Guidelines for Housing Development in Coastal Sri Lanka

Statutory Requirements and Best-Practice Guide to Settlement Planning, Housing Design and Service Provision with Special Emphasis on Disaster Preparedness

NATIONAL HOUSING DEVELOPMENT AUTHORITY

MINISTRY OF HOUSING AND CONSTRUCTION

Tsunami Disaster Housing Program

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LIST OF ABBREVIATIONS

BS	-	British Standards
BSCP	-	British Standard Code of Practice
CCD	-	Coast Conservation Department
CDMA	-	Code Division Multiple Access
CEA	-	Central Environmental Authority
CEB	-	Ceylon Electricity Board
CHPB	-	Center for Housing Planning and Building
CP	-	Code of Practice
CZMP	-	Coastal Zone Management Plan
EIA	-	Environmental Impact Assessment
ELCB	-	Earth Leakage Circuit Board
FAR	-	Floor Area Ratio
GI	-	Galvanized Iron
GTZ	-	German Technical Cooperation
ICC	-	International Construction Company (Pvt). Ltd.
ICTAD	-	Institute for Construction Training and Development
IEE	-	Initial Environmental Examination
LECO	-	Lanka Electricity Co. (Pvt.) Ltd.
MC	-	Municipal Council
MCB	-	Miniature Circuit Breaker
NBRO	-	National Building Research Organization
NERD	-	National Engineering Research and Development Center
NHDA	-	National Housing Development Authority
NPPD	-	National Physical Planning Department\
NWS&DB	-	National Water Supply and Drainage Board
PVC	-	Poly Vinyl Chloride
RCC	-	Reinforced Cement Concrete
SLLR&DC	-	Sri Lanka Land Reclamation and Development Corporation
SLS	-	Sri Lanka Standards
UC	-	Urban Council
UDA	-	Urban Development Authority
UPVC	-	Unplasticised Poly Vinyl Chloride

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PREFACE

On Sunday, 26th December 2004, Sri Lanka faced the most severe natural catastrophe in her recorded history. A tsunami wave resulting from an earthquake that occurred more than 2,000 km away from Sri Lanka in the sea bed near Sumatra, hit 1,126 km of the coastal belt in 13 of the 25 Districts in the island which accounts for 65 % of the total coastal belt of the country. Devastation was widespread, over 40,000 dead, more than 800,000 made homeless, with near-total destruction of the country's important economic means such as tourism and fishing industries.

Sri Lanka, not known to be susceptible to earthquakes, was not at all prepared to react to the situation. Lack of preparedness was also the main reason for the severity of the devastation and high loss of life.

Destruction to the housing sector was immense: more than 60,000 housing units were completely destroyed and another 40,000 were partially destroyed. Lack of proper construction standards to resist tidal waves and negligence on the part of home-owning public to follow even the available standards added to the severity of destruction.

Tsunami devastation has highlighted the need for disaster preparedness among the authorities and the public. In the housing sector, the need for appropriate disaster-resistant standards and quick recovery to re-house over 100,000 families is widely accepted. With the world quickly pledging to assist the re-building exercise, Sri Lanka hopes to receive substantial amounts of money in the form of outright grants and low-interest loans. Both local and foreign governmental and non-governmental organizations have embarked on re-construction assistance. The Sri Lankan government has realized the sensitiveness of these interventions, both in terms of social effects as well as environmental consequences and wishes to handle the intervention in a planned and efficient manner.

The local technical community involved in the housing sector at the grass-root level is not familiar with the intricacies of designing and constructing disaster-resistant housing. At the same time, an influx of donor-sponsored international experts who are here to assist the reconstruction efforts are unaware of local regulatory, statutory, planning and design requirements as well as the availability of building materials, technology and appropriate standards.

In this background, the National Housing Development Authority (NHDA), under the guidance of the Ministry of Housing & Construction, has initiated the formulation of a guideline to be used by the prospective house builders in the disaster-prone coastal belt of Sri Lanka. As the principal facilitator in the housing sector, the NHDA has come forward to shoulder the responsibility of helping the affected people to re-create their living environment in an environmentally sustainable and socially responsive manner. Such an intervention will help mitigate the negative consequences of large-scale disasters in future.

The primary purpose of this guideline is to cater to the needs of all categories of actors involved in the post-tsunami re-housing endeavors within the coastal belt. At the same time, the need to address other, more frequent natural disasters such as cyclones and floods is also recognized. As an initial step, the disaster-resistance issues that primarily affect the coastal belt of Sri Lanka, is given high priority.

In the present context, this guideline will only be a stop-gap measure intended to fill the vacuum of appropriate standards to cater to the immediate need. The Guideline is intended to cover the technical requirements relating to several natural disasters that might affect the coastal belt, such as tidal waves, earth tremors, floods and high winds. It is based on an initial draft developed by a team of professionals within the NHDA through a desk study of available regulations and relevant literature.

The first version of the document was presented to Hon. Ferial Ashraff, the Minister in charge of Housing & Construction by the Chairman of NHDA, Mr Parakrama Karunaratne on 20th May 2005, and at that occasion the Hon. Minister instructed the NHDA to present the document to the professional community of the country and other stakeholders involved in the housing sector for a review with the aim of arriving at a widely accepted guidelines for the sector.

Consequently, the NHDA with the support of the German Technical Cooperation (GTZ) organized a workshop on 20th June 2005 to review the initial version. This workshop was attended by many eminent professionals representing universities, professional institutions, consultancy firms, government regulatory bodies and donor organizations. The current version of the document is fortified with many suggestions that emanated from the workshop and supercedes the initial version dated May 2005.

Since the actual production of the guidelines in hard copy format takes time, the National Housing and Development Authority did not hesitate to publish the working guidelines on its webpage at www.nhda.lk (follow the links to "Tsunami Housing Guidelines") long before the present version appeared in print. It is our hope that all stakeholders involved in the provision of post-disaster housing will find this effort useful in providing a better living environment for affected people.

Mr. G.A.P.H. Ganepola
General Manager, NHDA

The need to compile existing guidelines for planning and construction of settlements into one volume became clear as nearly a hundred thousand households supported by several donors set out to reconstruct their homes after the Tsunami that hit the coast of Sri Lanka on 26th December 2004.

The German Technical Cooperation (GTZ) through its Tsunami Housing Support Project (THSP), implemented on behalf of the German Federal Ministry of Economic Cooperation and Development supports this initiative of the NHDA. We are glad to note that this initiative – though mounted by a single authority – has received wide support from several stakeholders involved in the housing sector: governmental and non-governmental organizations, professionals from the private sector and the academia contributed to revising and adding good practices to these guidelines on a pro bono basis.

Post Tsunami reconstruction will continue and we are working towards spreading good practices in housing and settlement development. It is our hope that at least the "Good Practices" part of this book will be a "living part" and all of us involved in the process will find ways to continue to share the knowledge built up here in Sri Lanka in post Tsunami reconstruction. The success of this effort is not in having the guidelines published, but in the implementation that brings about real change: A better living environment for the people affected by the Tsunami is what we are working for.

Mrs. Hilke Ebert,
Senior Advisor, GTZ

INTRODUCTION

1.0 ABOUT THIS PUBLICATION

1.1 Background

Sri Lanka has never faced a natural disaster of the magnitude of December 2004 Tsunami. It took the lives of over 40,000 people and made over 800,000 people homeless along the coastal belt of the island. As a result, major infrastructure networks such as roads, telecommunication, electricity and public and private buildings, including individual dwellings in most of the coastal areas were damaged or destroyed beyond repair.

The tsunami of 2004 was not an isolated natural disaster to strike the coastal belt. Coastal Sri Lanka faces natural calamities such as floods, land slides, cyclones and very occasionally earthquakes which have routinely claimed hundreds of lives and damaged or destroyed many houses.

Although the need for a working guideline that could facilitate the stakeholder action in the housing sector was highlighted by the tsunami, it was also felt that such a guideline should be a general one, addressing the salient technical issues related to disaster preparedness with respect to the coastal belt. Therefore, this document addresses the general issues related to tsunami re-construction as well as issues relating to possible disaster situations applicable to the coastal belt.

1.2 How to use this document

The present guidelines are meant to be used by individuals, state agencies and local and international non-governmental organizations who wish to undertake post-disaster housing development within the coastal belt of the island.

The document contains two sections: Section 1 deals with Sri Lankan building guidelines applicable to the coastal belt. These are culled from the relevant guidelines issued by the Urban Development Authority (UDA), local authorities and the Coast Conservation Department (CCD). Section 2 deals with “best practices” in the areas of participatory development approach, settlement planning, neighborhood and housing layout for energy efficiency and thermal comfort, sustainable design, appropriate use of materials, disaster-resistant housing and best practices in the provision of infrastructure services. While the former presents a quick guide to the current statutory provisions with respect to housing in the coastal belt, the latter is a distillation of the collective wisdom of key stakeholders in the area of housing provision. This is culled from stakeholders as diverse as academia, professional organizations, non-governmental actors, grass-root activists and users. It is hoped that the second section would grow over time, leading to a more rounded codification of best practices in the area of post-disaster housing reconstruction.

Both sections of the document are presented in the simplest possible manner for easy reference by key stakeholders involved in the reconstruction efforts. The following main aspects are covered by the guideline.

i. Settlement planning;
ii. Housing design;
iii. Technology and materials.

While the statutory section seeks to present the “essential” requirements (i.e. legally binding), the second section alludes to “desirable features” (best practice advice). The aim of the second section is to enable proponents of housing development to achieve environmentally sustainable, physically comfortable and socially responsive housing in a cost-effective manner.

2.0 INSTITUTIONAL ARRANGEMENT IN SRI LANKA

2.1 Institutions facilitating housing development

(a) National Housing Development Authority (NHDA)

The National Housing Development Authority (NHDA) is the apex housing organization in Sri Lanka vested with the responsibility of planning and implementation of state interventions in the housing sector. The NHDA was incorporated by the National Housing Development Authority Act No. 17 of 1979 with a development orientation as opposed to regulatory focus.

Since its inception the NHDA has reached over a million rural households spending over Rs. 12.53 billion in the process. The corresponding figures for the urban and the estate sectors are: 205,000 families (Rs. 4.42 billion) and 78,500 families (Rs. 0.44 billion). Thus, the NHDA's activities have benefited nearly half of the Sri Lankan population in its short history.

The NHDA's vision is to be the lead facilitator of housing provision in the nation. Towards this end, the NHDA has evolved its mission to constantly monitor the housing sector of the country and develop programs to meet the housing shortfall, evolve strategies to make housing affordable to all classes of society, facilitate individual families and the private sector to create new housing, facilitate management of existing housing stock and develop infrastructure complementary to settlement development that creates a confident, dignified society through home ownership.

During its quarter century of existence, the NHDA has been directly engaged in the construction of individual houses, apartments and community buildings. It has also formulated schemes to promote housing development projects in order to alleviate the housing shortage. Other activities include:

i. Clearance of slum and shanty areas and the re-development of such areas;
ii. Promotion of housing development;
iii. Development/re-development of land for housing;
iv. Make land available for housing development.

The NHDA follows the following strategies – among others – to achieve its aims:

i. Providing financial and material assistance through loans and grants (depending on income levels) with technical assistance to homeless families to build their own homes;
ii. Providing lands and infrastructure to create new settlements, at affordable costs;
iii. Implementing capacity development programs for key players in the industry;
iv. Generation and dissemination of knowledge on affordable building techniques and models;
v. Direct engagement in construction of houses in urban areas at affordable prices with easy pay-back schemes;
vi. Subsidized housing projects for deserving communities such as government servants;
vii. Refurbishing or rebuilding old settlements directly or with private sector participation;
viii. Facilitation of private sector involvement in new housing projects by concept development and providing lands;
ix. Converting rental housing to outright ownership, thereby ensuring tenure-ship for the poor;
x. Providing consultancy and other services to stakeholders in the housing sector.

The Authority with its head office in Colombo carries out its activities on an island-wide basis through a network of 26 district officers and a City office to cater to the Colombo municipal area.

2.2 Institutions regulating housing development

Much like conventional development, post-disaster re-building efforts are controlled by a multitude of regulatory agencies and service providing organizations. Planning clearance and statutory approval for the planning and development of individual houses and settlement projects have to be obtained from the relevant authorities prior to commencement of any development activity. In the Sri Lankan context, regulations declared by the Urban Development Authority (UDA), National Physical Planning Department (NPPD), Coast Conservation Department (CCD), Central Environmental Authority (CEA) and respective local authorities have to be adhered to in carrying out housing development. Additionally, it is important to keep in mind the role played by national-level service providers related to housing development.

(b) Urban Development Authority (UDA)

UDA is the national planner and promoter of urban areas to meet the aspirations of urban dwellers whilst improving the quality of life. It was established by a Law of the National State Assembly (subsequently re-named as the Parliament) (Law No. 41 of 1978) to achieve integrated planning and development of urban areas. The UDA's primary regulations may be cited as the UDA Planning & Building Regulations of 1986. Its latest version of development control was published in 1999. It is mandatory to obtain a UDA development permit to engage in housing development activity within the areas of its jurisdiction. This function is often delegated to local authorities in areas under the latter's jurisdiction.

(c) National Physical Planning Department (NPPD)

NPPD formulates national physical policies, plans and strategies to ensure the implementation of such policies through regional and local development plans. The primary mission of the NPPD is to promote and regulate integrated planning of social, physical and environmental aspects of land and territorial waters of Sri Lanka.

The NPPD was established in 2000 by amending the "Town and Country Planning Ordinance No. 13 of 1946" ("Town and Country Planning [Amendment] Act No. 49 of 2000.") Among its key functions are:

i. Preparation and updating of national physical plan, regional plans and local plans;
ii. Designing of house types for housing schemes and housing estates;
iii. Preparation of layout plans for housing and supervision of housing schemes;
iv. Preparation of comprehensive re-development schemes;
v. Development of new towns.

(d) Central Environmental Authority (CEA)

The CEA was established by an Act of Parliament (the National Environmental Act No. 47 of 1980) to protect and enhance the quality of the environment through pollution control, natural resource management and environmental education, in a manner that meets the aspirations of the present and future generations. With respect to the housing sector, the CEA's control function is exercised through:

i. Implementation of Environmental Protection License (EPL) to regulate, maintain and control the types of pollution which pose danger or potential danger to the quality of the environment;
ii Environmental Impact Assessment (EIA) to protect the natural resource base of the country by ensuring environmentally sound development interventions.

Depending on the nature of the proposed housing development, it may be necessary to obtain either an EPL or an EIA before commencing development activities.

(e) Coast Conservation Department (CCD)

The Coast Conservation Act No. 57 of 1981 was enacted for the management of development activities within the coastal zone. The primary vehicle for the implementation of the mandate received by the Act is the Coastal Zone Management Plans (CZMP). The latest in the series of CZMP currently applicable to the coastal zone was developed in 1997and parts of this plan were superceded by CZMP 2004.

The Coast Conservation Act defines the "coastal zone" (see Section I, Chapter 3, p. 11), a critical portion of which is further divided into two by the CZMP (1997): "reservation area" and "restricted area." While no permanent development (other than coast protection infrastructure) is allowed within the reservation area, limited development is allowed within the restricted area.

Permission for development within the coastal zone as a whole is given under two categories:

i. Major permit – These are permits issued by the Director of the Coast Conservation Department (CCD). Proposed development within the coastal zone such as large dwelling houses, extensions to existing buildings, large commercial and industrial structures as well as temporary structures within the reservation area would require a Major permit. Only the Director, CCD, is empowered to issue a major permit (See Table 1, p. 9 for details).

ii. Minor permit – These permits are issued by the Divisional Secretaries of coastal areas for the purpose of small-scale development. According to the currently applicable "Coastal Zone Management Plan" (CZMP, 2004 – see Section I, pp. 8ff, for more details) small dwelling houses, extension to small dwelling houses and minor commercial facilities are the only activities that could be carried oit with a Minor permit.

In terms of major development, while the CEA controls the issue of EIA, projects not requiring EIA/IEE will be reviewed using a CCD checklist by the CCD Planning Committee through a consolidated reviewing system before issuing a major permit. The system requires the proponent of a housing development plan within the coastal zone to submit an application to the CCD together with a detailed proposal, conceptual design, survey plans of the site and documentary evidence supporting EIA procedure.

(f) Sri Lanka Land Reclamation & Development Corporation (SLLR&DC)

The mission of SLLR&DC is to reclaim and develop areas declared as development areas by Ministerial order under Section 2 of the amendment to the SLLR&DC Act No. 15 of 1969. The goal is to ensure a flood-free habitat and to improve the environment by rehabilitating, re-creating and maintaining pollution free inland water bodies.

Areas declared as low-lying (or marshland / wetland) are gazetted under the SLLR&DC Act. Within the gazetted area, any person seeking to develop land by building or otherwise is required to obtain a clearance certificate from the SLLR&DC although the regulatory powers are still not embodied in the parent act. Action is currently being taken to rectify this lacuna.

(g) Municipal Councils and Local Authorities

The local level management of development function is controlled by local bodies. In the Sri Lankan context, three levels of local authorities are present: Municipal Councils, Urban Councils and "Pradeshiya Sabhas." While the first two are generally recognized as "urban" areas, less-urbanized areas usually fall within the purview of the "Pradeshiya Sabhas." The local bodies are established and operated under the legal provisions of the Municipal Councils Ordinance, Urban Councils Ordinance and Pradeshiya Sabha Act respectively. The legal provisions carry rules and regulations that are relevant to housing activities in their respective areas.

The more developed areas within the purview of a local authority may be designated as "Special Development Areas" under the provisions of the UDA Law. The UDA law (usually delegated to and administered by local authorities) will be applicable to these areas.

2.3 Service providing organizations

While the day-to-day provision of building services usually falls within the purview of local authorities, national-level service providers regulate these provisions to the housing sector among others.

2.0 INSTITUTIONAL ARRANGEMENT IN SRI LANKA CONTD.

(h) Ceylon Electricity Board (CEB)

At present, the Ceylon Electricity Board (CEB) is the main power generation, transmission and supply arm of the state. In most parts of Sri Lanka, the CEB manages the entire operations, from generation to transmission networks including transformer stations. The operation of low voltage distribution network including low voltage sub-stations, too, is within the purview of the CEB. However, the distribution function of the operation in several areas in the south-western coast of Sri Lanka is currently delegated to a wholly CEB owned, but private company called Lanka Electricity Company (Pvt.) Ltd. (LECO). Areas where LECO's distribution network currently extends include, Kotte, Kelaniya, Moratuwa, Kalutara and Negombo Municipal/urban Council areas.

(i) National Water Supply & Drainage Board (NWS&DB)

NWS&DB is the main institution responsible for the provision of safe and adequate drinking water and proper sanitation for the entire population of Sri Lanka.

With respect to the internal infrastructure for water and sanitation within a housing scheme, the NWS&DB is mandated to review the designs and guide the designers to ensure that the work will be carried out in conformity with applicable standards. With respect to sanitation (especially in the context of multi-storied buildings) NWS&DB will carry out design on request or review the design carried out by outside consultants so as to avoid environmental pollution and to ensure sustainable maintenance.

In areas where adequate water main pressures are not available in the system, the NWS&DB will provide water into a ground sump. In such cases, developers will be required to put in place a secondary pumping system.

Large scale developers of housing estates are expected to design and implement the internal water supply systems under the guidance of NWS&DB so that a management corporation or a Community Based Organization could take over the operations and maintenance of the internal infrastructure system in future.

SECTION I – STATUTORY AND PHYSICAL PLANNING GUIDELINES

3.0 GUIDELINES ON PLANNING ASPECTS

3.1 The "Buffer Zone"

The development control over coastal areas is exercised by the Coast Conservation Department (CCD). At present, the CCD prohibits construction activity within 300m from the first vegetation line . However, these regulations were not strictly enforced in view of the scarcity of coastal land for development. After the Tsunami disaster, it has been decided to strictly adhere to the coast conservation regulations and other guidelines imposed by the Coast Conservation Act.

