INVESTIGATIONS OF ASPHALTIC PAVING MIXTURES RELATIVE TO DEFORMATION OF SURFACES UNDER TRAFFIC

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During the past year the subject of bituminous mixtures and the effect of varying composition, particularly as to percentage of asphalt and filler, kind of filler, and sand grading, have been intensively studied by a number of investigators The degree of compression and influence of voids in the compressed pavement have also received considerable attention A number of valuable contributions to our knowledge of bituminous mixtures have been presented at conferences and meetings of societies, and continued interest in this important subject is evidenced by the papers presented, references to which are appended to this report

METHODS OF TESTING

The development of a suitable test or combination of tests which can be interpreted to indicate the probable behavior of bituminous mixtures under traffic, reported last year as the first phase in the study of mixtures, seems well under way, and a great deal of data have been published as obtained with these tests Hubbard and Field (9)[1] have outlined a number of proposed tests in a recent paper Among these are the penetration tests of MacNaughton (1) and Howe in which the depth of penetration of a rod or ball into a cylindrical specimen is determined The U. S Bureau of Public Roads (6) and Pennsylvania State Highway Department have utilized a test in which a load is applied to a cylindrical specimen, and the decrease in height is measured. Both static and impact conditions have been studied at constant temperatures.

Varieties of shear tests have been used by Skidmore, Emmons, and Anderton (7) and Hubbard and Field (8) In the first, the maximum load required to shear the free section of a specimen is taken as indicating the resistance to displacement Emmons and Anderton have described a shear test in which a load applied at the top of a rectangular block confined in a mold forces a portion of the specimen through three rectangular openings at the bottom and sides of the mold Hubbard and Field have developed a test made with a cylindrical specimen, in which stability is measured by the maximum load required to force the mixture through a circular orifice in the bottom of the mold confining the specimen. In these tests an increasing load is applied at the top of the specimen, maintained at a constant elevated temperature

It is not possible as yet to evaluate these tests since the correlation

[1] Numbers refer to list of references on pages 176 and 177

of values obtained with them, and behavior of corresponding mixtures in service has just begun It is quite likely that improvements in technique of testing will be found necessary and that other tests showing related characteristics of aggregate, filler and bitumen may have to be employed before we will be in a position to secure reliable data differentiating between mixtures of varied composition and conduct studies of bituminous pavements with laboratory tests leading to definite and accepted conclusions

TEST DATA ON MIXTURES

Thus far, however, investigators have studied several variables in composition and degree of compression, and drawn tentative conclusions on the data obtained Hubbard and Field on the basis of tests with several graded sands and variations of filler, utilizing castor oil and asphalt in the mixture, give as a summary of their earlier work the following indications (9)

"1 A sand of supposedly inferior grading and showing a relatively low stability value alone or combined with a small percentage of mineral filler may, when combined with a larger percentage of filler, develop a higher stability value than a sand of supposedly better grading combined with the same percentage of filler Thus alone, or with a small percentage of filler, the commonly accepted ideal light traffic sand developed less stability than the ideal heavy traffic sand, but when over 12 per cent of a commercial limestone filler was added to both, the light traffic sand gave higher stability values than the heavy traffic sand

"2 Stability values obtained from a number of sands of widely varying mesh composition mixed with 15 per cent or more of commercial limestone filler strongly indicate that our present specification limits for grading of sheet asphalt sands, while safe, are unnecessarily restrictive and that many sands which are now eliminated from use may be made to produce good stable paving mixtures

"3 The general trend of test results obtained upon mineral aggregates mixed with castor oil are confirmed with mixtures of the same mineral aggregates with asphalt cement This is important because in any study of the effect of variations in grading of mineral aggregate the castor oil mixtures may be much more quickly prepared and tested than the asphalt mixtures and are free from a number of important variable factors which are introduced by the presence of asphalt cement"

Quoting from Hubbard and Field, later work with three commercial fillers, limestone dust, Portland cement, and hydrated lime, indicated the following (9)

"1 Extreme fineness (that is, the presence of material passing the 350-mesh sieve), of at least a portion of the commercial filler is the most

important property tending to produce high stabilizing values in the total mineral aggregate

"2 Gradation of size particles in the mineral filler tending to reduce the percentage and size of voids is also an important stabilizing factor.

"3 The stabilizing value of fillers is to a considerable extent a direct function of their compressed volume equivalents

"4 Of the commercial fillers tested on an equivalent weight basis there was practically no difference between the stabilizing value of limestone dust and Portland cement, but hydrated lime produced much higher stability values than the other two fillers"

The influence of filler, varied as to character and quantity, upon mixtures of sand and filler as well as in asphalt mixtures, has been studied by several others, including MacNaughton (1), Milton Hersey and Company, and Skidmore (5) Reduction of voids by additions of filler has been emphasized, and investigation of voidage as related to bitumen content is exceedingly important Skidmore says

