FLY ASH-BASED GEOPOLYMER FOR WELL CEMENT DURING CO_2 SEQUESTRATION: AN ANALYTICAL STUDY

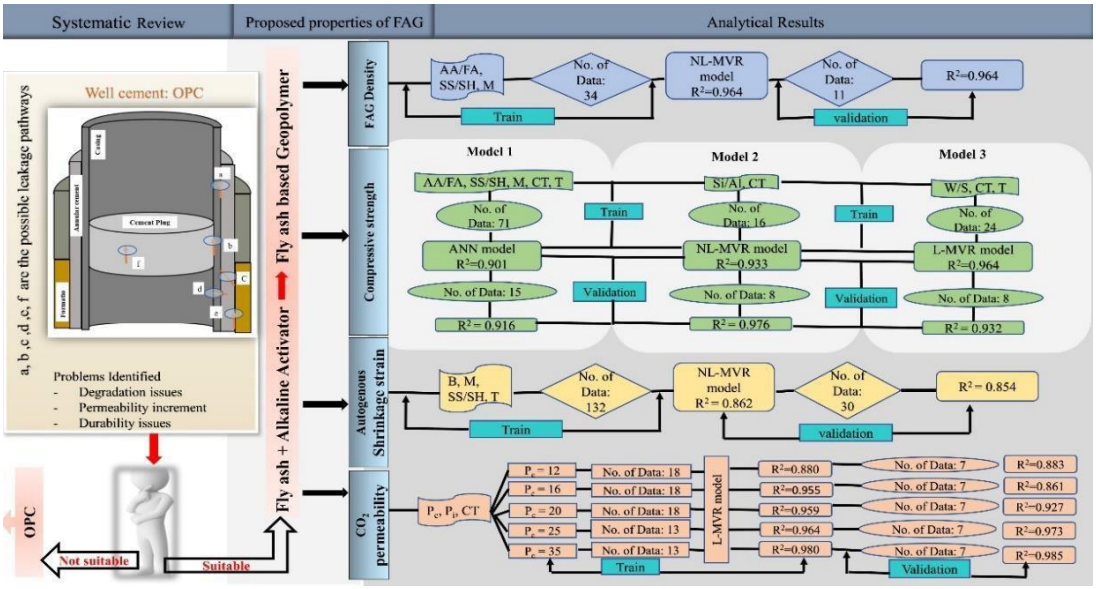
H.B.S. Sathsarani [1,*], K. H. S. M. Sampath [1]

[1] Department of Civil Engineering, University of Moratuwa, Moratuwa

Generally, Ordinary Portland Cement (OPC) is used as a well cement during the CO_2 sequestration process; however, it shows adverse failures in a CO_2-rich environment and loses its isolation properties in a short time. Based on the previous findings on OPC-based gas well cement, its uncertainty in providing effective well integrity is revealed. Therefore, studying a novel well cement is one of the main requirements to conduct a sustainable CO_2 sequestration process. Among them, fly ash (FA)-based geopolymer has a higher prominence due to the ability to reduce the gigantic amounts of fly ash piled up due to coal-fired power plant operations. The compressive strength and CO_2 permeability of well cement play major roles in downhole conditions to maintain the wellbore integrity at different temperature and pressure variations. This study was carried out to develop predictive models for compressive strength and permeability of FA-based geopolymer cement using different independent variables. For this purpose, databases were developed to collect data from many laboratory studies available in the literature. Two models were developed for predicting 7 days of compressive strength of well cement using linear and nonlinear multivariable regression (MVR) analyses and Artificial Neural Network (ANN), and they were validated using the experimental data. One of the models developed using Si/Al ratio and curing temperature as independent variables have shown a good prediction accuracy with R2 values of 0.9332 for training data and 0.9761 for validating data. In the case of developing prediction models for CO_2 permeability, five equations were developed under selected confining pressures using injection pressure and the curing temperature as independent variables. Coefficient of determination values (R^2) of 0.880, 0.955, 0.959, 0.964, and 0.980 were obtained for each trained data in categorised subgroups under confining pressure values of 12, 16, 20, 25, and 35 MPa respectively for these developed equations.

Keywords: Fly ash; Geopolymer; Ordinary Portland cement; Well cement

* Correspondence: sandunika37@gmail.com



List of Abbreviations

AA/FA-Alkaline activator to Fly ash ratio
B – Binder (mass of fly ash and alkaline activator that is included in m^3 of FAG mixture)
CT – Curing Temperature(^{0}C)
L-MVR- Linear Multivariable Regression
M- NaOH concentration
NL-MVR -Non-Linear Multivariable Regression
$\mathbf{P_c}$ – Confining Pressure (Pa)
$\mathbf{P_i}$ – Injection Pressure (Pa)
SS/SH – NaOH to Na_2SiO_3 ratio
T – Curing time