NATIONAL BUILDING RESEARCH ORGANISATION

NEWSLETTER

Volume : 38
March 2017

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Construction Materials in Sri Lanka: The Past and The Present

Dear Readers

We are happy to welcome you to read the first issue of NBRO Newsletter in the year 2017. This issue addresses issues on construction materials in Sri Lanka and contains few articles from other disciplines as well.

2016 ended remarkably well after hosting the NBRO's first International Research Symposium and nearly 50 technical papers from both local and international authors were published in the Symposium Proceedings. Year 2017 is expected to be another eventful year for NBRO. Research and Development programme of 2017 has been started already and laboratories have been equipped with new facilities.

Sri Lanka launched several major construction projects in the past decade which necessitated adoption of new construction methods, practices and materials. At the same time, the emerging construction sector had to face its own challenges; the need for testing stronger building materials for high-rise construction, scarcity of good quality raw materials and inadequate quality controlling procedures.

One of NBRO's primary duties is to assist the construction industry by providing laboratory testing and technical consultancy services and conducting research and development to overcome such challenges with a view to create a safer built environment. In this context, during for the first quarter of this year NBRO is providing exclusively the energy absorption test facility to Uma Oya Multi-Purpose Project, assisting Central Cultural Fund in developing cement-free mortar mixes to conserve ancient structures and developing a product certification scheme to ensure the quality of important construction materials in Sri Lanka.

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

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

Content

Groundbreaking Ceremony of the New Building of NBRO

National Building Research Organisation (NBRO) held a groundbreaking ceremony to commence construction of its laboratory complex on 16th February 2017. The religious ceremony was carried out at the site with the presence of the clergy and the staff of NBRO and Isuru Engineering (Pvt) Ltd. participated. Eng. (Dr.) Asiri Karunawardena, Director General of NBRO performed the groundbreaking together with Eng. Mahesh Pasqual, Chairman/ Managing Director of Isuru Engineering (Pvt) Ltd.

Eng. (Dr.) Asiri Karunawardena, Director General of NBRO performing the groundbreaking together with Eng. Mahesh Pasqual, Chairman/ Managing Director of Isuru Engineering (Pvt) Ltd.

Building Materials Research & Testing Laboratory of National Building Research Organisation was granted ISO 17025 Accreditation for the "Performing Mechanical Testing on Concrete cubes & Steel bars as per ISO and SLS methods".

THE FIRST LABORATORY IN SRI LANKA, GRANTED ACCREDITATION FOR STEEL TESTING.

SLAB

Certificate of Accreditation

Sri Lanka Accreditation Board for Conformity Assessment hereby declares that

Building Materials Research & Testing Laboratory
National Building Research Organisation

having being found to comply with the accreditation criteria for testing/calibration laboratories as described in ISO / IEC 17025 :2005, has been accredited as a testing laboratory under the field of

Mechanical Testing

and has been assigned the accreditation number
TL 064-01

This certificate is issued on 11 May 2016 and is valid until

10 May 2019

The accreditation was granted for the first time on 11 May 2016

The scope and conditions of accreditation are specified in the Schedule of Accreditation bearing the accreditation number appearing in this certificate.

Director / CEO
Sri Lanka Accreditation Board for Conformity Assessment
Colombo, Sri Lanka

Introduction of Low Cost Alternative Roofing Materials

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With the decision taken by the government of Sri Lanka in 2016 to ban the importation and production of asbestos roofing sheets by 2018 (http://www.president.gov.lk/steps-to-ban-import-of-asbestos-roofing-sheets-by-2018/), the Sri Lankans were keen on knowing the possible alternatives for asbestos roofing. The demand for roofing in Sri Lanka is met by clay tiles, zincalume sheets, concrete tiles and asbestos -cement roofing. Amongst these, asbestos-cement roofing meets over 35% of the market share (A report on the Use of Chrysotile Fiber in the roofing industry, Chrysotile Asbestos Cement Products Manufactures Association, 2015). Countries like Vietnam of which the socio-economic conditions are not too dissimilar to Sri Lanka, the Asbestos industry successfully partnered with their government to overcome their problems. This was also presented by the NBRO in consultative committee meetings held at the NBRO in 2015.

The following technologies and products package are expected to fulfill the roofing material requirement of low income stratum of the population and the vulnerable communities in disaster prone areas. Eventually; NBRO can provide compliance testing in respect of prospective materials that would be newly imported or manufactured.

Sri Lanka is rich in plant vegetation (e.g. "mana" and "iluk" grass) which remain unutilized at present. Coir fibre too is relatively inexpensive. Fibres from these sources can be used in the production of micro concrete tiles. This will not only improve tensile properties of the resulting tiles but reduces their brittleness too.

Manufacturing technology of asphalt based (i.e. asphalt + plant fibres or cotton wastes/ asphalt + paper pulp) corrugated roofing sheets is well established. Suppliers of manufacturing plants are available in some countries including India. This roofing material, particularly suitable for the central region of Sri Lanka can be popularized through estate and government sponsored housing schemes. Magnesium oxychloride corrugated roofing sheets are suitable for urban housing and they also could replace asbestos-cement sheets.

