10.1.4 Case Study 4

- *Holiday Units, Magnetic Island*

This set of holiday units, illustrated, is located on Magnetic Island, NE Australia, 10 km off the coast at Townsville which was hit in December 1971 by Cyclone Althea with winds of 55 to 60 m/s. The building was partially damaged in the cyclone but was saved from demolition by the upgrading systems, initiated by the architects, to provide anchorage and continuity to complement the existing adequate bracing in the walls.

The roof system consisted of a rafter spanning from ridge to top plate to eaves.

The roof sheeting was adequately fixed by screws and the battens were securely fixed to the rafters.

However, the rafters needed better fixing to the top plate.

The top plate was too small to support uplift forces.

There was inadequate tie down from top plate to the floor framing where the weight of the building could be utilised to resist the uplift forces.

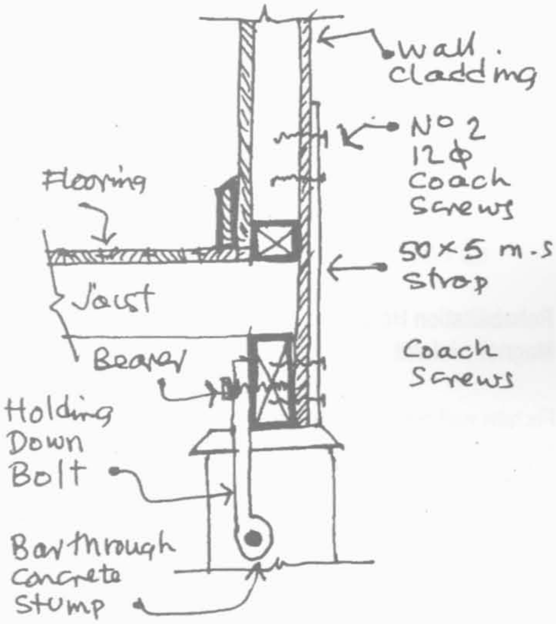
The existing external wall cladding was fibre cement sheets fixed vertically with joints covered by a 50 x 5 fibre cement cover strip.

Evaluations were carried out and a decision made to rehabilitate the building.

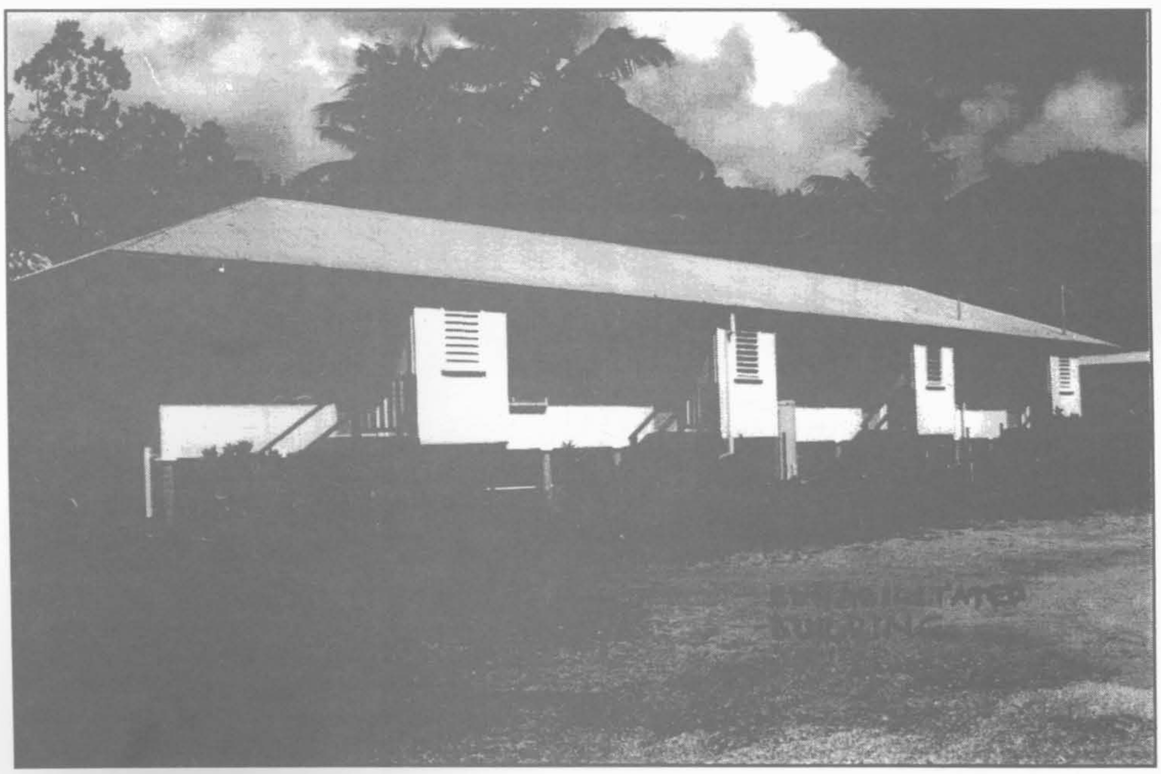
A new larger top plate was surface mounted on the face of the exposed studs at the junction with the roof and connected to rafters with metal framing anchors.

