PPA WORKSHOP

APRIL 7-8, 2009

MINNEAPOLIS, MN

INFLUENCE OF AGGREGATE, GRADATION, & BINDER ON MIXTURE PERFORMANCE

IMPACT OF PPA MODIFICATION ON RUTTING AND MOISTURE SENSITIVITY

by

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SCOPE OF PRESENTATION

1. WHAT QUESTIONS STILL NEED TO BE ADDRESSED REGARDING THE PERFORMANCE OF PPA MODIFIED BINDERS?
2. INVESTIGATION INTO RUTTING AND MOISTURE SENSITIVITY OF MIXES PRODUCED WITH BINDERS THAT CONTAIN PPA
   a. PPA is the only modifier
   b. PPA is used in conjunction with polymer
3. WHAT CAN BE SAID ABOUT RELATIVE PERFORMANCE OF PPA VERSUS POLYMER & PPA MODIFIED BINDERS?

KEEP IN MIND THE FOLLOWING

"Quod enim mavult homo verum esse, id poitus credit"

What man wishes were true, he more readily believes.

WHAT QUESTIONS REMAIN

I gave a talk at AMAP in 2005 on this same subject. Upon review of those comments many of them are still relevant today

- SOME POINTS TO PONDER GOING FORWARD
- ACID MODIFICATION HAS BEEN USED IN LOUISIANA FOR ABOUT 20 YEARS TO MAKE AC-30 AND AC-40 WITH SOME BINDERS
- BEGINNING IN 1992/1993 ACID ONLY MODIFICATION AND POLYMER + PPA MODIFICATION HAS GROWN IN USAGE ACROSS THE US
  - AT THIS POINT SUPPLIERS IN ALL PARTS OF THE US USE THIS PROCESS
  - I CONSERVATIVELY ESTIMATE THAT IN THAT TIME PERIOD AT LEAST 3,000,000 TONS OF BINDER CONTAINING PPA HAVE BEEN USED. THIS EQUALS ABOUT 51,000,000 TONS OF MIX
- GIVEN THESE QUANTITIES IF THERE ARE WHOLESALE PROBLEMS WITH THIS ADDITIVE DON'T YOU THINK WE ALL WOULD BE AWARE OF THEM?

COMMENTS

1. At the time I stated that more data won't convince the unconvincable—I still believe that, but I'm here today with more data.
2. Those that use and supply binders produced using PPA aren't asking for more data, but maybe they should be.
    a. Keep in mind the old saying "when things appear to good to be true, maybe they are"

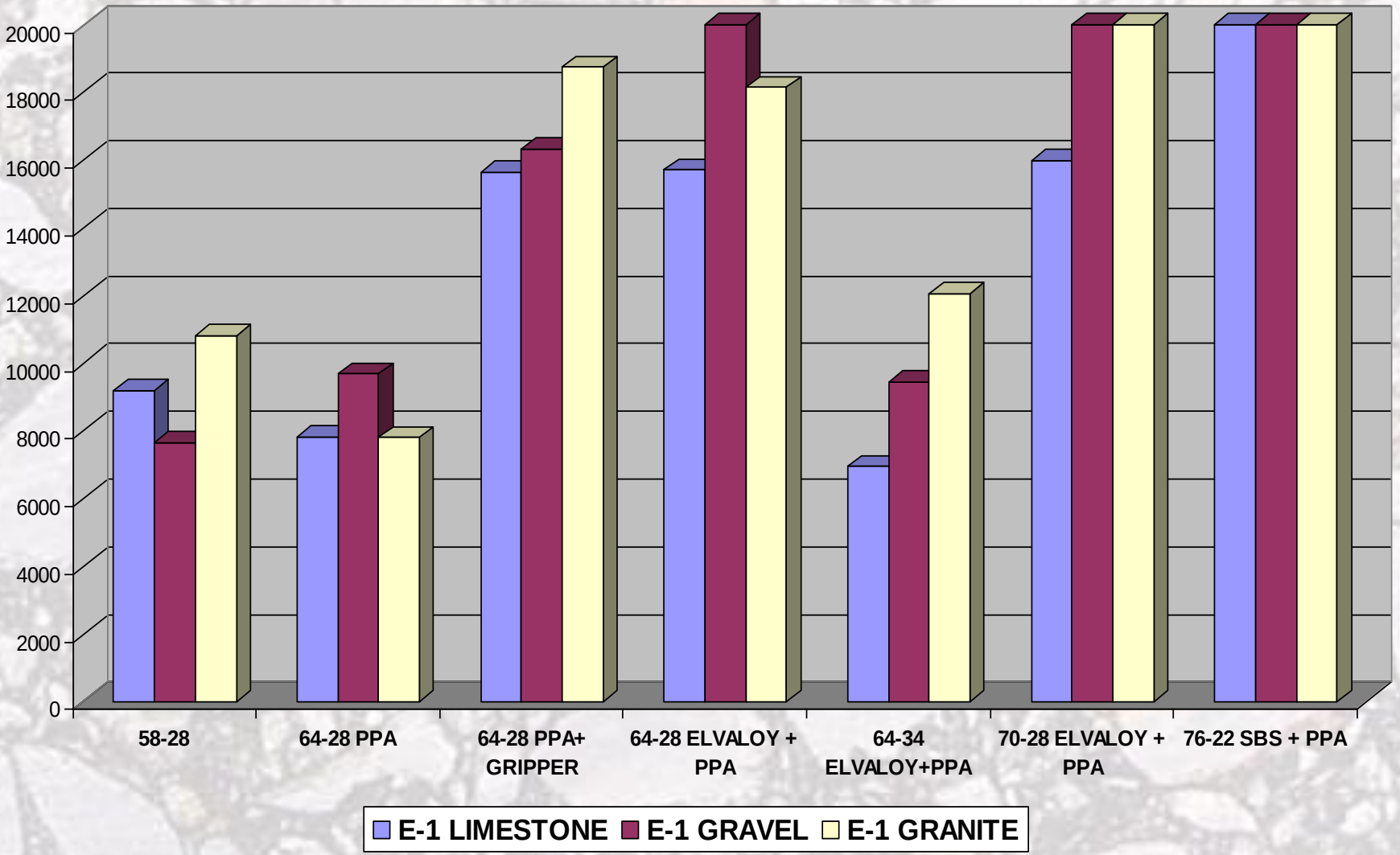
COMMENTS

1. THE TECHNICAL ISSUES SURROUNDING THE USE OF PPA ARE NOT AS CLEAR CUT AS THOSE ON EITHER SIDE OF THE DEBATE WOULD HAVE YOU BELIEVE
2. IN MY OPINION PPA USAGE IS NOT AN ISSUE FOR DEBATE. THESE ARE TECHNICAL QUESTIONS THAT HAVE TECHNICAL ANSWERS
3. THE ANSWER IS NOT ALWAYS "YES" AND IT IS NOT ALWAYS "NO"
4. MOST OF US ARE ENGINEERS AND SCIENTISTS—DATA SHOULD GUIDE OUR DECISIONS, NOT OPINION

