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VARIATIONS IN ASPHALT ADHESION AS A FUNCTION OF AGGREGATE TYPE

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ACKNOWLEDGEMENTS

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- Dr. J. Claine Petersen, Mr. James Beiswenger, and Tony Munari.

SUPERPAVE® PARAMETERS

$$\frac{G^*}{\sin\delta}$$

$$m - value$$

$$G^* \sin\delta$$

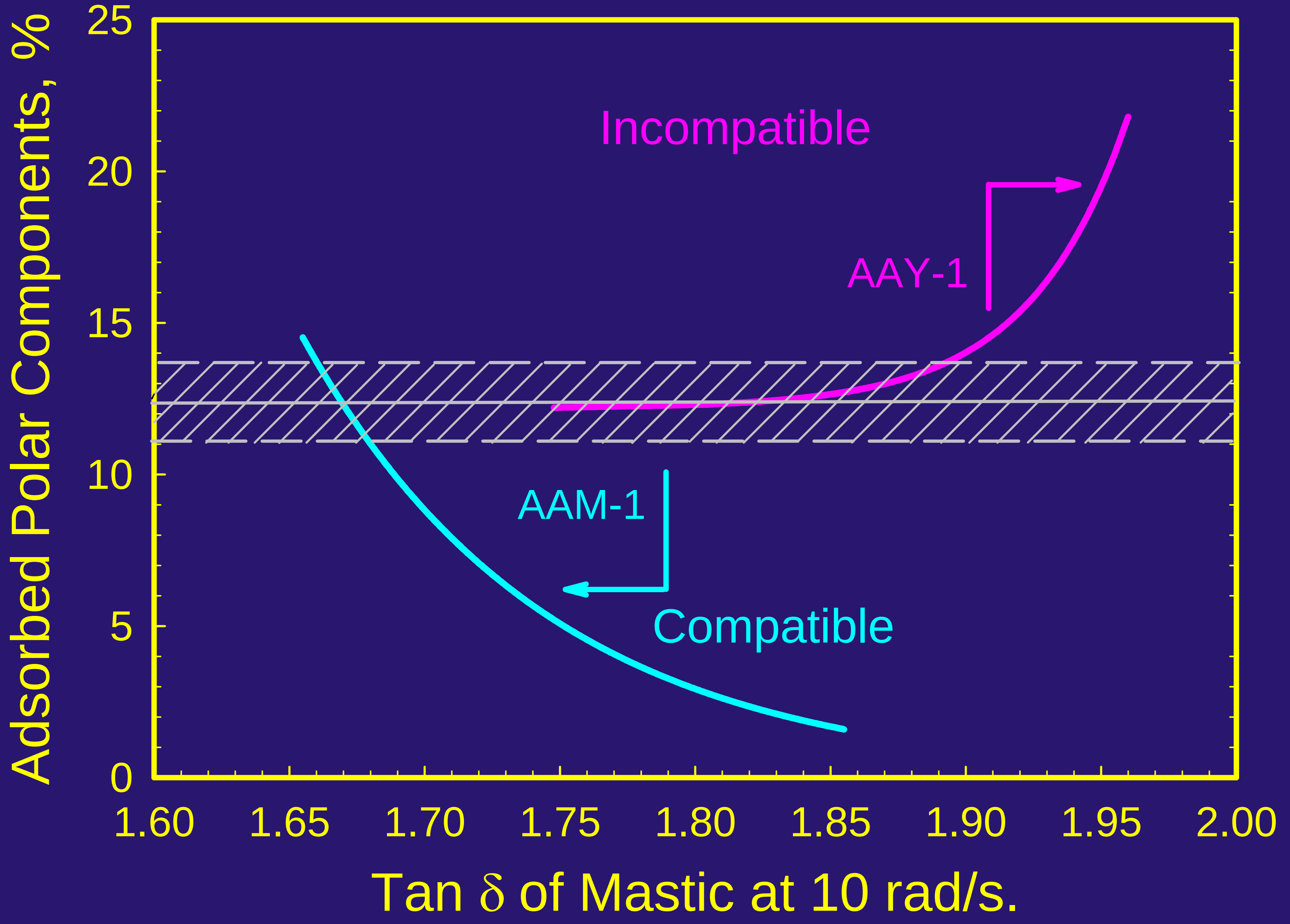
$$S - value$$

$$\frac{G^*}{[1 - \frac{1}{\tan\delta \sin\delta}]}$$

$$ZeroShearVis\cos ity$$

$$\frac{G^*}{(\sin\delta)^9}$$

PROPOSED MECHANISM MAP FOR ASPHALT-FILLER INTERACTION



LITERATURE

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- Fink, D.F. and R.L. Griffin – ASTM STP 309, 1961
- Marek, C.R. and M. Herrin – AAPT, Vol. 37, 1968
- Bikerman, J.J. – Journal of Materials, Vol. 1, 1966
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- Gastmans, Andre C. – 33rd PARC, 1996
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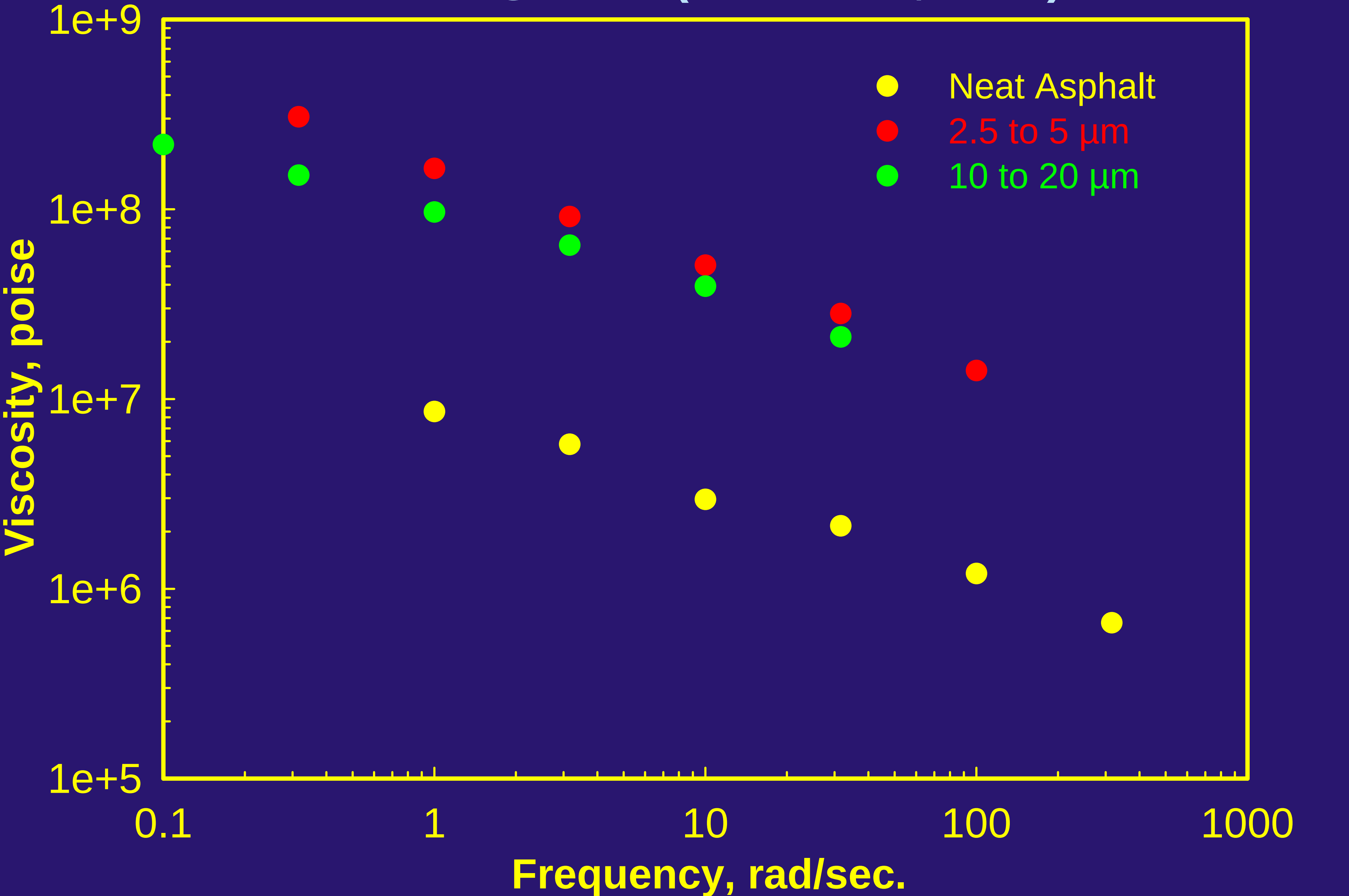
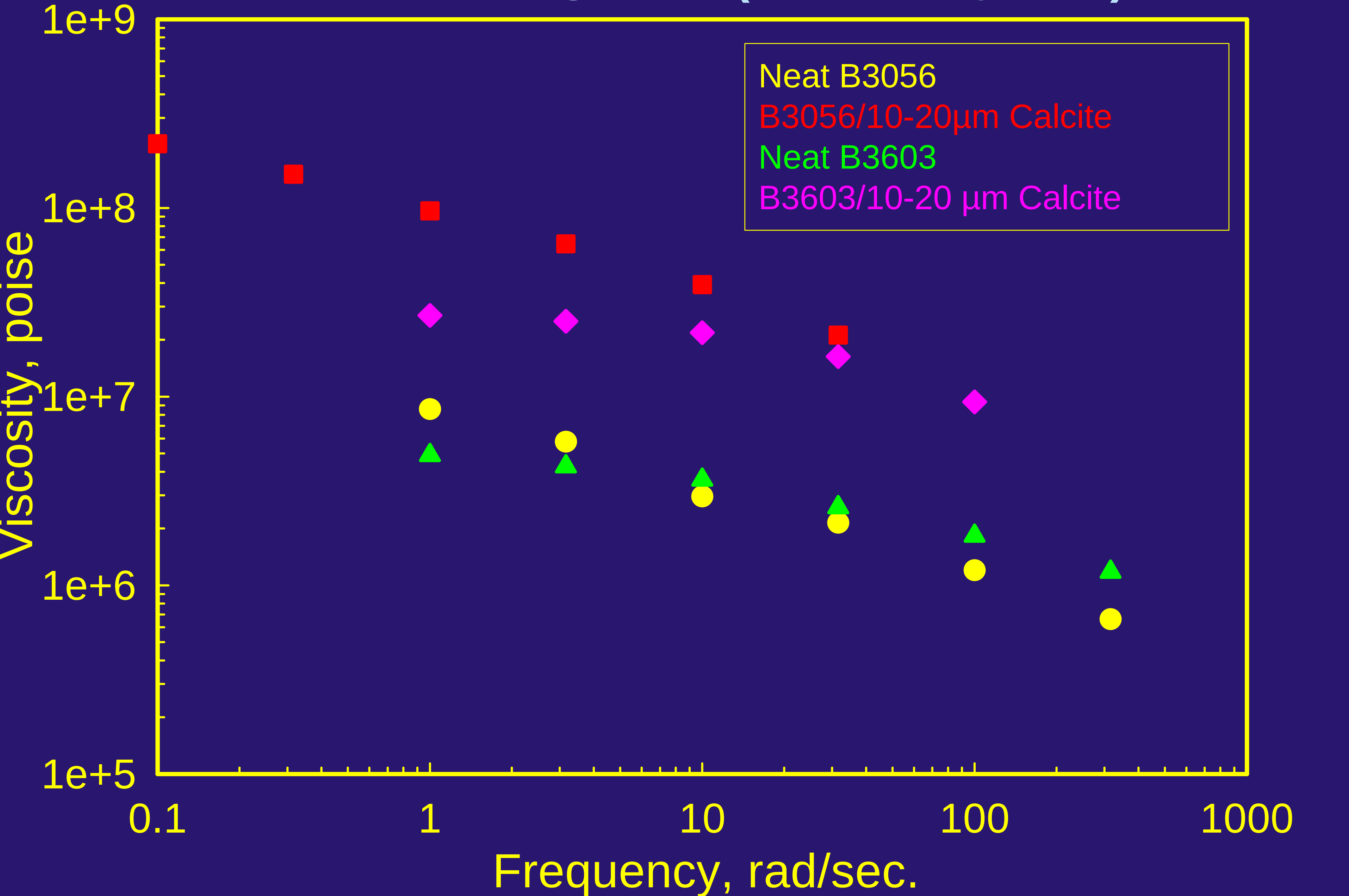
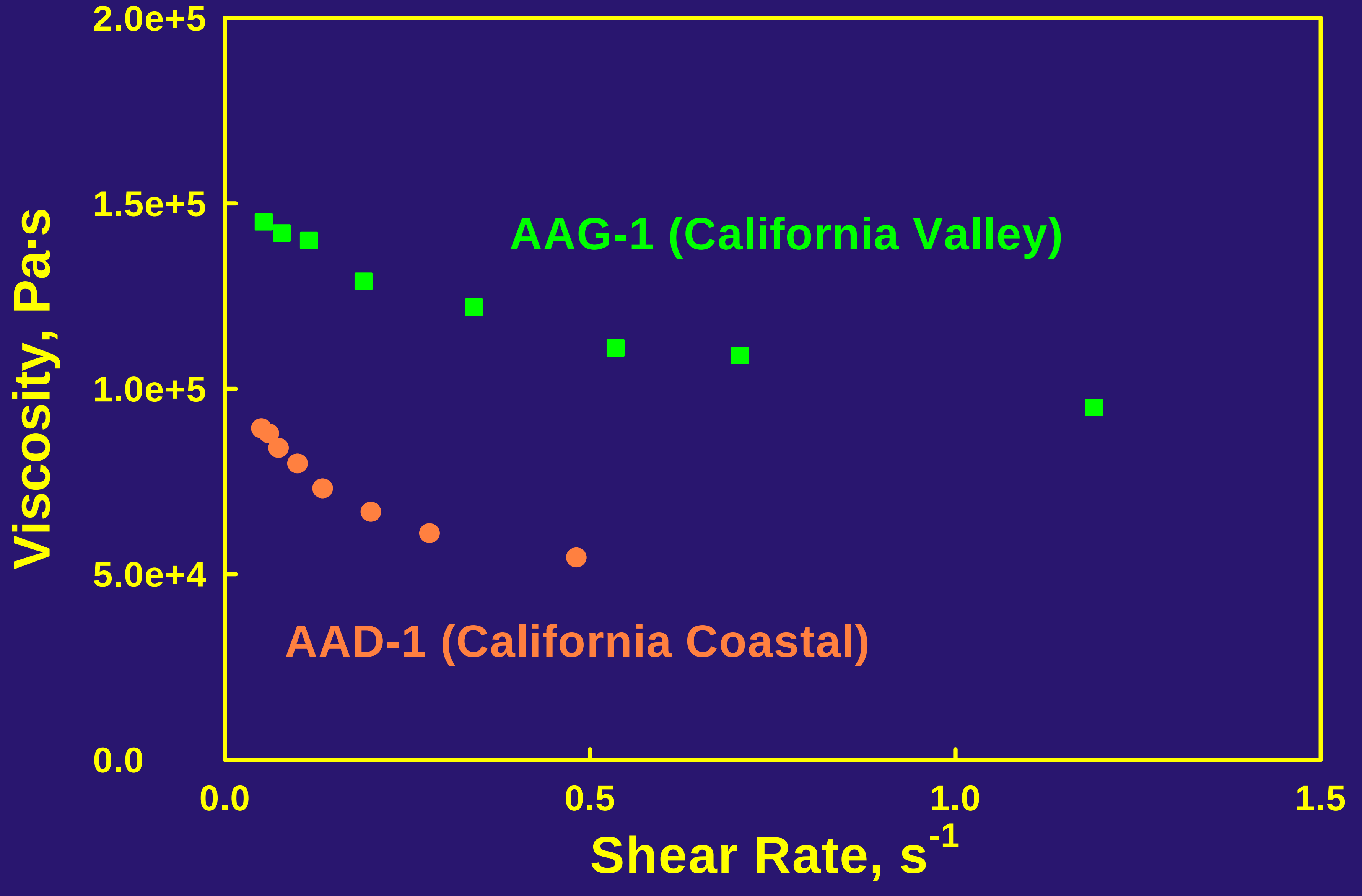
EFFECT OF SIZE OF CALCITE ON ASPHALT B3056 @ 25°C (Anderson, 1971)



