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Performance Graded (PG) Asphalt Binder Modification - Lessons Learned With the Hamburg and MSCR

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Washington State Department of Transportation

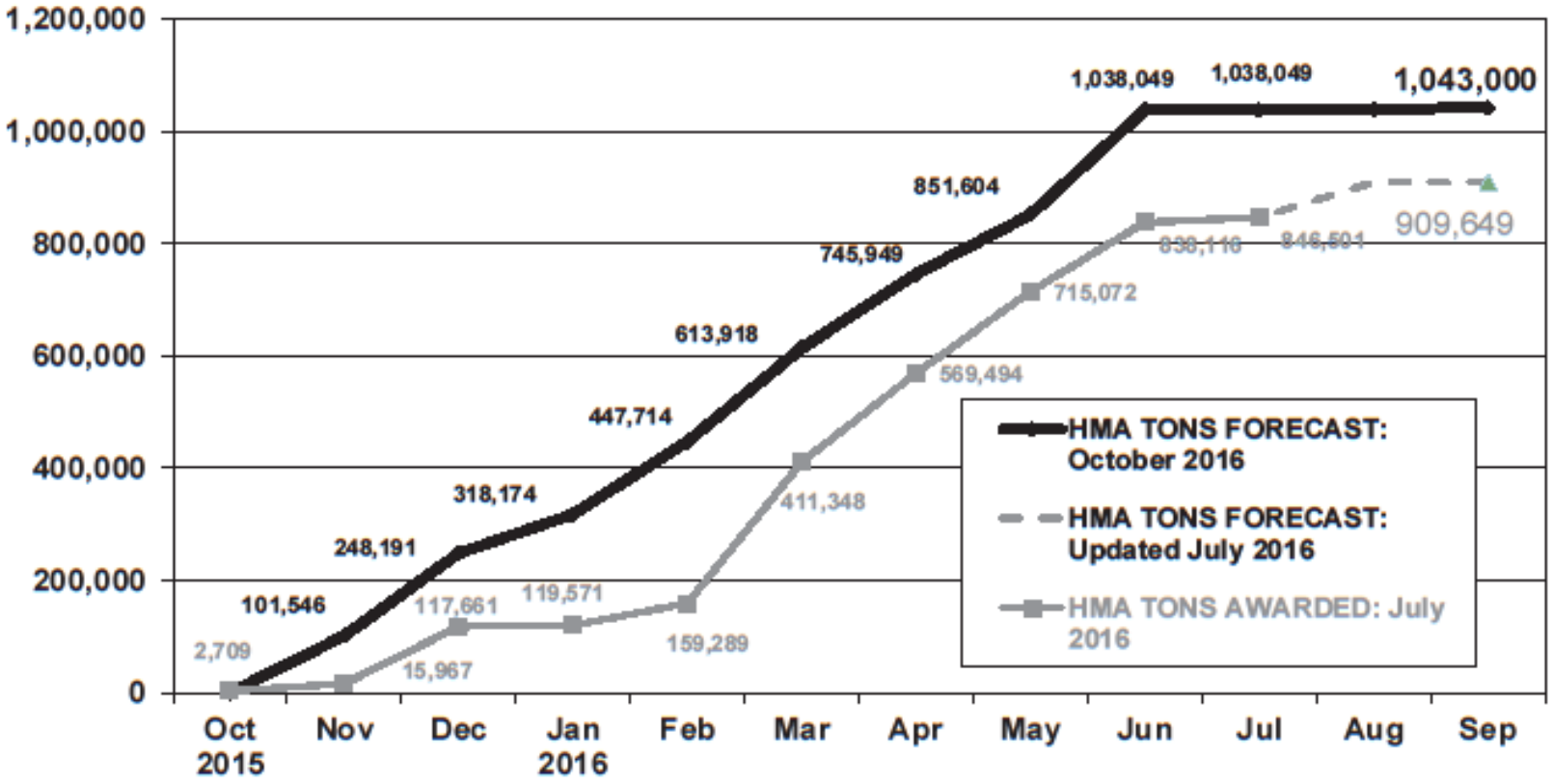
Washington State Department of Transportation

- Just the Facts
  - Connecting Washington Transportation Package
  - 16 Year, $16 Billion Package
    - $9.7 Billion, state and local road projects
    - $1.4 Billion, highway maintenance, operations, preservation
  - 11.9¢ Gas Tax, phased in over next two years

Washington State Department of Transportation

- Just the Facts
  - WSDOT manages 18,500 lane miles
  - Smooth, safe and economical pavements
  - 2016 forecast
    - 1,043,000 tons HMA
    - 586,555 tons HMA - modified asphalt

2016 HMA TONS FORECAST VS. ACTUAL



Washington State Department of Transportation

- Background
  - How we got to where we are
    - SHRP efforts - 1995
    - Implemented PG Binders - 2000
    - Superpave Volumetric Mix Design - 2004

