Best Practices for Airfield Concrete Pavement Design and Construction

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Count on Concrete PAVEMENT

Managing Expectations

- Desired Characteristics
  - strength
  - durability
  - Workability
- Which is better?
  - A well-built poorly designed pavement
  - A well-designed poorly built pavement

Quality Concrete

- Quality is not about Strength
- Quality is not about proper air content
- Quality is not about "slump" of plastic concrete
- Quality is not about 100% Inspection

Safe, durable, free of defects

Workability

Cost of Poor Quality

- For airport owner
  - Operational delays & loss of revenues
  - Cost of claims (litigation)
  - Reduced service life
- For contractor
  - Corrective measures
  - Partial payments
  - Cost of claims (litigation)
  - Liquidated damages

Differences between Airfields and Highways

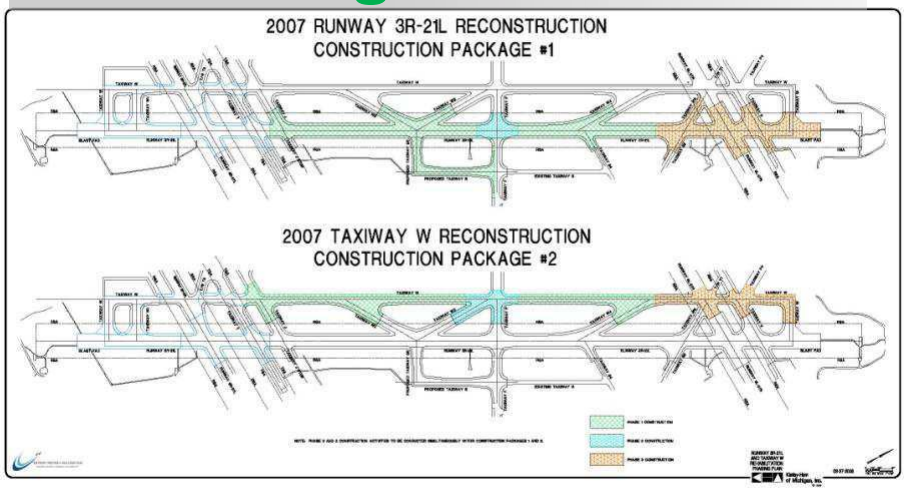
- Thickness (commercial and military)
- Longitudinal joints (doweled vs. tied)
- Critical nature of surface defects (FOD)

Critical Airport PCCP Design Features

- Subgrade support – uniformity & stability
- Base and subbase (uniformity, stability & drainage provisions)
- Slab thickness
- Concrete properties - (uniformity, workability, strength, & durability)
- Jointing details (layout, load transfer, & sealing)

Planning for Construction

Design Phase



Planning Considerations:

- Coordination with stakeholders
- Identify Key Personnel
- Eliminate the Unknowns
  - Geotechnical

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  - Geotechnical
  - Utilities
  - Weather

Weather

Planning for Construction

Construction Phase

Quality in Construction

- Quality must be built into a project. It is not a hit or miss proposition.
- Good materials and construction practices are key to producing high quality and long lasting airport concrete pavements

Variability

- Inherent part of any construction process.
- Sources of construction variability
  - Material
  - Process
  - Testing (precision and bias)
- Negative impact on the property being measured.

Understand the magnitude of the different sources of variability and attempt to reduce each type of variability.

GUIDELINES FOR REASONABLE LEVELS OF CONSTRUCTION VARIABILITY

(In terms of acceptable standard deviation)

- Subgrade Density (standard Proctor test): 1 to 3 lb/cu. ft (for uniform subgrade type)
- Base/Subbase Density (modified proctor test): 1 to 3 lb/cu.
- Concrete Thickness: 0.25 to 0.50 in.
- Concrete Flexural Strength (650 psi concrete): 40 to 60 psi
- Concrete fc (4,000 psi concrete): 300 to 500 psi
- Concrete Air Void (6% air void concrete): 0.5 to 1.0 %
- Pavement Smoothness ?????
- Grade/straight edge: 0.2 to 0.3 in.