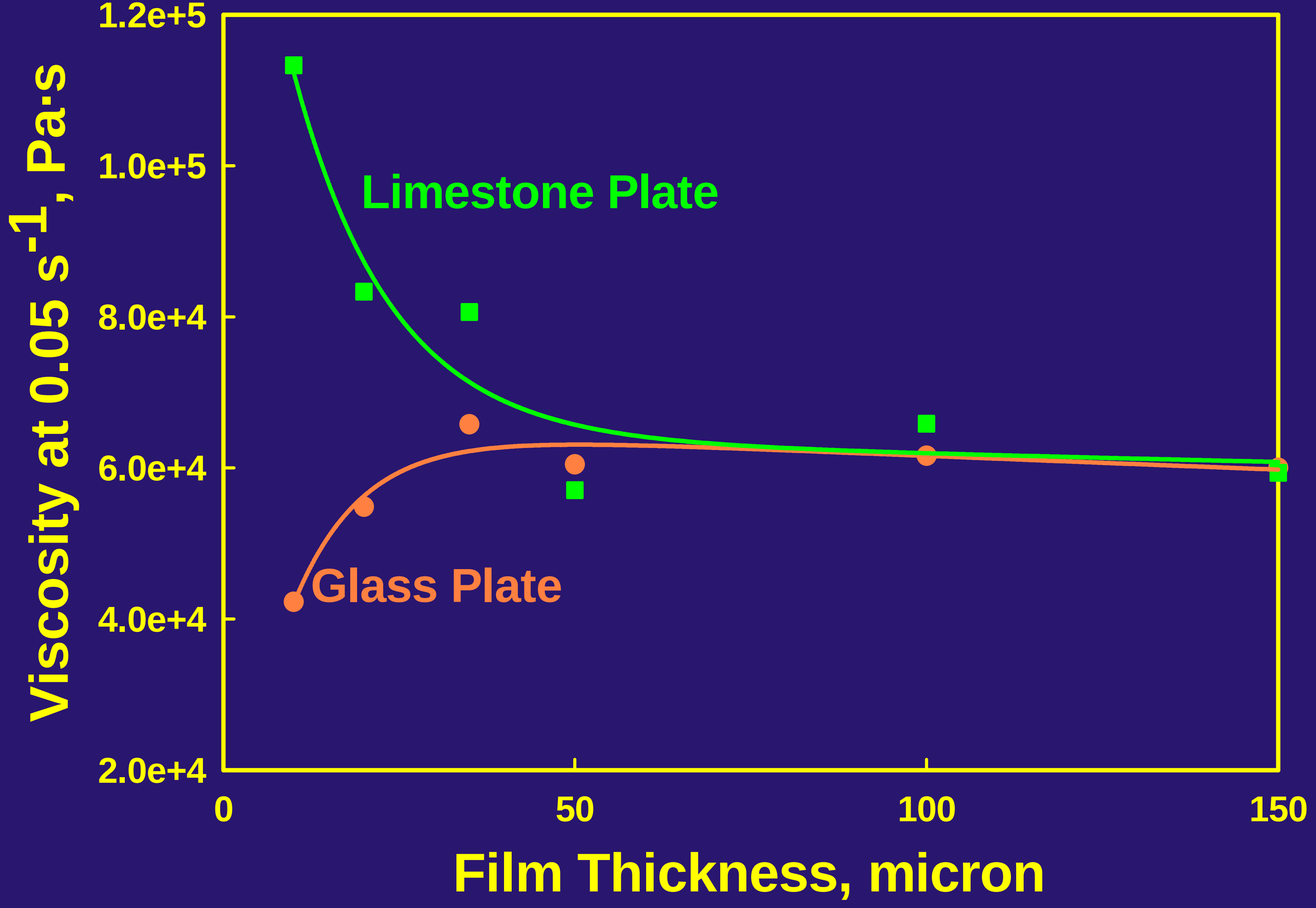
EFFECT OF CALCITE ON TWO DIFFERENT ASPHALTS @ 25°C (Anderson, 1971)



