# IC-IMPACTS India Workshop Series

**Date**: December 4 and 5, 2017

**Venue**: Tata Research Development and Design Centre (TRDCC)

**Location**: Pune, India

**Workshop:** This workshop hosted Canadian and Indian scientists, including members of Tata Consultancy Services Ltd. (TCS) and invited guests, who are working on current projects funded by IC-IMPACTS.

The format of the workshop consisted of a series of presentations made over the course of two days. Attendees presented updates about their projects, shared knowledge, and discussed future potential collaborations.

Research areas covered in the workshop consisted of:

- Infrastructure (smarter cities)
- Health (mobile health technologies and innovations)
- Water (treatment and sensing)
- TCS Research and Innovation

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# IC-IMPACTS India Workshop Series

**December 4 and 5, 2017**

Venue:

**Tata Research Development and Design Centre (TRDCC)**
54-B, Hadapsar Industrial Estate, Pune, Maharashtra 411013, India
TRDDC Contact: Mr. Sachin Parkhi: +97 6671 8844

## Important information for participants

| Sunday, December 3rd, 2017 | |
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| 19:00 – 21:30 | **Opening dinner reception hosted by IC-IMPACTS at Conrad Hilton**<br>Please meet at 7 pm in Vivanta Taj lobby, near reception |

| Monday, December 4th, 2017 | |
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| 7:00 – 7:30 | **Breakfast in Latitude restaurant at Lobby level in Taj** |
| 7:45 – 8:15 | **TCS Bus will leave Taj Vivanta at 7.45am to beat traffic.**<br>**ETA at TCS is 8.15 am if we start early at 7.45 am.** |

# Agenda

| Monday, December 4th, 2017 | | |
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| 8:30 – 9:00 | **Registration** | |
| 9:00 – 10:00 | MC: Shapoor Marfatia<br>COO & Network Manager, IC-IMPACTS | |
| | **Welcome & Opening Session :**<br>**Lighting of the Lamp**<br>Ravindra Naik<br>*Delivery Center Head , TRDDC*<br><br>Raju Goteti *(over phone)*<br>*VP and Global Head, COIN* | 15 min |
| | **Overview of IC-IMPACTS & Infrastructure Theme**<br>Nemkumar Banthia<br>*Civil Engineering Professor at the University of British Columbia*<br>*CEO, Scientific Director, and Infrastructure Theme Lead, IC-IMPACTS* | 15 min |
| | **Overview of Health Theme**<br>Stewart Aitchison<br>*Electrical & Computer Engineering Professor, UofT*<br>*Public Health Theme Lead, IC-IMPACTS* | 10 min |
| | **Overview of Water Theme**<br>Madjid Mohseni<br>*Chemical & Biological Engineering Professor, UBC*<br>*Representing Water Theme Lead, IC-IMAPCTS* | 10 min |
| | **Overview of TCS Research and Innovation**<br>Nita Sarang<br>*Principal Innovation Evangelist* | 10 min |
| 10:00 – 10:15 | **Coffee Break** | 15 min |

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| 10:15 – 12:30 | Public Health<br>**Multiplexed Assay for Point of Care**<br>Stewart Aitchison and Parama Pal<br>*University of Toronto* | 15 min |
| | Integrated Water Management<br>**Biomonitoring of Water Quality in Relation to Human Health**<br>Damase Khasa, Manzoor Shah, Sanjay Pal and Afreen Anwar<br>*Laval University, University of Kashmir, and University of Alberta* | 15 min |
| | **An overview of the Intelligent Infrastructures R&I program**<br>Venkatesh Sarangan<br>*TCS Research and Innovation* | 15 min |
| | Public Health<br>**Development of a Hand-Held Molecular POCT Device for TB**<br>James Mahony and Daman Saluja<br>*McMaster University and University of Delhi* | 15 min |
| | Integrated Water Management<br>**Bioremediation-green Technology**<br>Jaswinder Singh, Rameshwar Kanwar, & Neeta Raj (PI: Shiv Prasher)<br>*McGill University, Iowa State University, and LPU* | 15 min |
| | Safe and Sustainable Infrastructure<br>**Smart Sensor Deployment in Buildings**<br>Mark Fox and Krithi Ramamritham<br>*University of Toronto and IIT-Bombay* | 15 min |
| | Public Health<br>**Development af an Affordable Point-Of-Care Diagnostic Kit**<br>Anil Kumar and Aravindhan Ganesan (PI: Thomas Hobman)<br>*University of Alberta* | 15 min |
| | **Affordable healthcare Sensing**<br>Sanjay Kimbahune<br>*TCS Research and Innovation* | 15 min |
| | Safe and Sustainable Infrastructure<br>**India-Canada Initiative for Resilient Global Urban Shelter**<br>Farbod Pakpour (PI: Constantin Christopoulos)<br>*University of Toronto* | 15 min |
| 12:30 – 13:30 | **Lunch Break** | 60 min |

