Toolkit: A Manual for Implementation of the Hurricane-resistant Home Improvement Program in the Caribbean

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I. Preface

In 1994, the Organization of American States' Department of Regional Development and Environment contracted the Cooperative Housing Foundation (CHF) to assist in the implementation of two housing retrofit programs refered to as *Safer Construction Programs* in St. Lucia and in Dominica. The Safer Construction Program, one of six program areas in the Caribbean Disaster Mitigation Project (CDMP), is funded by the United States Agency for International Development (USAID) and is implemented throughout the Caribbean by the Organization of American States (OAS).

The Safer Construction Program was designed and implemented to promote the concept of pre-disaster *mitigation* in the homes of low-income families. In the Caribbean, institutional responses to hurricanes (particularly housing-related responses) have traditionally addressed damages reactively: after roofs have been lifted off, walls toppled, and foundations destroyed. Retrofitting for hurricane resistance involves the upgrading of existing structures to reduce the vulnerability of key components *before* damage can occur. With technical and managerial assistance from CHF and under the OAS's supervision, local NGOs design and implement outreach and publicity campaigns, conduct hurricane resistance construction and retrofit training courses and set up loan funds to assist low-income earning families in strengthening their existing homes.

The Safer Construction Project was implemented initially in St. Lucia and in Dominica. In St. Lucia, CARITAS (the lead implementing agency), the National Research and Development Foundation (NRDF) and the Sir Arthur Lewis Community College (SALCC) were selected by the OAS and CHF to manage the various components of the Program. In Dominica, the Program was implemented by the National Development Foundation of Dominica (NDFD) with technical assistance from the Safe Shelter Initiative.

The timing for the full launch of the pilot activities of the Safer Construction Program coincided with the busiest hurricane season in the Caribbean since 1933. Indeed, the destruction brought by hurricanes Luis and Marilyn in Dominica between the period of August 27 to September 18, 1995 served as an ominous reminder of the urgent need for housing mitigation activities in the region.

The high winds, storm surge and flooding caused damage or loss to 876 housing units. Most of the properties destroyed or damaged were small wooden structures belonging to low-income families. These structures, for the most part, did not meet local building codes requirements and nearly all sustained damage to roof elements. A total of 124 units were estimated as having been destroyed and the total loss to the housing sector is estimated at $4.265 mn. [*Summary of the Impact of Hurricane Luis on CDERA Participating States: Response Actions, Recovery and Rehabilitation Needs.* Caribbean Disaster Emergency Response Agency (CDERA); Barbados, 1995.]

In dramatic contrast to what was happening throughout the island, all houses retrofitted through the Safer Construction Program in the Carib Reserve of Dominica successfully withstood the winds wielded by the successive hurricanes—in fact, one house retrofitted with funds from the Program served as a community shelter in the Carib Reserve during the passage of Hurricane Luis.

In 1997, the Safer Housing Program was renamed the **Hurricane Resistant Home Improvement Program** to reflect the program's emphasis on incorporating hurricane resistance during general home improvements as well as specific hurricane resistant retrofitting.

The following technical portions of this Toolkit provide descriptions and guidelines necessary for the implementation of a successful home improvement and hurricane resistant retrofit program. Special thanks go to all our partners in USAID, the OAS and the following Caribbean organizations for their assistance in piloting this program and the provision of the materials included in this manual;

- CARITAS Regional Office
- National Development Foundation of Dominica
- National Research and Development Foundation, St. Lucia
- Safe Shelter Initiative, Dominica
- Sir Arthur Lewis Community College

Special thanks are also extended to Barclay's Bank of St. Lucia for their pioneer private sector contribution to the program.

II. Executive Summary

This *Tool Kit* is divided into the following key sections for the convenient use of any person or organization desiring to implement a program of constructing, improving or retrofitting homes to be hurricane resistant in the Caribbean setting:

- *Program Description.* An overview of a Hurricane Resistant Home Improvenemt Program's main components using the CDMP example.
- *Management Structures.* The roles and responsibilities of key partners in the implementation of the CDMP safer housing campaign.
- *Hurricane Resistant Home Improvement Basics*. The basic technical and programmatic tenets of the Program.
- *Loan Program.* A description of the home improvement lending methodology recommended for the implementation of successful safer housing initiatives in the Caribbean.
- *Outreach/Awareness/Marketing.* An overview of suggested steps to insure that targeted populations are made aware of and take full advantage of the Program.
- *Monitoring and Evaluation.*
- *Training Builders.* Suggested training strategies implemented by the CDMP during the course of the Program.
- *Appendices.* Tools implementing organizations may use in the operation of a Hurricane Resistant Home Improvement Program in the Caribbean.

The techniques and concepts included in this manual are the result of several years of pilot programs and earlier research efforts conducted in Jamaica and elsewhere. CHF invites any readers with suggested improvements to forward them to our offices in Silver Spring, Maryland for inclusion in future print and electronic verisons of the Tool Kit.

Important Note: **While there is a wide range of construction, land arrangement, drainage and wind break techniques that can be used to protect homes in hurricane prone conditions, the techniques included in this manual were selected for there importance, modest cost and availability to every family.**

It is critical that people throughout the Caribbean be made aware their homes no longer need be vulnerable to routine hurricanes. As demonstrated in this Tool Kit the affordable techniques and technology exist which can make their homes resistant to the Category I, II & III hurricanes that strike most Caribbean countries on the average of every to twenty years. While there are very little low cost technologies that could strenghten large numbers of homes against the devasting yet rarer Category IV and V hurricanes, with their winds in excess of 150 mph, we do have the capacity to drasticly limit the damage caused by all other storms. These techniques should become a standard part of all new construction and remodeling, upgrading and/or rehabilitation of homes throughout the Caribbean.

III. Program Description

In each country where it was implemented the CDMP Hurricane Resistant Home Improvement Program included the following activities:

- A home improvement and hurricane resistance retrofit campaign targeted to moderate and low-income families;
- A national publicity and community outreach program to make people aware that homes and buildings can be made hurricane resistant at modest cost, either during new construction, remodeling or retrofitting;
- A program of training for construction workers, contractors, craftsmen and families interested in home construction.
- A loan program designed to assist low-income families in financing basic home improvements which include the hurricane resistance components.

The home improvement and retrofitting process focuses primarily on protecting the roof structure on the house because in

a hurricane, the roof is the most vulnerable and plays a critical role in holding together the rest of the structure. The technology used is simple and incorporates time-tested construction techniques:

- Reinforcing all joints and connections (at the ridge board, between the joists and the top plate, between the floor and the foundation, and at the foundation footing);
- Using long, strong, wide headed screws or nails;
- Installing strong heavy-guage roofing material;
- Attaching hurricane straps on the rafters, joists and wall plates;

The installation of hurricane straps is the most essential component of strengthening a house to resist hurricane forces. The strap consists of a short piece of flat metal that can be used to secure roof joists to the top of wooden or cement walls. The strap, which can be purchased inexpensively in most hardware stores in the region, is key to ensuring that the roof structure remains intact when hurricane-force winds are blowing.

Another improvement is the use of long drive screws or wide-headed nails (at least two inches in length) to affix the corrugated metal commonly used for roofing. Strong screws or nails hold the roof in place, unlike common nails which often rip through roofing sheets during hurricanes.

Other improvements that help prevent roof-related damages include:

- enclosing the roof overhang with the addition of soffit and fascia boards,
- reducing the roof overhang (maximum 18"),
- increasing the roof pitch (22 degree minimum), and
- installing window storm shutters.

While these techniques are relatively inexpensive, many lower income families will require financing to complete their home improvements. To meet this need, CHF made a revolving loan fund available to families earning less than the median income for the country and living in sub-standard homes which are at significant risk with the coming of each hurricane season. Credit was made available to individuals and families for general home improvements which include hurricane resistance techniques and/or for hurricane resistance retrofitting specifically. Under the CDMP, the amount of the loan to beneficiaries has not exceeded EC$6,000, and the targeted average loan is currently EC$3,000. As a rule, monthly loan payments must not exceed 25% of household’s monthly income.

Residents in targeted project areas who satisfy the criteria established by the implementing agency obtain low interest loans to undertake the necessary retrofit activities either through contracted services or through self-help provided the workers are properly training. A more detailed description of the loan program used with CDMP is included in Chapter V.

A training component is necessary to instruct local builders in the hurricane resistance home construction and retrofitting techniques. A qualified training agency or individual can be selected to conduct these sessions. The lead trainer should be a qualified builder, architect, engineer or teacher with expertise in the specific area. **The instruction provided must include practical sessions which enable trainees to actually practice the various techniques utilized during the retrofitting process**. Past CDMP training courses have typically included the retrofitting of an existing structure to provide a demonstration model and give the trainees tangible, hands-on experience.

The goal of this training is to prepare a maximum number of artisans/crafts persons to analyze the hurricane resistant weaknesses of an existing home, draw a working plan to include improvements and retrofitting that will meet minimum standards of hurricane resistance, prepare a cost estimate and perform standard retrofitting work. Estimators and project technical officers should participate in the training to insure that all segments of the program are using the same information, standards and techniques.

To the extent possible, the training program should also provide community residents with a demonstration "model home" and should instill a basic understanding of safer construction techniques. Finally and in order to ensure the dissemination of proper hurricane resistant construction and retrofitting techniques, the Program should seek to institutionalize such training into existing construction curricula at technical schools, community colleges and construction seminars.

IV. Management Structures

Each organization implementing a Hurricane Resistant Home Improvement Program will have a unique management structure. For illustrative purposes the following chapter provides a description of the organizational structure of the participants in the CMDP. Organizations and their partners can borrow this example to create their own management structure

USAID/OFDA's Caribbean Regional Disaster Advisor and the OAS have provided the overall supervision for the Program. The Cooperative Housing Foundation, under contract from the OAS provides managerial and technical support. In St. Lucia, CHF works in collaboration with CARITAS, NRDF and SALCC. In Dominica, the local partners are the National Development Foundation of Dominica (NDFD) and the Safe Shelter Initiative (SSI). In 1997 the National Development Foundation of Antigua & Barbuda is expected to become an LIA for that country.

A. Roles of Collaborating Institutions

In each participating country, the OAS and CHF sought to identify agencies with experience in at least one of the following substantive areas:

- Loan Administration
- Project Management
- Construction, including experience in the provision of low cost shelters
- Construction Training

While it is unlikely that any one agency will possess all of the necessary skills, it is critical that the lead implementing agency (LIA) have strong management expertise, as the LIA will coordinate the activities of the other implementing agencies. The LIA will most likely enter into a contractual arrangement with the support agencies to undertake specific tasks such as publicity, training, and supervision of the construction site.

In undertaking the implementation of the Program the LIA is also advised to solicit the active participation of other supporting institutions/sectors. These include:

- The National Disaster Office
- The Financial Sector
- Building Supply Merchants
- Builders/Contractors
- Community Leaders
- Television, radio and newsprint
- Community organizations such as credit unions, cooperatives and other NGOs
- Vocational schools, community colleges or other instructional centers

The overall management structure of the housing component of the CDMP included:

1. *Organization of American States (OAS)*

   The OAS was selected by USAID to implement the Program on the basis of the OAS's long established presence in the Caribbean and of its track record in administering development assistance and disaster-related programs. The OAS's Unit of Sustainable Development and Environment (formerly Department of Regional Development and Environment) was responsible for providing management oversight for all aspects of Program implementation.

2. *Cooperative Housing Foundation (CHF)*

   Under contract with the OAS, CHF provided technical assistance to the Lead Implementing Agencies and monitors the project, through both specific visits and regular correspondence. All project documentation, including milestone reports and credit reports are consolidated by the LIAs and submitted to CHF. Payments to the LIAs and to any other implementing agencies are made by the OAS after CHF has had the opportunity to review the required documentation and has signified its concurrence to the OAS. Under separate agreement with the LIAs, CHF may made direct financial concessionary loans to each of the agency's to provide seed capital for their revolving loan

funds.

3. *Lead Implementing Agency (LIA)*
   Under contract with the OAS, the LIAs (with support from CHF) were responsible for preparing and conducting the training sessions; conducting outreach/public education; managing the loan fund; and implementing the home improvement and retrofit campaign. Specifically the LIAs carried out the following tasks:

   - Design and conduct national awareness and public education campaigns
   - Design and conduct surveys of potential participant communities
   - Conduct credit studies on the feasibility of loan programs for housing retrofit purposes
   - Conduct technical studies
   - Arrange training programs
   - Develop and log loan approval procedures and criteria
   - Administer reflows from the project's revolving loan fund
   - Contract and supervise a building estimator/inspector to estimate retrofitting costs and to verify work implementation
   - Provide transportation and logistical support
   - Promote and network with national and international donors to increase the value of the revolving loan fund
   - Prepare periodic progress reports and consolidate information from subcontractors and other implementing parties
   - Prepare quarterly credit reports for submission to CHF.

B. Project Implementation

A typical Hurricane Resistant Home Improvement project is implemented in three phases: (1) project design studies and start-up; (2) community outreach; and (3) household sign-up and construction.

1. Project Design Studies and Start-up

- Survey of potential participants. Household characteristics, community interests and needs, housing stock quality.
- Retrofit study. Cost-effectiveness study, retrofit guidelines, skills training needs.
- Training of building artisans and community members. Determination of current skills, preparation of training materials, design of training programs.
- Public education and awareness.

2. Community Outreach

- Selection of target communities. Outreach and community mobilization, awareness campaign.
- Training of artisans and community members. Selection of artisans, organization of training sessions,
- Training of participant households. Selection of households, organization of training sessions.

3. Household Sign-up and Construction

- *Household sign-up.*
- *Loan approval. Cost/work estimate, approval of loan package.*
- *Construction/Retrofit. Selection of contractor, retrofit completion and inspection.*

C. Household Sign-up and Retrofit

Under the Hurricane Resistant Home Improvement Program the construction/retrofit process is implemented in 13 different phases. A breakdown of these phases is provided as follows:

1. *Household becomes aware of retrofit program.*

Public education and outreach programs have been designed to inform *low-income* earning households. Outreach efforts should be focused and targeted toward households where the demand exists for small retrofit or home improvement loans.

2. *Household contacts LIA.*
3. *Estimator develops baseline data on household.*

   During the initial phase of the project, the Estimator may work under the supervision of the LIA. In the long run, the services of the Estimator should be included in the retrofit costs.

4. *Estimator prepares cost estimate, materials list and instructions for builders using the Minimum Standards Checklist.*

   This is a crucial phase of the loan making process. The Estimator is, in effect, preparing a financial and technical work plan that must be respected by the contractor.

5. *LIA approves or rejects loan.*

   LIA's approval should be contingent on the household's ability to repay the loan and on whether the work to be performed fits within the concept of hurricane resistance retrofitting.

6. *Upon loan approval, contractor is selected.*
7. *Supplier/Contractor receives 50% of the down payment to buy and deliver materials and begins work.*
8. *Contractor completes work.*
9. *Estimator performs final inspection using the Minimum Standards Checklist.*
10. *Upon Estimator's recommendation, final payment is made to the contractor.*
11. *Loan recipient makes first monthly repayment (30 days after initial loan disbursement).*
12. *Loan recipient makes final repayment at end of loan period.*
13. *Loan file is closed upon completion of loan repayments.*

D. Role of Estimator

The lead implementing agency directly supervises the work of the Estimator during the initial phase of the Program. The Estimator is specifically responsible for making structural cost estimates, preparing a list of needed construction materials and giving practical instructions to the builder/contractor. All loans that are approved by the LIA must be "pre-costed" by the project Estimator using the Minimum Standards Checklist. The Estimator is also responsible for final inspection of the retrofitting work and for authorizing final payment to the contractor.

In order to move to a more operationally sustainable program all costs incurred during the construction/retrofitting process (such as the cost of the Estimator) should be incorporated into the pricing of the loan products. While the LIA or a Funding Agency may subsidize the work of the Estimator during the early phase of the project, it is recommended that, in the future, the cost of purchasing the services of an Estimator be factored into the interest and fees associated with each loan product.

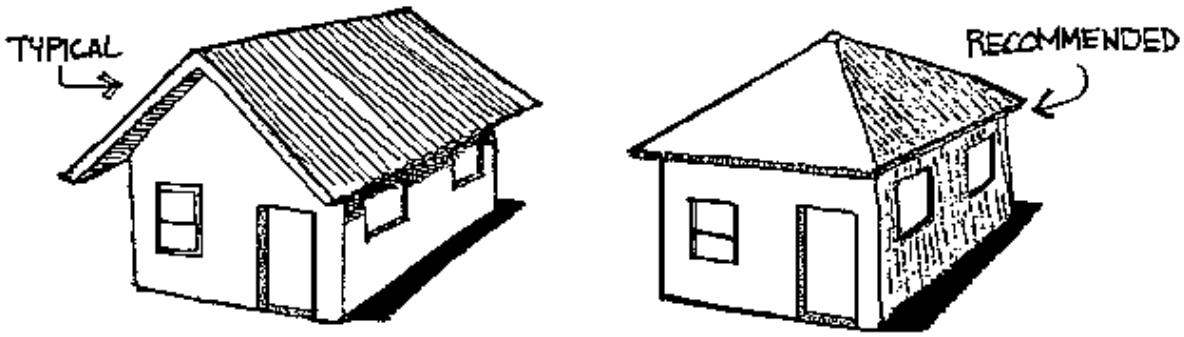
IV. Hurricane Safety Construction Basics

The work involved in strengthening key components of houses to withstand hurricane-force winds (retrofitting) as well as the incorporation of such strengthening techniques into general home improvements should conform to the minimum standards set forth by the country where the Program is implemented. These standards include national and local building codes and Organization of Eastern Caribbean States (OECS) guidelines. As an overarching goal, houses must achieve resistance to hurricanes by incorporating both robustness and consistency at key connection points. Simply increasing the size of the structural members of the house will still fail in strong hurricanes unless attention is paid to the key connecting points throughout the house. A proper balance of overall robustness and improved connections will also keep the clients costs to a minimum.

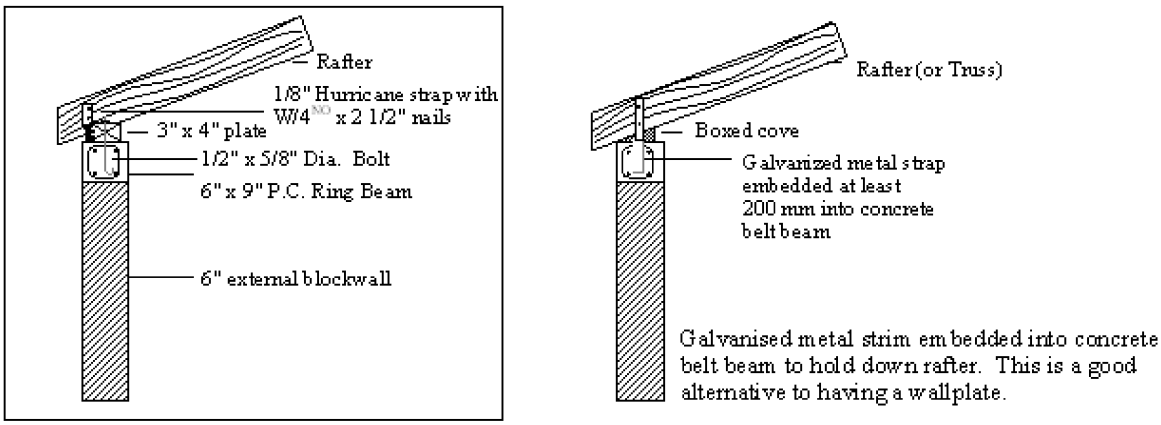
For each house to be retrofitted, competent personnel (Estimator, Project Officer, and Contractor) must perform an initial inspection. This inspection should focus on the house's "load path" (particularly any potential weakness of structure at key connections) and on the level of degradation of existing structural members. "External" factors (prevailing winds, soil conditions, site location, trees) should also be taken into account. These as well as other factors are included in an easy to use Minimum Standards Checklist (Appendix A) which the Program's technical staff can complete for each loan application.