The new wall top plate was coach screwed to each stud with two 12 mm coach screws, the studs were spaced at 450 cc, thus activating the timber studs to act as "holding down" posts.

The base of the studs were connected to the floor bearer by a mild steel strap (replacing part of the fibre cement cover mould).

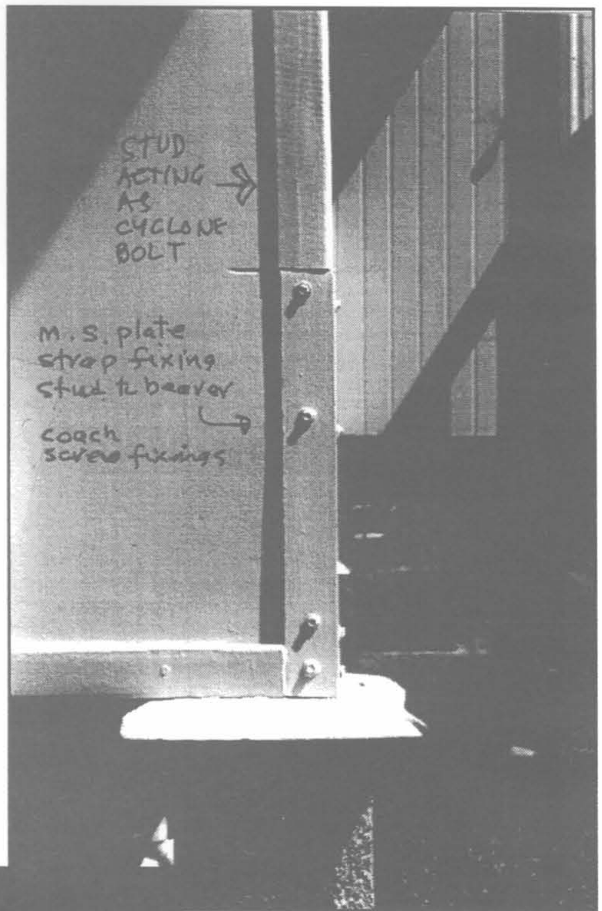


DETAIL



The 500 mm long, 50 x 5 MS. strap was extended from the bearer to 300 above floor level with two 12 mm Ø coach screws to both the bearer and to the stud.

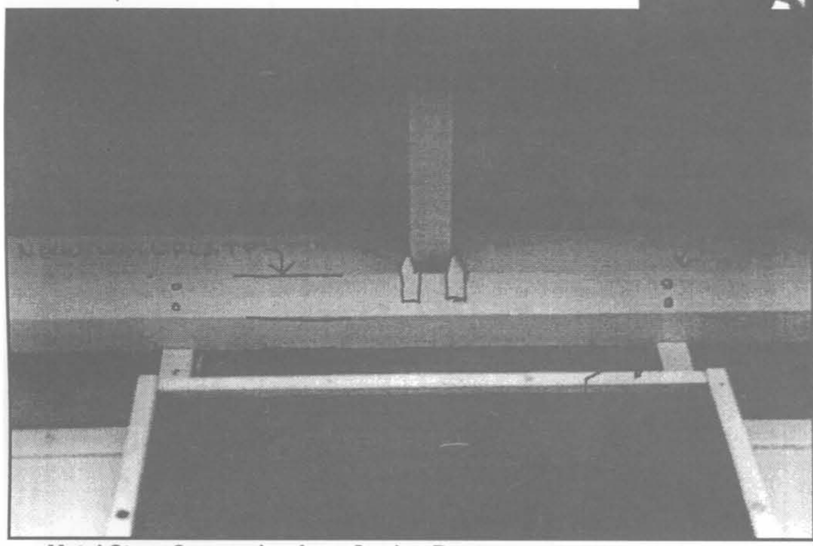
Thus, the roof loads were transferred to the new top plate. The top plate transferred the loads to the studs. The studs transmitted the loads down to floor bearer which in turn supported the floor joists and in effect the whole building.



