AMAP
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Austin, Texas
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TOPICS

1) Update on **M**artin **L**uther **K**ing Bridge Deck Overlay

AMAP Conference 2005

2) IDOT Study

Evaluating PG Grade in 4.75mm Sand Mixes

MLK BRIDGE

- One of 4 bridges Connecting Illinois to downtown St. Louis
- Commuter Bridge
- ADT 35000

Bituminous Bridge Deck Overlay
Year - 1999

Contract Specification
Surface Mix Design

- Type I D Surface Mix
- 75 Blow Marshall Mix Design
- AC 20 Liquid Binder

- Design Air Voids = 4.0%
- 92.0% – 96.0% Field Density Requirement
- 32mm or 1 1/4” Thickness
- 400 Tons

First Sign of Trouble

- Mat movement – Push & Shove

- Coarse Texture

- Low densities

More Signs of Problems

- Cracks Develop
- Mix Raveling
- Minor Rutting

Primary Cause of Failures

APPLICATION – Not the Mix Design

- Marshall Mix Design
  - Generic
  - “One Size Fits All” Design
  - **High** – Medium – Low Traffic Level
- Designed For High Traffic Only
  - Stiff/Brittle
  - Coarse Gradation
  - Low AC Content

Marshall Design – High Traffic

- Difficult to Attain Good Density
  - Susceptible to Rutting
    - No Vibratory Roller Allowed
- Low AC Film Thickness
  - Durability Problem
- Open Mat
  - Moisture Damage

Mix Design Change
Year 2000

- **Superpave N70 Surface Mix**
  - Aggregate Gradation Change
    - 12.5mm to 9.5mm
  - PG Grade Change
    - Increase Liquid Binder Content
    - AC 20 to SBS PG 76-28

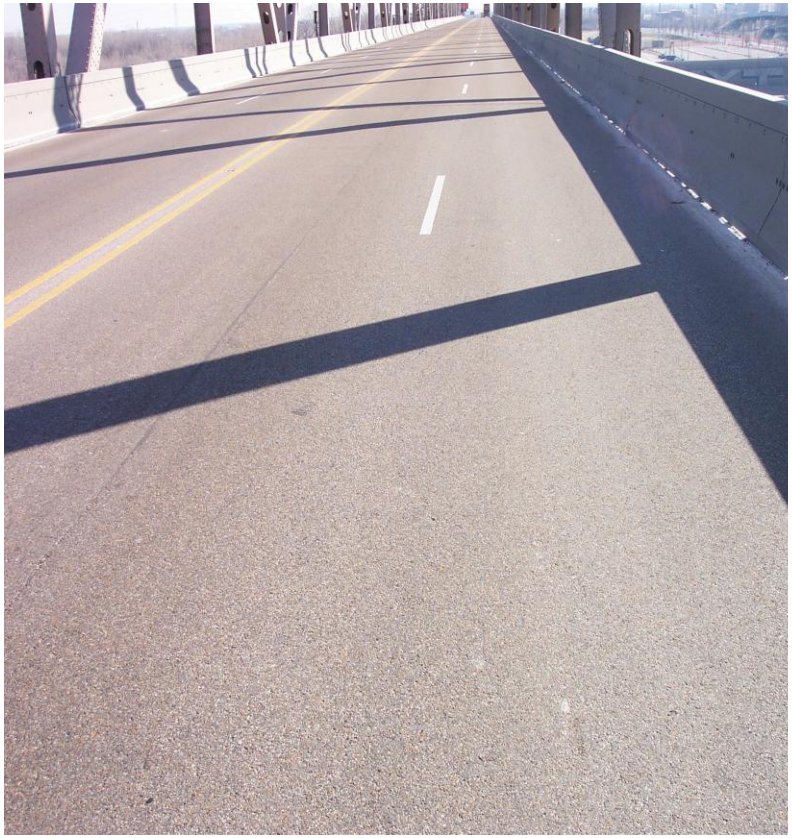
Mix Design Difference

- Aggregate Gradation
  - Lower NMAS – increase mat density
    - Lift Thickness > 3 x NMAS
- Liquid Binder
  - Increase content – increase mat density and film thickness (improve durability)
  - Added modifier – Rut Resistance & reduce thermal cracking