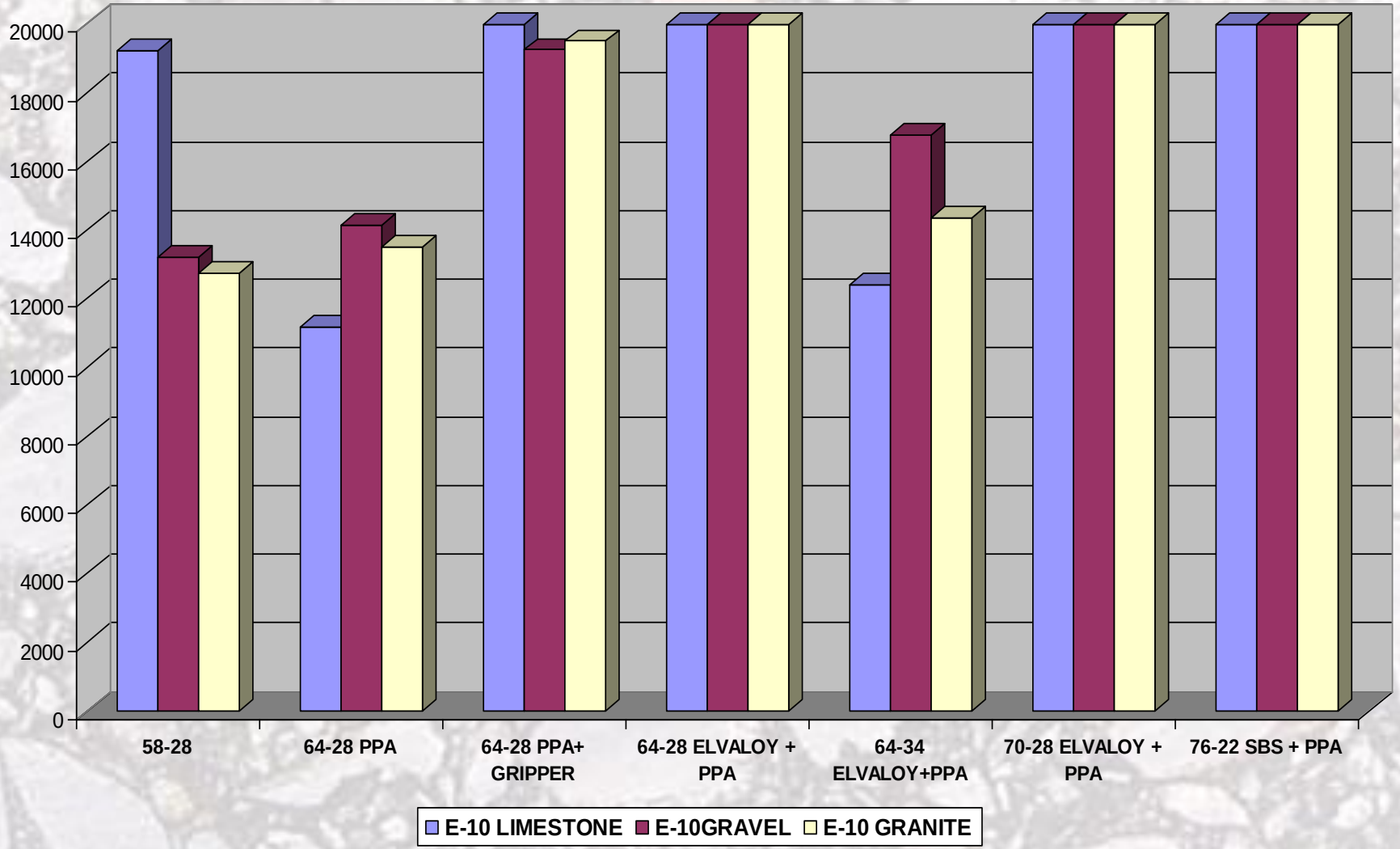
MOISTURE SENSITIVITY

1. A STUDY AT MTE LABELED "BRRS-4" FOR PHASE 4 OF OUR BINDER RHEOLOGY AND RUTTING STUDY--WE LOOKED DRY AND WET HAMBURG RUTTING RESULTS
2. WET HAMBURG CONDUCTED ON 7 BINDERS (6 CONTAINED SOME LEVEL OF PPA)
   a. PPA ONLY BLENDS HAD 0.75% PPA
   b. POLYMER AND PPA BLENDS HAD 0.3% PPA
3. 3 AGGREGATE TYPES—LIMESTONE, GRAVEL AND GRANITE
4. A 1 MILLION AND A 10 MILLION ESAL MIX FOR EACH AGGREGATE

