Concrete Pavement for Airfield Pavements

Concrete Mixture Optimization

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Count on Concrete PAVEMENT

Airfield Concrete vs Highway Concrete

- Thicker
- Larger slabs
- Deleterious Materials requirements
- ASR Testing
- Aggregate sizes
- Loads
- Mission
- Centered around FOD

Airfield Pavements vs Structural Concrete

- Common Specifications - ACI
  - No. 57 or No. 67 Stone
  - ASTM C33 Sand
- Produce gap-graded mix
  - Large aggregate + sand
  - High paste demand to fill voids between large aggregate
- Doesn't really work well for pavements

Gap-Graded Concrete

- Large aggregate Issues
  - Harsh, difficult to place and finish
  - Desire to add water, sand, superplasticizers
- Paste and mortar required to fill voids
  - Work concrete to finish
  - paste/mortar at edges
  - Creates mortar pockets
- All bad for airfield paving

Quality Airfields Are:

- Functional
- Proper Drainage
- Surface Characteristics
- Slab size/thickness/layer strengths
  - If incorrect = cracked slabs

Quality Concrete Is:

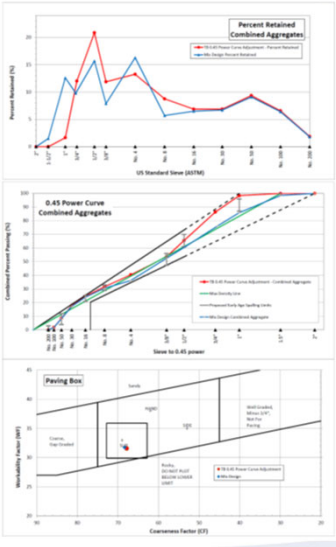
- Durable Concrete
  - No sliver spalls
  - No scaling, surface spalls
  - No reactivity / aggregate durability issues

Quality Concrete

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

Concrete Optimization

- Why?
- What?
- How?



Why?

Avoid Sliver Spalls!

- Within 1 inch of joint
- Max Depth = Seal Reservoir

What is Mix Optimization?

Combined Gradation

- Dense graded aggregates
- Concrete 85% Aggregate
- Aggregates control Concrete
- Similar in concept to
  - Granular Base
  - Hot Mix Asphalt

Tarantula Curve

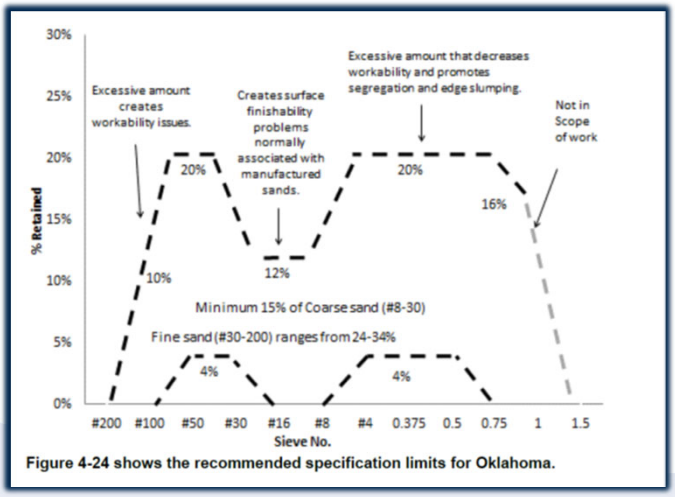


Figure 4-24 shows the recommended specification limits for Oklahoma.

