<table>
<thead>
<tr>
<th>3. TITLE AND SUBTITLE (240)</th>
<th>CMU/Intertect ultra low cost shelters in relief situations in Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSONAL AUTHORS (100)</td>
<td>Goodspeed, C. H.; Hartkopf, V. H.; Cuny, F. C.</td>
</tr>
<tr>
<td>CORPORATE AUTHORS (101)</td>
<td>Carnegie-Mellon Univ. Interdisciplinary Working Party; Intertect</td>
</tr>
<tr>
<td>DOCUMENT DATE (110)</td>
<td>1977</td>
</tr>
<tr>
<td>NUMBER OF PAGES (120)</td>
<td>18p.</td>
</tr>
<tr>
<td>ARC NUMBER (117)</td>
<td>RG391.54. G655</td>
</tr>
<tr>
<td>REFERENCE ORGANIZATION (130)</td>
<td>CMU</td>
</tr>
<tr>
<td>SUPPLEMENTARY NOTES (500)</td>
<td></td>
</tr>
<tr>
<td>ABSTRACT (950)</td>
<td></td>
</tr>
<tr>
<td>DESCRIPTORS (920)</td>
<td>Bangladesh Low-cost Housing Emergency relief</td>
</tr>
<tr>
<td>PROJECT NUMBER (150)</td>
<td>931022100</td>
</tr>
<tr>
<td>CONTRACT NO. (140)</td>
<td>AID/TA-0-1345</td>
</tr>
<tr>
<td>CONTRACT TYPE (140)</td>
<td></td>
</tr>
<tr>
<td>TYPE OF DOCUMENT (160)</td>
<td></td>
</tr>
</tbody>
</table>
CMU/INTERTECT ULTRA LOW COST SHELTERS IN
RELIEF SITUATIONS IN BANGLADESH

Review of Work Accomplished
under Feasibility Contract no. AID/ta-C-1174
and Present Contract no. AID/ta-C-1345

Interdisciplinary Working Party
Carnegie-Mellon University
Pittsburgh, Pa., 15213
May, 1977

CMU Co-Principal Investigators

Charles H. Goodspeed
Assoc. Professor, Department of
Civil Engineering, CMU

Volker H. Hartkopf
Assoc. Professor, Department of
Architecture, CMU

Director, Advanced Building
Studies, CMU

Consultant

Frederick C. Cuny
Partner-in-Charge
INTERTECT
Dallas, Texas

The two-year evaluation of the emergency shelter was conducted by Everett Ressler. This report was written with the assistance of Carolyn Weisner.
I. **Introduction**

The following is a report to the Agency for International Development on the two-year evaluation of the CMU/Intertect refugee shelter field test in Bangladesh. The test shelters were built during Spring, 1975, and revisited during Spring, 1977. For an account of the testing program, please refer to the *Feasibility Test of an Approach and Prototype for Ultra Low Cost Housing*. Final Report to the Agency for International Development, ARC:301.54, G655; TA/OST 75-26.

II. **History of the Project**

In 1973 an interdisciplinary team of architects, engineers, planners, and sociologists was formed at Carnegie-Mellon University in Pittsburgh, Pennsylvania, to develop shelters for emergency use in developing countries. The team consisted of professionals from Carnegie-Mellon and from Intertect in Dallas, Texas.

Beginning in Fall, 1973, several prototypical shelters were developed and tested in the Carnegie-Mellon laboratory and in the jungles in Guatemala. Materials used were bamboo, wood, juterope, grasses and palm leaves, and stabilized soil.

Simultaneously, interdisciplinary courses were conducted in Emergency Habitat. Students submitted two entries to the 1975 competition for the UNESCO Prize held in conjunction with the XII World Congress of the International Union of Architects, Madrid, Spain, and received the Prize of the Soviet Union.