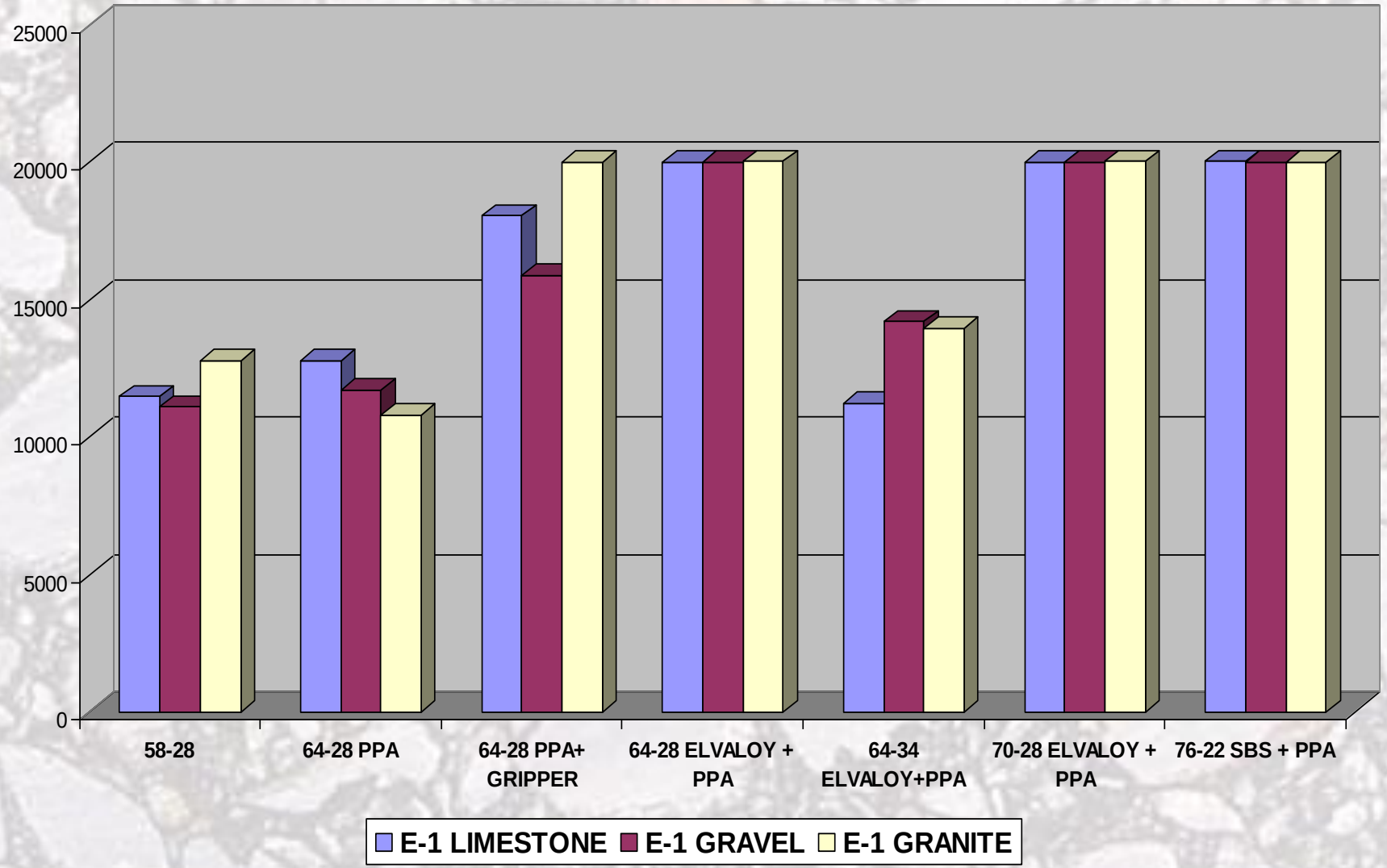
ONSET OF STRIPPING FOR E-1 LIMESTONE, GRAVEL & GRANITE



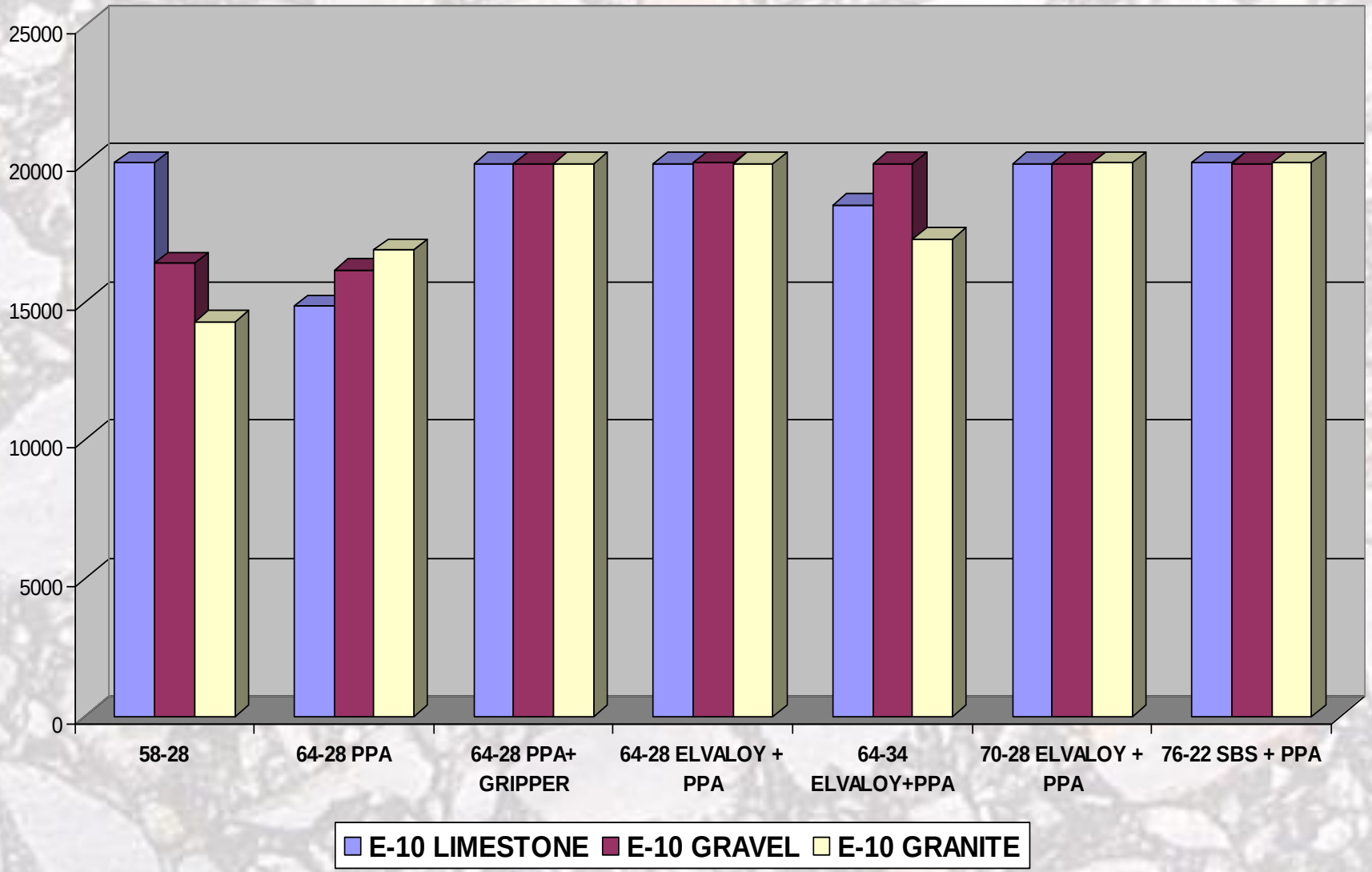
ONSET OF STRIPPING E-10 LIMESTONE, GRAVEL & GRANITE



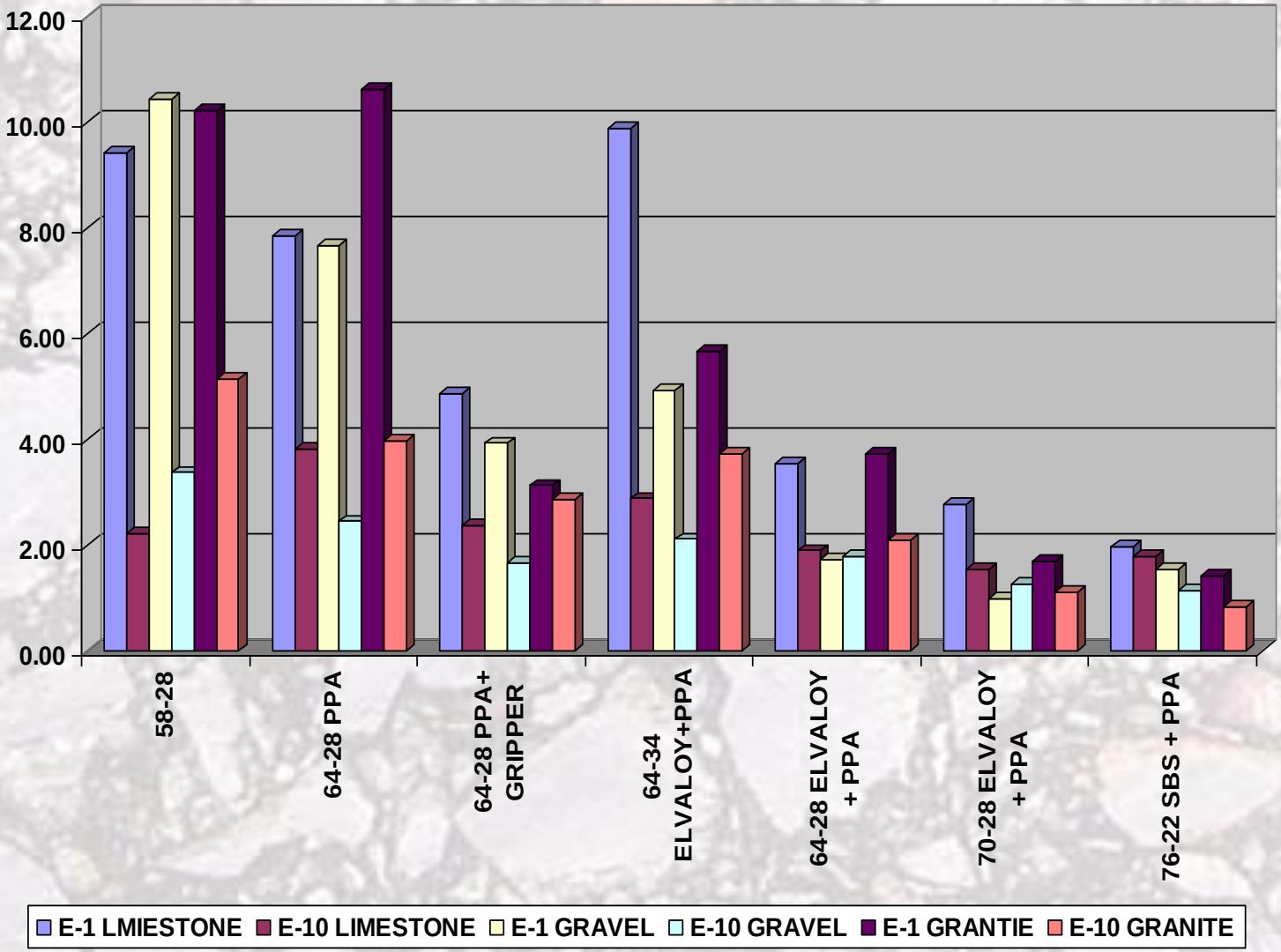
RUT PASSES TO 12.5 mm FOR E-1 LIMESTONE, GRAVEL & GRANITE



