D'Angelo Consulting

Asphalt Binders and Aging 20Hr or 40Hr PAV

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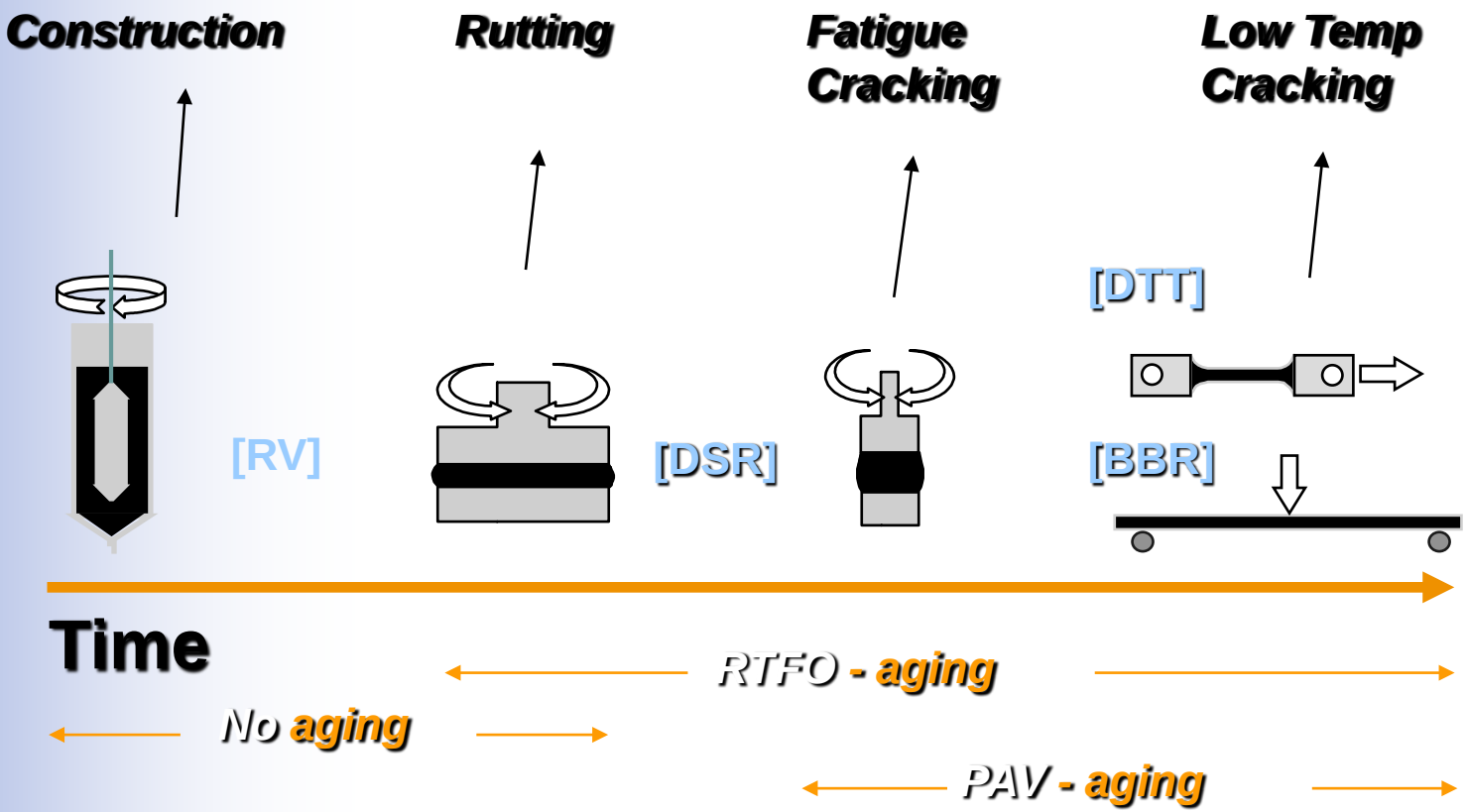
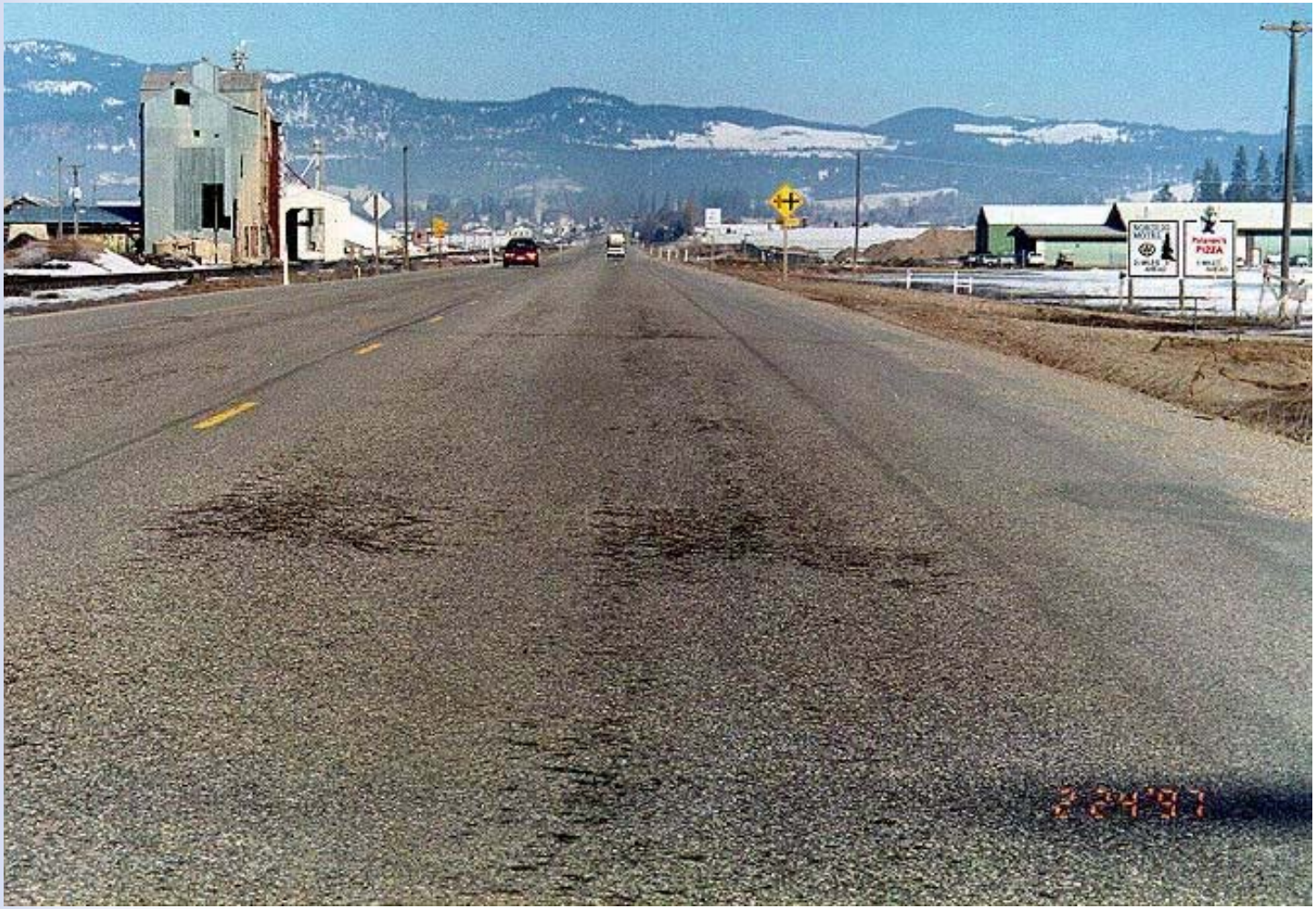
Superpave Binder Specification