- # Hamburg & MSCR

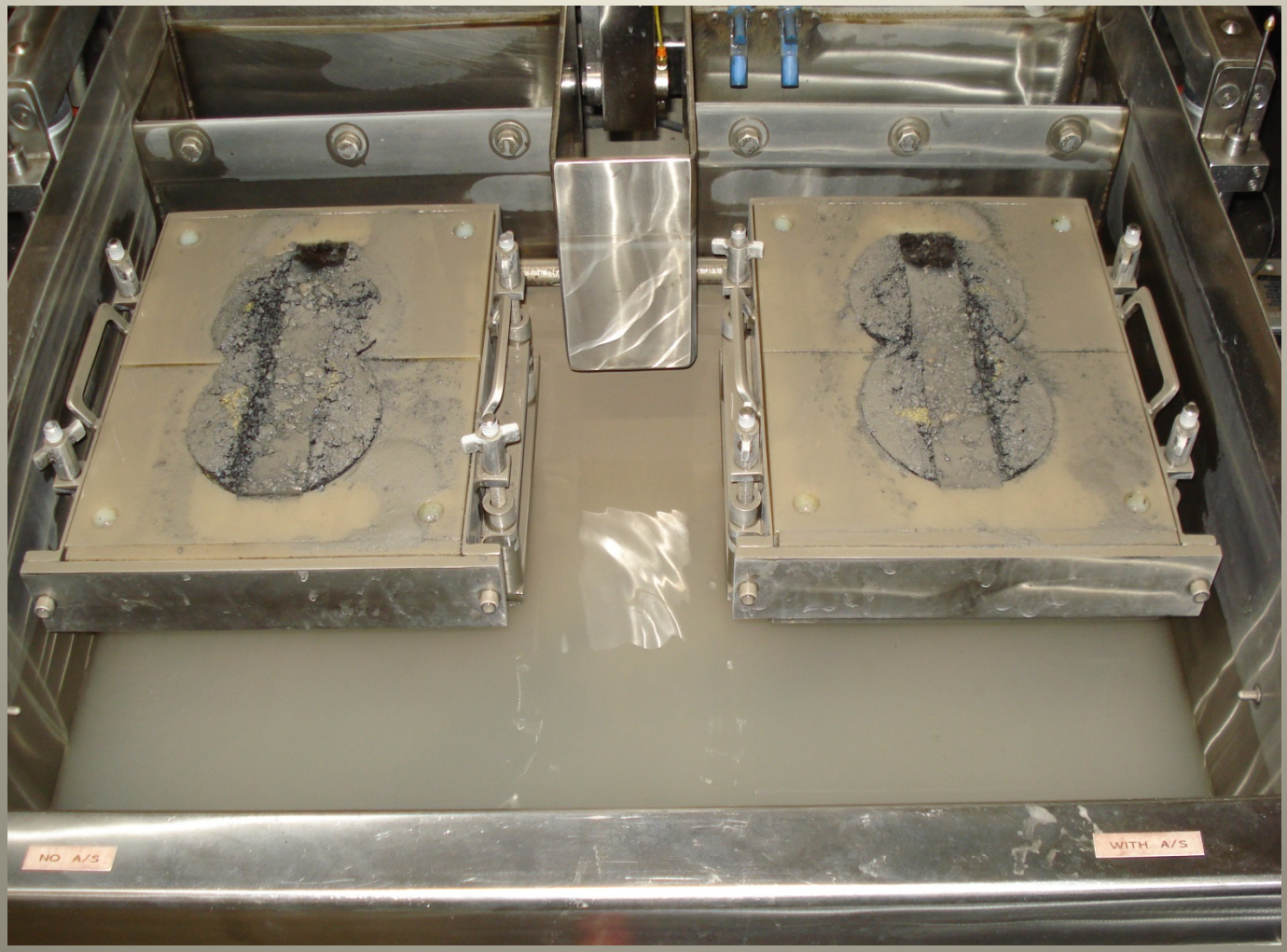
  - ## What have we learned?

    - Asphalt and Anti-Strip Compatibility
    - Asphalt Modification – Products and Processes
    - Benefits of Polymer Modification
      - Note: Dual testing AASHTO M 320 & M 332 since 2008