RUT PASSES TO 12.5mm FOR E-10 LIMESTONE, GRAVEL & GRANITE



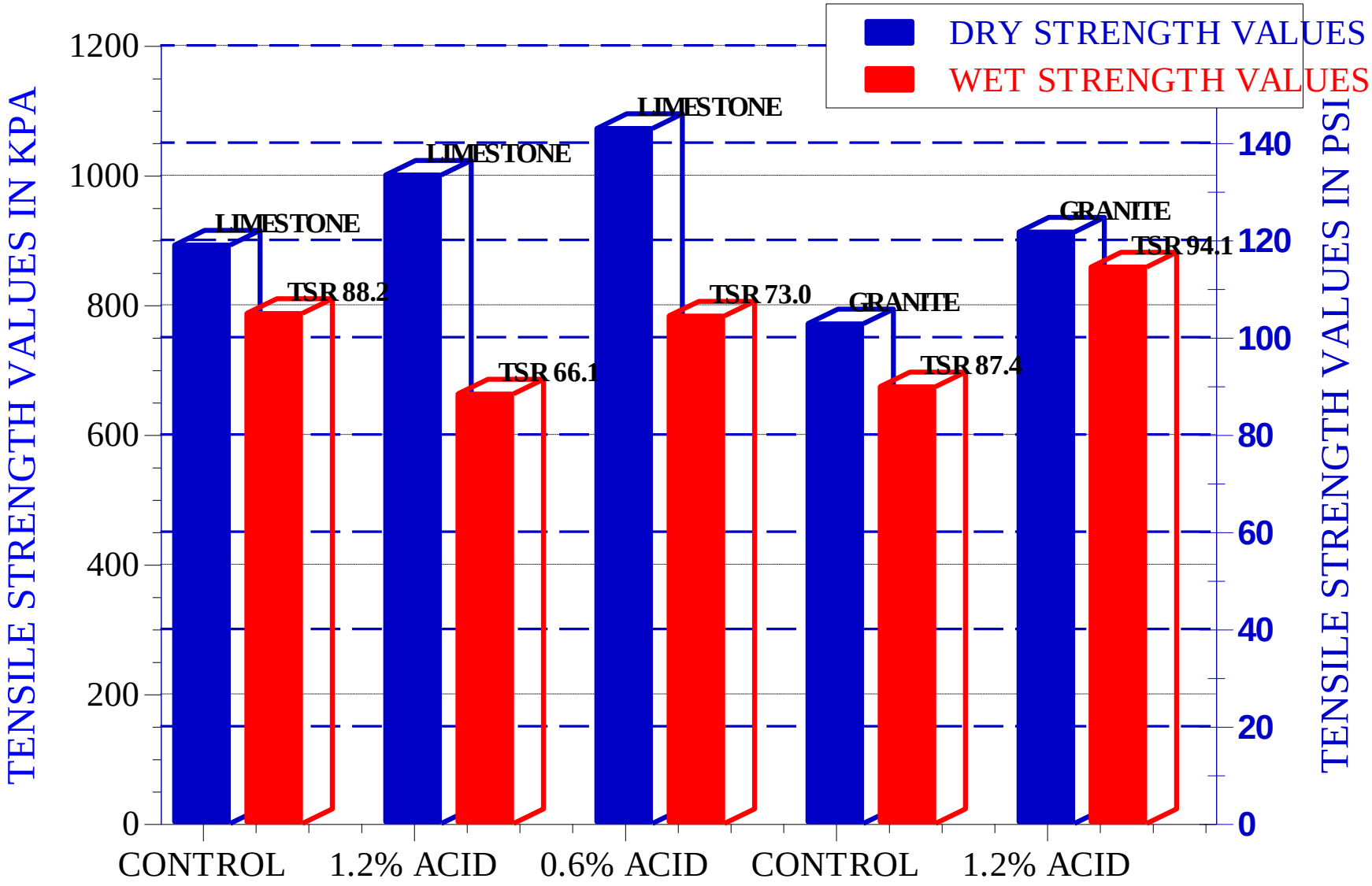
HAMBURG RESULTS @ 50°C WET, RUT DEPTH @ 10000 PASSES



MOISTURE SENSITIVITY

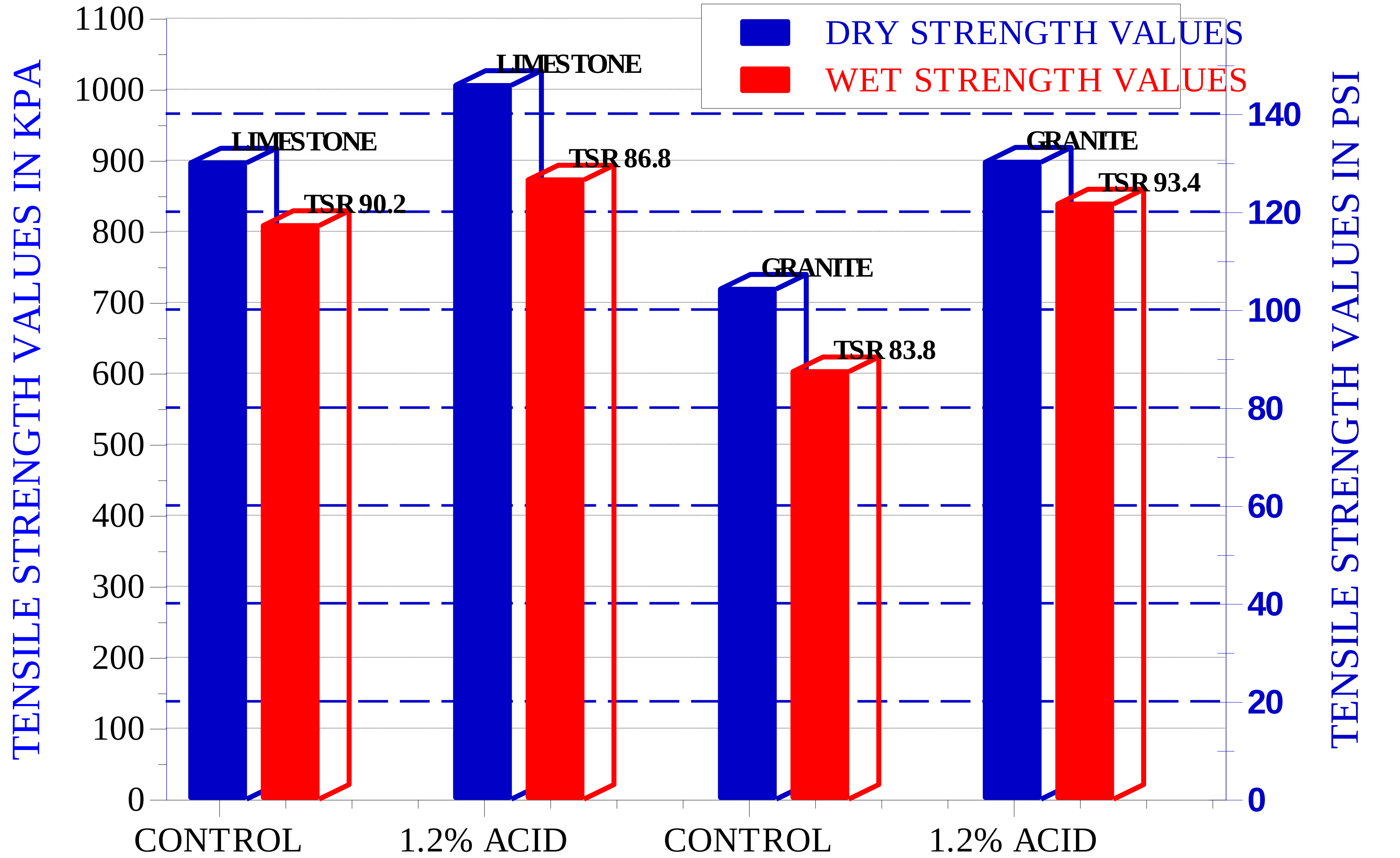
1. IN ANOTHER STUDY WE LOOKED AT TSR RESULTS OF LIMESTONE AND GRANITE MIXES PRODUCED WITH
    1) Citgo 67-22, 67-22 + 1.2% PPA = PG 82, 67-22 + 0.6% PPA= PG 76
    2) BP 64-22, 64-22 + 1.2% PPA = PG 72
2. NOTE THERE IS A PERFORMANCE PENALTY FOR USING TOO MUCH PPA WITH SOME BINDERS

AND SOURCE C 67-22 + 1.2% OR 0.6% POLYPHOSPHORIC ACID USING LIMESTONE AND GRANITE MIXES



ASPHALT USED WAS A CITGO 67-22

TENSILE STRENGTH TEST RESULTS FOR SOURCE B 64-22 AND SOURCE B 64-22 + 1.2% POLYPHOSPHORIC ACID USING LIMESTONE AND GRANITE MIXES

