Since the subject is "Developments in Concrete Pavement Construction", we will mention first the methods of mixing the concrete.

In the early days of concrete paving a single-drum 27E paver was used; however, there were smaller pavers before the 27E, but we will not go back that far. The cement for the paving operation was delivered in sacks to the paving site. It was dumped into the skip of the paver by a laborer, and at the end of a day the empty sacks were counted to determine the cement factor for the day.

It was not long until the pavers had been increased in capacity to a single-drum 34E and then, after a short while, twin-drum pavers were placed on the market and the use of bulk cement was started. The first bulk cement was shipped to a site near the paving operation in boxcars, and Georgia buggies were used to charge the batch trucks after being weighed on small platform scales. It was difficult to maintain a crew on this operation due to the cement dust and the confinement of the boxcar. Of course, the inspector on the scales had some advantage as he was on a small platform outside the boxcar.

It was not long until plants were on the market which had weigh hoppers for the aggregates as well as for the cement. The cement was generally unloaded from the railroad cars by a screw to the foot or base of a bucket elevator which charged the cement silo. Along about the same period of time, maybe a little later, tri-batch pavers were placed on the market and, as you know, several of the twin batches and tri-batches are in operation today.

Apparently it has been concluded that better production can be made with the use of central mixing plants near the paving site. Some of these plants commonly in use today vary from 5- to 9-cubic yard drums. It is not uncommon to find the mixers side by side, back to back and, for some time, a twin-drum arrangement has been used which operates similar to the twin batch pavers. Assuming such plants can discharge a batch every minute, we are talking of at least 480 cubic yards of concrete per hour if 8-cubic yard mixers are used. This is equivalent to 5,184 feet of 10-inch pavement in 8 hours. This brings to mind that, in the earlier days of concrete pavement, we always referred to the length placed in any particular day in hundreds of feet. Now, however, if only 2,500 feet are placed in one day, it is referred to as nearly one-half mile.

Editor's Note. This paper summarizes some of Mr. Woodward's pertinent remarks to the Conference. His presentation was illustrated by means of a series of slides.
With this large rate of production, cooperation is a "must" and an understanding between engineers and contractors' supervisory personnel as to the methods which will be followed has proven to be beneficial. Modern management requires that contractors' personnel have the knowledge and experience to direct the paving operations, and it is the responsibility of the engineer and inspectors to check the functions of the superintendents and foremen. Improvements have been made in communications between contractors' personnel and engineers relating to any parts of the paving operations that are questionable and, as we all know, many times a great deal is learned by listening.

It has been universally accepted that the proper amount of entrained air has a beneficial effect on the durability of concrete. It has not been many years since the air content was introduced into the mix by the use of one bag of natural cement with 5 bags of portland cement for each cubic yard of concrete. Later an ingredient was added at the cement plant to produce air entrained cement; however, generally speaking now, on most paving projects, the air entraining agent is charged into the mixing drum as the other ingredients are being charged.

What are we talking about when we refer to the durability of concrete? Generally it is meant that the concrete must be able to resist freezing and thawing and the use of salts to melt ice and snow. It might be well to mention here that strength alone is not a satisfactory measure of durability since it is possible to produce a concrete of 5000-psi compressive strength which would not resist the action of freezing and thawing. However, it has been discovered that it is possible to produce a concrete of 2000-psi compressive strength which would be resistant to freezing, thawing and de-icer but which would not resist the abrasive action of large traffic volumes. In other words, in most cases concrete is considered to be durable if the pavement can resist scaling.

Between 1938 and July 1 of this year, 25 States have built or have under contract continuously reinforced pavement. The total mileage contracted between the dates referred to is 5,316 miles and more than 5,000 miles of this total have been contracted since August 1959. This type of construction eliminates all transverse joints except at the end of a day's run. In Kentucky approximately 13 miles of 24-foot continuously reinforced pavement has been constructed during this year. The design depth of the pavement was 8 inches. The concrete for the continuously reinforced projects was mixed in twin batches operating on the shoulders of the road.

In some States, straightedging of the pavement is not accomplished as is the custom in the immediate vicinity. These States use a profilegraph which plots the irregularities in the pavement as it is moved over the pavement and, if an accumulation in inches per mile exceeds the limitations specified in the specifications, an adjustment is made.

After reviewing notes relating to remedial work, it is apparent that more attention should be given to the sawing of transverse joints in concrete pavement. The sawing of joints is often unduly postponed and cracks then develop in the vicinity of the load transfer assemblies. These have caused costly repairs as well as
delays in completion of the pavement. If there are indications of ravelling when the sawing is first started, it would be well to first check the saw-blade mounting for wear and alignment, as either will tend to cause a dragging action of the blade and the sawed joint will have the appearance of ravelling. It is a must that the sawing be accomplished before any random cracking develops.

The subject of joints bring to mind the header or transverse construction joint. It seems we are still having to do too much grinding at such joints. This means we need to exercise more care in finishing the pavement at the end of a day's run. It might be mentioned that it has been observed that a construction joint made in the morning or early afternoon will warp up and warp down at night.

There was an inspector on paving a few years ago who could insert his hand into a stockpile of sand and tell you the moisture content. Don't laugh as I did when he first made such a statement to me because we found after several tests that he was never off more than 0.1 percent. We never did change the mix design on his moisture percentage, but it is needless to say a check of the moisture content was made when the hand method indicated a drastic change.

Some day, maybe soon, there will be a testing device which can be inserted into a batch of concrete which will indicate the slump, expected strength and even the cement factor. If this happens there is a good possibility the device will also register the air content.