ABSTRACT

Utilization of cemented paste backfill (CPB) composite to ameliorate geomechanical stability of underground mine is in nascent stage in India. This thesis focuses mainly on the development of CPB using mill tailings of uranium bearing dolomitic limestone and determination of various properties for its flowability through pipe line reticulation system as well as for supporting underground stopes. Characterization of mill tailings is conducted in terms of physico-chemical properties such as particle size analysis and it is noticed that finer than 20 µm particles are 47 wt% having irregular shape. The hydraulic conductivity of mill tailings is found to be as low as 4.4×10^{-5} cm/s. Then suitable amount of binding agent and superplasticizer are added with mill tailings to form CPB. Geomechanical properties of CPB such as strength, modulus of elasticity, cohesion and friction angle are also evaluated and it is found that uniaxial compressive strength may exceed 1000 kPa for 6 wt% binder content providing sufficient supports to stope pillars. It is established that the mill tailing has the potential to form paste and the CPB has adequate strength to strengthen mine pillars, roofs and walls. A methodology is presented in the thesis for determining various rheological properties mainly yield stress, plastic viscosity and thixotropy of CPB mixture as a function of hydration age, binder and SP dosages for 78 wt% of mill tailings in the composite. Results from the experimental campaigns suggest that superplasticiser (SP) dosage has significant influence on rheological behavior of CPB and can be suitably exploited to enhance the flow characteristics of tailings rich in carbonates. Statistical models of these three rheological parameters are also developed considering input parameters as hydration age, binder and SP dosages and found that R^2 of all the models exceeds 0.95. The study is also extended to determine time dependent rheological properties of CPB as it travels to underground mine stope through pipeline reticulation. Based on the experimental as well as numerical pipe loop tests, a pressure gradient model is also developed considering input variables as diameter of the pipe, plastic viscosity of CPB and inlet velocity. It is found that pressure gradient varies nonlinearly with almost square of pipe diameter and linearly with plastic viscosity and inlet velocity. In addition, the thesis numerically analyses the stability of a room and pillar stope backfilled by the developed CPB in order to develop an understanding its strength and deformation behavior in the stope. The investigation suggests that almost 100% filling will be necessary to prevent yielding of pillars and hanging wall rock.

Keywords: Uranium; Tailings; CPB; Physico-chemical characteristics; Rheology; Compressive strength; Multivariate regression, Numerical analysis