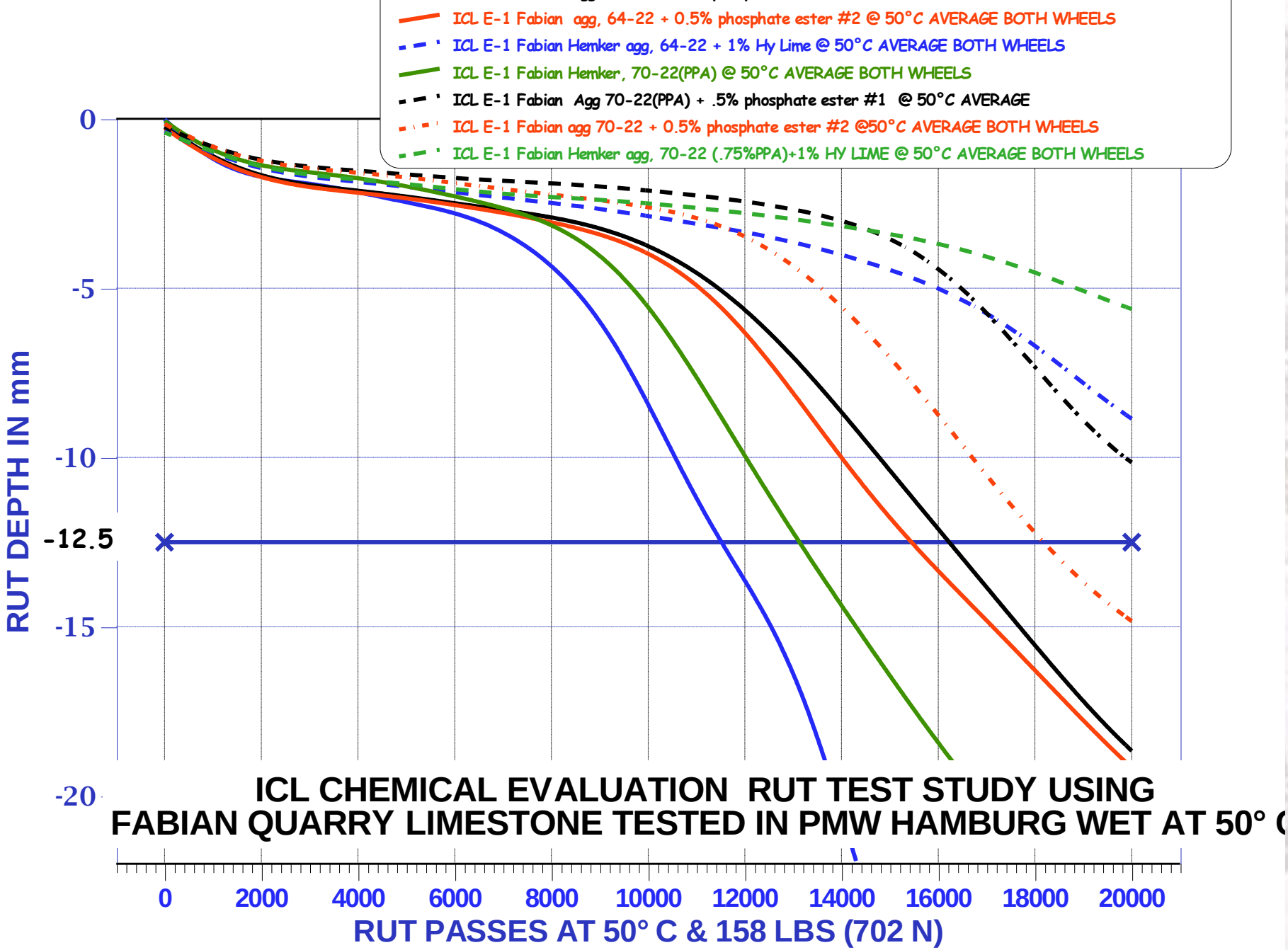


ASPHALT USED WAS A BP 64-22

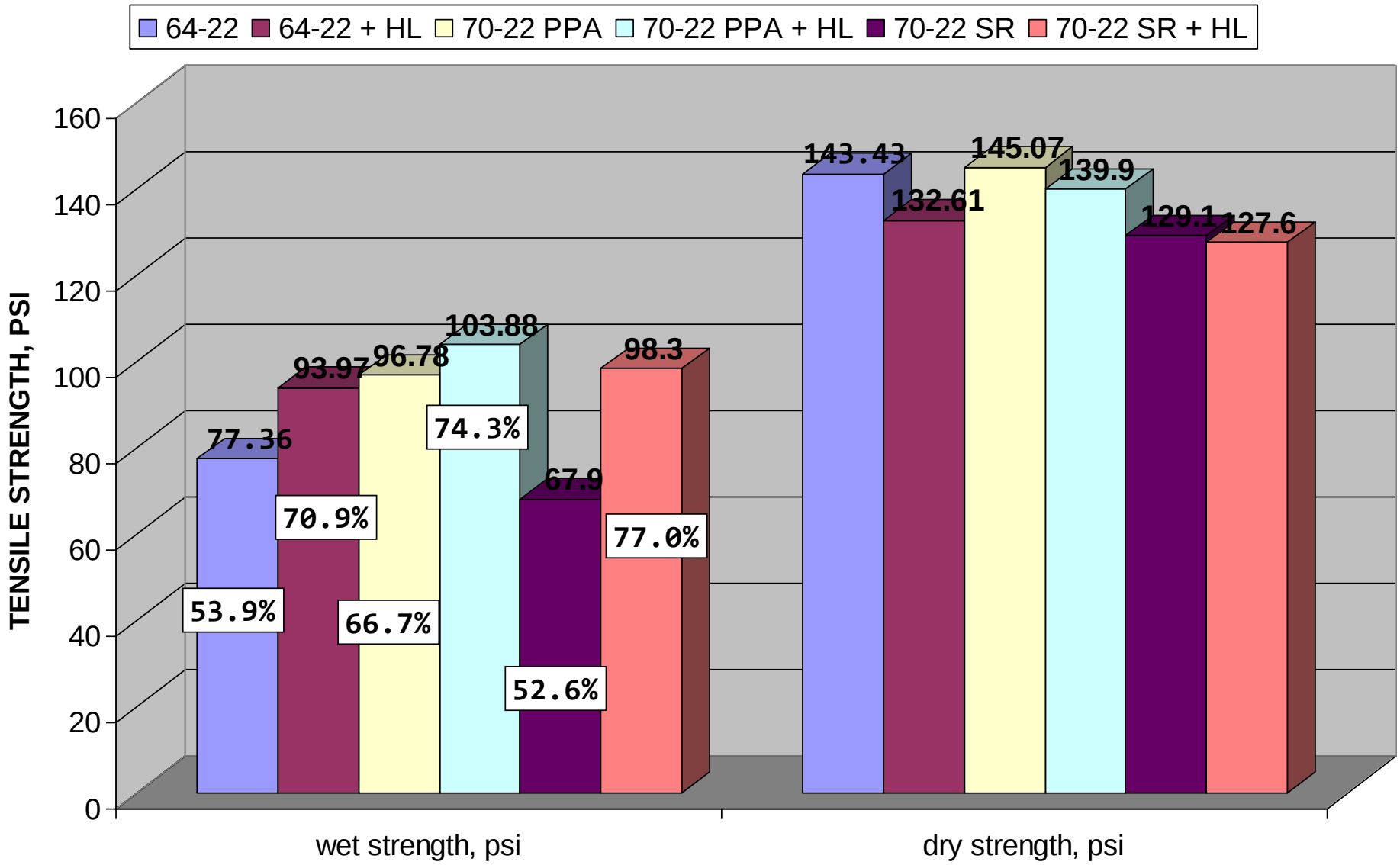
MATHY TECHNOLOGY

MOISTURE SENSITIVITY

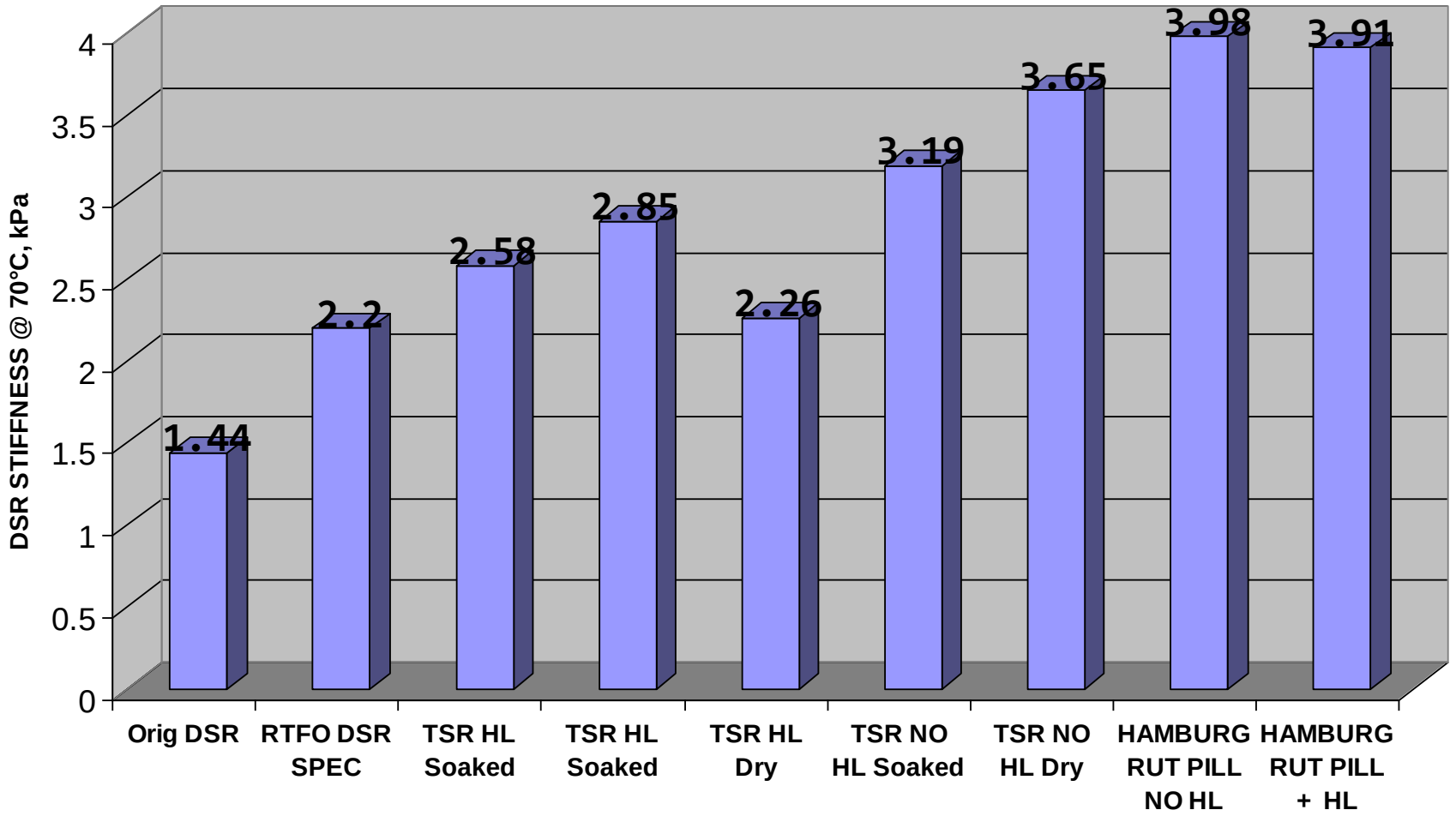
1. A SERIES OF MOISTURE SENSITIVITY STUDIES WERE PERFORMED FOR ICL.
   a. Marathon 64-22 Control asphalt
   b. Marathon 64-22 + 0.75% PPA = PG 70-22
   c. Hydrated lime was used with each binder in a limestone mix that typically results in low TSR values
   d. Two sources of phosphate ester antistrip were used with each binder
2. TSR testing was also performed