Fixing of Stud to Joist or Bearer by Metal Straps

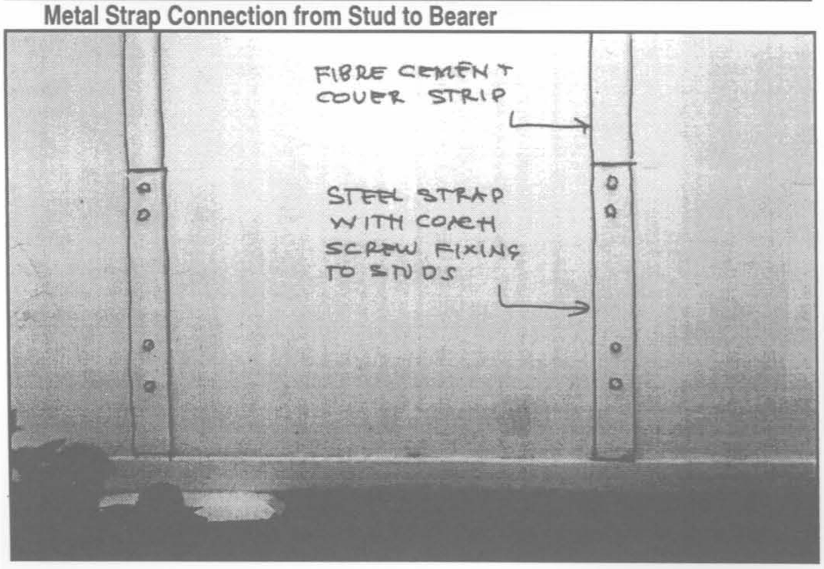
Rehabilitation Hold Down Method – Holiday Units, Magnetic Island

Fix new wall plate, Coach screw to studs, connect rafter to new plate with metal connectors



Use existing timber studs as 'Hold Down' Mechanism

Metal Strap Connection from Stud to Bearer



10.1.5 *Case Study 5*

(a) Two Level Timber School

This two level timber school, the Marian School, was affected by a 1971 cyclone and was able to be repaired.

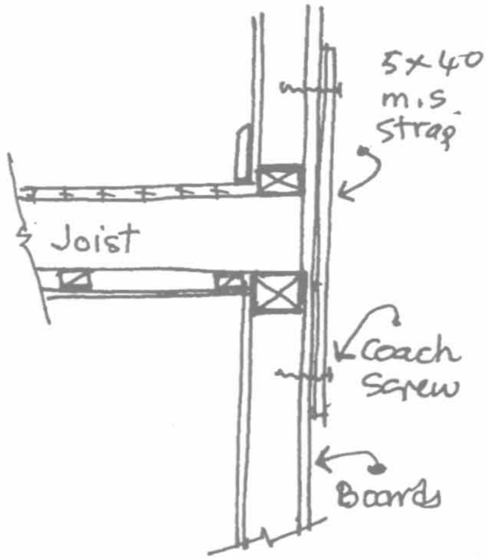
The construction consisted of bottom plate, studs to ground floor ceiling, bearer plate, upper floor joists, floor plate, studs to roof level, top plate and rafters bearing on to top plate.

This was defined as a "discontinuous" construction system.

The stability of the upper floor timber structure, sitting on a disconnected system of plates and joists at ground floor ceiling level, was in question when cyclone overturning forces were considered.

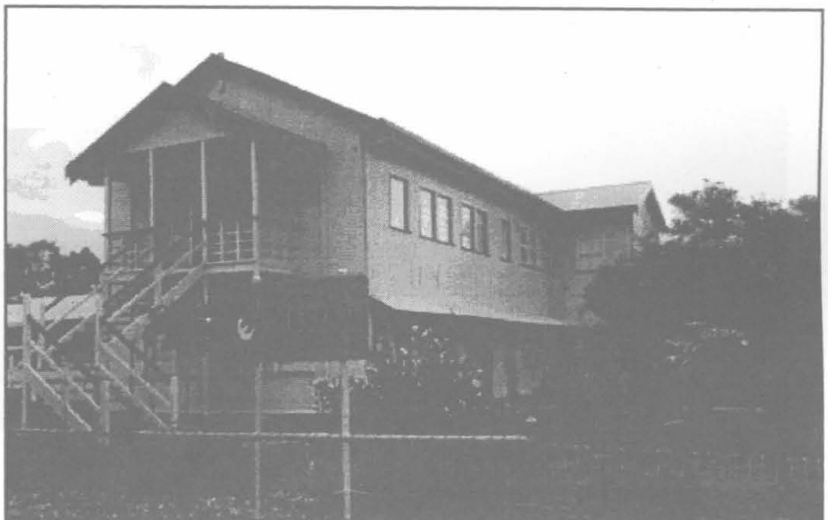
A decision was taken to provide continuity of fixing from the first floor studs to the ground floor studs without removing the external cladding.

