OFFICE MEMORANDUM

MICHIGAN
STATE HIGHWAY DEPARTMENT
JOHN C. MACKIE, COMMISSIONER

February 24, 1964

To: E. A. Finney, Director
Research Laboratory Division

From: L. T. Oehler

Subject: Progress Report on the Experimental Transverse Joint Project: I 96 from Meridian Rd to Wallace Rd. Research Project R-60 F-58. Research Report No. R-452.

This memorandum reports on a performance evaluation of the various design features incorporated in the transverse joint project on I 96 east of Lansing. It is prepared at this time for quantitative evaluation of some of the pavement design questions raised in N. E. MacDougall's letter of January 16, 1964 to H. E. Hill, where he discussed some performance aspects of the Experimental Transverse Joint Project, as reported by Bureau of Public Roads engineers.

As a result of Mr. MacDougall's letter, C. B. Laird arranged a field trip to inspect the pavement in the Experimental Transverse Joint Project as well as certain other experimental joint sealing features incorporated in other pavements near Lansing. The following people composed the inspection party on January 30, 1964: R. C. Brewster and D. E. Jones of the Bureau of Public Roads; and C. B. Laird, C. S. Lundberg, W. A. Sawyer, R. F. Durfee, A. J. Permoda, and L. T. Oehler of the Department.

On route to the Experimental Transverse Joint Project, the inspection group stopped on the I 496 Pine Tree Connector, to observe the performance of several experimental joint sealers placed last fall, including a section with preformed polyurethane foam sealants and individual sections for three cold-pour joint sealing materials. The cold-applied joint sealers have remained soft and pliable. Of the three sections with cold-pour joint sealers, one section currently shows no evidence of adhesion failure while the other two sections have some areas where a crack has developed between the joint groove face and the sealer, a preliminary indication of adhesion failure.

Research Laboratory Report No. R-428, describing the experimental features and the construction of the Transverse Joint Project, was distributed in January 1964. As stated in that report, 10 consecutive joints in each of the 18 test sections on this project have been instrumented and are being studied in great detail. The subjects raised in Mr. MacDougall's letter may be discussed in terms of performance of these joints, as follows:

Item 1 - Joint Seal Performance and Spalling

Mr. MacDougall states that "they have reported that the sawed joints on I 96 near the Livingston County Line, which were sealed with your standard rubber asphalt compound, are in good-to-excellent condition with very little spalling." In a survey of joint seal performance by J. E. Simonsen and L. T. Oehler on February 10, 1964, the data in Fig. 1 on joint seal adhesion failure were obtained. In the first winter (1962-63), there was no appreciable amount of adhesion or cohesion failure on any section of the project. The hot-pour joint seal is currently hard and not very pliable. This winter the beginning of joint seal adhesion failures is readily apparent. Bond has not been completely lost, but pulling away of sections of the joint seal is apparent to a depth of 1/8 to 1/4 in. along the joint groove face (Fig. 2). The length of adhesion failure varies from 57 ft for one section to as little as 2 ft for another, involving a total of 10 joints, or 240 lin ft. The use of shorter slab lengths (57 ft 3 in. and 71 ft 2 in.) has not appreciably reduced the amount of adhesion failure.

With respect to joint groove size, the general appearance of sealants in the 1- by 1-in. and 3/4- by 3/4-in. grooves is better than in the 1/2- by 1/2-in. grooves, even though as Fig. 1 indicates the adhesion failure may be greater in some cases for the larger groove sizes. The reason for this is that the seal in the larger grooves has not subsided nearly as much as in grooves of the smallest size (1/2- by 1/2-in.), and thus it is easier to observe the adhesion failure in the larger grooves than in the smallest ones. This subsidence of the sealer in the 1/2- by 1/2-in. groove leaves only a small area of contact between the groove face and the seal, since most of it has receded into the plane of weakness crack below the groove. In the case of 1/2- by 2-in. joint grooves, the sealant has also subsided considerably, and in some cases is covered with dirt or small stones which occasionally have already penetrated into the sealing material. Of all the groove dimensions observed, sealants in this 1/2- by 2-in. groove size were most wrinkled and adulterated. Only in grooves of this size were appreciable cohesion failures found (Fig. 3), which might be considered a more serious deficiency than the minor adhesion failures discussed previously.