With the high rate of industrial development, available natural resources are consumed in a very rapid manner. In order to ensure suitable development, it is a must to carry out long-term research on alternative building materials, especially on roofing materials and alternatives to wood-based products, and devise methods to cater the demand in immediate future. At the same time plans should be implemented focusing on the adaptation of newly developed building materials and technologies in developed countries to our country.

Can We Use Offshore Sand Just Like River Sand?

Building Materials Research and Testing Division
National Building Research Organisation

Offshore sand is used in many countries for construction work. It was proposed as a suitable alternative for river sand in Sri Lanka based on extensive research carried out in several research organizations. However, masons, house builders and the general public had doubts regarding its use and raised issues such as:

- How different is it from beach sand?
- Will it contain salt and sea shells which will affect the durability of construction?
- Is it possible to use offshore sand just like river sand?

Offshore sand pile in Naththandiya

Offshore Sand and Beach Sand

Offshore sand is extracted from the sea beyond a specified distance from the sea shore and is not the same as sand taken from the shore or beach. It is not legally permitted to extract sand from the beach in order to protect the sea shore. When compared with offshore sand, beach sand is very fine and contains salt accumulated by the continuous action of sea waves. Therefore it is not suitable for use in construction work.

On the other hand offshore sand has been identified as a viable alternative to river sand, the extraction of which is restricted due to environmental, economic and social reasons. However, offshore sand should be selected for a given application based on its properties.

Salt and Shell Content in Offshore Sand

There are locations where the shell content in offshore sand is very high. Therefore it is important to select suitable locations for extraction of offshore sand. It is also important to ensure that the sand is processed to ensure that its salt content is within specified limits so that the durability of construction will not be affected.

Use of Offshore Sand in Construction

Sand is used in construction mainly as a fine aggregate in concrete and for producing mortar, including plastering and rendering material. As per the statistics shown in "Alternatives for river sand-Policy Initiatives" - Report (unpublished) prepared by Construction Industry Development Authority: September 2015, production and demand for sand for above applications shows the need to expedite the production and use of offshore sand as aviable alternative to river sand.

It is applicable to all types of sand derived from naturally occurring material such as river sand or offshore sand, sand obtained by crushing gravel or rock, or produced from demolished concrete, industrial by-products etc. Thus it is clear that offshore sand could be used as any other sand type, provided it complies with the requirements specified in the standard.

NBRO Research

The NBRO carried out a sample survey of offshore sand in the region extending from Kalpitiya to Mirissa in 2001-2. Samples were obtained from the surface of the sea bed (by grab method) for testing and analysis.

Observations on Results of Laboratory Trials

Concrete made by combining several offshore sand samples exhibited better strength than that made from river sand in respect of 28-day strength. Even the samples that appeared to have a high shell content or were deprecated on visual basis exhibited a strength exceeding the designed strength of the concrete (25N/mm2). Other samples achieved over 90% of the strength of concrete (at 28 days) of the river sand sample. The strength gain in 7days in offshore samples was somewhat poor compared to the strength gain in the river sand sample.

Observations and Results of Field Trials

Field trials on concrete and masonry (plaster work) were carried out at a work site of a reputed private company using a combined sample of offshore sand. Proportions of materials used in in concrete and plastering mortar were in accordance with mix designs of the company. The observations and test results on concrete and mortar mixes made with offshore sand were comparable with those carried out at the site with river sand used by the company. The masons and technicians were satisfied with the performance of offshore sand samples provided.

Concluding Marks

Based on the observation and results of field and laboratory trials, samples of local offshore sands showed that they are suitable for processing for use in concrete and mortar as per the requirements specified in the Sri Lanka Standard. The need and importance of processing / washing the sand before use was reflected in the chloride content test (0.01 – 0.2 %). It was also seen from the offshore sand samples, that sand should be extracted from carefully selected locations. It is therefore clear that offshore sand is not a direct substitute but only an alternative to river sand. Unlike river sand, it is important to ensure that offshore sand should be extracted, produced under specified process control methods and marketed with an assurance on quality by a responsible organization.