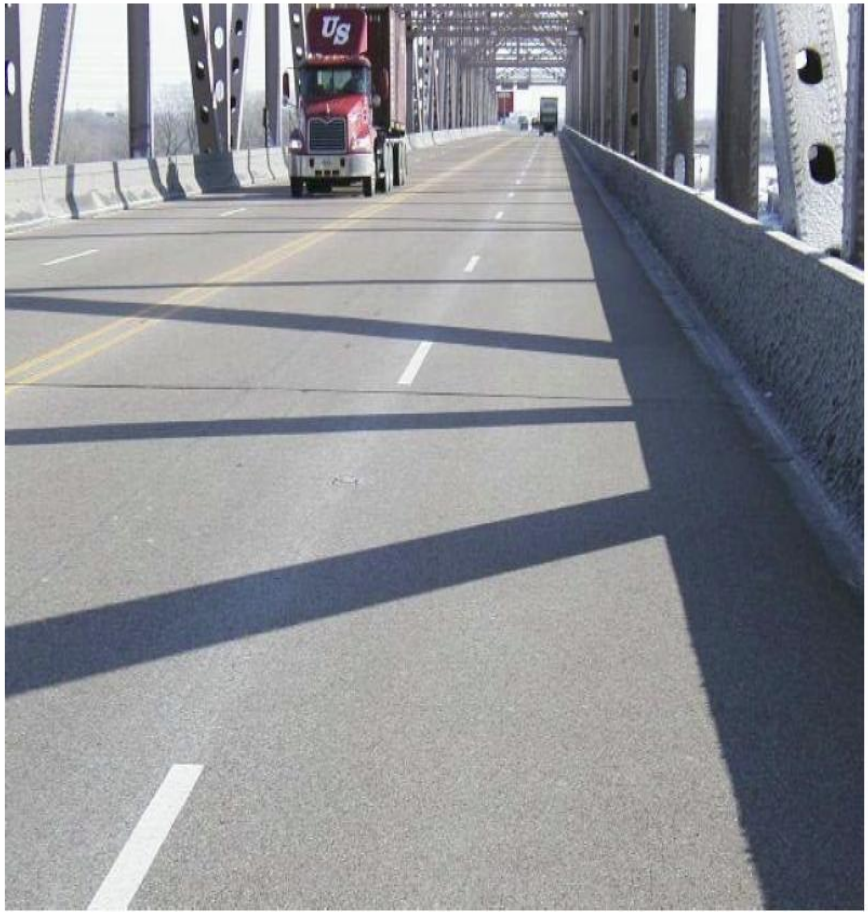
Year 2005

Year 2008

2005



2008



IDOT STUDY

Bureau of Materials & Physical Research

Reducing the Asphalt PG Grade in 4.75mm Sand Mixes

HMA Strength/Stability -Type Tests

OUTLINE

- Background
- Various Strength Tests Used
- Observations and Recommendations

Typical IDOT – Level Binder

- **Eliminate Minor Defects prior to surface lift**
  - **Rutting – Cracking – Slope Correction**
- **9.5mm Dense Graded Mix**
  - **3/4” to 1” Lift Thickness**
    - **Existing Pavt – Bit. Or PCC**
  - **Density Problems**
    - **3/4 “ Lift < 3 x NMAS 9.5mm**

4.75 mm Sand Mix - Level Binder

- 4.75mm Sand Mix – Experimental Use in 2004
  - 3/4 “ Lift > 3 x NMAS 4.75mm
- Rutting / Reflective Cracking
  - PG 76 – 28 (Typically over 8%)
    - High polymer content (high elastic recovery)
- Stability
  - High Manufactured Sand
- Permeability
  - Combination (High % - Man. Sand, -200, AC)
    - Low Value