Make the Right Connections, a booklet prepared by the Safe Shelter Initiative (SSI) of Dominica (Appendix I) provides a more detailed review of safe construction techniques promoted under the CDMP. The following is a summary of some of the most important points included in the booklet.

- *Site.* A house should be built on stable, flat and firm ground. Avoid construction sites prone to slide during the event of a hurricane. Avoid loose sands or sensitive clays. Avoid sites subject to rock falls, proximity of big trees, etc.
- *Shape.* Avoid asymmetric structures. Squared-shaped houses have a higher chance of withstanding high wind velocity than rectangular houses. Avoid complex designs and houses with more than one story.
- *Roof form and angle.* The roof pitch should not be less than 20° (ideally 30° or more), and hip roofs such as the one illustrated in the "recommended" house below are more hurricane resistant than gable roofs. If the house's roof has a pitch of less than 22 degrees, it may be improved by additional rafters and strengthening roof cladding.



- *Collar ties, gussets, or metal straps should be used to securely tie the ridge board to the rafters.* Rafters should also be securely tied to external walls with hurricane straps (see details below). Ridge connections can be improved by adding diagonal braces.



- *Roof sheets*. 24 gauge galvanized sheets (or thicker) are recommended. If 24 gauge are not available or are too expensive, extra reinforcements must be used for lightweight (26 gauge) sheets. The use of drive screws (at least two-inch deep into the purlin) is also recommended. If nails must be used, use galvanized coated nails (with wide heads) that are long enough to bend over below the lath.
- *Overhangs and Roof Extensions*. Overhangs should be no more than 18" (horizontal distance from wall) if boxed and 8" if unboxed; roof extensions for patio and verandas should be constructed separate from the main roof.
- *Walls*. The wall plate should be fastened and strapped to the top of the studs (uprights). Walls should be braced diagonally and fixed to the foundation by anchor bolts. Look for timber seepage and condensation, discoloration, fungus, insects, etc. The presence of knots and other defects make timber a non-homogenous material and its quality has a considerable effect on its performance in the event of hurricanes or other natural hazards Keep wood above ground level to prevent damage (humidity, decay, etc.) Connections in a frame can be made more rigid by adding metal strips or clamps
- *Foundations*. Concrete foundations should be reinforced, with wall reinforcement tied to the foundation. Avoid the use of sea sand for construction. Its high salt content may reduce concrete's resistance and durability and accelerate the corrosion of reinforcing rods. Soil must be well compacted before pouring concrete to avoid cracking and soil settlement

V. Loan Program

A. Overview

A critical component of the USAID/OAS/CHF initiative was the revolving retrofit loan fund, which was established and seeded by CHF. The fund provided low-income families an opportunity to improve and protect their homes from hurricane forces by providing access to small loans with monthly payments not exceeding 25% of monthly family income.

When establishing the loan ceiling and average, implementing agencies should take into account the financial profile of the families targeted by the program. For many countries, the necessary data for an accurate review of retrofitting costs may not become available until several houses have been completely retrofitted. After a review has been conducted, the initial loan ceiling may need to be adjusted in order to meet the actual construction and labor costs incurred. As a general rule, loans targeted at low-income families should average EC$3,000 and be no more than EC$6,000. Additional adjustments to the size of the loans may be necessary depending on the funding source and the local economic situation. In such cases, a combination of funding sources may be required to combine the beneficiaries' home improvement needs with the program's hurricane safety objectives.

The lending model used in CDMP was adapted from CHF's successful home improvement credit methodology. The basic tenets of this methodology are as follows:

- *Loans must go towards home improvement.*
- *Loans must target families earning the country's median household income or less*.
- *Small loan amounts.* Although there are wide variations in the average loan amount for in CHF programs, loans typically range from U.S. $500 to $2,500.
- *Short repayment period*. To mitigate possible loss of monetary value due to downward currency fluctuation, a six-month to three year period is considered an acceptable range for CHF programs
- *Loans must be extended to beneficiaries at or near-market rates*. In order for the program to be financially sustainable and meet the demands of clients, hurricane resistant home improvement loans should be at or near the prevailing market rates for similar housing loans offered through the formal financial sector.
- *Monthly loans repayment should not exceed 25% of beneficiaries' monthly income*.
- *Total household monthly debt burden (including housing loan) should not exceed 40% of monthly income.*
- *Local construction technology and materials should be used in the construction process*.
- *A certain amount of Self-help (sweat equity) should be incorporated into the construction process*.
- *Loans do not have to be collateralized, but there should be at least one credit-worthy co-signer.*

The revolving loan program has a dual function: (1) to help low-income families improve the condition and livability of their homes; and (2) to provide future institutional contributors with a track record of technical and financial viability. A long term objective of any loan program should be to capitalize the loan fund at the level needed to cover the program's

operating and financial costs with the reflows and interest earned on the loans.

The repayment rate on all of the revolving loan programs based on CHF's credit methodology has historically been at 95%, or higher, despite the fact that loan recipients usually belong to low-income earning families--a target group traditionally considered "high risk" by the formal banking sector. In the early stages, CHF's experience in the Caribbean fits the historical pattern. In St. Lucia, 20 out of 22 project loans were being repaid on time after the first nine months of Program implementation--despite the economic hardship that followed the passage of Hurricane Luis and Marilyn over the Eastern Caribbean.

B. Loan Conditions

The use of near-market interest rates for the loans is fundamental to the success of a hurricane resistant home improvement program. The effective rate must be low enough compete in the local market and attract a sufficient number of qualified borrowers within the target group of the loan program and yet high enough to generate the revenues needed to sustain the program. Further, near-market rate loans allow the borrower to build a credit history, which may open the doors to future home improvement loans with local commercial banks and credit unions.

In the case of the CDMP, loans were made by CHF in US dollars to the Lead Implementing Agency, which, in turn, on-lent to local beneficiaries in local currency. The highly stable Eastern Caribbean Dollar exchange rate minimized any loss in value due to currency fluctuations.

While the loans do not have to be fully collateralized, all loan applicants must have at least one co-signor with adequate income or collateral to support repayment of the loan should the borrower not be able to meet her/his obligations. The loan applicant and the co-signor must fully complete and sign the Loan Application Form. Other methods for improving loan recovery include: (1) accepting a bill of sale on goods or property owned by the beneficiary; (2) requiring a refundable cash deposit; and (3) requiring a repayment authorization to be drawn directly from the beneficiary's salary.

C. Program Marketing

For marketing, local implementing agencies target those individuals who have the potential of fulfilling the program's loan requirements and whose homes need to be upgraded to be hurricane resistant. A suggested marketing plan includes the following:

- *Prepare a brochure or flyer that highlights: benefits to families, target population, requirements, repayment methods, and suggested guarantees for the program.*
- *Distribute the brochure/flyer in target communities making use of churches, universities, and organizations or factories with eligible employees.*
- *Advertise in local newspapers, religious bulletins, and on local news and radio stations.*
- *Conduct briefings with various community-based organizations, unions and technical groups who have eligible members.*

The program should be promoted during all phases of the implementation in order to provide a gradual progress report to the general population. This method serves to successfully persuade residents on the importance of strengthening their homes as well as to demonstrate that the program is responsive to the needs of its targeted communities. A clear emphasis should be placed on the entire island making its homes safe and resistant to all but the most violent hurricanes.

D. Loan Application Process

The loan application process typically begins once the social marketing initiatives have generated a substantial number of prospective loan recipients. The Lead Implementing Agency is then develops loan approval procedure and criteria along with system of loan tracking.

The following tasks outline the recommended application process.

- *The LIA conducts an eligibility screening to verify that the potential applicant meets the basic requirements.*

- *The LIA must account for all individuals who did not meet the basic criteria and thus did not complete an application. A logbook should be kept to track all applications received by the LIA.*
- *Representatives from the LIA should explain all loan requirements to applicants who pass the eligibility screening--including any legal recourse available to the LIA should the borrower fail to repay the loan according to schedule.*
- *The LIA officer should help the applicant complete a Loan Application Form along with her/his co-signor. (see sample Loan Application Form in Appendix ___)*
- *Once all forms are complete, the Loan Application Form must be forwarded to the LIA's loan officer.*
- *The loan officer logs the loan application into its tracking system and submits a copy to the institution responsible for the management and implementation of the project.*
- *The loan is reviewed by the Program's loan committee and recommended for approval.*
- *Once approval has been granted, the LIA notifies the beneficiaries in writing and sets up a repayment schedule based on the loan amount, term and interest rate.*
- *The loan's first tranche is disbursed directly to the contractor or supplier.*

E. Construction Monitoring

The construction monitoring process provides the borrower with technical advice during the construction phase of the project and provides the LIA with insurance that the funds are being used in their intended manner. The Project Officer or the Estimator must thoroughly review and report on the progress of the construction work using the Minimum Standards Guidelines (see Appendix G).

The following recommended tasks are performed by the LIA for construction monitoring:

1. *Once the loan disbursement schedule is finalized, a Project Officer is assigned to the project.*
2. *A site visit schedule is then developed and is accompanied by a disbursement.*

   Disbursements should never exceed 50% of the loan and should be made directly to the contractor and/or suppliers. By minimizing the disbursement amounts and making payments directly to the contractor and suppliers the LIA reduces the risk that borrowers will divert the funds for family emergencies etc, rather than home construction/retrofitting. Diverted loan funds have historically produced repayment difficulties and jeopardize the entire revolving loan portfolio.

3. *The Project Officer monitors the construction and approves further disbursements. This process continues until minimum standards checklist is completed and the entire loan amount is disbursed.*
4. *Once a project is completed, the Project Officer summarizes the home improvement as part of the reporting requirements.*

F. Loan Collection Process

At the time the loan agreement is signed, a repayment schedule is provided to the borrower. Repayment typically begins 30 days after loan has been disbursed. Repayment locations should be as convenient to the borrowers as is reasonably possible. For example, arrangements can be made for payments to be made at local commercial banks if their branch offices are more assessable than the LIA.

The following outlines the recommended steps the LIA should take for the collection of loan repayments:

1. *Thirty days after the disbursement of the loan, the borrower makes her/his initial payment;*
2. *A receipt is provided to the borrower indicating the amount that was paid;*
3. *If a borrower is one week delinquent in repayment, the LIA sends a late repayment reminder;*
4. *After three weeks of non-payment, the LIA sends a second late payment notice informing the borrower of the consequences as outlined in the original agreement;*
5. *After six weeks of non-payment, the LIA sends a letter warning of enforcement action against the borrower and his/her guarantor;*
6. *Eight weeks after the scheduled repayment date, the LIA sends a letter from its legal counsel stating that legal action will be carried out on the 91st day of the delinquency. This notice also stipulates any further steps to be*

taken to insure repayment

VI. Outreach/Awareness/Marketing

In each country where a Home Improvement and Hurricane Resistance Program is implemented, the Lead Implementing Agency should coordinate outreach and awareness campaigns both at the community and national/governmental level.

A. Community Level

As a basic strategy, the LIA should take advantage of existing community structures to publicize the program and its benefits. Among other tasks, the LIA should:

- *Involve key community leaders and institutions, including: village councils, youth groups, sports teams, parliamentary representatives, Community-based Organizations, churches, Community Crier;*
- *Work through development/lending programs already in place (church groups, credit unions, national development foundations etc);*
- *Involve other implementing partners in presentation to the community (e.g., finance institution, disaster officer, retrofit trainers);*
- *Hold meetings with a wide representation of the community and give adequate publicity to the meetings; and*
- *Identify a committee or person to facilitate the mobilization of community members, arrange for a venue and moderate meetings.*

To ensure the proper dissemination of the program's message and to optimize the impact of community meetings, the LIA should seek to accomplish the following during these meetings:

- *Carefully prepare and provide clear and relevant information on the program's benefits (safer housing), affordability (modalities for loan repayment) using visual aids such as videos, slides, posters and brochures;*
- *Identify with community members the targeted geographic areas for the program, as well as the program's potential beneficiaries;*
- *Record the names, addresses and telephone numbers of potential beneficiaries;*
- *Set-up specific dates and times for further discussions with identified beneficiaries;*
- *Identify basic needs to be further researched through social and credit surveys, home visits and retrofit estimates;*
- *Undertake, for illustration purposes, the inspection/evaluation of a house to be retrofitted, and discuss vulnerability points in the structural framework of the house as well as possible action to reduce that vulnerability.*

The experience of the CDMP suggests that the first series of meetings, while critical to introducing the program to the community, should only be the first step in a coordinated outreach effort. Within two weeks of the last community-wide meeting, representatives from the LIA should contact directly any households that have expressed an interest in the Program. Upon verifying that interest, the LIA should proceed to schedule an estimation of the work to be performed.

B. National Level

From the inception of the program, the LIA should seek to involve relevant national organizations in planning, implementing and evaluating the results of a safer construction campaign. From both a political and a programmatic standpoint, the program will succeed only if it receives the support of the country's national disaster apparatus and of key personnel in the relevant government ministries or departments—including physical planners and housing officials.

The program should also seek the active involvement and expertise of architects, engineers and contractors specializing in disaster-resistant housing.

At the onset of the Program, the LIA should approach the country's major financial institutions, including local and foreign banks, national insurance companies and pension fund administrators. These institutions are ideally suited to become the long term funding partners of the LIA once a track record for a cost efficient home improvements program will have been established.

The LIA should plan for the systematic dissemination of the program's message through radio, television and newspapers. The following are suggestions for implementing a successful national awareness campaign:

- *Ensure the selection of popular programming time for the radio and television presentations;*
- *Identify the program in people's minds with an evocative slogan or jingle;*
- *Seek the collaboration of key media personalities to reduce advertising costs;*
- *Use government information programs and involve senior officials (including ministers) as much as possible;*
- *Prepare clear and concise press releases to coincide with program milestone (launching, first workshops, first training sessions, first loan agreement, etc.);*
- *Place billboards in strategic locations with LIA's telephone numbers clearly noted;*
- *Prepare and distribute flyers and posters explaining Program benefits;*

The critical message to transmit in all the public awareness efforts is that, never again should Caribbean peoples' homes be vulnerable to serious hurricane damage. **The existing construction techniques, technology and loan resources now make it possible for everyone's home to be made secure.**

VII. Monitoring and Evaluation

It is very important to establish a simple and consistent system for monitoring progress and evaluating the impact of the program. The on-going process of monitoring performance (tasks, schedule, costs/budget, other resources) and evaluating the relevance and acceptability of program activities within the community enhances the ability of managers:

- *to document program performance and identify successes;*
- *to identify and assess obstacles and constraints;*
- *to capture exceptions to the program plan;*
- *to forecast and revise program outcomes;*
- *to re-allocate and redirect program resources;*
- *to make performance reports on a timely basis;*
- *to track long-term influence, sustained use and replication; and*
- *to design new activities based on prior experience and lessons preserved in evaluations so that mistakes or shortcomings have a positive impact on future activities.*

A monitoring and evaluation plan should be developed during the planning stage of the program so that resources can be allocated specifically to this effort and so that all stakeholders (implementing partners and community leaders) are on board before completing the program design phase. Begin by clearly stating what it is that you want to achieve (objective), then list the activities that have been chosen to contribute to attainment of this objective. For example, if your objective is the adoption of building practices that will reduce natural hazard vulnerability, the activities selected for the program might be:

- *providing training in disaster-resistant construction techniques;*
- *establishing a revolving loan fund so that residents can invest in appropriate safety measures;*
- *carrying out a promotional/public awareness campaign; and*
- *completing actual retrofits or new construction incorporating safer construction techniques.*

Program partners (these might include a training group, a lending institution, a public awareness/promotion group, a community development organization, *et al*) are each responsible for establishing realistic program targets and indicators of achievement related to these program activities.

The final monitoring and evaluation plan should include the following:

1. A clear statement of the program's *objective*.
2. *Targets* stating the results or outcomes desired in order to achieve the objective. Targets may be either qualitative or quantitative and are directly related to the activities selected to achieve the objective.
3. *Indicators*: what will be measured to assess the intended changes and impacts of the program. Choose indicators that are easily measured and understood, and that are based on reliable data sources. Although a program may have

only 3 or 4 indicators to measure overall achievement of its objective, many other tasks and activities require performance monitoring, particularly those related to quality control and demand:

- Community awareness
- Demand
- Construction quality
- Loan arrears rate
- Number of persons trained who continue to use retrofitting techniques
- Outside resources leveraged
- Indirect impact (e.g., number of retrofits performed without program funds)
- Effective rate of vulnerability reduction, when possible (e.g., how many program houses, as a percentage, withstood hurricane-force winds compared to non-program houses)
- Unanticipated results

4. *Baseline data* reflecting the situation or status prior to initiation of the program, in order to assess changes brought about by the program. Information should be gathered on the country's housing stock, construction practices, building standards, and housing regulations/laws. Interest expressed in the program should also be documented to determine whether it translates into actual demand and whether promotional efforts are effective.
5. *Benchmarks* representing important program outputs over time. Benchmarks may be stated as interim targets or as essential steps and are usually related directly to the project schedule and budget. They enable assessment of progress at interim points so that a program's status can be determined and changes made, if necessary. Typical benchmarks might include: number (or percentage in community) of houses strengthened; number (or percentage in community) of builders trained; numbers of training sessions conducted; listing of any major deliverables (training manual, videos, etc.).

Include in the plan a clear statement of who is responsible for collecting and reporting what information, and a schedule for periodic reviews and evaluations. The mechanism for adjusting the program as a result of these reviews and evaluations should also be outlined in the M & E plan.

Periodically review the monitoring and evaluation system to ensure that it is providing reliable and timely information. If the system is not responsive to the needs of the implementing partners and other stakeholders, or if the information collected is not being used to improve decision-making, make changes, where necessary, to meet the objectives of the monitoring and evaluation plan.

If possible, arrange for local and national participants to continue providing periodic reports on continuation of efforts, spin-off activities, investment attracted, and other impact-related information that will create a true picture of the real value of this program over time. Particularly with regard to training or capacity-building activities, their effectiveness may not be easily discerned in the short-term, but these activities may produce a positive benefit stream for the target population over years far beyond the program period

VIII. Training Builders

In each country where the program is implemented, a cadre of builders, artisans, craftsmen and construction worker should be trained to assist in hurricane resistant construction/retrofitting techniques. In St. Lucia and in Dominica, for example CDMP training has been primarily provided by SSI and by SALCC.

While the duration of courses has varied from two days to a week, each course should include both classroom-type sessions on the theory/techniques **plus practical sessions on actual hurricane resistant construction/retrofitting--preferably completing the retrofit of an existing house.** Such a course is also recommended or housing loan program officers and estimators.