Copying the Nature: Biomimicry in Shaping the Future Urban Landscape

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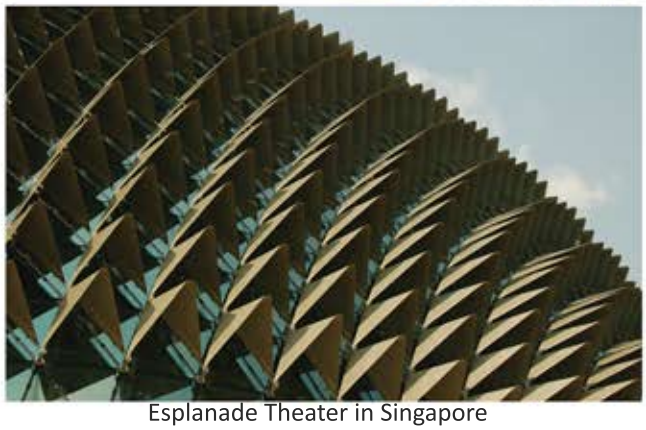
From the beginning of the civilization, prehistoric men have been imitating the natural features of their surrounding environment to make life easy. They have not only copied mechanisms of foraging, etc. but also build tools resembling the claws, teeth of vultures and predators to get ahead in the game of hunting. Yet along the road to the industrialization, mankind tried to break away from cohabitating with the nature to claim the throne of superiority among all the living. With the emergence of concepts like circular economics, green technologies and sustainable development, the grim trajectory have reversed and forced the human to come into a common ground with the nature. With this new development, biomimicry; designing and producing materials, structures and systems inspired by naturally existing biological entities and processes, was born. Since then Biomimicry have been used from making ultra-strong threads as spider silks, adhesives inspired by gecko feet to adopting wind turbine blades as the shape of whale fins. These entities and features have a massive success because they are evolved through the chronology of the planet to carve out their unique slot in the ecosystems and making them a far cry from the crude human-designed solutions.

In the age of rapid urbanization resulting the forceful transformation of non-urban or sub-urban land uses into energy intensive and heavily polluting urban centers, biomimicry is gaining its much needed momentum. Successful examples of this nature can be found all over the world and one of the classic examples is the Eastgate building of Harare, Zimbabwe which was modeled with the energy efficient passive cooling systems mimicking African termite mounds. The mid-rise building stays in thermos-regulated throughout the year without any conventional air-conditioning or heating. Another example is the Beijing Olympic national stadium which is inspired by bird's nest with having curved steel beams for strengthening and open spaces in roof which aid in insulating in the colder climates. Esplanade Theater in Singapore has a building exterior which looks and function exactly as the multi-layer Durian fruit. It works as a shading system which alter in order to allow only required amount of sunlight during the day thus reduce overheating inside the theater.

These success stories found in many parts of the world have inspired numerous researchers around the globe in looking beyond the beautiful shapes of meanders, spirals, etc. both hidden and clearly visible in our surroundings. Recognizing the concepts and principles behind the existence of these curves and edges might lead them to develop innovative solutions to the many problems humans are facing today. Also, it is evident that with a little bit of help from the nature, the ultimate designer, we are not far from reaching the pinnacle of building sustainable cities and rejuvenating sacrificed forested and other non-urban areas.

Birds' Nest Beijing 2008 Olympic Stadium
(https://sportspirits.wordpress.com & http://journal.jitt.travel)



Esplanade Theater in Singapore
(http://www.panoramio.com & https://commons.wikimedia.org)

Energy Absorption Test for Shotcrete Panels in Uma Oya Multipurpose Development Project

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Toughness of shotcrete is specified by either residual strength test for beam bending or energy absorption test for plate. Beam bending test is a well-known test to Sri Lankan Construction Industry, but energy absorption test is relatively new. Energy absorption test is carried out as per the test method specified in European Specification for Sprayed Concrete.

The definition of shotcrete as per American Shotcrete Association (ASA) is "Mortar or concrete pneumatically projected at high velocity onto a properly prepared surface". Shotcrete is reinforced with discrete steel fibre in order to increase the toughness.

Steel fibre reinforced shotcrete is widely used in the Uma Oya Multipurpose Development Project in constructing tunnels. In the contractor's specifications, values are specified for shotcrete used in tunnel construction. National Building Research Organisation (NBRO) is currently carrying out energy absorption tests for this project.

Performing energy absorption test for a shotcrete panel

For energy absorption test, a plate of 600 x 600 x 100mm size shall be supported on its 4 edges and a centre point load applied through a contact surface of 100 x 100mm. The load is applied opposite to the spraying direction. It means rough side is kept as bottom. This test is carried out by using special apparatus. For curing the prepared specimen shall be stored in water for a minimum of 3 days immediately before testing and kept moist during testing.

The load deflection curve shall be recorded and a curve obtained in NBRO laboratory is shown in Figure 1 as an example.

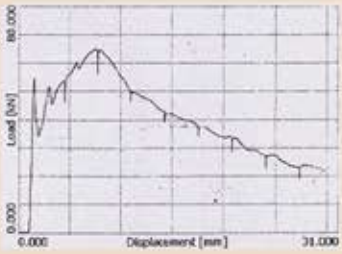

Figure 1: Load deflection

Figure 2: Energy absorption curve obtained

Test is carried out until a 30mm deflection occurs. Standard loading rate is 1.5mm centre point deflection per minute. Absorbed energy upto 25mm deflection is the standard energy absorption of the sample. This is area under the load deflection curve up to 25mm deflection. Advanced equipment automatically calculates the value and record. As an example, energy absorption curve is shown in Figure 2. As per the test results obtained, the samples submitted of shotcrete panels to our laboratory could be classified as class a (>500J), class b (>700J) or class c (>1000J) stated in the standard.