4.75 mm Sand Mix

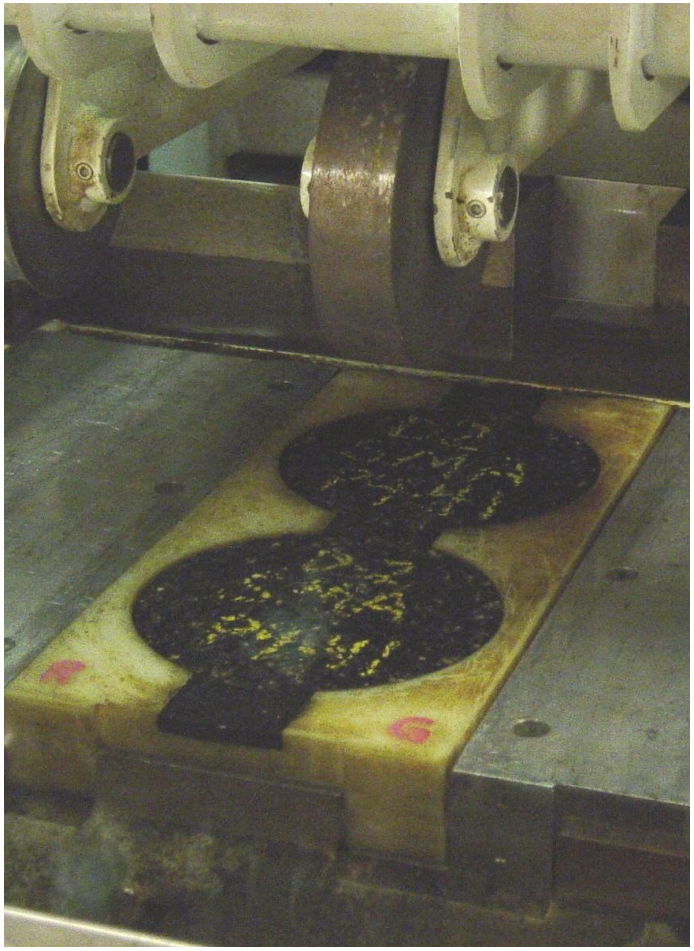
- Objective - Reflective Cracking Control?
- Indications – slow down but does not eliminate
  - Not effective as originally hoped
- Reason for Study
  - Can the PG Grade be lowered to save cost without compromising performance?

Strength & Stability Tests

- Asphalt Pavement Analyzer
  - Pressurized Rubber Hose
  - Steel Wheel (Modified)
- PINE Rut Tester
- Indenter
- Marshall Stability

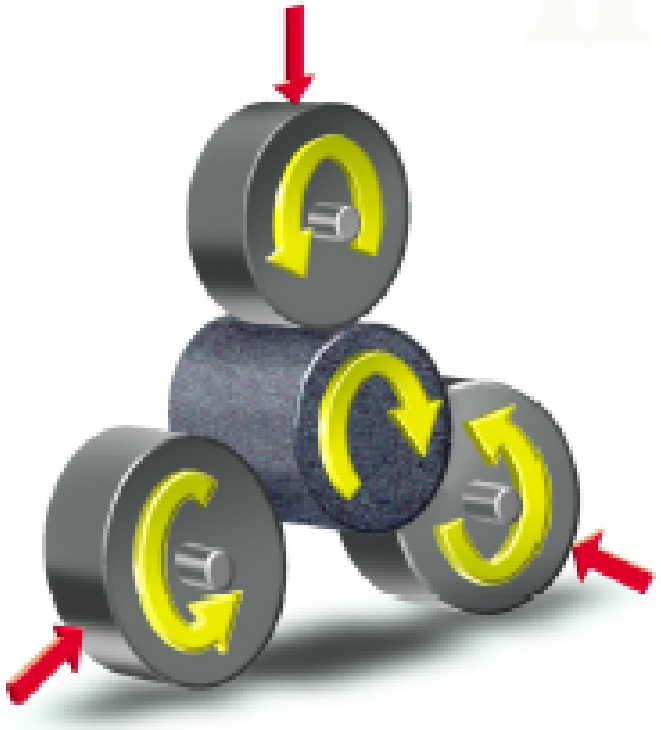
APA

APA with Steel Wheels



PINE Rut Tester

Loading



Three Hamburg Style Wheels

The unique design of our wheel tester continuously rotates an SGC specimen between three Hamburg style wheels, with each rotation of the specimen providing three load cycles.

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The path around the outside of the specimen is of infinite length, eliminating the need to prepare and join together multiple SGC specimens. Wheel velocity is constant, unidirectional, and easily adjusted from the front control panel.

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Indenter

ISU - Ph. D. Thesis

- Construction Phase
  - 135 C to 6% Voids
- Performance Phase (traffic)
  - In-service High Temp - 64 C
  - 300 additional gyrations
- Measures height changes -vs- # gyrations

Indenter

After Indenter Testing

Stability: 4” & 6”

- Marshall Stability has been a decent indicator of mix performance
- Tested the 4.75mm mixes for Stability with 4” Marshall & 6” Gyro specimens (both @ 2 ½ % voids)
- Stability Value (lbs) from 6” Gyro about Twice that of equivalent 4” Marshall

TESTS CONDUCTED

- Two IDOT - 4.75 mm mixes (Field Tested)
  - 75% Man. Sand & 8.7% AC
  - 80% Man. Sand & 8.6% AC
- 4 - Different PG Grades
  - PG 64-22, 70-22, 76-22, & 76-28
  - PG 70 & 76s – Modified SBS

