Report on Accelerated Techniques for Concrete Paving

Reported by ACI Committee 325

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This report covers state-of-the-art of accelerated concrete paving techniques. Accelerated concrete paving techniques are appropriate for roadways, airfields, streets and intersections, and other paved surfaces where early opening to traffic and quick access are required. Considerations include planning, concrete materials and properties, jointing and joint sealing, curing and temperature control, concrete strength testing, and opening-to-traffic criteria. Applications and uses of accelerated concrete paving are discussed.

Keywords: accelerated paving; admixtures; aggregates; airports; concrete pavement; curing; fast-track paving; gradation; highways; intersections; joint sealing compound; jointing; specifications; streets.

CONTENTS

ACI 325.11R-19 supersedes ACI 325.11R-01 and was adopted and published March 2019.

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

Airport authorities and road agencies face major challenges in repairing and maintaining their pavement infrastructure under ever-increasing traffic volumes while maintaining traffic on these structures. The duration that is involved with traditional concrete pavement construction can have significant consequences to users of the facilities and, as a result, transportation agencies seek alternative methods for accelerating this process when closure times become an issue. This can be especially demanding in urban areas where congestion is severe. Accelerated construction techniques for portland-cement concrete (PCC) pavement can address these problems by providing reduced construction closure for new construction, reconstruction, or resurfacing projects.

Accelerated paving encompasses various activities, including technological methods to accelerate concrete construction (using rapid-setting materials or innovative construction approaches) and contractual methods to minimize the construction time (such as time incentives and disincentives).

Traditional agencies have been using these time-of-completion incentives for many years, and contractors will often meet these requirements by lengthening the work day or increasing the size of construction crews. Using accelerated paving techniques, a contractor often can complete a project without increasing crew size or changing normal labor schedules.

If any accelerated paving project is to be successful, there should be buy-in from all parties involved on the project. There needs to be a partnership and effective communication between the transportation agency representatives, contractors, suppliers, and engineer consultants.

1.1.1 *Changes to construction specifications and processes*—To build an accelerated paving project, both the contractor and the agency will make some changes to traditional construction specifications and processes. Often, these involve high-early-strength concrete, but they

Table 1.1.1—Changes to project components useful to shorten concrete pavement construction time

Project component	Possible changes
Planning	a) Implement partnering-based project management. b) Implement lane rental charges, which is an innovative contracting practice that encourages contractors to lessen the construction impact on road users. c) Allow night construction. d) Allow contractor to use innovative equipment or procedures to expedite construction (for example, minimum-clearance machines, dowel inserters, and ultra-light saws). e) Specify more than one concrete mixture for varied strength development. f) Provide options to contractors, not step-by-step procedures to allow the contractor to provide options based on their experiences in paving, instead of prescribing how to perform the work. g) Use time-of-completion incentives and disincentives.
Concrete materials	a) Try different cement types (particularly Type III). b) Use accelerating and water-reducing admixtures. c) Use a well-graded aggregate that has a uniform distribution of aggregates on each sieve. d) Keep water-cementitious materials ratio (*w/cm*) below 0.45 for durability and strength. e) Use a prewetted lightweight aggregate sand to cause a higher-early-age and long-term strength.
Jointing and sealing	a) Allow early-age sawing, which is done during the initial concrete. set stage after compressive strengths reach about 150 psi (1.0 MPa) b) Use dry-sawing blades. c) Use step-cut blades for single-pass joint sawing. d) Use a sealant that is unaffected by moisture or reservoir cleanliness.
Concrete curing and temperature	a) Suggest blanket curing to aid strength gain when beneficial. b) Monitor concrete temperature and understand relationship of ambient, subgrade, and mixture temperature on strength gain. c) Improve characteristics caused by less than optimum temperature through internal curing by use of prewetted lightweight aggregate sand to improve early age and longer results.
Strength testing	a) Use nondestructive methods to replace or supplement cylinders and beams for strength testing. b) Use concrete maturity or pulse velocity testing to predict strength.
Traffic opening criterion	a) Revise from a time criterion to a strength criterion; channel early loads away from slab edges. b) Restrict truck traffic.

also can include project-specific opening-to-traffic criteria. Table 1.1.1 suggests changes to project components that can decrease construction time.