The Box Test

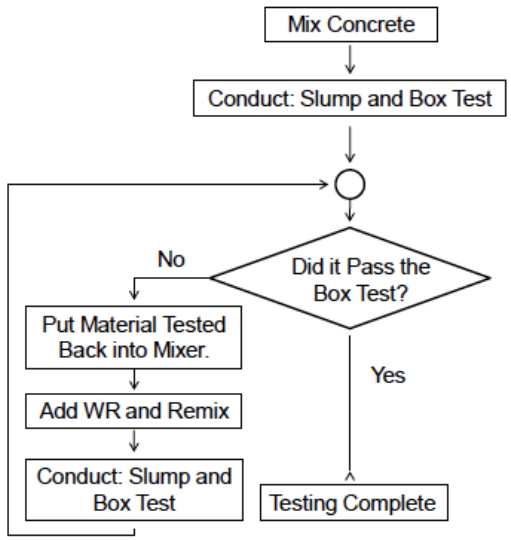


FIGURE 2-4 displays the flow chart of the Box Test procedure.

Steps of the Box Test

Step 1

Construct box and place clamps tightly around box. Hand scoop mixture into box until the concrete height is 9.5".

Step 2

Vibrate downward for 3 seconds and upward for 3 seconds.

Step 3

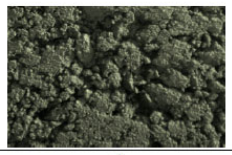
Remove vibrator.

Step 4

After removing clamps and the forms, inspect the sides for surface voids and edge slumping.

FIGURE 2-2 displays the four steps of the Box Test.

Assessing the Box Test



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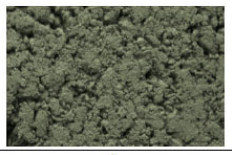
Over 50% overall surface voids.



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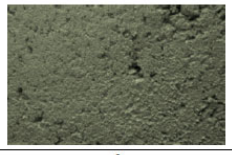
30-50% overall surface voids.



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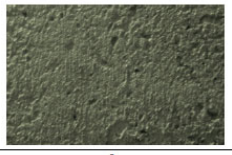
10-30% overall surface voids.



1

Less than 10% overall surface voids.

FIGURE 2-3 shows the visual and numerical surface void values used to rank mixtures in the Box Test.

The 0.45 Power Curve—good, bad, or useless?

In addition, others have used the straight line from origin through nominal maximum size to visually evaluate the overall distribution of the mixture. The technique was used on many mixture designs throughout the report. However, it was not found to be useful and will not be further discussed in this report.

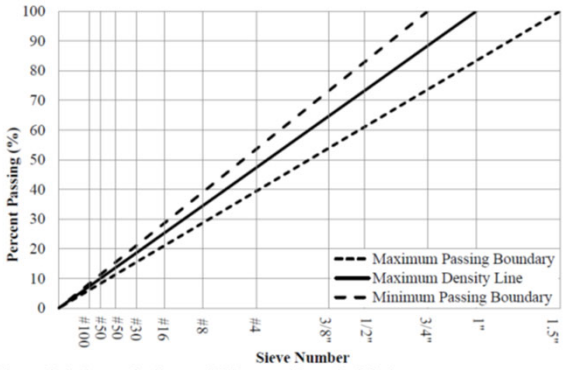
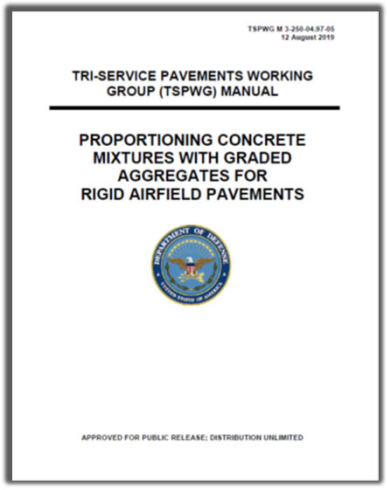


Figure 3-4 shows the Power 45 Curve with typical limits.

How Do I Optimize?