References:
EFNARC 1996, European specification for sprayed concrete, UK

Product Certification for Construction Materials

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Construction industry is important to a developing country like Sri Lanka as it plays a major role in the economy. Therefore it is important to assure quality in construction work, which depends on the key factors namely the technology, skills of workers, quality control methods and quality of the materials used. Out of these, maintaining the quality of construction materials is one crucial factor that NBRO can manifest its influence and control by introducing a product certification scheme to the country.

To cite a recent example, the quality of bricks purchased in the conservation of Deegawapiya Stupa at Ampara has been non-compliant. NBRO sampled and tested the bricks following a request made by the Department of Archaeology to verify the suitability of those engineering bricks. All the samples that were tested did not comply with the Sri Lankan standards for compressive strength.

Deegawapiya Stupa

Quality of materials has a great influence on the usage of product and its lifetime. Product certification is the process of certifying that a product has passed performance tests and quality assurance tests in order to meet the necessary local, national or international quality standards relevant to a particular market or product set. Product certification plays a major role in identifying the quality level of a product.

Product certification process is performed by an independent, qualified third party assessing the manufacturer's capability to constantly manufacture a product to a recognized standard. The product certification process involves assessing the manufacturer's production systems and facilities, and selecting representative samples of finished product for testing by independent accredited testing facilities.

Once certified, the manufacturer will be able to display the assessing body's certification trademark on their products. Regular auditing is required for the manufacturer to retain their 'certified' status.

There are number of benefits from product certification to a manufacturer as well as to a consumer. Sri Lankan government has specific regulations permitting to trade only certified products in local market, ex: cement. Product certification satisfies the requirements of the manufacturer to meet government regulations. Some retailers and dealers prefer to do their business works with certified products and systems. Product certification has the ability to maximize the market potential. Considering the above facts NBRO is in the process of implementing a product certification scheme for construction materials to promote good production practices which will ultimately benefit the consumer.

Bricks that were stacked had deteriorated due to weathering

Cement-Free Mixes for Conservation of Ancient Structures

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Known as the pearl of the Indian Ocean, Sri Lanka is a country with a proud cultural heritage. In the past, kings who ruled Sri Lanka had contributed heavily on constructing pagodas. It is still a mystery how the materials and technology used in the past to build such structures to last this date. Currently, both locals and foreigners visit these monumental places to witness this magnificent craftsmanship. At present, deterioration of some ancient structures is taking place due to the age of the structures, climatic change as well as human actions. Therefore, utmost care has to be taken in preserving these ancient structures for the future generation.

Central Cultural Fund (CCF) is a governing body under the Ministry of Cultural Affairs, responsible for the preservation of ancient structures in Sri Lanka. CCF has already identified structures in need of preservation and initiated conservation activities. As a result, CCF is currently engaged with Building Materials Research and Testing Division (BMRTD) of NBRO to produce cement-free mortar and concrete mixtures as repair materials for conservation works. The existing historic structures become vulnerable for further deterioration when repair works are being carried out using cement-based mortar and concrete mixtures. Therefore, the repair materials should possess low strength properties similar to existing historic structures for preservation.

Repair works carried out at Abayagiriya Stupa

CCF requested BMRTD to test certain mixes for their suitability as repair materials. CCF officials had several discussions with BMRTD and lime was identified as the main constituent in cement-free mortar mixes. Other identified raw materials are normal engineering brick powder, Calicut clay tile powder, wire-cut brick powder and sand.

It was suggested to carry out raw material testing in order to observe the behavior of raw materials prior to testing of mortar and other mixes. Several brands of lime will be tested to identify and select a suitable lime for testing proposed mixes. Field trials will be carried out for evaluating the suitability of such mixes.

Calicut-tile chips used to produce tile powder

Clay bricks used for conservation work

The Hill Capital is still at the Top on Air Pollution

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Recent air pollution monitoring results indicate that the Kandy urban area is still the highest polluted urban area in Sri Lanka. National Building Research Organisation (NBRO) is conducting the urban air quality monitoring program since 2012, at 09 major urban areas in Sri Lanka with the financial assistance of Vehicular Emission Testing Trust Fund. This programme measures air pollutant levels of Sulphur dioxide (SO_2) and Nitrogen dioxide (NO_2) at selected locations in urban areas of Colombo, Gampaha, Horana, Kalutara, Ratnapura, Galle, Kandy, Kurunagala and Anuradhapura.

According to the air quality monitoring results, the maximum pollutant levels in 2016 in each of the urban area presented in Figure 1, indicate notably high pollutant levels in Kandy urban area. The annual average levels of NO_2 and SO_2 in Kandy in 2016 were 56 µg/m^3 and 54 µg/m^3, respectively and they exceeded the respective WHO ambient air quality guideline values. Further, the results show a great spatial variation in distribution of pollutant levels within the Kandy city limits (Figure 2). During the study, the highest pollutant level recorded was in Good Shed junction, Kandy, whereas the locations at Clock Tower area and Colombo Street also showed relatively high pollutant levels (Figure 3). The spatial distribution analysis of air pollutants shows that the high concentration of pollutants in the Good Shed area contributes to the overall increased level of pollutants in Kandy city limits.