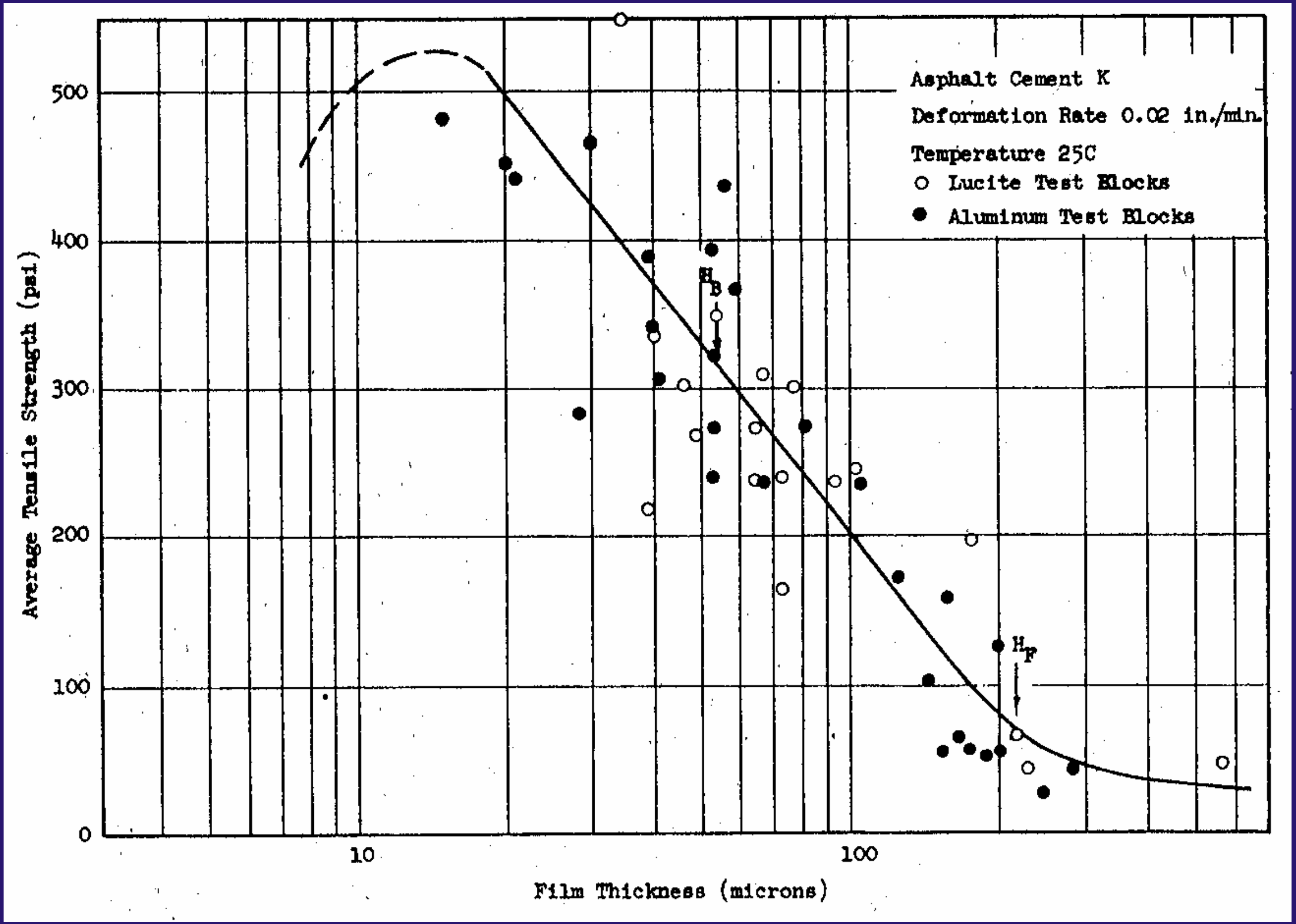
EFFECT OF ASPHALT SOURCES ON LIMESTONE SURFACE



EFFECT OF FILM THICKNESS ON DIFFERENT MATERIALS, AAD-1



INFLUENCE OF FILM THICKNESS ON TENSILE STRENGTH



Marek & Herrin, AAPT 1968

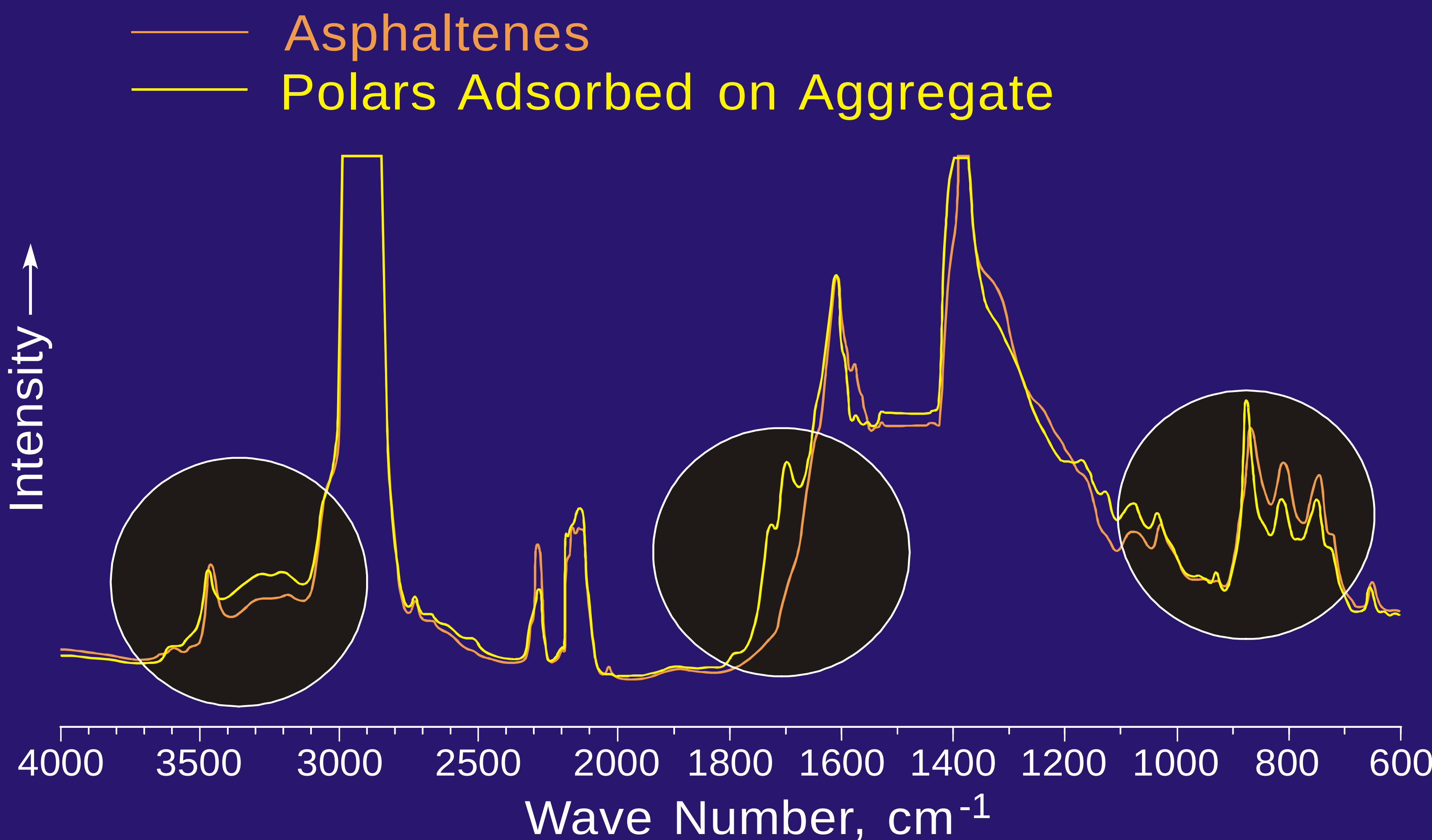
Superpave® Mixture Design

$$\frac{\text{Filler}}{\text{Asphalt}} = 0.6 \sim 1.6$$

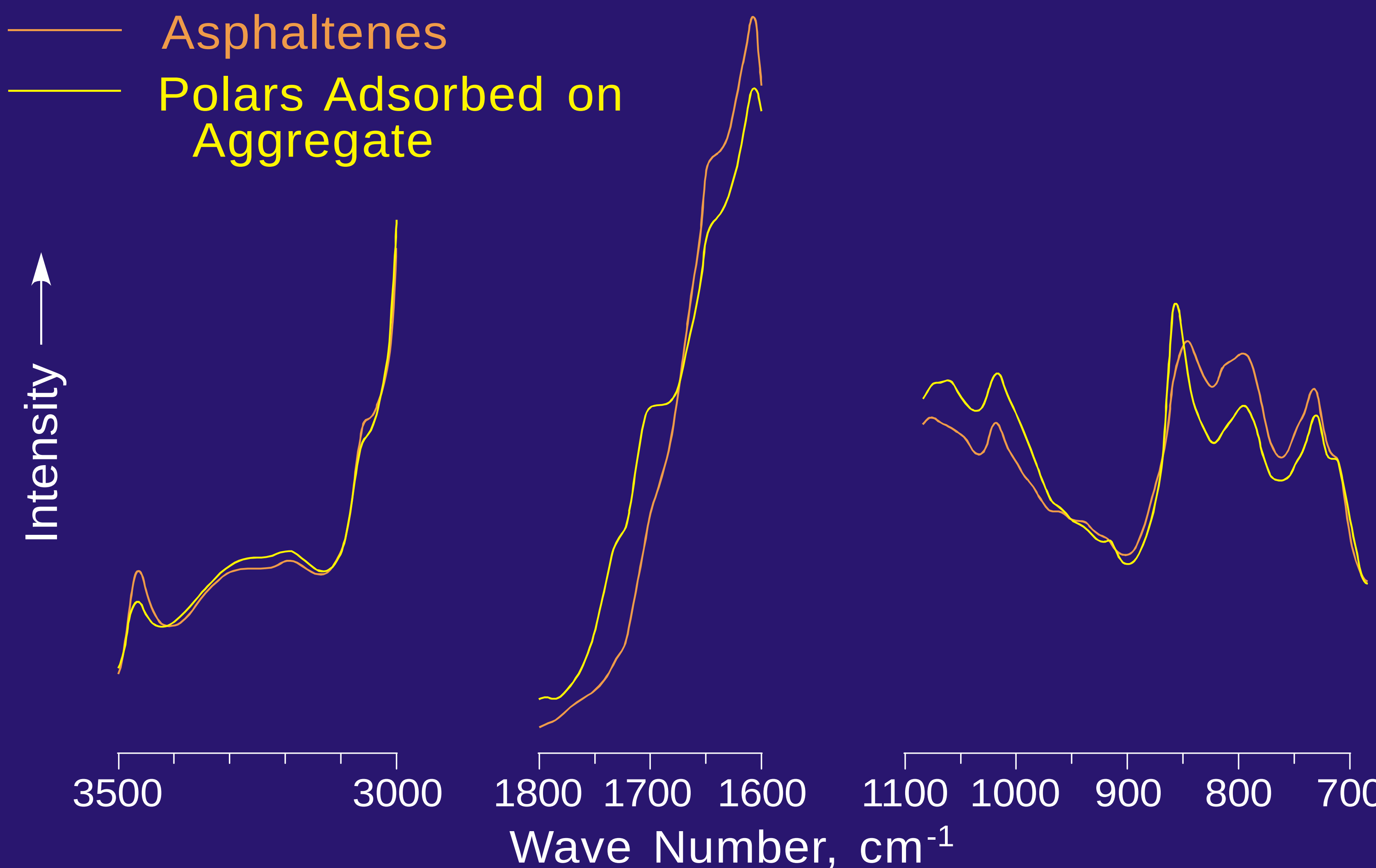
Volumetric properties (Air void, VMA...)