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| 13:30 – 15:00 | Safe and Sustainable Infrastructure<br>**Application of Precast Products Made using Bottom Ash & Fly Ash**<br>Rishi Gupta<br>*University of Victoria* | 15 min |
| | **Citizen Sensing and its role in Smart City services**<br>Venkatachari Raghavan<br>*TCS Research and Innovation* | 15 min |
| | Integrated Water Management<br>**Desalination of Brackish Water using Capacitive Deionization**<br>Madjid Mohseni<br>*University of British Columbia* | 15 min |
| | Safe and Sustainable Infrastructure<br>**SHM of Tall Buildings using Vibration Techniques**<br>S.K. Panigrahi and Timir Baran Roy (PI: Lucia Tirca)<br>*Concordia University* | 15 min |
| | Public Health<br>**Molecular Tools for Malaria Surveillance**<br>Ninad Mehta (PI: Stephanie Yanow)<br>*University of Alberta* | 15 min |
| | **Integrated Design, Manufacturing & Health Monitoring of Structures using TCS PREMAP Platform**<br>Amit Salvi<br>*TCS Research and Innovation* | 15 min |
| 15:00– 15:30 | **Coffee Break** | 30 min |
| 15:30 – 16:45 | Safe and Sustainable Infrastructure<br>**Energy & Water Disaggregation for Non-Intrusive Load Monitoring**<br>Angshul Majumdar (PI: Ivan Bajic)<br>*IIIT-Delhi* | 15 min |
| | Public Health<br>**Engaging Pharmacists in Early Tuberculosis Case Detection**<br>Tripti Pande and Srinath Satyanarayana (PI: Madhu Pai)<br>*McGill University and The Union* | 15 min |
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| | Safe and Sustainable Infrastructure<br>**Solar Energy Powered Net-Zero Energy Smart Buildings**<br>Olesia Kruglov (PI: Bruno Li)<br>*Concordia University* | 15 min |
| | Integrated Water Management<br>**Overview of other IC-IMPACTS Water Management Projects**<br>Madjid Mohseni<br>*University of British Columbia* | 15 min |
| | **Microbiome Research: Towards Next-Gen Diagnostics & Therapeutics**<br>Anirban Dutt<br>*TCS Research and Innovation* | 15 min |

Evening – free time

| Tuesday, December 5th, 2017 | | |
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| 9:00 – 10:00 | **IC-IMPACTS Partnerships with Community and Industry**<br>MC: Shapoor Marfatia<br>COO & Network Manager, IC-IMPACTS | 5 min |
| | Public Health<br>**Community Health**<br>Vissandjee Bilkis (Guest Speaker)<br>*University of Montreal* | 15 min |
| | Water Management<br>**Drinking Water Challenges in India; Solutions for the Future**<br>Satish Kumar (Guest Speaker)<br>*Eureka Forbes* | 15 min |
| | Safe and Sustainable Infrastructure<br>**EDCC Retrofit of URM Walls**<br>Salman Soleimani-Dashtaki<br>*University of British Columbia* | 15 min |
| 10:00 – 10:15 | **Coffee Break** | 15 min |
| 10:15 – 11:45 | **Household Water Purification Solutions**<br>Dilshad Ahmad<br>TCS Research and Innovation | 15 min |
| | **Commercialization of IC-IMPACTS Research through Partnership with Industry and Demo Projects in Communities**<br>*Bridging Research, Practice, and Community – Panel Discussion*<br><br>Moderator: Dr. Nemy Banthia<br><br>Panel: Consul General Jordan Reeves,<br>Ravindra Naik (TRDDC)<br>Dr. Stewart Aitchison (IC-IMPACTS),<br>Dr. Madjid Mohseni (IC-IMPACTS), and | 60 min |
| | **Concluding Remarks**<br>Ravindra Naik<br>*Delivery Center Head , TRDDC*<br>Nemkumar Banthia<br>*Civil Engineering Professor at the University of British Columbia*<br>*CEO, Scientific Director, and Infrastructure Theme Lead, IC-IMPACTS* | 15 min |