Raveling

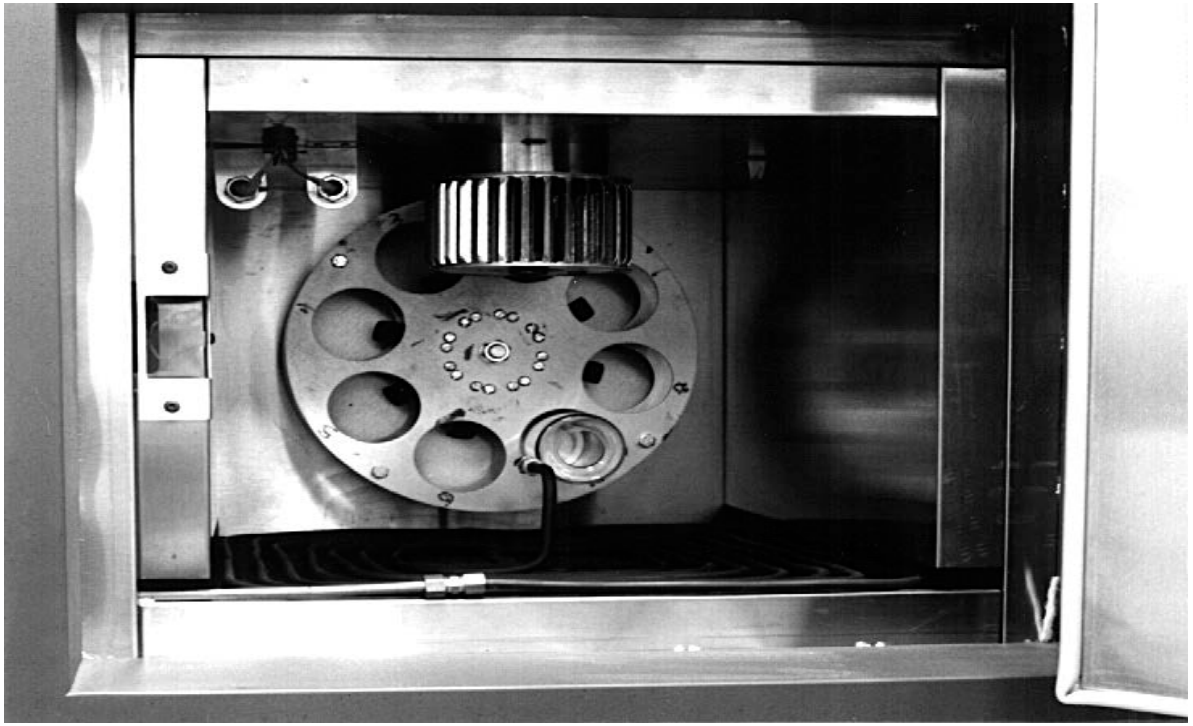


Fatigue Cracking

Low Temperature Cracking

Superpave Conditioning

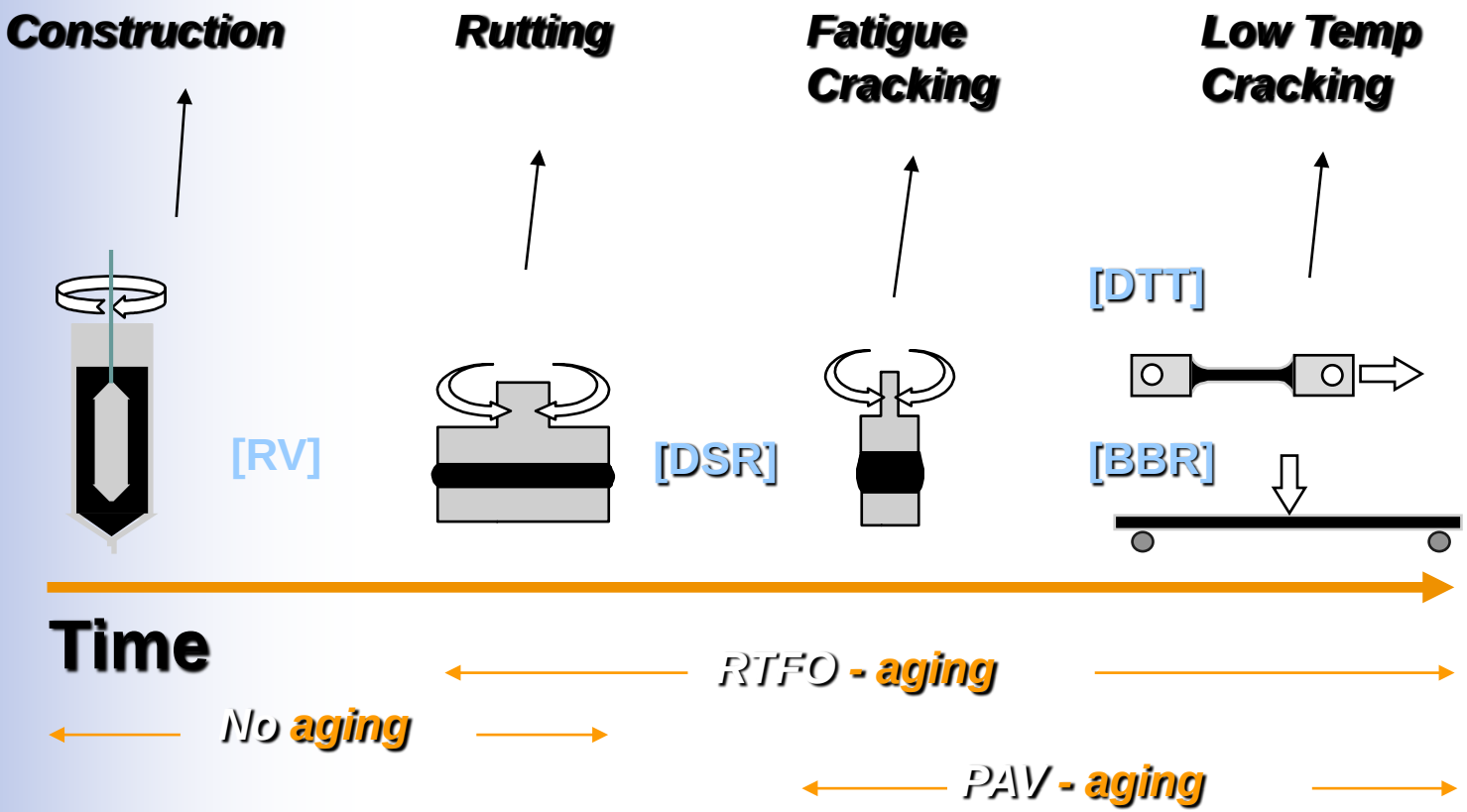
RTFOT – Short term aging



Aging Long Term

- Current PAV 20 hrs at 100 C, 100 psi.
- 20 hr PAV mandates two days for binder classification.

