National Building Research Organisation
Ministry of Public Administration & Disaster Management

NBRONEWSLETTER

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building buildings

Colombo Lotus tower is a 350 m high tower, will be the tallest in the region once its construction completed. This will be multifunctional telecommunication tower and entertainment center and occupy total area of 3 acres of land in Beira wewa water front.

The tower stands at 350m, with majority of it being a base resembling a flower stem, and the upper portion resembling the colorful lotus flower.

Tower shaft section is 200 m in height and consist of high speed lifts and stairs.

Tower head will be 33m in height and will consist of 8 floors. This section includes observation deck, revolving restaurant and a banquet hall. A super luxury hotel will occupy two floors of this section.

The mast will consist of TV, FM and other telecommunication antennas.

Conceptualized by the Telecommunications Regulatory Commission of Sri Lanka.

Led by CSEC in collaboration with the Faculty of Architecture at University of Moratuwa. China National Electronics Import & Export Corp/Aerospace Long – March International Trade Co. Ltd will be entrusted with the construction of this colossal structure.

Building Type: Mixed use
Coordinates: 06°55′37″N 79°51′30″E
Height: 350 m (1,148.3 ft)
Floors: 13 (6 in base, 7 in flower)
Tallest self-supported structure in South Asia.
Second tallest structure in South Asia.

Dear Readers...

We are happy to invite you to read the 2nd issue of NBRO Newsletter in the year 2019. This issue addresses construction of buildings and it also contains few articles from other disciplines as well.

The world is full of fascinating buildings, and it seems that, more and more are being constructed everyday using the latest construction techniques and materials.

Construction is important in terms of its contribution to the economy and also as an enabler of wider economic growth and development, providing buildings, infrastructure and environment that allows the nation to function and prosper.

However, demands on the construction sector are substantial. At a time when we are facing a shortage of the skilled, we have increasing workloads and aspirations to deliver ambitious infrastructure projects and targets alongside other modernization goals such as improving productivity.

We enthusiastically invite you to read and enjoy this edition of NBRO Newsletter. Further, we warmly welcome your feedback and ideas to incorporate them in our future activities.

Best wishes,
Eng. (Dr) Asiri Karunawardena
Director General
National Building Research Organisation

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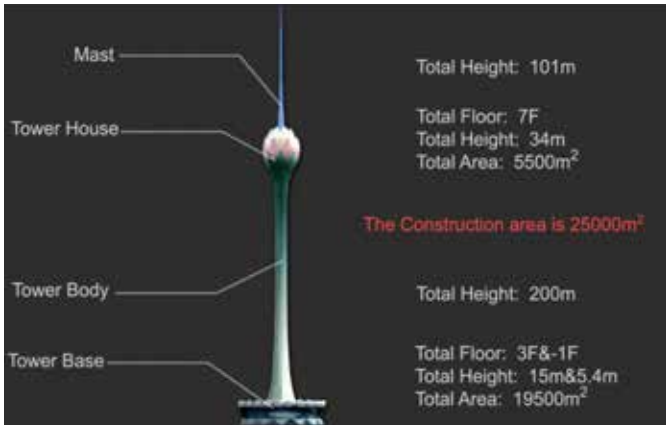

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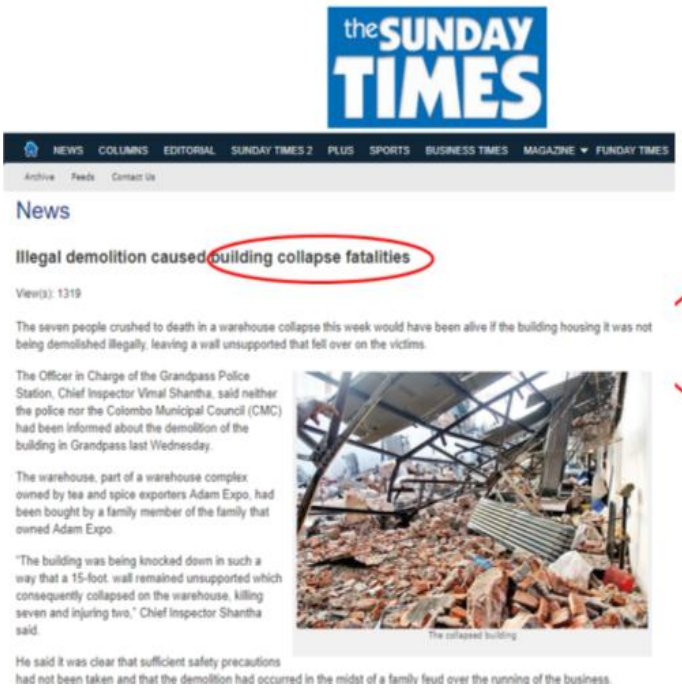
01 Technical Guidelines on Building Demolition Work in Sri Lanka

By: *Nawoda Gamage, Scientist, Project Management Division*



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News

Illegal demolition caused building collapse fatalities

View(s): 1319

The seven people crushed to death in a warehouse collapse this week would have been alive if the building housing it was not being demolished illegally, leaving a wall unsupported that fell over on the victims.

The Officer in Charge of the Grandpass Police Station, Chief Inspector Vimal Shantha, said neither the police nor the Colombo Municipal Council (CMC) had been informed about the demolition of the building in Grandpass last Wednesday.

The warehouse, part of a warehouse complex owned by tea and spice exporters Adam Expo, had been bought by a family member of the family that owned Adam Expo.

"The building was being knocked down in such a way that a 15-foot wall remained unsupported which consequently collapsed on the warehouse, killing seven and injuring two," Chief Inspector Shantha said.

The collapsed building

He said it was clear that sufficient safety precautions had not been taken and that the demolition had occurred in the midst of a family feud over the running of the business.

