Moderating Effect Model of Concrete Mix Variables on Concrete Strength

Charles Horace Ampong, PG (Dip), MSc (Eng), MBA
Northeastern Illinois University, Chicago, IL - Department of Mathematics

Abstract

Researches in the field of Concrete Technology has demonstrated that compressive strength of concrete is function of concrete-mix variables primarily water-cement ratio, admixtures (namely blast furnace slag, fly ash, plasticizer), coarse aggregate, fine aggregate, age and external factors such as temperature. These researches have focused on the individual impact of the concrete-mix variables improving the strength of concrete when used in a concrete mix. There still remains the need for more research to investigate the moderating impact of the concrete-mix variables on concrete strength so as to provide a better understanding of the synergistic or non-synergistic effect of the variables on compressive strength of concrete.

This study provides a statistical model for understanding the moderating effect of concrete mix design components on compressive strength of concrete. The study investigates the moderating impact of four concrete-mix variables specifically admixtures encompassing blast furnace slag, fly ash, superplasticizer on concrete compressive strength for a 28-day age sample. Currently, it has been found out compressive strength is inversely related to water-cement ratio with a maximum compressive strength occurring at a water-cement ratio of 0.27. Admixtures amount with values between 0-324kg/m3 has either a positive or an adverse effect on compressive strength of concrete. The impact of admixtures on compressive strength is explained by the statistically significant two-way model interaction between fly ash and superplasticizer and also between blast furnace slag and fly ash. The multiple regression model with compressive strength as dependent variable and water to cement ratio, admixtures as independent variables is statistically significant (Unadjusted R^2 = 76.47%, Adjusted R^2 = 76.19, P-value <0.0001).

Three dimensional models, Line graphs and contour plots of the two-way interaction effects show a visual and pragmatic analysis of mutual moderating effect of superplasticizer-fly ash chemistry and also fly ash-blast furnace slag chemistry with regards to impact on concrete compressive strength. Mutual moderating effect of superplasticizer - fly ash is seen as an "antagonistic" interaction effect (P-value<0.0001) whilst the mutual moderating effect of fly ash-blast furnace slag is seen as a synergistic interaction effect (P-value = 0.0275). The study also demonstrated the closeness in prediction of compressive strength between the linear model and a non-linear model in which the effect of admixtures is neglected.

Keywords: Moderating, Admixtures, Interaction, Synergistic, Antagonistic, Impact