Kandy is an administrative capital and UNESCO declared the city as a world heritage site in 1988 since it is the home of the Temple of the Tooth Relic, which is one of the most sacred places of worship of the Buddhists all over the world. Kandy city is located in the flood plains of Mahaweli River and surrounded by a mountain range that makes a basin-like geomorphology and acts as a barrier against dispersion of air pollutants while making stagnant conditions within the atmosphere of the city. Therefore, any developments and pollution control activities should consider this situation seriously and need to focus on reducing pollution sources especially at Good Shed junction, Clock Tower area and Colombo Street in Kandy city.

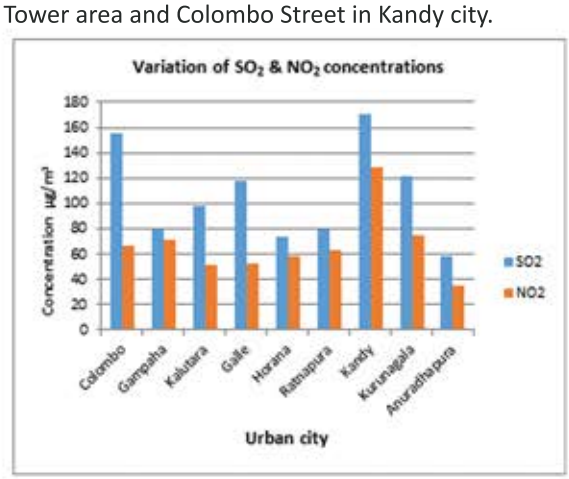

Figure 1: Variation of NO_2 and SO_2 in selected urban areas

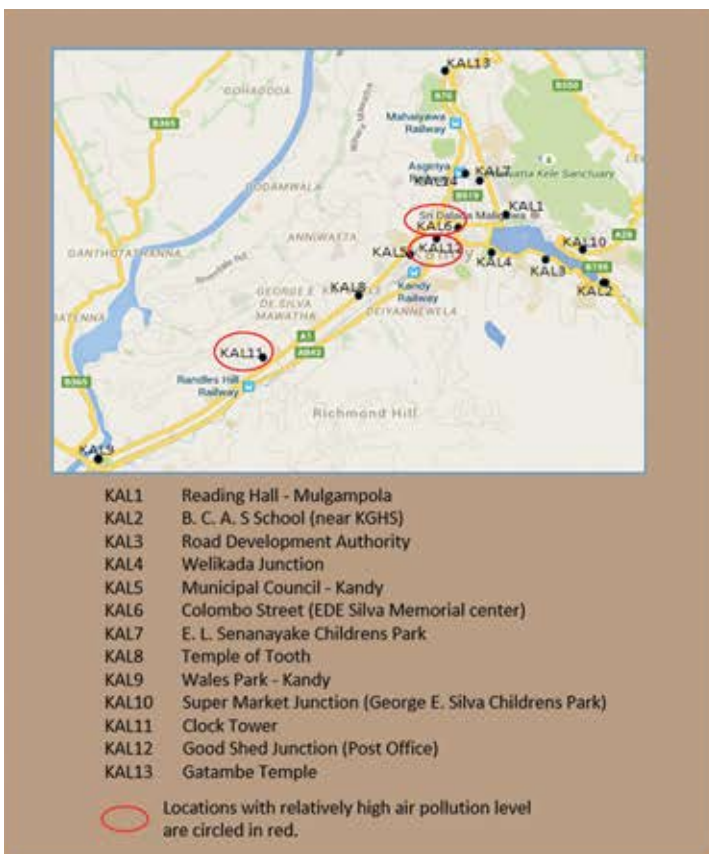

Figure 2: Sampling Locations Map in Kandy Urban area

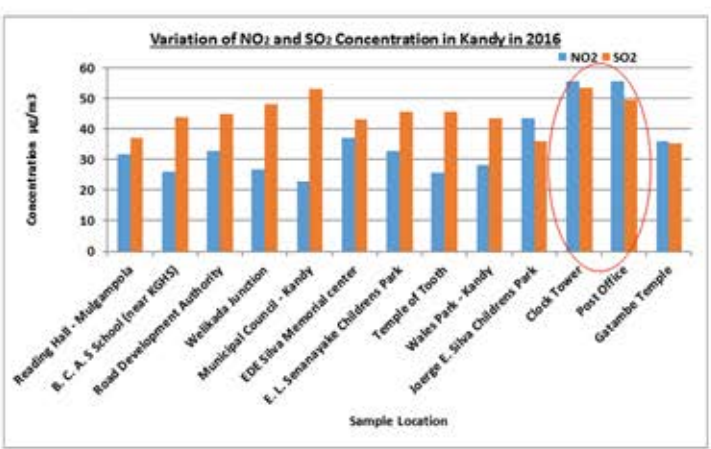

Figure 3: Variation of NO_2 and SO_2 Concentration in Kandy in 2016

NBRO is currently carrying out further studies in Kandy to facilitate the detection of long-term ambient air pollution trends to observe the effectiveness of the current air quality control regulations, with the objective to improve air quality management efforts by the local authorities of the Kandy urban area.