Superpave Binder Specification



New Criteria being looked at for Durability and Fatigue

- ΔTc Difference between BBR S failure temp and m failure temp
  - This is intended to capture brittle cracking
- Glover Rowe $G^*(\cos\delta)^2/\sin\delta$ Original parameter by Charles Glover Texas A&M to capture Ductility at 15°C 0.005 rads/s
- CAM Model R value
  - Defines shape of the master curve indicating if binder has higher G* lower δ.

Binder Relaxation Properties

- Bending Beam Rheometer measures Stiffness and m value.
- BBR m value measures relaxation of the binder at cold temperatures.
- As binder ages the m value continues to decrease indicating loss of relaxation properties while the stiffness increase levels off.
- The difference in temp where S = 300MPa and m value = 0.3 ΔTc is an indicator of embrittlement.

Binder Relaxation Properties

- Ductility
  - Ductility run on unaged or short term aged binders at one temperature does not relate well to cracking.
- Glover TAMU investigated recovered binders for the roadway and correlated ductility at 15°C to cracking.
  - Surrogate property rheological property $G'/(\eta'/G')$ measured at 15°C 0.005rad/s correlated to ductility.

Binder Relaxation Properties

- Rowe recalculated Glover property $G'/(\eta'/G')$ to $G^*(\cos\delta)^2/\sin\delta$. This can be plotted in Black Space.
- Glover TAMU study indicated ductility 5 cm indicates onset of cracking and ductility of 3 cm will exhibit cracking.

Current Aging approaches

- Current 20 hour PAV does not represent long enough aging condition to identify critical conditions
  - Extend 20 hour PAV to 40 hour PAV
    - Longer time to grade
  - Use thinner films in the PAV
    - Reduced material for testing
  - Use extremely thin films in an oven.
    - Very small amounts of material special testing 4mm DSR

