CHAPTER 4

A market-based programme to improve housing in the mountains of northern Pakistan: Addressing seismic vulnerability

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Abstract

The Building and Construction Improvement Programme (BACIP) has been working with the high mountain communities of the Gilgit-Baltistan region of Pakistan since 1997. Alongside its contribution to the general built environment and housing improvement of the area, the programme is engaged in the development and promotion of solutions for making the buildings seismically resistant. Gilgit-Baltistan falls in a high seismic zone and the earthquake of 2005 caused the death of nearly 90,000 people in the neighbouring state of Azad Kashmir and the Khyber Pakhtunkhwa province of Pakistan, which share long borders with Gilgit-Baltistan. BACIP believes that investment in making communities safer will minimize the chance of loss of life and assets and reduce the cost of reconstruction. BACIP works with local communities in a participatory manner to improve the local housing by improving safety and comfort without changing the local culture and way of living. For the sustainability of its approach, it has made efforts to make its solutions part of the local market so that entrepreneurs and artisans are available to manufacture, sell or construct these solutions. A number of profitable enterprises have been established. Alongside hands-on training and demonstration, BACIP uses media such as radio for the promotion of its solutions and awareness of communities. In December 2013 with the support of the Building and Social Housing Foundation (BSHF), BACIP revisited a number of houses that were constructed using seismic-resistant technologies and it was found that the solutions applied to these houses had greatly contributed to the safety and comfort of the users. 100 per cent of the houses were in use and were occupied by the original owners.

Keywords: Seismic resistant housing; Post-disaster reconstruction; Seismic wire reinforcement

The area – Gilgit-Baltistan

Gilgit-Baltistan, formerly known as the Northern Areas of Pakistan, was formed by the collision of the Indian tectonic plate with the Eurasian plate some 40 million years ago. It is located at the junction of three of the most famous

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mountain ranges – the Karakoram, Himalaya, and Hindu Kush – containing 14 of the world's highest mountains, all above 7,706 m high including world K2 at 8,612 m.

The area has strategic importance for Pakistan as it borders China in the east, Afghanistan to the north, and Jammu and Kashmir in the northeast. It is connected to the Khyber Pakhtunkhwa province of Pakistan in the west. The historical Silk Route passes through this area as well as the Karakoram Highway connecting the capital of Pakistan, Islamabad, to the southern part of China in Kashghar.

Over 1.5 million people, living in an area of some 72,496 km^2, depend almost entirely for their energy and construction needs on scarce natural resources, predominantly the forest. The glaciers and snow-melts from the mountains are the key source of fresh water. The river Indus has its source in Gilgit-Baltistan and flows through the plains of Pakistan to the Arabian Sea, irrigating agriculture across Pakistan and contributing significantly to the water needs of the country.

Alongside the beauty of the mountains lies danger. 80 percent of the estimated 150,000 households in Gilgit-Baltistan are living in an area of high seismic activity. Over 200 people lost their lives in the Diamer District in 1981, and another 22 people died in Astore District in 2002 when earthquakes hit the area. The magnitude of the earthquake in Diamer was 5.8 and in Astore was 5.5. About 90,000 people lost their lives as a result of the Kashmir earthquake of 2005 and 5,700 people died as a result of the Pattan earthquake of 1974 in the adjacent state of Azad Kashmir and Khyber Pakhtunkhwa province and the resultant damage has cost many millions of dollars. In these earthquakes, most people lost their lives due to the collapse of poorly constructed buildings with no seismic protection. These non-engineered buildings pose a great threat to the life of the local communities living in this high seismic area. Buildings which can stand up to earth tremors are important to protect human lives and minimize economic loss.

Local housing construction

The vulnerability of the local population is made more acute by the construction of their houses. There are an estimated 120,000 houses in the area and each year approximately 3,000 new houses are built (Ahmad and Abbassi, 2001). Over 90 per cent of the houses are non-engineered, built by the owners or local masons and have little or no seismic resistance measures.

The majority of the houses in this area are built with dry stone walls, made using mud and smaller stones to stabilize the larger stones. Wooden posts are often set into the walls to support a heavy roof, constructed from layers of grass, and birch bark on a layer of branches and topped with compacted clay soil. The branches lie on large wooden beams, which are supported by a number of heavy wooden columns in the centre of the house (see Figures 4.1 and 4.2). Large stones that span the widths of the wall provide some structural stability. Other construction types include cement blocks, adobe blocks, and stone construction stabilized with cement mortar (Sedky and Hussain, 2001). Even when cement mortar is used, it tends to be of low strength due to substandard aggregates and poor quality workmanship. The massive walls offer little resistance to ground movement, and combined with a heavy roof are a significant danger to life in an earthquake.

