ACI 117 Specification Section 8 Paving: New Research on Paving Thickness Tolerances

Jim Cornell
JN Cornell Associates, LLC

Ver3

Today's Scope of Presentation

Paving Specified as 'Minimum Thickness'

GPR Data Significant Digits

Concept of Sloped and Warped Pavement Surfaces

Analysis GPR Data for Sloped and Warped Surfaces

Paving Thickness Tolerances Qualification

- Focus today on paving of a typical privately developed project which would include fire lanes, traffic lanes with ‘some’ truck traffic, and parking areas.

- Excluded today would be terminal parking areas, public streets, highways and interstate paving.

Paving Thickness Tolerances Design

- The paving design begins with recommendations by the geotechnical engineer followed by ‘For Construction’ documents prepared by the civil engineer.
- The civil engineer may (or not) follow the recommendations of the geotechnical engineer.
- Both disciplines will use the term ‘Minimum Pavement Thickness’ to specify the thickness.
- LDP have been designing successfully concrete pavements with excellent service performance.

Paving Thickness Tolerances Design

- Both disciplines will as a rule will not specify a negative tolerance but respond and approve a Contractors RFI that ACI 117 specified tolerances do apply.
- Sometimes the specifier will refer to ACI 117 in the contract documents but not very often. If referenced ACI 301 Specification incorporates ACI 117.
- Generally, Minimum Thickness requirement is applied for acceptance only in the event of a lawsuit.

Paving Thickness Tolerances Design

- The tolerance values for SOG and Paving presented in ACI 117 have been set based on judgement and not measured data.
- ACI 117 is moving to tolerance values supported by research and a data base.
- ACI 117 has been collecting thickness data and is beginning to have enough data to draw conclusions.
- ACI 117 is not advocating changing how we design, 117 data recognizes our actual construction performance.

Paving Thickness Tolerances

- Current version of ACI 117-10(15) Tolerances.

  Section 12 Exterior Pavements & Sidewalks

- Is silent on the issue of subgrade tolerance.
- Is silent on the issue of thickness tolerance.
- Apparently assumes one would used Section 4 Slab-on-grade for thickness criteria but does not direct us there.

Paving Thickness Tolerances

- ACI 330.1-14 Specification for Unreinforced Concrete Parking and Site Paving

Section 3.10.2.2 directs us to utilize ACI 117 Section 4.5.4 for paving thickness tolerances.

ACI 117 Section 4.5.4 specifies how to measure, what method to use, analyze the data for an average of minus 3/8” with no individual test exceeding minus 3/4”.

Paving Thickness Tolerances

- ACI 117 is currently balloting Section 8 Paving.

New section will be very clear on how to measure, analyze data, requiring an average thickness that is greater than the design thickness minus 3/8”.

Based on new research and analysis of 117 data base the new section will also define paving surfaces into sloped paving and warped paving.

Changing the individual -3/4” is under consideration.

Paving Thickness Tolerances

- Balloted Sloped Paving Definition:

  'The finished concrete surface (and corresponding subgrade surface) sheet drains in one plane and one direction.'

- Balloted Warped Paving Definition:

  'The finished concrete surface (and corresponding subgrade surface) drains in multiple planes, contours, and multiple directions.'

Paving Thickness Tolerances GPR

- GPR is not specified but is included in the 117 Optional Checklist:

  GPR was new and expensive when 117 previously written. So the previous version focused on cores and impulse echo methods within the body of the spec.

Paving Thickness Tolerances GPR

- GPR is now economical but:
  - How to measure randomly?
  - How to analyze thousands of data points?
  - Easy to ‘hunt’ for non-compliance?
  - Accuracy issues: ASTM test procedure does not address accuracy and significant digits.

Paving Thickness Tolerances GPR

- GPR requires dielectric constant to be confirmed with core samples:

ASTM procedure for Cores rounds to nearest .05”

ASTM for GPR does not define accuracy or digits.

GPR Accuracy Range: Avg 5% Individual 10%

6” measurement 5% = ¼”

Providing GPR data to nearest .01” is misleading.