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| 11:45 – 12:45 | **Lunch Break** | 60 min |
| 12:45 – 14:15 | **Action points IC – IMPACTS and TCS**<br>**Moderator:** Nemkumar Banthia<br><br>*Civil Engineering Professor at the University of British Columbia*<br>*CEO, Scientific Director, and Infrastructure Theme Lead, IC-IMPACTS* | 30 min |
| 14:15 – 14:30 | **Closing Ceremony** | 10 min |

**Session for IC-IMPACTS PIs to meet with COO**
**(This special session is organized in conference room next to auditorium)**

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|---|---|---|
| 14:30 – 15.00<br>TCS Conference room | **Tips session –**<br>**Suggestions and Ideas on Operational Strategies, Social Media Strategies and Other Suggestions for IC-IMPACTS head office in Vancouver**<br><br>Moderator : Shapoor Marfatia<br>COO & Network Manager, IC-IMPACTS | 30 min |

Note:
Hotel checkout is at 12 noon.
If you don't need room on Dec 05th evening, please inform hotel that you will checkout in morning.

**Biomonitoring of Water Quality in Relation to Environmental and Human Health**

Damase P. Khasa[1], Afreen Anwar[2,3], Gaser N. Abdelrasoul[3], Scott MacKay[3], Marcus Tamura[3], Oleksandra Savchenko[3], Sheetal Rimal[1], Gowher Wani[2], Zafer A. Reshi[2], Manzoor Shash[2], and Jie Chen[3]
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Water is one of our most precious renewable resources on earth. The problem of water contamination is a serious concern both in Canada and India, though the magnitude of the problem varies. In view of the deteriorating water quality in both countries, the detection and identification of chemical pollutants and/or biological pathogens through biosensors and eDNA metabarcoding; development of novel water purification systems; and understanding wetland plants as support matrix surface or bioaccumulators of such pollutants are very important. Traditional and standard methods to identify different contaminants (biological or chemical) in the waters are slow, laborious, and can require specialized expertise. In our IC-Impacts funded project, we have been able to: i) design a label free-free DNA aptamer-based non-faradic impedance biosensor for the detection of *E. coli*. This point-of-care device (POC) is based on interdigitated electrodes (IDEs) technology and coated with *E. coli* OMP Ag1 Aptamer as a biomarker. The IDEs are successfully able to detect *E. coli* concentration as low as 5 bacteria /mL in less than 20 min. and capable of transmitting the information through a bluetooth module which connects to a smartphone/tablet application. This device can be applied to detect *E. coli* in water bodies, drinkable water and food. ii) assess bacterial communities (BC) in selected Canadian and Kashmir lakes through culture dependent and metagenetics in relation to water borne diseases and human health. The prevalence of different water borne diseases in and around Dal Lake in comparison to Manasbal Lake showed typhoid fever to have highest incidence among all diseases in both the lakes, followed by gastroenteritis and diarrhea, while Jaundice was seen to have least prevalence. Hepatitis-B was reported only in Dal lake. 16S ribosomal RNA gene (rDNA) metabarcoding, using Illumina MiSeq next-generation sequencing (NGS) technology, showed clear difference between the Canadian and Kashmir lakes with the Canadian lakes harboring the highest bacterial diversity. iii) develop a nanoparticle-based water treatment system to eliminate toxins and microorganisms in water. The developed three-dimensional (3D) silver nanoparticle (AgNP)-coated active carbon materials showed antimicrobial efficacy against phytopathogenic bacterial and fungal species. The effect of the filter on *Pythium* root rot control of hydroponically grown cucumbers was greater than 95% in the laboratory and that cucumber plants had no root infection in AgNP-AC filter treatment. The developed technique is a very efficient approach and has a great potential to be used in the greenhouse to manage plant root diseases. iv) evaluate gentle bioremediation technologies for wastewater treatment and contaminant sequestration of some invasive species. Wetland plants such as *Phragmites australis, Typha latifolia, Potamogeton crispus,* and *Salvinia natans* have been shown to have potential of bioaccumulating heavy metals such as copper, cadmium. In Canada, the harvested biomass of Phragmites and Typha has been transformed into biochar for use in land reclamation of mining areas. v) outreach stakeholders and communities for awareness and participation in addressing the water quality related issues. We will explore the perceptions of local communities to agricultural and industrial activities and the social acceptability of the above developed technologies through semi-structured interviews using a questionnaire administered to the communities and focus groups.