Figure 1a

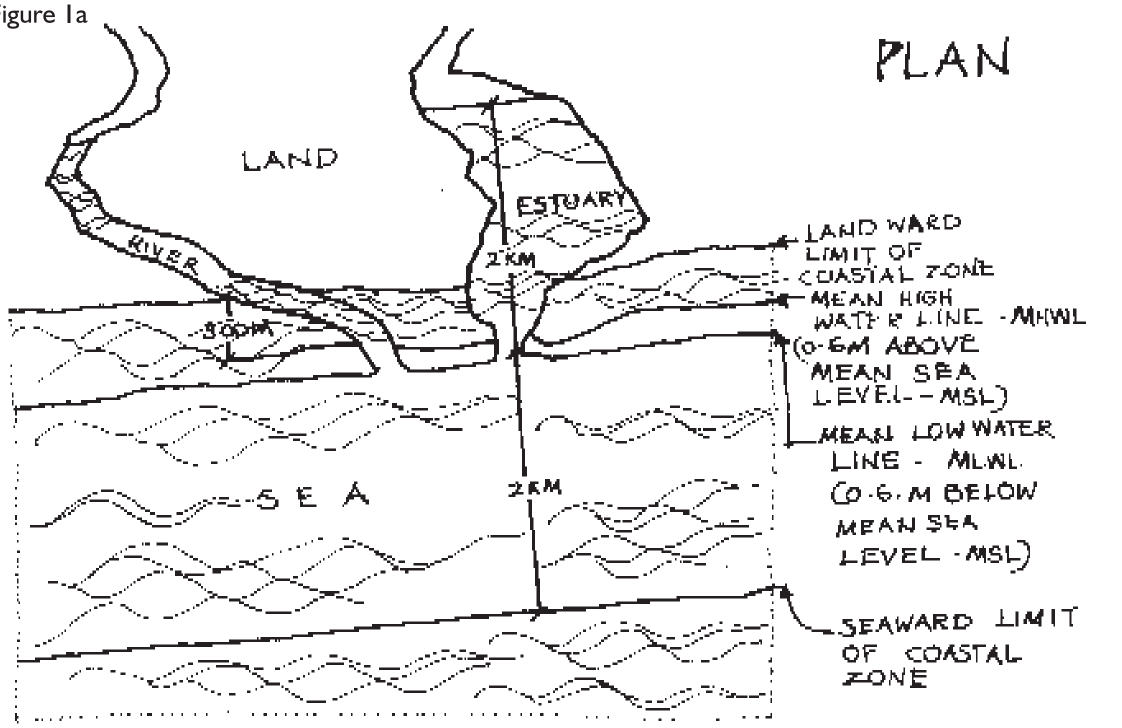
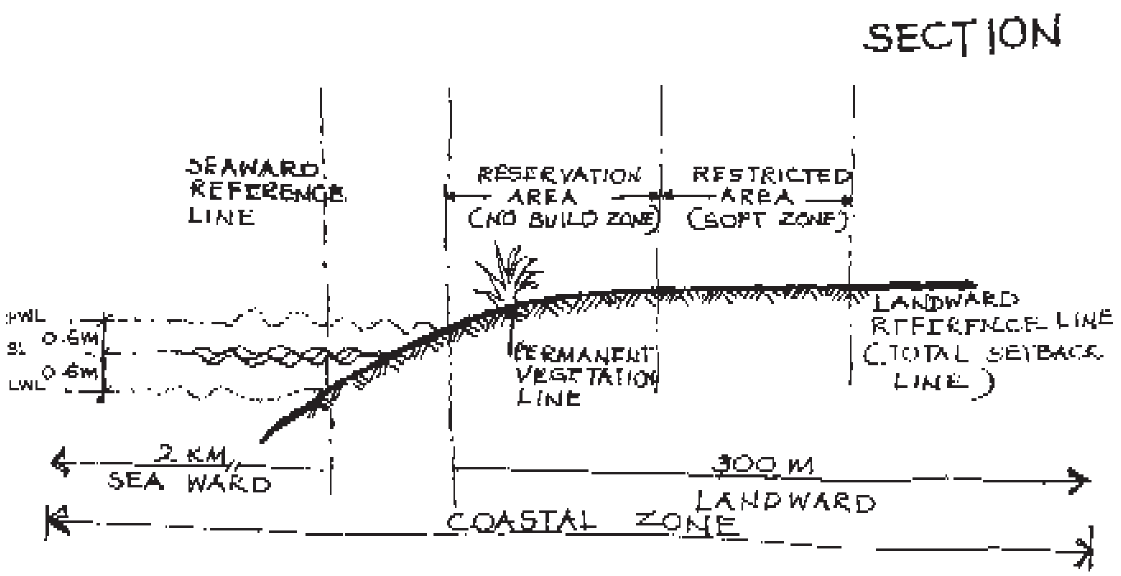


Figure 1b



The Coast Conservation Act requires the CCD to develop a Coastal Zone Management Plan (CZMP) every 5 years. The currently applicable CZMP was developed in 2004 (CZMP, 2004) and approved by the cabinet of Ministers in 2005. However the previous version of the CZMP (CZMP, 1997 approved by the Cabinet of Ministers on 10 September 1997) contains valuable references to the coastal zone and much of this information (if not superceded by the CZMP 2004) remains valid.

The Coast Conservation Act defines "coastal zone" thus (see Figure 1a/b for illustrations):
"Area lying within a limit of three hundred meters landward of the mean high water line and a limit of two kilometers seaward of the mean low water line, and in the case of rivers, streams, lagoons or any other body of water connected to the sea either permanently or periodically, the landward boundary shall extend to a limit of two kilometers measured perpendicular to the mean low water line."

All developmental activities within the coastal zone require a permit (either from the Director, CCD or the respective Divisional Secretaries – see Table 1).

Figure 1b shows a portion of the coastal zone considered critical for the well-being of the coastal eco-system. This area is divided into two: "reservation area" (no build zone) and "restricted area" (soft zone). As indicated in page 4-5, some development activity is allowed within the "restricted area."

The seaward reference line of this sensitive area is fixed (i.e. 0.6meter above the mean sea level). The landward reference line varies, according to the sensitivity of a given coastal area to sea erosion and other natural hazards. The CZMP (1997) has divided the coast of Sri Lanka into 70 segments and has proposed a varying landward reference line, depending on the risk factors mentioned above (See Appendix I for further details).

Following the tsunami disaster in December 2004, the landward reference line has been determined as follows:

i. 100 m landwards from the mean high water line in the following districts – Killinochchi, Puttlam, Gampaha, Colombo, Kalutara, Galle, Matara, Hambantota;
ii. 200 m landwards from the mean high water line in the coastal belt within the Jaffna, Mullaitivu, Trincomalee, Batticaloa and Ampara Districts.

Readers are requested to consult the CZMP (1997 and 2004) for further details on the coastal segments, their risk factors (Table 6.2, p. 86ff of CZMP, 1997 – See also Appendix I of this document), prohibited areas and the procedure to be followed when requesting development permits from the CCD (refer, Figure 8.2, p. 8-19 of CZMP, 2004).

Table 1 – Permitted development within the coastal zone

Location	Activity	Permit required from	
		Director, CCD	Divisional Secretary
Coastal zone (Landward of setback line)	Dwelling houses	> 1,500 ft^2 (162m^2)	< 1,500 ft^2 (162m^2)
Coastal zone (Landward of setback line)	Extension to dwelling houses	> 1,500 ft^2 (162m^2)	< 1,500 ft^2 (162m^2)
Coastal zone (Landward of setback line)	Commercial structures	> 350 ft^2 (32.5m^2)	< 350 ft^2 (32.5m^2)
Coastal zone (Landward of setback line)	Other structures	-- Director, CCD only --	
Within setback Restricted area	Tsunami reconstruction	-- Director, CCD only --	
Within setback Restricted area	Temporary structures	-- Director, CCD only --	

Source: Modified from Table 8.1 of CZMP, 2004, p. 8-4.

3.2 Selection of site

In selecting sites for housing development in the coastal belt, it is to be kept in mind that under no circumstances buildings should be constructed within the reservation area. Within the restricted area, housing development may be permitted by the CCD, if the land is at least 3m above the Mean High Water Line. Restrictions in terms of the extent of the individual housing units may apply (see Table 1).

The other statutory provision in site selection is that the site should be such that buildings could be located on stable foundations on soil strata having no susceptibility for liquefaction.

3.3 Planning of settlements

The primary requirement in settlement planning is to ensure the proposed housing development is in an area demarcated for residential land use (For tsunami housing, the settlements should be planned so that the minimum floor area of each dwelling unit is at least 46.5m^2 – 500ft^2). A schematic settlement plan fulfilling these criteria must be submitted for preliminary planning clearance from the relevant local authority and/or the UDA before proceeding with detailed design, so as to accommodate the statutory requirements of such authorities.

In the case of multi-site housing development, the developer should consult the relevant planning authority in the respective areas (MC, UC or Pradeshiya Sabha) for obtaining planning approval.

The legal requirement for settlement planning for a development consisting of 20 or more dwellings (individual housing units, semi-detached houses or condominium apartments) is given in Table 2.

Table 2 – Settlement planning requirements by the UDA[f]

Utilization	Coverage of Settlement Land
Housing – Neighborhood facilities	65% (Max.)
Common Area	10% (Min.)
Road, Streets, footpath and drains	20% (Min.)
Public and semi public (social infrastructure)	05% (Min.)

3.4 Plot size and coverage

Table 3 shows the plot size and general requirements for individual houses in areas where pipe-borne water supply and sewage disposal are not available.

Table 3 – Plot size requirements by the UDA[f]

Element	General Requirements
Plot size (individual dwellings)[b]	10 – 20 perches[a] (253 – 506 m^2)
Plot size for town house[d]	6 – 12 perches[c] (152 – 303 m^2)
Building line	Depends on the road size and the category of the road. If not available, assumed to be 12.5 m (40'-0" ft) from the center of the road
Street Line	Refer Figure 2
Rear Space	Refer Figure 2
Front Space	Refer Figure 2
Floor Area Ratio (FAR)[e]	1.5 (Max.)

Notes:

a. One perch = 272.25 ft^2 = 25.3 m^2

b. In areas where pipe-borne water and sewage disposal is available, the minimum plot size may be reduced to 6 perches on approval by the respective local authority. This determination will be made by the local authority based on the demand and availability of the services.

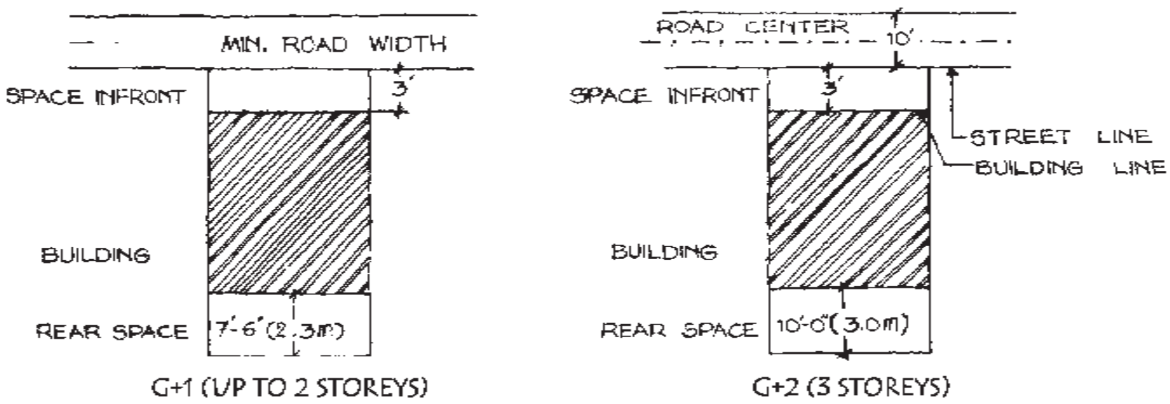
c. When a location is declared as a "special project area" by the relevant planning body, the plot size can be reduced to as little as 40m^2 (approx. 1.5 perches).

d. Town houses are dwellings that abut one or both of the side boundaries of the site.

e. Floor Area Ratio (FAR) = $\frac{\text{Total Building Area}}{\text{Land Area}}$

f. For areas not coming under the purview of UDA refer the gazette of Democratic Socialist Republic of Sri Lanka (extraordinary) No. 392/9 - 1986

Figure 2



* Refer Figure 6 also

3.5 Roads

The provision of access roads is governed by the number of housing plots in a given sub-division. The relevant UDA regulations are reproduced below.

Table 4 – Provision of access roads

Max. No of lots	Max. length of road	Min. width of road including drain	Building line
04	50 m	3 m(Drain in One side)	Min 1 m
08	100 m	4.5 m(Drain in One side)	Min 1 m
20	-	6.0 m(Drain in One side with pavements)	Min 1 m
>20	-	9.0m(Drain and pavements in both sides)	Min 1 m

Figure 3

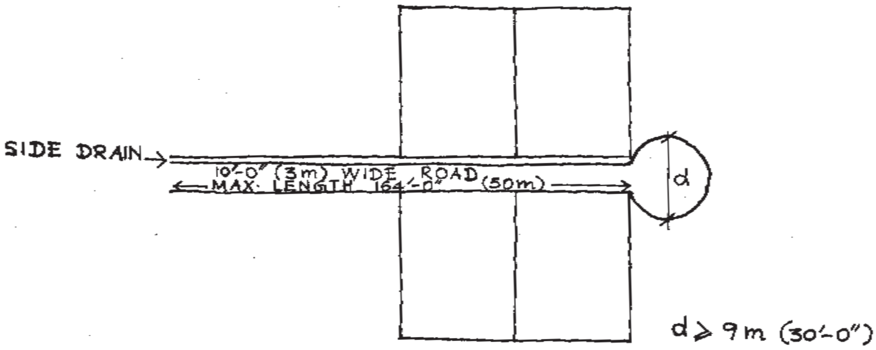


Figure 4

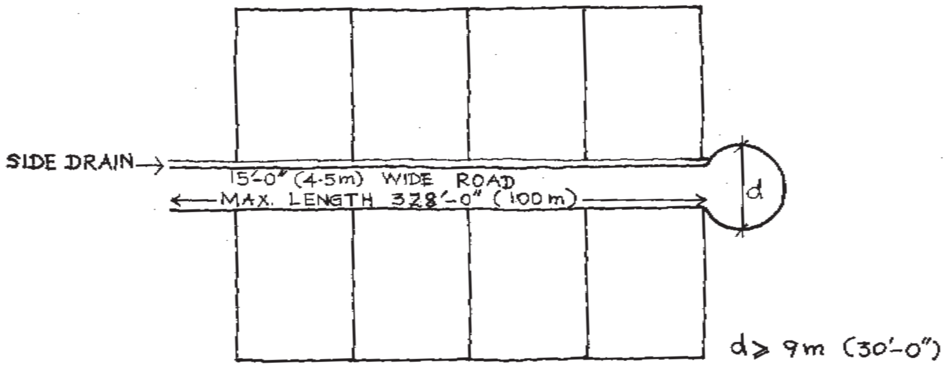
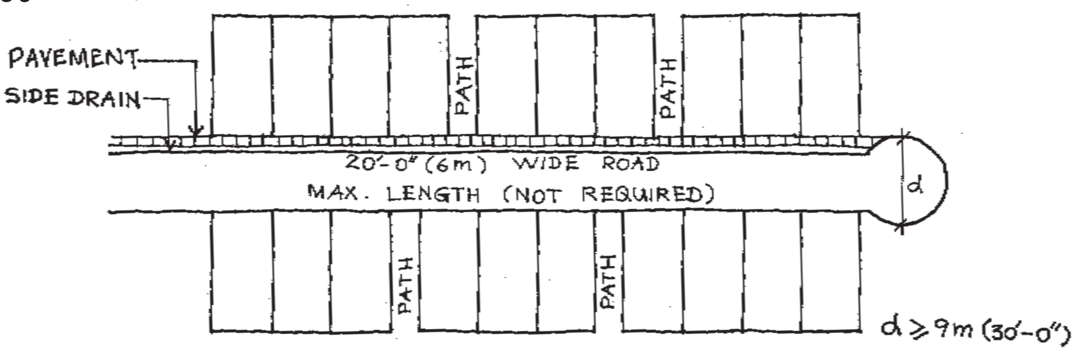


Figure 5



3.6 Parking requirements for residential buildings

The provision of parking space is governed by the extent (floor area) of the housing units or flats. Each parking bay should be of a minimum size of 2.4m x 4.8m (8'-0" x 16'-0").

Table 5 – Parking provisions

Housing category	Parking requirement
Flats, dwelling units (excluding individual housing units) and terraced houses having a floor area up to $50m^2$ ($538ft^2$)	1 for every 3 housing units
Flats with gross floor area between $50\text{-}75m^2$ ($538\text{-}807ft^2$)	1 for every 2 housing units
Flats with gross floor area less than $100m^2$ ($1,076ft^2$)	1 for each housing unit
Flats exceeding a gross floor area of $200m^2$ ($2,152ft^2$)	3 for every 2 housing units*
Dwelling units exceeding floor area of $200m^2$ ($2,152ft^2$)	1 for each housing unit

Note:

* Recommended parking = 3 for every 3 housing units.

3.7 Means of Evacuation

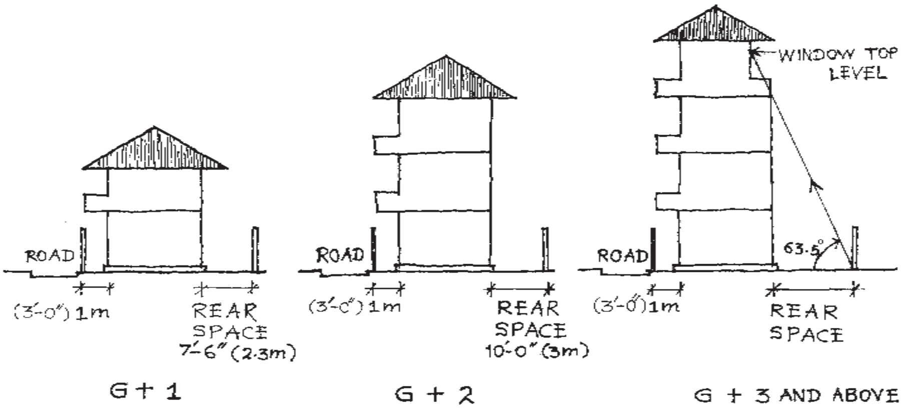
Evacuation paths and points should be considered when preparing layouts within the vulnerable areas. Evacuation paths should be opposite & perpendicular to the sea and clearly demarcated in the layout.

4.0 GUIDELINES ON SETTLEMENT DESIGN

4.1 Spatial aspects

The UDA regulations stipulate the siting of houses within selected housing plots. The requirements in coastal areas are graphically illustrated in Figure 6.

Figure 6



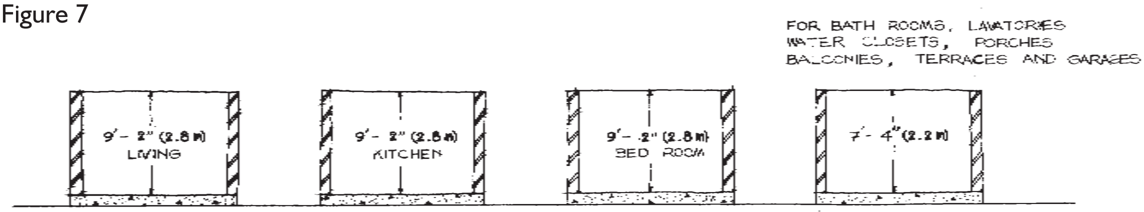
4.1.1 Regulations for Internal Spaces

The mandatory minimum sizes for internal spaces are given in Table 6. Figures 7 - 9 illustrate these provisions.

Table 6 – Internal space standards

Type of space	Mandatory minimum standard
Kitchen	Min. width – 2m; Min area – 5m^2
Storage / Utility area	2.5m^2
Lavatories, water closets and bathrooms	With pedestal type closet fittings – 1.7m x 0.8m Other than pedestal type – 1.3m x 0.8m
Height of rooms	See Figure 7

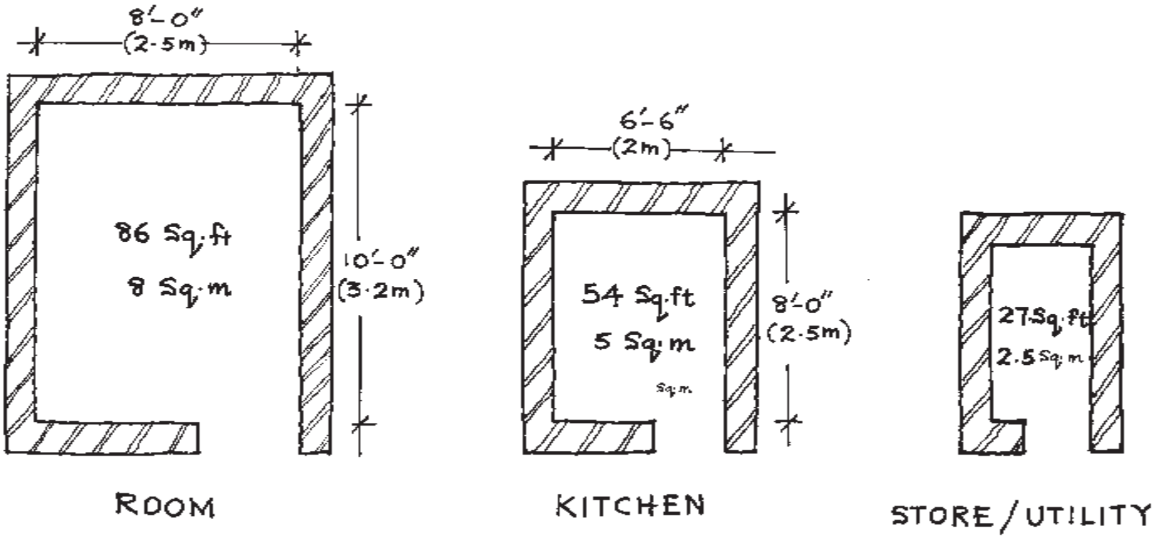
Figure 7



4.2 Structural considerations

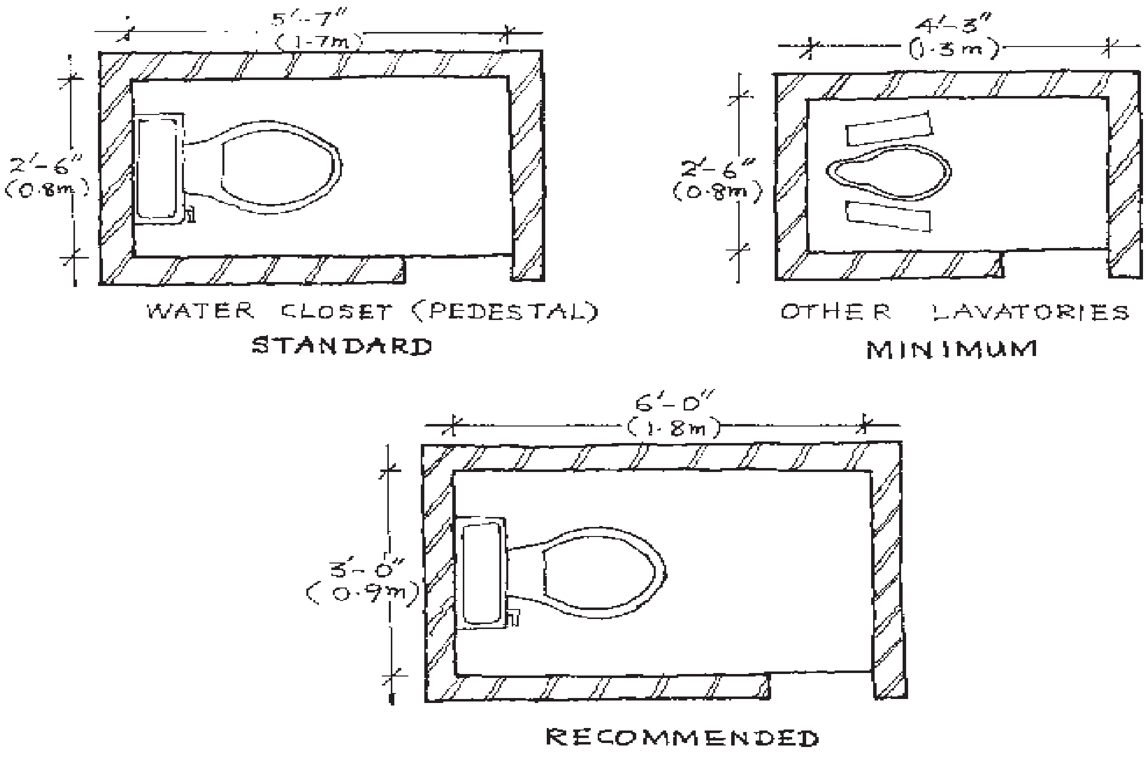
In its present form, the building regulations of Sri Lanka do not specifically refer to structural considerations. Therefore, this section consists of mandatory requirements from the relevant engineering Codes of Practice (British Standard Code of Practice – BSCP or the Institute for Construction Training and Development - ICTAD specifications) as applied to disaster-prone coastal areas of Sri Lanka, specifically targeting floods, cyclones, earthquakes and tsunamis.