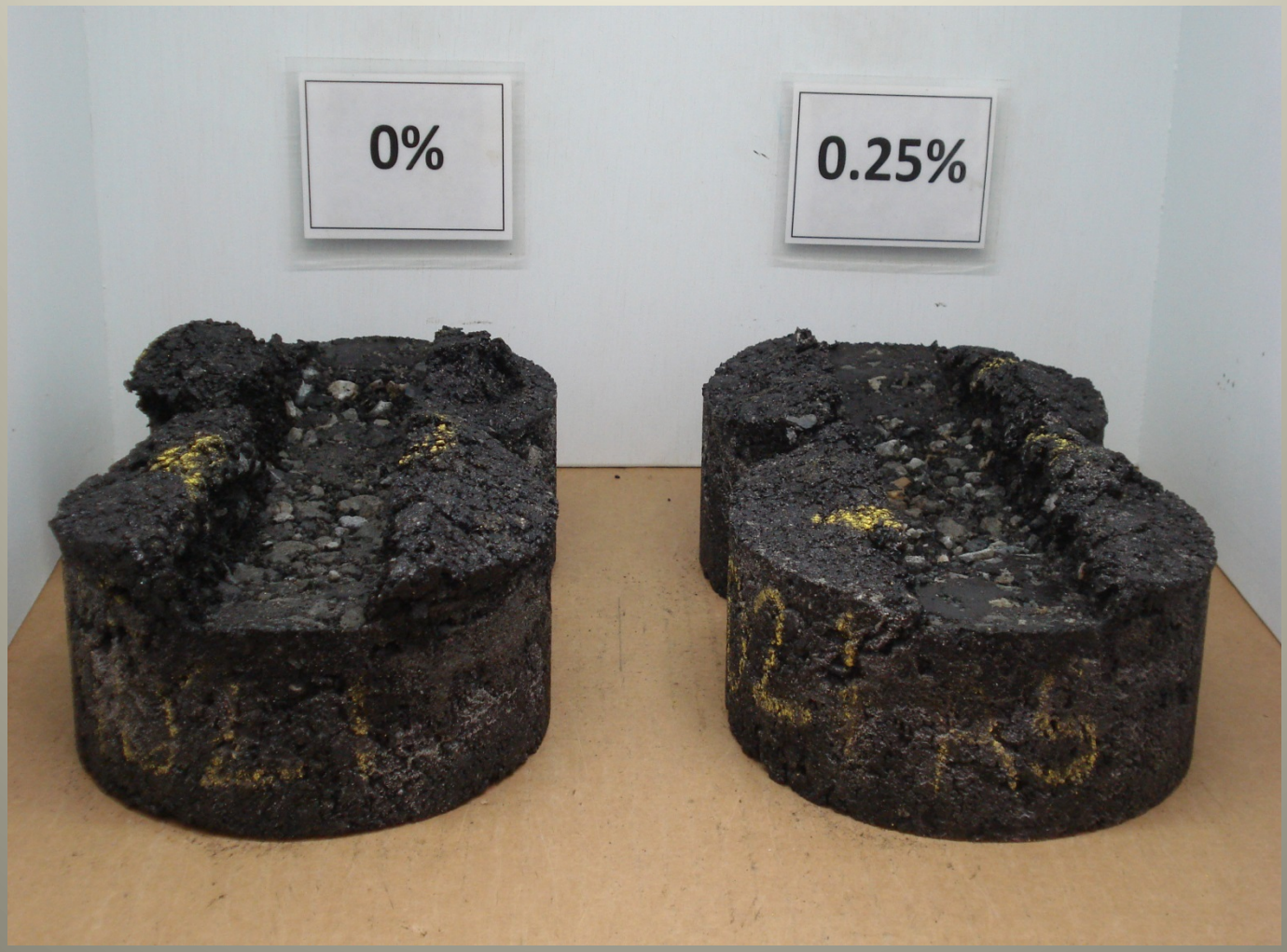

Shown with optional Crane Lift

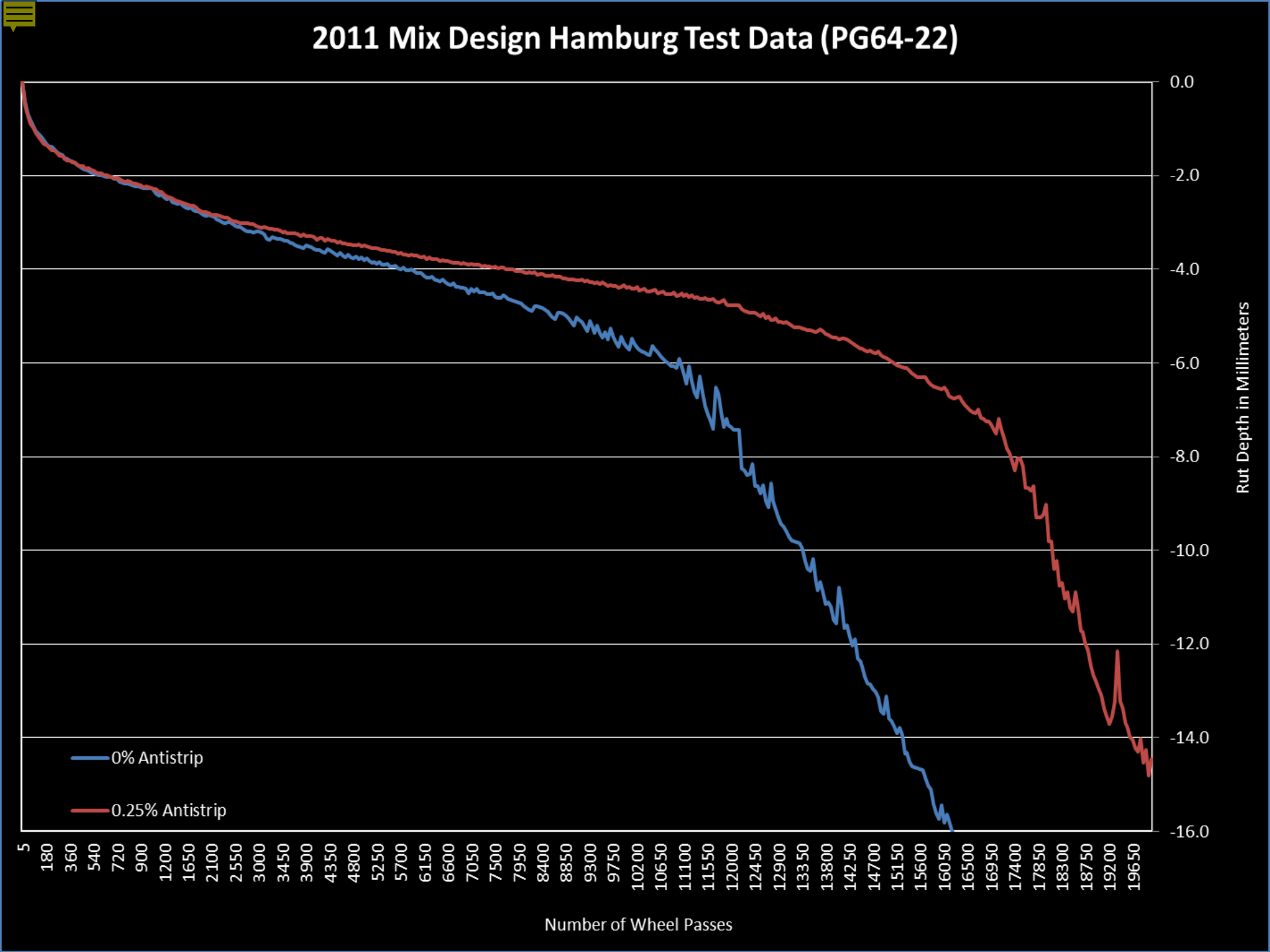
- Hamburg Testing

- Hamburg Testing

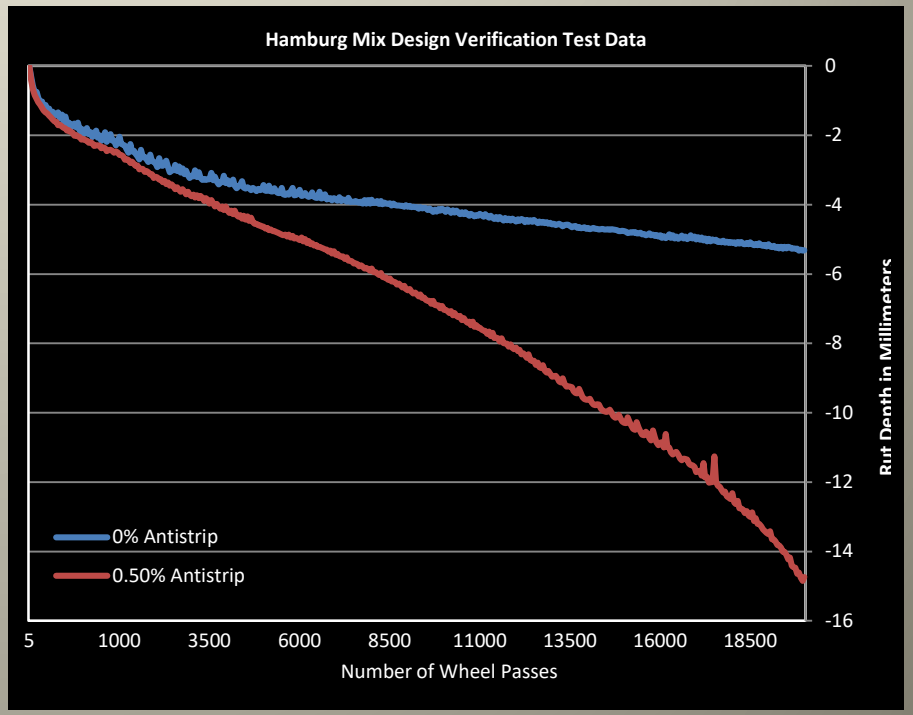


- Hamburg Testing




2011 Mix Design Hamburg Test Data (PG64-22)
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
Rut Depth in Millimeters
0% Antistrip
0.25% Antistrip
5
180
360
540
720
900
1200
1650
2100
2550
3000
3450
3900
4350
4800
5250
5700
6150
6600
7050
7500
7950
8400
8850
9300
9750
10200
10650
11100
11550
12000
12450
12900
13350
13800
14250
