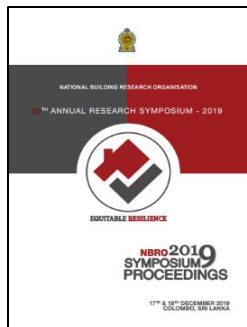


Research & Development Program- NBRO



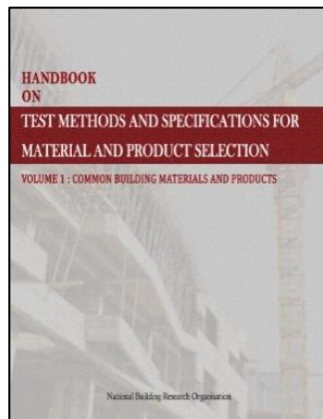
NBRO continued to receive annual government research grant of Rs. 15.0 Mn in 2019. An Industrial Consultation to learn research needs of stakeholder institutions and construction industry was held on 29th January 2019. R & D programme with research projects focused on creating disaster resilience was devised and carried out. Outcomes of research projects were presented and published at the 10th Annual Research Symposium of NBRO titled 'Equitable Resilience' held on 17th and 18th of December 2019 in Colombo. Altogether 48 technical papers were published in the Symposium Proceedings. The well attended symposium provided participants a platform for discussion and sharing experience.

R & D projects in 2019

Continuation of developing manuals on resilient construction

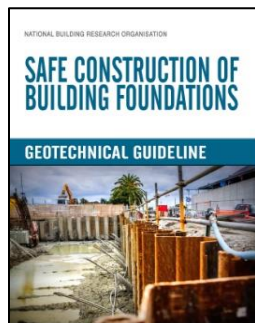
As requested at the Industry Consultation, NBRO formulated research projects to compile several manuals under the R&D Programme. Experts in respective fields assisted in this work and steering committees provided the required guidance. Drafts were first presented to representatives from stakeholder institutions and construction industry, and then, revised as per their advice. The final documents were published in December 2019 in parallel to the Symposium and made available for free downloading at NBRO website: www.nbro.gov.lk.

Development of guideline for selection of materials and products for construction industry



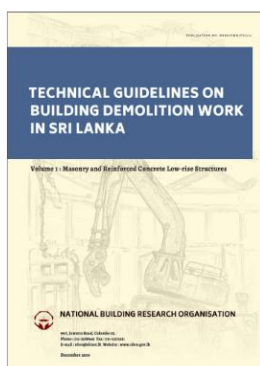
Having realized that, there is no country specific construction material and product selection handbook or a guideline for the construction industry professionals in Sri Lanka to ensure that the most appropriate materials and products are used in civil engineering construction, NBRO took a proactive role and formulated this research project. As the project outcome, 'The Handbook on Test Methods and Specifications for Material and Product Selection - Vol 1: Common Building Materials and Products' was compiled and published. This document is quite comprehensive and details properties, test methods and standards of all most all commonly used construction materials in the country. This document will be very useful in large housing construction projects such as housing projects for resettlement of disaster affected and disaster vulnerable communities. The project will continue for two more years to produce volumes II & III.

Development of geotechnical guidelines for high-rise buildings



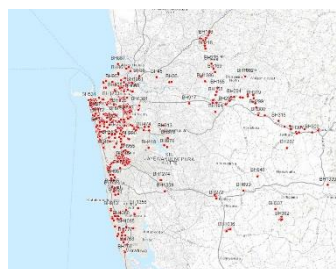
Excavation and other construction activities in high-rise buildings and large building complexes often affect stability of adjacent buildings and sometimes, damage them. As a prevention measure, it is necessary to develop mechanisms to guide design and construction personnel for them to follow proper and systematic work procedures. This research project probed into pros and cons in present design and construction work and prescribed correct procedures to follow and as the project outcome, this guideline 'Geotechnical Guideline on Safe Construction of Building Foundations' was compiled and published.

Preparation of Technical Guidelines for Building Demolition work in Sri Lanka



Building demolition work in Sri Lanka is carried out often without adhering to proper procedures because of the unavailability of statutory technical guidelines, codes, safety standards or regulations. The lack of involvement of relevant professionals in planning & direction, monitoring & supervision in ensuring safety of life and property are other contributory reasons for recent tragic incidents. Hence, NBRO as a R&D project conducted necessary studies on global and local practices of building demolition and contractor experience, and then compiled this guideline titled 'Technical Guidelines on Building Demolition Work in Sri Lanka' to provide guidance on safe and good practices for demolition works. This guideline elaborates safe practices on demolition of low-rise buildings of masonry & reinforced concrete framed structures with in-filled walls that are recommended to be adopted especially in urban and congested locations of Sri Lanka.