With regard to joint forming methods, it appears that subsidence of the sealer from the pavement surface is less pronounced where the plane-of-weakness crack was formed by a bituminous filler strip than by sawing (the groove size being the same). This appears to be due to the fact that in sawed joints, there is an additional area due to the initial saw cut, for more volume contraction of the joint sealant in cold weather. In the Unitube joints, the Unitube prevents the joint seal from penetrating the plane-of-weakness crack, and there is negligible subsidence of the seal in these joints even though the area of the joint groove is small (3/8 by 1/2 in.).

The amount of joint groove edge spalling on the various experimental sections is shown in Fig. 4. No distinction is made with respect to slab length, since that is not particularly pertinent to this performance item. It appears that sawing the joint groove, particularly for the wider grooves, resulted in less spalling than where the groove was formed by styrofoam or Unitube crimping. Since initial spalling occurs adjacent to the plane-of-weakness sawcut or bituminous filler, subsequent cutting of the wider joint groove obliterates or absorbs these initial spalls, resulting in an apparent reduction of overall edge spalling.

Item 2 - Reduction in Transverse Cracks with Reduced Slab Length

Mr. MacDougall states that "it was also their opinion that the reduction in slab cracking during the first two seasons would warrant serious consideration to a reduction in slab length on future work." It is to be expected that reduction in slab length will reduce transverse cracking and the Bureau's observations are confirmed by Figs. 5 and 6, where a frequency distribution of the percent of slabs with 0 to 6 cracks per slab is shown for the three different slab lengths. These observations were made during the 1963-64 winter condition survey of this project, but do not include the Unitube section so that the sample size is approximately the same for all slab lengths.

Another aspect of the experimental transverse joint study which is being followed is surface roughness. Fig. 7 indicates that two experimental features of this project appear to have no significant effect on surface roughness either as constructed or after approximately one year. One of these features is slab length; the latest roughness measurements give averages of 133.5, 134.1, and 127.5 in. per mi for 99-ft, 71-ft 2-in., and 57-ft 3-in. slab lengths, respectively. The other feature is joint groove width; it appears that the wider joint grooves do not contribute significantly to overall roughness.

Item 3 - Extruded Neoprene Joints on I 96 near M 99

Mr. MacDougall states that "the condition of the joints on I 96 near M 99, which were formed with styrofoam and sealed with extruded neoprene, was very unimpressive due to spalling, and it appeared that sawing of joints to be sealed with this material would be especially important." The installation of extruded neoprene joint seal on this initial section of pavement was highly experimental and did not include some of the provisions later incorporated into Department specifications in order to improve performance. At the time of installation it was realized that 1-in. wide extruded neoprene was not sufficiently wide to maintain a 20-percent compression as recommended under cold weather conditions when the slab groove is at its widest. However, at the time of this installation, the proper 1-1/4-in. width material was not available, and therefore the 1-in. was used. The most serious deficiency now noted in the performance of these joints is spalling along the joint groove, which probably occurred prior to the installation of the neoprene seal and permits infiltration around the seal in the area of the spall. This was an important consideration in writing of the current specifications for installation of neoprene seal; all spalls more than 1/4-in. wide and over 1/2-in. deep must be patched with an epoxy mortar prior to the installation of the sealer. Enforcement of this specification provision should eliminate this problem in future installations. Another deficiency in the trial installation is placing of the neoprene seal too low in the groove, permitting an accumulation of dirt and small stones above the seal which may lead to sealer damage and infiltration into the groove. This also could be remedied in future installations.

