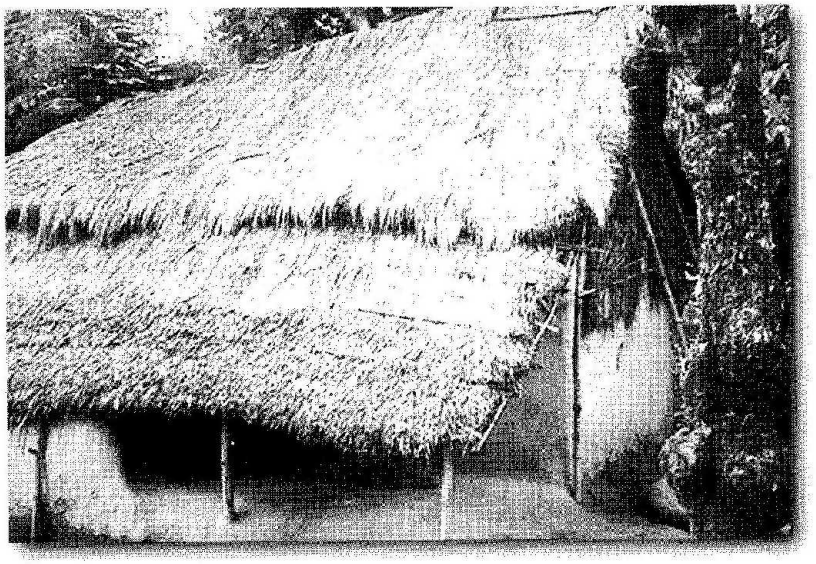

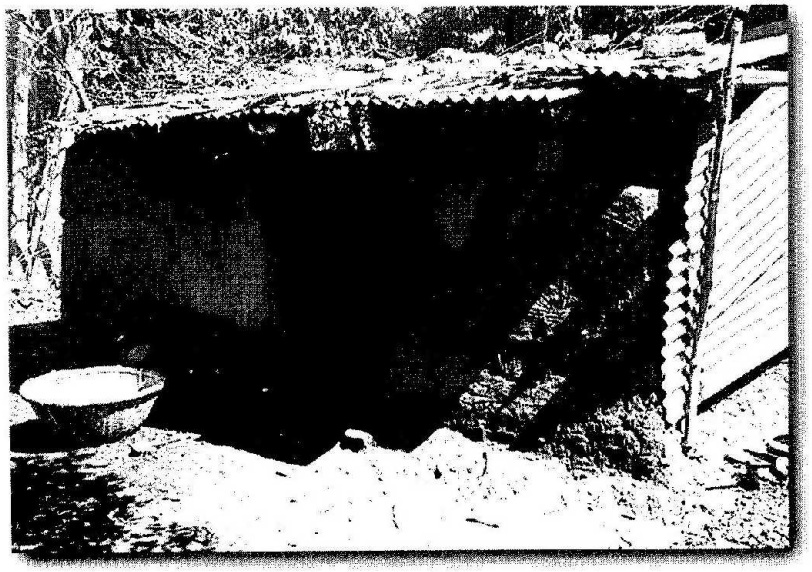

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# HAZARD-RESISTANT CONSTRUCTION TECHNOLOGY FOR RURAL HOUSING IN BANGLADESH: REINFORCED CEMENT CONCRETE POSTS

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## Introduction

Literature on hazard-resistant housing in Bangladesh often centred on traditional building materials versus improved construction (Borton, et al. 1992). The main criticism of the latter was its increased cost; traditional materials were well-adapted to local conditions, easily affordable and locally available. However, this argument has flaws: Firstly, traditional materials are no longer as widely available and inexpensive as formerly. Secondly, mechanisms of implementing improved construction such as housing credit programmes have successfully overcome cost constraints on improved construction; experience in the last decade suggests a great potential for replicability. Improvement of existing innovative technologies resulting in reduction of cost is possible, diffusing criticism and improving performance of the technologies and accessibility for low-income users.

This paper mainly deals with one particular technology applied to a critical part of a building: structural posts. The continuum originating from the supply constraints of bamboo, leading to the innovations that attempt to address the problem, are traced. This paper also discusses the dissem-ination of improved technology; this factor must complement studies of its applications.