## Development of a hand-held molecular point of care test (POCT) device for detecting Mycobacterium tuberculosis

Collaborating partners: Prof. Daman Saluja,
Dr B R Ambedkar Center for Biomedical Research, University of Delhi,
Dr Rajanish Giri, Indian Institution: Indian Institute of Technology Mandi.
Dr. James Mahony ,McMaster University, Hamilton, Canada

Tuberculosis is a significant cause of mortality and morbidity especially in resource-poor regions. However, in more than 85% of the cases, tuberculosis is a curable disease if diagnosed and treated properly. Traditional laboratory techniques such as direct microscopic observation and culture of *Mycobacterium tuberculosis* (Mtb) on semisolid or liquid medium, are not sensitive and specific and therefore inadequate for rapid detection of Mtb. Nucleic acid amplification tests including GeneXpert MTB/RIF (Cepheid), Inno-Lipa (Innogenetics), Amplicor MTB (Roche), Applied Mycobacterium tuberculosis direct test (Gen-Probe) and line-probe assays for point mutations can provide a rapid and sensitive result but they are restricted to centralized laboratories as these require power source, instruments, skilled personnel and are too expensive ($10/cartridge) for developing countries. Some POCT platforms exist but they are expensive and only semi-portable. Rapid peptide-based serum antibody assays to measure antibody to immunodominant epitopes have been developed (TD Biosciences) however, their clinical utility is still under investigation. A urine-based lateral flow antigen test (Alere) provides a rapid result and low cost ($3-5/test) but it is only 28% sensitive. There is a renewed interest in POCT using microfluidics, biosensors and nanotechnology to develop a simple and effective POCT device for TB. Isothermal amplification is perfectly suited for POCT since thermal cycling is not required. We have previously developed and evaluated isothermal amplification assays for Mtb which will be used in the test device. The POCT device we are developing will use self-regulated heaters and microfluidics and be simple in design consisting of only three steps including lysis of bacteria and release of DNA, isothermal amplification of target genes, and detection of amplified product using a DNA intercalating dye. The result will be read visually without the need for any instrument and will provide a result in 30 minutes. Current methods of sputum processing require several steps for decontamination, lysis and nucleic acid purification. These methods are tedious, require a skilled technician and are cannot be used on the POCT device. We are therefore developing a centrifugation-free protocol for Mtb lysis that can be fully integrated on the device platform and eliminate the requirement for instrumentation and operator training. This rapid and inexpensive POCT device will be useful for detecting tuberculosis infections in resource-poor settings without laboratory support and should help to reduce the number of new cases of TB in developing countries.

# Bioremediation – A Green Technology

**N. Raj*, J. Singh*, S. Pal**, K. Khajanchi***, R.S. Kanwar*, S. Prashar****, R. Rudra*****, J. Singh******

***Lovely Professional University, India; **Amrita University, India; ***Indian Agric. Res. Institute, India**

******McGill University, Canada; *****University of Guelph**

**Project entitled ''an Innovative green technology for treating municipal and industrial wastewater entering rivers and streams'' is being conducted in jointly by McGill ad Guelph Universitiesof Canada, and Lovely Professional University (LPU), Indian Agriculture Research Institute (IARI) and Amrita University of Indiato tackle two major societal challenges namely "waste water treatment and rice husk and paddy straw as agricultural waste management".**

