Guidelines for Climate Compatible Construction & Disaster Risk Reduction in Rural Punjab

PROVINCIAL DISASTER MANAGEMENT AUTHORITY (PDMA)

Acknowledgements

These Guidelines were developed for the PDMA Punjab from publicly available guidance and research on climate compatible construction techniques and through a consultation process with various government and non-governmental representatives, and other key stakeholders in Punjab who provided thoughtful comments and input, generosity with their time. We gratefully acknowledge these inputs. The guidelines have been reviewed and piloted by Sohail Saeed & Associates, Pakistan, as part of their Model Village planning assistance to the PDMA-Punjab in 2013.

Publication Details

The correct citation for these Guidelines is:
Mott MacDonald, 2013. “Guidelines for Climate Compatible Construction & Disaster Risk Reduction in Rural Punjab”. Available at www.cdkn.org

295442/EVT/PSCC/016/F – June 2013

Content

Foreword

Purpose of the Guidelines

These Guidelines are intended to assist government / planners by setting out a clear process for integrating climate resilience and disaster risk reduction considerations into village-level construction planning in rural Punjab. They give guidance for choice of location and layout, together with information on basic climate compatible building measures. This is intended to aid climate resilience through adaptation to a changing climate and by encouraging low carbon reconstruction techniques in order to mitigate the causes of climate change.

These Guidelines set out options for climate-compatible layout, designs, construction techniques, materials and resources that can be integrated and aligned with rural construction to reduce vulnerabilities and risks to natural hazards. The hazards covered by the Guidelines are earthquakes, flooding / excessive rainfall and extremes of temperature. These Guidelines also recommend that the users decisions are supported by: community consultation to accommodate local practices, knowledge, skills and needs; training; and monitoring and evaluation of construction in projects so that lessons can be learnt and used to influence future planning.

Reference to existing relevant guidelines and standards is given, where appropriate.

It is not the intention of these Guidelines to provide or duplicate existing standards and specifications for construction in rural areas. The intention is to complement existing practices by collating information based on lessons learnt from a sample of PDMA-Punjab's model village programme and providing references to additional sources of information. A comprehensive set of all building specifications is not included, but some guidance is given on key aspects.

Intended Users

These Guidelines are aimed at decision-makers involved in construction planning in rural Punjab, such as the PDMA-Punjab and associated government departments from tehsil level upwards, public and private agencies.

Background

These Guidelines were developed at the end of an 8 month project comprising:

- *desk-based research on global responses for climate resilience in post-disaster reconstruction (Global Knowledge Review);*
- *high-level mapping of key climate hazards in Punjab based on readily available secondary data (Hazard Maps and supporting Report); and*
- *a climate compatibility audit of a sample of model villages being constructed in Punjab (2010-2012) in order to identify any strengths and weakness in the design for climate and disaster risk exposure and to provide recommendations for reducing these (Technical Assessment based on fieldwork on selection of 6 model villages and desk based assessment of the generic model village plans).*

The options identified in these Guidelines are an amalgamation of designs and measures aligned with the Model Village designs appropriate for flooding / excessive rainfall and extremes of temperature, including the integration of low-carbon and earthquake resilience options, in accordance with the original scope of the project.

This project was commissioned by the Climate and Development Knowledge Network (CDKN) initiative 2010-2015, funded by the Department for International Development (UK).

Future Hopes

It is hoped that these Guidelines will provide a basis to develop a comprehensive set of climate-compatible building specifications which can lead to improvements to the planning framework and development of locally appropriate bye-laws in Punjab and rural Pakistan more generally, to help support the climate resilience of those living at the forefront of climate changes in Pakistan.

1. Climate Change

1.1 Global Change

A report by the United Nation's Economic and Social Commission for Asia and the Pacific (2006) [1] highlights that of the number of natural disasters recorded per year the total number of people affected each year has doubled from the 1990s to the 2000s and most of the victims are from developing countries. The report recognises that a developing country's entire economy can be affected by both the physical and human resource impacts following a natural disaster. For instance, the cost of the damage caused in Asia and Pacific Region in 2004 equated to about $55 billion, whilst in Pakistan significant financial repercussions have been recognised during flood and earthquake events.[2]

Countries such as Pakistan, with large rural populations and a high dependency on agriculture, are particularly vulnerable to climate-related disasters. Floods and droughts are common occurrences which are currently only partially mitigated by flood protection works or irrigation systems. In addition, populations living in coastal areas and river deltas are at risk of sea level rise, back water flooding and the effects of coastal cyclones.[3] The impact of even normal variations in rainfall can account for changes of several percent of the GDP, and extreme events can have clear dramatic economic impacts. This could undermine

Pakistan's long-term economic development, political stability and human security.[4]

The impact of climate-related and natural disasters is made much greater by the *"change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*"[5]. According to the IPCC (2007), one of the most important consequences of 'climate change' will be the increase in the frequency and magnitude of extreme events such as floods, droughts, windstorms and heat waves. Climate change may also trigger other hazards in which climate or weather conditions play a fundamental role, such as snow avalanches, landslides and forest fires.

1.2 Climate Change in Pakistan

The climate in Pakistan is generally arid with the annual seasons consisting of a cool, dry winter from December through February; a hot, dry spring from March through May; the summer rainy season from June through September; and the retreating monsoon period in October and November. The Punjab often experiences cool winters and extremely hot summers, with the rainfall providing sporadic relief.

Pakistan has been ranked at 'extreme risk' to climate change in a Climate Change Vulnerability Index, according to analysis of the global risks advisory firm Maplecroft (2010) based on social, economic and environmental factors.[6] Environmental

Analyst at Maplecroft, Dr Anna Moss, reported "*There is growing evidence climate change is increasing the intensity and frequency of climatic events, … Very minor changes to temperature can have major impacts on the human environment, including changes to water availability and crop productivity, the loss of land due to sea level rise and the spread of disease*." The rural poor are likely to be at the forefront of this vulnerability due to their dependence on natural resources.[7]

Source: Mott MacDonald

Pakistan has witnessed multiple natural disasters in the last 50 years, ranging from flooding, earthquakes, cyclones, landslides and drought. The floods in 2010 and 2011 (resulting from heavy rainfall, flash and riverine floods in the north and north-western regions of Pakistan) impacted large land areas, affecting millions of people, mostly by destruction of property, livelihood and infrastructure, and a significant death toll as villages were damaged and destroyed from the Himalayas to the Arabian Sea[4]. According to Mr Muhammad Javed Malik, Secretary (National Disaster Management Authority), Government of Pakistan, 2010 and 2011 were 'the years of "climate catastrophe" for Pakistan' due to flooding, rapid glacial melting and drought.[8].

Climate predictions indicate that Pakistan will be under increasing risk of further catastrophic climate-related disasters following increased incidence, frequency and intensity of extreme climatic events (such as flooding or pronounced droughts)[9]. Hazard mapping based on climate projection data from IPCC (Hadley 3 model, 3rd assessment) produced as part of this project support these predictions of increased risk in the Punjab region.

The Government recognises that Pakistan needs to respond to climate vulnerability and recently renamed the Ministry of Disaster Management to the Ministry of Climate Change (April 2012) to serve as the focal point for National Policy, Legislation, Plans, Strategies and programmes with regard to Disaster Management and Climate Change, including Environmental protection and preservation.

1.2.1 Floods

The most frequent climate hazards in Pakistan are floods. As reported by IRIN Asia – Humanitarian News and Disaster[10] between independence in 1947 and 2010, Pakistan faced eight severe flood disasters. These floods have resulted in more than 8,000 deaths, affected more than 100,000 villages and towns, and eroded some 285,000 ha of land.

There are two sources of rainfall in Pakistan: the monsoon (July to September) and the western depression (December to March). Heavy rain in the plains and catchment areas in the Punjab, together with snow melting in the northern mountains in July to September causes the swelling of the river Indus and its tributaries causing annual floods. Although there are flood banks and river training works along the major rivers, these are occasionally breached or overtopped. It is this failure of river training works which causes the greatest flood damage.

Source: Mott MacDonald

Extreme flooding occurred in both 2010 and 2011. In late July 2010, flooding occurred as a result of heavy rainfall, flash and riverine floods in the north and north-western regions of Pakistan. Approximately one-fifth of Pakistan's total land area – about 800,000 km^2 was under water, directly affecting about 20 million people, by destruction of property, livelihoods and infrastructure. The direct death toll was close to 2,000 and at least 1.8 million homes were damaged or destroyed.[4] In 2011, four heavy spells of rain from mid-August to mid-September 2011 were responsible for flooding and many parts of the Punjab were impacted, affecting 26,393 people and 125,513 acres of cultivated land within the province[11].

Climate predictions do not yet include flood modelling in Pakistan. Global models of precipitation suggest that even if there is little change in annual totals, there may be dryer winters and wetter summers with more intense rainfall. This will greatly increase the risk of flooding. However there is a need to downscale climate models and update river flood flow forecasts in order ensure that river training works are designed to provide an adequate level of protection.

1.2.2 Temperatures

Maximum temperatures are generally uniform across much of Punjab at 45 degrees Celsius (^{O}C), apart from the hill areas in the extreme north. Minimum temperatures are more variable across the province dropping to -6^{O}C in the north and -2^{O}C in the south of Punjab.

Source: Mott MacDonald

Mapping IPCC climate change projection data shows temperatures in this region are anticipated to increase during 2020s both in minimum and maximum temperature by 1 – 2 ^{O}C in areas already at risk of uncomfortable heat.

1.2.3 Drought

Drought in the past has brought extensive damage, particularly to South Punjab where the average rainfall is low (200-250mm). Severe drought in 2000-2002 affected livelihoods, resulting in human deaths, pushed tens of thousands of people into migration and killed a large number of cattle. The main reason for drought is failure of the monsoon, combined in some locations with lack or poor management of irrigation. Drought is a more insidious climate-related disaster which is slow in onset and less visible in its impact, but can be just as serious as flood in terms of damage to livelihoods.

Source: Mott MacDonald

1.2.4 Impacted Communities

The communities who suffer most from these climatic changes are often already poor, marginalised and vulnerable. Their response can make the difference between a climatic event being manageable or a disaster. Climate risk can be reduced by improving the resilience of communities through social, economic and environmental changes. Reconstruction and retrofitting offers an opportunity to include appropriate adaptation techniques into structures and infrastructure that can aid their resilience to climatic hazard.

References and Further Reading

[1] United Nations-Economic and Social Commission for Asia and the Pacific (2006) Enhancing Regional Cooperation in Infrastructure Development, Bangkok

[2] see National Disaster Risk Framework Guidelines 2007 available online at: http://www.ndma.gov.pk/Docs/NDRMFP.doc

[3] Aslam, M A (2001) Scoping Study: Possible Involvement within the Climate Change Sector in South / South East Asia, IUCN.

[4] UN OCHA (2010) Pakistan Flood Response Factsheet, Nov 3. 2010. Available online at: http://pakresponse.info/LinkClick.aspx?fileticket+ekh82IrLXVQ%3D&tabid+96&mid=667

[5] United Nations Framework Convention on Climate Change. Article 1.

[6] Available online at: http://maplecroft.com/about/news/ccvi.html

[7] Oxfam GB (2009) Climate Change, Poverty and Environmental Crisis in the Disaster Prone Areas of Pakistan.

[8]Statement during the 17th Conference of Parties to the UNFCC(Durban, 08/12/2011). Available online at: http://unfccc.int/files/meetings/durban_nov_2011/statements/application/pdf/111208_cop17_hls_pakistan.pdf

[9] Oxfam (2010) 'Climate Change Adaptation in Coastal Pakistan'. Available online at http://www.oxfam.org.uk/resources/policy/climate_change/downloads/climate_change_adaptation_practice_Pakistan.pdf

[10] IRIN Asia – Humanitarian News and Disaster Website: http://www.irinnews.org/Report.aspx?ReportId=90115

[11] See http://www.dawn.com/tag/pakistan-floods

2. Guideline Structure

To assist government / planners these Guidelines set out a clear framework and options for design and layout to integrate climate resilience and disaster risk reduction into village-level construction planning in non-mountainous areas of rural Pakistan.

The options identified are a combination of designs appropriate to specific climatic and earthquake circumstances and aligned with current Model Village designs . Low carbon options have been highlighted.

Reference to existing guidelines and standards is given, where appropriate.

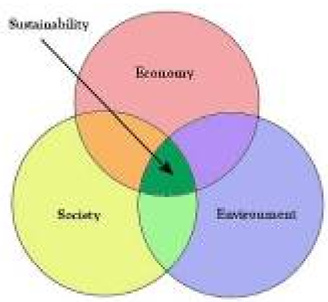
These Guidelines are structured to integrate:

2.1.1 Sustainability Principles

through the following aspects:

- *Environmental: by encouraging design that works within environmental constraints and minimises the carbon footprints of construction to aid mitigation of climate change*
- *Social: by encouraging a bottom-up approach to reconstruction planning to integrate appropriate and replicable technologies.*
- *Economic: by encouraging design and construction that will improve climate resilience in the long-term to support investment in their economic development.*

Aspects of Sustainability



Source: Mott MacDonald

2.1.2 Options for Resilience

Building and layout options that aid resilience to the following projected climate changes:

- *Increased rainfall and flooding*
- *Water insecurity*
- *Temperature extremes*

A non-climate related natural hazard to which Pakistan is susceptible has also been included as required by the project terms of reference :

- *Earthquakes*

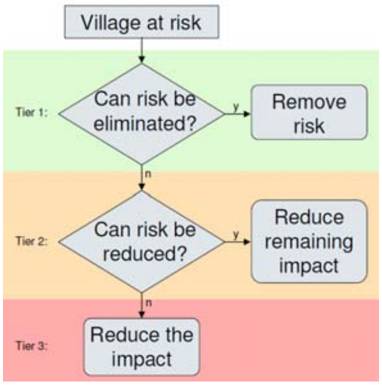
2.1.3 Low Carbon Options

The primary interest of the community is in resilience against future disasters, but reconstruction after a disaster creates opportunities for 'building back better' and creates openings for low-carbon reconstruction. Although the carbon footprint of an individual rural house is low, reconstruction after a major disaster is on such a scale that the aggregate carbon footprint is significant.

Guidelines Structure

2.1 Planning Framework

Planning Tiers



Source: Mott MacDonald

These Guidelines use a standardised tiered approach to planning:

1. ***Relocation - Planning tier 1***

The first step is a risk assessment for the existing location and decision as to whether to relocate to a lower risk area.

Consideration should be given to associated issues and challenges, such as land ownership / availability issues as well as impact on livelihoods and many other issues. It should normally only be considered where the risk of future flooding in the present location is unacceptable (typically because it is within the flood bunds and not protected by them).

Note: Relocation may only be possible for climatic risks that are localised (such as flooding). The risk areas for drought, temperature change and earthquake are less discrete such that it would not be possible to locally relocate villages away from risk areas.

2. ***Protection - Planning tier 2***

Once the location is selected and locational risks are identified, the second step is considering the measures which can be taken to protect the overarching development at the chosen location. This will not result in the total elimination of risk.

3. ***Design Intervention -*** *Planning tier 3*

Once the risks are clear and the level of protection to the chosen location established, the focus can shift to design interventions for layout, buildings and services. The intention is to reduce the impact of risks alongside options for energy efficient construction and operation, and additional considerations such as supervision, training and evaluation.

Note: the **participation** of the community. Communities can provide valuable input in planning and decision-making as well as on the details of implementation. Community engagement enables each project to develop specific variations to account for local needs (such as climate, local skills and materials) allowing for regional and local variations to adapt these designs. Adopting a bottom-up approach to planning, and taking into account the needs and views of the community (particularly the most vulnerable) underpins this framework.

2.2 Provisos

As indicated earlier, serious flooding in Pakistan is largely due to excess river flows and failure of flood bunds. Proper design and maintenance of these bunds (taking account of future climate change) is a pre-requisite for safe villages. No details of layout, design or construction will compensate for failure of flood bunds.

These guidelines assume that the flood bunds are properly maintained and provide guidance on achieving an acceptable domestic environment given local climatic conditions (including direct rainfall on the village).

Most construction at village level in Pakistan is managed by the villagers themselves. In the case of a major disaster, they will need considerable assistance. This can be in the form of reconstruction by the Government, possibly including a programme of Model Villages, or by support to owner-reconstruction. There are many arrangements and variations possible.

Options should vary according to each community's needs, and need to be planned in conjunction with the community[12].

References and Further Reading

[12] Vincent, K., Naess, L.O. and Goulden, M (2010) 'National Level Policies versus Local Level Realities - Can the Two be Reconciled to Promote Sustainable Adaptation?'

3. Legal & Planning Framework

Rural development in Pakistan has been subject to top down and bottom up planning process between federal and provincial level governments. A brief overview of the institutions governing rural planning is summarised below.

3.1 Institutional Structure

At the national level, urban and rural planning is under the remit of the **Ministry of Finance, Revenue, Planning and Development** (through the Planning Commission)[13] and the **Ministry of Housing and Works** (MOH&W) (which replaced the federal Local Government and Rural Development Department).

At the date of writing there is no single national level policy strategy focused purely on managing rural development.[14] It was expected the Pakistan Academy for Rural Development at Peshawar would be responsible for rural planning and development in all provinces but to date it has focused on training and research rather than strategic thinking.

3.2 Rural Planning Strategies

Until 2008, rural development policies and programmes were written in a chapter in Pakistan's 'Five Year Plans', which were developed and reviewed by the National

Working Group from the Planning Commission.

At present, rural planning is governed under various Local Government Ordinances, institutions at federal, provincial district and sub district and union council levels that are responsible for formulating planning standards, guidelines for rules, regulations, zoning and Land subdivisions for housing schemes, development plans, building constructions and development control mostly in urban areas of various districts.

Accordingly, Pakistan's rural development objectives are spread amongst a variety of policy documents such as the Vision 2030 and Poverty Reduction Strategy Paper II, which build on Pakistan's national economic strategy of macroeconomic stability, financial discipline and sound policy as key to broad-based growth, job creation and poverty reduction. These policies are aimed at strengthening the rural economy, improving the quality of life of rural people and enhancing living conditions in rural villages.

To meet these objectives, the Government has committed to (amongst other things) augmenting the supply of critical water resources, improving rural infrastructure, delivering social amenities and implementing projects that meet these communities' needs (for example, see the National Drinking Water Policy 2009).

National level standardised conditions and requirements for rural planning and structures across Pakistan, village level retrofitting and repairs to buildings, and opportunities for providing guidance on low carbon development at a much broader scale are missing.

Following decentralization of planning (as triggered by Punjab LG-Ordinance 2001[15]) planning in Punjab is administered as follows:

- **The Planning and Development Department,** Government of Punjab, is the principal planning organization at the provincial level.. This department coordinates and monitors development programs and activities of various departments of the provincial government. The department also prepares an overall medium term development framework of development activities in the province. Currently, there are no formal provincial bye-laws in place specifically focused on rural planning in the Punjab province.

- **The Urban Unit (USPMU)** established in March 2006 as a Project Management Unit, with in the Planning and Development Department of the Govt. of the Punjab. The Unit manages aspects related to Geographical Information Systems (GIS), Urban Planning, Solid Waste Management, Water & Sanitation, Urban Transport, Urban economics, sociology and Municipal Finance.[16]

- At the District level, **District Officer Coordinators (DOCs)** are responsible coordinating specific planning rules and regulations for their district as created at the tehsil level. There are no current formal district bye-laws in place to cover all rural planning in all the districts of Punjab.

- The **Tehsil** is the second-lowest tier of local government in Pakistan (each tehsil is part of a larger District). In each tehsil municipal area the respective administrations (Tehsil Officers, Town Officer for Planning and Coordination (TOP & C), Town Officer for Infrastructure and Services, Town Officer for Regulations and Town Officer for Finance are responsible for developing the specific rules and regulations for their tehsils and adopting relevant bye-laws to control their area. Some have been adopted but these are more generally framing building bye laws for urban areas of tehsil rather than rural villages and neighbourhoods.

- The lowest tier of local government is the **Union Council**. Each Tehsil is subdivided into a number of union councils. Efforts towards building bye laws and constructions have not been taken up by the respective secretaries in coordination of TOP & Cs and experts in rural planning and development.

A brief overview of the relevant policies, rules and regulations governing rural planning is summarised in the following table:

Table 3.1: Overview of relevant policy, rules, regulations and standards, Punjab

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
National Reference Manual (NRM) on Planning and Infrastructure Standards Ref: Govt of Pakistan. Ministry of Housing & Works (Environment & Urban Affairs Division), Consultant: Pakistan Environmental Planners Architectural Consultants (PEPAC) prepared in 1986	(1) City & Regional Planning Department (CRP) of University of Engineering & Technology, Lahore (2) Many Development Authorities considered the use of this manual in development projects (3) Early Municipal Committees (MCs) and later City District (CD) and Tehsil Municipal Administrations (TMAs) of various large cities and towns of Pakistan (4) Pakistan Council of Architects and Town Planners (PCATP) considered a valid guideline manual in the country.	The major purpose was to utilize uniform planning standards and guidelines by city and regional planning academic institutions and in applied field of development authorities notably LDA, MDA, FDA which worked for big cities from 1986 to 2009.	The respective city and regional planning educational institution at Lahore and building regulation departments of development authorities	Areas delineated in municipal corporation limits in development authorities of medium cities and metropolitan (greater urban areas) areas in the respective districts. But the non urban areas are not included	(1) During 1986-2009, the NRM was, applied in Development authorities areas, Municipal Committees and PCATP considered it valid guidelines for planning and development in city and town planning schemes in Pakistan. (2) NRM had the limited scope of applications even in Urban areas. (3) On 23 February 2010 in a UNDP level Seminar on Housing Policy considered NRM an outdated document and suggested to be reviewed for urban as well as rural areas.

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
The Punjab Local Government Ordinance (PLGO-2001) Reference Sections: Section: 191. Rules Ch xix p.126 Section. 192. Bye Laws p.126 Section. 198. Decentralized offices Notified- by Punjab Government on 14-Aug 2001	District councils, tehsil councils, town councils and union councils in Punjab (1) The heads (Nazims), administrators and TOP&Cs / representatives of village / Neighborhood councils of District councils, tehsil councils, town councils and union councils which are responsible for making rules and bye laws for planning and development under sections 191, 192 and 198 for their areas in Punjab	This document permits the decision makers and planners to formulate rules, regulations and building bye laws for respective (rural / urban areas). To date the main focus has been on urban areas. . The Matching Grant (MG) initiated under the (no longer applicable) Local Governance Ordnance for Punjab 2001 (LG- Ordnance 2001). intended to allow local rural areas to engage with their local departments to initiate a bottom-up approach to planning..	The respective institutions under PLGO-2001: the concerned administrative authorities, TMAs and City districts and union councils are considered bound to implement these rules and clauses of the ordinance.	The applications of these is bound to areas within city districts, TMAs and union councils. But practice has been focused in urban areas and centres.	(1)Some of the heads (Nazims) of districts or tehsil, administrators under the directions of Local Government and Community development tried to formulate some rules, regulations and bye laws for planning and development under sections 191, 192 for their areas in Punjab notably. (2) Majority of heads/TOP &Cs ignored and those who prepared have omitted sections 198 and subsections related to bye laws and regulations (subsection xxix of section 198) for rural development.

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
Model Building and Zoning Bye Laws for Town Municipal Administration By Govt of Punjab, Local Govt & Community Development Department-2007 Under the Section 192 of Punjab Local Govt Ordinance-2001	Town Municipal Administrations (TMAs) of respective districts of Punjab. (1) Town Nazims, Town Municipal Officers, TOP&C of respective Town Municipal Administrations (TMOs) under section 192 are empowered to make and apply respective building and zoning bye laws for their administrative areas in tehsils.	Under PLGO-2001, the Local Government and Community Development (LG&CD) encouraged district and sub districts level nazims and technical staff notably TMOs, TOP &Cs and TO to formulate model buildings and zoning bye laws for their cities, towns municipal areas.	Since 2009, Town Planning, Town Office of finance and infrastructure of TMAs are responsible to applications of these bye laws	The laws are applicable to the areas of respective tehsils of specified boundaries. But they are not appropriate to rural areas.	(1) A few of TNs TOP&C of respective TMAs have formulated respective building and zoning bye laws for their administrative areas in tehsils. (2) Director Planning of Provincial LG & CD considered them improper and irrelevant to the urban areas and invalid for rural areas outside the sub districts-the flood prone zones.

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
Punjab Private Housing Schemes and Land use Subdivision Rules By Notification No. SOR/LG-38-2/2004-P (Local Govt & Community Devt on 13-3-2010) Reference to Punjab LGO-2001, Section 191 p.126 Section-191 Rules Clause (i) Section-191-Rules Clause (xxiii) "Master plan" & "Peri urban area" p-2	(1) The decision makers and Town Officers for Planning and development. (2) TOP&Cs and TO Infrastructures are responsible to check housing schemes within land subdivisions in "Master Plan", "structure Plan" and " Peri urban areas" of respective tehsils.	Developed by the Punjab Government with reference to "master Plan" and "peri Urban areas".	The locally elected registered housing societies in Punjab are responsible in the urban land use and subdivision regulations.	The details in chapter III (Page 5-11) has specific locational and allocation standards but are not specific to planning in rural areas.	(1) Although in this document space allocations by standards and guidelines are marked but they are not valid in different conditions of land in the respective cities/towns. (2) Master plans and peri urban areas are silent or do not represent rural areas subject to flood disasters and respective planning guidelines. (3) In practice these have not been widely implemented, in particular for rural housing schemes which apply separate rules and regulations

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
Building Code of Pakistan (BCOP) 1986	Development authorities, TMOs of all over Pakistan in particular cities/towns and villages	It was referenced by engineers but not mandatory, and not enforced.	At federal level Ministry of Housing and Works with reference to disaster management issues and control. Major responsibility comes of NDMA at national level which has been extended by Provincial Disaster Management Authorities (PDMAs)	All areas	(1) Technological changes have meant it is viewed as out of date
Building Codes of Pakistan : seismic provision 2007 Ref: Ministry of Housing & Works (National Housing Authority), Govt of Pakistan. adopted in September 2008 to revise and update BCOP 1986 Consultant: NESPAC completed in 2009/2010	Development authorities, TMOs of all over Pakistan in particular cities/towns and villages of seismic zones.	Minimum standards required for the structural design of buildings, tests and inspection needs, aiming to provide broad-based structural awareness for making buildings safe through disaster resistant construction techniques. Intended for application in all structures of reinforced concrete, steel and masonry (excluding infrastructure such as tunnels, transmission power lines, dams).	As for Building Code of Pakistan	Areas are specified in seismic identified districts of Punjab and other districts of Pakistan.	(1) For structural development in earthquake experts from ERRA, UNDP and Nazims of respective districts are valid and useful but omits guidance for resilience associated with other climate issues such as flooding.

Planning

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
BCOP (Energy Provisions) 2011, draft only:	Development authorities, TMOs of all over Pakistan in particular cities/towns and villages	Minimum requirements for energy-efficient design and construction of buildings and building clusters with total connected load of 100kW or greater, or a contract demand of 125 kVA or condition areas of 900m2 or unconditioned buildings of 1200 m2 or more.	As for Building Code of Pakistan	All areas	(1) These provisions are aimed at high-end domestic and commercial consumers, although they do not specifically exclude rural areas. (2) The intention stated is to aid the design of better systems that minimize energy consumption and improve energy efficiency, to be integrated into the BCOP 1986, and integrate low carbon development

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
Model Building Bye Laws and Zoning Regulations 2007: Developed by the City District Council under the Punjab Local Government	Development authorities, TMOs of all over Pakistan in particular cities/towns and villages	Apply to town and urban areas of the particular tehsil (sub district).	Since 2009, Town Planning, Town Office of Finance and Infrastructure of TMAs are responsible to applications of these bye laws	The laws are applicable to the areas of respective tehsils of specified boundaries.	(1) A few of TNs TOP&C of respective TMAs have formulated respective building and zoning bye laws for their administrative areas in tehsils. (2) Director Planning of Provincial LG & CD considered them improper and irrelevant to the urban areas and invalid for rural areas outside the sub districts-the flood prone zones.
Lahore Development Authority Building and Zoning Regulations 2007	Lahore Development Authority (LDA)	Under Chief Metropolitan Planner (CMP) and respective Town Planners (TPs) these Regulations are for buildings to be established and being established within Lahore Metropolitan (greater urban) areas under LDA boundaries. These do not apply to rural areas.	Building Control and town planning department are responsible for enforcement of building rules and regulations	The building and zoning regulations are applied in Areas specified in the LDA boundaries of metropolitan level.	(1) On the other hand metropolitan planning -the non urban or greater rural areas has not been ignored by CMP and TPs in their building bye laws and Zoning regulations.

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
Punjab Housing and Town Planning Agency (PHATA) Building and Zoning Regulation	The respective Director and Deputy Director or Town Planners have to apply these rules and regulations in the housing schemes for low and medium income level people	These were intended for application in PHATAs low cost income housing schemes and other development projects located outside of city centres.	Planning and building control departments under the administrations of directors, deputy directors and assistant directors of respective sections.	These areas come under city and peripheries under PHATA jurisdiction.	(1) These housing schemes have been in the greater peripheries of cities, for example Township scheme at Kot Lukhput planned but failed to relocate people cores Lahore city. (2) function of these regulations have not been specified for vast rural hinterlands or villages. (3) In general these do not fit well within rural development or village level planning and development in the rural hinterlands of the respective districts, and so if frequently limited within the district urban limits

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
Cantonment Board By-Laws	Separate respective wings of Cantonment Board in the respective city are the controlling administrations in respective cantonment parts of the cities..	Cantonment boards have their own rules and bye laws and they have well applied and controlled in their areas , but often not applied in the peripheral villages or rural land. By-Laws under Cantonment Board in the respective city are administered and controlled by the concerned wings of the board are practiced.	Building control and building bye laws department are responsible for cantonment boards which are separate form the development authorities of towns and cities.	Cantonment areas are defined on the master plan or structure plan of major cities regardless rural areas associated in the greater city or district.	(1)These are by-Laws under Cantonment Board are administered and controlled by the concerned wings in the cantonment parts of cities not in the rural hinterlands or villages in the respective districts. (2) In some instances these rules are applied to villages, Villages adjacent to Cantonment board areas or Development Authority are called trapped villages or urban villages in cities..
PCATP (Pakistan Council of Architects and Town Planning) Hand Book	The wings of Chairperson and Deputy Chairman or planning executive team.	The wings of Deputy Chairman or planning executive team visit and examine the town planning rules and regulations appropriate to planning.	So far these are followed by large development authorities in the major cities.	The hand book does not differentiate rural urban divide.	The main focus of Deputy Chairman or planning executive team have been for urban areas and settlements than the rural areas or villages in the districts.

Relevant Policy, Rules, Regulations and Standards	Unit /Responsible for Managing	Role	Institutions Responsible for Implementations	Applicable areas	Remarks
DHA (Defense Housing Authority) construction By-laws	Director (Building Construction)/ team	DHA is a specialized Authority which formulates their own rules and regulations, bye laws and implement in their own urban areas. They are strictly applied in the respective areas in Lahore, Karachi and Islamabad DHA Lands. Inspection and examination of residential and other buildings with team at different stages of building constructions in control defense areas in Lahore, Islamabad and Karachi etc.	The director and his staff for building construction in DHA implement these DHA by-laws.	DHA areas in Punjab both in Lahore and Islamabad. The by-laws are not applicable to rural areas	(1) The rules and regulations are specific for house design planning and constructions in DHA areas. (2) Building bye laws are confined to DHA land and buildings not for rural settlements or villages which are outside and away from DHA boundaries. Their rules and regulations are frequently not applicable nor applied in low-cost urban and rural areas in Punjab.

Source: MM Pakistan (Pvt.) Limited, 2012

3.3 Changes Anticipated

The federal MOH&W is reported to be reviewing the existing Housing Policy 2001 with a view to updating with a clearer focus on building codes and standards, however the current policy is generally focused on urban development and it is not clear how these standards and codes will be applied in rural areas at this stage.

Zoning and land subdivision has been developed for 6 out of the 9 city districts of the "Integrated Master Plan for Lahore 2021". However, it is widely commented that in general these are not being followed; they do not consider flood or disaster management, and the guidelines in the Master plan are not clear nor the areas that could be protected according to their land uses.[17] It is also believed that the Land use rules 2009 are in conflict with the Master Plan 2021 for Lahore[18]. A Seminar on the 'Review of Lahore Master Plan 2021' held on 12 May 2012 by Lahore Development Authority has introduced a broader vision to protect flood disaster areas by virtue of 'DRR based Guided Master Plan' of disaster prone districts in Punjab (Dawn, 13 May 2012). It is anticipated that this broader vision will allow more cross-sectoral approach to management of planning and disaster risk reduction.

3.4 Policy Recommendations

The broad vision of Guided Master Plans at district levels and the lessons learnt from this project suggest the following recommendations for policy facilitating climate compatible development:

- Clear integration of CCA and CCM alongside DRR and rural planning to develop strategic planning decisions. These can be aligned with the vision in the National Disaster Risk Management Framework (NDRMF) 2007 and the accepted (draft) Climate Change Policy 2011 for integration of these issues across cross-cutting policy areas, managed at the federal level by the new Ministry of Climate Change (previously known as the Ministry of National Disaster Management).

- Provision of a clear and manageable institutional framework that enables people and institutions with technical knowledge of CCA and CCM to integrate their ideas for climate resilience in planning for rural development (such as buildings, water, energy and flood management), alongside the integration of DRR. The NDMA (under the new federal Ministry of Climate Change) should act as the lead body for coordination and management of these issues, extending its previous mandate beyond DRR. This step is preferable to the creation of a separate climate change institutional framework. The objectives and policy measures in the (draft) Climate Change Policy 2011 need to be effectively implemented and may benefit from action management tools such as a 'road map' setting out: the interrelationships between bodies in planning, infrastructure, DRR, CCA and CCM; what each body is responsible for; what happens if there are overlaps in duties and responsibilities; who ultimately has to take a lead on the development of requirements and research; and how lessons learnt are to be shared and responses coordinated.

- Develop clear, simple and enforceable building codes and standards for rural areas, encouraging designs and construction techniques that will improve the resilience of rural buildings and infrastructure to generic climate issues. This should also standardise the construction of these buildings (in accordance with the NDRMF 2007 and as recognised in the Rural Housing Reconstruction Strategy 2006). Allowance should be made for these to be flexible enough to allow for specific contextual issues to be accommodated (which can be developed with assistance with from the appropriate tehsil authority and local communities), cost constraints, and to enable updating / retrofitting as techniques improve and develop, without reducing the implementation or enforceability of the building codes and standards.

- Need to develop land use plans for rural development. This should aim to facilitate active resource management (forestry, production systems compatible with resources and agro-forestry, pasture management, nature protection and erosion control, water and flood management), through government consultation (environmental strategy planning, agricultural sector planning, development planning, assessment of potential land classified into suitable land capability and land suitability) and community support.

- Those bodies responsible for the management of flood infrastructure (such as PIDAs, WAPDA) need to agree standardised recommendations about management and construction of flood protection and coordinate their activities and share data with the DRR organisations to create a cohesive and integrated management of extreme and annual risks associated with flooding and water management.

- Need to enhance the monitoring and evaluation of construction and reconstruction to learn lessons for future planning (starting with the model village programme). This should be expanded to include analysis by CCA and CCM experts and programmes supported at the policy level not as a 'blame' exercise but a way of making better decisions in the future. This could be facilitated through project committees, members and secretaries of citizen community boards, inspection by Town Officers for Planning and Coordination and District Office Coordinators, and feeding information up to the Provincial Disaster Management Authorities (PDMA) and the NDMA.

- Cooperation and coordination on collection of information, data and mapping for planning pre- and post-disaster management. This could be facilitated through Command, Control and Communication Centres (such as the new Centre opened by the PDMA-Punjab early 2012). Information gathering should be standardised, regularly updated and shared amongst a wide variety of stakeholders. This should be available at a minimum to those assisting in the disaster management planning and development in general of both buildings and infrastructure, from the local level upwards. The NDRMF envisaged the PDMA as the main focal point for coordinating actions within the province by both the humanitarian community and lower planning bodies. The PDMAs would be the ideal level to plan this form of information gathering and sharing.

- Integrate local perceptions, needs and capabilities (recognised globally as aiding more appropriate long term development) based on the project scope through active community engagement. This bottom-up approach enables awareness creation of the issues, dialogue, consultation and consensus for the designing, construction and maintenance of buildings and infrastructure and an ability to identify and utilise indigenous knowledge in building construction options for responding to local climate, culture and available materials. Community engagement must involve vulnerable groups and offers an opportunity to enhance gender equality between women and men as part of the post-disaster response.

These Guidelines should be utilised as part of the development of clear, simple and enforceable building codes and standards for rural areas, encouraging designs and construction techniques that will improve the resilience of rural buildings and infrastructure to generic climate issues as well as building the groundwork for community involvement in planning how the spaces they occupy and use will be developed for their benefit and those of future generations.

References and Further Reading

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[13] Planning Commission official website: http://www.pc.gov.pk/National_Plans.html. and Ministry of Housing and Works official website: http://www.housing.gov.pk/

[14] Following the devastating earthquake in 2005 the Earthquake Reconstruction and Rehabilitation Authority (ERRA) did develop a 'Rural Housing Reconstruction Strategy' (2006) relates to the earthquake hit districts of the then NWFP and AJK

[15] Punjab LG-Ordnance 2001 available online at http://www.scribd.com/doc/45043944/Punjab-Local-Government-Ordinance-2001

[16] See Official Website of Urban Unit: http://www.urbanunit.gov.pk/sectors.asp

[17] Interviews between Dr Qamar ul Islam and Mr Rai Shahnawaz Hassan (TOP& C for Jauhar Town) 8-5-2012

[18] Chief Metropolitan Planner letter No. LDA/CMP/PS/ 183 dated 08-5-2012

4. Stakeholder Engagement

The devolved planning system for rural planning and disaster risk reduction in Pakistan means that administrative levels from National, Provincial through to District, Tehsil, Town Authorities, and Union Councils have a valuable role in the success of reconstruction programmes, as do the local communities.

Stakeholder Engagement

Source: Mott MacDonald, 2012

These Guidelines promote the use of Community Based Adaptation (CBA) - a **community-driven** method used for considering whether proposed adaptations are in line with community needs, moving beyond village planning to include livelihoods and lifestyles, and the preservation or resilience of the resources on which they depend. This allows physical planning to consider social aspects of planning, helping to address the cross-cutting issues associated with adaptation.

The steps of the CBA planning process are summarised below: [19]

1. *Assess current vulnerability, risks and local livelihoods*
2. *Assess future climate risks*
3. *Design location-specific adaptation strategies and plans*
4. *Up-scale strategies and link to local and regional development plans.*

The CBA planning process has not been set out in full in these Guidelines as there are separate guidelines available for this purpose provided by internationally recognised organisations, such as Practical Action and the International Federation of Red Cross and Red Crescent Societies[20].

4.1 Social Assessment

Source: MM Pakistan (Pvt) Ltd

In order to effectively capture the needs of the communities who shall be affected by new village construction or reconstruction projects, it is recommended that a participatory social assessment is carried out.