ICL E-1 Fabian agg, 64-22 + 0.5% phosphate ester #2 @ 50°C AVERAGE BOTH WHEELS
ICL E-1 Fabian Hemker agg, 64-22 + 1% Hy Lime @ 50°C AVERAGE BOTH WHEELS
ICL E-1 Fabian Hemker, 70-22(PPA) @ 50°C AVERAGE BOTH WHEELS
ICL E-1 Fabian Agg 70-22(PPA) + .5% phosphate ester #1 @ 50°C AVERAGE
ICL E-1 Fabian agg 70-22 + 0.5% phosphate ester #2 @50°C AVERAGE BOTH WHEELS
ICL E-1 Fabian Hemker agg, 70-22 (.75%PPA)+1% HY LIME @ 50°C AVERAGE BOTH WHEELS
0
-5
-10
-12.5
-15
-20
RUT DEPTH IN mm
ICL CHEMICAL EVALUATION RUT TEST STUDY USING
FABIAN QUARRY LIMESTONE TESTED IN PMW HAMBURG WET AT 50° C
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
RUT PASSES AT 50° C & 158 LBS (702 N)

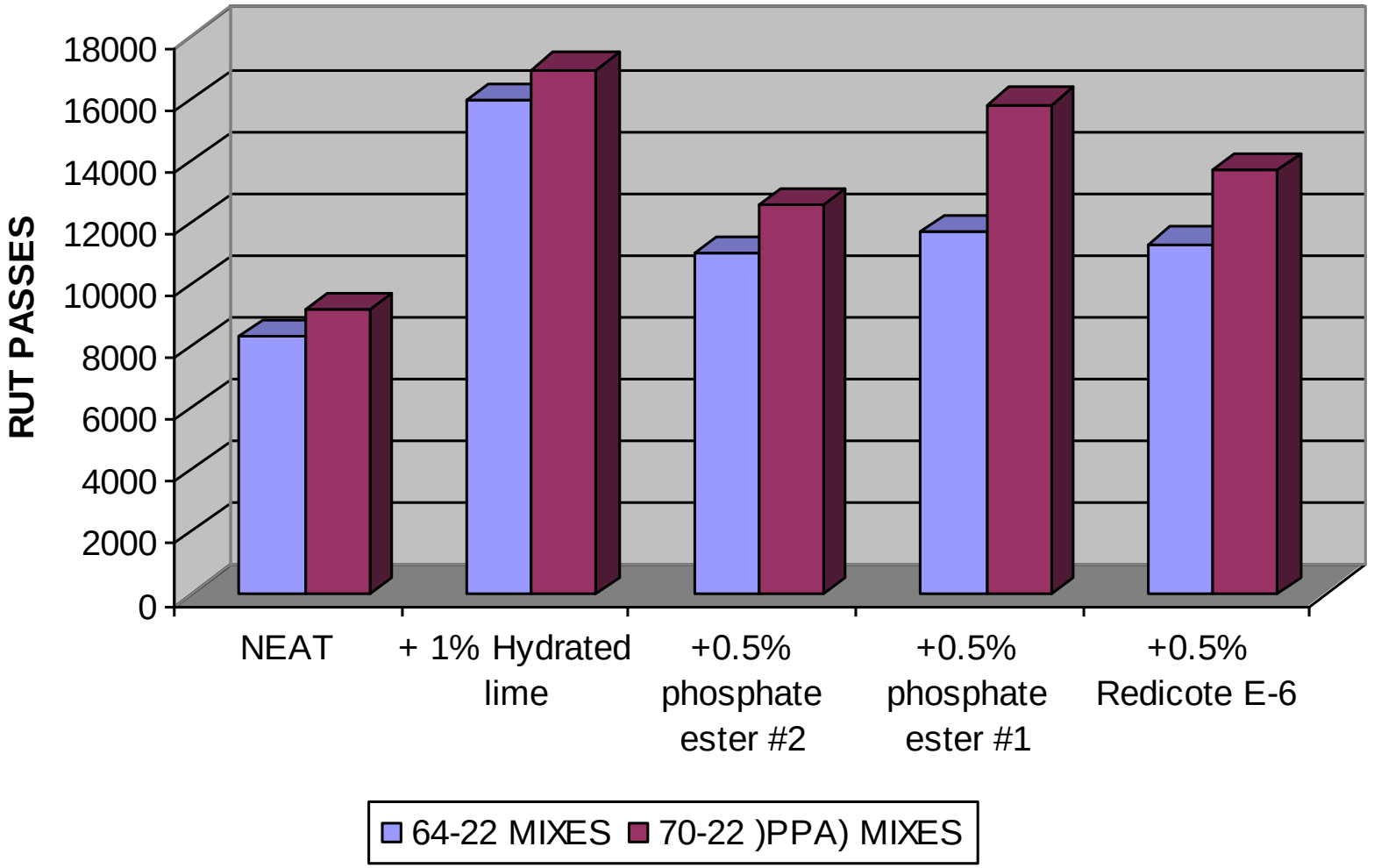
COMPARE WET AND DRY STRENGTH WITH AND WITHOUT LIME

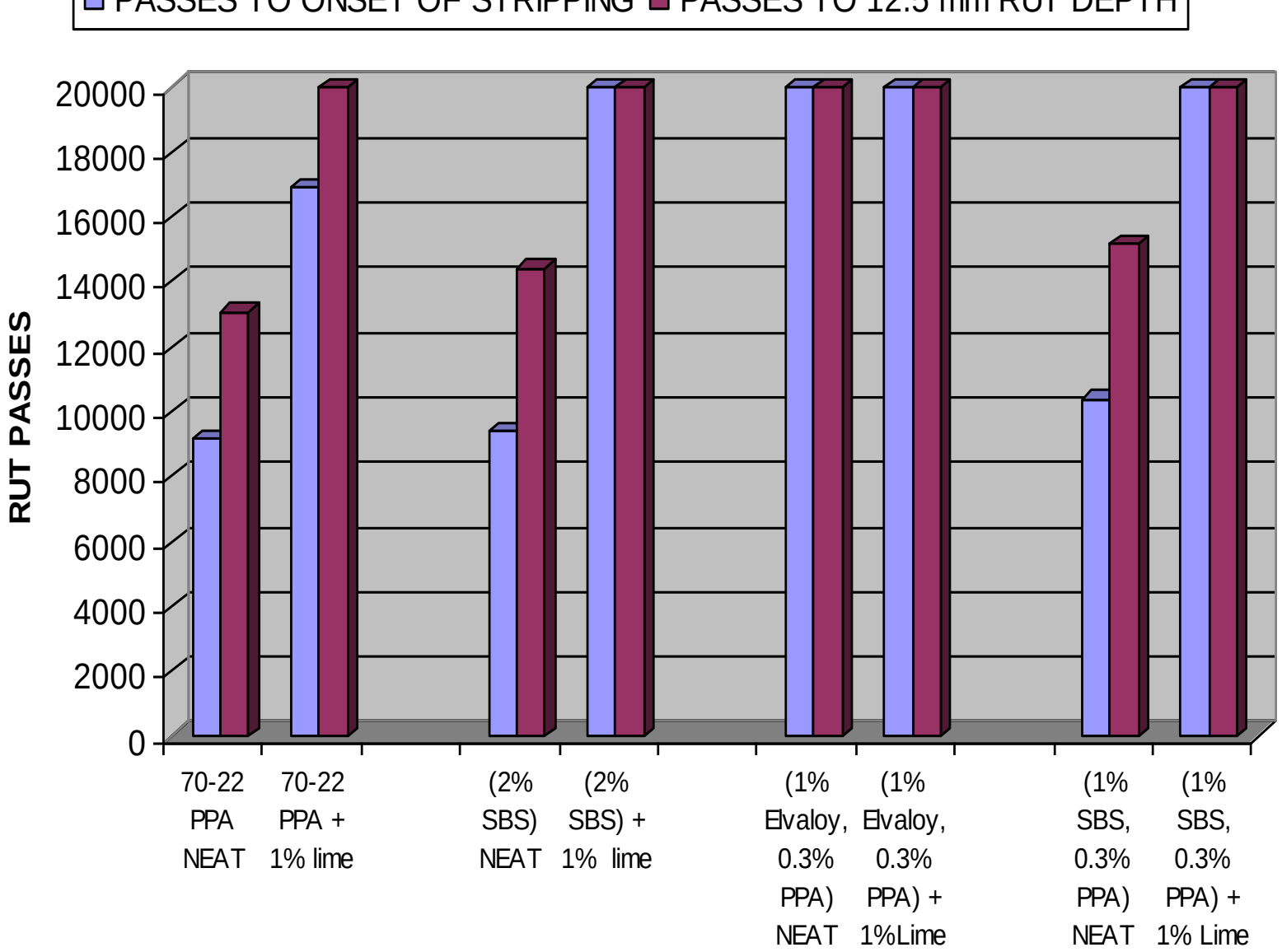


DSR STIFFNESS OF PG 70-22 (PPA MODIFIED BINDER) RECOVERED FROM TSR SPECIMENS



ONSET OF STRIPPING HAMBURG RUT TEST WET @ 50°C




PASSES TO ONSET OF STRIPPING
PASSES TO 12.5 mm RUT DEPTH
RUT PASSES
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
70-22 PPA NEAT
70-22 PPA + 1% lime
(2% SBS) NEAT
(2% SBS) + 1% lime
(1% Elvaloy, 0.3% PPA) NEAT
(1% Elvaloy, 0.3% PPA) + 1%Lime
(1% SBS, 0.3% PPA) NEAT
(1% SBS, 0.3% PPA) + 1% Lime

CONCLUSIONS FOR MOISTURE SENSITIVITY

1. HYDRATED LIME IMPROVES THE MOISTURE SENSITIVITY OF ALL MIXES REGARDLESS OF THE USE OF ACID
