Notes from experience in post-earthquake rural housing reconstruction in Pakistan.

Presented at Building Back Better workshop, Beijing, China, July 2008.

This document was originally a powerpoint presentation mainly of photographs.

The written text is a record of the verbal presentation, not prepared as a written paper.

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Owner driven housing

'Owner driven' housing is an iterative programme.

Pakistan

The reconstruction of rural housing in Pakistan after the Kashmir earthquake of 2005, represents a large scale implementation of the 'owner driven' model. After earlier development in Gujarat and post tsunami, the implementation in Pakistan faced new challenges of harsh climate and difficult terrain. Addressing these difficulties and additional problems like landslides, hazardous sites, material shortages, monsoon rains, on a frequent basis meant this had to be a flexible, responsive programme.

Crisis can also mean opportunity, and the rural housing reconstruction programme in Pakistan can also show how flexibility and responsivenes meant local potential was recognised and endorsed, skills developed, relationships forged and solutions devised on an ongoing basis.

We want to discuss how this programme evolved, what 'owner driven' meant in this programme, specifically in the context of buidling standards and construction techniques.

What does Owner Driven mean?

We have heard about 'owner driven' programmes for housing reconstruction, but are we clear what the owners are driving?,

Are they only driving construction as contractors, or are they also driving standards for example?.

If the owners are driving, can they drive the Government?. Can they drive policy or implementation needs?.

How does this happen?. What mechanisms are required?

In an 'owner driven' programme, what is the role of technical support, including professionals like engineers?.

Owner driven housing

The observations and notes presented are based on fieldwork over the last 2 and a half years as technical support partner to the Government of Pakistan's Earthquake Reconstruction and Rehabilitation Authority. (ERRA)

Rural housing reconstruction has been a very successful programme in terms of both completion rate and the widespread adoption of safer construction techniques.

Key to the success of this programme has been the fact that owners were responsible to construct their own houses, generating the momentum needed to achieve such a huge task in very difficult conditions. This momentum has also been problematic as households took initiative to reconstruct faster than information or the limited technical support could reach them. Overall owner responsibility to meet standards has resulted in a broad based awareness and education and the development of a new building culture.

There have been shortcomings in the Pakistan implementation, including overstretched resources for technical support, delays in the adoption of standards, and quality control issues, all of which should be reviewed in order to improve next time.

There have also been successes, including the evolution of a dynamic iterative process, both top down and bottom up, the balance of which was vital to optimise both the result and the process, to mitigate frustration and to ensure resources are used effectively.

There has been an active system of monitoring and reporting issues from the field back to policy makers and those responsible for standards, and a practical, problem solving approach from the Government to address those issues and enable solutions back at field level.

These successes should also be reviewed in order that key factors like the iterative and responsive character of the programme can be understood for the future.

The progress in rural housing reconstruction in Pakistan has been remarkable, less than 3 years after the earthquake, people visit the area and ask "where was the affected district"?. Over 170 000 damaged houses have been repaired, and almost 400 000 of the 450 000 completely destroyed have been replaced with new houses. The progress has been all the more remarkable considering the time constraints caused by snow bound winters and monsoon rains in summer.

Rural housing is over 90% of the building stock and affects almost every family. Recovery in housing is an important step in recovery for the whole community, socially and economically.

Construction in transition

Kashmir

The area affected by the Kashmir earthquake of 2005 is very remote, but Kashmir is also densely populated, highly literate and with modern aspirations.

People have a picture of remote, rural mountainous regions as built of local materials, heavy stone walls, deep timber beams and mud roofs. This is a true picture and most houses of this type collapsed easily in the earth-quake.

Construction in transition

Transition

But this is not the full picture.

Like many countries across Asia, rural Pakistan is a landscape in transition, and a high proportion of buildings before the earthquake were also reinforced concrete frames, with block or brick, multi storeyed and with flat slab roofs.