A training video was developed by SALCC and is available to interested parties. LIAs should also seek opportunities to provide community residents with periodic training on a step-by-step approach to self-help retrofitting for hurricane resistance.

Appendices

Appendices A through H are sample forms developed during the pilot phase of the CDMP Safer Roof Program. The forms are provided for use by LIAs launching or expanding a Home Improvement and Hurricane Resistance Program. Users should feel free to adapt these forms to accommodate specific local needs and organizational identification.

A. Survey Questionnaire
B. Loan Application Form
C. Loan statistical Summary
D. Project Estimate Form
E. Loan Decision Form
F. Loan Arrears Report
G. Minimum Standards Checklist
H. Easy Guide Checklist for Retrofitting Modest Homes
I. Technical Booklet - *Make the Right Connections*

Appendix A.
Survey Form / Questionnaire
Page 1

Hurricane Resistant Home Improvement Program
Survey Questionnaire

PERSONAL
(1) AGE: _____ (2) SEX: M/F _____ (3) MARITAL STATUS (M/S/D/F)_____

(4) OCCUPATION:_____ (5) FULL TIME/ PART TIME

(6) INCOME FREQUENCY: Weekly Fortnightly Monthly Otherwise

(7)

WEEKLY	FORTHNIGHTLY	MONTHLY
Under 100, 101-250. Over 250	Under 200, 200-250, 500-750 Over 750	Under 500, 501-1000, 1001-2000 Over 2000

(8) Do you have any sources of income?_____

HOUSE
(9) What type of house do you own?

(a) Wooden (b) Concrete (c) Wooden -Concrete (d) Other

(10) How many rooms are in the house? (a) 1 Room (b) 2 Rooms (c) 3 Rooms (d) More

(11) Who owns the house? (a) Self (b) Family (c) Friend (d) Other (specify):_____

(12) Is the house insured? Yes_____ No _____

(13) How many persons live in the house? (a) 3 (b)4 - 6 (c) 7 - 9

(14) How many in the household work?_____

HOUSE OWNERS
(15) How was the house constructed?

(a) Contractor (b) Workers (c) Self-Help (d) Other

(16) How much did your house cost to constructed?

(a) Under 20,000 (b) 20,001 - 40,000 (c) Over 40,000

(17) Has your house ever been struck by hurricane? Yes _____ No_____

Hurricane Resistant Home Improvement Program
Survey Questionnaire

(18) If yes, what section was damaged? (a) Roof (b) Walls (c) Other

(19) How would you rate house safety during a hurricane?

(a) Unsafe (b) Slightly Safe (c) Safe (d) Very Safe

(20) Can the house be made Safe? Yes _____ No_____

(21) If yes, how? Reinforcing Roof _____ Other _____

(22) What are the major constraints in making your house safer?

(a) Money (b) Contractor (c) Time (d) Other

(23) If loans were available at any of the following would you accept?

(a) Credit Unions _____ (b) Banks _____

(c) National Development Foundation _____ (d) Others _____

(24) If loans were available, what type of loan would you like?

(1) Size: (a) Under 1000 (b) 1001-2000 (c) 2001-3000

(2) Duration: (a) Under 6 mths (b) 7 mths - 12 mths (c) 13 mths-18 mths (d) Above 18 mths

(3) Security: (a) Cash _____ (b) Guarantor_____ (c) Bill of Sale_____ (d) Other___

(25) Would you be interested in loans for repairs of other sections of your house?

Yes _____ No _____

(26) If yes, which sections? (a) Foundation _____ (b) Walls _____ (c) Other _____

Appendix B.

Loan Application Form

LOAN APPLICATION

Page 1

All information given in this form will be held in the strictest confidence.

NAME: _____ APPLICANT NO:_____

ADDRESS: _____

TEL NO. (H) _____ (W) _____

SEX: M/F _____ AGE: _____ MARITAL STATUS (M/S/D/P) _____

CONTACT ADDRESS:_____

NO. OF DEPENDENTS: _____ EDUCATIONAL BACKGROUND: _____

MAIN EMPLOYMENT: _____ INCOME (P/M) _____

PLACE OF EMPLOYMENT:_____

OTHER EMPLOYMENT: _____ INCOME (P/M) _____

STATEMENT OF AFFAIRS

ASSETS	LIABILITIES
Bank Accounts:_____	Bank Loans: _____
_____	_____
_____	_____
	Land/Building_____
	__ Other Loans:_____
Vehicle: _____	_____
Other (state): _____	Other (State):_____

TOTAL ASSETS: _____ TOTAL LIABILITIES:_____

LOAN APPLICATION

Have you applied to _____ before? Yes_____ No_____ Result_____

Date of previous application _____

If rejected, reason _____

How did you find out about this loan program:_____

Location _____ (N, S, E, W, NE, SE, NW, SW) Area: (Rural/ Urban)

Status of ownership of (1)Building _____

(2) Land _____

If lease hold for any of the above, then a copy of the lease agreement must be submitted along with written permission from the Landlord to carry out the stated repairs.

Loan Amount requested: $_____

Purpose of loan request:		Details
1.	Purchase of Material _____	_____
2.	Payment of Labour _____	_____
3.	Transportation _____	_____
4.	Other (State) _____	_____

TOTAL REQUEST _____

Initial Funding for construction of building (1) _____

Other Sources of Funding (2) _____

Amounts outstanding from (1) and (2) above $_____

Is Certificated of Title to Property available? Yes_____ No _____

What is the value of the property: $_____

P.S. All applications must be accompanied by Bill of Quantities certified by an estimator recognized by _____ as having the authority to do so.

LOAN APPLICATION

		Value
Security Offered:	_____	_____
	_____	_____
	_____	_____

TOTAL VALUE OF SECURITIES: _____

Method of Repayment:

(1) Salary Reduction (Self):

(2) Salary Deduction Guarantor:

(3) Authorization on Crop Sales:

(4) Other Sales:

(5) Over the Counter:

I hereby certify that all the information given in this document is true and correct and that I have not held back any information that would negatively effect the decision to make the loan.

I further agree that as a condition of approval of the loan, that loan agency officers or anyone authorized by the loan agency Director will be allowed to inspect my premises at any reasonable time, during the renovation/operation, to obtain relevant information re the use of loan funds and compliance with the loan agreement.

Signed this _____ day of _____ 19 _____

_____ _____

SIGNATURE OF APPLICANT **SIGNATURE OF OFFICER**

Appendix C.
Loan Statistical Summary

LOAN STATISTICAL SUMMARY

CLIENT'S NAME	GENDER	AMOUNT REQUESTED	AMOUNT APPROVED	LOCATION	DATE APPROVED

Appendix D.

Project Estimate Form

Page 1

HURRICANE RESISTANT HOME IMPROVEMENT PROJECT ESTIMATE FORM

1. NAME OF ESTIMATOR _____ 3. OWNER _____
2. ADDRESS _____
4. ADDRESS _____
5. OCCUPANT_____
6. OWNER AUTHORIZED RETROFITTING? YES_____NO _____
7. IF YES OWNER'S SIGNATURE _____
8. TYPE OF CONSTRUCTION: TIMBER_____ CONCRETE_____
9. IF OTHER, BRIEF DESCRIPTION _____
10. SHAPE OF BUILDING
    (ATTACH SKETCH WITH DIMENSIONS).
11. SIZE OF BUILDING: LENGTH_____
    WIDTH_____
    TOTAL AREA_____
12. SHAPE OF ROOF: GABLE _____
    HIP _____
    MONO PITCH _____
    OTHER: DESCRIBE _____
13. TYPE OF ROOF COVERING: GALVANIZED _____
    SHINGLES _____
    OTHER: DESCRIBE _____
14. CONDITIONS OF ROOF
    COVERING GOOD_____
    POOR _____
    VERY POOR _____

Project Estimate Form

15. GENERAL CONDITIONS OF BUILDING
GOOD_____
POOR _____
VERY POOR _____

16. ROOF RETROFIT?: YES _____ NO _____

Description	Size	Length	Quantity	Unit Price	Total Price
FASCIA BOARD GALVANIZED	____	_____	_____	_____	_____
SHEETS	____	_____	_____	_____	_____
GALVANIZE NAILS	____	_____	_____	_____	_____
RAFTERS PURLINS OR	____	_____	_____	_____	_____
LATHS	____	_____	_____	_____	_____
ROOF PLATE	____	_____	_____	_____	_____
RIDGE POLE	____	_____	_____	_____	_____
HURRICANE TIES	____	_____	_____	_____	_____
ANCHOR BOLTS	____	_____	_____	_____	_____

17. TYPE OF FOUNDATION:
CONCRETE PILLARS _____
TIMBER PILLARS _____
LOOSE BLOCKS OR STONES _____
CONTINUOUS CONCRETE _____
WITH FLOOR SLAB _____
OTHER: DESCRIBE _____

Project Estimate Form

18.RETROFIT FOUNDATION ? YES _____ NO _____

HEIGHT OF FLOOR ABOVE GROUND _____ FEET.

Description	Size	Length	Quantity	Unit Price	Total Price
EXCAVATION	____	_____	_____	_____	_____
_CONCRETE BLOCKS	____	_____	_____	_____	_____
CEMENT BAGS	____	_____	_____	_____	_____
SAND CUBIC YARDS	____	_____	_____	_____	_____
AGGREGATE CUBIC YARDS	____	_____	_____	_____	_____
REINFORCEMENT STEEL		____ _____	_____	_____	_____
BINDING WIRE	____	_____	_____	_____	_____
ANCHOR BOLTS	____	_____	_____	_____	_____

19. RETROFIT FLOOR? YES_____ NO _____

Description	Size	Length	Quantity	Unit Price	Total Price
FLOOR _STEEL	____	_____	_____	_____	_____
BOARDS	____	_____	_____	_____	_____
NAILS	____	_____	_____	_____	_____

Project Estimate Form

20. RETROFIT WALLS? YES_____ NO _____

STUDS: SIZE:_____ LENGTH_____ QUANTITY_____

SIDING: SIZE:_____ LENGTH_____ QUANTITY_____

NAILS: QUANTITY_____

21. ANY OTHER MATERIALS NEEDED FOR RETROFITTING ?
YES_____ NO _____

EXPLAIN AND LIST QUANTITY: _____

_____

_____

ESTIMATOR'S SIGNATURE_____ DATE_____

Do not write beyond this line

FOR OFFICIAL USE ONLY

COMMENTS REVIEW COMMITTEE_____

_____

_____

_

AMOUNT RECOMMENDED:_____

CHECKED BY:_____ APPROVED BY_____

DATE: _____ DATE: _____

Appendix E.
Loan Decision Form

LOAN DECISION FORM

NAME OF CLIENT:_____ APPL. NO. _____

DATE: _____

ADDRESS: _____ TEL NO: (H) _____

_____ (C) _____

_____

SEX: M/F _____ LOCATION: (Rural/Urban)_____

AMOUNT REQUESTED: $ _____ AMOUNT RECOMMENDED:$ _____

CONDITIONS: _____ INT. RATE: _____

_____ TERM: _____

_____

COMMENTS BY PROJECT OFFICER & ESTIMATOR

_____

_____

_____

SIGNATURE: _____ DATE: _____

DECISION - Executive Director/ or Credit Committee Chairman:

_____

_____

_____

_____ _____

SIGNATURE **DATE**

Appendix F.
Arrears Report

ARREARS REPORT
(EC $)

Client#	Location	Due date		Monthly Repayment	Amount Disbursed	Repayment Received during Month	Interest Charged	Principal Paid	Principal Balance
		1st Paym.	Last Paym.						

Appendix G.

Minimum Standards Checklist

MINIMUM STANDARDS FOR CONSTRUCTION/RETROFITTING HOMES TO WITHSTAND HURRICANE WINDS UP TO 130 MPH (CLASS III)

A. Foundation:

1. Solid cement/concrete pillars firmly embedded 18 inches in ground with ½" steel reinforcement bar extending 12-14 inches (300mm - 350mm) above foundation

or

2. Wooden pillars (6"x 6"minimum or 8" diameter) treated lumber, sunk more than 4 feet into the ground

B. Walls:

1. Wall plate/sill attached to cement foundation/pillars by min. 12-cm anchor bolts

or

2. Wall plate/still attached to wooden pillars by straps and nails
3. Floor joists toe-nailed to wall plate
4. Wall uprights (studs) fixed to sill and top wall plate with hurricane straps
5. Wall uprights located at 2' 0" centers
6. Double studs around doors and windows, cross braces at corners

C. Roof:

1 Hip or gable shaped roof with at least a 22° - 30° degree slope.
2 Overhang NTE 8" unenclosed, or 18"enclosed
3 Ventilation installed in gable ends facing away from the hurricane winds
4 Rafters attached to wall plate with twisted metal straps
5 Rafters located at centers NTE 2' 0"
6 Every second set of rafters connected by collar ties beneath the ridge board
7 Cross-laths (purlins) located at centers NTE 2' 0"
8 Galvanized sheets of ideally 24 gauge and no thinner than 26 gauge.
9 Galvanized sheets to overlap longitudinally at least one complete **o**rrugation, and laterally 6"-8".
10 Galvanized sheets nailed at top of every corrugation at eave and ridge board and every second corrugation on lath/purlins
11 Ridge is capped and nailed at every corrugation
12 Dome head galvanized nails orwashered bolts used for roofing
13 Patio/veranda roof is separate from house roof

D. Windows/Doors

1. Shutters made and attached for rapid closing

or

2. Shutters pre-made and stored to be nailed in place before storm strikes
3. Family trained to either keep all entrances closed throughout storm period and/or open entrances on opposites sides of house to allow air pressure to neutralize.

Summary

Building meets all minimum hurricane resistance standards of Caribbean Disaster Mitigation Program:_____ _____

(Signature) (Date)

Building fails to meet minimum hurricane resistance standards of Caribbean Disaster Mitigation Program. The following items must be completed in order to qualify for final loan disbursement:

1)
2)
3)
etc....

(Signature)_____
(date)

Appendix H.

Easy Guide Checklist for Progressively Retrofitting Modest Homes

EASY-GUIDE CHECKLIST

PROGRESSIVELY UPGRADING FOR HURRICANE RESISTANCE HOMES OF LOWER INCOME FAMILIES OF THE EASTERN CARIBBEAN

Premises:

1) The families owning these properties have a modest income, desire to do home improvements and will need to be guided as to the value and importance of including hurricane resistance measures in their home improvements plans.

2) Any hurricane resistance measures included will need to be folded in under larger home improvements the family desires.

3) Families mayhave to do both their home improvements and hurricane resistance retrofitting in progressive stages, for they may not have enough funds to complete the entire project at one time.

Priorities:

When a complete retrofitting project cannot be financed then the priorities come in this order:

1) Strengthening and tying down the roof as much as possible since heavy rains and winds are perennial. If the roof fails, whether in hurricane or regular storms, all the other home improvements will be damaged and possibly wasted.

    - replace any rotten roofing sheets and/or rafters
    - adding extra nails with dome heads in corrugated sheeting
    - eliminate overhang in excess of 18" (horizontal distance) enclosed or 8" unenclosed.
    - insert extra lath/purlins and nail sheeting to the laths
    - metal strap roof rafters to wall plate and ridge beam
    - place collar ties on every second set of rafters

2) Establishing a firm footing/foundation and tying the house to this solid foundation. If a house shifts off of its footings during a storm there will be great water leakage and damage to other home improvements.

    - embed four or more concrete/wood pillars to strengthen footing
    - bolt/strap floor sill to new and old footings/foundations

3) Strengthening the walls at the corners, around doors and windows and where they are attached to floor sill and wall plate.

- metal strap wall studs to floor sill and wall plate
- double studs around doors and windows and cross braces in corners
- add extra studs if currently located wider than 2 feet.

4) Strengthen doors and windows to withstand winds/construct shutters.

- teach family how to completely close and/or leave open opposite entrances to neutralize air pressure in hurricane force winds.
- construct prefit nail-on shudders

5) Remainder of minimum standards checklist and/or additional amounts of each of the above (i.e. six footing pillars instead of four; more metal straps; additional studs etc.)

6) Other hazards — think of flooding, landslides, etc. when selecting or evaluating a site.

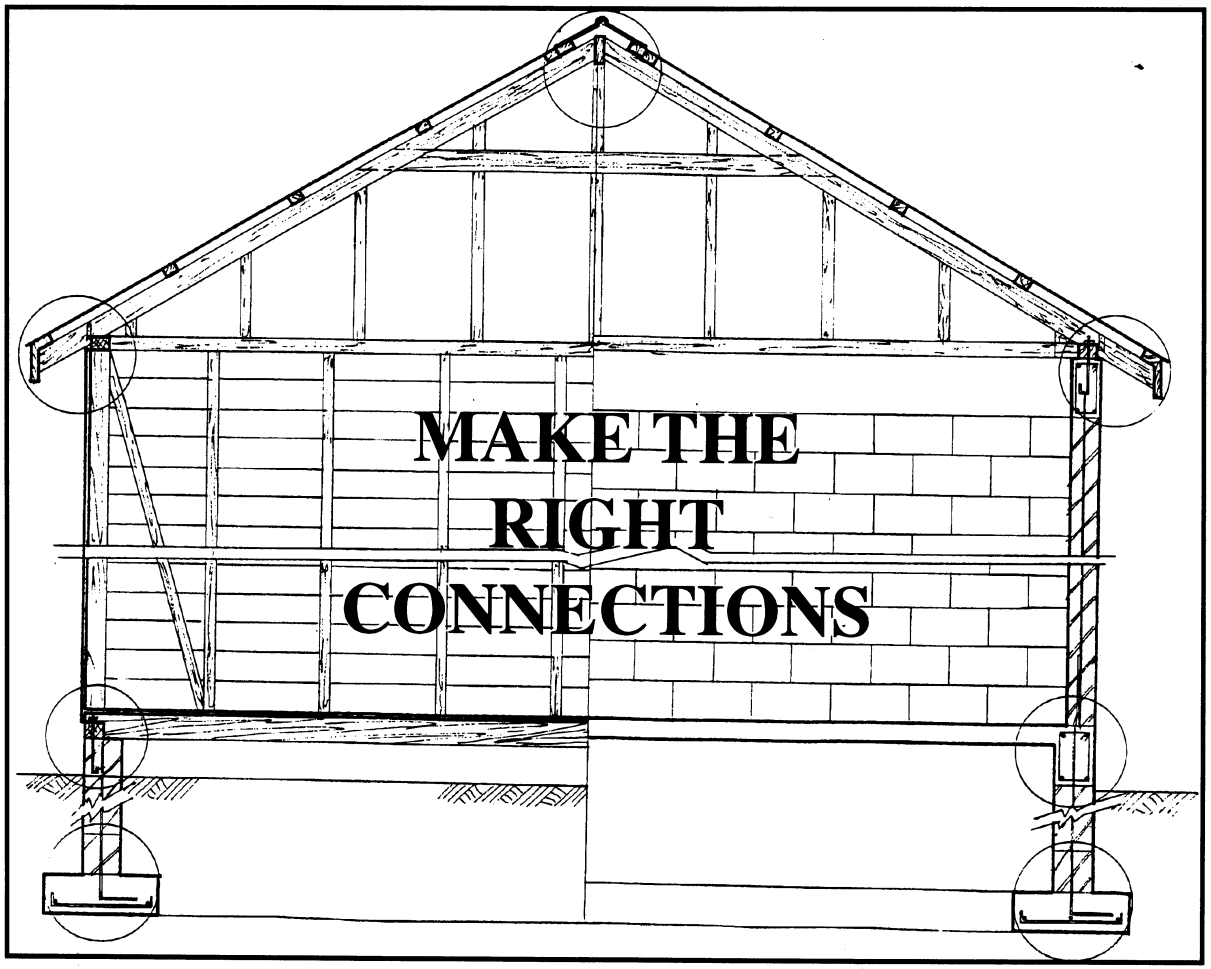
N.B.