OFFICE OF TESTING AND RESEARCH

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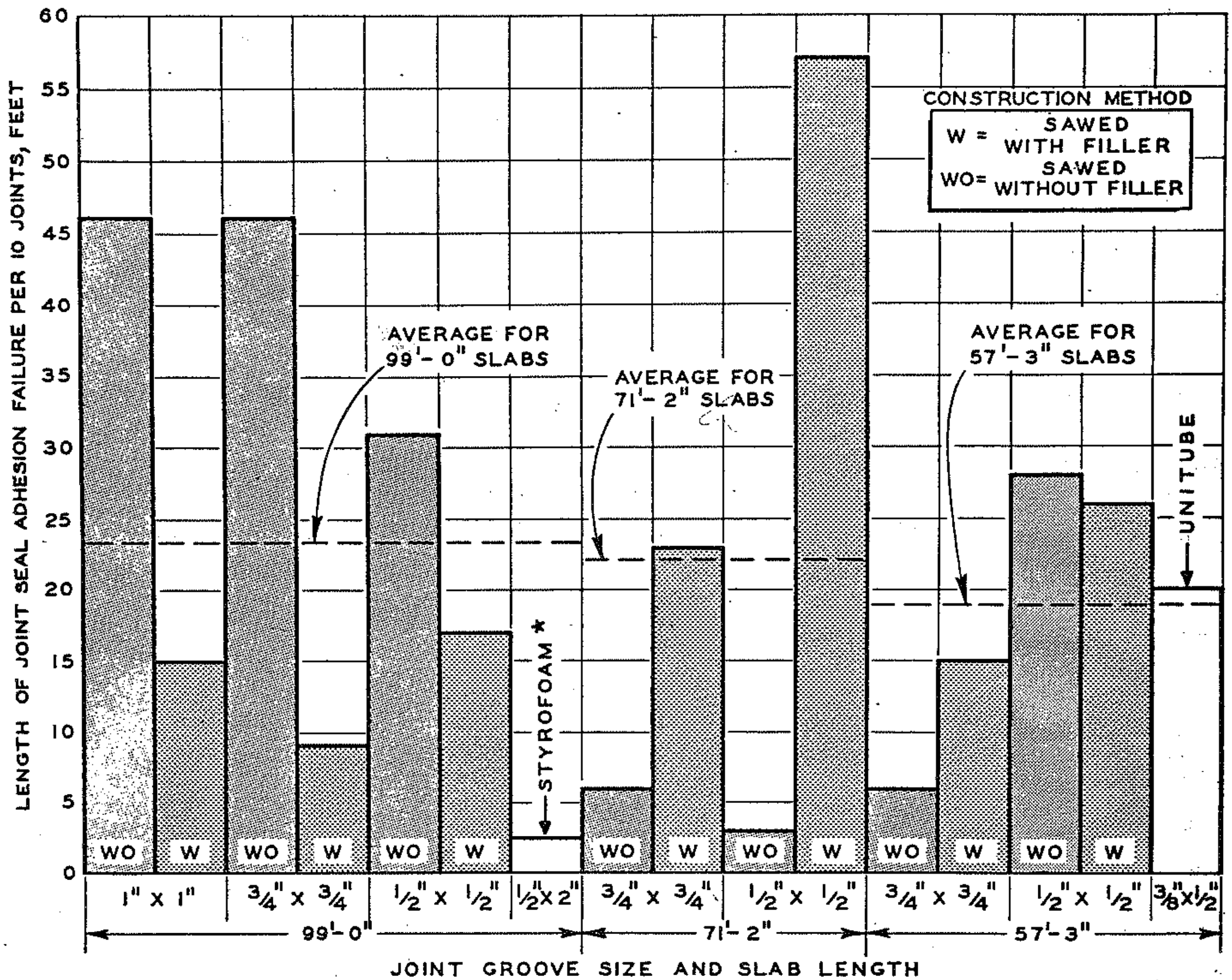


* The joint seal in these joints is depressed more than in any of the others and cohesion failure has occurred in the center of the depressed seal. A total length of 42 ft of cohesion failure per 10 joints was noted. Because of the depressed surface of the seal, sand and small stone infiltration appears more serious in these joints.