TEST PARAMETERS

Lab Test	Test Temperature	Target Air Voids	Test Condition
APA with Hoses	64 C	6.0 +/- 0.5	Dry
APA with Steel Wheel	50 C	6.0 +/- 0.5	Submerged
Stability	60 C	2.5 +/- 0.5	Submerged
Pine Rut	50 C	2.5 +/- 0.5	Submerged
Indenter	64 C	6.0 +/- 0.5	Dry

					STABILITY		
	APA HOSE	**APA STEEL**	**PINE**	**INDTR**	4” @ 7%	4” @ 2.5%	6” @ 2.5%
M1 76-28	6	4	3	4	6	6	3
M1 76-22	6	4	3	3	7	6	3
M1 70-22	6	4	3	3	6	6	3
M1 64-22	6	4	6	4	6	6	3
M2 76-28	6	4	5	3	6	6	3
M2 76-22	6	4	5	3	6	6	3
M2 70-22	6	4	5	3	6	6	3
M2 64-22	6	4	6	3	6	6	3
TOTAL	48	32	36	26	49	48	24
	263						

Asphalt Costs

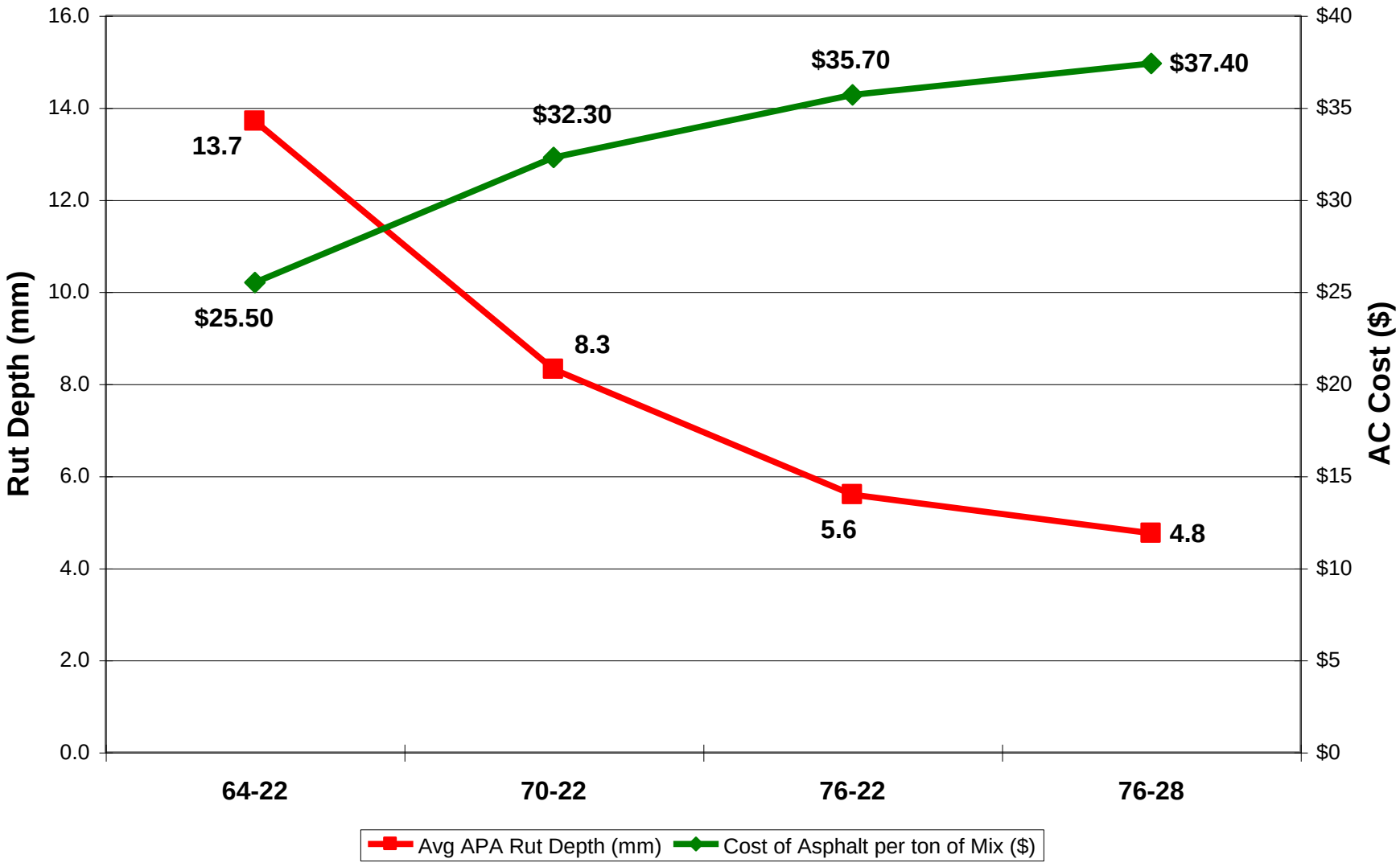
PG Grade	# 1 Supplier	#2 Supplier	#3 Supplier	Ave. Cost Per Ton
64-22	$ 295	$ 305	$ 300	**$ 300**
SBS 70-22	$ 385	$ 380	$ 375	**$ 380**
SBS 76-22	$ 420	$ 425	$ 415	**$ 420**
SBS 76-28	$ 435	$ 445	$ 440	**$ 440**

