

- (7) Consistency of the mixture is important not only as it affects ease of handling in the mud-jack but also as it affects the performance.
- (8) The flow-table appears to be a satisfactory method for determining consistency of the mixture for field control.
- (9) The water-cement ratio influences the strength of mud-jack mixtures.
- (10) Traffic should be kept off treated joints for at least two days to permit the mud-jack mixture to "set".
- (11) Using durability tests as criteria, it is indicated that relatively high percentages of admixtures may be required. While this may make the mixture fairly expensive, it should be emphasized that the materials involved are a relatively small amount of the total expense and that the most durable mixture would be the cheapest over a period of years.

## DISCUSSION OF "PUMPING OF RIGID PAVEMENTS UNDER WARTIME TRAFFIC"

R. F. Berns, Engineer of Construction,  
State Highway Commission of Indiana

Mr. Shelburne's excellent paper on "Traffic Pumping of Pavements" deals with a highway problem that has been in existence to some extent as long as we have had pavements. However, it did not develop to a point of extreme concern to the highway official until recent years and did not appear to warrant much excitement until the advent of modern, heavy motor truck transportation. Since the advent of this type of traffic, particularly during the present war emergency when it is not in the public interest to enforce load limits rigidly, this thing called "pumping of pavements" has indeed become a bogeyman to many of us. It was, therefore, timely and fortunate that the Purdue Joint Highway Research Project, an organization that has become one of the nation's leaders in highway research, selected this problem for detailed study.

Mr. Shelburne has indicated to you the three principal factors causing this ravaging action that is taking place at so many places on our street and highway systems. They are, namely, poor subgrade soil, presence of free water, and heavy commercial truck traffic. These same factors are the primary cause of a large percentage of all of our various types of pavement failures.

He has indicated also that our problem is two-fold. First, there is the question of what to do about existing pavements

that already evidence various stages of this destructive action; and second, there is the question of how to design and construct pavements in the future that will be immune to it.

The paper suggests some practicable answers for both of the above questions, and I am sure further progress of this research will bear fruit in the form of additional assistance. It is hoped that this research may continue.

By way of digression from the paper, I should like to suggest to you that there might well be a third important phase of this problem that should be given some serious consideration at this particular time. What about one of the three previously mentioned contributing factors to our troubles, the truck? What should be the future course with reference to load limits and highway financing that will result in this factor's bearing its just share of the burden of extra cost it so obviously causes? I am not prepared, nor do I presume myself qualified, to suggest an answer to this question; but I do believe it merits, and is getting, some very serious thought on the part of our legislators and those upon whom they depend for enlightenment on such matters.

### MUD PUMPING

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Our first experience with mud pumping in the LaPorte District was on U.S. 20 in Porter County. This is a forty-foot cement concrete pavement built in 1931 and carrying the heavy traffic from Chicago and the Calumet industrial region across the north part of the LaPorte District. Traffic counts show that as much as 30% of these vehicles are heavy trucks. Surface failure of a serious nature was first noticed on this road about three years ago, and "mud pumping" was observed immediately. The action of the heavy trucks on this slab, over certain types of unstable subgrade, causes a slight up-and-down movement each time a truck goes over it. This movement at first is very slight; but soon, under certain weather conditions, particularly when the subgrade has become saturated, there begins a pumping action that forces water and mud through the pavement cracks and joints onto the surface. The subgrade material thus removed from under the slab causes a void near the joints and cracks and eventually traffic breaks off sections of the slab of from four to ten feet in length. At this rate it would not have been long until complete disintegration of the pavement had taken place. In order to save as much of this surface as possible, we diverted