Higher levels of variability may indicate that the construction process is not under control or testing procedures are marginal .

Role of Construction Specifications

- Establish the acceptable parameters
  - Civilian: Based on FAA AC150/5370-10A
  - Military: 2003 Unified Facilities Criteria document
- May be prescriptive and/or end-result based
- Provide guidance/requirements for:
  - Materials
  - Construction methods
  - Methods of measurement for compliance with specs
  - Testing requirements
  - Basis of payment

Pre-Bid Activities

- Project overview
- Administrative/contractual details
- Construction scheduling & phasing
- Contractor's access to site & staging area
- Addendums to plans & specifications, if any
- Detailed review of project scope of work
- Bidder's questions
- Site visit

(THIS IS THE TIME TO RESOLVE ANY QUESTIONS/CONCERNS OF THE CONTRACTOR)

Partnering

- A joint meeting between QC and QA reps before construction starts
  - Review project requirements
  - Review action and suspension limits
  - Identify & clarify gaps and ambiguous items
  - Review handling of non-conforming test results
  - Review chain of command for decision making
  - Establish QA/QC data management & data review plan
- Designer, Owner, Program Manager, Contractor

Construction Logistics

- Readiness of all operations
- Concrete plant setup & readiness
- Haul roads availability
- Availability of crews, equipment, & materials
- Subcontractor readiness
- Construction and airport traffic management
- Concrete placement needs (rate of placement)
- Electrical items needs
- QA/QC requirements & backup testing equipment
- Project phasing, if any

Opening to Traffic Issues

- Typically construction related and not aircraft traffic related.
  - Develop specific criteria
    - typical construction equipment
    - different concrete pavement thickness and
    - for edge and interior loading.
  - Consider trade-offs between
    - higher strength requirement and
    - extra thickness
    - Optional base type
  - Develop alternate designs for fast track areas.

Lead Time – ASR & F-T Testing

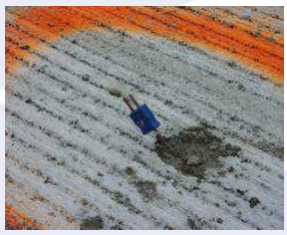
- ASTM C 1260 (ASR) - 16 days for testing.
- ASTM C 1293 (ASR) - 1 year to test aggregate for potential reactivity; 2 years to test effectiveness of mitigation measures.
- ASTM C 666 (F-T) - 2 to 3 months.
- Modified ASTM C 1260

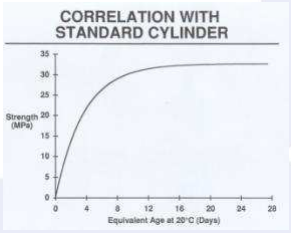
Notes:

1. About 60 days is available from contract award to start of work, so aggregate acceptance needs to be done within that time or before award.
2. ASTM C 1260 can be used to test the effectiveness of mitigation measures. Several combinations of cementitious materials can be tested simultaneously.

Test Strip

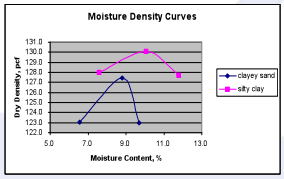
- Used to evaluate concrete batching, transporting, placement, finishing, curing & QA/QC
  - Photos of acceptable and unacceptable sawcuts
  - Establish/validate maturity data or NDT for sawcutting





