DISCUSSION OF REPORT OF COMMITTEE ON STRUCTURAL DESIGN OF ROADS

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As I read over those of the reports that I had the opportunity to see beforehand, one half-hazy notion in my mind became very definite We want to get this material across to the engineers who are doing the actual roadbuilding They are working a good eight-hour day or more How many of them have the energy or acumen at the end of such a day to peruse lengthy technical reports, and glean from them what is immediately applicable to their own work? The reports of the committee as now published are splendid, and most serviceable to the men who will use them But how about those who shy off from what looks like stiff reading? Yet they are doing road work and spending road money

My suggestion is that these reports be summarized under two headings

First, definitely proven conclusions, which, expressed in terse sentences, would fill scarcely a page, such as might be read with the morning's mail At the bottom, in footnotes, should be clear bibliographical references, so that the ambitious engineer desiring to follow up any particular topic would know where to turn for it

The second category would be a list of hypotheses and problems on which more work must be done before valid conclusions can be drawn

We must all be troubled, as we travel around meeting various engineers, at the assurance with which haphazard guesses are treated as absolute facts If they could be recognized as being only theories, which experience and experiment must prove or disprove, we should have, I think, throughout our profession a more scientific attitude toward road-building and far greater interest in it as a department of human knowledge, rather than a meal ticket Moreover, having read on the sheet sent him that we still need much information about the varying bearing power of different subsoils, the local engineer may be moved to send us the results of his observations Many a valuable clue have I gained from a chance five minutes with the man on the job If he realized that what he was doing came under the head of one of our problems, might he not send us some suggestions? His interest would be valuable to him and even though his suggestions might not always be to us, we certainly should gain through his more professional attitude In short, my suggestion is

that in addition to the report as now published, the work of these committees be further summarized for the use of all road builders, in one or two sheets of not too technical language, in terse paragraphs of not more than a sentence or two each, so that every one may know what definite facts he is justified in applying at once, and what are the pressing problems toward whose solution he may contribute

So far, much waste and failure has resulted from the trial and error method with which we were plunged pell mell into large-scale road construction by the advent of the motor car Some optimistic souls dreamed that the Highway Research Board would be able immediately, out of a plowed rut, to determine economic treatment and design Considering that most road work to date had been done in a mad scramble to bear present traffic, regardless of future needs, the Board has achieved more than could have been reasonably expected in establishing from observation and reseach both definite facts and definite problems Some of the facts established in the papers sent on to me are

1 A layer of porous material placed over a base of poor soil will reduce the number of cracks in a concrete pavement

2 During the early period of curing, when concrete is least resistant to stress, the greatest care must be taken to keep it moist and covered

3 The danger of rupture from curling, which is due to change of temperature and to moisture, is diminished by the use of the divided slab

Blow-ups are due to lack of adequate provision for expansion

4 Greater extensibility of the concrete and other benefits are definitely shown to be gained through the use of mesh reinforcement

5 Savings in freight and handling may be safely effected through the use of thinner brick (2½-inch thick), the product, however, being subject to more uniform control

6 Field observations on bituminous macadam roads prove again the need in building them of scrupulous observance of the fundamental principles of all good road work

Other facts from the papers read should be added to this list of what is definitely known Some of the problems stated or implied in the papers that I read are

1 There is need of getting uniformly good specifications for materials and methods of work Beware of the easy way of writing specifications with shears and a paste-pot

2 What is the influence of the subgrade upon road surfaces? (Here reference should be made to the ambitious study outlined)

3 What are the economics of strengthening the base? Should good material be wasted to strengthen the entire base, where some locations are already sufficient in bearing power? Should the entire pavemnt be strengthened to meet the worst condition of the base? What is effective compromise?

