Project Title: Climate Change analysis using daily rainfall data for Indiana

Undergraduate Research Position
Faculty: Chandramouli Viswanathan
Mentors: Le Zeng, Graduate Student

Global climate changes cause several influences. To analyze the climate change characters, several indices were proposed. Using long term daily rainfall data these indices were calculated. Indices such as RX1day (maximum one-day precipitation), RX5 day (maximum five day precipitation), SDII (simple daily intensity index), R10mm, R20mm (count of precipitation days with rainfall rate greater than 10 mm and 20 mm), Rnnmm (count of days where rainfall rate is greater than a threshold value), CDD (consecutive dry days), CWD (consecutive wet days), R95pTOT (percentage of wet days) and R99pTOT (percentage of extremely wet days) are popularly used to study the climate changes. Student will work with Indiana, Kentucky, Illinois, Ohio state rainfall data and analyze these indices to check the trends in the region.

Project Title: Wind Energy Study

Undergraduate Research Position
Faculty: Xiuling Wang
Mentor: Xiuling Wang

Wind energy, as one of the cleanest renewable energy, is becoming increasingly important. Both the installed wind power and the generated energy are increasing by 30% per year world-wide. In wind energy study, students will be exposed to various related research topics: economic analysis for wind energy analysis; 3-D wind fields construction; aerodynamics analysis for wind turbine blades; weak effects analysis for wind turbine blade.

Project Title: Parametric Study of Hybrid Spring-Membrane System for Fouling Control

Undergraduate Research Position
Faculty: George Nnanna
Mentors: Nina Zhou, PhD student; and Dr. Yu, PostDoc.

Filtration technology such as membrane has been commonly used to remove physical-chemical-biological contaminants from water to meet the standards set by Safe Water Drinking Act. Membrane is a permselective barrier or interface between two phases: phase 1, the feed or upstream side and phase 2, permeate or downstream side. Feed solution permeates through the membrane while the contaminants are retained resulting in fouling of the membrane surface. The mechanisms of fouling include the pore blockage, the cake layer formation, and the concentration polarization. The rapid initial drop in permeate (pure water) flux is attributed to the quick blocking of membrane pores by retained particles when feed solutions flow cross the membrane surface. Further flux decline after pore blockage is due to the formation and growth of the cake layer on the membrane surface as the amount of the retained particles increases. Concentration polarization is also an important factor causing flux decrease. It is a phenomenon in which the solute or particle concentration in the vicinity of the membrane surface is higher than that in the bulk. Fouling often results in reduced system performance, the decrease in permeate flux and the increase in pressure drop due to fouling adversely impact the membrane filtration efficiency. Therefore, it is important to minimize the fouling of the membrane.

The aim of this investigation is to mitigate fouling using hybrid spring-membrane system with emphasis on the effect of coil and wire diameter, stiffness, and pitch on the rate of fouling. The presence of spring induces turbulent; alter flow pattern and the rate of particle deposition on the membrane surface. In the membrane filtration system, the spring will be inserted or attached to the channels of the tangential flow filtration module in order to increase the turbulence in the channels and to prevent the occurrence of concentration polarization.

Project Title: Indoor Air Quality Simulation

Undergraduate Research Position
Faculty: Xiuling Wang
Mentor: Xiuling Wang

Indoor air quality (IAQ) has a big impact on human health – most people spend 90 percent of their time indoors whether at home, at work or in a car traveling. Researchers have pointed out that indoor air pollution problem can be much worse than outdoor air pollution problems. Accurate and fast predict indoor contaminant dispersion will become important in risk assessment.

In this research project, students will learn how to apply Computational Fluid Dynamics in set up a numerical model in simulating indoor air quality related contaminant dispersion problems under different scenarios; conducting parametric study to find out the most influencing parameters, experimental data will be provided to validate and verify the numerical results.

Project Title: A New approach to the Calculation of Deflection and Crack opening in a flexure member

Phase1:
According to the findings and observations, the current methods (Branson's Equation[1] and the recommended Bischoff's Equation[2]) underestimate the deflection of concrete beams reinforced with high-strength steel bars. This conclusion is based on the comparison between the experimental results and the parametric studies that were performed within NCHRP 12-77 project.

Phase2:
The concept of bar spacing which is based on crack control in concrete beams reinforced with conventional steel bars (A615 ASTM)[3] may not be valid for concrete beams reinforced with other type of reinforcement. For instance, one of the advantages of using high-strength steel bars, is to decrease the reinforcing ratio. Therefore, the bar spacing formulation should be different from the physical based model proposed by Frosch[4],[5] and adopted by ACI.

A new method of calculating the crack opening is proposed based on mechanical properties and strength of materials in reinforced concrete members. This new approach will open doors to the ongoing research studies on crack control in reinforced concrete. This research proposal in its preliminary state needs a comprehensive literature review on crack opening and deflection. The review should include all available experimental flexure tests and the specification of test design (Concrete type, reinforcement bar type, reinforcement bar ratio, bar spacing and including all other dimension and applied loads) and provide all available resulting data such as crack opening, crack width, deflection and moment curvature of the flexure member.

[1] Branson, D . E ., 1963, "Instantaneous and Time- Dependent Deflections of Simple and Continuous Reinforced Concrete Beams", Research Report No. 7, Alabama Highway Department, Montgomery, Aug. 1963, 94 pp.

[2] Bischoff P. H. 2007, "Rational Model for Calculating Deflection of Reinforced Concrete Beams and Slabs", Can. J. Civil Engineering. 34, pp. 992-1002.

[3] ASTM A615/A615M-06. Standard Specification for Deformed and Plain Carbon-Steel for Concrete Reinforcement. Conshohocken, PA: ASTM International, 2006.

[4] Frosch, R. J. , 2001, "Flexural Crack Control in Reinforced Concrete, Design and Construction Practices to Mitigate Cracking", SP 204, American Concrete Institute, Farmington Hills, Mich., pp. 135-154.

[5] Frosch, R. J., 1999, "Another Look at Cracking and Crack Control in Reinforced Concrete", ACI Structural Journal, V. 96, No. 3, May-June, pp. 437-442.