4.1.1 Baseline

The assessment should enable an understanding the socio-economic baseline (pre-disaster) conditions of the village identifying:

- *socio-economic infrastructure (such as health and education facilities),*
- *the socio-economic behaviour (such as employment activities and trade) and*
- *the socio-economic status of the village (income levels and education status).*

The proposed reconstruction should aim to improve or at least maintain these conditions.

These conditions can be identified through a combination of techniques, including key informant interviews, participatory mapping, formal questionnaire surveys, and other participatory techniques.

4.1.2 Public Consultations & Considerations

There should be a programme of public consultation on the proposed reconstruction. There are many existing tools and methods that can be used to engage affected communities in decision making, such as the use of 'Community Citizen Boards' envisaged under the Punjab LG - Ordnance 2001.

Source: Mott MacDonald

Public consultations should be completed can consist of group and or targeted consultations with affected communities and should aim to provide key information regarding the proposed construction activities and seek the views of the stakeholders, identifying any problems or specific needs of the community to be considered.

The views and concerns raised during the consultations should be incorporated into designs where appropriate, and there may need to be an iterative approach to ensure that they are acceptable.

4.1.3 Vulnerable Groups

Source: MM Pakistan (Pvt) Ltd

Planners should consider the needs vulnerable groups, through their involvement in participatory planning processes as where they may be most affected by the impacts of climate change. Steps should be taken to **empower the most vulnerable and actively include them in the decision making processes, including their representation in public consultation**

Vulnerable groups can be identified through surveys and will include all those earning below the official poverty line for 2011/12 of 1,735 PKR/capita/month[21]. Other vulnerable groups may be identified through the participatory studies and could include some of the following:

- *Those without formal land rights (squatters)*
- *Tenants*
- *Women*
- *Elderly*
- *Children*
- *Unemployed*
- *Long-term displaced people and refugees*
- *Landless labourers*
- *People with disabilities or long term illnesses / injuries*
- *Those with addictions to alcohol or drugs*

The views and concerns of vulnerable groups regarding the construction should be gained through direct consultation. The aims of the direct consultations are the same as the public consultations. The conclusions of the public consultation should be reported to vulnerable groups for their reaction, comment and feedback and these views must again be represented in public meetings.

House which are located to offer ease of access to markets and economic centres should be made available to vulnerable groups. Where possible, vulnerable groups should also be prioritised for training (see section 12.3) to provide them with a means for new employment opportunities.

The charity 'Practical Action' provides useful guidance on how to consider vulnerable groups in reconstruction[22]. These include involving such groups in consultations, identifying ways to give them employment during reconstruction, ensuring that those without formal documentation of land tenure are not neglected.

4.1.4 Gender

Source: MM Pakistan (Pvt) Ltd

It is essential that women are involved in the planning process

The effect of climate change will vary between males and females. In Punjab, females are especially vulnerable to the effects of climate change - typically they are poorer, have had less access than males to formal education, and are excluded from political and household decision-making processes. In addition, women generally have fewer assets and are more dependent upon natural resources.

As for vulnerable groups, the views and concerns of women and girls regarding the construction should be gained through the careful use of participatory techniques. The team must include female specialists who are able to interact directly with women in the village.

These views must be represented within COs and the findings of public consultations reported as for vulnerable groups (see section 4.1.3). This shall not only reduce their vulnerability to climate change but shall ensure the planning benefits from their knowledge and skills.

It can be expected that women will have useful views on many aspects of village layouts as well as on the details of design –

Source: Mott MacDonald

such as location of water services, storage arrangements within houses, etc.

The needs of women should be ensured by encouraging a fully participatory process which enables gender mainstreaming – **gender assessments should not be an add-on.**

Although the unique views of women within the community to be effected by a development must be sought, common issues effecting female community members are briefly listed below, and detailed in the sections referenced:

- *Privacy* (see section 4.1.5)
- *Land Ownership* (see section 5.4.2)
- *Proximity to livestock and fuel wood* (see section 5.4.2)
- *Provision and storage of water* (see section 11.2.3)
- *Access to cooking areas* (see section 7.11)
- *Emergency Response* (see section 11.1.2)
- *Education on Climate Change* (see section 4.3.3)

Violence towards Women[23]

Violence towards women has been reported when families relocate from temporary shelters to their points of origin or new relocated homes, due to their families own detrimental coping strategies. This kind of violence is often perceived differently by communities and women themselves, and they are less likely to report familial or community endorsed violence than stranger-related violence. Likewise, the police are less likely to intervene in cases of domestic violence.

Following the 2010 floods, the Gender Equity Program[23] recommended that formal institutional arrangements be put in place for gender-based violence, including police training and community-level gender-sensitive alternative dispute resolution mechanisms. The report also recommended adult literacy programs and awareness campaigns to include information on rights, available protections and guarantees within the Constitution.

Such actions may be aligned through the government's Lady Health Worker program.

4.1.5 Purdah & Social Acceptance

The practice of purdah is highly valued throughout Pakistan, especially for women within rural areas. It is important that the family home can be maintained as a private area, providing a separation between the family and the public (including neighbours).

While providing single stand-alone houses allows maximum privacy, construction of stand-alone houses to the standards proposed in these guidelines would be less cost effective than block housing.

Villagers have concerns about the lack of privacy afforded by dense back-to-back and side-to-side layout used for model village houses.

To balance these issues, these Guidelines consider the resilience options for small housing blocks (four houses per block). If these forms of cluster housing are used, communities should be engaged to understand reasons for this design choice.

4.2 Communication

Effective communication during village reconstruction is key to the success of any project. Communication must focus on three aspects:

- *Communication of the aims, objectives and benefits of reconstruction to gain 'buy-in' from the local community*
- *Consultation with local communities to understand their needs*
- *Consultation with local communities to understand their current skill base to tailor reconstruction efforts around this*

These objectives can be achieved through a two-way flow of information between the decision makers and communities and will ensure trust, consensus, participation and ownership within communities.

Community Organisations (COs) can be formed to facilitate this communication. Cos should include representatives from a cross-section of the community, in terms of age, wealth, gender, and vulnerable groups either by a nominated representative or a member of the sociology team, as discussed in the section on Social Assessment above. The COs can be a forum for workshops, seminars, and participatory approaches to community engagement.

Case Study
Bottom-Up Planning: Tamil Nadu, India
Source: World Bank[32].
Following the 2004 Tsunami, the South Indian Federation of Fishermen Societies involved house owners in every step of reconstruction through: habitat mapping and communication of results to community; presentation of layouts for discussion before finalisation; construction of model houses; family design meetings; cluster committees to monitor construction Almost 100% occupancy was achieved

COs can enable the community to have a clear mechanism to make decisions related to their villages, to take into account their existing and future needs, and following planning, into the management and maintenance of their settlements.

It may be appropriate to engage all the impacted communities, for instance in cases of relocation those communities being relocated and those in the receiving villages, although there needs to be clarity as to the purpose of these meetings so that if grievances are aired they are in the appropriate forum and do not negatively impact the communities participation.

Transference of knowledge between local level planners and the community, needs to be fed back to stakeholders at higher levels who are responsible for coordination, designing, managing and evaluating rural development programmes, such as the national planning commission and disaster management authorities.

Case Study
Community Organisations
Punjab, Pakistan

Before construction of the Ittehad Model Village, Engro Foundation moved the residents to an adjacent reception area so they could be involved in design and site conception process from the onset. This provided maximum ownership and played a key role in strengthening the villagers' involvement in the project.

Integration of community's needs from planning through to construction and training will promote best practice in construction.

Communication experts should be involved at a high level early in the planning process to allow them to develop the external message to be conveyed to ensure participation from the local communities.

Communication techniques should be employed throughout the life of the project, especially through the consultations described in section 4.1 and attendance of planners in the meetings of COs.

The World Bank Handbook for Reconstructing after Natural Disasters (2010)[24] offers further guidance and case studies of the role of communication in planning reconstruction projects.

4.3 Training

Punjab Vocational Training Council Building, Miani Mullah Model Village

Source: MM Pakistan (Pvt) Ltd

4.3.1 Institutional Training

These Guidelines are focussed on providing guidance to planners and decision makers in integrating climate considerations into planning of new construction or reconstruction villages.

Where training needs within the planning administration are identified, these Guidelines can be used as a basis for the content of training courses to supplement training modules in disaster risk management developed by the NDMA[25].

4.3.2 Training within the Community

In order to achieve the successful implementation of these Guidelines, additional training within communities may be required on construction techniques and the use of climate friendly services. This is discussed in greater detail in sections 8.4 and 12.3.

4.3.3 Gender[26]

In the rural areas of countries such as Pakistan, where women are involved in both household management and agricultural practices, women are seen as key environmental resource managers. Significant success in effecting change in the everyday practices such as diversification of women's income sources, reduction in wood-cutting and tree planting (which mitigates the threats of flooding, landslides and desertification) and the use of energy efficient stoves has been experienced where education and training is delivered to women within the community.

Source: Mott MacDonald

Although outside the scope of these Guidelines, education on, and awareness raising of, best environmental practices should be delivered to communities and reach female community members to ensure sustainability can extend beyond the reconstruction into the use of the communities effected by these guidelines.

References and Further Reading

[19] UN FAO (2011) 'E-Learning Tool - Community based adaptation to climate change'. Available online at http://www.fao.org/climatechange/67624/en/

[20] Ruskulis, O. (2010) 'PCR Tool 7 - Planning with the People' Practical Action, Rugby, and International Federation of Red Cross and Red Crescent Societies, Geneva.

[21] Poverty line calculated by applying 12% inflation rate per annum to the 2005/06 official poverty line of 879PKR/capita/month (Pakistan Economic Survey, 2005/06)

[22] Ruskulis, O. (2010) 'PCR Tool 6 - Integrating Livelihoods' Practical Action, Rugby, and International Federation of Red Cross and Red Crescent Societies, Geneva.

[23] Brohi, N (2011) 'Effects of 2010 Floods on Women in Pakistan' Gender Equity Program, Aurat Foundation. Funded by USAID. Available online at: http://af.org.pk/gep/deskStudies/Edited%20Floods%20-%20N%20Brohi.pdf

[24] Jha, A., Barenstein, J., Phelps, P., Pittet, D. and Sena, S. (2010) 'Safer Homes, Stronger Communities. A Handbook for Reconstructing after Natural Disasters', The World Bank, Washington

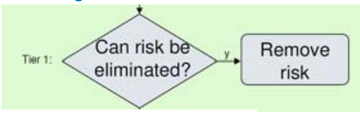
[25] NDMA Disaster Risk Management Modules available online at: http://ndma.gov.pk/publications_drm_manuals.html

[26] International Strategy for Disaster Reduction (2008) 'Gender Perspectives: Integrating Disaster Risk Reduction into Climate Change Adaptation', United Nations

5. Site Assessment

Relocation or Reconstruction?

Planning Tier 1



Source: Mott MacDonald

Planning Tier 1

The primary planning issue is where to build. If the construction is following a disaster the question is whether to reconstruct in the village on the same site or to relocate.

A basic principle is to (re)locate from a hazardous area to a non-hazardous area as **this will remove the risk**.

The successful relocation of a village involves a complex series of issues as set out in this Section. **Planners must assess the climate risks associated with the existing location as against the options and constraints to relocation**.

If the hazard cannot be eliminated through relocation, the planning must focus on tiers 2 and 3: reduction of risk and impact through protection, and design intervention.

The initial step in planning reconstruction (and planning construction more generally) is to consider the hazards which have been demonstrated to exist at the site and to assess the risk of reoccurrence of the hazard. Multiple hazards should be considered, even though the cause for reconstruction may have been caused by a single hazard.

This section focuses on examples flood and earthquakes.

5.1 Policies, Regulations and Guidelines

When planning the location of any new development, reference to the following existing policies, regulations and guidelines should be made:

- *Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:Sand Mortar in Earthquake Affected Areas (2006), Earthquake Reconstruction and Rehabilitation Authority*
- *Land Use Rules 2009 (Classification, Reclassification & Redevelopment) (Under - Punjab Development of Cities Act 1976)*
- *Punjab Private Housing Schemes and Land Sub-Division Rules, 2010*
- *Building Code of Pakistan (Seismic Provisions 2007)*

5.2 Flooding Risk Assessment

- ✓ **Determine level of flood risk**
- ✓ **Development within the annual flood extents (Zone 2) is prohibited**
- ✓ **Any development with the super flood extents (Zone 1) should be accompanied by flood resilient designs (see chapters 9 and 10)**
- ✓ **Verify development is not within the flood zone of planned breaching section[27]**

5.2.1 Flood Risk Zone Maps

Flood risk zone maps produced by Mott MacDonald (2012) define the risk zones as follows:

- *Zone 1: Super flood extents, based on 2010 flood extents as provided by the Pakistan Meteorological Department*
- *Zone 2: Annual flood extends*

Note; the flood extents for future super floods may differ from the extents identified in Zone 1 of the maps dependant upon maintenance conditions of flood protection bunds in the province.

5.2.2 Flood Zone 1 – Extreme Risk

The **2010 flood** was an extreme event, and it is not anticipated that floods will reach this extent (**Flood Zone 1**) on a regular basis. However, according to the Intergovernmental Panel on Climate Change (IPCC) (2007) **the frequency and magnitude of extreme events such as**

flooding shall increase globally due to the effects of climate change.

This provides cause to **relocate any village currently sited within the annual peak flood flow extents to an area outside the 2010 flood extent.** Any development within flood Zone 1 areas must be accompanied with flood resilient building designs as defined in section 9.

For a village currently positioned outside the annual flood extents, but within the 2010 flood extents, planners must assess the risk of flooding of the site as against the difficulties of relocation (discussed in section 5.4.4). The basis of the decision will most likely be based on the availability of suitable land, access to amenities and financial constraints.

5.2.3 Flood Zone 2 - Annual Flood Risk

The **annual peak flow flood extents (flood Zone 2)** represent areas that experience flooding on an annual basis. These are typically confined between flood bunds along the main areas. Any village subject to reconstruction planning must primarily consider options to **resettle communities away from the flood extents**. Reconstruction within these higher risk areas requires more investment to improve community resilience to this threat and could result in considerable investment in flood prevention and protection that may outweigh the advantages of remaining on the same site. Construction of new villages within flood risk Zone 2 areas (as identified in the flood risk zone maps produced by Mott MacDonald) should be prohibited.

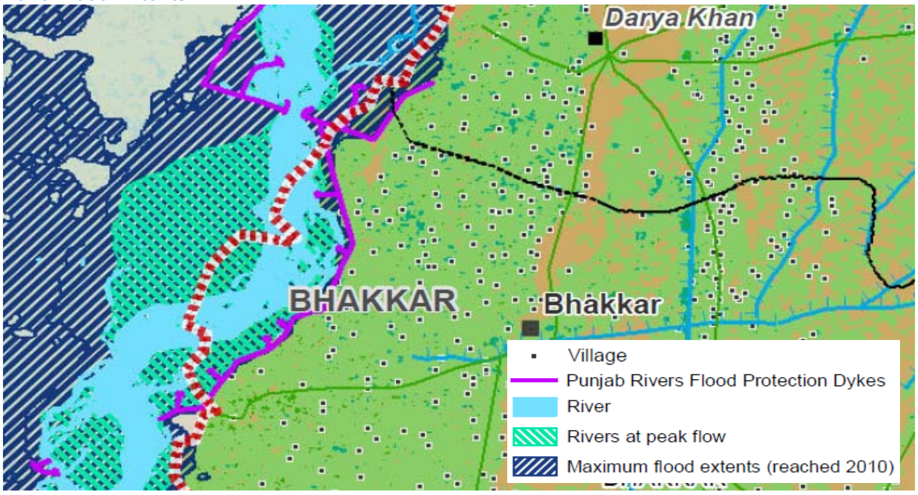
Relocation must consider availability of suitable land and access to amenities

5.2.4 Maintenance of Flood Bunds

There is an imperative need for ongoing maintenance and repair of flood bunds to prevent the flooding of areas. Flood hazard mapping focused purely on past flood experiences will not necessarily identify potential flood extents as a result of the **failure of flood protection bunds unless the failure previously occurred during the data period**.

When making a risk assessment it is advised that: the risk of flood protection failure is identified (by mapping flood bunds and other flood protection infrastructure); the relevant government or community body responsible for maintaining the same is engaged in discussions on the future planning for this protection.

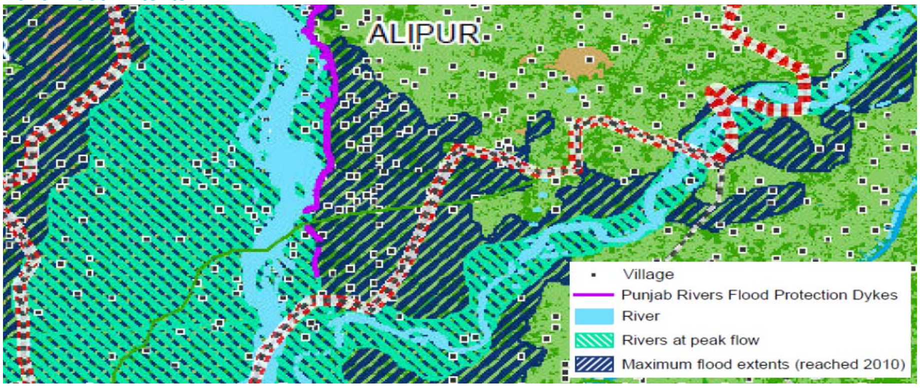
2010 Flood Extents



Source: Mott MacDonald[28]

The map below shows flooding in 2010 of villages at Alipur in Muzaffargarh district behind flood protection bunds, where these bunds have failed.

2010 Flood Extents



Source: Mott MacDonald[28]

With the increased frequency of extreme flood events, bunds may become weakened, and such failures of bunds may become more common. Maintenance is the key to protect against such weakening.

5.2.5 Planned Breaching Sections

Example of damaged flood bunds post 2010 floods

Source: MM Pakistan (Pvt.) Ltd

Planners should be aware that 18 selected sections of flood protection bunds in Punjab are designated as **breaching sections to release discharge from rivers and canals** to prevent damage to major hydraulic structures, bridges or key populated areas.[29] The breaching sections are operated by the Irrigation and Power, Railway and Highway Departments and these should be contacted (see Contacts Section) to ensure the village locations will not be effected by these breaching sections.

References and Further Reading

[27] The following department are responsible for planned breaching sections:

Irrigation Department - Phone: +92 42 992135 95/97

National Highways Authority - Phone: +92 051 9260 417/214

Ministry of Railways - Phone: +92 051 9218 515

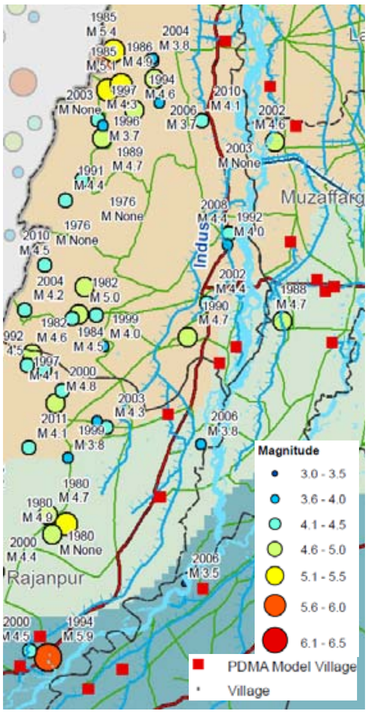
[28] Mott MacDonald (2012) 'Hazard Mapping Report' Climate and Development Knowledge Network

[29] Provincial Disaster Management Authority (2008) ‘Disaster Risk Management Plan, Punjab’ PDMA, Lahore

5.3 Earthquake Risk Assessment

- ✓ **Do not build within 650ft of an active fault line**
- ✓ **Determine the seismic risk for the development area**

Earthquake Hazard Map (1973- 2011)



Source: Mott MacDonald

The hazard areas for earthquakes are far less discrete than for flooding, so it is **not usually possible to locate a village away from a seismic area within a single locality**. The main planning actions will be focused on building designs (see Design Section).

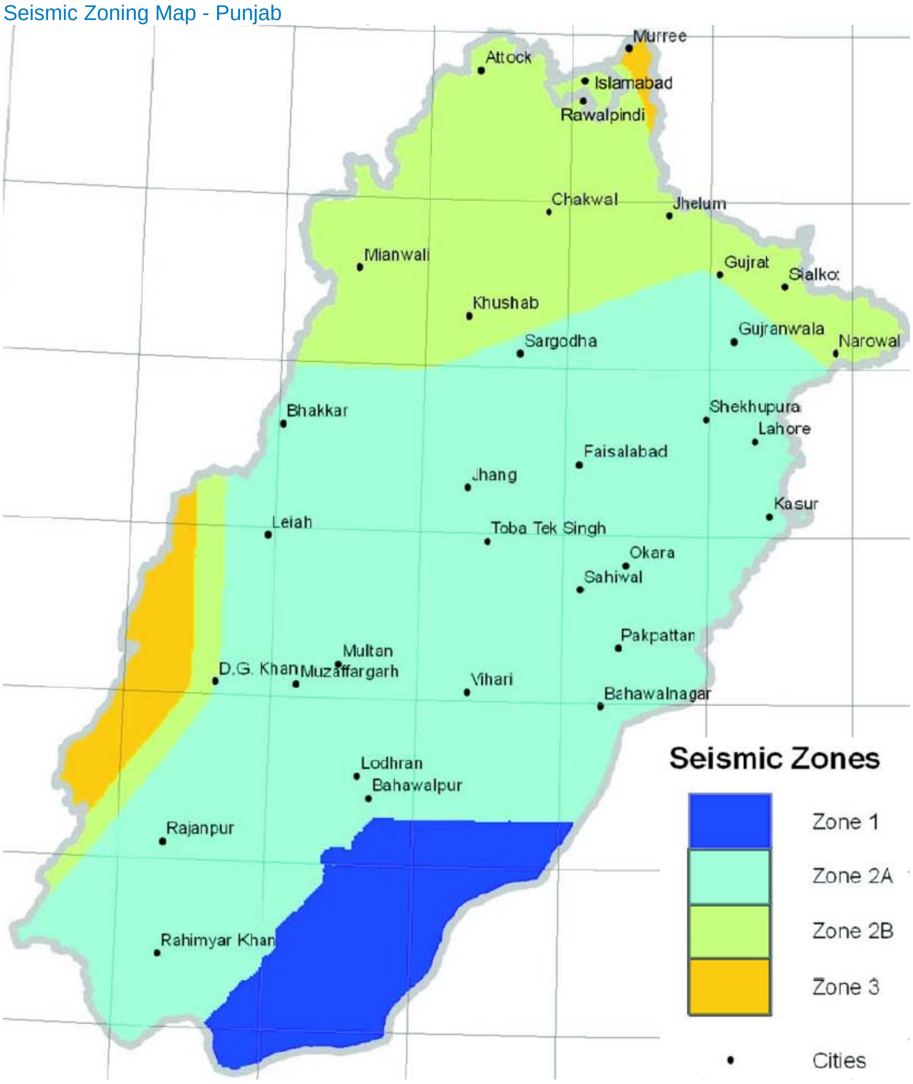
The Building Code of Pakistan (Seismic Provisions) 2007[30] requires that no important building shall be located within 200m (656ft) of an active fault. This should be taken into account in the planning of any village in Pakistan.

A map of fault lines in Pakistan has been produced by UN-Habitat[31]. As shown opposite mapping can be developed further to indicate the locations and magnitudes of earthquakes which have occurred in the past. This showed that between 1973-2011 there are zones in west and north-east Punjab that are prone to seismic events.

5.3.1 Seismic Risk Maps

In order to define the level of protection required during layout planning (see section 7) and building design (see section 9), the earthquake risk should for the development should must be determined using the seismic zone maps included within the Building Code of Pakistan[30] (reproduced on the following page).

Seismic Zoning Map - Punjab



Source: Extract from Building Code of Pakistan[30], Fig 2.4.

References and Further Reading

[30] Pakistan Engineering Council (2007) 'Building Code of Pakistan (Seismic Provisions - 2007)' www.pec.org.pk/buildingcode.aspx

[31] UN-HABITAT (2010) 'Earthquake Fault line and Zone range'. Available online: [accessed 17th February 2012] www.unhabitat.org.pk/newweb/Maps/EQ/UNH_PAK_EQ_Zones_V02.pdf

5.4 Successful Relocation

Land use planning
The public policy exercise of designation and regulation of land to improve a community's physical, economic and social efficiency and well-being and identify land uses that support local development

The importance of land use planning and the identification of a suitable site for relocation cannot be over-stressed. Unsuitable sites can lead to lost livelihoods, lost sense of community and social capital, cultural alienation, poverty and abandonment of the new site.

In 2010, the World Bank published a Handbook for Reconstructing after Natural Disasters[32]. Section 5 offers practical guidance in developing relocation plans, including the following principles for successful relocation:

Adequacy of new site

Consideration as to the land use, access to services, transport links, communication and road networks are vital both in determining adequacy for reconstruction and occupation.

Equitable Land Tenure

Issues related to land allocation are complex and require detailed planning and consideration and need to be carefully managed.

Relocation should take place as close to the original community as possible

Proximity to livelihoods and social networks

The site must be close to grazing land, fuel, food sources, relatives, social networks, livelihoods, markets and as close to the original community as possible.

Socio-Culturally appropriate layout

This is discussed further in the Layout Section.

Community Participation

Community participation should occur at every level of planning

Consultation with the community at an early stage will ensure an understanding of their needs and values and capture the views of current residents / land users. It can help to instil a sense of ownership and responsibility for the settlement, and could include developing employment opportunities.

Accurate Budgeting

The budget must allow for infrastructure, provision of services, construction, training, social assistance, and provision for those without land ownership rights.

Further guidance on resettlement needs is identified in the Guidance material referenced at the end of this booklet.

5.4.1 Vulnerable Communities

Source: MM Pakistan (Pvt) Ltd

The needs of the most vulnerable (the poor, elderly, young, disabled and women) should be prioritised in any relocation plan. In some cases, it may be appropriate to favour relocation of vulnerable communities as they may not possess the financial and / or physical means which are required to implement the measures required to protect themselves from hazards such as flooding and earthquakes.

5.4.2 Gender

As detailed above, sites must be located in areas which are close to grazing lands and fuel sources. This is a major factor impacting upon women's lives as the responsibility of collection of fuel and care of livestock often lies with female family members.[33]

Relocation also offers an opportunity for the re-allocation of land rights. Male family members should be offered incentives and encouraged to enter into shared land right agreements with their female counterparts, or suitable areas of land offered exclusively to women. Further information on this recommendation is provided by the Aurat Foundation[34].

5.4.3 Environmental Assessment

For any relocation, an environmental assessment must be completed for the proposed sites as per the requirements of the Punjab Environmental Protection Department (see Contacts Section).

5.4.4 Barriers to Relocation

Three major considerations for relocation need to be considered:

Land Tenure

Plan to provide suitable land for those without tenure rights in any relocation proposal

Groups without rights to the land they occupy or proof of ownership are often the first to return to disaster stricken settlements as the need to secure property where land demarcations have been wiped out is particularly acute[35]. These groups will often be the most resistant to relocation for the fear of losing land.

These groups must be provided with **informed and voluntary relocations options** which tackle the current inequalities of favouring land owners and provide suitable land for those without tenure rights. The easiest mechanism for achieving this, is to allocate public land for reconstruction[35]. Other options include acquisition of private land or long-term rental assistance. The PDMA must provide assistance to land administration agencies and developers to accelerate the land administration procedures.

Access to Water

Source: Mott MacDonald

The main reason for the location of existing villages within flood plains is the ready access to land and to surface water from the nearby watercourse. Access to water at any relocated site must be considered a priority, as well as any land needs, and an assessment of its availability must be made for any potential relocation site. In addition, any measures to conserve or reuse water must be adopted. Such measures are discussed in Design and Services Sections.

Grazing and Cultivatable Land

Grazing and cultivatable land is often crucial to support families. Fertile grazing areas are often created as a result of the regular flooding of the land adjacent to watercourses and ease of access to irrigation supplies to support the livelihood of villages situated there. Communities may have developed techniques to cope with annual flooding in their area in order to remain in that location.

These communities are likely to be resistant to relocation. It is therefore vital that effective flood resilient design modifications and emergency provisions can be incorporated into any design where reconstruction is being promoted back in these higher risk areas. See section 5.2.1 below.

References and Further Reading

[32] Jha, A., Barenstein, J., Phelps, P., Pittet, D. and Sena, S. (2010) 'Safer Homes, Stronger Communities. A Handbook for Reconstructing after Natural Disasters', The World Bank, Washington

[33] United Nations Development Fund for Women (2011) 'Rapid Gender Needs Assessment of flood affected communities' UNIFEM

[34] Brohi, N (2011) 'Effects of 2010 Floods on Women in Pakistan' Gender Equity Program, Aurat Foundation. Funded by USAID. Available online at: http://af.org.pk/gep/deskStudies/Edited%20Floods%20-%20N%20Brohi.pdf

[35] Thomas, A. and Rendon, R (2010) 'Confronting Climate Displacement: Learning from Pakistan's Floods'. Refugees International, Washington DC

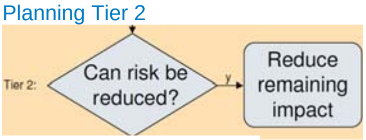
Intermediate Technology Group - South Asia (2004) 'Guidelines for planning in the re-building process - Resource pack'. Available online at: http://practicalaction.org/docs/region_south_asia/guidelines-planning-rebuilding.pdf

6. Site Protection

6.1 Residual Risk

Reduce the Risk

Planning Tier 2



Source: Mott MacDonald

Planning Tier 2

Once a decision has been made to relocate a village or to rebuild it on its original site, consideration should then be given to measures to reduce all the risks for the village site as a whole. Such measures are likely to require considerable investment. As **with Planning Tier 1**, this step is only applicable to the flooding and earthquake hazards.

These Guidelines are particularly important where the proposed development is within a hazard risk zone.

6.2 Policies, Regulations and Guidelines

The Building Code of Pakistan (Seismic Provisions) 2007[40] gives specific guidance for site consideration and the rules of this code should be followed.

6.3 Overview of Site Based Considerations

Site Criteria for Climate Change Resilient Village Reconstruction

Risk Level	Flooding	Earthquake
High Risk	Provide or strengthen existing flood protection bunds (6.4.1)	Locate away from top of unstable or steep slope (6.5)
	Provide raised peripheral road acting as a local bund with ditches/flood storage and flood resistant plantation to reduce water flows inside the villages (6.4.3)	Locate away from base of unstable or steep slope or rock fall area (6.5)
	Raise ground level of the site, where applicable (6.4.4)	
Low Risk	Provide raised peripheral road acting as a local bund, Raise ground level of refuge area (6.4.3)	*As for high risk*

6.4 Flooding

- ✓ **For development within flood risk Zones 1 and 2, planners must incorporate maintenance or strengthening of flood protection bunds into the development**
- ✓ **For development within flood risk Zone 2, a raised peripheral road should be provided acting as a local bund with ditches/ flood storage and flood resistant plantation to reduce water flows inside the villages**
- ✓ **For development within flood risk Zone 2, the ground level of the village or building site must be raised to 2 feet above flood levels.**

This section contains suggested measures to reduce the risk of reduce the flood risks from surface water and flood waters in the event that relocation is not an option. It must be appreciated that a **risk of failure of these measures exists and that the impacts from such a failure can be catastrophic**. These measures must be supplemented with additional impact reduction measures (see following sections) where possible.

If the decision is made to protect a location within a flood risk area, planners must also make provision for evacuation of the area during a flood, understanding that the surrounding area will be inundated.

Remember: Failure of bunds can lead to sudden and catastrophic flooding impacts. Adequate maintenance is vital

6.4.1 Engineered Flood Protection Bunds

The traditional response is to use hard-engineering structures to provide, or strengthen and heighten existing, flood protection bunds where a village is located within a flooding hazard area.

In determining the measures required, an appreciation of higher flows due to climate change must be made. Planning must include provision for adequate maintenance and management in coordination with the Irrigation Department[36].

6.4.2 Planting of Vegetation

Soft-engineering methods can be applied using ecosystem services, as shown by the case study opposite.

Case Study
Bamboo Plantation, Nadeswar Village, Pakistan
Source: [32]

During each monsoon period, the villagers desilt local river channels and use the silt to build new and strengthen existing flood bunds. Grass is then planted over the bunds to stabilise the top soil and a month later bamboo shoots are planted. The deep roots of the bamboo bind the soil and strengthen the embankments.

Vegetation (if properly managed) can provide:

- strengthening flood bunds against erosion by planting indigenous vegetation;
- retention / planting of indigenous vegetated areas to reduce rapid run-off during time of flood and increased infiltration of surface water to ground water;
- retention / plantation of indigenous vegetated buffer between watercourses and villages to impede water flow through villages thereby creating a time lag between peak flows in the watercourse and flooding in a village allowing more time for evacuation.

Care needs to be taken to identify appropriate indigenous vegetation to be planted based on site conditions, maintenance needs and risks caused by vegetation, such as tree debris.

See Section 7.11 for more details.

6.4.3 Raised Peripheral Road

The provision of raised peripheral road can be one of the solutions that delays the immediate impact of flood water intrusions in the villages and in generating sufficient time for evacuation in disaster event.

The raised peripheral road can act as a local bund to prevent flooding into the village in case of failure of major protection bunds on rivers. The provided heavy flood resilient vegetation along the road and ditches for surface water runoff will further help in controlling the flood water and to minimize the immediate destruction. These measures will provide ample time to village occupants for evacuation and to gather their belongings to reach safe places/ refuge areas in time of emergency.

This road will serve different purposes including:

- Evacuation route
- External access route
- Emergency landing space
- Featuring landscape and drainage route
- Connectivity and communication route
- Security and alarm positioning
- Surveillance

6.4.4 Raised Ground Level

Villages located within annual flood plains (**flood Zone 2)** may be reluctant to relocate away from the fertile grazing land which supports their livelihood. An alternative is to raise the ground level of the site, select buildings (such as emergency refuges), or certain parts of the village to benefit the most vulnerable, such as schools or livestock sheds.

To construct the raised platform, earth fill must be placed over the scarified existing surface. The earth fill should be placed in 6 inch deep layers, and each layer compacted to 95% of dry density. The FAO[37] recommend a masonry retaining structure to surround the earth fill within 10 ft of the perimeter of the platform. The outer slope of the platform should be at a gradient of 1 (vertical) to 1.5 (horizontal).

Case Study
Cluster Villages, Bangladesh
Source: Practical Action[109]

Practical Action oversaw the development of a cluster village built on a raised platform 3 ft above the highest flood recorded over the previous 40 years. The platform covered an area of 5 acres (20,000m^2) and allowed for the construction of 100 houses. The project benefited the poorest people, such as the landless, displaced, widows, elderly and beggars.

At least two sets of stairs with 6ft width should also be provided to each community structures. Steps should have a height of no greater than one foot and a depth of six inches. A ramp to each community building must also be provided for disabled access. The ramps must have an unobstructed width of no less than 5ft and a gradient of 1:12[38].

Raised platforms for community structures must be constructed to a level of two feet above the highest level recorded during previous flood events.

When considering the cost of a raised village level, which can be prohibitive, planners must consider the likely reduction in risk of flooding on the site and access needs during time of flood.

6.4.5 Flood Diversion

Drainage ditches can be built around a village to divert surface runoff during storms into the ditches and convey this flow away from the village. Regular maintenance of these ditches will be required to ensure they do not become blocked.

In determining the size of drainage ditches, planners should consider the size of the catchment area and its land use as well as study rainfall records in the area. Large catchments of impermeable or unvegetated land will result in high volumes of surface run off during storms and require the largest drainage ditches, especially where these occur in areas of high recorded rainfall. Further detail is in given in Section 7.6 and by the World Health Organisation[39]. The ditches should be located around the perimeter of a village where the ground level outside the village is higher than the level within the village itself. The ditches should discharge at a level lower than the village (preferably to a watercourse) but not to a location which could cause flooding to another inhabited area.

Drainage ditches will have little effect to prevent flooding in the event of failure of any flood protection bunds to major rivers. They are only like to negate the impacts of high volumes of surface runoff flowing towards a watercourse.

References and Further Reading

[36] Irrigation Department - Phone: +92 42 992135 95/97

[37] Ehsan, Muhammad (2011) 'Design of Raised Platforms in Flood Affected Areas of Badin and Mirpurkhas Districts' Food and Agriculture Organization of United Nations

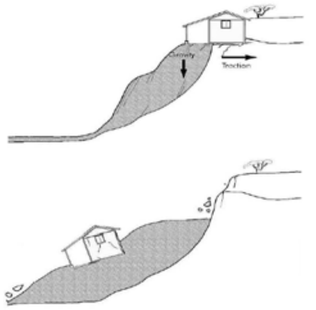
[38] HM Government (2010) 'The Building Regulations 2010. Access to and use of buildings' Section M. NBS, Newcastle Upon Tyne

[39] World Health Organisation (1991) 'Surface Water Drainage for Low-Income Communities' WHOO, Geneva

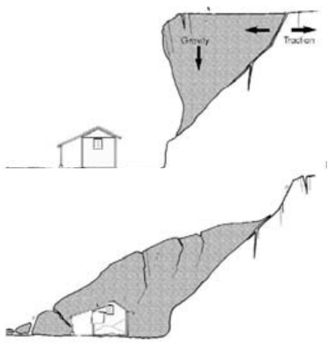
6.5 Earthquakes

✓ **When locating structures near steep or unstable slopes, follow the provision of the Building Code of Pakistan (Seismic Provision) 2007[40]**

Landslide Hazard: Top of Unstable Slope



Landslide Hazard: Below Unstable Slope



Source: ERRA[41]

Without relocation, there are no measures available to eliminate the risk to a site within an earthquake prone area.

The hazard can be substantially reduced by locating buildings away from known slip areas, for which there are two major at risk locations (as depicted opposite):

1. *On top of steep or unstable slope*
2. *Below unstable slopes or rock fall areas (such as the foot of a cliff)*

Even apparently stable slopes can be unstable during an earthquake- Abnormally inclined trees on a hillside can be an indication of instability.

Where it is not possible to relocate villages away from unstable slopes, the slope stability can be improved by ensuring adequate plantation of the slope, reducing the angle of the slope or terracing the slope alongside improved drainage. Alternatively, engineering interventions such as piling, ground anchors, gabion walls or retaining walls may be used.

Further guidance is provided by the Earthquake Reconstruction and Rehabilitation Authority[41] and the Building Code of Pakistan[40].

References and Further Reading

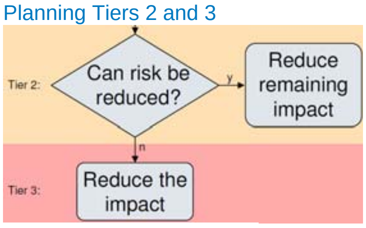
[40] Pakistan Engineering Council (2007) 'Building Code of Pakistan (Seismic Provisions - 2007)' www.pec.org.pk/buildingcode.aspx

[41] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

7. Layout

Successful planning of layout can improve how a village can communally cope with the impacts of climate change, in both day to day impacts (such as temperature extremes) and extreme events (such as flooding or earthquakes).

