SOME FALLACIES IN CEMENT TESTING.

A DANGER that invades the testing of cement, in that it frequently leads to numerous unfounded complaints and disputes as to its quality, is the judgment expressed from results obtained by an inexperienced operator in carrying out such tests. These operations are no longer exclusively confined to the laboratory of the expert as they once were, and almost every user of cement in any considerable quantity either carries his own tests on the material, or delegates the work to one of his staff. W. L. Gadd, F.I.C., M.C.I., read a very interesting paper at a meeting of the Concrete Institute of Great Britain on December 11th, 1913. Although the address did not enlarge materially upon the recognition of cement testing as a highly specialized work requiring a skilful and extended knowledge of the properties and characteristics of the material, it was clearly pointed out that several fallacies appeared to underlie some of the recognized or suggested processes of testing. The author observed, at the same time, that the accuracy of the testing was necessarily so pronounced that the mere following of instructions given in a booklet or a specification would not suffice.

In the main, the paper dealt with the fallacies mentioned above, and the points in the British standard specifications which appeared open to criticism. The portion of his paper dealing with this phase of the subject is reproduced as follows:—

The standard specification stipulates that before any sample of cement is submitted to certain tests it "shall be spread out for a depth of 3 in. for twenty-four hours in a temperature of from 58 deg. to 64 deg. Fahr."

The object of this procedure appears to be twofold—i.e., (*a*) to cool the cement to the normal temperature of the atmosphere, and (*b*) to obtain conditions similar to those governing cement which has lain in sacks or casks for two or three weeks—i.e., during the possible period between shipment and use.

As regards (*a*), this can be very simply done without exposing the sample to air; as regards (*b*), the author has made experiments which show that there is no relation between the effects of aërating cement for twenty-four hours and storing in sacks for two weeks or a month; further, that the setting time is differently affected when the same cement is aërated or stored in bulk in different localities or at different periods. In some cases the effect of twenty-four hours' aëration is the opposite to that produced by storage, and storage or aëration at one period has an opposite effect to storage or aëration at another period. For instance, one sample aërated for twenty-four hours at the beginning of the month of July resulted in a quickening of both initial and final sets, whereas the same sample aërated for twenty-four hours in the same room a fortnight later resulted in the exactly opposite effect on setting time.

This appears to effectively dispose of the somewhat prevalent idea that changes in setting time are due to some inherent property of different cements. The erratic behavior found is common to all the samples tested, the composition of which varied within considerable limits, the lime contents, for instance, ranging from 64 to 59 per cent.

The retardation or acceleration of setting time on storage or aëration cannot, therefore, be due to peculiarities in the cements themselves, but must be due to chemical changes brought about by the absorption of some constituent present in the atmosphere.

Cement has a strong affinity for moisture in the first place, and for carbonic anhydride in the second place, and these constituents are present in the atmosphere in variable proportions at different times and in different localities.

From former experiments and reasoning I have held the opinion that absorption of moisture results in a retardation of setting time, while absorption of carbonic anhydride produces an accelerating effect. Cement exposed to both influences will therefore have its settling characteristics affected one way or the other according to the relative amounts of moisture and carbonic anhydride absorbed, the net effect being the resultant of the two opposing forces.

In order to test this theory I have made the following laboratory experiments, where the conditions can be under control and standardized, which is rarely possible in so-called "practical" tests.

A quantity of slow-setting cement (600 grammes) was placed in a large glass tube, which it half filled, and a current of purified air, freed from ammonia, carbonic anhydride and moisture, passed over it continuously for twenty-four hours. The total volume of air passed through the apparatus was about 173 litres.

The air was purified by being bubbled through dilute sulphuric acid (which served to measure the rate of flow as well as to remove any ammonia vapors), then drawn through a soda-lime tower to remove carbonic anhydride, and finally through a large calcium chloride U-tube to remove every trace of moisture. U-tubes of calcium chloride and of soda-lime were also attached to the exit end of the cement tube and between this tube and the pump.

The loss constituents and the setting time were determined both before and after the treatment. Further quantities from the same sack of cement were then treated in a similar manner to a current of moist air, freed from carbonic anhydride and of carbonic anhydride itself respectively, and examined in the same way. The results indicate that pure, dry air has no effect upon the setting time of cement, the loss constituents remaining practically constant.

On the other hand, the effect of moist air freed from carbonic anhydride is distinctly marked, although the percentage of moisture absorbed is comparatively small.

This is probably due to the fact that the cement taken for the experiment was already high in loss constituents, the total loss on ignition being 2.39 per cent.

The acceleration of setting time by absorption of carbonic anhydride is clearly proved.

Fineness.—The British standard specification stipulates that the fineness of grinding shall be such that not more than a certain percentage of residue shall remain upon a sieve of a stipulated mesh, under the conditions of the test. It is obvious that the most important point in this connection is to ensure that the sieves used shall be of standard and definite dimensions, and this is provided for by the following clause:

"The sieves shall be prepared from standard wire, and the diameter of the wire for the 5776 mesh shall be .0044 in. and for the 32400 mesh .002 in. The wire cloth shall be woven (not twilled), the cloth being carefully mounted on the frames without distortion."

The standard specification, therefore, stipulates that for the first-named sieve there shall be 76 warp and 76 weft wires of a definite diameter; and for the second sieve 180 warp and 180 weft wires of a definite diameter per square inch.