Building Safer Houses in Rural Bangladesh

Salek M. Seraj and K. Iftekhar Ahmed

Bangladesh University of Engineering and Technology

Published by Bangladesh University of Engineering and Technology
Dhaka 1000, Bangladesh
URL: http://www.buet.ac.bd

First published 2004

ISBN 984-32-1280-5

Typeset, printed and bound by Progressive Printers Pvt. Ltd.
Nilkhet, Dhaka 1205, Bangladesh.

Contents

Preface 01

Foreword 04

1. Context of Housing and Hazards 06

1.1 Introduction 06

1.2 Design, Construction and Building for Safety 07
- 1.2.1 Types of Natural Hazards 08
- 1.2.2 Natural Hazards in Bangladesh 09
- 1.2.3 Impacts of Hazards on Housing 09
- 1.2.4 Review of Present Situation in Bangladesh 09
- 1.2.5 Government Policy 10
- 1.2.6 Engineered Housing 10
- 1.2.7 Non-Engineered Housing 11
- 1.2.8 Housing in Flood-Prone Areas 13
- 1.2.9 Post-Construction Repair and Retrofitting 14
- 1.2.10 Mud-Walling Technologies : Some Notes 14
- 1.2.11 Bamboo and Thatch 15
- 1.2.12 Improved Structures 15
- 1.2.13 The Way Forward 16

1.3 Some Key Issues in Building for Safety 16
- 1.3.1 Risk Assessment 17
- 1.3.2 Building for Safety 17
- 1.3.3 Effective Training 18
- 1.3.4 Community Based Programmes 18

1.4 Low-Income Housing Pattern 20
- 1.4.1 Method of Study 20
- 1.4.2 Questionnaire 20
- 1.4.3 Data Collection Area 21

1.4.4 Analysis 21
1.4.5 Housing Pattern 22
1.4.6 Implications 24

5 Rural Housing Typology, Construction Technology and Indigenous Practices 26
1.5.1 Rural Housing in Bangladesh 26
1.5.2 Some Important Characteristics 27
1.5.3 Design Process 27
1.5.4 Housing Layout 28
1.5.5 House Form 31
1.5.6 Amenities and Services 31
1.5.7 Construction Materials and Technology 32
1.5.8 Rural House Types 33
1.5.9 Bamboo Walled Houses 33
1.5.10 Mud Walled Houses 34
1.5.11 Timber Houses 34
1.5.12 Timber and Brick Houses 35
1.5.13 Corrugated Iron (CI) Sheet Houses 36
1.5.14 Thatch/ Straw Houses 37
1.5.15 Indigenous Practices in Rural Housing 37
1.5.16 Prospects 39

6 Role of Women in Rural Housing 41
1.6.1 Objectives of the Study 41
1.6.2 Methodology 42
1.6.3 Analysis of Findings of the Study 42
1.6.4 Interval and Involvement of Family Members in Construction, Repair and Maintenance 43
1.6.5 Sources of Funds and Types of Problems Faced by Women During Construction, Repair and Maintenance 44
1.6.6 Women's Contribution 45

1.7 Bamboo Cultivation and Rural Housing 46
1.7.1 Scarcity of Bamboo 47
1.7.2 Redressing Bamboo Scarcity 51
1.7.3 Bamboo Research –Stage 1 51
1.7.4 Bamboo Research– Follow-up 52
1.7.5 Need for Initiatives 53

1.8 Ethnic Housing Pattern in the Chittagong Hill Tracts 54
1.8.1 Socio-Cultural Aspects of the Ethnic Population 54
1.8.2 Worldview, Rituals and Housing 55
1.8.3 Land System 56
1.8.4 Settlement and Housing Pattern 56
1.8.5 Building Technology 58
1.8.6 Aesthetics 60
1.8.7 Usage of House 60
1.8.8 Adaptive Value 60
1.8.9 Other Housing Typologies 61
1.8.10 Importance of Ethnic Housing 62

2. Building Technologies for Hazard Resistant Housing 64

2. Introduction 64

2.2 Hazard Resistant Rural Houses 65
2.2.1 Development of Durable Plinth 65
2.2.2 Common Failure Modes and their Prevention 68
2.2.3 Properties of Bamboo as a Framing Material 70
2.2.4 Full Frame under Cyclic Lateral Load 72
2.2.5 Future Directions 75