Water from the Heavens

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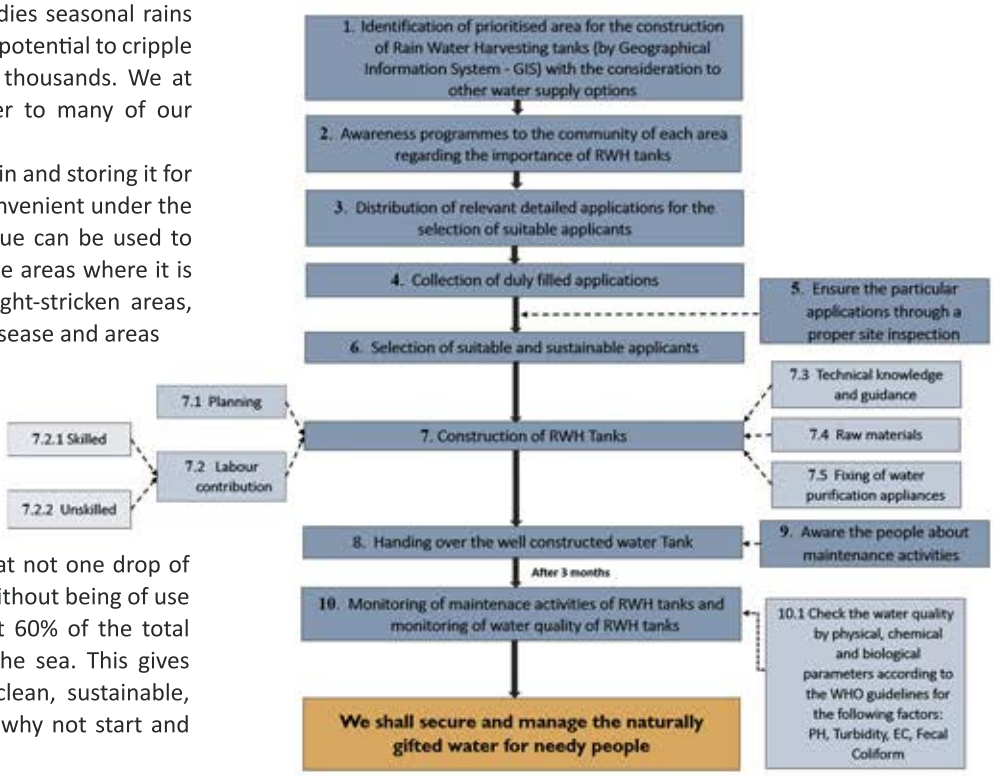
As Sri Lanka is facing what is said to be the most severe drought in four decades it is time we look for new methods of obtaining the water that we need. In spite of the fact that the island nation has a vast supply of fresh water in various water bodies seasonal rains are vital because droughts such as this have the potential to cripple food production as well as the livelihoods of thousands. We at NBRO see rain water harvesting as an answer to many of our problems.

Rainwater harvesting is capturing water from rain and storing it for later use. Rain can be captured on any place convenient under the sky and stored in a pit or a tank. This technique can be used to obtain clean drinking water especially in remote areas where it is most needed. It can be very helpful for drought-stricken areas, areas where polluted water is causing kidney disease and areas with unpalatably brackish water. Rain water harvesting has already been proven successful in many countries of our region and we are confident that it could deliver valuable benefits to our country as well.

We all know from the childhood about the twelfth century king who famously decreed that not one drop of rain should be allowed to flow into the ocean without being of use to man. However, the fact remains that about 60% of the total rainfall received by the island flows off into the sea. This gives plenty of rainwater for us to harvest. It's a clean, sustainable, cheap and easy concept that we propose. So, why not start and give it a try?

Given below is the schematic diagram illustrating the method for the practical implementation of rain water harvesting (RWH) in a selected locality.



A Model House to Promote Disaster Resilient Construction Culture and Use of Alternative Materials in Construction

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A model house is being constructed by NBRO to promote disaster resilient concept for Tsunami and wind in Yayawatte, Tangalle. Specific considerations in land selection, layout arrangement, orientation of the house, shape of the structure based on the wind and Tsunami direction and also specific structural features to maintain its overall stability at a disaster situation are incorporated in this design.

Within this research model, NBRO is also concerned in using alternative materials for housing construction in order to enhance the thermal comfort level and also to reduce the overall construction cost. A light weight bottom ash block replacing cement blocks, an expanded polystyrene bead board and a rammed earth wall using a slip-form method are used as three different research components in constructing this model house.

Properties such as radioactivity, thermal comfort, durability for weathering, optimum flexural and compressive strength to withstand the force exerted from a flood wave or high wind are tested in laboratory conditions and performance of all three materials are proven preferences for construction than the existing materials in the market. Further establishment of these material properties through ground testing will be carried out after completion of the construction of this model house. With ompletion, this model house can be used as an awareness tool to educate the community on disaster resilient housing construction as well as the use of alternative materials.