During Spring, 1975, under contract from the Agency for International Development (A.I.D.), U.S. Department of State, (contract no. AID/ta-C-1174) tests of the A-frame were conducted under actual field conditions in Bangladesh. Several test sites and programs were chosen. They were:

--- Rehabilitation of a section of Mirpur
--- Prototype for construction for Demra
--- Prototype for Tongi
--- Village of Kunda, Comilla District

In June, 1975, Dr. Vijai Singh, a sociologist from the University of Pittsburgh, visited a number of the test sites to evaluate the cultural acceptability of the units in their various roles and to report on their status several months after occupancy. Details of the testing program and of this preliminary evaluation are provided in the *Feasibility Test of an Approach and Prototype for Ultra Low Cost Housing* cited above.

In June, 1976, A.I.D. granted a new contract to the CMU/Intertect team (contract no. AID/ta-C-1345). One phase provided funds for a two-year evaluation of the project in Bangladesh in Spring, 1977. The following sections discuss the findings of this evaluation.
III. Two-Year Evaluation of CMU/Intertect A-Frames as Emergency Shelter in Bangladesh

General Impressions

The status, or general condition, of the people living in the relief camps is difficult to describe or analyze. The first impression was very positive. The camps (Mirpur, Demra and Tongi) all had a feeling of life and vitality, best characterized by activity.

The camps appeared orderly and clean. The small, self-constructed minimal shelters, that characterized the camps initially, have almost entirely been replaced with housing units provided by international donors and the Government of Bangladesh.

There appeared to be an expanding number of shops and markets in each camp, producing and selling a wide variety of utilitarian items. This atmosphere may reflect the reportedly improved economic condition of Bangladesh.

Impressions of the residents in the camps were also positive. The children appeared well cared for and happy. Many are attending school. The women were actively involved in activities, and many men reportedly were working in Dacca.

Status of Camps

The status of Mirpur, Section XVI, remains as uncertain as it has for the last several years, with frequent rumors that it is to be moved immediately. In general, however, the orientation of the Government seems to be the acceptance of bustee camps as permanent residential areas; and they are reported to have granted land holdings to some residents.

Since the 1974 repatriation by Pakistan, there has been no further major repatriation of the Bihari people. The stance of the Bangladesh Government towards the Bihari people appears to be changing with an increasing acceptance. There is reportedly a movement to give back houses to the Bihari people and to grant them land.

The camps are still generally administered by camp committees and relief agencies. The Mennonite Central Committee, who held responsibility for the Mirpur camp, has turned over all responsibility to the camp committee as of February 1, 1977. The camp committees appear, however, to be quite tenuous and very political.

Background

The first block of the CMU/INTERTECT houses were completed in May 1975, and from the date of completion the shelters have been completely occupied. It is from this perspective of time and nearly two years' use by the residents that information about these shelters is collected.
A. Observations of Use

1. Care of the Structures by Occupants:

A general inspection revealed the units to be in good condition. There is no evidence of abuse. The inside was, without exception, clean and well cared for.

The structural component which showed the most wear was the door. Doors were often patched and reinforced. These repairs are indicative of personal input into maintenance.

The ropes used as cross-braces were often very loose but were intact. There was no evidence of the cannibalization of any part of the structure.

2. Occupancy:

The occupancy rate appears to have remained about constant with three-to-five families per unit. There were several exceptions where units had been taken over largely by one family. There existed an obvious orientation for family units of the same family grouping to be living in the same shelter. This appeared to be positive.

3. Modifications:

No modifications to the main structure were noted, nor have there been any real alterations of entrance, windows, ventilation systems or storage areas. (The comment most often heard regarding any modifications was an affirmation of how poor the family was.)

The most significant changes are the additions being made to the A-frames. The common courtyard, designed for a garden, has in part been taken over by family enclosures built around the doors of the units. This addition, common to all types of structures in the camps, is a fence or barrier which is built to provide a small, protected area through which one must pass to reach the door. Within these enclosures, small bamboo structures are being erected and used as living quarters.

4. Problems:

The major disadvantage of the A-frames is the floor space lost because of the shape, which is significant in such a small living area. The problem with using this space for storage is that materials stored at ground level are more likely to be damaged by rats and rain.