2.3 Cyclone-Resistant Domestic Construction 76
2.3.1 Improved Domestic Construction for Cyclone Resistance 77
2.3.2 Hazard Class 78
2.3.3 Wind Risk Areas 79
2.3.4 CGI Roofing 79
2.3.5 Improved Traditional Construction 80
2.3.6 Siting and Layout 80
2.3.7 Plinth 80
2.3.8 Frame 81
2.3.9 Walls and Openings 81
2.3.10 Roof 81
2.3.11 Survival of Cyclone-Resistant Kutcha Construction 81
2.3.12 Tree Planting 82
2.3.13 Improved Pucca Construction 82

2.3.14 Implementing Improved Domestic Construction 84
2.3.15 Promulgating Improved Construction Technology 84
2.3.16 Future Directions 85

2.4 Building Design for Disaster Management 86
2.4.1 Community-Based Multipurpose Cyclone Shelters 86
2.4.1.1 Organisational System 86
2.4.2 Cyclone Resistant Housing 88
2.4.3 Graphical Presentation of Social Survey 88
2.4.3.1 Physical Survey of Selected Houses 89
2.4.3.2 Architectural and Structural Details of Houses 89
2.4.3.3 Technology Intervention in House Building 91
2.4.4 Specific Case of Technology Intervention 91
2.4.4.1 Transformation of the Wind Resistant Hut 91
2.4.5. Building Materials 93
2.4.6 House Typology 93
2.4.7 Case Study: House that Survived 94
2.4.8 Preservative Treatment of Traditional Building Materials 94
2.4.9 Construction Techniques, Structural Components and Details 95
2.4.10 Guidelines for Cyclone Resistant Houses 95
2.4.10.1 Layout and Orientation 95
2.4.10.2 House Plan 95
2.4.10.3 House Roof Shape 95
2.4.11 Social, Economical and Environmental Considerations 96
2.4.11.1 Socio-Economic Problems 96
2.4.11.2 Environmental Problems 96
2.4.12 Indigenous Building Materials 96
2.4.12.1Bamboo and Wood 96
2.4.13 Steel Sections and Pre-Cast Concrete Members 97
2.4.14 Foundations 97
2.4.15 Flooring 97
2.4.16 Walls 98
2.4.17 Roof Structure and Cladding 99

2.4.17.1 Roof Structure 99
2.4.17.2 Roof Cladding 99
2.4.17.3 Fixing of C.I. Sheet Roofing
2.4.18 Construction Technologies for Wind Resistance 100

2.5 Effect of Wind on Rural Housing 102
2.5.1 Experimental Setup and Description of Models 103
2.5.2 Description of Windbreaks 105
2.5.3 Measurement of Wind Force 106
2.5.4 Measurement of Wind Speed 107
2.5.5 Boundary Conditions 107
2.5.6 Experimental Results 107
2.5.6.1 Effect of Wind Incident Angle 107
2.5.6.2 Effect of Presence of Verandah 109
2.5.6.3 Effect of Windbreaks 111
2.5.7 Summary Study in the Wind Tunnel 113

2.6 Selection of Post-Disaster Shelter 114
2.6.1 Plastic Sheet-Bamboo (Shelter Option S1) 115
2.6.2 Canvas Tarpaulin (Shelter Option S2) 115
2.6.3 Permatent Shelter (Shelter Option S3) 116
2.7.4 Canvas Tents (Shelter Option S4) 117
2.6.5 C.I. Sheet-Bamboo (Shelter Option S5) 117
2.6.6 Thatch Bamboo (Shelter Option S6) 118
2.6.7 C.I. Sheet Wood-Bamboo-RC/PC Columns (Shelter Option S7) 118
2.6.8 All PC Dryland Model (Shelter Option S8) 118
2.6.9 Plastic Sheet only (Shelter Option S9) 119
2.6.10 C.I. Sheet only (Shelter Option S10) 120
2.6.11 C.I. Sheet-Steel Truss (Shelter Option S11) 120
2.6.12 LGED Model 10A (Shelter Option S12) 120
2.6.13 LGED Model 10E (Shelter Option S13) 120
2.6.14 Governing Factors 120
2.6.15 Quality Factor 121
2.6.16 Cost Factor 121
2.6.17 Methodology for Evaluating Options 122
2.6.18 Weightage of Quality Factors 122
2.6.19 Relative Quality Scoring 123
2.6.20 Value for Money (VfM) 124
2.6.21 Ranking of Shelter Options 124