> In the event of a major earthquake, the pillared construction would remain standing, but periphery non-masoned walls would eventually fall out of their framing. If the walls of the adjacent rooms (stores) fail to withstand the earthquake, the pillars would topple sideways causing the whole massive roof to collapse, burying the inhabitants under the heavy roof and rubble (Nienhuys, 2006).

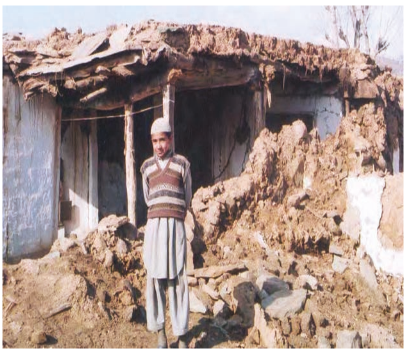

Figure 4.1 Heavy roof construction held up by wooden posts

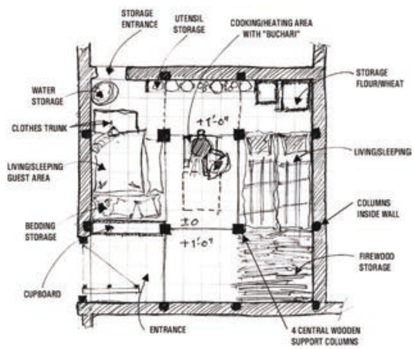

Figure 4.2 Plan of traditional house construction

Analysis of the 2005 Kashmir earthquake showed three main reasons for the major destruction of housing and infrastructure.

1. Many of the collapsed buildings were constructed prior to the introduction of the building code in 1986, and were constructed via self-build.
2. Many of the buildings constructed after 1986 did not follow the code.
3. Elongated buildings with large openings performed poorly; in an earthquake area, square-shaped buildings are recommended. The concrete quality of nearly all constructions was substantially under the design values due to poor execution in the application of steel reinforcements, low quality of the aggregates and poor curing under hot or too cold local climate conditions (AKPBS, 2013).

In 2007, the Government of Pakistan supplemented the Pakistan Building Codes 1986 by adding the Pakistan Building Code – Seismic Provision 2007.

This provides specific codes for professional engineers and structural designers for the seismic design of buildings and building structures for the whole of Pakistan.

However, there are a number of challenges for the implementation of the Pakistan Building Codes in remote and mountainous regions like Gilgit-Baltistan, where over 90 per cent of the buildings are constructed by villagers themselves (self-help builders and artisans) themselves without involving engineers and professional designers. One of the major challenges is the absence of building control mechanisms in the form of a building control authority and legislation in Gilgit-Baltistan especially for the remote areas and villages.

Lack of education, capacities, affordability, and required infrastructure are major challenges for the endorsement of these codes in the region. For these reasons the codes should have been supplemented with simple construction guidelines in the form of manuals, books and other documents, preferably in local languages, well illustrated, and accessible to the local builders and artisans working during the construction of seismic-resistant and thermally efficient buildings and structures. The manuals do not need to explain the engineering principles behind the improvements. Besides these simple guidelines, hands-on training of artisans and demonstrations of the techniques and technologies in the field for education and awareness of the community are essential.

The Building and Construction Improvement Programme (BACIP)

The Aga Khan Planning and Building Service in Pakistan (AKPBS,P), through a social development programme, have been working on a project with the aim of creating resilient communities and building capacities to address issues of housing improvement and disaster risk reduction. It is not strictly a reconstruction project, as there is no specific disaster that triggered the programme, but has been motivated by the high seismic activity of the region, which suffers frequent medium-sized earthquakes. BACIP started in 1997 in the high mountains of northern Pakistan and is still being implemented at the time of writing.

Development of the programme

BACIP started as an action research project in 1996. The main aim of the research was to investigate the housing and living conditions in the area. Particular issues that were examined included thermal comfort in the cold climate, ventilation, and smoke pollution from cooking and heating. Seismic vulnerability was identified in the research aims as one of the issues with a significant impact on living conditions.