GPR Data Analysis

- 6” Reinforced traffic lane and parking areas.
  - GPR data dielectric constant confirmed with cores.
  - Data analysis to 117 specifies that average thickness exceeds 117 requirement of > 5.6”. With individual points greater than -3/4”, 5.2”

GPR Data for Sloped Paving

- 6” design thickness

  473 Data Points Thickness range: 4.2” to 9”
- Avg Thickness: Raw 5.8” 117 Modified 5.8”

  Standard Deviation: Raw .44 117 Modified .41

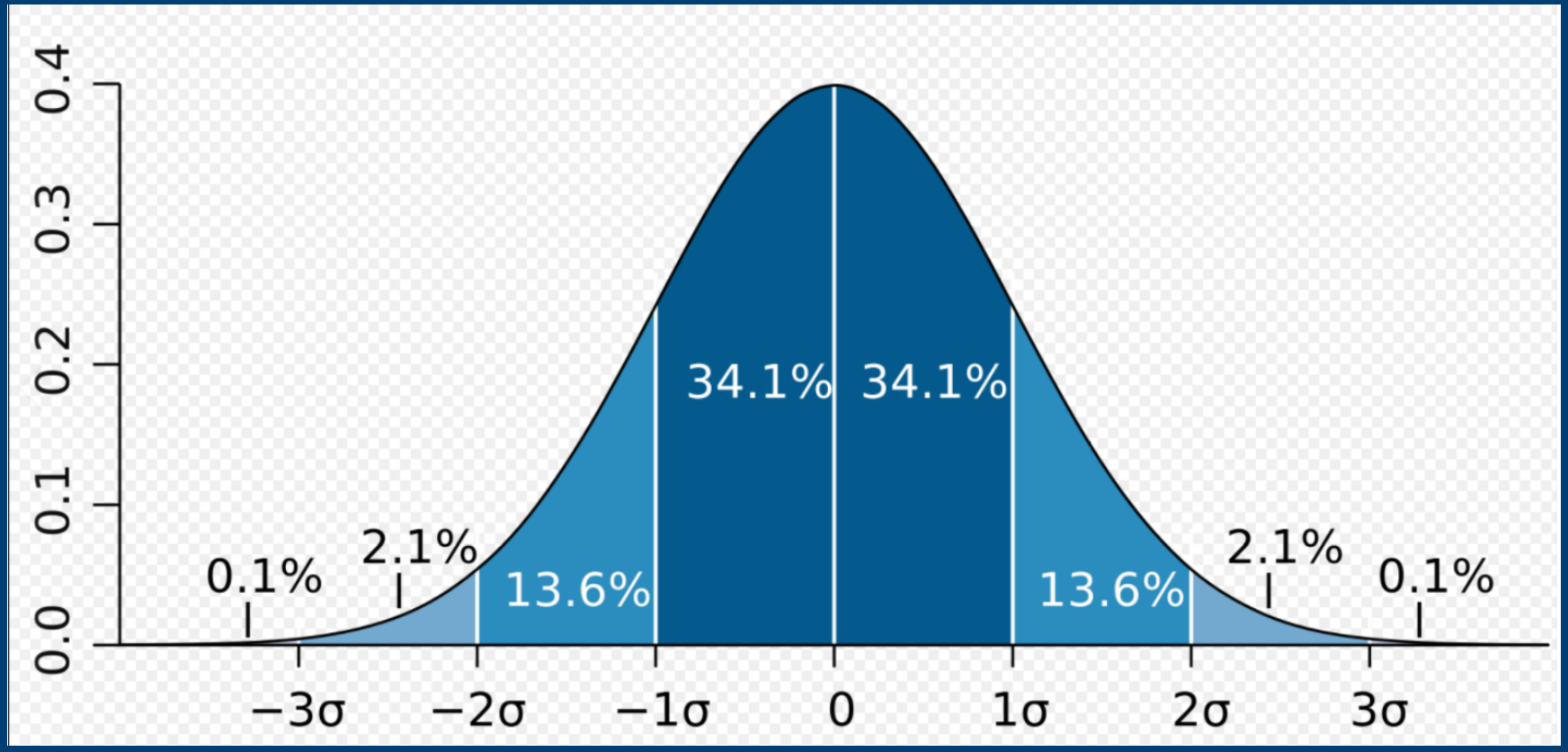
  Meets 117 average thickness criteria of ≥5.6”
- Individual Minus Thickness:

  Minus ¾” 44 points for 91% compliance.

