Later tests seem to indicate that the gradation of the sand, which is made of great importance in the surface area theory, is of less consequence than has generally been supposed, although it is a factor which cannot be disregarded.

The criticisms which Prof. Abrams has made of the gradings of the aggregates used in recent Bureau of Standards tests were fully answered in the August 14th, 1918, issue of "Engineering News-Record." With reference to the aggregates which were included in Table 4, and which were made up similar to those of Table 2, Lewis Institute Bulletin No. 1, the following statement was made:—

"The aggregates used in the concretes of Table 4 are criticized as being too coarse, probably on account of the low strength results obtained in some cases with the constant water-cement ratio. These low strengths are not due to coarseness but to adherence to the Abrams water formula, which provides too much mixing water for coarse aggregates, resulting in concretes having unequal flows which are not comparable. It should be noted that these so-called poor aggregates 2, 3, 7 and 8, when tested with flows constant, showed good strength increases, which indicated them to be the best aggregates in the group. It would seem that any standard of coarseness which would rule out such aggregates must be seriously in error.

"Aggregates 7 and 8 are criticized as being decidedly freakish, in that all material is contained on the 28 or 48-mesh sieves. This same criticism can equally well be made of the Abrams' aggregates 271 and 276, Table 2, Lewis Institute Bulletin No. 1. However, tests show that all of these aggregates are satisfactory from the standpoint of workability and compressive strength, when proper account is taken of flowability."

It seems clear to me that no tests, other than those reported by the proponents themselves, are required to disprove the theories. Mr. Young's discussion is based upon the assumption that the test data offered by both are correct and fully represent the true values which should be found for the aggregates employed. He disregards the basic requirement of equal consistencies, which is accepted by both proponents but apparently employed by neither in obtaining the test data used to support their respective theories.

I have attempted in the foregoing discussion to point out what seems to be the fundamental error, both in testing and in interpreting the results of the tests reported. Whatever further tests along such lines may show, the test data so far presented seem to discredit both theories.

However, a few tests, made by those who are interested in the subject of proportioning concrete, will do more to settle the points involved than any amount of discussion.

Since the first and main criticism of these theories deals with the question of consistency or flowability, it should be an easy matter for any laboratory equipped with sand sieves to screen and regrade an aggregate to correspond with the gradings used by the advocates of these theories in their work. Reproduction of a few of the mortars and concretes used by each should furnish test data to conclusively affirm or deny their claims.

"Hydro's" Reply to Bureau of Standards' Criticisms

Mr. Williams' Contentions Said to Hinge on Question of Consistency--"Hydro's" Laboratory and Field Experiences Contrary to His Conclusions

By RODERICK B. YOUNG

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MR. WILLIAMS' contentions in the above article hinge on the question of consistency, and here the issue he raises is one of fact. He claims that because he was unable to duplicate the results reported by Messrs. Abrams and Edwards, that their results could not have been as stated. Our opinions are based on the assumption that the test data offered by these gentlemen were correct, and on the supporting evidence of some thousands of tests along similar lines made in our own laboratories. These experimental studies do not support Mr. Williams' contentions, but agree in the main with the results obtained by Messrs. Abrams and Edwards.

Our field experience has also been contrary to Mr. Williams' conclusions. We are obtaining concretes of the required strength by proportioning their mixtures to obtain the water-cement ratio previously established by test as corresponding to that compressive strength for the materials being used.

We are obtaining mixtures of uniform mobility by proportioning the cement and water according to the surface area of the aggregates after establishing the relation between these for the desired consistency.

With this method we are getting concrete mixtures of the consistency we are after; we are getting these consistencies continuously in spite of the variations encountered in the gradation of the agregates; we are getting from these mixtures concretes of the expected strength (as has been repeatedly proven by our field tests); and we are getting these results with less cement than would have been necessary had we followed the usual methods.

We believe that it is possible—in fact, probable—that the theories under discussion do not hold for extreme conditions, such as dry concretes, freak gradings and mixtures, etc. Evidence in hand seems to show that they are true only within well-defined limits, but our experience is that these limits cover the range of consistencies and materials ordinarily encountered in good practice. To most of us engaged in actual concrete construction this is the important feature; what happens outside these limits is only of academic interest.

It is not my intention to discuss in any detail Mr. Williams remarks, but I would like to ask him one question: What has fineness modulus or surface area got to do with differences in locality?

Both fineness modulus and surface area are functions of the grading, and the same grading, if encountered in any number of localities, would have the same value for fineness modulus and surface area.

Mr. Williams has but to plot the fineness modulus of the first fifty sands of Table 1 of the Bureau of Standards' Technologic Paper No. 58 against their surface area, and he will obtain a chart similar to Figs. 1, 2, and 3 of my paper. These fifty sands represent materials from 21 states, scattered from Massachussetts to California on the one hand, and from Minnisota to Texas on the other,—a sufficient range of locality to satisfy the most critical.

We do not consider Technologic Paper No. 58 as good evidence against these theories. The results from which my Fig. 7 was taken, represent the only series which we were able to find in this paper in which the range of proportions used were confined within practical limits and in which there were a sufficient number of mixtures of similar aggregates comparable on the basis of workability, from which to plot a curve. It was interesting to us, and we thought to others, that in this case their results were similar to those being obtained by Prof. Abrams and ourselves.

Figs. 1 and 2 of Mr. Williams' discussion can possibly be explained from the fact that all manner of aggregates of widely different mineralogical composition and structural value were used in these tests. Fig. 2 also includes a large number of rather impractical concrete mixtures, such as 1:1:5 and 1:2:7. Under such conditions it is our experience that concordant results are not to be expected.