DOES NOT TAKE INTO ACCOUNT
THE PHYSICO - CHEMICAL INTERACTIONS
BETWEEN ASPHALTS AND FILLERS

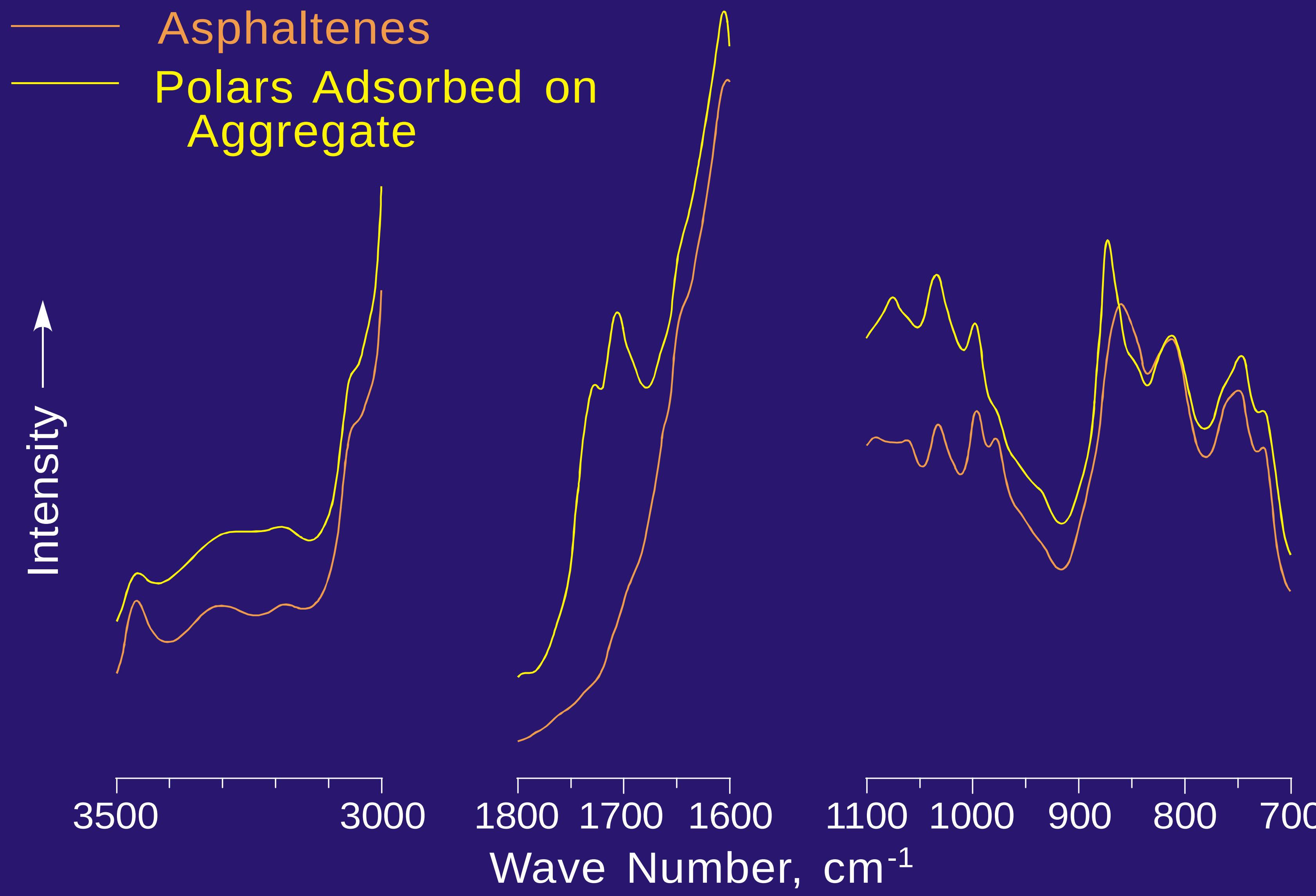
IR SPECTRAL RESULTS OF AAG-1 WITH LIMESTONE PLATES



IR SPECTRAL RESULTS OF AAD-1 WITH LIMESTONE PLATES



IR SPECTRAL RESULTS OF AAK-1 WITH LIMESTONE PLATES



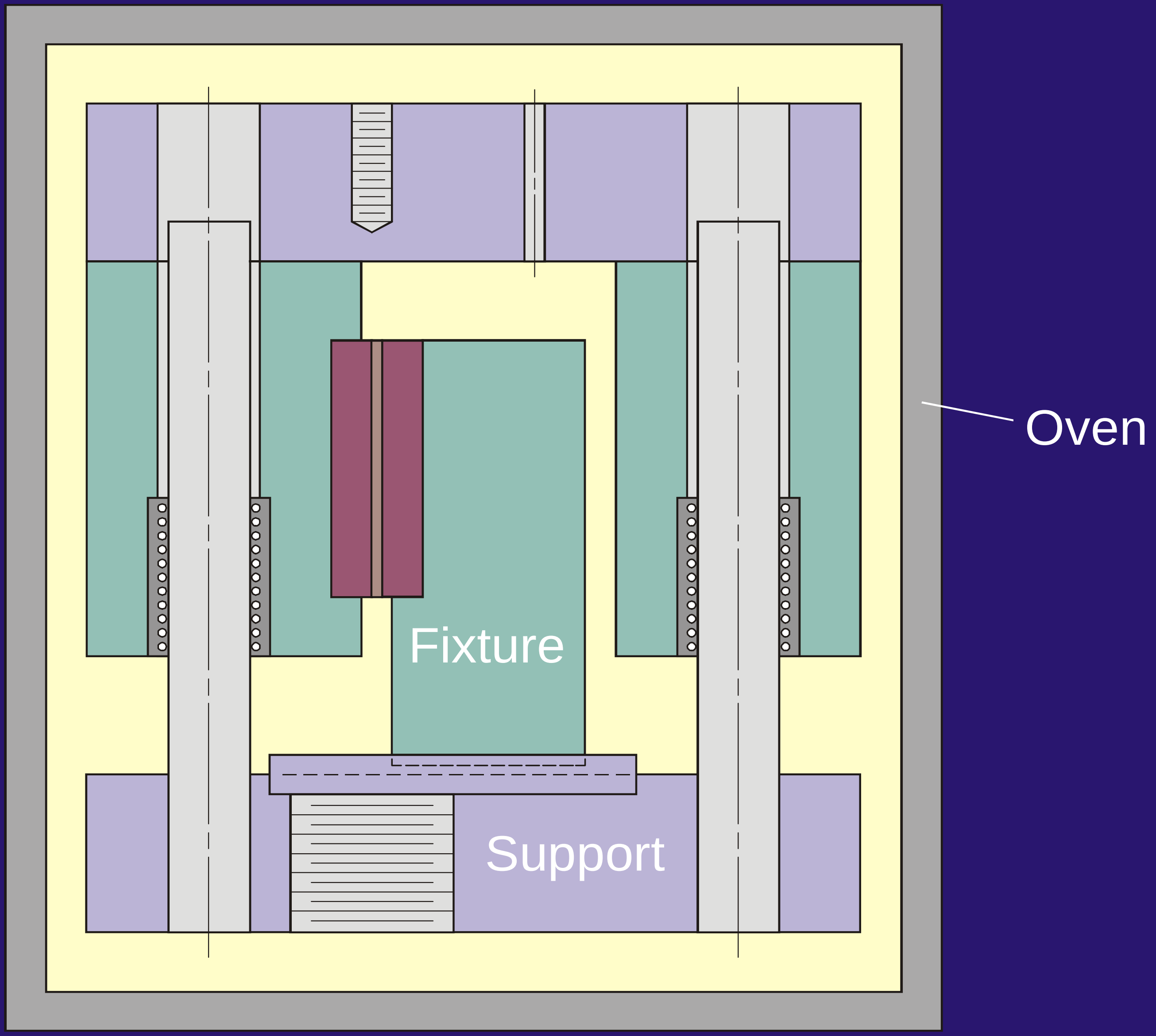
HYPOTHESIS

- The physical properties of thin asphalt films on mineral aggregates are not completely predictable from experiments using thick (1.0 mm) films on steel surfaces, which is the methodology employed in the current Superpave® rheological specifications.

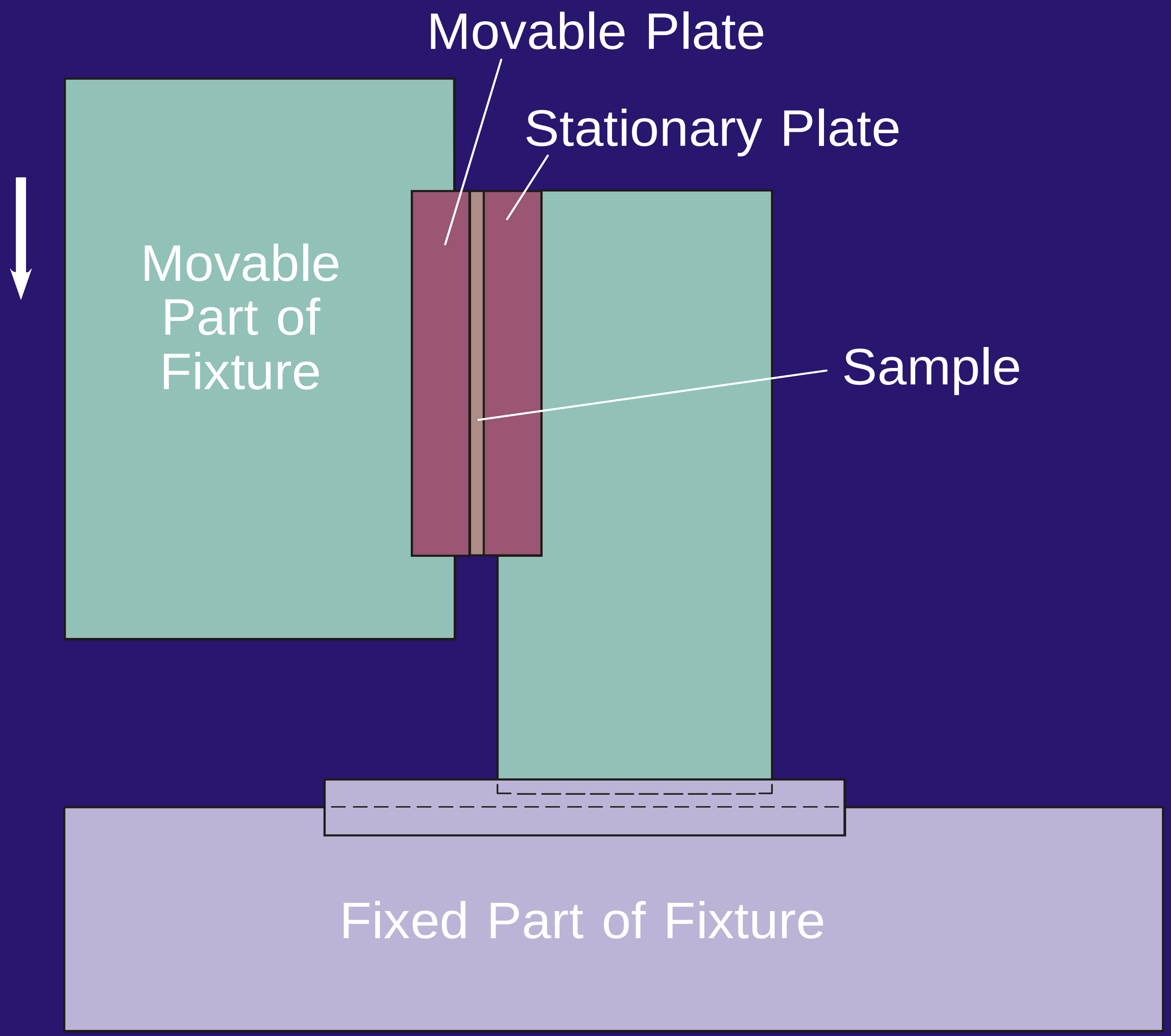
OBJECTIVE

- To develop a simple method that enables the interactions between thin asphalt layers and various aggregate surfaces to be measured.

