

AC NO: 150/5370-9

DATE: 6/7/73




ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION

SUBJECT: SLIP-FORM PAVING - PORTLAND CEMENT CONCRETE

1. PURPOSE. This advisory circular transmits guidance for the construction of Portland Cement Concrete pavements by the slip-form method.
 2. REFERENCES. Material presented in this advisory circular contains references to AC 150/5370-1A, Standard Specifications for Construction of Airports, dated May 1968.
 3. BACKGROUND. This advisory circular is of interest to all parties concerned with the approval of airfield construction plans and specifications for which Federal funds have been allocated under the Airport and Airway Development Act of 1970 and/or furnishing airport design and construction advisory services to the public. Slip-form paving is considered to be an acceptable construction procedure for Portland Cement Concrete airfield pavements. Suitable pavements can be constructed using the slip-form method of placement when proper controls are exercised.
 4. IMPLEMENTATION. The use of the slip-form placement method should be offered as a contractor's option in the paving contract. Often cost savings can be realized by using the slip-form placement method. Local conditions at the particular project will control in determining whether slip-formed or formed placement will be most economical.
 5. HOW TO OBTAIN THIS CIRCULAR AND REFERENCES.
 - a. Obtain additional copies of this Advisory Circular 150/5370-9 Slip-Form Paving - Portland Cement Concrete, dated 6/7/73 from the Department of Transportation, Distribution Unit, TAD 484.3, Washington, D. C. 20590.
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- b. Advisory Circular 150/5370-1A, Standard Specifications for Construction of Airports, may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, at a cost of \$3.50. Send a check or money order with your request made payable to Superintendent of Documents. No c.o.d. orders are accepted.



CLYDE W. FACE, JR.
Director, Airports Service

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1. INTRODUCTION. When construction by the slip-form method is offered as a contractor's option, the following provisions and recommendations concerning equipment, mix design, construction and control of the work shall govern and shall replace any conflicting provisions of AC 150/5370-1A, Standard Specifications for Construction of Airports (1968), Item P-501.
2. GRADE. The compacted subgrade or subbase on which the pavement will be placed shall be widened to extend beyond the paver a sufficient distance to support the paver without noticeable displacement. Normally the subbase widening should be a nominal 3 feet (1 m.). Stabilized or granular subbase and/or the subgrade on which the pavement is to be placed shall be finished to the requirements of these specifications. After the subgrade or granular subbase has been placed and compacted to the required density, the areas which will support the paving machine, and the area to be paved, shall be trimmed to the proper elevation and profile by means of a properly designed machine. The cutting of the finished grade of the natural subgrade or the granular subbase on which the concrete pavement is to be placed shall be controlled automatically by steel guide wires erected and maintained by the contractor. If the density of the base is disturbed by the grading operations, it shall be corrected by additional compaction before the concrete is placed. The grading operations should be delayed as long as possible and immediately precede paving insofar as practical, particularly if the base course is subjected to haul traffic. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placement of concrete. The prepared grade should be well moistened with water immediately ahead of concrete placement to prevent rapid loss of moisture from the concrete.
3. PLACING CONCRETE. The concrete shall be placed with an approved crawler-mounted, slip-form paver designed to spread, consolidate and shape the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with requirements of the plans and specifications. The paver shall be fully energized, self-propelled, and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement, true to grade, tolerances and cross section. It shall be of sufficient weight and power, to construct the maximum specified concrete paving lane width as shown in the plans, at adequate forward speed, without transverse, longitudinal or vertical instability or displacement. Side forms and finishing screeds shall be adjustable to the extent required to produce the specified pavement edge and surface tolerance. The side forms shall be of dimensions, shape, and strength to support the concrete laterally for a sufficient length of time that no appreciable edge slumping will occur. Final finishing shall be accomplished while the concrete is still in the plastic state.

4. VIBRATION. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Vibration shall be accomplished by internal vibrators with a frequency range variable between 7,000 and 12,000 vibrations per minute. The amplitude of vibration is also important and the suggested average amplitude is between 0.025 (0.6 mm) and 0.06 inch (1.5 mm). More detailed information concerning concrete vibration is available in the American Concrete Institute Standard 309-72. The number, spacing, frequency, and eccentric weights shall be approved by the engineer and shall be changed as necessary to achieve an acceptable concrete density and finishing quality. Adequate power to operate all vibrators at the weight and frequency required for a satisfactory finish shall be available on the paver. The internal vibrators may be supplemented by vibrating screeds operating on the surface of the concrete. The frequency of surface vibrators shall be not less than 3,500 vibrations per minute. The contractor shall furnish a tachometer or other suitable device for measuring the frequency of the vibrators periodically. The vibrators and tamping elements shall be automatically controlled so that they shall be stopped as forward motion ceases. Any override switch shall be spring-loaded, momentary contact type.
5. CONCRETE.
- a. The proportioning requirements of Item P-501-3.5(a) shall be modified as required to produce a $\frac{1}{2}$ inch (13 mm.) slump. Low slump concrete is a necessity, particularly for pavement with keyways or for pavement in excess of 10 inches (250 mm.) thick. The minimum cement contents shown under Item P-501-3.5(a) shall be maintained to produce concrete of suitable durability and workability. The maximum water-cement ratio specified in Item P-501-3.5(a) shall not be exceeded. Entrained air shall be required to increase durability and provide workability and shall be in accordance with the provision of Item P-501-3.5(a).
- b. A high degree of uniformity in the plastic concrete is required. If difficulty occurs during placement operations in maintaining the required plasticity and workability with $\frac{1}{2}$ inch (13 mm.) slump, the mix may be modified to increase the slump up to $1\frac{1}{2}$ inches (38 mm.). The air entrainment specified in Item P-501-3.5 ranges from 3 to 7 percent. Caution should be exercised in establishing the air entrainment percentage as excessive air entrainment will aggravate edge slumping and insufficient air entrainment will result in poor concrete durability. Batches with slumps in excess of $1\frac{1}{2}$ inches (38 mm.) shall be wasted. Some edge slump of the wet concrete behind the side form will occur, even with low slump concrete. This may continue, though very slowly, until initial set has taken place. Provision for adequate compensating adjustment in the side form and in the final screed must be incorporated in the paver.

