Community Development Centres and Cyclone Shelters
Cox’s Bazar District, Bangladesh

I. Introduction

Three Community Development Centres and Cyclone Shelters (hereafter called Cyclone Shelters) were commissioned by PRISM (Projects in Agriculture, Rural Industry, Science and Medicine – an NGO with a Bangladesh office). The three structures are located in the upazilas/thanas (sub-districts) of Chakaria, Maheshkhali and Kutubdia respectively, within the Cox’s Bazar district of Bangladesh. The district is almost completely flat and only a few feet above sea level. The entire western coast and the islands are open to the Bay of Bengal and are vulnerable to cyclones and tidal waves. The population, which is concentrated mainly in villages, comprises farmers, farm workers, fishermen and salt-extraction labourers. They live in homesteads, which tend to be blown or washed away during storms. The shelters, therefore, serve as sanctuaries for the local communities and their livestock when cyclones and tidal waves occur. At other times the Cyclone Shelters are used as PRISM’s area office, as the local dispensary, and as a place where groups involved in various development programme activities (such as income generation and informal education) can hold meetings. The shaded space on the ground floor is generally used for spontaneous gatherings and other combined endeavours. The local communities view these majestic structures in their villages with a sense of pride.

II. Contextual Information

a. Historical background

Bangladesh, a low-lying delta nation at the foot of the Himalayas, is prone to many natural disasters, especially floods and windstorms – including tornadoes and cyclones. More than three million people live in high-risk areas along the 400-kilometre coast. The deadly cyclone of April 1991 killed more than 138,000 people, injured about the same number and left more than 300,000 homeless, bringing the count of those affected by the disaster to about 15.5 million, with an estimated damage of USD 1.8 billion. Following this the government of Bangladesh, along with many international NGOs, began a programme of disaster preparedness and management, which included the construction of cyclone shelters in vulnerable coastal areas. Today a disaster warning system and evacuation procedures are in place, alongside around 1,200 multi-storeyed concrete cyclone shelters along the coastline. Consequently, in the severe cyclone of 1997, even though the number of people made homeless reached one million, the number killed and injured were 111 and 10,000 respectively, demonstrating a great improvement over the 1991 figures.

In response to the disaster of 1991, many of the NGOs involved in relief operations also decided to build cyclone shelters. The Public Works Department, Bangladesh Red Crescent Society, Christian Commission for Development and CARITAS had already begun to build such shelters. In addition, new projects were sponsored by the Bangladesh Rural Advancement Committee, the Grameen Bank, PRISM, the Japanese International Cooperation Agency, the Swiss Red Cross, as well as Saudi-sponsored shelters designed by...
government departments, and European Union-funded schools and cyclone shelters. All these are multi-storeyed and have different designs. In addition, PRISM Bangladesh, which was already running various community-based programmes in the islands, sought funding from Catholic Relief Services in the United States to build community development centres in their areas of operation which would serve as shelters during the time of cyclones and tidal waves. The Cyclone Shelters aimed to respond to the needs of local communities, facilitate the NGO development programmes, and meet requirements at times of emergency. In short, the aim was to provide multi-purpose facilities that would also incorporate protection during cyclones.

\[b.\] \textit{Climatic conditions}

The three sub-districts where the cyclone shelters are located lie between 21°05’ and 21°55’ northern latitude and 91°50’ and 92°05’ longitude on the south-east coast of the Bay of Bengal. The region has a tropical monsoon climate, with heavy rainfall from late April to September. January is the coolest month, with the lowest temperature hovering around 10°C. The low, flat terrain, a ‘funnelling’ coastal configuration, and frequent severe tropical storms combine to produce an average of one major cyclone every three years. The worst seasons are April to June and October to November, and Cox’s Bazar is the area where damages most frequently occur. Unlike other places in Bangladesh, where the wind blows from the south-east, in Cox’s Bazar it blows from the south-west.

