

Theoretical Analysis of Rectangular Clay Paste Extrusion

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Abstract – The present theory concentrates on deriving basic equations that control the clay paste flow behavior of rectangular extrusion process during the steady-state flow. The flow stress of the clay paste from compression test was evaluated and the theoretical extrusion pressure results were analyzed and discussed thoroughly. Finally, it can be concluded that the present theoretical analysis serves to place the present approach in the context of work on other extrudable materials of different geometries.

An important aspect of clay paste extrusion is the pressure as a function of extruded velocity/distance traveled. The main parameters which control the extrusion pressure are the effective stress in compression of the clay paste, the geometry of extrusion tools and billet, operational conditions and the coefficients of friction between the barrel and the die land surfaces. In the derived expressions proposed in this work, empirical constants determined from the composition of the ingredients are not needed. The main objective here is to present semi-theoretical models to predict the average extrusion pressure based on the modified plasticity equations.

A mathematical model for evaluation of the plasticity of clay bodies was developed from applied concepts of the plasticity theory by using the stress/strain diagram under compression. Fig. 1 demonstrated that the theoretical curves correlated well with the experimental data. It could be interpreted that this simple model can be used for different types of clay with variable amounts of moisture content.

Previously published experimental extrusion curves had been carried out with pastes and are reproduced here for comparison purposes [1]. On close examination of the Fig. 2, it becomes evident that certain values of the coefficient of friction can be selected so that the best fit occurs between the theoretical and the experimental curves. These values were obtained from the curve fitting technique since they are not available so easily in published literature.

The factors that influence the behavior of the clay during its processing were used to evaluate the average extrusion pressure. Among these factors, it was clear that the effective flow compressive stress of the clay subjected to uniaxial compression is a predominant factor. The excellent agreement between the experimental and the theoretical results makes the present theory more reliable and a potentially useful tool for the evaluation of clay materials with optimized properties for a given application.

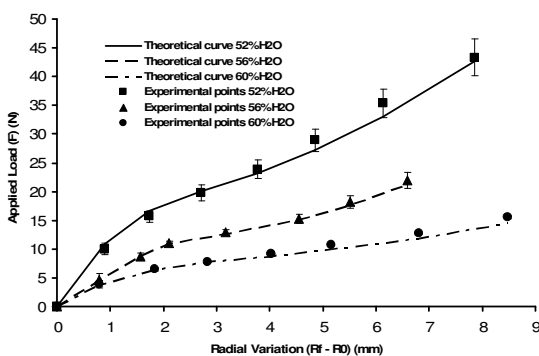


Figure 1: Comparison between theoretical curves and experimental points for kaolin clay paste having different levels of moisture

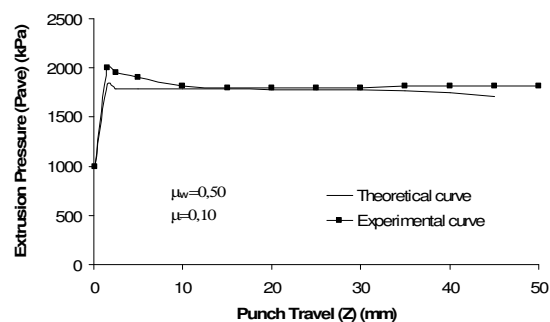


Figure 2: Comparison between theoretical (analytical approach) and experimental curves for the extrusion process of kaolin clay paste for defined coefficients of friction

References

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