Available online at www.sciencedirect.com
SCIENCE DIRECT®
Minerals Engineering 18 (2005) 41–44
MINERALS ENGINEERING
This article is also available online at: www.elsevier.com/locate/mineng

Experimental characterization of the influence of tailings fineness and density on the quality of cemented paste backfill

M. Fall *, M. Benzaazoua, S. Ouellet

University of Quebec in Abitibi-Temiscamingue (UQAT), Unité de Recherche et de Service en Technologie Minérale (URSTM), 445 Boulevard de l'Université, Rouyn-Noranda, Qué., Canada J9X 5E4

Abstract

Mill tailing are one of the most important components of cemented paste backfill (CPB). However, there is still a lack of knowledge on the effect that tailings fineness and density has on the quality of paste backfill. Therefore, this paper presents the results of an experimental study done to evaluate the influence of the tailings particle size and density on the quality of CPB. The criteria examined of the paste backfill quality are: its mechanical strength (uniaxial compressible strength), economic performance (based on binder cost), water demand (pulp density and water to cement ratio) for a given consistence and its microstructure (porosity and pore size distribution). The end results have shown that the tailings fineness and density significantly influence the properties of the hardened (strength, cost, microstructure) and fresh (water demand) paste backfill.

Keywords: Mining; Tailings; Hydrocyclones; Particle size; Wasteprocessing

1. Introduction

Cemented paste backfill (CPB) is an engineered mixture of dewatered tailings (generally composed of fine silt-size particles) from the milling or processing operation of the mine, water and hydraulic binders containing between 70% and 85% solids by weight. CPB represents a relatively new technology. Hence, many fundamental factors affecting paste backfill quality are not well understood. Among these aspects, the effect of tailings fineness and density on the quality of fresh and hardened paste backfill is not well understood. Only a few works (Landriault et al., 1997; Benzaazoua et al., 2003; Fall and Benzaazoua, 2003; Kesimal et al., 2003) have shown that the tailings particle size can influence the strength of the hardened paste backfill. But these works only briefly described the influence of tailings particle size on CPB uniaxial compressive strength. They had no information on the effect of tailings particle size on all of the most important quality criteria for paste backfill. They also did not account for the influence of tailings density. Because of the lack of information, it is necessary to evaluate the effect of the tailings particle size and density on the quality of the paste backfill. The main quality criteria of hardened paste backfill are mechanical and economic performance and one of the most important quality criteria of the fresh paste backfill is its water demand to ensure its transportability or flow ability. Microstructure of the hardened paste backfill is an important factor in the mechanical properties and durability of the paste backfill (Belem et al., 2001; Fall and Benzaazoua, 2003).

Therefore, the main purpose of this study was to evaluate by a series of experiments the influence of tailings fineness and density on the performance properties of the paste backfill. The studied performance properties included the strength, cost and microstructure of the hardened paste backfill and the water demand for the fresh paste backfill.

2. Experimental program

2.1. Materials and sample preparation

The tailings materials used in this study were collected from a gold (Mine A) and a polymetalic (Mine

* Corresponding author. Tel.: +1-819-762-0971x2558; fax: +1-819-797-6672.
E-mail address: mamadou.fall@uqat.ca (M. Fall).

0892-6875/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.mineng.2004.05.012

B) in eastern Canada. The sampled tailings were reprocessed to create several grain size classes corresponding to fine (20 μm particles >60 wt%), medium (35–60 wt% of 20 μm particles) and coarse (15–35 wt% of 20 μm particles) tailings. This was done by separation of the tailings by hydrocyclone and/or sieving (elimination the coarse tailings particles). Since the density of tailings materials is strongly dependant on the sulphur content (Fall and Benzaazoua, 2003), the desulphurization process (Leppinen et al., 1997, etc.) was used to create tailings materials with different densities. The main physical and chemical properties of the tailings materials used are given in Fall et al. (2004). Type I Portland cement (PC I), type V Portland cement (PC V) and blast furnace slag (Slag) were used as binders. PCI and PC V were blended in the ratio 50/50, while PCI and Slag were blended in the ratio 20/80. Tap waters was used to prepare the paste backfill mixtures.

