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Effect of shape and surface texture of aggregates during high intensity vertical shaft impact autogeneous crushing

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ABSTRACT The demand for quarry industry to produce high quality aggregates is increasing parallel with the demand of high strength concrete. Focus on the high quality aggregates production is very essential as 70% of the concrete consist of aggregates. High quality aggregate is characterised according to its shape, surface texture and its size distribution. The cubical and more equidimensional aggregates are characterised as high quality aggregates. Besides photomicrograph of aggregates, Flakiness and Elongation indices are important empirical measurements to determine the quality of the aggregates. The Barmac Rock On Rock Vertical Shaft Impactor proved that the shape of the aggregates can be improved by various crushing mechanisms as the EI and FI values were low and 75% of the cubical particles were observed in the crushed aggregates.

(Aggregates, Concrete, Surface texture)

INTRODUCTION

Wide range of aggregates products is available in the market for various purposes, ranging from low quality aggregates for fill and to high quality aggregates for concrete. Currently the aggregates industries or the quarry operators are more keen to produce high quality aggregates that are more cubical and equidimensional. High quality aggregates is sellable at higher price compare to the normal aggregates [1]. Improved shape and graded size distribution aggregates have been proven to be a major factor in the reduction water to cement ratio of concrete production. The high quality aggregates also enhance the compressive strength of the concrete [2]. The study of shape and the surface texture of the aggregates are very important as these improve the quality of the aggregates. This paper will focus on the shape and the surface texture of these aggregates.

MATERIAL AND METHODS

The sample used as feed material in this study was a granite sample (100% passing 20 mm) taken from a local granite quarry. Crushing work was carried out in a laboratory scale Rock On Rock Vertical Shaft Impactor crusher (Barmac model B3000 Duapactor) with maximum capacity of 20 tonnes per hour. The rotor speed of the crusher was varied to determine the shape improvement during crushing process. Flakiness index and elongation index were used to determine the shape improvement of the crushed coarse aggregates. The void content test was done to determine the shape improvement of the fine aggregates. The scanning electron microscope (SEM) model S2000 Cambridge, United Kingdom, with resolutions of 60 Å was used to determine the shape, surface texture and the size of the aggregates. Photographs of the features observed were taken at the magnification showing the clearest morphological characteristic.

RESULTS AND DISCUSSION

Figure 1 and 2 show the flaky and elongated particles in the feed samples fed into the Barmac crusher respectively. In this work improvement of particle shape would be referred to converting the poorly shaped particle into a cubical and more equidimensional particle to be used in concrete.

Analysis of crushed aggregates through electron microscope proved that poorly shaped particles (flaky and elongated) could be improved to a more cubical and equidimensional particles. Figure 3 shows the shape of the crushed products and the shaped of these product is more cubical and equidimensional. There was a significant improvement in the aggregates shape after crushing where more than 75% of the aggregates products exhibit better cubical or equidimensional shape compared to the feed samples.