**The location (Buddha Nalla) of this study comprises of four different sites based on the type of pollutants. This study emphasized on the role of bioremediation to decolorize and detoxify textile dyes in Buddha Nalawhich are being used most commonly by textile industries in Punjab region. The dyes were selected after surveying the textile industries of Ludhiana, Punjab locating in the close vicinity of study site where textile effluent is being thrown into Buddha Nalla. Our team has successfully developed microbial consortium to decolorize the dyes. Also, we have tested the degradation products for toxicity in plants, with the elucidation of pathways indicating the breakdown of azo bonds of the parent azo dyes, by microbial consortium in the presence of dye degrading enzymes such as Laccasse and Azo reductase. Amrita university research team has been engaged in developing microbial consortium and bacteriophages for bio-control of infections (V. cholera, E. coli, Shigella) and smell of sewage water. Interestingly, 3-5 log reduction with liquid formulation of phage cocktail was noted which will be checked further for Buddha Nalla water followed by the fabrication of microbial filters in the form of biofilm onto the biochar medium to treat textile dyes and infectious bacteria along with foul smell of sewage water. IARI team is working on the removal of heavy metals from wastewater and have optimized the methods for Nickel (Ni) removal. LPU team established a pilot filtration assembly in the wastewater drain passing through LPU and checked the efficiency of such system in removing heavymetals. The experiment was completed with encouraging results leading to the establishment of a large scale set up on the same drain to explore the potential of flood plain soil in removing contaminants.**

**As part of this IC-Impact project, an International Conference was organized at LPU campus on Wastewater Cleaning Technologies jointly by project partners (LPU, McGill, Amrita U, IARI, and Guelph U) on Nov. 17-18,2017 at LPU which was attended by 500delegateswith 100% participation of PIs of this project which showed a strong collaboration among team members.**

**McGill University project team has characterized biochar at different temperatures and conducted studies on the role of biochar in successfully removing heavy metals from wastewater. The University of Guelph team is conducting lifecycle analysis on paddy straw and biochar for removing contaminants from wastewaters and use of clean water for agricultural use. McGill team has also studied role of wastewater in growing vegetables and found significant amounts of heavy metals in potato peels.**

# Identification Of High Affinity Ligands Against Dengue Virus NS1 For The Development Of An Affordable Point-Of-Care Diagnostic Kit

Dengue is the most prevalent mosquito-borne viral infection worldwide and is the leading cause of illness and death in tropical/subtropical areas [1]. Over 400 million people are infected with dengue each year. While most of the cases are self-limiting, dengue hemorrhagic fever and shock syndrome can be fatal. There are no approved vaccines or drugs against dengue infection. Current treatments are limited to either symptom-based management of the fever or maintaining the blood volume during hemorrhage. Given that the initial symptoms are similar to many other mosquito transmitted viral infections, early and accurate diagnosis of the disease is critical [2,3].

Current dengue virus assays are relatively insensitive or expensive and are time consuming. This can delay or misguide early medical intervention, which is critical for managing the infection. In developing countries, the ease of access, availability of required infrastructure and the cost of diagnosis are usually prohibitive. In these countries, the need for efficient low-cost diagnostic tools is urgent.

NS1 is a virus-encoded glycoprotein that can be detected in patient sera at the same time as symptoms develop. Therefore, it is an ideal diagnostic marker. Current NS1-based assays vary in their accuracy to detect different serotypes. Moreover, they exhibit lower sensitivity to secondary dengue infections, the more likely type of infection that can progress to a hemorrhagic shock syndrome. To overcome these problems we will develop serotype-specific, high-affinity small molecules targeting the NS1 protein for diagnosis of dengue infection. Small molecules will be stable, affordable and efficient for detecting dengue infection compared to current antibody-based diagnostic kits. At the first stage of the project, we have been indeed able to develop a cell-based system to generate the NS1 protein in high quantities to use for the binding assays. Our initial screening was able to identify several ligands that can bind at two different binding sites on the surface of the NS1 protein. We are continuing our efforts to enhance the activities of the identified ligands and discover better ligands that can hopefully reach the testing stage.

## References


[1] Rey, F.A. (2003) Dengue virus envelope glycoprotein structure: new insight into its interactions during viral entry. *Proceedings of the National Academy of Sciences of the United States of America* 100. 6899-6901.

[2] Thisyakorn, U. and Thisyakorn, C. (2015) Dengue: Global Threat. *The Southeast Asian journal of tropical medicine and public health* 46 Suppl 1. 3-10.

[3] Mangold, K.A. and Reynolds, S.L. (2013) A review of dengue fever: a resurging tropical disease. *Pediatric emergency care* 29. 665-669; quiz 670-661.