2.6.22 Discussion of Results 127
2.6.23 Value for Money Index 129

2.7 Improving Rural Housing In Bangladesh 130
2.7.1 Population Increase 130
2.7.2 Ratio of Kutcha to Pucca Construction 130
2.7.3 Forces of Nature 130
2.7.4 Regional Vulnerabilities 131
2.7.5 Economic Forces 132
2.7.6 Disaster Preparedness Provisions 133
2.7.7 Appropriateness of Improvements 133
2.7.8 The Emergency Period 134
2.7.9 Dissemination of Knowledge 134
2.7.10 Timescale for Change 137
2.7.11 Funding 138
2.7.12 Proposed Strategy 138
2.7.13 Proposed Alternative Housing Programme 139
2.7.14 Need for Change 141

3. Implementing Hazard-Resistant Housing 142

3. Introduction 142

3.2 Affordable Financing for Housing 143
3.2.1 Affordable Improvements to Housing 144
3.2.2 Lowering the Cost of Building Materials 144
3.2.3 Making Finances Available to People with Low Affordability 145
3.2.4 Creating Financing Institutions for the Rural Poputation 145
3.2.5 Providing Hazard Safe Housing through Government Initiatives 146
3.2.6 Making Solutions Effective 147

3.3 Rural Housing Initiatives by Development Agencies 148
3.3.1 The Present Scenario 148
3.3.2 Purpose of the Study 149
3.3.3 Proshika Palli: A Case Study 150
3.3.4 Beneficiary Selection 150
3.3.5 Site Selection and Location 151
3.3.5.1 Land Value 151
3.3.5.2 Preparation of Land 151

3.3.5.3 Existing Resources 151
3.3.6 Employment Opportunity 152
3.3.7 Physical Planning 153
3.3.7.1 House Placement on the Site 154
3.3.7.2 Plot Size 155
3.3.7.3 Kitchens - Tradition and Demand 156
3.3.7.4 Water and Sanitation 157
3.3.8 House Construction 158
3.3.9 Building Materials 160
3.3.9.1 Chemically Treated Bamboo 161
3.3.9.2 MCR Tile 161
3.3.9.3 MS Angle Roof Frame 161
3.3.10 Maintenance 162
3.3.11 The Way Forward 162

3.4 The Housing and Hazards Workshop Process
3.4.1 Poverty: A Persistent Bar in the Path of Progress 165
3.4.2 Help with Building Materials: Contradiction or Complement to the H&H Approach? 168
3.4.3 The Need for Follow-Up Activities 169
3.4.4 The Role of Women in Home-Building and Maintenance 171
3.4.5 Realising Potential 174

3.5 Implementing Building for Safety in Dinajpur
3.5.1 Location and Geography 176
3.5.2 Programme Rationale 177
3.5.3 Dissemination Path 178
3.5.4 Village Survey 178
3.5.5 Roof Materials and Construction 179
3.5.6 Target Group for Dissemination 182
3.5.7 Key Messages 182
3.5.7.1 Visual 182
3.5.7.2 Audio 183
3.5.8 Recapping the Sundarban Experience 183
3.5.9 Typical Kutcha Housing in Sundarban 184
3.5.10 Why Change Traditional Methods? 185
3.5.11 What is Meant by "Low-Cost" 185
3.5.12 Brick 187
3.5.13 Bamboo 188
3.5.14 Timber 189
3.5.15 Thatch 189

3.5.16 Corrugated Iron Sheet 190
3.5.17 Incremental Construction 190
3.5.18 Homestead Form 191
3.5.19 The Housing Process 191

3.6 Implementing Building for Safety in Gopalgonj 192
3.6.1 Conceptual Framework 192
3.6.2 Methodology 193
3.6.3 Building-for-Safety (BFS) Options used in Demonstration Houses 197
3.6.3.1 Cement Stabilised Mud Plinth 197
3.6.3.2 Hollow Concrete Stump (Katla) 198
3.6.3.3 Bamboo Treatment 198
3.6.3.4 Painting Walls with Bitumen 199
3.6.3.5 Cross-Bracing 199
3.6.3.6 Rainwater Gutter 199
3.6.4 Monitoring 199
3.6.4.1 Demonstration House Condition 200
3.6.4.2 Local Perception and Future Prospects 201
3.6.4.3 Vulnerability Reduction 202
3.6.5 Observations 202

3.7 Review of Participatory Practice 204
3.7.1 Participation in the Bangladeshi Context 205
3.7.2 Participation: An Exogenous Concept? 207
3.7.3 Context-Specific Participatory Development 208
3.7.4 A Case for Participation 209
3.7.5 Search for New Directions 210

4. Dissemination of Building for Safety Messages 211

4.1 Introduction 211

4.1.1 Non-Governmental Organisations (NGOs) 211
4.1.2 National Legislators 211
4.1.3 Technical Professionals 212
4.1.4 Local Government Administrators 212