14700
15150
15600
16050
16500
16950
17400
17850
18300
18750
19200
19650
Number of Wheel Passes

- Hamburg Testing
  - Asphalt & Anti-Strip Compatibility

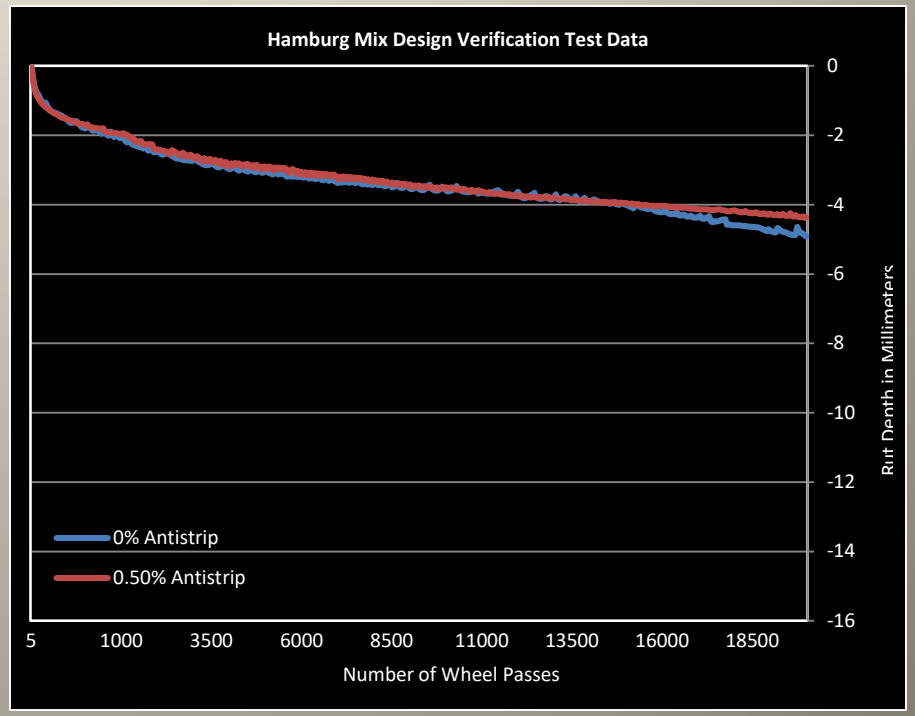


Hamburg Samples with PG64-28 "<u>Original Formulation</u>"

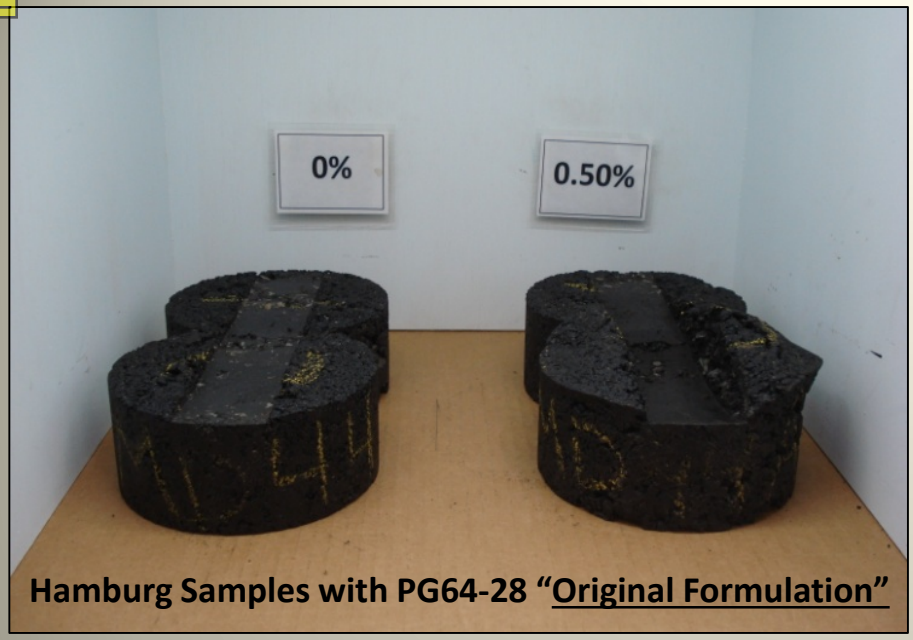
- Hamburg Testing
  - Asphalt & Anti-Strip Compatibility
    - Results of data analysis
      - AASHTO M 320 – binder meet specification
    - Mix design
      - Lottman – improved TSR with anti-strip
      - Hamburg – significant rutting with anti-strip