## Bamboo

Bamboo is the most widely used natural building material in Bangladesh. The 1981 Housing Census (BBS 1989), shows that more than 60 per cent of dwellings in the whole of Bangladesh, and more than 70 per cent in rural areas used it. Bamboo is generally available in two varieties, thick-walled and thin-walled. Thick-walled bamboo is used for structural members such as posts, roof rafters and purlins. Thin-walled is split and woven into a variety of stiff mats that are used as walls and sometimes as roof cladding (Ahmed, 1994; Wells, 1995).

## Supply constraints

Based on a literature review and also primary observation, Wells (1995) has provided an account of the increasing scarcity and consequent rise in the price of bamboo in Bangladesh, which has been widely documented in various

sources (Wells, 1995). The price of bamboo has almost tripled during 1980-90. As shown in Figure 1, this was a rise greater than the rate of inflation (SKAT 1991). Supply constraint, reflected in increase in price, is also evident in greater distances travelled by traders for village bamboo supplies (Abedin and Quddus, 1990; Johnson and Ritchie, 1993), reduced number of bamboo traders, harvest of immature culms, smuggling in from India and illegal appropriation from state forests (SKAT, 1991).

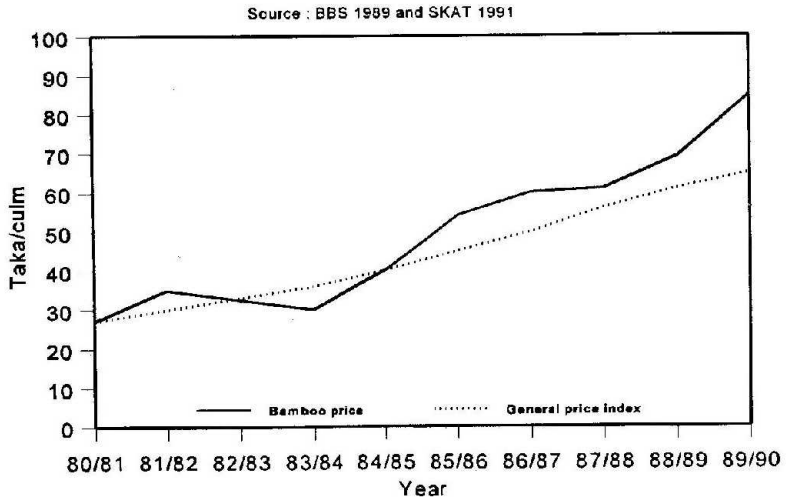


**Figure 1 : Increase of Bamboo Price in Dhaka, 1980-90**

### Reasons for scarcity

Scarcity is due to various factors. Most sources consider population increase as its main cause (for example, see SKAT, 1991); several other factors greatly exacerbate the situation. Poor management of bamboo resources, both in the villages and forests, has led to declining production (Abedin and Quddus, 1990; Johnson and Ritchie, 1993). Estimates from the Forestry Master Plan (Wells, 1995) and Johnson and Ritchie (1993) indicate that forest bamboo reserves are declining at a rate of about three per cent per year. Bamboo blight (Boa and Rahman, 1987) and dependence on rural bamboo supply for increased requirements in urban construction, such as for scaffolding (Abedin and





Quddus,1990, Johnson and Ritchie 1993) further deplete supply.

### Impact of natural disasters

Another major contributor to the reduction of bamboo supply is the effect of natural disasters. Bamboo cannot grow on water-logged land, requires a well-drained site (Abedin and Quddus, 1989), and generally is grown on high land. But unusually high floods, such as those in 1987 and 1988, greatly devastated the already dwindling stock. Secondly, destruction of houses by floods and cyclones results in increased demand for building materials for new houses. Estimates are that in 1988, of total houses destroyed by the floods, more than eighty percent were of bamboo and thatch (Dunham, 1989), adding to existing pressure on supply (Abedin and Quddus, 1989). Reduced supply eventually affects the ability of rural communities to recover from disasters (Dunham, 1989), and leaves them more vulnerable to further hazards.