5. Impact of Design:

No evidence was seen that would indicate any incorporation of the principles of triangulation used in the A-frames, or of the venti-
lation systems used, in any other structures built in the area. All structures in the vicinity of the A-frames -- even those adjacent which were damaged by the wind storm of November 1976 -- were rectangular and conventionally built. All additions built within the enclosures (as described in "C" above) were rectangular and conventional.

In Demra, the Mennonite Central Committee has been using an A-frame for a family planning clinic. When a second building was needed, a traditional bamboo building was constructed. Although the A-frame in use was defended as strong, useful and cool, the traditional type was built because "permanence was needed and the traditional type was cheaper". This conclusion was often heard.

The one example of carry-over of the design was seen in Demra where A-frames were built; but the original design of the CMU/INTERTECt team was significantly modified. The units were designed to be two-family units, and the doors were moved from the sides to the ends. Windows were eliminated. The roof was constructed of bamboo mats and plastic, and the amount of bamboo was reduced. The cost was much more comparable with that of conventional bamboo shelters. The design was changed because the CMU/INTERTECt structures were considered too complex, more costly, and they required much closer supervision during construction. The modified structures were quite dilapidated and had the following overt problems. In the first place, the November 1976 winds had torn off the ventilation flaps and some had not been replaced. In one, the peak had been rounded which prevents any ventilation. Secondly, the main structural poles had sheared off at ground level during the wind. Finally the shelters were hotter and darker than those provided by the CMU/INTERTECt Refugee Housing Team. In general, this use (or mis-use) of triangulation provided very poor shelters.

B. Acceptability

The acceptability of the structures is evidenced both through preferences verbalized by the occupants and through observations of use. As had been described, the shelters appear to be both occupied and cared for. From a cursory examination, there appears to be no negative social stigma associated with them. One indication of this is the fact that one of the administrators of a family planning unit lives with his family in one of the units. They have fenced in an enclosure, added a small separate building for sleeping, installed electric lights, and have made it quite an exceptional place.

The comment most often heard from the residents is that they would prefer a house like the other commonly built structures within the camp. The reason for this indicated preference may, however, involve more than preference for a particular shape of house. Other variables may include the amount of usable floor space, privacy within the structure, and degree
of autonomy from one's neighbors. Individual shelters are probably preferred over semi-detached and more certainly over multi-family units. There is no question, however, that the residents prefer a more conventional structure (brick is preferred). More study would be required to analyze this in detail.

Construction Detail

The shelters built as designed by the CMU/INTERTECT team appear to have been well constructed.

Frame: The frames appear in good shape with no splitting or undue sagging.

Bindings: Joints were checked and the bindings were found to be quite secure. In fact, no loose bindings were found.

Floor: The raised bamboo floor and the mud plinth floor both appeared to be in good shape with no obvious faults.

Roofing: The roofing is without question the most problematic component. In the houses where only bamboo shingles were used for roofing, there were complaints of leakage. The use of plastic between bamboo panels seems to have eliminated the leaks, but consequently has made the shelter much hotter, as it prevents air from circulating through the thatch.

Another problem evidenced with the use of plastic sandwiched between bamboo mats is that the plastic tended to slide down the roof. This was seen several times.

It was also interesting to note that bamboo was often slightly torn away from the part of the roof on either side of the entrance, near ground level. It was noticed only on the roofs made with bamboo and plastic.

Doors: The doors were certainly the most used components and consequently showed the most wear. Often the bamboo had come apart or the hinge arrangement broken. Some doors were reinforced and some replaced with cloth.

Windows or Ventilation Flaps: They appeared in good order.