Light weight bottom ash block replacing cement blocks: Light weight, Low cost, Less raw material used – use of bottom ash waste taken from Norochcholai coal power plant

An expanded polystyrene bead board: Light weight, Resistant to seismic forces, High thermal comfort level achieved, High workability

A rammed earth wall incorporating building demolition waste: High workability, Low cost, High thermal comfort level achieved, Less raw material used – the mix is made using building debris, In situ monolithic wall, Resistant to natural disasters such as flood

Resilient Model House in Yayawatte to resist Wind and Tsunami hazards

Using Stones as a Construction Material in Ancient Sri Lanka

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Constructions in ancient Sri Lanka date back to more than three hundred centuries as evidenced by various ancient manmade structures such as palaces, stupa etc. Ancient constructions had not been restricted only to buildings but they are also characterized by irrigation structures, tunnels, gardens etc. It is believed that technologically those constructions were highly advanced and technically sound. One of the best examples is "Yoda Ela" the canal that connects Kala Wewa a giant water tank to Thissa Wewa yet another.

Ancient constructions of Sri Lanka have been identified as manmade structures that merge harmoniously with the surrounding environment. Use of totally natural materials for construction had been reported, earth resources being the most abundantly used raw material. The studies conducted by the author over the past fifteen years infer that the traditional knowledge of ancient people on geological environment is surprisingly remarkable.

It is clearly noted since the early stages of Anuradhapura era, most of the constructions were based on stones. Studies reveal that almost all the stones extracted for ancient constructions are mainly metamorphic rocks which were chiefly quarried from the surrounding areas. Quarrying is highly specified and mainly characterized by wedging technique. The wedging technique had been further specified in Anuradhapura period by oval shape wedging holes and after in Polonnaruwa period by square shape wedging holes. Systematic blows by different sizes of hammers had given needed force to split those rock slabs according to their requiremnt. In addition, the natural weak zones such as foliation, joint pattern and fracture pattern were followed in splitting process. Split rock slabs were further trimmed by various sizes of chisels and smoothened by using different sizes of sands.

One of the most interesting findings of the study was tracing the ancient rock quarries in Sri Lanka. Those quarries were found in Wessagiriya, Isurumuniya and Ranmasu Uyana in Anuradhapura scared city and Galviharaya and Polongala area in Polonnaruwa scared city. These quarries can even be found in Sigiriya, Yapahuwa, Dambadeniya, Thissamaharamaya and Kandy archaeological sites.

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Community Awareness on Home Owner Driven Housing Construction Programme

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NBRO identified that there are 1962 families living in high risk locations in landslide prone areas within the Kegalle district and the government of Sri Lanka has initiated re-settling of these families in safe locations. Most of the landslide affected families will be given houses constructed by donors which in turn will reduce the burden on them.

Other families living in high risk areas will be re-settled under the Home Owner Driven Housing Programme, in which two sub-options will be offered to beneficiaries to select a one. In the first option, a land plot of approximately 10 perches will be provided to a beneficiary from already selected lands and in addition, a sum of Rs. 1.2 Mn will be given to build the resilient core house. In the second option, the beneficiery will be allowed to build their house on their own land for which an additional Rs. 0.4 Mn will be given as an incentive over the Rs. 1.2 Mn. Guidelines on these two resettlement options have been formulated by NBRO for the benefit of both the authorities and the beneficiaries.

NBRO recently conducted a community awareness workshop on Home Owner Driven Housing Construction Programme at Kegalle Divisional Secretariat Division. Beneficiaries of Kegalle DS Division, Technical Officers of the Kegalle DSD, officers of National Disaster Relief Service Centre and the Director Planning participated in the workshop. The workshop mainly focused on creating awareness among beneficiaries on the programme procedure, methods of installment payments, plan selection, construction of houses, material selection, and the responsibilities of beneficiary etc.

Community Awareness Workshop on Home Owner Driven Housing Construction Programme at Kegalle Divisional Secretariat Division

"Risk Awareness and Future Challenges"
NBRO International Research Symposium 2016

The first International Symposium of National Building Research Organisation – 'Risk Awareness and Future Challenges' was held on 6th and 7th December 2016 at Waters Edge, Battaramulla.

At the Inaugural session Eng.(Dr) Asiri Karunawardena, Director General, NBRO delivered the welcome address. He remarked on the significant research outcomes in the year 2016 and the future research activities planned for the year 2017. Prof. Dilanthi Amarathunga, Global Disaster Resilience Centre, University of Huddersfield, UK delivered the keynote address, "Risk Awareness and Future Challenges: The Role of R & D". Then Mr. S. S. Miyanawala, Secretary to the Ministry of Disaster Management and H.E Thorbjorn Gaustadsaether, the Ambassador of Norway in Sri Lanka addressed the audience. Dr Rajinder Bhasin and the team from Norwegian Geotechnical Institute (NGI) handed over a tomography GPR survey instrument to NBRO.