### Consequences of scarcity

For poor households, the result of scarcity has been to use smaller and weaker pieces of bamboo, consequently reducing the quality of the dwelling and rendering it more susceptible to natural hazards (Dunham, 1989; Dunham, 1991). Bamboo posts have traditionally been used as the main supporting members, embedded directly into the ground (Ahmed, 1997) and tending to decay in contact with sub-soil water and insect attack (Ahmed, 1994). Frequent replacement was traditional, which was consistent with the former wide availability of bamboo. In the face of its current shortage, poor households are unable to obtain or afford bamboo regularly and live in houses with a weakened and hazardous structure, which sometimes tend to collapse entirely, rendering the household homeless (Norton, 1990).

### Case Study: Grameen Bank Rural Housing Programme

The onslaught of natural disasters such as floods, cyclones and river-bank erosion, and the resulting increase in rural homelessness (Rahman, 1991) and hardship has drawn attention from the government, international development agencies and other organisations. Estimates are that around 4,000 new houses had been built through the initiatives of agencies within a year after the 1988 floods (Hodgson and Whaites, 1993). The Grameen Bank Housing Programme began in 1984 and was among the first to provide financial credit to rural homeless or poor households to construct a new house or restore an existing one (Islam, Chowdhury and Ali, 1989).

Recognition of declining quality of rural housing and increase in people who could not afford to build a house prompted the foundation of this

programme (Rahman, 1991). After the heavy floods of 1987 and 1988, it was improved and extended. The bank also provides general loans at 16% simple interest per annum, while the rate of interest for housing loans is 5% (Islam, Chowdhury and Ali, 1989). The loan recovery rate (98%) has been excellent (Rahman, 1991). Initially the general loans establish income generation, and after a year, when the household becomes financially more stable, the housing loan is provided, and loans gradually repaid in instalments (Norton, 1990).

**Reinforced Cement Concrete (R.C.C.) Posts**

Use of a Grameen Bank housing loan is tied to the use of four R.C.C. posts and corrugated iron (C.I.) sheet for roofing. The posts, supplied by the bank, must be bought with the loan money, and C.I. sheet is usually bought from the market (Islam, Chowdhury and Ali, 1989). Here the discussion is limited to R.C.C. posts. Because of problems in supply and maintenance of bamboo posts, the bank provided and stipulated R.C.C. posts, more permanent than bamboo. Most rural houses generally require more than four posts; therefore along with the four R.C.C. posts, the beneficiaries of the loan have to use bamboo posts (Islam, Chowdhury and Ali 1989, p.28 [15]). The idea is that four R.C.C. posts, one at each corner of the house, keep it stable if the bamboo posts decay. The bamboo posts can be replaced when opportunity permits, without the household living in a hazardous structure. Also, in floods, the R.C.C. posts would not be damaged (Norton, 1990) (see Figure 2, opposite, and Figure 3, printed on page 99). The Grameen Bank provision of R.C.C. posts has been adopted by several agencies implementing rural housing programmes (for example, see Caritas, 1996; Concern, 1996; Proshika, 1994 ). Thus R.C.C. posts can be considered as a pioneering example and a great innovation in hazard resistant housing.

**Problems facing R.C.C. posts**

- In most of the programmes R.C.C. posts are solid and square in section. Some programmes, such as those mentioned above, provide six posts instead of four, thus reducing the number of bamboo posts. It is assumed that the building is then more sturdy and less vulnerable to natural disasters, but at an increased cost. Bangladesh produces very little cement and steel reinforcement rods; they are or the raw materials for their production are mostly imported, contributing to their high cost. Also, 'cement-based materials involve a high embodied energy' (Wells, 1993), especially true for imported manufactures because of transport involved. Thus R.C.C. posts represent a major portion of the cost of a rural house.





