

CONCLUSIONS

This survey revealed that the designated hurricane shelters and health service facilities require upgrading to make them suitable for use as shelters.

The recommendations made in the previous sections dealt mainly with the most obvious areas for rectification which may be achieved with least difficulty. This is sometimes reflected in the cost estimates of Apendices B and C.

The use of a building as a shelter will in general be the secondary function for that structure, but since hurricanes will subject the building to extremes of wind loads, this function may determine the design parameters. If it is recognised initially that a given building will be designated as a hurricane shelter, then the designer may incorporate hurricane resistant characteristics in the design. The client therefore, who describes the purpose of his project, has a significant role to play in producing successful designs.

Central to the problem of providing safe buildings is the unwillingness to accept that disastrous events, ie hurricanes, floods and earthquakes will occur in one's own territory.

The cost of providing adequate protection is inversely proportional to the degree of consciousness about the risks. A high degree of consciousness leads to appropriate design concepts which in turn lead to economical solutions. Solutions should be affordable, should accept that there is a non-zero level of risk in all buildings, should perform in the manner intended by the client and be in harmony with the traditions of the community.

The advent and implementation of the Caribbean Uniform Building Code for the countries of the Commonwealth Caribbean is likely to produce a general raising of the standard of design and construction which would facilitate the achievement of the higher-than-average standards of safety that are required for hurricane shelters.

Considering the potentially hazardous effects of hurricanes and the nature of the majority of the housing stock, the Caribbean territories cannot afford to ignore the need to provide shelters which are hurricane resistant.

Of the various materials available for building structures in the Caribbean, reinforced concrete provides the most favourable result in the majority of cases. Reinforced concrete roof slabs with reinforced concrete block masonry walls offer the best protection.

The evaluation of the listed shelters revealed that the roofs are the most vulnerable elements. These invariably are clad with corrugated sheeting. The effects of cyclone Tracy on the city of Darwin in Australia in December 1974 has demonstrated that corrugated sheeting cannot be guaranteed to remain intact on a roof during a hurricane. Almost all of these corrugated roofs failed in Darwin. In order to establish the reasons for this failure of the cladding, the Australian Department of Housing & Construction carried out an investigation and produced a report entitled "Appraisal of Metal Roofing Under Repeated Wind Loading - Cyclone Tracy, Darwin, 1974". The conclusions and recommendations of this study are reproduced in Appendix E.

In summary, corrugated metal sheets may be expected to fail in fatigue due to repeated loading on the sheeting-fastener assembly at wind speeds between 30 and 40 m/s.

In the Caribbean, corrugated metal sheets are widely used as roof cladding. Considerable resistance may therefore be expected to any recommendation which calls for a sudden departure from this practice. It is therefore expected that for some time to come corrugated sheets will continue to be used for roof cladding. However, there are certain measures which may be taken to reduce the vulnerability of the roof. These are:

1. The use of a heavier gauge sheeting - 22 gauge minimum for steel and 20 gauge minimum for aluminium. Inspections should be carried out to ensure that the specified gauge is installed.
2. Increased frequency of roof cladding fixings in high suction areas at the eaves, gable ends and ridges.
3. Steeper roof pitches - 25° to 40°.
4. The use of short or no overhangs. If shading is required over windows and doors then separate canopies should be employed, failure of which would not endanger the main roof structure.

5. The use of hipped roofs instead of gable roofs.
6. Incorporating ridge ventilators to reduce the internal pressures.
7. The use of parapets to reduce uplift at the edges.

The window and door openings were the next most vulnerable areas. The windows usually contain a high percentage of glass which is particularly vulnerable to flying debris and therefore require protection. This may be achieved by using storm shutters. Where feasible, to ensure that they are available when required and to eliminate the need to provide storage, these should be fixed permanently to the building.

The Hurst Awning Company Inc of Miami, Florida is one manufacturer producing a range of suitable aluminium shutters which are easy to install.

It is not sufficient to rely on standard bolts to secure doors and large windows as the wind forces on the doors may cause the bolts to fail at their fixings. It is recommended that braces be employed for both doors and window shutters. These may be secured in slots in the wall on either side of the opening or in brackets bolted to the wall. See figures 2 and 3.