- Shilstone
- ~~1997 USAF ETL 97-5~~ Tri-Services Pavement Working Group (TSPWG) Manual—Proportioning Concrete Mixtures with Graded Aggregates For Rigid Airfield Pavements
- UFGS 32 13 14.13—#4s & #67 at minimum; FAA requirement?
- CF & WF
- Percent Retained
- 0.45 Power Curve


TSPWG M 3-250-04.97-05
12 August 2019

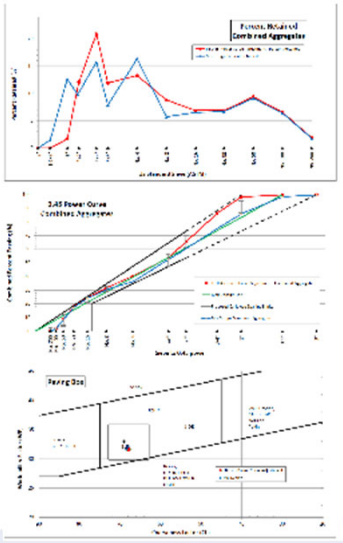
TRI-SERVICE PAVEMENTS WORKING GROUP (TSPWG) MANUAL

PROPORTIONING CONCRETE MIXTURES WITH GRADED AGGREGATES FOR RIGID AIRFIELD PAVEMENTS

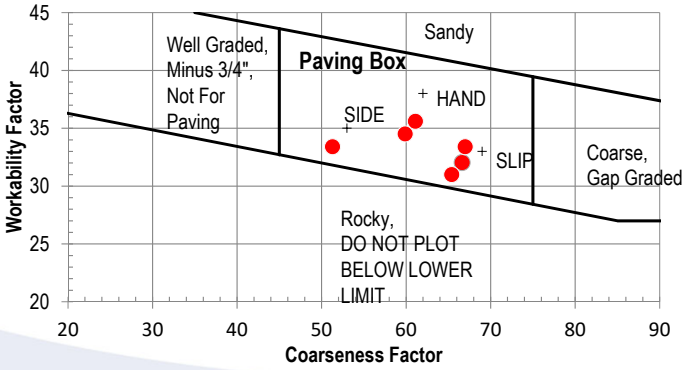
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Optimization Guidelines

- Use Combined Materials
- Workability and Coarseness Factors
  - WF: Percent Pass No. 8 Sieve
  - CF: 3/8 Retained % / No. 8 Retained %
- Percent Aggregate Retained
- 0.45 Power Curve



WF & CF

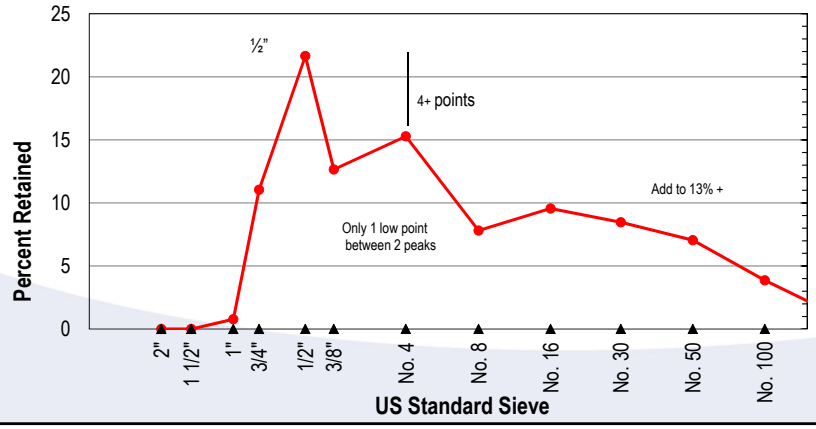


WF & CF = "Big Box"

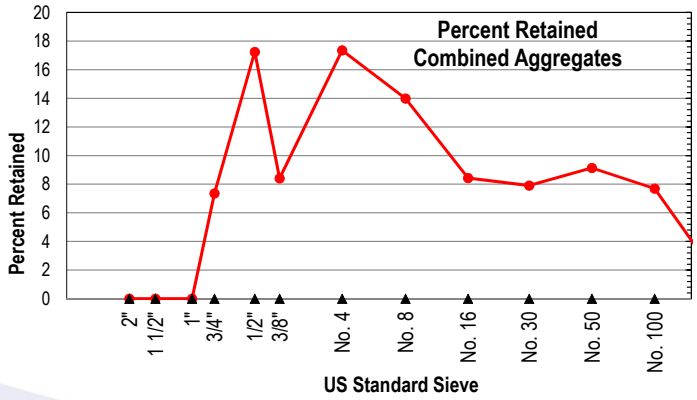
- Big Box is mandatory
- Outside, mix will not work
- Inside, mix occasionally has issues
- Percent Retained & 0.45 Power Curve help refine