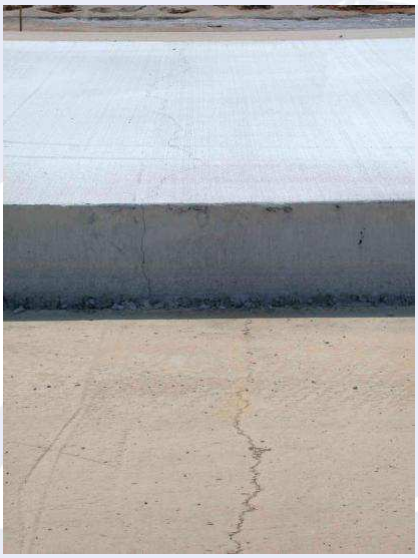
Subgrade Issues

- Proper Compaction
  - Assess moisture sensitivity of subgrade material
- For difficult soils, consider
  - Replacement with better fill material
  - Subgrade modification with lime or cement
- Grade tolerances – ensure correct grade



Stabilized Bases

- Stabilized bases – CTB, LCB (econocrete), ATB, PATB
  - Strength issue for CTB/ LCB – specify min/max values
  - Base stiffness affects pavement performance
  - Potential for random cracking increases



Base Tolerances

- Enhance pavement performance
- Minimize loss of concrete
- Minimize/eliminate pavement thickness PWL penalties
- Enhance pavement smoothness

Concrete Plant Checklist

- Foundation of stockpiles - stable/well drained
- Stockpiles – minimize segregation, contamination
- Aggregate moisture content control
- Bins – minimize intermingling of particles

Slipform Pavers

- Self propelled with two or four tracks
- Weight > 2,000 lb/ft width
- Variable speed hydraulically controlled internal vibrators
- Can carry a head of concrete in front of screed
- Continuous auger/plow pan to distribute concrete
- Finishing attachments

Bridge Deck Pavers

- Truss system with suspended screw auger to spread concrete, oscillating vibrator & a roller
- Ride on forms or self propelled wheels
- One or two vibrators that move transversely
- Do not carry a head of concrete
- Weigh < 1,000 lb/ft width



Light Weight Finishing Machines

- Truss screed or roller screed
- Typically used for thin pavements or non-critical small areas
- Requires manual strike-off, manual vibration, and considerable bull-floating behind screed
- Excessive mortar at surface = poor air void system

Manual Paving

- Labor intensive
- Used for small areas only

String-line Management

- Important for final surface smoothness
- Provides accurate reference for elevation and alignment control of all grade operations
- Stakes ≤ 25 ft
- Stringless Pavers?

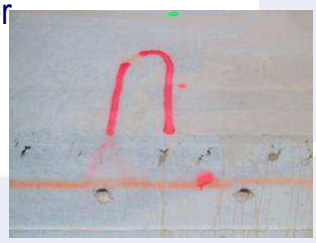
STRINGLINE AIDS
•Use rigid stakes
•Use quality line
•No perceptible sagging
•Eyeball for staking errors
•Re-survey staking errors
•Monitor & maintain line

Concrete Placement

- Deposit concrete as close to paver as possible
- Avoid stop & go operation
- Maintain uniform speed
- Maintain uniform head
- Manage/monitor vibration
  - Check for vibrator trails
- Maintain steady concrete delivery
  - Number of trucks
- Proper distribution

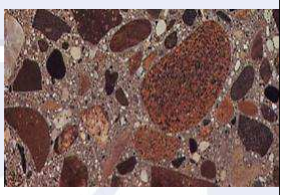
Concrete Placement Issues

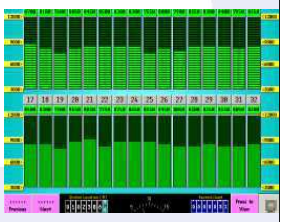
- Proper vibration effort
  - Consolidation Control
  - Provide surface fines for a tight finish
- Concrete dumping
  - In front of paver – better – can control control concrete head better, but dowel basket caution
  - Side loading belt placer or spreader
- No water addition
- Voids along slipformed sides



Concrete Consolidation

- Inadequate consolidation
  - Lower in-place concrete strength
  - Honey-combing
- Over-consolidation
  - Poor air void system
  - Less durable concrete
- Monitor vibration effort regularly
  - vibrator smart system recommended – continuous monitoring