Experience has shown that walls may be blown down by hurricane winds. Reinforcement is therefore required in blockwalls. (Since all the territories in this survey are also subject to earthquake loads, reinforcing blockwalls would be doubly beneficial.)

A comprehensive programme of retro-fitting is therefore envisaged to upgrade the existing facilities. Future construction providing the required level of hurricane resistance at minimum cost may be achieved by close collaboration between the client, architect and engineer; appropriate choice of form during the conceptual design; simplicity and a faithful attention to the best principles of design.

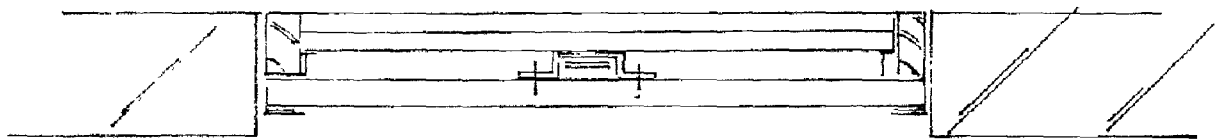
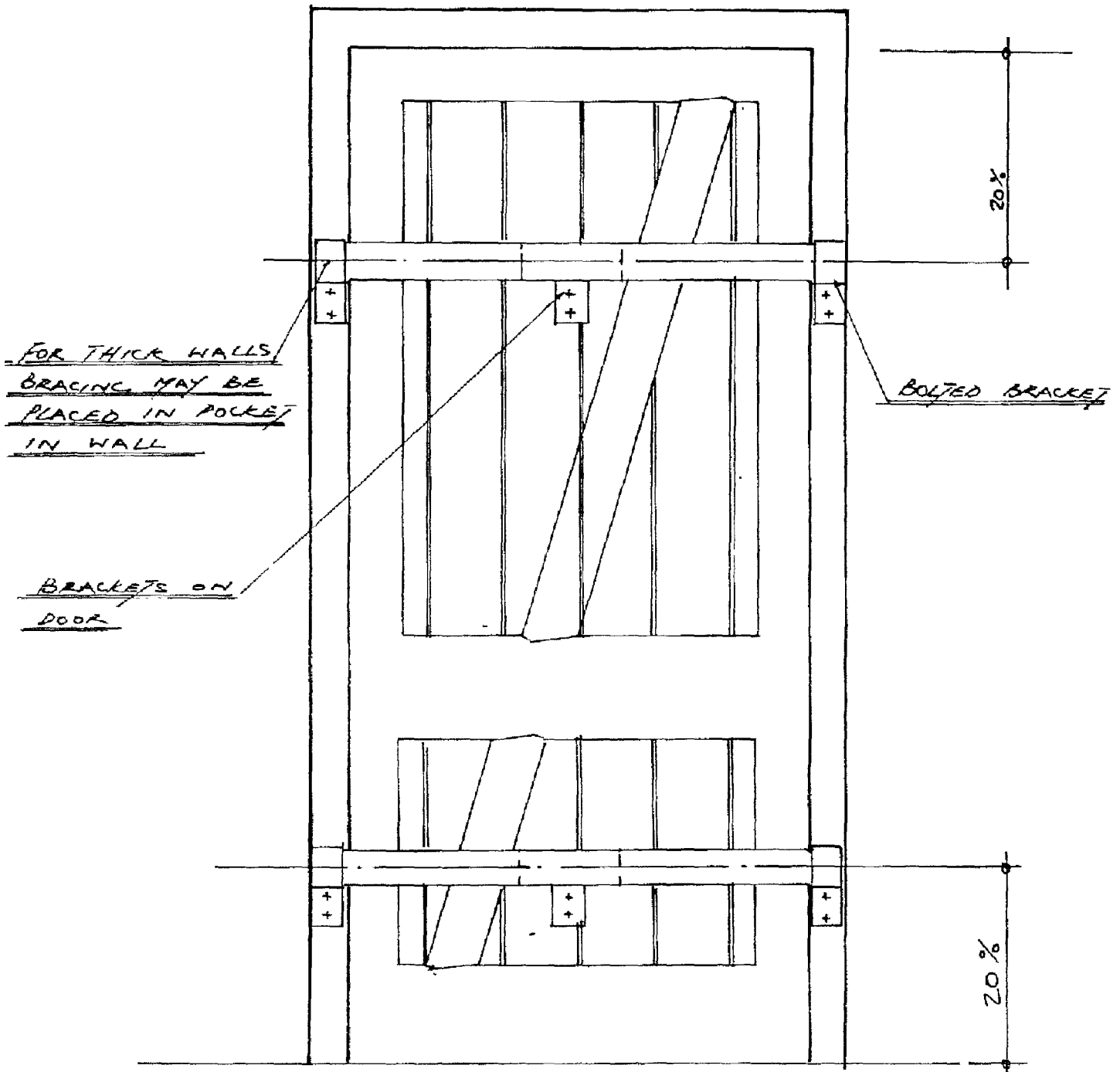