Daily News

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SEVEN DEAD IN GRANDPASS

DEMOLITION WORK BEHIND 130 YEAR OLD ADAM EXPORTS BUILDING LED TO COLLAPSE

A recent collapse (15.02.2018) of a building due to improper building demolition work at the adjoining site

Trend of urban renewal with high rate of population density and employment/service centers, has created an urgent necessity for buildable space for regeneration of urban centers with high density/high rise modern buildings and infra structure facilities. Together with the above global transition, Sri Lanka also has shown a rapid increase in urban development during the last decade, especially within the Colombo district with high rise/ high density buildings and developments in urban areas such as Colombo city.

Therefore, in order to cater to such demands, a lot of new high rise/ high density urban buildings have been emerging in the urban areas. Sometimes not only obsolete structures but structures which are structurally and functionally acceptable are being replaced by new structures due to space demand.

Records of the Building Demolition Contractors in Sri Lanka reveal that the number of building demolition projects in Sri Lanka has also been increasing.

Therefore, careful and systematic demolition activities would ensure safety of life and properties and prevent tragic incidents such as seven fatalities caused by the partial collapse of a warehouse in Grandpass, Colombo 14 in February 2018 as a result of demolition work of an adjoining building that had taken place without following proper safety standards.

(a) Improper Demolishing site; unsafe free standing walls without lateral supports

(b) Collapsed warehouse building

There have been similar cases reported in the recent past also.

At present, no guidelines are available in Sri Lanka for building demolition and such works appear to be carried out mostly without professional involvement. Further, it is revealed that no institution has been formally made responsible by the government to monitor and supervise building demolition work in order to ensure safety of life and property.

During the Industry Consultation meeting organized by the National Building Research Organisation (NBRO), held in February 2018 in Colombo, with the participation of Urban Development Authority (UDA), Central Environmental Authority (CEA), Universities and several other state and private sector agencies, one of the highlighted was the need for preparation of Guidelines for building demolition work. Also at this meeting, UDA commented that building demolition work was considered a construction activity to be carried out with prior approval of the respective local authority.

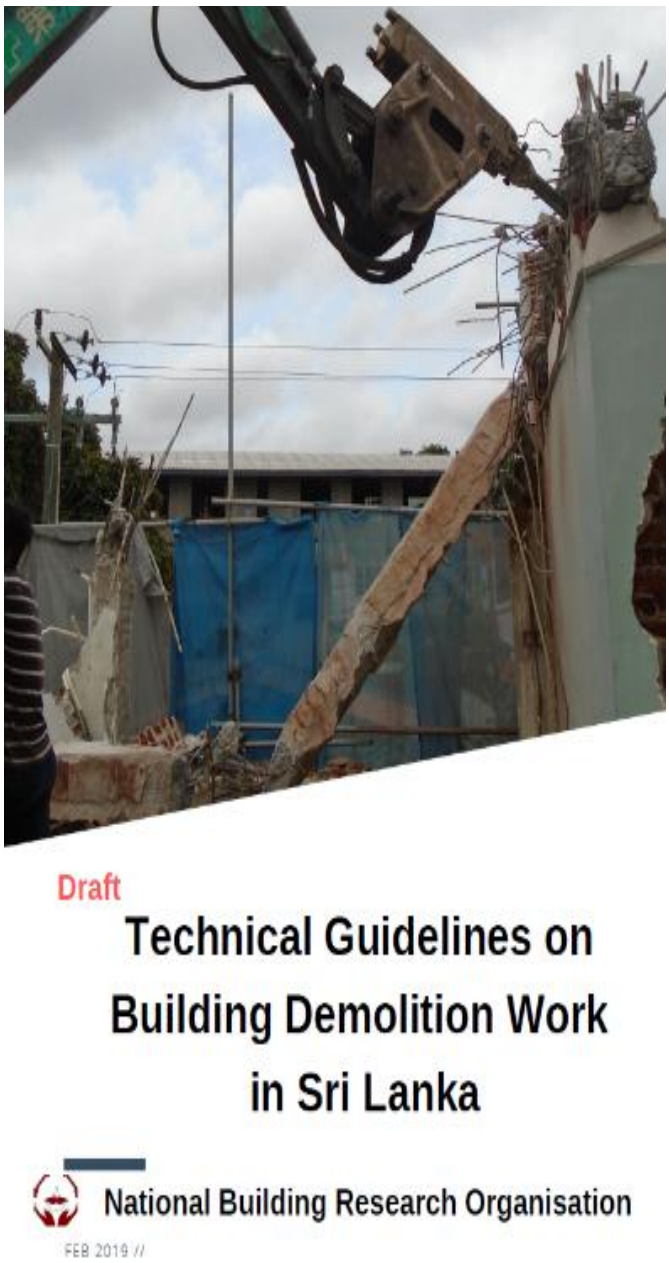
Hence, preparation of a set of Professional Guidelines on Planning & Execution of Safe Building Demolition Work in Sri Lanka, has become an urgent need.

NBRO, as a pioneer Institute contributing in the field of Civil Engineering in Sri Lanka, initiated the approach of preparing technical guidelines in the local context to fill in the gap due to absence of national guidelines on building demolition works already published in Sri Lanka.

NBRO, arranged compilation of the guideline through a Working Committee consisting of senior academics, professionals and scientists in the field of construction.

The current practice of building demolition projects is mostly done with the experience of the contractors. Introducing these guidelines would make them aware of the technical approach to the demolition activities.

This document contains basic information for the practitioners on better planning and control when carrying out demolition work. It is planned to publish this document at the forthcoming NBRO symposium and will be freely available for the public at NBRO web site.



ORIENTATION PROGRAM at Administration Division of NBRO
By: A. Abeysinghe, Admin officer, Admin Division

Administration Division of NBRO organized an orientation program to introduce newly recruited Scientists/ Engineers to NBRO on 13 June 2019 at NBRO auditorium. Director General and all Directors were present to conduct this session. Mr. Clarence Perera, Consultant of NBRO, gave an introduction on NBRO at its activities. All Directors of NBRO introduced themselves, talked about the structure and role of their divisions, and then, welcomed newly recruited Scientists/Engineers to NBRO. Later on, all newly recruited Scientists/ Engineers visited to the three main laboratories of NBRO.