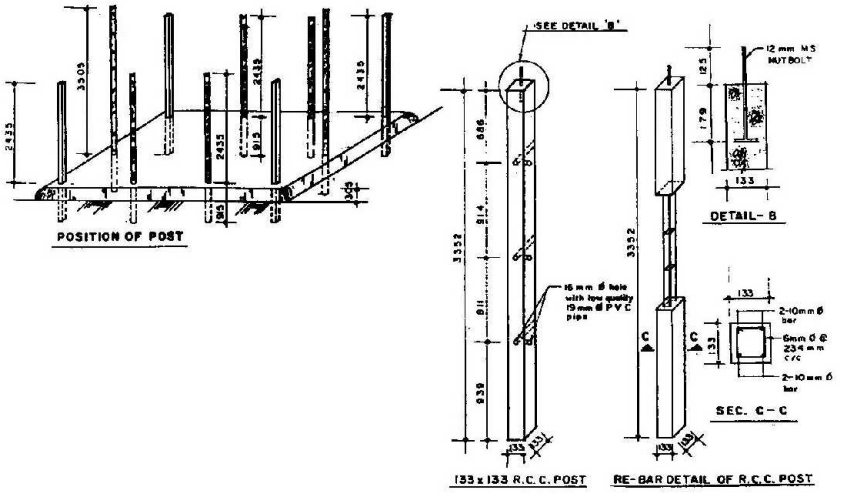


**Figure 2 : Typical layout of posts in Grameen Model House**

Apart from their cost, several problems with current R.C.C. posts can be identified:

1. Solid posts are quite heavy and difficulties in transporting them on tricycle carts on unpaved village roads from the supply depot result. Many Grameen Bank beneficiaries are women; it is difficult for them to install such heavy posts on a self-help basis, hence entailing dependence on men.
2. Square section posts tend to get chipped off at the corners during transport and handling. Also, the square shape is not favourable to hand grip during lifting and construction.
3. The length of Grameen Bank posts is 335 cms. They are usually embedded 45 cms into the ground, which does not ensure sufficient stability, especially in areas with high wind velocity. Thus in many cases the beneficiaries have embedded them further (Islam, Chowdury and Ali, 1989). With ground penetration greater than 45 cms and with an average plinth height of 30-45 cms head height becomes uncomfortably reduced.

4. It has been observed by the author that provision of innovative building components such as R.C.C. posts has initiated production of these components by local informal sector entrepreneurs. These components appear similar and yet are sold at a lower price than those provided by the Grameen Bank. Beneficiaries who have already taken a loan feel that they have incurred a loss by buying dearer posts from the Grameen Bank, but quite often informally produced posts are not high quality; less cement and more sand may be used in the concrete mix. Such posts appear to be the same as those provided, but tend to wear out and develop cracks within a short time. Households who opt for them lose out soon (Ahmed, 1993).

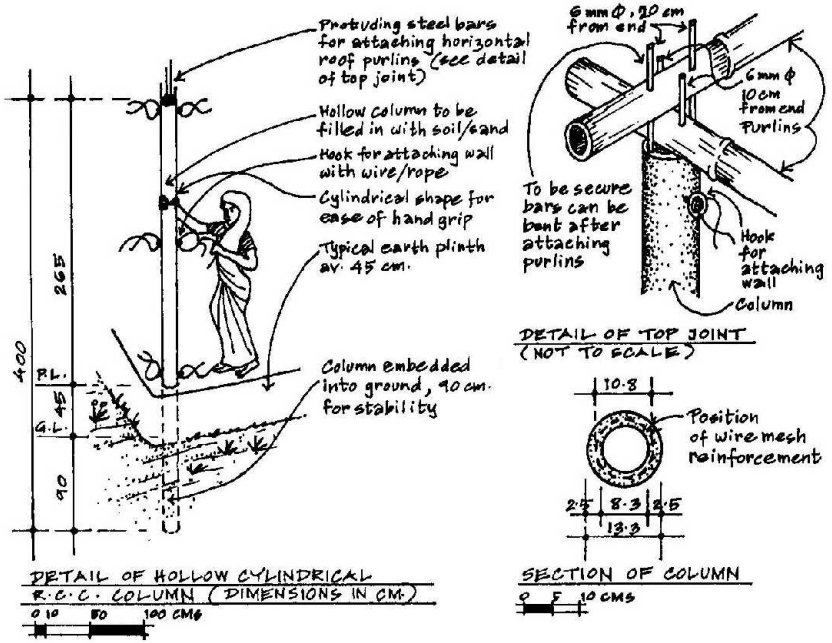


**Figure 4 : Hollow Cylindrical R.C.C. Post details**
(Ahmed, 1995)





**Hollow Cylindrical R.C.C. Posts**

The author recently completed a research report for the Grameen Trust, proposing the design of hollow cylindrical R.C.C. posts to overcome some of the problems associated with solid square-section posts (Ahmed, 1995) (see Figures 4 and 5). It is expected that such posts would provide the following advantages as compared to the problems identified above:

