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Screening of Crushed Rock Material

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ABSTRACT

The quality requirements for sand, gravel and crushed rock material used on roads and railroads have been raised in recent years, hence suppliers must meet more rigorous demands. It is now necessary to improve the understanding of all parts of the production line. In this project, screens are studied, since they are used widely in the aggregate producing industry. The objective of the research is to develop a physical model that explains the behaviour of a crushed rock material bed on a screen. The model should make it possible to predict the capacity of the screen and the size distribution of both the passed and the remaining material, in order to optimize the screening process. The screen is assumed to have a wire cloth and a circular stroke: this is common at the last stage of the aggregate production process in which the final fractions are produced.

Two major processes occur during screening: *passage* of fine particles through the apertures and *stratification*. The stratification process probably includes both separation and mixing of particles of different sizes within the material bed on the screen surface. To take into account the size distribution, the material was divided into an arbitrary number of fractions. The properties of the particles within each fraction were assumed to be the same. To model the stratification process, the material bed was separated into multiple layers containing varying proportions of the assorted fractions. For the beginning of the screen, the simplification was made that the fractions were evenly distributed in the bed. The upward and downward flows of each fraction between layers were determined by continuity, the mass flow of a fraction within each layer and two stratification rate parameters. These parameters include the influences of both mixing and separation. The passage of material through the apertures in a screen cloth depends on the mass flow of each fraction close to the screen surface, in a contact layer, and on the passage rate parameters for the fractions. Constitutive relations for the stratification and passage rate parameters were obtained from experiments. The transport velocity of a single particle along a screen was determined by the laws of mechanics. In addition, Monte Carlo simulation was used to reproduce the interaction between the particles in the bed. The validity of the assumptions was confirmed by experiments. The mass flow of material between interacting screen planes was also modelled.

The model was implemented in a computer program, after which its validity was verified by a large number of full-scale tests. Thus, it is now possible to optimize a screening process, with respect to the percentage of over and undersized particles allowed, by varying the frequency, stroke, inclination, length, width and aperture size of the screen, as well as the feed rate, feed size distribution and number of interacting screen planes. If a set of simulations is made for a given screen, a *screening performance map* can be obtained which, in turn, can be used when optimizing a given screening task.

Keywords: aggregate, ballast, mixing, modelling, particle size, passage, rock material, screening, separation, stratification, transport velocity.

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Appended Papers

Paper A: Layer model of stratification during screening

Paper B: Determination of stratification and passage rate parameters for screening: Experiments with crushed rock material, Part I

Paper C: Interaction between screen planes: Extension of a screening model

Paper D: Transport velocity of a crushed rock material bed on a screen

Paper E: Determination of stratification and passage rate parameters for screening: Experiments with crushed rock material, Part II