3D Subsurface geological geotechnical model for disaster resilience housing of Colombo



In Colombo, many building construction projects are in progress at any given time and at the same time, many new projects are in the planning stage. It is always advantageous to know about subsurface condition of a construction site before commencing any geotechnical investigation and foundation design. NBRO possesses a large database on geotechnical data from investigations carried out in the past. These data were collated and a computer model giving 3D Subsurface Geological Geotechnical Data of Colombo Municipal Council area was prepared by this research project. This model is now made available at the NBRO website for web browsing and it will benefit geotechnical practitioners and constructional professional. More data will be collected and added in future to enrich the model.

Preparation of building codes for Resilient Sri Lanka



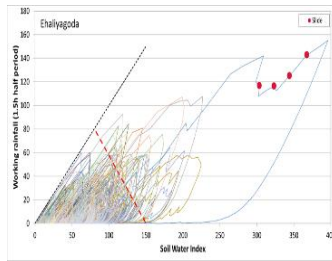
NBRO is assisting Construction Industry Development Authority (CIDA) in the preparation of suitable country specific building code for Sri Lanka. On the recommendation of International Code Council, the CIDA has selected to adopt International Building Code in the Sri Lankan codes development process. In this context, NBRO is developing "Building Code for Disaster Resilience" and it is expected to complete this task in the next 9-12 months period.

Designing a transitional shelter for disaster-affected communities

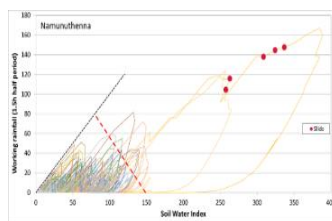


Occurrence of disasters has increased in the recent past due to effects of climate change and expansion of unplanned human settlements. People living in high hazard areas are ordered to evacuate homes at times of a potential disaster and they may have to live in temporary shelters until permanent shelter solutions are made available. Temporary shelters in current practice are school buildings, tents, or other public buildings. In this research project, a transitional shelter that can be assembled quickly and adequate in size for a family to live in for a period of about 1 -2 years was designed. Developed shelter is liveable, low in cost, stable against natural disasters and with minimum impact to the existing environment.

Determination of thresholds based on rainfall indices for the occurrence of landslides in Kalu Ganga basin, Sri Lanka



This study was carried out to investigate the relationship between date/time of landslides occurred and rainfall indices in Kalutara district. Learning from previous events, it was identified that landslides trigger from either high intensity rainfall with low cumulative rainfall or low intensity rainfall with high cumulative rainfall. Therefore, the study was focused on determination of localized rainfall thresholds by an empirical approach, with the aid of the combination of long term and short-term rainfall indexes. Soil water index (SWI), 72 hours half period working rainfall, 72 hours and 24 hours cumulative rainfall are used as long term rainfall indices while 1.5 hours half period working rainfall and hourly rainfall are used as short term rainfall indices.



The obtained results show more uniform pattern with the combination of SWI and 1.5h half period working rainfall compared to the other indices. The study proved that the use of the combination of SWI and 1.5h half period working rainfall lead to improve the early warning accuracy. Furthermore, it is proved that large scale landslide events have mainly occurred in high SWI, but small scale slope failures have occurred even in low SWI. For the Kaluganga basin area, all the landslides initiated exceeding the value 80 of 1.5 hours half period working rainfall and 140 to 300 SWI values depending on the locality. But it is difficult to set the exact critical values based only on the study. Thus, more research with more landslide and rainfall records is needed to investigate the relationship of rainfall to trigger a landslide event and to improve the current early warning system.

Hydrological functions of small tank eco systems and its role in sustainable water management



This project aimed at developing an evidence based technical guidelines for small tank rehabilitation. Tank (wewa) is considered to be the most crucial water management unit in the dry zone of Sri Lanka due to its unique capability in sustainable water management. The architecture of ancient tanks includes several hydro ecological zones (HEZ) having unique water conservation functions. Among these functions water holding capacity and the hydrological functionality of HEZs to compensate evaporation losses during dry seasons is considered to be a significant factor in the sustainable water management in the dry zone. This research focuses on studying the aspects of hydro ecological functions of HEZ in selected tanks in Anuradhapura (Kunchikulama and Hiripitiyagama) to establish an evidence basis pertinent to HEZs water retention properties under varying meteorological conditions to be used in developing guidance document for the stakeholder institutions to use in tank construction and rehabilitation works.

