UTILISATION OF RICE HUSK ASH FOR SOIL STABILISATION

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Rice husk ash (RHA) is one attractive additive that can be used for the enhancement of engineering properties of problematic soils as a full/partial replacement of cement/lime. The present study reviews the production of RHA and its basic characteristics as it relates to the performance of RHA-stabilized soils. For each soft ground improvement application, a substantial amount of time, money and effort is required for conducting extensive laboratory tests to evaluate the improvement of geotechnical properties of stabilized soil and identify the optimum mixture of additives. As an indirect approach, the present study explores the development of predictive models for geotechnical properties using multiple regression analysis (MRA) and artificial neural network (ANN) analysis. Laboratory experimental data sets from an extensive literature review were used to develop the models. The models for the prediction of Unconfined Compressive Strength (UCS), Soaked California Bearing Ratio (S-CBR), Maximum Dry Density (MDD), Optimum Moisture Content (OMC), and Plasticity Index (PI) of RHA-stabilized clayey soil were proposed. It is noticed that at the prediction of S-CBR, and MDD, MRA gives better correlations with more than 95% prediction accuracy. Since MRA does not provide satisfactory performance for the prediction of UCS, OMC, and PI, ANN models were developed with R^2 of more than 0.95. The proposed models were validated using the independent sets of data which is 30% of total data points. All the models express a good prediction capability with a prediction error of less than ±7.5%. A parametric analysis is performed to evaluate the variation of UCS of RHA-stabilized soil with the effect of influencing input parameters. The result of PA suggests that 6-12% of RHA in combination with a very little amount of cement (4-8%) or lime (3-6%) is the optimum mix proportion for RHA-stabilized soil ensuring the robustness and reliability of the proposed model. Hence, the proposed correlations may give easy access for facilitating the engineering decisions during the pre-feasibility assessment. Further research into the production process of RHA, the application potential of other waste materials to incorporate with RHA-cement-lime binder mixtures and evaluation of indirect approaches to assess the characteristics of stabilized soil systems could lead to the utilization of RHA as a beneficial and productive alternative in soil stabilization.

Keywords: Artificial Neural Networks; geotechnical properties; Multiple Regression Analysis; Rice Husk Ash

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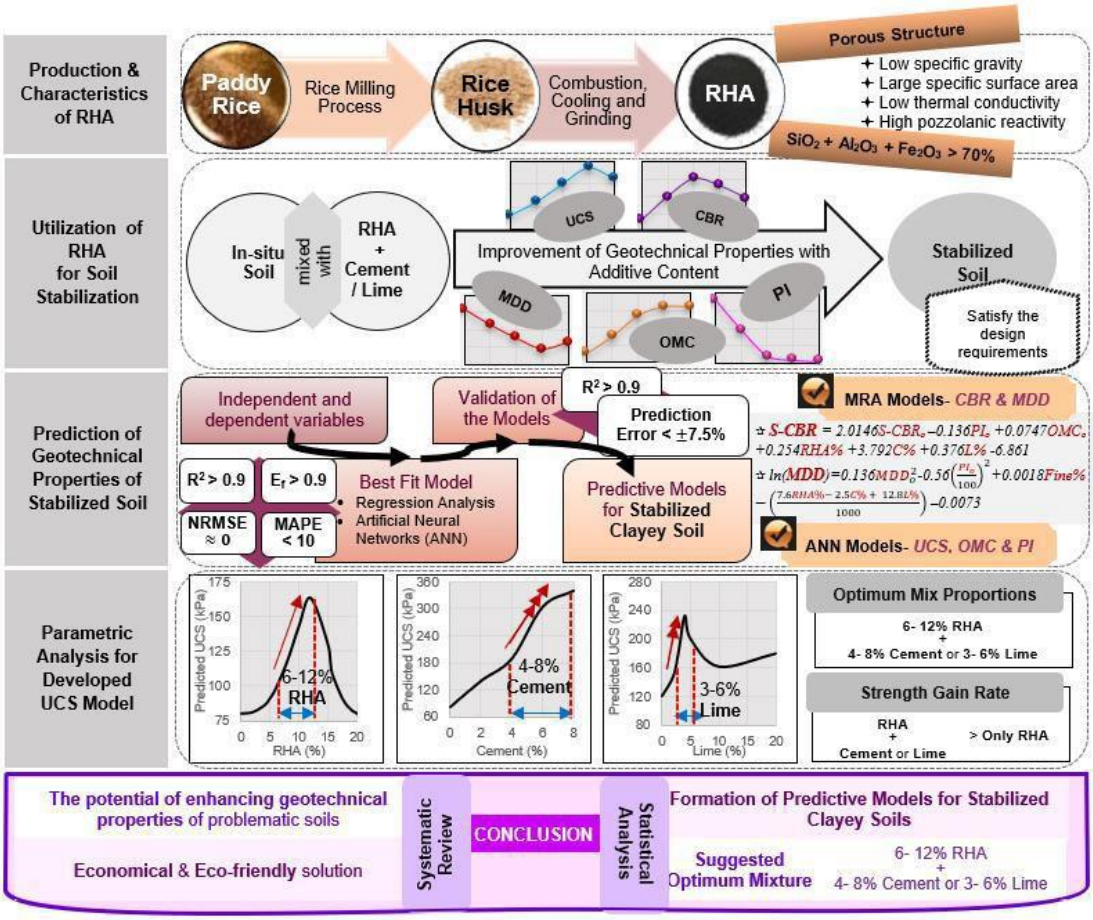
Production & Characteristics of RHA
Paddy Rice
Rice Milling Process
Rice Husk
Combustion, Cooling and Grinding
RHA
Porous Structure
Low specific gravity
Large specific surface area
Low thermal conductivity
High pozzolanic reactivity
SiO2 + Al2O3 + Fe2O3 > 70%
Utilization of RHA for Soil Stabilization
In-situ Soil
mixed with
RHA + Cement / Lime
UCS
CBR
MDD
OMC
PI
Improvement of Geotechnical Properties with Additive Content
Stabilized Soil
Satisfy the design requirements
Prediction of Geotechnical Properties of Stabilized Soil
Independent and dependent variables
Validation of the Models
R² > 0.9
Prediction Error < ±7.5%
MRA Models- CBR & MDD
S-CBR = 2.0146S-CBRo –0.136PIo +0.0747OMCo +0.254RHA% +3.792C% +0.376L% -6.861
ln(MDD)=0.136MDDo-0.56(PIo/100)^2 +0.0018Fine% –(7.6RHA%– 2.5C% + 12.8L%/1000) –0.0073
R² > 0.9
Ef > 0.9
NRMSE ≈ 0
MAPE < 10
Best Fit Model
Regression Analysis
Artificial Neural Networks (ANN)
Predictive Models for Stabilized Clayey Soil
ANN Models- UCS, OMC & PI
Parametric Analysis for Developed UCS Model
Predicted UCS (kPa)
6-12% RHA
RHA (%)
4-8% Cement
Cement (%)
3-6% Lime
Lime (%)
Optimum Mix Proportions
6- 12% RHA + 4- 8% Cement or 3- 6% Lime
Strength Gain Rate
RHA + Cement or Lime
> Only RHA
The potential of enhancing geotechnical properties of problematic soils
Economical & Eco-friendly solution
Systematic Review
CONCLUSION
Statistical Analysis
Formation of Predictive Models for Stabilized Clayey Soils
Suggested Optimum Mixture
6- 12% RHA + 4- 8% Cement or 3- 6% Lime