All of the above skills can be taught to any family member that has a working knowledge of hammer, saw, measuring tape and nails. Therefore, a family with severely limited resources can save cost by doing much of the work themselves under the watchful eye of a technical supervisor.

Each of these steps can be done progressively as and when the family has the funds to buy the supplies. A family may choose to repair and strengthen the roof in the first year, then construct a new kitchen (with some hurricane resistance included) in the second year. In subsequent years they can do the footings, the wall strengthening. Each step will make the house stronger and more hurricane resistance. The risk is that a strong hurricane will hit midway in the project and destroy the repairs made before the entire house is fully strengthened.

Appendix C.

MAKE THE RIGHT CONNECTIONS



NDFD
BUILDING
DOMINICA

SSI

A manual on Safe Construction Techniques prepared as part of the
OAS/USAID Caribbean Disaster Mitigation Project (CDMP)

Material prepared by CRDC (Kingston Jamaica) and SSI (Roseau Dominica).
Produced by the Safe Shelter Initiative and the National Development Foundation of Dominica.

PREFACE

The publication of this booklet forms part of the Informal Housing Retrofit and Safe Construction Pilot Project administered in Dominica by the National Development Foundation of Dominica (NDFD) with technical input from Safe Shelter Initiative (SSI).

The Project is sponsored by the Caribbean Disaster Mitigation Project (CDMP), a regional disaster mitigation project being implemented by the OAS Department of Regional Development and Environment (DRDE), in conjunction with the Regional Housing & Urban Development Office, Caribbean (RHUDO/CAR), located in the USAID Jamaica Mission, and USAID missions in the region. CDMP is funded by the Office of Foreign Disaster Assistance of the U.S. Agency for International Development.

The objective of CDMP is to establish public/private sector mechanisms for disaster mitigation which measurably lessen the loss of life, reduce physical and economic damage, and shorten the disaster recovery period. The project addresses some of the major issues in the disaster-development linkage in the Caribbean: the need to reduce natural hazard vulnerability in existing and planned development in order to achieve sustainable growth; mapping of hazard prone and environmentally fragile areas and the use of information in public awareness and development decision-making; and, the capacity of the insurance industry to better manage risk and maintain adequate catastrophe protection for the region.

The Informal Housing Retrofit and Safe Construction Pilot Project is a two year activity, the primary goal thereof being to assist governments, contractors, artisans and small builders throughout the eastern Caribbean to adopt appropriate and cost effective hurricane vulnerability reduction measures in the informal housing sector. The project implemented in Dominica has three main components: (1) Public awareness, (2) Training of persons involved in the construction industry, particularly, small builders and (3) A revolving loan fund for house retrofitting. Seed financing for the loan program is provided by the Cooperative Housing Foundation (CHF) based in Maryland, USA.

The terms of reference are:

1. Study the technical aspects and cost effectiveness of the retrofitting program and prepare appropriate training material for use in the Project.

2. Design and carry out public education and awareness campaign at the national level.

3. Organize and administer training workshops for builders, artisans and homeowners in selected communities.

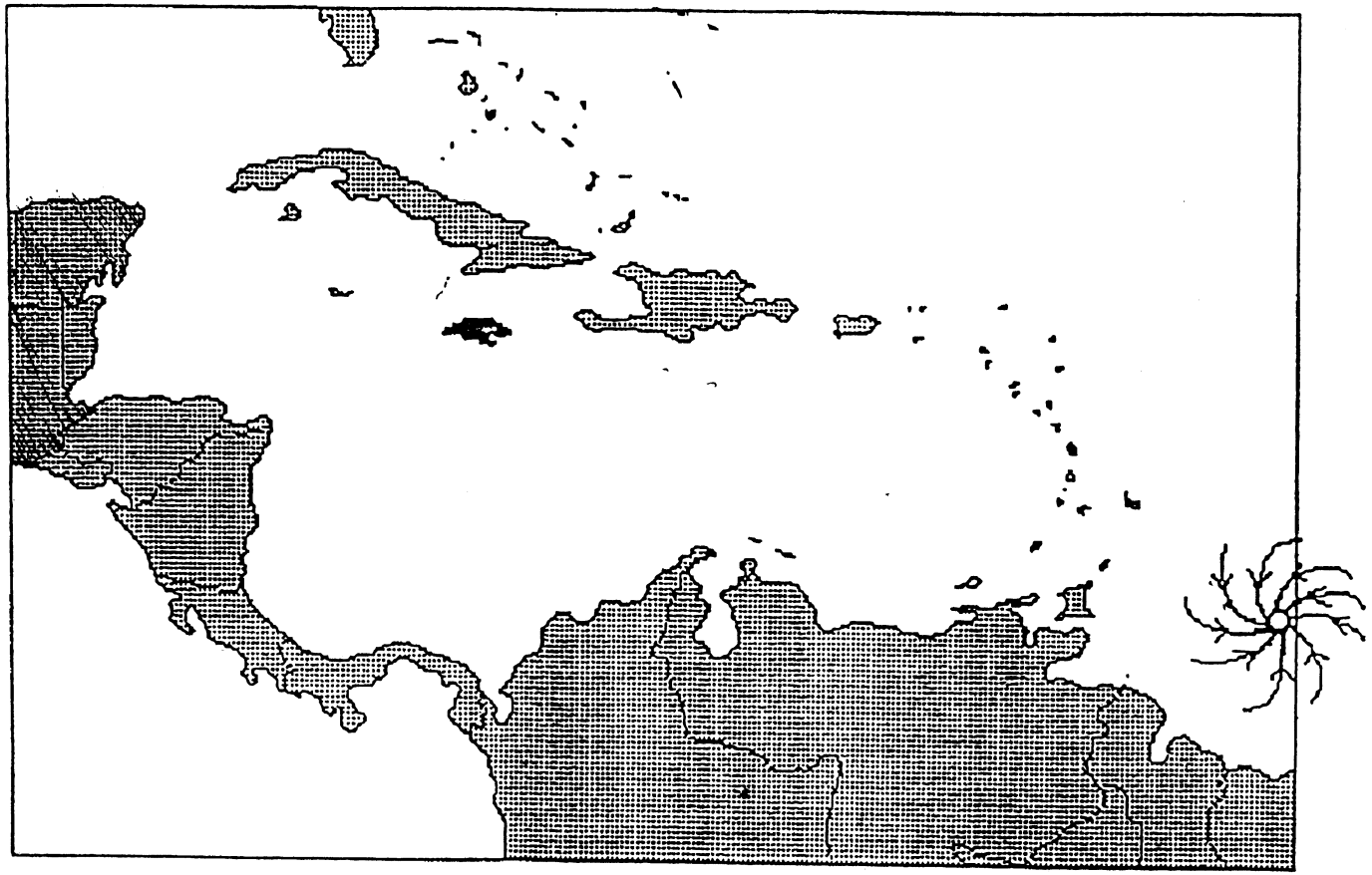
4. Develop a series of practical training manuals targeting specific aspects of safe construction and function of buildings.

The information presented in this booklet is intended to assist homeowners and small builders in the informal housing sector in applying safety measures for reducing housing vulnerability when building or retrofitting.

MAKE THE RIGHT CONNECTIONS

HURRICANES

A HURRICANE IS A SWIRL OF WIND WHICH MOVES AS IT TURNS WITH THE HIGHEST WINDS NEAR THE CENTRE. THE CENTRE IS CALM AND IS CALLED THE EYE.



The wind can come from any direction.

You may get a lull as the eye passes over.

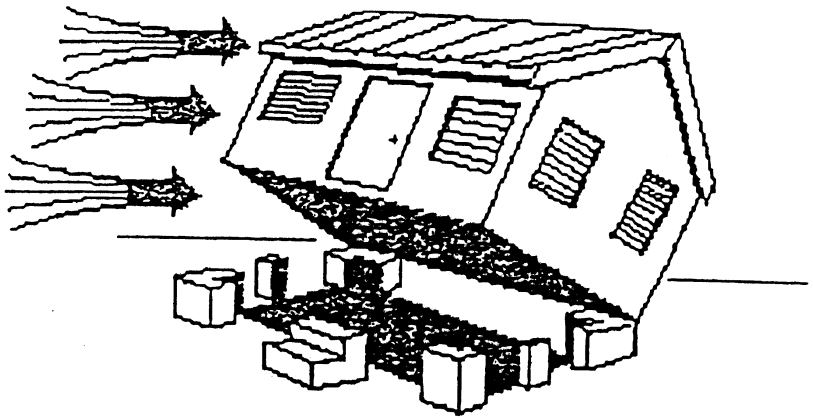
After the eye passes, the wind will come again from a different direction.

MAKE THE RIGHT CONNECTIONS

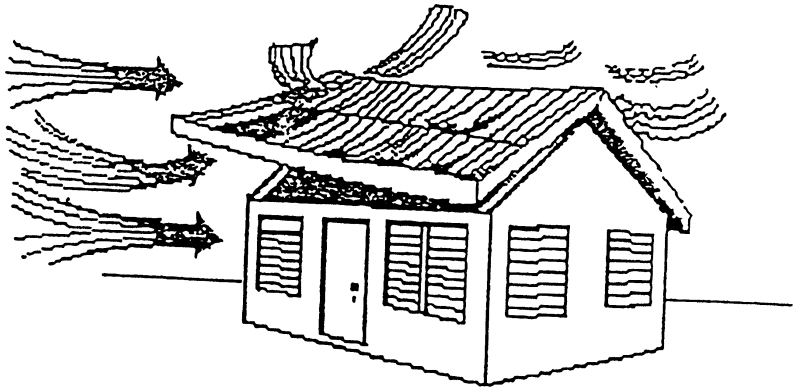
HURRICANES

HURRICANES AFFECT HOUSES BECAUSE OF ENORMOUSLY POWERFUL WINDS.

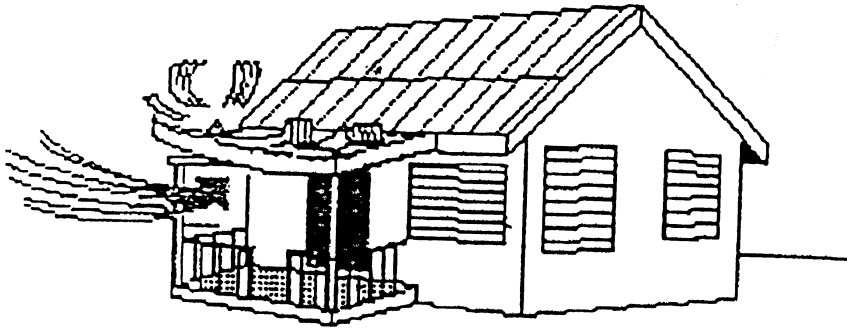
THEY CAN:



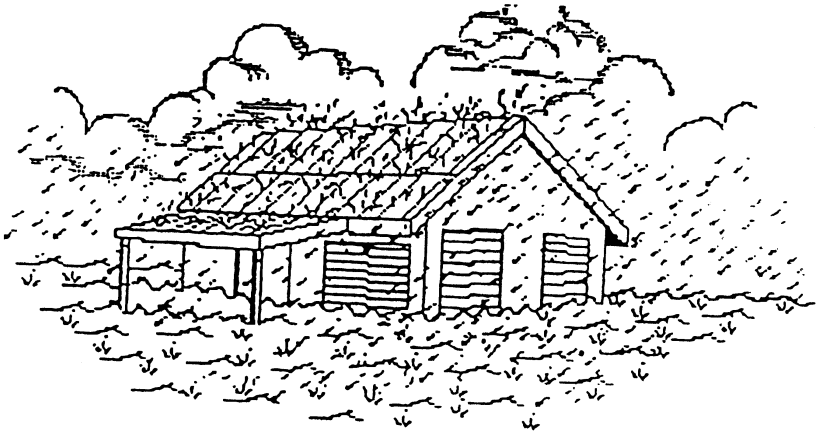
(1) Blow it off its footing



(2) Take off the roof



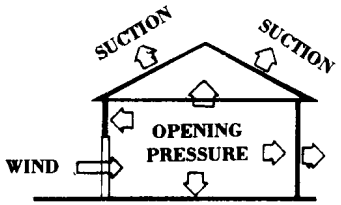
(3) Remove verandah and garage roofs.



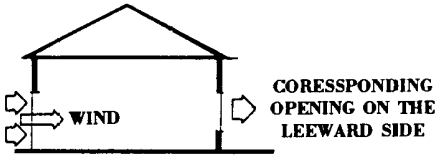
(4) Cause flooding because of heavy rains.

MAKE THE RIGHT CONNECTIONS

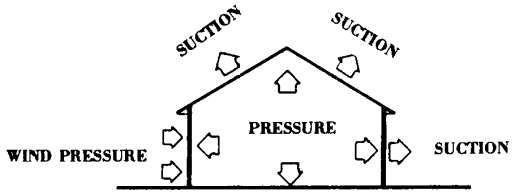
HURRICANES



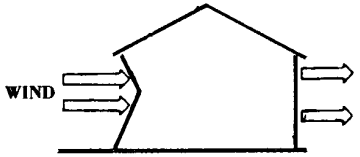
Wind generating opening on the windward side during a hurricane will increase the pressure on the internal surfaces. This pressure, in combination with the external suction, may be sufficient to cause the roof to blow off and the walls to explode.



During a hurricane an opening may suddenly occur on the windward side of the house. The internal pressure which builds up as a result may be relieved by providing a corresponding opening on the leeward side.

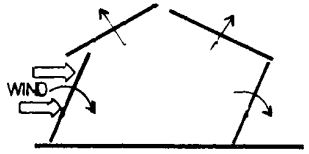


Failure of the Wall: Wind forces on the walls of the house may produce failure. Wind striking a building produces pressure which pushes against the building, on the windward side, and suction which pulls the building on the leeward side and the roof. If no air enters the building, then there is pressure inside which is pushing against the walls and the roof.



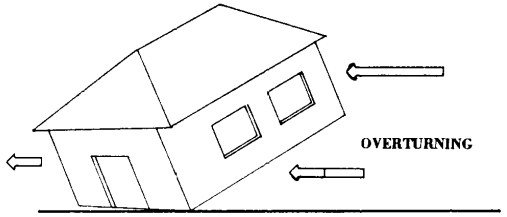
Windward face of the building collapses under pressure of windforce

Another mode of failure occurs when the windward side of the house collapses under the pressure of the wind.



Collapse starts at the roof building leaning in the wind direction

If the building is not securely tired to its foundations, and the walls cannot resist to push/pull forces the house tends to collapse starting the roof with the building leaning in the direction of the wind.



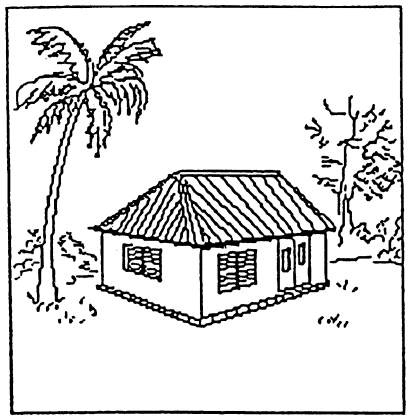
Overturning is another problem for light structures. This occurs when the weight of the house is insufficient to resist the tendency of the house to be blown over.

All modes of failure can be avoided by bracing timber structures and reinforcing the concrete walls.

MAKE THE RIGHT CONNECTIONS

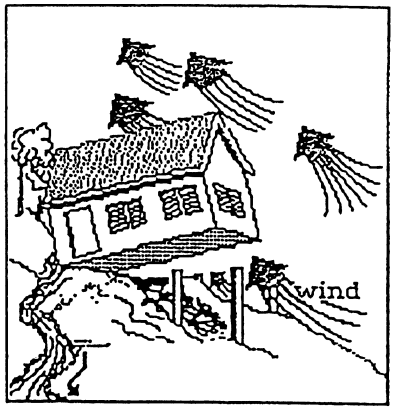
SITING

WHEN CHOOSING A SITE FOR YOUR HOUSE, CONSIDER THE FOLLOWING:

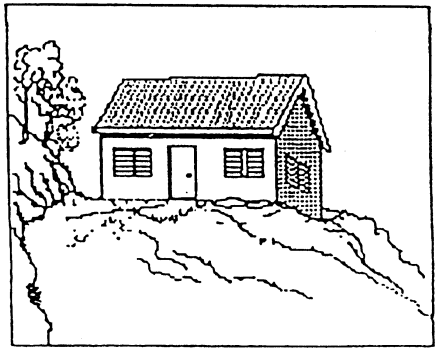


A house is best built on a flat firm site provided it is *well drained.*

If your lot is on a slope don't place the house like this *unless it is properly anchored.*



The wind and water can dislodge the house.



Cut and fill is a common means of leveling a house site. Avoid building on the fill. *Foundation should be on solid ground.* This house is safer, cut into the side of the hill.

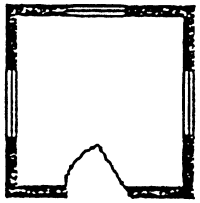
MAKE THE RIGHT CONNECTIONS

DESIGN OF THE HOUSE

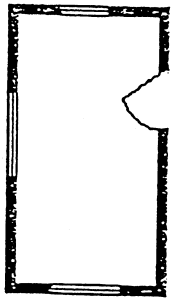
THE CHOICE OF HOUSE DESIGN IS ALSO VERY IMPORTANT IN MAKING IT DISASTER RESISTANT.

THE BEST SHAPE TO RESIST HIGH WINDS IS A SQUARE BECAUSE
- IT ALLOWS HIGH WINDS TO GO AROUND THEM.
- IT IS BETTER BRACED AGAINST EARTHQUAKES.

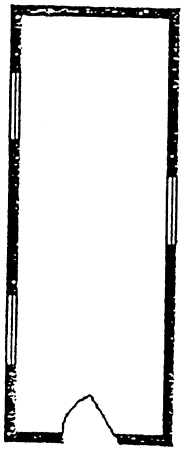
IF OTHER SHAPES ARE DESIRED EFFORTS SHOULD BE MADE TO STRENGTHEN THE CORNERS.