The widescale destruction in 2005 affected not only the old building types, but also the new. This is a fact easily and quickly forgotten, as engineers devising standards for reconstruction tend to reject local construction as inherently poor and regulate towards reinforced concrete, as inherently stronger.

The reconstruction of housing in Pakistan is a story of old materials and skills, and new materials and skills and the transitions in between. In this transition there are choices about the use of previous techniques and the level of promotion of new techniques and complex situations for providing technical guidance.

Reconstruction can involve rebuilding the same risks as people rebuild out of need based on what they have and what they know. It also involves the construction of new risks as people construct approximate versions of new standards and mixtures based on both old and new materials and practices.

This paper is not about specific standards. There is enough knowledge and experience, national and international codes for both engineered and non engineered structures. It is important to be aware and make use of this knowledge, and make early decisions about appropriate and agreed standards particularly for new conventional construction, but standards alone will not provide all the answers.

All areas and communities have their own specifics, conditions, traditions, needs, aspirations and opinions that must also be considered as factors. The consideration of this context is the first step in an iterative process.

When people rebuild they do not start in a vacuum, they start from existing materials and skills. If a programme is going to be owner driven, then it is important to know where the owners are starting from, to predict what they may do, and to understand and meet their needs for technical support.

Start from the evidence

Start from standards, but also start from the field evidence.

Assess the materials available, both salvage, locally available materials, their quality, transport and other factors and assess the skills available, through discussions with contractors, masons, and also through looking at the buildings themselves.

Most importantly at this stage, diagnose which types of construction performed well, and why, and which buildings did not and why. This activity should happen as early as possible before clearance of debris or repairs are carried out.

This is a lesson for the technical community and relief community all of whom arrive into disaster areas with answers and references, but less with their eyes open.

They are expected to already have answers rather than seek them. Seeking them means looking at the evidence, and listening to what people have to say.

Engineers like proof, that a given specification and design will perform adequately in an earthquake. They believe in and rely on their calculations. Ordinary people also want proof and reassurance. For those who have experienced a major earthquake this desire is a natural one. The most accessible proof is to look at how buildings performed, to see what type of damage occurred and understand why, to see what performed well and understand why.

This is the opportunity to investigate any local construction techniques on evidence as they are extremely difficult to evaluate by calculation; they may be the basis of good options for reconstruction and will be popular if they are already known and affordable.

It is also the opportunity to identify common shortcomings as all previous mistakes are likely to be repeated. If diagnosed in time, training and information can target and redress mistakes.

Start from the evidence

Technical assessment and diagnosis needs community involvement, particularly to find and visit buildings that performed well in areas of otherwise heavy damage.

Assessment also needs engineering experts, who can read and interpret the evidence.

Field assessment provides an invaluable opportunity for people to get explanations, to gain understanding, before the rubble is removed and people make the same mistakes again. It is important for the community to take part in the diagnosis, to be part of recognising the failures and devising the solutions rather than simply waiting for standards to be issued. It may also mean that the standards are more appropriate and acceptable.

Technical experts will need skills and resources to work with the community in this way. It is a critical learning opportunity not only for the community but also for the engineers, and student engineers, and if the fieldwork is limited, at least ensure a comprehensive documentation of damage and building performance and access to this documentation by the technical professionals.

It is important to engage with house owners and all other clients, masons, and contractors, to ask what they would like to do, what they are planning to do, to anticipate their preferences and needs. This should start from an early stage and be an ongoing process, with structured collection and analysis of the information. It is vital intelligence to inform policy and technical support.

Local solutions

The potential of local solutions:
Dhajji Dewari infilled timber frames.

This is again the local house type. It is made of stone, timber and mud. The walls are not tied, the roof is not connected to the wall, the entire building is very heavy.

These houses generally pancaked in the earthquake, leaving large quantities of stone and timber as salvage.

