SCHOOL OF CONSTRUCTION AND THE ENVIRONMENT

CURRENT RESEARCH IN THE CIVIL ENGINEERING DEPARTMENT

Research in the civil engineering department varies from short-term applied research projects to multi-year funded grant programs. Following are examples of the most recent research projects currently ongoing or completed.

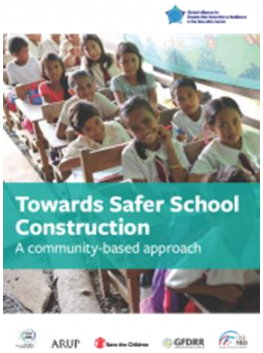
Dr. Sudip Talukdar, PhD, PEng:

- **Alternative uses for hemp waste as cement replacement**
  With funding from NSERC, this research was a collaboration with the University of British Columbia (UBC) and the sponsoring company Nextleaf. The study focused on an environmentally friendly alternate ─ the use of hemp waste as biofuel and cement replacement. The findings showed that hemp ash had the potential to be added to concrete as a filler, which would reduce environmental impact and costs by replacing cement.
  As a result of the team's research findings, Nextleaf Solutions has filed a patent for this process. Their research has also been accepted into a peer-reviewed journal published by Springer Journals Editorial Office.

- **Climate change impact on the Canadian concrete infrastructure**
  In this research, Dr. Talukdar performed computer simulations to study the effect of climate change on concrete in Vancouver and Toronto. In the cases of Vancouver and Toronto, Talukdar developed computer-based climate scenarios for both cities that included climate change-induced variations in concentrations of atmospheric carbon dioxide, temperature and humidity, seasonal fluctuations in temperature, and a gradual lengthening over time of summer. He then ran simulations to predict the effect of climate change on the progress of carbonation-induced corrosion in reinforced, unloaded concrete.
  The results of Talukdar's research showed that, in both cities, climate change will significantly increase the deterioration of undamaged, unstressed and unloaded concrete caused by carbonation.

Dr. Bishnu Pandey, PhD, PEng:

- **Seismic safety of schools**
  Around the world, schools are one of the hardest hit in disasters, particularly in earthquakes. Dr Pandey has been involved in several research work focusing on impact of earthquakes in schools and their mitigation measures. Recent works of Dr. Pandey in this field include guidelines (book) on Towards Safer School Construction: A Community-based Approach, Peer reviewed papers: School Construction as Catalysts for Community Change (Int. J. Mass Emergency and Disaster, 2015), Challenges and benefits of community-based safer school construction (Int..J. Disaster risk reduction, 2020), Research-into-practice briefs (GADRRRES, 2018), several research reports and book chapters and conference papers.



- **Seismic performance of reinforced concrete buildings**
  Study of seismic performance of reinforced concrete buildings is another research field Dr. Pandey in carrying out for several years. Recent published works in this area include the study of impacts of wall density in the reinforced concrete frame, comparison of RC frame capacity in equivalent reinforced concrete confined masonry system and post earthquake assessment reports of RC constructions. Mr. Pandey is currently carrying out research on quantification of performance indicators of non-ductile RC buildings to the seismic loading.

- **Study of variability of ground motion affecting soil- structure interaction in buildings**
  In collaboration with researchers from university of British Columbia (UBC), Dr. Pandey is investigating the impact of combined effect of kinematic and inertial effects of seismic ground motions in the response buildings looking at the records of instrumented buildings and developing combined soil- building model. The research shows that there are cases where ground motion does not always necessarily get reduced at the foundation compared to that of free-field but the factors including stiffness ratio of building to soil deposit, mass of the building and pre dominant frequency of input motion could amplify the shaking.

- **Cause of deaths and injuries in the 2015 Gorkha earthquake**
  Dr. Pandey joined researchers from several countries in the study on causes of casualty in the 2015 Gorkha earthquake commissioned by Save the Children. While the field research confirmed that the drop-cover-hold approach for personal emergency response is effective in reducing the casualties, it also points out that a detailed and customized set of the emergency response is needed that consider local construction, types and placement of non-structural items and level of awareness.

