Data-driven Concrete Autogenous Shrinkage Prediction

### Academic Disciplines:
- ELECTRICAL & COMPUTER ENGINEERING
- MECHANICAL ENGINEERING
- CIVIL ENGINEERING & ENVIRONMENTAL

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#### Research Objective

- The goal of the project is to use data-driven methods to perform predictive modelling of the autogenous shrinkage from limited experimental dataset
- The work proposes new physics guided deep learning model B5Net to predict autogenous shrinkage

#### Dataset

- 319 unique tests
- Average ~24 points per test
- Around ~300 unique tests available, although some have incomplete compositional parameters
- Input: \( ab, wb, t+1 \text{ dry} \)
- Output: \( \text{shrinkage strain} \)

#### Dataset B5Net

- Average time of test ~262 days

#### Problem and Data Augmentation Workflow

- A typical autogenous shrinkage curve is shown below.
  - One can see a sharp decrease in strain followed by a slower plateau
  - Not all tests look as “neat” as this one
  - Swelling can be observed for certain tests

#### B5 Model

\[
\epsilon_{\text{auto}} = \epsilon_{\text{0,001}} \left( \frac{wb}{4} \left( \frac{1}{1+(\tau_{\text{sw}}/4)^{m}} \right) - \left(1 - \frac{wb}{4} \right) \left( \frac{1}{1+(\tau_{\text{sw}}/4)^{m}} \right) \right)
\]

1. Use B5 model to perform curve fitting for each shrinkage set and calculate the value of parameters (\( \epsilon_{\text{0,001}}, \tau_{\text{sw}}, \tau_{\text{au}}, m, n \))
2. Perform data augmentation by using B5 model and parameters for each shrinkage set (create 100 data point each)
3. Use the augmented data to train the deep neural network with following layers \([1024-512-256-128-64-32-1]\)

#### B5Net Results

- We used deep neural networks with augmented data to learn the physics behind the nature of the autogenous shrinkage curve to reproduce similar curve for test set
- The prediction suggests we were able to learn the physics via the augmented data to produce physics guided deep neural network

#### Future Work

- Establish relationship between B5 coefficients and compositional parameters (currently no strong correlation for one of the constants)
- Create Website

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