Percent Retained

- Highest Peak on 1/2 inch sieve or larger
- At least 4 points difference between peaks
- Sum of two adjacent points is 13% or more, except for maximum size, No. 100 and No. 200 sieves
- No more than 2 low points between 2 peaks



Percent Retained – Equal Peaks



Highly sensitive to water—too hard to pave

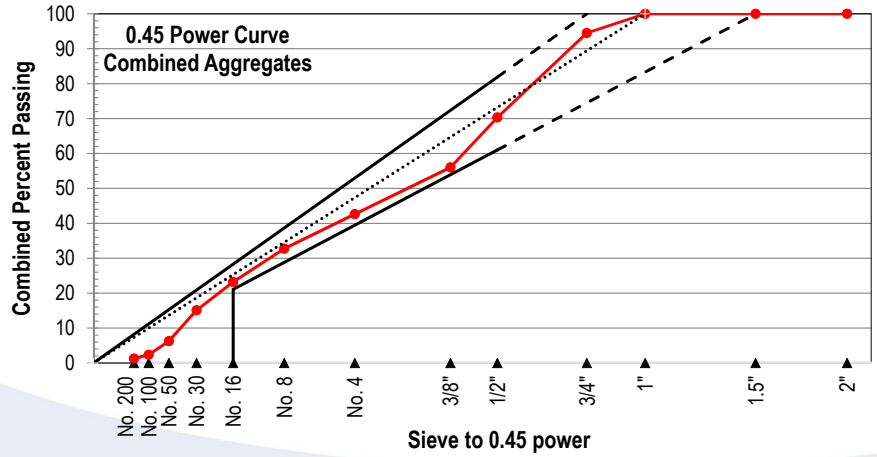
Two Peaks -Water Sensitivity

0.45 Power Curve

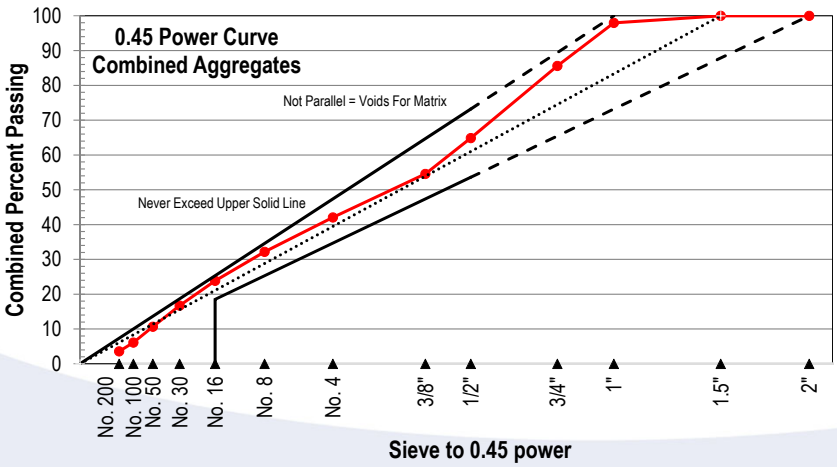
-Antidotal Evidence that the Upper Control Line Controls Sliver Spalls
-Especially in the No. 16 to No. 100 Sieves
-Parallel Contributes to Sliver Spalls, difficult to work

- Never exceed upper solid line
- Never consider exceeding upper solid line
- Avoid exceeding upper solid line
- Do not parallel the maximum density line