02 Dome Houses and their Impact on Resettlement in Sri Lanka

By: *Savani N. de Zoysa, Scientist, Human Settlements Planning and Training Division*

Housing is a crucial factor for the success of a resettlement program. Housing or the building system of a resettlement should be compatible with the social, cultural, technical and environmental aspects. Dome housing is a new housing concept which has been introduced in tsunami resettlement in Sri Lanka.

Figure 01: Dome house construction process
(Source – Hammer, C. (2006). Optimization of Dome Housing in Sri Lanka)

When considering about the technical aspects of the dome house construction, the design is more suitable for the house constructions in flat terrains. Comparatively to the contemporary construction methods which are currently practicing in Sri Lanka, it saves construction time and helps to provide shelters for the homeless communities within a short time period. Other than that, the circular shaped building form of the houses creates a resilient structural environment for the community from the disasters such as floods, high winds, tsunami, etc.

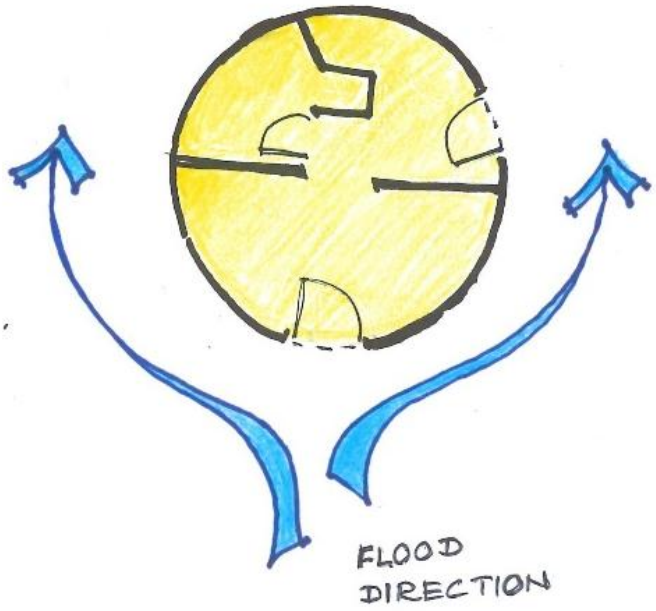


Figure 02: Plan form of a Dome House

Also, the ferrocement shell has less impact on spreading fire as well. But, the existing foundation structure is not resilient for the constructions in areas prone to disasters such as landslides, floods and expansive soil.

According to the stack effect ventilation system which has been used in the dome houses, the internal temperature of the houses is favourable for the occupants.

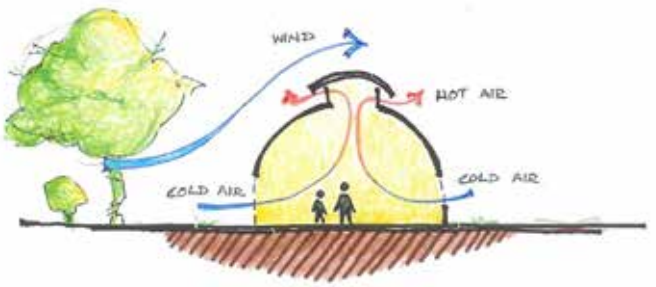


Figure 03: – Sectional form of a Dome house

In a broader view of the resettlement housing projects, house is the breathing place of a community. Therefore, in each and every housing unit, there should be a homely feeling rather than being just a house or a shelter. In other words, the occupants should feel that, they belong to the built and natural environment of the context. Therefore, the entire house design should reflects the identity of each community, and addresses to the social and cultural issues of the context through the building form, material selection and use, construction methods, internal space arrangement, connection between indoor and outdoor environment, etc.

As per the observations of the dome houses constructed at the tsunami resettlement site at Pottuvil, it was identified that there is a considerable issue on internal space arrangement of the houses. Due to the curved shape of the walls, and the circular shape of the building, it creates unusable narrow corners inside the house. Also, the construction materials and the methods are not familiar with the relevant community. Not only that, but also the construction methods limited the possibility of future expansions of the housing units and it acts as a barrier for the future developments and the dreams of the occupants.

Figure 04: Unusable narrow corners of the living area.

Figure 05: Covered the area allocated for permanent ventilation by using temporary materials.

In the traditional Sri Lankan architecture, centralized courtyards and verandahs are dominant features of the houses. Verandahs create visual links with the community, and it could helps to make better social and communal interactions. But in these dome houses there aren't any verandahs, and can be observed that the people are gathering outside of the houses under a tree or a temporary shelter. Therefore, it shows that, there is a need of more outdoor communal spaces for the houses, and the given house design could not be able to provide the required facility. The centralized courtyard system provides more privacy to the occupants and helps to increase the natural light and ventilation inside the houses.

Further, it is observed that, several houses have a detached kitchen made out of commonly available materials with a typical gable roof form which are very familiar with the people. This shows the identity of the community and their actual needs of the houses. With all these issues, the social perceptions on the appearance of the building shape creates marginalized communities. Also, the setting out of the resettlement housing reflects an unplanned development pattern thorough out the context. Visual and physical connectivity between each housing unit is very poor in condition.

Finally, it is required to understand that, to make resettlement projects successful, it is paramount to consider that, construction is a 'social process'.

