Data-driven Concrete Autogenous Shrinkage Prediction

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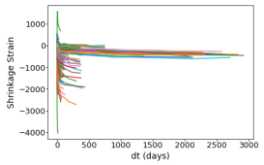
Research Objective

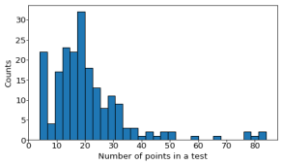
Outline

- 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

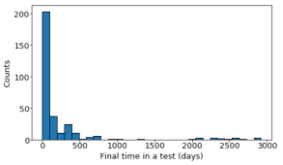
Dataset



319 unique tests



Average ~24 points per test

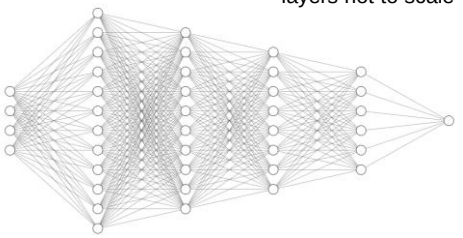


Average time of test ~262 days

Around ~300 unique tests available, although some have incomplete compositional parameters

B5Net

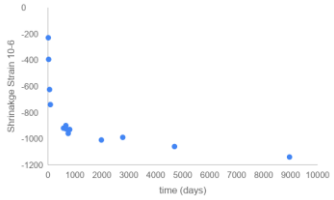
*layers not to scale

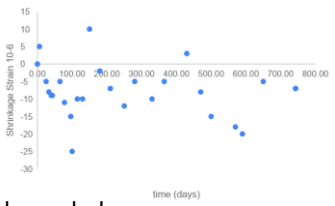


Input: t+t dry ab, wb,

Output: shrinkage strain

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

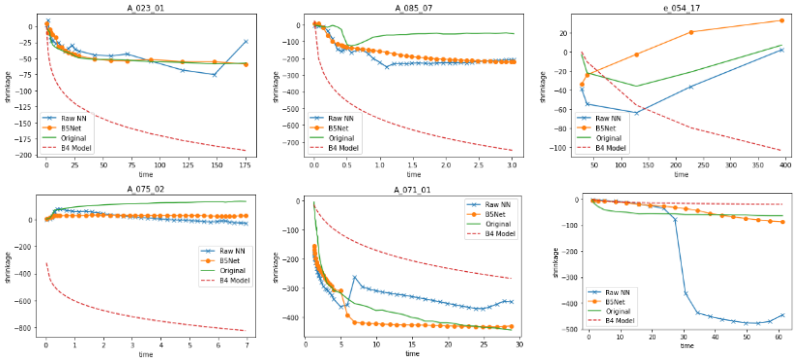
For autogenous shrinkage

B5 Model

$$\varepsilon_{auto} = \varepsilon_{s\infty}\left(\frac{wb}{1+ab}\right)\left((wb/4)\frac{1}{1+(\tau_{sw}/t)^m} - (1-wb/4) * \frac{1}{1+(\tau_{au}/t)^n}\right)$$

1. Use B5 model to perform **curve fitting** for each shrinkage set and calculate the value of parameters (epsilon_inf, t_{sw}, t_{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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