

# **GIMME SHELTER: TSUNAMI MITIGATION AS PART OF A PERMANENT SHELTER PROGRAM FOR ACEH, NORTH SUMATRA.**

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## **Abstract**

The resulting housing solutions developed for permanent shelter as part of aid packages and reconstruction often belie the complexity of their resolution. This paper briefly outlines the often hidden subtleties in such designs and in particular the complexity that “mitigation” can require. Mitigation is the accepted “notion” that any reconstruction should address former issues by reducing those perceived problems and issues. The hope is that they can be completed eliminated so that the disaster does not happen again. This may not always be achievable.

The development of a permanent shelter reconstruction program for the United Nations High Commissioner for Refugees (UNHCR) for tsunami victims on the west Coast of Aceh, North Sumatra is documented. And in this program the obvious mitigation need was for “tsunami proofing” of housing. Drawing on the tsunami report by Wilkinson, the paper highlights the process, design and planning considered as part of this mitigation and the practicalities of “balancing” the wishes of people to return home to sites ravaged by the tsunami against the responsibility to ensure “safe” housing (Wilkinson, 2005). The starkness of the engineering “numbers” against the social costs is compelling and the paper highlights in practical terms the difficulties sometimes faced to reduce and thus “mitigate”.

*Keywords; Tsunami, permanent shelter, safety, mitigation.*

## **DEVELOPMENT OF A PERMANENT SHELTER STRATEGY**

The development of any shelter program requires answers to three main questions:

“What” do we build?

“Where” do we build?

“Whom” do we build for?

The first question of what to build was addressed by a spatial survey of low cost housing in Banda Aceh (USAID 1996).

### **A SPATIAL SURVEY OF LOW COST HOUSING IN BANDAR ACEH.**

The need to recognise local standards and norms into any proposed house design was understood by all the NGO's and UN Agencies involved in permanent shelter in Aceh (Fox 2004). However, there was not full agreement on how that should be achieved. Our approach was to initiate a spatial survey of low cost housing complexes in Bandar Aceh. The aim was to ensure that whatever the house design the size and scale of the house was comparable (and preferably slightly less) than existing low cost houses. Otherwise, provision of "better" housing to tsunami victims could generate long term jealousies within the community. On the other hand it is debatable that the provision of a "mortgage" free house (when those living in Government low cost houses were often paying it off over 20 years) would not generate such jealousies nonetheless? This dilemma could never be resolved short of not helping those in need. And consequently, the integrated programs (housing together with schools, roads, water sources, mosques, health clinics etc) had to be managed so that existing communities also felt that they were "benefiting". This was never going to be simple.

Over 30 such housing complexes were reviewed and it was noted that an Acehese house had the following four main "zones" with the following typical dimensions and areas:

- Porch area 4.00m<sup>2</sup> and average dimensions of 2.61m by 1.43m.
- Living/ lounge area 14.26m<sup>2</sup> and average dimensions of 4.68m by 3.03m.
- Kitchen 10.09m<sup>2</sup> with average dimensions of 3.78 by 2.54 metres
- Toilet/bathing area 4.31m<sup>2</sup> with average dimensions of 2.28 by 1.84 metres.



Figure 1: Low Cost Houses for Hospital, Police and Government Workers.

Low cost houses typically had two bedrooms. But the inclusion of separate bedrooms into the UNHCR proposed house was abandoned in favour of one common living area or lounge area. Families would initially live in the living/ lounge area and subsequently extend the house to suit their requirements. This subtle but important design aspect was not well understood but can be understood when one considers the family

demographics. For example, if the family consisted of one set of parents and children of the same gender then a two bedroom house would “fit”. However, if the children were of different genders or if there were grand parents staying in the house as well then a two bedroom house would not be sufficient. Who would “sleep on the couch?” Moreover, the “two bedroom house” design did not lend itself to modification. Thus, for the latter family not only would someone be sleeping on the couch but the family would be helpless to easily alter the house to better accommodate the family. Such a situation is unsustainable from several points of view and hence the development of the core house concept.

The size of the core house would vary by changing the length of the lounge area (while holding the width of the house) for different family sizes as follows:

Family size up to 4 people	3.2 metres length of lounge area
5-7 people	4.8 metres length of lounge area
8-9 people	6.4 metres length of lounge area
10+ people	Special design.