A series of mild steel straps were used to connect the studs adjacent to windows on the upper floor to the studs on the lower floor. Surface mounted straps were used with Ø 20mm coach screws.



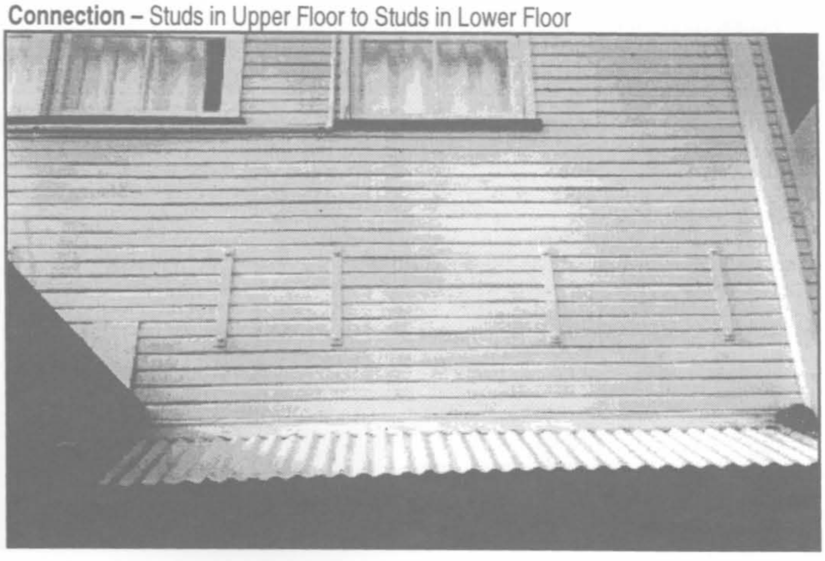
DETAIL

Providing Continuity from Roof to Foundation



View of School

Connection – Studs in Upper Floor to Studs in Lower Floor



(b) *School Toilet Block Structure – The Marian School*

This detail of design and construction of a small toilet block at a school illustrates a number of details.

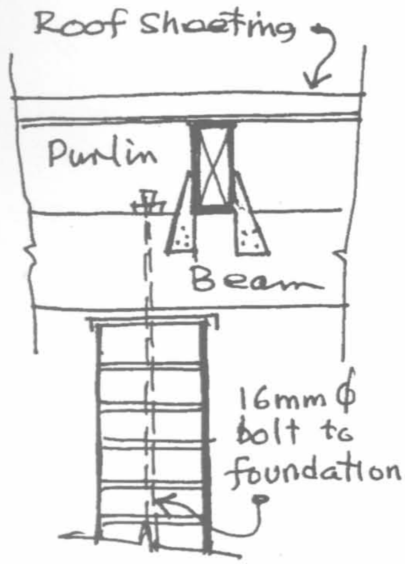
1. The space between the top of the wall and the roof is open. This avoids the application of internal pressure when calculating wind forces, saving over 35% of the wind loads applicable if the structure were closed.

   The ventilation is also useful in this building.

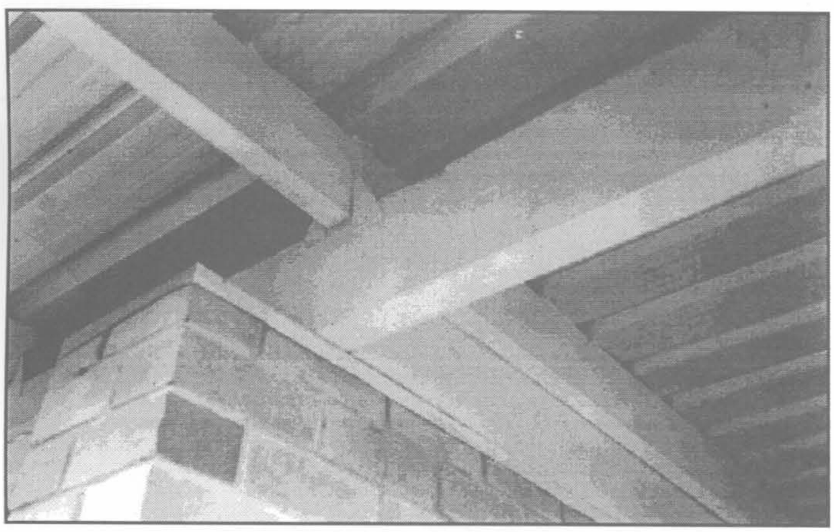
2. The purlins are shown connected to the supporting beams by metal framing anchors.