Figure 8



MINIMUM AREA OF ROOMS IN RESIDENTIAL BUILDINGS

Figure 9



DIMENSIONS OF LAVATORIES & WATER CLOSETS

4.2.1 General principles of design to withstand natural disasters

In addition to the normal task of designing a building to prevent it from falling down under gravity, buildings subject to cyclones, flooding and earthquakes must be prevented from being pushed sideways and/or lifted upwards. In general, this calls for the introduction of steel reinforcement into the building envelope. For coastal buildings not subject to cyclones, flooding and earthquakes, steel reinforcement is best avoided, as the introduction of steel not only increases cost, but also introduces the inevitable onset of corrosion in due course.

Contrary to conventional wisdom, it is desirable to increase the weight of structures in order to resist cyclones and flooding.

Earthquakes can occur anywhere, but their intensity is low in Sri Lanka and hence moderate provision for earthquakes may be sufficient. Cyclones are frequent on the North and East coast and therefore design against uplift is essential, not only near the coast, but probably in the entire Eastern and Northern Provinces. The flooding considered here is mainly coastal flooding.

Any building within 500m in general and up to 2km along the East Coast and/or 3m elevation from mean sea level should be designed according to these guidelines.

Buildings designed to withstand natural disasters in the coastal belt of Sri Lanka must adhere to the following principles:

i. Building must be held down to the foundation. Hence at least 4 reinforced concrete columns at the four corners are essential.
A 150mm x 150mm corner column can be constructed inside one half of a 200 mm thick hollow block into which concrete is poured after piercing one of the 150 mm x150mm hollows in the block. Blocks in alternate courses placed in mutually perpendicular directions will have a common opening 150mm x 150mm or so (Figure 10).
Alternatively, the concrete could be poured in after constructing the walls, but GI stirrups should be placed at every 4th course in the masonry to stick into the column (Figure 11). For wall lengths exceeding 6m, an additional intermediate column along that wall should be introduced. These columns (and the pad footings described below), are essential for buildings within the coastal belt subject to flooding. They are desirable for resistance against earthquakes and cyclones.

ii. Below ground level, the column should be of 200mm x 200mm size and be connected with a concrete pad footing of size 750mm x 750mm x 150mm, with the column reinforcement bent at least 300 mm into the footing. The footing reinforcement can be 6 nos. 10mm tor steel in each direction. The formation level of the footing should be at least 1.0 m-1.5m below ground level (Figure 12).

iii. The columns (if provided) and all other walls should be connected together at the lintel level. This lintel beam can be of 100mm depth with just two 10mm tor steel bars (Figure 44). This will ensure that frame action and load transfer from walls to frames can take place in the presence of columns. Even if there are no columns, the lintel will tie walls together and improve their resistance to earthquakes and cyclones. Hence, this simple lintel beam is probably the single most important disaster-mitigation element, as it will provide some resistance against all natural disasters.

iv. The reinforcement from the columns should be connected to the wall plate of the roof.
The slope of the roof should be 22-30° to minimize wind uplift. Ideally roofing sheets should be used, fixed at intervals of not greater than 1.5m in both directions to the underlying roof timber. This provision is important for cyclone prone areas. If columns have not been used, single 10mm steel bars encased in concrete of cross section 100mm x 100mm (minimum) should be connected to the wall plates on the one hand and the lintel beam on the other. The bars should be bent into the lintel beam (prior to concreting the beam) for a length of 450mm. If a concrete roof is being used, columns are essential (in addition to the lintel beam).

v. For flooding and cyclonic conditions, walls should be made as heavy as possible; if hollow blocks are used they should be at least 200mm thick, and if 100mm thick walls are used, they should be of solid block work or brick work. Where flooding and cyclonic conditions do not prevail, minimizing the wall weight is desirable.

Figure 10

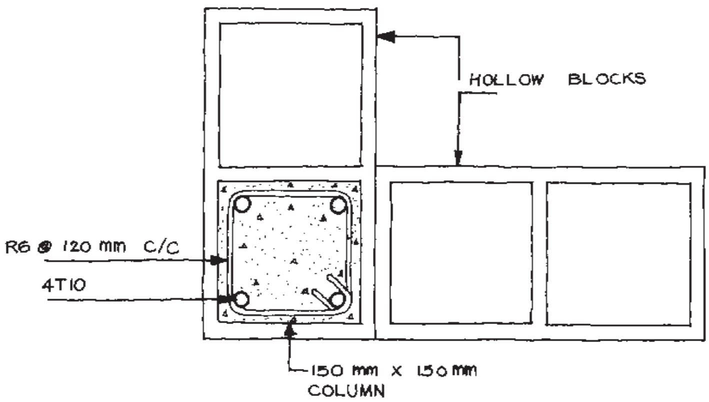


Figure 11

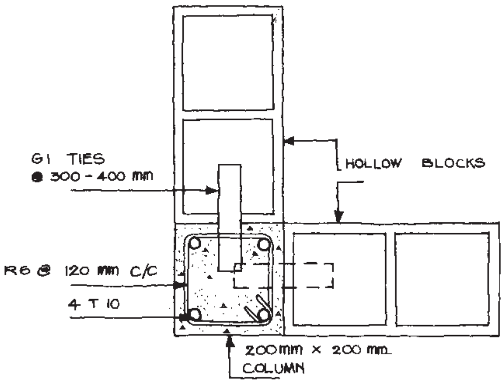
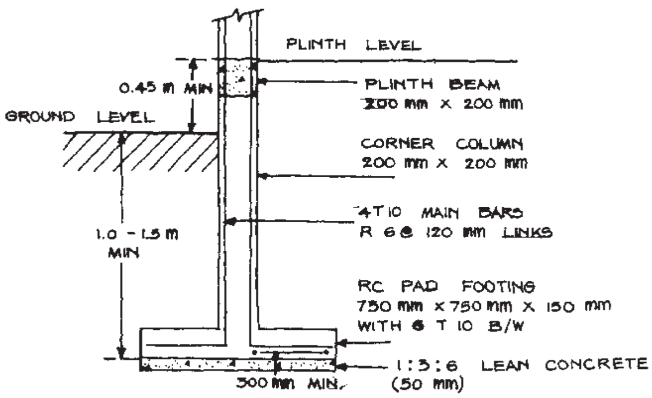


Figure 12



vi. Good quality materials should be used, especially if excessive loads may have to be resisted. For binding mortar, the mix proportions should not be leaner than 1:6 cement:sand. For making cement blocks, the proportions should be 1:10 (cement:sand or quarry dust). It could also be 1:7:10 (cement : sand : 6-8mm aggregate chips). Cement blocks should ideally be used only after 1-2 months after casting, to allow for shrinkage.
The quality of concrete should be at least Grade 20 (i.e. cement : sand : coarse aggregate = 1:2:4). Use Grade 25 for multi-storey buildings near coast. This can be achieved using a 1:1½:3 mix (cement : sand : coarse aggregate) or using a Grade 20 concrete with 15% extra cement (see, SSESL, 2005: 2-3ff).

4.2.2 Foundations

The essential requirements of foundations to withstand typical coastal disasters are given below (see also, Figure 13a and b):

Figure 13A

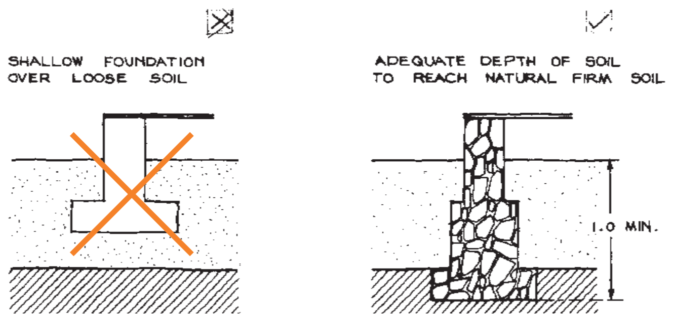
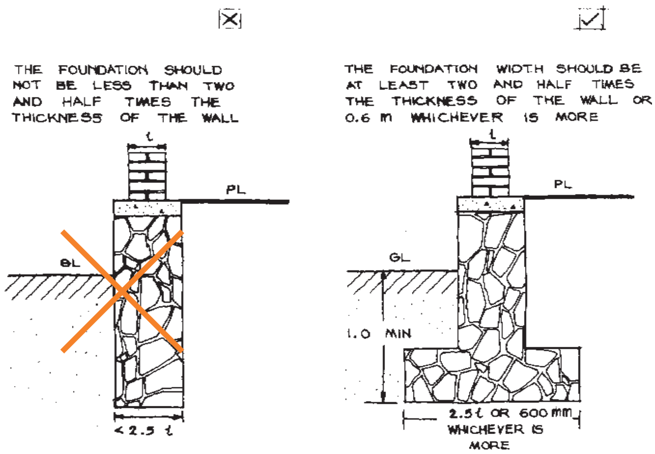


Figure 13B



i. Buildings can have shallow foundations on stiff sandy soil;
ii. When there is risk of scouring due to storm surge, a minimum depth of foundation 1.0 m below natural ground level should be provided in the coastal zone;
iii. Where a building is constructed on stilts, the stilts should be properly braced in both the principal directions. This will provide stability to the complete building under lateral loads. Knee braces are preferable to full diagonal bracing so as not to obstruct the passage of floating debris during tidal surge/tsunami;
iv. The wall foundation should have a width of two and half times the thickness of wall (not less than 0.6m in any event). Footings should be constructed in stone or cement blocks, and not in brick work;
v. The plinth height should not be less than 0.45 m above natural ground level or as per topography requirement;
vi. The columns should be founded on pad footings.

Table 7 – Minimum width of load bearing foundations for single and two-storied houses

Type of sub soil	Condition of sub soil	Min. width in mm (in) for total load in kN/m	
		15 kN/m	30 kN/m
Rock	-	Equal to width of wall	
Gravel	Compact	150 (6")	300 (12")
Sand	Compact	150 (6")	300 (12")
Clay	Stiff.	150 (6")	300 (12")
Sandy Clay	Stiff.	150 (6")	300 (12")
Clay	Firm	175 (7")	350 (14")
Sandy Clay	Firm	175 (7")	350 (14")
Gravel	Loose		
Sand	Loose	300 (12")	600 (24")
Silt Sand	Loose		
Clay Sand	Loose		
Silt	Very Soft		
Clay	Very Soft	425 (17")	850 (34")
Sandy Clay	Very Soft		
Silt Clay	Very Soft		

Notes:

1 Width of foundation should be greater than the minimum given in the Table, in order to minimize the adverse effects due to tree roots where necessary.

2 Loads on walls of domestic buildings are unlikely to exceed 30 kN/m for 2 storey and 15 kN for single storey.

4.2.3 Two and multi-storied framed structures

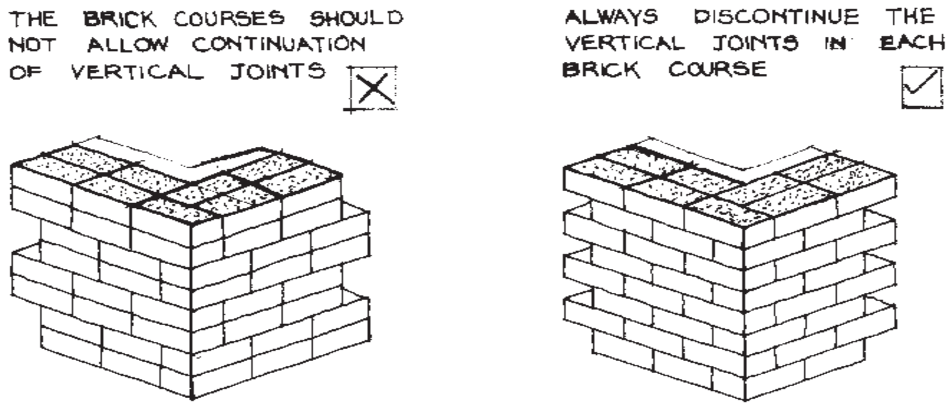
Types and sizes of foundations mainly depend on the load transferring method to soil (through column or walls) and the bearing capacity of soil.

Concrete frame with infill walls above first floor with columns having lateral bracings at ground level is recommended. In such buildings ground floor should be structurally detailed for seismic resistance.

4.2.4 Walls

i. All external walls or wall panels must be designed to resist the out of plane lateral pressure adequately. For this, the walls should be sufficiently buttressed by transverse walls.
ii. A small building enclosure with properly interconnected walls is ideal. Buildings having long walls should be avoided.
iii. It is necessary to reinforce walls by means of at least one horizontal reinforced concrete band at lintel level.
iv. The thickness of the load bearing and/or external walls should not be less than 200mm; other walls can be 100mm thick. If external walls are 100mm thick, they must be of solid cement blockwork or brickwork.
v. Since tensile and shear strength are important for lateral resistance of masonry walls, use of mud or very lean mortars should be avoided. A mortar mix leaner than 1:6 cement : sand should never be used.
vi. For achieving full strength of masonry, the usual bonds specified for masonry should be followed so that the vertical joints are broken properly from course to course (Figure 14).
vii. Concrete columns (200mm x 200mm) founded as pad footings must be provided at least at the four corners of the building. These columns should be connected by a continuous lintel beam.
viii. The free-standing wall height should not be greater than 3m.

Figure 14



4.2.5 Openings

i. Openings should be avoided or minimized in walls facing the sea;

ii. Openings should be located away from the corners by a clear distance equal to at least 25% of the height of opening or 600mm whichever is more (Figure 15);

iii. The total length of openings should not exceed 50% of the length of the wall between consecutive cross walls in single storey construction. (This figure should be reduced to 42% in two storey construction and 33% in three storey buildings);

iv. The horizontal distance (pier width) between two openings should not be less than 50% of the height of the shorter opening or 600mm, whichever is more (Figure 15).

Figure 15A

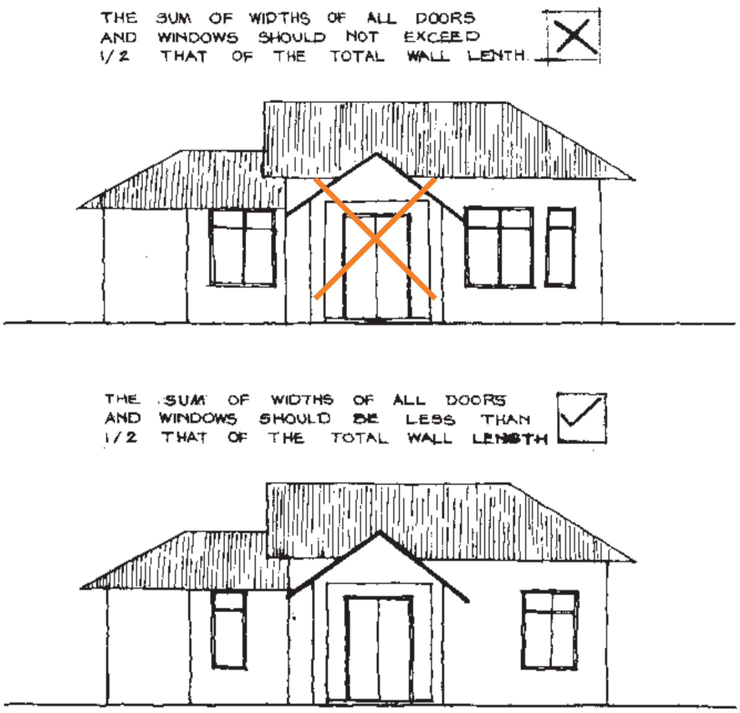
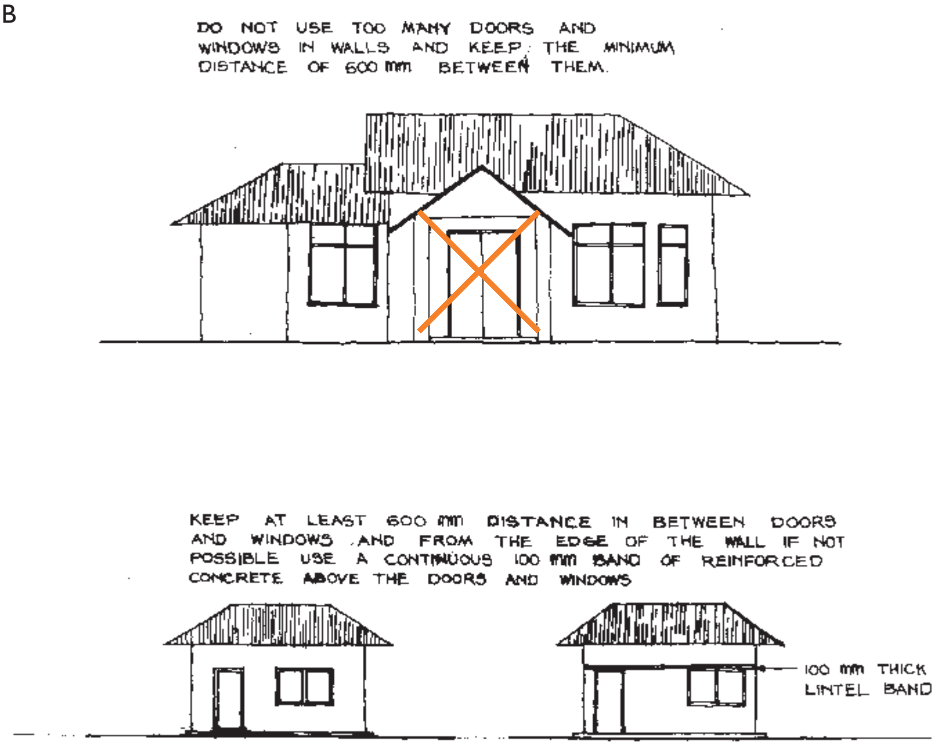


Figure 15B



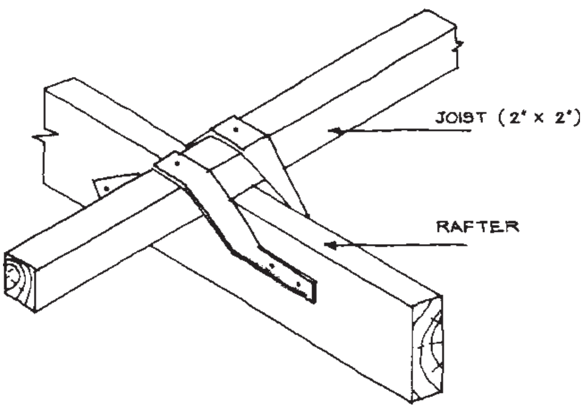
4.2.6 Roof structures

i. Light weight low-pitched roofs should be strongly held down to purlins, with fastenings spaced not exceeding 1.5m in both directions (i.e. along and across slope) (see Figures 16-18 for fixing details);

ii. Similarly, purlins should be tied to rafters, the rafters to the wall plate and the wall plate to the reinforcement coming up from the walls;

iii. Pitched roofs with slopes in the range of 22° to 30° i.e. pitch of 1/5 to 1/3.5 of span will reduce suction on roofs and facilitate quick drainage of rainwater.