Planning Tiers 2 and 3



Source: Mott MacDonald

Planning Tier 2 and 3

Now an assessment of the remaining risks must be made. Decisions as to the layout should include facilitating efficient human intervention in terms of emergency shelter and evacuation. This Section has been split into categories based on the possible climate risks identified for the Punjab of flooding, earthquake and temperature extremes.

7.1 Policies, Regulations and Guidelines

When planning the layout reference to the following existing policies, regulations and guidelines should be made:

- *Land Use Rules 2009 (Classification, Reclassification & Redevelopment) (Under - Punjab Development of Cities Act 1976)*
- *Punjab Private Housing Schemes and Land Sub-Division Rules, 2010*
- *National Reference Manual on Planning and Infrastructure Standards*
- *Building Code of Pakistan (Seismic Provisions 2007)*
- *Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cementsand Mortar in Earthquake Affected Areas (May 2006)*

According to the Punjab Private Housing Schemes and Land Sub-division rules, an application for a new development must be accompanied by a layout plan with proposed division of the scheme into residential and commercial plots, road networks, open spaces, graveyard and public buildings. Section 10 of the Rules define the requirements for land sub-division as follows:

- *Open space or park: greater than 7% of total scheme area*
- *Graveyard: greater than 2% of total scheme area*
- *Commercial area: 5% of total scheme area*

- *Public buildings: 5 to 10% of total scheme area*
- *Maximum residential plot size: 1,000 square yards*
- *Solid waste management area:10 marla for each 1,000 plots*
- *Plots reserved for low income groups: 20% of all plots (up to 5 marlas)*
- *Location of tube well, overhead reservoir, pumping station and disposal station if required by WASA and other agencies*
- *Site of grid station to be provided if required by WAPDA or other agencies responsible for electricity*
- *Green strip under high tension electricity line as per requirements of WAPDA or other agency responsible for electricity*
- *Approach road in 5 City Districts not less than 60ft and not less than 40ft in other districts*
- *Internal roads with minimum 40ft right of way*
- *Accommodation of roads proposed in master plan*

These rules are reproduced in the sections below where they are relevant to climate change construction or disaster risk reduction.

7.2 Overview of Layout Based Considerations

Layout Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extreme
Housing	Provide adequate and uninterrupted drainage from roof top and road level to outside of village (7.6)	Reduce number of houses per block (7.7)	Segmented groups of 4 houses per block (7.8)
		Maintain minimum clearance greater than height of buildings between housing blocks and buildings (7.7)	Maintain street width equal to building height (7.10)
			Locate kitchen away from living areas (7.11)
Plantations	Provide permeable park areas within the village (7.5)	No tree plantation adjacent to living quarters (7.12)	Provide organically planned green areas with tree plantation for shade and to reduce heat island effect (7.12)
	Provide big & thick leaf tree plantations along the periphery	Set back tree from emergency access and evacuation routes (7.12)	
	Provide small leaf tree plantations within properties for water exclusion		
Emergency Response	Provide high strength refuge building(s) and platforms above previous flood levels with storage for food and livestock (11.2.2)	Provide high strength refuge building(s) and platforms with storage (11.2.2)	Provide disaster resilient shelters to act as comfortable temperature enclosures for the area
	Provide elevated platforms accessible from refuge(s), or flat roofs to refuge(s) to act as evacuation points (11.2.9)	Provide two access routes to village (11.2.7)	
	Build access route to village on high level ground (11.2.7)	Ensure trees and utility poles are set back from access and evacuation routes (11.2.7)	

7.3 Contents

This section shall cover the following:

- *Housing block organisation*
- *Housing orientation*
- *Street width*
- *Tree plantation*
- *Position of the kitchens*

7.3.1 Flooding

The main reduction in flood impact will be through the flood resilient layout of village and increased efficiency of passing rainfall through and away from the village (water exclusion strategies).

7.3.2 Earthquakes

The Design Section provides guidelines for earthquake resistant structures. However, effective layout planning can further reduce the damage resulting from an earthquake.

In terms of layout, damage during an earthquake can be reduced by **isolating the damage** and **preventing a 'domino' scenario of collapse**.

7.3.3 Temperature Extremes

The layout of village buildings can aid the management of extremes of temperature through principles of thermal mass, orientation and shading as set out below (which are often also of low carbon options).

7.4 Typical Layout

The typical layout on the following page illustrates the guidance given in this section of the guidelines. This layout is designed to provide a balance between protection against flooding, earthquake, temperature extremes and emergency response.

Other examples of layouts used for the construction of PDMA villages are included in the Appendix of these guidelines:

- *Example layout for protection against flooding: Section 15.2.1*
- *Example layout for protection against temperature extremes: Section 15.2.2*
- *Example layout for emergency response: Section 15.2.3*


Prevailing summer wind
= building height (but not less than 5ft)
Pedestrian Access to side & rear
Pedestrian Access to front
= building height (but not less than 10ft)
Local Distributor (2-way without services on berms)
Secondary Emergency Access Road (seismic zones 2B & above only)
Secondary Emergency Access
Local Access (2 way)
> building height
Main External Road
Minimum clearance between buildings for local distributor (2 way with services)
Primary Emergency Access Road 1ft above flood level for flood zones 1 & 2
Centrally Located Emergency Refuge
Water treatment facility adjacent to refuge
Local Distributor (2-way with services on berms)
Primary Emergency Access
Parkland covering >7% of development area
Culverts provided under roads for open drainage systems
15ft clearance between utility poles/ trees and emergency access routes
Windows only in north or south facing walls
East-west alignment
Kitchen separate and remote from living areas
Min. clearance between trees
Min. clearance between trees and living areas
Max. 4 houses per block
Drainage system discharging away from village
N
Prevailing winter wind

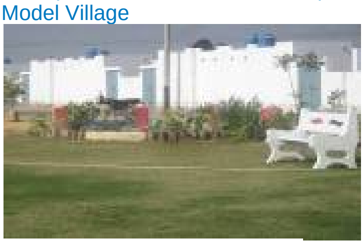
7.5 Flooding - Permeability

- ✓ **At least seven percent of a new development must be designated as open space or park land[42]**
- ✓ **Permeable park land areas should be organically planned taking advantage of the natural terrain of the area**
- ✓ **The permeable areas should be based on green sustainable approach balancing the ration of constructed and open areas**
- ✓ **Ground coverage within a single residential or commercial plot must not exceed[43]:**
- ✓ **- 75% for a plot size of up to 105m^2**
- ✓ **- 70% for a plot size from 105m^2 to 160m^2**
- ✓ **- 65% for a plot size greater than 160m^2**

Designate and maintain parks within the village

Leave undeveloped areas between housing sectors

Example: Park areas within Fazalpur Model Village



Source: MM Pakistan (Pvt.) Ltd

The surface of an undeveloped area (i.e. soil) is permeable allowing surface water to soak-away and recharge the groundwater table. When these permeable areas are covered with impermeable areas, such as pavements, roads and buildings, the water cannot pass directly into the soil. Without adequate drainage, this can result in significant flooding following heavy rains.

During planning, multiple undeveloped areas should be incorporated into the layout to retain vegetative areas and uncovered areas must be left within housing plots. Park areas can provide space for community activities, such as park land, and help relieve flood levels by filtering them into the soil. Ideally, the village layout should incorporate several village areas separated by permeable land.

References and Further Reading

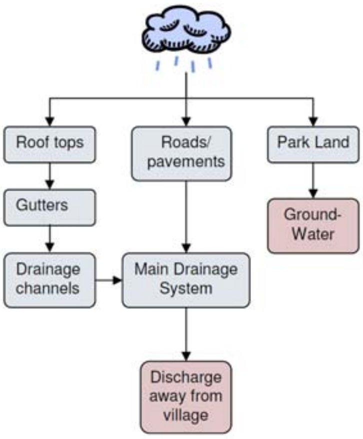
[42] Local Government and Community Development Department (2010) 'Punjab Private Housing Schemes and Land Sub-Division Rules' Section 10. (a), Government of the Punjab

[43] Ministry of Housing & Works, Environment and Urban Affairs Division (1986) 'National Reference Manual on Planning and Infrastructure Standards' Section 4.2, Government of Pakistan

7.6 Flooding - Stormwater Drainage

- ✓ **Drainage capacity must be based on a design storm with a return period of 2 years in normal circumstances, or 3 years where the effected community is vulnerable**
- ✓ **The runoff coefficient for design must be adjusted to account for developed areas (see below for details)**
- ✓ **Calculate drainage capacity using the rational method**
- ✓ **Adopt trapezoidal drainage channels**
- ✓ **Design drainage systems to maintain a self-cleansing velocity of at least 2ft/s, but not exceed maximum permissible velocity for the soil type (see below for details)**
- ✓ **Provide concrete or masonry lined drainage channels where the system is constructed within fine sand or sandy loam**
- ✓ **Install 1/2 inch diameter pipes at 3ft intervals through both sides of lining where the lining depth exceeds 1ft**
- ✓ **Adopt closed drainage systems only where funds are available and reserved for regular formal maintenance**
- ✓ **Provide training to community for maintenance of open drains**
- ✓ **Provide pedestrian crossings over open drains to access buildings**
- ✓ **Provide culverts where open drains cross roads**
- ✓ **Provide discharge from drainage system into a watercourse or an infiltration/flood retention basin**
- ✓ **Provide overflows from flood retention basins to ensure extreme flood flows are channelled to a watercourse before the pond is overtopped**

Village Drainage Paths



Source: Mott MacDonald

The importance of efficient stormwater drainage cannot be overestimated. The diagram opposite depicts an ideal drainage path for rainwater. In this depiction, rainwater is collected from the built environment (roofs, pavements, roads) and diverted into drainage channels. If there is any break in this drainage path (such as no connection between roof drainage and surface drainage, or a blockage of the surface drain) the entire system is at risk of being ineffective and could cause further damage.

Drainage systems should also incorporate rainwater harvesting techniques as discussed in section 8.3.3.

Maintaining clear boundaries around properties to convey roof drainage water to the main system is recommended. Measures must be taken to ensure these channels and the main system do not become blocked. **Regular maintenance of drainage channels is essential.**

7.6.1 Derivation of Required Drainage Capacity

The design of a drainage system is dependant upon the rainfall within the catchment (rainfall intensity, storm duration and frequency) and the portion of rainfall which shall infiltrate to groundwater and that which remains as surface water (soil conditions, terrain and land use).

Rainfall

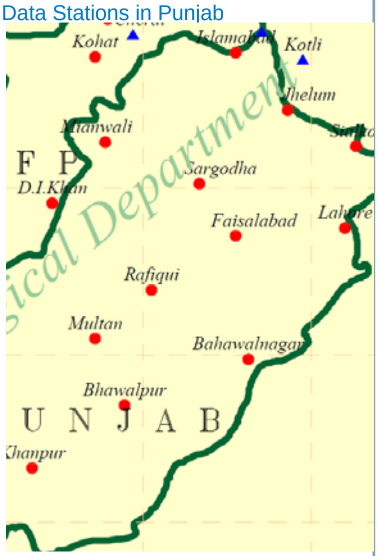
Through analysis of past rainfall records it is possible to estimate the **probability** of a particular rainfall intensity occurring. The storm which produces this rainfall is referred to as the **design storm** and the probability of its occurrence is referred to as its **return period**. For example: a design storm with a return period of 20 years is expected to occur on average once every 20 years.

By designing a stormwater drainage system for a high return period, the probability of the system being overfilled resulting in flooding of the area is reduced, however the cost is increased and the full capacity rarely used. Therefore a balance between protection and cost must be reached.

Current guidelines in Pakistan require a return period of up to 2 years for small urban sectors[44], however, this should be increased to up to 3 years to account for climate change and where the effected community is vulnerable or assets are valuable (such as community structures and/or refuges).

The volume of rainfall which will fall during a storm is highly variable and is difficult to estimate given the unpredictability of the weather. In addition, records of rainfall data are limited, however intensity-duration curves are available for Lahore and Islamabad which can be used for areas nearby. For areas outside of this vicinity, climatic data can be purchased from the Pakistan Meteorological Department (PMD)[45]. The location of PMD stations in Punjab are shown opposite.

Data Stations in Punjab



Source: Pakistan Meteorological Department[45]

Runoff

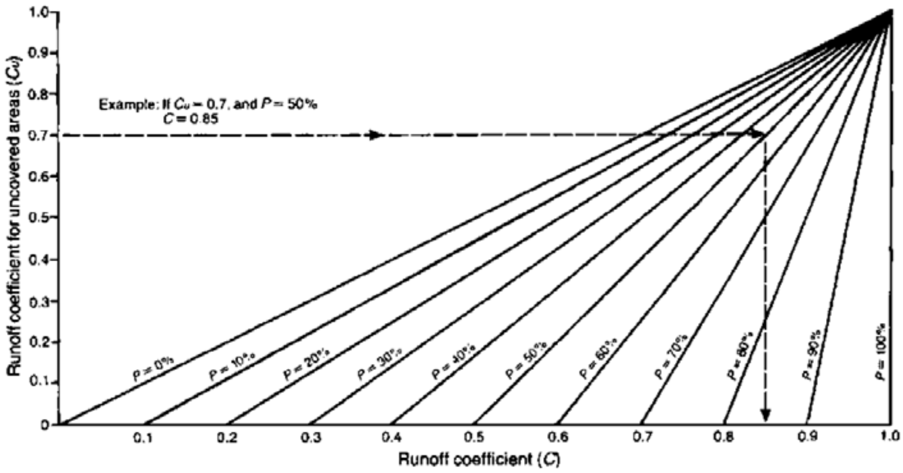
Not all the rainfall within the catchments area shall be conveyed to the drainage system within a village. Much shall infiltrate into the ground water in undeveloped areas outside of the village, and surface water shall also be lost within a village to infiltration through open spaces and park land and through evaporation from roofs, pavements and roads. To account for this, a runoff coefficient for the undeveloped land is assumed, and adjusted to account for the percentage of impermeable paved and covered areas within the entire catchment. According to the WHO[47], this percentage can be assumed based on population density as per the table opposite and the runoff coefficient derived using the graph below.

Percentage of Paved Areas in a Catchment (P)

Population Density (residents/ha)	P (%)
0-50	0-12
100	25
200	50
300	75
>400	100

Source: World Health Organisation[47]

Derivation of Runoff Coefficient for Design



Source: World Health Organistation[47]

Typical Manning's n

Open Channel Type	n
Unlined rough channel	0.027
Unlined dressed channel	0.022
Brick lined channel	0.015
Concrete finished channel	0.013

Source: Chow[46]

Design Flow

The peak flow for design can be calculated using the Rational Method:

Q = CIA

Where:

Q = Design Flow (ft^3/s)

C = Runoff Coefficient

I = Rainfall Intensity (inch/h)

A = Catchment Area (acre)

7.6.2 Channel Design

Channel Area

Once the design flow has been determined, Manning's formula can be used to calculate the required drainage cross-sectional area.

$$Q = A * 1.486/n * (A/P)^{2/3} * S^{1/2}$$

Where:

Q = Design Flow (ft^3/s)

A = Drainage cross-sectional area (ft^2)

P = Length of the perimeter of cross-section in contact with water (ft)

S = bed slope of drain (e.g. for a1% slope, S =0.01)

n = Manning's Number

The manning's number can be found in most hydraulic design text books, including Chow[46]. Typical values are given in the table opposite.

Trapezoidal drainage channels should be adopted with side slopes of 1:1.5 to 1:2 (dependant upon the soil type).

Flow Velocity

The velocity of the flow in the channel must be checked to ensure a self-cleansing velocity is achieved, but that the velocity is not so high as to erode an unlined channel.

The maximum permissible flow velocities for different soil types of unlined drains is given opposite.

Maximum Permissible velocities

Soil Type	Maximum permissible flow velocity (m/s)
Fine sand	1.3
Sandy loam	2.3
Medium sand	2.6
Silty loam	2.6
Ordinary firm loam	3.3
Coarse sand	3.3
Stiff clay	4.9
Alluvial silt	4.9
Fine gravel	4.9
Coarse gravel	5.9
Grass cover to erodible soils	3.9
Grass cover to stable soils	5.9

Source: Chow[46]

A self-cleansing velocity of at least 2ft/s must be maintained when the drain is running full[47], although a velocity of 3ft/s is ideal. Where the self-cleansing velocity exceeds the maximum permissible velocity for the soil type in which the drainage channel are to be built, a lined channel must be proposed (see below).

Lined Drainage Channels

Where the self-cleansing velocity exceeds the maximum permissible flow velocity, lined drainage channels must be proposed.

Lining should be solid concrete or masonry. Where the depth of a lined drains exceeds 1ft a build up of water pressure behind the lining can cause failure. To prevent this ½ inch diameter pipes should be provided through both sides of the lining at intervals no greater than 3ft[47].

7.6.3 Open vs. Closed Drainage Systems

Planners must consider the merits of open or closed drainage systems in relation to the skills and budget of the community the system shall benefit. A discussion of the two options is given below.

Example damaged closed drainage system

Source: MM Pakistan (Pvt) Ltd

Closed Drainage

The main advantage of closed drains is that they do not take up surface space and reduced health and safety risks associated with trips and falls into open drains. In addition, they prevent the ingress of debris and therefore prevent blockages and the need for regular maintenance. However, the following disadvantages must be considered:

- *Higher capital cost to construct*
- *Informal maintenance activities will be hindered due to difficulty of access*
- *Adequate ventilation is required to prevent the build up of gases that can attack cement and concrete*
- *Mosquito breeding is harder to control*

If a closed drainage system is chosen, the design must ensure the following:

- *Connections between house guttering and the drainage channel*
- *Regular openings for surface water to inflow into the drainage system*
- *Drainage covers must weigh no more 50kg so they can be removed without machinery to provide for maintenance access (such as removing debris)*

- *The covers themselves must not be allowed to deteriorate and it will need to be clear how these will be maintained and the cost of this maintenance and replacements*

Open Drainage

Regular maintenance and clearing of any drainage system is vital to its success and is only achievable through coordinated community action

Construction and access for maintenance costs are lower for open drainage. Maintenance can also be achieved through community participation, rather than formal planned maintenance. However, the following disadvantages must be considered:

- *Maintenance needs will be higher as they are more easily damaged by vehicles and more vulnerable to blockage*
- *Access through communities is hindered by open drains*
- *Greater care and supervision is required during the construction of an open drainage system to ensure no lower points exist in the system which may result in standing water, enabling mosquitoes to breed.*

Blocked surface drainage

Source: MM Pakistan (Pvt) Ltd

If open drains are adopted, the community must be made aware if they are responsible for maintaining and regularly clearing debris from the drainage channel. Communities must also be trained on maintenance activities and on why this process is needed.

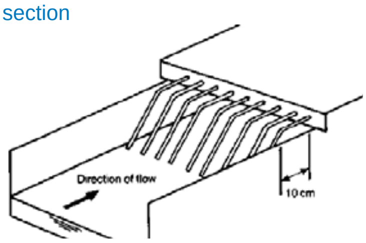
Crossings must also be built over open drains to provide pedestrian access to properties. Without the provision of crossing, villagers may place stepping stones in drainage channels causing a blockage.

Where open drainage channels pass across roads a closed culvert section shall be required to prevent damage to the drains. To prevent solids entering the closed sections, an iron grill should be placed in the channel at the upstream side of the section (as shown opposite) and the grill cleaned regularly.

Use of open drains still needs to be aligned with connecting gutters and overflows.

7.6.4 Drainage Outflow

Grill at entrance to closed drainage section



Source: WHO[47]

The outflow of the drainage system requires careful planning as, if successful, the drainage system will convey large volumes of water from one location to another. It must be ensured that outflow from a drainage system does not result in flooding of a second vulnerable area

Ensure that the outflow of the drainage system does not increase the flood risk of another

The drainage system should discharge into a watercourse with adequate capacity and freeboard or a specially designated flood retention/infiltration basin (an adequately bunded permeable area). If a flood retention basin is adopted, an overflow must be incorporated to ensure flow from an extreme event is safely diverted to a watercourse away from vulnerable areas instead of simply overtopping and eroding the embankments (which may lead to catastrophic failure).

Maintenance of the system must be completed along its entire length: from the village to the watercourse.

7.6.5 Infiltration Ponds

Infiltration ponds can be used to reduce and delay peak flood flows through a drainage system

Planners may also consider **infiltration ponds** within the village. These ponds are built in permeable soils and would usually remain empty to be filled by rainfall runoff during a storm. These ponds collect runoff and encourage infiltration of this rainwater into the groundwater. They should be designed not to discharge into the drainage system under normal storm conditions but incorporate overflow structures to channel flood waters to the drainage system (which should be adequately sized) during an extreme event. Infiltration ponds can reduce the total volume of flood water passing through a village during normal storms, and can attenuate the flow and delay the peak flood volume to provide valuable time for warning and evacuation.

References and Further Reading

This section has discussed requirements for surface water drainage, and not the drainage and treatment of sewage (as this is outside the scope of guidelines for climate change construction and disaster risk reduction). Guidance on the wastewater conveyance can be found in the following resources:

Ministry of Housing & Works, Environment and Urban Affairs Division (1986) 'National Reference Manual on Planning and Infrastructure Standards' Section 8.2, Government of Pakistan

Building Research Establishment (1980) 'Building in Hot Climates. A selection of Overseas Building Notes' Her Majesty's Stationery Office, London

Khanna (1991) 'Indian Practical Civil Engineers' Hand Book' 13th Ed. Engineers' Publishers, New Dehli

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[44] Ministry of Housing & Works, Environment and Urban Affairs Division (1986) 'National Reference Manual on Planning and Infrastructure Standards' Section 8.3.2 (a), Government of Pakistan

[45] Climate Data Processing Centre (Pakistan Meteorological Department), available online at: http://www.pmd.gov.pk/cdpc/home.htm (accessed 18th June 2012)

[46] Chow, V. T. (1959) 'Open Channel Hydraulics' McGraw-Hill, Singapore

[47] World Health Organisation (1991) 'Surface Water Drainage for Low-Income Communities' WHOO, Geneva

7.7 Earthquakes - Damage from Buildings

- ✓ **Preferably no more than four houses should be constructed in a single housing block**
- ✓ **Maintain a clearance between buildings of no less than the height of the buildings**
- ✓ **Maintain a clearance between buildings and utility poles of at least 15ft**

Planners should understand that **failure of a critical element of one housing block during an earthquake may result in the destruction of that entire block**.

7.7.1 Housing Blocks

Reduce the number of houses in each block

Allow adequate clearance between buildings

Individual families are most likely to favour detached housing, however, it is recognised that this may not be possible due to cost, land and other requirements. The number of houses linked together by blocks should be minimised where feasible. This rationale should also be applied in section 7.8

If planning multiple houses per block, it is recommended that no more than four houses are included in each block to prevent damage to surrounding buildings from the collapse of one house.

In addition, adequate clearance should be maintained between housing blocks to ensure the failure of one block does not cause damage / destruction of the adjacent block.

According to the Earthquake Reconstruction and Rehabilitation Authority[48], housing blocks should be built with a clearance no less than the height of the buildings, as shown below.

Required building clearance in earthquake prone areas

Source: Earthquake Reconstruction and Rehabilitation Authority[48]

7.7.2 Housing Lengths

To ensure strength of the building during an earthquake, the length of a building (along the east-west axis) **must not exceed three times its width (along the north-west axis**). Where longer buildings are necessary, additional strengthening measures are discussed in Chapters 8 and 9.

References and Further Reading

[48] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in cement:sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

7.8 Temperature - Building Organisation

✓ **Preferably no more than four houses should be constructed in a single housing block**

Reduce the number of houses to 4 in a block

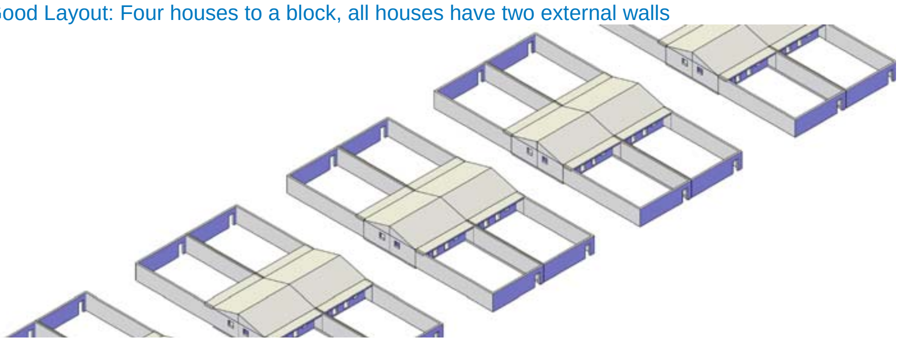
Align streets with the prevailing wind direction

The guiding principle for management of temperature is to maximise the number of external walls in order to allow ventilation.

As windows can only be installed on external walls, it is important to avoid blocks creating only one external wall as it restricts the options for the flow of air within properties.

If block housing is proposed, it is recommended that a maximum of four houses per block is planned- each with two external walls. Example of a good layout is shown below.

Good Layout: Four houses to a block, all houses have two external walls



Source: Mott MacDonald

The Design Section to these Guidelines considers shading and ventilation options for individual buildings (especially houses), achieved in the main by verandas and window orientation.

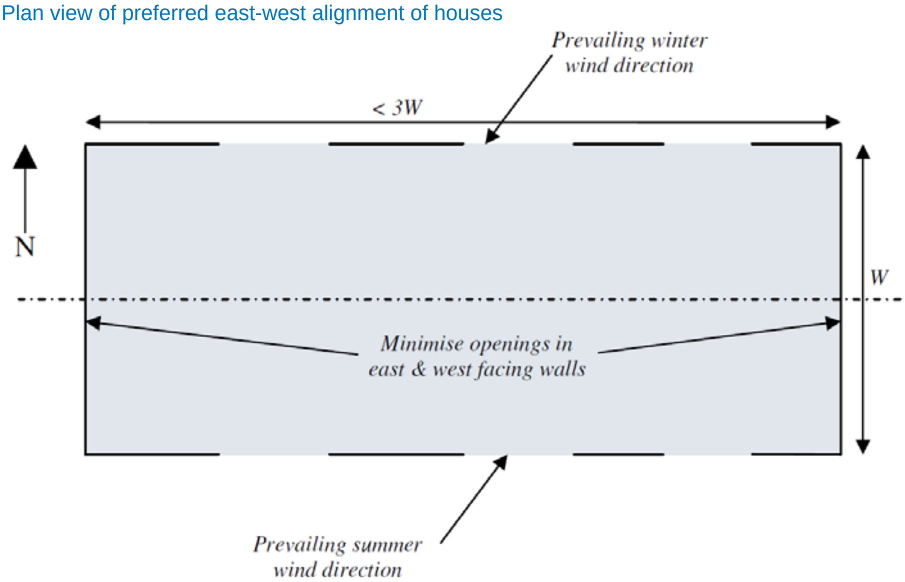
7.9 Temperature - Building Orientation

- ✓ **Align buildings along an east-west axis**
- ✓ **Length of building must not exceed three times its width**
- ✓ **Minimise openings in east and west facing walls**

See the sun path diagrams included within the Appendix.

Walls facing east and west receive more radiation from direct rays of sun and should therefore be kept as short as possible. To achieve this, rectangular buildings with an axis as close to east-west as practical should be adopted[49] (as shown below) and openings in the east and west facing walls minimised as far as possible.

Plan view of preferred east-west alignment of houses



Source: Mott MacDonald

Ventilation can also be assisted by setting openings at an angle to the line of the direction of the prevailing wind (rather than at right angles)[49].

The wind direction in Punjab varies with the monsoon season, coming from the north-east in winter and south-west in the summer[50] and this aligns well with a east-west orientation of houses.

Where the prevailing wind direction would not favour an east-west alignment of buildings, an east-west orientation should still be adopted as the sun shall be the prime factor in terms of temperature gains.

References and Further Reading

[49] Building Research Establishment (1980) 'Building in Hot Climates. A selection of Overseas Building Notes', Note No 158 - 'Building for Comfort' (1974), Her Majesty's Stationery Office, London

[50] Pakistan Meteorological Department (2007) 'Monsoon Dynamics: It's Behavioural Impact in Pakistan's Perspective' Pakistan Journal of Meteorology, Vol 4 Issue 7. Available online at: http://www.pmd.gov.pk/rnd/rnd_files/vol4_issue7/4.%20MONSOON%20DYNAMICS.pdf

UN-Habitat (1990) 'National Design Handbook Prototype on Passive Solar Heating and Natural Cooling of Buildings

7.10 Temperature - Street Width

✓ **Clearance between buildings must be no less than the height of adjacent buildings**

✓ **The following street widths based on street uses must not be exceeded (except where the height of adjacent buildings is greater)**

Street Type	Street Width (ft)	Building to building Clearance (ft)
Local Distributor (2 way traffic with services at berms)	30	65
Local Distributor (2 way traffic without services)	30	30
Local Access (with services at berms)	25	50
Local Access (2 way traffic flow)	25	25
Local Access (1 way traffic flow)	20	20
Pedestrian Access to front	10	10
Pedestrian Access to rear & side	5	5

Source: National Reference Manual[51]

Narrow streets by reducing clearance between housing blocks

The effects of higher temperatures can be reduced by providing shade within the village, especially in the streets and beside buildings.

By reducing the clearance between the housing blocks and narrowing the streets, the time during which the streets and areas between buildings shall be shaded will be increased. The exact times during which streets shall be shaded additionally depends on the height of the buildings. These times can be calculated by referring to the sun path diagrams included in the Appendix.

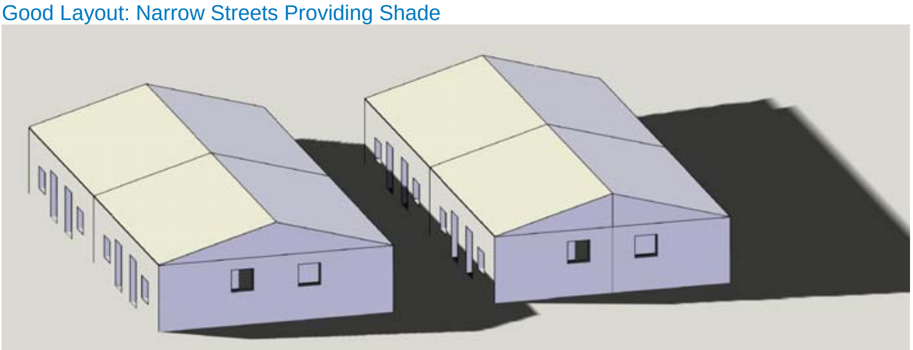
Narrow streets providing shade in Engro Foundation Model Village

Source: MM Pakistan (Pvt.) Ltd

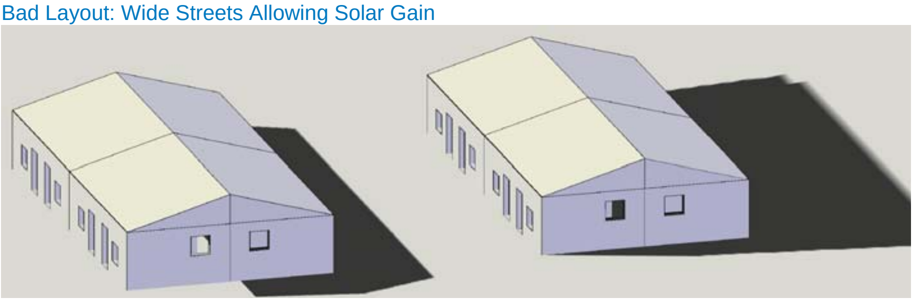
The minimum width of the street must be no less than the height of the highest adjacent building, as advised for earthquake planning in section 7.7 above.

The clearance between buildings depends on the land use (vehicular or pedestrian access) and existence of services (such as utility poles) adjacent to roads and is based on requirements of the National Reference Manual on Planning and Infrastructure Standards[51].

Good Layout: Narrow Streets Providing Shade



Bad Layout: Wide Streets Allowing Solar Gain



Source: Mott MacDonald

References and Further Reading

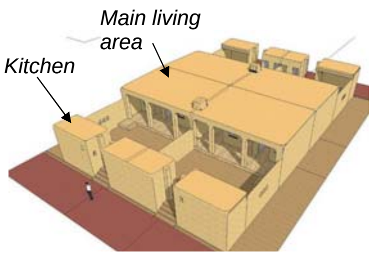
[51] Ministry of Housing & Works, Environment and Urban Affairs Division (1986) 'National Reference Manual on Planning and Infrastructure Standards' Sections 4.2 & 7.1, Government of Pakistan

7.11 Temperature - Position of Kitchen

✓ **Locate kitchen separate from the inhabited areas of a house**

Source: MM Pakistan (Pvt) Ltd

Model Village Block Design



Source: .floodrelief.punjab.gov.pk

Cooking practices need to be accommodated so needs are adequately addressed.

The kitchen is a significant source of heat and smoke within a home and a daily activity for family members, especially women and children.

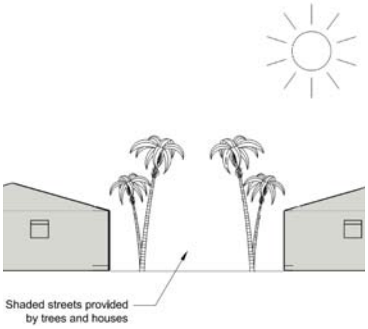
Locating cooking spaces away from the main inhabited housing areas and techniques to minimise health issues associated with smoke inhalation should be incorporated (i.e. smoke and heat extraction under a covered area to minimise temperatures whilst cooking).

Good practice has been observed in Model Villages where the kitchen is situated at the opposite end of the courtyard to the house, shown in the figure opposite.

7.12 Temperature - Tree Plantation

- ✓ **Plant trees within residential plots and parks, around community structures and lining streets (see below for quantification)**
- ✓ **Maintain 15ft clearance between trees**
- ✓ **Maintain 15ft clearance between trees and living quarters**
- ✓ **Maintain 15ft clearance between trees and emergency access roads**
- ✓ **Plant saplings of a least 1.5ft height**
- ✓ **Train community members in tree plantation and aftercare**
- ✓ **Recommendation of providing household and commercial plot owners locally appropriate 60% fruit and 40% shade trees in proportion to plot size (see below for quantification and species)**

Provision of Shade to Houses



Source: Mott MacDonald

Trees planted along the streets between houses uses their canopy to provide shade to the streets.

Including a plantation plan throughout the village provides an opportunity for multiple ecosystem benefits, such as minimised visual impacts of development, and providing shade within the village. The flood benefits are discussed in section 6.4.2.

Plantation has proved successful previously in the Punjab[52] under a program led by UN-Habitat.

7.12.1Tree Species

A mixture of shady and fruit trees should be provided for plantation. Suitable species for plantation in Punjab are given in the table below:

Tree Species for Plantation in Punjab

Fruit Trees		Shade Trees	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Kinnow (Orange)	*Citrus nobilis / Citrus deliciosa*	Bakain	*Melia azedarach*
Mulberry	*Morus alba*	Sheesham	*Dalbergia sissoo*
Mango	*Mangifera indica*	Neem	*Azadirachta indica*
Jamun	*Syzygium Cumini*	Eucalyptus	*Eucalyptus camaldulensis*
Amrood (Guava)	*Psidium guajava*		
Lemon	*Citrus Limon*		

7.12.2 Plantation Plan

Trees should be planted both within the courtyard of the plots and also along the external perimeter of plots to line streets. Trees should not be planted within 15ft of the living quarters of any building (due to risk of damage from falling tree, especially during an earthquake) or of another tree.

To prevent access routes becoming blocked, trees must not be planted within 15ft of any access road which links with a primary or secondary road that may be used for access a village in the event of an emergency.

Trees should also be provided at community structures including mosques, schools, health centres based on the table opposite and in parks. In addition, four shady trees should be planted at any public stand-post.

Number of Trees per Plot

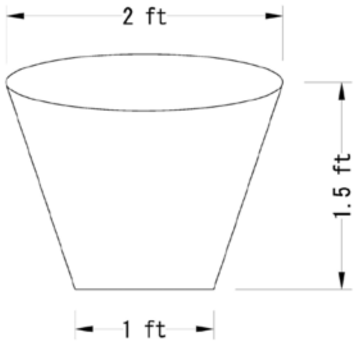
Area of Courtyard or Garden (ft^2)	Number of trees
< 225	None
225 - 450	1
450 - 900	2
900 - 1350	4
> 1,350	6

Length of External Plot Perimeter (ft)	Number of trees
<30	1
30 - 45	2
45 - 60	3
> 60	4

Source: Mott MacDonald

It is recommended that residents and business owners should be provided with a mixture of trees, 40% should be shady and 60% fruit trees. The number of trees to be supplied to each household or commercial plot owner is dependant upon the size of the courtyard or garden within the property and length of external perimeter of the plot (i.e. length of plot which is bounded by a street and not by another plot) as shown in the tables opposite.

Plantation Pit Dimensions



Source: UN-Habitat

7.12.3 Plantation Methodology[52]

Saplings of a height of at least 1.5ft must be planted no closer than 15ft to another tree or the inhabited quarters of any building. Before plantation, a trapezoidal pit of 1.5ft depth, 2ft upper diameter and 1ft lower diameter (see opposite) must be dug. The roots of the saplings should be thoroughly watered before roots are placed in the pit and the pit half filled with water. Finally the pit should be backfilled.

7.12.4 Community Involvement

Villagers should be involved in planning and participate in the tree plantation. Maintenance and aftercare to support the plantation must be managed by the villagers, to include safe removal of dying/unstable trees close to buildings before they fall in an extreme event causing damage to property or pose a health risk.

Plantation projects completed by UN-Habitat found that the following aims can be achieved by involving local residents[52]:

- *Reduce local environmental degradation*

- *Reduce the affect of high temperatures*
- *Provide access to fruit, fuel and fodder at a local level*
- *Improve the aesthetics within the village*
- *Raise awareness and promote a culture of tree plantation*

Source: MM Pakistan (Pvt) Ltd

Villagers should informed of the purpose of the plantation, may require additional training in the plantation and after care of trees. A plantation plan for both construction and post-construction can be agreed and implemented for this purpose.

UN-Habitat employed various tactics for ensuring community involvement, including the following:

- *Encourage beneficiary families to name trees after family members to ensure adequate aftercare*
- *Inauguration ceremonies at district level with District Officer visiting to plant a tree*
- *Displaying awareness posters*[53]
- *Conducting awareness sessions at villages and schools with demonstration of planting techniques*
- *Use of media (press and radio)*

References and Further Reading

[52] UN-HABITAT (2012) 'Tree Plantation Campaign in flood affected areas of Pakistan, from 15 January to 15 February 2012' Available online at: http://www.unhabitat.org.pk/Tree-Plantaion.html

[53] Tree plantation awareness posters available for download at http://www.unhabitat.org.pk/Publication.html

7.13 Emergency Refuge

- ✓ **Provide centrally located refuge(s)**
- ✓ **Maintain a clearance from emergency access roads of the refuge(s) of 15ft for trees or utility poles**
- ✓ **Maintain a clearance between emergency access roads and buildings of no less than the building height**
- ✓ **Provide evacuation points which are accessible from refuges**

FLOOD ZONES 1 & 2

- ✓ **Build main access roads at a level of 1ft above previously recorded flood levels**

SEISMIC RISK ZONES 2B & ABOVE

- ✓ **Provide two access routes to refuge(s)**

This section provides guidance on the location and layout surrounding an emergency refuge. Further guidance on the design and management of emergency refuges is given in section 11.2.