These conditions allow for the cultivation of rice, the extraction of salt, and fishing, making the people relatively affluent compared with those in the northern parts of the country. Unfortunately, however, the location is hazardous and vulnerable, causing repeated dislocations of the population.

\[c.\] \textit{Site, surroundings and topography}

At Chakaria the Cyclone Shelter is located in Ujjaintia village. Formerly an island, Chakaria has now become part of the mainland and is accessible via a brick-paved road and muddy tracks. At the time of construction the road was non-existent. The Cyclone Shelter on Maheshkhal Island is located in Deshi Haji Para, and that on Kutubdia Island is in Ali Akbar Deil. Both these islands are accessible by speedboat (only operating during daylight hours) or truck boat from the port at Cox’s Bazar. During low tide the boats cannot reach the shore and it is only possible to reach the pier by gliding through the slippery mud or by hopping over a chain of no fewer than twenty-five boats.

The area is rich in vegetation. Trees, along with the indigenous houses, dominate the landscape of the coast and the islands. The concrete cyclone shelters provide local landmarks.

All of the sites are flat, with the structures being raised above ground to protect during cyclones. They are situated on agricultural land, which includes paddy.
d. Local architectural character

The traditional houses in the high-risk cyclone zones of the Cox’s Bazar district blend with their natural surroundings. Their orientation, layout and roof shape have developed in response to the harsh climate, the local topography and the building materials available in the area. Bamboo or wood is used both for vertical support and for roof trusses (in thatch or sheet form), while bamboo mats or wood planks are employed to create walls. Steel and pre-cast concrete sections can now be occasionally seen, but they are still rare. The bamboo used for building is not treated and is therefore susceptible to attack by fungi, termites and marine bore. The craftsmanship seen in the use of local materials demonstrates a continuity of knowledge and collective experience.

The indigenous houses typically have a pashchati (common area) and a ghar (private area). The walls around the pashchati, especially in the case of the mat wall, contain the water that penetrates the ghar during gusty winds with heavy rains. In order to reduce high pressure on the internal surfaces of the wall the houses have only one opening, which can be secured during a cyclone. The houses are light and are not anchored firmly to their foundation. When subjected to external pressure and suction caused by heavy winds, therefore, they tend to blow away. Some houses are pucca (permanent) structures with brick walls. The main towns and bazaars tend to have pucca structures.

III. Programme

a. Programme formulation and objectives

The Cyclone Shelters were conceived as a focal point for the development activities of PRISM Bangladesh and the community/village in which they are located. The building process involved dialogue with the community. The programme required that the centres should respond to the needs of the community both in normal times and at times of crisis. As a result they are designed to be in full time-use for community development activities, and also to be used as shelters during cyclones and other similar disasters. Having observed other cyclone shelters, PRISM, along with the architect, developed a design programme that would be appropriate for multi-purpose use.

b. Functional requirements

The Cyclone Shelters were planned to accommodate about 1,500 people and numbers of valuable livestock during cyclones occurring within a 1.5-kilometre radius. For regular activities each centre was planned to serve as a health clinic with a medicine dispensing area; as a seed/grain store; as a focus for education, training and community information; and as a communication centre and office for PRISM. The requirements included water and sanitation facilities within the main structure. Both the upper floors have toilets. In evolving the design brief special consideration was given to the use of the shelter in normal times; to disaster preparedness; to capacity; to livestock protection; and to maintenance and construction details.
IV. Description

a. Building data

A three-storied structure with a hollow ground floor, each Cyclone Shelter is built upon a platform 60 centimetres above the site level and reaches a height of 12 metres including the platform and the parapet. The first floor, accessible by a ramp, is at a height of 4.6 metres to safeguard livestock during a cyclone. A staircase from the first floor goes right up to the roof via the second floor. Altogether the area comes to around 725 square metres, including the roof. The standard adopted has been to provide 0.46 square metres per person to allow them to sit comfortably on the floor during storms. It is assumed, however, that people will continue to take shelter there even when it is filled to capacity, which may reduce the space per person to 0.14 square metres.

b. Evolution of design concepts

The design is the result of a synthesis of a number of factors: the programme requirements; the adoption of a logical structural system; the construction budget; and the architect’s understanding of the interaction among space, form and milieu. The heights of the different floors were dictated either by external forces or by practical considerations regarding their planned use. Although function and context were decisive factors in the design of floor heights, ramp, structural elements and finishes, these elements have been brought together and presented as a cohesive architectural expression within a rural environment.