3. The beams are connected to the foundations by 16 mm Ø steel bolts extending through the centre of the 230 thick brick wall.

4. The brick walls provide mass and bracing to the building.

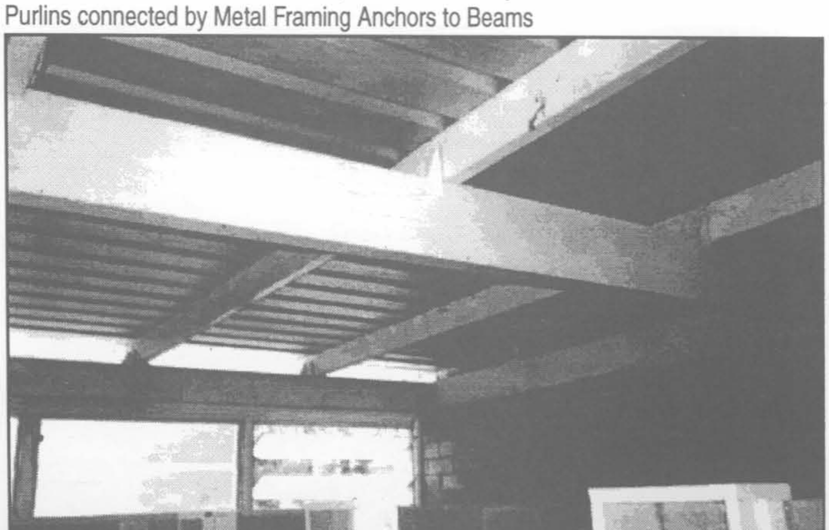


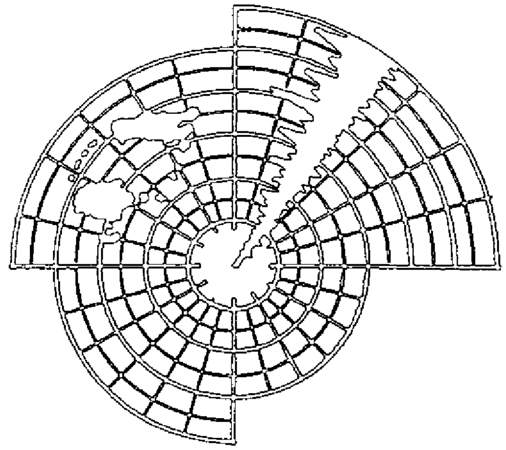
DETAIL



Beam Held Down by Bolt Through Brickwork to Foundation
Purlins connected to Beam by Metal Framing Anchors

Ventilation above window reduces pressure internally
Purlins connected by Metal Framing Anchors to Beams