- # Hamburg Testing

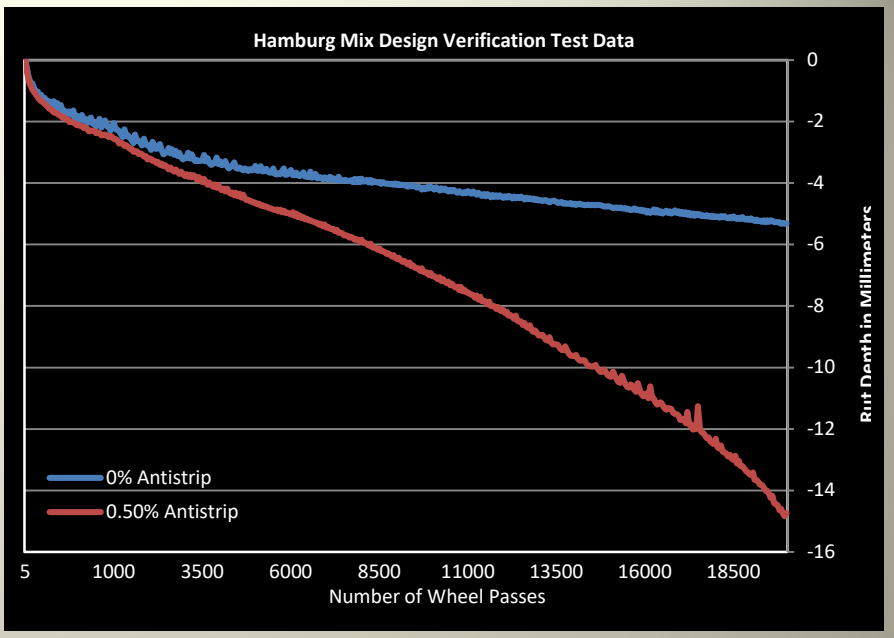
  - ➢ Asphalt & Anti-Strip Compatibility

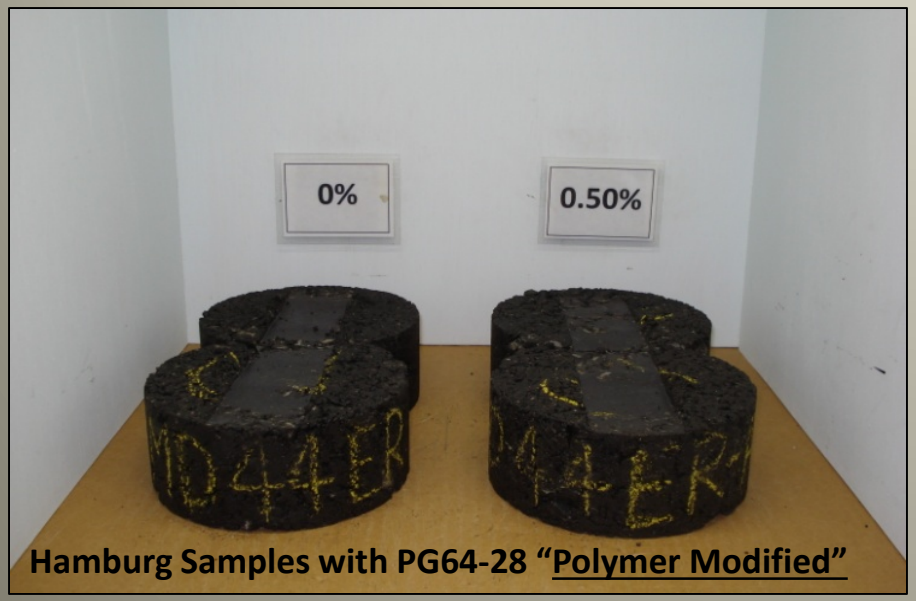


Hamburg Samples with PG64-28 "<u>Polymer Modified</u>"

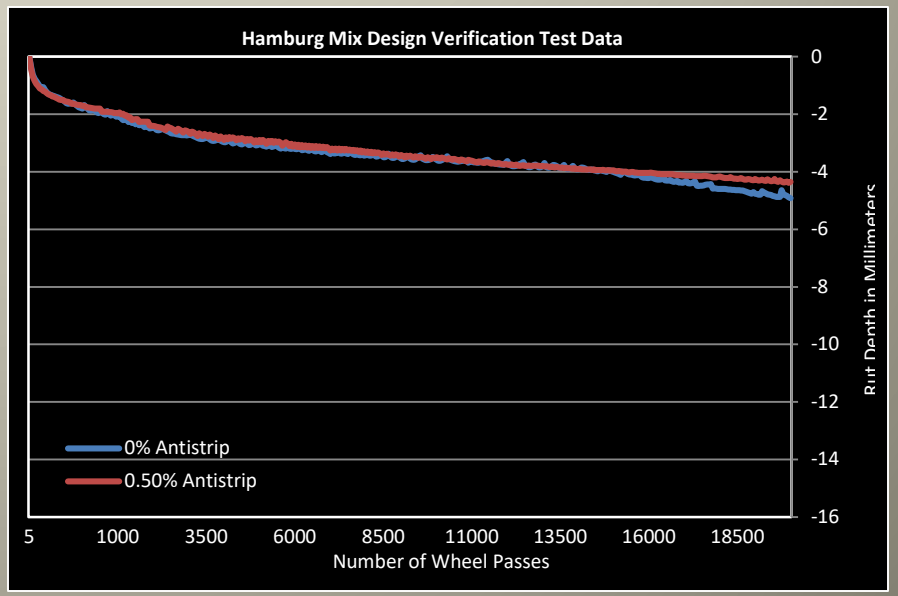


Hamburg Samples with PG64-28 "Original Formulation"





Hamburg Samples with PG64-28 "Polymer Modified"