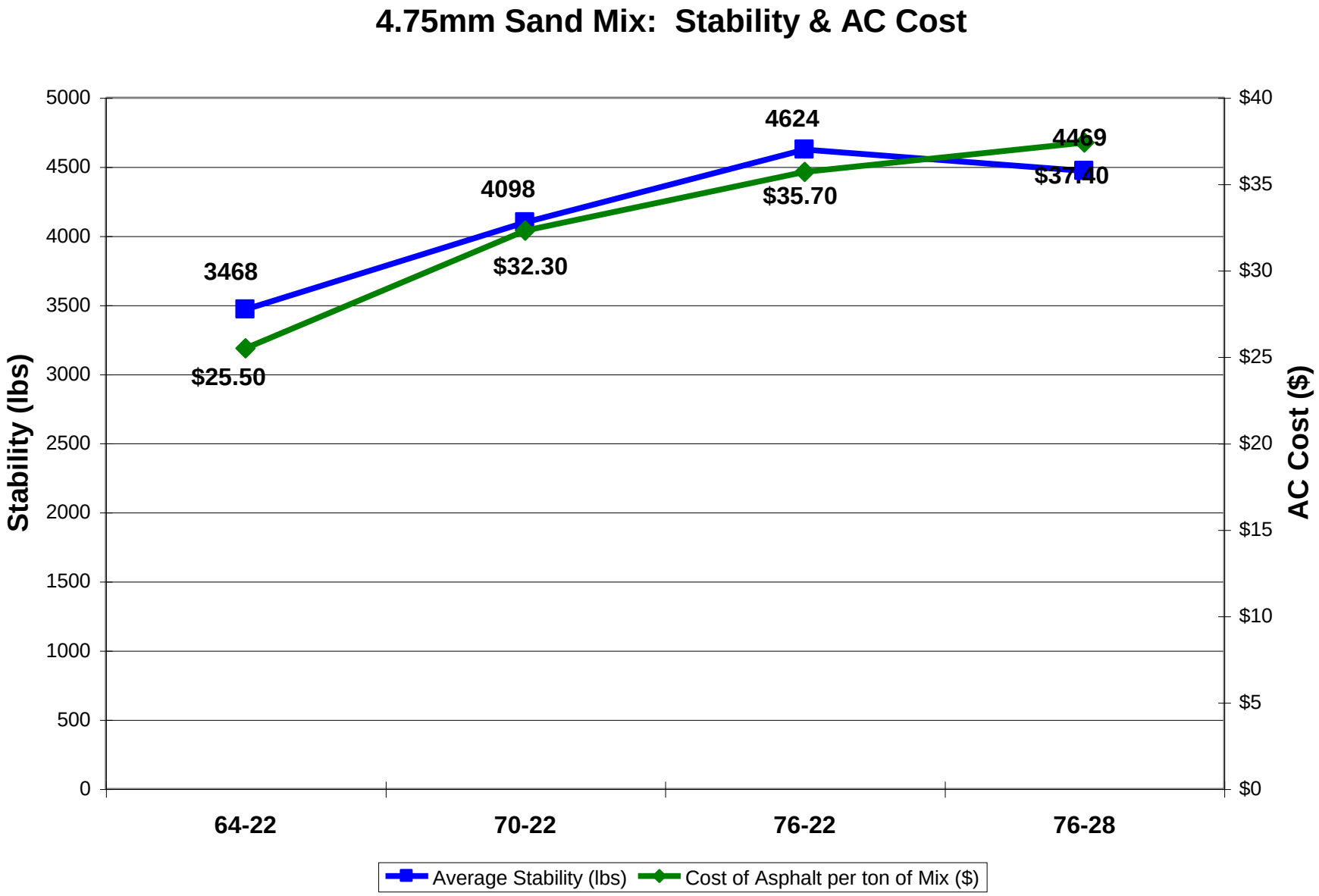
Cost of Asphalt per Ton of Mix

PG Grade	Cost ($)
64-22	$25.50
70-22	$32.30
76-22	$35.70
76-28	$37.40

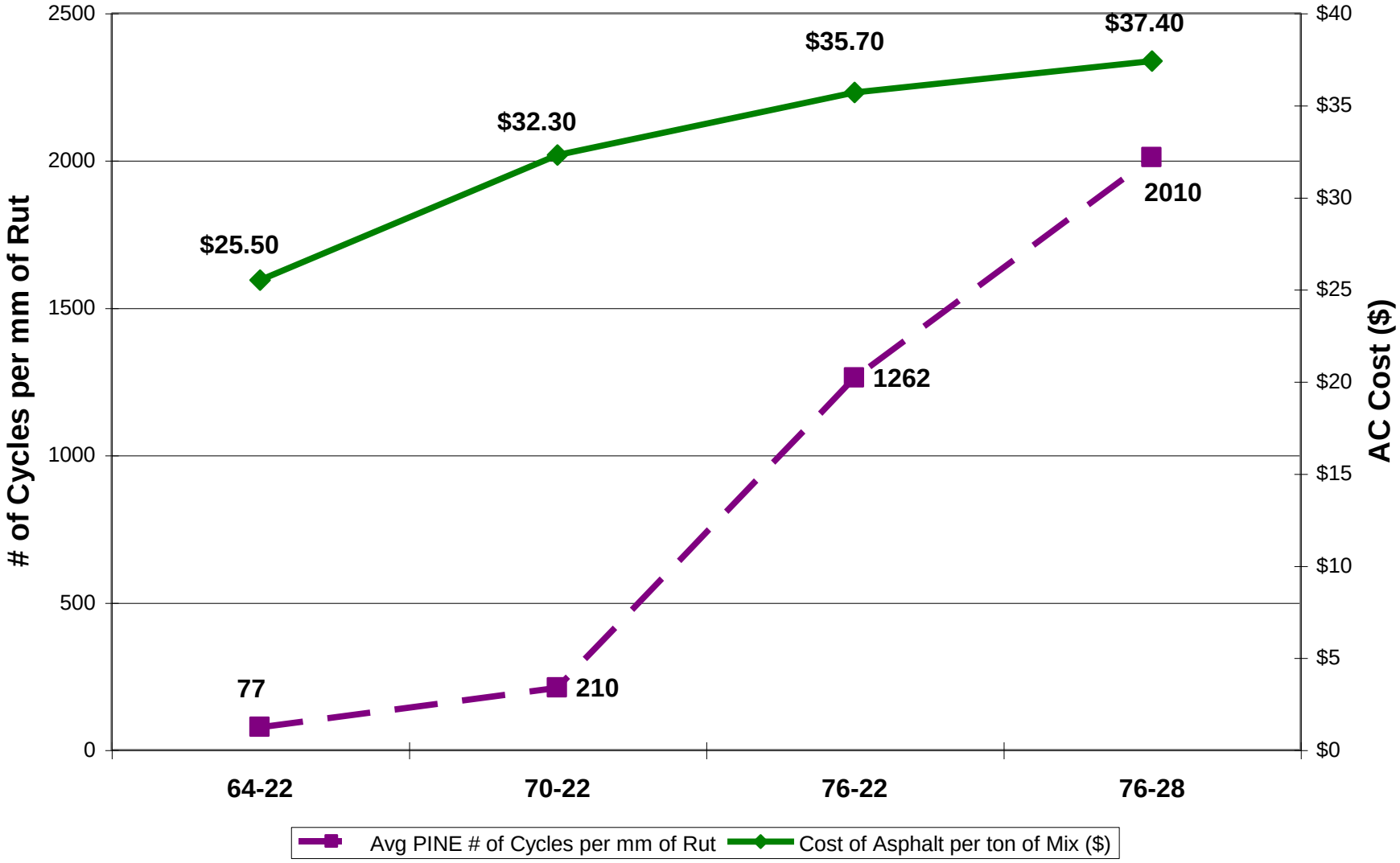
Difference in Cost of Asphalt, per ton of mix, using different PG Grades			
From	To	Cost Increase ($)	Cost increase (%) Compared to PG 64-22 Cost
64-22	70-22	$6.80	27
64-22	76-22	$10.20	40
64-22	76-28	$11.90	47
70-22	76-22	$3.40	13
70-22	76-28	$5.10	20
76-22	76-28	$1.70	7