7.13.1 Location

The emergency refuge areas should be centrally located, or if multiple buildings are built evenly dispersed around the village to ensure ready access during an emergency.

7.13.2 Access to Village

The village layout should consider access to the village in times of an emergency for the delivery of aid or rescue.

For locations at risk of flooding, the main access routes which connect to primary or secondary roads should be constructed at a level of 1ft above previously recoded flood levels, taking advantage of the natural topography of the area to reduce construction costs.

Road Building in Punjab

Source: MM Pakistan (Pvt) Ltd

Provide two entrances to villages in seismic risk areas in case the first becomes blocked or destroyed.

Provide multiple access routes

Ensure structures are set back from main access routes

Main access routes should be identified during planning and structures, trees and utility poles should be set back from these routes by 15ft to ensure that their collapse does not hinder access. In addition, warning sings should be placed on poles supporting overhead electricity transmission lines, warning residents of the potential for electrocution within flood waters around a fallen transmission line. Buildings should also be set back from emergency access routes by a distance of no less than the building height to ensure access does not become blocked by a damaged building.

7.13.3 Evacuation points

Provide raised evacuation areas accessible from refuges

Evacuation points should be identified for cases where vehicular access is not possible (during flooding for example). These areas should be elevated and accessible for emergency services and incorporated within the refuge. The two options are as follows:

1. *The elevated platform on which the refuge(s) is built is extended to provide an safe area for evacuees to gather*

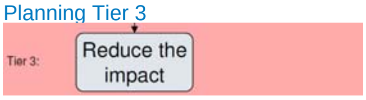
2. *The refuge(s) is built with a flat roof designed to support the loading of the evacuees, and access to the roof is provided (such as steps on the outside of the building)*

References and Further Reading

Johannessen B. (2008) 'Building Rural Roads' International Labour Office, Bangkok. Available online at:
http://www.ilo.org/asia/whatwedo/publications/WCMS_100216/lang--en/index.htm

8. Services

Planning Tier 3



Planning Tier 3

This section focuses on those services which provide resilience to climate change impacts, energy and water. A myriad of other non-climate change related services are suitable for rural areas, but are outside the scope of these Guidelines.

The community must be involved in the planning and implementation of any service to ensure that each service meets the needs of the community, that it can be maintained by the community and / or identify any additional training needs (see section 4).

8.1 Critical Infrastructure

ALL DEVELOPMENTS:

- ✓ **Prioritise the protection of key infrastructure through site location, protection and design quality (see sections 5, 6 and 9)**
- ✓ **Provide an alternative energy source for key infrastructure (such as water supply) to ensure continued operation following an extreme event**

Prioritise the protection of critical infrastructure

It is vital that any layout plan identifies the critical infrastructure, and that measures are put in place to prioritise the protection of this infrastructure against the impacts caused by natural disasters so that they may remain functional after a disaster event.

Key infrastructure includes, but is not limited to:

- *Health centres/hospitals*
- *Meeting halls, schools and refuges*
- *Water supply*
- *Power supply*
- *Communication facilities*
- *Emergency services*
- *Disaster Warning*

Source: MM Pakistan (Pvt) Ltd

Necessary measures include **locating these services in low hazard areas, or the provision of a greater level of protection** (for example, Indonesian design codes require that the factor of safety for schools and hospitals is increased to 1.4[54]).

Critical infrastructure should operate independently of other infrastructure

It is preferable that critical infrastructure can operate independently so that it will not be affected by the loss of another service. Where systems are inter-dependant (for example water supply is dependant on energy supply) consideration must be given to providing redundancy within the system to ensure failure is confined only to non critical areas. The community should be responsible for installing, operating and maintaining infrastructure - supported with adequate training and funding.

References and Further Reading

[54] Da Silva, J (2007) 'Infrastructure and Disaster Risk Reduction' Arup International Development, London

8.2 Renewable Energy

- ✓ **Depending on the skills and financial resources of the community, provide the following biogas facilities:**
  - **- Balloon plant where skill base and financial resources are low**
  - **- Floating drum plant where skill base in low but financial resourses are high**
  - **- Fixed dome plant where skill base is high**
- ✓ **Install mono-crystalline photovoltaic panels on south facing roofs of community buildings, especially refuges and health clinics, to supply renewable energy when grid electricity is unavailable**
- ✓ **Promote the use of photovoltaic panels and solar water heating systems in residential homes**
- ✓ **Raise awareness in communities of the use of energy efficient products**

As the impacts of climate change become more acute, the demand and supply of energy is projected to increase / decrease respectively. The introduction of renewable energy technologies will not only reduce the reliance of a community on grid delivered electricity or provide electricity in rural areas not previously able to benefit from this technology, but enhance the sustainability of the community if correctly installed, maintained and replaced.

The use of two renewable energy technologies (biogas and solar) is already provided in Model Villages in rural Punjab.

8.2.1 Biogas

Biogas can be naturally generated by bacteria during the bio-degradation of organic material, such as animal or

Biogas Plant at Hote Lashari MV

Source: MM Pakistan (Pvt.) Ltd

agricultural waste. Biogas can only be generated where air is excluded from the bio-degradation process and thus anaerobic conditions are forced.

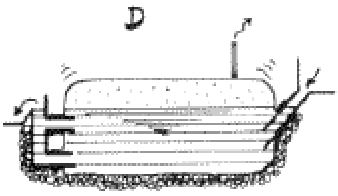
Biogas can be used to fuel gas cookers/stoves, lamps, heaters, refrigerators and even biogas fuelled engines. Biogas systems can also produce high quality fertilizer.

Biogas plants are being provided in Model Villages, however it has been observed that uptake has been poor[55]. In view of the fact that the main capital cost is in the installation of the plants, it is imperative that installation is accompanied by adequate training to villagers to ensure the use of this plant.

Successful generation of biogas is dependant upon the retention time, temperature, quality of the substrate and pH value within the system. Further details are provided by Kossman and Pontiz[56].

There are different types of biogas plant, and the decision on which to construct should be dependant upon the skill base of those constructing and operating the plant in the community. Three common types of biogas plant are described in the sections overleaf.

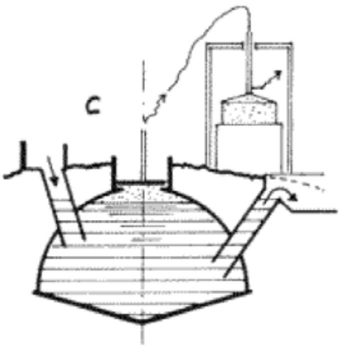
Biogas - Balloon Plant



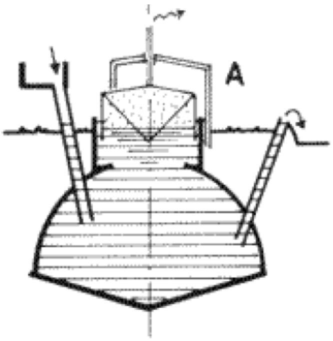
Balloon Plants

The biogas is stored in the upper part of a digester bag (usually PVC) to which the inlet and outlet are attached. Gas pressure is provided by the elasticity of the bag and weights added to it. These plants are low cost, easy to transport, construct and

Biogas - Fixed Dome Plant



Biogas - Floating Dome Plant



maintain although there is a relatively short life span and they are easily damaged.

Fixed Dome Plants

Fixed dome plants have a fixed gas holder on top of an underground digester and a high level compensation tank to which slurry is displaced as gas production proceeds. Gas pressure increases as the gas volume increases causing a greater difference in the height between the slurry in the compensation and digester tanks. These plants are cheap to construct with a long life span. Skilled (and trained) local labour is required to operate the plant. However, leakage of gas is common in poorly constructed gas holders so supervision by experienced biogas technicians is required during construction. Also, the plant experiences large fluctuations in gas pressure, and high digester temperatures are often difficult to achieve.

Floating Drum Plants

These plants have an underground digester and a moving gas holder, guided by a frame which rises or lowers dependant on the volume of gas stored. These plants are simple to construct and operate, providing a constant gas pressure. Material cost and maintenance costs are high and the plants have a shorter life span that fixed drum plants due to corrosion.

Further guidance on biogas design and operation is provided by the Practical Action charity: practicalaction.org

8.2.2 Solar

Solar energy can be used in two ways to enhance the sustainability of a village.

Photovoltaic Panels

Battery for solar panel in model village house

Source: MM Pakistan (Pvt) Ltd

Photovoltaic (solar) panels consist of cells which convert the suns energy into electricity. They should be provided in homes along with a solar battery (to store the electricity) and a regulator to prevent damage to the battery. Alternatively, they can be provided en-masse for electricity for distribution to the entire community. These systems are appropriate for reconstructed villages in solar rich areas of Pakistan, especially where there is no, or unreliable electricity supply. They are easy to use, reduce dependency on grid generated electricity, are sustainable, and are cheap to run. However the initial capital cost is high.

There are three main types of photovoltaic panels:

Solar panels at Engro Foundation

Source: MM Pakistan (Pvt.) Ltd

- *Mono-crystalline cell modules: These cells have the highest efficiency (15-18%) but the highest capital cost.*
- *Multi-crystalline cell modules: These are lower cost modules, but with lower efficiency (15%)*
- *Amorphous silicon modules: These are the cheapest modules, but with the lowest efficiency (10-12%) and there is some degradation in generation over time.*

Photovoltaic systems are valuable for electrification of buildings in remote villages, street lighting, pumping for drinking water or irrigation, water treatment, refrigeration in clinics, TV and radio receivers.

Case Study
Solar Energy in the Himalayas, India
Source: Practical Action[109]

The Barefoot College in Rajasthan has been training illiterate and semi-literate rural villagers in installation and maintenance of solar equipment. For ten years, villages have been returning home to install and maintain solar systems without further external assistance.

Consideration should be given to the installation location of the panels. The most appropriate location for houses is on a pitched roof, facing south to maximise the potential solar exposure. Locations which are likely to be shaded, either by trees or other buildings should be avoided. Photovoltaic panels can also be provided on stand alone street lights.

Photovoltaic panels are being provided in many Model Villages. Installation of photovoltaic panels should be accompanied by an awareness raising campaign on the benefits and long-term savings associated with the system as well as training in the installation and maintenance to instil a sense of ownership of the system within the community. Design options should be considered to minimise the risk of these panels being removed. This could be achieved through communal panels or individual panels.

Solar Heating

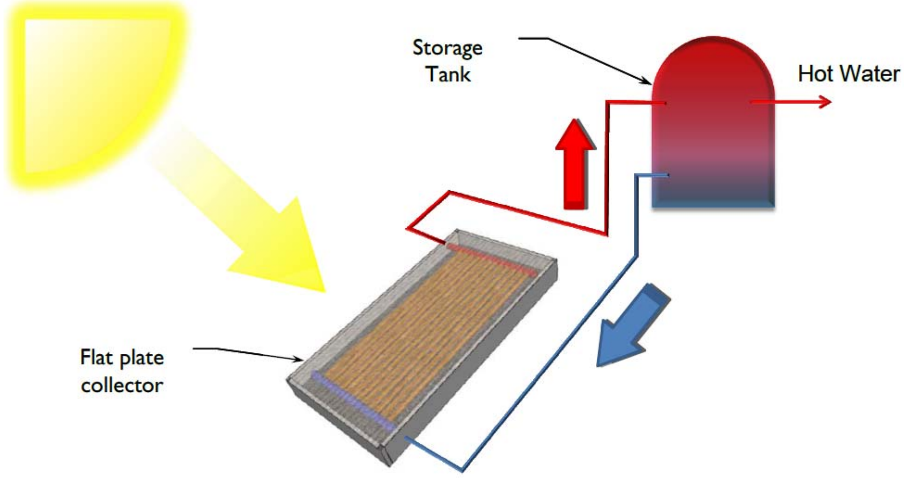
Solar heating water butts at Model Village

Source: MM Pakistan (Pvt.) Ltd

The suns thermal energy can easily be harnessed to heat domestic water supplies. While there are many methods of solar heating, one of the simplest and cheapest is to position water butts on roof tops in order to maximise solar gain. This practice is already being adopted in many villages as shown in the adjacent case study box.

An alternative solution is the direct solar collector. This consists of a series of black painted pipes inside a glass fronted, insulated box which passes the heated water to a storage tank located above. The natural tendency of hot water to rise induces a circulation between the collector and the tank which continues until the water in the tank and collector are equal. Running and maintenance costs are low. A pump may be installed to avoid the system producing an inconsistent rate of circulation, which requires electricity to run. A schematic for the system is shown below:

Schematic of a solar collector heating system



Source: Practical Action[57]

Direct systems are not suitable where freezing temperatures may occur, as this damages the equipment, and the systems may suffer from corrosion leading to blockages dependant upon the water quality.

Indirect systems, which use a closed system to pass a heat transfer medium (water or other) through a solar collector and to a hot water tank where the heat is exchanged from the medium to the water supply may be more beneficial in such areas. However, indirect systems are more expensive. The advantage is that as the heat transfer medium is not released into the water supply, it is possible to add chemicals such as antifreeze or corrosion inhibitors. These systems use two different types of solar collector: flat plate which is cheaper but less efficient, and evacuated tube which is more efficient but more expensive.

The provision of any complex solar heating system must be accompanied by training to the community in its use and maintenance.

Case Study
Solar water heating, India
Source: Practical Action[109]

Marios Cleovoulou built a direct solar heating system for a physiotherapy school out of recycled materials. The most expensive component was a $36, 250 litre tank. The fuel savings have more than paid for the installation of the system.

8.2.3 Energy Efficient Products

Although less a issue for planners, villagers should be engaged in an awareness raising campaign of the benefit of energy efficient products such as light bulbs, stoves, ovens and solar cookers in order to reduce their energy consumption.

References and Further Reading

Further guidance on solar energy systems is provided by the Practical Action charity: practicalaction.org

[55] Mott MacDonald (2012) 'Technical Assessment Report' Climate and Development Knowledge Network

[56] Kossmann, W. and Pinitz, U (2011) 'Biogas Digest, Volume 1 Biogas Basics' Deutshe Gesellschaft fur Technische Zusammenarbeit, Eschborn

[57] Punter, A. (2011) 'Solar Water Heating: Technical Brief' Practical Action, Rugby

8.3 Water Supply

- ✓ **Install facilities to provide water supply of 45 litres/person/day**
- ✓ **Prioritise the protection of water supply facilities through site location, protection and design quality (see Chapters 5, 6 and 9)**
- ✓ **Provide a renewable energy source or standby generators for water supply facilities to ensure continued operation following an extreme event**
- ✓ **Consider the use of solar water pumping where an uncontaminated water supply is available**
- ✓ **Install inline water butts on down pipes of community and residential building drainage systems**
- ✓ **Install hand pumps in an unpolluted ground water source for use in case of failure of the main supply system**

According to the WAPDA, per capita water availability plunged from 5,20m^3 per year in 1951 to 1,100m^3 in 2006. This is expected to decrease further as the population increases and the impacts of climate change are felt.

The IPCC also predicts a continued decline in freshwater availability in large basins like the Indus

As discussed in the Location section, access to water is a key constraint to the relocation of communities away from hazard prone areas. A common cause of ill health and death is the lack of safe drinking water.

According to Practical Action, water consumption for rural water supply is estimated at 15-60 litres/person/day[58]. The Ministry of Environment requires that at least 45 litres of drinking water per person per day should be provided to rural communities[59]. In addition, the maximum flow capacity of supply should be assessed as against the current and projected future community demand and population growth.

Note: Availability of water is decreasing, and will continue to decrease as climate change progresses. Appropriate methods of supply should ensure villages are not dependent on large volumes of surface and groundwater abstraction.

8.3.1 Treatment and Supply

It is vital that an efficient water system is operated for supply and removal of waste water that the community can afford and operate. If water treatment and supply plants are proposed planners should:

- Investigate the different supply and treatment methods and select those appropriate to the community.
- If a new water supply is provided it should be determined whether payment is required and whether communities will be willing to pay for the service[60].
- Include resilient design options to ensure their continued operation even following a natural disaster;
- Ensure the supply of electricity to these plants should be prioritised above other users, and a redundancy built in to ensure continued electrical supply in case of failure of the primary supply.

This redundancy may be provided by renewable energy such as solar power or standby generators. A redundancy should also be built into the plants themselves to ensure continued water supply in case of component failure or during maintenance of the primary treatment/delivery facility.

Miani Mullan Model Village Water Filtration Plant

Source: MM Pakistan(Pvt) Ltd

8.3.2 Solar Water Pumping

Where the supply of surface water may be difficult, an appropriate and uncontaminated groundwater supply should be identified and assessed for suitability.

Planners may consider wells and the adoption of solar water pumping for extraction from ground water supplies.

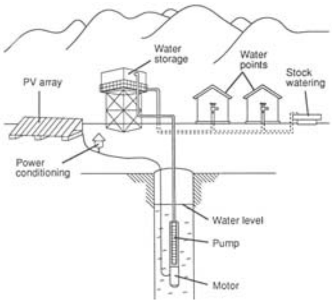
Solar water pumping uses an array of photovoltaic panels to power a pump situated within the groundwater in a borehole or well. Groundwater is pumped and stored in a high level tank which supplies gravity fed water to the community. A schematic of the system is shown opposite.

If the initial high capital costs can be covered, the systems provide unattended operation with no fuel costs. They are easy to install with low maintenance and a 20 year life span[61].

The size of the water storage tank needs careful consideration and is dependant upon the demand within the community and also the period of time during which it is anticipated the photovoltaic panels will not generate due to cloudy conditions.

Further guidance on solar water pumping is provided by the Practical Action charity: practicalaction.org

Schematic of a solar water pumping system

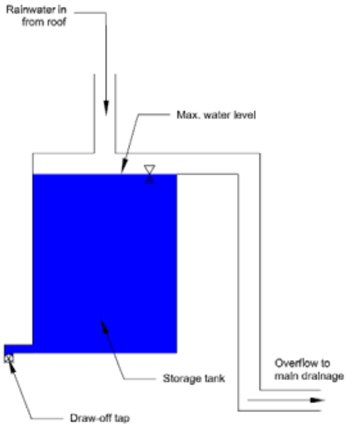


Source: Practical Action

Case Study
Solar water pumping, Badin, Pakistan
Source: Oxfam (2011)

Oxfam installed solar water pumps in existing water ponds at the villages of Mohammad Ali Chandio and Khanmoon Mullah and provided training on maintenance to one community member from each village. 43 households now have access to safe drinking water and woman no longer need to walk 15km daily to collect water.

Rainwater harvesting schematic



Source: Mott MacDonald

Case Study
Cement Mortar Jar
Source: Practical Action[109]

A hessian sack is filled with stand and placed on a concrete base to create the shape of the jar. Cement mortar is plastered over the sack and once set the bag is emptied and the bag removed. The inner walls can be strengthened with cement slurry. The jar can then be used to hold water following two weeks of curing.

8.3.3 Rainwater Harvesting

According to the UNHCR, rainwater harvesting cannot be relied upon in all emergency situations, but in cases where rainfall is present every effort should be made to capture it, as it provides a clean, safe source at low cost[62].

Rainwater harvesting is a simple and low cost method of reducing a households dependency on pumped / piped water supply: connecting water butts to building drainage systems, the rainwater collected from roofs can be stored in these butts for use by the occupants.

Down-pipes (vertical drainage pipes) transfer water draining from a roof to the ground level drainage system (rainwater drainage systems are discussed in further detail in the Design Section). The use of corrugated steel or iron on the roof can facilitate the collection of rain water, and the material is also easy to clean, preventing biological contamination of the collected water.

By allowing the lower end of a down-pipe to discharge into a water butt, this butt can store water for later use. It is important that an adequately sized over flow pipe be fitted at an upper level of the water butt to transfer rain water from the butt to the ground level drainage system before the water butt over fills.

Alternative, low cost methods using traditional techniques can be used to create a storage vessel for the rainwater to replace a water butt - such as the Cement Mortar Jar described in the case study opposite.

Larger scale rain water harvesting techniques also exist to store surface run off for irrigation use. This is achieved by constructing a watertight underground tank which intercepts the natural surface flow of rainwater (shown opposite) and stores it in the tank for use in irrigation.

Further guidance on rainwater run-off harvesting is provided by the Practical Action charity: practicalaction.org

8.3.4 Hand Pumps

Meeran Mullan Model Village Hand Pump

Source: MM Pakistan (Pvt) Ltd

Hand pumps should be installed where a clean unpolluted source of groundwater is available. Where other water supply techniques are used which rely on power supply, hand pumps should also be installed as a back-up.

Hand pumps are capable of lifting relatively small amounts of water in areas with limited power supply. They are easy to install and operate. Maintenance of the hand pump and lifter will be required.

Where hand pumps are installed, an assessment of the ground water quality must be carried out, taking into account sand and sediment (which can reduce the life expectancy of a hand pump provided without a strainer) and any contaminants which are harmful for health. The World Health Organization the Pakistan National Environmental Quality Standards provide details on acceptable drinking water quality standards.

An assessment of the ground conditions may also be required, as a borehole may be required where a hand-dug well is not possible (such as in rocky soil).

Hand pumps must be suitable for all users, such as women, children, elderly and disabled. Consideration should be given to the force required to operate the pump, the height of the pump, accessibility, location, lighting, cleaning and maintenance needs.

8.3.5 Water Storage

Where water sources are not available within close proximity of houses, storage facilities should be provided regularly throughout communities. This reduces the distance and regularity at which women must travel to collect water and the wastage incurred during collection and transport in small containers[63].

References and Further Reading

[58] Olley, J (2008) 'Human-Powered Handpumps for Water Lifting' Practical Action, Rugby

[59] Ministry of Environment (2009) ‘National Drinking Water Policy’ Government of Pakistan, Islamabad

[60] Mott MacDonald (2012) 'Technical Assessment Report' Climate and Development Knowledge Network

[61] Maupoux, M. (2010) 'Solar (Photovoltaic) Water Pumping: Technical Brief' Practical Action, Rugby

[62] UNHCR (2007) 'Handbook for Emergencies' The UN High Commission for Refugees

[63] Economic Commission for Africa (2009) 'Gender and Climate Change, Women Matter' UNECA

8.4 Training

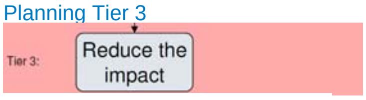
✓ **Assess the skills of the community and provide training to fill the gap in any skills required for the installation, use and maintenance of any service provided**

For any service which is installed within a community, an assessment of the training needs which accompany its installation must occur. The final level of training required will be dependant upon the level and types of services previously provided to each community, their skills and experience in the installation, operation and maintenance. The need for training should not be seen as a reason to omit provision of such services within communities. (see Construction Section).

Failure to provide adequate training may result in the failure of any service which is provided. This will not only result in a loss in the use of that installed service, but shall also produce a negative view of the service in general that shall discourage future users from using services with the potential to increase their resilience to the impacts of climate change.

9. Community Buildings

Planning Tier 3



Source: Mott MacDonald

Source: MM Pakistan (Pvt) Ltd

Planning Tier 3

This Section presents an overview of different design options for developing **community buildings (such as schools, health centres, religious buildings and meeting halls)** that are resilient to the impacts of flooding, earthquakes and extremes of temperature. Guidelines for residential buildings are discussed in section 10. This includes some variance between this section in recognition of potential cost limitations for home owners.

It is recommended that where it is not possible to give a high level of protection for all buildings, a higher level should be provided for community structures which may offer a place of refuge in the case of an extreme event or be occupied by more vulnerable members of the community.

It is also recommended that village layouts should be based around the traditional *chopal*. The *chopal* is viewed in local communities as an elevated place in the villages where villagers can congregate during the day to communicate and exchange views. Keeping in view the social system of rural Punjab, community buildings should reflect and be aligned with the traditions of the rural societies. To this end, the *chopal* can also act as an emergency refuge within a village.

In practice, planners will need to develop their own detailed specifications for their construction proposals in consultation with the community and will make cost estimates based on their design decisions whilst considering the skills required to replicate their designs.

9.1 Policies, Regulations and Guidelines

The Building Code of Pakistan (Seismic Conditions 2007)[64] gives specific guidance for construction and the rules of this code should be followed.

9.2 Overview of Design Based Considerations

Elevation Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Ground Elevation	Construct a raised platform to an elevation of 2ft above the highest recorded flood level (9.6)	*Not applicable*	Provide elevated location of community building to promote thermal comfort

Geometric Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Shape	*Not applicable*	Adopt square or rectangular buildings. Building length must not exceed three times the width or 26ft, unless cross-walls or buttresses are used (9.7)	Adopt Linear (square or rectangular) buildings to provide better ventilation and air currents inside
Length	Length between cross-walls or buttress must be less than 26ft (9.7)	Length between cross-walls or buttress must be less than 26ft (9.7)	

Foundation Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake
Materials	Fired bricks or concrete blocks (9.8.1)	Fired bricks, stones or concrete blocks (9.8.2)
	Cement/sand mortar. Consider the addition of lime. Do not use mud mortar (9.8.1)	Cement/sand mortar. Do not use mud mortar (9.8.2)
	Waterproof plaster applied to inside and outside faces up to flood level (9.8.1)	Waterproof plaster applied to inside and outside faces up to ground level (9.8.2)
	Provide a damp proof course below plinth level (9.8.1)	Provide a 6" concrete strip below the foundation (9.8.2)
Depth	At least 3ft below platform top and 1ft below ground level (9.8.1)	At least 3ft below ground level (9.8.2)
Height	0.5ft above ground or platform level (whichever is highest) (9.8.1)	0.5ft above ground or platform level (whichever is highest) (9.8.2)
Width	2.5ft for a single storey and 3.5ft for a double storey building (9.8.1)	2.5ft for a single storey and 3.5ft for a double storey building (9.8.2)
Reinforce-ment	Provide 2 Steel bars of ½ inch diameter embedded in concrete to avoid differential settlement as per drawing (9.8.1)	Cast 4ft long steel J rods into foundation at 6ft centres (9.8.2)

Base Slab Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake
Base Slab	*Not applicable*	Provide a continuous reinforced seismic band at plinth level (9.9.2)

Wall Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Materials	Concrete, concrete blocks, fired bricks or dressed stones (9.10.1)		Concrete, concrete blocks or dressed stones (9.10.3)
Plaster	Waterproof plaster or paint to external faces (9.10.1)	*Not applicable*	Reflective paint to external walls (9.10.3)
Room Height	12ft (9.10.1)	12ft, single storey (9.10.2)	12ft (9.10.3)
Reinforcement	Reinforced concrete columns at building corners and joints in walls (9.10.1)		
	Not applicable	Continuous reinforced concrete seismic band at roof and lintel level (9.10.2)	*Not applicable*

Window and Door Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Opening Width	Window opening up to 4 ft maximum. Entrance/ Exit doors minimum 6 ft with additional reinforcement provided. All other doors openings up to 4ft maximum (9.11.2)		
Position	Clearance between windows of at least 50% of the narrower opening and no less than 2ft (9.11.2)		
	Clearance between windows and building edges of at least 25% of the narrower opening and no less than 2ft (9.11.2)		
	Symmetrical arrangement		
	Not applicable	*Not applicable*	Windows only in north and south facing walls (9.11.3)
	Not applicable	*Not applicable*	Minimum sill level of 6.5ft below roof level (9.11.3)
Sum of opening width	Less than 30% of wall span (9.11.2)		
Reinforcement	Provide reinforced concrete lintel above all doors, windows, openings and verandas	Provide reinforced band to surround windows (9.11.2)	Provide reinforced concrete lintel above all doors, windows, openings and verandas
		Continuous reinforced concrete seismic band at lintel level (9.11.2)	
Window Type	*Not applicable*	*Not applicable*	Provide glazed windows on hinged frames (9.11.3)
			Provide shutters (9.11.3)
Ventilation	Provide ceiling fans for air circulation when doors and windows are not operational in an emergency situation	*Not applicable*	Provide ceiling fans for thermal comfort (9.12)

Roofing Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Design	Flat roof to be provided to ensure roof can be used as evacuation point	Pitch roof at 30º on all buildings except those used as refuges where the roof shall be used as an evacuation point (9.13.1)	Flat roof
Roof Type	Pre-cast RCC slabs and beams	Provide pucca roof truss with cross braces (9.13.2) Connect roof truss to seismic band using steel anchors (9.13.2) Steel straps to strengthen connections between tie-beams, king posts, braces and rafters (9.13.2)	Pre-cast RCC slabs and beams
Top Finishing Materials	Use impermeable materials or achieve water proofing through traditional techniques: - 2 coats of bitumen - 1 layer polythene - 4” layer of earth and mud plaster laid in slope - Brick tiles ($4^1/_2$x9x$1^1/_2$”) fixed with mud plaster - Joints sealed with 1:3 cement sand plaster	Impermeable materials e.g.: corrugated iron, steel or tiles (9.13.1)	Use impermeable materials or achieve water proofing through traditional techniques: - 2 coats of bitumen - 1 layer polythene - 4” layer of earth and mud plaster laid in slope - Brick tiles ($4^1/_2$x9x$1^1/_2$”) fixed with mud plaster - Joints sealed with 1:3 cement sand plaster
Drainage	Provide drainage guttering at perimeter of roof and incorporate into rainwater harvesting (9.13.1)		

9.3 Contents

This section is subdivided into the following building elements:

- *Building Geometry*
- *Ground Elevation*
- *Foundations*
- *Base Slab*
- *Walls*
- *Windows & Doors*
- *Induced Ventilation*
- *Roofing*

Specific actions due to flood or earthquake risk, or to mitigate against the effects of temperature extremes are highlighted in each section.

9.4 Cost Estimates

Cost estimates for a variety of different housing options have been completed by UN Habitat as part of the Housing Early Recovery scheme[65]. These include detailed cost estimates for the building types defined in these guidelines and are freely available online. This information is not repeated here. Please refer to the UN Habitat website referenced for further information.

9.5 Quality of Design

Prioritise the protection of community buildings against the impacts of climate change

A higher level of protection is needed for community buildings. These buildings may become hubs for rescue efforts following a natural disaster, as defined in section 11 Emergency Reponses.

Buildings which provide essential services, such as water supply and electricity should also be protected to the highest level (as discussed in the Services Section).

For example, a health centre may need to administer life saving aid or medication following a natural disaster, or the structural performance of a community building during/after an extreme event may dictate the well being of those seeking refuge within. If community buildings, such as schools, remain inhabitable following a natural disaster they can also provide accommodation for those whose houses have been destroyed and prevent them from relocating while reconstruction efforts are underway.

For these reasons, these Guidelines propose pucca building designs for community structures.

References and Further Reading

[64] Pakistan Engineering Council (2007) 'Building Code of Pakistan (Seismic Provisions - 2007)' www.pec.org.pk/buildingcode.aspx

[65] UN-Habitat 'Housing Early Recovery Working Group'. Available online at: http://115.186.134.22:43038/default.aspx

9.6 Ground Elevation & Raised Platforms

FLOOD ZONE 1 & 2:

- ✓ **Construct a raised platform to a level of 2ft above the highest recorded flood level from earth fill compacted to 95% of dry density**

ALL DEVELOPMENTS:

- ✓ **Provide two sets of 6ft wide steps and a single ramped access 5ft wide at a gradient of 1:12 to all community buildings.**

9.6.1 Flooding

Where the ground level is below the flood level a compacted raised platform for the community structures must be constructed to ensure the floor level of the structure is above the flood level.

Please refer to section 6.4.4 for details of constructing a raised platform.

9.6.2 Earthquake

No specific guidance.

9.6.3 Temperature Extremes

No specific guidance.

References and Further Reading

Ehsan, Muhammad (2011) 'Design of Raised Platforms in Flood Affected Areas of Badin and Mirpurkhas Districts' Food and Agriculture Organization of United Nations

HM Government (2010) 'The Building Regulations 2010. Access to and use of buildings' Section M. NBS, Newcastle Upon Tyne

9.7 Building Geometry

SEISMIC ZONES 1 & ABOVE:

- ✓ **Construct symmetrical square or rectangular buildings only**
- ✓ **Provide cross-wall or buttresses where the building length exceeds three times the width or the wall span exceeds 26ft**

9.7.1 Flooding

No specific guidelines.

9.7.2 Earthquake

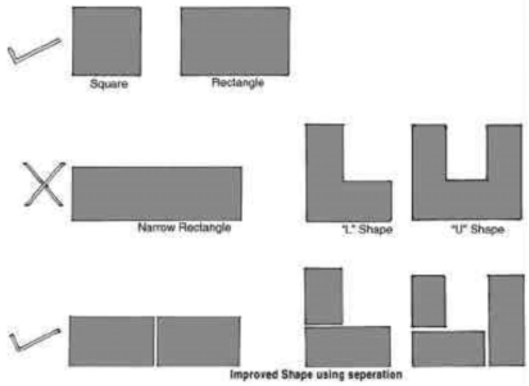
The geometry of a building is critical to its performance during an earthquake. Buildings must be as symmetrical as possible. Asymmetric designs induce asymmetric forces during an earthquake that a building cannot withstand, leading to failure. The guidance below is based on guidelines produced by the Earthquake Reconstruction and Rehabilitation Authority[66] and represents good practice which should be applied for the design of any community structure, regardless of the seismic zone in which the development lies.

Shape

Regularly shaped buildings, such as square or rectangular, resist earthquakes more effectively than irregular shapes, such as L-shapes as depicted below:

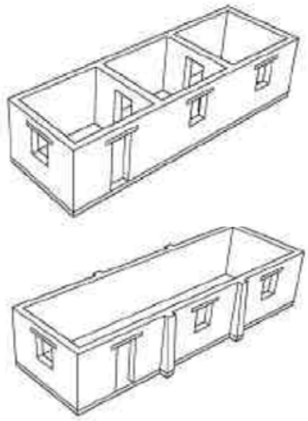
Construct square or rectangular building in earthquake prone areas

Earthquake resistant and non-earthquake resistant housing shapes



Source: Earthquake Reconstruction and Rehabilitation Authority[66]

Dealing with long walls in earthquake prone areas



Source: Earthquake Reconstruction and Rehabilitation

Wall Length

Long and narrow buildings are more susceptible to failure during an earthquake. The construction of long buildings should be avoided as these buildings shall be weaker during earthquakes. **The length of a building should not exceed three times its width**. Due to the uses for community buildings (classrooms, meeting halls), long narrow buildings could be unavoidable. Wall length for pucca walls should also not exceed 26ft without the provision of cross-walls or buttresses as shown opposite[89] or 14ft for katcha walls (which are not recommended for community buildings).

Further information is provided by the Earthquake Reconstruction and Rehabilitation Authority[66] and in the Building Code of Pakistan[67].

9.7.3 Temperature Extremes

No specific guidance

References and Further Reading

[66] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:Sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

[67] Pakistan Engineering Council (2007) 'Building Code of Pakistan (Seismic Provisions - 2007)' www.pec.org.pk/buildingcode.aspx

9.8 Foundations

ALL DEVELOPMENTS:

- ✓ **Use fired bricks or concrete block and cement:sand (1:4) mortar for construction of foundations**
- ✓ **Foundation width of at least 2.5ft for a single storey and 3.5ft for a double storey building**
- ✓ **Maximum foundation length of 16ft**
- ✓ **Provide a damp proof course immediately below plinth level (2" thick concrete, overlaid by bitumen and covered by plastic sheet)**
- ✓ **Foundation must extent to 0.5ft above ground or platform level (whichever is higher)**
- ✓ **Provide two steel bars of ½" diameter cast into foundation**

FLOOD ZONES 1 & 2:

- ✓ **Add 1 part hydrated lime to 5 parts of foundation mortar**
- ✓ **Base of foundation must be at least 3ft below platform top and 1ft below ground level**
- ✓ **Maintain clearance of 10ft between foundation platform edge**
- ✓ **Provide two steel bars of ½" diameter cast into foundation**

SEISMIC ZONES 1 & ABOVE:

- ✓ **Base of foundation must be at least 3ft below ground level**
- ✓ **Cast 4ft long steel J-rods into concrete pads at 6ft intervals. Half the rod should be above foundation level to be cast into the wall**

SEISMIC ZONES 2A & ABOVE:

- ✓ **Provide a 6" concrete strip below the foundation**

Damaged mud walls due to foundation damage, Punjab

Source: MM Pakistan (Pvt) Ltd

Erosion at base of wall - Punjab

Source: UN-Habitat[68]

Use cement/ sand mortar

Standing water will dissolve mud mortar!

9.8.1 Flooding

The most common damage to structures resulting from flooding is due to the undermining and settlement of foundations and scouring at the base of walls leading to destruction of the building[68]. This damage can be reduced by:

- *Strengthening foundations*
- *Deepening foundations*
- *Increasing foundation height*

It is vital that a strong foundation is constructed in flood zones 1 & 2. **The strength of an entire structure depends upon the integrity of its foundation**, therefore its strength must be adequate to withstand settlement or scouring during a flood.

The following guidelines are based on the UN-Habitat guidelines for flood resistant buildings[69].

Foundation Materials

The following materials should be used for the foundation of all community structures:

- *Fired bricks, or*
- *Concrete blocks*

Dissolved mud mortar - Muzaffargarh, Punjab

Source: UN-Habitat[68]

A cement/sand mortar should be used. Mud mortar performs poorly during a flood as it can be dissolved by standing water, leading to collapse of the structure (as shown opposite), and must therefore not be used. Addition of lime to the mortar should also be considered due to its ability to wick dampness in the foundation to a surface where this can evaporate which is especially important following a flood. Addition of one part of hydrated lime to 5 parts of mortar enables the mortar to transfer any dampness in the foundation to a surface where this can evaporate.

Foundation Excavation

The depth of excavation must be to depth of at least 1ft below the natural ground level, and no less than 3ft from the top level of the platform.

A clearance of 10ft must be maintained between the outer edge of the excavation and the edge of the raised platform (if used).

Adequately compact any raised building platform

The width of the excavation should be at least 2.5ft for a single storey building and 3.5ft for a double storey building. The uninterrupted length of a foundation should extend no further than 16ft.

Damp Proof Course

A damp proof course provides a barrier between the foundation and the structure above to prevent the seepage of water in the ground (or at the foundation level during a flood) up into the walls of the structure, extending the life of a structure.

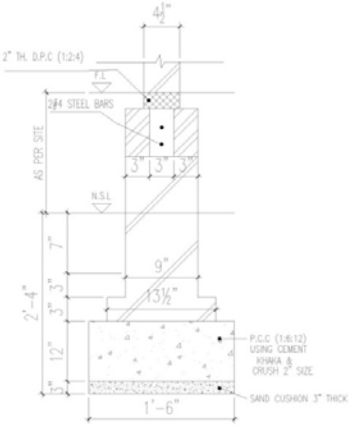
The damp proof course should be laid immediately below the plinth level and is made up of three layers:

1. *2" thick concrete layer (1:2:4 - cement:sand:gravel), overlaid by*
2. *Bitumen layer, overlaid by*
3. *Plastic sheet*

Foundation Height

The foundation must continue to a level 0.5ft above the platform level. A cement:sand plaster (1:6) should be applied to the inside and outside faces of the foundation above ground level.

Horizontal foundation reinforcement



Source: PDMA Architect

Reinforcement

Foundations should be strengthened by providing two ½" diameter horizontal steel reinforcement bars embedded in concrete at plinth level of the building (as shown in the diagram opposite). This will help avoid cracks in walls due to differential settlement.