2. PHOSPHATE ESTER ANTI-STRIP ALWAYS IMPROVES THE HAMBURG PERFORMANCE OF ANY MIX WHETHER PPA IS USED OR NOT

CONCLUSIONS FOR MOISTURE SENSITIVITY

3. FOR ANY BINDER THERE IS A LEVEL OF PPA THAT IS TOO HIGH THAT WILL RESULT IN DECREASED MOISTURE RESISTANCE PERFORMANCE
   a. It seems preferable to me to limit the amount of PPA modification to 1 PG grade and set an upper limit on the amount of PPA that can be used. Some binders are just not suitable for PPA modification

CONCLUSIONS FOR MOISTURE SENSITIVITY

4. SOME BINDERS MODIFIED WITH PPA ONLY MIGHT EXPERIENCE A REDUCTION IN DSR STIFFNESS WHEN MIXED WITH HYDRATED LIME CONTAINING MIXES BASED ON EXTRACTED BINDER TESTS
    a. This is difficult to verify because we don't know to what extent HL retards binder aging and because of the difficulty of quantitatively removing all phosphorus containing compounds from the aggregate

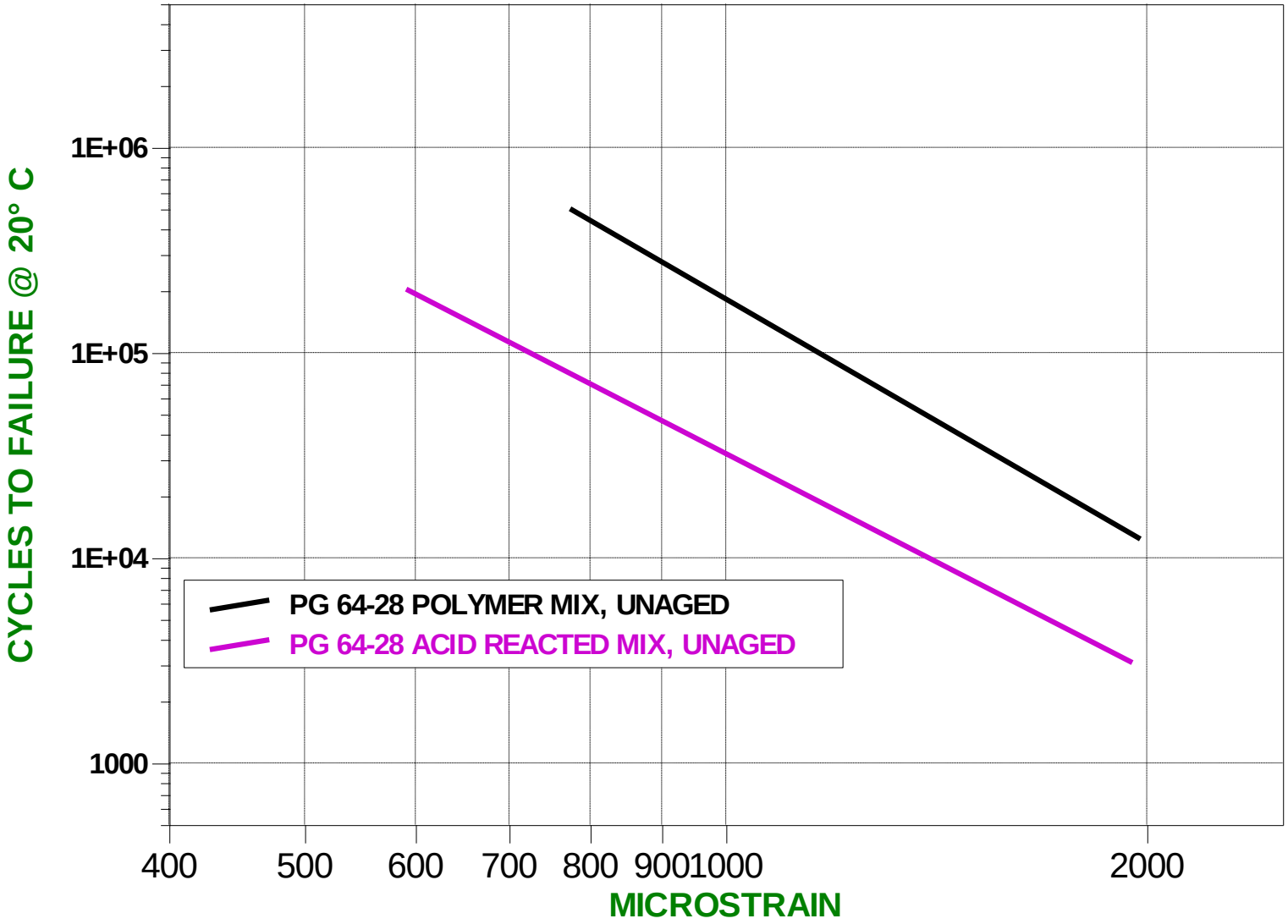
CONCLUSIONS FOR MOISTURE SENSITIVITY

5. PPA MODIFICATION BY ITSELF IS NOT THE EQUIVALENT TO POLYMER MODIFICATION IN TERMS OF RUTTING AND MOISTURE SENSITIVITY
6. THE USE OF PPA IN CONJUNCTION WITH PPA RESULTS IN MIX PERFORMANCE THAT IS GENERALLY BETTER THAN POLYMER ALONE

FATIGUE

1. DSR TORSIONAL FATIGUE WAS PERFORMED ON MIXES PRODUCED WITH 64-28 + 1% PPA ONLY AND 64-28 PRODUCED WITH ELVALOY + 0.3% PPA
2. MIXES WERE TESTED UNAGED, AFTER 5 AND 10 DAYS OF AGING AT 85°C IN A FORCED DRAFT OVEN