It is interesting that the above dimensions were based on the logistical requirements for the corrugated iron. In Indonesia the thickest corrugated iron sheet is 0.4 mm thick (compared to the thinnest section of 0.55 mm used in New Zealand). When stacked sheet lengths longer than 1.8 metres can not be lifted with a fork truck without buckling and consequently this is the maximum sheet length. Allowing for roof angle and sheet over lap results in a working plan dimension of 1.6 metres and hence the above room sizes. Failure to recognise this would result in excessive (and unnecessary) wastage.

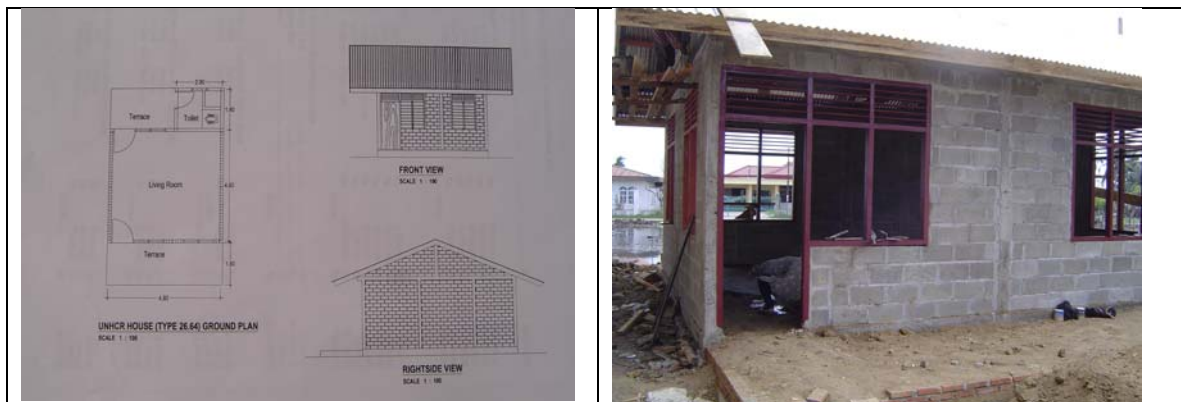


Figure 2: The UNHCR Permanent Shelter House or “Core” House

An Acehnese house (much like many South East Asian communities) actually has two kitchens. One is a “dry” kitchen and the other is a “wet” kitchen. Unlike many “western” households where food such as chicken arrives frozen ready for storage and later cooking. In an Acehnese household the food arrives “alive” and for example chickens would need to be killed, plucked and cooked. All this would be completed in the “wet”

kitchen with the cooking of rice and eating meals being done in the “dry” kitchen. The “core” house only provided the “wet” kitchen which was also the case in many modern low cost housing complexes reviewed.

From this work evolved the UNHCR “core” house drawn and photographed in figure 2 above.

### **HARMONISED PERMANENT HOUSE DESIGN FOR UN AGENCIES AND NGO’S**

An agreement was also reached between the UN Agencies and NGO’s in Aceh involved in permanent shelter regarding house specifications. This agreement was intended to eliminate (or at least minimise) any significant differences between the housing aid programs offered by the different agencies. The following was agreed:

- Houses would have concrete floor
- Houses would have a corrugated iron roof
- The house cladding material was left up to each Agency.

The final decision of the cladding material was left to each Agency in developing their permanent shelter program. At the time it was felt that specification of the cladding would result in a “monotone” housing landscape. Moreover, there were several competing values associated with the selection of the cladding material and together with a lack of site resource information made any such selection premature. These competing values made any selection complex and the selection of the cladding material for the UNHCR house is discussed in more detail later in this paper. That aside, this agreement was a major achievement and one that was particularly appreciated by those NGO’s with large programs.

### **THE SELECTION OF THE HOUSE CLADDING MATERIAL**

Three locally used cladding materials were identified namely:

- Timber
- Concrete Block with grouted infill
- Brick with a concrete frame.

Examples of these (taken from the Spatial Survey) are shown in figure 3 below. Other options such as styrene foam boards, rice board, bamboo and rammed earth were not considered as it was felt that the use of non local materials could be easily rejected by beneficiaries despite any “technical” advantages.

However, such options were not discarded completely but because of the complexity of the issues involved it was felt that further complication with a new material would not be advisable. Consequently, only these three options were studied.