4.2 Educating Decision-Makers and Technical Personnel 212

4.3 Graphical Representation of Technical Concepts
4.3.1 Leaflet Series 215
4.3.2 Baul Song Team and Video 225
4.3.3 Calendar and Pocket Calendars 228
4.3.4 Website 230
4.3.5 Mass Media 230
4.3.6 Training Programmes 231
4.3.7 Long-Term Impact 232

4.4 Guidelines for Dissemination of Research Findings

References

Preface

A safe, sound and healthy house, which safeguards its inhabitants from the adverse effects of natural forces and calamities, is recognised universally as a basic human right. During the last few decades, substantial amount of research has been carried out on developing hazard-resistant housing. Despite these earnest efforts, millions of low-income families, especially in developing countries such as Bangladesh, still remain at the mercy of cyclones, floods, earthquakes and other natural hazards. It is not the lack of available technological or engineering solutions, but the sheer absence or lack of affordability of the poverty stricken majority of the population that make them vulnerable to natural hazards, which they encounter almost on a regular basis. Consequently, what would otherwise have been termed as a hazard in a developed scenario, reaches the news-stands as disasters in an underdeveloped context. As a matter of fact, as with cyclones, floods and earthquakes, poverty is also a disaster in the developing world.

Bangladesh University of Engineering and Technology (BUET) and the University of Exeter, U.K., have been informally collaborating since 1996 to conduct practical research into affordable technologies that could help those most in need of secure homes. Between 1998 and 2002, the UK Department for International Development (DFID) funded various activities of the higher education link (HEL) established between these two institutions. The partnership has supported laboratory and field studies, resulting in improved understanding of natural and local building materials, behaviour of non-engineered rural construction, process of low-income home procurement, and socio-economic aspects of low-income housing. During the course of this collaboration, it was attempted to raise awareness of housing issues among professionals and decision-makers through international seminars and national workshops. Participatory dissemination techniques have also been developed,

which are appropriate for rural communicators and can be utilised at village level workshops.

The book Building Safer Houses in Rural Bangladesh is a direct outcome of the DFID funded link, which had the same title. It addresses various housing issues with the understanding that to be effective, technological improvements must be appropriate, accessible, available and, above all, affordable. This book has been divided into four chapters entitled 'Context of Housing and Hazards', 'Building Technologies for Hazard Resistant Housing', 'Implementing Hazard Resistant Housing', and 'Dissemination of Building for Safety Messages', which as the titles suggest, cover the salient aspects of the subject.

While drafting the book, the authors have extracted liberally from the papers of various researchers that were included in one or more of the three conference proceedings edited and published under the BUET-Exeter link. The authors of this book gratefully acknowledge the contributions of co-writers of various sections, whose research endeavours and fruitful discussions during the writing of this book, helped in shaping this edition. The co-writers of various sections of this book, shown in parentheses after their names, are as follows: J. R. Choudhury (1.2); I. Davis (1.3); M. Hossain (1.4); M. Hasan, M. S. Ullah and C. D. Gomes (1.5); M. A. Alam and M. Hasan (1.6); I. Rasul (1.7); Z. Islam, N. Akter, M. Z. Hossain and N. Akter (1.8); U. K. Roy, P. S. Roy, M. S. Alam and S. Saha (2.2); J. Lewis and M. P. Chisholm (2.3); B. Haq (2.4); K. M. Amanat and R. L. P. Hodgson (2.5); T. M. Al-Hussaini, M. K. Islam, A. M. M. Safiullah and J. R. Choudhury (2.6); M. P. Chisholm (2.7); R. Hafiz (3.2); Y. Ara and R. Kabir (3.3); S. A. M. Magne (3.4); R. L. P. Hodgson and M. L. Carter (3.5); K. H. Kabir (3.7); R. L. P. Hodgson (4.1).

The authors are indebted to Dr. R. L. P. Hodgson of the University of Exeter, who jointly coordinated the HEL along with Dr. S. M. Seraj of BUET. Dr. Hodgson was very active in various stages of the HEL and also authored and co-edited various publications that resulted during the HEL. Dr. Hodgson also acted as an inspiration towards writing this book. Prof. J. R. Choudhury, Vice-Chancellor of BRAC University and an international expert on hazard-resistant design, guided the authors in the right direction and was always a source of encouragement. Prof. Choudhury's contribution is gratefully acknowledged. The past Vice-Chancellors of BUET, Prof. Iqbal Mahmud and Prof. Nooruddin Ahmed supported and personally patronised the link activities. We thank them very much for their

