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Estimated Economics of Operation Mobile Screens in Dry Screening Process Production of Final Aggregates for Hot-Mix Asphalt

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Abstract

The last important production step in hot-mix asphalt aggregates production is a final screening (classifying) of secondary or tertiary crushed materials, which has to ensure high quality screening curves of end-products in accordance with standards and this process should run in most valuable economic way. The data of the screening machines from different 5 top manufacturers in same machine class were analysed in accordance with output, screening efficiency and owning and operation costs. This paper demonstrates to quarry managers possible correct choose of mobile screens, which ensure high production outputs and quality requirements and saves operation costs.

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Keywords: mobile screening plants, screening efficiency, aggregates, hot-mix asphalt

1. Introduction

The mobile aggregates processing interlinked plants are worldwide widely used for the high quality products for hot-mix asphalt mixtures, concrete, railway sub-ballast and other end-products production. In recent last 20 years,

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Nomenclature

MW	screen mesh size
UD	screen upper deck
MD	screen middle deck
LD	screen lower deck
DS	screen mesh wire diameter

worldwide market share of the mobile plants has grown from approx. 20% to estimated approx. 60% in 2020. The most important criteria at this production for asphalt aggregates stage is a screening efficiency to ensure a gradation of the aggregates to meet the standards [15−17]. In technical requirements of aggregates used for the road construction there is specified that portion of oversize and undersize of each fraction for the hot-mix asphalt should not exceed more than 10% [13, 14]. Normally quarry managers seek to have 5–7% undersize as during loading, transportation and unloading of aggregates more fine particles are appearing. The gradation of an aggregate has a profound effect on the performance of hot-mix asphalt and concrete [1, 2, 6, 7]. Same applies to a railway sub-ballast [3]. Not only the proper selection of the screening media in screens gives the best results as size separation is never a perfect operation and a certain quantity of undersize material will generally end up in the oversize stream [4]. For the asphalt aggregates screening efficiency should be at least 95%. Screening efficiency is described as the comparison of the undersize material carried over the screening media and discharged with the oversize product in contrast to the input amount of undersize that was initially fed into the screen [5]. On the other hand the performance of hot-mix asphalt greatly depends upon the aggregate characteristics which are the result of aggregates production on plant [8]. Asphalt mixture design concepts are presented that use aggregate interlock and aggregate packing to develop an aggregate blend that meets volumetric criteria and provides adequate compaction characteristics [12]. End-product (and later hot-mix asphalt) price depends on the material quality, proper equipment purchase and operation cost. Mobile screens manufacturers are presenting machine data figures only for the maximum output of machines not giving any figures about the screening efficiency or output of required final products which are very important for the final hot-mix asphalt aggregates.

2. Investigation of the screening process

Lot of factors are involved in a screening process and required screen area A_{th}, m^2 is calculated according formula [5]:

$$A_{th} = \frac{S_f - S_o}{f_1 \times f_2 \times f_3 \times f_4 \times f_5 \times f_6 \times f_7 \times f_8 \times f_9}, \quad (1)$$

where S_f – screen feed, t/h; S_o – screen overflow, t/h; correction factors: f_1 – specific throughput performance of screen cloth, t/hm^2. Figures are based on bulk density of 1.6 t/m^3, screen inclination 20^o. All the screen mesh open area was calculated in consideration that for UD MW 12.5 mm DS 3.5 mm sieve, for MD MW 9.0 mm DS 3.0 mm and for LD MW 5.6 mm DS 2.2 mm sieves should be used. f_2 – oversize in feed factor which takes into account screen deck load with material (see Fig. 1);

$$f_2 = \frac{S_o}{S_f}, \quad (2)$$

f_3 – screening accuracy factor. Screening accuracy should be at least 95%. f_4 – half mesh size factor, which depends on percentage of grains smaller than half mesh size. All grains smaller than the half clear mesh size (MW) do not influence on sizing of the screening area. f_5 – wet screening factor. If process is dry this factor equals to 1. f_6 – shape