A participatory process was facilitated by BACIP, engaging community households using Participatory Rapid Appraisal Techniques, and 60 different issues were identified by the participants related to their living conditions such as issues of cold, damp, poor ventilation and smoke, and poor quality construction. Demonstration projects were developed from the research findings to explore and define responses and solutions to these issues. BACIP developed solutions around five thematic areas: thermal efficiency, illumination, indoor air pollution, cooking/heating, and seismic resilience.

> Wall, roof and floor insulation products as well as roof-hatch windows control leakage of warmth. Better smoke-free stoves, stabilized mud floors and wall construction techniques address the problems of dust and smoke. Lighting is addressed by the construction of windows, promoting energy efficient tube-lights and creating awareness about painting while improved wall and roof construction and water proofing techniques reduce dampness. BACIP's culturally sensitive and cost-effective toilets provide convenience to the house-dwellers while the shortage of space is addressed by in-house items such as bedding racks, kitchen cabinets, washing/cutting tables and better grain storage techniques. On a broader scale, the wall and roof construction techniques provide greater resistance to seismic shocks and create awareness about housing construction outside historical landslide and flood regions which reduce the danger to life (Sedky and Hussain, 2001).

The solutions or technical improvements were primarily developed by experts, however local community households had a chance to reflect on the performance of the solutions during their testing period. Feedback from participants in the trial period reverted to the process to further refine the solutions and improvements. The solutions were then placed in various houses to demonstrate their possible uses and to raise awareness amongst local households. The households selected as demonstration households were given the product for free but on condition that they used the products as per the BACIP guidelines, and that they allowed the neighbours to visit the house and observe the benefits of the product to inspire replication of the products in their houses. BACIP observed that on average, one demonstration project gave rise to ten replications.

As a result of this action research project, local households that had not participated in the trial started approaching the BACIP programme asking for the same solutions in their own homes. The next part of the project was to consider how to ensure wide take-up of these solutions. BACIP decided that the best approach was to figure out how to make these solutions available in the market. The rationale was that although the people in the area would not be reliant on an organization to facilitate the solutions, there would be an organic market-based take up of the ideas and products. The initial focus was on building the capacity of individuals or firms that were already doing related activities. BACIP supported the development of enterprises in the area to develop and market these solutions by funding entrepreneurs and training artisans in relevant techniques and to produce the materials as they were new and not available in the market place. Two specific criteria were applied: first, that the person must be in a similar business or trade; and second, that they are willing and have the capacity to become a BACIP entrepreneur. For example, there were already carpenters who could manufacture windows, so they were taught to make the BACIP roof-hatch windows and double-glazed windows. Similarly there were tin smiths in the market who already had some infrastructure in place and with additional skills they could manufacture the energy-efficient stoves.

As a first step, BACIP mobilized active entrepreneurs and manufacturers who were in a similar business, trained them in additional skills, and provided them with start-up finance to support the production of these new products or buy some extra tools needed for manufacturing these products. Skills training was also given in marketing and sales techniques. Loans were interest-free but required two guarantors; and in the majority of cases loans were repaid in full within the time. Repayment periods were generally 12 to 30 months depending on the size of the initial loan. The funding of entrepreneurs helped to generate a small industry in the area. BACIP developed some 60 housing solutions but there were about 10 products for which there was high demand and enterprises were established around these products. From an initial 15 grant-funded entrepreneurs in 2004, a market of over 50 enterprises has developed in the region (see Figure 4.3) (BACIP, 2013). As the market grew and the demand for BACIP products increased, people approached BACIP proactively wishing to undertake training, access start-up loans and become entrepreneurs. Those completely new to the sector received longer-term intensive support to ensure the success of their enterprise.

The final phase of the project was to move towards institutionalizing the products and lessons that had been shown to work. This involved working

Figure 4.3 A BACIP enterprise that is selling stoves, water warming facility

with local government to formalize the techniques in building guidelines. Building codes do exist in the area, but as the vast majority of the houses are owner built, the building codes are not followed. The building guidelines were more likely to be followed as they were far more user friendly than the codes, they were written in both national and local languages (building codes in Pakistan are written in English), and they had additional pictorial information. The guidelines were developed in partnership with the Pakistan Engineering Council and local universities. Still, an approach that just involved policing through codes and guidelines would not work on its own. Therefore, in parallel with technical advice, awareness-raising activities were organized, such as radio talk shows and radio drama programmes that incorporated technical themes. Radio is the most popular medium in the area and all households own one. Other awareness-raising activities included roadshows, brochures, and seminars and conferences with professional groups. The building principles were also institutionalized through partnerships with local universities to ensure the ideas and solutions are part of the curriculum for engineering students who will in the future be the planners and builders for the area.