4.75 Sand Mix: APA with Hoses - Rut Depth and AC Cost

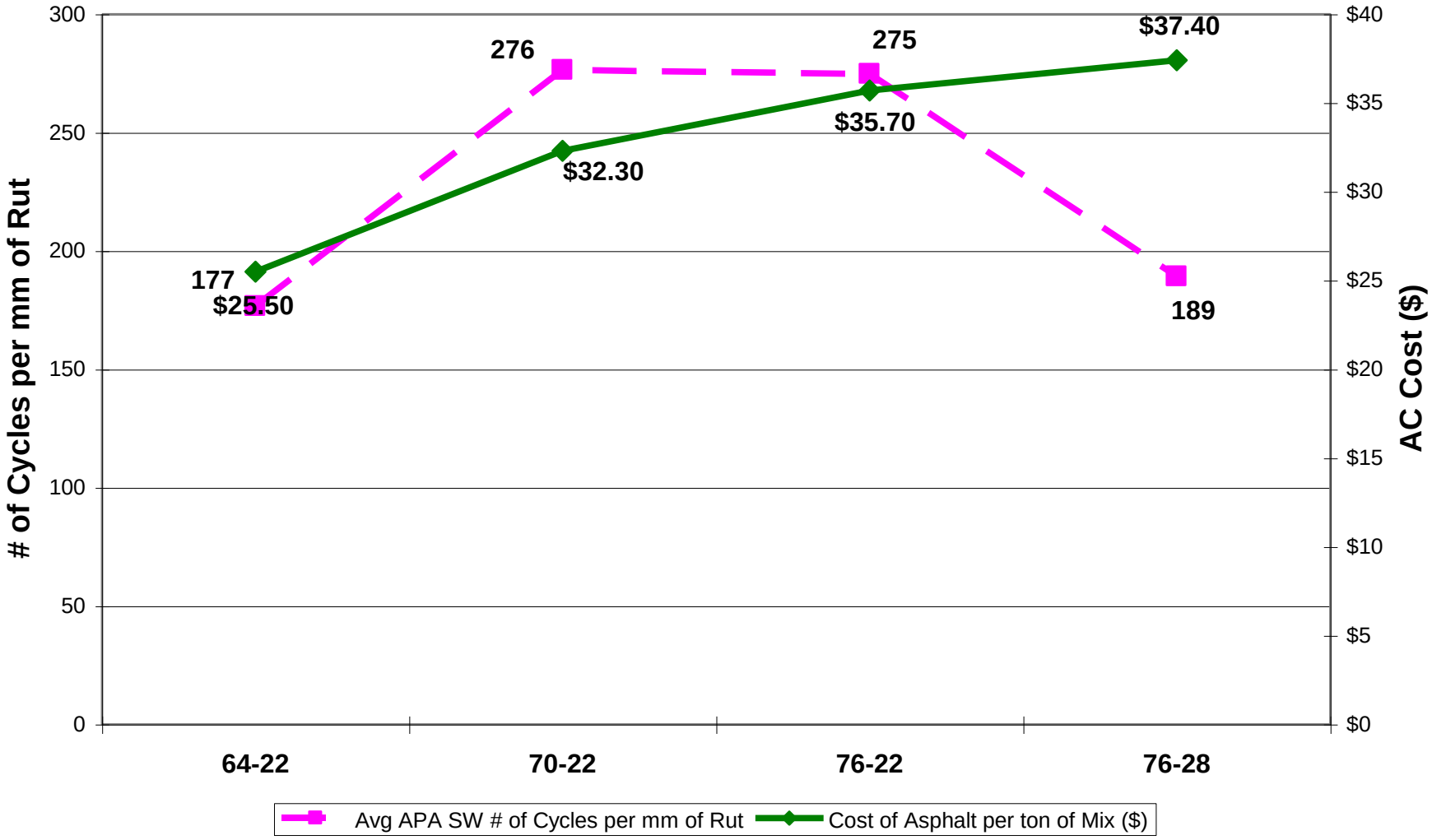



4.75mm Sand Mix: Stability & AC Cost
Stability (lbs)
AC Cost ($)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
$40
$35
$30
$25
$20
$15
$10
$5
$0
3468
4098
4624
4469
$25.50
$32.30
$35.70
$37.40
64-22
70-22
76-22
76-28
Average Stability (lbs)
Cost of Asphalt per ton of Mix ($)