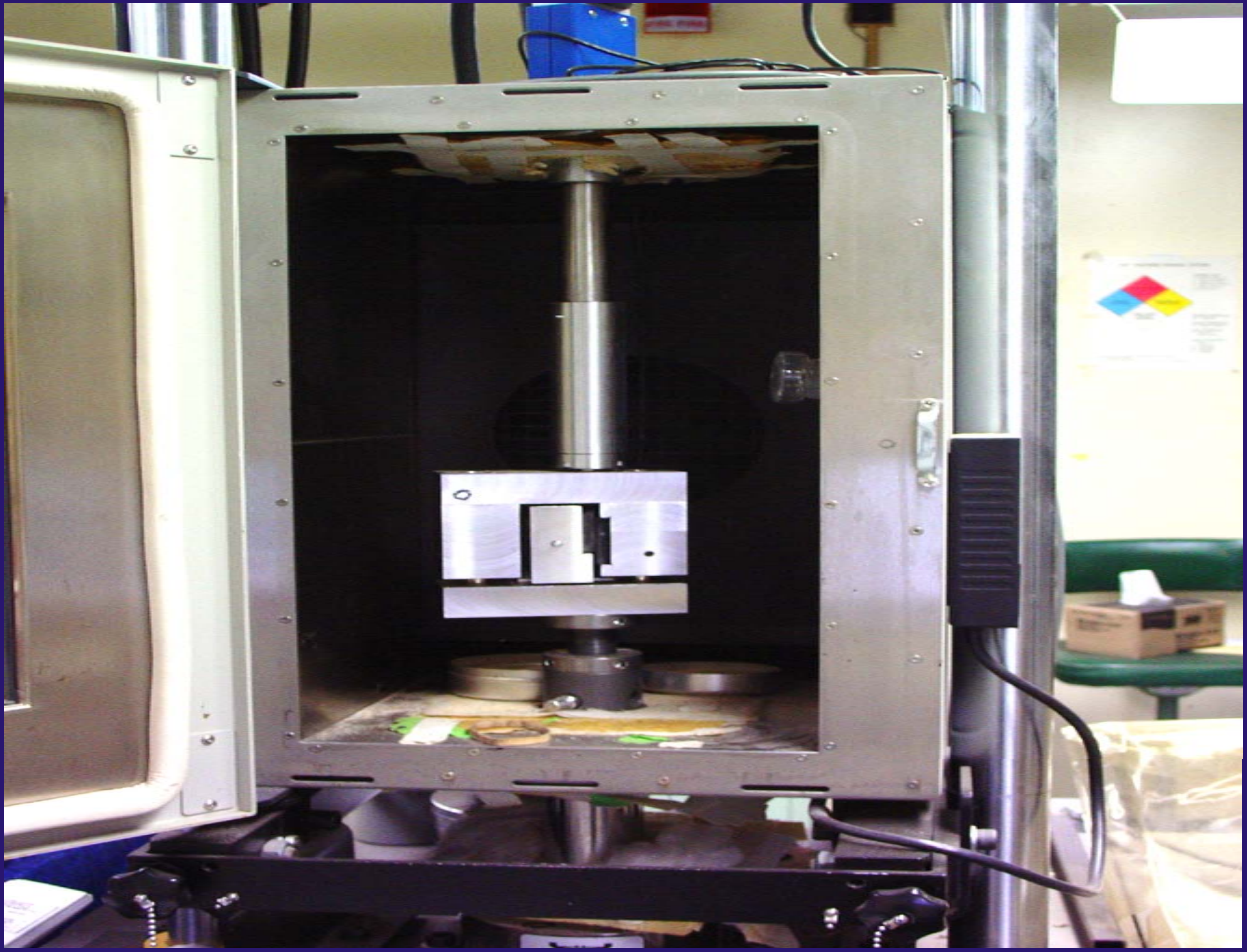
CROSS-SECTIONAL VIEW OF FIXTURE



DESIGNED FIXTURE

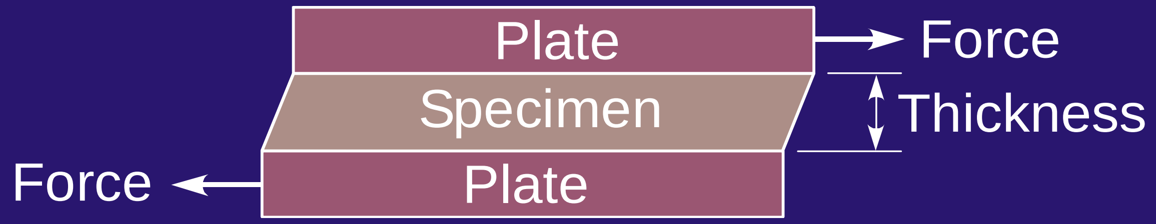


SLIDING PLATE VISCOMETER



SANDWICH SPECIMEN

SIMPLE FLUID SYSTEM



$$\tau = \eta \frac{d_\nu}{d_r} \longrightarrow \eta = \frac{\tau}{\frac{d_\nu}{d_r}}$$

τ = Shearing Stress, dynes/cm^2

η = Viscosity, poises

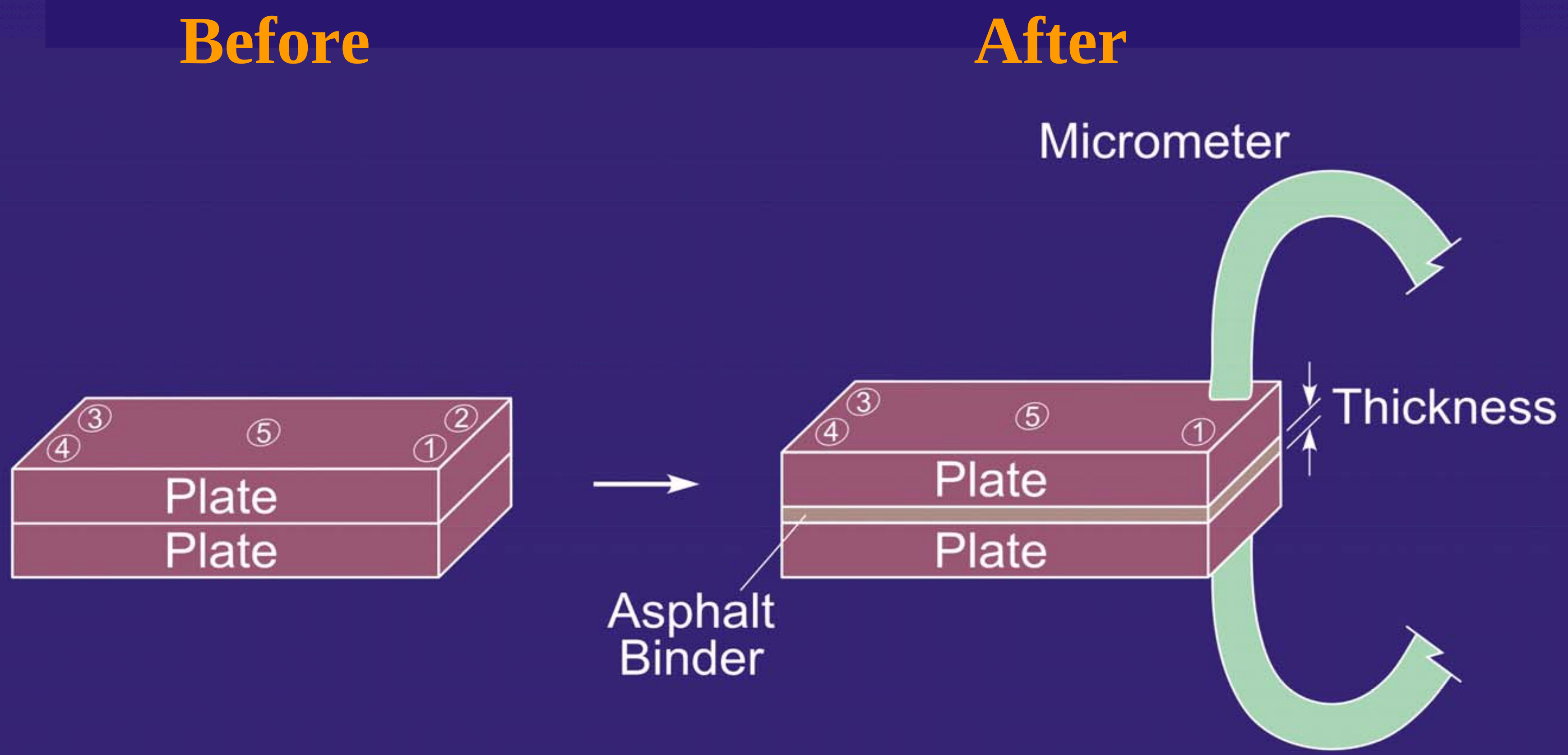
ν = Velocity of Plate Movement, cm/sec

r = Thickness of the Film, cm

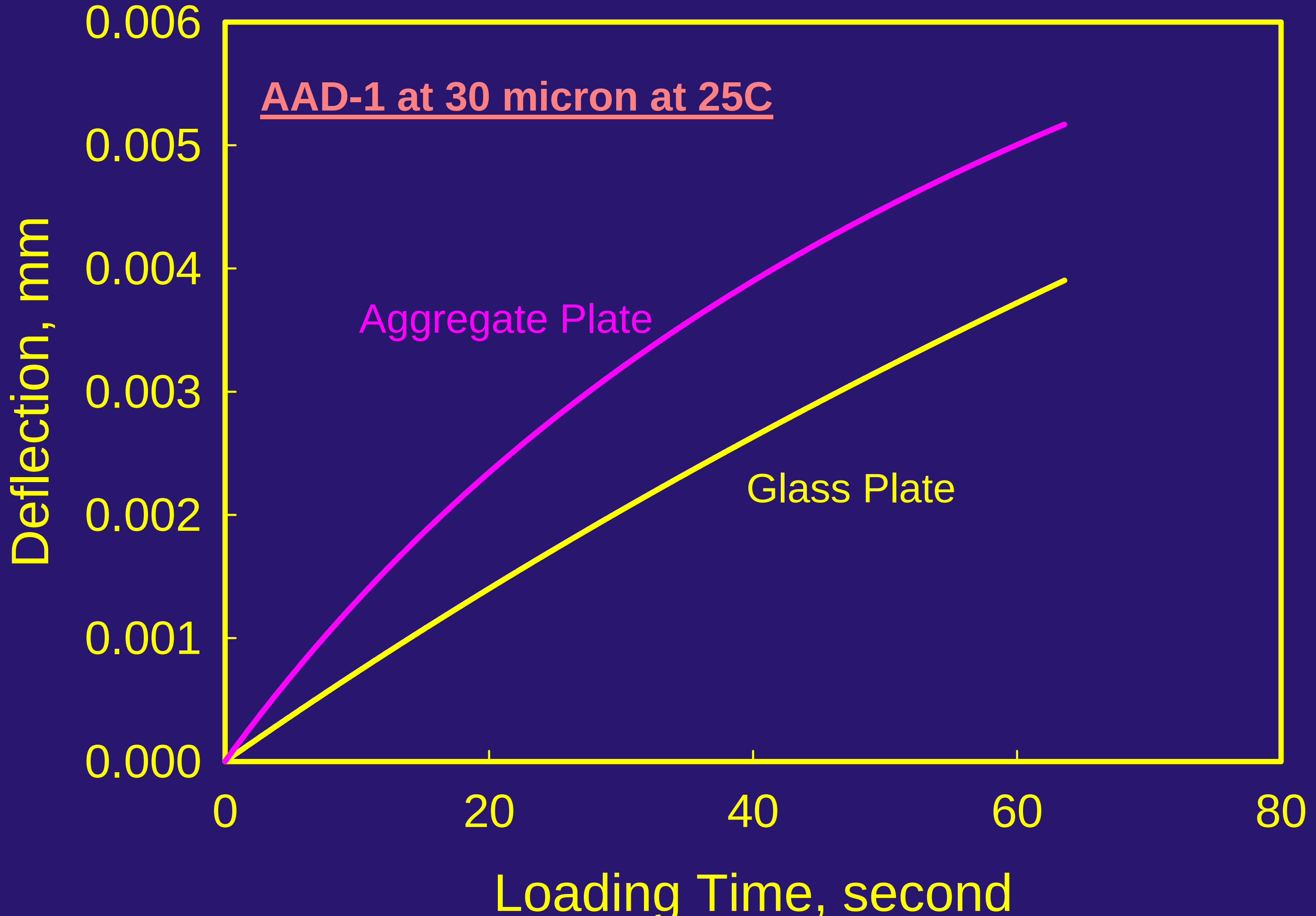
$$\dot{\gamma} = \frac{d_\nu}{d_r} = \text{Rate of Shear, sec}^{-1}$$

$$= \frac{\text{Movement (cm)}}{\text{Time (sec)} \times \text{Film Thickness (cm)}}$$