The second picture is another local house from before the earthquake, also made of stone, timber and mud, but the building is lightweight with thin well braced walls. All of these houses performed well.

This is a local type known as Dhajji Dewari, (meaning patchwork walls). It is found in India, Pakistan and in areas from Turkey to Portugal to South America, it has evolved as a building type economical with materials and resistant to earthquakes.

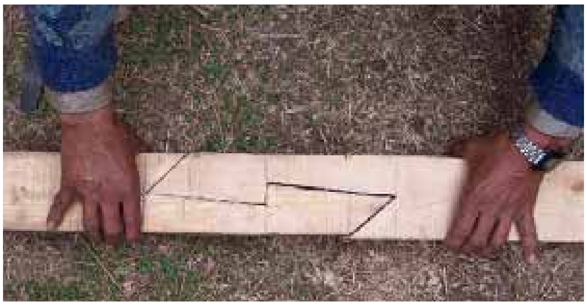
The third picture of open framed house was photographed in November 2005, a few weeks after the earthquake, the owner is a carpenter and he had decided already to recycle the materials from his heavy old house into a timber frame before the winter. The corrugated iron roofing sheets were donated to all families for winter shelter as Government policy and encouraged many people to move from flat to pitched roofs.

In high and remote areas the community began to replicate the Dhajji timber frame house. For local families, evidence of excellent performance by all pre earthquake Dhajji timber frame buildings, and the fact that they had the materials, skills and tools to use them, was enough to convince them.

The Government of Pakistan, has over the last 2 years, responded to these local solutions, formally adopting a range of local techniques based on comprehensive engineering evaluations. This has increased the range of construction options for people especially in remote areas where local materials are the only affordable choice. The local techniques endorsed include Dhajji braced timber frames and timber reinforced masonry (Bhatar).

The process of adoption of these techniques was slower and more complex than necessary, due in part to the technical community not investigating early enough and due to the complexity of arbitration of standards. Incremental expansion of standards has frustrated some, but the opposite situation of having too rigid standards would have caused even greater frustration. The solution may be to investigate and devise the options as early and actively as possible and as an ongoing process.

Local solutions



Those of us involved in technical support for housing did not need to do much to promote timber frame, people took it up themselves, using the same materials they had as salvage. After official endorsement it has spread rapidly and widely in areas even where it was not known, as the materials and skills are familiar enough to adopt.

Our role has been to identify and advocate for this option and other local seismically resistant techniques, to investigate its potential in close partnership with local artisans and the engineering experts. This involved documention, consolidation and promotion understanding of the technique and best practice including joint detailing, and development of appropriate tools for training and information. We did not import Dhajji timber framing into the area, it was already there, but it could easily have been lost rather than revived, as happened due to the status accorded by the Government of Pakistan.

Before the earthquake Dhajii timber framing was a little known tradition with less than 5000 houses remaining, now there are over 100, 000, built at a fraction of the cost of new materials and with a significant reduction in building vulnerability. It has also regenerated local skills, and is preferred not only by lower income families but also by many with the resources to build very large houses.

In a globalising world of reinforced cement concrete, this is an environmentally sustainable, affordable solution for housing. We are losing local construction knowledge as rapidly as we are losing ecosystems and local languages. We cannot afford to lose this knowledge, it has evolved over centuries and without it we would have fewer answers to real and current problems.

A system of standards has to find a way to be open to incorporate this type of knowledge and a system of regulation needs to find a way to respond to endorse solutions not generated by the engineers, but generated by the field.

Relearning local skills

Understanding field practices.
Through stones.

Poor building performance is caused by loss of traditional skills, and by poor execution of new technologies. Both need to be addressed through training in reconstruction.

In Pakistan most skilled masons know about 'through stones': using long stones acrpss the wall to make the wall stronger by tying the masonry of both faces together. The abandonment of this practice for the expediency of using dressed stones only on the outer face and filling the centre of the wall with small rubble resulted in numerous cases of delamination and failure of walls.