FIGURE 2

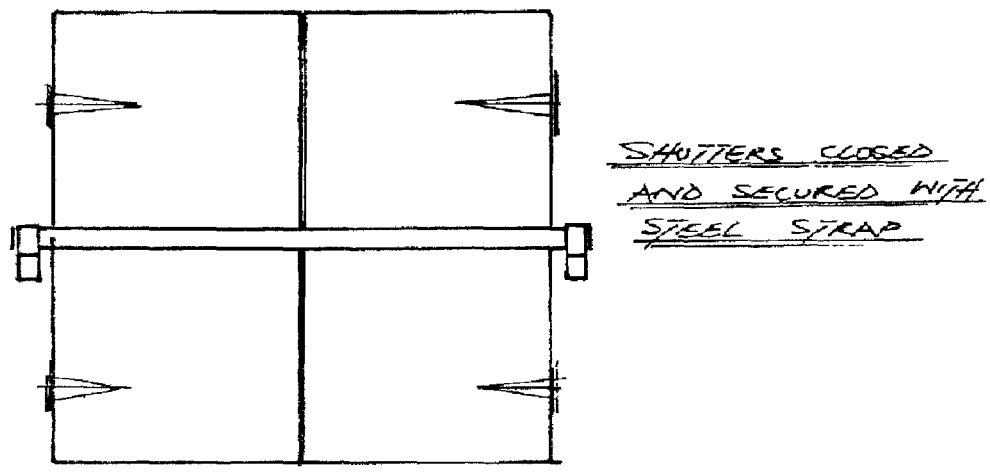
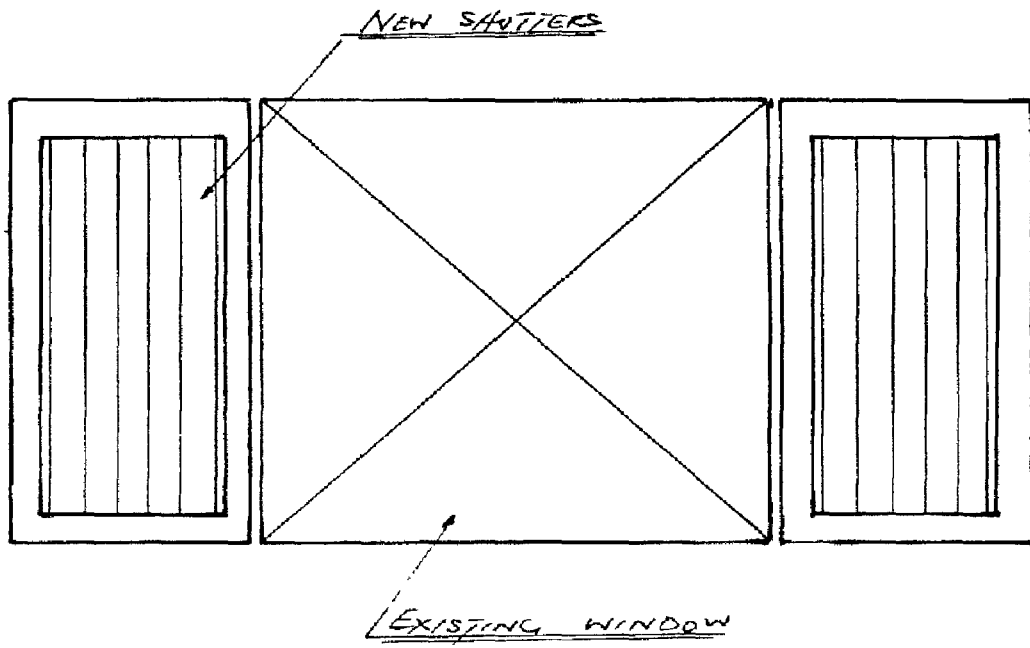