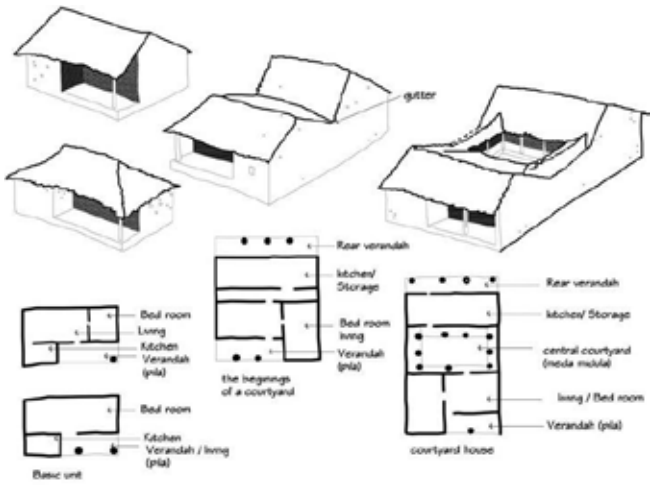


Figure 06: Evolution of a courtyard house (Source – de Vos (1988))

Therefore, the built and the non-built environment should understand, absorb and reflect the social, cultural, technological, environmental and economic conditions of the relevant community to make a better living environment for the living beings.

Figure 07: Detached kitchen

03 Practical Barriers in Implementing Resilient Construction Methods in Resettlement Housing Schemes

By: *Sitheek Infas, Scientist, Human Settlements Planning and Training Division*

As far as Sri Lanka is concerned the housing requirement has been increasing progressively notably aftermath of the tsunami, ethnic conflicts, landslides and floods. Housing assistance to victims of such disaster was provided through construction of housing schemes for resettlement.

Anyhow, the million dollar question is whether all these houses built in housing schemes would withstand and sustain over another natural hazard or man-made hazard. That means, are they capable from a perspective of resilience? Hence, an alarming environment has been created on housing schemes from the point of view of resilient construction. Adaptation of resilient features in domestic house construction had been emphasized. But there are lots of challenges and barriers when introducing resilient techniques in housing schemes. This article mainly focuses on those key challenges.

Eastern part of the country comprises establishment of many housing schemes. Each housing scheme varies in terms of value of the project (cost per unit house), method of construction, and attention paid on the quality of the end product. But, at the ground level, resilient features have not been addressed in the construction processes as much as they should have been done. The following points are identified as obstacles for adoption of resilient features in housing projects.

- **Poor technical knowledge in resilient construction**
  Most of the housing schemes have been looked after by a technical officer attached to the corresponding Divisional Secretariat division. Though, knowledge of a technical officer may meet the required level of technical competence, he or she may not have previous experience in resilient construction. As a result, supervision and inspection by such officer may not satisfy the expectations of National Building Research Organisation (NBRO).

- **Ideology of the public**
  The general public does not understand the importance of resilient features in their shelters. In owner driven housing schemes where owners of lands construct their own houses with the financial support of the government or a donor agency, beneficiaries often do not tend to

incorporate resilient key features in their houses. Frequency of disaster occurrence is less in some parts of the country where people do not show much attention to resilient construction because their thought is that, this approach is more suitable only for high hazard prone areas.

On the other hand, more stakeholders of donor driven housing schemes where donors themselves construct houses through hired contractors and hand over to do not exhibit the attentiveness, because of their lack of knowledge over the benefits of resilient perspective.

- **Quality of the construction**
  There is no special team assigned to supervise and ensure quality assurance during the planning and construction phases. Hence, final outcomes may not satisfy the required level of quality. It would directly affect the end-user in various forms. Many resettlement projects are proposed by the government and non-government organizations in order to satisfy the housing requirements of the victims. Even though the monetary value of the project is collectively high, availability of technical staff assigned for those projects is less. Hence, each person should take care of large portion of the project. It undoubtedly leads to imperfection of the final product.

- **Higher cost of a resilient house**
  Each and every structural element should adhere to resilient requirements under resilience featured houses unlike in the conventional housing construction. Further, openings, connections, roof frames and outer walls, column construction and connections to roof coverings should be firmly fixed. When quality of the house increases, the cost of construction also shows proportional rise.

- **Ineligibility of victims to become beneficiaries**
  The beneficiary selection criteria used by Divisional Secretariat divisions or other related government agencies are not suitable from a resilience perspective. That means, a potential beneficiary may earn high points based on poverty, degree of damage by disaster and others. But the particular potential beneficiary may not be eligible due to hazard-prone land ownership and past records of the events over disaster vulnerability.

- **Improper linkage between the planning phase and the construction phase**
  All housing schemes have their own pattern of architectural appearance and structural features/attributes. Properties of soil, terrain of the land and some other factors influence on deciding the depth of the foundation, method of construction and specific construction procedures. As far as the resettlement housing projects are concerned, nature of land of each and every beneficiary varies in term of soil properties, and level differences on the land. In order to maintain a streamline along the project it is executed as per the design produced for the whole project. At this point, hazard resilient housing method would not be achieved.

  In order to overcome above mentioned barriers, new approaches should be introduced to resettlement housing schemes for victims in a sustainable manner in the near future.

04 NBRO Representation in the Session of Re-Naturing Through Nature Based Solutions for a Resilient Future, Under the Asia-Pacific Climate Week, Sep 2-6, 2019, Bangkok, Thailand

By: *Chinthaka Rathnasiri, Senior Scientist, Human Settlements Planning and Training Division*

Asian Disaster Preparedness Center (ADPC) collaborates with Global Resilient Partnership (GPR), Red Cross Red Crescent Climate Center (RCCC), Mercy Crops, Overseas Development Institute (ODI), Stockholm Environment Institute (SEI) and United Nations Development Programme (UNDP) organized one full day session on "Stepping up Actions on Delivering a Resilient Future" on 3rd September 2019 during Asia-Pacific Climate Week 2019 at UNCC, Bangkok, Thailand.

Under the session, National Building Research Organisation (NBRO) of Sri Lanka was invited to be a Panelist in the sub session of Re-Naturing through Nature Based Solutions for a Resilient Future and to share experiences, success stories and lesson learned of "Nature Based Landslide Risk Management Project" in Sri Lanka funded by the World Bank and implement under the Technical Support of the ADPC.

Plnr. Chinthaka Rathnasiri, Senior Scientist of the Human Settlement Division of the NBRO attended the session representing NBRO and there were four more panelist representing IUCN, FAO, Bangkok Metropolitan Administration and Stockholm Environment Institute.