The spaces are well-conceived vis-à-vis their relative functions. The design takes into consideration the development programme activities of PRISM; questions of gender; the accommodation of livestock; the safety of the users; appropriate water and sanitation facilities; air circulation; and anticipated hazards.

At Chakaria the land for the Cyclone Shelter was donated by the then-chairman of the PRISM Council; in the other two cases PRISM bought the construction plots. In all cases the land has been transferred to the name of PRISM. Each Cyclone Shelter is sited upon agricultural fields. The structure is robust, but the use of natural-colour concrete means that it blends in with the rural landscape. There is no boundary wall, which asserts the fact that it is open for community use.

The pillars that hold the structure above the ground, combined with the cantilevers and the tapering of the beams, imbue the building with a sense of lightness. The downward slope and corner curvature of the walls allow the rainwater to slide off, and also soften the appearance of the structure. The massing and articulation of the design gives the building a dynamic feel and has added to the vocabulary of designs for utilitarian buildings. Based on the concept of creating resistance against cyclones, the structure as a whole exudes boldness while at the same time depicting movement and avoiding the monotony one would expect in such a building. While creating a permanent architectural statement the Cyclone Shelters relate to the rural indigenous housing by being simple, functional and free of decoration.

Community Centre & Cyclone Shelter, Various locations, Bangladesh
c. **Structure, materials, technology and building services**

The Cyclone Shelters are reinforced concrete structures designed to withstand cyclonic winds with speeds of up to 260 kilometres per hour. Because of the low-bearing capacity of the soil, together with anticipated wave action and soil erosion, the foundations are constructed to a depth of 2.7 metres. Investigation of the soil was of paramount importance when designing the structure. The 4.6 metre high ground-floor pillars are braced to minimize the bending movement when subjected to lateral load caused by the stormy winds. This height was determined by the need to resist tidal surges of up to 4.6 metres (each site is around 1 kilometre from the shore). The bars in the peripheral pillars have tension loops, while the internal pillars have compression loops. Beam stirrups extend into the pillars, tying the entire frame together. The beams are 60 centimetres deep; over a length of 120 centimetres they are cantilevered and tapered by 30 centimetres to support the ramp and the overhang on the floor above. The strength of concrete used is 20,684 Pascals.

Being finished in concrete, the buildings call for little or no maintenance. Chemical hardener has been used in the concrete mix to attain minimum porosity, so that there is the least possible water absorption. The partition walls dividing the internal spaces are 12.5 centimetres thick and of exposed brick.

Doors and windows are of wood. There is no glass in the windows so as to avoid accidents; instead, wooden louvres are employed and these can be adjusted for light and air.

Fresh water is supplied through tube wells and is available on the premises. A septic tank is provided at the rear to take care of sewerage waste. Complete internal wiring has been carried out on all Cyclone Shelters, irrespective of the availability of electricity in the area, in order to cater for future requirements.

d. **Origin of technology, materials, labour force and professionals**

**Technology and materials**

The materials and technology used in the construction of the Cyclone Shelters are not new to the country, and have been appropriately employed. The locally available building materials – bamboo, untreated wood, and bamboo mats – are impermanent, and for this project permanence and strength of materials were imperatives. Hence the materials used to construct the Cyclone Shelters – namely cement, steel, aggregates, stones and wood – had to be transported by boat from Chittagong to the various islands. The materials were unloaded at the pier, and from here were either carried on shoulders or loaded on pushcarts for transfer to the construction site. To obtain good quality casting and *in situ* concrete construction, steel shuttering were used, again transported to the site via Chittagong port. The use of steel shuttering was a new element in construction for the locals. Care was taken to limit the construction materials to concrete and timber in order to avoid the expense of procurement and transportation from faraway locations.
Labour force

The project gave an opportunity for locals to participate as unskilled labour in raising the structures, and gave them exposure to reinforced cement concrete construction. Since experience of concrete construction was uncommon locally, all skilled labour was brought in from either Dhaka or Chittagong. Local carpenters had an opportunity to brush up their skills by working with carpenters from the cities. Concrete construction is not the norm in these areas and the local construction labour force does not have regular opportunities to work with these materials; for this reason no formal training was given during construction.