Masons needed to relearn the purpose and importance of this practice, through visiting damaged buildings to diagnose the problem, and ensuring all new masons learned the skill as key. Just as importantly, the clients, house owners needed to learn about through stones to be able to appreciate that good detailing in masonry or in timber joints for example is important in quality control, often making the difference between buildings performing well or building failure.

Adopting new materials

Concrete Blocks.

The greatest change in preferences after the earthquake was from flat roofs to pitched roofs, the next greatest change was from stone to concrete blocks.

This was due to a combination of factors, including fear, but also the high cost of masons, the lower level of skill required to lay blocks, high transport costs, and high costs for mortar.

Concrete block production started rapidly and widely the first spring after the earthquake, with small businessmen investing in machines and starting production from local materials. They often had no experience or understanding of block production. Variations and shortcomings in mix and curing has affected block quality. Customers were equally inexperienced in judging quality and purchased mainly on price.

It is a key role of government to guide and regulate quality control for building components like blocks, through spot checking and testing, issuing specifications for purchasers, etc.

Sample surveys carried out in the first winter indicated that a large number of households planned to construct in blocks, but this information was not systematically collected or acted upon, to anticipate the need for controls, guidance for producers or customers or to supplement supply pipelines for materials.

Moving from old to new

Transition: Timber posts in blocks.

The move to concrete blocks from stone walls, sometimes represented a partial change in technologies. A number of households who started reconstruction early with new concrete blocks re used their previous method of timber posts built into the masonry to hold up the roof.

In stone construction the width of the wall is usually around 15 to 18 inches, and the stones are interlocked around the posts. The post is protected from the weather and the wall has some limited integrity as masonry.

When a timber post is used in new narrow concrete block construction the post is now exposed to the weather, there is no interlocking of the masonry and the post actually separates panels of masonry, so there is no connection of one wall to the next. This is extremely vulnerable construction as the panels are essentially free standing and can easily fall over, there are no bands tying the walls together and the vertical posts have no anchorage.

Why do people use timber posts?.

The reasons are many: they had used timber posts for a thousand years, timber posts were available in the salvage, to many people the posts seemed just as strong as steel bars as vertical reinforcement, and in phased reconstruction the priority for many was to erect posts first to get a roof overhead and the walls could be built later when time and resources allowed.

All of these reasons could have been anticipated and understood through early diagnosis and discussions with houseowners and masons, and measures taken in training and information campaigns.

Introducing new standards

4 bars are better than 1?

The initial reinforced masonry standard promoted by the Government was to use steel reinforcement, single bars at 4 ft centres.

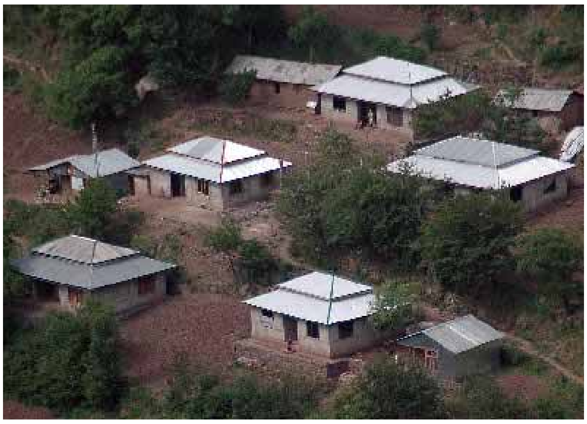
Many people said they didn't believe a single steel bar that can wave around freely when you bend it, could be strong enough to reinforce a house.

So, although the required standard was single bars, over 80% of people decided that they preferred to use 4 bars at the corners and junctions, increasing the amount of material and the cost, and all based on the owner's perception.

This does provide additional vertical reinforcement, but brings us to a new problem, the building is now a semi-framed structure. The walls may not be connected to each other, or to the columns.