The session concluded and emphasized the importance of conserving and restoring the natural systems, and also the necessity of application and promotion of nature based solutions in development sectors in order to enhance the climate resilience, which has affected to alarming level at present.

Further, it is discussed the importance of nature-based solutions; not only to protect and conserve the nature, but also to create socioeconomic opportunities to the society through proper planning.

Clearpoint Residencies.

Located in Rajagiriya, Sri Lanka
Architect- Milroy Perera Associates
Contractor- Maga Engineering.
Dubbed the 'world's tallest vertical garden'.
Sri Lanka's first sustainable high-rise apartment complex.

Plants growing in all 46 of its floors as a 'green cover', which acts as a natural cooling system.
All apartments having a private garden terrace.
Built up with a process to reduce carbon footprint and more importantly, reduce maintenance cost across the board.

05 Guidelines for Geotechnical Risk Management

By: *Darsha Dasanayaka, Scientist, Geotechnical Engineering Training Division*

Rapid urbanization with growing population and scarcity of land in urban areas lead to large scale construction of high-rise buildings and buildings with large basements. Further, such construction has even penetrated into suburban areas through mega development projects like Megapolis. Existing buildings in close proximity of large construction sites are often vulnerable to damage, because such construction involves piling, excavation and dewatering, which may cause adverse impacts on adjacent structures. As a result, occupants in affected buildings seek legal assistance to halt construction projects through the courts.

Therefore, it is necessary that any authority granting approval for any construction or development activity involving deep excavation, underground excavation, ground improvement, retaining structures or substructure construction work which may adversely affect the subject site, should assess the effect of the proposed development on adjoining properties and the environment, prior to granting approval.

Figure 01: Effect of inadequate support system to neighboring structure.

Source: NBRO/PMD/CR-161/2017

Figure 02: Development of cracks in adjacent structures due to inadequate earth retaining systems

Urban Development Authority (UDA) and other relevant agencies requested the National Building Research Organisation (NBRO) to assess the geotechnical stability of large construction sites prior to granting its approval for construction. During this process, NBRO learnt that the awareness on required documentation is lacking and hence it takes a long time for application processing.

In the absence of a suitable mechanism to evaluate the potential impacts caused by a proposed construction on adjacent structures, NBRO is in the stage of developing a guideline for geotechnical risk management. This guideline would provide guidance to all stakeholders, such as government institutions, professionals, consultants, and contractors etc., especially in the preparation of proper documentation prior to commencement of any such large-scale construction that need to be submitted at each approval stage as prescribed by the Urban Development Authority (UDA). This document will contain several important sub topics: pre construction condition survey, preparation of geotechnical investigation report, design of the excavation support system, foundation designs, dewatering plans, blasting methods, instrumentation and monitoring process during and after construction, contingency plans and construction in hilly areas.

06 Research Study on "Life Two Years After Relocation: Status Quo of Natural Hazard Induced Displacements and Resettlements in Sri Lanka"

By: *L.J. Prasanna, Scientist, Human Settlements Planning and Training Division*

Sri Lanka is prone to natural disasters such as floods, landslides and drought. Increasing trend of population growth in Sri Lanka has adversely affected the stability of central highlands due to various human activities. Disasters have affected housing as long as mankind has been around. The 2016 landslide tragedy in the Kegalle district fully damaged 158 houses and partially damaged 1631. After these landslides, the Government of Sri Lanka decided to resettle 1600 families who were affected and identified as living in high risk areas of landslides in Kegalle District, in safer lands, with the technical assistance of the National Building Research Organisation (NBRO).

NBRO, in tandem with the Ministry of Disaster Management, developed a framework to resettle these people as a new approach to disaster risk management.

Previous research findings on post disaster housing reconstruction had identified significant challenges such as lack of access to previously settled land, logistical issues in planning and delivery, and scarcity of resources faced by the relocated people. Therefore, revisiting post disaster permanent housing schemes that have been occupied by the recipients can suggest valuable lessons for future practice. It is against the above background, the research project "Status quo of natural hazard induced displacements and resettlements in Sri Lanka" has been initiated in collaboration with Social Policy Analysis and Research Centre, University of Colombo and University of Huddersfield, United Kingdom and the NBRO, Sri Lanka. Aim of this research study is to understand the impact of the disaster induced relocation on the affected people. The present study revolves around the relocation in Kegalle which was initiated post landslides in 2016. This research study anticipates to be a great platform in understanding the impact of relocation on people displaced due to landslides.

The launching of this research project was held at NBRO on 28 May 2019 with the participation of practitioners engaged in post disaster housing reconstruction. It was attended by 30 invited delegates representing various government, and non-government stakeholder organizations, professional bodies and universities involved in post-disaster re-construction work in Sri Lanka. Invitees at the inauguration appreciated the initiative as this study anticipates to draw recommendations for policy level changes to enhance the current relocation process. Participants also appreciateed this research initiative as it expects to assess the drawbacks encountered in the current relocation process and the positive and negative consequences faced by the occupants due to relocation.

07 3D Subsurface Geological Geotechnical Model for Disaster Resilience Housing of Colombo Municipality Council

By: *Lakshika Palamakumbure, Scientist, Geotechnical Engineering Training Division*

Subsurface soil mapping can be used to verify the distribution of soil layers and many decisions can be inferred related to disaster resilient housing construction activities. The depth, thickness and various geotechnical properties of soil strata can be revealed using borehole investigations at different locations so that subsurface profile variation could be mapped, which can be interpreted later against different types of geotechnical issues.

Soil has several major constituents, namely gravel, sand, silt, clay and organic soils. These major soil types occur in various amounts and percentages in soil as a whole, and the most dominant type of soil is the one that gives its main geotechnical properties. Moreover, the distribution of these soil types in a particular soil profile defines its geotechnical behavior and thus it is quite important to know the subsurface details of construction works. Behavior of soils makes it quite difficult to predict the stability of a particular construction if the soil in question is not properly assessed.