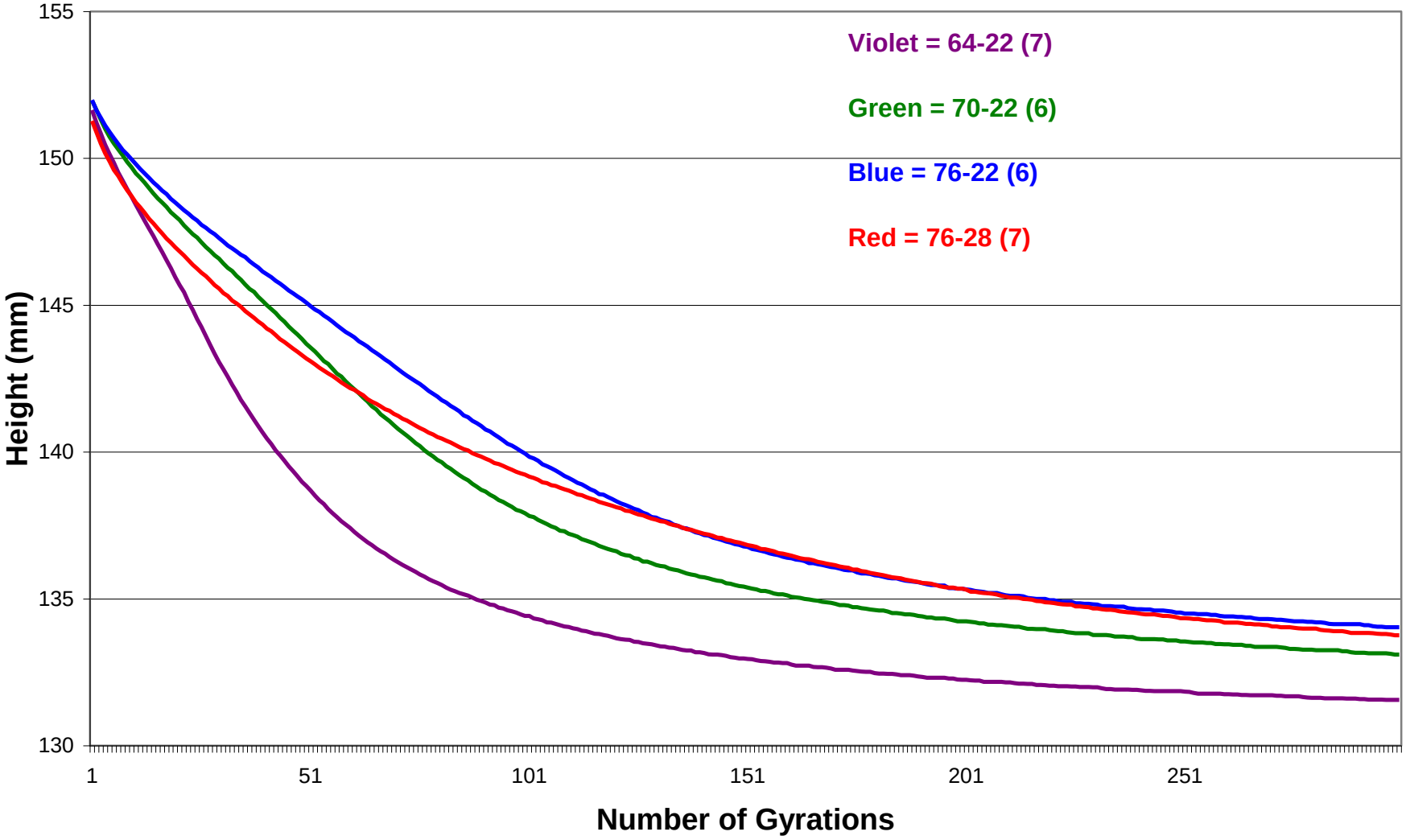
4.75mm Sand Mix: PINE - Number of Cycles per mm of Rut & AC Cost



4.75mm Sand Mix: APA with Steel Wheels - Number of Cycles per mm of Rut & AC Cost



Indenter: Sand Mixes - AVERAGE Height vs Number of Gyrations



Observations

- PG 64-22 to PG 70-22
  - Significant Improvement on ALL Tests - ($6.80 per ton justified)
- PG 70-22 to PG 76-22
  - Significant Improvement on 4 of 5 Tests ($3.40 per ton justified)
- PG 76-22 to PG 76-28
  - Improvement on 2 of 5 Tests (attributed to softer base)

    ($1.70 per ton questionable – unless thermal cracking and low PG Temperature are a concern)

4.75mm Sand Mix Recommendations

- District 1 – 3
  - PG 76 – 22 or
  - PG 76 – 28 (Thermal Cracking)
- District 4 – 9
  - PG 76 – 22

Thank You

Questions?