New details, standards and information are needed for this construction technique, it is no longer reinforced masonry, but confined masonry. It is also not an engineered reinforced concrete frame and has limitations which must be adhered to.

Approximate standards



Its not only about the costs.

An iterative process is necessary to identify and respond to defects and mistakes.

Generally in Pakistan, people have tried to meet the standards, both to ensure compliance and eligibility for financial assistance and also for the safety of their families.

Here is a house: there are too many openings, it could be better. Is there anything else wrong with this house?.

There is vertical reinforcement, there is a band at plinth, lintel and roof level.

But look closely at the steel in the roof band.

The bars meet at the corner, they do not turn the corner. The band does not tie the two walls together, and it is not restrained, the band is not doing its job. A band should be like a belt tied around the building, and a belt is no use if it is open. Strong corner reinforcement is most important.

This pattern repeats itself across a number of sites. Despite the owner paying for the steel, the steel fixer does not understand the principle. This building is very unsafe.

Approximate standards

Approximate reinforced concrete detailing results in heavy damage or destruction. Consulting engineers continue worldwide to specify steel reinforcement and concrete for earthquake areas, but the gap between the specification and the execution on the ground must be understood in terms of the available skills capacity and the anticipated safety of the end result.

The supply of materials can be solved, the supply of labour can be solved, but developing understanding of new techniques is a complex and slow process.

The understanding of the chemical processes in concrete and correct placement of steel, all require supervised instruction and experience. Globally there are columns without anchorage, concrete mixed at 1: 10, and poor curing. This is approximation to standards, sometimes executed by people who know better, but more commonly by people who have had ad hoc training or experience and are unaware of the consequences of approximate standards.

Reinforced cement concrete buildings are sensitive to errors and if calculated or constructed incorrectly they can be extremely vulnerable. This is an issue fully understood by many of the engineers specifying reinforced concrete, but not necessarily understood by the clients, or builders who often believe concrete and steel represent progress and are inherently strong and safe.

In Pakistan we diagnosed the corner reinforcement shortcoming from the damaged buildings and in new construction, and focus on demonstrating the correct corner detailing, providing drawings, sample corner steel stitches for replication, or providing trained steel fixers to give practical advice on site, following up information with explanations.

In terms of technical support, this example shows the importance of communicating not only standards but principles. Standards can be learned, but without principles those standards will not be understood. The standards say steel must be provided of certain diameter at certain levels in the wall, the principles say the band is to tie the building together.

Remedial Measures

And if its too late?.

If there is no band or if the band is inadequate, it is possible to improve the performance of the building?.

An external band of wire mesh as developed in Gujarat or of steel can easily be fitted to block or brick masonry. This may be the single most useful contribution to improving the building, it limits out of plane bending and ties the walls together at the top where they are more vulnerable.

In areas where this problem was common for previous or new buildings, we have promoted an external band.

We provide a mason, carpenter and steel fixer to demonstrate the work and to train additional labour on one house. The objective for our team is not to carry out this work as a contract, but to leverage other households with similar defects to do the same work.

Despite a slow start and scepticism, we are now finding that for each demonstrated remedial measure around 20 house owners copy this measure, some in order to pass final inspection and be eligible for the final payment, but a large number of others are now adopting measures simply to improve the safety of the building.

The Government of Pakistan acknowledged from an early stage the need to devise solutions for households who have constructed without meeting the standards. They have tried to ensure such households can potentially achieve compliance and receive their final payment, as well as achieving a better safety standard.

The greater majority of houses not meeting the standards are those who started early, before standards were confirmed and before information and technical support could reach them, often in high and remote areas. The housing reconstruction policy is based on equity, equal financial assistance, and equal access to technical support. The focus on remedial measures has been based on delivering technical support retrospectively to ensure this principle. It also helps ensure access to the full financial assistance by many families of lower income for whom the Government financial contribution is more critical.