• Asphalt Binder Testing

➢ Data Analysis

Original Formulation

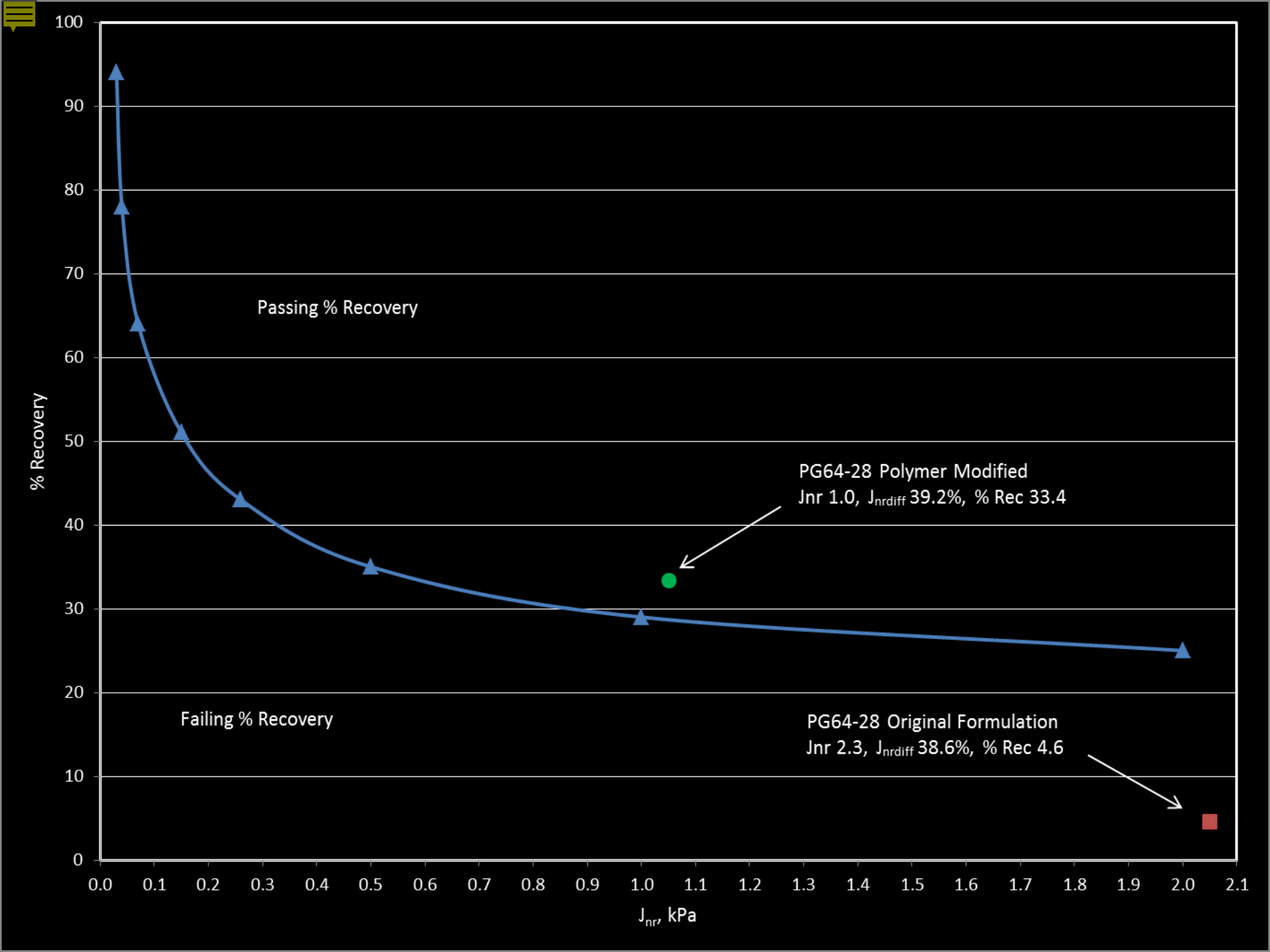
- Met Conventional PG Specs (AASHTO - M 320)
- Met MSCR Specs * (AASHTO - M 332)
- Elastic Recovery = 25% (AASHTO - T 301)

*Excluding Appendix X1

Polymer Modified

- Met Conventional PG Specs (AASHTO - M 320)
- Met MSCR Specs ** (AASHTO - M 332)
- Elastic Recovery = 74% (AASHTO - T 301)

**Including Appendix X1


100
90
80
70
60
50
40
30
20
10
0
% Recovery
Passing % Recovery
Failing % Recovery
PG64-28 Polymer Modified
Jnr 1.0, Jnrdiff 39.2%, % Rec 33.4
PG64-28 Original Formulation
Jnr 2.3, Jnrdiff 38.6%, % Rec 4.6
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
Jnr, kPa

- # Asphalt Binder Testing

  - ## Data Analysis

    - Typical Modified PG Binders
      - Met all specifications requirements (AASHTO - M 320)
      - Passed MSCR (AASHTO - M 332) *

        *Excluding Appendix X1 (% recovery)
      - Tested elastic recovery (AASHTO - T 301)

- Hamburg & MSCR
  - Where are we today?
    - Elastic Recovery Specification - 2012
    - Hamburg and IDT Specification - 2014
    - Multiple Stress Creep Recovery - 2018

Elastic Recovery Specification

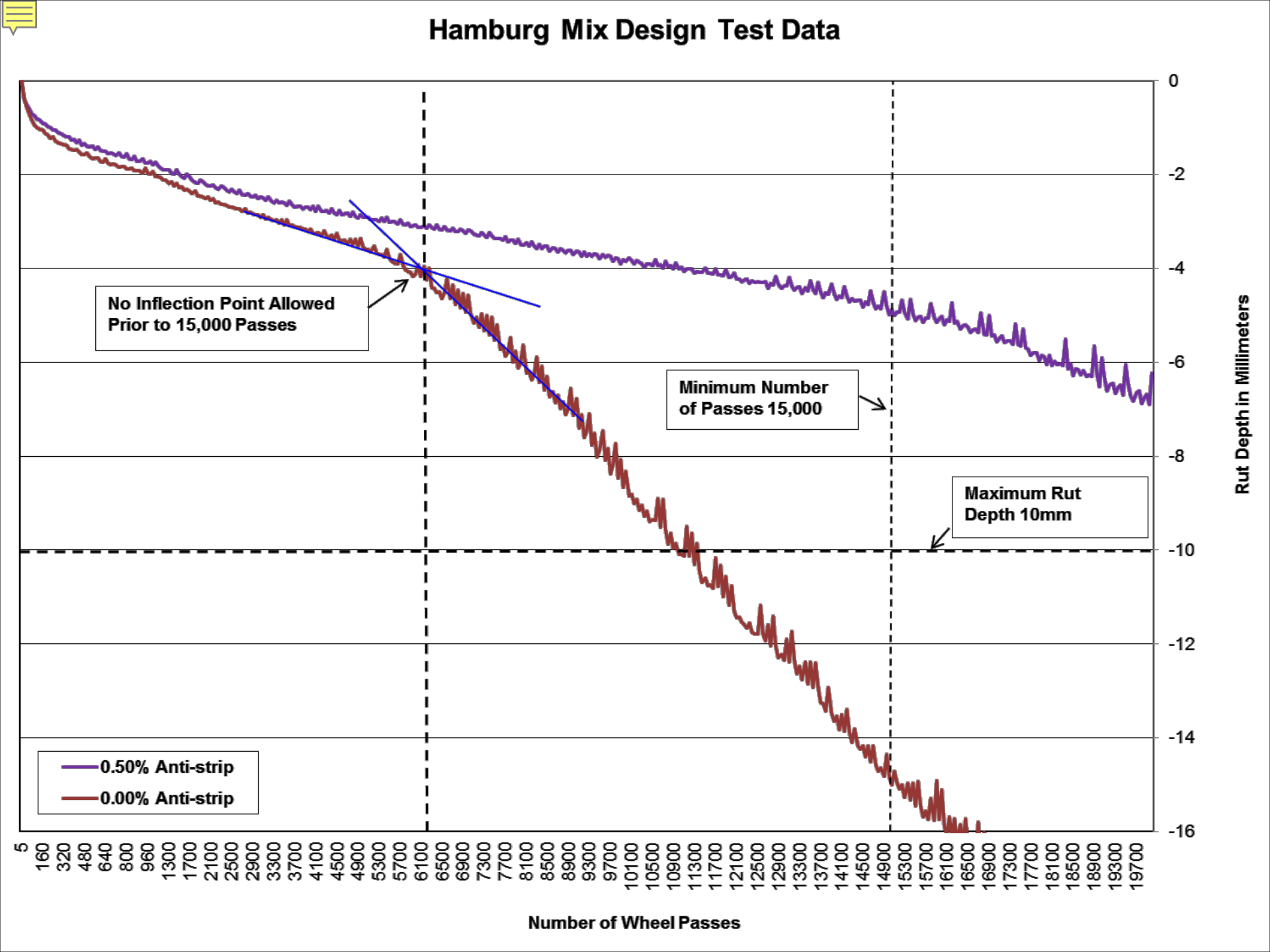
Property	Test Method	Additional Requirements by Performance Grade (PG) Asphalt Binders					
		PG 58-22	PG 64-22	PG 64-28	PG 70-22	PG 70-28	PG 76-28
RTFO Residue:							
Elastic Recovery[1]	AASHTO T 301[2]	--	--	60% Min.	60% Min.	60% Min.	60% Min.
Notes:							