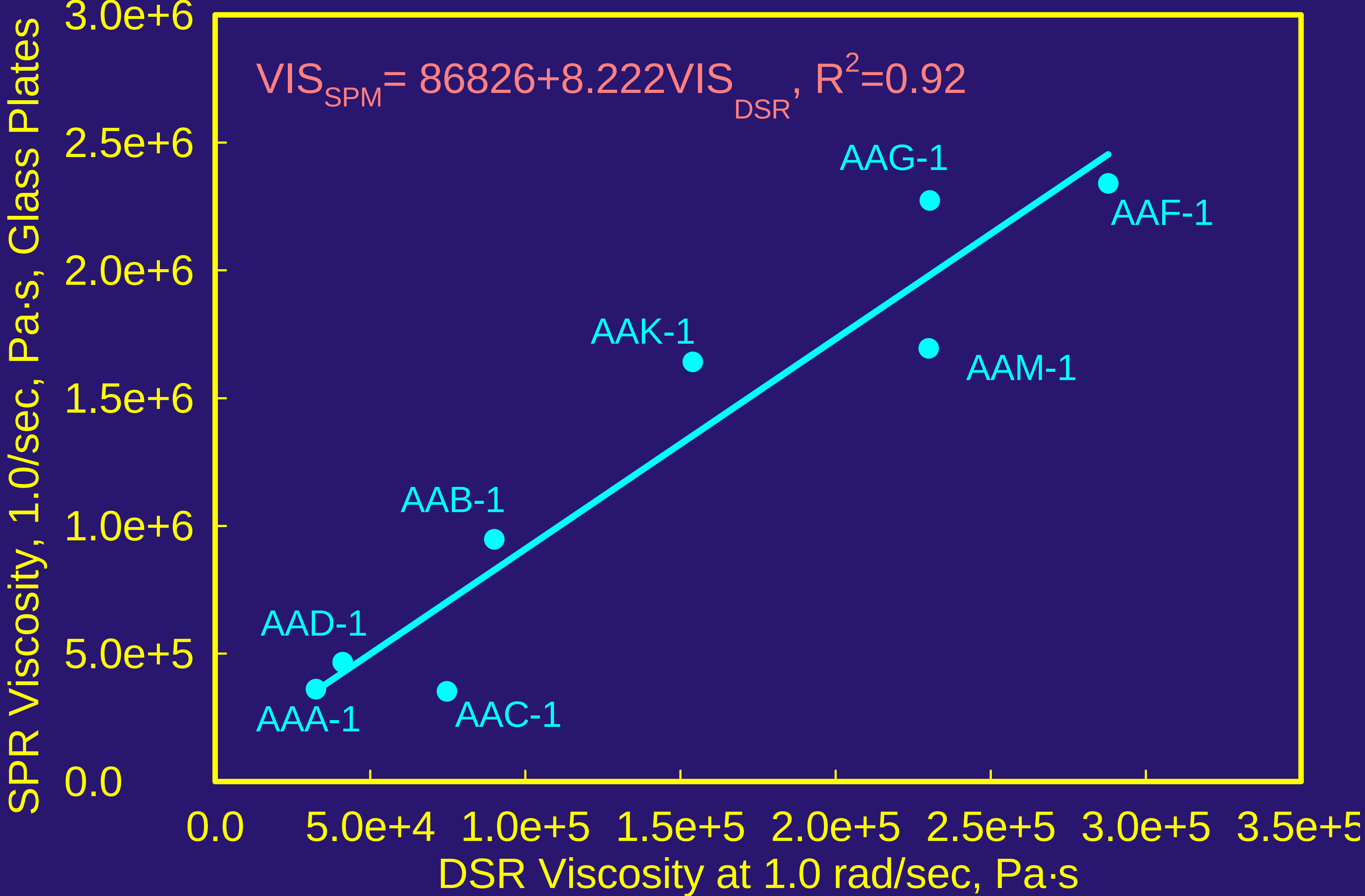
SAMPLE PREPARATION



TYPICAL CREEP CURVE



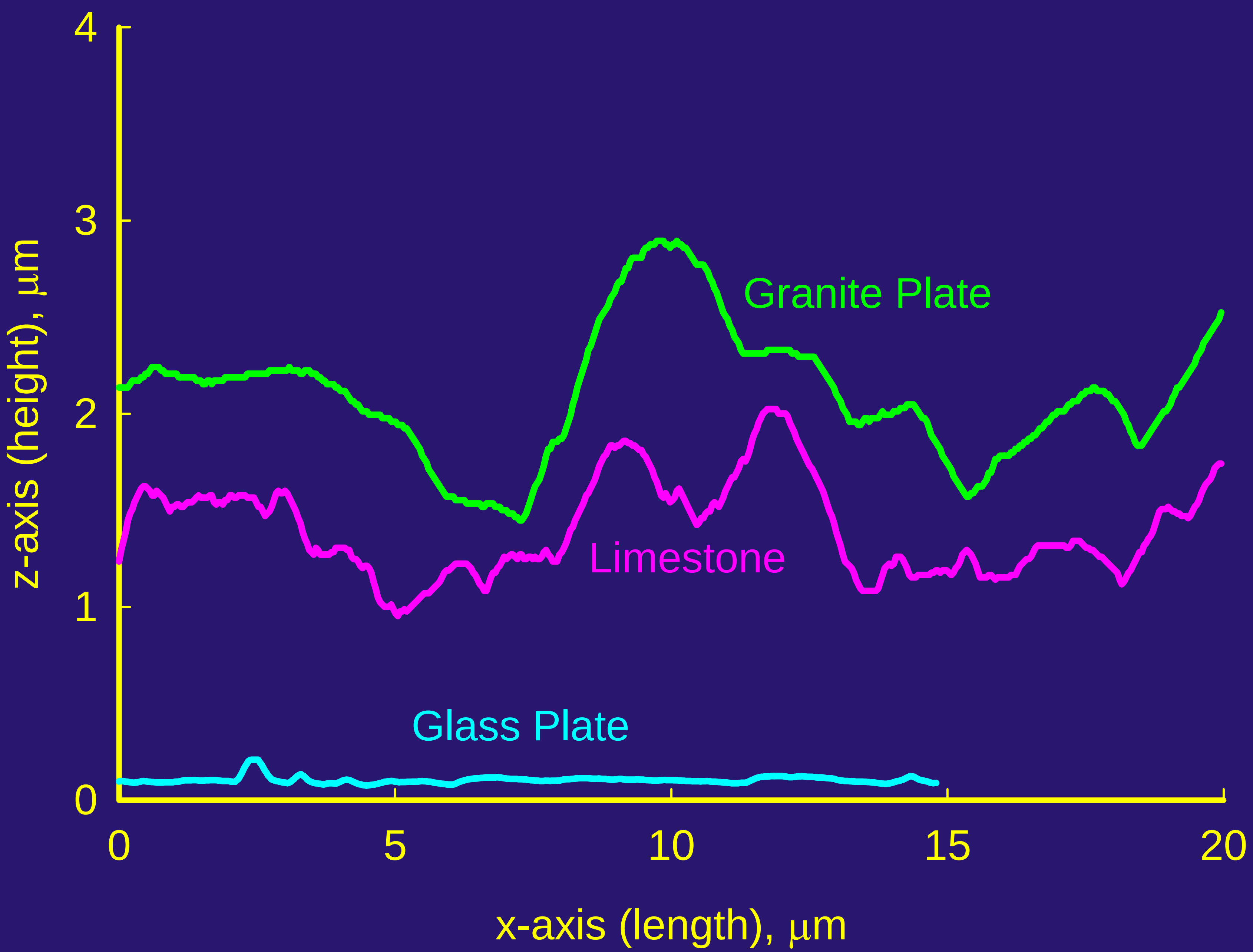
COMPARISON OF VISCOSITY MEASURED AT 25°C



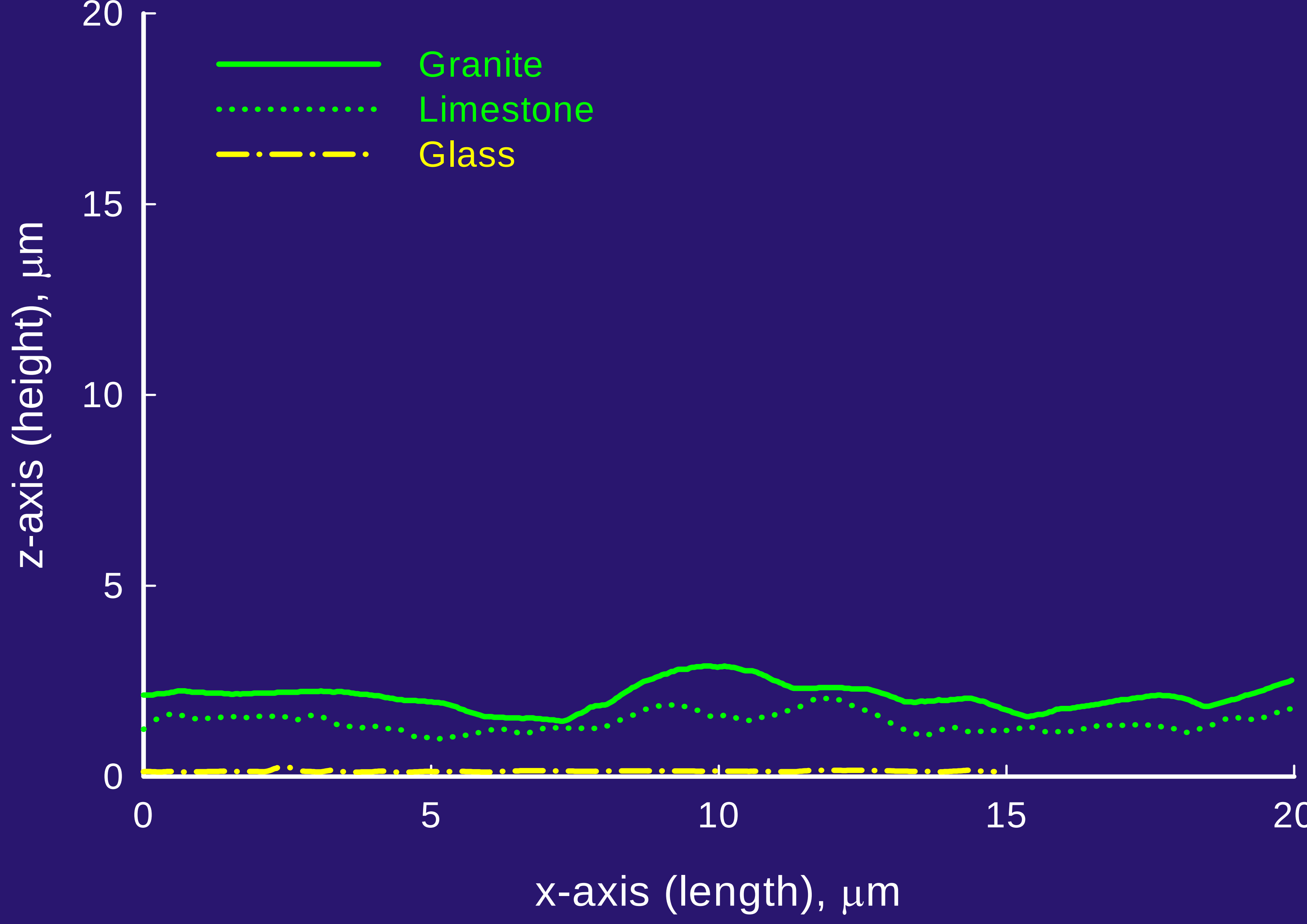
QUESTION?

How about the aggregate surface?
porosity, roughness...