The diagnosis of defects has been based on feedback from building inspection, from those providing technical support and monitoring and by technical evaluation teams in the field. While new correct construction is the priority of all information and training campaigns, the development of capacity among engineers and artisans to understand and execute retrofitting works is equally important.

The development of remedial options has been iterative with design engineers proposing solutions which are then tested and refined on site for practicality, cost, and acceptability before rechecking, approval and promotion as retrofitting standards.

These are standards and must be addressed like other standards.

Standards and preferences

Adjusting standards to preferences?.

Standards generally come from the top down, but preferences come from the bottom up. How do they meet?.

Large rooms.

In line with all common earthquake codes, we have advised people not to make large rooms. The maximum size advised in Pakistan is 15ft by 15ft. When people made larger rooms, we advised them to provide a cross wall.

What we didn't understand was that they want and need a large room for social purposes, and for shared use in the winter. Instead of adjusting their lives to the engineering, we needed to adjust the engineering to their lives.

There is of course an engineering solution to larger rooms, and we should have anticipated the need earlier, rather than assuming engineering overrules people.

Engineers as facilitators

Our engineers are not in charge.

The role for engineers and architects in an owner driven programme is to diagnose, to explain, to convince, to motivate, to ask people what are they planning to do.

This is a new role for them. They are familiar with being the experts, with issuing orders and instructions, with their orders being followed. In a programme like this, they have to be accessible, they have to actively make others know and understand what they know.

Technical professionals are not the decisions makers in this programme, the owners are, the masons are. Our role is to inform and support their decisions.

Engineers as facilitators

Engineers must be on the ground

Engineers have to explain safe construction in simple and normal language, they have to understand from the point of view of the houseowner and the mason, they need to interpret needs, and assist with generating options and optimising the resources.

Apart from learning earthquake engineering, the engineers have to learn from masons and carpenters about local construction techniques, and how to solve practical problems in partnership.

Engineers have to learn communication skills, training skills, advisory skills. This is vital to make them more effective.

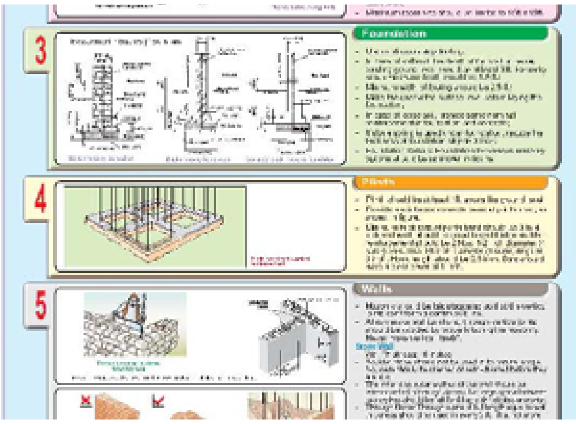
The conventional means of construction quality control for engineers have to be reconsidered in a programme of this scale, speed and with very limited numbers of engineers available, and with different relationships between all stakeholders. Technical support and particularly the role of engineers must be strategic.

The field technical support are the ones responsible for analysing patterns of construction preferences, patterns of defects, they monitor issues of material quality and supply and they represent the field in technical and policy reviews as required.

The therefore play a pivotal role in the iterative process between the field and the policy makers.

The engineers have to actively ensure that all involved in reconstruction are technically sound as far as possible and act as a reference and resource supporting a wider team involved in dissemination and promotion of technical advice. They therefore need to constantly and enthusiastically explain and support, and they need to listen to all questions.

Communication



Devising information strategies is an iterative process. It needs to respond to questions which evolve over time, and it needs to be tested.