Figure 16



4.0 GUIDELINES ON SETTLEMENT DESIGN CONTD.

Figure 17

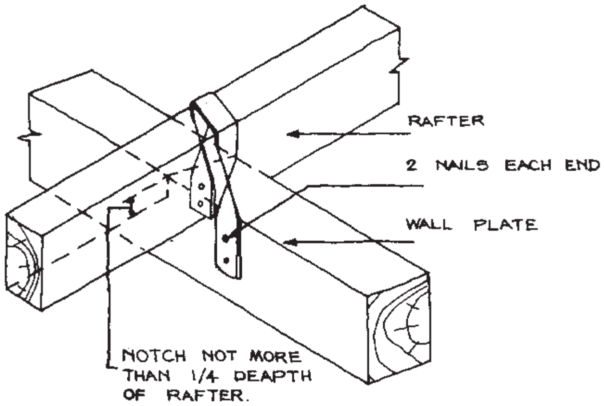
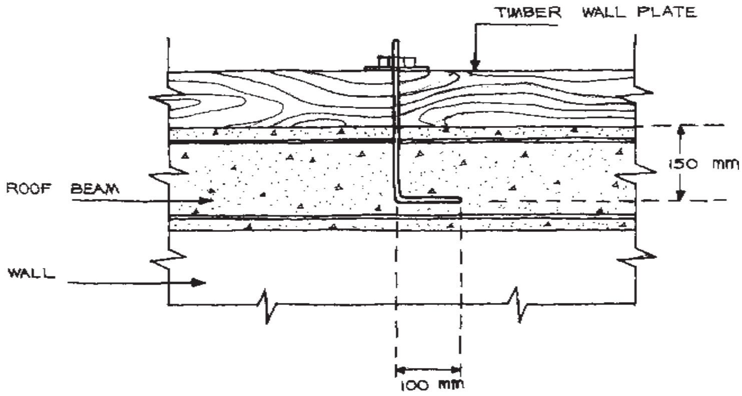


Figure 18



5.0 GUIDELINES ON PROVISION OF PHYSICAL INFRASTRUCTURE

5.1 Water supply

All housing settlements should have access to safe drinking water, either by a piped water supply system or by a protected well or from ground water (tube well). The supply system must have the concurrence from the water supply authority (NWS&DB or local authorities) in terms of quantity and quality of the supply.

Pipe systems should be designed for carrying capacity (flow) and pressure conditions. Thus, assessment of the water demand and the requirement of pressure are the basic considerations in designing a water supply system. When calculating the quantity of water required to a settlement or a storied apartment complex, the recommended per capita consumption is 140 liters per person per day.

The following are suggested as the basic requirements for a satisfactory water supply system:

i. The pressure head available (residual pressure) at any point of the distribution system should be more than 5m;
ii. The minimum velocity in a pipe line should not be less than 0.6m/s to prevent deposition of silt;
iii. Air valves and scour valves should be provided at high and low points respectively;
iv. A minimum of one day's requirement must be stored at site;
v. When ground and elevated storage is provided, the common practice is to provide 70% of the total storage as ground storage and the balance as elevated storage;
vi. Pipe line laid in flat terrain should have a minimum gradient of 1 in 500 to drain and expel air in the line;
vii. When laying pipe lines in trenches, the minimum trench width should be d+300mm, where 'd' is the diameter of the pipe (in mm). The minimum earth cover for buried pipes should be 0.8m (normal conditions) and 1.0m (in roadways). Water and sewer pipes should never be laid in the same trench. Water pipes should always be laid above sewer/drainage pipes;
viii. The minimum horizontal clearance of any sewer line should be 3m and the bottom of the water line should be at least 0.5m above the top of the sewer line.

5.2 Electricity

5.2.1 Power supply system

Depending on the location of the proposed housing development, consumers will have to approach either the CEB or LECO to obtain new service connections. Upon receipt of a request for the supply of electricity, the supply authority will estimate the cost of infrastructure provisions (construction work connected with cabling as well as equipment such as transformers, if needed).

Electricity required for community settlements can be obtained from power supply authorities by using one of the following methods.

i. For few houses – from the existing single phase or 3 phase line
ii. For a large settlement (more than 24 nos. housing units) – from the existing high voltage lines (33kv & 11 kv) through a transformer installed within the premises of the project site.

The entire on-site access roads, footpaths, streets, etc., should be illuminated with street lighting.

Wherever possible, provide underground cables for electricity supply to avoid damage due to falling of overhead cable lines on houses and the public during high wind. Underground cabling will also help avoid illegal connections.

The decision to locate transformers should involve consultations with the residents. In any event, transformers should be located so as to keep the minimum distance specified by CEB between the transformer and the nearest house. It is advisable to consult the CEB area office to get this information.

No construction is allowed under any transmission line passing through a proposed project site. A horizontal distance of 2m (6'- 0") from either side of the transmission line should be reserved as a service reservation for the transmission line.

5.2.2 Internal distribution system

The internal distribution system should comply with the latest IEE regulations published for internal wiring of buildings. Select the most suitable method of wiring out of the three methods indicated below.

i. Concealed conduits buried in slabs and walls;
ii. Surface mounted PVC casings and boxes;
iii. Surface mounted PVC conduits/casing.

Items and materials selected should be in compliance with the latest BS/SLS or their equivalent. The correct type of protective devices (MCB & ELCB) must be selected for the distribution board to protect the system against overload, short circuit and earth leakage/electric shock. Care must be taken to ensure that the correct type /size of cables are selected so as to reduce construction cost and to avoid abnormal heating / fire hazards.

The request for type of supply (15A/30A single phase or 15A/30A 3-phase) should be made according to the recommendations shown in Table 8.

Table 8 – Recommended CEB/LECO service connections

System	MAXIMUM NO. OF POINTS TO BE USED				
	Lamps & Fans	5A Socket outlets	15A Socket outlets	Exhaust fan, shaver sockets, electrical bells	Recommended power supply
Type 1	8	4	-	1	* Single phase 15A
Type 2	25	8	-	2	Single Phase 30A
Type 3	25	7	1	3	Single phase 30A
Type 4	25	5	2	3	* Three phase 15A
Type 5	75	21	3	3	Three phase 30 A

* could be obtained only for Colombo metropolitan area

Note:

15 Amp socket outlets not recommended for 15 Amp service (Type 1)
15 Amp sockets 02 Nos. are not recommended for 30 Amp service (Type 2)

5.2.3 Lightning conductors

Following factors will necessitate the installation of lightning conductors in buildings:

i. Project site situated in a relatively isolated area;
ii. Project site located in a lightning-prone area;
iii. Houses / Housing blocks proposed to be constructed will be the tallest objects in the area;
iv. Risk indicators calculated for the buildings are above the standard marginal values.

If needed, the most suitable system is the conventional type (Franklyn rod) as opposed to the more expensive systems such as an early streamer emission system. No radioactive type is allowed (see, ICTAD publication SCA /8, Aug. 2000).

The applicable specification for the system should be the British Standard (BS 6651), Code of Practice (CP 326) or SLSI publication : 2004.

Table 9 – Recommended installation heights

Electrical installation	Recommended height of installation (mm above floor level)
Switches	1350
Socket outlet (low levels)	300
Socket outlet (Kitchen area/ pantry)	1200
Pendent Lamp	2400
Florescent Fittings	2400
Ceiling fans	2400
Consumer Units	2100
Wall Bracket Lamps	2250

IMPORTANT NOTES

1. All lamps with metal parts should be earthed.
2. All florescent lamps should be of power factor corrected type.
3. All cables shall be PVC/PVC/Cu except earth wire which could be PVC/Cu. PVC/PVC/Cu - PVC insulated, PVC sheathed cables with copper conductor [Rigid/strained, single core or twin multi core]. PVC/Cu - PVC insulated Copper conductor without sheath.
3. Lamps, fan circuits and 5 Amp socket outlets shall be wired with 1/1.13 mm ($1mm^2$) cable and 7/0. 67mm ($2.5mm^2$)earth wire.
4. Switches, socket outlets and distribution board should be flush or surface mounting type.

Table 10 – Sub-circuit arrangement

Circuit Type	No. of points per circuit	M.C.B. Rating
Lamps, fans, bells	8	6 A
5 A. Plugs	2	10 A
15 A Plugs	1	16 A
Ring circuits (with 13 A plugs)	Any number	16/20 A

5.3 Telecommunication

Telecommunication is a fast changing area of infrastructure that has seen unprecedented growth in the recent past. The primary provider of telecommunication services (Dept. of Telecommunications) was privatized in 1997 (Sri Lanka Telecom) and several privately owned fixed and wireless local loop operators are present in Sri Lanka. With the introduction of Code Division Multiple Access (CDMA) technology, telecommunication facilities can be obtained virtually over the counter.

The only restriction the present guideline wishes to point out is that no telecommunication transmission tower is allowed within housing project sites. It is further recommended that the distance from a transmission tower to a nearby building should be twice the height of the tower.

5.4 Waste water disposal

Wastewater can be treated in three different ways:

i. On-plot waste water disposal;
ii. On-site waste water treatment and disposal;
iii. Off-site waste water treatment and disposal.

5.4.1 On-plot waste water disposal (Toilet waste included)

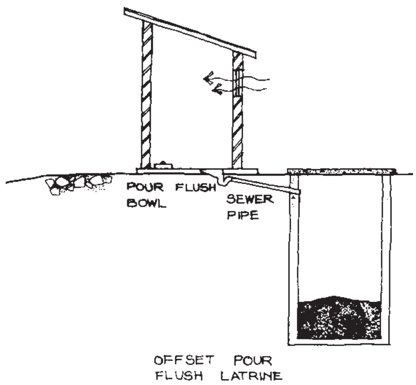
The primary mechanism of on-plot waste water disposal system is a septic tank followed by a soakage pit (either pre-cast or cast in situ). Pre cast septic tanks can also be used as an alternative for the cast in situ types. Popular sizes of the tanks available in Sri Lanka for a single family unit consisting 5 members are:

0.6 m (2'-0") Diameter and 2.4 m (8'-0") length;
1.0 m (3'-3") Diameter and 2.4 m (8'-0") length.

High absorption capacity in the soil and low water table are the prime requirements to introduce this type of soakage pits.

Other systems of on-plot waste water disposal are, double pit compost toilets and a pour flush pit latrine.

Figure 19



5.4.2 On-site waste water disposal

The primary components of an on-site system are, a Septic tank followed by an anaerobic biological filter and soakage pit, soakage drain field, evaporation mounds or discharge into an open water body after purification. The NHDA possess vast experience in designing these types of wastewater disposal methods for medium density housing settlements (60 housing units per acre) and walkup apartment complexes island-wide. (Design assistance in this connection can be provided by the NHDA on request. See Figure 20 for typical details).

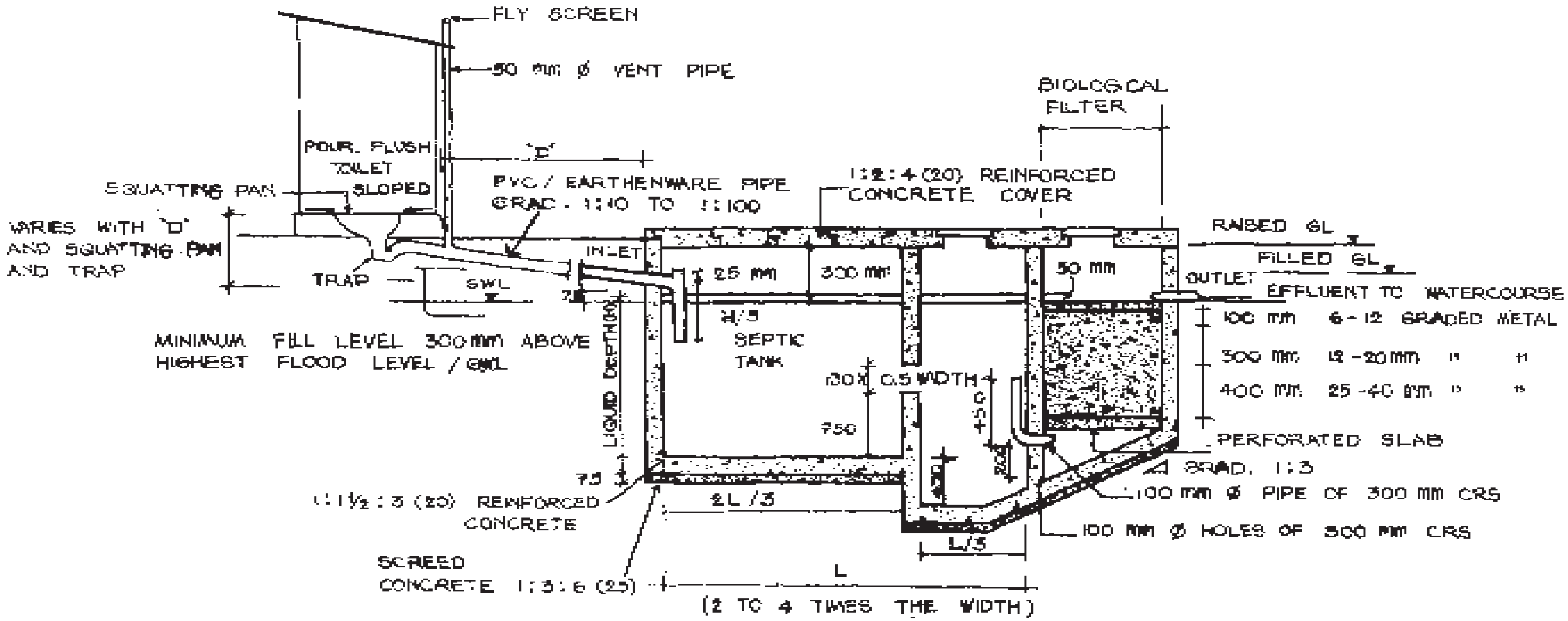
Compacted water treatment plants such as oxidation ponds, package treatment plants, and aerated lagoons, too can be selected to suit the site conditions.

If the compacted water treatment plants are planned to be used at site, clear distance (buffer zone) from the housing units are to be maintained as indicated in the respective plant specifications. (As a rule of thumb, the plant should be located approximately 30 m away from the nearest housing unit).

Selection criteria of the above systems are governed by the following factors.

i. Population density;
ii. Volume of waste water produced;
iii. Presence of shallow wells susceptible to waste water pollution;
iv. Soil permeability;
v. Unit cost of waste water collection;
vi. Socio economic and cultural considerations.

Figure 20



Note:

Not to scale

Dimensions may vary depending on number of users & ground conditions

Source: GUILDLINES for portable water supply, waste water and storm water drainage, domestic sewage disposal and solid waste management of designated low income housing projects in Sri Lanka, P. 41

5.4.3 Off-site waste water treatment systems

Off-site options should be considered when on-site treatment could entail direct risks to public health or ground water. The risk of fecal contamination or eutrophication of coastal waters exists in more densely populated areas.

Discharging into a city sewerage system is the best option to overcome all the issues pertaining to disposal of domestic and community level waste accumulation.

Before planning a housing project, an important action is to invest in the improvement of existing sewerage treatment facility or introduce a proper off-site sewerage network first and then design the housing scheme accordingly.

5.4.4 Identification of the location of septic tank

The septic tank should be located in an open area with access to a suction tanker (Gully Emptier).

5.4.5 Soakage pit

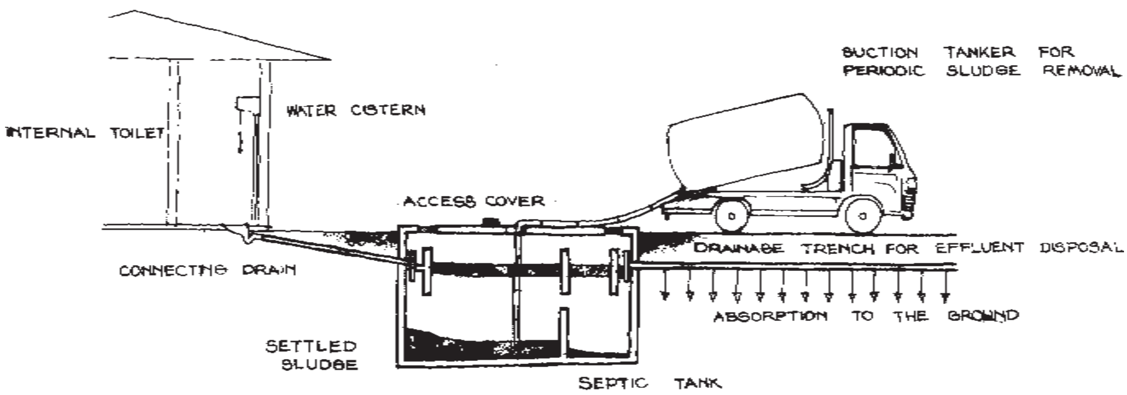
Soakage Pits should be located in an open area and satisfy the following requirements;

i. At least 15m away from the nearest well or other drinking water sources;
ii. At least 5m away from the nearest building.

5.5 Storm water disposal

Onsite drainage network has to be designed to dispose all the storm water (i.e. water which runs-off the buildings and land as a result of rain fall).

Figure 21



Storm water drains are of two different types:

i. Site drains (primary drains);
ii. Off-site drains (secondary drains).

Site drains are constructed on the side/s of internal roads, foot paths, streets, backyards etc., and convey the accumulated water into the secondary drains, which sometimes disposes water into a near-by stream or canal. Most of the secondary drains are off-site drains, the maintenance of which comes under the purview of the respective Local Authority. See Figures 22-29 for further details.

Figure 22

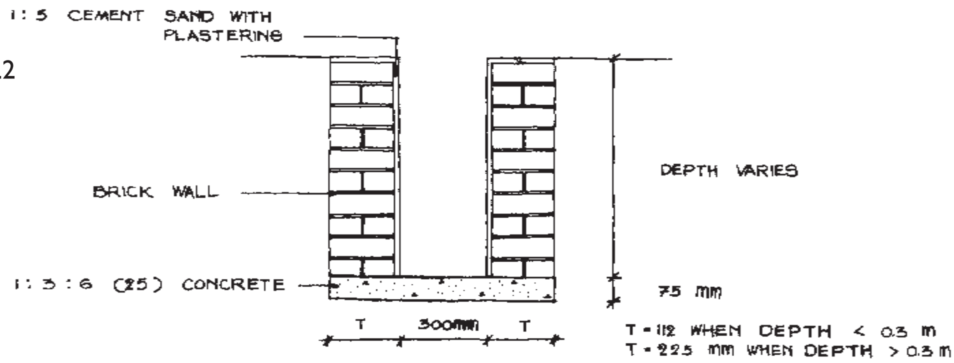


Figure 23

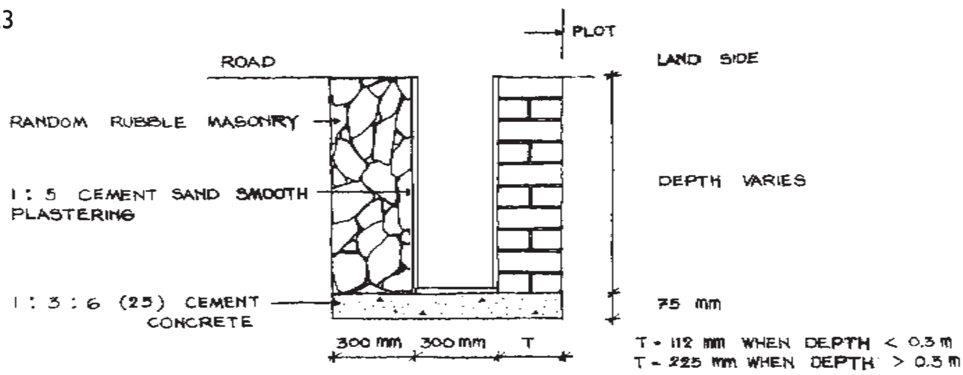
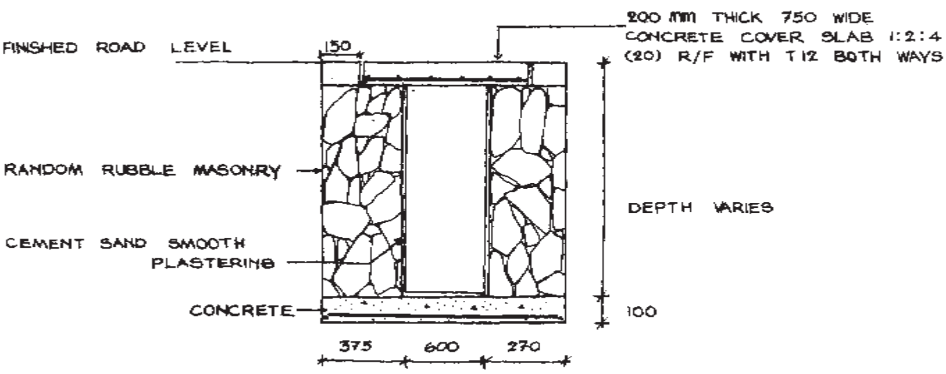


