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Design of non-woven geotextiles for coal refuse filtration

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ABSTRACT

This paper presents research findings on grain size distribution changes of coal refuse affecting the design of non-woven geotextiles used as filters in rock drains at coal waste impoundments. The research involved performing hydraulic conductivity tests on refuse – geotextile filters followed by grain size distribution tests. Data was evaluated for geotextile filter retention, permittivity, and clogging potential requirements as published by the U.S. Mine Safety and Health Administration's Second Edition, "Engineering and Design Manual Coal Refuse Disposal Facilities".

Key findings indicate that refuse particles undergo slaking and aggregation which change the initial grain size distribution. Grading envelopes were developed and indicate that particle size zones influence the geotextile design parameters for retention, filtration, and clogging. The clogging criteria do not appear to be easily satisfied by the typical ranges of coarse coal refuse, at pre- and post-compaction grain size, for compatibility with non-woven geotextiles having an AOS = 0.212 mm.

Conclusions impacting the specification and field installation of geotextiles include: i) post grain size distribution tests are suggested to be performed on specimens and at all compaction levels to observe changes in key indices of D_{85} and D_{15} for meeting retention and clogging criteria requirements; ii) the evaluation of the initial refuse stability indicate that at the low compaction energy conditions, which have mobile fines and high Cu values, are initially unstable with regards to their internal soil gradation; and iii) construction of geotextile wrapped drains is preferred to be made in pre-compacted refuse lifts. This condition is beneficial because the filter becomes more stable for retention and permeability; however clogging is still a concern.

1. Introduction

The coal mining industry, long the backbone of West Virginia's economy, produces refuse which is a reject material from run-of-mine coal supplied to preparation plants for cleaning. It is the first level of separated, non-combustible material rejected from the plant's cleaning circuit and is disposed of on-site in large, above-ground structures called refuse impoundments. The refuse material is used in the construction of the impoundment structure which provides storage for these materials as well as water that is continuously used by the coal preparation plant.

According to D'Appolonia (2009) all earth and coal refuse impoundment structures, to some extent, are pervious to water. When compared to general earth structures, coal impoundments are more pervious, as they are built of coarse and fine coal refuse materials. D'Appolonia (2009) reports that different types of drains and filters are used within, and under coal refuse embankments to control the internal groundwater seepage elevations at critical locations where internal erosion or unstable conditions may develop. The internal drains include geotextile wrapped rock drains.

The replacement of natural granular filters with geotextile materials in mining applications for filtration and barrier designs have been cited prior to 1980: van Zyl and Robertson (1980), Lawson (1982) and most recently by Palmeira et al. (2010). The reasons for using geotextiles for filter construction in mine tailings impoundments have not changed since the 1980's because geotextiles continue to be an economical application or a replacement option when granular material is not available.

The *Second Edition of the Engineering and Design Manual – Coal Refuse Disposal Facilities* was published in December 2009 by the U.S. Mine Safety and Health Administration, D'Appolonia (2009). MSHA permits the use of geotextiles as filters in coal impoundments only after engineering design and testing, with site-specific materials, are found acceptable.

This research follows the United States Congress's response to findings reported by the National Research Council's (NRC) study of the Martin County Coal Corporation impoundment accident

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