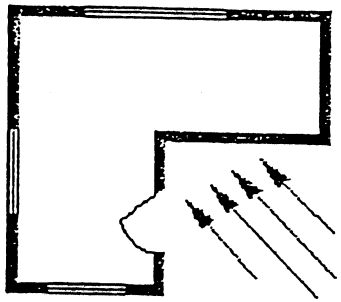
Square (Best)



Rectangle



Long Rectangle



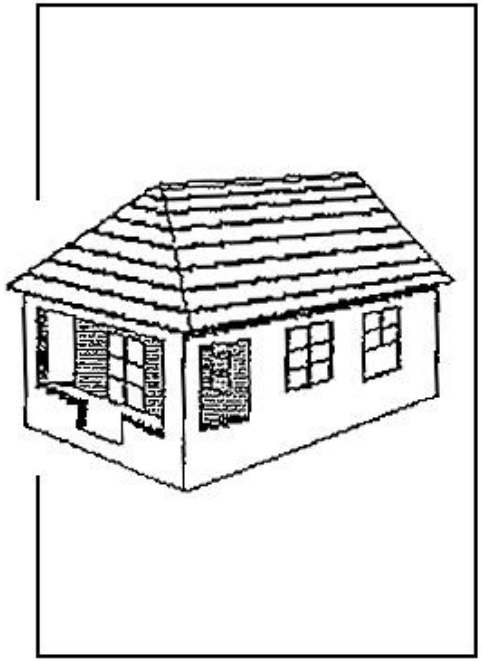
L-Shape

If longer shapes are used, they must be designed to withstand the forces of the wind.
Most houses are rectangular and the best layout is when the length is not more than three (3) times the width.

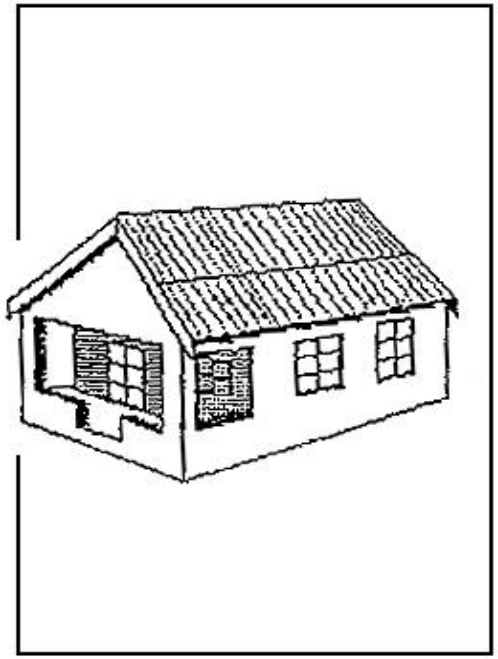
MAKE THE RIGHT CONNECTIONS

DESIGN OF THE HOUSE

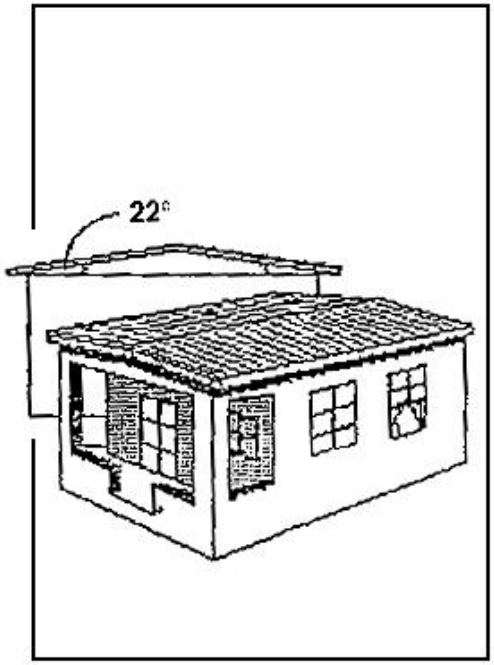
LIGHTWEIGHT FLAT ROOFS ARE EASILY BLOWN OFF IN HIGH WINDS. IN ORDER TO LESSEN THE EFFECT OF THE UPLISTING FORCES ON THE ROOF, THE ROOF PITCH SHOULD NOT BE LESS THAN 22º. HIP ROOFS ARE GOOD, THEY HAVE BEEN FOUND TO BE MORE HURRICANE RESISTANT THAN GABLE ROOFS.



Hip roof



Gable roof

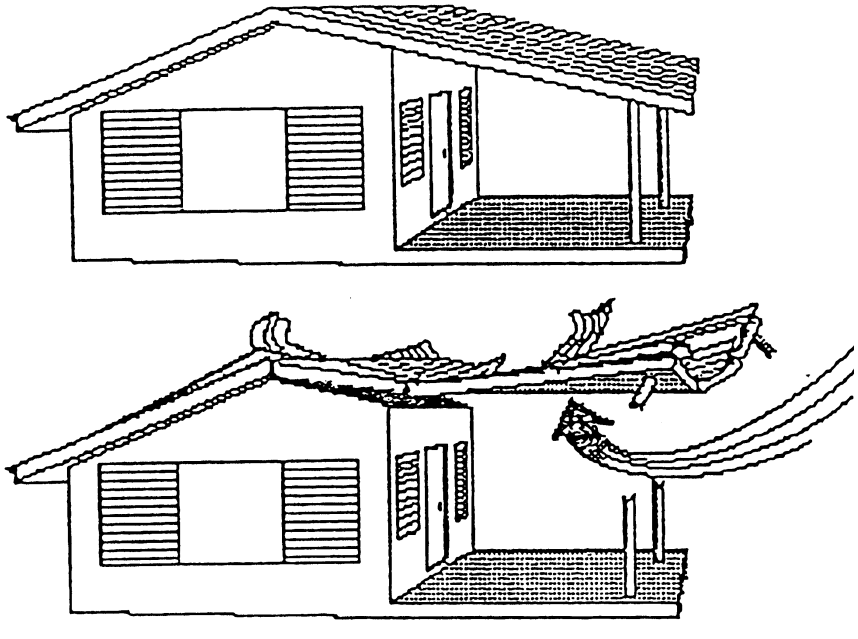


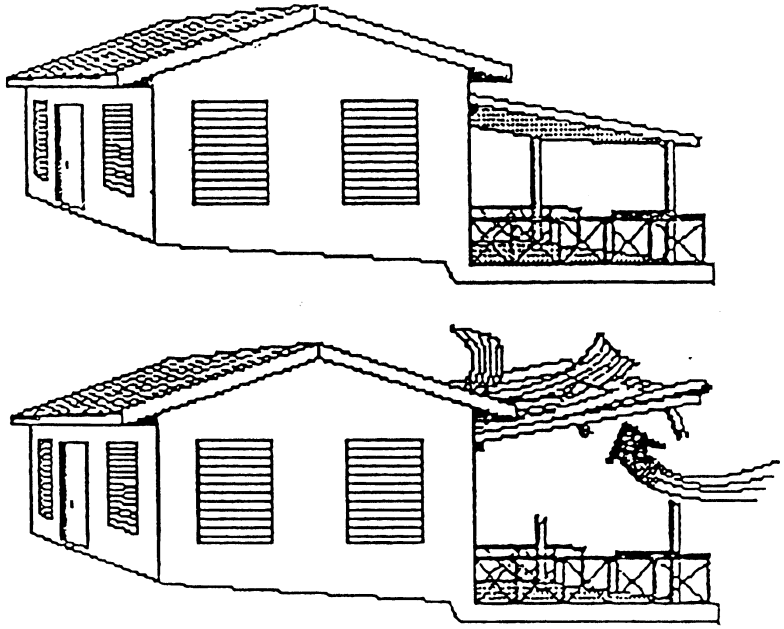
Flat roof

GENERAL DESIGN CONSIDERATIONS

1. Avoid a low pitched roof, use a hip roof or a high pitched gable roof.
2. Avoid overhanging roofs. If overhangs or canopies are desired, they should be separated from the main roof structures.
3. Avoid openings which cannot be securely closed during a hurricane. Where openings are already in existence, hurricane shutters should be provided.
4. Best plan shape for wind resistance is a square or rectangle with length to width ration no more than 3:1.

OVERHANGS, PATIOS AND VERANDAHS EXPERIENCE HIGH WIND PRESSURES AND SHOULD BE KEPT SHORT AND SMALL.





- **Avoid large overhangs as high wind force build up under them.**
- **Overhangs should not be more than 18 inches *at verges or eaves.***

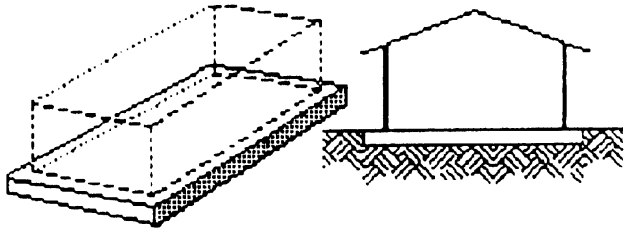
- **Build verandah and patio roofs as separate structures rather than extensions of the main building.**
- **They may blow off without damaging the rest of the house.**

MAKE THE RIGHT CONNECTIONS

FOUNDATIONS

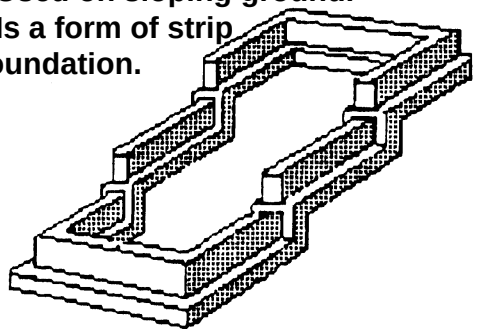
THE FOUNDTATION IS THE PART OF THE HOUSE WHICH TRANSFERS THE WEIGHT OF THE BUILDING TO THE GROUND. IT IS ESSENTIAL TO CONSTRUCT A SUITABLE FOUNDATION FOR A HOUSE AS THE STABILITY OF A BUILDING DEPENDS PRIMARILY ON ITS FOUNDATION.

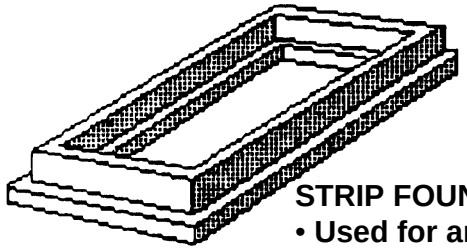
For low cost construction the main types of foundation are:



SLAB OR RAFT FOUNDATION
- **Used on soft soils.**
- **Spread the weight over a wider area**

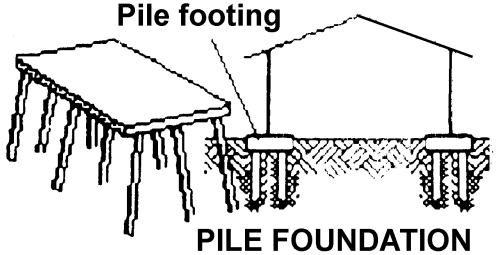
STEPPED FOUNDATION
- **Used on sloping ground.**
- **Is a form of strip foundation.**



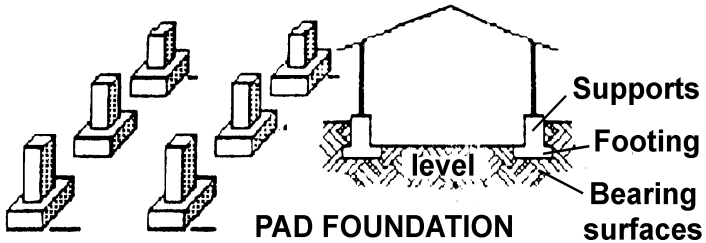


STRIP FOUNDATION
- **Used for areas where the soil varies.**
- **Most common.**
- **Supports a wall.**

Short bored Pile footing



PILE FOUNDATION
- **Are deep foundations for heavy buildings.**
- **Not often used in small buildings.**



PAD FOUNDATION
- *** Used on firm soil**
- *** Used for columns and poles.**

NOTE: Tie beams between pads are used in some islands of the Caribbean.

MAKE THE RIGHT CONNECTIONS

FOUNDATIONS

CONSTRUCTION TECHNIQUES

Foundation

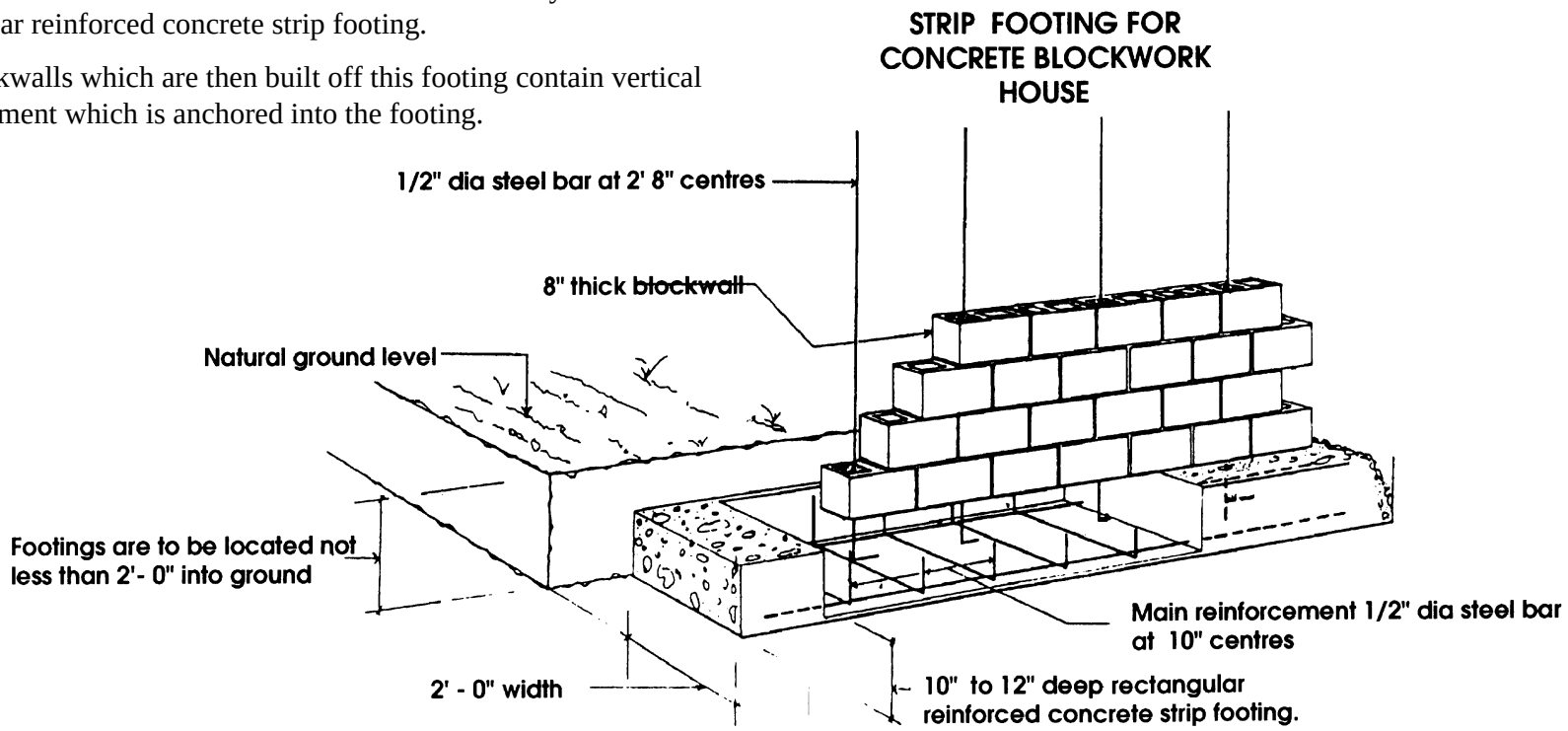
The functions of the foundations are:

1. To securely anchor the house to the ground to prevent wind forces from lifting the entire building or blowing it over.

2. To transmit the building loads to the ground. Foundations should be securely connected to the rest of the structure and located not less than 2 feet into the ground on firm strata.

The foundation for the blockwall construction is usually a continuous rectangular reinforced concrete strip footing.

The blockwalls which are then built off this footing contain vertical reinforcement which is anchored into the footing.

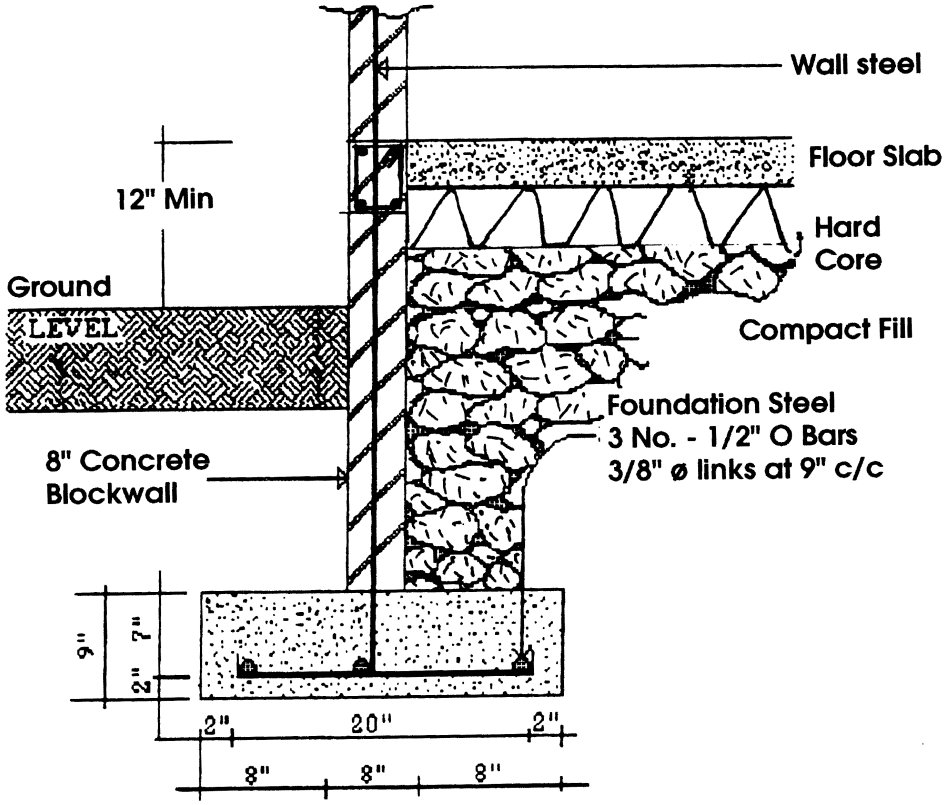


MAKE THE RIGHT CONNECTIONS

FOUNDATIONS

REINFORCEMENT

THE FOUNDATION FOR A CONCRETE BLOCK BUILDING SHOULD BE CONSTRUCTED OF CONCRETE WHICH MUST BE REINFORCED. THE REINFORCEMENT IN THE WALL TIED TO THAT OF THE FOUNDATION.