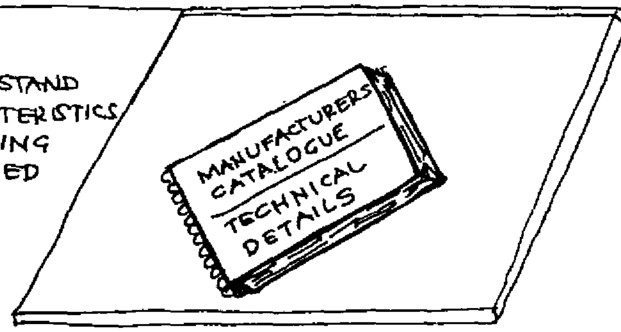


11 RESPONSIBILITIES & CONCLUSIONS

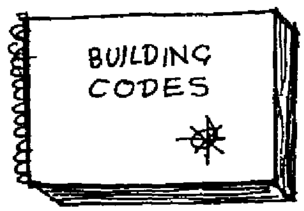
CONTENTS

DESIGNER'S RESPONSIBILITIES

- DESIGNER TO UNDERSTAND PERFORMANCE CHARACTERISTICS OF ALL OF THE BUILDING MATERIALS SPECIFIED

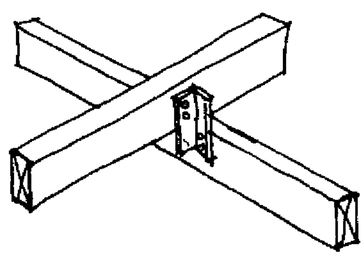


- DESIGNER TO UNDERSTAND LOCAL AND NATIONAL BUILDING CODES



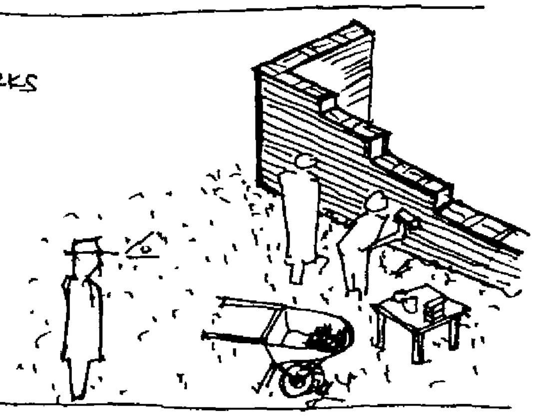
- DESIGNER TO DETAIL AND SPECIFY THE FIXING DETAILS AND WORKMANSHIP

  MAINTAIN EXPERIENCE IN CONSTRUCTION DETAILS



- DESIGNER TO INSPECT THE WORKS FROM TIME TO TIME

  SUB-CONTRACT SPECIALISTS AND CONTRACTORS TO SUPERVISE THE INSTALLATION



There are many sections of a society that bear responsibilities for the mitigation of the effects of disasters, of which cyclones are one of the most damaging.

A typical scenario of concern encompasses the following:

- Relief
- Rehabilitation.
- Reconstruction.
- Research & Testing.
- Mitigation.
- Preparedness.

We are, in the design and construction industry, concerned with a number of these situations.

However, as stated in the Introduction, the Governments of individual countries are primarily responsible for mitigation against disaster events and the establishment of criteria and standards in their own country.

International co-operation and co-ordination can assist in establishing correct standards and should be supported by all governments and research establishments.

Technical data banks should be established at selected epi-centres in the disaster regions so that expert local advice can be obtained from people familiar with the region.

11.1 UNESCO CONTRIBUTION

UNESCO has been playing its part in assessing regions at risk in the Pacific and Indian Oceans and in the Caribbean and has sponsored Sub-Regional and National Training Courses for member states in these regions

The publication no. 4 in this series, "School Buildings and Natural Disasters" in 1982 by D J Vickery, identified the overall problems, diagnosed the risk recognition and response and identified programme areas

Subsequent UNESCO missions outlined above have been addressing the problems of education of professional and technical personnel to create an international cartel of experienced advisers in the field of disasters and in particular in the mitigation of the effects of cyclones.

The UNESCO mission to Bangladesh in April 1990 established wind code loading tables which estimated maximum wind speeds of 146 mph; and set out criteria for this speed. Workshops were held in the four major centres to pass on the information and experience and to learn of the local response.

In 1991, 12 months later, the highest wind speed in the recorded history of the country gusted at speeds up to 145 mph (65 m/s).

This should confirm the validity of the criteria already offered.

Some general overview should be maintained, as is presently done by UNESCO, to ensure that cyclone disaster events are properly examined and evaluated so that overlap is avoided, wherever possible, on major research projects.

11.2 RESEARCH, DISSEMINATION & EDUCATION

The following statements, initially made in the Introduction, are repeated hereafter to reinforce the need for consideration of these important matters.

Support of independent research and evaluation by experienced teams, whether government agencies, academic institutions, private committees or commercial ventures should be sponsored.

Another prime need is for collation and dissemination of research done to date. A great deal of research is lost once it is complete due to lack of publication. The cost of reproducing research and technical data is a hurdle to be crossed. Perhaps support from manufacturers or from the re-insurance industry and governments could assist in this regard, providing a suitable co-ordination body or council is set up to provide control.

The major problem is to instil into the education courses for both professional and technical students the input needed to make these future leaders aware of the wind problems and its effect on construction details.

Unfortunately, too often schools do not upgrade their course material on a regular basis and the time lag in imparting new techniques is too slow

With the growing demand in the nations for better buildings, the need to update educational material is vital.

In any case, architects, engineers and their clients have a need to re-examine the security and integrity of constructions in regard to resistance in high wind damage areas.