9.8.2 Earthquake

A strong foundation is also vital in all seismic zones, as the foundation must resist the seismic forces during an earthquake to prevent failure of the entire structure. Consequently, many of the requirements for a high strength foundation in a seismic area are the same as the requirements for a flood zone.

Foundation Materials

As for flooding.

Foundation Excavation

The depth of excavation must be no less than 3ft[70]. A 6 inch concrete (cement:sand : aggregates to 1:4:8)[70] strip should be cast at the base of the excavation to provide additional stability in seismic Zones 2A and above.

The width of the excavation should be at least 2.5ft. The uninterrupted length of a foundation should extend no further than 16ft.

Damp Proof Course

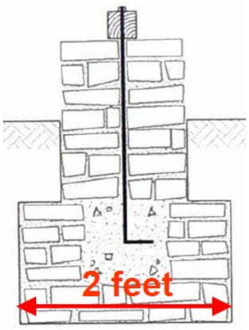
As for flooding.

Foundation Height

The foundation must continue to a level 0.5ft above ground level.

Reinforcement

Vertical foundation reinforcement



Source: Schacher[111]

Vertical reinforcement must be provided between the foundation and the wall above to prevent overturning during an earthquake. To achieve this, 4ft long steel J-rods may be cast into a concrete pad within the foundation at 6ft intervals around the foundation as shown opposite. A 2ft length of rod should be left protruding from the foundation to be cast into the wall above. Although this is most critical in earthquake prone areas, this reinforcement is good practice and should be provided on all buildings.

9.8.3 Temperature Extremes

No specific guidance

References and Further Reading

[68] UN-HABITAT (2010) 'Monsoon Flood 2010 Pakistan, Rapid Technical Assessment of Damage and Needs for Reconstruction in Housing Sector', Islamabad

[69] UN-HABITAT (2011) 'Guidelines for flood resistant house' Available online: http://www.unhabitat.org.pk/Publication.html

[70] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:Sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

9.9 Base Slab

SEISMIC ZONE 3:

✓ **Provide a continuous reinforced concrete seismic band at plinth level**

Provide seismic bands at plinth, lintel and roof level in severely earthquake prone areas

9.9.1 Flooding

No specific guidance

9.9.2 Earthquake

A **seismic band** is a continuous reinforced concrete beam which runs around the perimeter of a building that binds, reinforces and makes all the walls act together, providing improved strength during an earthquake. It is vital that the reinforcement at the corners of the bands are adequately tied - further guidance on this is provided by the Earthquake Reconstruction and Rehabilitation Authority[71] and within the Building Code of Pakistan.

A certain amount of reinforcement is provided by J-rods between the foundation and walls, therefore, a seismic plinth band must only be provided for structures founded within seismic Zone 3 areas (as well as at roof and lintel level as discussed below).

9.9.3 Temperature Extremes

No specific guidance

References and Further Reading

[71] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:Sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

9.10 Walls

ALL DEVELOPMENTS:

- ✓ **Construct walls from concrete, fired bricks or dressed stones**
- ✓ **Room height of 12ft**
- ✓ **Wall length must not exceed three times the room width or 26ft (which ever is shorter) without a buttress or cross-wall**
- ✓ **Provide reinforced concrete columns at the corners of buildings and joints in load bearing walls**

FLOOD ZONES 1 & 2:

Do not use mud mortar or plaster

- ✓ **Add 1 part hydrated lime to 5 parts of a cement:sand (1:6) plaster for external faces, or paint external faces with waterproof paint**

SEISMIC ZONES 2B & ABOVE:

- ✓ **Provide a continuous reinforced concrete seismic band at lintel and roof level**
- ✓ **Provide only single storey buildings**

AREAS OF EXTREME TEMPERATURE:

- ✓ **Construct walls from concrete or dressed stone**
- ✓ **Apply a reflective paint (such as lime wash) to external walls**

9.10.1 Flooding

Materials

The following materials can be used for the construction of walls:

- *Concrete (cement:sand:aggregate 1:3:6)*
- *Concrete blocks (cement:sand:aggregate 1:3:6, 8" wide x 12" deep x 6" high)*
- *Fired Bricks*
- *Dressed Stones*

Plaster

Dissolved mud mortar - Muzaffargarh, Punjab

Source: UN-Habitat[72]

Use water proof plaster on external faces

Waterproof plaster should be applied to the external face of the walls to provide protection against ingress of rain water. A cement:sand (1:6) plaster should be used. Addition of one part of hydrated lime to 5 parts of plaster enables the plaster to transfer any dampness in the wall to a surface where this can evaporate. This is especially important for post-flood water damage.

Alternatively, waterproof paint or can be applied over walls.

Mud mortar can be easily dissolved by water and should be avoided.

Wall Height & Length

Each storey height should not exceed 12ft, and the wall length should not exceed 3 times the room width or 26ft (whichever is shorter) without a buttress or cross-wall for all developments.

Effects of poor bonding at corners - Jatoi Punjab

Source: UN-Habitat[72]

Corners and Joints

It is essential that there is **adequate bonding of all load bearing walls**, both within the foundations and the walls.

Reinforced concrete columns should be provided at the corners of buildings and joints between load bearing walls. Minimum acceptable reinforcement should be provided in these columns to prevent thermal cracking of the concrete.

Erosion and damage at the corners of buildings was found to be a cause of collapse of many buildings during the 2010 floods[72]

Guidance on achieving this is provided by the Earthquake Reconstruction and Rehabilitation Authority[73].

Seismic Bands

Not required.

9.10.2 Earthquake

Materials

As for flooding.

Plaster

Plaster is optional.

Wall Height & Length

In order to reduce the risk of the collapse of a wall during an earthquake, only single storey buildings should be constructed in seismic Zones 2B and above.

Each storey height should not exceed 10ft, and the wall length should not exceed 26ft without a buttress or cross-wall for all developments.

Corners and Joints

As for flooding.

Seismic Bands

Following specifications for shelters prepared by UN-Habitat[74], seismic roof & lintel bands should be provided in seismic zones 2B and above. A seismic roof band should be provided just below the roof level. This band can also serve as a support for the roof truss. A seismic lintel band should be provided at the top level of the windows and doors. However, where windows are at different levels to aid cross-ventilation, this may not be possible (see section below) and lintels over openings should be provided instead.

9.10.3 Temperature Extremes

Materials

Thermal mass design is appropriate where there is a variation in day and night temperatures

Thermal mass design may be adopted in areas prone to temperature extremes. Thermal mass is the ability of the construction material to store heat, and represents a technique where materials are chosen which absorb the external heat during the day (to prevent an excessive internal heat rise) and where cooler night time temperatures and night time ventilation allow the materials and interior to cool during the night.

A significant difference between day and night temperatures is required for its success in areas of high temperature.

Materials with a high density, high specific heat capacity and moderate conductivity should be chosen. These materials have an ability to absorb more heat without emitting this to the interior of the building. Low density materials would help structural cooling if cooler night time temperatures are not present, but would also allow for quicker heating up of the structure as temperatures rise in the day.

The density and conductivity of a range of materials suitable for community structures is given in the following table. All materials have good thermal mass properties, although concrete and stone should be favoured for areas with high day time temperatures.

Thermal Properties of building materials

Material	Average Density (kg/m^3)	Average Specific Heat Capacity (Wh/kgK)	Average Conductivity (W/mK)	Effective Thermal Mass
Fired bricks	1,600	0.28	0.69	Medium-High
Concrete	2,300	0.27	1.6	High
Stone	2,400	0.23	2.4	High

Source: Rosenlund[75]

The technique is dependant upon the ability to close any openings in the room (i.e. doors and glazed windows) during the day and then to ventilate the interior during the cooler night time period by opening windows, allowing the room and materials to cool.

The thermal mass approach can also be used in colder climates, or areas which experience both warm summers and cold winters. The process is similar for the winter as it is for the summer, except during the night, ventilation is not allowed, instead any heat absorbed by the walls during the day from solar gain is emitted to the interior of the building, raising the temperature.

Plaster

A reflective finishing such as lime wash should be applied over the plaster to reduce internal temperatures.

Wall Height

The room height also has implications on the interior temperature. A certain room height is required to achieve a stratification of air to create a cooler, lower occupation zone. A room height of 12ft should be adopted, as this shall also promote ventilation. This height shall also allow for fans to be installed.

References and Further Reading

[72] UN-HABITAT (2010) 'Monsoon Flood 2010 Pakistan, Rapid Technical Assessment of Damage and Needs for Reconstruction in Housing Sector', Islamabad

[73] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:Sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

[74] UN-Habitat 'Housing Early Recovery Working Group'. Available online at: http://115.186.134.22:43038/default.asp

[75] Rosenlund, H. (2000) 'Climatic Design of Buildings using Passive Techniques' Lund University, Lund

9.11 Windows and Doors

ALL DEVELOPMENTS:

- ✓ **Window opening up to 4 ft maximum**
- ✓ **Entrance/exit door width of 6 ft with additional reinforcement provided. All other doors openings up to 4ft maximum**
- ✓ **Clearance between openings must be greater than 50% of the narrower opening and no less than 2ft**
- ✓ **Clearance between openings and corners of building must be greater than 25% of the opening and no less than 2ft**
- ✓ **Sum of opening widths must not exceed 30% of the wall span**
- ✓ **Maintain symmetrical opening arrangement**
- ✓ **External doors and windows to open out, not in to the building**
- ✓ **Provide RCC lintel above all doors, windows opening and veranda**

Do not place openings at the corners of buildings

SEISMIC ZONES 2B & ABOVE:

- ✓ **Provide reinforced band to surround windows and doors**
- ✓ **Provide continuous reinforced concrete seismic band at lintel level**

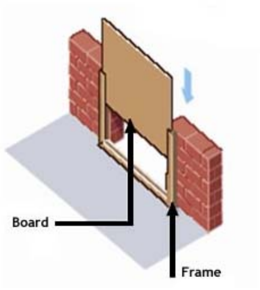
AREAS OF EXTREME TEMPERATURE:

- ✓ **Provide windows on north and south facing walls only**
- ✓ **Provide adequately sized windows to ensure an air flow of 0.35ft^3/s per person (considering maximum room capacity) can be provided - see section 9.11.3**
- ✓ **Provided glazed windows on hinged frames with shutters**
- ✓ **Maintain a minimum window sill level of 6.5ft below the roof level**

9.11.1 Flooding

Windows and doors provide an essential means of access and ventilation. Where the base slab of a building has not been sufficiently raised, these openings can also provide access to flood waters. To prevent ingress of low level flood waters, temporary, free-standing and removable products such as flood boards (see opposite) and flood skirts can be installed. Stable doors can also be provided which allow the bottom half of the door to be closed while access/evacuation is still possible through the upper half.

Flood Board



Source: UNDP India[77]

It is important to remember that **during severe flooding it is preferable to allow the ingress of water into buildings** to equalise the water levels inside and out preventing the build-up of pressure that may cause collapse of the walls.

All external doors and windows should open to the outside of the building and not open into the building.

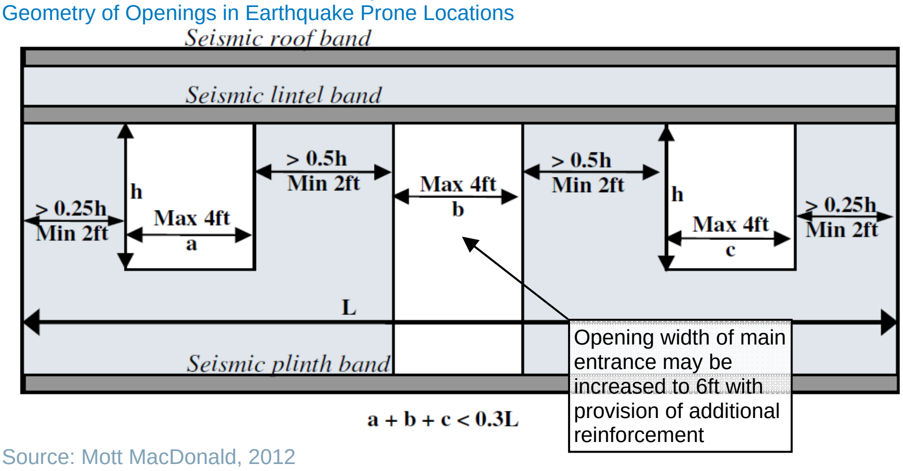
9.11.2 Earthquake

Where seismic lintel bands are not possible, lintel beams should be provided above windows and doors

Inclusion of windows and doors in a building can act to weaken the structure during an earthquake. The following rules should be followed to prevent excessive structural weakening for all constructions[76 & 77]:

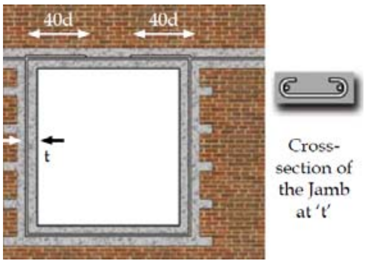
- *Window opening up to 4 ft maximum*
- *Entrance/exit doors minimum 6 ft with additional reinforcement provided. All other doors openings up to 4ft maximum*
- *Maintain a clearance between openings of at least 50% of the narrower opening and not less than 2ft*
- *Maintain a clearance between openings and corners of a building of at least 25% of the opening and not less than 2ft*
- *The sum of opening widths in a wall must not exceed 30% of the wall span*
- *Opening arrangement should be symmetrical*

Geometry of Openings in Earthquake Prone Locations



Source: Mott MacDonald, 2012

Reinforced Bands surrounding Windows



Source: UNDP India[77]

In areas of seismic risk 2B and above windows should be surrounded with a reinforced band as shown opposite. Further information is provided by UNDP India[77].

Where possible (i.e. where the top level of windows and doors is constant), a seismic lintel band should be provided. Where the level of the openings vary (i.e. where cross-ventilation is adopted), lintels (reinforced concrete or timber beam) should be provided over the openings to transfer the weight of the wall above to the wall below on either side of the opening. The lintel should be 6" deep and of the same width as the wall to reduce stress.

9.11.3 Temperature Extremes

Openings in the buildings provide many measures for dealing with temperature extremes through ventilation of the building.

Cross-Ventilation

Ventilation through buildings shall be driven by wind as well as natural thermal pressure differentials, providing ventilation even when the wind speed is zero. In windy conditions, the effect of thermal pressure differentials will be insignificant, so the direction of cross-ventilation should be aligned at 45 to 90 degrees to the prevailing wind direction[78] (windows on north and south facing walls shall achieve this). Ventilation is important to provide relief from high temperatures. Ventilation will also prevent the build up of warm air in pockets above windows and doors which can be transferred by convection to the occupation zone.

The size of windows to be provided is dependant upon the maximum number of people who may occupy each room of the building and therefore the ventilation requirements. Adequate openings must be provided to supply $0.35ft^3/s$[78] per person within a room where high temperatures may be experienced, or a minimum of $0.17ft^3/s$[79] in all other cases. Where buildings are not within the wind shadow of adjacent buildings (Tutt and Adler offer guidance on calculating this[79]), this air flow can be assumed to be driven by wind speeds and calculated as follows[78]:

Q = EAv

Where:

Q = Air flow (m^3/s)

E = 0.25 for windows at 45 degrees to wind, 0.5 for windows at 90 degrees to wind

A = Area of window (m^2)

v = Wind speed (m/s)

This air flow should also be supplemented by the installation of ceiling fans as discussed in section 9.12.

Limit the number of south facing windows

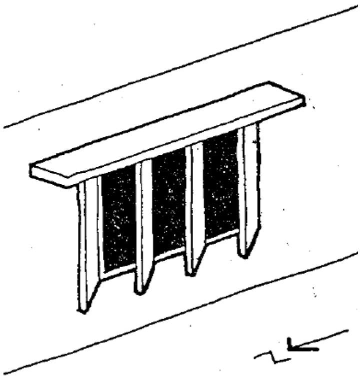
Window Orientation

North facing windows are preferable for hot climates. As the sun tracks from south-east to south-west, this will minimise the penetration of the sun. South facing windows are beneficial for colder climates as they increase the possibility of solar access during colder winter seasons when the path of the sun is slightly lower. Windows should not be installed in east or west facing walls where high temperatures are prevalent.

Glazed Windows

By providing hinged and glazed window frames, occupants shall be able to close the windows during the day to exclude the heat and open these during the night to allow the intake of cooler air. This is vital if passive cooling measures such as thermal mass are adopted. It also provides flexibility between the seasons and security.

Angled Vertical Vane Shutters



Source: UN-Habitat[80]

Shutters

Shutters can be provided, to be closed during the day to prevent solar gain. Alternatively, to allow natural light to enter the building, vertical vane shutters can be provided - for windows on east or west facing elevations these vanes should be angled to the north (as shown opposite) to prevent sunlight shining directly between the shutters.

Further information on climatic design using passive techniques is provided by Rosenlund[78] and UN-Habitat[80].

References and Further Reading

[76] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

[77] Government of Tamilnadu and UNDP India (2007) 'Disaster Resistant Construction Practices. A reference Manual'

[78] Rosenlund, H. (2000) 'Climatic Design of Buildings using Passive Techniques' Lund University, Lund

[79] Tutt, P., Adler, D (1979) 'New Metric Handbook' The Architectural Press, London

[80] UN-HABITAT (2009) 'National Design Handbook Prototype on Passive Soar Heating and Natural Cooling of Buildings' UN-Habitat, Nairobi

9.12 Induced Ventilation

AREAS OF EXTREME TEMPERATURE:

✓ **Provide ceiling fans or electrical power socket for use of standing fans**

9.12.1 Flooding

Installation of ceiling fans within community buildings should also be considered to promote air circulation when it may not be possible to open windows and doors during an emergency.

9.12.2 Earthquake

No specific guidance

9.12.3 Temperature Extremes

Provision of ceiling fans in community buildings (such as schools and mosques) is recommended

Ventilation can also be induced by installing fans. Ceiling and standing fans create air movement which can increase the tolerance of inhabitants to high temperature rather than lowering the interior temperature during the summer. The benefits are similar to, although more pronounced than, cross-ventilation.

Ceiling level fans should only be installed in rooms of at least 10ft height for effectiveness and efficiency.

Ceiling fans operated with the windows and doors closed can shift the warm air that rises to the top of the room to the occupation zone, raising the temperature of that area, aiding heat circulation during cooler months.

9.13 Roofing

ALL DEVELOPMENTS:

- ✓ **Provide adequate slope with guttering to convey rainwater from the roof to the village drainage system**
- ✓ **Incorporate rainwater harvesting into drainage system (see 8.3.3)**
- ✓ **Use impermeable materials for the roof construction or water proof using traditional techniques (2 coats of bitumen and a layer of polythene sheet covered mud & husk plaster 4” thick Laid in slope and finished with brick tiles)**

SEISMIC ZONES 2B & ABOVE:

- ✓ **Support the roof with a pucca roof truss**
- ✓ **Incorporate cross-braces into the roof truss**
- ✓ **Connect the roof truss to the seismic roof band using steel anchors**
- ✓ **Strengthen connections between tie-beams, king posts, braces and rafters of the roof truss with steel straps and plates**

AREAS OF EXTREME TEMPERATURE:

- ✓ **Extend roof eaves at a pitch of 30º over north and south facing walls (where openings are present) for a horizontal distance of 3ft**
- ✓ **Provide verandas over external door ways, extending horizontally out from the building by at least 6ft, and continuing for at least 6ft each side of the door**
- ✓ **Provide a paper board false ceiling at a room height of 10ft and lay expanded polystyrene in roof cavity**
- ✓ **Paint external face of roof with lime wash**

Unlike the foundations, failure of the roof is unlikely to result in destruction of an entire building but can lead to loss of life as heavy elements fall from height. Poor drainage from the roof can result in the gradual deterioration of walls and foundations.

9.13.1 Flooding

There are three main aspects to consider during roof design. These are related to rainfall rather than surface flooding and are therefore applicable for construction in all areas:

Pitched or Flat Roof?

The UN-Habitat rapid assessment following the 2010 floods[81] noted that flat roofs became water logged (especially mud roofs) which added additional mass to the roof leading to collapse of the roof (see opposite) and the walls.

Ponding of rainwater on a flat roof leading to collapse - Balochistan

Source: UN-Habitat

While this common cause of failure can be avoided by provided a pitched roof, flat roofs are a benefit on community buildings as they can also serve to provide an evacuation point during a flood. Construction of flat roofs is also easily replicated by local communities. Therefore, flat roofs should be allowed on community buildings but must be high quality constructions with a raised parapet embedded with drainage pipes.

Provide flat roofs where emergency evacuation from roof tops may be required following a disaster event

Due to the possible increase in mass of a flat roof during rainfall, flat roofs must be of adequate strength. Therefore the use of pre-cast reinforced concrete roof slabs is recommended.

Where adequate strength cannot be provided, or evacuation from the roof is not required, a pitch (angle) to the roofs should be provided. By adding a pitch and using less absorbent materials water can be drained away from the roofs. This reduces leakage through the roof as water is speedily conveyed away from the roof and prevents collapse. A pitch of between 30º to 40º should be adopted to resist uplift.

Drainage

A pitched roof will ensure that rainwater does not accumulate on a roof. Care must be taken to convey this rainwater to the drainage system in a manner which does not compromise the structural integrity of the building. Rain water must not be allowed to drain onto the walls or foundations of the buildings as this can cause significant damage (as shown opposite).

Example drainage off roof eaves, down-pipe missing, Thar Desert, Sindh

Source: Mott MacDonald, 2012

Where flat roofs are used, a slight fall over the roof must be provided to prevent pooling of water on the roof top.

The easiest way to achieve effective drainage is to provide guttering around the perimeter of the roof to convey the water to down pipes (vertical drainage pipes) which lead directly to the main drainage system described in the Layout Section. The roof gutter must be sloped in the direction of the down pipe to ensure water is efficiently drained. This method may also be combined with rainwater harvesting techniques (see Services Section) to reduce dependency on pumped supply or ground water.

Roofs must convey rainwater to the main drainage system without coming into contact with the walls or foundation

Water Proofing

Where impermeable roof materials (such as corrugated iron/steel or tiles) are used for the roofs of community buildings, further water proofing will not be necessary.

If impermeable roof materials are not used, traditional methods may instead be used to provide water proofing through layering of impermeable materials as follows:

- *2 coats of bitumen*
- *Layer of polythene sheet*
- *4” thick earth laid in Slope*
- *Mud & husk plaster*
- *1 ½” brick tiles grouted with cement sand slurry*

9.13.2 Earthquake

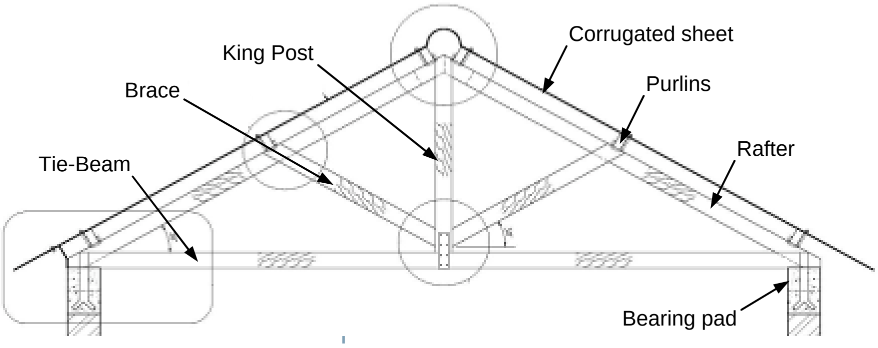
Use lightweight roofing materials

The ground acceleration that occurs during an earthquake will ultimately result in forces exerted upon the roof structure. As force is a multiple of mass and acceleration, the heavier the roof, the higher the seismic force that will be experienced.

In large community buildings, the use of heavier building materials for roofs can be unavoidable, therefore a high quality roof truss must be provided.

The roof truss supports the weight of the roof. A truss has four main elements: two rafters, a king post, two braces and a tie as shown below.

The main elements of a roof truss

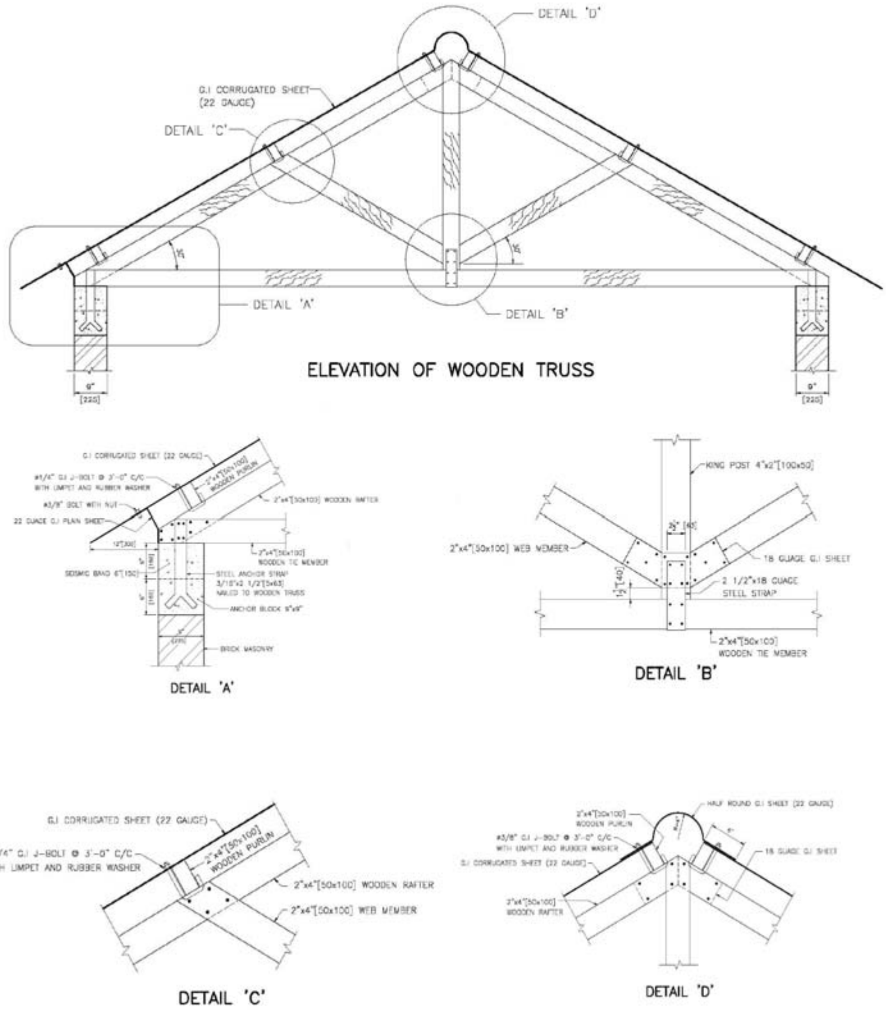


Source: Earthquake Reconstruction and Rehabilitation Authority[82]

The tie-beam holds the two rafters together. The king post supports the top of the rafters. The braces provide additional stability. The rafters transfer the load of the roof to the walls. Bearing pads of concrete or wood should be provided between the rafter and wall to spread the load evenly. Purlins may be provided to support the roof covering. Cross-braces may also be provided between the trusses for stability in seismic zones 2B and above.

Strong connections between all elements of the roof truss, the truss and wall are vital for its successful performance during an earthquake. Steel anchors should be used to connect the truss to the seismic roof band, steel straps and plates used to strengthen connection of the elements in seismic zones 2B and above. Connection details are provided in the following figure.

Typical roof truss connection details



Source: Earthquake Reconstruction and Rehabilitation Authority[82]

See earthquake resistant roof construction are provided by Schacher[83] and the Earthquake Reconstruction and Rehabilitation Authority[82]

9.13.3 Temperature Extremes

The design of the roof presents an opportunity to include measures to reduce the impact of temperature extremes.

Roof Eaves

Provide roof eaves and verandas to reduce solar gain

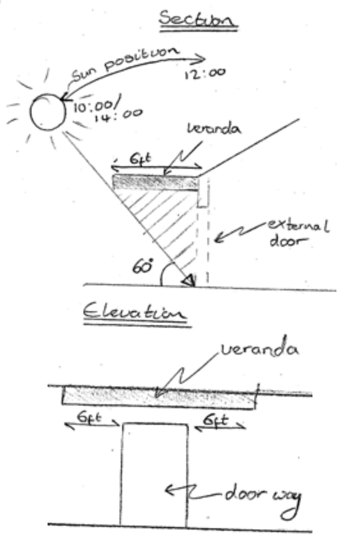
In areas susceptible to high temperatures, the eaves of the roof should be extended to provide shade over the windows. This prevents direct exposure of the window and interior to solar gain during the day. As discussed in the previous section, windows should not be provided in east or west facing walls.

The suns radiation is greatest between 10am and 2pm (approximately 50% of the suns daily radiation on a horizontal surface occurs between these hours)[84]. From the sun path diagrams provided in the Appendix, the sun's altitude varies from 60º to 90º during these hours in the summer season. By providing roof eaves over north and south facing walls at a 30º roof pitch, extending three horizontal feet from the building, the top 6.5 feet of the building shall be shaded during these hours, thereby shading the windows from solar gain. Windows should not be placed in east or west facing walls.

Verandas

A veranda should be incorporated into the design of the roof and building at the location of external door. This will again prevent solar gain through the windows and doors, but also provide a cool shaded buffer between outside and the inside of the building.

Provision of Veranda



Source: Mott MacDonald

Hollow clay roof tile

Verandas must extend a minimum of 6ft beyond the building, and continue for 6ft either side of an external door to prevent solar gain through the external doors of a building from 10am to 2pm during the summer (as shown opposite).

Insulation

The roof of a building is the element which receives the most solar energy. To reduce internal heat rise during high temperatures and reduce heat loss during low temperatures, insulating materials should be considered for the roof.

The following readily available materials offer good insulation:

Brick tiles

Hollow Tiles (Fired clay extruded hollow tiles -pictured opposite)

- *Mud with high density Styrofoam*
- *Expanded polystyrene*
- *Smart concrete tiles (polystyrene sandwiched between concrete layers)*

Specialist ready made insulating roof tiles and material are also available such as:

- *Air Conditioning tiles (terrazzo mixed with white epoxy and styrofoam)*

Other traditional practices of roof insulation such as laying inverted earthen ware on roof tops and covering with earth or brick tiles may also be adopted.

Reflection

Use insulating roof materials with a reflective finishing to reduce temperatures in internal spaces during the summer and reduce heat loss in the winter

Absorption of heat through the roof can also be reduced by applying and regularly cleaning reflective finishes such as:

- *Lime wash*
- *White enamel paint*
- *Weather shield white paint*
- *OCEVA-MOL chemical*
- *Aerosol heat reflective paint*

These finishes will require full reapplication at least once every ten years.

False Ceiling

A false ceiling can be constructed at the level of the wall top. This ceiling acts as a buffer between the inside and outside temperatures and should be strong enough to mount ceiling fans. During the summer the false ceiling shall prevent heat from radiating from the roof directly into the building, and in the winter it shall reduce the loss of heat through the roof.

The following materials can be used for a false ceiling:

- *Gypsum board*
- *Aluminium backed gypsum board (aluminium on the upper face)*
- *Paper board*
- *Styrofoam*

The National Energy Conservation Centre of Pakistan carried out an assessment[85] of the cost, constructability and performance (in terms of temperature reduction) of the insulation, reflection and false ceiling techniques described above.

From the thermal data collected by the National Energy Conservation Centre, the installation of a paper board false ceiling and use of expanded polystyrene are the most effective measures to reduce the interior temperature. **Lime wash finishing of a roof is an effective and low cost measure to reduce temperature** although does not offer benefits in preventing heat loss during the winter. It is also possible to combine the three methods to provide better cooling effects.

Performance of Insulation Techniques

Material	Interior Temp. at 3pm (ºC)	Interior Temp. at 12am (ºC)	Special Skills Required	Installation Cost (PKR/ft^2)	Annual Maintenance Cost (PKR/ft^2)
Outside temperature	41.0	32.0	-	-	-
Control house	36.2	36.7	-	-	-
Cement stabilised mud	35.3	35.4	None	32	3.2
Brick tiles	33.1	33.9	None	39	3.9
Hollow tiles	34.1	33.8	None	81	8.1
Mud and styrofoam	33.6	34.1	None	52	5.2
Expanded polystyrene	32.2	32.0	Basic concreting & masonry	76	7.6
Smart concrete tiles	33.7	32.0	None	70	7.0
AC tiles	33.0	33.4	None	80	8.0

Source: National Energy Conservation Centre[85]

Performance of False Ceiling Techniques

Material	Interior Temp. at 3pm (ºC)	Interior Temp. at 12am (ºC)	Special Skills Required	Installation Cost (PKR/ft^2)	Annual Maintenance Cost (PKR/ft^2)
Outside temperature	41.0	32.0	-	-	-
Control house	36.2	36.7	-	-	-
Gypsum board	34.6	34.9	Skills to fix frame	44	4.4
Aluminium backed gypsum	34.9	34.5	Skills to fix frame	45	4.5
Paper board	32.2	31.7	Skills to fix frame	22	2.2
Styrofoam	34.4	33.6	Skills to fix frame	30	3.0

Source: National Energy Conservation Centre[85]

Performance of Reflective Techniques

Finishing	Interior Temp. at 3pm (ºC)	Interior Temp. at 12am (ºC)	Special Skills Required	Installation Cost (PKR/ft^2)	Annual Maintenance Cost (PKR/ft^2)
Outside temperature	41.0	32.0	-	-	-
Control house	36.2	36.7	-	-	-
Lime wash	33.1	32.6	None	3	3
White weather shield paint	33.7	32.6	None	8	8
White enamel paint	33.1	32.9	None	8	8
Aerosol paint	34.2	33.4	None	39	39
OCEVA-MOL	34.7	33.6	Specialist required	35	35

Source: National Energy Conservation Centre[85]

References and Further Reading

[81] UN-HABITAT (2010) 'Monsoon Flood 2010 Pakistan, Rapid Technical Assessment of Damage and Needs for Reconstruction in Housing Sector', Islamabad

[82] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority

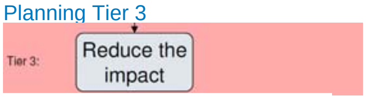
[83] Schacher, T. and Ali, Q (2009) 'Dhajji Construction for one and two storey earthquake resistant houses' UN-Habitat, Islamabad.

[84] Brown, G. Z., & DeKay, M (2001) ' Sun, Wind & Light, Architectural Design Strategies' John Wiley & Suns, Inc., New York

[85] National Energy Conservation Centre (2010) 'Energy Efficient Housing: Improvement of Thermal Performance of RC Slab Roofs' UN-Habitat, Islamabad

10. Residential Buildings

Planning Tier 3



Source: Mott MacDonald

Planning Tier 3

This section presents an overview of different design options for developing **residential buildings that are resilient to the impacts of flooding, earthquakes and extremes of temperature**. Guidelines for community buildings are discussed in section 9.

A range of design solutions to the impacts are discussed for different budgets and skills. In practice, planners will need to develop their own detailed specifications for their construction proposals in consultation with the community and will make cost estimates based on their design decisions whilst considering the skills required to replicate their designs.

Specific actions due to flood or earthquake risk, or to mitigate against the effects of temperature extremes are highlighted in each section.

10.1 Policies, Regulations and Guidelines

The Building Code of Pakistan (Seismic Conditions 2007)[86] gives specific guidance for construction and the rules of this code should be followed.

10.2 Design Based Considerations

Elevation Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Ground Elevation	Construct a raised platform to an elevation of 0.5ft above the highest recorded flood level (10.6.1)	*Not applicable*	Provide elevated location of community building to promote thermal comfort

Geometric Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Shape	Adopt linear (square or rectangular buildings)	Adopt square or rectangular buildings (10.7.2)	Adopt Linear (square or rectangular) buildings to provide better ventilation and air currents inside
Length	*Not applicable*	Building length must not exceed three times the width nor 26ft where pucca walls are proposed or 14ft where katcha walls are proposed, unless cross-walls or buttresses are used (10.7.29.7)	

Foundation Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake
Materials	Fired bricks, stone or concrete blocks (10.8.1)	
	Use a cement:sand (1:4) mortar (10.8.1)	
	Waterproof plaster applied to inside and outside faces up to flood level (10.8.1)	*Not applicable*
	Provide a damp proof course below plinth level (10.8.1)	
Depth	2ft in hard soil, 4ft in soft soil (10.8.1)	3ft in hard soil, 4ft in soft soil (10.8.2)
Height	0.5ft above ground or flood level - whichever is highest (10.8.1)	
Width	At least 2ft (10.8.1)	
Reinforcement	Provide 2 Steel bars of ½ inch diameter embedded in concrete to avoid differential settlement as per drawing (10.8.1)	Cast 3ft long steel J rods into foundation at 6ft centres (10.8.2)

N.B: A pucca foundation should be provided, even when this supports a katcha building. The integrity of the foundation is key to the strength of the entire building.

Base Slab Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake
Base Slab	*Not applicable*	Provide a continuous reinforced seismic band at plinth level (10.9.2)

Wall Design Criteria for Climate Change Resilient Village Reconstruction

Category	Housing Type	Flooding	Earthquake	Temperature Extremes
Materials	All	Preferably brick with cement mortar. Adobe or mud use only on adequate foundation (10.10.1)		
Plaster	*All*	Apply cement:sand (1:4) or waterproofed mud plaster to outside faces (10.10.1)	*Not applicable*	Apply a reflective finish to external wall faces e.g.: lime wash (10.10.3)
Thickness (10.10.1)	*Brick*	9"	9"	9"
	Adobe	13.5"	13.5"	13.5"
	Mud	18"	18"	18"
Room Height	*Brick*	Not less than 10ft	10ft (10.10.2)	Not less than 10ft (10.10.3)
	Adobe	Not less than 10ft	8ft (10.10.2)	Not less than 10ft (10.10.3)
	Mud	Not less than 10ft	8ft (10.10.2)	Not less than 10ft (10.10.3)
Reinforcement	*Brick*	*As per traditional techniques*	Reinforced concrete or timber seismic band at roof and lintel level (10.10.2)	*As per traditional techniques*
	Adobe	*As per traditional techniques*	Reinforced concrete or timber seismic band at roof level (10.10.2)	*As per traditional techniques*
	Mud	*As per traditional techniques*	Reinforced concrete or timber seismic band at roof level (10.10.2)	*As per traditional techniques*
			Symmetrical arrangement of openings (10.11.2)	

Window and Door Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Opening Width	Less the 4ft (10.11.2)		
Opening Height	*Not applicable*	*Not applicable*	3ft in 10ft high walls, 2ft in 8ft high walls (10.11.3)
Position	Clearance between windows of at least 50% of the narrower opening and no less than 2ft (10.11.2)		
	Clearance between windows and building edges of at least 25% of the narrower opening and no less than 2ft (10.11.2)		
	Symmetrical arrangement (10.11.2)		
	Not applicable	*Not applicable*	Windows only in north and south facing walls (10.11.3)
	Not applicable	*Not applicable*	Low level windows at front of building with sill level 2ft above base of wall (10.11.3)
	Not applicable	*Not applicable*	High level windows at rear of building with a top level 2ft below roof level (10.11.3)
Sum of opening width	Less than 30% of wall span (10.11.2)		
Reinforcement	Provide timber or reinforced concrete lintels above openings in brick built houses	Provide timber or reinforced concrete lintels above openings (10.11.2)	*Not applicable*
Window Type	*Not applicable*	*Not applicable*	Provide glazed windows on hinged frames (10.11.3)
			Provide shutters (10.11.3)

Roofing Design Criteria for Climate Change Resilient Village Reconstruction

Category	Flooding	Earthquake	Temperature Extremes
Materials	Impermeable materials e.g.: corrugated iron, steel or tiles (10.12.1)		
	Not applicable	Use lightweight building materials (10.12.2)	Paint external face with lime wash (10.12.3)
Design	Prefer construction of pitched roof at 30º on all buildings (10.12.1). Flat roofs should only be allowed where pre-cast reinforced concrete slabs are provided and the roof is waterproofed with bitumen and polythene sheet.		
			Extend roof eaves 2.2ft (for 10ft high wall) or 1.75ft (for 8ft high walls) at the rear of the building (10.12.3)
			Provide veranda extending at least 3.5ft (for 10ft high walls) or 2.6ft (for 8ft high walls) at the front of the building (10.12.3)
Drainage	Provide guttering at perimeter of roof or a concrete lined channel at ground level and incorporate into rainwater harvesting (10.12.1)		

10.3 Contents

This section is subdivided into the following building elements:

- *Ground Elevation*
- *Building Geometry*
- *Foundations*
- *Base Slab*
- *Walls*
- *Windows & Doors*
- *Induced Ventilation*
- *Roofing*

Specific actions due to flood or earthquake risk, or to mitigate against the effects of temperature extremes are highlighted in each section.