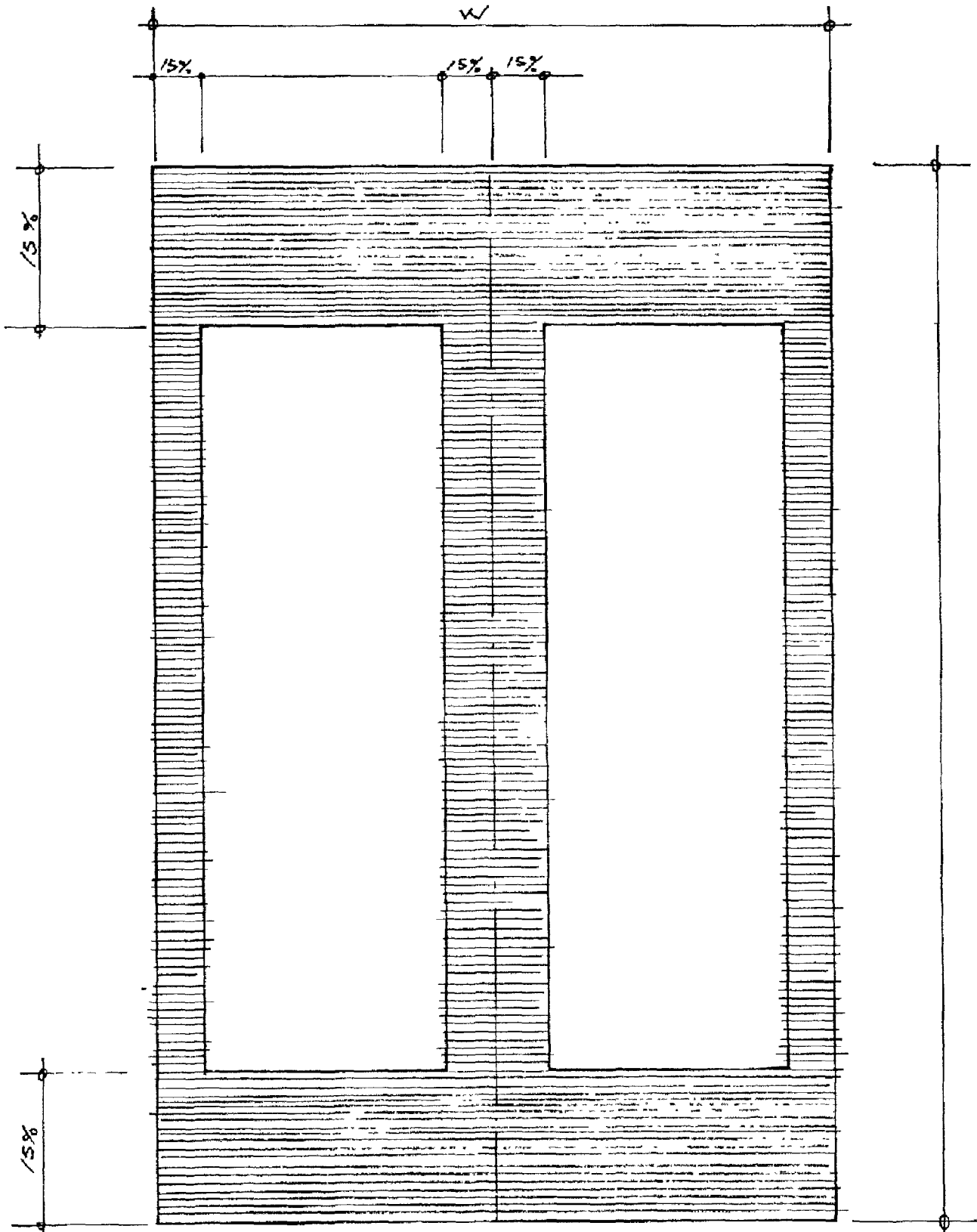


FIGURE 3



ROOF PLAN SHOWING AREAS FOR
INCREASING SHEET FIXINGS

FIGURE 4