Professionals

The architect, consultants, contractor and client are all Bangladeshi nationals based in Dhaka. The client, however, has area/field offices in all three project areas. The professionals' commitment to this project, which is of benefit to the whole community, is demonstrated by the logistics involved and by the end product.

V. Construction Schedule and Costs

a. Project history

The programme was formulated during the relief operations that followed the disastrous April 1991 cyclone. PRISM wanted some space for implementing its health, education and economic programmes, and the relief operations assisted them in formulating the concept of a multi-purpose shelter. Financing was then required, and later in 1991 the US organization Catholic Relief Services agreed to fund the project. The designs were in due course completed and in October 1992 the government granted approval for construction. Building construction in all three sites began almost simultaneously, first in Chakaria followed by Kutbdia and then in Maheshkhali. All three buildings were completed by the end of 1993.

b. Total costs

The cost of construction incurred on one Cyclone Shelter was BDT 3,900,000 (USD 100,000). The total cost of construction of all three units, including consultancy and supervision, services amounted to BDT 12,168,000 (USD 312,000). The cost of construction per square foot works out at USD 14.60. This cost is minimal when compared with the great benefit that the communities derive from the Cyclone Shelters.

c. Comparative costs

The average costs per square foot of the PRISM Cyclone Shelters was BDT 520, which is the lowest of all community centres/cyclone shelters built during this period. The highest cost incurred was for that built by the Local Government Engineering Department (at BDT 1,604), followed by those funded by the European Union (BDT 1,111), Saudi Arabia (BDT 1,040), and the Bangladesh Red Crescent Society, Grameen Bank and the Bangladesh Rural Advancement Committee (BDT 800). It should also be noted that in spite of being the lowest
in cost, the Cyclone Shelters under review are the only ones that cater for livestock as well as humans, and are also the largest in terms of covered area.

d. Maintenance costs

The project has been designed to ensure minimal maintenance. The shelters have been in use for the past seven years and no repairs have been necessary. The façades tend to collect grime, but this can be easily brushed away.

The cost of structural upkeep is minimal or non-existent. No major maintenance works, either structural or related to plumbing, etc., have been recorded to date. The running cost of the centres is also minimal. Chakaria has a windmill-generated electric unit, Kutubdia has no electricity, and Maheshkhali has a regular, metered electrical supply. Water is available through the centres' own tube wells, which were installed during construction.

VI. Technical Assessment

a. Functional assessment

The flexible design of space within the Cyclone Shelters allows them to cater for multiple activities. Each floor can be used in its entirety and enjoys a pleasant breeze as a result of openings on two opposite sides. The hollow ground floor, the roof and the two floors in-between can be used for different purposes simultaneously without disturbance, as a result of the staircase being placed on one side. The provision of a ramp facilitates disabled access to these shelters. Unlike other such projects, these Cyclone Shelters have toilets and water taps on each floor, an idea that has proved very successful. The grain store allows people to safeguard their limited supplies during cyclones; it is also used by PRISM to store emergency feeding supplies for cyclone victims, especially for small children who spend a couple of days in the shelter after the cyclone has passed. Overall, the basic necessities for times of crisis have been thought through, spaces have been planned accordingly, and the buildings have been well used.

b. Climatic performance and lighting

The interiors receive maximum light when the windows are open. The louvred windows allow for some light penetration when the shutters are closed while also permitting continuous flow of air across the halls. The building remains comfortable throughout the day, as the halls are not directly exposed to the sun.

