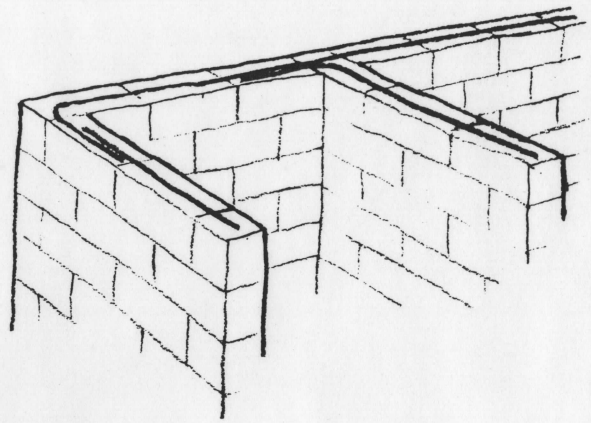
- 15 All timber floor joists must be firmly connected by pairs of connectors or metal straps.



- 16 All masonry construction must be reinforced. The voids for the reinforcement must be filled with concrete.



- 17 Horizontal reinforcement should be used around corners, between intersecting walls, and between columns and infill walls.

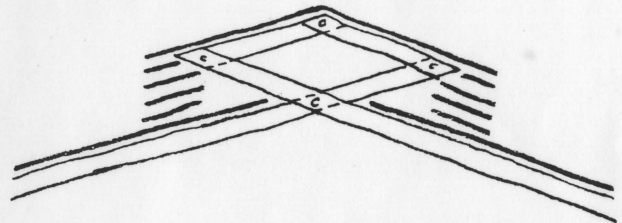


- 18 Ensure positive connections between door frames, window frames and lintels and the walls in which they are placed.

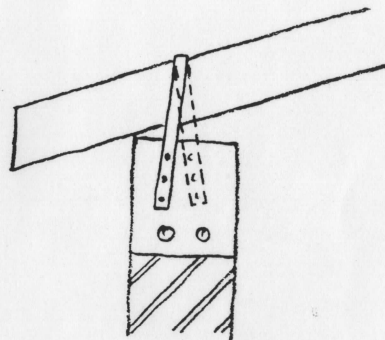
Roof construction:

- 19 WHATEVER THE FORM OF ROOF CONSTRUCTION, BE SURE TO TIE IT SECURELY TO ITS SUPPORTING WALLS OR POSTS. IGNORING THIS CAUTION IS THE GREATEST SINGLE CAUSE OF DAMAGE DUE TO HURRICANE WINDS.

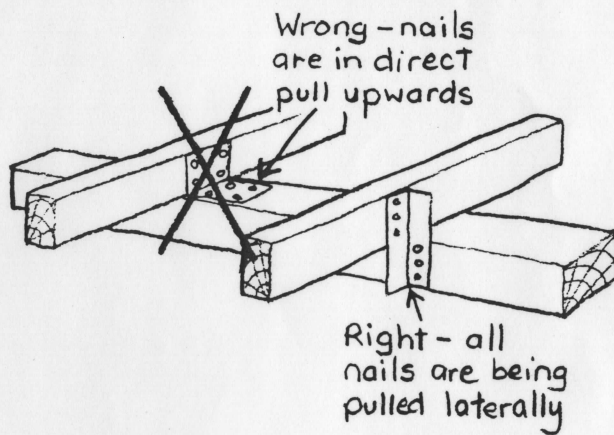
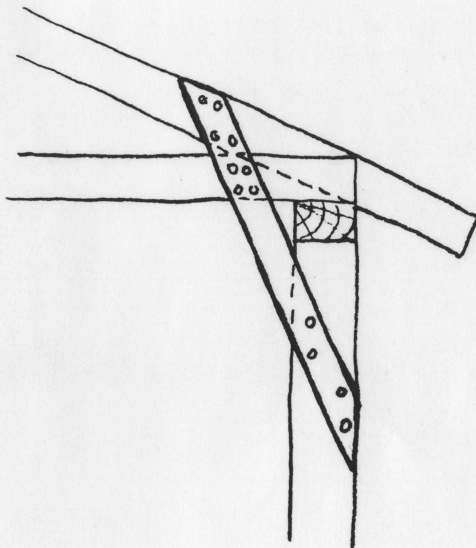
- 20 Consider using a ridge ventilator to reduce the internal pressure and thus decrease the total roof uplift.