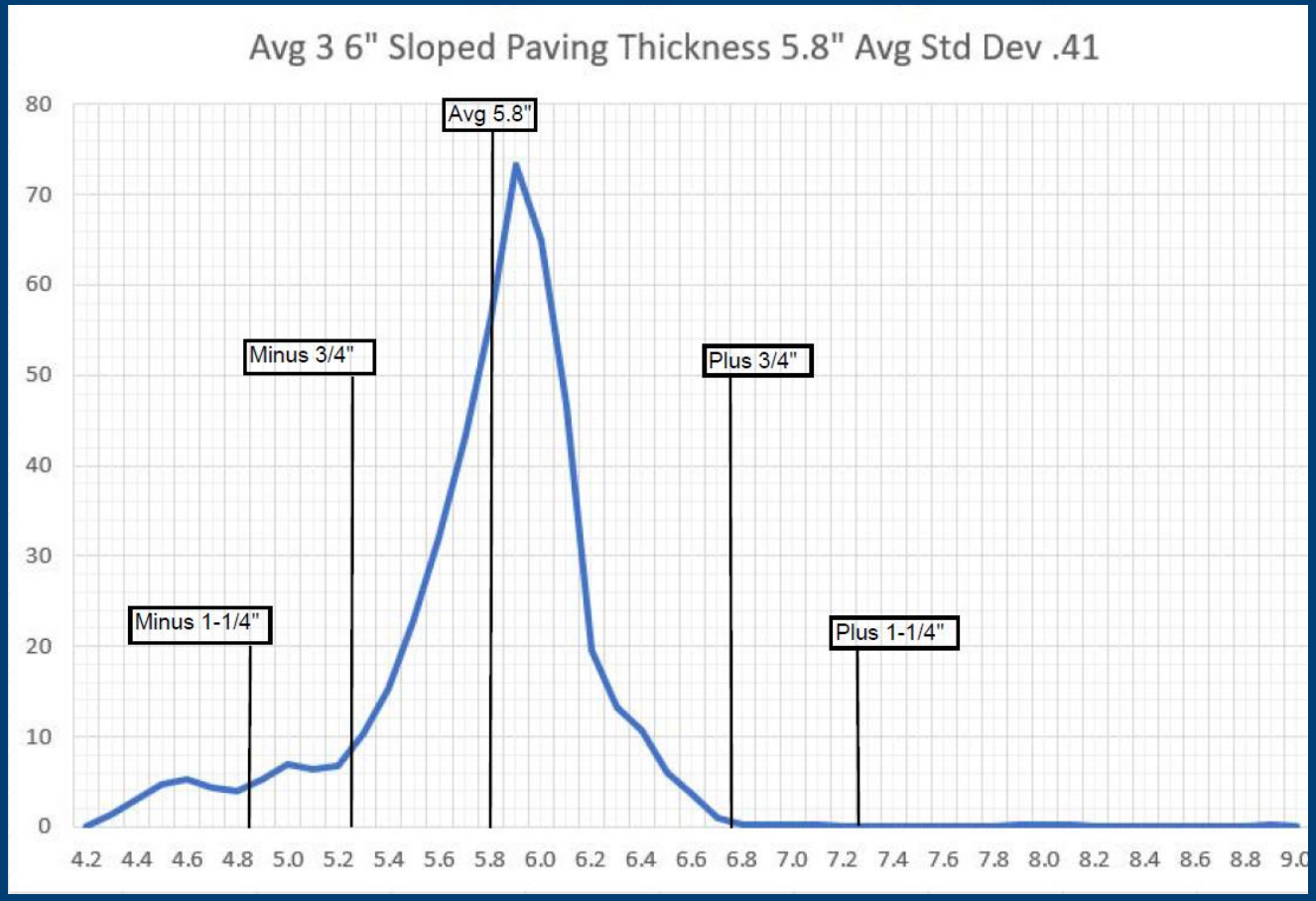
  Minus 1-1/4” 20 points for 96% compliance.

  Minus 1-1/2” 4 points for 99% compliance.

Statistical: Uniform Distribution Curve



New GPR Data for Sloped Paving



GPR Data for Warped Paving

- 6” design thickness

  1175 Data Points Thickness range: 3.2” to 10”

- Avg Thickness: Raw 5.8” 117 Modified 5.7”

  Standard Deviation: Raw .93 117 Modified .68

  Meets 117 average thickness criteria of ≥5.6”