The solutions were installed in about 40,000 houses in the area. Of these, 10,000 were directly supported by BACIP. The remaining 30,000 were installed as a direct result of the incentives and activities to institutionalize the awareness of the issues and facilitate the solutions through the market.

BACIP's comment on how this was achieved in practice:

> Once we developed a successful solution (techniques/technology/product), we then trained a number of manufacturers and entrepreneurs around those products who will manufacture these products and sell them in the market. BACIP does the marketing through awareness and marketing programmes. People who are interested in those products and services either contact BACIP, who then connects them to these entrepreneurs, or people directly contact the entrepreneurs for services or products. The entrepreneurs / manufacturers are in turn paid by the households (personal communication with BACIP, 24 March 2014).

BACIP anticipated how demand could be assessed and met as the market grew. They assessed demands from communities through a representative, known as a 'resource person', in each village. There is at least one resource person supported by BACIP for each village with a population of 100 households. These resource people get a small percentage from the installation of products in one house. They work as a marketing force for the programme. There are over 200 resource people throughout the region.

Seismic resistance

The seismic risk mitigation solutions developed by BACIP included site planning advice to raise awareness of risky sites, techniques to make the roof construction lighter in order to reduce the risk to life of a roof collapse, and an innovative wire mesh wall reinforcement technique. The wall reinforcement is seen as the most effective seismic resistance technology in the construction of these types of houses to minimize risk to life in an earthquake. About 100 houses in the area were built by BACIP to demonstrate the wire mesh wall reinforcement techniques. However, this construction technology has been slower to replicate than the other issues due to affordability of the necessary work.

So far, the seismic resistant principles have been adopted in 253 buildings. The take-up of seismic-resistant building is expected to expand due to the raised awareness of disasters after the 2005 earthquake and 2010 floods, and the need to rebuild flood damaged houses due to the 2010 floods. AKPBS,P recently planned a reconstruction project for the flood-affected households of 2010 and some 500 households potentially will adopt these solutions in the rebuilding of their houses during 2014–2017.

There was an awareness of seismic-resistant construction in traditional construction in Gilgit-Baltistan, with historical evidence present in large ancient buildings such as the forts. Vernacular seismic resistance is evident in housing in the timber-frame structure locally known as Katore- or Daji- (Dhajji) style construction, where there is clear cross bracing offering resistance to ground movement.

> In the past, a wooden tie-beam construction was made in the length of the wall consisting of two parallel (fruit tree) wood sections connected to each other with short sleepers. In some cases, these lengthwise wooden strips have been applied in the corners of the walls only (Nienhuys, 2006) (see Figure 4.4).

This traditional construction is made out of wood which is unaffordable for construction due to over-exploitation of the available forests. Almost all of the 1.5 million people in the area directly or indirectly depend for their energy and construction needs on the forest, which covers less than 5 per cent of Gilgit-Baltistan. Wood is, therefore, too precious to use as a building material. Hence, there is a need to develop solutions which do not use timber construction.

One solution would be reinforced concrete buildings, which offer significant earthquake resistance- (better than that offered by wire mesh wall reinforcement) but they are very expensive for the majority of the local population. A traditional house in one of the villages would cost about US\$100–\$150 per m^2. A building strengthened with reinforced concrete would cost two to three times as much, at an unaffordable \$300 per m^2. A more economical solution was needed, and one of the technological solutions developed during the BACIP programme was an innovative new construction: galvanized wire mesh to bind different layers of the building together (see Figure 4.5). It was cheap and easy to manufacture and BACIP ensured it was available in the market by developing enterprises around wire-mesh manufacture and distribution. This technique added only 10 to 15 percent to the cost of a traditional house.

Galvanized wire reinforcement is a technique that has been utilized to offer seismic resistance where wood is scarce and where good quality concrete is not achievable, either due to the difficulty of obtaining suitable materials or inadequate workmanship.