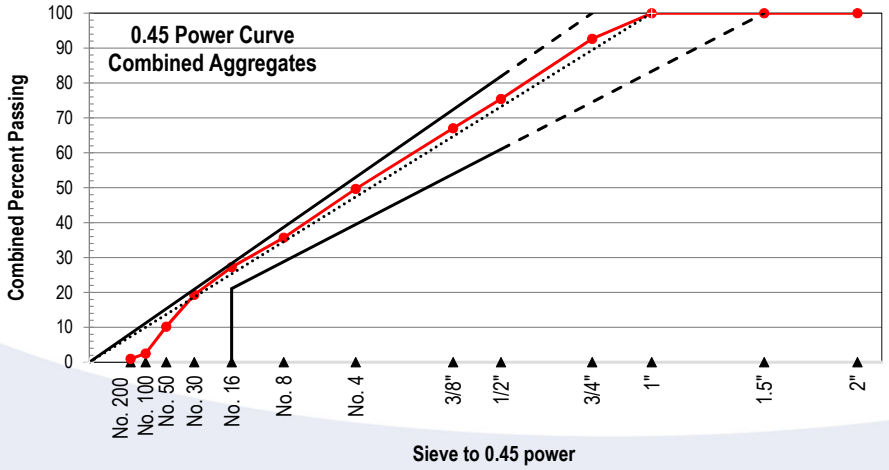
0.45 Power Curve



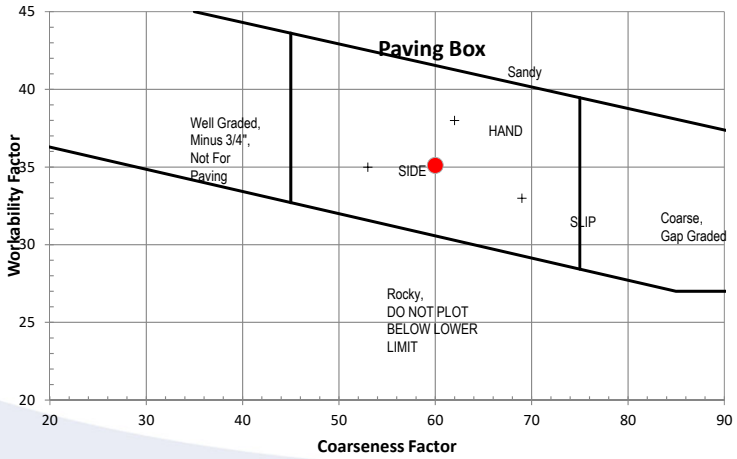
0.45 Power Curve - Good



Parallel Max Density—not so good



Runway Project



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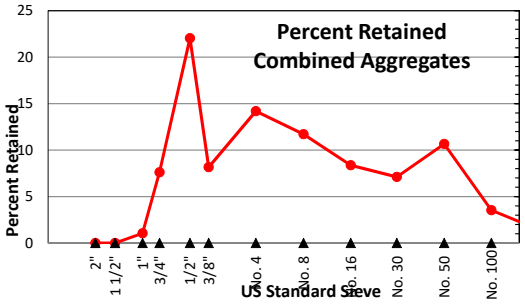
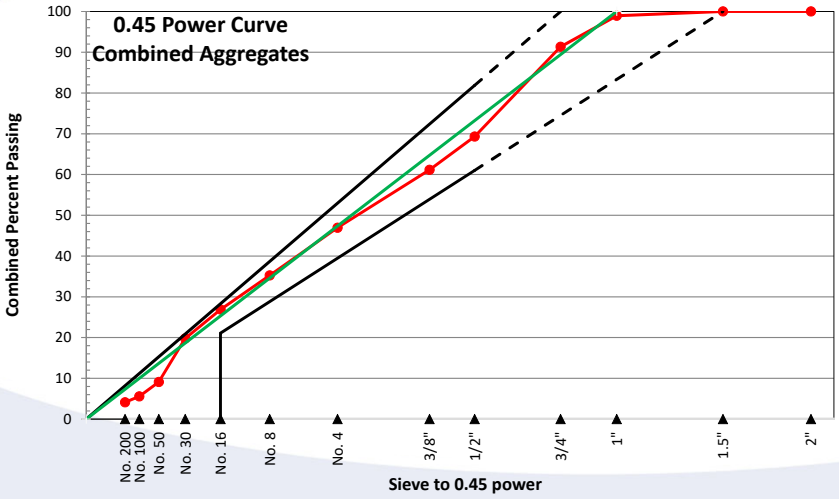