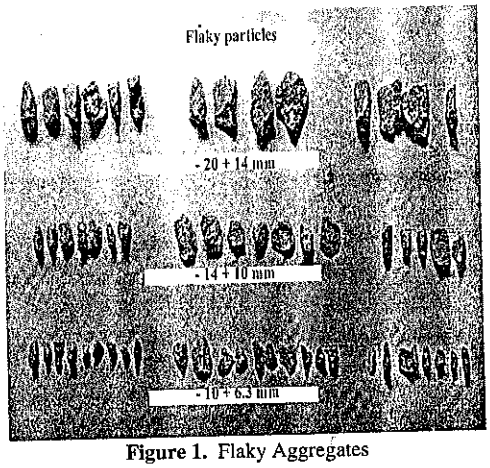

Figure 1. Flaky Aggregates

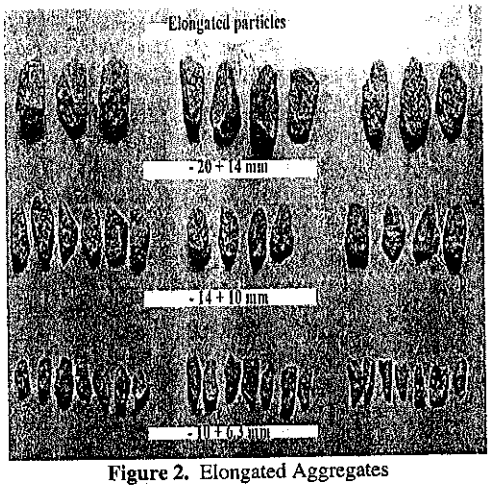

Figure 2. Elongated Aggregates

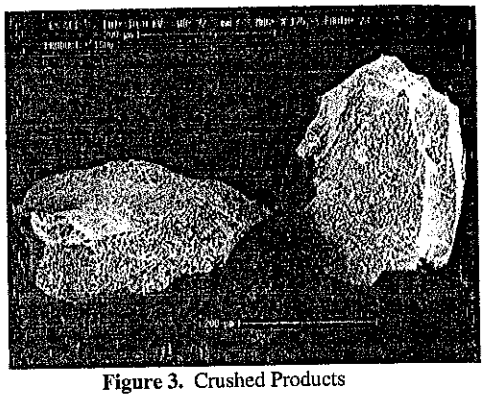

Figure 3. Crushed Products

This result was further proved by the flakiness and elongation indices. Figure 4 and 5 show the flakiness and elongation indices respectively for the various rotor speeds at different levels of feed rate. There is a large decrease in the flakiness and elongation indices for the crushed products. In Figure 4 and 5, the values of flakiness and elongation indices decrease as the rotor speed increase. The minimum value for the flakiness index and low elongation index occurred at a rotor speed at approximately 4496 rpm. The increase in the feed rate from 11 tonnes to 15 tonnes has brought significant increase in the flakiness index of the aggregates particles.

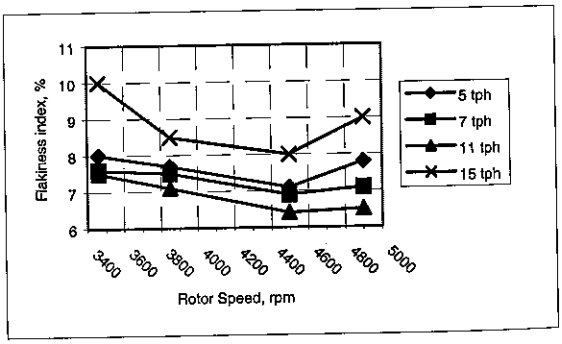

Figure 4. Flakiness index for various rotor speed at constant feed rate

The aggregates can be considered less flaky and less elongated if the flakiness and elongation indices are low. Lower values of these indices indicate the improvement of the shape of these particles that is more cubical and equidimensional.

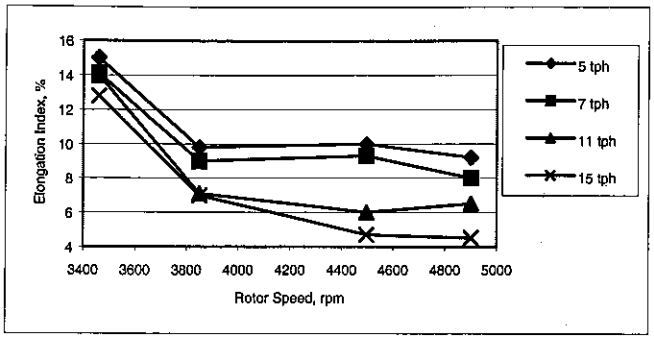

Figure 5. Elongation index for various rotor speed at different level of feed rate

The surface texture of the feed material and the crushed products were examined under SEM. Figure 6 and 7 show the surface texture of the feed material and the crushed products of the Barmac crusher. The surface texture of the feed material can be considered as being rough, irregular surface and contained many pits. The product however exhibited more uniform texture with most of the sharp edges being trimmed. As the feed material was subjected to various breakage mechanisms in the Barmac crusher, the particles were being reshaped and their surfaces being ground to a more uniform texture.

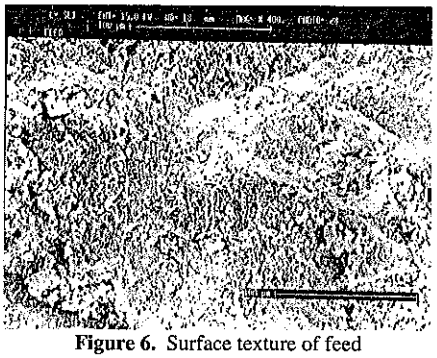

Figure 6. Surface texture of feed

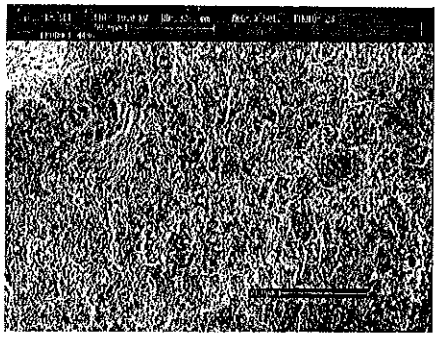

Figure 7. Surface texture of product.

CONCLUSION

The crushing mechanism in the Barmac RoR VSI can improve the aggregate particle shape and its surface texture. The SEM results and the EI and FI indices further prove the shape improvement as the values for the indices were low and 75% of the particles were observed to be cubical and equimensional particles.

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