PREFACE

With the increase in world population and land costs, the fulfillment of the severely increasing continuous demand for a suitable construction site is becoming harder day-by-day. On the other hand, a large quantity of industrial by-products generated worldwide is bringing serious concerns regarding disposal, environmental and health problems. Under this preview, the ultimate goal is to convert the entire waste produced into a useful engineering material.

Red mud is a major industrial solid waste residue produced by the Bayer process for the extraction of alumina from bauxite ores. It is usually disposed off in the form of slurry, containing 80–90% as mud and the rest being sand, in the nearby areas of the alumina producing industry. At the same time, red mud has massive problem of storage which requires lot of space nearby alumina plant where it looks like huge mountain-size mounds. Nowadays, lots of alumina plants are running out of space for the dumping of red mud. Thus, it is now essential to develop environmental friendly and sustainable cutting-edge technology to reduce, reuse and safe utilization of such industrial reject. However, red mud has some environmental and logistical concerns with handling, storing and disposal due to its characteristics such as high alkalinity (pH10 - 13:5), sodicity and fine particles. Thus, red mud cannot be used without treatment and required pre-treatment before civil engineering application. Hence, an attempt has been made in this thesis to explore, compare and validate different approach to evaluate the factors affecting the mechanical properties of red mud. It is also tried to develop predictive equation as ready reference for practicing engineers. Further, the data sets obtained from the different approach are used for artificial neural network application to see their effectiveness in predicting response. Finally, the uses of proposed predictive equations for the field applications are also demonstrated at the end.

The content of the thesis is broadly divided into six Chapters - viz., Introduction, overview of literature, Experimental program and procedures, Evaluation and comparison of mechanical properties of stabilized red mud with conventional and experimental designed approach, Application of artificial neural network for predicting the strength of stabilized red mud based on different data sets, Potential of these mixes for different civil engineering applications and Summary and conclusions. The overview of different industrial wastes, stabilization techniques,

literature survey and detailed scope and organization of the thesis has been presented in **Chapter 1. Chapter 2** summarizes types and procedures for different test and working procedure of design of experiments and artificial neural network for the current study. Procedures for identifying the mineral and micro structure of red mud with a and without treatment such as scanning electron microscopy (SEM) and electron dispersive spectroscopy are also presented in this chapter. **Chapter 3** brings out different phase of the study on the red mud. In the first phase, the effect of various factors such as molding moisture content, dry density, curing time and amount of cementing agent (lime) on unconfined compressive strength of red mud are studied. Further, different predictive equations assuming two-phase water by lime (w/L) ratio and three phase porosity by volumetric lime (η/L_v) ratio have been developed to predict the strength of stabilized red mud that may be used as dosage methodology for practicing geotechnical engineers for the range of study. However, the limitations of multi variable studies using conventional approach are a large number of experiments which is time-consuming and expansive. So, to overcome this problem, an experimental designed approach is used in the second phase. Central composite design (CCD) and the Box-Behnken design (BBD) are used to design the experiment based on nature and operability region of this study.
Finally, the efficacy of both approaches is checked within the range of studies, and it is observed that the predicted response using experimental designed approach are in good agreement with the measured response with the conventional approach which confirms that the experimental designed approach can be used for the evaluation of mechanical properties of stabilized red mud. So in a third phase, other studies on stabilized red mud such as split tensile strength, wetting-drying and Leachate study using alternative approach have been incorporated.

Finally, Sensitivity analysis is also carried out to find the relative contribution of inputs parameters on the response. It is seen that lime content, dry density, and curing time contributes much more than that of moisture content on the unconfined compressive strength(q_u) of red mud. Further, it is seen that the parameters such as amount of lime, dry density, curing time and molding moisture influence directly whereas parameters like ratio w/L, η/L_v influences indirectly on q_u. It also infers that the contribution of parameters η/L_v is more as compared to w/L on q_u and may be preferred as a fundamental parameter for the assessment q_u of stabilized red mud.

Chapter 4 explored the performance of an artificial neural network model to predict the unlimited compressive strength of stabilized red mud based on two different approaches. The results suggest that performance of experimental designed ANN models are similar to that of conventional designed ANN model and thus, may be adopted as a useful tool where the generation of data set is time-consuming and tedious. **Chapter 5** summarizes the potential of stabilized red mud for different civil engineering applications such as pavement material and unfired bricks because some of the combinations of the mixes satisfy the design criteria. Finally, the major conclusions and scope of the future work of the thesis are presented in **Chapter 6.**