

**LABORATORY MANUAL OF
BITUMINOUS MATERIALS
FOR THE USE OF STUDENTS
IN HIGHWAY ENGINEERING**

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Laboratory manual of bituminous materials for the use of students in highway engineering by
Prévost Hubbard

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STUDENTS IN HIGHWAY ENGINEERING

BY
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PREFACE

DURING the past five years a number of our leading universities have inaugurated courses in highway engineering in which laboratory instruction is given in the testing of bituminous materials. A general tendency appears to exist upon the part of many other educational institutions to develop the same line of activity because of the desire of highway engineers throughout the country to familiarize themselves with these materials.

While numerous technical and scientific papers have been published upon this subject in more or less detail, no attempt has as yet been made to furnish the student in highway engineering with a complete laboratory manual. As the result of his experience since 1912 in laboratory instruction in bituminous materials given in the Graduate Course in Highway Engineering at Columbia University, the author has endeavored to prepare a manual which may perhaps fill a want both upon the part of instructors and students and also those highway engineers in charge of State, county, or municipal work who have, or expect to have, a laboratory at their disposal. The author fully realizes that no first attempt along this line is apt to meet the many-sided demand, and will welcome criticisms and suggestions from those who are sufficiently interested to make them.

In the preparation of this manual no attempt has been made to trace down the obscure origin of many methods of testing which are described. The author has, however, endeavored to give credit in all cases where the originator is known, and if by chance any are unintentionally slighted, he takes this occasion to offer his sincere apologies. Many of the methods described are taken practically verbatim from U. S. Department of Agriculture Bulletin No. 314, by Hubbard and Reeve. Other publications which have been drawn upon for

original descriptions are "The Modern Asphalt Pavement," by Clifford Richardson; "Methods for Testing Coal Tars and Refined Tars and Oils and Pitches Derived Therefrom," by S. R. Church, and The Proceedings of The American Society for Testing Materials, and The American Society of Civil Engineers. For many helpful suggestions relative to the arrangement and development of the subject-matter of this book the author wishes to express his indebtedness to Professor Arthur H. Blanchard.

PRÉVOST HUBBARD.

WASHINGTON, D. C.

July 15, 1916.

INTRODUCTION

THIS manual is primarily intended as a laboratory guide for the student of highway engineering and not as a treatise upon methods of analyses and tests of bituminous materials. Its object is to describe methods in sufficient detail to enable the student to perform the more common and widely used tests with a reasonable degree of accuracy, provided his work is carefully conducted and he is supplied with the necessary laboratory equipment. Certain tests not in general use have been entirely eliminated from consideration, while others which have been included, together with those of minor importance, are shown in fine print to separate them from the more common and more important methods.

The arrangement of subject-matter in the following pages is designed to develop not only the abstract technique of the bituminous material laboratory, but also to deal with the interpretation of results of tests in connection with the identification, suitability for specific purposes, and control of uniformity of materials tested. The treatment is intended to be as brief as lucidity permits. Certain fundamentals not strictly a part of laboratory work have, however, been included in Part I for a guide to students not well versed in the nomenclature, classification, and uses of bituminous materials.

In the matter of interpreting the results of tests it should be realized that it is impossible to take into account all conceivable combinations of conditions. Moreover, our knowledge of the subject is yet far from being perfect, and many conflicting ideas are held by different highway engineers and chemists regarding certain matters. To some extent, therefore, interpretation of test results should be considered as opinions based upon personal observations at the time such opinions are expressed. As new facts are developed and observations are

extended, these opinions become subject to modification or entire change. If the matter is viewed in this light it becomes apparent that at the present time any dissertation upon interpretation of results should be considered more as a guide than as a collection of definite rules or laws which are not subject to modification.

There are a number of important considerations which have to be reckoned as variables affecting conclusions drawn from a comparison of laboratory tests with service results. The first of these is variations in test results from different laboratories, due to lack of standardization of methods, and also to careless operation. Too careful attention cannot be paid to even the apparently minor details of a method if consistent results are to be expected. The second point is, what constitutes satisfactory service results? That which is quite satisfactory to one engineer in view of past experiences may prove far from satisfactory to another of a more exacting nature. It is of course highly desirable to approach the ideal as nearly as possible, but in attempting this the question of what is practical under ordinary conditions must not be disregarded.

Quite frequently unsatisfactory service results are obtained from the improper or careless use of first-class materials. In such cases, unless the true cause of failure is plainly apparent, there is a natural tendency to place the blame upon the character of the material used. This is apt to lead to much confusion in interpreting the results of laboratory tests.

In the case of bituminous highways it should be remembered that the bituminous material constitutes but a relatively small proportion of the road structure, and that failure is quite as likely to be due to the use of inferior products other than the bituminous material. The quality of such materials as broken stone, gravel, sand, filler, wood, etc., is of as much importance from the standpoint of success or failure as of the bitumen. Moreover, some types and grades of bituminous materials which will prove satisfactory with one type of aggregate will not prove as satisfactory with another type of an apparently equivalent grading.

Another frequent cause of unsatisfactory service results is faulty construction. Thus, poor drainage may cause rapid disintegration and failure of a carefully constructed wearing course laid with good material. A rough, uneven, or poorly compacted foundation will almost invariably produce an unsatisfactory surface. Last but not least, the selection of the wrong type of pavement to meet existing traffic and other local conditions may result in failure through no inherent fault of the materials themselves except that they were not of the proper grade or character to meet the given conditions.

The laboratory may be made a valuable asset in highway engineering, but unless the engineer understands the principles involved in the analyses of bituminous materials and thoroughly appreciates the necessity of correlating test values with service results, it may prove to be a handicap, particularly in the matter of formulating specifications. There should be close cooperation and frequent interchange of ideas between the highway engineer and the testing engineer or chemist if the maximum value of the laboratory is to be developed.