2.2. Paste backfill mix proportions and testing methods

About 150 CPB samples, which had tailings particle size or density differences, were prepared to study the effect of tailings fineness and density on the properties of CPB. Some paste backfill cylinders were punched at their bases to study the effect of drainage according to tailings fineness on porosity of the fresh paste backfill and the consequence on the CPB properties. The tailings materials, binders and water were first mixed and homogenized in a double spiral mixer to produce the paste backfill mixtures. After that, slump tests, according to ASTM C 143-90, were done to evaluate the transportability of the backfill. The pulp density and the water/cement ratio were also determined to evaluate the water demand of the CPB. The paste backfill mixtures produced were then poured into curing cylinders, 10 cm in diameter and 20 cm high. These samples were then sealed and cured in a humidity chamber at

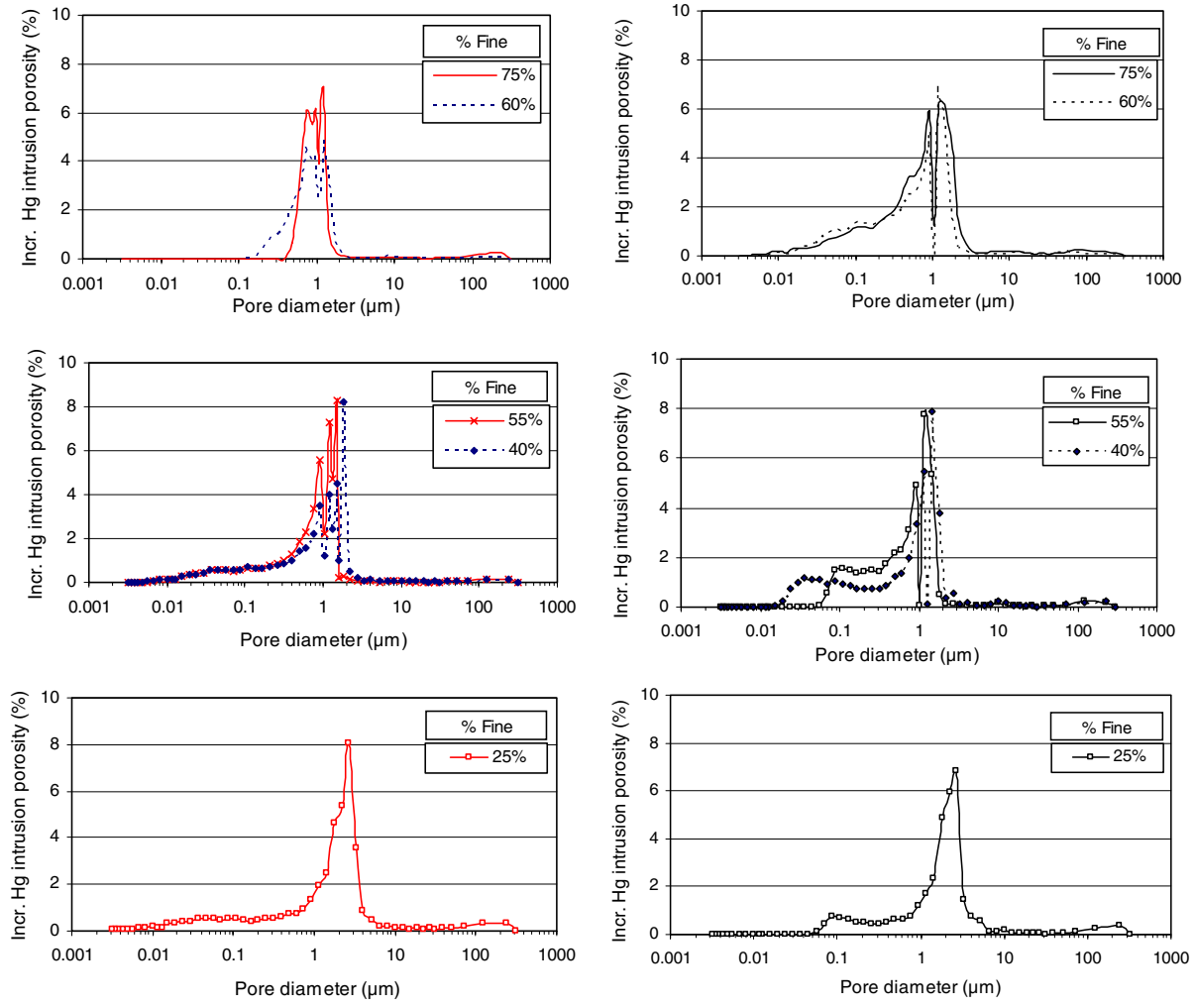

Fig. 1. Effect of tailings fineness on pore size distribution of paste backfill specimens cemented with PCI/PCV (left) and with PCI/Slag (right) after 28 days of curing (CPB made from gold tailings); Incr.: incremental; PCI: Portland cement type I; PCV: Portland cement type V; Slag: blast furnace slag.