Design for Wind Resistance: The A-frames were designed to be wind resistant. There is general acceptance that the design is an improvement over the typical bamboo structures, but field experience has provided little information of limits. The only significant encounter with the wind occurred in November, 1976. The wind strength was enough to damage large bamboo roof sections but did little other damage. No damage was sustained by the A-frames at that time.
IV. Evaluations by Voluntary Agencies

In assessing housing options for Demra, a more conventional structure was compared with the CMU/INTERTECT shelter and the following analysis was presented:

It was eventually decided to use the conventional pitched-roof design since, cost being equal, usable floor space was much higher than that of the A-frame. A-frames were very difficult to ventilate cheaply and simply, resulting in their being stuffy and hot; while conventional shelters enabled an air stream to pass between the side walls and the roofs. It was conceded that the A-frames had a stronger structural form, but it was decided that the rarity of a storm sufficient to destroy a conventional shelter counter-balanced this. Also, the conventional type was far more popular with occupants and helped create a more normal Bangladesh environment.

This analysis typifies the response and feeling of voluntary agencies involved in housing in the camps. It differs only in cost analysis. The A-frames are more expensive than the conventionally built shelters with equal floor space, if they are constructed as designed. Administrators could not justify the added expense in benefit to the people.

V. Conclusions

There may have been many attempts to develop a better emergency shelter using canvas, cardboard, plastic, metal, domes, etc. These proposed solutions have all had advantages and disadvantages. It is a comparison of the two that serves to pass judgment on the viability of the proposed solution. The basis of the decision is usually cost and acceptability.

The structures as tested by CMU/INTERTECT have proven that local materials can be used to build a more wind-resistant shelter. The experience of nearly two years' use has indicated that shelter's ability.

The disadvantages of the units lie in the low risk probability of wind damage in Dacca. If frequent threat of wind damage existed and the A-frames compared with the conventionally built bamboo houses, then the A-frames may prove to have a distinct advantage.

If, however, the risk of wind damage is negated, then the conventionally built houses have advantages with lower cost, more usable floor space, more traditional style, and may be easier to construct.

The sociological acceptability of the A-frames probably rests largely in use. Complaints about the shape were not heard from those families who had been able to acquire more floor space around or within the A-frame. More analysis, however, would probably indicate a preference for conventional-type structures.
The cost factor of the A-frames is a major consideration at field level. If the cost of these units is compared with the cost of brick shelters, then the units are a bargain. But field workers do comparisons between the least expensive options, and in this case they are much more expensive than the conventional shelters preferred by the occupants.

VI. Lessons Learned From Bangladesh Field Test

In conclusion, the following categories represent a summary of the lessons learned through the field test and the 2-year evaluation:

A. Context:

The field work in Bangladesh underscores the need for a specific response appropriate to each encountered situation, instead of universally fitting prototypes based on geographical and cultural considerations. Even within a single geographic and cultural region, conditions vary enough to cause significant design modifications from one relief situation to another. The original design was conceived to answer a situation like the one created by the massive influx of refugees into India during the 1971 War of Independence in East Pakistan.

Information the team obtained from relief organizations active in Bangladesh during 1972-75 indicated that the then prevailing situation, affecting large numbers of people, was virtually the same as the one encountered in India in 1971. As a result the team designed a structure to respond to those conditions. The field tests demonstrated, however, that conditions were in fact quite different in the encountered situations. Instead of being short term they were long term if not permanent. The major participants, the donors and the displacees, did not agree concerning the permanency of the camps. Relief organizations insisted the camps to be temporary, whereas the displacees have accommodated themselves for long term occupancy. As a result a structure was designed which was largely inappropriate. The relief agencies, not wanting to encourage permanency, considered the structures' strength and durability too permanent and costly. The occupants, on the other hand, knowing that the situation would be long term, complained about lack of space and privacy. This brings out three major points:

1. The design process must originate in the field.
2. Specific Designs cannot be transferred from situation to situation.
3. The original CMU/INTERTECT design concept and process remains untested.

B. Approach:

1. The design process must originate in the field. It is impossible for the designers to be completely aware of all the constraints unless they are on site and comprehend fully both the operational constraints and the local housing process.
Among the issues which the designers must take into consideration are how structures are built and what building skills are used locally, who participates in the building process, and how space is organized and allocated.