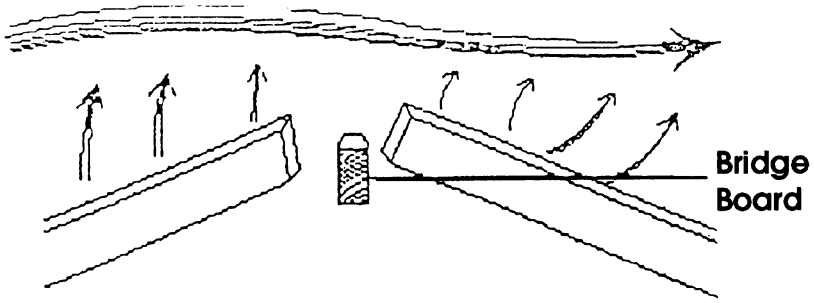


REINFORCEMENT TO STRIPFOOTING

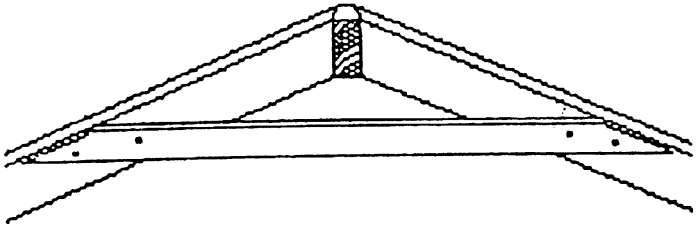
MAKE THE RIGHT CONNECTIONS

THE ROOF

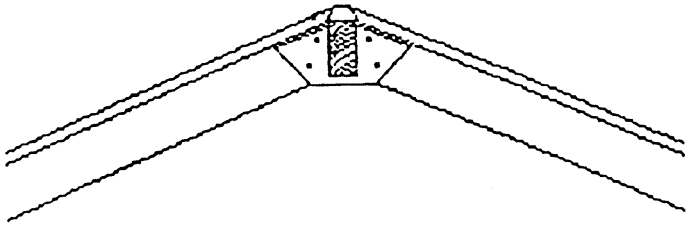
WHEN THE WIND PASSES OVER THE ROOF IT SUCKS THE ROOF UPWARDS AND THE RIDGE CAN PULL APART. THE RIDGE MUST BE HELD TOGETHER. THIS CAN BE DONE BY USING:



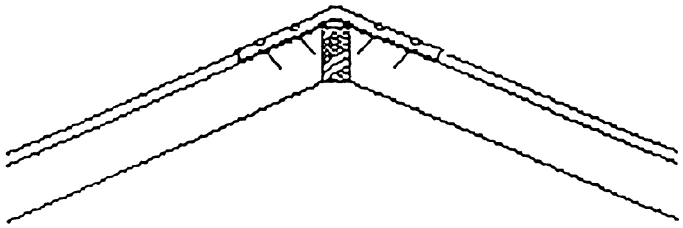
If the rafters are not secure, the ridge can fall apart when strong wind passes over the roof.



<u>COLLAR TIES</u> - Timbers connecting the rafters. Nail them to the side of the rafters, not the face or the nails will pull out.



<u>GUSSETS</u> - Usually made of steel/plywood. This is used at the ridge.

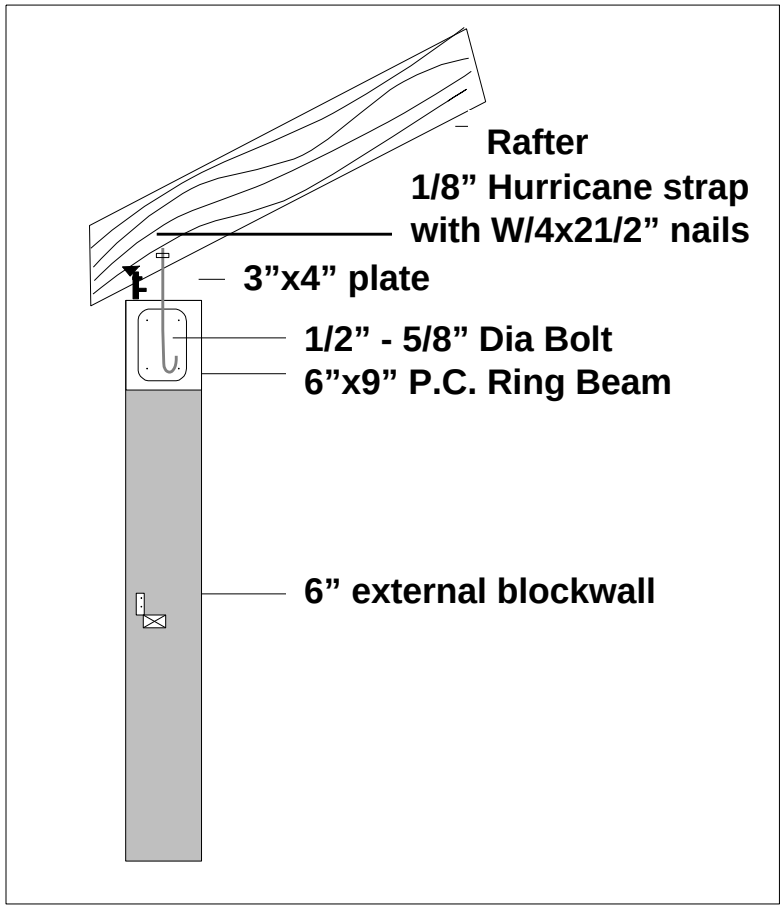


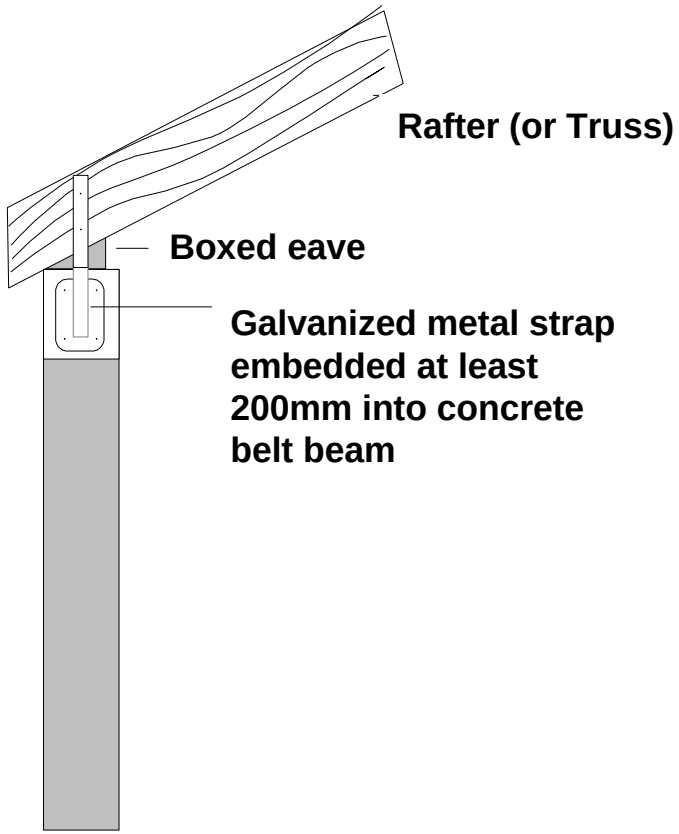
<u>METAL STRAPS</u> over the top of the rafters.

MAKE THE RIGHT CONNECTIONS

THE ROOF

ROOF CONNECTIONS FOR CONCRETE WALLS





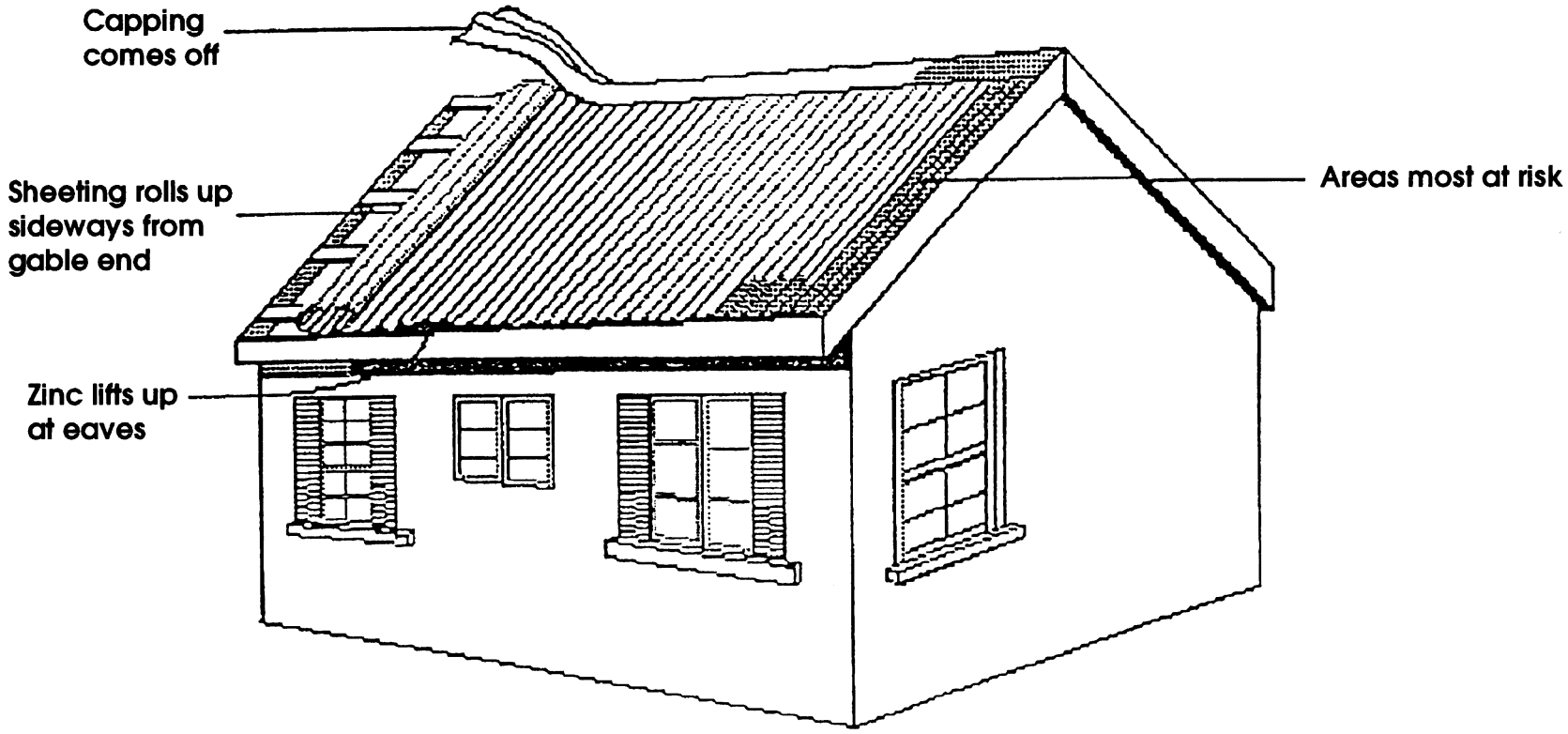
Galvanized metal strip embedded into concrete belt beam to hold down rafter. This is a good alternative to having a wallplate.

MAKE THE RIGHT CONNECTIONS

THE ROOF

CORRUGATED GALVANIZE SHEETS ARE GAUGED BY NUMBERS. THE HIGHER THE NUMBER THE THINNER THE MATERIAL. EXAMPLE 24 GAUGE GALVANIZE IS SUPERIOR TO 28 GAUGE.

HOW DOES ROOF SHEETING FAIL IN HURRICANES?

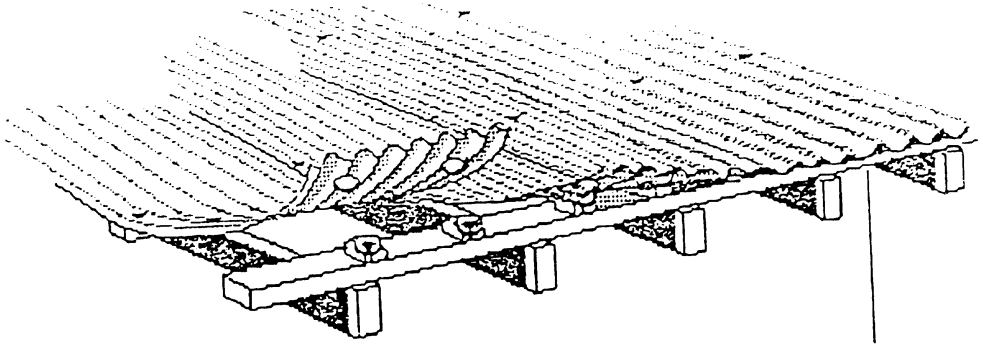


MAKE THE RIGHT CONNECTIONS

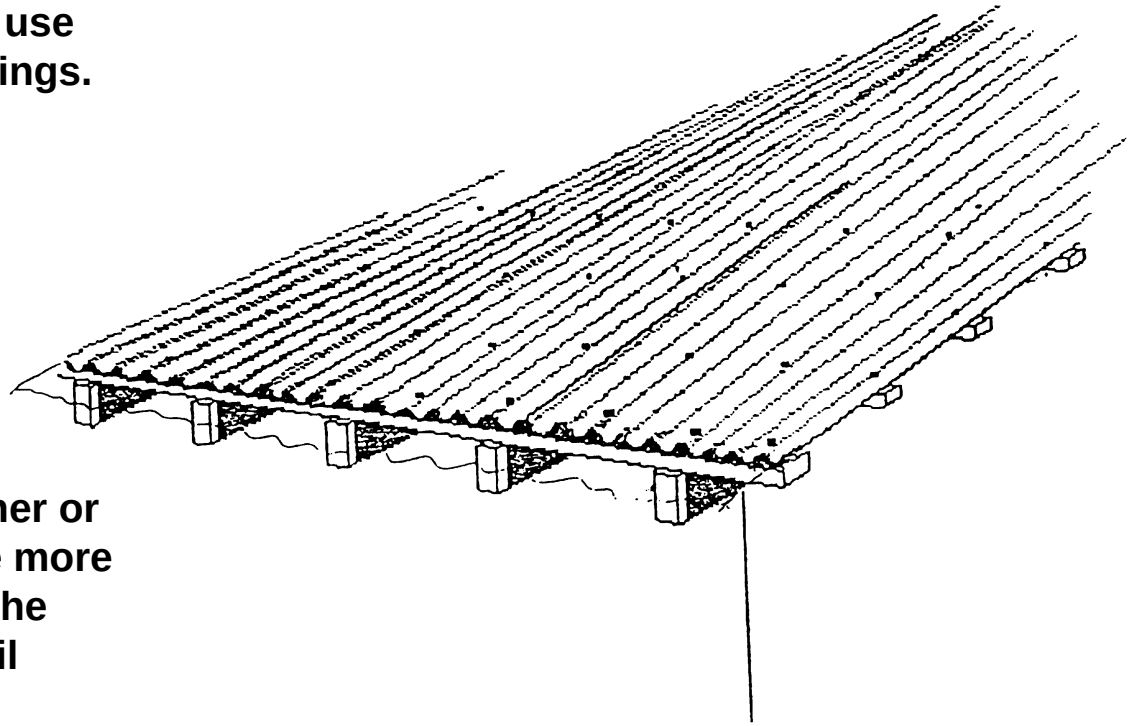
THE ROOF

FAILURE IN ROOFS

IF THE SHEETING IS TOO THIN OR THERE ARE TOO FEW FITTINGS, THE NAILS OR SCREWS MAY TEAR THROUGHT THE SHEET.



To prevent this type of failure use more fixings for thinner sheetings.



Use fittings with a broad washer or dome head (zinc nail). To use more fixings for each sheet, put in the laths at closer centres and nail closer together.

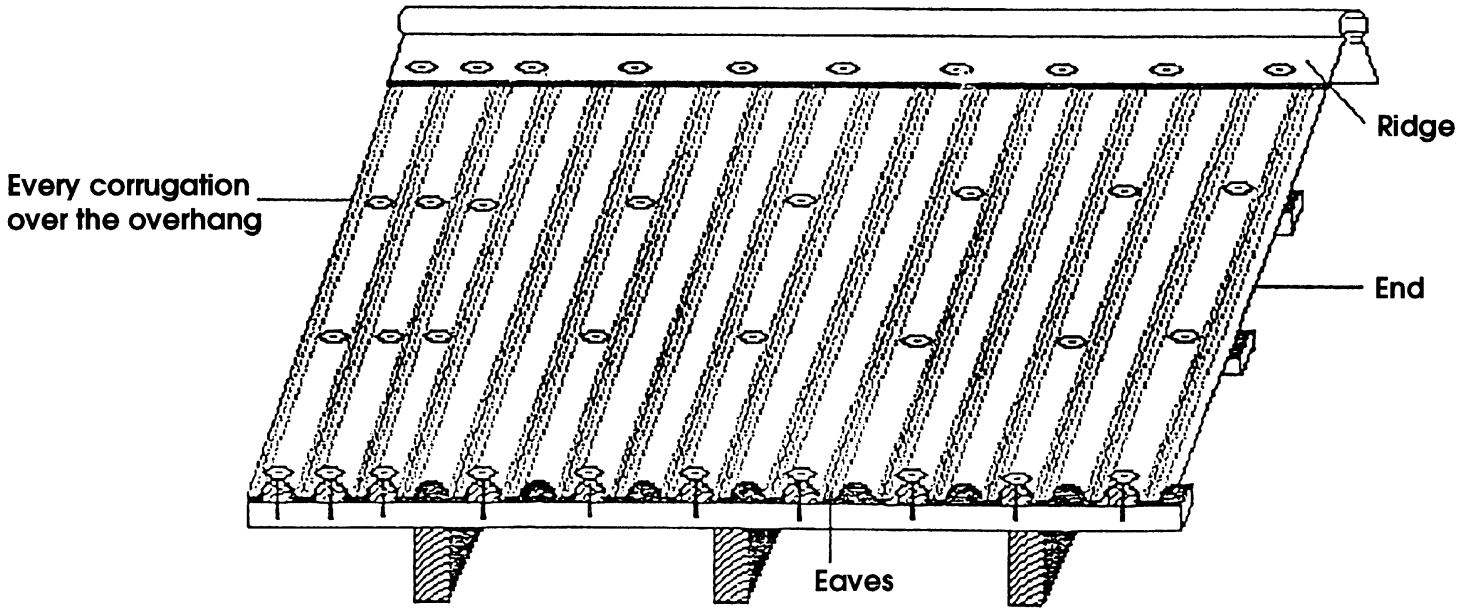
MAKE THE RIGHT CONNECTIONS

THE ROOF

ROOFING MATERIALS GALVANIZED SHEETS

IF GALVANIZED SHEETS ARE USED 24 GAUGE IS RECOMMENDED

IF YOU MUST USE 26 GAUGE WHICH IS THINNER, THIS IS HOW TO HOLD YOUR SHEETING TO THE ROOF STRUCTURE.



At ridges, eaves and overhangs - fixings every two (2) corrugation.

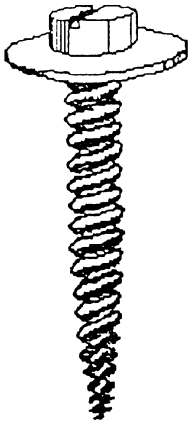
All other locations, fixings every three (3) corrugation. Maximum spacing.

MAKE THE RIGHT CONNECTIONS

THE ROOF

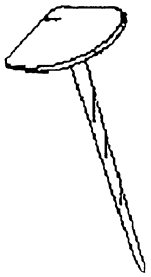
FIXINGS FOR SHEETINGS

SCREWS



- USE PROPER DRIVE CREWS FOR CORRUGATED GALVANIZED ROOF SHEETS.
- BE SURE THAT THE SCREWS GO INTO THE PURLINGS AT LEAST TWO (2) INCHES.
- USE LARGE WASHERS UNDER THE SCREW HEADS TO PREVENT THE ROOF SHEETS FROM TEARING WHEN PULEED UPWARD BY HIGH WINDS.
- REMEMBER TO USE SUFFICIENT SCREWS SO THAT THE EHADS WILL NOT TEAR THROUGH.