**IC-IMPACTS Project Summary**
**Title: India-Canada Initiative for Resilient Global Urban Shelter**


**Abstract**

The primary objective of this project is to develop new cost-effective seismic isolation platform (SIP) concepts that can be mass implemented for the most commonly designed buildings in urban settings in India. SIPs, which consist of a very low cost and highly resilient layer that is built at the base of the buildings, absorb the seismic energy that is induced by earthquake events. This provides protection from earthquakes even if the buildings are designed and built with limited seismic resistance following current construction practices in India. Thus, the performance of these buildings to seismic action is greatly improved, not only ensuring that the buildings do not collapse and kill their occupants but also reducing structural damage to a point where the structure can resume its function almost immediately after a major seismic event. In addition, the proposed system is also engineered to provide protection against floods.

To this end, the most common residential housing building types for affordable housing in India's cities that are resilient to natural disasters such as earthquakes and are suitable for mass implementation were identified and assessed using advanced numerical analyses. Then few low-cost seismic isolation platform (SIP) concepts were preliminary designed based on current technology and construction practice in India. To validate the seismic performance of this proposed concept, a few experimental programs are undergoing at the Structural Testing Facility at the University of Toronto.

Upon completion of experiments, the performance of the benchmark building models with and without the most promising developed seismic isolation systems will be assessed. The final stage would be the development of the full design and mass implementation plan of the developed isolation system along with a robust cost analysis and quality control plan.

## FULL FIELD NON-CONTACT SHM PROTOCOLS FOR LONG SPAN RAILWAY BRIDGES AND HERITAGE STRUCTURES

The project focuses on the development of non-contact structural health monitoring protocols for long span bridges and heritage structures using Unmanned Aerial Vehicle (UAV) system. The researchers have designed a UAV system that could carry upto 2 kg of pay load which consists of multiple sensors including radiometric infrared camera. In addition to this, the researchers have successfully designed a UAV mountable laser spot system that could be used to quantify the structural defects such as crack length/width, map cracking density, corrosion and delamination. The team is currently exploring UAV's autonomous flight capability to inspect a long span bridge including piers. Along with these non-contact Non-Destructive Testing Techniques (NDTs), the researchers are also developing the degradation and reliability model for reinforced concrete bridge decks using various contact NDTs such as rebound hammer, half-cell potential, electrical resistivity, ground penetrating radar, ultrasonic pulse velocity and acoustic based impact echo method. For this, a total of 15 scaled reinforced concrete slabs have been cast. The researchers have successfully applied the developed technology onto a 70 years old prestressed concrete span railway bridge – Poiney River Bridge in Tamilnadu, India and a heritage structure –Lakshmi Vilas Palace in Vadodara, Gujarat, India. The outcome of the project is in terms of an application of a patent in India, publication of a journal and a conference proceeding and the formation of a start-up company in Canada.

## APPLICATION OF PRECAST PRODUCTS MADE USING BOTTOM ASH AND FLY ASH FOR PAVEMENTS

The created carbon dioxide (CO2) emissions are massive in producing only a ton of Portland cement, which is one of the main ingredient of concrete. One solution to reducing cement consumption and concurrently utilizing by-product materials is to manufacture "cement-less" concrete called "Geopolymer Concrete". Geopolymer Concrete (GPC) typically utilizes industrial wastes like fly ash, slag with activator solutions like sodium hydroxide and sodium silicate. Limited work has been performed with potassium-based GPC and no previous work could be recognized that utilized bottom ash as a precursor with potassium-based.

This proposed project deals with optimization of potassium-based GPC made by fly ash and bottom ash. It is expected to lead to applications of GPC, especially in the precast industry. It is hypothesized that the mixes developed will have the suitable compressive strength, and other durability characteristics required for the material to be used as a paver blocks. Even though GPC is now being extensively used, there are concerns discouraging its use in the construction industry. GPC have been used for precast industry for applications such as railway sleepers. However, this sustainable material has so far not been implemented in major projects especially for pavements. Frost damage is a fatigue process and it has been a practical concern to improve the freeze-thaw durability and to prolong the service life of paver blocks in real environmental conditions. Hence, a challenge that can be highlighted in GPC studies is freeze-thaw resistance of paver blocks in sub-zero temperature areas.

Leach-ability of concrete is another important issue and interest topic in engineering, which should be considered in environmental studies. Leaching is the process by which a liquid dissolves and removes the soluble components of the concrete to the environment.

Compressive strength of hardened concrete were selected as the performance criteria and basically, longer curing time enhanced the polymerization process resulting in higher compressive strength. Higher curing temperature of steam curing resulted in larger compressive strength, although an increase in the curing temperature beyond 80◦C did not increase the compressive strength substantially.