Prejudgment on the subsurface features is of immense help to avert unnecessary structural failures, such as cracking, bending, subsidence, tilting and heave, which may take place as a result of volumetric change and displacement through natural hazards such as consolidation settlement and ground subsidence. It is evident that knowing the nature of the subsurface soils is crucial in construction works. To achieve successful prejudgment, visualizing subsurface features in a 3D plane is more effective and 3D geological models are quickly becoming the standard for assessing water and mineral resource potential, geological risk for both industry and government agencies, and economic development, because they are effective tools to more easily explain and portray the often complex subsurface conditions. They are also used frequently and successfully to assist with stakeholder engagement and communication.

Hence, 3D subsurface soil mapping is a useful tool to provide consistent and accurate data to aid safe construction. By identifying this timely need, NBRO initiated a project to develop a web based 3D Subsurface Geological Geotechnical Model for Disaster Resilience Housing of Colombo MC using details obtained from more than 2000 core logs. The 3D Subsurface Geological Geotechnical Model is developed using ESRI ARCGIS platform and an interpolation method is used to predict subsurface conditions where borehole data is not available.

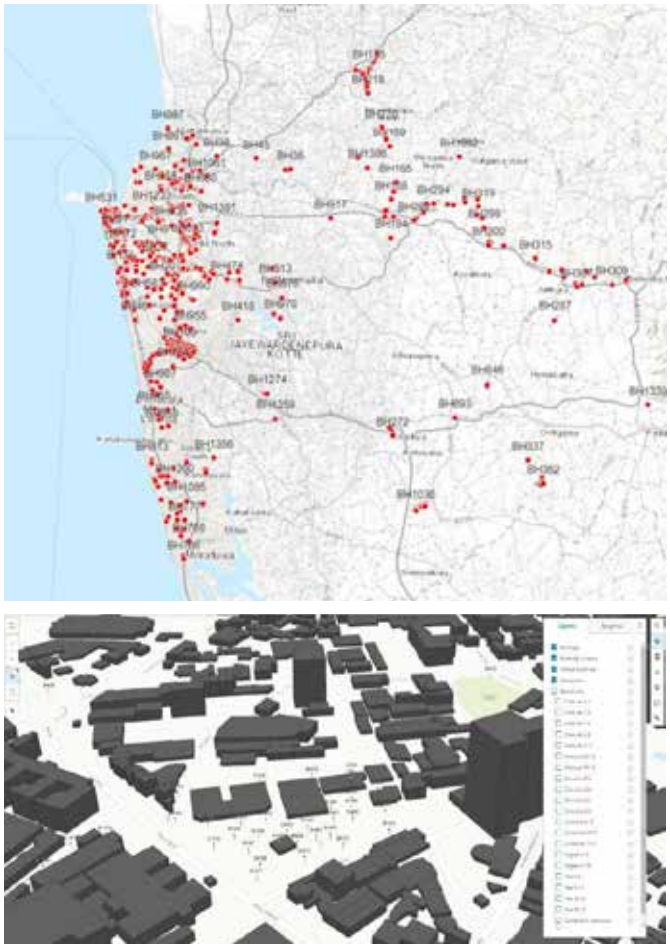


Figure 01: Available borehole locations in Colombo MC

The project is initiated under several phases. “Phase1” is to develop a 3-D model along with corresponding 2-D maps with the help of geological and geotechnical information using available borehole data. Construction of geotechnical hazard zonation maps, to interpret all possible geotechnical changes and behavior leading to damage or hazard will be the final phases of the project.

Under “Phase1”, borehole data was imported as 3D geographical points based on depth information. Then, using interpolation methods, a continuous geological surfaces which has the same geological

classification were constructed. The project is currently at the final stage of phase one. The biggest challenge encountered during phase one was to improve the accuracy of the interpolated layers where borehole data was not available. Manual editing of the geotechnical layers was carried out by geotechnical engineers and geologists using the available subsurface cross section profiles in order to improve the accuracy of the mode.

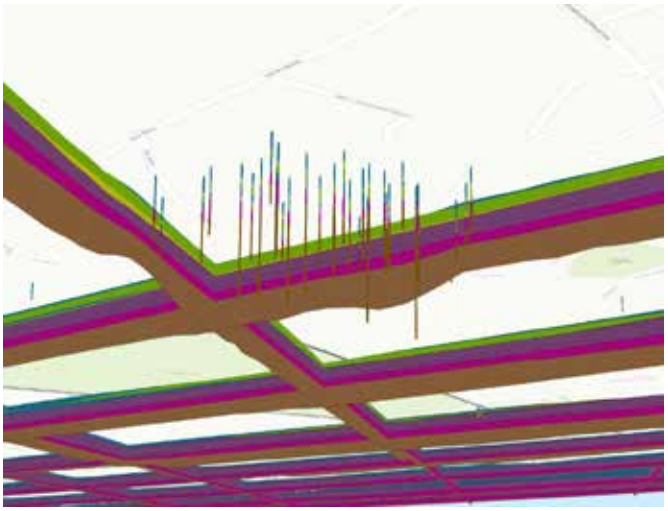


Figure 02: Borehole data was imported as 3D geographical points based on depth information.

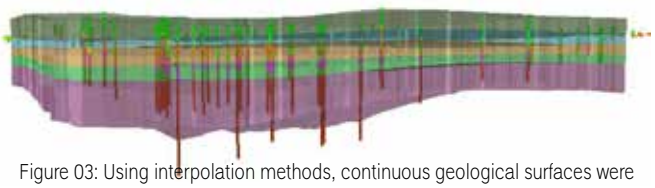


Figure 03: Using interpolation methods, continuous geological surfaces were constructed using borehole points with the same geological classification

Final output of phase one will provide depth, thickness and type of subsurface geotechnical layers, soil consistency, and groundwater conditions in a 3D model at any location within Colombo MC along with a pdf document of the available borehole logs in the vicinity. NBRO expects to publish this web based 3D Subsurface Geological Geotechnical Model in the near future and access will be granted to potential stakeholders. Final output of phase one will provide depth, thickness and type of subsurface geotechnical layers, soil consistency, and groundwater conditions in a 3D model at any location within Colombo MC along with a pdf document of the available borehole logs in the vicinity. NBRO expects to publish this web based 3D Subsurface Geological Geotechnical Model in the near future and access will be granted to potential stakeholders.

