“Effects of Particle Interference in Mortars and Concretes”
by C. A. G. Weymouth, Consulting Engineer
Published in ROCK PRODUCTS magazine, February 25, 1933.

Treval Powers clarified Weymouth’s work in his text PROPERTIES OF FRESH CONCRETE with the following explanation:

“Although Weymouth was originally interested in concrete mixtures, and was concerned with the effect of particle interference on water requirement and workability, including the tendency of different-sized particles to segregate during handling, he illustrated his concept in terms of dry mixtures of aggregates, using the model shown in Fig 6.1. Fig. 6.1 “a” represents, in two dimensions, a mixture of two sizes of particles. The larger particles are few and are widely separated by the smaller particles; the average clear distance between is considerably greater than the diameter of the smaller particles. . . In diagram “b”, the relative number of the larger particles is greater, and the average distance between them is supposed to be just equal to the diameter of the smaller particles. According to Weymouth, for the composition represented by either diagram, the mixture can be stirred without changing the uniformity of the “void pockets” defined by the smaller particles.

Fig 6.1 – Weymouth’s Examples

“In Fig. 6.1 "c", the concentration of the larger particles is such that the average clearance between them is less than the diameter of the smaller particles, making it impossible for the interstitial spaces of the larger particles to be filled uniformly with the smaller. Weymouth said that when such a one-layer mixture on a tray is stirred, there is a tendency for the two sizes to run into separate groups, each of its own kind; in other words, stirring such a mixture tends to produce segregation of the two sizes. To apply this observation to a deep mass, he visualized a given size group as forming a sort of grid structure through which the smaller particles move both horizontally and vertically during manipulation of the mixture; so long as they can move freely, the mass remains homogeneous, but if the larger particles interfere with the movement of the smaller, segregation occurs, and large void pockets are developed “with a great loss of strength and workability.”

Edmund Shaw, Editor of ROCK PRODUCTS wrote in an introduction to Weymouth’s paper:

“With so many factors to take into consideration, it seems simpler to him to examine gradings of commercial aggregates and correct them by the addition of those sizes in which gradings appear to be deficient.”

Shaw’s recommendations were included in ASTM C33-93 and been expanded since with the addition of new sizes.