10.4 Cost Estimates

Cost estimates for a variety of different housing options have been completed by UN Habitat as part of the Housing Early Recovery scheme[87]. These include detailed cost estimates for the building types defined in these guidelines and are freely available online.

As such this information is not repeated here. Please refer to the UN Habitat website referenced below for further information.

10.5 Housing Types and Local Replication of Designs

Designs are focussed on the following selected existing building techniques currently found within rural Punjab[88]:

- *Fired brick with mud mortar (42%) ('Pucca')*
- *Adobe (39%)*
- *Mud house (16%) ('Katcha')*
- *Reinforced block/brick (4%)*
- *Jumpari (local bushes and twigs woven around vertical timber posts and finished with plaster inside and out) (0.2%)*

Typical House in Rural Punjab

Source: UN-Habitat[88]

Following the 2010 flood in Pakistan, a rapid assessment carried out by UN-Habitat and the National Disaster Management Authority (NDMA)[88] considered the performance of these houses during the flood and concluded the following:

Flood performance of common housing types in Punjab

Housing Type	Fully Destroyed	Partially Destroyed	Minor/No Damage
Brick with mud mortar	20%	45%	35%
Adobe	56%	36%	8%
Mud house	82%	16%	2%
Reinforced block/brick	17%	28%	55%
Jumpari	100%	-	-

Source: UN-Habitat[88]

Reinforced block/brick houses ('Pucca') were the most resilient to the flood water according to this study, whilst mud and jumpari houses performed poorly. This section considers design options for traditional mud housing, adobe and brick (with mud mortar).

Flood destroyed mud houses at Zoor Village near Hote Lashari

Source: MM Pakistan (Pvt.) Ltd

When considering the appropriate building design (in particular housing), consideration must be given to availability of materials, financial constraints, and construction capabilities within the community being assisted.

For long-term resilience and sustainability, communities must be able to build, maintain and replicate the designs in their future construction. Community needs assessments, dialogue and consultation should identify cultural and skills needs and expectations. Consultation also allows communities to understand the design and construction constraints to reconstruction, which should aid acceptance of final planning decisions.

Variations to these design options and additional training (see Construction Section) may be required. The need for additional training should not be seen as a reason to discount designs in favour of sub-quality designs where their performance has been shown to be poor.

References and Further Reading

[86] Pakistan Engineering Council (2007) 'Building Code of Pakistan (Seismic Provisions - 2007)' www.pec.org.pk/buildingcode.aspx

[87] UN-Habitat 'Housing Early Recovery Working Group'. Available online at: http://115.186.134.22:43038/default.aspx

[88] UN-HABITAT (2010) 'Monsoon Flood 2010 Pakistan, Rapid Technical Assessment of Damage and Needs for Reconstruction in Housing Sector', Islamabad

10.6 Ground Elevation & Raised Platforms

FLOOD ZONE 1 & 2:

✓ **Construct a raised platform to a level of 0.5ft above the highest recorded flood level from earth fill compacted to 95% of dry density**

10.6.1 Flooding

Where the ground level is below the flood level a compacted raised platform for the community structures must be constructed to ensure the floor level of the structure is above the flood level.

Please refer to section 6.4.4 for details of constructing a raised platform.

Raised platforms for residential buildings must be constructed to a level of 0.5 feet above the highest level recorded during previous flood events.

10.6.2 Earthquake

No specific guidance.

10.6.3 Temperature Extremes

No specific guidance.

References and Further Reading

Ehsan, Muhammad (2011) 'Design of Raised Platforms in Flood Affected Areas of Badin and Mirpurkhas Districts' Food and Agriculture Organization of United Nations

10.7 Building Geometry in Earthquake Prone Areas

SEISMIC ZONES 1 & ABOVE:

- ✓ **Construct symmetrical square or rectangular buildings only**
- ✓ **Provide cross-wall or buttresses where the building length exceeds three times the width or the wall span exceeds 26ft where pucca walls are proposed or 14ft where katcha walls are proposed**
- ✓ **Building length must not exceed three times the building width**

SEISMIC ZONES 2A & ABOVE:

- ✓ **The length of brick walls with mud mortar must not exceed 16ft**
- ✓ **The length of adobe or mud walls must not exceed 14ft**

10.7.1 Flooding

No specific guidelines.

10.7.2 Earthquake

Earthquake damage to rural home

Source: MM Pakistan (Pvt) Ltd

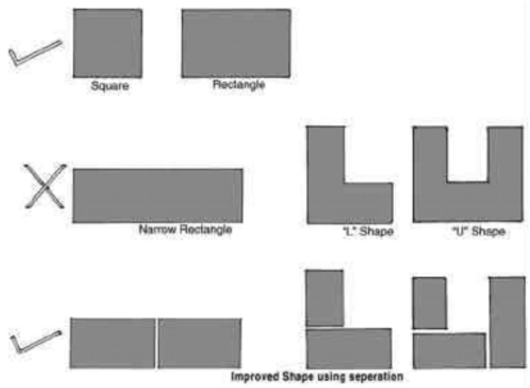
The geometry of a building is critical to its performance during an earthquake. Buildings must be as symmetrical as possible. Asymmetric designs induce asymmetric forces during an earthquake that a building cannot withstand, leading to failure. The guidance below is based on guidelines produced by the Earthquake Reconstruction and Rehabilitation Authority[89].

Construct square or rectangular building in earthquake prone areas

Shape

Regularly shaped buildings, such as square or rectangular, resist earthquakes more effectively than irregular shapes, such as L-shapes as depicted below:

Earthquake resistant and non-earthquake resistant housing shapes



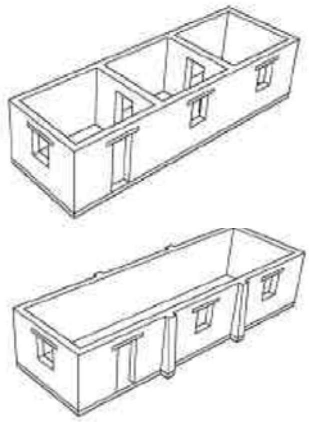
Source: Earthquake Reconstruction and Rehabilitation Authority[89]

Wall Length

Long and narrow buildings are more susceptible to failure during an earthquake. Therefore, housing blocks should be limited to four houses, arranged within one square building (as described in the Layout Section). The **construction of long rows of houses should be avoided** as these buildings shall be weaker during earthquakes.

The **length of a building should not exceed three times its width**. Wall length for pucca walls should also not exceed 26ft without the provision of cross-walls or

Dealing with long walls in earthquake prone areas



Source: Earthquake Reconstruction and Rehabilitation

buttresses as shown opposite[89] or 14ft for katcha walls.

In order to reduce the risk of the collapse of a wall during an earthquake, the following maximum room dimensions should be adopted in seismic Zones 2A and above for katcha buildings::

Maximum room dimensions in earthquake prone areas

Housing Type	Wall Length (ft)
Brick with mud mortar	16
Adobe	14
Mud house	14

Source: UN-Habitat[90]

Further information is provided by the Earthquake Reconstruction and Rehabilitation Authority[89] and in the Building Code of Pakistan[91].

10.7.3 Temperature Extremes

No specific guidance

References and Further Reading

[89] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

[90] UN-HABITAT (2011) 'Guidelines for flood resistant house' Available online: http://www.unhabitat.org.pk/Publication.html

[91] Pakistan Engineering Council (2007) 'Building Code of Pakistan (Seismic Provisions - 2007)' www.pec.org.pk/buildingcode.aspx

10.8 Foundations

ALL DEVELOPMENTS

- ✓ **Use fired bricks, stone or concrete blocks with cement:sand (1:4) mortar for construction of foundations**
- ✓ **Foundation depth of at least 2ft in hard soil or 4ft in soft soil**
- ✓ **Foundation width of at least 2ft**
- ✓ **Maximum uninterrupted foundation length of 16ft where supporting pucca wall construction, or 14ft for katcha wall construction**
- ✓ **Provide a damp proof course immediately below plinth level (2" thick concrete, overlaid by bitumen and covered by a plastic sheet)**
- ✓ **Foundation height must extend to 0.5ft above ground or maximum flood level (whichever is higher)**

FLOOD ZONES 1 & 2:

- ✓ **Apply a cement:sand plaster (1:4) to the entire outside face and the inside foundation face up to flood level, or:**
- ✓ **Where cement:sand plaster is not available, add a hot bitumen:kersone (5:1) mix to 20 parts of a fermented mud:sand:straw plaster and apply in two layers**
- ✓ **Provide two steel bars of ½” diameter cast into foundation**

SEISMIC ZONES 2A & ABOVE:

- ✓ **Foundation depth must be at least 3ft**
- ✓ **Cast 3ft long steel J-rods into concrete pads within the foundation base at 6ft intervals**

10.8.1 Flooding

The most common damage to structures resulting from flooding is due to the undermining and settlement of foundations and scouring at the base of walls leading to destruction of the house[92]. This damage can be reduced by:

- *Strengthening foundations*
- *Deepening foundations*
- *Increasing foundation height*

Overturned wall due to foundation settlement - Muzaffargh, Punjab

Source: UN-Habitat[92]

Regardless of the housing type adopted, it is vital that a strong foundation is constructed in flood zones 1 & 2. **The strength of an entire structure depends upon the integrity of its foundation.** Its strength must be adequate to withstand settlement or scouring during a flood.

Erosion at base of wall - Punjab

Source: UN-Habitat[92]

These guidelines propose pucca construction of houses up to the flood level for residential buildings. Pucca or katcha construction techniques can be used above this level and appropriate training for these techniques integrated.

The following guidelines are based on the UN-Habitat guidelines for flood resistant homes[93] and apply to any housing type:

Use cement/sand mortar where the mortar is below the flood level

Standing water will dissolve mud mortar!

Foundation materials

The following materials should be used for the foundation of all houses:

- *Fired bricks*
- *Stones, or*
- *Concrete blocks*

Damaged mud walls due to foundation damage, Punjab

Source: MM Pakistan (Pvt) Ltd

A cement:sand (1:4) mortar should be used, and at the least, where alternative mortar is used, a cement:sand mortar must be used for pointing of the masonry work. Mud mortar performs poorly during a flood as it can be dissolved by standing water, leading to collapse of the structure (as shown opposite).

Foundation Excavation

The depth of excavation depends on the strength of the soil. As a general rule:

- *2ft in hard soil*
- *4ft in soft soil*

Adequately compact any raised building platform

Where the foundation is to be placed within a raised platform it is imperative that the base of the excavation is adequately compacted (as well as the platform itself). In addition, a clearance equal to the height of the platform (and no less that 3ft) should be maintained between the excavation and the edge of the platform.

The width of the excavation should be at least 2ft. The uninterrupted length of a foundation should extend no further than:

- *16ft for brick/stone or block walls*
- *14ft mud walls*

Damp Proof Course

A damp proof course provides a barrier between the foundation and the structure above to prevent the seepage of water in the ground (or at the foundation level during a flood) up into the walls of the structure, extending the life of a structure.

The damp proof course should be laid immediately below the plinth level and is made up of three layers:

1. *2" thick concrete layer (1:2:4 - cement:sand:gravel), overlaid by*
2. *Bitumen layer, overlaid by*
3. *Plastic sheet*

Foundation Height

Katcha houses should be constructed on pucca foundations

If a good quality foundation is provided which raises the walls above the flood levels, traditional construction techniques less resilient to flooding can be used above this level, benefiting from local knowledge and cheaper construction and may be more appropriate due to available materials and local skills, cost and maintenance needs.

Provide a strong foundation to above the flood water level

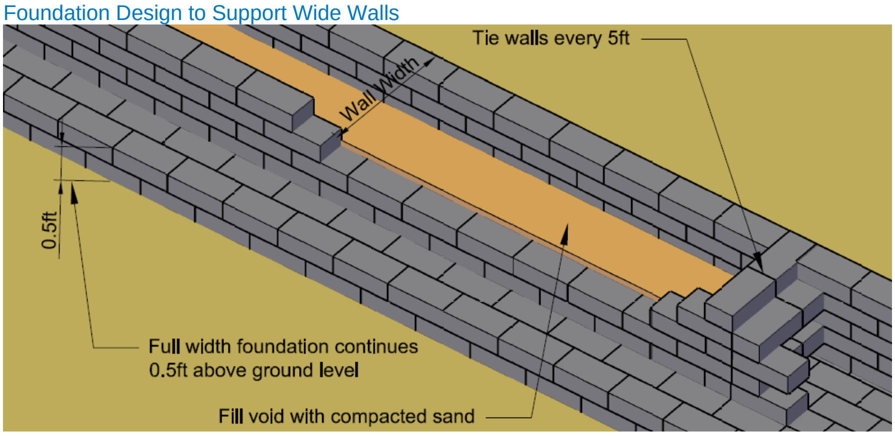
The maximum flood level at the site should be identified (from water marks on existing structures) and, where this is reasonable, the foundation should be continued to at least 0.5ft above this level (to account for increased flood intensity due to climate change) or 0.5ft above the ground level, whichever is higher.

Provide full width foundation to 0.5ft above ground level

Where it is not possible to raise foundations above the flood level (due to high anticipated flood level), further consideration to relocation should be given. If not possible, the pucca design of flood resistant buildings or a solid frame structure adopted (see page 197). If a katcha design is still to be adopted, the width of the foundation should be reduced to wall width at a level above 0.5ft above the ground level.

Where the wall thickness is high (in mud houses for example), further savings can be achieved by constructing two walls at the inside and outside faces, joining the walls (with bricks) at 5ft intervals and filling the voids with compacted sand as shown in the following figure. Least preferred alternate is mud and adobe walls can be clad with fired bricks up to the water level.

Foundation Design to Support Wide Walls

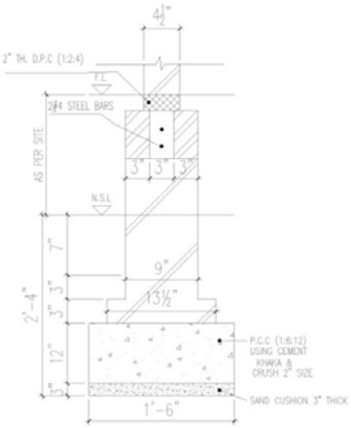


Source: Mott MacDonald

Plaster

A cement:sand plaster (1:4) should be applied to the foundation (inside and outside wall faces) up to the flood level. Where it is not possible to use a cement/sand plaster, the waterproofing of mud plaster can be improved by the addition of bitumen and kerosene to a mud / sand / straw mixture. A 5:1 ratio mix of hot bitumen and kerosene should be combined with 20 parts of a fermented mud / sand / straw mix. Water should then be added to this mix and the plaster applied in two layers, with the second layer only being applied once the first layer is dry.[94]

Horizontal foundation reinforcement



Source: PDMA Architect

Reinforcement

Foundations should be strengthened by providing 2 ½" diameter horizontal steel reinforcement bars embedded in concrete at plinth level of the building (as shown in the diagram opposite). This will help avoid cracks in walls due to differential settlement.

10.8.2 Earthquake

A strong foundation is also vital in all seismic zones, as the foundation must resist the seismic forces during an earthquake to prevent failure of the entire structure. Consequently, many of the requirements for a high strength foundation in a seismic area are the same as the requirements for a flood zone.

Foundation Materials

As for flooding.

Foundation Excavation

As for flooding, except the depth of excavation must be no less than 3ft[95] in seismic Zones 2A and above.

Damp Proof Course

As for flooding.

Foundation Height

As for flooding.

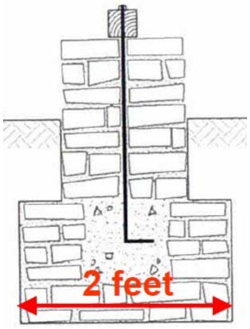
Plaster

Optional, not required.

Reinforcement

It is important that vertical reinforcement is provided between the upper and lower sections of the foundation to prevent overturning during an earthquake or flooding. To achieve this, 3ft long steel J-rods may be cast into a concrete pad within the foundation at 6ft intervals around the foundation as shown opposite. Although this is most critical in earthquake or flood prone areas, this reinforcement is good practice and should be provided on all buildings.

Vertical foundation reinforcement



Source: Schacher[111]

10.8.3 Temperature Extremes

No specific guidance

References and Further Reading

[92] UN-HABITAT (2010) 'Monsoon Flood 2010 Pakistan, Rapid Technical Assessment of Damage and Needs for Reconstruction in Housing Sector', Islamabad

[93] UN-HABITAT (2011) 'Guidelines for flood resistant house' Available online: http://www.unhabitat.org.pk/Publication.html

[94] Practical Action (1999) 'Technical Brief. Mud Plasters and Renders', Practical Action, Rugby

[95] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

10.9 Base Slab

SEISMIC ZONE 3:

✓ **Provide a continuous reinforced concrete or timber seismic band at plinth level**

10.9.1 Flooding

No specific guidance

10.9.2 Earthquake

A **seismic band** is a continuous reinforced concrete or timber beam which runs around the perimeter of a building that binds, reinforces and makes all the walls act together, providing improved strength during an earthquake. It is vital that the reinforcement at the corners of the bands, or timber joints are adequately tied - further guidance provided by ERRA[96]

Reinforcement shall be provided by the J-rods between the foundation and wall. However, for structures founded seismic Zone 3 a seismic band should be provided at the plinth level.

10.9.3 Temperature Extremes

No specific guidance

References and Further Reading

[96] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:sand Mortar in Earthquake Affected Areas' ERRA.

10.10 Walls

ALL DEVELOPMENTS:

- ✓ **Use traditional construction techniques and materials for construction of walls above flood level**
- ✓ **Adopt the following minimum wall thickness:**
  - **9" for brick walls**
  - **13.5 " for adobe walls**
  - **18" for mud walls**
- ✓ **Begin construction of walls at the corners of a building**

FLOOD ZONES 1 & 2

- ✓ **Apply a cement:sand plaster (1:4) to the outside wall face, or:**
- ✓ **Where sand:cement plaster is not available, add a hot bitumen:kersone (5:1) mix to 20 parts of a fermented mud:sand:straw plaster and apply in two layers**

SEISMIC ZONES 2A & ABOVE:

- ✓ **Adopt the following maximum room heights:**
  - **10ft for brick walls**
  - **8ft for adobe and mud walls**

SEISMIC ZONES 2B & ABOVE:

- ✓ **Provide a reinforced concrete or timber seismic roof band**
- ✓ **Provide reinforced concrete or timber seismic lintels over openings band for room heights greater than 8ft**

AREAS OF EXTREME TEMPERATURE

- ✓ **Do not use wood or metal as the main construction material**
- ✓ **Apply reflective finish (such as lime wash) over external wall faces**

In this guidance the choice of walls will depend on the house type, and walls refers to what is constructed above the flood level on the foundation detailed above.

10.10.1 Flooding

Materials

As detailed in section 10.8, katcha building materials and techniques can be used for the construction of walls where pucca foundations have been provided. Therefore, building materials are based on those generally found in rural areas (see section 10.5) in order to ensure replication of these designs shall be possible within rural areas.

The following materials can be used for the construction of walls:

- *Fired bricks*
- *Adobe bricks*
- *Mud/sand/straw mixture*

Plaster

Dissolved mud mortar - Muzaffargarh, Punjab

Source: UN-Habitat[99]

Waterproof plaster should be applied to the external face of the walls to provide protection against ingress of rain water. Ideally a cement:sand (1:6) plaster should be used.

Mud mortar can be easily dissolved by water and should be avoided. Where it is not possible to use a cement:sand plaster, the waterproofing of mud plaster can be improved by the addition of bitumen and kerosene to a mud / sand / straw mixture. A 5:1 ratio mix of hot bitumen and kerosene should be combined with 20 parts of a

Use water proof plaster on external faces

Minimum wall thickness

Housing Type	Wall Width (inches)
Brick with mud mortar	9
Adobe	13.5
Mud house	18

Source: UN-Habitat[98]

Effects of poor bonding at corners - Jatoi Punjab

Source: UN-Habitat[99]

fermented mud / sand / straw mix. Water should then be added to this mix and the plaster applied in two layers, with the second layer only being applied once the first layer is dry.[97]

Wall Thickness

The minimum wall thicknesses for the different housing types are shown in the table opposite.

Further general details of wall design for these housing types (non climate-change specific) is provided by UN-Habitat[98].

Wall Height

No specific guidance

Brick Work at Corners

It is essential that there is **adequate bonding of any brickwork at corners** of the building, both within the foundations and the walls. Wall construction should begin at the corners of a building to ensure adequate bonding.

Erosion and damage at the corners of buildings was found to be a cause of collapse of many buildings during the 2010 floods[99].

Guidance on achieving this is provided by the Earthquake Reconstruction and Rehabilitation Authority[100].

Seismic Bands

Not required.

10.10.2 Earthquake

Materials

As for flooding.

Plaster

Plaster is optional.

Wall Thickness

As for flooding.

Wall Height

The height of walls in seismic Zones 2A and above should be limited in order to achieve the room heights detailed in the table opposite.

Maximum Room Height

Housing Type	Room Height (ft)
Brick with mud mortar	10
Adobe	8
Mud house	8

Source: UN-Habitat[98]

Brick Work at Corners

As for flooding. Effective performance during an earthquake is dependant upon each element of the building acting together.

Seismic Bands

Following specifications for shelters prepared by UN-Habitat[101], reinforced concrete or timber seismic roof & lintel bands should be provided in seismic zones 2B and above. A seismic roof band should be provided just below the roof level. This band can also serve as a support for the roof truss.

A seismic lintel band should also be provided in brick houses with room heights greater than 8ft. The lintel band should be provided at the top level of the windows and doors. However, where windows are at different levels to aid cross-ventilation, this may not be possible (see section below) and lintels over openings should be provided instead.

10.10.3 Temperature Extremes

Materials

Thermal mass design may be adopted in areas prone to temperature extremes. Thermal mass is the ability of the construction material to store heat, and represents a technique where materials are chosen which absorb the external heat during the day (to prevent an excessive internal heat rise) and where cooler night time temperatures and night time ventilation allow the materials and interior to cool during the night.

A significant difference between day and night temperatures is required for its success in areas of high temperature.

Thermal mass design is appropriate where there is a variation in day and night temperatures

Materials with a high density, high specific heat capacity and moderate conductivity should be chosen. These materials have an ability to absorb more heat without emitting this to the interior of the building. Low density materials would help structural cooling if cooler night time temperatures are not present, but would also allow for quicker heating up of the structure as temperatures rise in the day.

The density and conductivity of a range of materials suitable for residential buildings is given in the following table. As shown in the table below, steel and wood have low thermal mass performance and should therefore not be used as the primary building material for walls in areas of temperature extremes.

Thermal Properties of building materials

Material	Average Density (kg/m^3)	Average Specific Heat Capacity (Wh/kgK)	Average Conductivity (W/mK)	Effective Thermal Mass
Adobe bricks	1,350	0.29	0.55	Medium-High
Fired bricks	1,600	0.28	0.69	Medium-High
Clay	1,800	0.23	0.68	Medium-High
Concrete	2,300	0.27	1.6	High
Steel	7,800	0.13	55	Low
Stone	2,400	0.23	2.4	High
Wood	700	0.71	0.15	Low

Source: Rosenlund[102]

The technique is dependant upon the ability to close any openings in the room (i.e. doors and glazed windows) during the day and then to ventilate the interior during the cooler night time period by opening windows, allowing the room and materials to cool.

The thermal mass approach can also be used in colder climates, or areas which experience both warm summers and cold winters. The process is similar for the winter as it is for the summer, except during the night, ventilation is not allowed, instead any heat absorbed by the walls during the day from solar gain is emitted to the interior of the building, raising the temperature.

Plaster

A reflective finishing such as lime wash should be applied over the plaster to reduce internal temperatures.

Wall Thickness

No specific guidance.

Wall Height

The room height also has implications on the interior temperature. A certain room height is required to achieve a stratification of air to create a cooler, lower occupation zone. Ideally, a room height of 10ft should be adopted, as this shall also promote ventilation. However, for adobe and mud built houses built in seismic zones where this is not possible, insulation at the roof (see Roofing section of this Section) should be adopted as the reduction in room height where insulation is provided will have little, if any, significant effect on radiation of heat from the roof[102].

Brick Work at Corners

No specific guidance.

Seismic Bands

Not required.

References and Further Reading

[97] Practical Action (1999) 'Technical Brief. Mud Plasters and Renders', Practical Action, Rugby

[98] UN-HABITAT (2011) 'Guidelines for flood resistant house' Available online: http://www.unhabitat.org.pk/Publication.html

[99] UN-HABITAT (2010) 'Monsoon Flood 2010 Pakistan, Rapid Technical Assessment of Damage and Needs for Reconstruction in Housing Sector', Islamabad

[100] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:sand Mortar in Earthquake Affected Areas' ERRA.

[101] UN-Habitat 'Housing Early Recovery Working Group'. Available online at: http://115.186.134.22:43038/default.aspx

[102] Rosenlund, H. (2000) 'Climatic Design of Buildings using Passive Techniques' Lund University, Lund

10.11 Windows and Doors

ALL DEVELOPMENTS:

- ✓ **Width of opening must not exceed 4ft**
- ✓ **Clearance between openings must be greater than 50% of the narrower opening and no less than 2ft**
- ✓ **Clearance between openings and corners of building must be greater than 25% of the opening and no less than 2ft**
- ✓ **Sum of opening widths must not exceed 30% of the wall span**
- ✓ **Maintain symmetrical opening arrangement**
- ✓ **External doors and windows must open outwards**
- ✓ **Provide timber or reinforced concrete lintel beams above openings and veranda in brick built buildings**

Do not place openings at the corners of buildings

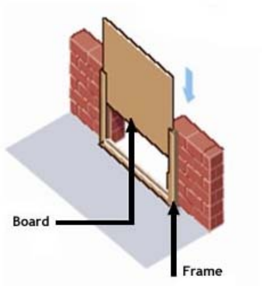
SEISMIC ZONES 2B & ABOVE:

- ✓ **Provide timber or reinforced concrete lintel beams above openings**

AREAS OF EXTREME TEMPERATURE:

- ✓ **Provide windows on north and south facing walls only**
- ✓ **Provide low level windows in the front wall (north or south facing) with a sill level 2ft above the base of the wall**
- ✓ **Provide high level windows in the rear wall (north or south facing) with a top level 2ft below the top of the wall**
- ✓ **Provide windows of the following height:**
  - **3ft in 10ft high walls**
  - **2ft in 8ft high walls**
- ✓ **Provided glazed windows on hinged frames with shutters**

Flood Board



10.11.1 Flooding

Windows and doors provide an essential means of access and ventilation. Where the base slab of a building has not be sufficiently raised, these openings can also provide access to flood waters.

To prevent ingress of low level flood waters, temporary, free-standing and removable products such as flood boards (see opposite) and flood skirts can be installed. Stable doors can also be provided which allow the bottom half of the door to be closed while access/evacuation is still possible through the upper half.

It is important to remember that **during severe flooding it is preferable to allow the ingress of water into buildings** to equalise the water levels inside and out preventing the build-up of pressure that may cause collapse of the walls.

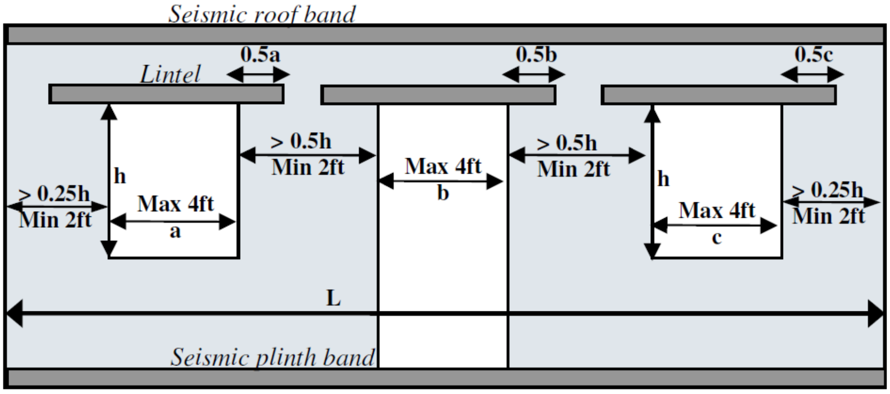
All external doors and windows should open to the outside of the building and not open into the building.

10.11.2 Earthquake

The inclusion of windows and doors in a building can act to weaken the structure during an earthquake. The following rules should be followed to prevent excessive structural weakening[103 & 104]:

- *Opening width must not exceed 4ft*
- *Maintain a clearance between openings of at least 50% of the narrower opening and not less than 2ft*
- *Maintain a clearance between openings and corners of a building of at least 25% of the opening and not less than 2ft*
- *The sum of opening widths in a wall must not exceed 30% of the wall span*
- *Opening arrangement should be symmetrical*

Geometry of Openings in Earthquake Prone Locations



a + b + c < 0.3L

Source: Mott MacDonald

Where room heights are greater than 8ft, lintels (reinforced concrete or a timber beam) should be provided over each of the openings to transfer the weight of the wall above to the wall below on either side of the opening. The lintel should be 6" deep, of the same width as the wall to reduce stress and extend each side beyond the opening by 50% of the opening width.

10.11.3 Temperature Extremes

Openings in the buildings provide many measures for dealing with temperature extremes through ventilation of the building.

Cross-Ventilation

Ventilation through buildings shall be driven by wind as well as natural thermal pressure differentials, providing ventilation even when the wind speed is zero. In windy conditions, the effect of thermal pressure differentials will be insignificant, so the direction of cross-ventilation should be aligned at 45 to 90 degrees to the prevailing wind direction[105] (windows on north and south facing walls shall achieve this). Ventilation is important to provide relief from high temperatures. Ventilation will also prevent the build up of warm air in pockets above windows and doors which can be transferred by convection to the occupation zone.

Thermal Stack Effect[106]

Providing a high level opening opposite a low level opening can induce cross-ventilation

As discussed above, natural thermal differentials can be utilised to induce an air flow when the wind speed is zero. This can be used to provide night time ventilation and cooling.

In still areas or where buildings are within the wind shadow of other buildings, a low level and high level window should be provided in each room.

As hot air rises, the higher level window shall act as an exhaust of the hot air from the room, to be replaced by cooler, heavier night time air from the outside entering through the low level window. This will induce an air flow from the low to the high window, and to facilitate this air flow, the direction from the low to high window should be close to the prevailing wind direction where possible.

The rate of ventilation is proportional to the size of windows and difference in level between the windows (as well as the difference between indoor and outdoor temperatures and can be calculated as follows (in metric units) [106]:

$$Q = 0.121\ AH\ (T_i - T_o)$$

Where:

Q = Air flow (m^3/s)

A = Area of each window (m^2)

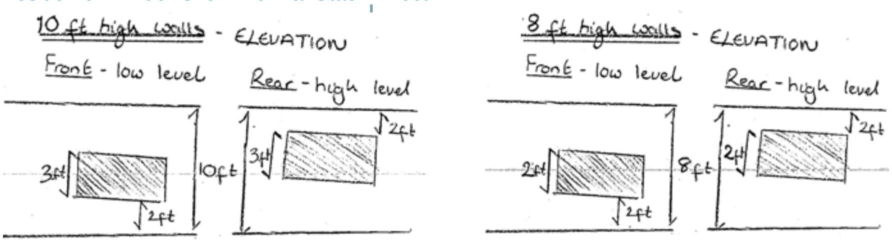
H = Vertical distance between the centre of each opening (m)

T_i = Inside temperature

T_o = Outside temperature

Using the equation above, it can be seen that the thermal stack effect is most efficient where **windows of 3ft height are installed within 10ft high walls, or 2ft high in 8ft high walls** as shown below. A clearance of 2ft should be maintained between the windows and the top and bottom of the walls to ensure strength of the wall during an earthquake (see section 10.11.2).

Position of Windows for Thermal Stack Effect



Source: Mott MacDonald

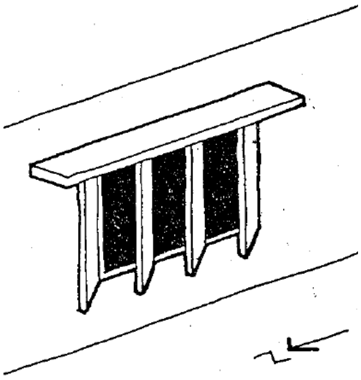
The effect of the ventilation shall be increased if the windows are placed on opposite walls. Where possible, low level windows should be installed in the front facing wall, shaded by a veranda, and high level windows in the rear facing wall (as shown above), shaded by roof. This shall minimise the overhang required to the eaves at the rear of the building eaves (see section 10.12.3) in order to shade these windows. Given the eat-west alignment of the buildings (section 7.9), no windows should be placed in the side walls (east or west facing).

Window Orientation

Limit the number of south facing windows

North facing windows are preferable for hot climates. As the sun tracks from south-east to south-west, this will minimise the penetration of the sun. South facing windows are beneficial for colder climates as they increase the possibility of solar access during colder winter seasons when the path of the sun is slightly lower. Windows should not be installed in east or west facing walls in areas high temperature.

Angled Vertical Vane Shutters



Source: UN-Habitat[106]

Glazed Windows

By providing hinged and glazed window frames, occupants shall be able to close the windows during the day to exclude the heat and open these during the night to allow the intake of cooler air. This is vital if passive cooling measures such as thermal mass are adopted. It also provides flexibility between the seasons and security.

Shutters

Shutters can be provided, to be closed during the day to prevent solar gain. Alternatively, to allow natural light to enter the building, vertical vane shutters can be provided - for windows on east or west facing elevations these vanes should be angled to the north (as shown opposite) to prevent sunlight shining directly between the shutters.

Further information on climatic design using passive techniques is provided by Rosenlund[102105] and UN-Habitat[106].

References and Further Reading

[103] Emergency Architects, NESPAK, UN-Habitat (2006) 'Guidelines for Earthquake Resistant Construction of Non-Engineered Rural and Suburban Masonry Houses in Cement:sand Mortar in Earthquake Affected Areas' Earthquake Reconstruction and Rehabilitation Authority.

[104] Government of Tamilnadu and UNDP India (2007) 'Disaster Resistant Construction Practices. A reference Manual'

[105] Rosenlund, H. (2000) 'Climatic Design of Buildings using Passive Techniques' Lund University, Lund

[106] UN-HABITAT (2009) 'National Design Handbook Prototype on Passive Soar Heating and Natural Cooling of Buildings' UN-Habitat, Nairobi

10.12 Roofing

ALL DEVELOPMENTS

- ✓ **Prefer provision of a pitched roof at 30º on all houses**
- ✓ **Only allow flat roof where pre-cast RCC roof slab is provided and roof is waterproofed with bitumen and polythene**
- ✓ **Provide guttering along perimeter of roof or a concrete lined drainage channel at ground level at the perimeter of the building to divert rainwater to the main drainage system**
- ✓ **Incorporate rainwater harvesting into any guttering system (see section 8.3.3)**
- ✓ **Use impermeable materials for roof construction or provide a water proof lining below mud or bamboo on roofs**

SEISMIC ZONES 2B & ABOVE

- ✓ **Use lightweight building materials for roof construction (such as bamboo)**

AREAS OF TEMNPERATURE EXTREME

- ✓ **Extend pitched roof eaves at rear of building by:**
  - **2.2 horizontal feet in 10ft high walls**
  - **1.75 horizontal feet in 8ft high walls**
- ✓ **Provide a veranda at the front of the building extending no less than:**
  - **3.5 ft in 10ft high walls**
  - **2.6 ft in 8ft high walls**
- ✓ **Apply a lime wash finish to the roof top and reapply annualy**

Unlike the foundations, failure of the roof is unlikely to result in destruction of an entire building but can lead to loss of life as heavy elements fall from height,. Poor drainage from the roof can result in the gradual deterioration of walls and foundations.

10.12.1 Flood Protection

There are three main aspects to consider during roof design. These are related to rainfall rather than surface flooding and are therefore applicable for construction in all areas:

Do not use mud for roof construction

Pitched or Flat Roof?

The UN-Habitat rapid assessment[107] following the 2010 floods noted that flat roofs became water logged (especially where mud roofs were used) which added additional mass to the roof leading to collapse of the roof (see opposite) and the walls.

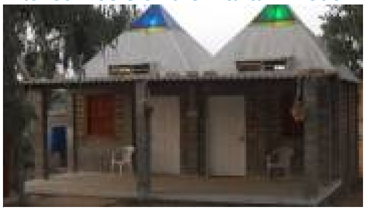
Ponding of rainwater on a flat roof leading to collapse - Balochistan

Source: UN-Habitat[107]

By adding a pitch (angle) to the roofs and using less absorbent materials water can be drained away from the roofs. This reduces leakage through the roof as water is speedily conveyed away from the roof and prevents collapse. A pitch of between 30º to 40º should be adopted to resist uplift.

Although not the typical roofing technique in parts of rural Pakistan, pitched roofs have been successfully introduced by UNDP in Sindh (as shown opposite), under the low-cost, energy-efficient and disaster resistant housing scheme known as the 'Benazir Model'[108].

Pitched Roofs on the 'Banazir Model'



Source: UNDP[108]

Use pitched roofs in place of flat roofs

While it is preferable to adopt a pitched roof, a flat roof may be tolerated if reinforced concrete roof slabs are provided to support the extra mass of the roof should it become waterlogged. However it is likely that this shall be outside the financial means of many and therefore pitched roofs should be preferred.

If a flat roof is used, additional waterproofing shall be required to prevent failure during heavy rainfall. To achieve this, either impermeable roof materials should be used, or traditional methods employed to provide water proofing through layering of impermeable materials as follows:

- *2 coats of bitumen*
- *Layer of polythene sheet*
- *4" thick earth laid in Slope*
- *Mud & husk plaster*
- *1 ½" brick tiles grouted with cement sand slurry*

A gentle fall to the flat roof should also be adopted to prevent pooling of water on the roof top.

