RSM-based modelling of cement mortar with various water to cement ratio and steel slag content

Ho C.M., Doh S.I., Li X. Chin S.C., Ashraf T.
Faculty of Civil Engineering Technology, Universiti Malaysia Pahang, Gambang, Pahang, 26300, Malaysia

ABSTRACT
The water to cement ratio (w/c) has a direct effect on the hydration process of cement mortar. It basically dictates the workability and mechanical properties of cement mortar or concrete. Steel slag (SS) is one of the industrial by-products which is used in concrete as supplementary cementitious materials. Utilizing SS in concrete could mitigate the impact of the massive amount of concrete demand and promise an alternative to industrial waste management. However, previous studies show that steel slag has high water absorption during the mixing stage due to its grains' morphology. This study intends to determine the influence of SS content of 0%, 2.5%, 7.5%, and 12.5% (by mass) in cement mortar with 0.40, 0.45, 0.50, and 0.55 w/c ratios. A series of experimental tests were conducted to investigate the workability, compressive strength, flexural strength, and water absorption characteristic in this study. The results show that a 0.4 w/c ratio with 2.5% SS substitution presents a very low workability as compared to 7.5% and 12.5% SS content. Moreover, the higher substitution of SS in cement mortar has significantly decreased its strength. However, by decreasing the w/c ratio from 0.55 to 0.40, the strength is enhanced at 28 days. Based on the experimental results, response surface methodology (RSM) analysis was performed to develop the statistical model to predict the loss in cement strength as a function of the SS contents and w/c ratios. The predicted models are validated by examining the correlated coefficient of determination (R^2). The R^2 values for models of compressive and flexural strength are 0.9995 and 1.0000, respectively. From the results, it was confirmed that the incorporation of SS into cement mortar with a low w/c ratio has significantly increased the strength performance of the cement mortar.

KEYWORDS
Compressive strength; Flexural strength; RSM approach; Steel slag; Water to cement ratio

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