Figure 4.4 Traditional building with wooden tie beams

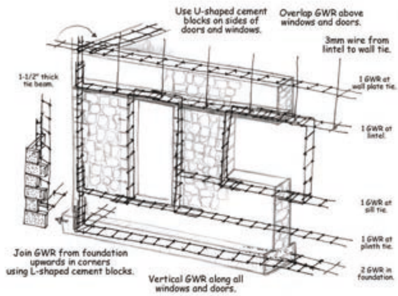

Figure 4.5 BACIP galvanized wire technology (GWR) for new construction

Galvanized wire reinforcement offers less seismic resistance than a reinforced concrete framing technology, however, in addition to the cost there are technical issues with reinforced concrete which can make it less desirable for use in remote areas. First, if quality control of the construction process is not carefully controlled the finished product is significantly weaker than the design expectations; Nienhuys suggests only half as strong. Second, reinforcement design is often seen to be faulty. These technical issues can only be overcome by a well-trained workforce, and quality control is difficult to implement with non-engineered and owner-built replication of the technology.

In addition, in high mountain areas such as Gilgit-Baltistan, effective curing of the concrete can only be achieved if the temperature is warm enough, and this time in the year tends to conflict with the time necessary to plant crops. Construction is, therefore, often carried out at unsuitable times.

The wire technology is primarily for non-engineered buildings which are built by poor families with very little or no engineering inputs. These are self builders and in the majority of cases the houses built are single storey. The challenge is that for the poor it is an additional cost to their budget for construction of a house. Microfinance programmes were implemented in partnership with a local bank for small-scale housing improvements and about 700 households have obtained such loans up to 2014. The repayment rate is over 95 per cent. However, for the ultra poor, who cannot even repay the loan amount, BACIP have not been able to come up with a solution except providing a high subsidy.

Looking back at the project

In 2013, the project was revisited to assess the performance of the interventions carried out by BACIP (see Figure 4). The focus of the visit was to review the aspects of the project related to reducing earthquake risk, but these initiatives also need to be seen within the context of the wider programme. Twenty out of the original 100 seismically resilient houses were revisited, selected through simple random sampling from the data available with BACIP. The households were evaluated on the five impact indicators: user satisfaction, beneficiary targeting, replication, technical performance, and livelihood impact.

Qualitative research methods were followed to gather information on how projects have changed since they were completed, and how that has impacted the life of the inhabitants and the wider community. Data was gathered from beneficiaries through in-depth interviews and focus group discussions. Findings of previous internal and external programmatic studies were used to corroborate the findings of field research study. Findings have also been substantiated with physical observation by the researchers, pictures, and other evidence where possible.

User satisfaction

In terms of user satisfaction, the results were very encouraging. Almost 100 per cent of the households said that the house has increased their safety and comfort and decreased the maintenance needed. The users also expressed the belief that they had a reduced chance of subsequent damage due to earthquakes.

> Retrofitting has been done in our house with the application of different earthquake resistant construction techniques such as BACIP wire. Other energy efficient and housing improvement products have also been installed. We know that these techniques have enhanced the resilience of our house and also it is energy efficient, therefore it is now more comfortable, safe, durable and secure. Now we feel that we will be safe in any earthquake (BACIP, 2013).

Beneficiary targeting

Out of the 20 houses visited, inhabited by some 180 people, 100 per cent were still occupied by the original owners, with no renting or letting (see Figures 4.6 and 4.7).

Replication

The uptake and replication of the seismically resilient wire-mesh building techniques has been slower to replicate than other BACIP initiatives such as

Figure 4.6 Shahbaz Khan, a disabled person and the original owner of the house, with his wife outside their improved house

thermal insulation. In private homes, this is mostly due to the affordability of the necessary building work. BACIP comment that households would like to build the new seismic-resistant technology into their houses but cannot afford to do it [BACIP reference]. As a result of the 100 houses built in the area demonstrating seismic-resilient building practice, 253 buildings have subsequently been constructed by communities and organizations replicating the use of these techniques.

Figure 4.7 External view of Shah Raise's house which was reconstructed using seismic-resistant technology, thermal insulation, and illumination techniques

BACIP has been working on making communities aware of the seismic risk in the area since 1996. However, after the Kashmir Earthquake of 2005, communities observed the destruction caused by the earthquake. BACIP also started radio programmes on creating awareness of the use of the BACIP wire technology in making their new houses safer. As a result of the awareness from the radio programmes and the experiences of the 2005 earthquake, many households have decided to build seismic-resistant houses. When the floods of 2010 destroyed and damaged about 3,000 houses in Gilgit-Baltistan area, some 500 households [BACIP reference] potentially will be facilitated in the construction of seismic-resistant houses under a reconstruction programme of AKPBS,P in 2015–2017.