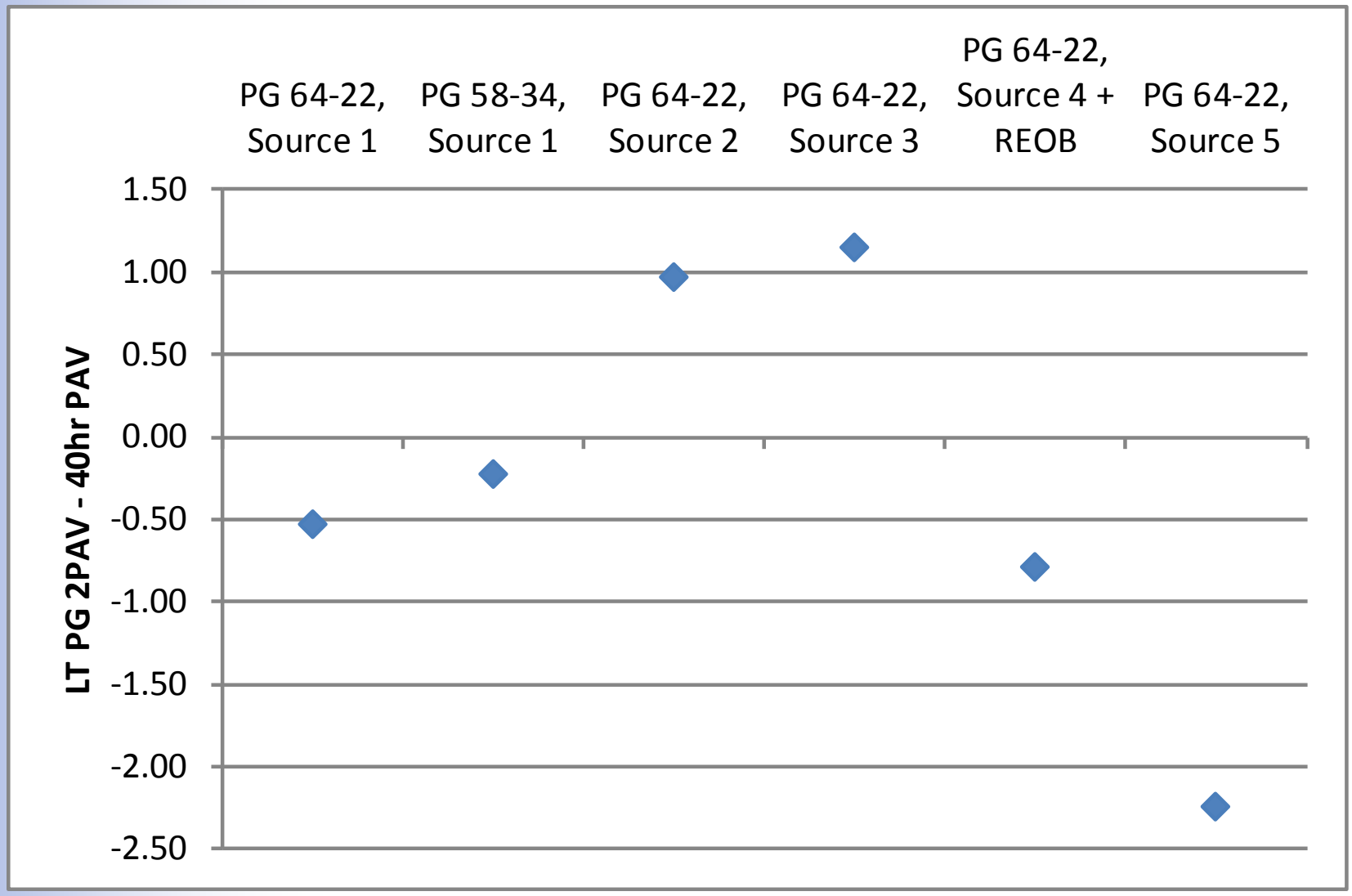
Binder Aging

- Longer Aging times being look at to identify embrittlement.
  - Are Longer times needed?
  - Longer time to grade binders
- Can aging ratios identify the same issues?
  - More tests
  - Same time for grading binder