Sustainable roof-based rainwater harvesting system to overcome domestic water deficit condition in Anuradhapura



Water stress in an area occurs as a consequence of prolong drought. Attention has now been focused on RWH strategies to address the long-term water stress prevailing in the dry zone of Sri Lanka. However, the latest analysis of the surveys conducted by ESSD on community perception related to Roof RWH shows that it has not yet been popularized among majority of the people.



Realizing the importance of roof RWH as a sustainable solution for the domestic water stress, drawbacks with the existing systems were analysed systematically and design considerations were developed in order to make the systems more user friendly and sustainable.

Development of cost-effective green masonry products using textile waste



Rubber-mixed fabrics like polyester spandex in fabric offcuts from apparel industry is a waste difficult to dispose. This research project developed polyester spandex embedded masonry products with desired strength and other properties needed in construction industry. Paving blocks were developed incorporating shredded form of polyester spandex, which shows superior energy absorption capability. Furthermore, water permeability of this paving block is 100 times higher than that of conventional cement based paving blocks.

Development of alternative fibres to asbestos fibres for roofing materials



This research project investigated the use of natural fibres as viable alternative to asbestos fibres in roofing materials. Natural fibres such as Palmyra and Bristle coir fibre were tested in laboratory in search of their suitability for cement-based roofing sheet. Roofing sheet samples have been fabricated and tested to analyse the mechanical and durability properties.

Analysis of waste sludge produced from water treatment plants as a substitute for clay in the manufacturing of clay tiles



This research investigated the possibility of utilizing the water treatment plant sludge (WTS) as a replacement for conventional tile making clay in manufacturing of clay roofing tiles since a considerable amount of sludge is generated each year by water treatment plants in Sri Lanka. Calicut clay tiles were cast in an industrial clay manufacturing factory and tested in accordance with Sri Lankan standards.

Suitability of Fly Ash Blended Cements for Construction of Concrete Water Storage Tanks



This research is focused on investigating the leaching of toxic elements from concrete containing fly ash as supplementary cementitious material under two scenarios; (i) the effect of FA content when used as a cement replacement and (ii) the effect of water cement ratio. Cylindrical mortar specimens were cast according to the NEN 7375:2004 sample preparation specifications where the Ordinary Portland Cement (OPC) was replaced by FA in the contents. Finally, the leached constituents were compared with the Sri Lankan Specification for Potable Water.

Developing a methodology for conducting Social Impact Assessment (SIA) for structural landslide mitigation measures

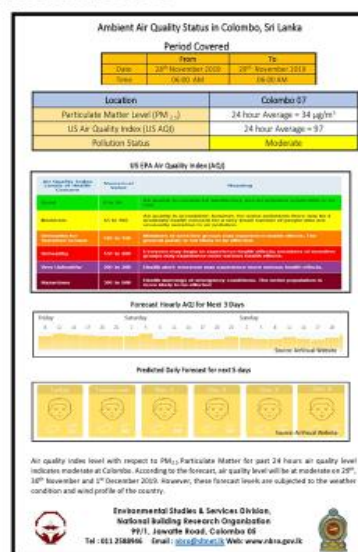
This research project was carried out jointly with consultants from University of Colombo to develop a methodology for conducting social impact assessments when planning and implementing structural mitigation measures in landslide affected areas. A draft methodology was developed and tested in a pilot study conducted in Athwalthota landslide affected area in Kalutara district. A verification study has been planned for the next year as the project continuation.

Development of real-time air quality monitoring network in urban areas in Sri Lanka for air quality prediction and preparedness system

AIR QUALITY STUDIES



Remarkable Increase in Ambient Air Pollution Levels in Colombo, Sri Lanka between 5th & 7th November 2019



NBRO developed sensors for monitoring air quality with the guidance of Dr. Ajith Kaduwela of California Air Resource Board and established a station for real-time monitoring of ambient air quality at the premises of Department of Meteorology in 2018. This work continued in 2019 and with further guidance of Dr. Kaduwela. NBRO verified performance of developed sensors against the Beta Attenuation Monitoring (BAM) and published results at the NBRO Symposium. Now, stations have been established in Colombo, Kurunegala, Vavuniya and Puttalam that give real-time air quality readings to a dedicated website linked to NBRO website.