BACIP also report much interest in seismic-resistant building techniques from public and community organizations who are building schools and health facilities and other communal buildings (see Figure 4.8).

Figure 4.8 Principles of seismic resistance and thermal efficiency have been adopted in Faizabad School

Technical performance

Since the time the seismically resilient wire-mesh building techniques have been used, no major earthquake has occurred. There have been medium-sized earthquakes, which have left the 20 houses surveyed unscathed. No cracking was visible when they were inspected.

There is additional evidence to support the strength of the BACIP house technology from a different type of disaster. A landslide in Attabad caused a blockage of the Hunza River and created a 20-kilometre long lake, inundating several villages, and causing the collapse of all houses with the exception of one house built using the BACIP wire-mesh technology.

There have been some concerns raised about the durability of the galvanized wire (Nienhuys, 2010) due to corrosion of the welded junctions in the wire. When galvanized wire is welded, the welding process removes the galvanization protecting the steel, and corrosion can occur. For gabions made out of this material, and exposed to the environment, the wire mesh is expected to last some 20–30 years. But inside the dry construction of a building, the mesh will corrode much more slowly, with a life expectancy of 40–60 years. A better solution is to use a wire mesh which is galvanized after welding, or a knitted wire where the manufacturing process does not remove the galvanic protection. These types of wire are estimated to last 100 years.

BACIP continues to advocate the wire mesh technology and has been working in collaboration with partners to achieve wider acceptance of the technique. The technical designs have been vetted and endorsed by university partners and the Pakistan Engineering Council which gives further confidence in technical performance. However, the technology has still not been declared an official engineering option and, therefore, will not be used by local authorities and so is unlikely to be widely used in urban areas. However, BACIP is continuing to advocate for its formal endorsement and approval of the building guidelines.

With increasing road access, it is likely that the use of reinforced concrete ringbeams bands as seismic resistance will increase, however the wire mesh technology was designed for the self-builders and those with the most limited resources: 'The GWR technology is not a cheaper substitute for good quality and slender reinforced concrete wall framing, but an option for people in remote villages having no access to finance or good quality reinforced concrete. New reinforcement methods are under development with flexible polypropylene and glass fibre mesh (netting) to overcome the possible doubts about the durability of the galvanized wire-mesh.' (Nienhuys, 2010: 3).

Livelihoods

The 20 households surveyed described financial savings in maintenance and said that the house was now an asset, not a liability. Better insulation and reduced indoor air pollution had resulted in savings on medical bills due to less frequent cold-related and respiratory diseases, as well as up to 60 per cent savings from reduced fuel consumption.

BACIP facilitated the development of 50 entrepreneurs for the manufacturing and sale of BACIP products. Many of these entrepreneurs have increased their income multiple times which has supported the education, health, and other living costs of their family.

Figure 4.9 Internal view of Noor Shah's house, where the family is using the energy-efficient stove to cook food

> Initially, I was reluctant to become an entrepreneur and take any risk. But the professionals at BACIP encouraged me and gave me the necessary training that raised my confidence. BACIP also provided me financial support in the shape of start-up capital with orders for manufacturing of the products. Today, because of my business, I am able to send my children to English medium schools and give them quality education. Moreover, I am able to provide my family with good food, clothes and shelter. Today, my own parents are proud of me and are living with us a happy life. All my family members are glad that our standard of living is improving.
>
> Respondent in BACIP survey (BACIP, 2013)

Lessons learned

This is a successful project with good results, albeit from a small sample, showing satisfied users, replication of the lessons outside the project, strong technical performance, and positive impacts on livelihoods. What was done in this project which made it work well? The Aga Khan Planning and Building Service in Pakistan have been working in Gilgit-Baltistan for over three decades. The organization has built on its learning of over three decades of continuous participatory projects carried out jointly with the local communities. They did not bring in ready-made technical solutions from outside but rather engaged the local community in the issue, mapping and developing local solutions with strong technical support. To minimize the loss to life and property, the project believes in pre-disaster preparation as compared to a major post-disaster response. It has, therefore, come up with solutions which will help to reduce damage in case of an earthquake. Buildings will be safer, technology and skills will be available locally for responding to a disaster.

