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GUIDELINES ON CONCRETE MIXTURE OPTIMIZATION IN VARYING WEATHER CONDITIONS

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Project No. 0-5550: Guidelines for the Use of Fly Ash and Ground Granulated Blast Furnace Slag Blends in Concrete Pavement

P1: Guidelines on concrete mixture optimization in varying weather conditions

The substitution of a portion of cement in concrete with supplementary cementing materials (SCM) frequently results in delayed setting and low early strength. When SCM-containing concrete is placed during cold weather and/or contains certain chemical admixtures, set time and strength problems can intensify and seriously impact both the early performance and durability of a pavement.

Prevention of delayed setting

Ideally, concrete mixtures that will experience delayed setting should be identified prior to placement in the field. This demands that all concrete mixtures, which will be used in the field, first be evaluated for set times and early strength at the temperatures expected during paving on the project. At this point, the most accurate technologies available for detecting the potential for delayed setting of concrete mixtures are not simple enough for use in the field. However, in most cases, delayed setting can be prevented by following the recommendations below:

- Setting time problems should be identified before field placements through testing of the trial batches. Testing the 24-hour compressive strength of a mix cured *under similar temperature conditions to the field* gives an indication of setting time. The results of this project show that 24-hour strength greater than 500 psi indicates that the mix set in a reasonable window of time (final set < 10 hours).
- Actual delivered mixture proportions in field concrete should be monitored to ensure that they do not deviate from the approved mix designs. If the source of fly ash, cement or chemical admixtures changes, the mixture must be re-evaluated as specified in Item 421 and appropriate adjustments made.
- *The manufacturer's recommended dosage of chemical admixtures should not be exceeded.* The dosage should be calculated using the manufacturer's guidelines, particularly with regard to dosing based on the amount of cementitious material (cement + SCM) or based on the amount of cement. Dosing based on cementitious material may result in the addition of too much admixture, causing delayed setting, especially during cold weather. The intended admixture dosage and SCM proportions should be discussed with the manufacturer's representative to identify any unforeseen problems with cold-weather concreting.
- Admixture dosage *in the field* must be monitored closely and recorded accurately on the batch ticket.

Early identification of problems related to setting

If the above procedures are not followed, it is possible that some concrete mixtures will experience delayed setting. Early identification of potentially problematic mixtures is possible, before performance problems set in. Compressive testing of field cylinders (stored outdoors) at 24-hours will help identify problems. 24-hour compressive strengths less than 500 psi indicate that the concrete might have potential problems due to a delayed setting. The mixture designs must then be evaluated to identify the cause of the delayed setting and appropriate adjustments made.