Runway Project



Aggregate Shape & Size

- Slipform needs crushed aggregate
- Sideform may use gravels or crushed
- Maximum size –
  - Engineer should specify top size— ¾ inch plus
  - Larger max size requires more intermediate sizes
  - Larger size may provide better load transfer
  - 1.5” rock is not available everywhere (i.e. #4s)

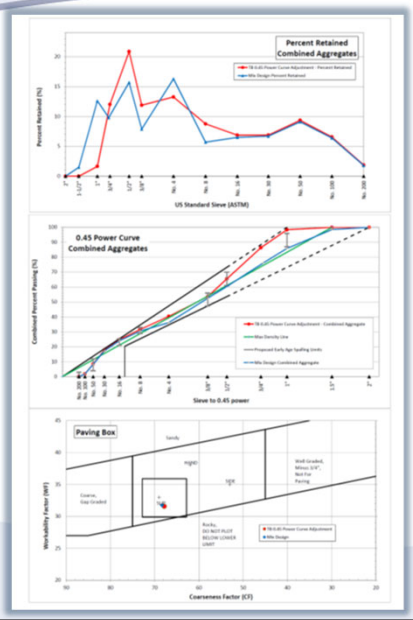
To Be Wise

- This is all “paper” analysis
- Must make trial batches with batch plant
- Must adjust proportions to optimize mix
- Must pave and adjust proportions to paver and site
- *Combined* proportions are the approved mix
- Must control gradations at the stockpile

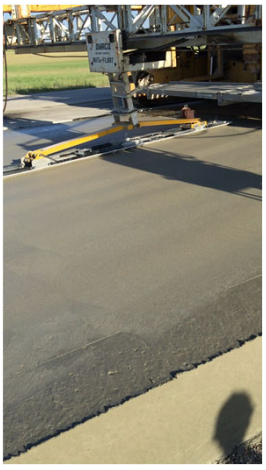
Daily Paving

- Gradation of each stockpile prior to paving
- Mathematically check combined gradation
- Adjust individual batch weights to achieve target combined gradation
- If WF is ± 3pts and CF ± 5 pts,
  - May see placement workability changes
  - No measurable strength changes
- Communication between the paver and plant

Air Force Base Taxiway



Air Force Base Paving Video



How Do you Know its Right?

TIGERBRAIN ENGINEERING, INC.

Not Quite There

TIGERBRAIN ENGINEERING, INC.

But it looks good?

TIGERBRAIN ENGINEERING, INC.

But after fixing the plant…

TIGERBRAIN ENGINEERING, INC.

Memphis ANG

TIGERBRAIN ENGINEERING, INC.

Memphis ANG

TIGERBRAIN ENGINEERING, INC.

Memphis R/W 9-27

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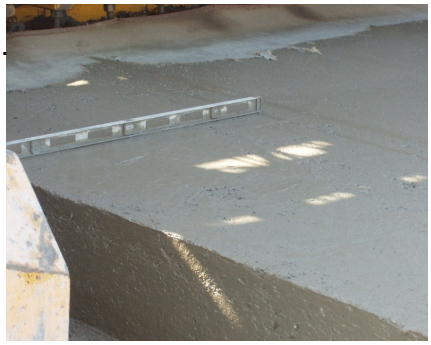
San Juan R/W 10-28

Not Quite…



San Juan R/W 10-28

Got it!

This is what it should look like…

Questions or Comments…