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EFFICIENT AUSTRALIAN RELIEF SYSTEM NEEDS PRE-DISASTER BACKING

There is no question that the Australian reaction to tropical cyclone "Namu" which hit the Solomon Islands on 18 May 1986 was swift, generous and efficient.

Now that there is a demonstratively sound system for providing post-disaster relief from Australia to neighbouring countries, attention must be directed to stepping up programmes of assistance in disaster prevention and preparedness.

Australia's machinery for launching overseas disaster relief operations and coordinating governmental and non-governmental efforts is simple and effective. The Australian Development Assistance Bureau (ADAB) is responsible for policy and finance, under the Minister for Foreign Affairs. Operations, other than the mere donation of cash, are then executed either by the Natural Disasters Organisation (NDO), if government resources are involved, or by AODRO, if the mobilisation of community efforts is considered best. NDO and AODRO then work closely together to coordinate execution into an economical, efficient and controlled national response. The contributions made to cyclone "Namu" relief by the community through AODRO, in the form of material aid and a medical team of Emergency Workers, are described separately in this issue of the NEWSLETTER.

An efficient relief system is, however, not enough. The progressive reduction of losses by disaster prevention measures and a growing capacity to respond internally are more important in the long term to the developing countries in the South Pacific. In its submission to the Sub-Committee on the South Pacific of the Joint Parliamentary Committee on Foreign Affairs and Defence, AODRO said, on pre-disaster aid: "Here is a clearly-defined and firmly-declared need for assistance in an area with potential for vital impact on development. The way is open for thorough, sympathetic intervention by friendly neighbours, such as Australia."

Cyclone "Namu" had a devastating impact on the Solomon Islands, as have a series of exceptionally destructive cyclones in Fiji, Vanuatu and Tonga stretching back to 1979 and beyond. Action to halt future losses of this magnitude is urgent. The technology is available to make an immediate impact if it can only be focussed on the problem. Australia, in collaboration with the countries concerned, other bilaterals and the multilateral aid groups can help to achieve this if it so resolves.

[redacted]

Greg Reardon, and
Keith Eaton

[Greg Reardon is Technical Director of the Cyclone Structural Testing Station at James Cook University, in Townsville, North Queensland. Affiliated with the Department of Civil and Systems Engineering, the Cyclone Testing Station was established in 1977 as a joint university-industry venture. The Station is under the management of a committee which has members drawn from industry, government, building associations and the architectural and engineering professions. The principal activities of the Station are research and testing of building structures in high-wind environments, dissemination of information relating to design and construction of high-wind resistant structures, and the investigation of damage to buildings caused by cyclones and other severe winds.
Dr Keith Eaton is now Head of the Structural Design Division of the Building Research Establishment, UK Department of the Environment. As Head of the Overseas Division he dealt with the problems involved in the design and construction of low-income housing in areas subject to earthquakes and tropical cyclones. The Overseas Division of the UK Building Research Establishment helps the construction activities of developing countries by carrying out research and by providing information and advice.]

POST-DISASTER ACTION

On 3 March 1982, tropical cyclone "Isaac" hit the islands of the Kingdom of Tonga in the South Pacific. Damage to buildings and crops was extensive. On some islands in the central Ha'apai group more than 90% of the houses were damaged, many beyond repair.

On the main island, Tongatapu, where about two-thirds of the population live, there was extensive damage to villages on the north-west peninsula but not very much damage at Nuku'alofa, the capital. This was fortunate as it allowed post-disaster operations like the distribution of tents to alleviate the immediate problem caused by the destruction of some 2,000 houses, to go ahead.

At the same time as this operation was under way, longer term plans were being made by the Tongan National Office for Disaster Relief and Construction and the UK Building Research Establishment (BRE) for a reconstruction programme to build approximately 2,000 new houses, plus necessary school classrooms, in under two years.

The Tongan Ministry of Works and the BRE combined to design a cyclone-resistant house for this programme and the Cyclone Testing Station, at James Cook University, gave further specialist advice. A demonstration house was built, supplies of timber and building components were soon arriving from international emergency aid programmes, and before long new houses were being constructed.