1. Hollow posts would result in a reduction of cost, as less cement and reinforcement are needed than in solid posts. Minimising their expense would be beneficial to low-income households. According to the author's research, hollow posts cost almost one-half that of solid posts. This reduction could best be utilised by providing more R.C.C. posts than four, reducing the need for bamboo posts that have to be replaced.
2. Hollow posts would be lighter than solid ones, easier to transport and install - a definite advantage given rural transport and female users. Once installed, the posts can be filled with soil or sand for stiffness, strength and stability, resulting in enhanced perfor-mance in strong winds.

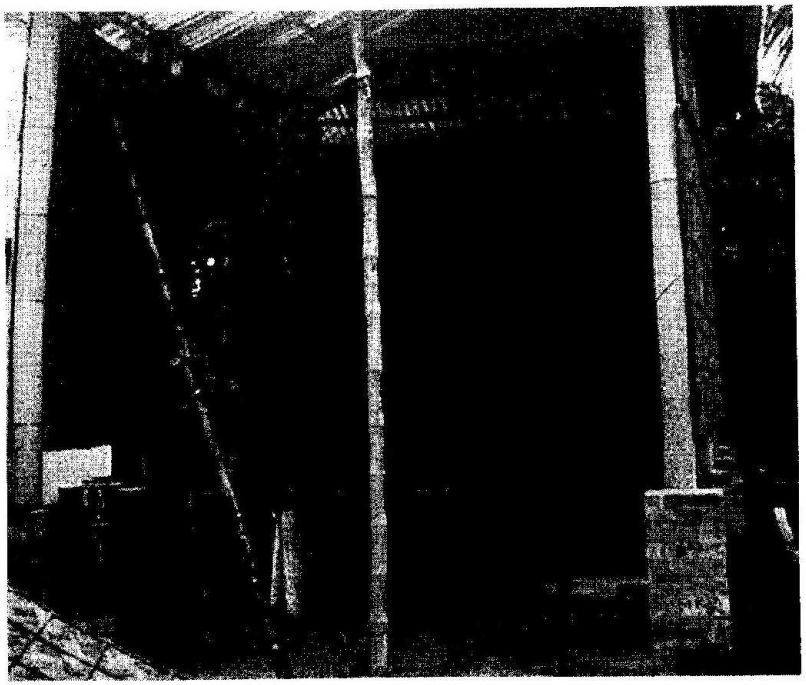

Figure 5: Model House using Hollow Cylindrical R.C.C. Posts

3. The cylindrical shape would be conducive to hand grip, an advantage during construction and transport.
4. To overcome the insufficient ground penetration of current Grameen Bank posts, it is suggested that hollow posts be 400 cms long, allowing 90 cms for ground penetration for adequate stability and comfortable head height. The overall lower cost of hollow instead of solid posts would allow this increase without too great an impact on the cost.
5. To overcome the problems arising from informal replication, institutions like the Grameen Bank could link with the informal sector instead of providing posts produced in their own workshops. Thus, quality control could be achieved and production brought closer to the community. The technology of hollow cylindrical posts would not be entirely unfamiliar. Presently hollow R.C.C. sewage pipes are commonly produced, in many cases by informal sector entrepreneurs, and this offers an effective channel for dissemination of the technology of hollow R.C.C. posts.
6. During the author's research, a model house since subjected to several strong storms, windy and rainy weather was constructed, using hollow posts. It has withstood these stresses without damage. Thus the technology has good potential in hazardous areas with strong winds.
7. During hazards such as floods and riverbank erosion, affected households often salvage building materials/ components and then remove their house to another location (Borton, et al., 1992; Hodgson and Waites, 1993). Hollow posts, due to their lighter weight, would allow greater ease in this practice.