NBRO – JICA Join Collaboration.

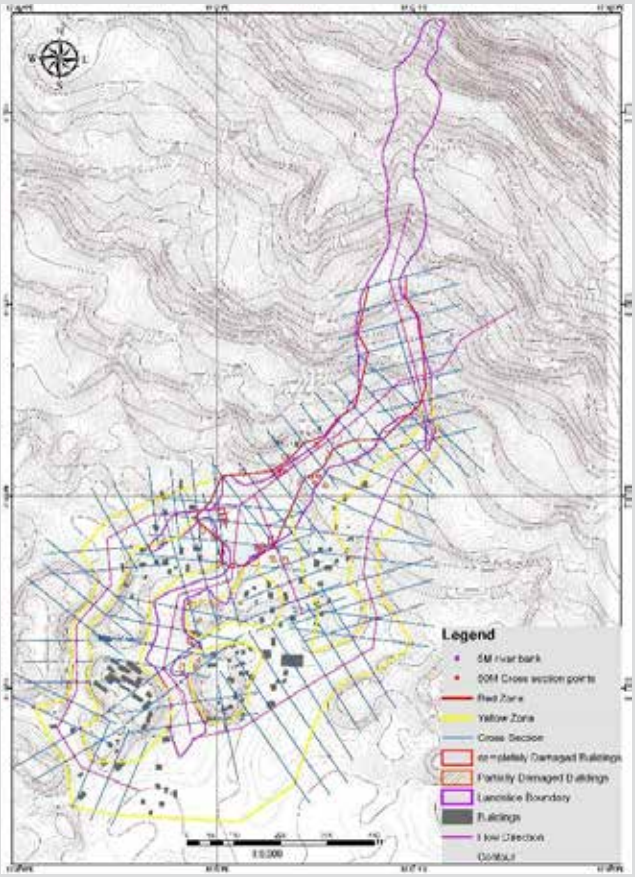
By: Hasali Hemasinghe, Scientist, Landslide Research and Risk Management Division.

The National Building Research Organisation (NBRO) jointly with Japan International Cooperation Agency (JICA) has commenced a project on capacity strengthening on development of non-structural measures for landslide risk reduction in Sri Lanka (Project SABO). This project aims to strengthen of capacities to conduct site specific hazard mapping and risk assessment, to issue landslide early in warning regional level while improving the existing system and to apply risk assessment of sediment disaster(s) to land use planning and development standards.

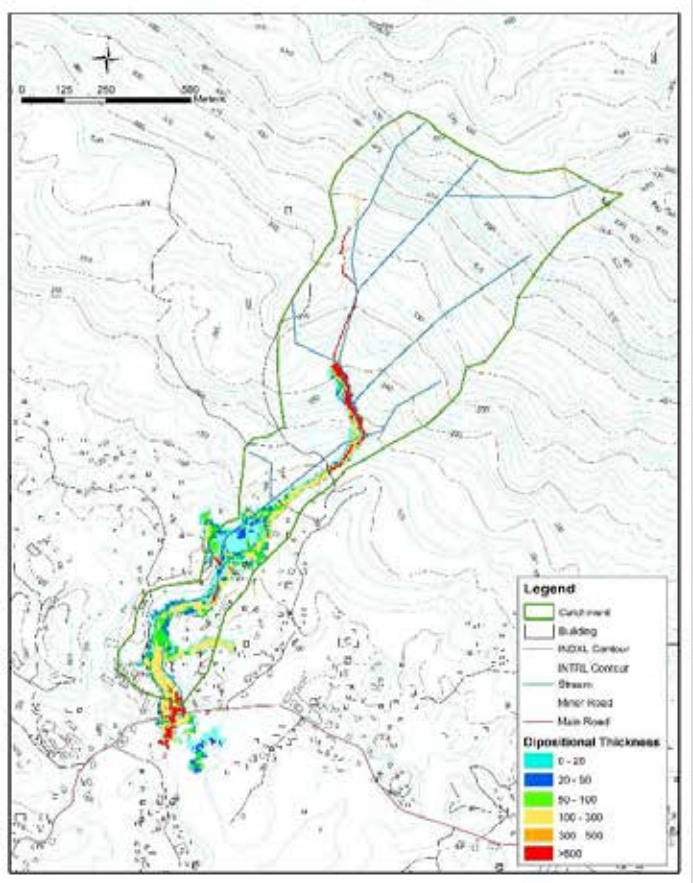
Under this project training on site specific hazard mapping (setting Yellow zone and red zone) and debris flow simulation was held on 13th June 2019. The training aimed at practical preparation for the Yellow zone and the working team of the project manually drew the Yellow zone in order to understand the principle method. Flow path simulation using Hyper-KANAKO model was tentatively carried out using the assumed deposit amount and other parameters.

Field investigation was carried out at Morawakkanda site on June 20-21 in order to verify the result of the debris flow simulation and yellow zone prepared on desk. The working team also verify the micro-topography and possible flow range of debris flow that cannot be identified in 1:10,000 scale map. Meanwhile, soil samples were collected for grain-size analysis in order to acquire the actual parameters which is used for the simulation instead of the tentative parameters. In addition, locations of the fully destroyed houses were collected, that information will be referred to set Red zone in the site specific hazard mapping.