Toxicity Characteristic Leaching Procedure (TCLP) and stripes papers tests are performed in accordance with USEPA 1311 and Guidelines for Canadian Drinking Water Quality. The TCLP is considered to determine the mobility of both organic and inorganic present in the paver blocks in real environmental conditions. Results show that all the metals meet the guideline criteria.

The main idea of this project is to investigate the effect of freeze-thaw cycles on the durability of GPC paver blocks in real environmental conditions. In this regards, small patch (90 $ft^2$) is paved in parking lot of University of Victoria with GPC and Portland Cement Concrete (PCC) to compare the effect of freeze-thaw damages on durability of concretes under real traffic. Non-Destructive testing techniques (NDTs) such as Resonant Frequency device, Schmidt hammer will be employed to measure the various factors which have effect on durability of concretes and subsequently, to produce the predictive models.

**Solar Energy Powered Net-Zero Energy Smart Buildings**


## Abstract

This project aims to take advantage of the abundant solar resources in India and arrives to practical solutions to turn low-rise mixed use buildings into smart performing solar energy powered net-zero energy buildings. At this early phase of the project, we identified the typical building typology and investigated the technical difficulties of incorporating the solar energy generation technologies into the buildings.

Two types of building typologies were reviewed. One is a typical low-rise, 4-story building consisting of 4 apartments and retail or parking spaces on the ground level. The available rooftop area of this building is 220 $m^2$. The second typology is a 3-story single family home with parking on the ground floor. From these typologies, the first 4-story typology was chosen for energy analysis.

The building envelope properties for energy analysis were selected based on BEEP (2016) *Design Guidelines for Energy-Efficient Multi-Story Residential Buildings: Warm-Humid Climate*. The building is divided into 12 thermal zones for the apartments and 1 zone for the retail or garage spaces. Results show an average annual energy use intensity of 173 kWh/$m^2$. The energy model is based on ideal control with an assigned constant cooling COP of 2.5, assuming there is no HVAC system. The next step will be to involve basic HVAC and a renewable energy system design to assess the potential for energy savings.

One of the ways to implement renewable energy into the building design is to use a modular rooftop building-integrated photovoltaic/thermal (BIPV/T) system. This project will feature a low-sloped system due to the proximity to the equatorial latitude. The BIPV/T system incorporates the production of electricity and useful heat, while considering the building envelope requirements for both wall and roof applications. These systems can be alternatives to traditional cladding, while retrofitting with BIPV/T can turn unused or semi-conditioned spaces into fully enclosed conditioned spaces.

For a roof coverage of 180$m^2$ and average summer day conditions in Chennai, India, a typical system would have an electrical output of 147 kWh and a thermal output of 228 kWh. With a focus on common building practices and the use of local materials for framing design, the potential for modular and unitized systems to achieve energy savings is even greater for large scale applications. Finally, for a climate such as the one in India, a BIPV/T application can utilize heat driven technologies such as absorption cooling systems.

# DRINKING WATER CHALLENGES IN INDIA; SOLUTIONS FOR THE FUTURE

**Dr. M. Sathish Kumar, DGM**

**Eureka Forbes R&D**

Due to growing human population, severe neglect and over-exploitation of water is becoming a serious concern. Only 0.3% fresh water is available on the surface of the earth, out of which only 1% can be used by humans.

Groundwater is the largest source of usable and fresh water in the world. In many parts, especially where surface water supplies are not available, domestic, agricultural, and industrial water needs can only be met by using the water beneath the ground. Due to constant ground water pumping, water table level is depleting. Pumping water out of the ground at a faster rate than it is replenished over long-term causes water quality issues. Ground water that is deep within the ground is intermixed with salt water which cannot be consumed.

In order to improve the quality of ground water, the water needs to be treated in order to remove certain minerals and bacterial contaminants if any. Such treatment is in response to earlier discoveries of contaminants that percolated into groundwater supplies. Most ground water treatment techniques utilize a combination of technologies (chemical and biological)

Presently, RO is a very common method to reduce TDS and thus reducing many other harmful ions from drinking water especially in household level operation (filter). But water wastage by RO technology have become a grave concern due to increase in water scarcity. There are lot of innovative technologies emerging in the market in order to improve the water quality and making it available for consumption.