The rapid growth of population in many countries has identified the need to provide greater protection now that a larger community is at risk. The reliance on a limited number of experienced professionals and contractors is no longer satisfactory.

11.3 THE EASY SOLUTIONS

As soon as a cyclone strikes a community and the subsequent damage reports are published we are faced with a litany of what we should not do in future development. Some of the easy solutions are offered:

Avoid roof overhangs:
Lose your shade

Avoid flat roofs:
Pitch all roofs at 30°

Avoid large windows:
Sweat all summer

Avoid wave surges:
Build in the hills

Avoid exposed sites:
Don't build in the hills

Don't use aluminium or fibre cement:
Build everything in concrete

Don't use nails or glue:
Bolt everything to the floor

Don't build near the sea:
Live on a farm

Don't build near trees:
Cut them down

Don't have fancy roof shapes:
Live in a box.

Avoid Cyclones:
Live in a cave and design for rock slides!

And so it goes on .

Obviously, these suggestions are impractical. But, well considered solutions must be developed to all of the problems confronting us so that the future population has an economical choice of solutions to allow the flexibility that is so necessary to maintain some individuality and comfort.

The results must be practical, economical and attractive additions to our environment.

After a disaster of significant magnitude, governments are catalysed into initiating research.

But, advantage must also be taken of the practical experience that is available and mix some of these practical people with the theorists while the theories are being developed in order to try and halve the time lag from conception through acceptance to use

11.4 PEOPLE INVOLVED

The dissemination of material from the theorists mentioned above should pass on to and between the following diverse groups who should be involved in some occasional, at least, interaction at conferences and workshops.

- Professionals and technicians
- Industry and manufacturers.
- Trade and contracting personnel.
- Local government departments and inspectors.
- Financiers of all colours.
- Insurers and government advisers
- Developers.
- Occupants and the public at large
- Media.
- Schools of education at both trade and tertiary level throughout the nation.

A great amount of design is carried out by individuals who are not aware of the implications involved in the design solution.

Government officials need to understand some of these considerations when a brief is formulated for a particular building project, especially where disaster prevention and post disaster functions may be needed to be served by the building

Properly trained designers are often involved in only a minor percentage of the building stock in any country The importance of the design stage should therefore not be underestimated nor the value of communication between the Construction Authority and the design team or between the design team and the end users of the building. Each should understand the problems of implementation, bureaucracy, current practice, codes and regulations and the need for clear and concise documentation and presentation.

Design solutions should be presented in a manner that is easily understood by the Construction Authority and the user. They should indicate which solutions the design is solving and also those matters that the design has not attempted to resolve. Awareness is a key factor in this stage.

The selection of the design team is therefore a most important decision which is often taken too lightly. The design team should be aware of current practice, traditional techniques and should also possess an administrative ability and the skill to relate the cost of the design to achievable budgets and the economy of the region where the building is to be erected.

Buildings subject to a post disaster function such as schools which should be available for shelter and service should be nominated prior to design stages by the construction authority and designed for higher loads to give these buildings a greater chance of survival to enable them to secure a post disaster function.

11.5 TRADITIONAL TECHNIQUES

There are many traditional techniques of building construction used around the world

A lot of these have been developed in disaster-prone regions, most of which up until recent decades have small underdeveloped populations and little cross communication between each other. However, it is surprising how similar most of these traditional methods are to each other. There is a need for a study to be made to locate the details used in different regions and to study their similarity and their development in solving the problems of construction in disaster areas.

There are regions with common development techniques and others where there is a marked difference in construction techniques between developed and underdeveloped areas.

These lesser developed areas are not necessarily lacking in expertise in survival construction.

Adequate study may show unique solutions already resolved and proven which may save the cost of duplication of theory and development in these areas and assist in productivity allowing research to concentrate on unresolved problems.

Research alone, tends to isolate the elements and often fosters complex technical solutions. There is little published on how to integrate the elements into a simple practical and economic solution

There are many papers on "How the wind blows", but very few on "How many nails to use"

The paper attempts to offer some practical solutions to the problem of disaster resistant design and construction by identifying "where" problem areas exist and to indicate "how" these problem areas can be resolved

11.6 SUMMARY

Most of the population consider Architecture as providing suitable aesthetic and spatial solutions to a building design problem

Architecture in disaster areas demand that this solution be consistent with a satisfactory structure.

Unfortunately, whilst architects study structure during training, some promptly forget or underestimate this discipline and delegate the responsibility. Likewise, many engineers look only to steel and concrete to solve problems and often have a less than intimate experience in timber design. Builders often care more about deflection and maintenance problems than extreme events. Some owners prefer to carry insurance against damage and build a cheaper structure rather than building stronger buildings.