Figure 1. Effect of slab length, joint groove size, and joint crack forming method on joint seal adhesion failure.

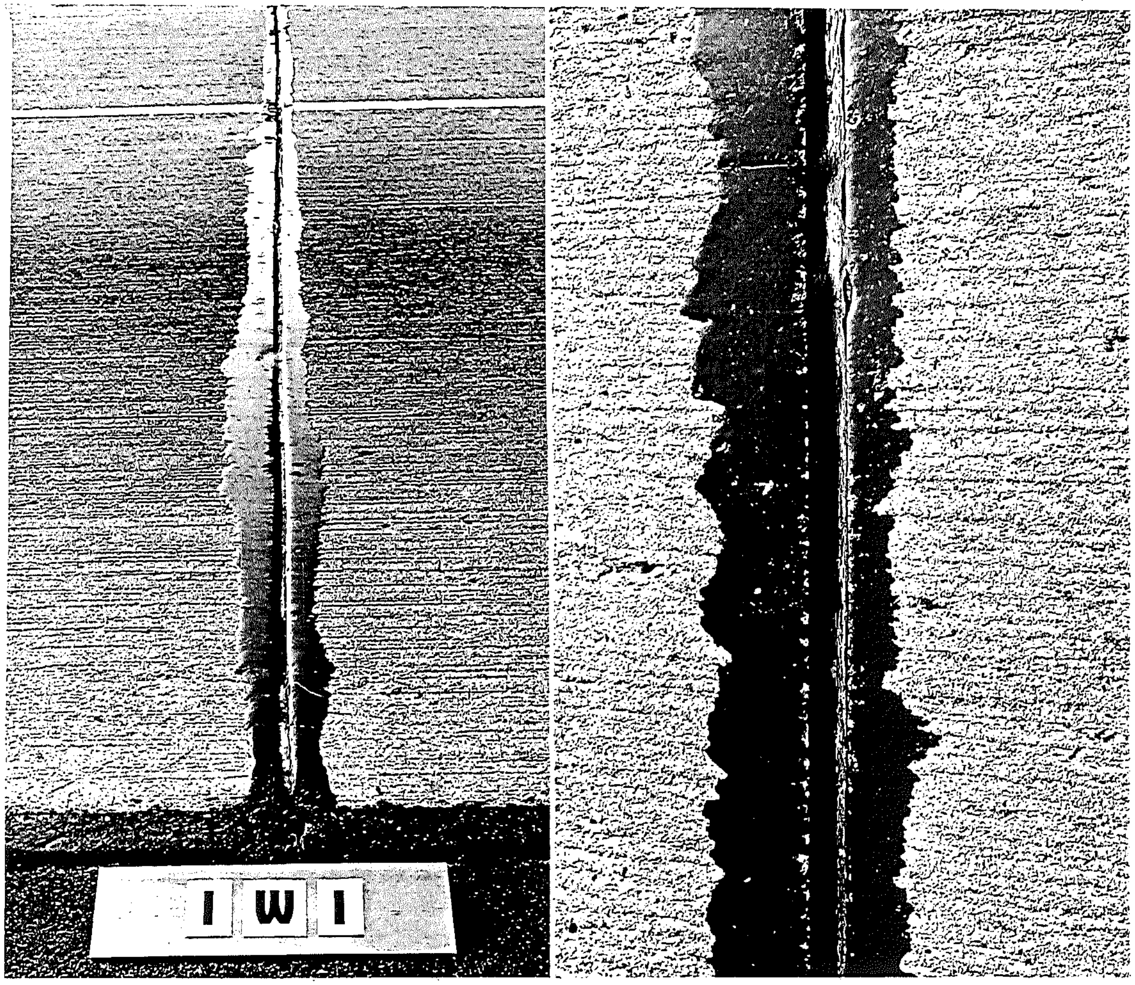


Figure 2. Overall view (left) and detailed view (right) of typical adhesion failure of joint seal.