2. The process must involve from the outset all participants, including the victims and intervenors, which are donors and designers.

3. Critical constraints, particularly trade offs of desired performance and associated costs, must be established jointly. Critical cost levels, below which the safety of the future occupants cannot be guaranteed must be understood.

4. The final selection of suitable materials, components and layouts among the developed alternatives must rest with the future inhabitants.

5. Before beginning full scale construction, it is desirable to conduct small scale demonstration projects wherein occupants are provided with a range of options in order to select the most applicable design.

C. Structures:

The most important factor in developing designs acceptable to future occupants is cultural acceptability. This, in turn, depends largely on two major points:

1. The amount of useable space allotted per family and

2. The degree of resemblance to traditional forms the designs achieve.

Therefore, the designer must begin with indigenous designs and/or forms and analyze their appropriateness for the situation at hand. Should the indigenous structures exhibit deficiencies, modifications which improve performance (i.e. structural strength, suitability for mass construction, etc.) must be incorporated. To reiterate: the intervenor must begin with what already exists. Any modification must achieve utmost simplicity.

D. Sites and Services:

Sites and service considerations (layout, provisions of water, sanitation and services) are as important as the design of individual units. It can safely be argued that the quality of a camp environment is dependent on sites and services provided as on the designs of individual units.

E. Construction Process:

Methods chosen to train the construction teams did not prove effective in transferring the technology. More information must be developed on how to teach, how to transfer technology and how to present the information. (The team is addressing this area under the present contract.)
F. Operational Needs:

The experience indicates that the majority of agencies conducting housing projects are not fully cognizant of the differences in constraints imposed in different relief situations. This points to the need to assist agencies in assessing needs and constraints for each specific situation.

G. Spread effect:

The project demonstrates the failure of the concept of simply delivering materials and training aids to the disaster area and attaining a "spread effect." As stated earlier, the design process must begin on site and experience shows that trained personnel must be present continuously to promote new concepts or designs.

H. Timing:

The project underscored the importance of proper timing of construction. In most developing countries there is a "building season," in other words, a time when material, capital, and labor, combine to facilitate construction. Rarely, does a disaster alter this time frame. Unless the disaster occurs at a time when exposure risk is a major threat, housing construction will not tend to override other concerns. In the Bangladesh Field Test, the best time for construction proved to be the two months before the monsoon (March, April). The best time to evaluate performance was during and immediately after the monsoon, and the most logical time to initiate the second phase of construction was March, April, the following year. The team was unable to take advantage of these opportunities because of discontinuity in funding. In the future, to insure effectiveness, contracts must be structured to promote long-term continuity.
Rehabilitation of Section of Mirpur Camp, Spring, 1975

1. Conditions before rehabilitation

2. Work in progress—Levelling of land

3. Erection of A-frames
Rehabilitation of Section of Mirpur Camp (cont'd)

4. Cross-bracing and stringers attached

5. Making of bamboo shingles for roofing

6. Application of shingles
7. Apex of triangular door repaired

8. Modification of triangular door to become rectangular

9. Chicken coop integrated into entrance
10. Cross-bracing of A-frames during construction

It appears that some of the cross bracing has been removed to increase useable space. This shows a lack of structural understanding on the part of the residents.
Use of Outdoor Space Between CMU/I Structures at Mirpur
The layout of the rehabilitated section of the camp facilitated the structuring of a sequence of public and private spaces.
12.
15. General view

16. Entrance area

17. Untreated A-frame component sheared off in storm as a result of rot
Indigenous Village Housing in Khunda in Bramanbaria Area

18. Well-maintained house

19. Reinforced house — note angled bamboo posts meant to prevent structure from leaning

20. Structural as well as roof damage as a result of storm
Indigenous Village Housing Close to Khulna in Southern Bangladesh

21. Roof and wall connection, lack of triangulation

22. Joining of earthen plinth and wall

23. New house construction with earthen wall finished with cowdung plaster