1. Elastic Recovery @ 25°C ± 0.5°C
2. Specimen conditioned in accordance with AASHTO T 240 – RTFO

Hamburg and IDT Specification

Mix Criteria	HMA Class							
	⅜ inch		½ inch		¾ inch		1 inch	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Hamburg Wheel-Track Testing, WSDOT FOP for AASHTO T 324 Rut Depth (mm) @ 15,000 Passes		10		10		10		10
Hamburg Wheel-Track Testing, WSDOT FOP for AASHTO T 324 Minimum Number of Passes With no Stripping Inflection Point	15,000		15,000		15,000		15,000	
Indirect Tensile (IDT) Strength (psi) of Bituminous Materials WSDOT FOP for ASTM D 6931		175		175		175		175

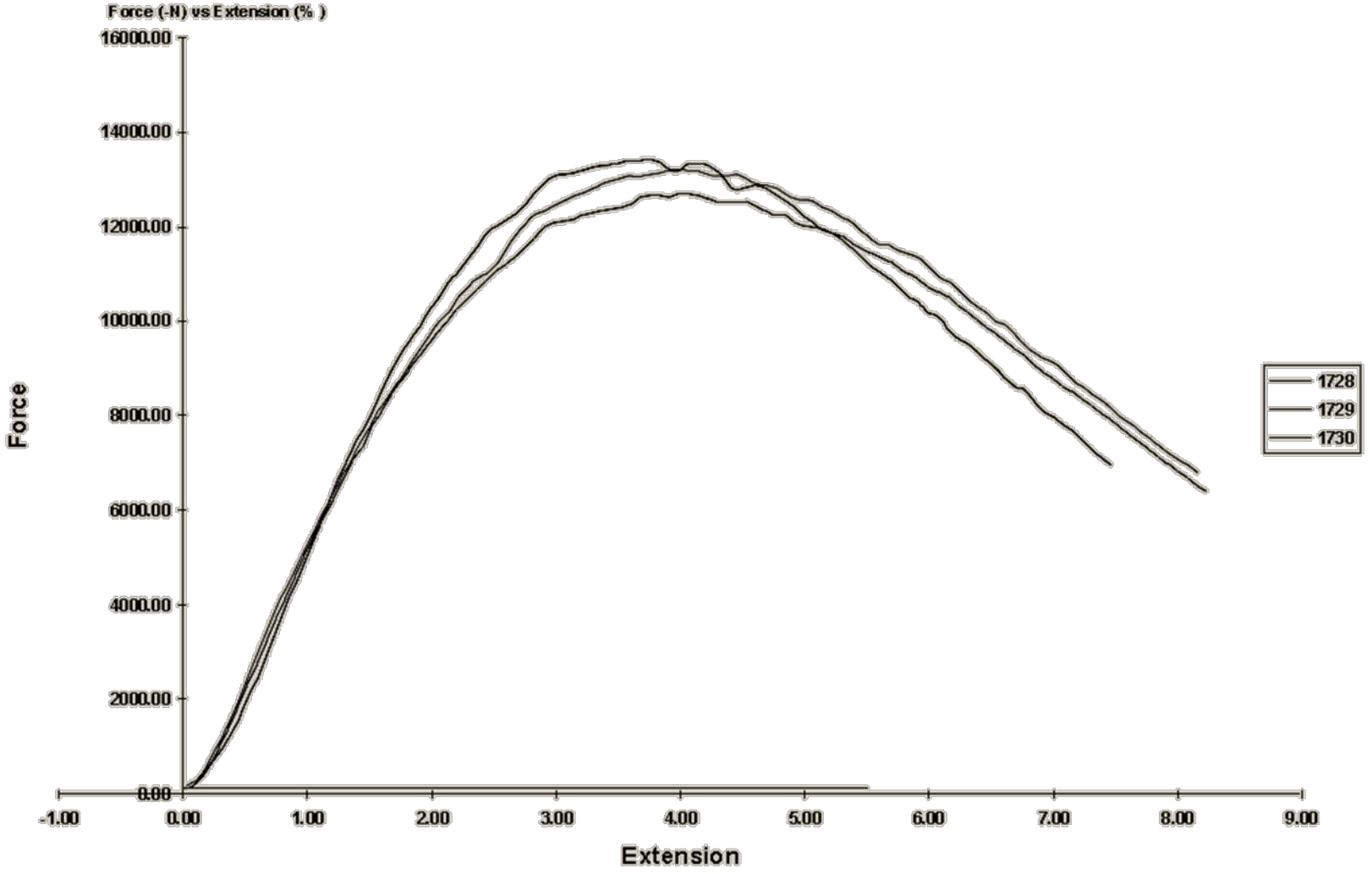
Hamburg Mix Design Test Data



WSDOT HQ Materials Laboratory

Report No

Indirect Tensile Strength (IDT) - Mix Design



Template 102 Testing Machine STM-100K 04

- Multiple Stress Creep Recovery

  - Where we're headed next!