NAILS



- NAILS DO NOT HOLD AS WELL AS SCREWS.
- USE NAILS WITH WIDE HEADS AND LONG ENOUGH TO BEND OVER BELOW THE LATH.
- GALVANIZED COATED NAILS ARE BETTER THAN ORDINARY WIRE NAILS.

LATHS SPACING AND FIXING

- SPACING FOR LATHS AND NUMBER OF FIXINGS WILL VARY WITH THE GAUGE OF SHEETING USED.
- SCREWS HOLD BETTER THAN NAILS SO FEWER SCREWS CAN BE USED. BUT THE SHEETING MUST BE THICK OR THEY WILL TEAR THROUGH.
- LATHS SHOULD BE PLACED CLOSER TOGETHER FOR THIN SHEETS TO PROVIDE SPACE FOR EXTRA FIXINGS.
- A GUIDE TO THE NUMBER OF FIXINGS AND SPACINGS OF LATHS IS SHOWN BELOW.

Gauge of Sheeting	Spacing of Laths
26	18 ins - 2 ft.
25	2 ft. - 2 ft. 6 ins.
24	2 ft. for nails 3 ft. for screws

MAKE THE RIGHT CONNECTIONS

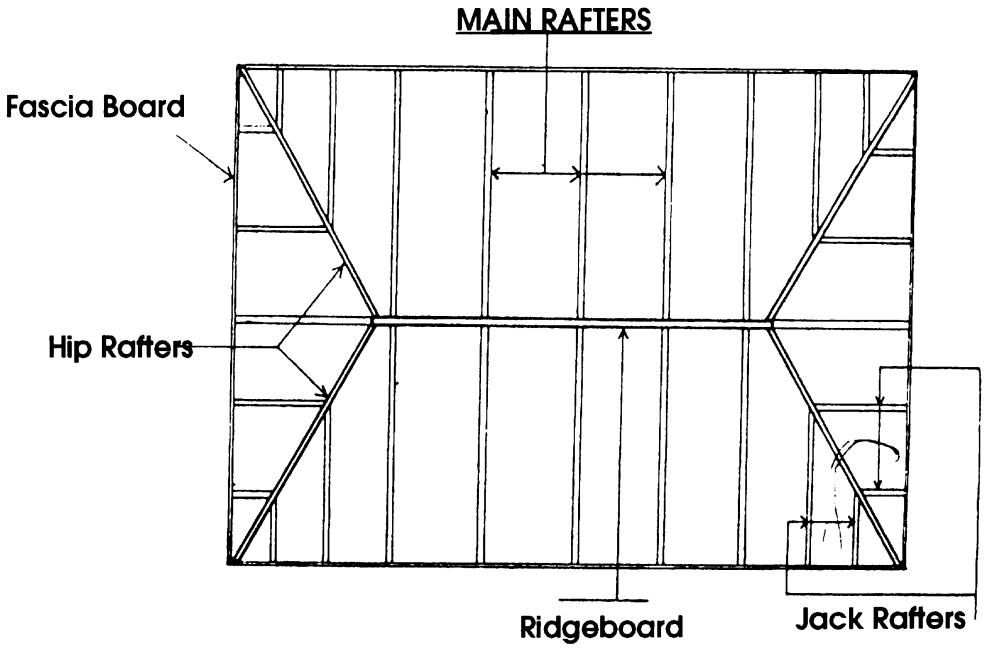
THE ROOF

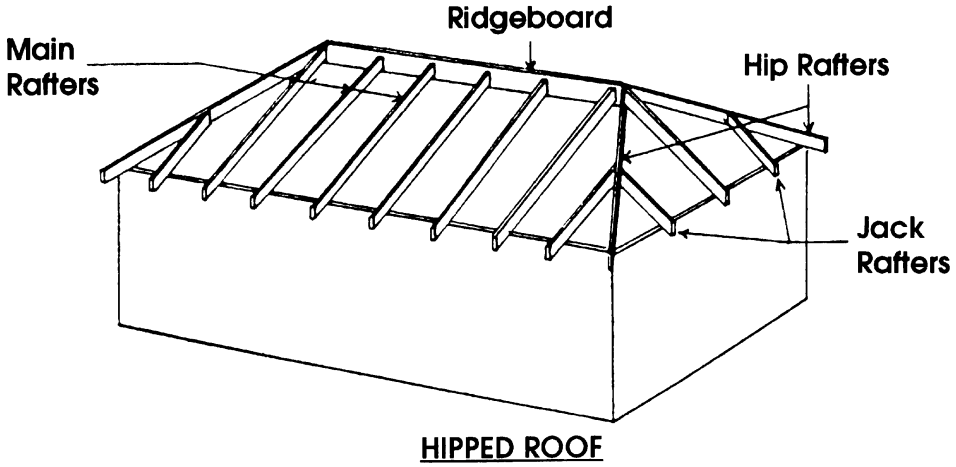
HIPPED ROOF

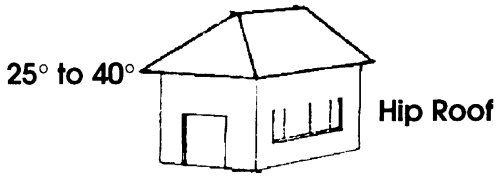
This is the strongest type with all sides of the roof sloped. There are no gable ends in this roof. Instead, rafters come across diagonally from the corner and meet the ridge board a short distance from the ends of the house. These are the hip rafters.

Other shorter rafters go from the wall plate to the hip rafter and are called jack rafters.

After the ridge is firmly in position, the rafters are attached to fit neatly onto the wall plate.







Experience and experiment have shown that the hip roof with the pitch in 25° to 40° range has the best record of wind resistance.

MAKE THE RIGHT CONNECTIONS

THE ROOF

ROOF CLADDING

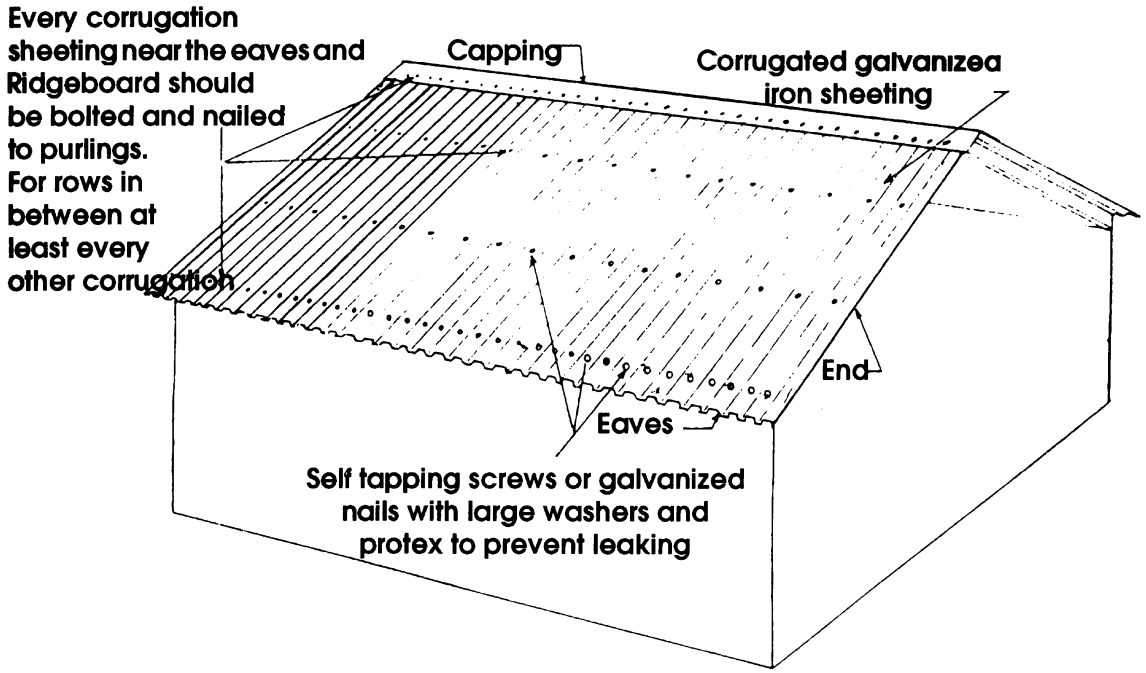
In addition to the roof structure being fixed to the supporting wall, the cladding must be able to resist and transfer the wind loads to the purlins. Purlins are therefore important structural members of the roof and flat boards should not be used for this purpose. Purlins should be either 2" x 3" or 1" x 4" at no more than 2'0" spacing. Purlins should be fixed to each rafter passed over using hurricane straps or metal cleats.

• Corrugated galvanized steel sheeting is the most commonly used form of cladding in the Eastern Caribbean. Sheeting which is too thin and with inadequate numbers of fixings is extremely vulnerable during hurricanes. The minimum thickness of corrugated steel sheeting should be 6mm.

• Sheets should be fixed to the purlins using self-tapping screws or galvanized nails with large washer.

• At the eaves and ridge as well as the gable ends, the fitting should be two corrugations apart, and for the rest of the roof, no more than three corrugations apart.

CONNECTION OF SHEETING & CAPPING



• The corrugated sheeting should be properly overlapped (at least 2 1/2 corrugation) to prevent water from blowing under the seam.

• Roof capping should be made from materials as strong as the sheeting itself, it should be bolted or screwed down to the purlin on either side of ridge or ridgeboard or hip.

• Spaces between the sheeting and the wall plate should be closed up to prevent the wind from getting under the sheeting and lifting it. This can be done by nailing a fascia board to the wall plate and rafters.

MAKE THE RIGHT CONNECTIONS

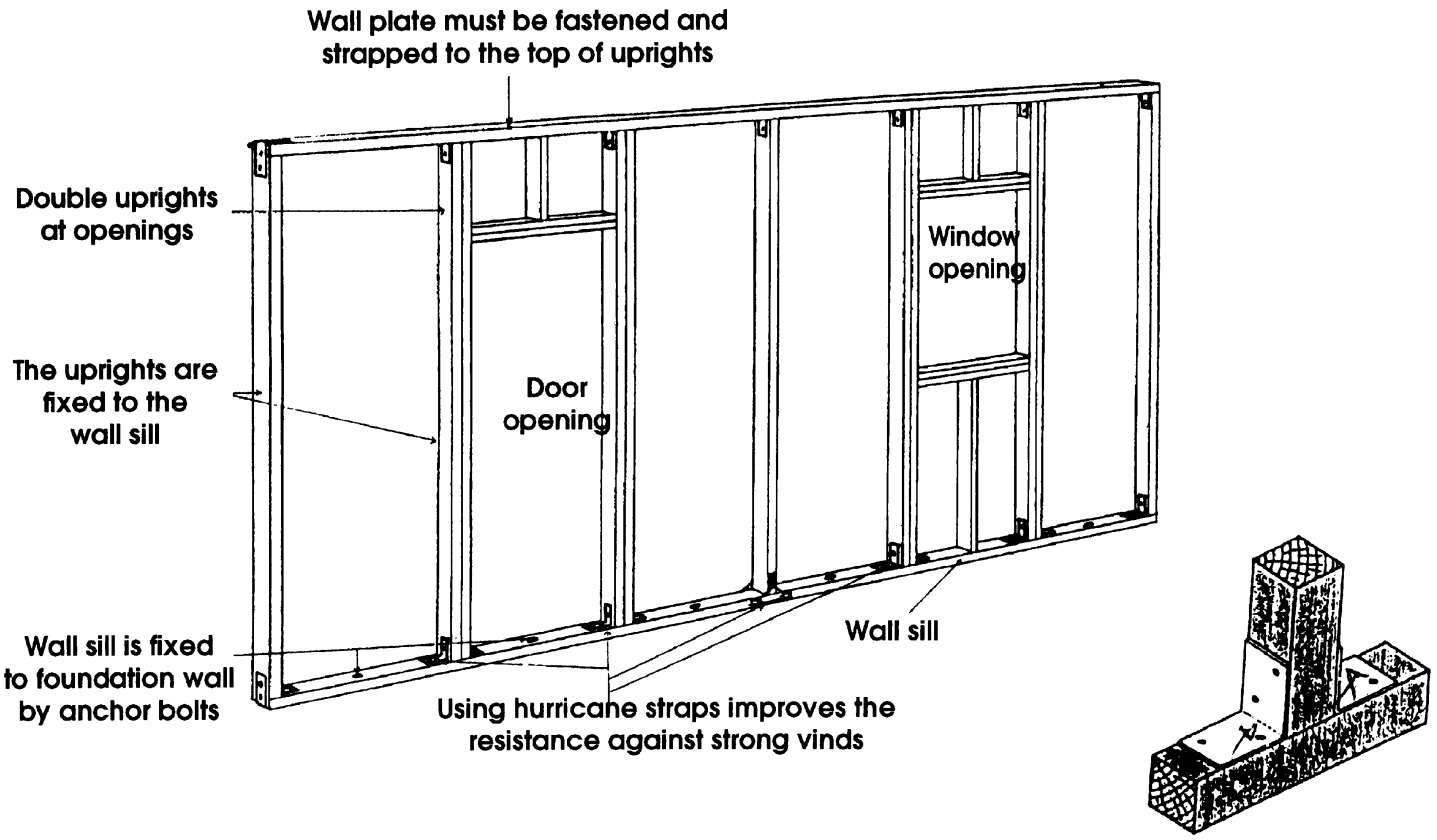
THE WALLS

WOODEN WALLS

The uprights (or posts) are fixed to the wall sill which is bolted to the foundations wall.

Using metal straps with nails improves the hurricane resistance of timber houses.

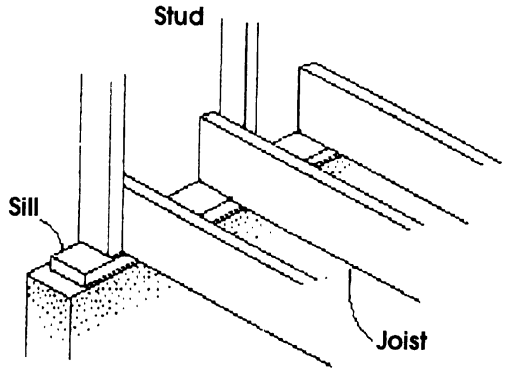
WOODEN WALL



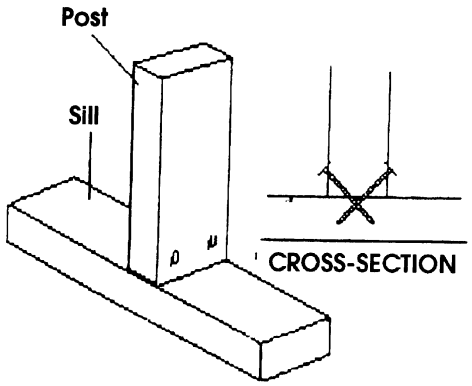
MAKE THE RIGHT CONNECTIONS

THE WALLS

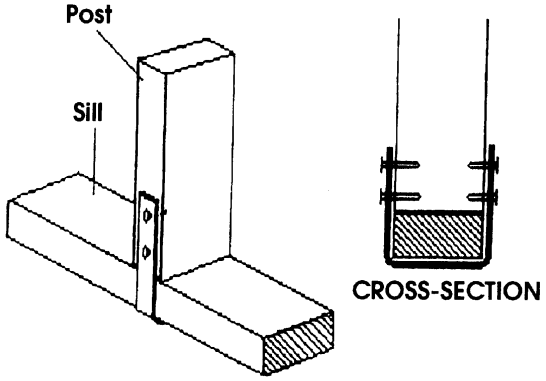
THE WALLS MUST BE SECURELY TIED TO THE FOUNDATION TO PREVENT THE WIND FORCES LIFTING UP THE ENTIRE BUILDING OR BLOWING IT OVER.



CONNECTION FOR TIMBER WALLS



TOENAIL CONNECTION



CONNECTION WITH HURRICANE STRAPS

MAKE THE RIGHT CONNECTIONS

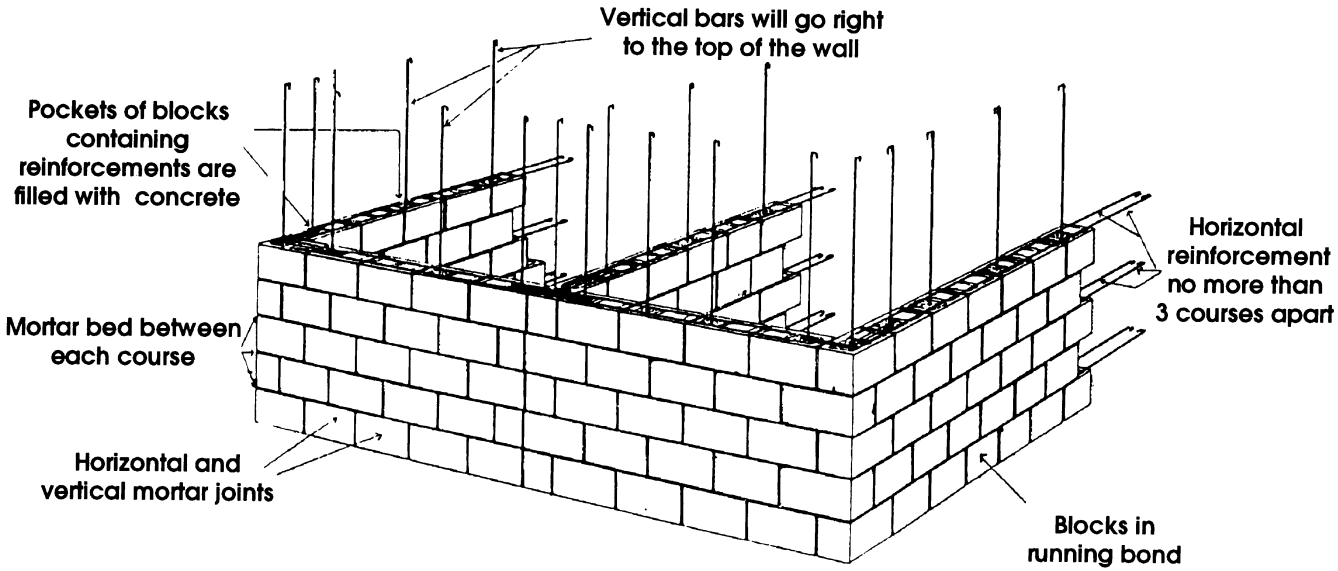
THE WALLS

WALLS

Concrete Block Walls

• starter bars coming out of the foundation will tie the wall to the foundation.
• Lay blocks so that those starter bars come out through block pockets. For earthquakes the recommended minimum vertical reinforcement is 3/8” diameter bars at 32” centres, this will provide adequate resistance to hurricanes. As more courses are laid you must add more lengths of steel to overlap for at least 12” with starter bars.
• These lengths of steel will go right to the top of the walls.
• pockets of block containing reinforcement are to be filled with concrete
• as each course of blocks is laid, it must be set into a 1:3 mortar bed placed on the last course, mortar is also required on the sides of the blocks to form the vertical joints. Mortar joints should be 1/2” to 5/8” wide.
• Galvanized horizontal reinforcement, Dar-O-Wal or Brickforce, should be laid after every third course. (Two 1/4” diameter bars are often used, but they are likely to rust in the thin mortar joints).
• Horizontal reinforcement increases the resistance of the wall to hurricane force winds (and to earthquakes).
•Vertical bars are required at all junctions and window and door openings.
• Blockwalls should be constructed in running bond rather than stacked bond.