Figure 24



5.0 GUIDELINES ON PROVISION OF PHYSICAL INFRASTRUCTURE CONTD.

Figure 25

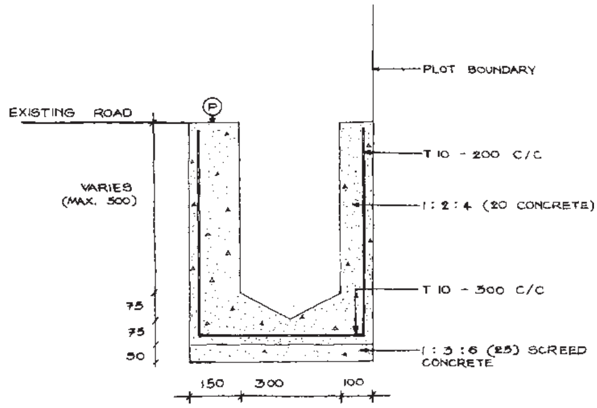


Figure 26

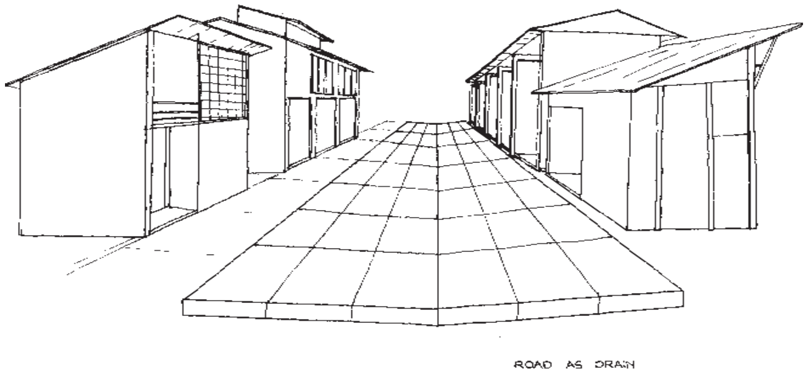


Figure 27

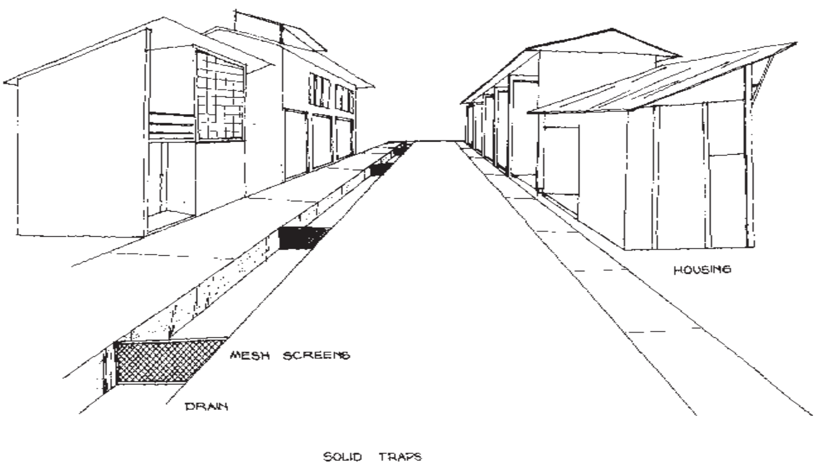


Figure 28

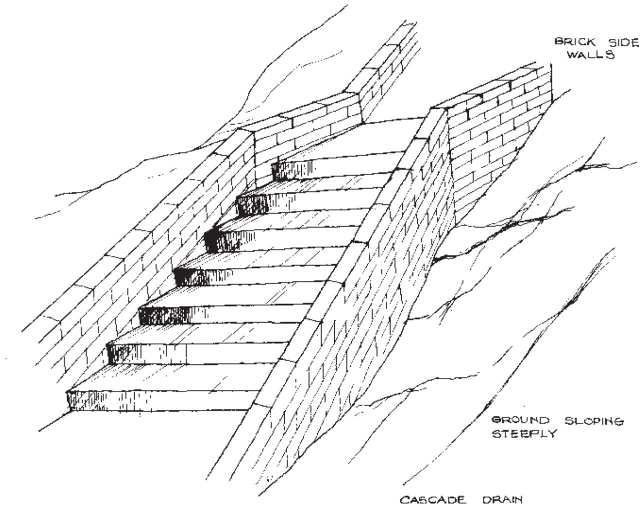
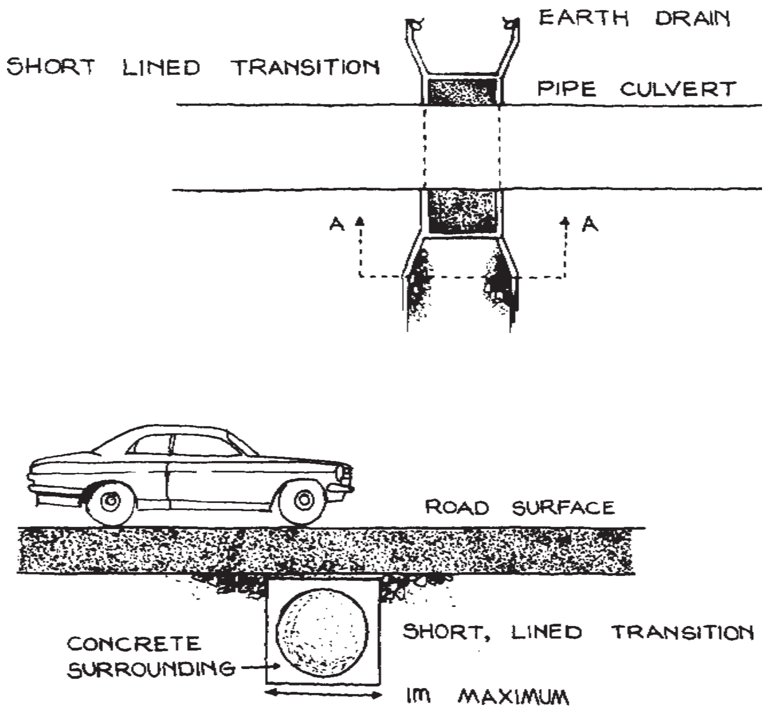


Figure 29



Sizes of the storm water drains are governed by factors such as rainfall intensity, ground slope and the drain type.

The following guidelines can be used to determine a suitable drain for housing development:

Table 11 – Drain capacities (in liters / second) for rectangular brick/block/rubble lined drain with smooth cement mortar rendering

Bed slope	Drain size (width x depth) in mm			
	1000 x 500	750 x 375	500 x 250	250 x 125
1:150	1,080	500	170	27
1:300	760	350	120	19

Table 12 – Drain capacities (in liters / second) for unlined earth drains

Bed slope	Top width of drain (mm)		
	1000	750	500
Unlined earth drain with side slope 1:2			
1:200	*	38	13
1:300	67	31	11

Bed slope	Top width of drain (mm)		
	500	400	250
Unlined earth drain with side slope 1:1			
1:200	35	19	6
1:300	29	16	5

Note:
* Indicates that severe erosion will be likely.

5.6 Solid waste disposal

All households should be provided with a proper garbage disposal system.

Sorting of bio-degradable and non bio-degradable materials at domestic level should be encouraged and communities should be directed towards domestic composting methods.

Recommended value for consideration of total domestic waste accumulation is 0.3 kg/person/day. In the Sri Lankan case, this could be assumed to consist of 80% bio-degradable and 20% non bio-degradable materials.

Proponents of large housing schemes are strongly encouraged to introduce and establish a commercial level waste re-cycling center to ensure the reduction of the accumulation of garbage at site. In order to facilitate the timely removal of garbage, adequate access must be made available in the design for collection and disposal of garbage by the Local Authority.

Section II – BEST PRACTICE GUIDE

6.0 GENERAL PRINCIPLES

6.1 Post-tsunami observation

Even a cursory observation of the structures affected by the tsunami waves would reveal that the most severely damaged structures are those constructed close to the sea. Although the degree of damage correlates to the magnitude of wave pressure, factors such as structural form, shape of buildings and orientation in relation to the wave direction also had significant bearing on the extent of damage.

Building with load-bearing walls, especially those that are perpendicular to the direction of the waves had shown less resistance to the ocean waves and had been completely destroyed, whereas framed structures with reinforced concrete columns and beams as well as load bearing walls that are parallel to the direction of the waves have shown a higher degree of resistance.

While the extent and severity of damage provides clues towards best practice, the re-construction exercise itself could benefit from best practices developed elsewhere in post-disaster renewal and rejuvenation. On the one hand, the social aspects of re-construction, especially an inclusive and participatory approach has proved to be successful in many contexts. On the other, post-disaster scenarios often provide a golden (if perverse!) opportunity to "design with nature" that not only will withstand future disasters well, but are also cost-effective.

This section is a distillation of the collective wisdom of several key stakeholders involved in post-disaster housing in terms of social, environmental and technological aspects. It is hoped that the best practices advocated here will re-kindle the imagination of all players in the Sri Lankan post-disaster housing scene. It is also hoped that the wisdom contained herein will continue to grow even as greater experience in these matters is accumulated.

6.2 Best social practices – Community centered planning

Rebuilding communities and involving them in the early stages of shelter programming is essential. Providing a "dignified living" is first of all a matter of enabling the people to make appropriate choices themselves and set their priorities at all stages of project implementation.

Lack of substantive, effective and continued community involvement carries great risks both to the community and to the success of a housing project. The risks to the community (or families within the community) of ineffective community involvement include, the creation of structures and site arrangements that do not satisfy their needs or desires; and lack a sense of ownership of the asset.

This can result in community unrest that delays or challenges the completion of the project; un-utilized or abandoned structures, either in small or large numbers and the degeneration of the settlement over time so that it becomes a slum due to the lack of satisfactory livelihood opportunities or greater distance from necessary resources.

The affected families and communities will take ownership of the process and the results only if they are involved in the decision-making and implementation process. When the community takes ownership of the process and the results, there is a greater likelihood of short and long-term project success and the minimization of the concomitant risks.

In essence, community mobilization and participatory approach to housing development would involve:

i. understanding who the beneficiaries are and prioritizing their needs,
ii. incorporating the resources and capacities of the community, and building capacity and awareness for effective decision-making in the process,
iii. utilizing designs and site plans that are appropriate to the social, cultural and physical context,
iv. recognizing and responding to the priorities of the community, and especially of vulnerable populations,
v. community decision-making process at all stages.

6.2.1 Steps for a participatory approach

A. Preliminary steps:

i. Understand the background context. It is important to recognize the demographics, ethnic or group relations, political dynamics and civil society structures which might influence particular sensitivities or generate conflicting interests.

ii. Consult beneficiary households through local social animation activities. Households should be provided with informed choices as to their entitlement, consideration of relocation sites, the approach to construction and their involvement. Community groups should be consulted to ensure that the voices of vulnerable groups are represented, eventually organizing focus group discussions (for example, women-only groups).

iii. Establish clear terms of reference for the committee(s) involved in community consultations and decision-making. Committees can supervise most of the activities. If the Committee is well-structured, its role can include purchasing local materials for housing support and conducting community hearings on transparency, accountability, and efficiency.

iv. Sign formal agreements between the beneficiary family, implementing agency, and local authorities on house allocation. Procedures for housing and land allocation must be clear, transparent and fair. Land tenure rights are the pre-requisite to all housing schemes.

v. With the community, assess and evaluate needs and priorities, livelihood options and social, cultural, and religious practices. Discuss how these might impact housing and settlement choices and designs.

vi. Guarantee avenues for accountability. The community has the right to adequate information on their entitlement, relocation options, livelihood conditions and the commitments of the implementing agency (or agencies).

B. Planning and design steps:

i. In design workshops, allow the community to take decisions about site planning and aspects of their shelter. This should include size, materials used, planned structure, and construction process. Whatever housing construction is chosen it must be sustainable both technically and financially (repair, maintain a good state etc).

ii. Where groups are relocated together, promote shelters in small clusters which enable social networking and kinship through sensitivity to proximity and shared social spaces.

iii. Utilize community action planning techniques. Community Action Planning (CAP) encourages participants to detail the expectations and functions of the shelter according to accepted standards, local technologies and cost and time limitations.

iv. Incorporate government and other stakeholders into the consultative process. Provide regular feedback to all stakeholders and consciously integrate them into the process at various defined stages. This will guarantee adequate information for all relevant parties, strengthen understanding, avoid confusion and maintain support throughout the process.

C. Construction steps:

i. Develop prototype building(s). Use the prototype(s) to compare alternatives, constraints and advantages and disadvantages of types of structure.

ii. Involve the community in the construction phase. The beneficiary family should have the option of helping to construct their houses. Discuss availability of skilled and unskilled labor of the affected community. This can infuse income into the community, increase skills and capacity and promote a sense of ownership.

iii. Promote construction through the Rehabilitation Committees. The rehabilitation committees are social institutions developed to assist (re)construction operations. These committees can be good vehicles for delivering permanent houses. The committees will organize building material production, procure the materials and identify construction teams, organize on-the-job training if skilled teams are not readily available, supervise the construction and manage the whole intervention under the guidance of technical support teams.

iv. Develop Self Help Housing by the families - The families will actively participate in construction and own the intervention from the very beginning. They will assist the mason teams during construction and cure the building and also care for the safety of all the building materials. The family will identify the masonry team and get assistance on the construction. They will receive periodic payments based on the progress they have made.

6.0 GENERAL PRINCIPLES CONTD.

Other participatory initiatives should be considered to improve the living environment and re-establishing livelihood options. The most important sectors that need to be considered are:

i. Durable solutions for water and sanitation supply and innovative initiatives to make use of existing resources (for example, rainwater harvesting);
ii. Solid waste management schemes through community involvement;
iii. The use of alternative sources of energy (for example, solar devices and/or windmills for water pumps);
iv. Improvement of drainage and common infrastructure;
v. Construction of Community Resource Centers and other facilities to launch common activities and training.

7.0 BEST PRACTICES IN ENVIRONMENT-CONSCIOUS DESIGN

7.1 Sustainable design – conceptual issues

Sustainable design in the resource-starved, highly populated and warm humid tropics depends to a large extent on climate-sensitive design. However, before we attempt climate sensitive (and therefore energy efficient design) at building scale, it is important to design the neighborhoods and collections of houses in a sustainable manner so that greater improvements to the environmental quality occur at the macro (urban) scale.

Sustainable and climate sensitive design at the neighborhood scale must achieve the following goals:

i. Energy efficient site planning layout;
ii. Minimize input quantity and maximize output quality of water use;
iii. Reduce the need for fossil-fuel powered transportation;

7.1.1 Energy efficient layout

While energy efficiency can be achieved at several scales, a useful starting point is the very form of the neighborhood. Overall form determinants need to be put in place right at the beginning, if we are to regulate the housing development, in an efficient manner. In the context of the tropical climate, energy-efficient layout needs to address the following issues:

i. Site and building orientation for avoidance of sun
ii. Site and building orientation for encouraging air movement
iii. Shading device requirements for open spaces
iv. Landscaping requirements for heat-gain reduction.

At the same time, the efficiency of human activities depends on the number of people served: in other words, density. And density is not necessarily proportional to height. Density is achieved by a reorganizing of street patterns and rethinking of the importance of automobile to neighborhood life.

Another strategy for dealing with density is to restrict plot sizes. In the Indian context, Correa (1989) suggested a medium size of 50 – 100 m^2 (540 - 1080 ft^2) in his new Bombay proposals and found that they were acceptable for both the poor and the affluent sections of the society.

7.1.2 Reduce need for fossil-fuel transport

The greatest impediment to neighborhood quality-of-life comes from automobiles. The most sensible approach will be the encouragement of the most energy-efficient modes of transportation. These include walking and bicycles, closely followed by public transportation.

The problem with walking and riding bicycles in the tropics is that the high air temperature coupled with high relative humidity makes these activities enervating. To encourage these modes therefore, shaded pathways exclusively designated for pedestrians and bicycles need to be provided. These actions will positively impinge upon the climatic quality of the neighborhood.

7.1.3 Minimize input quantity and maximize output quality of urban water

Neighborhood-scale water cycle is both large in volume (due to increases in supply and waste – see Figure 30) as well as poor in quality (due to pollutants, heavy run-off and turbidity).

Figure 30

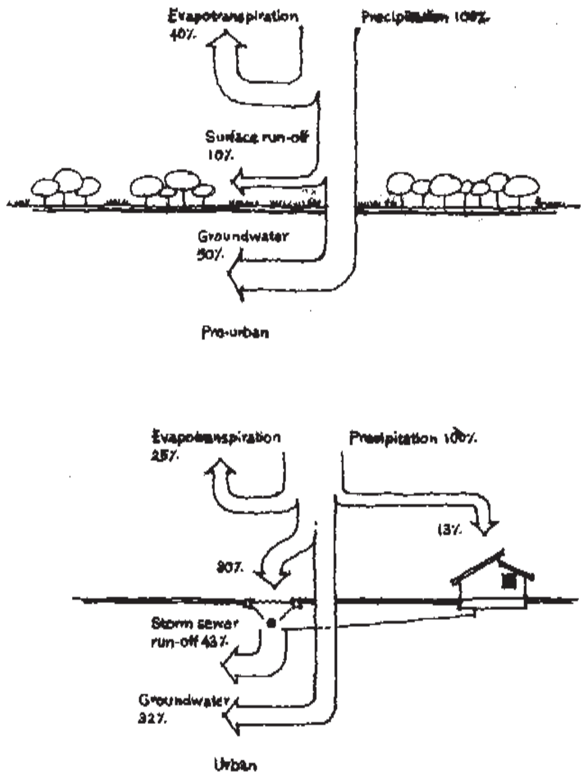
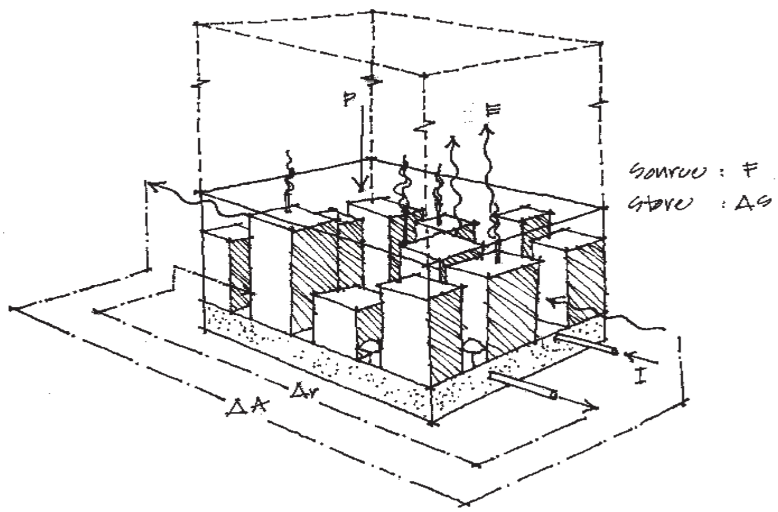


Figure 31



While neighborhood design may not have much influence on the supply side of urban hydrological balance, it certainly can influence the relative partitioning of output water into hydrological sinks. Generally speaking, a greener neighborhood has more possibilities for increased latent heat partitioning (and therefore less sensible heat outflow, less Urban Heat Island effect), lower thermal inertia in the built fabric (thus lower heat storage), and slower – but higher quality run-off from the neighborhood.

Enhancement of evaporation involves increasing green surfaces in the neighborhood as well as impoundment of rain water. Storage can also be improved by encouraging porous street surfaces and sidewalks. The quantity of net water output can be reduced by impoundment as well as using waste water as a useful by-product of the neighborhood. This in turn can improve the quality of run-off water.

The general principle of neighborhood hydrological management is best captured by the phrase, "reduce need and improve output quality." It would translate into at least four design strategies:

i. Waste as resource;
ii. Land as a filter;
iii. Retention ponds & lakes;
iv. Enhancement of green surfaces.

7.2 Tools for enhancing neighborhood environmental quality

Environment-conscious designers have at least three tools for the realization of the goals of thermal comfort improvement (energy efficiency), transport reduction and water quality improvement.

i. Zoning laws;
ii. Building laws;
iii. Landscape control.

Table 13 – Design tools for urban physical quality enhancement

Design Tool	Possible Form	Design Goal	Environmental Effects
Zoning Law	Sub-division size regulation, built density control, land-use control, street width & type control, specifications for bicycle lanes and pedestrian paths, promenade and neighborhood squares regulations, waterfront development controls	Energy efficiency, transportation reduction	Air Quality, Climate Quality improvements
Building Regulations	Building and site orientation guidelines, building form guidelines, building envelope control, arcade development guidelines, building height limits, shading requirements, energy audits	Energy efficiency	Climate quality improvements
Landscape Control	Type and density of green space guidelines, Water impoundment requirements, hedge and fence controls, public green space guidelines	Energy efficiency	Climate quality, Water quality improvements

7.3 Design strategies

Design strategies for the enhancement of neighborhood physical environmental quality are specific suggestions utilizing one more of the above-mentioned design tools. In order to achieve the design goals of energy efficiency, transportation reduction and water quality improvement, design strategies could take one of the following forms:

i. Building form guidelines;
ii. Activity pattern controls;
iii. Control of relationship to natural features.

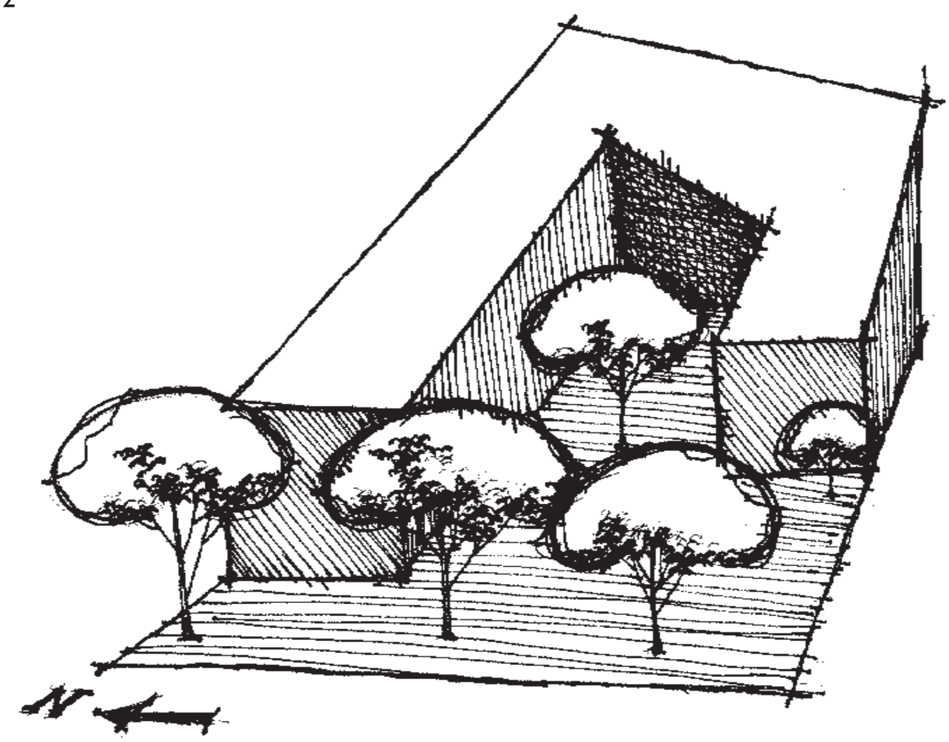
The primary controlling factor in all these strategies is SHADING. Additionally, these strategies augment the cooling potential of shading by promoting urban ventilation and evaporative cooling.