highly positive role. The present Vice-Chancellor of BUET, Prof. Md. Alee Murtuza has also been very supportive and has inspired the authors with his foreword to this book. We highly appreciate his gesture. The authors are indebted to many colleagues, who throughout the years have encouraged them in conducting research on building safer houses, as well as in writing this book. Among many, mention must be made to Professors S. Ahmad, M. S. Z. Bosunia, A. M. Hoque, M. F. Ahmed, A. M. M. Safiullah, M. H. Ali, M. A. Rouf, M. M. Hoque, Sk. S. Ali, M. M. Rahman, I. Ahmed, K. Enam, F. H. Mallick, Dr. M. A. Ali and Mr. M. Z. Islam. Lastly, the authors wish to express their appreciation to Ms. Tayyeba Nasir and Ms. Sangeeta Barua of the British Council, Dhaka for sincerely taking care of the administrative details of the link between BUET and Exeter, and to Mr. Arifur Rahman and his team at Progressive Printers for patiently and painstakingly accommodating the publication process and for the quality of printing of this volume.

Most of the existing housing and the majority of the houses which are going to be built in the near and distant future in the developing world are likely to be non-engineered. Spiralling house rebuilding costs as well as the poverty trap are expected to dominate the housing scenario of the predominantly poor millions of people around the world. The present endeavour cannot, perhaps, even touch the tip of the iceberg. The authors would be happy as long as this book keeps the vision of building safer houses alive, which may trigger small, but meaningful changes. Although this book has been written in the context of Bangladesh, it is expected that its contents should be relevant in other hazard-prone areas of the world.

S. M. Seraj
Mississauga, Ontario, Canada

K. I. Ahmed
Dhaka, Bangladesh

Foreword

As I write this foreword, more than one billion people of the world continue to live in a state of severe poverty, at a level where they are unable to meet their basic needs of food, clothing, shelter, education, health care, clean water and sanitation. Even though it is widely accepted that only through fulfilling these basic human needs, the security of an individual can be ensured, apparently most of our efforts continue to respond to emergencies with short-term humanitarian assistance. The most logical question that needs to be asked and answered honestly is also the question that is being pushed under the rug: Which is of greater importance to humanity – crisis management or long-term poverty alleviation?

The need for a protected shelter cannot be overemphasised. Good housing conditions are usually considered as pre-conditions for health and well-being. Family and culture are nourished upon the safety of a house – people habitually call this their home. Unfortunately, a very large number of people of this world are denied a secure home due to poverty, natural calamities and human conflicts. Nowhere is this truer than in the so-called developing countries of the world. Although the new millennium of globalisation is opening up new doors of opportunity to the privileged few of the world, unfortunately most poor people are either remaining poor or becoming poorer, and in many cases, totally destitute. As a result, millions of low-income families remain at the mercy of winds, floods, earthquakes, fires and other natural and human-induced hazards. The story is almost the same everywhere. Proper housing which is strong enough to counter the effects of natural forces remain beyond the economic capacity of the poor. Available technological solutions are expensive and often incomprehensible to ordinary people. What can be deemed essential is to ensure grassroots participation and empowerment, local capacity-building and adoption of concerted poverty reduction strategies, thereby achieving better knowledge

and understanding of local context and promoting an enabling macro-economic and political environment. This is a tall order: easier said than implemented.

In their book Building Safer Houses in Rural Bangladesh, Professor Dr. Salek Seraj and Dr. Iftekhar Ahmed have gone into details of the precarious housing situation that exists in rural Bangladesh and have suggested appropriate and affordable ideas that could perhaps bring positive change within this existing situation. This book is a valuable compilation relevant to the situation of the hazard-vulnerable population of rural Bangladesh. Founded on a thorough treatise of the context, locally appropriate concepts for building hazard-resistant housing and methods for their implementation and dissemination have been elaborated upon.This book starts with an in-depth description of the context of housing and hazards. It is, indeed, a valuable compilation of relevant information, subsequently allowing to suggest in the book locally appropriate technological concepts for building hazard-resistant housing for the disadvantaged section of the community, as well as methods for their implementation in the field. At the end, suitable dissemination techniques have been elaborated upon. I am confident that the contents of this book will inspire further studies in this field. I certainly feel that the ideas described in this volume can be suitably adapted in other parts of the world. I hope this book will be a valuable source of information and contribute towards bringing improvements to the housing situation of the poor.

Professor Dr. Md. Alee Murtuza
Vice-Chancellor
Bangladesh University of Engineering and Technology

Dhaka, April 2004