Poor Consolidation

Finishing Operations

- Finishing needs are minimized by
  - A workable mixture
  - Proper paving equipment operation
- Excessive hand finishing will work water to the surface



Concrete Curing

- Maintain adequate moisture & temperature regimes in freshly placed concrete
- Inadequate curing
  - Excessive moisture loss at surface => plastic shrinkage cracking
  - Weak surface – durability problems
  - Excessive slab warping
- Timely curing behind paver

Paving Around In-Pavement Structures

- Lights, hydrant pits, utility manholes & drainage structures (trenches)
- Properly planned for and executed – consider during design phase
- For light cans, methods include
  - Blockouts
  - Split can & coring

Adverse Conditions

- **Hot weather**
- **Cold weather**
- **Rain**

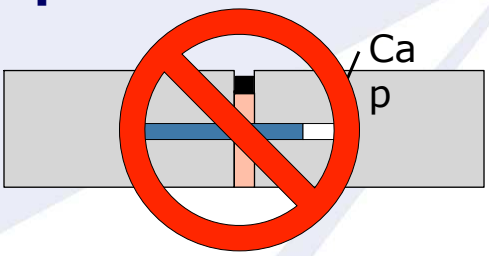
Joint Sawing & Sealing

- Joint sawing & sealing is an art & not an exact science
- Requires experienced crew
- Sawing and sealing operation effectiveness
  - Understand window of opportunity
  - Understand sawing process
    - Blade type & speed of sawing vs. aggregate type
  - Maintaining a clean reservoir
  - Correctly installing sealant material