7.3.1 Building form

a. Courtyard forms

Courtyards have had long architectural traditions. Though originated in hot-dry areas like in the Middle-east, European influence in the hot-humid region has produced adapted courts for various purposes, primarily dwelling.

Figure 32



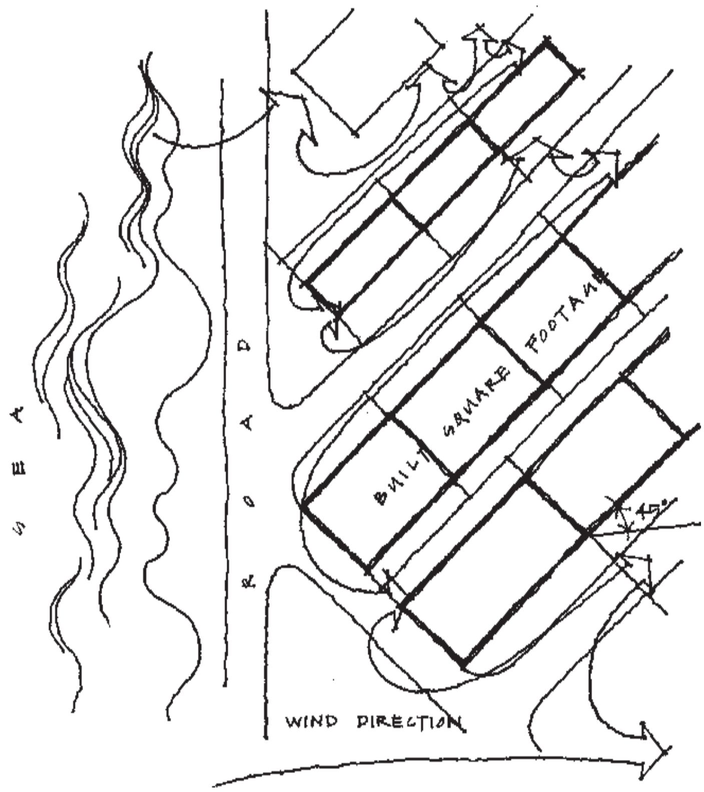
While the courts in hot, dry zones have a cooling function (drawing hot air towards the cool court), the possibility of creating a shaded "common" in the middle of the house is an appealing proposition for tropical dwellers. However, care must be taken not to jeopardize thermal comfort in the built spaces. There is proof that wrongly oriented and proportioned courtyard buildings are detrimental to thermal comfort in weak-winded areas like the equatorial tropics.

Therefore, where private "commons" are desired, let the buildings enclose a court. The buildings themselves must be minimal, as thin as possible, the emphasis being on the shading they create upon the court. The height of building will be the critical factor. A three-sided court with no buildings on the west will be the ideal, the west being the most difficult orientation to shade the low latitudes.

b. Orientation

The high altitude of sun during most of the year in the hot-humid regions dictates that west and south facades are the most difficult to shade. Thus site layout and building orientation incentives can be built into the building ordinances of Sri Lankan cities to encourage north/east orientations.

Figure 33



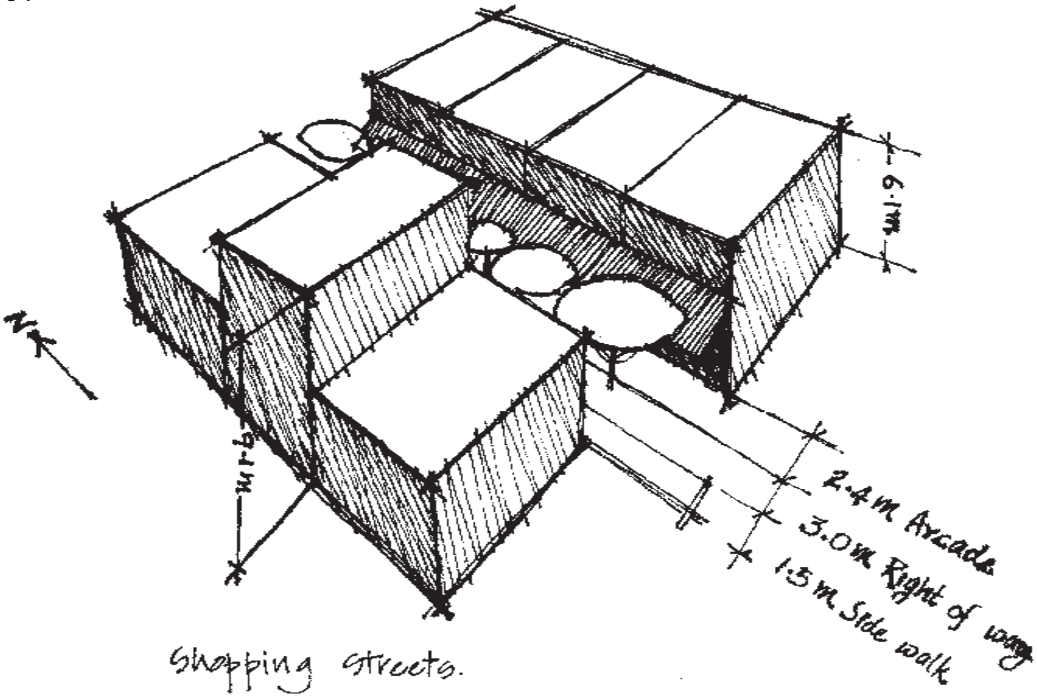
7.3.2 Activity pattern control

Thermal comfort cannot simply come from shading the outdoors; people do not stay long enough at a place to achieve a stable thermal equilibrium with the environment. Air movement can therefore be most welcome when moving.

c. Shopping Streets

Certain types of specialized vending tend to be located in large groups. Thus, every town has its own streets of jewelers, textile businesses, stationers, etc. There is an inherent sense of satisfaction and a feeling of choice that arises from shopping in such specialized streets. The movement from one vendor to another is part of the bargaining process that shoppers undertake almost ritually. And this movement must be predominantly pedestrian. While the shoppers need access to these shopping streets, the actual activity of shopping itself does not benefit from traffic. The need therefore is to create a built form that is of a humane scale, close enough to cast a shadow on the street itself, offering protection from the elements and discouraging motorized traffic.

Figure 34



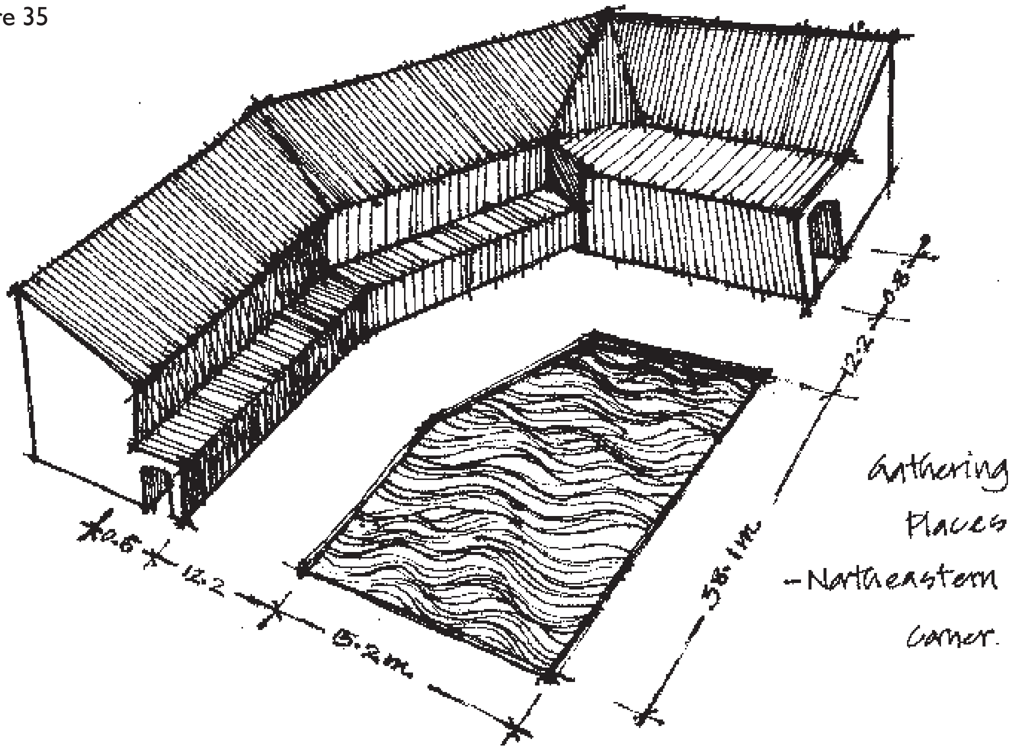
Therefore, create canyon-like shopping streets in housing neighborhoods. The street itself should preferably be north/ south running, with buildings on the west being slightly taller than those on the east. Line both facades of street-facing buildings with arcades, so as to provide adequate protection from rain and sun. If north/south running streets are not available, create narrow shopping cul-de-sacs off traffic arteries, thus ensuring adequate protection from traffic, while maintaining accessibility.

d. Gathering Places

While all climates need gathering spaces, the particular need in tropical climates is for negative ionization, a potential brought out by carefully designed outdoor environment. The presence of water has no rival in the tropics to match its revitalizing negative ionization effect. Thus, one could see thousands of city dwellers on Colombo's waterfront every evening. The same is the case on Chennai's Marina beach, the second largest in the world. Rio de Janeiro's waterfront promenades of course are legendary. People go there every day (except when it rains continuously) even though some of these environments are not thoughtfully developed.

The tropics are blessed with highly usable outdoors. The design issue therefore is one of thoughtful manipulation of outdoor design variables like awnings, canopies, landscaping, street furniture, etc., for gathering.

Figure 35



Therefore, create waterbodies at neighborhood scale and surround them with a built form edged by arcades. Locate public activities along the arcade, overflowing into the commons. If north/east facing promenades are desired, locate the buildings in an "L" shape along the southern and western edges of water. If south/west facing arcades are desired, locate buildings along the northern edge of water, in a staggered manner. The commons in the latter case needs to be wider. Trees need to be planted so as to provide intermittent shading to the commons. Dissuade all activities that do not directly benefit from water's edge from locating on the waterfronts.

e. *Provisions for evening life*

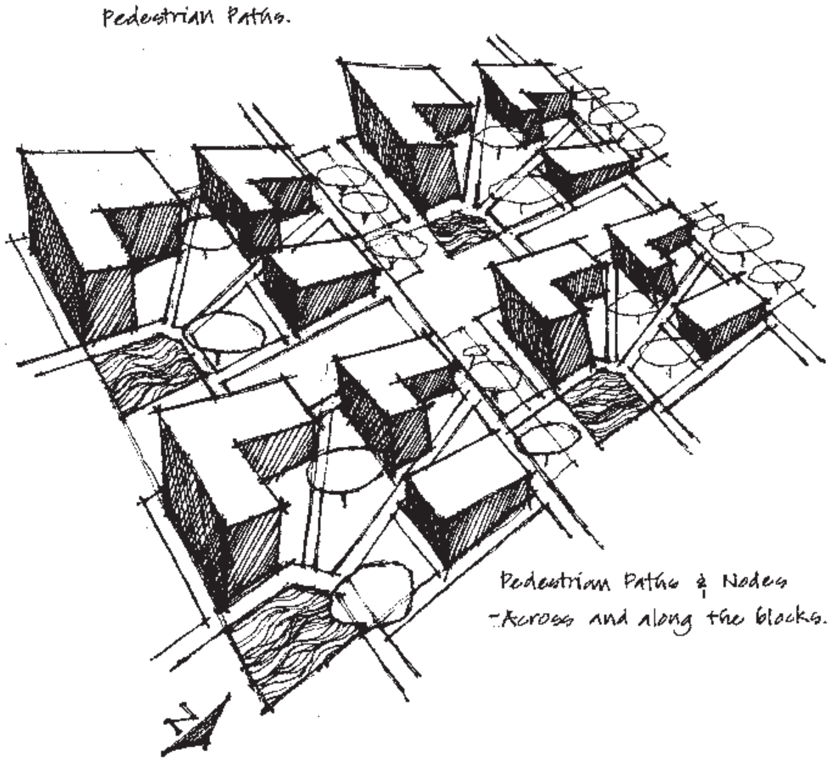
Evenings are tropics' winter. The places deserted in the heat of the day are slowly re-occupied by throngs of people as the searing afternoon sun bids farewell and darkness envelopes the land. Thus, city centers in southern Indian small towns and beach resorts from Sri Lanka to Brazil begin to come alive at dusk with evening bazaars and pedestrians.

Street corners are especially attractive to be incorporated into the evening life, particularly if they intersect northerly and easterly orientation.

f. *Pedestrian Paths and Nodes*

There are two kinds of traffic: transport which is motorized, capital-intensive and therefore scarce by definition, and transit which is self-powered and therefore labor-intensive. In the resource-starved hot-humid regions, it is clear that traffic must be biased towards transit. It is the most energy-saving and ecologically-sound thing to do in the region.

Figure 36



The problem of pedestrianizing lies in the connections provided. Not only the provision of a safe lane, but also connecting activities that people most frequently use, is necessary. It must also be remembered that most people have an upper limit on the distances they prefer to walk. Some kind of mixing of pedestrian and motorized modes is therefore necessary.

It goes without saying that the pedestrian path must be climatically appropriate for movement in the tropical regions. This would largely mean adequate shading.

Therefore, establish a network of pedestrian links independent of the street network. Paths within housing blocks could be the primary carriers of cool air (say from a pond). Wherever the pedestrian path crosses the vehicular path, establish a place to pause. At places, let the pedestrian path merge with the street network, especially if the street is north/south running. Let such streets be very narrow, buildings on both sides providing shade to the entire street. Line the rest of the path with trees, or alternatively, cover it with a light roof.

g. Network for Cars

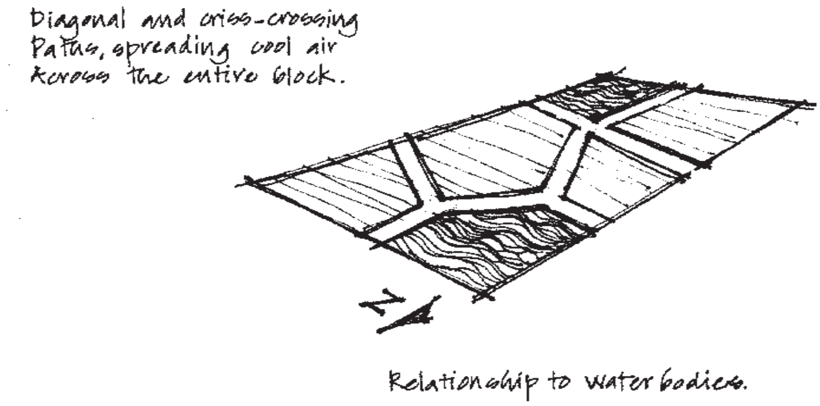
The car is a necessary part of modern urban life. Just as pedestrians need cars at some point, cars also need people. While too much merger is dangerous for the pedestrians, total separation of the two results in dead spaces.

Therefore, re-organize the neighborhood street network by converting the east/west running streets into vehicular paths and north/south running ones into pedestrian paths. The former can be wide lined with arcades, and not entirely in the shade. (It is easier to shade south or north-facing buildings that line up such streets). The other network for pedestrians will be narrow and perpendicular to the vehicular paths. Where these modes meet, establish an activity node where people can linger.

7.3.3 Relationship to natural features – landscape controls

The cooling potentials of natural elements like water and vegetation in a hot-humid place should be well utilized. Yet urban environments also are harmful to the well-being of vegetation and waterbodies.

Figure 37



h. Relationship to Waterbodies

The potential of water in cooling is substantial even in the humid regions. However, care must be taken not to overload the already heavy relative humidities of the tropics.

Contemporary thermal comfort equation shows that high humidities can be compensated by lower air and radiant temperatures. Although it is generally assumed that the primary cause of thermal discomfort in the tropics is humidity, studies have shown that at lower air temperatures humidity's effect on comfort is minimal.

The design strategy in incorporating water into neighborhood design in the humid regions is one of careful provision of just adequate water for evaporation. Furthermore, if waterbodies can be located to take advantage of the general air movement patterns in the region, the air itself can be "conditioned," thus increasing its potential for cooling.

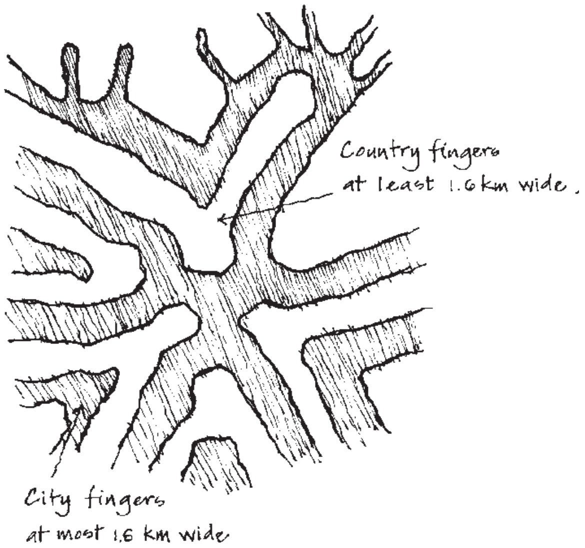
Therefore, locate waterbodies in every neighborhood at the northeastern / southwestern corner of city blocks. Let some major traffic routes (pedestrian paths if within a housing block) connect these pools of water diagonally. At larger scales, rearrange street network to take advantage of air movement thus created by such diagonal paths (i.e. perpendicular to the diagonal paths). Plant trees around waterbodies to increase the cooling potential of air.

i. Contiguous Green Areas

Instead of opening up large parts of the proposed development to greenery, contiguous greens can be provided that take into account the general wind patterns of a neighborhood and the general monsoon wind directions. Thus the cooling potential of air can be enhanced, the ability of greens to reduce flash floods increased, and the spread of evapo-transpiratory agents can be made more even. The size of greens, however, is a critical factor.

Another important factor is the type of greens provided. While most green areas in cities are park-like (single or groups of trees amidst lawns), climate-enhancing potential of green areas can be increased by the provision of neighborhood-scale "mini-forests," where wild growth of trees is encouraged. Make every effort to connect green areas in a diagonal manner (northeast-southwest). Combine such connected greens with the pedestrian network.

Figure 38



j. Collection of Rainwater

It rains for an average of 150-180 days a year in Southwestern coastal regions of Sri Lanka. Periodic flooding of streets is a frequent phenomenon in these parts. It is a pity that such abundance of water is not utilized for climate amelioration.

It is well known that urbanization increases the chances of flash flooding. There are fewer possibilities for rainwater to linger in cities. Our ideas of "keeping dry feet" often clash with urban hydrology. Furthermore, the rapid encroachment upon urban wetland fringes makes cities even more vulnerable to flooding.

Therefore, collect rainwater run-off from roofs, etc., to form shallow pools of water on the western edge of housing blocks. Since these edges are hard to shade and therefore have to be left bare, the presence of water can be a welcome relief.

k. Topographical Relationships

The effect of elevation change on tropical climate is remarkable; so remarkable that up-land areas are designated as separate climatic zones. Even a slight change in grade is instantly noticed by dwellers in these regions who constantly bathe in sweat.

Therefore, when planning for a new housing development, give preference to north/east sloping sites. Avoid west-sloping sites. If unavoidable, permit only very short buildings (maximum height: single-storey) on west-slopes. If the site is north-sloping, the built massing can be raised according to the slope. If east-sloping, the built massing will be taller only on east. If west sloping, the built massing will have to be lowered proportionately.

7.4 Layout of individual houses

In the coastal belt of Sri Lanka, the following strategies may bring better thermal comfort and offer greater protection against sea surges, storms and tsunamis:

i. The buildings should be oriented in such a manner that the shorter side of the building faces the sea.
ii. Wherever possible, sea facing walls should be braced by cross walls, so that the length of an unsupported wall does not exceed 3m.
iii. The aspect ratio of the building (Length to Width ratio) should not be greater than 3.
iv. Ornamental features such as elaborate cornices, vertical or horizontal cantilever projections, fascia stones and the like should be avoided.
v. The openings in the building will encourage flood penetration. Hence large openings on the seaside should be avoided.

When locating a group of buildings, a cluster arrangement should be chosen in preference to row type arrangement (Figure 39). However, clear paths should be identified for evacuation to high ground or to a nearby community building.

Another important factor to be considered is the proportions of a typical plot. The length and breadth of a typical plot should be determined, giving importance to the following factors:

i. Positioning of building line;
ii. Rear space required by local authority;
iii. Allowable distance between well and septic tank;
iv. Provision for vertical and horizontal extension of house.

Boundary wall / fence: Recommended

Live fence (using plants that are best suited to the coast)
Stone wall (not more than 3'high)

The means of evacuation can be elevated podiums, platforms, towers or roof terraces. Cycle tracks and walkways are recommended to be provided in the settlements, if the density of housing exceeds 20 units.