**Other Methods**

Another way of improving performance of bamboo posts, instead of replacing them with R.C.C. posts, might be improvement at their base, the part most prone to decay, to prolong their life. For example, concrete blocks, each with a hole for insertion of a bamboo post, could be used for protecting the base of bamboo posts. Before insertion the end of the post could be coated with a layer of bitumen for further protection from water and insects. Where cement is not affordable, simpler and less expensive methods could be adopted. As suggested by Chisholm (1979), such a method would be to burn the lower part of a bamboo post until it is black, then coated with old sump/motor oil. Scorching dries the post out completely, depleting internal cellulose from





which insects derive nourishment, thus retarding insect attack. Coating it with oil prevents further access by insects, and additionally protects from sub-soil water. Instead of motor oil, bitumen can be used where available. Sump/motor oil, an industrial by-product, is generally less expensive than bitumen, but bitumen performs better (see Figures 6 and 7).

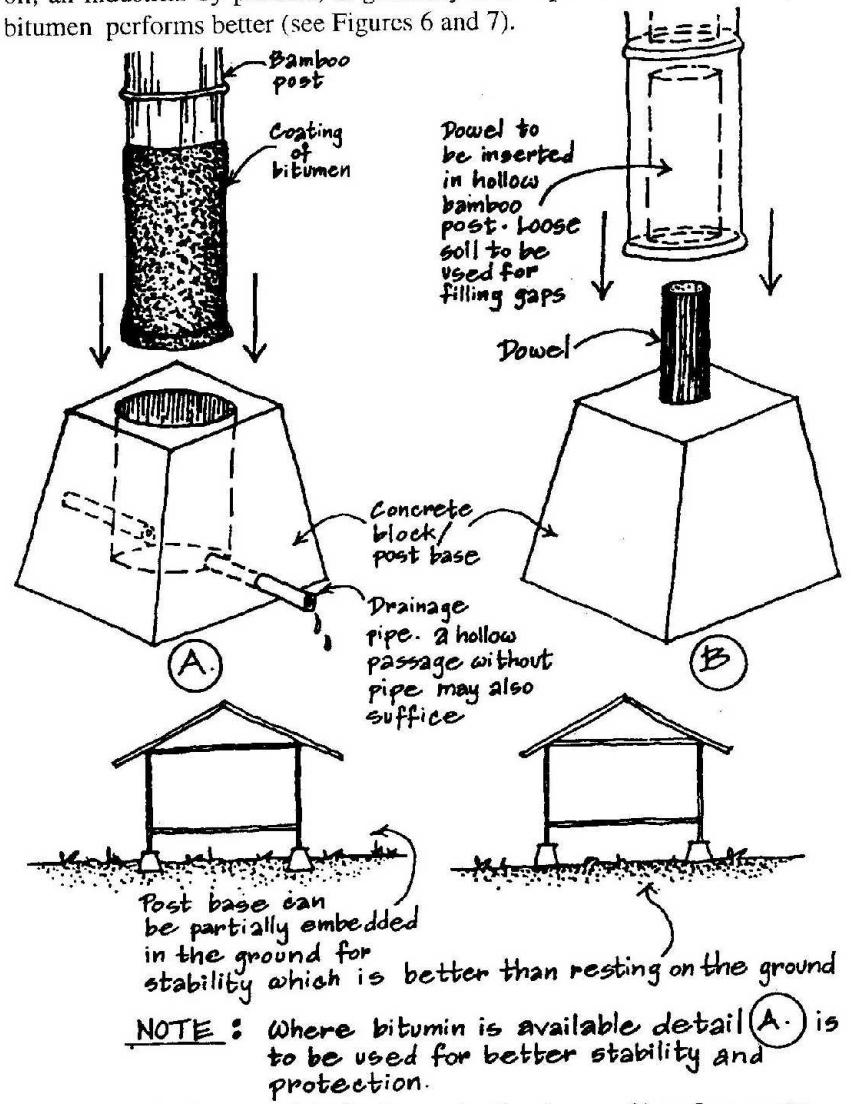


**Figure 6 : Concrete blocks for protecting bases of bamboo posts**
(Ahmed, 1994)

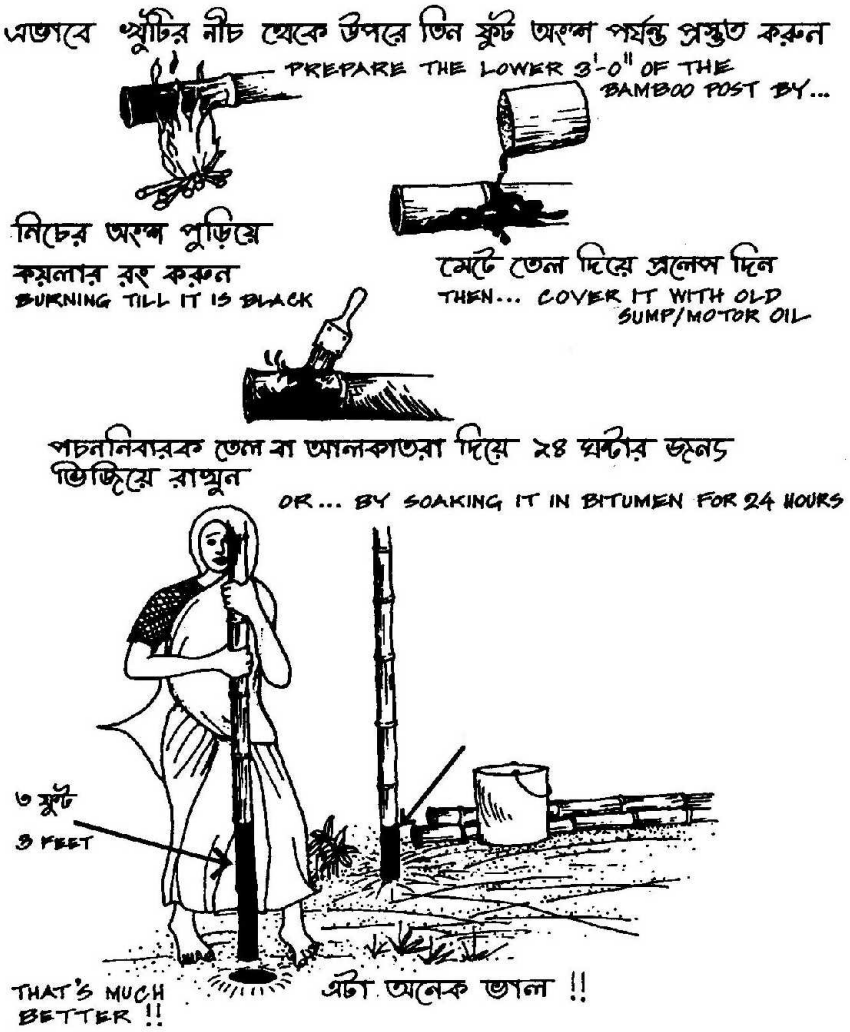


**Figure 7: Inexpensive treatment method for bamboo post base**
(Ahmed, 1994, adapted from Chisholm 1979)

Such methods indicate that improvement at low cost and in keeping with local building patterns is possible. Research into such methods and ways of introducing potentially effective innovations to rural communities is needed. Most such research lacks dissemination; good publicity for successful research into technological improvements for rural dwellings is essential.





**Dissemination of Research Findings**

Lack of dissemination of potentially effective technologies is a problem. Technologies designed by professionals or in research institutions, quite often technically sound and tested rigorously may result in cost effectiveness if implemented. However, comparatively few have achieved widespread impact and social acceptance (Spence, Wells and Dudley, 1993). There is little detailed research on aspects of social success or post-project performance.

For example, in Bangladesh where mud houses are greatly susceptible to hazards such as floods, many collapsed in 1987 and 1988 in areas where floods were unexpected (Dunham, 1989 UNDP, 1987). Building with cement/lime stabilised earth blocks may help to overcome this collapse (SKAT, 1991; UNDP, 1987). The national House Building and Research Institute has undertaken extensive research into improved methods of mud construction. However, in spite of all the suggested improvements, there are very few examples of application in the field or dissemination of findings exist (SKAT 1991).