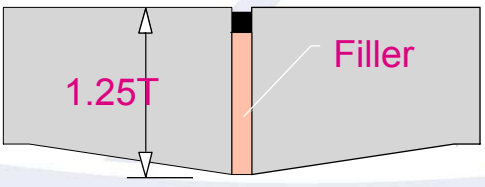
Terminology Change

Isolation/~~Expansion~~ Joints

Doweled

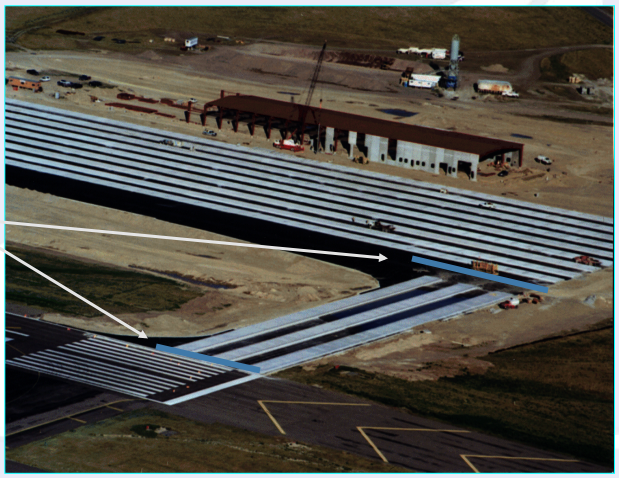


Thickened Edge



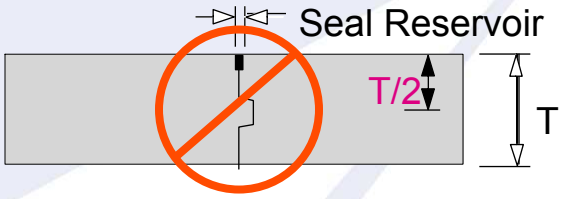
Where to Isolate…

Different
Movement
Axis



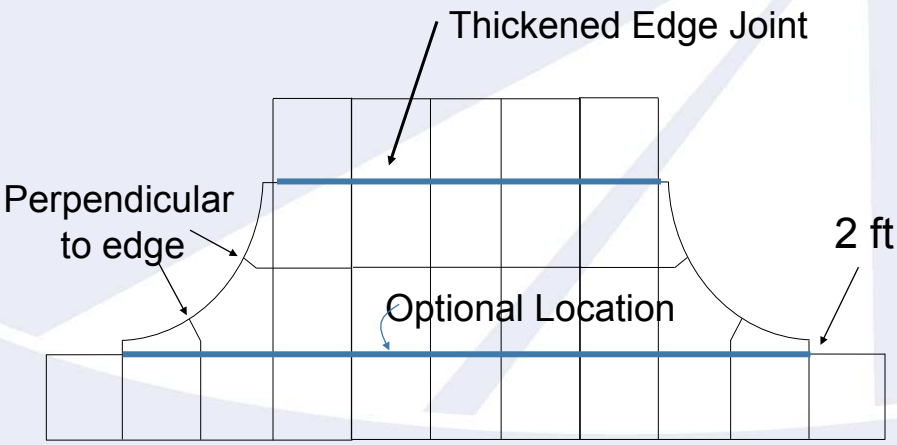
Construction Joint Details

Keyed



FAA AC/150-5320-6E – Detail
has been removed

Filet Details

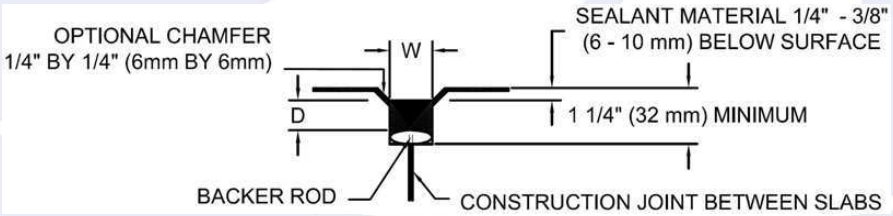


Fillet Details

Rigid Pavement Design – Details

Rigid Pavement Joint Types and Details

- Beveled Joint Detail
  - Intended to reduce chipping and spalling attributed to snow plows



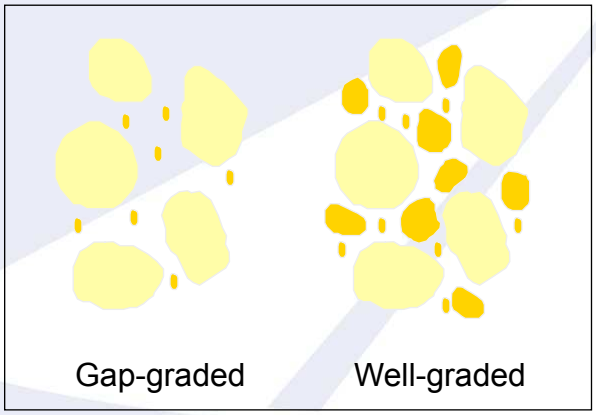
Concrete Mix Issues

- Concrete quality
  - aggregates quality
  - paste quality
  - bond between the two
- Paste quality => amount of water & admixtures
- Key properties of concrete
  - Workability – easily placed, consolidated, finished
  - Strength – required strength at desired time
  - Durability – long term durability under service conditions

Defining Workability

Component	Placement	Consolidation	Finish
Aggregates			
Coarse	**C**	**C**	**M**
Fine	**M**	**M**	**C**
Cement		**S**	**M**
Water	**C**	**C**	**C**
Admixtures			
Air Entraining	**M**	**M**	**S**
Mineral	**M**	**M**	**M**
Chemical	**C**	**C**	**S**

Aggregate Grading (Optimize)



Summary of Critical Factors for Concrete Paving Best Practices

- A good concrete mixture
- A good grade & track line for paving
- Stringline management
- Continuous supply of concrete to paver
- Consistent concrete workability
- Well maintained paving equipment
- Proper operation of paving equipment
- Controlled density of concrete – just the right vibration & finishing
- A skilled and dedicated crew

THANK YOU!

Please contact Gary L. Mitchell with questions or comments:

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