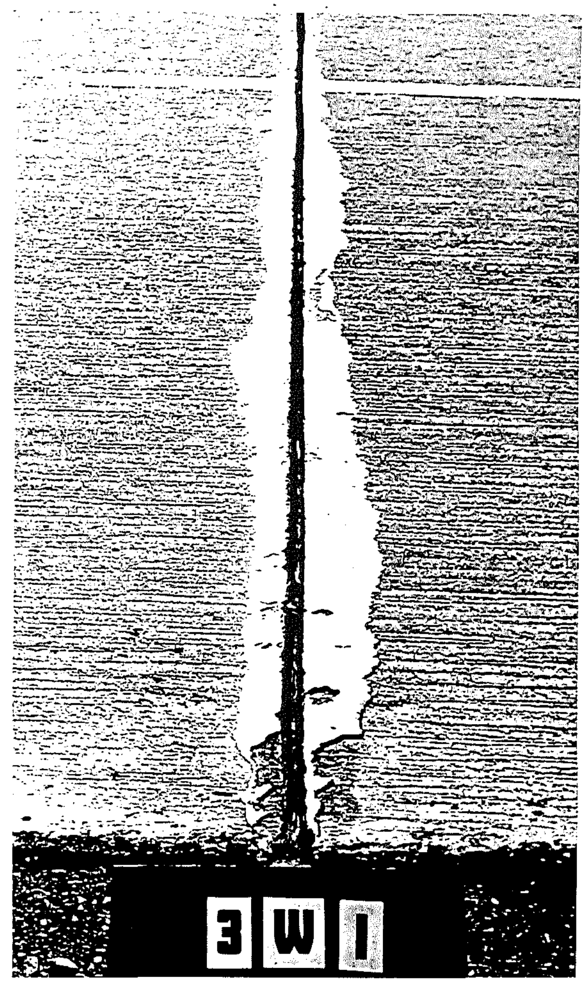


Figure 3. Typical joint seal in 1/2- by 2-in. joint groove showing some cohesion failure of the folded and wrinkled seals.

