Study on Variation in Geotechnical Properties of Practicing Backfill Material on Addition of Mill Tailing Collected From Tailing Pond

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Abstract: **--**The aim of the present work is to investigate the mineralization of host rocks of UCIL as well as analyze the variation in the geotechnical properties on addition of rejected mill tailing collected from tailing pond of UCIL Jaduguda in various proportion to the mill tailing of stowing paddock, currently using for hydraulic backfilling in underground mines of UCIL, Jaduguda. On the basis of the laboratory test and experimental results, authors have critically analyzed the variation in their geotechnical properties based on its elemental composition and size gradation of tailing particles. Finally, use of rejected mill tailings containing fines with the coarser mill tailing is suggested which is already in practice for successful hydraulic backfilling. The main purpose of this study is to reduce the scarcity of backfill material which is an emerging issue of the availability of river sand and backfill material for underground stowing.

Keywords: **--Hydraulic Backfill, Coarser Mill Tailing, Tailing Fines, Permeability.**

Introduction

Numerous backfilling techniques have been adopted now-a-days all over the world. In India, mining with backfilling is common, especially for metal mines. Waste rock extracted during development and mill tailings from the ore processing plant are widely used filling material. In the ore processing plant, hydrocyclones separates the coarser tailings from the finer. In hydraulic backfilling the particle size having less than 0.01mm is considered as fines whereas for paste backfilling, fines are the particles having grain size less than 0.02mm (Potvin, 2005). The maximum proportion of fines having size less than 0.01mm is limited to 10% in hydraulic backfilling. Increase in the percentage of fines (i.e having particles of size less than 0.02mm) increases water demand for paste formation and also reduces strength of cemented paste backfill (Fall, Benzaazoua&Ouellet; 2004). But fines should at-least be 15% of total paste backfill for adequate transportation through pipes (Potvin, 2005). Belem et al (2002) experimentally determined the influence of particle size distribution of backfill on its drainage properties. It has been observed that for a minute difference between the size distribution of two tailings results in a significant difference between there draining capacity as well as reduction in there percolation rate with the course of time. Fall et al (2005) reported that increase in the proportion of fines, reduces pulp density. Mineralogical composition of tailing is also an influencing factor concerning geotechnical properties of backfill. Kesimal et al (2003) concluded that for the same size gradation, the backfill sample having tailing of higher silicate content results in higher water retention and thus comparably lower in strength. In this paper the author highlights the variation on the geotechnical parameters of backfill material with the logical reasons which has been concluded by mineralogical and textural features of used mill tailing.

Materials and Methods

2.1 Material

The ore processing plant is fed by four UCIL mines located at Jaduguda, Bagjata, Narwapahar and Bhatin in the district of East Singhbhum of Jharkhand. Cut and fill mining method with simple backfilling with dense slurry of mill tailing without using binder is being practiced in all these four mines. The coarser tailings are suitable for backfilling and mill tailings associated with silt and fine materials beyond certain limit are not suitable for hydraulic filling. The courser mill tailing which are being discussed in this paper are the tailings used for backfill purpose of four above mentioned mines and which are not suitable for hydraulic filling are rejected and deposited to tailing ponds of Jaduguda mine. The samples of mill tailing (courser) are collected from collected from stowing paddock and rejected mill tailing (fines) are collected from tailing pond situated at Jaduguda for this study.

2.2 Method and standards

The geotechnical properties of collected tailing samples and their mixture in various proportions determined on following the methods used for soils as per the Indian Standards (IS-2720 codes). The specific gravity has been determined using the standard IS-2720 part 3-1980. The standard proctor compaction test of the samples are determined using the standard IS 2720 part 8-1983. The cohesion and angle of friction of all the samples are determined after addition of the water equal to their optimum moisture content before 1 day of the direct shear test so that the moisture uniformly distributed throughout the mixture. As per the particle size analysis, the tested samples having mixture of fine sand and silt size particles thus the coefficient of permeability of the samples are determined using falling head method as per IS-2720 part 8-1986.