"In summarizing the points brought out in this discussion, the outstanding one obviously is that of the application of the voidage principle to the design of asphalt mixtures As previously indicated, the lowest total voids possible with any conceivable sand grading in combination with filler is not necessarily the criterion, as this would unquestionably entail the use of entirely too much coarse material which would give a mixture theoretically possible but not entirely practicable because of high temperatures necessary to prevent segregation of the filler, causing a 'balling' of the mixture By virtue of the application of the voidage principle to the design of sheet asphalt mixtures, the stability of the mixture may be readily controlled to suit the needs of traffic and climate according to a definite scientific principle Total voids is, of course, important within the range of practical mixtures Likewise the reduction in size of individual voids is very important and can be readily accomplished by the use of well graded filler It is well known that thin films of glue provide the greatest measure of cementing ability It appears that this same principle is likewise applicable to asphalt mixtures It is, therefore, important to use no more bitumen than is actually required to fill unoccupied space"

MacNaughton, in his University of Michigan Fellowship report, discusses voidage in sheet asphalt aggregates extensively, and describes a cone for the determination of voids in dry aggregates A standardized method for this is needed, and at present several laboratories are cooperating in the study of various methods with a view to developing a reliable procedure for estimating the significant value for voidage

It has been clearly brought out that initial compression of the paving mixture is of prime importance Hubbard and Field (9) have described results of coordinated stability tests with laboratory and street speci-

mens, a beginning in the interpretation of laboratory tests in terms of pavement behavior. The Bureau of Public Roads experimental roadway is designed to serve a similar purpose Traffic tests have been completed on these sections, but considerable laboratory work on samples of the pavements remains to be done before a study of the relationship of tests and movement under traffic can be attempted

Possibly the most striking fact that several independent investigations have brought out is the rapidly decreasing stability occasioned by increasing bitumen content beyond a certain point The most suitable percentage of bitumen for a given aggregate to obtain maximum stability is largely dependent upon the voids in the compressed aggregate, and is likely also effected by surface characteristics of the aggregate Although it is the theory of some investigators that the bitumen should be sufficient, or almost so, to fill the voids existing in the aggregate when the grains are in as close contact with one another as they exist in a pavement, it appears from other tests that maximum stability with most mixtures of the sheet asphalt type, may be obtained with a proportion of bitumen considerably less than this amount.

An attempt to abstract the papers listed on tests and design of bituminous mixtures would extend this progress report to an unwarranted scope, and it is designed to indicate only what work is under way and the tendency of investigations

In conclusion, it may be said that the last year has seen the publication of a great deal of valuable information on the properties of bituminous mixtures, and continued work should soon lead to many definite facts on which to base a scientific procedure for using available materials for asphaltic mixtures in the most economical and satisfactory manner

REFERENCES

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3 The Present Day Design of Sheet Asphalt Mixtures, by Gene Abson Municipal & County Engineering, Vol 67, No 6, p 300 (Dec , 1924)

4 A Simple Method for Studying the Relative Value of Mineral Fillers for Asphalt Paving Mixtures, P Hubbard and F C Field Proc American Road Builders' Association, 1925, 22d Annual Convention, p 137

5 Sheet Asphalt Mixture Research, H W Skidmore Engineering & Contracting, Roads and Streets, Vol 63, No 4, p 693 (Apr 1, 1925)

6 A Deformation Test for Asphaltic Mixtures, H M Milburn Proc American Society for Testing Materials, 1925

7 A Stability Test for Bituminous Paving Mixtures, W J Emmons and B A Anderton Proc American Society for Testing Materials, 1925

8 A Practical Method for Determining the Relative Stability of Fine-Aggregate Asphalt Paving Mixtures, P Hubbard and F C Field Proc American Society for Testing Materials, 1925
9 Researches on Asphalt Paving Mixtures, P Hubbard and F C Field Proc Fourth Annual Paving Conference, Detroit, Michigan, 1925

HIGHWAY TRAFFIC LINE (ZONE) PAINT [1]

SUGGESTIONS CONCERNING PHYSICAL TESTS FOR TRAFFIC PAINTS

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The conditions under which traffic paints are used suggests that the following are the most important factors involved and are those for which laboratory tests of one kind or another are essential in selecting paint for such service

I Consistency (i e, freedom from clogging tendencies when applied by mechanical method)
II Spreading Rate
III Hiding Power (opacity)
IV Drying Time
V Light Resistance
VI Visibility (Day and Night)
VII Durability (Resistance to weather and abrasion)

I. *Consistency*—Where mechanical means are used for application, it is difficult closely to define proper consistency Obviously different types of apparatus will vary in their capacities for handling a wide range of consistencies Proper consistency will, then, have to be largely determined in relation to the peculiarities of the apparatus in question

Unsuitable consistency would probably be evidenced by (1) heavy paint, (2) too thin paint, and (3) presence of coarse material that might clog openings in the apparatus One sample of paint examined which was classified as "unsatisfactory," because it clogs the apparatus, besides being very thick, had a considerable amount of coarse material present (possibly sand), which had separated out Either factor would undoubtedly contribute to bring about trouble in any mechanical apparatus, where the material must flow through a restricted orifice under moderate pressure

The subject of consistency is being studied with the ultimate aim that some laboratory apparatus can be devised to give accurate determinations on suitable consistency required for machine application, giving proper consideration to spreading rate

[1] The Research Division of the New Jersey Zinc Company cooperated in this report and furnished much valuable data