1.1.2 *Sustainability*—Sustainability broadly refers to a focus on emphasizing key environmental, social, and economic factors in the construction decision-making process. Transportation agencies and authorities, contractors, and material suppliers alike are all working to improve the sustainability of highway systems to reduce environmental impacts, reduce costs, and provide societal benefits. Sustainability-related benefits of accelerated concrete pavement construction include:

(a) Accelerated opening disruptions to the users of the facility, reduced user delay costs, and reduced work-day length without increasing crew size.

(b) Use of more environmentally friendly materials (less energy intensive to produce), such as supplementary cementitious materials (SCMs) and limestone cements, in conjunction with approved local aggregates.

Additional information on sustainability as related to pavement materials and construction can be found in Van Dam et al. (2015), ACI 325.9R, and ACI (308-213)R.

1.2—Scope

Concrete mixtures used in accelerated concrete pavement construction may be more susceptible to durability-related distress than conventional concrete. Further, the ability to detect durability-related problems during mixture design and construction is more limited (Van Dam et al. 2005). Chapter 5 discusses the design and durability considerations of 6- to 8-hour and 20- to 24-hour concrete pavements. The risks involved in using accelerated paving techniques should be considered carefully before using an accelerated paving option. In addition, the cost of accelerated construction will be higher than conventional, so its use should be limited to those situations where it will provide an overall construction benefit.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

E = mass of water evaporated, in lb/ft^2 /h (kg/m^2 /h) of water-covered surface per hour

$M(t)$= temperature-time factor, deg-days or deg-hours.

Q = quotient of the activation energy E (in J/mol) divided by the universal gas constant R (8.314 J/mol-K), K.

r = relative humidity of air surrounding the concrete; expressed as percentage of relative humidity of air divided by 100 (air relative humidity is measured at a level approximately 4 to 6 ft [1.2 to 1.8 m] above the evaporating surface on the windward side and shielded from the sun's rays).

Ta = average temperature of concrete during time interval Δt, K (air temperature is to be measured at a level approximately 4 to 6 ft [1.2 to 1.8 m] above the evaporating surface on the windward side and shielded from the sun's rays)

te = equivalent age at specified temperature Ts, days or hours

T_c = temperature of the evaporating surface taken as the concrete temperature, °F (°C)

T_o = datum temperature, °F (°C) (typically 14°F [–10°C]).

Ts = specified temperature, K.

V = average wind speed in mph (km/h), measured at 20 in. (508 mm) above the evaporating surface.

Δt = time interval, days or hours.

2.2—Definitions

ACI provides a comprehensive list of definitions through an online resource, ACI Concrete Terminology.

CHAPTER 3—PROJECT APPLICATIONS

3.1—Highways and tollways

Many highway agencies use accelerated techniques for concrete paving to expedite construction and ease work zone congestion. Accelerated-concrete pavement minimizes revenue loss by allowing early access at high-congestion areas such as toll booths and interchanges.

The need for accelerated techniques on rural highway or road construction is more limited. A contractor may use accelerated techniques to speed construction on portions of a project to allow construction equipment on the pavement sooner than usual.

3.2—Streets

Accelerated paving technology also provides solutions for public access on residential and urban streets. Residents or businesses along suburban streets can usually gain access to their driveways within 24 hours.

3.3—Intersections

Intersections pose major construction staging and traffic interruption challenges because they affect two or more streets. Reconstructing intersections one quadrant at a time allows traffic to continue to use the roadways. With accelerated construction techniques and quadrant construction, a contractor can pave the intersection in less than 1 week. Where it is feasible to close the entire intersection for a short time, a contractor can use accelerated paving techniques to complete reconstruction over a weekend.

3.4—Airports

On airport aprons, runways, and taxiways, accelerated-concrete paving speeds sequential paving placements. Such pavement gains strength quickly and allows contractors to operate slipform equipment sooner on completed adjacent paving lanes. The construction schedule is reduced by shortening the wait before paving interior lanes. Accelerated paving techniques also can speed reconstruction of cross-runway intersections, runway extensions, and runway keel sections. This may be necessary to maintain traffic at commercial airports or for the national defense at military air bases. Accelerated concrete paving reduces the time that passenger loading gates are out of service at commercial airports for apron reconstruction.