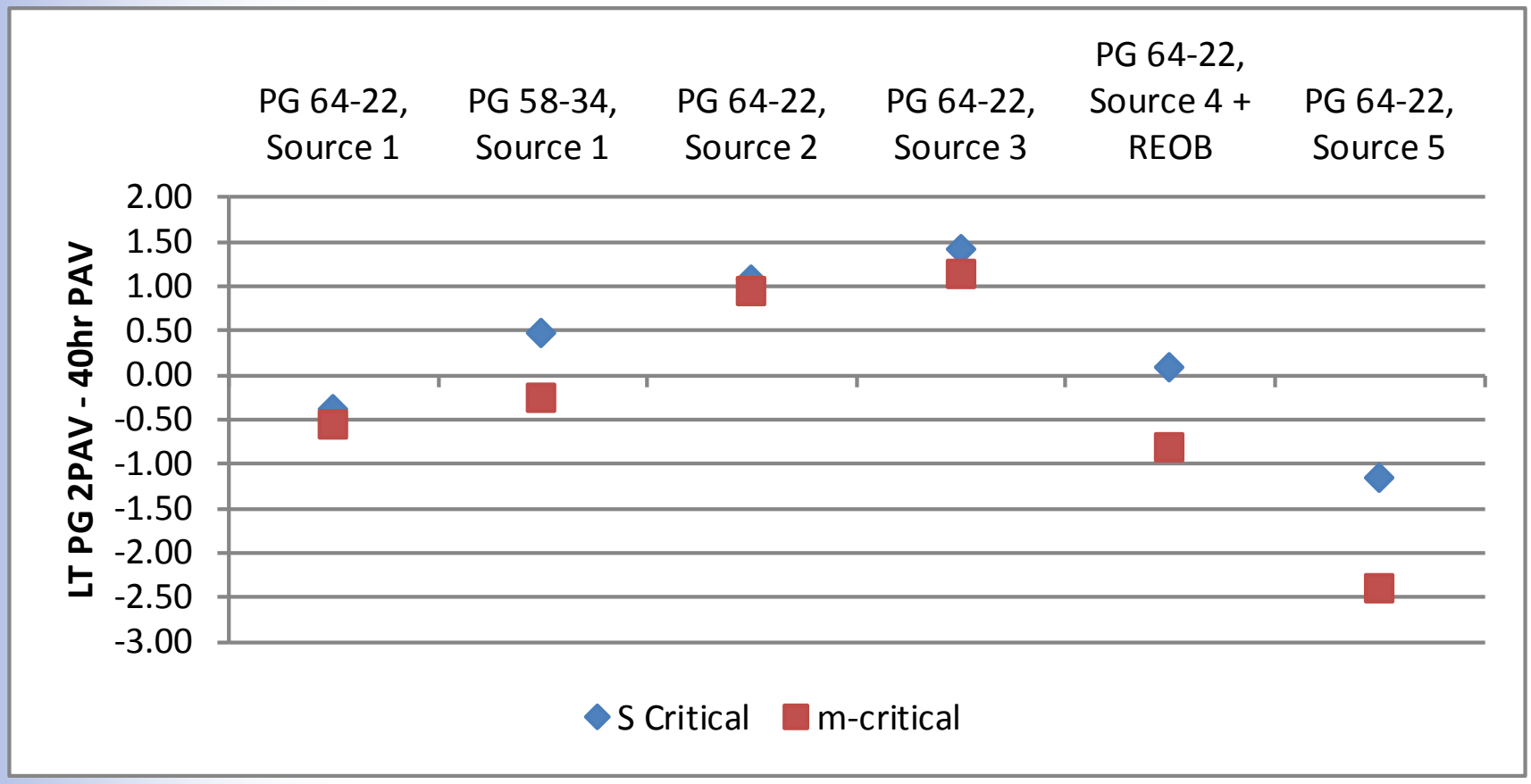
Binder aging

- Does one 40hr PAV provide similar results to two 20hr PAV conditioning back to back?
- Mathy has done small preliminary study.

