

The measurement of the workability of dry concrete mixes*

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I was very interested to note Dr Cusens's conclusion that "leaner mixes require appreciably more applied work for consolidation than richer mixes of the same compacting factor", so that it "appears that the compacting factor gives an unrealistic figure for the workability of dry mixes requiring vibration". Dr Cusens therefore recommends the Vebe principle as a more generally applicable method. I have inclined to this view for some time but have had little factual evidence other than the rather approximate guide given by the time required for compacting the concrete in a cube mould. The Vebe test would appear to measure the properties of concrete under vibration rather than under the somewhat arbitrary condition of the compacting factor test and also avoids the inaccuracy caused by the tendency for certain concrete mixes to stick in one or both of the hoppers.

I feel, however, that the Vebe test is also liable to error caused by the determination of the "end point" at which the glass plate is completely covered with concrete and all cavities in the surface have disappeared, particularly when different operators are concerned in the testing of dry mixes. The simple modification shown in Figure A was therefore devised to record the movement of the glass plate during the period of vibration. As will be seen, the sliding rod is connected by means of a thin wire over pulleys to a pen recording on graph paper fixed to a drum which is rotated by a standard display turntable. The speed of revolution is easily adjusted to give a convenient scale (e.g. 1 inch represents 2 seconds) on the graph paper. The electrical connexions are arranged so that both the turntable and the vibrating table are switched off together at the end of the test although each may be operated independently if desired. Hence it is possible to obtain from the graph an accurate indication of the Vebe time.

It was assumed that the trace produced by the pen during vibration would correspond to an equation of the form

$$y = A - Be^{-Ct}$$

(Figure B) indicating the velocity of the glass plate to be proportional to its distance from its ultimate position. This function can be reduced to a linear relation by plotting the logarithm of $(A - y)$ against the time of vibration, t .

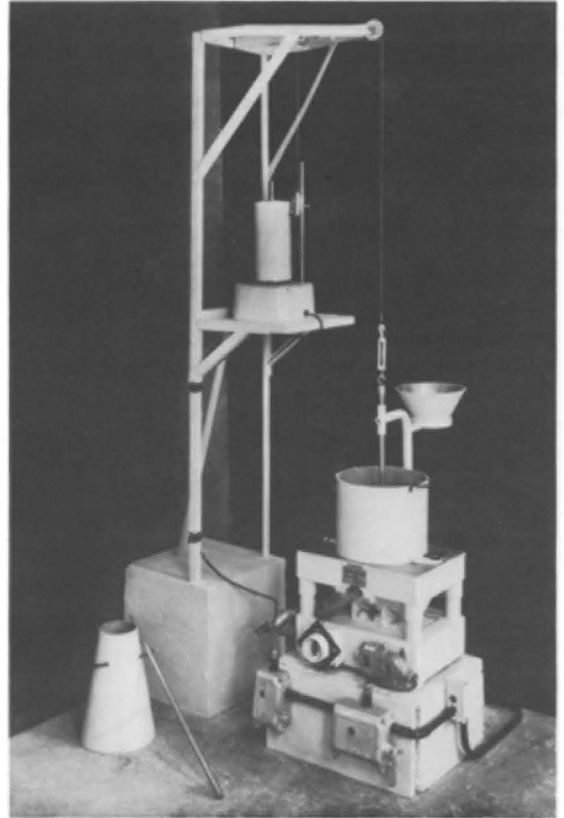


Figure A: Vebe apparatus with modification.

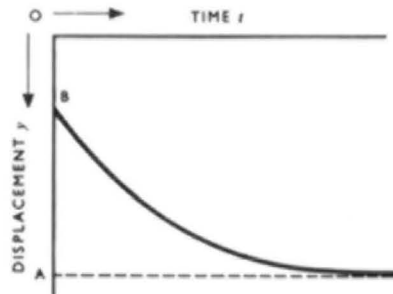


Figure B: Graph of $y = A - Be^{-Ct}$

*Pages 23-30.

Discussion

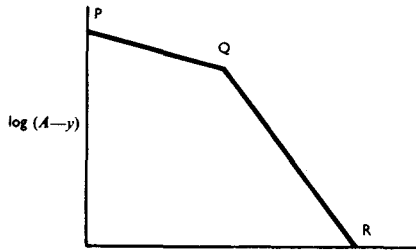


Figure C: Relation between $\log (A - y)$ and t for normal concrete mixes.

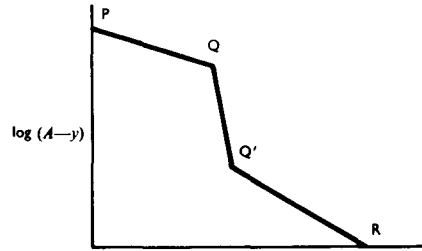


Figure D: Relation between $\log (A - y)$ and t for drier and leaner mixes.

Preliminary results, however, indicate that, in general, the relation consists of two straight lines (Figure C), the line QR apparently corresponding to the compaction of the concrete and the line PQ to compaction and the change in shape of the concrete from a truncated cone to a cylinder.

For concrete of high workability, which slumps appreciably after placing the glass plate in position, i.e. $(A - y)$ is low when $t = 0$, there is little further change in shape under vibration and the portion PQ tends to disappear. With drier and leaner mixes there appears to be a period of disintegration as indicated by the very steep line QQ' (Figure D) when the glass plate falls very rapidly owing to the absence of sufficient cohesion in the concrete; in very lean mixes the line PQ may be very short.

This modification to the standard Vebe apparatus gives a graph of the compaction of the concrete which is proving to be of considerable value in investigating the behaviour of concrete during vibration. It would appear that this method gives a more reliable measure

of the workability of dry mixes since it eliminates any error due to different operators judging the "end point" of the test.

Reply by the author

Bearing in mind the considerable experience that the research staff of the Cement and Concrete Association have had in the use of the compacting factor test I am glad to have Mr Erntroy's confirmation of my main conclusions.

His method of determining the "end point" of the Vebe test provides a useful extension of the test for accurate work. The form of Figures C and D also provides an explanation of the results of some tests of my own made at two frequencies of vibration with a modified Vebe apparatus. These will be given in more detail elsewhere.

On site, and more particularly in the factory, the normal Vebe test should give results of sufficient accuracy and deserves wider recognition.