Problems in research dissemination are indeed formidable. Yet some guidelines might facilitate it:

1. Any increase in cost, even slight, meets resistance from poor communities who survive on subsistence incomes. Technologies clearly have to be combined with access to funds. The Grameen Bank demonstrated the potential for such a course.
2. Poor communities, especially those in vulnerable situations and exposed to hazards, are reluctant to take risks with new and unfamiliar technologies. Demonstration through pilot projects are needed. New technologies used in institutional or community buildings often convince local communities of their merits. In a housing project in Zambia for instance it was initially conceived that machine-pressed stabilised earth blocks were for use for house building, and blocks were made available to project beneficiaries. However, they did not prefer the blocks, which were then used in building a school. This highlighted their effectiveness and attractiveness; local households then began using them for their houses (Goethert, 1990).
3. Rural development programmes run by agencies need to be supplemented by research institutions, leading to a two way process. Feedback from the field enhances the work of research institutions and field-based agencies benefit from the expertise of research institutions. The Grameen Trust Programme for Research on Poverty Alleviation is a move in this direction; academics and professionals contribute the results of research to field-based projects, leading to a channel for dissemination.

4. Agencies working in the field need to connect to existing bodies of information. For example, as suggested by Hall (1995), improved construction technology with bamboo developed in central America and the Solomon Islands, could have relevance to Bangladesh. International linkage may have much to offer.
5. Again, as suggested by Hall (1995) support to extension workers by manuals, books and instruction sheets on construction methods prepared by professionals/ academics may be useful. Such literature should be prepared in local language, with pictorial matter for effective communication, and mass or popular media may also utilise these methods. Documents in a technical language that confines it to experts is not useful; they have to be translated into simple, easily comprehensible form for rural populations.
6. Post-project evaluation with surveys of user needs is a necessary component of any applied research, and also provides an opportunity to assess receptiveness of communities to new technologies. The author's research for the Grameen Trust (Ahmed, 1995) suggested a survey to compare responses of current users of Grameen Bank posts and prospective beneficiaries, to assess perceived problems with current posts and receptiveness to the idea of hollow posts. This would encourage participation, and assist in understanding the potential for acceptability at community level.

## Conclusions

Dealing with natural hazards is linked to a wider set of social, cultural, economic and environmental issues; technological innovation has to be understood with respect to these. Technologies that appear sound are sound only if able to reach the community in a participatory manner and enhance aspirations that the community has.

Environmental hazards and the crisis of natural resources in Bangladesh have greatly impaired the ability of low-income rural communities to resist future hazards. The initiative of agencies, such as the Grameen Bank, to assist them is encouraging. But such agencies cannot work well in isolation; they need much support from other quarters. This paradigm of vulnerable communities, agency intervention and need for further professional support is illustrated by the case of R.C.C. posts in this paper (see Figure 8).





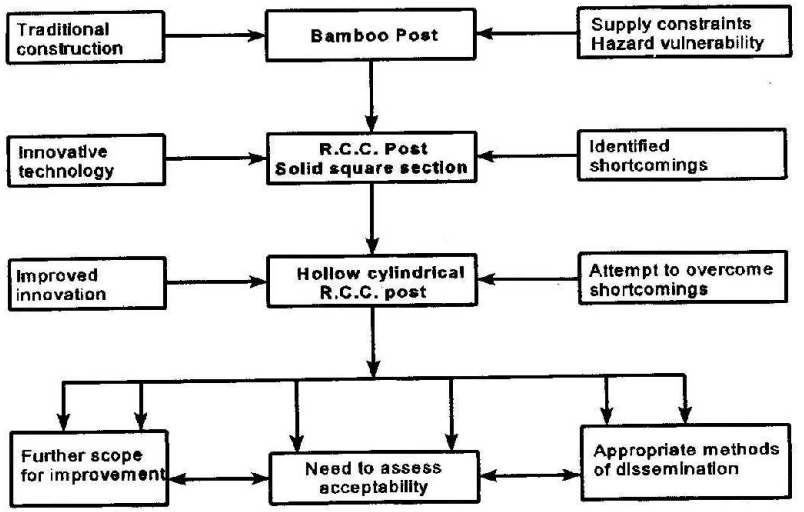


**Figure 8 : Case Paradigm of R.C.C. Post**

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