These positions should be reversed. The professional should co-ordinate their knowledge to achieve some unity in their approaches to design for disasters Professionals and builders should meet more often together to resolve the conflicts that occur between design and construction, so that each side understands the other's problems.

Owners and insurers need to be more aware of the real costs of failure so that briefing and legislation take due account of this future cost.

Researchers should intermingle more with the people involved in the construction of buildings. Experienced practitioners should be more involved in the research carried out. They should also be involved in the framing of codes and regulations.

Funding where necessary should be made available to promote this mixture of research and practise.

The insurance industry needs to look very seriously at their involvement in the research and implementation of the results.

Education is still a vital area of concern to both technical personnel and the public at large

Dissemination of information follows as a natural flow on from research and education.

The time lag between research and implementation must be shortened

Policing of implementation needs upgrading by inspectors, financiers, insurers and government

Publication to be economical and available to the full range of involved personnel.

There are many papers on how the disaster occurs.

There are too few papers on how to put the elements together.

11 7 DESIGN GUIDELINES CHECKLIST

The checklists set out in this paper relate to those matters to which the designer should give consideration where the building is in a disaster region

Whilst the list of considerations is detailed, it is important to understand that most designers already pay attention to many of these factors from an aesthetic point of view

The purpose of this set of guidelines is to make the designer aware of the factors to be considered when the building is in a disaster area. Resolution of most of these items does not involve a lot of time when the designer has a basic knowledge of the problems associated with disaster building construction techniques.

However, some of the matters to be checked do need some education and awareness of what the problem areas are, where to look for solutions, and of how to resolve these problems into aesthetic, economical design solutions related to the scale of the project, its budget and to the environment of the region.

The checklist points to a need to introduce an awareness programme into the curriculum for education of architects, engineers and building construction operatives

National Code and Regulation Authorities need to understand the importance of not only production of Manuals of Construction but also the more important point of adequate policing of these matters. All major elements of the building have, and should have, a part to play in providing security for the occupants.

It is vital, in protecting our built environment, to adopt a policy of knowing the performance of all materials and of using the load sharing abilities of each of these materials when properly fixed.

Universal adoption of these principles can only result in improved design and greater respect for the design team.

11.7.1 Practical Solutions

In the development of a Disaster Resistant design theory, the designer must of course continue to service the desirable aesthetic and comfort motives in order to provide a satisfactory design solution.

However, he must also provide himself with a list of security items to avoid the consequences of improper detailing and inadequate construction.

The following is a set of "Disaster Resistant design" guidelines for use by a designer in the course of designing disaster resistant buildings. Before commencing the drafting of working drawings, reference should be made back to these guidelines to confirm all considerations have been taken into account.

11.7.2 Site Selection

- ❑ Identify site, location, proximity to sea.
- ❑ Study future developments, viz. growth patterns.
- ❑ Establish terrain category in relation to known disasters.
- ❑ Is this likely to change in the life of the building?
- ❑ Establish flood heights and possible surge levels.
- ❑ Is site a flood plain?
- ❑ Is evacuation possible immediately prior to disaster?
- ❑ Study neighbours' proximity to proposed building construction
- ❑ Study extent and size and rate of growth of trees in immediate vicinity
- ❑ Advice of possible effects of damage by debris from both trees and neighbours' properties.
- ❑ Where near rivers and open spaces, estimate effects of micro-turbulence and effects of wind and flood patterns.

11 7 3 Landscaping

- ❑ Study topography in immediate vicinity.
- ❑ Can advantage be taken of mounds, etc. to give protection or reduction in a disaster situation?
- ❑ Can trees be planted that are more resistant to fracture and collapse?
- ❑ Can tree foliage be easily pruned to reduce effects of debris?
- ❑ Well located screen walls can break-up flow patterns and act as debris barriers.

11.7.4 Floor Levels

- ❑ Study topography and drainage in storm rains to determine flood-free floor levels
- ❑ Evaluate implications of number of flood levels needed; one, two or more depending on intensity.
- ❑ Rises in height introduce higher loads from winds and earthquakes

11.7.5 Shape

- ❑ Consider shapes to be adopted
- ❑ Can roof profile be designed to transfer loads more evenly over whole roof?
- ❑ Advise where roof projections and shapes cause local turbulence - e g chimneys, vent pipes, sharp direction changes, out-riggings, etc., where these are dangerous if they collapse during floods, windstorms and earthquakes