of the engineer, cannot be corrected to permissible tolerances, the engineer may halt paving operations until proper adjustment of the equipment or procedures has been made. In the event that satisfactory procedures and pavement are not achieved after not more than 2,000 lineal feet (600 m.) of single lane paving, the contractor shall process the balance of the work with the use of standard metal forms and the formed method of placing and curing in Specification P-501.

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6. CURING. The approved curing media shall be applied uniformly to all surfaces of the pavement including exposed edges and as specified in Item P-501-3.13. Membrane curing compounds shall be applied from a suitable mechanical application device, which bridges the fresh concrete, designed to provide a uniform application. Other curing systems shall be applied in a manner which will preclude marring of the concrete surfaces.
7. JOINTS.
 - a. In addition to the provisions of Item P-501-3:10, the following shall apply: When keyed construction joints are called for, a sheet metal keyway liner shall be required. The liner may remain in place permanently and become part of the keyed joint and shall be galvanized, copper clad, or of similar rust resistant material, of sufficient stiffness to support the upper keyway flange. Two-piece hook bolts may be installed in either the male or female side of the keyed joint providing the installation is made without distorting the keyed joint dimensions or causing edge slump. The use of bent tie bars is not recommended because the straightening of the bars is accomplished by cold bending and can considerably weaken the bars. If a bent tie bar installation is used, the tie bars shall be inserted through the sheet metal keyway liner on the female side of the joint only. The bent tie bar installation may cause breaking of some small amount of laitance where the bar goes through the liner when the exposed portion of the bar is bent for extension into the adjacent lane. In no case shall a bent tie bar installation be permitted which will require chipping away of concrete to perform the straightening of the tie bar. Alternate methods of bar installation may be approved by the engineer if the keyway can be formed to a tolerance of 1/8 inch (3 mm.) in any dimension and without distortion or slumping of the top or male flange.
 - b. Transverse joints with dowels will require particular care to insure the dowels are accurately placed and not disturbed during concrete placement. Transverse dowels will require use of an apparatus to firmly hold the dowels perpendicular to the joint and parallel to the slab surface. During the concrete placement operation, it is advisable to place plastic concrete directly on the dowel assembly immediately prior to passage of the paver to help maintain dowel alignment.
8. PROTECTION AGAINST RAIN. In order that the concrete be properly protected against the effects of rain before the concrete is sufficiently hardened, the contractor will be required to have available at all times materials for the protection of the edges and surfaces of

the unhardened concrete. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than 2 inches (50 mm.) and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as curing paper or polyethylene sheeting material for the protection of the surface of the pavement. The metal forms, wood planks and curing paper shall be kept on trucks or towable vehicles, within reasonable hauling distance, at a site shown on the plans or as designated by the engineer; or, as an alternate, rolled polyethylene sheeting at least 4 mils (0.1 mm.) thick of sufficient length and width may be used without the temporary side forms if properly anchored to cover the plastic concrete slab and exposed edge. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

9. TOLERANCES. Extreme care must be exercised in all phases of the slip-form operation to assure the pavement will pass the smoothness tolerances. This is particularly true for transverse smoothness. Edge slump, tie bar installation, etc., all directly affect transverse smoothness and must be constantly checked and carefully performed so as not to impair transverse smoothness. A great deal of expense can be encountered in correcting transverse roughness and is not always successful. The following tolerances are applicable:
 - a. Lateral deviation from established alignment of the pavement edge shall not exceed ± 0.10 foot (30 mm.) in any lane.
 - b. Vertical deviation from established grade shall not exceed ± 0.04 foot (12 mm.) at any point.
 - c. Surface smoothness deviations shall not exceed 1/4 inch (6 mm.) from a 16 foot (5 m.) straight edge placed in any direction, including placement along and spanning any pavement joint or edge.
10. REJECTION OF SLIP-FORM PAVING METHOD. It is the intent of this specification to produce a high quality, dense, long lasting, and smooth pavement suitable for the high speed operations of roughness sensitive heavy jet aircraft. This requires that all joints, and particularly all longitudinal joints, meet the specified tolerance throughout their length. The engineer may direct that paving lanes in an apron, taxiway, or the outer runway paving lanes be used for the initial paving operation. In the event that slumping or sloughing occurs behind the paver or any other structural or surface defects which, in the opinion

of the engineer, cannot be corrected to permissible tolerances, the engineer may halt paving operations until proper adjustment of the equipment or procedures has been made. In the event that satisfactory procedures and pavement are not achieved after not more than 2,000 lineal feet (600 m.) of single lane paving, the contractor shall process the balance of the work with the use of standard metal forms and the formed method of placing and curing in Specification P-501.



AC NO: 150/5370-9 TAD-494.4
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Director, Airports Service

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