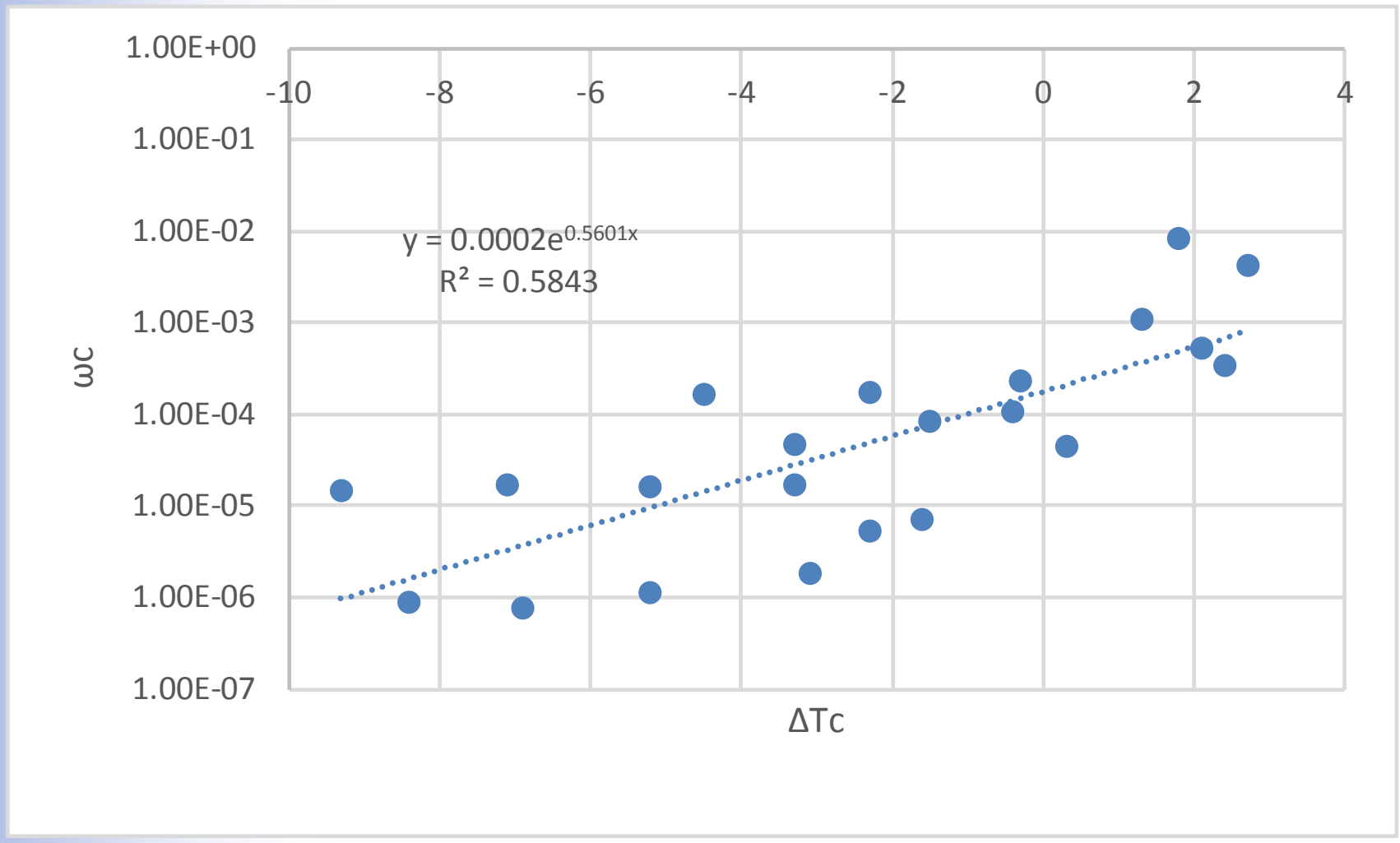
2 20hr PAV vs 40hr PAV



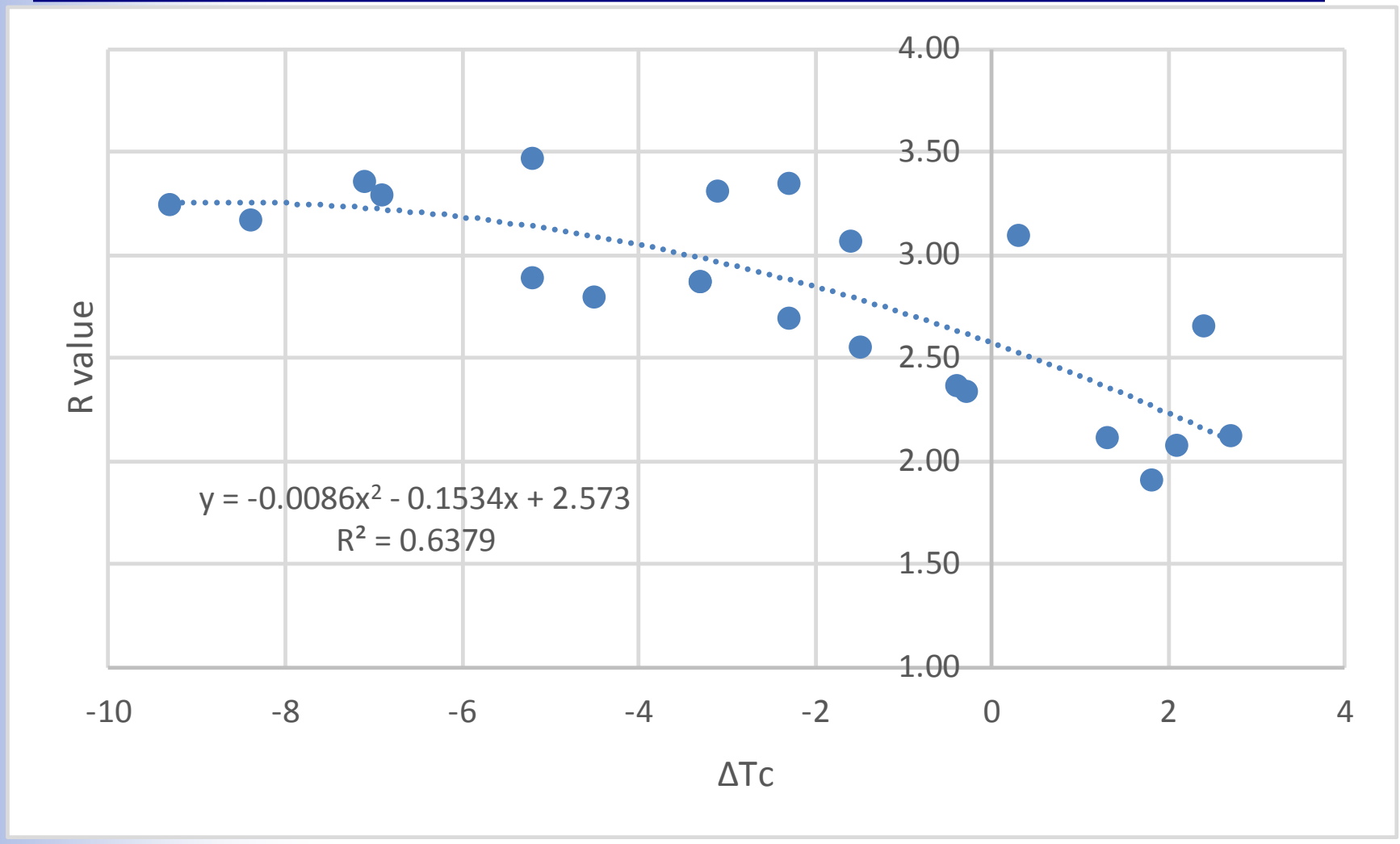
2 20hr PAV vs 40hr PAV



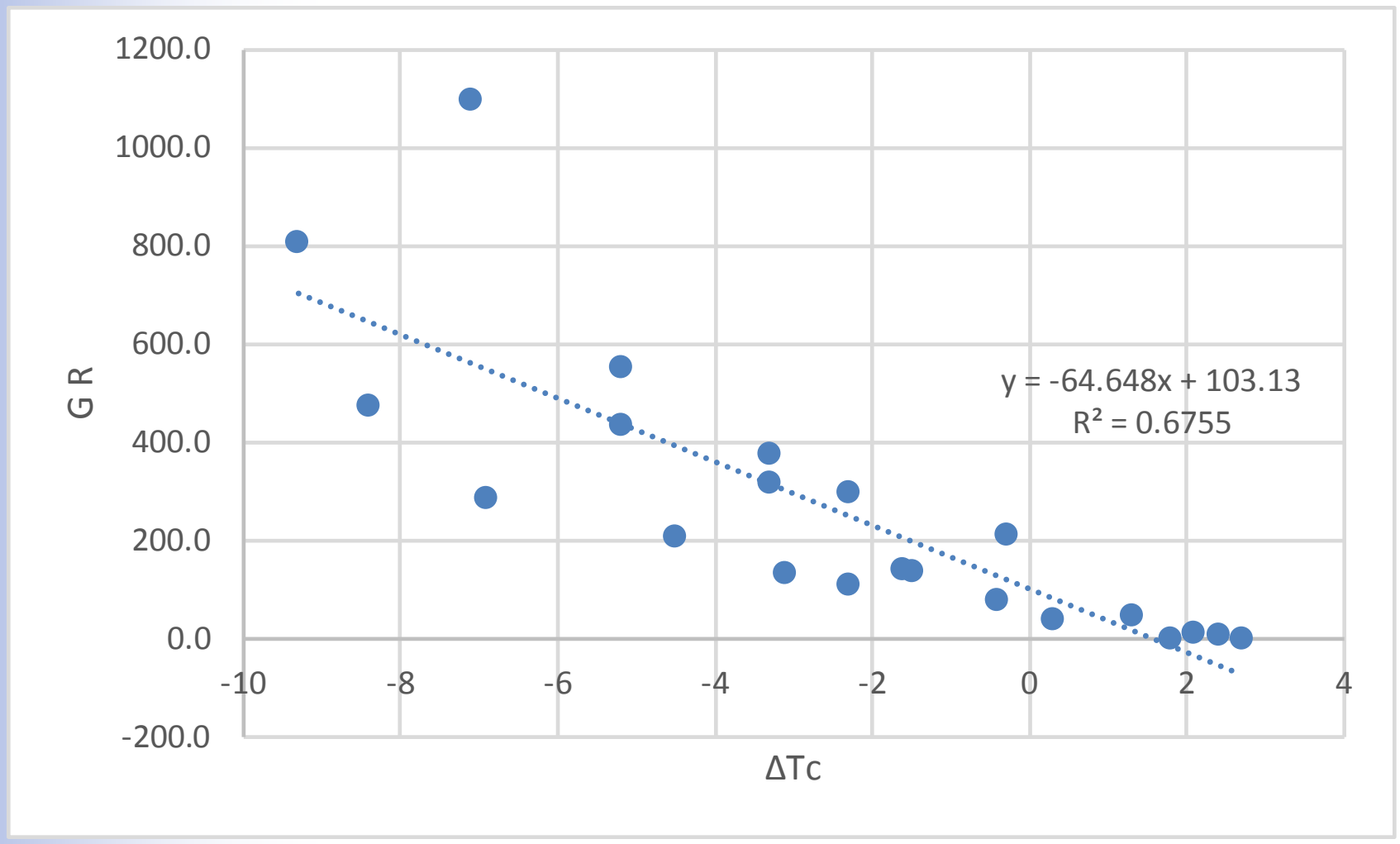
Relationship of crossover Frequency to ΔTc



Relationship of R value to ΔTc



Relationship of GR to ΔTc



ΔTc 20 and 40 hour PAV

- Can we determine where the 40hr PAV value we go based on the 20hr PAV?
- Look at the 20hr value and the change from original to 20hr.

ΔTc