Field visit at Morawakkanda



Site specific hazard map (indicate yellow zone)



Landslide flow path (simulated using drone data)

08 Permeable Paving Blocks for Sports Surfaces

By: *G.K.B.M. Gannoruwa, Scientist, Building Materials Research & Testing Division*

In Sri Lanka synthetic fiber blended fabric offcuts considered as waste which create a significant waste disposal problem. Currently it is being sent to a cement manufacturing plant where it is incinerated as fuel in the cement kiln or it will be ended up with illegal dumping in land fillings. The better way to manage this waste is use of waste as a raw material for another industry considering environmental preservation. Accordingly paving block was developed with the use of fabric waste as a result of research activities. Fabric embedded paving blocks shows special features like water infiltration capability and shock absorption capability when compared with conventional cement based paving blocks. Water permeability of polyester spandex fabric embedded paving blocks is 100 times higher than that of commercially available cement based paving blocks. This feature leads to reduce surface runoff during raining while recharging underground water table. This will be the solution to reduce instant flooding on open concrete areas during heavy rain.

Small fabric pieces act as reinforcing fibers in the cement matrix. As a result of that failure pattern of this block is transforms to more ductile failure mode from conventional brittle failure mode which gives an indication on shock absorption capability of the fabric embedded paving block. Accordingly it is suggest that this paving block can be used for sports surfaces which gives better foot comfort.

09 Experience Sharing Lecture on Building Code

By: *Lakshika Palamakumbure, Scientist, Geotechnical Engineering Training Division*

The National Building Research Organisation (NBRO) and Construction Industry Development Authority (CIDA) have initiated the development of a building code for Sri Lanka. Already NBRO and CIDA are working together in the preparation of Building Code for Sri Lanka.

Prof. Harsha Munasinghe, Professor of School of Architecture, George Brown College, Canada has recently given his contribution for the preparation of a Building Code for Canada. We believe that his experience and learning outcomes of this project will be useful for Sri Lanka. Therefore, an experience sharing lecture was held on Monday, 24th June 2019 at Auditorium of NBRO.

It was a well explained lecture from the beginning to the end; what is a building code, why do we need building codes and what is the importance of it, where we are as a nation in relevance to this subject and where Canada does stand, what we have to do to improve Sri Lankan building codes etc.

Following article is the summary of Prof. Harsha Munasinghe's lecture as reported by senior scientist Dayan Munasingha.

Building codes are required for;

1. Solving architectural and engineering problems
2. Social and accessibility of the community
   a. How a building can be accommodated by people, activities, etc.
3. Fire safety or hazard resilient construction
   a. Most people died due to fire smoke, not due to collapse of frame structures
4. Proper construction mechanism for foundations, supper structures... etc.

The building codes are required for creating healthy and secure live space in the building. This has included, light and ventilations. In addition, accessibility, fire safety and environmental sustainability are the key components. The accessibility is newly added component for preparation of these building codes. The alternative objective is to control the resources without burdening the untouched natural resources. Now 20-25% embodied energy can be secured thorough improving the building codes.

These building codes are required for resettling of disaster victims and people in underserved settlements to improve their settlements up to proper standards.

People need to build proper shelters for protecting them from weather and for safety. It is required to understand the materials, weather and some other factors before construction of buildings. Earlier days, wood was used as a material for building houses in North America, which is easily to recycle, and good for earth as well. But in Sri Lanka, we used concrete and cement based on the weather conditions and culture. But construction might be a disruption to the earth behavior and a clear mechanism for sustainable solution is required for development with construction and nature. As an example, the Sooriyawewa university was built in a natural area and it should have been built as nature-based construction.

National Research Council of Canada has developed broad building codes for national use. This has taken so many years to develop and every year, the Council updates this building code. The provincial council has updated the codes in every 5-year period. This building code has started in 1941, through the National building code and it was revised in several years. The numbering of building code is important part and these numbering should be in consistent manner. Renovation and change of old buildings can be used for adhering to new or revised codes. If the buildings are declared as historic buildings, the owners can escape from all the new building codes.

The code should be implemented by the Municipal Council and officers should be qualified for the building inspection through various exams or courses. These officers should be responsible for all the construction.

The high-rise buildings are trending now, and it is required to have community facilities inside the building and based on the community activities building becomes active. In addition, due to weather conditions, most of the people try to go through these buildings to escape from

adverse weather conditions. The accessibility and ventilation facilities are highly important factors of the building and that help to improve walkability. Building data management systems are important to monitor the building construction activities in the area and that helps to monitor the building construction activities from time to time.

Mid-rise wood framed buildings are trending in Canada for achieving of better performance and reduce the costs. However, fire systems are required to initiate as from the beginning. Fire safety is major issue in Canada and therefore, building and fire codes were introduced to the buildings. Fires safety related materials, operations and infrastructure are implemented in the buildings. Since 1947 Canada have 67 codes. The new code is developed for doors where directions, bells, etc. this was developed because of during the emergency period, it is hard to break or evacuate from the building due to various door construction methods.

The building codes should have technical requirements, minimum provisions and maintaining officer of the building code; as an example, building owner is the maintaining officer of the building.

Land use is one of import section of the building code. In residential area, Lot coverage percentage should be below 60% and there are different building codes are adhering for the buildings. The permissions are required to modify the green coverage around the buildings. It is required to control the urban sprawl in the cities and the building should have different identity better understandability of the urban areas. The public spaces and building designs should be considered under the building codes.

The building code have main two sections. In the first section discuss the definitions, acceptable solutions for different subject areas; plumbing, fire safety, etc., professionals who should involve for designing of the buildings and what are the basic qualification of the persons. The standards of the buildings; comfort conditions of the buildings, lighting levels and different standards are also discussed in the first section. All the standards are briefly discussed, and values are given for different types of the buildings. The process of the building application and time framework are given in the document. (www.e-laws.gov.lon.ca)

The building codes should have series of objectives to formation of the different codes; fire safety, structural safety, sanitation, noise protection, privacy, view to the outdoors, barrier free path of travel, barrier free path facilities, etc.

Then it is required to functional statements which discuss how the objectives achieved while implement each step. The next part is acceptable solutions which discuss technical details of the constructions. Building solutions are differ according to the use do the building. Therefore, it is required to identify the potential building uses while developing the building codes.

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