The damage sustained by most of the houses during "Isaac" pointed to the lack of engineering input during their construction. As is often the case, the joints between structural members, particularly at the roof level, were generally inadequate. To prevent structural shortcomings like this it was decided that the rebuilding programme would include setting up a prefabrication yard to manufacture components which, after transporting to the site, would be erected under supervision. The 35 m^2 houses cost approximately $T 2,900 for materials, labour and transportation, of which the owners contributed $T 700. The balance was provided (by the supply of materials) by the Commission of the European Communites.

HOUSE CONSTRUCTION

The houses were erected on site by gangs of men from the Ministry of Works, assisted by additional local help - usually the future occupants and their families. Early houses were erected on solid concrete foundations incorporating tie-down hurricane bolts. This was modified after the first 100 houses had been built. Subsequent houses were constructed on suspended wooden floors to a grid of short pile stumps which were in turn cast into concrete footings. This system proved quicker to construct, was cheaper, and is preferred by the occupants as it is cooler.

One gang of five men was able to set-out and construct foundations for two houses per day. When engaged on house erection, one gang of five men was able to build two houses per week. Therefore it required six gangs (plus unpaid local self-help) to complete ten houses in a week. The whole task of building new houses to replace the 2,000 plus lost in Cyclone "Isaac" was completed in two years.

Simplicity was the programme's basic concept. The decision was made to have only one floor plan but suitable for later extensions by the owner. The plan is based on modular wall panels 2.4 metres long. Each panel has either a door frame or half a window opening, the latter panels being made either left or right handed to provide a full 1.2 metre window opening. The framework for the panels is 100 mm x 50 mm studs at 600 mm centres, together with top and bottom plates. They are clad externally with either plywood or fibre cement board. There is no internal wall lining. Roof trusses were fabricated with hammer-in-type toothed plate connections. They were attached to the wall panels using proprietary steel straps. Roofs were clad in corrugated steel sheets.

Details of the house design were in accordance with three New Zealand Standards:

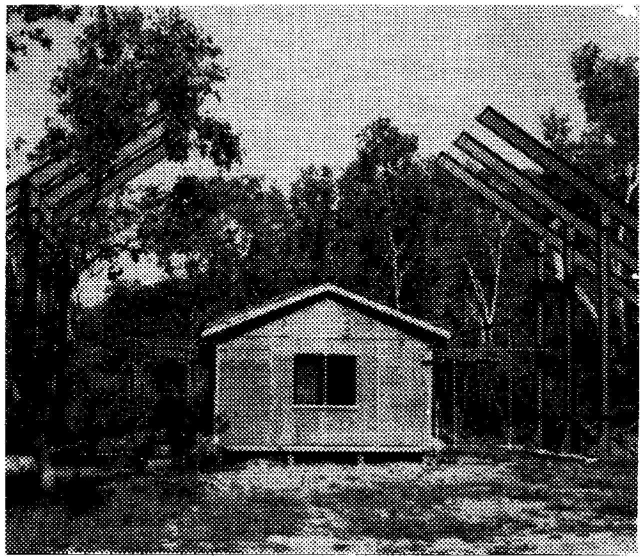
- NZS 3604:1978, Code of Practice for Light Timber Frame Buildings;
- NZS 3603:1981, Code of Practice for Timber Design; and
- NZS 4203:1976, Code of Practice for General Structural Design and Design Loadings for Buildings

The basic cyclonic wind speed gust used in the design calculations was 66 metres per second (m/s). With appropriate factors this gave a design velocity of 62 m/s and led to a net total uplift on the roof structure of 103 kilo newtons (kN, wherein 1kN = 100 kg force)) and a horizontal racking force at the top of the wall of 30 kN.

COMPLETED HOUSES

The Building Research establishment was aware that the Cyclone Testing Station at James Cook University had the facilities to conduct simulated wind load tests on full-scale houses. It was therefore suggested to the Tongan Ministry of Works that it would be invaluable to have a prototype house tested. By doing this, the strength of the house under simulated cyclone conditions could be determined and compared with the design loads. Furthermore, if there were any unforeseen weaknesses in the design they could be pinpointed during the test and modifications made to the houses in Tonga as necessary - before the next cyclone.