Results and discussion

3.1 Mineralization of UCIL mines of East Singhbhum

Uranium has been deposited and extended to about 180 km along the shear zone of Singhbhum belt. The present work is mostly focused on the mineralization of the host rock, on the basis of which the properties of mill tailing has to be expected. The mineralization of host rocks of uranium mines located in the East Singhbhum is summarized and giving below:

Table 1 Mineralization of host rocks of UCIL, Jaduguda

S.no	UCIL Mines	Mineralization of host rock
1	Jaduguda	Autoclastic conglomerate and Quartz-chlorite-apatite-Tourmaline magnetic-schist
2	Bhatin	Brecciated quartzite and biotite chlorite schist
3	Narwapahar	Chlorite-quartz schist
4	Bagjata	Quartz chlorite biotite schist

Based on the Radioactive Minerals, R. Dhana Raju, Geological Society of India, Bangalore, 2005, and websites of Department of Atomic Energy, Govt. of India, www.wikipedia.com and other websites

It can be concluded from the above data that host rocks of uranium mines are comprises of crushed conglomerate i.e. Autoclastic conglomerate and various schist. Thus, it can be expected that coarse grains are because of auto-clastic conglomerate whereas fines are due to schist of chlorite and biotite.

3.2 Geotechnical properties

Different geotechnical properties of samples are determined with great accuracy and summarized in Table 1. The specific gravity of sample collected from tailing pond is greater than that of stowing paddock sample, hence it can be concluded that even the fine particles are also composed of heavy elements which has been complimented with the EDX report of tailing fines as shown in Fig.2. This paper concerned to the influence of the addition of rejected tailing fines in various proportions with the practicing backfill material in respect to different geotechnical characteristics. Hence EDX and as well as FE-SEM analysis are conducted to the sample collected from tailing pond. The shape of particles plays an important role in geotechnical behaviour of the soil mass. Different shape of silt size particles are determined through SEM imaging as given in figure 1, in which almost all the particles are angular in shape supporting high degree of

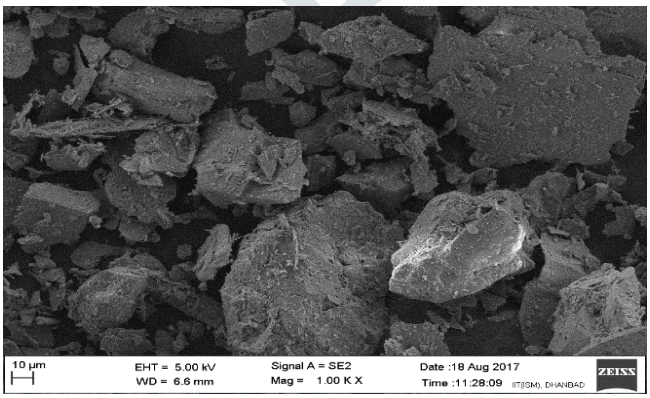

Fig 1 SEM micrograph of mill tailing particles

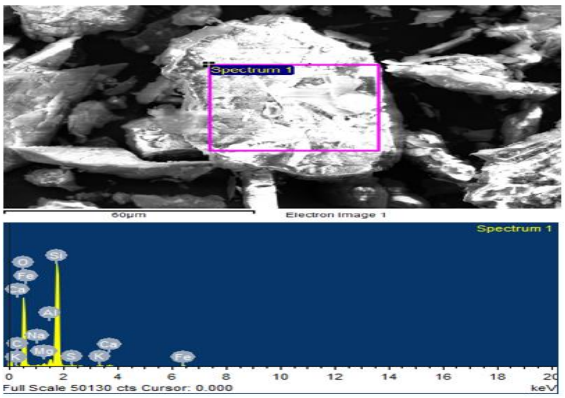

Fig 2 EDX analysis of tailing particle

compaction during self settlement of hydraulic filling with less voids. It has been determined through sieve analysis as per IS 2720 part IV that percentage of particles by weight passing through 0.075 mm sieve size is 11 and 30 but the interesting thing is that only 1.2 and 2.5 % by weight of particles having clay size for samples collected from paddock and pond respectively. Fig 3 represented the grain size distribution curves for samples collected from stowing paddock and tailing pond. Due to the presence of negligible amount of clay size particles in the collected samples, no any significant variation has been observed in their permeability even on addition of 50% of tailing pond sample to the practicing tailing material as shown in Fig.4.