Eng. (Dr.) Asiri Karunawardena delivering the welcome address

Prof. Dilanthi Amarathunga delivering the key-note speech

Mr. S. S. Miyanawala, Secretary to the Ministry of Disaster Management and H.E Thorbjorn Gaustadsaether, the Ambassador of Norway in Sri Lanka

The four structured technical sessions on the Day 1 were the following: Advanced Technologies in Disaster Risk Reduction, Adaptation to Climate Change, Technology Transfer in Disaster Risk Reduction, and Novel Hazard Mitigation Approaches in Hilly Areas. These sessions were chaired by Mr. N.M.S.I. Arambepola, Dr. U.P. Nawagamuwa, Mr. Hiroki Hashimoto and Dr. Nadeej Priyankara respectively.

Day 2 started with a Panel Discussion on 'Innovative Approaches on Risk Management Culture and the panel members were Dr. Rajindra Bhasin, Dr. Asiri Karunawardena, Dr. Joshua T. Bazuin, Mr. Christophe Balg and Prof Richard Haigh and the moderator was Mr. Nayana Mawilmada. The second day had three technical sessions namely: Investment on Innovative Approaches in Risk Tolerance and Risk Treatment, Risk Transfer and Terminating Options and Adaptive Built Environment, chaired by Prof Richard Haigh, Prof. H.A. Dharmagunawardena and Prof. Kulathilaka respectively. Eng Clarence Perera, consultant NBRO deliverd the vote of thanks noting that 2016 NBRO symposium was the best to date held in the recent NBRO history.

Panel Discussion on 'Innovative Approaches on Risk Management Culture'

Mr. Mitsuya OKAMURA, Japan Overseas Cooperation Volunteers, JICA presenting on 'Verification Survey with the Private Sector for Disseminating Japanese Technologies for Slope Disaster Mitigation Technology with Shotcrete Cribwork using Unit Type Wire Net Formwork'

Mr. Anurudda Vijekumara, Scientist, NBRO presenting on 'Permanent Shelter Option for Kegalle District Landslide Victims'

Building Materials Research and Testing Division

Building Materials Research and Testing Division (BMRTD) laboratory is one of the oldest testing laboratories established for testing of construction materials. Its services now have expanded considerably, making itself as one of the leading and reputed laboratories in Sri Lanka. We offer services including physical and mechanical testing for laboratory samples, building investigation, awareness and training programs and R & D in the field of construction materials.

Laboratory was accredited by Sri Lanka Accreditation Board (SLAB) to comply to the ISO 17025 for the mechanical testing on concrete cube crushing in accordance with SLS 1144 and Tensile testing on reinforcement bars in accordance with (BS 4449 & SLS 375) ISO 6892 & SLS 978. Apart from that we offer testing facilities on Aggregate, Cement, Concrete products, Destructive and non-destructive tests, Brick, Blocks, Timber, Tiles and other Miscellaneous tests.

For further detail you may contact:
Mrs.S.S.K Muthuratne - Director/Building Materials Research and Testing Division (nbro.bmd@gmail.com), 2588946 Ext 631

Recently Developed Building Products at Building Materials Research and Testing Division at NBRO

Lightweight Bottom Ash Cement Blocks

Research was conducted to investigate the suitability of using bottom ash to produce cement blocks and it was revealed that bottom ash can be used for partial replacement of fine aggregate in the production of cement blocks. For casting of bottom ash blocks, a mix design was optimized by producing trial samples with different mix designs using bottom ash, fly ash, cement and microsilica. Physical and mechanical properties of bottom ash blocks cast according to the optimized mix were tested and all the desirable parameters were found to be within the limits specified in SLS 855. The produced bottom ash blocks were light in weight (dry weight is 10kg per block), have low thermal conductivity (0.3 W/m.K) and found to be cost effective (Production cost is Rs.28 per block) when compared with conventional cement blocks.

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Ms. Maheshi Gannoruwa, Scientist (bhagyagannoruwa@yahoo.com)

Ready-Mixed Plastering Mortar Pack Incorporating Quarry Dust

In this research project, utilization of crushed rock sand as a full replacement for river sand for general plastering purposes was studied. It was found that flexural and compressive strength (CS IV category in BS EN 998-1:2010) of crushed rock sand mortar showed significantly higher strength values compared to river sand plastering mortar for same pre-determined compositions. Fines content in crushed rock sand was found to be playing a pivotal role in determining strength development as well as workability of the plastering mortar. Rest of the mortar properties tested were found to be in compliance with general purpose plastering mortar, as per BS EN 998-1:2010.

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Glass Fibre Reinforced Fly Ash-Cement Roofing Tiles

In this study coal fly ash (CFA) from Norochcholai power station was size fractioned and they were used to replace cement by partially in making fibre reinforced cement roofing tiles. Physical and mechanical were performed in accordance with SLS 1189. All the samples satisfy the strength requirement as specified and high water absorption was observed. The average dry density of the tiles were around 1.65±0.03g/cm^3 which is in comparable with the dry density of asbestos cement sheets and the average transverse strength (1.4-1.7kN) is in comparable with Calicut clay tiles. Therefore, CFA is promising to use in cement roofing tiles in raw form and fractioned form. The durability properties of have to be rigorously proved by experimentation.

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