in which the consistencies were determined by the "eye" and "feel" of an experienced operator, it was later found that as much as 25% more mixing water should have been used with certain of the aggregates to result in the same consistencies for the whole group. In the case of a group of mortar mixtures which the operator intended to have the same consistency, even greater discrepancies in the quantities of mixing water actually needed were found. These are not extreme or unusual cases but are representative of errors which are certain to occur in laboratory practice until some method is obtained for properly measuring consistency.

At present the only definite figure which has any bearing on consistency is the quantity of mixing water, usually expressed as a percentage based on the total weight of the mix, or upon the cement content alone, but such a figure is of little value in itself because of the wide variations in water requirements due to great variations in surface areas or number of particles in a unit volume of different aggregates.

Occasional Strength Tests Desirable

The cylinder slump test has been proposed as a means of measuring and controlling the consistency. However, tests have shown that while this apparatus has some merit when working with very rich mixtures, or for controlling the consistency of the same proportions of the same aggregates, it often gives very erratic and misleading results when with aggregates of widely varying granular composition which are met with in the laboratory. The range of water content which can be accurately measured under ideal conditions is rather narrow, and when carefully used with the same aggregate has resulted in such absurdities as a 1:2½:5 concrete being stronger than a 1:2:4: proportion.

Lack of means for accurately recording and expressing consistencies of mixtures has made it difficult to make real progress in studies of concrete aggregates. Results show that the same operator cannot duplicate the same consistencies with any degree of accuracy, and the task of comparing the results obtained in two different laboratories, when working with different aggregates, is almost hopeless, since the figures for per cent. of making water mean little under such conditions. Were it possible to assign some accurate and definite values to this most important property, the results obtained in different laboratories would be comparable after taking into account the physical properties of the cements used. Such a scheme would be of very great value to the field engineer, since the laboratory, in testing any aggregate for field use, could state the range of strength values which might be expected for different consistencies of the same proportion. Determination of the consistencies from time to time on the job would then permit of close estimates of the ultimate strengths which might be expected for that particular lot of concrete. Occasional strength tests would permit any slight adjustments to be made in the range of strength values used in case the field concrete values should differ greatly from the laboratory tests, due to curing conditions,

No Common Basis for Comparison

Due to the present lack of means for measuring and controlling consistency, and the apparent failure to recognize its importance in connection with laboratory tests of concrete, the test data obtained in the many different laboratories must in most cases remain as small and isolated groups of tests, none of which bears any definite and known relation to those of another laboratory, since there is no common basis for comparison.

Consideration of the above methods and lack of methods in the laboratory can only lead to the conclusion that the field engineer and contractor is often justified in giving scanty attention to the results of laboratory tests and recommendations. There is no doubt that the causes for such a condition can be eliminated by devoting more attention in the laboratory to the conditions under which the concrete materials must be used in the field. A full appreciation of the limitations and requirements of the process of producing and placing concrete "on the job" will do much to eliminate "laboratory specifications" for concrete, which so often result in confusion and expense before their impracticability can be impressed upon the engineer who is responsible for their enforcement. The assistance which the laboratory should render to the practical user of concrete is great, and should result in bettering the quality of field concrete and the methods which are used in producing it, but such tests and recommendations which will assist in bringing about such improvements must result from the application of proper laboratory methods which take into account the conditions met with in practice.

DEVELOPMENT OF RAILWAYS

D. O. LEWIS, District Engineer, Canadian National Railways, recently read a paper to the members of the Victoria branch of the Engineering Institute of Canada on "The Development of Railways."

The speaker traced the progress of locomotion from the days of the horse-hauled wagons of the collieries of England and Scotland in 1693, to the first steam propelled vehicles of Watts, Coulau, Murdock and Stevenson between 1770 and 1823.

Some of these early models of steam locomotives in use for coal transportation were in use for over fifty years, said Mr. Lewis, and grew out of the horse-hauled cars on rails. The horse-drawn wagons were unique in some respects, the train running on its edge or plate railed track, and when the train came to a down grade it started to move of its own weight, the horses were slipped and jumped on to a low flat car behind, riding in state behind the train until the next level, where the horses got out and worked again.

The growth of steam traction was clearly elaborated by the speaker, who told of the skepticism of the people of the country, and the laughter of the members of Parliament, when the locomotive builders suggested that they would build locomotives to haul many tons at speeds of twelve to fifteen miles per hour. For a long time the railways were restricted by law to eight and nine miles an hour.

The development of the modern rails from wooden affairs with metal tops and flanges was traced, and the gradual adoption of metal wheels with flanges. Sleepers or ties were of stone in those days, he continued.

The paper was followed with interest by all, and admirably illustrated by lantern slides depicting the earlier models of locomotive traction. In 1825 the first official demonstration of a real locomotive hauling a string of wagons with passengers and freight was made, and on this occasion a man on horseback rode ahead with a flag to signal the approach of the train.

Stevenson, who was running the locomotive, got tired of the progress at six miles an hour, and signalled the rider out of the way. It is recorded that the train attained twelve and even fifteen miles an hour in places, and the demonstration was concluded with some 600 people hanging on to all the available space on board.

ACKNOWLEDGMENT OF TEST DATA

IN the article, "Present Status of Reinforced Concrete Design," by F. G. Engholm, which appeared in last week's issue of *The Canadian Engineer*, there were some results of tests made by the Emergency Fleet Corporation and the U.S. Bureau of Standards. We regret that in presenting this article, acknowledgment to W. A. Slater and A. R. Lord was overlooked. These gentlemen, who were the engineers in charge of the tests for the Emergency Fleet Corporation and the U.S. Bureau of Standards, kindly furnished Mr. Engholm with the test data and also with the photographs showing beams after test.

The sixteenth annual meeting of the American Wood Preservers' Association will be held at Hotel Sherman, Chicago, Ill., February 10th, 11th and 12th.