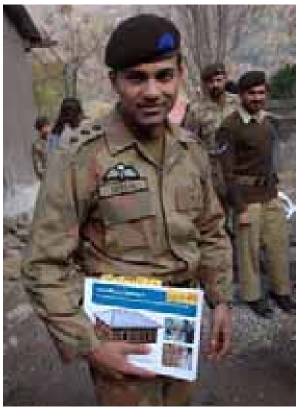
The language of engineering is only for engineers. Information needs to be accessible for masons, for shopkeepers, for school children. Everyone should know why there should be a band around the building.

Our experience has been that people do not like engineering information, they like photographs, recognisable information, step by step. Photographs seem to be more easily understood than any drawings.

When using photographs show the correct version, but also show the wrong one. Explain mistakes so people know what not to do and why. And if possible show how to put it right when its wrong.

It is important to always explain the why, simply if possible.

Communication



Different target audiences need different materials:

Engineers need reference materials and sometimes the theory and calculations.

Masons need the step by step procedure, and quantities. House owners need to know the why, the cost and the benefit.

Devising information should be done early, but it must be planned as an ongoing activity, following owner preferences, responding to new issues, common concerns and allowing for discussion. A point or lesson is often made more convincingly in discussion and debate than issued as a decree.

The best communication tool is a model house or demonstration.

They should be based on local preferences in material and layout to maximise replication. They should be planned in close discussion with the community to enure they are appropriate and relevant.

They should be used as training, and for documentation to create step by step photographs as discussed earlier.

All site based demonstrations, need to have structured visits and events to maximise exposure and involvement, to collect comments, questions and feedback.

Model buildings are important as a long term information resource and reference for people constructing in future after the initial reconstruction.

'Owner driven'

Inspection

Training and information, however tailored, will not be enough to convince people to build safer buildings. There are over 450 000 houses reconstructed in Pakistan. We cannot achieve good standards only by technical support or only by enforcement.

The leverage achieved through stage approvals of construction and certification for payment, has been a vital incentive for people to learn about and meet standards. On the other hand it is not possible to achieve good standards only by threats, it is important that people are already aware of, convinced of and able to execute the correct standards.

Solution driven

Under the leadership of ERRA, we have had a round table approach so that those responsible for policy, technical standards, technical support and training, inspection and the community themselves can regularly review the progress and decisions can be taken to respond to needs.

Concerns may be the rate of construction, the supply of materials, increasing the range of options, addressing defects, information campaigns, or taking care of special architectural heritage.

Experience from Pakistan shows that despite enormous field difficulties and very limited technical capacity, the willingness to review and respond, to learn each other's constraints and have a problem solving approach, has contributed greatly to the successful outcome. Housing policy makers have learned engineering, engineers have learned community mobilisation, the Pakistan Army as building inspectors have learned housing policy. All stakeholders had to be flexible in their workplans, staffing, timing, and to discuss and work based on available capacities and comparative advantages.

The examples given in this presentation show how the rural housing programme in this instance was an iterative one, responsive to realities on the ground, responsive to needs and based on finding solutions to those needs. This path has been constructive, but it has not always been easy.

It is true that greater anticipation of those needs and solutions can take place the next time and streamline the process in the interests of all those rebuilding. The fact remains that not everything can be anticipated in the best laid plans for programmes of this nature, and an important by-product of the incremental process in Pakistan has been the development of trust and mutual understanding between the community, technical support and the Government.

Rural Housing

We wish to thank the following:

Waqas Hanif, ERRA Programme Manager Rural Housing.
General Nadeem Ahmed, ex Deputy Chairman ERRA, General Sajad Akram, Deputy Chairman ERRA.
Brigadier Sher Afghan Niazi, ex Director General Monitoring and Evaluation ERRA.
Shaukat Qadeer, Tahir Shamahad, NESPAK.
Surya Shrestha and NSET team, Nepal
Tom Schacher, Randolph Langenbach, Norbert Wilhelm,.
The 80 NGOs who participated in technical support activities.
The Government and people of Kashmir and NWFP.

CIDA, SIDA, DFID, USAID, SDC.