- There are clear indications that the 20hr PAV and the change from original provides clear indications if 40 hr PAV will fail.
- Rate of change of RTFOT to 20hr PAV (RTFOT ΔTc – 20hr PAV)/20hr projected to 40hr

Prediction of 40hr ΔTc

To predict 40hr ΔTc determine rate of change RTFOT to 20hr PAV (ΔTc RTFOT - ΔTc 20hr PAV)/20hr , to predict 40hr ΔTc

Age	ΔTc,°C													
RTFO	0.5	1.0	-2.6	1.7	2.8	2.3	-1.3	1.3	0.6	1.9	0.4	1.3	1.7	1.6
20 hr. PAV	-3.3	-0.9	-7.0	-1.0	1.7	-0.5	-4.8	-0.9	-2.7	0.8	-3.1	-0.5	-0.7	-2.3
40 hr. PAV	-6.1	-1.4	-12.4	-2.3	0.8	-4.7	-7.6	-2.6	-5.8	-2.6	-8.7	-2.9	-2.2	-8.4
predicted	-7.1	-2.8	-11.4	-3.8	0.6	-3.3	-8.3	-3.0	-6.0	-0.3	-6.6	-2.3	-3.1	-6.2
diff	1.1	1.4	-1.0	1.5	0.2	-1.4	0.7	0.5	0.2	-2.3	-2.1	-0.6	0.9	-2.2

Asphalt Binder Aging

- Are longer aging times needed?
- Binder aging ratios may capture the same issues without longer aging times.
- The task group will continue to evaluate more materials and different criteria to determine if poor materials can be identified without longer aging.

Thank You

Discussions