7.5 Housing types suitable for coastal re-building

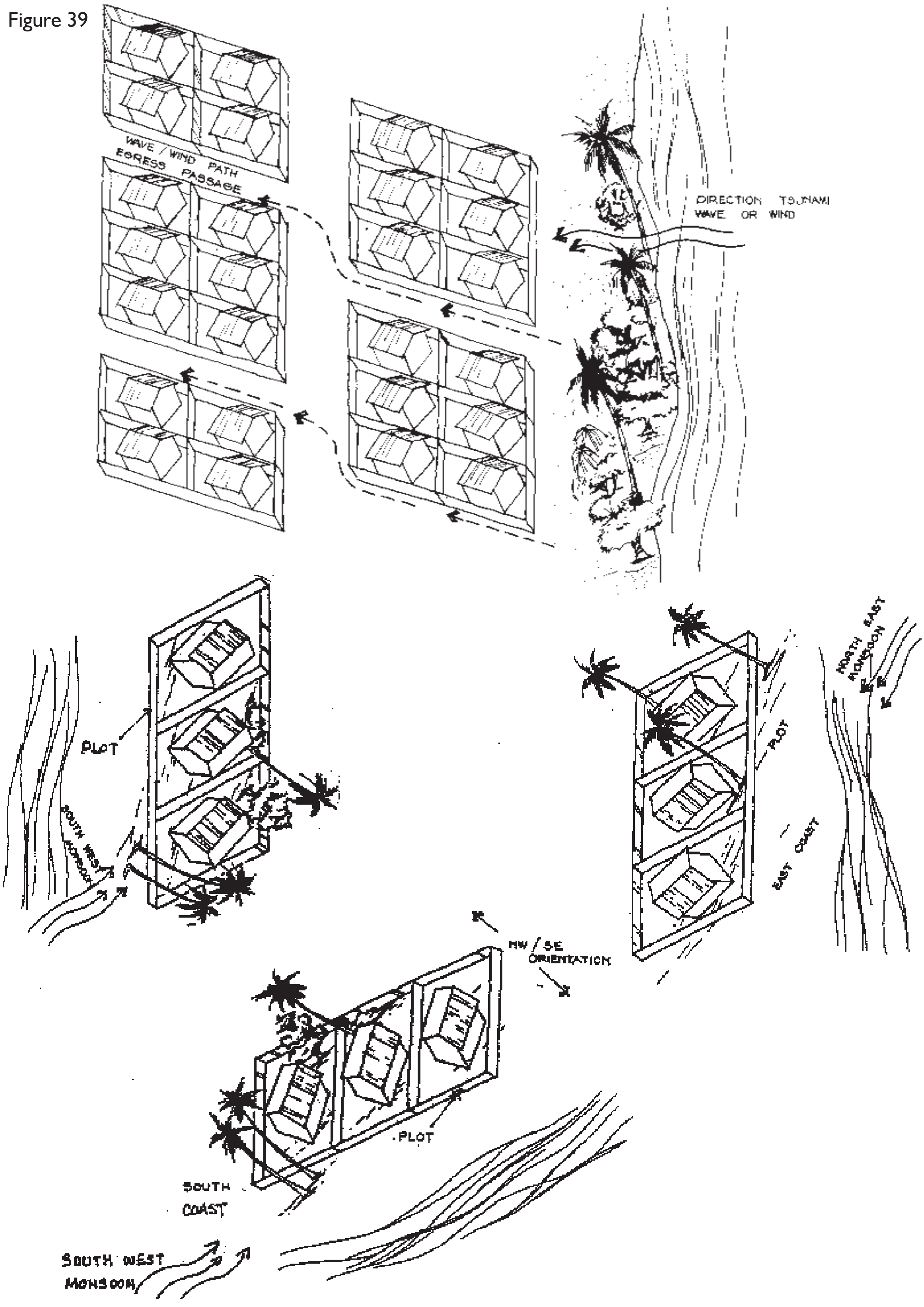
As far as possible, a variety of house forms and a multitude of detailing should be adopted in a settlement to avoid monotony and establish identity of the beneficiary families.

i. Stand alone house forms
   (a) Single storey
   (b) Storied individual housing
   (c) Storied attached houses/town houses (row-houses to be avoided in vulnerable areas)
ii. Walk-up apartments (physical infrastructure is a decisive factor)

Positive aspects of stand-alone houses (single storey, storied individual or storied attached):

i. Housing unit stands on an individual plot of land with front and rear garden.
ii. Possible user participation in design and construction is very high.
iii. In a "Core shell" concept, the core of the house is provided by the designer or developer with the essential spaces such as living room, kitchen and toilet. Rest of the building has to be completed by the beneficiary according to his means and to meet his aspirations. Incremental (vertical and horizontal) expansion is also possible.
iv. House stands on individual plot of land with individual services (sewage and waste water disposal and electricity / water supply)
v. Maintenance done by the occupants themselves without inconvenience to neighbor or burden to the local authorities.

Figure 39


WAVE / WIND PATH
EGRESS PASSAGE
DIRECTION TSUNAMI
WAVE OR WIND
PLOT
SOUTH WEST MONSOON
NORTH EAST MONSOON
PLOT
EAST COAST
NW / SE ORIENTATION
PLOT
SOUTH
COAST
SOUTH WEST
MONSOON

The walk-up apartment is an assembly of housing units, arranged in different floors, one over the other in vertical form (up to ground and three upper floors and ground and four upper floors, if ground floor is used for parking). Elements being shared with one another are structure, services, staircase, walkways and common land for recreational and other common activities.

The following suggestions will reduce unfavorable conditions of flats for community living.

i. Ensure grouping of vertical service lines into a service core, which is accessible for servicing from a common lobby but not through individual units.
ii. Avoid horizontal service lines from crossing the apartments, but provide service connections to each unit directly from the vertical service core.
iii. Make provisions to carry-out maintenance (repairs/color washing) work on exterior walls.
iv. Maintenance of the common elements/areas should be made the responsibility of not only the occupants, but also the local authority.

8.0 DESIRABLE TECHNICAL FEATURES IN POST-DISASTER HOUSING

8.1 Accessibility for all

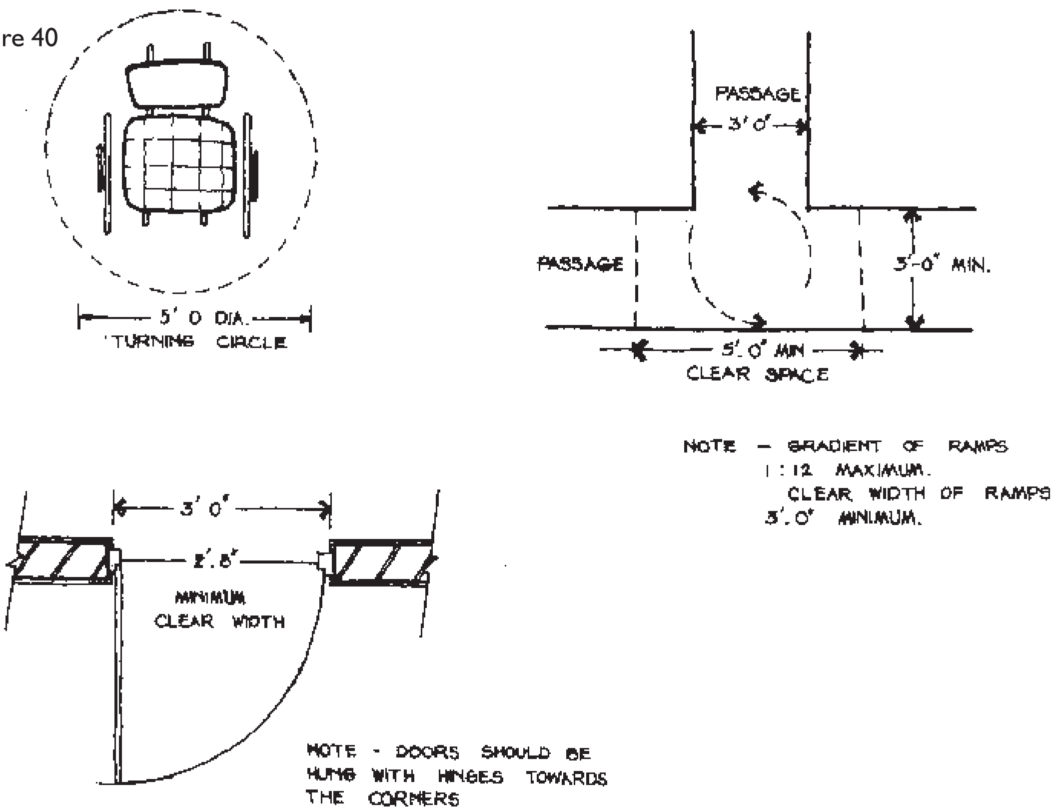
Post-disaster re-construction needs to pay special attention to the needs of the physically challenged individuals and the elderly. While accessibility for all is a desirable goal, its importance gains added significance in times of great upheaval, as is the case following natural and man-made disasters.

8.1.1 General principle

The main goal of the exercise is to ensure that buildings and facilities be accessible for the wheel-chair bound. Under normal circumstances, this would mean that the most basic facilities are located on grade or, if impossible, accessible by a shallow ramp.

Figure 40 shows the basic considerations recommended to be adopted in designing buildings for universal access.

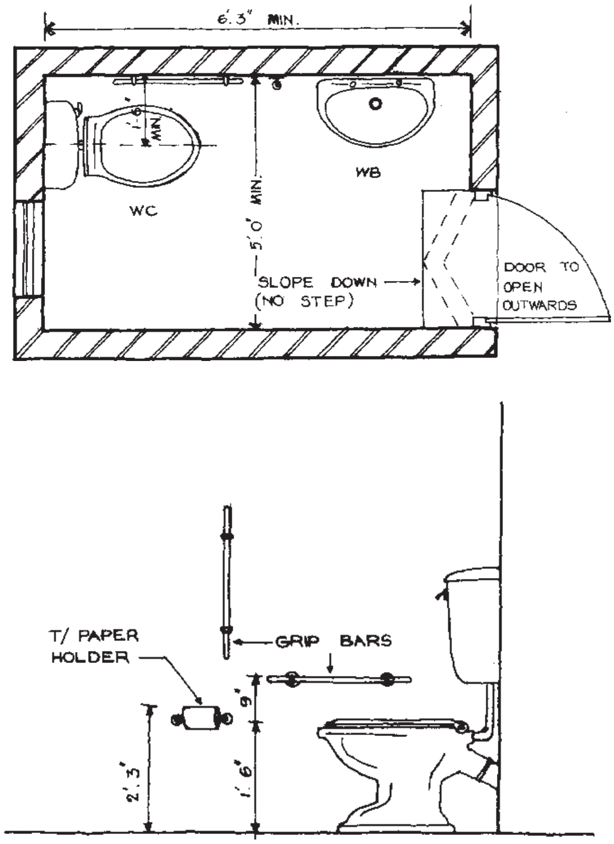
Figure 40



8.1.2 Toilets

A particularly challenging need is to provide accessible toilets. Although it is desirable that several other crucial facilities be provided with wheelchair access, it is recommended that at least one toilet in each communal building be made wheelchair-accessible.

Figure 41



8.2 Structural features to resist coastal disasters

8.2.1 Foundations

i. If possible, the individual reinforced concrete column footings should be connected by means of RCC beams at plinth level. These beams will be intersecting at right angles and form an integral housing unit. The plinth beam should be in one level and be connected continuously. (Figure 42)

ii. Continuous reinforced concrete footings are considered to be most effective from earthquake considerations as well as to avoid differential settlements under normal vertical loads and loss of contact during flooding. Hence they are preferable. They offer better resistance to scouring.

Average values for depth of foundation are 1000mm (3'-0") to 1500 mm (4'-6") for 225mm or 200mm (9" or 8") walls and 750m (2'-6") to 1000 mm (3'-0") for 113mm or 100 mm (4½" or 4") walls. However depth of foundation may be increased if necessary due to unfavorable formation of different soil strata & scour level. Scour level is dependent on the soil type and water table. For hard soil strata, scour level with respect to ground level is low.

Figure 42

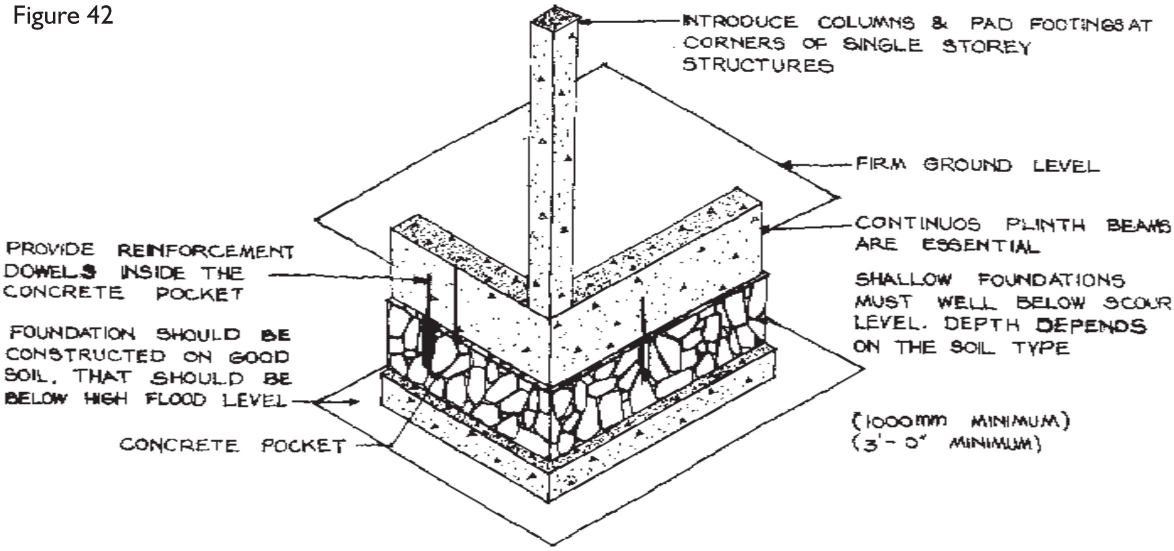


Figure 43

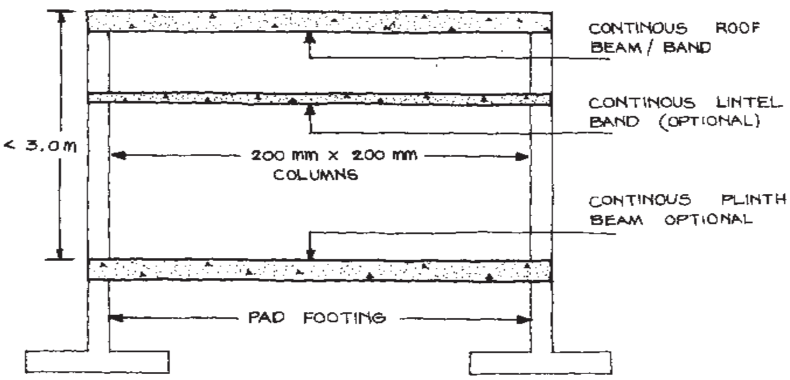
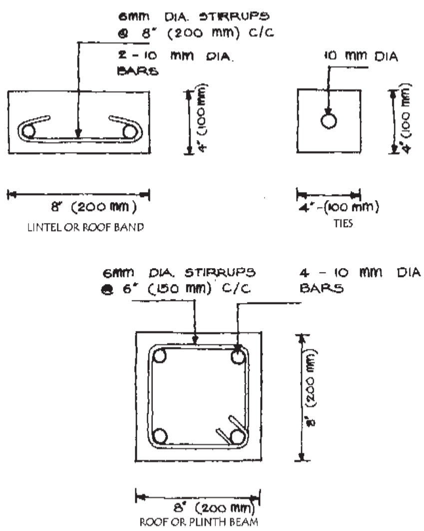


Figure 44



8.2.2 Walls

i. In addition to the lintel beam and corner columns, a continuous, plinth beam and roof band can be considered (see Figure 43), on both external and internal walls. This will make the building act as an integral unit under lateral forces.

ii. Reinforcing bars can be introduced at wall intersections and jambs of openings. These should be surrounded by concrete of size 100mm (Figure 44). The anchorage should extend from the ground beam to the roof beam. All bars should have an 'L' bend of 300 mm in length.

8.3.3 Openings

i. It is desirable to provide reinforced bands or ties around the openings. (Figure 44)

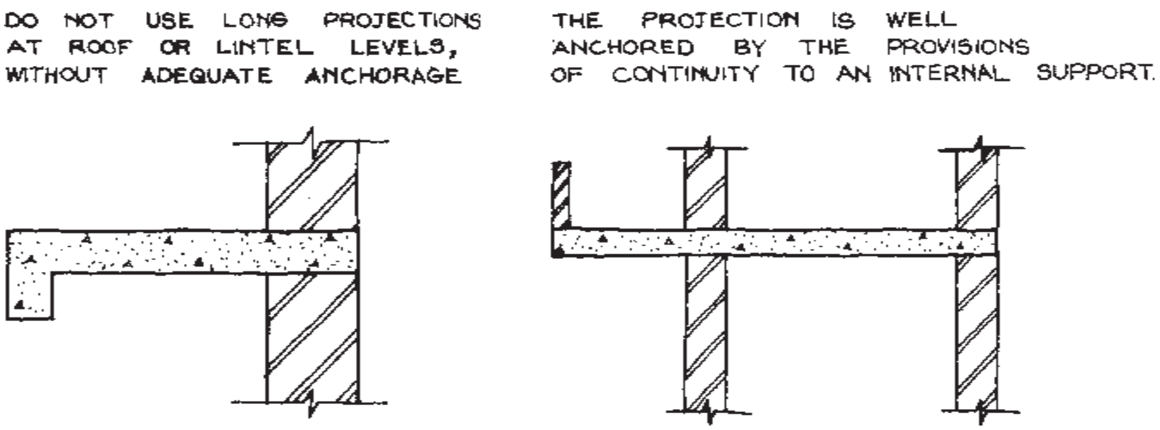
ii. The frames should be well anchored to the walls.

8.3.4 Roof structures

i. A flat reinforced concrete roof is preferable to the lightweight roofs discussed above. A minimum thickness of 100mm and minimum grade of 20 should be used. A gentle slope provided for the flat roof (e.g. 1 in 100) will enable quick drainage of rainwater. Vertical reinforcement bars from the walls should be tied and anchored in the roof slab.

ii. If cantilevers cannot be avoided, they should be well anchored to protect them from earthquake damage. (Figure 45)

Figure 45



9.0 BEST PRACTICES IN MATERIAL USE

The Institute for Construction Training and Development (ICTAD), National Engineering Research and Development (NERD) Center, National Building Research Organization (NBRO) and Sri Lankan private-sector manufacturers of building materials have published best practice guides for building materials and their usage. Appendix 2 refers to some of the most pertinent materials. Readers are advised to consult these publications for further information.

9.1 Alternate materials and methods

A. Walls

An alternate material for coastal re-building is the stabilized soil blocks. The positive features of this material are:

i. Decentralized production with the help of a simple manual compaction press,
ii. Scales of production can be adjusted depending on the requirement,
iii. Production on site, thus avoiding transportation,
iv. Wet compressive strength in the range of 35-45kg/cm^3,
v. Local employment generation potential (six direct jobs per block-making machine),
vi. Large block size (23cm x 19cm x 10cm) reduces mortar consumption, speeds up wall construction and increases wall strength,
vii. Neat and dense blocks are erosion resistant and hence do not require external plastering, thus saving on cost of construction,

If burnt brick is the choice wall material, efficient construction is possible with rat trap bond which saves up to 25% of the walling cost and improves thermal comfort without compromising the structural stability.

To save cost of reinforced cement concrete lintels, it is possible to use arched openings for doors and windows. Arches could be built with stabilized soil blocks or burnt bricks and are aesthetically pleasing.

B. Doors and window sashes and frames:

An alternate to wood/metal door and window frames is the Reinforced Cement Concrete (RCC) frames. These RCC frames can be locally manufactured and are up to 25% cheaper than the timber or steel frames. Furthermore, they require less maintenance and do not require painting.

Alternate sash materials include:

i. Mild steel,
ii. Ferro cement,
iii. Cement bonded particle board.

C. Roofing:

Roof frame and joists could be made of pre-cast RCC or ferro cement joists. They are cheaper, maintenance free and resistant to termites.

Although micro-concrete roofing tiles are a viable roof cover option in Sri Lanka, poor thermal properties and the need for mechanized production may not make them suitable for housing in the warm-humid zone.

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APPENDIX 1 – Setback requirements for development activities in the coastal zone

(Source: CZMP, 1997, Table 6.2, pp. 86-90)

Segment No.	Area	Source Map (one inch)	Geographical Coordinates Latitude (N)	Geographical Coordinates Longitude (E)	Level of Vulnerability	Setback Distance in (m) Reservation Area	Setback Distance in (m) Restricted Area	Total Setback Area (m)
1	Kala Oya River mouth to Kandakuliya	Kalpitiya	8°17'56" 8°12'36"	79°55'00" 79°41'55"	Medium(-)	15	30	45
2	Kandakuliya to Uddappu South	Puttalam Battulu Oya	8°12'36" 7°44'30"	79°41'55" 79°47'16"	Medium(+)	20	30	50
3	Udappu South to Sinna Karukkapone	Battulu Oya Chilaw	7°44'30" 7°37'30"	79°47'16" 79°47'50"	Medium(-)	15	30	45
4	Sinna Karukkapone to Toduwawa North	Chilaw	7°37'30" 7°29'35"	79°47'50" 79°47'40"	High(-)	20	35	55
5	Toduwawa North to Mudukatuwa	Chilaw Kochchikade	7°29'35" 7°24'05"	79°47'40" 79°49'05"	Low(+)	15	25	40
6	Mudukatuwa to Porutota	Kochchikade	7°24'05" 7°15'36"	79°49'05" 79°50'22"	Medium(+)	20	30	50
7	Porutota to Kamachchode	Kochchikade Negombo	7°15'36" 7°12'52"	79°50'22" 79°49'55"	Low(+)	15	25	40
8	Kamachchode to Duwa	Negombo	7°12'52" 7°12'28"	79°49'55" 79°49'07"	High(+)	25	35	60
9	Duwa to Uswatekeiyawa	Negombo	7°12'28" 7°02'40"	79°49'07" 79°51'15"	Medium(-)	15	30	45
10	Uswatekeiyawa to Mount Lavinia Hotel	Negombo Colombo	7°02'40" 6°50'06"	79°51'15" 79°51'35"	High(-)	20	35	55
11	Mount Lavinia Hotel to Pinwatta Railway Station	Colombo Kalutara	6°50'06" 6°41'17"	79°51'35" 79°54'35"	Medium(-)	15	30	45
12	Pinwatta Railway Station to Tangerine Hotel	Kalutara	6°41'17" 6°36'23"	79°54'35" 79°56'46"	Low(-)	10	25	35
13	Tangerine Hotel to Sinbad Hotel	Kalutara	6°36'23" 6°33'54"	79°56'46" 79°57'32"	High(+)	25	35	60
14	Sinbad Hotel to Payagala South	Kalutara Aluthgama	6°33'54" 6°31'13"	79°57'32" 79°58'37"	Medium(+)	20	30	50
15	Payagala South to Maggona Bridge	Aluthgama	6°31'13" 6°29'54"	79°58'37" 79°58'42"	Low(+)	15	25	40

APPENDIX I CONTD.