Drainage

A pitched roof will ensure that rainwater does not accumulate on a roof. Care must be taken to convey this rainwater to the drainage system in a manner which does not compromise the structural integrity of the building. Rain water must not be allowed to drain onto the walls or foundations of the buildings as this can cause significant damage (as shown opposite).

Rainwater erosion to the base of a mud wall - Balochistan

Roofs must convey rainwater to the main drainage system without coming into contact with the walls or foundation

Example drainage off roof eaves, down-pipe missing, Thar Desert, Sindh

Source: Mott MacDonald, 2012

The easiest way to achieve effective drainage is to provide guttering around the perimeter of the roof to convey the water to down pipes (vertical drainage pipes) which lead directly to the main drainage system described in the Layout Section.

The roof gutter must be sloped in the direction of the down pipe to ensure water is efficiently drained. This method may also be combined with rainwater harvesting techniques (see section 8.3.3) to reduce dependency on pumped supply or ground water.

The expense of factory-made gutters may be avoided through the use of corrugated iron or steel sheet. Steel sheets can be easily bent into a V-shape suitable for guttering through use of a clamp, as described by Practical Action[109]. Alternatively, plastic pipes can be cut in half length ways. The use of timber guttering should be avoided as it will degrade quickly. These methods can also be linked to rainwater harvesting discussed in section 8.3.3)

The second method is to provide concrete lined drainage channels around the perimeter of a building and allow water to fall directly from the roof into this channel which will convey the water to the main drainage system of the village. If this method is chosen it is vital that the roof is built with sufficient over hang beyond the walls and foundation of the building so the falling water does not saturate the wall or erode the ground around the foundation. The overhang shall also provide shade around the building and reduce solar gain through the windows and doors.

When designing the buildings, the roof must be seen as a single entity for an entire block of houses - separate pitched roofs should not be constructed for each house in a block.

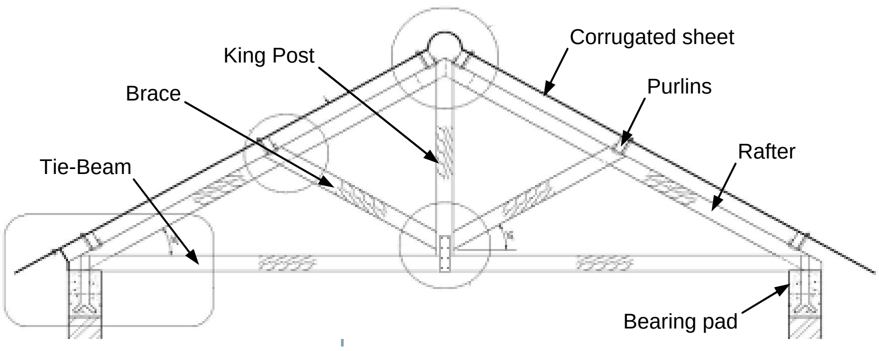
10.12.2 Earthquake

Use lightweight roofing materials

The ground acceleration that occurs during an earthquake will ultimately result in forces exerted upon the roof structure. As force is a multiple of mass and acceleration, the heavier the roof, the higher the seismic force that will be experienced. Therefore, in earthquake prone areas, it is important to use lightweight roofing materials (such as bamboo) avoiding heavier materials (such as steel). Not only will this result in less likelihood of collapse of the roof and walls, but shall also mean that in the event of a collapse, heavy elements shall not be falling from height which would pose a serious safety risk.

The roof truss supports the weight of the roof. A truss has four main elements: two rafters, a king post, two braces and a tie as shown below.

The main elements of a roof truss



Source: Earthquake Reconstruction and Rehabilitation Authority[110]

The tie-beam holds the two rafters together. The king post supports the top of the rafters. The braces provide additional stability. The rafters transfer the load of the roof to the walls. Bearing pads of concrete or wood should be provided between the rafter and wall to spread the load evenly. Purlins may be provided to support the roof covering.

Further details of earthquake resistant roof construction are provided by Schacher[111] and the Earthquake Reconstruction and Rehabilitation Authority[110]

10.12.3 Temperature Extremes

The design of the roof presents an opportunity to include measures to reduce the impact of temperature extremes.

Roof Eaves

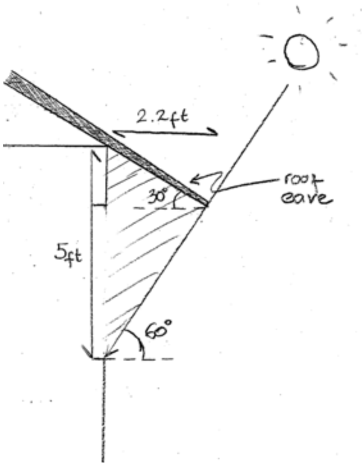
In areas susceptible to high temperatures, the eaves of the roof should be extended to provide shade over the windows in the rear of the building. This prevents direct exposure of the window and interior to solar gain during the day.

Provide roof eaves and verandas to reduce solar gain

The suns radiation is greatest between 10am and 2pm (approximately 50% of the suns daily radiation on a horizontal surface occurs between these hours)[112]. From the sun path diagrams provided in the Appendix, the sun's altitude varies from 60º to 90º during these hours in the summer season.

Following the guidance for window height and position within section 10.11.3, 5ft

Provision of Eaves over rear wall



Source: Mott MacDonald

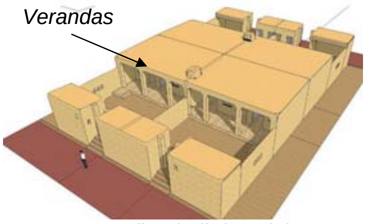
below the roof level must be shaded for windows in 10ft high walls, and 4ft below the roof level must be shaded for windows in 8ft high walls while the sun is at an altitude of between 60º to 90º. This can be achieved by extending roof eaves over the rear wall at a 30º roof pitch, extending 2.2 horizontal feet from the building (for 10ft high walls as shown opposite) or 1.75 horizontal feet from the building (for 8ft high walls).

Windows at the front of the building should be shaded by a veranda (see below), and assuming an east-west alignment of the house (see Layout section 7.9), there shall be no windows in the east or west facing side walls in areas of high temperature (see section 10.11.3).

Verandas

A veranda or lean-to roof should be incorporated into the design of the roof at the front of the building. This will again prevent solar gain through the windows and doors, but also provide a cool shaded buffer between outside and the inside of the building. Not only does this reduce the heat to the entrance of the building, but also provides a cool outside area for families to occupy during the day.

Provision of verandas in Model Villages



Source: www.floodrelief.punjab.gov.pk

Verandas should be provided at the front of the house and must provide shade to the low level windows described in section 10.11.3 - affording shade from the roof level to the cill level of the windows at the front of the house (2ft above plinth level) from 10am to 2pm during the summer.

From reference to the sun path diagrams provided in the Appendix, this can be achieved be providing a veranda extending at least 3.5 horizontal feet from front of the building for a 10ft wall height, or 2.6 feet for an 8ft wall height.

Insulation

The roof of a building is the element which receives the most solar energy. To reduce internal heat rise during high temperatures and reduce heat loss during low temperatures, insulating materials should be considered for the roof.

The following readily available materials offer good insulation:

Hollow clay roof tile

- *Brick tiles with stabilised mud*
- *Hollow Tiles (Fired clay extruded hollow tiles -pictured opposite)*
- *Mud with high density Styrofoam*
- *Expanded polystyrene*
- *Smart concrete tiles (polystyrene sandwiched between concrete layers)*

Specialist ready made insulating roof tiles and material are also available such as:

- *Air Conditioning tiles (terrazzo mixed with white epoxy and styrofoam)*

Other traditional practices of roof insulation such as laying inverted earthen ware on roof tops and covering with earth or brick tiles may also be adopted.

Use insulating roof materials with a reflective finishing to reduce temperatures in internal spaces during the summer and reduce heat loss in the winter

Reflection

Absorption of heat through the roof can also be reduced by applying and regularly cleaning reflective finishes such as:

- *Lime wash*
- *White enamel paint*
- *Weather shield white paint*
- *OCEVA-MOL chemical*
- *Aerosol heat reflective paint*

These finishes will require full reapplication at least once every ten years.

False Ceiling

Where there is adequate height in a room, a false ceiling can be constructed at the level of the wall top. This ceiling acts as a buffer between the inside and outside temperatures. During the summer the false ceiling shall prevent heat from radiating from the roof directly into the building, and in the winter it shall reduce the loss of heat through the roof.

The following materials can be used for a false ceiling:

- *Gypsum board*
- *Aluminium backed gypsum board* *(aluminium on the upper face)*
- *Paper board*
- *Styrofoam*

From the thermal data collected by the National Energy Conservation Centre[113] on the cost, constructability and performance of the insulation, reflection and false ceiling techniques detailed above (see section 9.13.3 for details of these results) it can be concluded that the installation of a paper board false ceiling or expanded polystyrene are the most effective measures to reduce the interior temperature where the funds and skill levels are available. However neither are low cost solutions and both require a moderate skill level. **Lime wash finishing of a roof is an effective and low cost measure to reduce temperature when reapplied to the roof surface annually.** However, lime wash does not offer benefits in preventing heat loss during the winter. It is also possible to combine the three methods to provide better cooling effects.

Note: lime wash can quickly become ineffective in mainly dry areas due to accumulation of dust and dirt. In such areas, laying of reed panels over roofs have been found to be a viable alternative[114], although these must be replaced once every two years to maintain effectiveness.

References and Further Reading

Further information on roof design is provided by the Building Research Establishment:

Ahmad, A. M (1974) 'On Ceiling Heights and Human Comfort' Overseas Building Note No 155, Building Research Establishment, Her Majesty's Stationery Office, London

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10.13 Alternate Building Solutions

Case Study
Low cost Houses: Bangladesh
Source: World Bank

Solid frames supplemented by traditional building techniques. Their pilot project constructed houses on raised platforms made from a mixture of sand, clay and concrete foundations with frames constructed from concrete pillars and treated bamboo poles strengthened with metal tie rods. Reinforced concrete footings are used for the bamboo posts and more resilient foundations increase resilience to flood waters whilst keeping costs low. Woven bamboo walls are fixed to the frame using bracings and fastening through a network of holes and notches. These walls can be removed when a severe flood is forecast.

Solid Frame House with Bamboo Walls

Source: Practical Action

This section presents alternative housing solutions that may be suitable in flood zone 1 (solid frame structures) or seismic zones 2B and above (Dhajji houses). They are not commonly found in Punjab but offer alternate building solutions where the options above may not be available.

Solid Frame Structures

Where villages are to be reconstructed in areas which are at particular risk of flooding or earthquake damage, planners may consider the use of a solid frame structure. The philosophy of this structure is that a robust frame is constructed by professional craftsmen that will withstand the effects of these events. The walls and roofs may then be constructed using traditional techniques (such as mud cladding), but it shall be accepted that **during an event, there may be considerable damage to the cladding or roofing - however, the frame shall still be intact**.

A steel or high quality timber frame should be provided on a high quality foundation. If this method is adopted, it is important that the inhabitants are aware of the inherent risks. Before the onset of extreme flooding, it should be possible for the villagers to dismantle a structure to store the frame elements on elevated ground to allow rebuilding once flood waters recede.

In order to increase the resilience of the cladding against flood damage, a wire or polypropylene mesh should be incorporated between the frame and the cladding applied to this mesh.

Dhajji Houses

Dhajji houses are known for their exceptional performance during an earthquake. Their use should be considered at sites where earthquakes are of particular concern.

Dhajji houses are constructed using a subdivided timber frame infilled with masonry, as shown over the page.

The guidelines in this section are adapted from UN-Habitat guidelines on Dahji construction[115]:

Foundation

The foundation should be prepared as already described. In order to connect the timber frame to the foundation, a dasa (plinth beam) of 4" by 4" should run along the perimeter of the foundation, and be anchored into the foundation using bolts. The dasa should be protected by painting with old engine oil.

Frame

The frame is a critical component of this structure. If a strong frame is constructed on an adequate foundation, this can withstand damage during an earthquake or flood. Following an extreme event, superficial damage to the infill can be easily repaired while the house remains standing.

The frame should be constructed with the main posts at 6ft intervals. Secondary posts

Case Study
Dhajji Houses: Kashmir
Source: World Bank[32]

Following the 2005 7.6 magnitude earthquake in Kashmir, it was noted that traditional Dhajji houses sustained less damage/collapse than modern constructions. The houses sustained many cracks to the masonry, but remained intact, saving lives. The houses make use of local materials (wood, stones, mud), are economic with a low environmental impact. During reconstruction, their construction was promoted and rapidly adopted by the community providing a high level of satisfaction.

An Un-plastered Dhajji house

Source: Schacher[115]

(studs) should be erected between the main posts at 2ft intervals. A wall plate should be provided around the perimeter of the top of the frame - this shall be the support for the roof. An experienced carpenter is required to construct the frame structure using tenon and mortise joints (steel straps with adequate anchorage for added stability) to connect the posts to the dasa and wall plate, and tenon joints at the corners. Guidance for the roof is provided from page 206. It is vital that roof trusses are located above main posts.

Boards

Horizontal boards should be provided at 2ft intervals to create square openings between the posts and the boards. 2" thick diagonal bracing boards should be fitted in these openings connected to the posts and horizontal boards to subdivide the frame. There are many different local methods of subdividing the frame, and those most familiar to the community should be adopted.

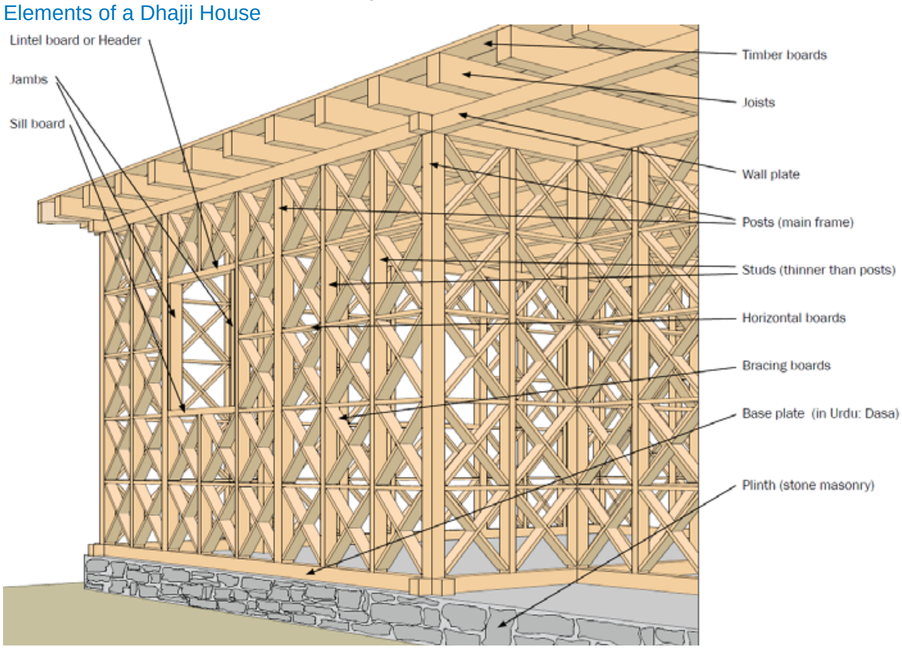
Masonry Infill and Plaster

The voids in the frame should be filled with small stones and mortar, finished with a plaster inside and out.

For earthquake resistant Dhajji houses, mud mortar, with the addition of pine needles and straw to increase elasticity, is preferred. As this mortar will be less resistance to flooding, maintenance of the infill shall be required following a flood, or else cement mortar adopted.

The elements of a Dhajji house are shown on the following page.

Elements of a Dhajji House



Source: Schacher[115]

References and Further Reading

115 Schacher, T. and Ali, Q (2009) 'Dhajji Construction for one and two storey earthquake resistant houses' UN-Habitat, Islamabad.

11. Emergency Response

Rural village planning in higher risk areas should include provision for emergency response activities during or following an extreme event such as flooding or earthquakes. The following guidelines are applicable for development within areas at risk of flooding or earthquakes.

11.1 End to End Early Warning System

FOR ALL DEVELOPMENTS

✓ **An early warning system must be defined for every community**

✓ **The early warning system should tie in with national and local policy and be defined in consultation with relevant bodies (see section 11.1.1) in order to ensure the system operates 'end to end'**

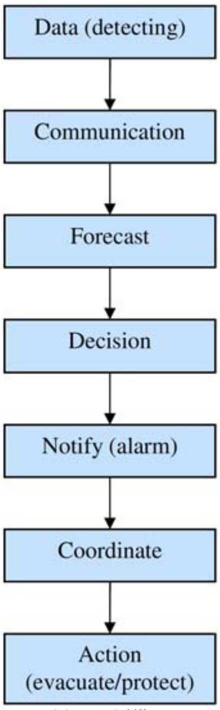
✓ **The early warning system must define the following:**

- **Procedure and responsibility for monitoring for a national or local warning**
- **Procedure and responsibilitiy for disseminating the alert throughout the entire community**

✓ **The emergency response plan must define the following:**

- **Building(s) nominated as emergency refuge(s)**
- **Areas nominated as refuge for livestock and storage of goods**
- **Identification of evacuation routes from houses to refuges**
- **Identification of airborne evacuation points**
- **Procedure for assisting vulnerable community members**
- **Provision of food, water, first aid, protection and rescue equipment at the refuge(s)**
- **Provision for review of the plan**
- **Provision for regular testing and drills**

End to End Early Warning System



Source: World Bank[116]

An early warning system can provide valuable time required for evacuation and save lives. An end to end early warning system ensures that adequate data is collected to forecast an extreme event. Policy must be in place to translate this data into actions required, to raise an alarm when required, communicate the alarm to those effected and coordinate the evacuation or protection required. This process is depicted in the figure opposite[116].

11.1.1 Current Policy in Pakistan

The first step is for policy makers (National Disaster Management Authority, Provincial Disaster Management Authority and District Disaster Management Authority) to ensure strengthened national and local policies and procedures in consultation with those involved in forecasting natural disasters and those responsible for coordinating the emergency response.

Forecasting Natural Disasters

The following bodies are active in the forecast of natural disasters in Pakistan: Department[117]

- *Pakistan Meteorological Department (PMD) - consider hazards on a national level*
- *World Meteorological Department - consider hazards on an international level*
- *Water and Power Development Authority - collection of hydrological data for flood forecasting*
- *Irrigation Department - collection of hydrological data for flood forecasting*

- *Provincial Irrigation Departments - collection of hydrological data for flood forecasting*
- *Punjab Relief Department - monitor hazards and relief in Punjab*
- *Ministry of Water and Power, Federal Flood Commission - Covering only areas flooded by the Indus River*

All of the above should be consulted when preparing an early warning and emergency response plan.

Case Study
Early warning alarms, Bangladesh
Source: Trust.org

The government of Bangladesh has signed an agreement with two mobile phone operators to inform subscribers of disaster early warnings through text alerts

Much of Bangladesh relies on 42,000 volunteers from the Red Crescent Society who travel on bicycles with megaphones informing people of impending danger and advising evacuation

Raising the Alarm

The Pakistan Meteorological Department rely on media to disseminate the warning of a natural disaster such as a flood, with many communities keeping track through the extensive media coverage which often accompanies such an event. Warnings are also passed down to vulnerable communities through the district and Tehsil channels, and some have developed their own early warning systems.

Communities in remote areas or those without ready access to media are targeted by army and police helicopters.

Emergency Response

At present the following bodies are involved in the coordination of an emergency response:[118 & 119]

- *National Disaster Management Authority*
- *Provincial Disaster Management Authorities*
- *Civil Defence Department*
- *Home (Police) Department*

- *Punjab Emergency Services*
- *Information, Culture and Youth Affairs Department (responsible for dissemination of warning messages)*
- *Pakistan Red Crescent Society*
- *Agricultural Department*
- *Livestock and Dairy Development Department*
- *Irrigation Department*
- *Environment Protection Department*
- *Health Department*
- *Food Department*
- *Pakistan Railways*
- *Housing, Urban Development and Public Health Engineering Department*
- *Planning and Development Department*
- *Finance Department*
- *Communication and Works Department*
- *Information Technology Department*
- *Industries Department*
- *Forest Wildlife and Fisheries Department*
- *Education Department*
- *Special Education Department*
- *Water and Power Development Authority*
- *Water and Sanitation Authority*
- *NGOs*

See the Disaster Risk Management Plan[119] for full details of the responsibilities of each body and section 13 for current contact details.

All of the above should be consulted when preparing an early warning and emergency response plan.

11.1.2 Rural Early Warning Systems

A village based early warning system must tie in with national and local procedure (including local government, Tehsil and Union Council level procedures) and must clearly define roles and responsibilities within the community. The system should focus on the following three areas:

Case Study
Early warning systems save lives, Bangladesh
Source: World Bank[32]

An early warning system installed in Bangladesh following a cyclone in 1970 which caused 300,000 deaths proved effective in 1997 when only 200 people died following a cyclone of similar magnitude.

Receiving a warning

Tying in with national and local procedure (and in consultation with the bodies listed in section 11.1.1), during high risk periods there should be periodic reviews of nationally/locally issued warning. Warnings may be issued by government officials or bodies such as the Pakistan Meteorological Department, through media (television or radio) or by NGOs.

Communities should also partake in hazard monitoring through the monitoring and measurement of river levels.

Raising the alarm

The system should define those people responsible for disseminating the warning to the village. A nominated public building should be fitted with a loudspeaker

Case Study
Early warning system in Nepal

Nepal has a high occurrence of natural disasters and is especially prone to low land flash flooding. Traditional early warning systems of high lookout towers and sirens have been upgraded. Now the system relies on upstream communities monitoring river levels and alerting downstream communities, police and emergency services once the river level reaches a certain height. Electric sirens have also been provided which are run on batteries due to the unreliable electric supply anticipated during a flood.

(preferably a mosque) to aid this. Sirens, drums, loud hailers, door to door messaging and phones can also be used to raise the alarm which should reach all, including those remote from a village.

Emergency Response Plan

A public building(s) of adequate capacity should be nominated as an emergency refuge and evacuation points identified. The refuge shall be afforded additional protection in design (see Chapter 9) against likely hazards and ideally be situated in a low risk area. Refuge points for livestock should also be identified. Evacuation routes through and to the village should be considered in the layout of the village and clearly defined in the emergency response plan.

Members of the community should be allocated responsibility for ensuring vulnerable groups (the elderly, ill, young and disabled) are attended to in the event of an extreme event. The plan should also define and provide for required basic medical and first aid equipment, protection and rescue equipment (shovels, ropes, life-jackets) allocating responsibility to those who are trained in their use. Any additional training needs should be identified and acquired. The provision of emergency supplies of food and water should also be available and accessible whenever an extreme event may occur.

Where necessary, the evacuation plan must incorporate the movement of livestock, household goods and building materials is refuges.

The success of early warning systems shall be improved by taking the following steps:

- *Effective communication of the system to the villagers (prior to an emergency), including identification of refuge(s)*
- *Regular review*
- *Regular testing and drills*

Regular testing and clearly defined roles and responsibilities will ensure that at the onset of an event people will not panic, act in unsafe ways or not assist others in need.

Electrocution During a Flood

During the 2010 floods in Pakistan, a significant number of deaths from electrocution were reported. All utility poles supporting overhead transmission lines in flood zones 1 and 2 must display warning signs at eye level which inform community members of the potential risk of electrocution from fallen electricity poles during a flood. The sign should inform the reader to maintain a clearance of at least 50ft (as per international guidance[120]) from a fallen pole during a flood.

Awareness of the risk of electrocution, both from overhead transmission lines and domestic electric circuits should be raised as part of the emergency response plan.

Gender[121]

An early warning system must ensure there is provision for communicating at early warning to women in the community. Men often receive emergency warnings through face-to-face interactions, whereas women do not have such an interface with others outside of their home. Following the 2010 floods, it was found that loudspeakers in mosques, FM radio announcements and military rounds were effective means of informing women of an early warning.

Training of women as to actions they must take in the event of receiving a warning is also required. Where advance warning was provided prior to the 2010 floods, many families failed to evacuate, with reports linking their reluctance to evacuate with disbelief of the warning, concerns of theft or losing claim to land (as many have no land entitlement papers), reluctance to move to camps or hesitation about taking women and girls out of their protected home environment and exposing them to strangers.

Following the 2010 floods, there were reports of distress sales of assets in order to finance transportation to evacuate families, especially amongst female headed households. Truck transporters and boat ferries were found to have been charging many times over their normal rates during an emergency. It is vital that emergency plans and evacuation plans include provision for orderly and free of cost (or subsidised) transportation that ensure families are kept in tact.

References and Further Reading

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11.2 Emergency Refuge

FOR ALL DEVELOPMENT

- ✓ **Prioritise the protection of refuges through site location, protection and design quality (see Chapters 5, 6 and 9)**
- ✓ **Refuge buildings or areas must be provided (a community building such as a school or mosque can be used) allowing an area of 32ft^2 per person within centrally located positions**
- ✓ **Refuge areas for livestock and building materials must be provided (if applicable)**
- ✓ **A small covered refuge is required where the livestock refuge is separate to the main refuge building**
- ✓ **Refuges must incorporate storage areas for the permanent storage of emergency supplies of food, water, cooking fuel, clothing and first aid**
- ✓ **Refuges should be provided with generators or a renewable energy supply**
- ✓ **Refuges should be located in close proximity to water supply facilities**
- ✓ **Sanitation facilities must be provided at refuges**

FLOOD ZONES 1 & 2:

- ✓ **Access route from main external roads to the refuges should be constructed above flood level**
- ✓ **Identify airborne evacuation points which are accessible from the refuge (either a flat roof or extended elevated platform above flood level)**

SEISMIC ZONES 2B & ABOVE

- ✓ **Provide two external access routes to the refuge**

In higher risk areas villages should be provided with somewhere to go during an emergency. This could include elevated areas or a building(s) which is suitable for use as an emergency refuge.

11.2.1 Elevated areas

Identify and construct strong refugees in centrally located positions

At times of flood, villages may relocate to the elevated areas and bring with them livestock and household goods. If given enough warning before severe floods, communities could dismantle buildings and store the building materials on the platforms for reconstruction activities. Elevated areas must provide adequate storage for livestock, household and personal possessions and building materials for the duration of the flood as well as refuges for villagers.

According to the FAO[122] the plan area of the platform should allow 32 ft^2 per person. This area allows for accommodation of villagers in a lying position with storage of utensils. If platforms are required to accommodate building materials and livestock then the area of the platform should be increased according to the building type and number of livestock.

11.2.2 Buildings

These do not need to be separate buildings. A community structure of sufficient capacity such as a meeting hall, school, mosque or health centre would serve this purpose. It should be ensured through design that these buildings will be capable of withstanding a higher level of stress from floods or earthquakes and accommodate cultural needs. The choice of building

Case Study
Community Built Shelters
Source: Oxfam (2011)

Community-led consultation in the villages of Mohammad Ali Chandio and Khanmoon Mullah lead to the formation of three committees for construction, purchasing and monitoring and selecting the location of an emergency shelter. The shelter was built on a raised platform 8ft above ground level with enough space for the entire community and livestock with bathrooms and a safe water supply. The shelter proved effective as the villagers were able to take refuge during cyclone Phet in June 2010.

should also consider vulnerable groups, i.e. use of a school may mean more vulnerable groups are already located in the emergency refuge. See section 9 for further design details.

It may be necessary to **provide a livestock shed at an elevated level** in order to provide refuge for livestock during a flood. A small refuge may also be required at the same location to house those caring for the livestock during a flood.

11.2.3 Storage

Refuges must also incorporate storage areas within the buildings for emergency supplies such as food, water, clothing and medical supplies. The required area will depend on the number of residents using the refuge and the items to be stored. A community needs assessment should aid decision making for this.

11.2.4 Refuge Services

In the event of an emergency, the critical health and welfare needs should be addressed for the refuge building (i.e. health centres may need emergency electricity for refrigeration of medical supplies).

The supply of drinking water to emergency refuges should be prioritised, either through storage of drinking water for use in emergency, or proximity to main water treatment and supply facility with a renewable energy backup supply in case of grid failure.

Adequate sanitation (including provision of latrines) should be available at refuges to ensure hygiene can be maintained during an emergency and prevent the spread of diseases.

Emergency supplies of fuel for cooking should also be stored within the refuge.

11.2.5 Emergency planning

Village consultation should identify what actions villagers would take in an emergency situation (i.e. whether they will attempt to bringing livestock with them to place of refuge, what are the best ways of warning them of flooding) to identify any specific design needs.

11.2.6 Location

The emergency refuge areas should be centrally located, or if multiple buildings are built evenly dispersed around the village to ensure ready access during an emergency.

11.2.7 Access to Village

Provide multiple access routes

Ensure structures are set back from main access routes

The village layout should consider access to the village in times of an emergency for the delivery of aid or rescue.

For locations at risk of flooding, the main access routes should be constructed at as higher level as possible, taking advantage of the natural topography of the area to reduce construction costs.

Ideally, there should be two entrances to villages in seismic risk areas in case the first becomes blocked or destroyed. Main access routes should be identified during planning and structures, trees and utility poles should be set back from the routes to ensure that their collapse does not hinder access.

11.2.8 Village Services

The impact on critical infrastructure such as power, communications and water should be considered and necessary services secured. A higher level of protection should be afforded to the facilities and structures which house facilities that may increase the resilience of a community during a disaster, such as water treatment and supply, health care. This can be achieved by affording higher standards of flood or earthquake resistant design to the structures housing critical facilities, locating them in low risk areas or by providing renewable energy as a back up power supply to ensure continued operation during an emergency when grid based power supply may be lost. Further guidance is given in section 8.2.

11.2.9 Evacuation points

Provide raised evacuation areas accessible from refuges

Evacuation points should be identified for cases where vehicular access is not possible (during flooding for example). These areas should be elevated and accessible for emergency services and incorporated within the refuge. The two options are as follows:

1. *The elevated platform on which the refuge(s) is built is extended to provide an safe area for evacuees to gather*
2. *The refuge(s) is built with a flat roof designed to support the loading of the evacuees, and access to the roof is provided (such as steps on the outside of the building)*

References and Further Reading

[122] Ehsan, Muhammad (2011) 'Design of Raised Platforms in Flood Affected Areas of Badin and Mirpurkhas Districts' Food and Agriculture Organization of United Nations

12. Construction

Source: MM Pakistan (Pvt) Ltd

High quality construction is essential to ensure the effective realisation of impact reductive designs. Effective monitoring during construction by those experienced in the chosen techniques is imperative to ensure implementation of required quality assurance procedures.

The designs discussed in these Guidelines are chosen and adapted based on existing designs and construction techniques that have been demonstrated in rural Punjab, ensuring that they can be replicated within the communities.

This section briefly covers the selection of building materials and training requirements. As this document is aimed at policy makers, discussion of good construction practice is outside the scope of these Guidelines. This development of construction specifications based on these designs aimed at the communities who shall be involved in the construction activities is recommended.

12.1 Low Carbon Construction

These layout and structure design options included in these Guidelines have included techniques to reduce dependency on non-renewable energy and by reducing the energy needs of inhabitants in choosing materials and design considerations that are locally and climatically appropriate.

During construction the following issues arise in relation to climate change and sustainability:

- *Resource Base:* The construction industry places a huge demand on naturally occurring and finite resources (such as limestone) which in some areas are becoming depleted and construction should aim to avoid worsening this situation / recycling / reusing where appropriate.
- *Embodied Carbon:* The embodied carbon considers the energy used, and carbon emitted, during the extraction, production and transport of materials. Materials with low embodies carbon should be favoured.

The main construction materials are considered against these criteria below:

12.1.1 Adobe Bricks

Adobe bricks are a highly sustainable building material due to their low embodied carbon and abundant and widespread resource base.

The raw materials used in the production of adobe bricks (sand, water, manure and straw) are naturally occurring and abundant in rural areas of Punjab. The production of adobe bricks requires a low technical base, and the bricks are left to dry naturally, requiring very little energy during production.

As the raw materials required for production of adobe bricks are locally abundant, minimal transport is required in their production and production can be carried out nearby the proposed construction further reducing transport needs.

12.1.2 Mud Bricks

Mud bricks can be considered a sustainable building material.

The raw materials required for the production of mud bricks (clay, mud, sand and water mixed with a binding material such as husk or straw) are also abundant and naturally occurring. However to ensure the quality of the mud brick, pure clay is required which is often extracted from deep quarries, having a negative environmental impact on the area in which they are established (see section 12.1.5). The carbon emitted from mechanised quarrying and the transport from the quarry also contributes to the embodied carbon of mud bricks.

Other than any quarry activities that may be associated with their production, the production of mud bricks also requires a low technical base with little energy use.

12.1.3 Cement

The use of cement embodies a large quantity of carbon into concrete blocks and reinforced concrete used in construction due to the extraction of raw materials and the production process itself.

The raw materials used in the production of cement include chalk, limestone or clay used in the production of cement.

For each tonne of cement produced, 60 to 130kg of fuel oil and approximately 110kW of electricity[123] are required to power a kiln at a temperature of 1450ºC. In addition, during cement production, calcium carbonate is heated producing lime and the emission of greenhouse gasses such as carbon dioxide, nitrogen dioxide and carbon monoxide. The cement industry alone accounts for 5% of the worlds man-made carbon emissions.

Transport requirements are also high for the delivery of cement or cement based products to site as cement can only be manufactured in specialised factories. o blocks from the production site, although they can be delivered on mass. Where concrete blocks are manufactured on site, the transport requirements for the delivery of cement are also high.

Low Carbon Alternatives

Eco-Cement, is an alternative, low carbon cement which replaces calcium carbonate with magnesium carbonate. Although carbon dioxide is still released during the heating of the compound, the process requires lower kiln temperatures (600 to 700ºC), therefore reducing the embodied carbon.

The use of lime as an alternative to cement is also common, although the reduction in carbon emissions may be minimal, less nitrogen and sulphur dioxide are released during the production of lime.[124]

Reductions in the emission of carbon dioxide during the manufacture of cement can also be achieved through the production of blended cements (such as blending with pulverised-fuel ash or ground blast furnace slag), the selection factories using the most efficient processes, a fuel with lower ration of carbon content to calorific value (such as natural gas) and/or raw materials with lower organic matter content[124].

12.1.4 Reinforced Concrete

As with concrete blocks, the embodied carbon within reinforced concrete is also high due to the dependence on cement and also steel for reinforcement. As for cement, the manufacture of steel is also an energy intensive process and can only be manufactured at specialist sites, necessitating further transport.

12.1.5 Quarry Stones

Although quarry stones used in construction are natural materials, not requiring the use of energy in their production, the quarries established to win these materials have negative impacts to the environment including:

- *Noise pollution from the use of heavy equipment*
- *Visual pollution from the change in landscape*
- *Land degradation - loss of fertile top soil*
- *Biodiversity - loss of natural habitat*

Without careful management of quarries following their use, the ground can also become contaminated. This pollution can be spread to adjoining areas during the monsoon period[125].

12.2 Building Materials

Materials used should be of adequate strength, and testing of these materials on site may be required.

Materials and components which are available locally should be preferred.

Where numerous villages are to be built within one locality, building yards may be set up and stocked.

The use of building yards can ensure that there is control over the quality of the material which is used in construction and guarantee a local and adequate supply of the materials required. Such building yards should be centrally administered to allow bulk buying of materials at lower costs. These costs savings should then be passed onto the communities who are purchasing the materials for construction of climate change resilient villages.

12.3 Training

Plan for effective training and construction supervision

An important feature of any construction project is training as it facilitates ensuring a skills needed during construction are available locally and well as creating a skills legacy needed as part of ongoing maintenance and livelihood needs[126].

It is recommended that a training plan is included for post-disaster reconstruction planning.

Training programs and curriculum for vocational training courses (such as carpentry, plumbing, electrical, masonry) are provided by the National Vocational and Technical Education Commission based in Islamabad as well as non-governmental organisations. There are various routes for funding, both national and international, which will support such training schemes. These options should be explored by policy makers.

Training must be delivered to advisors, supervisors and trainers as well as builders and owners

The training programme should focus on simple training techniques based on every day experiences of the trainees and should instil a safety mindset in builders. Training topic examples are given in section 12.3.5. **On-the-job training** is valuable. Training is required not only where new building techniques are proposed, but also in best practice of well established traditional techniques.

Training is required not only for the builders and owner/operators, but also to technical advisors, supervisors and the trainers themselves.

12.3.1 Training Roles

Jha et al[126] identify four key training roles:

1. *Chief Training Officers*

A highly experienced chief training officer should be appointed for the reconstruction within a province, responsible for preparing training material. This officer should be supported by a senior mason and a senior carpenter to deliver practical demonstrations. The officer shall first train the trainers, oversee subsequent training and pilot activities.

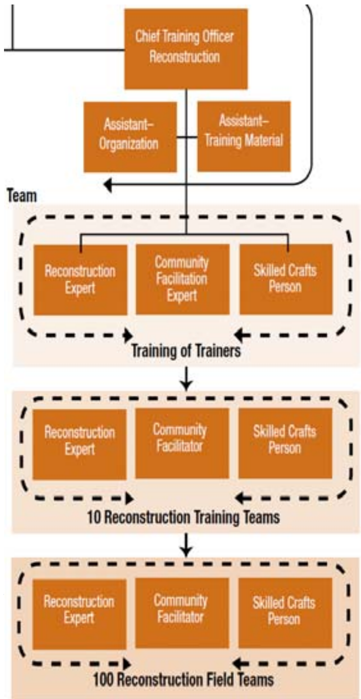
2. *Assessors*

An assessment team should be employed to carryout field supervision. Ideally, these assessors should have been involved in any damage assessments following a natural disaster.

3. *High Level Trainers*

High level trainers should be responsible for the training of field training teams. These training sessions should include technical training and training on the social aspects. On completion of this training, the high level trainers supervise and cross-check the field training teams. Their role shall be to identify any barriers to the realisation of the designs and update practices accordingly. They should achieve a transfer of knowledge through the field reconstruction teams.

Proposed structure of the training team



Source: Jha et al[126]

4. *Field Training Teams*

After receiving initial training, the field trainers are responsible for training the field reconstruction teams. They should provide supervision, advice and on-the-job training to the builders, owner/operators in the field. They shall also ensure the implementation of quality assurance procedures.

5. *Crafts Persons*

Each training team should have one crafts person to oversee hands-on activities during the training.

The structure of the training teams is shown opposite.

Source: MM Pakistan (Pvt) Ltd

12.3.2 Timing

To ensure reconstruction does not begin without guidance or supervision, training should commence as soon as possible after the disaster, once reconstruction plans and training material are prepared.

12.3.3 Delivery

Preparation of training materials must start early and must be aligned with a communications strategy which may employ radio, television or other media. The training should be based on the following:

- *Model houses which are developed based on these guidelines*
- *The skills required to implement these guidelines*
- *Construction specifications written as a result of these guidelines*

Training sessions must be followed up in the field and with ongoing on-the-job training.