Figure 3: Local Cladding Options for Low Cost Permanent Housing in Aceh

The complexity of what is apparently a straight forward issue can be gauged from table 1 below. Many do not understand the “balancing” process involved in selecting cladding nor the process and design of shelter let alone permanent shelter. Nonetheless, this has to be done and initially because of cost it was felt that the cladding selection tended towards timber but with the proviso that availability be confirmed at each location. This was countered by the need to complete a sustainability evaluation and the need to ensure that a sustainable harvesting scheme was adopted. There was a concern with the perceived quality of timber over the other two hard surface materials. This was confirmed both by UNHCR’s spatial survey of low cost housing in Bandar Aceh and by national construction figures obtained from BPS (Indonesian Government Statistics Department) that 95% and 94% of houses had hard surfaces. This was countered by the traditional wooden house (more common in rural areas) and the feeling amongst UNHCR national staff in Bandar Aceh that if you did not have a house than any house was a better option. Thus, in the initial stages timber appeared to have potential advantages over the other two options.

This was followed by intense concerns based in part around the East Timor Shelter program experience that the selection of the cladding (and the complete permanent shelter solution) was largely a question of logistics and procurement (UNHCR, 2001). The impact of at least the logistic issue can be seen in the number of 40 kg bags of cement that are required for each of the housing types. A timber house requires 25 bags while a concrete block house requires 100 bags (4 times that of the timber house) and a brick house requires 150 bags (6 times that of the timber house option). Given that corrugated iron and cement would be the two “bulky” and heavy items to be potentially transported to site underlines the impact of the above figures. On the face of it this would appear to also favour timber but the difficulty of grading, quality control and procurement meant that timber also had a down side.

Table 1: Competing Issues for Different House Cladding Options

Issue	Timber	Concrete Block	Brick with a Concrete Frame
Cost <sup>1</sup>	19,000,000 Rph	22,000,000 Rph	26,000,000 Rph.
Cement Usage <sup>2</sup>	25 bags each 40 kg	100 bags each 40 kg (not including cement in concrete blocks).	150 bags each 40 kg
Building Expertise	low	high	High
Quality Perception	Lower quality material	Higher quality material. 94% of buildings have "solid" walls.	Higher quality material. 94% of buildings have "solid" walls.
Material Life	2-5 years	30+ years	30+ years
Specification Issues	Highest. Previous experience suggests issues of grading, source, durability and problems with	Medium. Skilled trades people required for concrete and block laying	Medium. Skilled trades people required for concrete and brick laying
Capacity Building	Good	Better	Better
Seismic Design	Light seismic loads and better seismic performance	Heavy seismic loads and the need for specific seismic design and detailing to achieve acceptable seismic performance.	Heavy seismic loads and the need for specific seismic design and detailing to achieve acceptable seismic performance.
Construction time	1.-2 weeks	4 weeks	4 weeks
Sustainability Issues	Deforestation and potential erosion	Embodied energy and source of materials	Embodied energy and source of materials
Thermal Properties	Fast to heat and cool	Slow to heat but slow to cool	Slow to heat but slow to cool
Material resources at site	Timber is anticipated as being available in Lhoong and Lamno areas. Confirmed availability in Calang/Krueng Sabe but is not expected to be readily available further south in Teunom	Sand, aggregates and stone are available in Calang/Krueng Sabe and are anticipated to be available in Lhoong and Lamno but is not expected to be readily available further south in Teunom	Suitable clay materials for bricks could be expected between Lhoong and Calang/Krueng Sabe but is not expected to be readily available further south in Teunom.
Tsunami debris generation.	high	low	Low

Notes 1: Based on Bandar Aceh prices (March 2005) with no ceiling or painting and no plastering of the concrete block and brick options.

2. This does not include the cement required for the concrete block production.

Those with experience from earlier shelter programs both in Indonesia and Sri Lanka were strongly suggesting the use of light gauge steel sections and the use of hard surface materials.

Work by UNHCR's Tsunami/Coastal Protection expert pointed to the need for the reduction of debris and that timber houses within any potential tsunami zone (within 3.5 kilometres of the shore line) should be restricted or preferably eliminated (Wilkinson, 2005). The presence of timber not only doubles the tsunami loads on other buildings (by increasing the "density" of the water flow) but also creates "projectiles" within the tsunami itself that increases any death toll.