Dr. Colleen Chan, PhD, PEng:

- **Enhanced water quality improvement in green infrastructure design**
  This research is a collaborative research initiative between Department of Civil Engineering, Ecological Restoration, Department of Chemistry and Chemical and Environmental Technology at BCIT. The research project is funded by BCIT's Green Values Strategy fund and supports two M.Sc. and several undergraduate research projects. The study aims to investigate novel ways of improving stormwater runoff quality by incorporating biochar into green infrastructure systems such as bioretention cells. Factors such as filtration system design, impacts of biochar physico-chemical characteristics on stormwater pollutant removal and plant growth were examined. The results from the research project will further inform the design of infiltration based green infrastructure designs to improve water quality in creeks and streams receiving stormwater runoff. Results to date have been presented at the Ecocity (2019) conference and published as book chapter Eco-cities Now (2020).

- **Comparison of rainwater attenuation in green roofs and blue-greenroofs**
  This is a collaborative project between Civil Engineering and the Building Science program at BCIT. The aim of the project is to compare the hydrological responses of green roof and blue-greenroofs, and examine how flow attenuation is achieved in these systems. Various greenroofs installed at Vancouver City Hall and BCIT are studied through computer modelling and validated with experimental data collected. The impacts of climate change on the hydrological response of the roofs are examined as well.

- **Redesign of a biosand filter to remove chemical contaminants from drinking water**
  This research is a collaborative project with the Dept. of Chemistry and funded by BCIT's Discovery Parks fund. With increased mass agriculture practices in low income countries, chemical pollution of water sources from pesticide application is becoming a public health concern for those who rely on the contaminated water supply. The project examined the use of an intermittently operated biochar/biosand filtration system, in conjunction with a biosand filter to remove environmentally relevant concentrations of various pesticide and hydrocarbons from drinking water sources. Results showed that designed filtration system is shown to be a promising technology in removing chemical contaminants drinking water sources. The results from the project were presented in IWA Water and Development Congress (2018), and published in the International Journal of Environment and Technology (2020).

Dr. Kian Karimi, PhD, PEng:

- **Contemporary issues in design and fabrication of tubular steel structures**
  This research is an ongoing collaboration between BCIT and the University of Victoria. Funding was provided through BCIT's VP Research Seed Fund and the University of Victoria`s NSERC Discovery Grant for 3 consecutive years.
  The study aims at developing solutions to improve service life of exposed tubular steel structures and to facilitate design of high-performance steel structures in Canada. It will help Canadian engineers fully utilize the structural and architectural advantages of the new generation of HSS and treat design and construction of high-performance tubular structures with ease.

- **Comparison of analysis approaches for seismically isolated buildings using Equivalent Lateral Force (ELF) method versus Time-History Analysis (THA)**
  Seismic design of structures has evolved significantly over the last several decades. The current seismic design approaches rely on the ductility of structures in dissipating earthquake energy. These approaches result in an economical design and predictable failure mechanisms, however, could leave the building with substantial damage following a seismic event.
  Seismic Base Isolation can be used as a solution to minimize earthquake damage to the superstructure by reducing the inter-story drifts and concentrating the damage at the base. This research focuses on comparing two base isolation design procedures (ELF and THA). The Canadian National Building Code lacks a simple static procedure for the preliminary design of base isolation systems. The study evaluates the accuracy and potential of the static procedure and discusses whether in the future a standardized static procedure could be developed for design of seismic base isolation systems.

- **Analytical investigation of the application of seismic base isolation to wood buildings**
  Seismic Base Isolation (SBI) systems are used to mitigate earthquake effects on structures. In this study, an analytical approach was used to determine the effectiveness of SBI systems to low and mid-rise wood frame buildings. Timber buildings were selected for this study due to their prevalence in North America, particularly in residential construction.
  Time history analysis of two sample wood frame residential buildings (low rise and mid-rise) was undertaken to assess their behaviour and choose an appropriate SBI system. The project aimed to provide an analytical case study to help engineers with better assessment of the application of SBI systems to timber buildings and its associated benefits and limitations.