AFM ROUGHNESS PROFILE



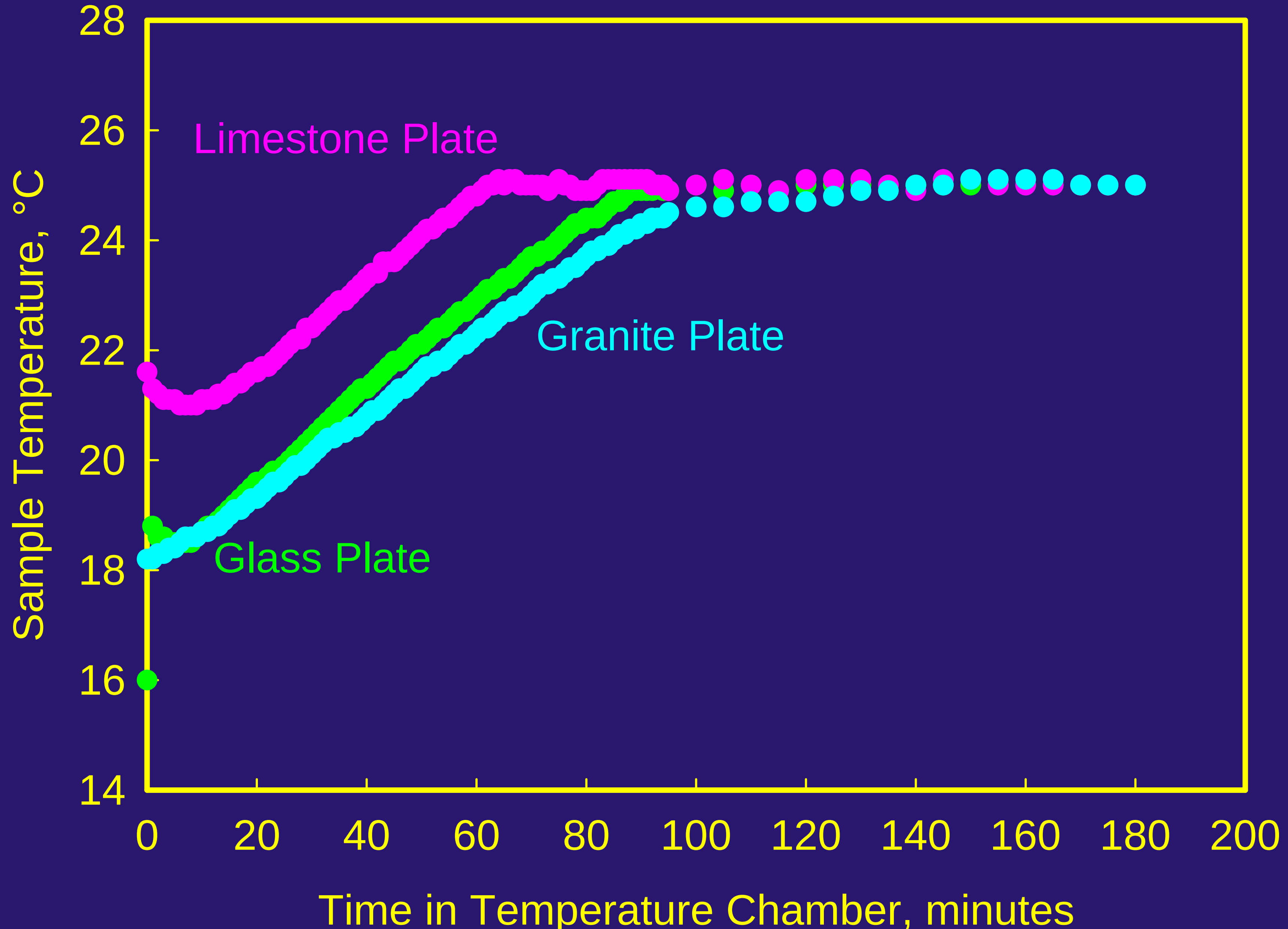
SURFACE ROUGHNESS



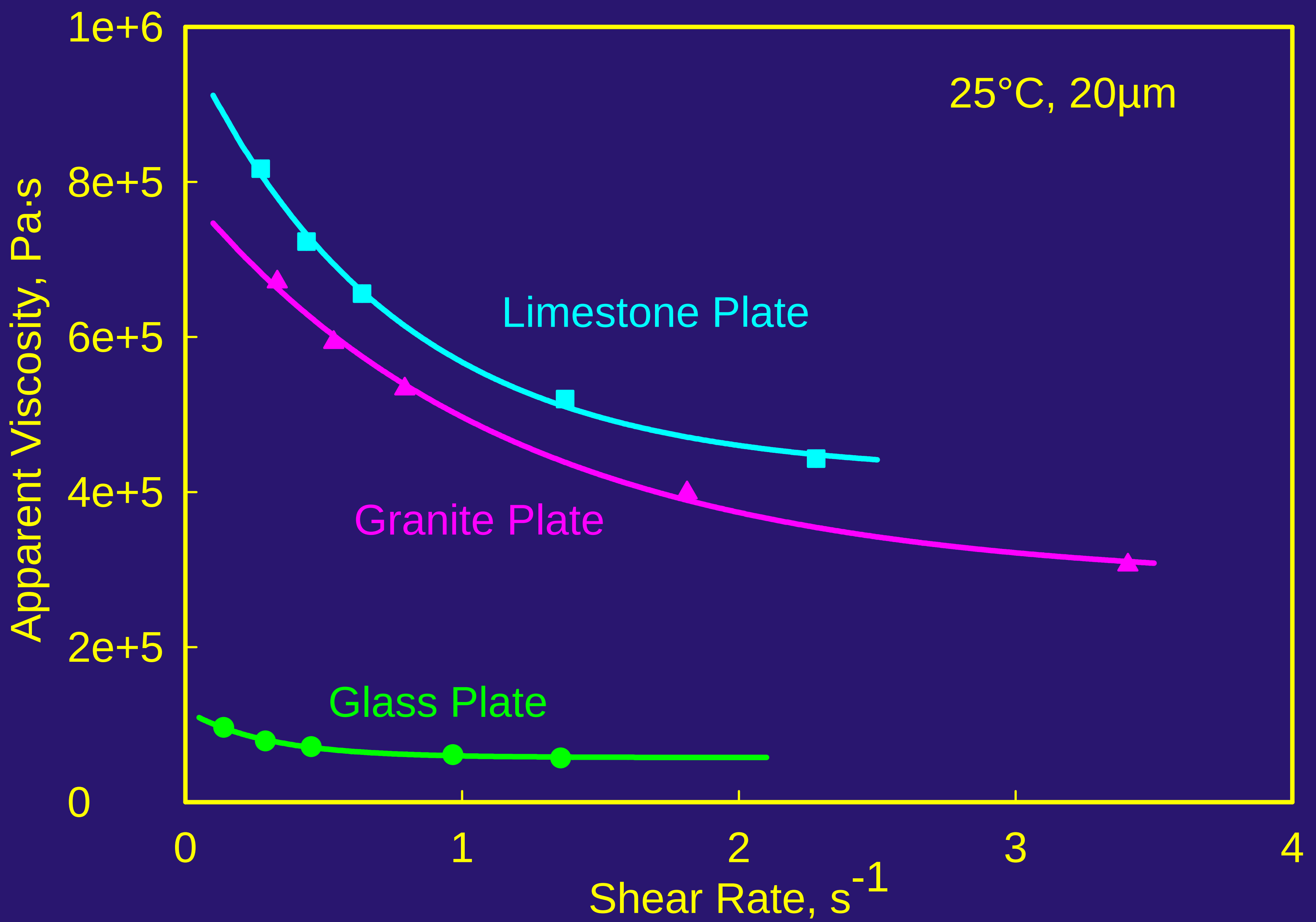
QUESTION?

How about the sample temperature?