CONCRETE BLOCK WALL



MAKE THE RIGHT CONNECTIONS

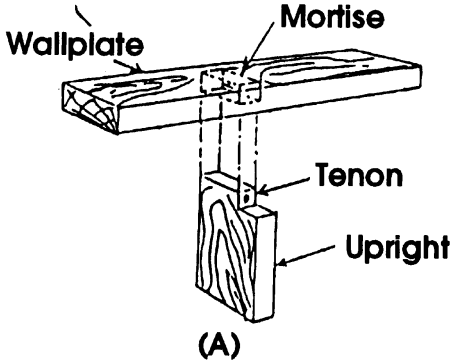
CONNECTIONS

TIMBER WALLS

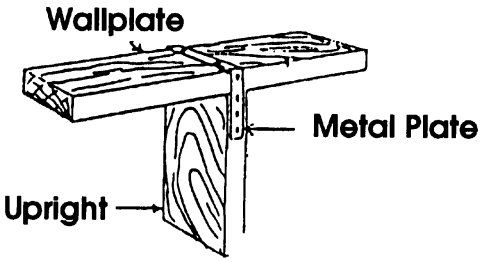
In timber houses the rafters or trusses are connected to a wall plate which is supported by the vertical posts.

Two connections need to be considered.

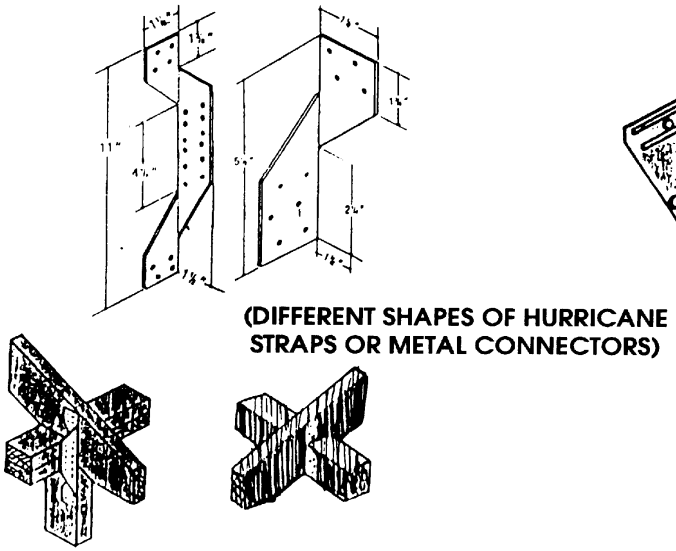
1. The first is the connection between the plate and the uprights which, should be made using metal straps. The conventional solution is a mortise and tenon joint (Figure A) using glue and sometimes dowel pins. Suction forces on the roof may cause this joint to fail.
2. The second connection is that between the rafter and the plate. The standard solution is to nail or spike the rafter to the wall plate. Under high suction forces these nails or spikes may pull out. It is strongly recommended that hurricane straps (or metal connectors) be used for these connections. The connectors may either be purchased off the shelf or made up on site using 20 gauge galvanized sheet metal.



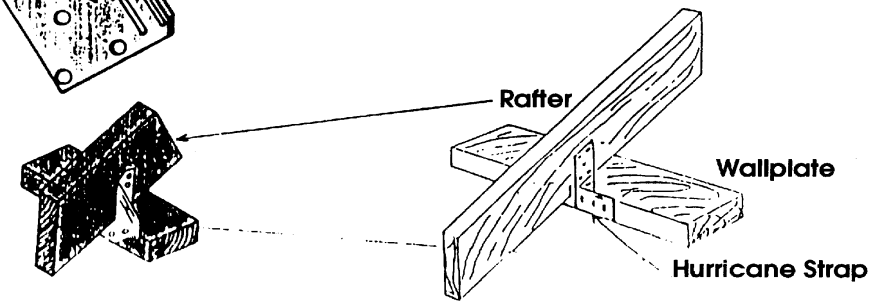
(A)



(B)

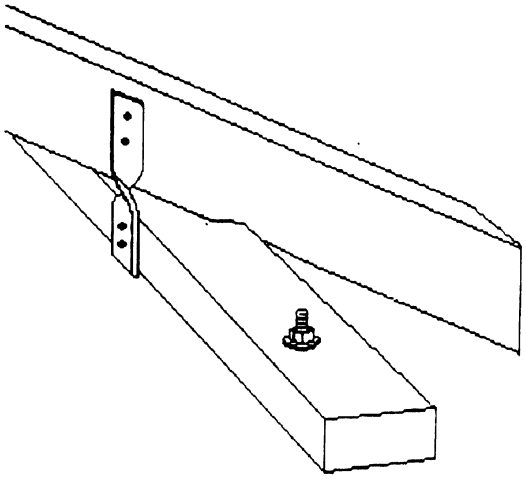


(DIFFERENT SHAPES OF HURRICANE STRAPS OR METAL CONNECTORS)

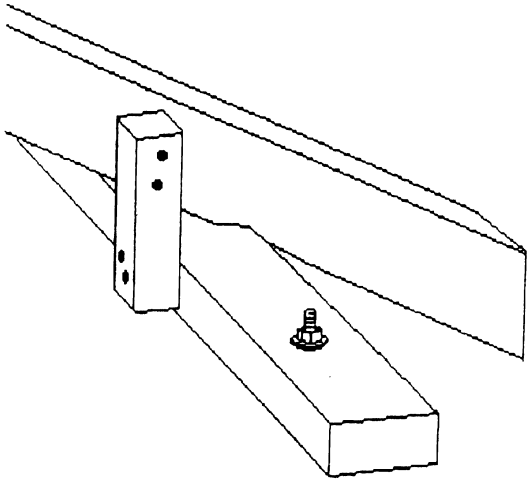


MAKE THE RIGHT CONNECTIONS

RAFTERS WILL LIFT OFF WALL PLATES IN HIGH WINDS. THEY MUST BE HELD DOWN BY MORE THAN NAILS. STRAPS CAN BE INSTALLED IN EXISTING ROOFS TO STRENGTHEN THEM.



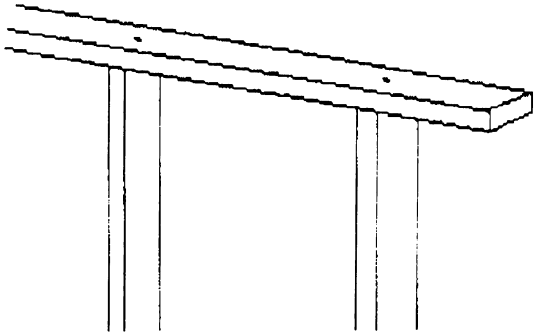
Twisted straps nailed through rafter with 21/2 inch nails. Bend over the ends of nails. Be careful when selecting hurricane straps, ensure that they can be properly affixed so that when nailed, the nail is not too near the edge.



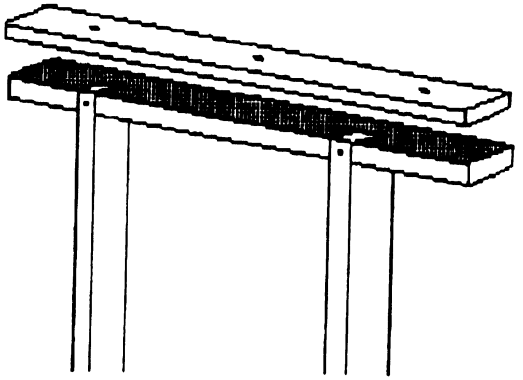
Timber connector may be used as an alternative. Make sure that the wood is strong.

MAKE THE RIGHT CONNECTIONS

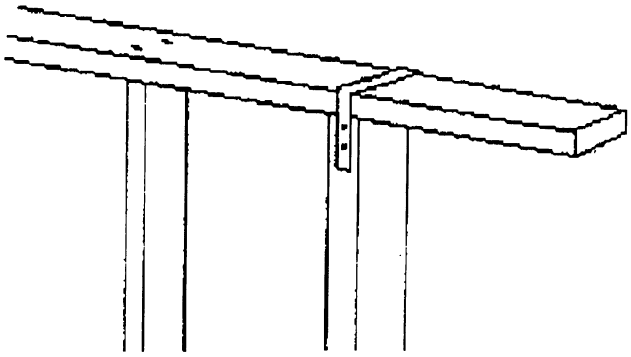
WALL PLATES FOR WOODEN BUILDINGS ARE CRITICAL BECAUSE THEY PROVIDE STIFFNESS FOR THE BUILDING AND ALSO SERVE TO HOLD THE ROOF DOWN.



- They are often insecurely held down by nails into the end grain of posts.

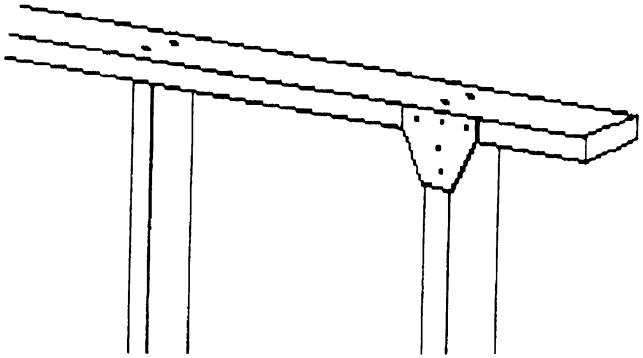


- If a double plate is used, notch and nail the lower one and secure the top one well.



- To strengthen use a strap over the top

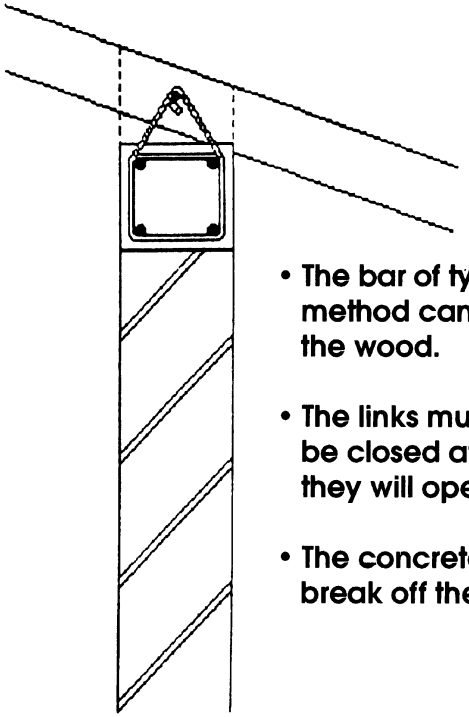
OR



- Use a gusset of zinc or plywood.

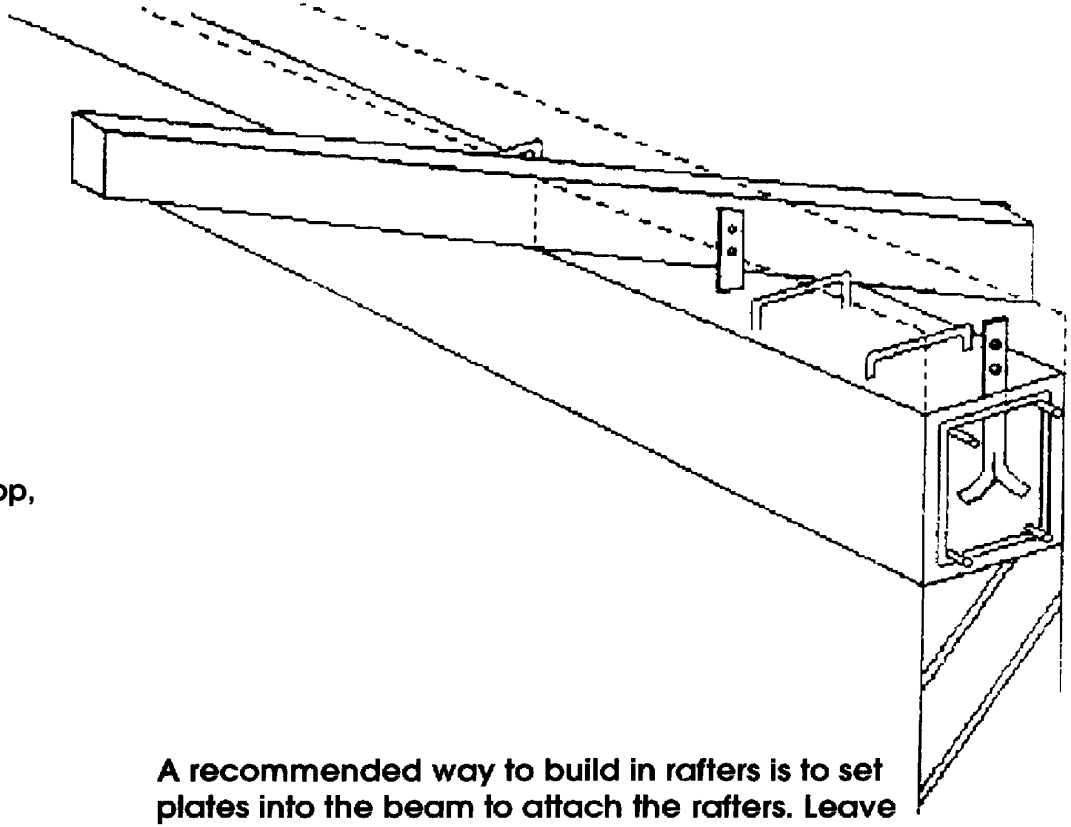
MAKE THE RIGHT CONNECTIONS

RAFTERS MAY BE BUILT INTO THE BELT BEAM AT THE TOP OF THE WALL. HOWEVER THIS PRACTICE IS DISCOURAGED BECAUSE OF FAILURES OBSERVED AFTER RECENT HURRICANES.



- The bar of typical method can split the wood.
- The links must not be closed at the top, they will open.
- The concrete will break off the wall.

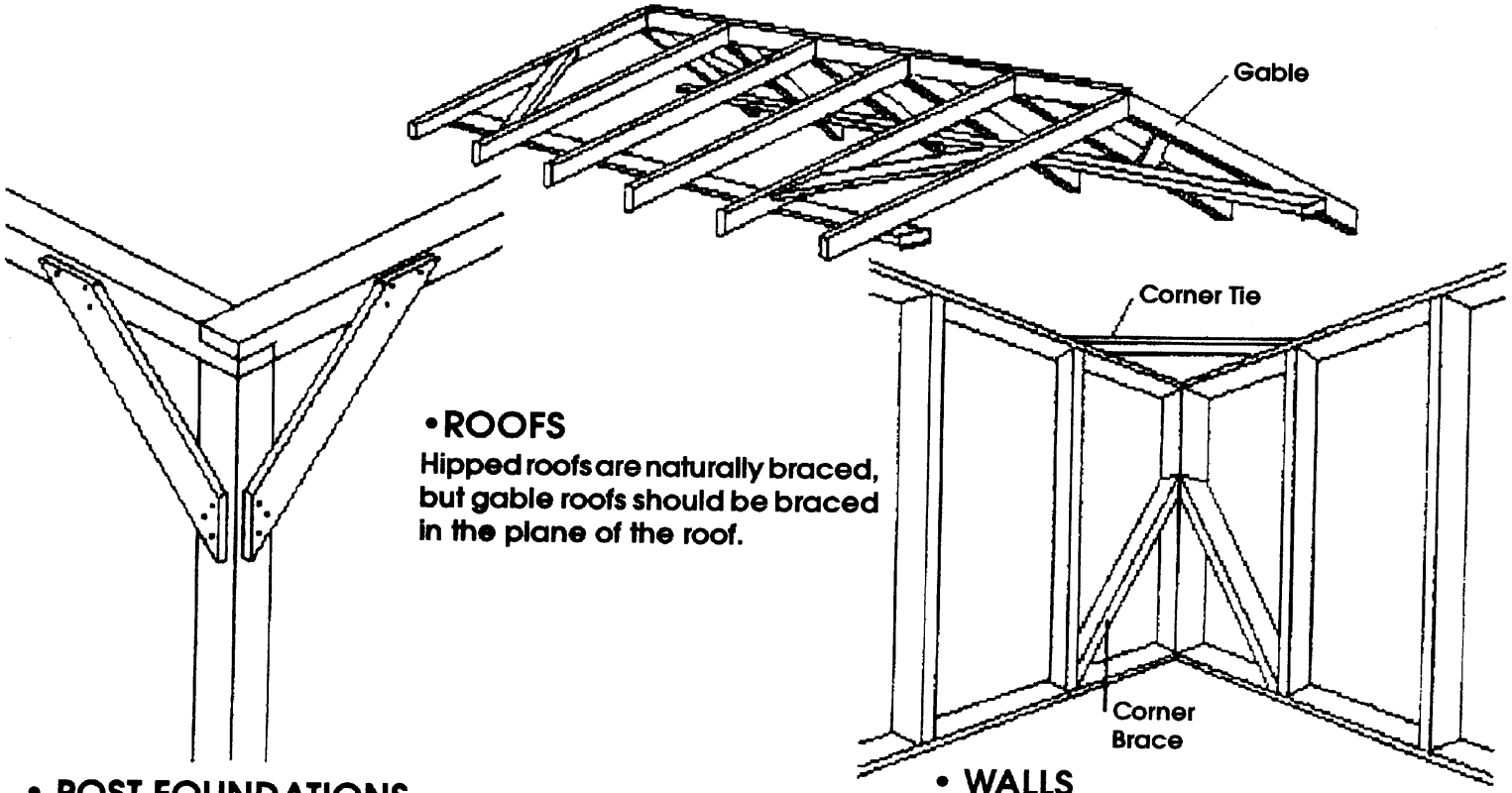
FAILURE MODES
OF
TYPICAL METHOD



A recommended way to build in rafters is to set plates into the beam to attach the rafters. Leave some links showing after securing the rafters to the plates, concrete is cast between them up to sarking level.

MAKE THE RIGHT CONNECTIONS

IN TIMBER BUILDINGS, POST FOUNDATION, ROOFS AND WALLS MUST BE BRACED IN EACH DIRECTION.



• **ROOFS**
Hipped roofs are naturally braced, but gable roofs should be braced in the plane of the roof.

• **POST FOUNDATIONS**
Where posts are more than 3ft., brace both ways.

• **WALLS**
Walls should be braced across corners at plate level and at both corners of each wall.

MAINTENANCE

1. Experience and statistics show that the lack of maintenance is a significant contributing factor in damage to houses by hurricanes.

2. Regular maintenance is necessary in order to ensure that a structure continues to be hurricane resistant.

3. Check the entire house regularly inside and outside - to see if anything needs repairing or replacing, and fix it immediately.

4. The most important areas for regular checks are:

(a) Roof cladding for damage and fixings for missing screws or bolts.

(b) Roof structure; rafters and purlins for soundness.

(c) Joints and connections in timber and masonry construction for structural integrity and durability.

(d) Concrete blocks and slabs for cracks.

(e) For houses on wooden supports, check supports for rot, especially those below ground level.

(f) Check for termites and treat when evident. Obtain specialist advise for this problem.

Material for this Booklet compiled by:
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