COMPARISON OF FATIGUE FAILURE BETWEEN PG 64-28 POLYMER MODIFIED AND PG 64-28 ACID REACTED



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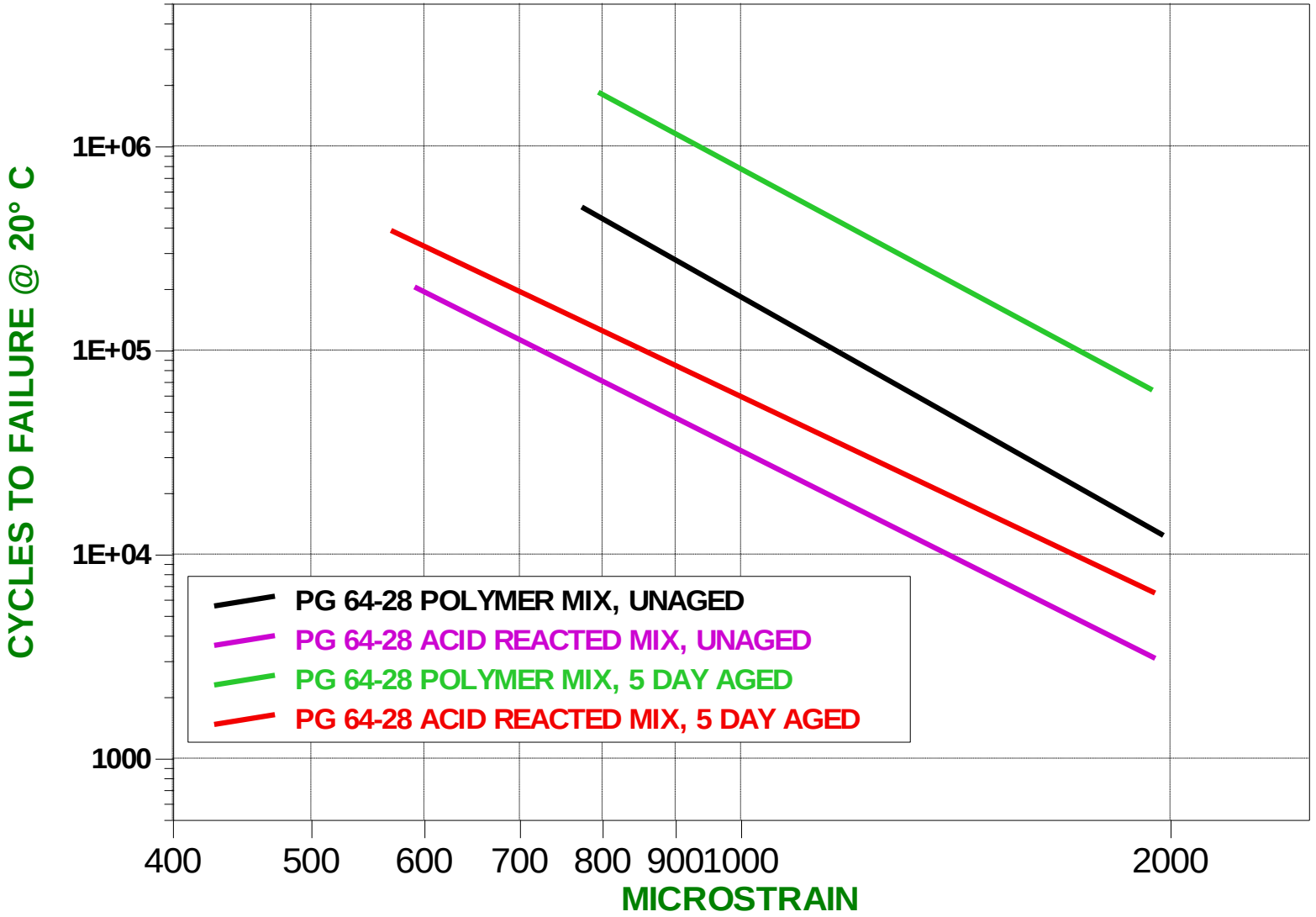

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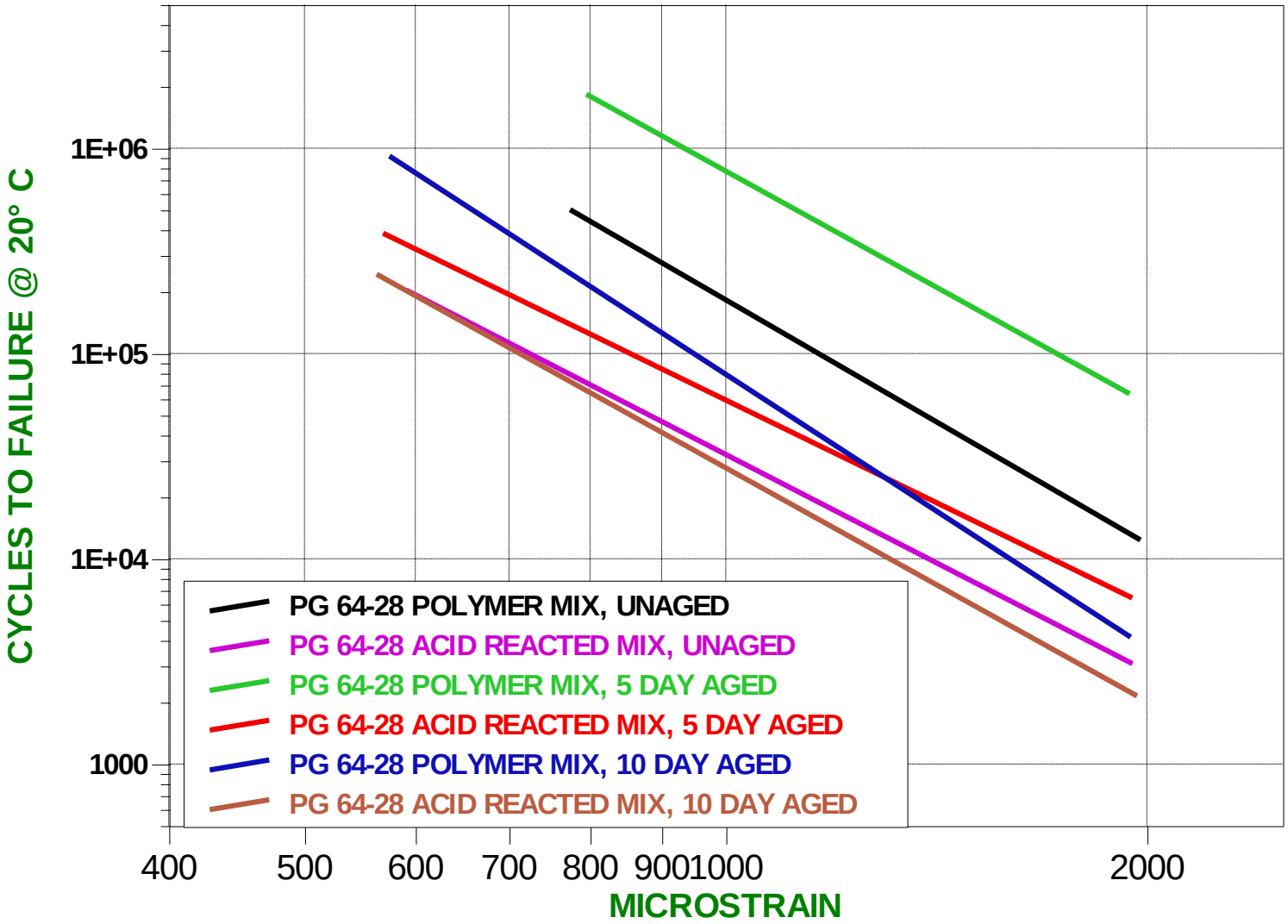

FATIGUE CONCLUSIONS?

1. IT DOES APPEAR THAT MIXES PRODUCED WITH POLYMER HAVE BETTER FATIGUE PERFORMANCE THAN THOSE PRODUCED WITH JUST ACID
2. THIS NEEDS TO BE STUDIED IN MORE DEPTH DESPITE WHAT MANY WOULD SAY IS OBVIOUS

AND DON'T FORGET THIS

"Quod enim mavult homo verum esse, id poitus credit."

KEEP CHALLENGING YOURSELF

What man wishes were true, he more readily believes.

THANK YOU FOR YOUR ATTENTION

QUESTIONS

COMMENTS