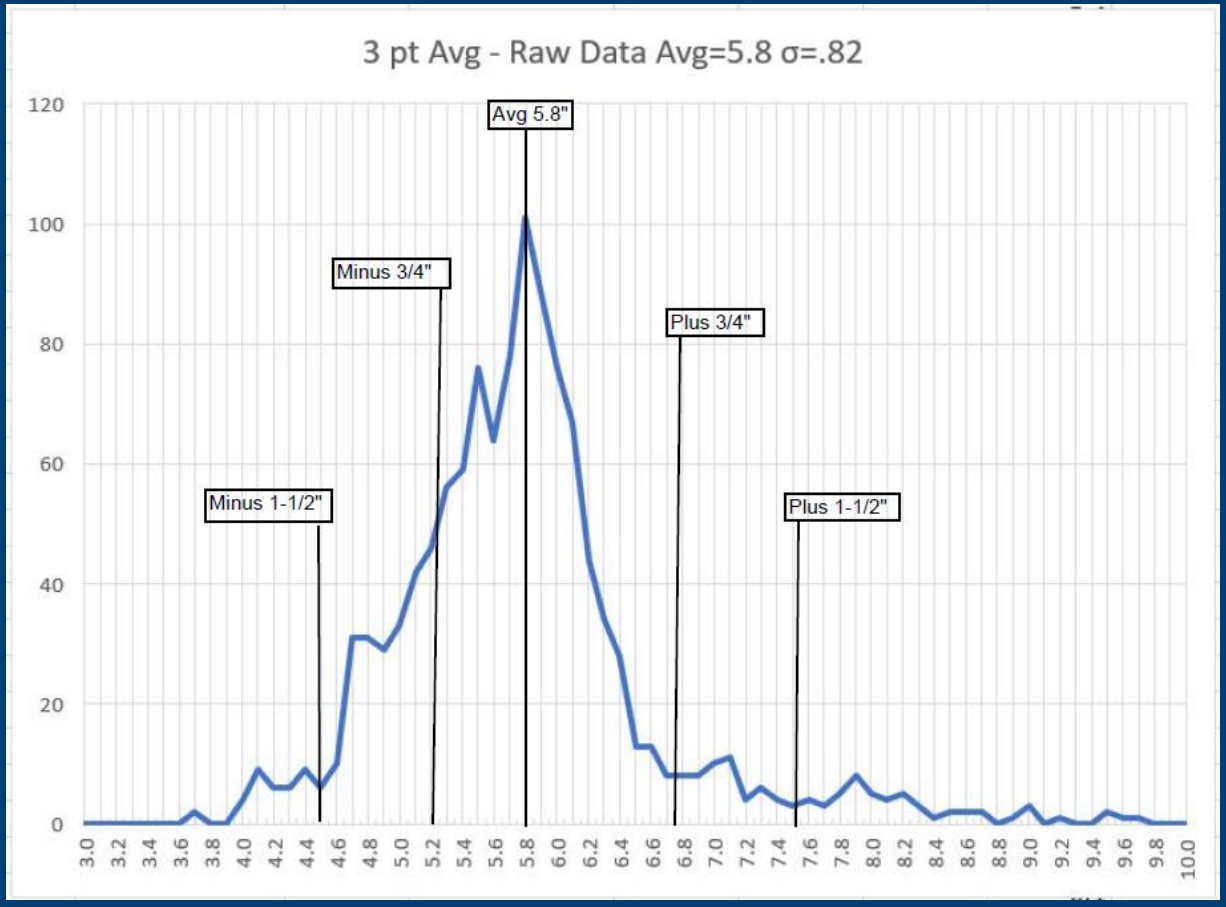
- Individual Minus Thickness:

  Minus ¾” 241 points for 80% compliance.

  Minus 1-1/4” 106 points for 91% compliance.

  Minus 1-1/2” 61 points for 95% compliance.

New GPR Data for Warped Paving



Paving Thickness Tolerances Conclusions

- For GPR testing to become main stream, methods and analysis of GPR test data needs to become standardized. Issue of accuracy of measurements needs to be addressed.
- LDP needs to clarify Minimum Design Thickness allows for minus tolerances.
- LDP needs to reference ACI 117 Section 8 for minus tolerances, measuring methods, and data analysis.

Paving Thickness Tolerances Conclusions

- ACI 117 is balloting a more enhanced Section 8 on Paving to give design professional and Contractor a standard reference.

- ACI Section 8 ballot is responding to new research showing significant deviation in thickness results depending on type of paving. Use of two classifications of paving: sloped and warped.

Paving Thickness Tolerances Conclusions

- Test data presented confirms that there is a significant difference in thickness between sloped and warped paving.
- Test data presented confirms that use of thickness standard deviation is an indicator to quality of contractors means + methods.
- Test data confirms that proposed new tolerances of minus 1-1/4” for sloped and 1-1/2” for warped will achieve about 95-96% compliance.

Paving Thickness Tolerances Conclusions

- Test data confirms that 100% compliance could be possible but Contractor would need to set a target thickness greater than the design thickness.

- To emphasis for the second time:

  GPR testing needs become standardized and not subjective.

  Issue of accuracy of measurements needs to be addressed.

Thank you

For the most up-to-date information please visit the American Concrete Institute at:
www.concrete.org