From this apparent melting pot developed the view that the paramount issues for the cladding selection were the following:

- The quality of the material
- The durability of the material
- The perception of timber being an inferior material.

And despite logistical and cost disadvantages the house cladding material should be concrete block.

The selection of concrete block over brick was made not only because of cost (though this appears to be significant itself) but because of concerns relating to structural integrity, thermal comfort, weathering and constructability. In all these areas concrete block has advantages (though at times marginally so) over brick but taken overall these constitute a definitive preference.

## **TSUNAMI PROOFING**

It was accepted by the humanitarian community that the issue of tsunami design should be addressed and that new houses should be have better "tsunami proofing" where previously there was none (Molin-Valdes 2003). The first suggestion by central Government was to build houses outside a "green zone" of 3 kilometres from the shore line. This was decisively rejected by the local authorities in Aceh. Moreover, victims had already started moving back to their original house sites and had started erecting temporary shelters. Thus aid agencies were faced with the dilemma of assisting victims to rebuild in areas that were clearly tsunami risks. And it was anticipated that a smaller tsunami wave than the 10+ metre event that occurred on December 26 2004 would be sufficient for design. The assumption was that the December event was "rare".

However, expert advice was that this event was not rare and had a return period of once every 100 years (Wilkinson, 2005). It was in effect the engineering design event. Moreover, the Wilkinson report also stated that in the next 30-40 years that the return

period of a tsunami in the area was of the order of 1 in 35 years. To make matters worse, the report also concluded that an early warning system would not work for the habitants along the west coast of Sumatra (including Banda Aceh) and thus other options had to be investigated. These options were as follows:

- Safe haven (natural)
- Safe havens (constructed)
- Moving people away from the coast

Though there was a 15-20 minute time lapse after the earthquake before the tsunami came a shore, 10 minutes of that time was taken up by severe ground shaking. People could not move. Consequently, the “evacuation” time was as little as 10 minutes and based on this it was estimated that any safe havens would have to be no further than 250 metres away from houses. Unfortunately for most (if not all of the west coast area) this meant that there were minimal natural safe havens such as hills. And those safe havens would need to be constructed. Moulds were quickly deleted from any further considerations. Besides being 10+ metres in height to match the tsunami they also had to be another 15 metres to protect against the tsunami run up. Cost and space simply made such an option impractical. Steel frames were also considered but again would be required at 500 metres spacing in village areas and would have to be designed for the full tsunami loads which would have been in the order of 50-100 times the required code seismic loads. Housing budgets would be taken up quickly by such structures.

And there remained the issue of early warning. Certainly one could evacuate at every earthquake but not every earthquake will result in a tsunami.

Thus, the conclusion was that people would have to shift to higher ground. And this was the position of the Wilkinson report.

Unfortunately, in almost all the areas along the west coast the Indonesian Government and Local Government confirmed that there was no land to move tsunami victims to. And more over people did not want to move away from their original sites and their associated (but diminished) communities. Thus, at least in the immediate future moving was in most (if not all) cases not possible. (And moreover, would quickly out price itself if land purchases were to go ahead).

Thus the conclusion for many of the tsunami victims was that they would suffer a similar event potentially within the next 40 years. And the consequent dilemma for aid agencies was should they assist by building new homes back on tsunami risk sites?

It was clear that mitigation against the tsunami, despite good intentions was not feasible. And as noted by Quarantelli people in such situations faced by a “... lack of data and inadequate preparedness of citizens has led residents to respond in the only way they thought they could save themselves – prayer. In a survey of two coastal



communities in Bangladesh struck by a cyclone, it was found that “praying to Allah” was undertaken by 73 percent of residents in one village and 90 percent in another. In both localities, it was the most frequent precautionary measure taken” (Quarantelli 2002).

## **CONCLUSION**

This shelter program (and others) has been described as constructing thousands of “garages”. And while on the face of it this is correct such a comparison belies the complexity of such shelter programs. A complexity that required both spatial surveys and detailed analysis for the cladding selection.

Moreover, when this is combined with the need to “mitigate” further highlights the complexity of such an apparently “simple garage”.

And what about building houses back in tsunami risk areas? The decision to put Indonesia nationals back into risky situations is one that no agency should make and the decision must rest with Indonesian Government (or its representative).

Shelter programs are complex and sometimes the option to mitigate is not possible. This is disturbing.

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