A collaborative project was set up by BRE and the Cyclone Testing Station, with financial contributions being provided by the Governments of Australia, New Zealand, Tonga and United Kingdom. The components of one house from the production line in Tonga (funded by the EEC) were shipped to Townsville and erected by the Tongan Assistant Secretary of Works, who ensured the construction techniques used to erect the house in Australia matched those in Tonga.



Tongan house being tested at James Cook University by staff of the Cyclone Structural testing Station. Construction techniques used to erect the dwelling matched those used in Tonga, and the building components were brought in from Tonga.

Forces were applied to the house and distributed so that they produced the same structural effects as the design loads. Uplift wind pressures acting on the roofing and lateral wind pressures on the walls were simulated by hydraulic rams operating a series of cables, beams and load spreaders. Transducers monitored the loads and deflections all over the structure. A programme of cyclic load tests were conducted to simulate the continual buffeting that a house receives during a tropical cyclone. For the roof uplift, 8,000 cycles of 5/8 design load were applied, then 2,000 cycles at 3/4 design load, then 200 cycles at design load. For the wall racking, 1/10 of the number of cycles at each level were applied. At the completion of this sequence both uplift and racking loads were increased in stages until failure occurred.

During the cyclic tests, some of the light steel straps used to tie the roof trusses to the walls failed, basically because the straps had been weakened by the cyclic test loading. At this stage it was decided to improve the roof/wall connection by inserting a batten on the trusses over each wall and bolting through to the wall top plate. This method was chosen because it could easily be incorporated into those houses already erected in very exposed locations in Tonga.

Testing was restarted and the modified house sucessfully resisted the sequence of cyclic loading that simulated a four-hour tropical cyclone with wind gusts up to a design velocity of 62 m/s. The house deflected significantly during this time and some joints broke, but the structural redundancies in the system allowed the unit to maintain its integrity. Ultimate failure of the system was caused by a facture of the top chord of a truss, at 1.3 times the design uplift and racking loads.

OUTCOME

Tropical cyclones are not new to the Kingdom of Tonga. Over 100 cyclones have affected the country in the past 160 years. Cyclone "Isaac" might not have been the worst occurrence, but it did create several hours of strong winds, heavy rain and storm surge which caused six deaths, injured about 150 people, left thousands homeless, polluted water and destroyed food crops.

The project outlined here was an excellent example of the application of research work to alleviate the suffering caused by the disaster. Furthermore, it demonstrated the benefit of carrying out a collaborative programme at more than one institute, and proved that a combined input from several countries could, literally, pick up the peices after such a storm and put people back in houses. All this was achieved in a relatively short time-scale with the willing co-operation of the Tongan Government.

The subsequent opportunity of taking one of the post-disaster houses and subjecting it to full-scale tests is, as far as is known, a unique situation. The tests demonstrated an unexpected weakness in the design which was notified to the Tongan Ministry of Works, with the recommendation that some strengthening may be needed in exposed locations. But the main success story of the tests was the overall capability of the unit under a cyclic loading regime, simulating the effects of a tropical cyclone, to give a final failure load of 1.3 times the design value.

The Building Research Establishment and the Cyclone Testing Station have collaborated on building design in cyclone areas for many years. Further knowledge has now been gained from the Tongan project and advice can be given in other cyclone-prone countries, particularly elsewhere in the South Pacific. In fact the people of the Solomon islands, recently devastated by cyclone "Namu", may be able to gain significantly from the Tongan experience. They could use the expertise developed within the Tongan Ministry of Works to assist them to establish a similar reconstruction programme. If necessary, some features of the Tongan house could be altered to suit the architectural style of the Solomon Islands, but the basic structural details would still be incorporated. This would avoid the need for designing a series of buildings to virtually the same criteria as used in Tonga and result in a more rapid solution to the acute housing problems of the Solomon Islands.

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