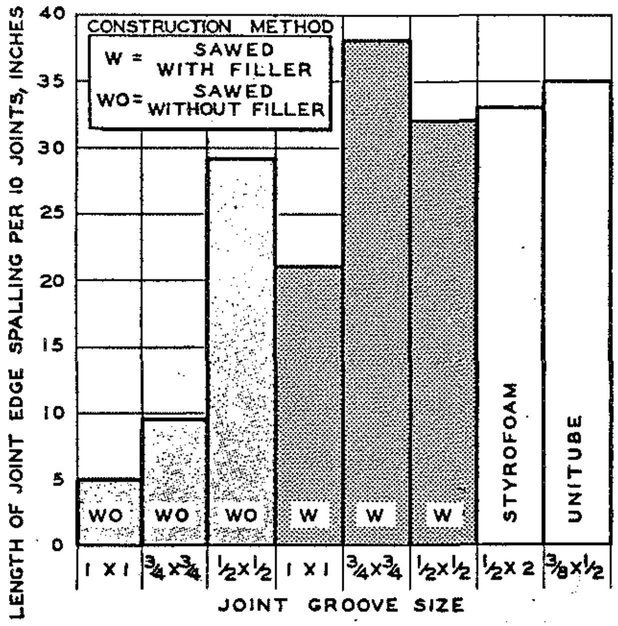
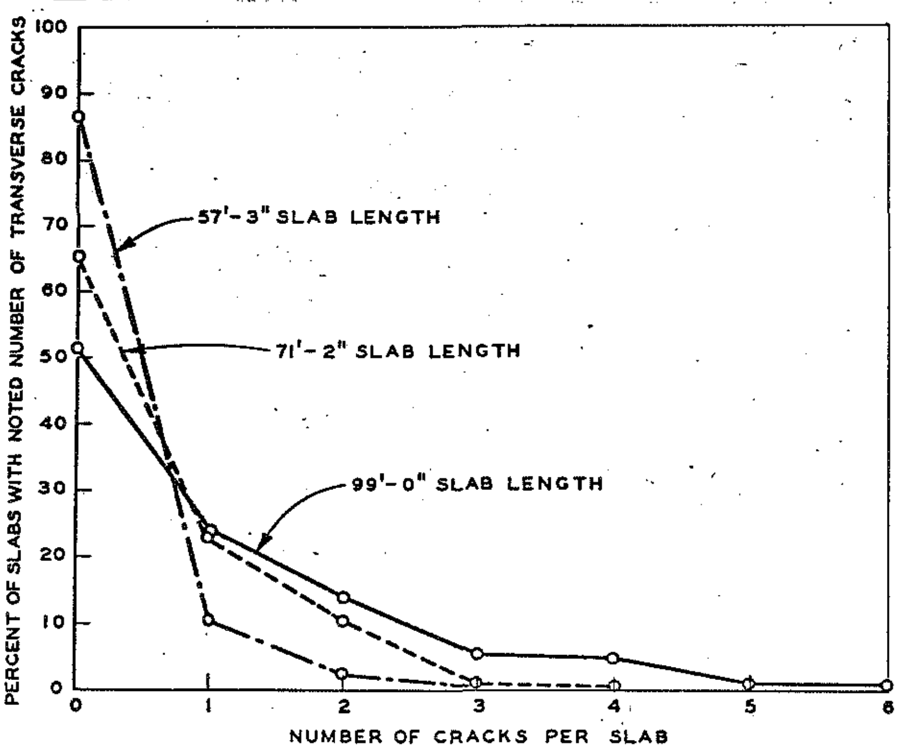
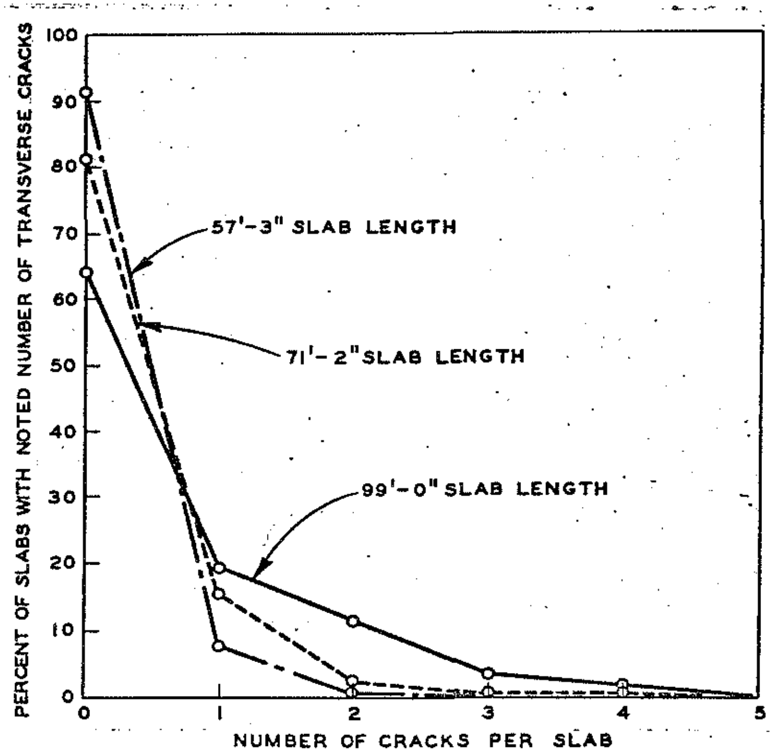


Figure 4 (left). Effect of joint groove size and joint crack-forming method on joint edge spalling.