4 In addition to the definite conclusions regarding the utility of planes of weakness, I would suggest the probable advantage of carrying a sheet of mesh reinforcement across the longitudinal plane of weakness for the full width of the pavement This would help hold the adjacent slabs in close interlock, would transfer part of the load, and would provide resistance against horizontal displacement

C L McKesson, California Highway Commission, Sacramento, Calif (by letter) The report on Sub-base Tests in Ohio, by Professor Eno, indicates that effect of subgrade treatment in Ohio is very similar to that noted in California, although climatic conditions vary greatly A report of a similar experiment in California (page 129, Part I, Proceedings of Highway Research Board, 1925) closes with the following remarks, which closely check Mr Eno's conclusions

"That soil adulteration with cement or lime compounds is not an efficient or economical method of securing stability in heavy soils" . "That a sand or layer is an efficient and economical method of minimizing damage to pavement resulting from swelling or shrinkage of subsoil"

It would seem that the results of the two studies taken together might be accepted as conclusive

The comprehensive series of tests on Experimental Curing Slabs, reported by Mr Pauls, is bringing out much new data and is confirming results obtained in earlier but less extensive test series The compressive and flexural strength tests upon specimens cured with and without water very closely check results obtained in curing tests made by the California Highway Commission in 1925 and by the Structural Materials Research Laboratory and this Commission, cooperatively, in 1924 (See Bulletin 15, Structural Materials, and Proc A S C E, 1926)

In the 1924 test series concrete exposed in pans without covering lost water very rapidly the first few hours The loss of water in the first eight hours was 62 per cent of the total amount lost in 96 hours and after 24 hours the loss was slow Similarly in concrete, concrete

which received no wetting lost 32 per cent of its original mixing water in a 90-day curing period, while specimens watered three days lost only 7 2 per cent of their original mixing water in 87 subsequent days of exposure in dry air These earlier tests and the present series indicate that water, if kept in concrete for the first day or so, will become more or less fixed and will remain to carry on hydration

Data regarding humidity and temperature during curing period in the present test series will be of great interest to States desiring to make use of the results The amount of mixing water used will be of interest also in studying the results in order to determine amount of water which remained for hydration of cement

W H CONNELL, Pennsylvania Department of Highways, Harrisburg, Pa (by letter) —

Reinforced Concrete Pavement —The type of cross-section used by this Department for its standard type of pavement is eighteen feet in width with two inch surface crown and thickened edge, center joint and parabolic subgrade A modification of this cross section has been used during the past year and consists of the flattening of the subgrade in the center to obtain an additional one-half inch of thickness of pavement adjacent to the center joint, which is accomplished for approximately $500 00 a mile

The reinforcing used by the Department has been two three-quarter inch diameter round bars along the thickened edges two inches from the surface of the pavement and one bar of the same size along either side of the longitudinal joint In our first work with this type of reinforcing in 1924, when the bars were lapped eight inches, we had considerable trouble with triangular corner breaks apparently at the points where the reinforcing bars were lapped This lap was increased to twelve inches and there has been a very marked decrease in the number of corner breaks We have further tried a type of welded fabric with four one-quarter inch wires, six inches apart along each edge and adjacent to the center joint, and No 6 wires spaced six inches between the heavier wires, and No 6 wires spaced twelve inches transversely, the sheets being lapped twelve inches on each end We are constructing some seventy-five miles of this type of construction and believe that the distribution of the metal in the slab will result in fewer corner breaks and a more satisfactory pavement

We are also omitting the laps between these fabric sheets at intervals of thirty, forty-five and sixty feet on sections of considerable length in order to determine the correct spacing for planes of weakness and to localize the transverse cracking This work is follow-

ing out some similar work undertaken about five years ago in which the laps were omitted at intervals too long to eliminate the transverse cracking between the planes of weakness

The Department is following up this year an experiment of last year by which the center joint is formed by cutting the pavement from the top while the concrete is still soft instead of inserting a metal joint plate The advantage of this scheme is cheapness, the avoidance of staking and keeping the joint plate straight, and the performance of all joint work after the concrete pavement is placed so as not to interfere with the operation of the mixer in the placing of the concrete

The Department is continuing its studies of calcium chloride as an admixture for curing concrete pavements and is studying the acceleration in hardening which results A great many simple testing machines for breaking test beams transversely are being used in the field where the beams are made and cured under field conditions and valuable information on the strength of concrete at early ages is being accumulated

Flexible Types of Pavements —This Department is using a thickened edge type of broken stone base course or one course bituminous surface treated macadam on its light traffic roads with the crown of the finished surface and the subgrade parabolic

The results of our experimental work and changes in design cannot be stated at this time and will be observed and reported on from time to time

CHAIRMAN HATT We shall now hear the report of the Committee on Character and Use of Road Materials