During cyclones there is not much light outside and the interior tends to remain dark; however, even when the shutters are drawn, fresh air filters through the louvres to ensure that the inside environment does not become claustrophobic. In some ways these louvres behave like the air-permeable bamboo-mat walls found in indigenous houses. Despite the fact that all surfaces are hard there is little problem with echo, but the cross-breeze tends to diminish audibility within the interior during normal times. This may be an advantage, however, when the shelter exceeds its capacity during cyclones.
c. **Response to treatment of water and rainfall**

Since these centres are used in cyclones, in which storms are generally accompanied by rains and/or tides, the Cyclone Shelters are designed so that the water flows down the roof, through the spouts, and then drains off. Although pitched roofs are generally seen as the most efficient solution for areas susceptible to torrential rains, to provide useable space the Cyclone Shelters have flat roofs with a gradual slope to allow for gravitational flow. The roof floors are coated with lime, which appears to have worked well and they have withstood the ravages of sun and rain for a number of years. There is no evidence of water seepage inside the buildings.

d. **Response to & planning for emergency situations**

The Cyclone Shelters are purpose-built to handle emergencies. With a well-equipped warning system now in place there is ample time for people to reach the centres, thus avoiding a panic situation. The Cyclone Shelters work well both as mass gathering places during an emergency and as transit centres after a cyclone has passed.

e. **Ageing and maintenance problems**

The Cyclone Shelters have been in use for the past seven years, and have withstood a number of cyclones without needing maintenance. At present there appear to be no major problems in the structure or the services. There are, however, a few minor maintenance issues. The exteriors of the buildings have over the years collected layers of soot-like dust, making them grey in colour; this appears to have been overlooked by the organization in charge. Another problem has been the operation of the louvred windows, which tend to get jammed due to the use of improper hardware and lack of maintenance. In Maheshkhali a further problem has arisen: in spite of the concealed wiring done during construction, when an additional electric meter was installed and the system extended, careless workmanship resulted in exposed wiring. It would appear that the area office staff takes such maintenance decisions locally without consulting the head office or the architect.

f. **Design features**

Following the overall brief and the technical requirements of the facilities, the buildings have responded very well to their multi-purpose needs. At the same time the architect has tried to make the overall form interesting. The tapering of the cantilevered beams, and the curving of the façades and the grain stores are features which demonstrate that the designer has taken his role seriously; he has presented to the rural communities utilitarian structures that are also pieces of ‘architecture’, while at the same time enhancing the community’s spatial needs.
VII. Users

a. Description of those who use or benefit from the project

All the Cyclone Shelters are in areas where they are of great value to their communities; indeed, they are lifesavers for them and their livestock during cyclone emergencies. The Cyclone Shelters are a source of great pride to the people living in these areas, and they know that even in normal circumstances they are free to use the centres as they desire.

The buildings are still under-utilized during normal times, however, as the potential for use throughout the day is tremendous. Though these are Community Centres, there is no sense of ownership (even social) within the community as all decisions regarding their use are made by PRISM, who is the legal owners of these facilities.

b. Response to project by clients, users, community

In other projects of this nature the involvement of architects has been minimal; professionals have usually only been involved to the extent of engaging civil/structural engineers, as it is recognized that these need to be ‘functional and strong buildings’. At the same time, few architects are interested in going to remote places and designing buildings that will not be widely seen. His peers and the new generation of architects alike respect the architect for the Cyclone Shelters: his works are appreciated as being relevant to their context and to the social and economic condition of Bangladesh.

The impact of these projects may be judged from an independent assessment of the designs and performance of all the existing cyclone shelters in Bangladesh, commissioned by the Swiss Red Cross. (The results are shown in Table 1, attached below.) Based on the results of this assessment the architect of the PRISM Cyclone Shelters was assigned to design the Swiss-sponsored community-based cyclone shelters, which went through a process of community participation and have a local management committee.

Although the Cyclone Shelters programme itself did not seek the involvement of the community during the evolution, planning and construction of the buildings, the project is responsive to the needs of the communities. Not having gone through the process of community participation, the communities distance themselves from issues regarding the buildings, but this does not affect the extent to which they use the facilities. The only complaint that the local communities have, at all three locations, is that ‘the building lacks colour; instead of grey concrete it should be painted in bright colours’.
Table 1: Assessment of cyclone shelters in Bangladesh

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VIII. Persons involved

Client: PRISM Bangladesh (chairman, Mr Ikramullah).
Structural engineer: Dr Syed Fakhrul Ameen.
Contracting company: Bricon Engineers and Construction Company.

Khadija Jamal
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