The main thing that stands out when looking back at this project, is the ongoing work necessary to create the effective conditions which encourage people and organizations to see the sense in taking up the solutions for themselves, and particularly to pay the additional costs necessary to implement a resilient technology. Concurrently, there must be engagement with local authorities on building codes and the introduction of locally appropriate building guidelines; and finally, engagement with the next generation of planners and builders through embedding knowledge in the curriculum of relevant local training and higher education courses. This, if it gathers enough momentum, will create a whole culture of locally embedded safer building practice, and make the seismic resistance sustainable, not just for the life of the project but for many generations to come.

It was not enough to utilize participatory methodology to create and test and demonstrate workable solutions, in this case for the seismic resistance, the wire-mesh technology. For them to be replicated, it needed an understanding of where to intervene in the market to ensure the products were locally available and affordable, it needed both technical assistance and trained artisans to be locally available, and equally important, a recognition that market-based financial mechanisms needed to be available for people to access even the modest increase in cost necessary to implement the technology.

Design locally

When a reconstruction project or community building project is proposed, it is often the case that engineering solutions will lead the design. BACIP has learned that this direction is not the right way. Local, indigenous knowledge needs to be integrated in the design and planning process. The key learning is that external agencies or technical specialists can make improvements but should not change the way of living in the area.

Integrated design has a high impact

The seismic-resistant wire mesh technology was not the only improvement made to the houses by BACIP. Thermal efficiency, lighting, and indoor air pollution were also addressed, which gave a more significant impact to the whole standard of living of households and the cumulative impact was enormous. The design did not only concentrate on making houses seismic resistant but also made them thermally efficient by using insulation techniques. Other simple techniques and technologies were used to reduce indoor air pollution and illuminate the house. The impact was a reduction of up to 60 per cent in fuelwood consumption, a reduction in indoor air pollution, increased light inside the house, reduced labour of women and children for fuelwood collection, reduced labour of women for cleaning the house, and reduction in respiratory ARI diseases.

Make the technology accessible in the market

For replication to succeed this is crucial. There are three components to making technology accessible in the market. The first is that technical assistance is available in the region to ensure knowledge of resilient and sustainable technology is transferred through trained engineers and technical guidance. Second, appropriate building materials must be readily available to buy, in this case the local market was monitored, supply was increased and manufacture supported and increased in high-demand areas via capacity-building local enterprise. Third, knowledge is transferred to skilled artisans who can implement the technology to ensure safe homes are constructed.

Access to finance

The issue of access to finance is key to replication and BACIP has worked with local financial institutions to achieve this. According to a BACIP PEECH report (Janjua, 2013), some 700 households have already benefited from such loan financing and the repayment rate is over 95 per cent.

> One of the most successful and impressive partnership arrangements under the project was undertaken with the First Micro Finance Bank [FMFB]. The role of FMFB in providing financing for households to purchase the [BACIP] products was considered one of the most important aspects of ensuring the sustainability of the market chain. In spite of the pre-existing relationship between AKPBS and FMFB, as members of the Aga Khan Development Network (AKDN), FMFB was reluctant to participate in the project when the time came for their entry in 2010. Largely due to the massive defaults on loans that were occurring in the wake of the floods and large scale displacement of beneficiaries at the time, FMFB was averse to taking on any risky new interventions. Microfinance had not previously been offered for non-performing [i.e. financially unproductive], home improvement assets. They realized, however, that the [BACIP] products could be considered 'indirectly productive', as they saved the beneficiaries valuable cash, and that this freed up more of a beneficiary household's cash to make the repayments (Janjua, 2013).

Conclusion

BACIP started as a small-scale action research project in the Gilgit-Baltistan region of Pakistan aimed at identification of housing improvement issues and development of solutions, and has proved to be a highly successful development programme for improving the living standards of communities, building assets and creating livelihoods through the promotion of a safer built environment. The housing improvement solutions range from indoor air pollution to making buildings thermally efficient, illuminated, and safer from seismic hazard. The products and approaches have been replicated in Tajikistan which also shares a similar context. For the long-term sustainability and replication of its solutions, the project has made its solutions part of the mainstream market where skilled entrepreneurs manufacture and sell these products. It has not only contributed to making the existing buildings safer but also to job creation and improving the overall quality of life.

Through long-term engagement, support, technical advice and training, BACIP have begun a cultural shift in the manufacturing and construction sector in the region in favour of resilient and appropriate technologies ensuring safe homes for local people. The unique approach of the project is investing in making communities safer which will minimize the chance of loss of life and property and reduce the cost of reconstruction.

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