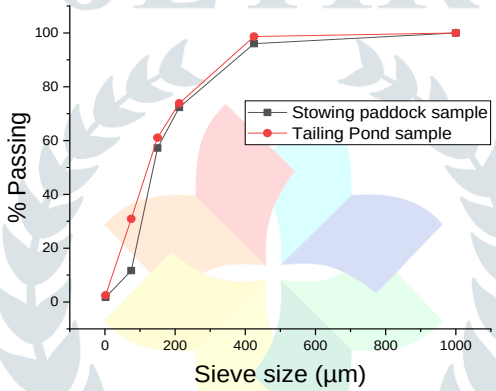

Fig 3 Grain size analysis of collected mill tailings

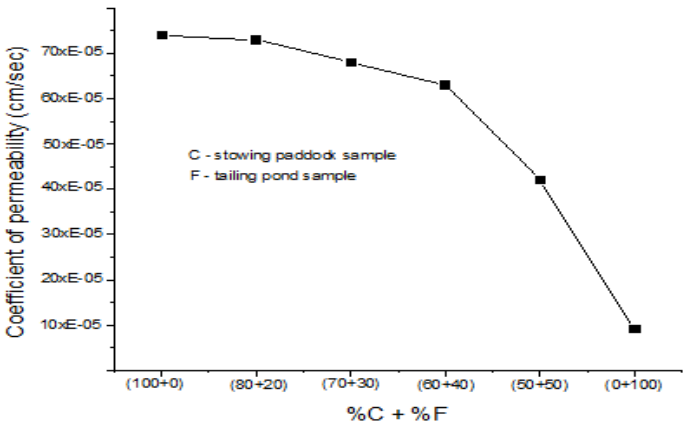

Fig 4 Hydraulic conductivity of different tailing mixtures

The compaction curves for different tailing mixture showing the variation of dry density with moisture content has been given in Fig.5. The optimum moisture content for different tailing mixtures are reduces with the addition of tailing fines as it reduces intermittent voids between the coarse particles and hence increases the maximum dry density. In the present work the cohesion and angle of friction of the mixture of coarser and finer tailings are determined by direct shear test by adding water of amount equal to their optimum moisture content and the direct shear test had been carried out after 24 hrs of moisture addition in order to get uniformly distributed moisture throughout the sample before the test. It has been noted from the shear test results that the

addition of moisture to the sample is the foremost influencing factor for increase in cohesion of the sample and reduction of angle of friction than that of addition of fines (Fig 6).

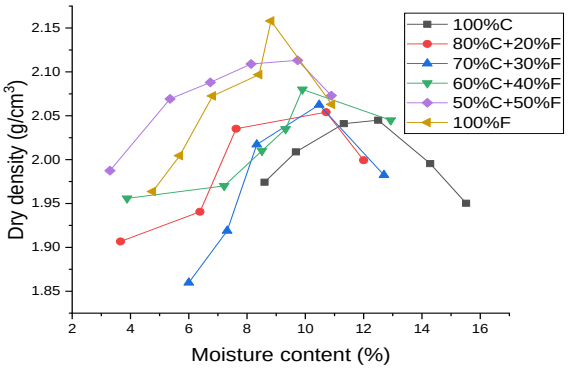

Fig 5 Compaction curves of tailing mixtures

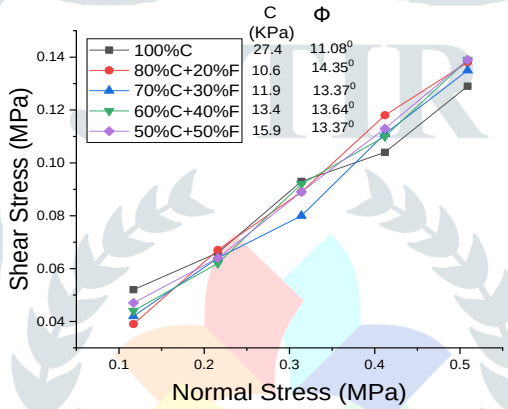

Fig 6 Direct shear test results of tailing mixtures

Conclusion

The objective of this study was to investigate the changes in the geotechnical properties of tailing mixture containing different proportion of rejected fines and comparing it with the properties of practiced backfill material. The presented results have shown that there is not very much variation in their geotechnical properties on increasing the proportion of fines with the practiced backfill material. Permeability of tailing containing fines does not reduces significantly on addition of fines but at the same the maximum dry density of tailing mixture increases with increasing percentage of tailing fines upgrading the settling behavior of hydraulic backfill. Thus it would be possible to utilize a proportion of rejected tailing fines with the coarser tailing.

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