    - Multiple Stress Creep Recovery - 2018

      * Working with PCCAS, Regional Task Group & WAPA

    - Would Replace Elastic Recovery

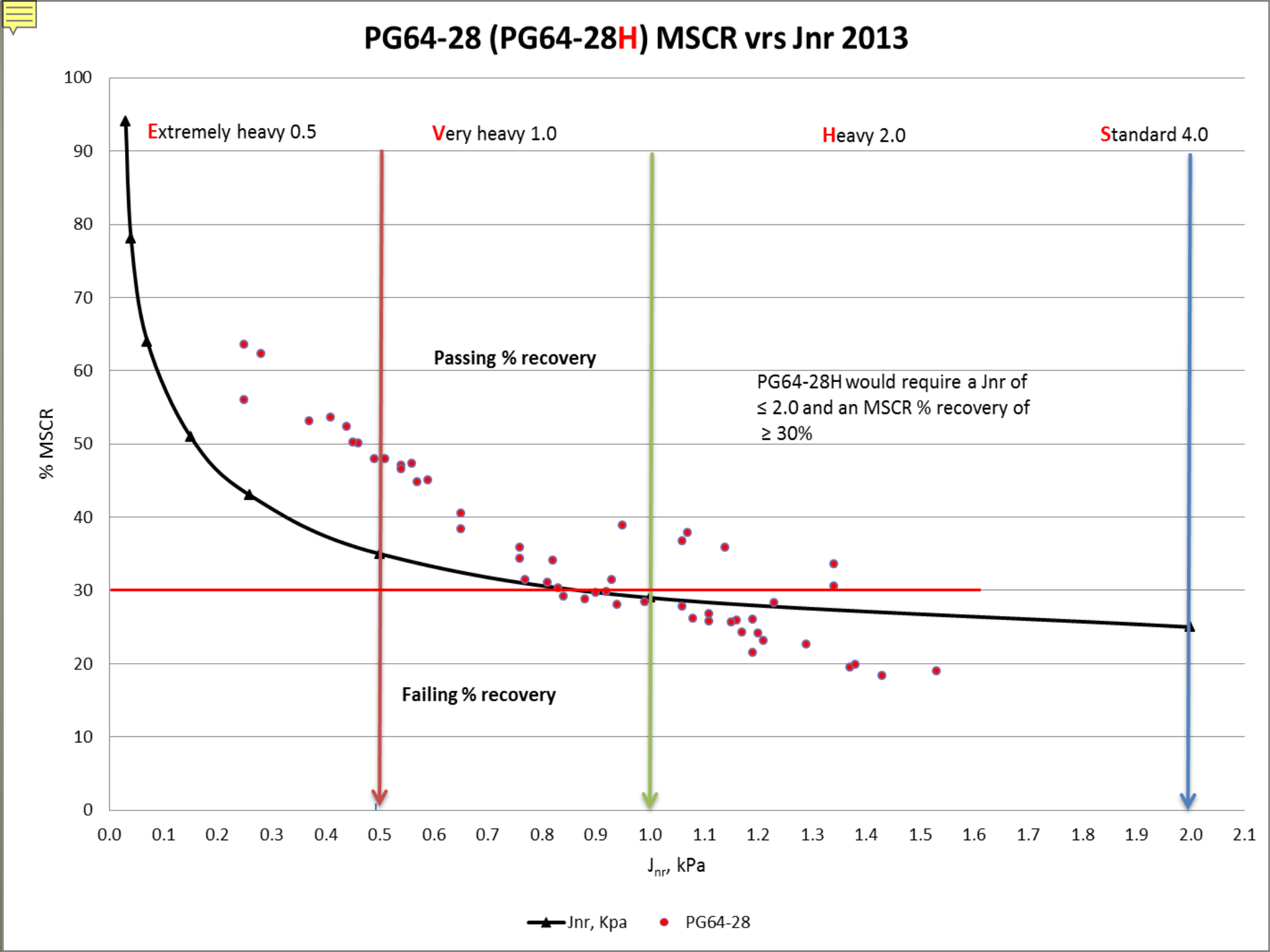
    - New PG Grading Terminology

• Asphalt Binder Grading - 101

- Current Grading System
  - Base grade (Environment)
  - Grade bump (Traffic/Load)
  - Bump = same stiffness at higher temperature
  - Allows for products & processes that may affect performance
- MSCR Grading System
  - Base grade (Environment)
  - Grade bump (Traffic/Load)
  - Bump = increase stiffness at service temperature
  - Requires products & processes that ensure performance

Asphalt Binder Grading - 101

- Current Grading System
  - PG58-22
  - PG64-22
  - PG70-22
  - PG64-28
  - PG70-28
  - PG76-28
- MSCR Grading System
  - PG58S-22 (Standard)
  - PG58H-22 (Heavy)
  - PG58V-22 (Very Heavy)
  - PG64S-28
  - PG64H-28
  - PG64V-28


PG64-28 (PG64-28H) MSCR vrs Jnr 2013
Extremely heavy 0.5
Very heavy 1.0
Heavy 2.0
Standard 4.0
Passing % recovery
PG64-28H would require a Jnr of
≤ 2.0 and an MSCR % recovery of
≥ 30%
Failing % recovery
% MSCR
J_{nr}, kPa
Jnr, Kpa
PG64-28

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Questions?

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State Construction Office - Information

http://www.wsdot.wa.gov/business/construction

Washington State Department of Transportation