Segment No.	Area	Source Map (one inch)	Geographical Coordinates Latitude (N)	Geographical Coordinates Longitude (E)	Level of Vulnerability	Setback Distance in (m) Reservation Area	Setback Distance in (m) Restricted Area	Total Setback Area (m)
16	Maggona Bridge to Confifi Hotel	Aluthgama	6°29'54" 6°27'17"	79°58'42" 79°58'31"	High(+)	25	35	60
17	Confifi Hotel to Yakgahagala to Induruwa	Aluthgama	6°27'17" 6°23'55"	79°58'31" 80°00'16"	Low(+)	15	25	40
18	Yakgahagala to Kosgoda River Mouth	Aluthgama	6°23'55" 6°20'25"	80°00'16" 80°01'24"	Medium(+)	20	30	50
19	Kosgoda River Mouth to Wellawatte Balapitiya	Aluthgama Balapitiya	6°20'25" 6°16'00"	80°01'24" 80°01'53"	Low(-)	10	25	35
20	Wellawatte Balapitiya to Coral Gardens Hotel, Hikkaduwa	Balapitiya Ambalangoda	6°16'00" 6°08'55"	80°01'53" 80°03'52"	Medium(-)	15	30	45
21	Coral Gardens Hotel, Hikkaduwa to Devapatiraja Maha Vidyalaya, Ratgama	Ambalangoda Galle	6°08'55" 6°04'57"	80°03'52" 80°08'46"	Low(-)	10	25	35
22	Devapatiraja Maha Vidyalaya to Gintota River	Galle	6°04'57" 6°03'25"	80°08'46" 80°10'32"	Medium(+)	20	30	50
23	Gintota River to Maha Modara	Galle	6°03'25" 6°02'25"	80°10'32" 80°11'30"	Medium(-)	15	30	45
24	Maha Modara to Cement Factory, Galle	Galle	6°02'25" 6°01'40"	80°11'30" 80°14'25"	High(-)	20	35	55
25	Cement Factory, Galle to Welle Dewalaya	Galle	6°01'40" 6°00'20"	80°14'25" 80°14'25"	Low(+)	15	25	40
26	Welle Dewalaya to Koggala Housing Scheme (129km)	Galle	6°00'20" 6°00'25"	80°14'25" 80°15'03"	Low(-)	10	25	35
27	Koggala Housing Scheme (129km) to Kataluwa Bridge	Galle	6°00'25" 5°58'55"	80°15'03" 80°20'00"	Medium(-)	15	30	45
28	Kataluwa Bridge to Midigama	Galle Matara	5°58'55" 5°57'30"	80°20'00" 80°23'55"	High(-)	20	35	55
29	Midigama to Walliwala East (140km)	Matara	5°57'30" 5°57'45"	80°23'55" 80°25'08"	Low(-)	10	25	35
30	Walliwala East (140km) to Palana	Matara	5°57'45" 5°58'17"	80°25'08" 80°26'06"	High(+)	25	35	60
31	Palana to Madiha East	Matara	5°58'17" 5°56'17"	80°26'06" 80°30'05"	Low(+)	10	25	35

Segment No.	Area	Source Map (one inch)	Geographical Coordinates Latitude (N)	Longitude (E)	Level of Vulnerability	Setback Distance in (m) Reservation Area	Restricted Area	Total Setback Area (m)
32	Madiha East to Devinuwara	Matara	5°56'17" 5°55'30"	80°30'05" 80°35'35"	High(-)	20	35	55
33	Devinuwara to Goyambokka Peace Haven Hotel	Matara Tangalle	5°55'30" 6°00'55"	80°35'35" 80°47'02"	Low(-)	10	25	35
34	Goyambokka to Kapuhena	Tangalle	6°00'55" 6°02'30"	80°47'02" 80°49'08"	High(+)	25	35	60
35	Kapuhena to Henagahapugala	Tangalle	6°02'30" 6°04'42"	80°49'08" 80°56'07"	Low(+)	15	25	40
36	Henagahapugala to Lunama	Tangalle	6°04'42" 6°05'07"	80°56'07" 80°57'43"	High(+)	25	35	60
37	Lunama to Wanduruppa	Tangalle	6°05'07" 6°06'22"	80°57'43" 81°01'06"	Low(+)	15	25	40
38	Wanduruppa to Godawaya	Hambantota	6°06'22" 6°06'28"	81°01'06" 81°03'01"	High(+)	25	35	60
39	Godawaya to Mirijjawila	Hambantota	6°06'28" 6°06'55"	81°03'01" 81°05'30"	Low(+)	15	25	40
40	Mirijjawila to Koholankala	Hambantota	6°06'55" 6°08'20"	81°05'30" 81°08'46"	High(+)	25	35	60
41	Koholankala to Parawamodaragala (Yala National Park)	Hambantota Tissamaharama	6°08'20" 6°46'05"	81°08'46" 81°49'25"	High(+)	45	80	125
42	Parawamodaragala to Murugatena Lagoon	Yala, Panama Potuvil	6°46'05" 6°57'23"	81°49'25" 81°51'30"	Low(-)	20	30	50
43	Murugatena Lagoon to Kandaraj	Potuvil	6°57'23" 7°04'08"	81°51'30" 81°51'46"	Medium(-)	30	50	80
44	Kandaraj to Tambiluvil	Potuvil Tirukkovil	7°04'08" 7°07'58"	81°51'46" 81°51'21"	Low(+)	25	40	65
45	Tambiluvil to 228 Mile Post, Cemetery	Tirukkovil	7°07'58" 7°12'30"	81°51'21" 81°51'40"	High(+)	45	80	125
46	228 Mile Post to Periya Kallar	Tirukkovil Kalmunai	7°12'30" 7°27'45"	81°51'40" 81°48'58"	Low(+)	25	40	65

APPENDIX I CONTD.

Segment No.	Area	Source Map (one inch)	Geographical Coordinates Latitude (N)	Longitude (E)	Level of Vulnerability	Setback Distance in (m) Reservation Area	Restricted Area	Total Setback Area (m)
47	Periya Kallar to Ondachchimunai	Kalmunai	7°27'45" 7°29'59"	81°48'58" 81°48'11"	High(+)	45	80	125
48	Ondachchimunai to Kallady	Kalmunai Batticaloa	7°29'59" 7°43'03"	81°48'11" 81°43'00"	Low(-)	20	30	50
49	Kallady to Bar Light House, Batticaloa	Batticaloa	7°43'03" 7°45'38"	81°43'00" 81°41'01"	High(+)	45	80	125
50	Bar Light House, Batticaloa to Kalkudah	Batticaloa Kalkudah	7°45'38" 7°55'08"	81°41'01" 81°34'48"	Medium(-)	30	50	80
51	Kalkudah to Pulsri Point	Kalkudah	7°55'08" 7°59'36"	81°34'48" 81°32'37"	Low(+)	25	40	65
52	Pulsri Point to Foul Point, Kevuliya	Kalkudah, Vakaneri, Kathiramalai	7°59'36" 8°31'30"	81°32'37" 81°19'00"	High(+)	45	80	125
53	Foul Point, Kevuliya to Fort Frederick	Trincomalee	8°31'30" 8°35'00"	81°19'00" 81°14'37"	Low(-)	20	30	50
54	Fort Frederick to Alles Garden	Trincomalee	8°35'00" 8°36'45"	81°14'37" 81°13'06"	High(-)	40	70	110
55	Alles Garden to Thavikallu	Nilaweli	8°36'45" 8°46'11"	81°13'06" 81°08'40"	Low(-)	20	30	50
56	Thavikallu to Kokulaikanni	Nilaweli Padaviya	8°46'11" 8°59'00"	81°08'40" 80°58'06"	Medium(-)	30	50	80
57	Kokulaikanni to Thumpalai	Kokilai, Mulathivu Eranamadu Elephant Pass Point Pedro	8°59'00" 9°49'20"	80°58'06" 80°15'09"	High(+)	45	80	125
58	Thumpalai to Thiruvadiniaya	Jaffna Point Pedro	9°49'20" 9°46'42"	80°15'09" 79°55'34"	Low(-)	20	30	50
59	Thiruvadiniaya to Mandathivu	Jaffna, Delft	9°46'42" 9°36'53"	79°55'34" 80°00'15"	Medium(-)	30	50	80

Segment No.	Area	Source Map (one inch)	Geographical Coordinates Latitude (N)	Longitude (E)	Level of Vulnerability	Setback Distance in (m) Reservation Area	Restricted Area	Total Setback Area (m)
60	Delft Island to Nayinativu, Karaitivu and other Islands	Jaffna, Delft	All Island		Medium(+)	35	60	95
61	Kalmunai to Devil Point	Pooneryn	9°35'56" 9°23'45"	80°02'58" 80°03'12"	Low(-)	20	30	50
62	Devil Point to Weeravandinmunai	Thunakkai	9°23'45" 9°21'08"	80°03'12" 80°03'30"	Medium(-)	30	50	80
63	Weeravandinmunai to Sinnativu	Thunakkai	9°21'08" 9°19'45"	80°03'30" 80°05'04"	High(-)	40	70	110
64	Sinnativu to Periya Aru	Thunakkai	9°19'45" 9°09'04"	80°05'04" 80°05'15"	Low(+)	25	40	65
65	Periya Aru to Padaviturai	Manthai	9°09'04" 9°05'29"	80°05'15" 80°04'15"	High(-)	40	70	110
66	Padaviturai to Nayatumunai	Manthai	9°05'29" 9°00'53"	80°04'15" 80°01'40"	High(+)	45	80	125
67	Nayatumunai to Manthai	Manthai	9°00'53" 8°57'04"	80°01'40" 79°57'10"	High(-)	40	70	110
68	Mannar Island	Murukkan Talaimannar	Entire Island		Medium(+)	30	50	80
69	Manthai to Aruvi Aru River Mouth	Murukkan	8°57'04" 8°17'56"	79°57'10" 79°55'00"	High(+)	45	80	125
70	Aruvi Aru River Mouth to Kala Oya River Mouth (Wilpattu National Park)	Murukkan	8°17'56" 8°12'36"	79°55'00" 79°41'55"	High(+)	45	80	125

APPENDIX 1 CONTD.

Classification of Coastal Segments by Level of Vulnerability and Setback Distances (in meters)

Level of Vulnerability	Coastal Segment Nos 1-40			Coastal Segment Nos 41-70		
	Reservation Area	Restricted Area	Total Setback	Reservation Area	Restricted Area	Total Setback
Low -	10	25	35	20	30	50
Low +	15	25	40	25	40	65
Medium -	15	30	45	30	50	80
Medium +	20	30	50	35	60	95
High -	20	35	55	40	70	110
High +	25	35	60	45	80	125
Protected Areas			300	Protected Areas		300

APPENDIX 2 – Best practice in the use of conventional building materials

	Part of the building	Materials	Method of Application	Relevant Specification	Recommended Uses / Limitations
1	Foundation	Rubble	Random rubble masonry	ICTAD Specifications for Building Works, vol. 1, Clause 7.2	Use in shallow foundations in firm ground (Preferable for single storey buildings, for multi storey buildings obtain professional advise)
		Bricks	Brick masonry	- Do - Clause 6.2	Use in shallow foundations in firm ground (Preferable for single storey buildings, for multi storey buildings obtain professional advise)
		Cement Blocks	Block masonry	- Do - Clause 6.3	Use in shallow foundations in firm ground (Preferable for single storey buildings)
		Concrete	RCC Column footing	- Do - Clause 5.0	Use for multi storey buildings in firm ground
			RCC Strip Footing for masonry foundation	- Do - Clause 5.0	Use for load bearing walls
			RCC plinth beam for Masonry foundation	- Do - Clause 5.0	Use for medium rise buildings in a weak soil
			RCC raft foundation	- Do - Clause 5.4.4.2	- Do -
			RCC pile foundation	- Do - Clause 5.0	Use for multi storey buildings in a weak soil condition
2	Walls	Brick	Brick masonry walls	- Do - Clause 6.2	4 1/2" thick, only for non load bearing walls
					9" thick walls can be used as load bearing
		Cement Hollow blocks	Block masonry works	- Do - Clause 6.3	4" thick, only for non load bearing walls 6" thick & 8" thick walls can be used as load bearing
		Cement-Stabilized Soil Blocks	Block work using Cement-Clay Grout		Preferable for single storey buildings
		Wall construction using quarry dust & cement	Using Slip-form shutters	NERD Low-Cost Housing System	Involve less skilled labor
		Wall construction using Cement-Stabilized Soil	Using Slip-form shutters	CHPB Low-Cost Housing System	- Do -

APPENDIX 2 CONTD.

	Part of the building	Materials	Method of Application	Relevant Specification	Recommended Uses / Limitations
3	RCC Floor Slab	Form work (steel and timber)	--	ICTAD Specifications for Building Works, Vol. I, Clause 5.2	For any structural elements
		Steel bar reinforcement	As per BS 8110 or equivalent	- Do - Clause 5.3 and Appendix 5A	Structural Engineer's advise to be obtained
		Concreting	As per BS 8110 or equivalent	-Do - Clause 5.4 and Chapter 4	Structural Engineer's advise to be obtained
4	NERD Floor-slab System	Pre-stressed beams, Ferro Cement panels, 2"x2" Gauge 10 welded mesh	Pre-cast Concrete	Refer NERD specification	
		Concrete	As per BS 8110 or equivalent	ICTAD Specifications for Building Works, Vol. I - Clause 5.4 and Chapter 4	
5	ICC Floor-slab system	Pre-stressed beams, Pre-cast cement blocks, 2"x2" Gauge 10 welded mesh	Pre-cast Concrete	Refer ICC specification	
		concrete	As per BS 8110 or equivalent	ICTAD Specifications for Building Works, Vol. I, Clause 5.4 and Chapter 4	
6	Roof Frame	Timber	Fabrication as per BS 5268 Part 2	- Do - Clause 8.2 and Appendix - 8A	
		Steel	Fabrication as per BS 5950	- Do - Clause 9.0	
		Pre-Cast Concrete Purlins	As per BS 8110 or equivalent		

	Part of the building	Materials	Method of Application	Relevant Specification	Recommended Uses / Limitations
7	Roof cladding	Clay tiles	Laying on the roof frame	- Do - Clause 12.1	
		Corrugated asbestos cement roofing sheets	- Do -	- Do - Clause 12.2	
		Cement tiles	- Do -	As per the manufacturer's specifications	Obtain professional advice
		G.I. corrugated sheets	- Do -	ICTAD Specifications for Building Works, Vol. I – Clause 12.3	
		Zinc - Aluminum coated Profiled steel roofing sheets	-Do - as per AS 1397	- Do - Clause 12.4	
8	Rain water gutters	UPVC Gutters & Down Pipes	Fixing using PVC Solvent Cement and Brackets as per BS 4514	- Do - Clause 12.9.2 and Clause 12.10.5	For any structure and the requirements of the client
		Zinc - Aluminum coated Profiled steel gutters and down pipes	Fixing using GI brackets as per AS 2180	- Do - Clause 12.9 and Clause 12.10.2	
9	Door/Window frame	Timber	Joining of members	- Do - Clause 8.4 and Appendix 8A	
		Concrete	Pre-cast concrete frames	- Do -	
		Aluminum	Fabrication of members		
		Plastic / PVC		As per the manufacturer's specifications	
10	Door/Window sashes	Timber	Joining of members	ICTAD Specifications for Building Works, Vol. I, Clause 8.5 and Appendix 8A	As per the client's requirements
		Aluminum	Fabrication of members		
		Plastic / PVC			
		Glazing (For timber/ Al. Sashes)	Fixing to the rebated sash / frame by beadings or putty	- Do - Chapter 13	

APPENDIX 2 CONTD.

	Part of the building	Materials	Method of Application	Relevant Specification	Recommended Uses / Limitations
11	Iron Mongery	Hinges	As per the designers instruction and relevant code based on the material proposed	ICTAD Specifications for Building Works, Vol. I, Clause 10.1	
		Door Closer		- Do - Clause 10.2	
		Door Bolts		- Do - Clause 10.3	
		Door Handle		- Do - Clause 10.4	
		Mortice Latch / Mortice Lock / Mortice Latch and Lock		- Do - Clause 10.5	
		Casement Fastener		- Do - Clause 10.6	
		Casement Stays		- Do - Clause 10.7	
		Hooks and Eyes		- Do - Clause 10.8	
		Hasp & Staples		- Do - Clause 10.9	
12	Wall plaster	Lime-cement and sand	Lime, cement plaster	- Do - Clause 11.1.1, 11.1.2 and 3.3	
		Cement, sand	Cement plaster	- Do - Clause 11.3 and 3.2	
13	Ceiling Frame	Timber	Fabrication	- Do - Clause 8.2 and Appendix 8A	
		Aluminum	Assembling and fixing	- Do - Clause 9	
14	Ceiling panel	Asbestos cement sheets	Fix to the ceiling timber frame	- Do - Clause 11.2.1	
		Timber planks	Fix to the ceiling timber frame	- Do - Appendix 8A	
		Gypsum / Superflex boards	Fix to the ceiling aluminum frame	- Do - Clause 11.2.2	
15	Floor Paving	Brick, sand, cement			
		Concrete	As per BS 8110 or equivalent	ICTAD Specifications for Building Works, Vol. I, Clause 5.0	

	Part of the building	Materials	Method of Application	Relevant Specification	Recommended Uses / Limitations
16	Floor finishes	Cement, sand	Rendering and finished smooth /semi-rough on concrete /brick paving	- Do - Clause 11.3.4	
		Floor tiles	Lay on concrete paving using cement grout	- Do - Clause 11.3.1 and 11.3.8	
		Timber floor deck	Planks fixed to the timber frame	- Do - Clause 8.6 and Appendix 8A	
		Terrazzo floor finish	On concrete paving	- Do - Clause 11.3.5	
17	Painting and Decoration of walls	Lime	White / Color wash, apply with a brush	- Do - Clause 14.1 and 14.2	
		Oil Bound Distemper	Apply one coat of primer and two coats of Distemper	- Do - Clause 14.3 and 14.4	
		Cement Paint	Apply two coats of Cement Paint	- Do - Clause 14.5 and 14.6	
		Plastic Emulsion Paint	Apply one coat of primer and two coats of paint	- Do - Clause 14.7 and 14.8	Weather Shield paint should use for external walls
18	Painting and Decoration of woodwork	Enamel Paint	Apply one coat of primer and two coats of paint	- Do - Clause 14.9.1 and 14.9.2	
		Varnish	Apply one coat of primer and two coats of paint	- Do - Clause 14.10 and 14.11	
		French Polish	Apply three coat of polish	- Do - Clause 14.12 and 14.13	
19	Painting of Steel surfaces	Anti-corrosive Paint (primer) and Enamel Paint	Apply one coat of primer and two coats of paint	- Do - Clause 14.9.3 & 14.9.4	
20	Plumbing and Engineering Installation	UPVC water supply and sewerage pipes	Refer BSCP 312 - Part 1 and BSCP 305 - Part 1	Sri Lanka Specification for Building Works (Volume II) – Sanitary Installation	
21	Internal Wiring	PVC cables, PVC conduits and accessories, PVC casings and accessories, Switches, Plugs and sockets, Lamps, fittings and bulbs etc.	Buried conduits or Surface casings	Relevant PS Codes, SLS Codes, IEE Wiring Regulations - 16th Edition and ICTAD Publication SCA/8 – Aug. 2000	

APPENDIX 2 CONTD.

Basic Building Materials

	Part of the building	Materials	Method of Application	Relevant Specification	Recommended Uses / Limitations
22	Cement	Ordinary Portland Cement	As per BS 12	SLS 107	For any construction activity
		Masonry Cement	Wall plastering	SLS 515	Not allowed to be use for structural concrete works
23	Lime	Lime	Wall plastering, White / Color wash	SLS 552, ICTAD Specifications for Building Works, Vol. I – Clause 1.6	
22	Fine aggregate	River Sand	As per BS 410 Concrete work Plastering & Rendering work	ICTAD Specifications for Building Works, Vol. I – Clause 1.6	
		Manufactured Sand (Crushed Stone Sand)	Masonry work, concrete work, Plastering & Rendering work	ICTAD Specifications for Building Works, Vol. I – Clause 1.6	Usage as per the professional advise
		Pit Sand	Masonry work, Concrete work, Plastering & Rendering work	ICTAD Specifications for Building Works, Vol. I – Clause 1.6	
		Off Shore Sand	Masonry work, Concrete work, Plastering & Rendering work	- Do - Clause 4.1.3.1, Conform to BS 882	
23	Metal	Hot-rolled MS angles	BS 4848 - Part 4	ICTAD Specifications for Building Works, Vol. I – Clause 9.2 & 9.3	Usage as per the professional advise
		Hot-rolled MS round bars	SLS 26	- Do - Clause 5.3	
		Hot-rolled high yield steel bars	BS 4449		
		Cold worked deformed steel bars	SLS 375		
		Hard drawn MS wire	BS 4482		
		Steel fabric	SLS 95		

NOTES

NOTES CONTD.

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