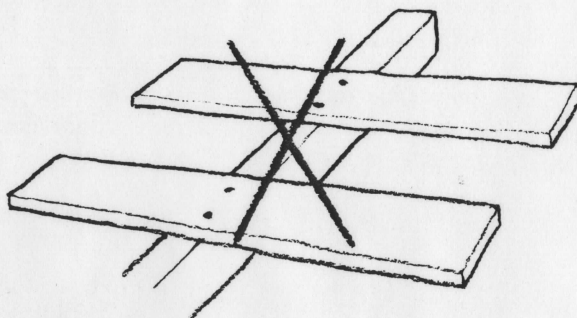
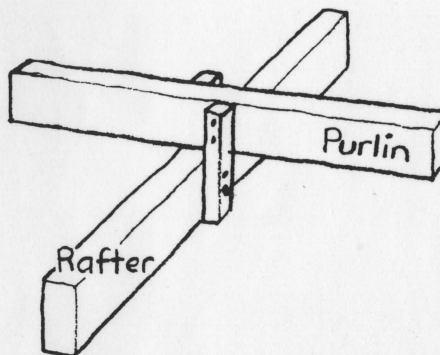
- 21 When connecting a timber roof to a masonry wall, use a fastening strap or reinforcing bar that is firmly embedded in the concrete or masonry.



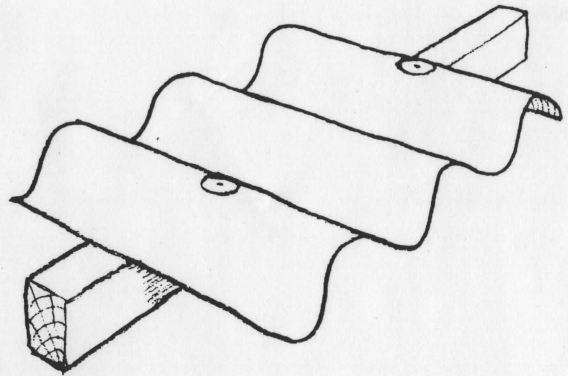
- 22 Tie roof members to timber walls with straps, brackets or wooden cleats. Nail the connectors to all members, **MAKING SURE THE NAILS ARE DRIVEN IN LATERALLY, NOT IN DIRECT PULL.**



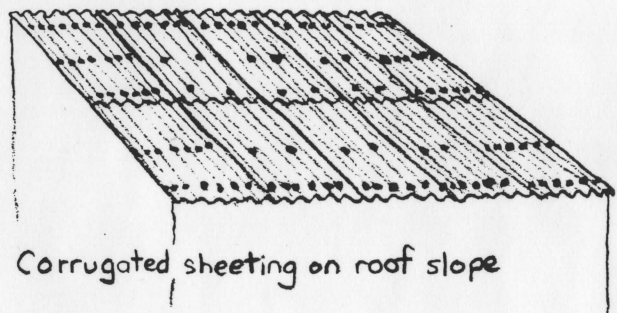
- 23 Tie all purlins to all rafters by at least one, and preferably two, connectors. **DO NOT NAIL PURLINS FLAT ON TO RAFTERS.**



- 24 When nailing corrugated roof sheeting to purlins, nail through the top of the corrugations and use a washer at least $\frac{3}{4}$ inch in diameter.



- 25 Nail every corrugation along the bottom purlin (at the eaves); nail every corrugation along the top purlin (at the ridge); nail every corrugation on the end sheets (at the gable ends); nail every third corrugation over the rest of the roof. Ignoring these nailing recommendations results in the tremendous loss of roof sheeting in hurricane winds.



The information in this paper is based on research that has been carried out at the Building Research Establishment of the UK Department of the Environment, and is published by permission of the Director. Part of the work has been carried out on behalf of the Overseas Development Administration.

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