12.3.4 Training of the Field Training Teams

High level training teams should be formed which are led by the following three experts who are familiar with these guidelines:

- *Technical expert*
- *Trained crafts person*
- *Community liaison officer*

Initial training should comprise of the theoretical and practical training of the field training teams delivered by high level trainers (including technical experts and crafts persons) through lectures and the construction of model villages over a one to two week period.

Case Study
Training in Model Villages: Punjab
Source: Engro Foundation

During construction of Ittehad Model Village, the Engro Foundation trained over 60 participants on construction trades such as welding, masonry, carpentry and steel-fixing

The content of training delivered to the field training teams should include:

- *Disaster impacts on buildings*
- *Principles of reconstruction and mitigation*
- *Technical skills*
- *Model demonstrations*
- *How to hold training sessions*
- *Social sensitivities*
- *Grievance procedures*
- *Typical mistakes*
- *Material quality and testing*
- *Model-building projects*
- *Safe construction techniques*

12.3.5 Training of the Field Reconstruction Teams

The field training teams shall have a similar composition to the training team described above. A technical expert and crafts person shall supervise reconstruction and be responsible for quality assurance. In addition, the crafts person will support the team through training of the reconstruction team in the field. The community liaison officer shall facilitate the relationship with the community to understand their needs and ensure these are reflected in the reconstruction efforts. The community liaison officer should also be trained in communication techniques so as to ensure the positive aims of the reconstruction are heard by the villagers and that their views are heard by decision makers.

Training to the reconstruction teams should be delivered to the builders, user/operators and community leaders. It is recommended this begins with a series of lectures showing disaster effects and reconstruction requirements.

Practical training of builders will be achieved through on-the-job training and by constructing model buildings. The model buildings should be ideal examples of best practice, by choosing a key community building which doubles as a refuge as the model building, this shall ensure the highest level of protection is provided to a key building.

The field training teams should be monitored by the first level training teams through site visits during the construction period.

Additional information on training for reconstruction is provided in Section 16 of the World Bank published handbook: Safer Homes, Stronger Communities[126].

Case Study
Use of demonstration buildings: Northern Pakistan
Source: World Bank [126]

Following the 2005 earthquake, the Pakistan Poverty Alleviation Fund and Sarhad Rural Support Program demonstrated building technologies and provided on-the-job training through the use of model houses. The project focussed on using public buildings (training centres, meeting halls or storage buildings) as model buildings and ensured that these model buildings reflected the funds and skills available to those who would replicate the designs.

12.4 Monitoring and Evaluation

As well as effective training, a programme of monitoring and evaluation of the success of the reconstruction projects should be implemented.

12.4.1 Monitoring

The main monitoring activities should be completed by the Tehsil Authorities and will include supervision of the construction of villages. This shall be achieved by the high level trainers and the field training teams who shall be responsible for day-to-day monitoring of the construction teams in the field. The Planning and Development Department's standard monitoring form ,PC-III(B) form (2005), should be used.

The overall objective of the monitoring is to ensure a high level of construction is achieved and the aims are to ensure the following:

- *Compliance with the designs and specifications*
- *Implementation of quality assurance procedures*
- *Use of adequate materials (strength, availability, sustainability)*

This monitoring procedure should follow a construction supervision plan, which should be prepared by policy makers such as the PDMA and be based on the construction specifications.

12.4.2 Evaluation

The evaluation role should be undertaken by the PDMA using the high level trainers following their training of the field training teams.

The Planning and Development Department's standard evaluation form ,PC-IV form (2005), should be used.

This evaluation is completed at a higher level than the monitoring and the aims are as follows:

- *Assess the appropriateness of completed designs in terms of replication by local communities*
- *Evaluate the performance of completed designs against the impacts of climate change*
- *Identify any issues encountered during implementation of the design*
- *Update procedures and/or designs in response to any of the above*
- *Disseminate lessons learnt to other reconstruction projects.*

The planning of reconstruction projects should be seen as a 'live' process. Projects should adapt based on the findings of the evaluation of the previous reconstruction projects. Where the evaluation identifies shortcomings or potential improvements to the planning process or design options, these guidelines should be updated accordingly.

It is vital that there is a strategy to communicate lessons learnt from these evaluations to other reconstruction teams to ensure a continual improvement and prevent the repetition of errors.

The evaluation also extends to the uptake of the services provided to a village (see Services Section). This evaluation should ascertain the level of use of the services and identify reasons for their failure. Potential reasons for the failure of services include, but are not limited to:

- *Cost - prohibitively high running costs*
- *Operation - lack of training or understanding*
- *Maintenance needs*

The evaluation of services should propose solutions to the problems not only for villages where reconstruction is complete, but also for future reconstruction projects. Such solutions may include, but are not limited to:

- *Specification for service with lower running costs*
- *Provision of training*
- *Awareness raising campaigns*
- *Provision of skilled labour*
- *Specification for service with a higher level of reliability*

References and Further Reading

[123] The European Cement Association 'Cement industry - main characteristics'. Available online at: http://www.cembureau.eu/about-cement/cement-industry-main-characteristics

[124] International Finance Corporation (2007) 'Environmental, Health and Safety Guidelines. Cement and Lime Manufacturing', World Bank Group

[125] Department of Ecology & Environment (2003) 'State of the Environment Report - Mining and Quarrying' Government of Karnataka, India

[126] Jha, A., Barenstein, J., Phelps, P., Pittet, D. and Sena, S. (2010) 'Safer Homes, Stronger Communities. A Handbook for Reconstructing after Natural Disasters', The World Bank, Washington

13. Contacts

Contact details for the current key Disaster Management stakeholders are provided in the following table.

Disaster Management Stakeholders (Punjab)

Stakeholder	Key Role	Contact
Provincial Disaster Management Authority	To develop operational, logistical and financial policies, guidelines and procedures. Develop links and engage with technical agencies, donors and NGOs Develop training materials Plan and manage emergency relief	Ph: +92-42-99204409 (A.D. Admin) Fax: +92-42-99204405 Address: 40-A, Lawrence Road, Lahore www.pdma.gov.pk
Agricultural Department	Ensure sustainable livelihood in areas of current climate risks. Assess disaster risks for food and agriculture sectors in hazard prone areas. Promote adoption of flood and drought resilient crops through research.	Ph: +92-42-99211749 +92-42-9921199 www.agripunjab.gov.pk
Livestock and Dairy Development Department	Undertake vulnerability and risk analysis for fodder, livestock sectors in hazard prone areas particularly in relation to drought, floods and locust. Joint coordination with PDMA to identify appropriate actions for reducing vulnerability of livestock to flood and drought risks. Ensure sustainable livelihoods in areas of recurrent climate risks. Develop disaster risk management plan	Ph: +92-42-5914628 Fax: +92-42-5914627 E: dspldd@punjab.gov.pk Address: 30 Tariq Block, New Garden Town , Lahore http://www.lddb.org.pk/
Irrigation Department	Supervise, direct and control flood prevention measures and bund protection activities. Carry out survey and inspection of flood protection works and develop disaster risk management plan to deal with hazard and disasters	Ph:+92 42 99213595-97 Fax: 92 42 99213598 www.irrigation.gov.pk

Stakeholder	Key Role	Contact
Environmental Protection Department	Incorporate Natural Disaster Assessment in the Environmental Impact Assessment Guidelines Undertake vulnerability assessment of natural resources to natural and human induced hazards. Create an emergency response cell in the department to respond to environment related emergencies	Ph: +92-51-9267621 +92-51-9267636 Fax: +92-51-9267625 www.environment.gov.pk
Health Department	Undertake vulnerability and risk analysis for health facilities and services Develop disaster risk management plan for each level of health facilities	Ph: +92-42-9210035 +92-42-9210749
Housing, Urban Development and Public Health Engineering Department	Develop disaster risk management plan to deal with hazards and disasters. Coordinate with PDMA/DDMAs and jointly identify appropriate actions for reducing vulnerability of infrastructure and services.	Ph: +92-51-9206036 http://punjablaws.punjab.gov.pk/index/listdept/d/HUD+and+PHE
Planning and Development Department	Ensure that all projects include disaster risk assessment (DRA) in the PC-1 format. Ensure all departments undertake vulnerability and risk analysis for their development programmes.	Ph: +92-42-99210339 Fax: +92-42-99214205 Address: Near Chouburgi, Lahore http://www.pndpunjab.gov.pk/
Local Government and Community Development Department	Evaluate development projects in disaster prone areas. Undertake vulnerability and risk analysis for rural population To integrate vulnerability reduction strategies in the development of infrastructure and property.	Ph: +92-42-99212439 Fax: +92-42-99211578 Address: Near MAO College, Lahore

Stakeholder	Key Role	Contact
Communication and Works Department	Provide provincial guidelines for safer construction of Government houses, buildings and infrastructure in hazard prone areas for multiple hazards e.g. floods, landslides etc Incorporate disaster risk assessment in the planning process for new construction. Develop Guidelines for conducting damage and loss assessment to infrastructure and Government buildings in the wake of disaster and conduct assessment after disaster.	Ph: +92-42-99263000 Address: Provincial Buildings, Circle-2, Wahdat Road, Lahore
Forest, Wildlife and Fisheries Department	Develop disaster risk management plan with regard to the mandate of the department. Supply of drought resistant seeds of tree species to farmers and communities Ensure pollution free livelihood environment in the area of mandate.	Ph: +92-42-99200782 Ph/Fax: +92-423-7721702 Address: CDG, Town Hall, Ravi Road, Lahore and 24-Coper Road, Lahore
Education Department	Identify and prepare an inventory of vulnerable educational institutions and infrastructure of the department in hazard prone areas. Develop a disaster risk management plan for the department covering aspects of the reduction, preparedness and response.	Ph:+92-42-99211518 Fax:+92-42-99213198 Address: Civil Secretariat, Lahore http://www.schools.punjab.gov.pk/
Social welfare, women development and Baitul Mal Department	Ensure risk awareness of decision makers about special vulnerabilities and capacities of women with relation to the disasters. Support post-disaster rehabilitation of livelihoods of women survivors.	http://www.pbm.gov.pk/new/contact_us.html Ph: +92-42-6369471 Fax. +92-42-6369472 Address: 41-B-1, Empress Road, Lahore
Pakistan Metrological Department	To disseminates warning about hazards to relevant users for early response such as evacuation. To elaborate communication network in order to broadcast the hazard warning throughout the province and country.	Ph: +92-51-9250360-1 Fax: +92-51-925036 Headquarter Office Sector H-Address: 8/2, Islamabad http://www.pmd.gov.pk/ E:pmd@pmd.gov.pk

Source: Provincial Disaster Management Authority (2008) 'Disaster Risk Management Plan, Punjab' PDMA, Lahore

14. Further Reading

A range of guidelines and references are available to assist in the planning and reconstruction of villages in Pakistan. Relevant resources are given in the end notes to each section, and can also include the following:

14.1 Policy and Planning of Reconstruction

Date	Description	Location	Online Resource	Author etc
2010	Safe Homes, Stronger Communities: a Handbook for Reconstructing after Natural Disasters. Prepared to assist World Bank staff, as well as the Bank's government counterparts, engaged in large-scale post-disaster housing reconstruction programs	Global	http://www.housingreconstruction.org/housing/	Global Facility for Disaster Reduction and Recovery (GFDRR)
2008	ProAct - Climate compatibility and disaster resilience	Global	http://proactnetwork.org/proactwebsite/media/download/PApolicies/drr_caa_policy_paper.pdf	ProAct Network
2007	How to turn practice into policy	Global	http://www.tearfund.org/webdocs/Website/Campaigning/Policy%20and%20research/Practice%20into%20Policy%20D5.pdf	TearFund
2006	Technologies for Adaptation to Climate Change	Global	http://unfccc.int/resource/docs/publications/tech_for_adaptation_06.pdf	UNFCC

Date	Description	Location	Online Resource	Author etc
2005	A Toolkit for Delivering Water Management Climate Change Adaptation Through the Planning System	UK	http://www.espace-project.org/publications/library/SEERA%20toolkit_1-5.pdf	The Environment Agency and the South East of England Regional Assembly, as part of the ESPACE project
2003	Guidelines for Building Measures after Disasters and Conflicts – pp88 -92	Global	http://www.gtz.de/de/dokumente/en-gtz-building-guidelines.pdf	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn 2003

14.2 Case Studies

Date	Description	Location	Online Resource	Author etc
Aug-08	ProAct - The role of environmental management and eco-engineering in disaster risk reduction and climate change adaptation	Global	http://proactnetwork.org/proactwebsite/media/download/CCA_DRR_reports/em_ecoeng_in_drr_cca.pdf	ProAct Network
2008	Indigenous Knowledge from Disaster Risk Reduction: Good Practices and Lessons Learned from Experiences in the Asia-Pacific Region	Asia-Pacific	http://sheltercentre.org/sites/default/files/ISDR_IndigenousKnowledge.pdf	UNISDR Asia and Pacific Region

14.3 Risk Assessments and Community Involvement

Date	Description	Location	Online Resource	Author etc
2004	Guidelines for planning in the re-building process – Resource pack	South Asia	http://practicalaction.org/docs/region_south_asia/guidelines-planning-rebuilding.pdf	Intermediate Technology Development Group – South Asia

14.4 Development of Hazard Maps, Assessments and Guidelines

Date	Description	Location	Online Resource	Author etc
2009	Guidance Notes on Safer School Construction. Highlight key points that should be considered when planning a safer school construction and/or retrofitting initiative and a compilation of basic design principles to identify some basic requirements a school building must meet to provide a greater level of protection.	Global	http://toolkit.ineesite.org/toolkit/INEEcms/uploads/1005/INEE_Guidance_Notes_Safer_School_Constr_EN.pdf	Darren Hertz. Published by Inter Agency Standing Committee, UNISDR, the World Bank, GFDDR, and the Inter-Agency Network for Education in Emergencies (INEE)

14.5 Earthquakes

Date	Description	Location	Online Resource	Author etc
Various	Collection of information and publications on seismic resistance of various building technologies	Various	http://www.world-housing.net	World Housing Encyclopaedia, an EERI and IAEE initiative,
Ongoing	Earth-based building materials and technologies	India	http://www.earth-auroville.com	Auroville Earth Institute, Tamil Nadu, India
2010	Model Bamboo houses and mitigating against climate change	Ecuador, Guayaquil	http://www.inbar.int/Board.asp?Boardid=296	International Network for Bamboo and Rattan,

Date	Description	Location	Online Resource	Author etc
2008	Confined Masonry for one and two storey buildings in low-technology environments: a guidebook for technicians	Pakistan	www.seismic.co.net	Seismic Co. Tom Schacher
2007	"Bunga" houses built with compressed stabilized earth blocks; earthquake-resistant structures derived from traditional houses of cylindrical shape	India	http://hunnar.org	Hunnarshala Foundation for Building Technology and Innovations, Bhuj, India
2006	Improving the Earthquake Resistance of Small Buildings, Houses and Community Infrastructure.	Global	http://www.preventionweb.net/english/professional/publications/v.php?id=1390	AC Consulting Group Limited
Various	Guidelines for earthquake-resistant construction of non-engineered rural and suburban masonry houses in cement:sand mortar in earthquake-affected areas	Pakistan	www.erra.gov.pk	ERRA, Government of Pakistan
2005	Manual for restoration and retrofitting of rural structures in Kashmir	Kashmir, India	http://kashmirdivision.nic.in/Disaster_Management/Man_res_retro_kmr_chpt1.pdf	UNDP, UNESCO, NCPDP

14.6 Flooding

Date	Description	Location	Online Resource	Author etc
2010	Monsoon Flood 2010 Pakistan: Rapid Technical Assessment of Damage and Needs for Reconstruction in Housing Sector	Pakistan	http://www.unhabitat.org.pk/Publication.html	UN-Habitat and National Disaster Management Authority Pakistan
2010	Guidelines for flood resistant house	Pakistan	http://www.unhabitat.org.pk/Publication.html	UN-Habitat, UN-Pakistan
2008	Manual on hazard resistant construction in India: For Reducing Vulnerability in Buildings Built without Engineer	India	http://www.ncpdpindia.org/Manual_on_Hazard_Resistant_Construction_in_India.htm and http://data.undp.org.i	UNDP India and NCPDP

Date	Description	Location	Online Resource	Author etc
			n/dmweb/pub/Manual-Hazard-Resistant-Construction-in-India.pdf.	
2005	Handbook on Design and Construction of Housing for Flood-Prone Rural Areas of Bangladesh	Bangladesh	http://sheltercentre.org/sites/default/files/handbook_complete-b.pdf	Prepared under the Asian Urban Disaster Mitigation Program (AUDMP) (this did not include Pakistan). Published by Asian Disaster Preparedness Center

14.7 Higher Temperatures

Date	Description	Location	Online Resource	Author etc
2010	Designing for Future	UK	http://www.innovateuk.org/ourstrategy/innovationplatforms/lowimpactbuilding/design-for-future-climate-report-.ashx	Technology Strategy Board
2007	Climate change and innovation in house building Designing out risk	UK	http://www.nhbcfoundation.org/LinkClick.aspx?fileticket=viZ9mWU9cqQ%3Dandtabid=339andmid=774andlanguage=en-GB	NHBC Foundation
2007	Climate Change Adaptation By Design: a guide for sustainable communities	UK	http://www.tcpa.org.uk/data/files/bd_cca.pdf	TCAP (Shaw, R., Colley, M., and Connell, R)
2006	Technology, Post-Disaster Housing Reconstruction and Livelihood Security	Global	http://www.practicalaction.org.	Twigg, John
2000	Climatic Design of Buildings using Passive Techniques	Global	http://sheltercentre.org/sites/default/files/Climatic_Design_of_Buildings_using_Passive_Techniques.pdf	Hans Rosenlund. Building Issues 2000, Vol. 10 (1)

14.8 Housing, Schools, Roads etc

Date	Description	Location	Online Resource	Author etc
2003	Housing Reconstruction after Conflict and Disaster, Dec 2003	Global but example from Vietnam	http://www.odihpn.org/documents/networkpaper043.pdf	Sultan Barakat, Humanitarian Practice Network (at Overseas Development Institute):
2008	Manual setting out how to prepare a transport plan, design road routes, cost and then construct using simple road construction techniques for rural roads based on best practices from rural road-building programmes in Africa, Asia and the Pacific. [No specific focus on climate change]	Africa, Asia and Pacific	http://www.ilo.org/asia/whatwedo/publications/lang--en/docName--WCMS_100216/index.htm	International Labour Organisation
2001	Hazard resistant construction - School Vulnerability Reduction (Caribbean project)	Global	http://www.oas.org/CDMP/schools/schlrcsc.htm	USAID, OAS, ECHO

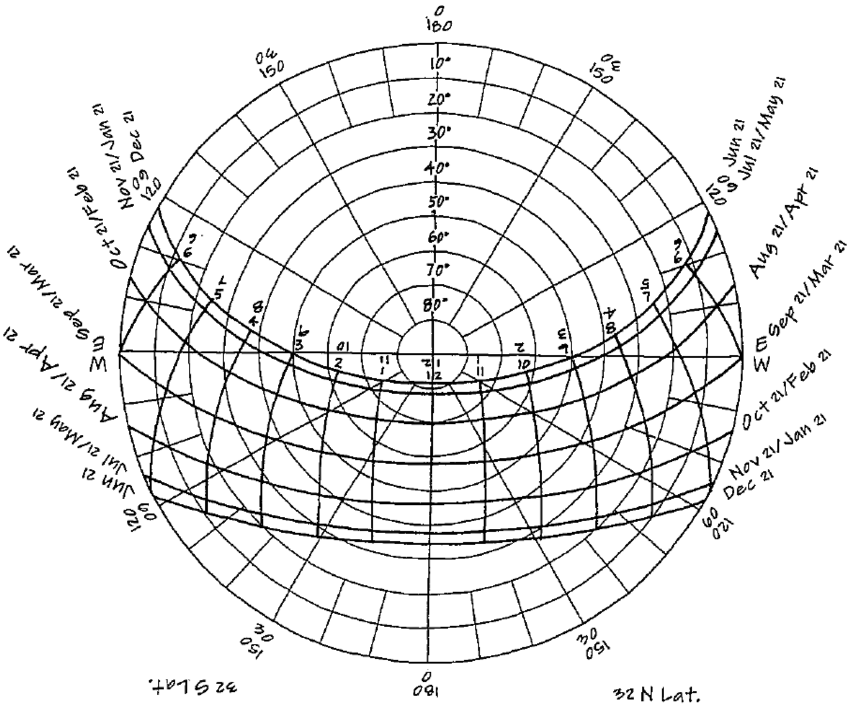
15. Appendix

15.1 Sun Path Diagrams

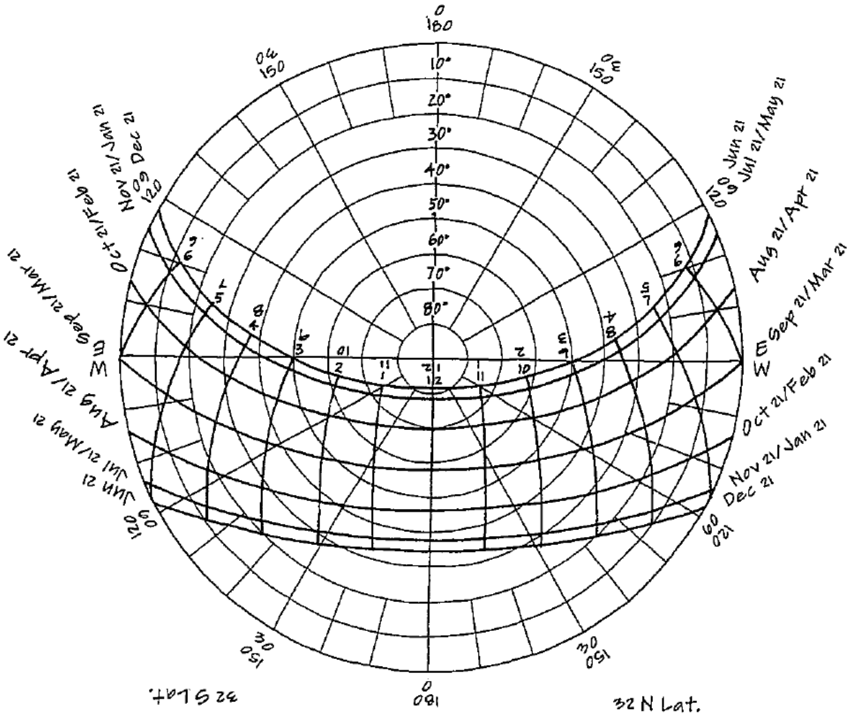
Sun path diagrams can be used to determine the position of the sun at any time, for use in planning and design. Sun path diagrams for 28º latitude (south Punjab) and 32º (north Punjab) as produced by Brown and DeKay[127] for use alongside these Guidelines are provided below..

Heavy lines running from east to west represent the path of the sun on the 21st day of each month of the year. Heavy lines running perpendicular to the sun path lines indicate time of day and the concentric light lines indicate the sun's altitude. Light lines radiating from the centre of the diagram indicate the sun's position as an angle (as seen in plan) measured from south.

Sun Path Diagram for 32º Latitude (north Punjab)



Sun Path Diagram for 28º Latitude (south Punjab)



Source: Brown and DeKay[127]

References and Further Reading

[127] Brown, G. Z., & DeKay, M (2001) ' Sun, Wind & Light, Architectural Design Strategies' John Wiley & Suns, Inc., New York

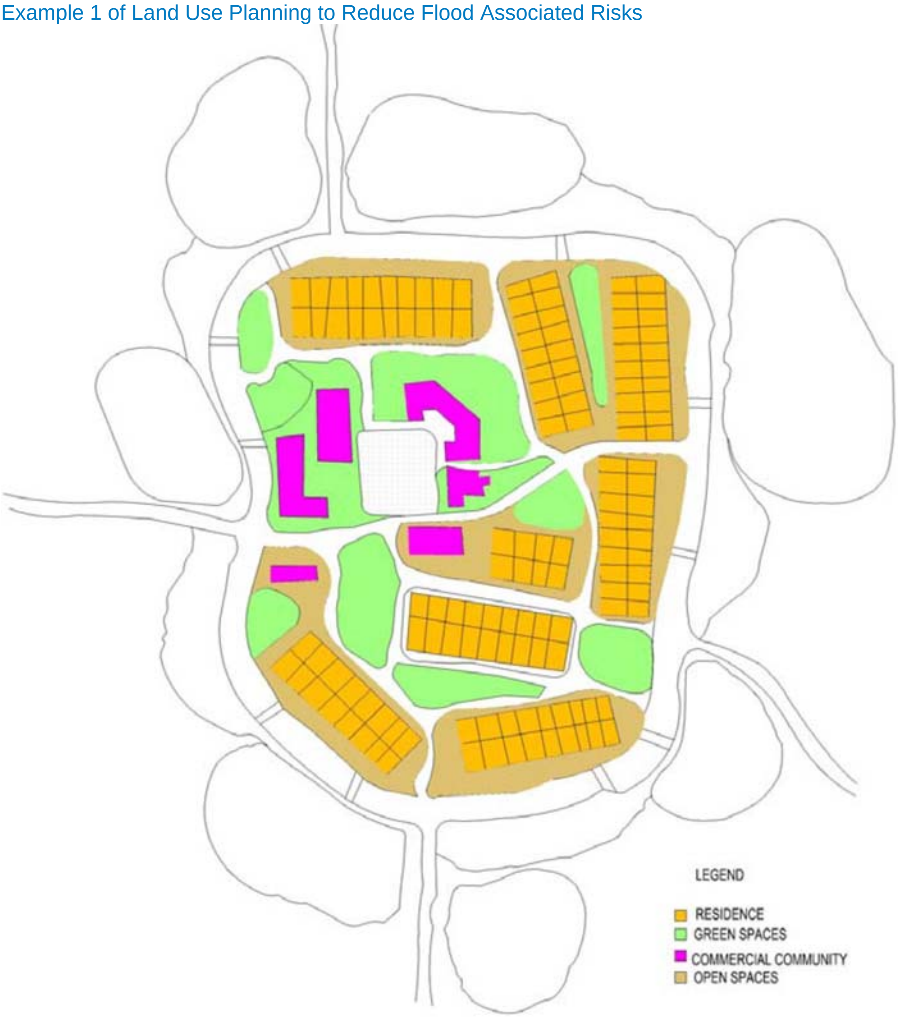
15.2 Example Layouts

15.2.1 Flooding

Example of Peripheral Road Acting as a Local Bund against Flooding

Source: Sohail Saeed & Associates

Example 1 of Land Use Planning to Reduce Flood Associated Risks



Source: Sohail Saeed & Associates

Example 2 of Integrated Landscape Planning & Drainage to Reduce Flood Impacts

Source: Sohail Saeed & Associates

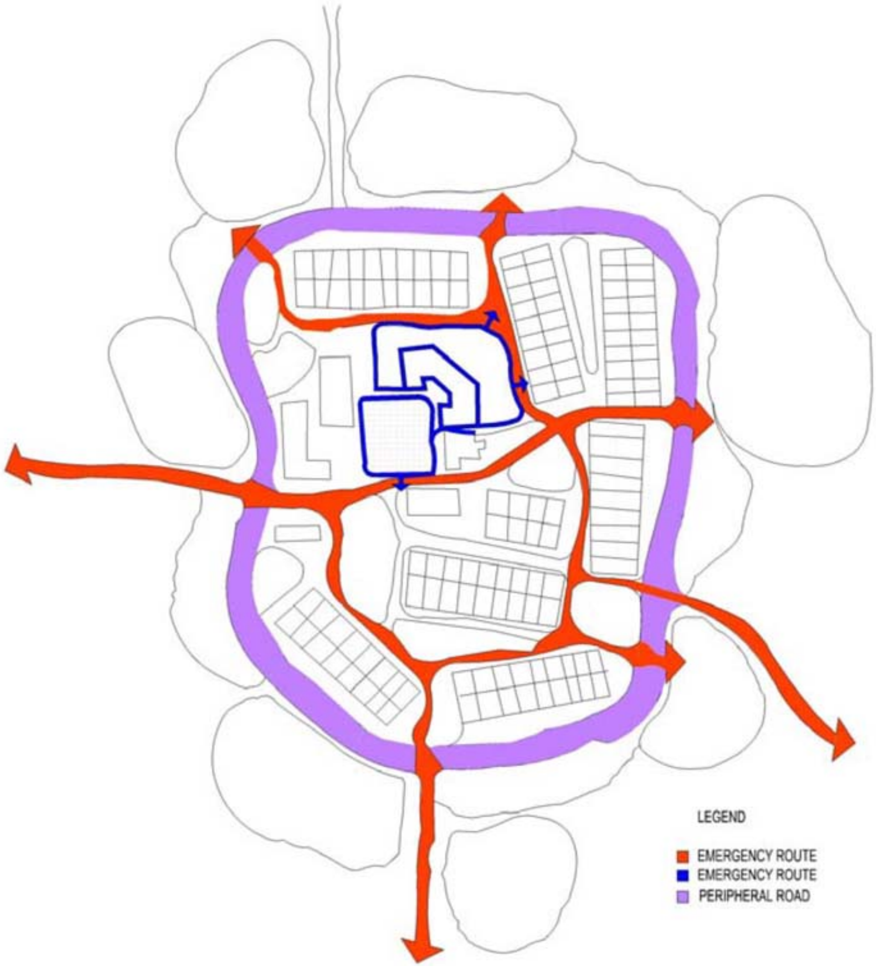
15.2.2 Temperature Extreme

Example of Land Use Planning to Reduce Heat Island Effect

Source: Sohail Saeed & Associates

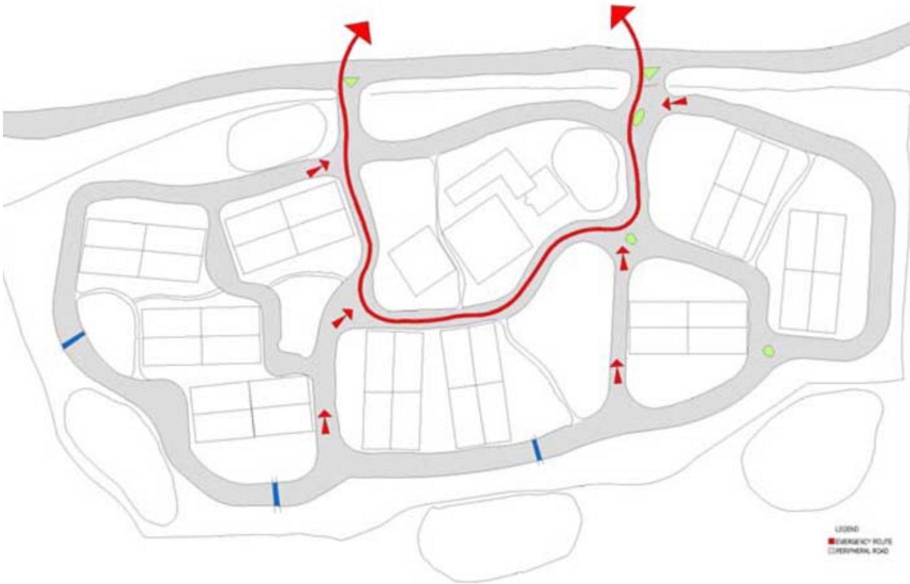
15.2.3 Emergency Response

Example 1 of Emergency Response Plan showing Emergency Routing & Evacuation Strategy



Source: Sohail Saeed & Associates

Example 2 of Emergency Response Plan showing Emergency Routing and Evacuation Strategy



Source: Sohail Saeed & Associates

Example of Peripheral Road for Community Evacuation in Case of Emergency

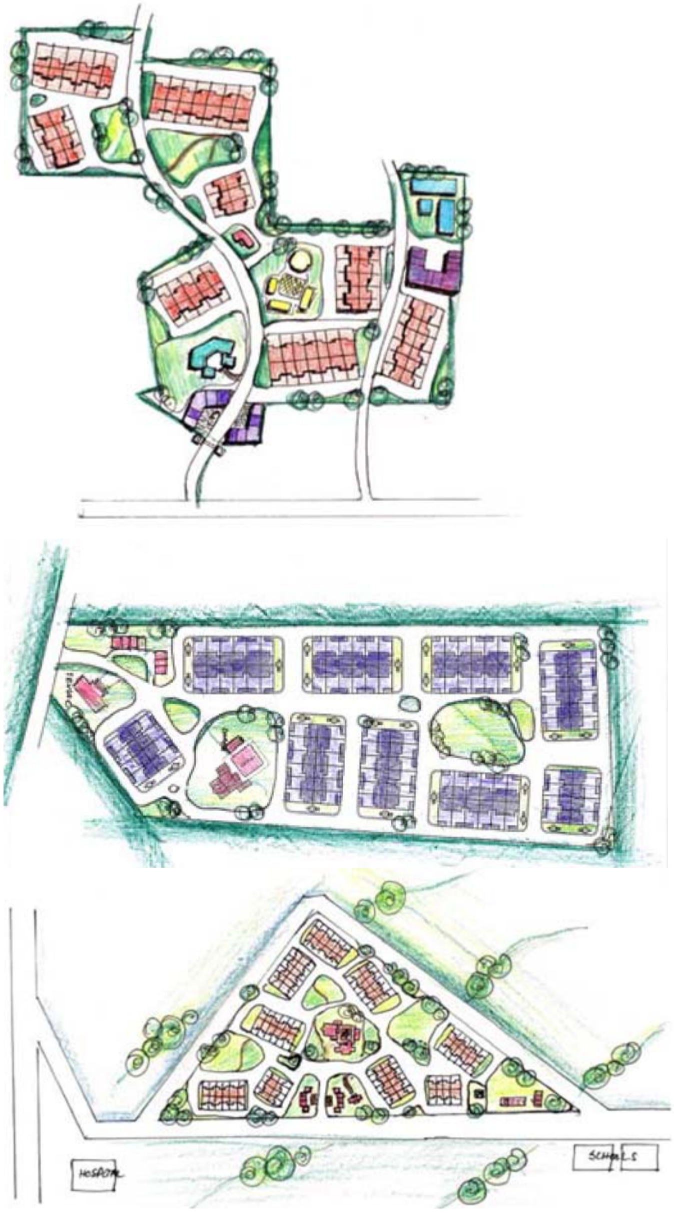
Source: Sohail Saeed & Associates

15.2.4 Generic Layouts

Example of Land Use Planning

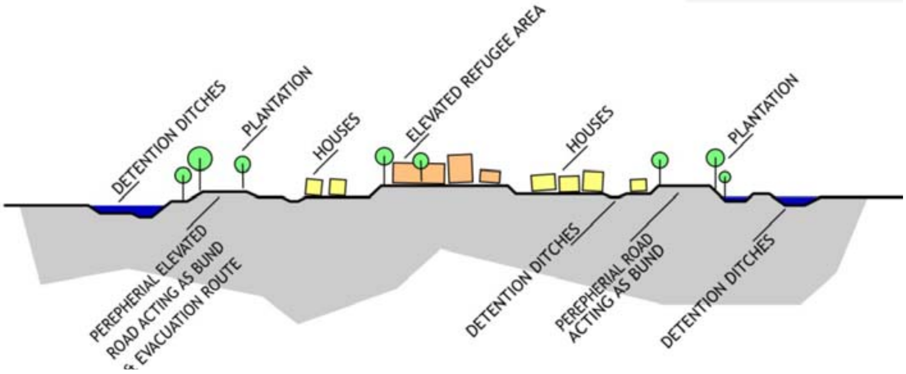
Source: Sohail Saeed & Associates

Example Layout Options for Model Villages Constructed by PDMA



Source: Sohail Saeed & Associates

Example of Section Detail of Site Layout



Source: Sohail Saeed & Associates

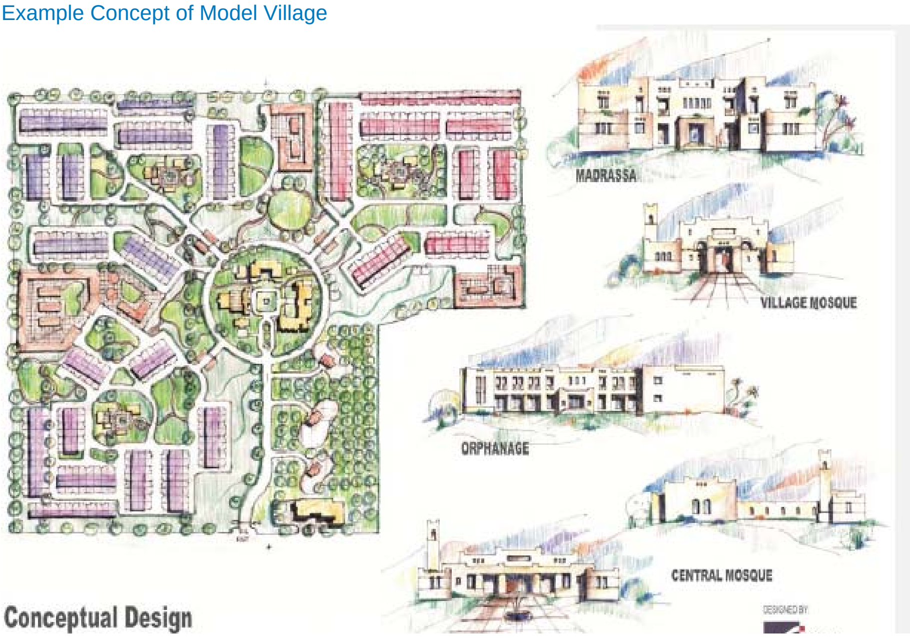
Example of Chopal (Central Refuge Area)

Source: Sohail Saeed & Associates

Example of Housing Blocks arranged around Chopal

Source: Sohail Saeed & Associates

Example Concept of Model Village



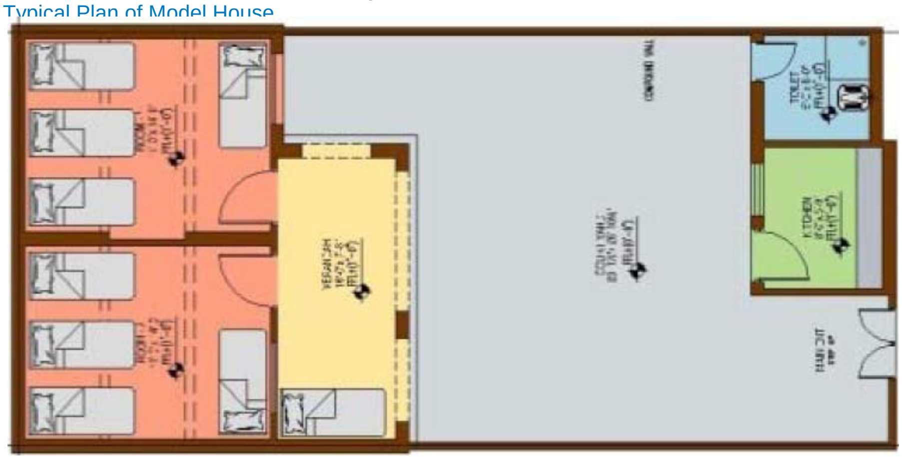
Source: Sohail Saeed & Associates

15.2.5 Example Residential House Plans

Typical View of Model House

Source: Sohail Saeed & Associates

Typical Plan of Model House



Source: Sohail Saeed & Associates

Example of Staggered House Layout

Source: Sohail Saeed & Associates

Climate & Development Knowledge Network

www.cdkn.org