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APPLICATIONS OF MODERN TOOLS IN AGRICULTURE

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MODELLING THE BREAKDOWN OF AGGREGATES IN THE WET-SIEVING METHOD

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INTRODUCTION

Aggregate stability of each size fraction is determined because the stability and properties of each size aggregates size fraction is different from one another. To determine the stability of each aggregate size fraction is to determine the proportion of water-stable aggregates of each size fraction (*i.e.*, 4.76 – 8.0 mm, 2.83 – 4.76 mm, 2.0 – 2.83 mm, 1.0 – 2.0 mm, 0.5 – 1.0 mm, 0.3 – 0.5 mm). This means that each aggregate size fraction has to be wet-sieved separately and the intact aggregates left on each sieve is weighed.

Wet-sieving method is a common method to measure aggregate stability. Unfortunately, this method is not effective in determining the aggregate stability of each aggregate size fraction. To wet-sieve separately involves tedious steps and energy as well as time consuming. Wet-sieving using the nested sieves is a sure alternative way to speed up this process due to the simultaneous sieving. However, the drawback will be the fact that intact aggregates of each aggregate size fraction (accept the aggregates in the uppermost sieve) will be mixed with the ruptured aggregates (breakdown from the larger aggregates) from the sieves above. Ruptured aggregates are fragments of the larger unstable aggregates.

Christopher *et al.* (1998) developed a mathematical equation to determine the aggregate stability of various aggregate size fractions but the equation needed calibration. Therefore, the objective of this study was to develop an improved equation to estimate the breakdown of individual aggregate size fractions in the wet-sieving method using nested sieves. The improved equation would be developed so that it would be more representative of the actual distribution of aggregate breakdown, hence more accurate.

THEORY

The key to develop this equation was the two assumptions made. During the development of this equation, it was assumed that the aggregates in each sieve breaks down simultaneously during wet-sieving and equal breakdown of aggregates in the same sieve. The breakdown of aggregates from various sieves is represented by:

$$b_{i,j} = \frac{-B - \sqrt{B^2 - 4AC}}{2A}$$

Three equations were developed in the improved model:

$$A = -\left\{ \sum_{k=1}^{i-2} 2^{k} \, Wa(i-k) \prod_{\substack{j=2 \\ j \neq i-k}} b_{i,j} \right\} - \left\{ 2^{i-1} \prod_{j=2}^{i=1} b_{1,j} \right\} \qquad (1)$$

$$B = \sum_{k=1}^{i-2} \left\{ 2^{k} \{ Wa(i-k) \prod_{\substack{j=2 \\ j \neq i-k}}^{i-1} b_{1,j} \} [D_1 - \sum_{\substack{j=2 \\ j \neq i-k}}^{i-1} b_{1,j}] \right\} - \prod_{j=2}^{i-1} b_{1,j}$$

$$[2^{i-1} \sum_{p=2}^{i-1} b_{1,p} + \sum_{k=1}^{i-1} 2^{i-1-k} Wa(k+1) - 2 \times D_1 + D_2] \quad (2)$$

$$C = Wai\ (D_1 - \sum_{j=2}^{i-1} b_{1,j}) \prod_{j=2}^{i-1} b_{1,j} \quad (3)$$

Whereby, Wai is the weight of each original aggregate in the sieve, *Di* and *Di*-1 are the weight of aggregates that has passed through sieve *i* and *i*-1 respectively and b *i, j* is the ruptured aggregates from sieve *i* and has settled in sieve *j*.

MATERIALS AND METHODS

The equation's accuracy was tested on several treatments of wet-sieving duration (t = 5, 15, 30, & 45 minutes) and sample pretreatment (air-dried and saturated). Six soil types, consisting of four soil series (Munchong series, Melaka series, Bungor series and Prang series) were taken at different land use. Sampling of topsoil and subsoil was done for each sample as well. For each soil, each aggregate size fraction was separately wet-sieved and data acquired was then combined to simulate data that would have been produced if each aggregate size fraction was sieved together in the same nested sieve.

RESULTS AND DISCUSSION

When the simulated aggregate breakdown was plotted against actual aggregate breakdown, all values fitted tightly along the y = x line with less than 10% average of error. There appeared to be no obvious difference among various wet-sieving duration and sample pretreatment. The improved mathematical equation was successful in estimating accurately the actual aggregate size fractions during wet-sieving using the nested sieves.

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