Figure 5 (lower left). Effect of slab length on frequency of transverse cracking (traffic lanes only).

Figure 6 (lower right). Effect of slab length on frequency of transverse cracking (passing lanes only).





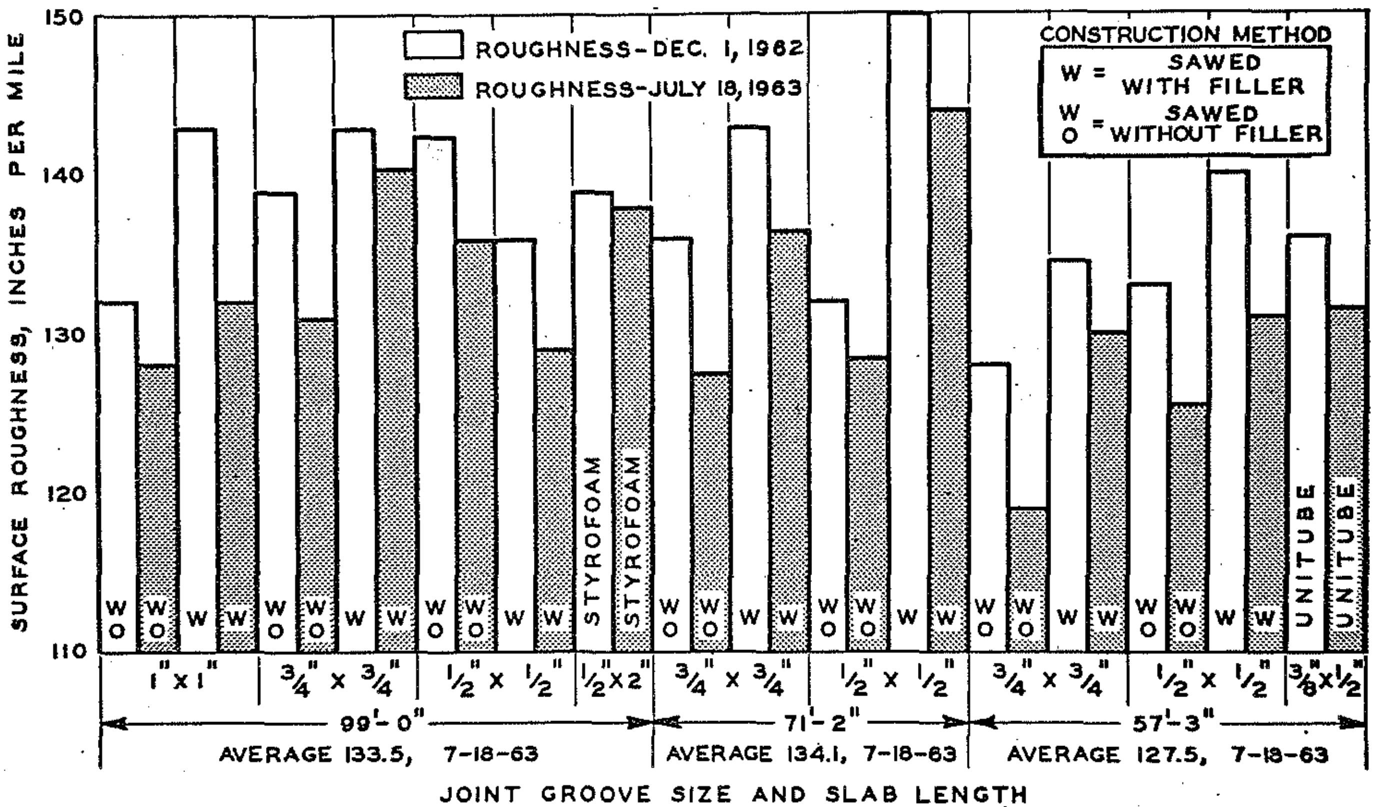


Figure 7. Effect of slab length, joint groove size, and joint crack forming method on surface roughness.