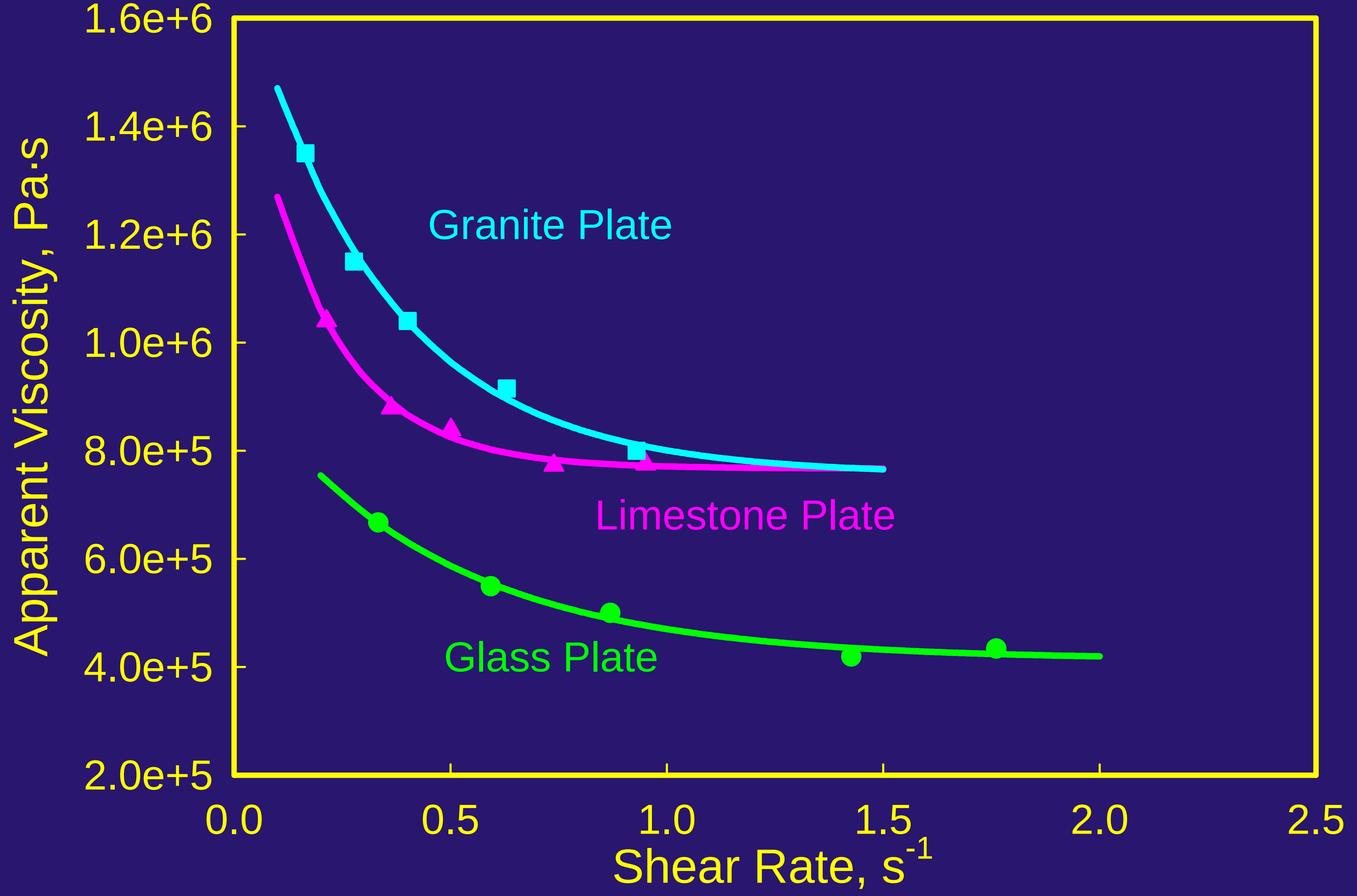
TEMPERATURE VARIATIONS



EFFECT OF AGGREGATES ON AAD-1



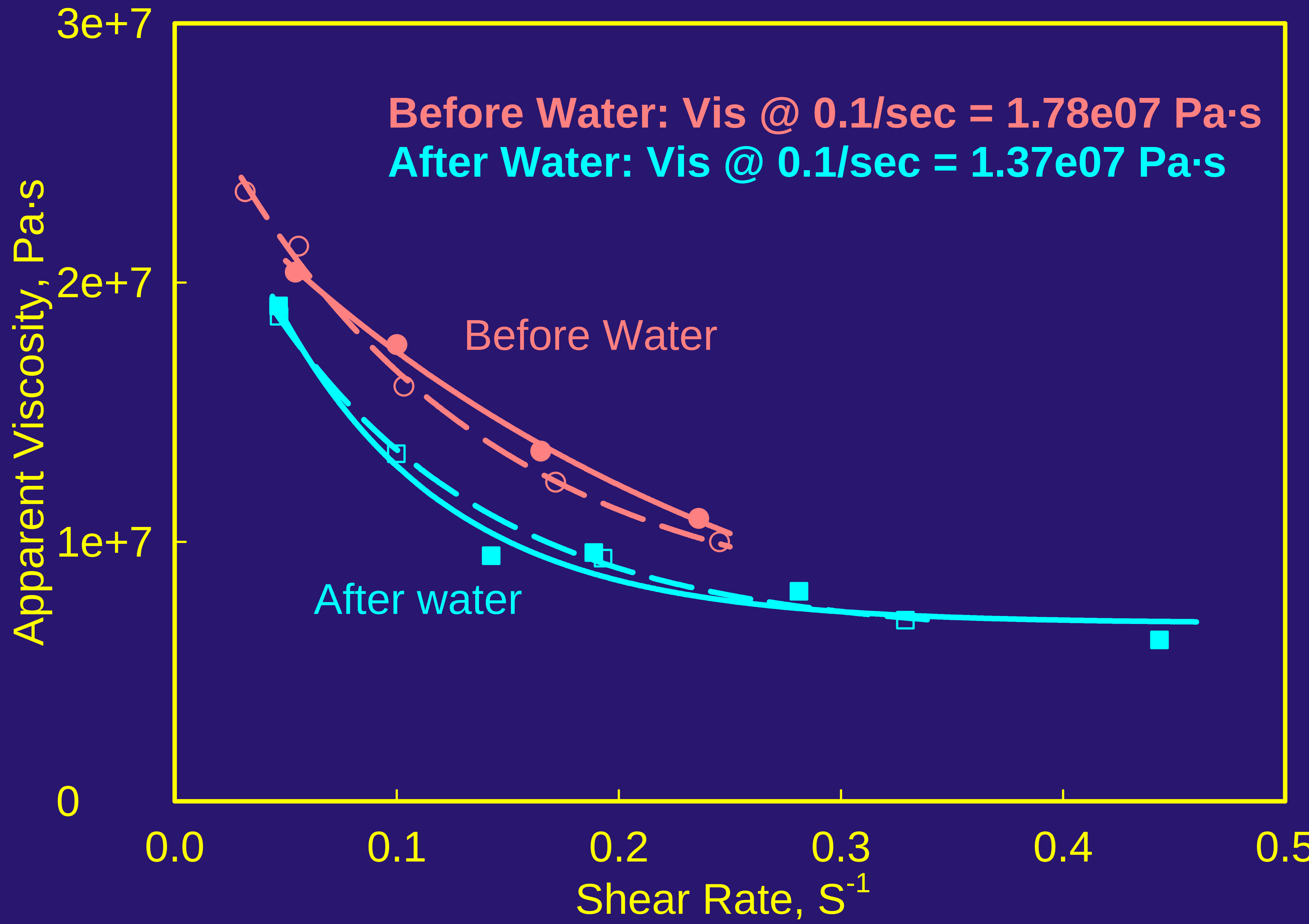
EFFECT OF DECANEDICARBOXYLIC ACID IN AAD-1 ON DIFFERENT PLATES @ 20μm



SO WHAT!

What has this to do with pavement performance?

IMPACT OF WATER ON PAV-AGED AAD-1 ON GLASS PLATES @ 30µm

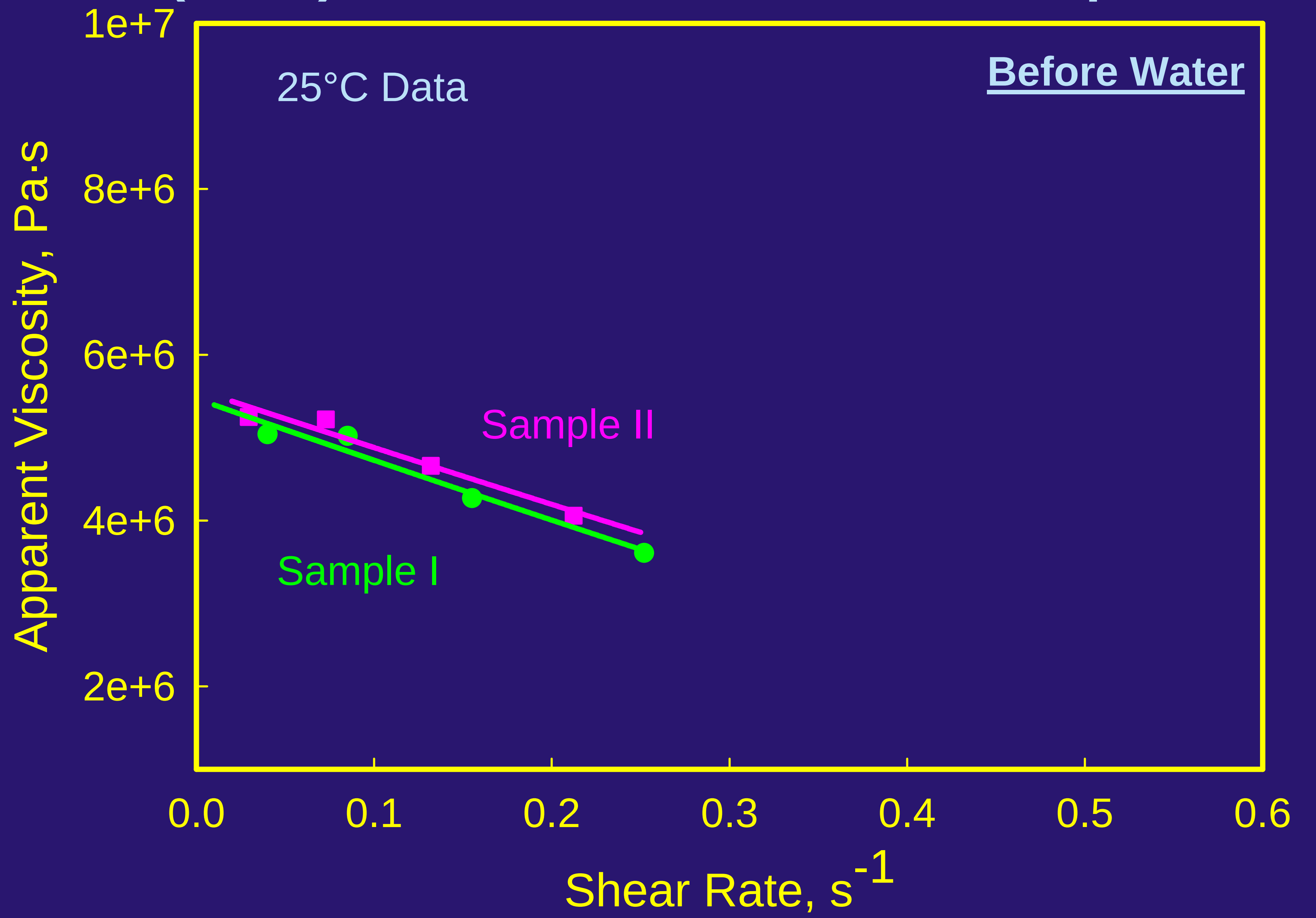


Moisture Damage Index (MDI)

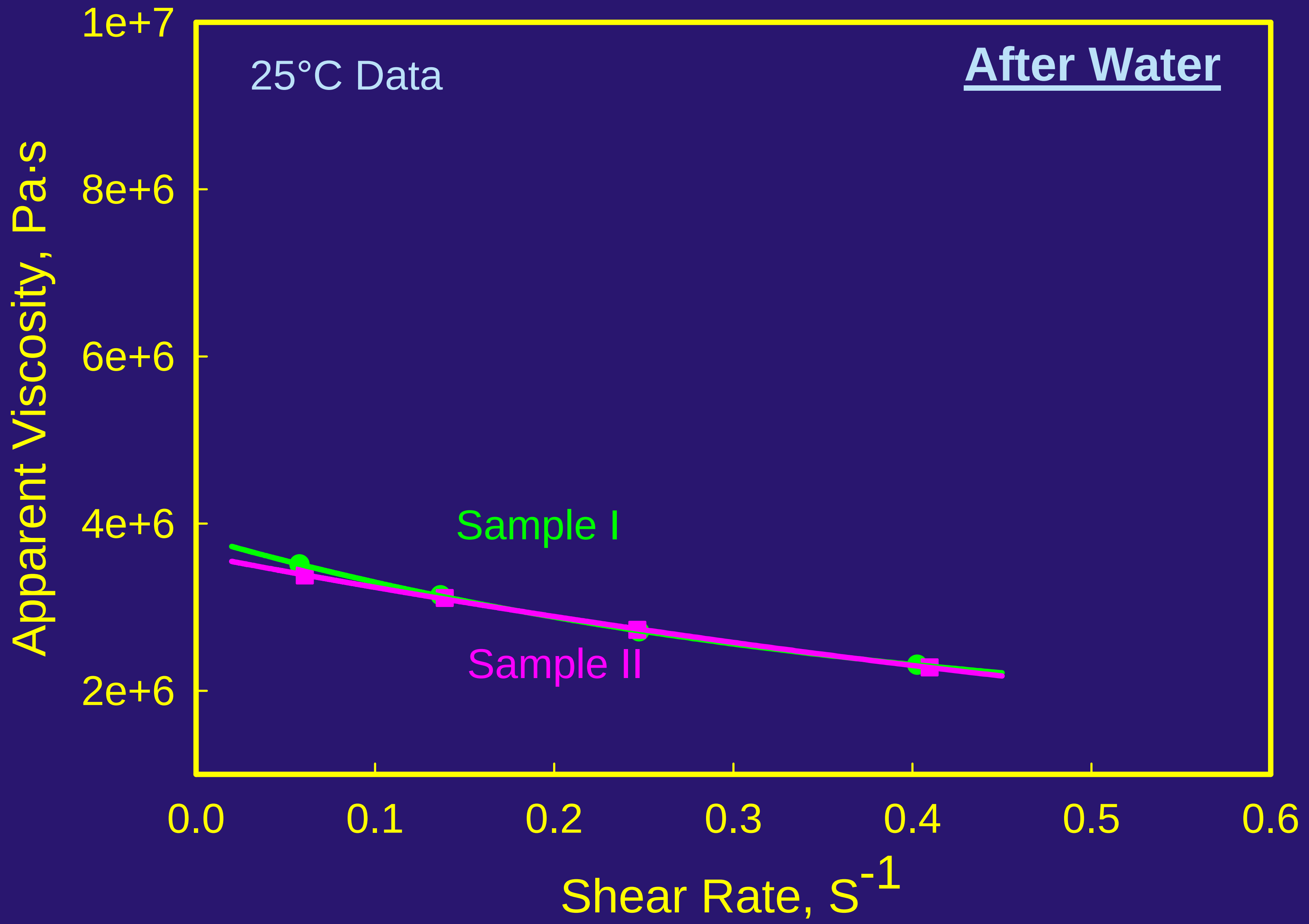
$$\text{MDI} = \frac{\text{Viscosity After Moisture Damage}}{\text{Viscosity Before Moisture Damage}}$$

0.77

IMPACT OF WATER ON AAD-1/GRANITE (#325) ON GLASS PLATES @ 70 μm



IMPACT OF WATER ON AAD-1/GRANITE (#325) ON GLASS PLATES @ 70 µm

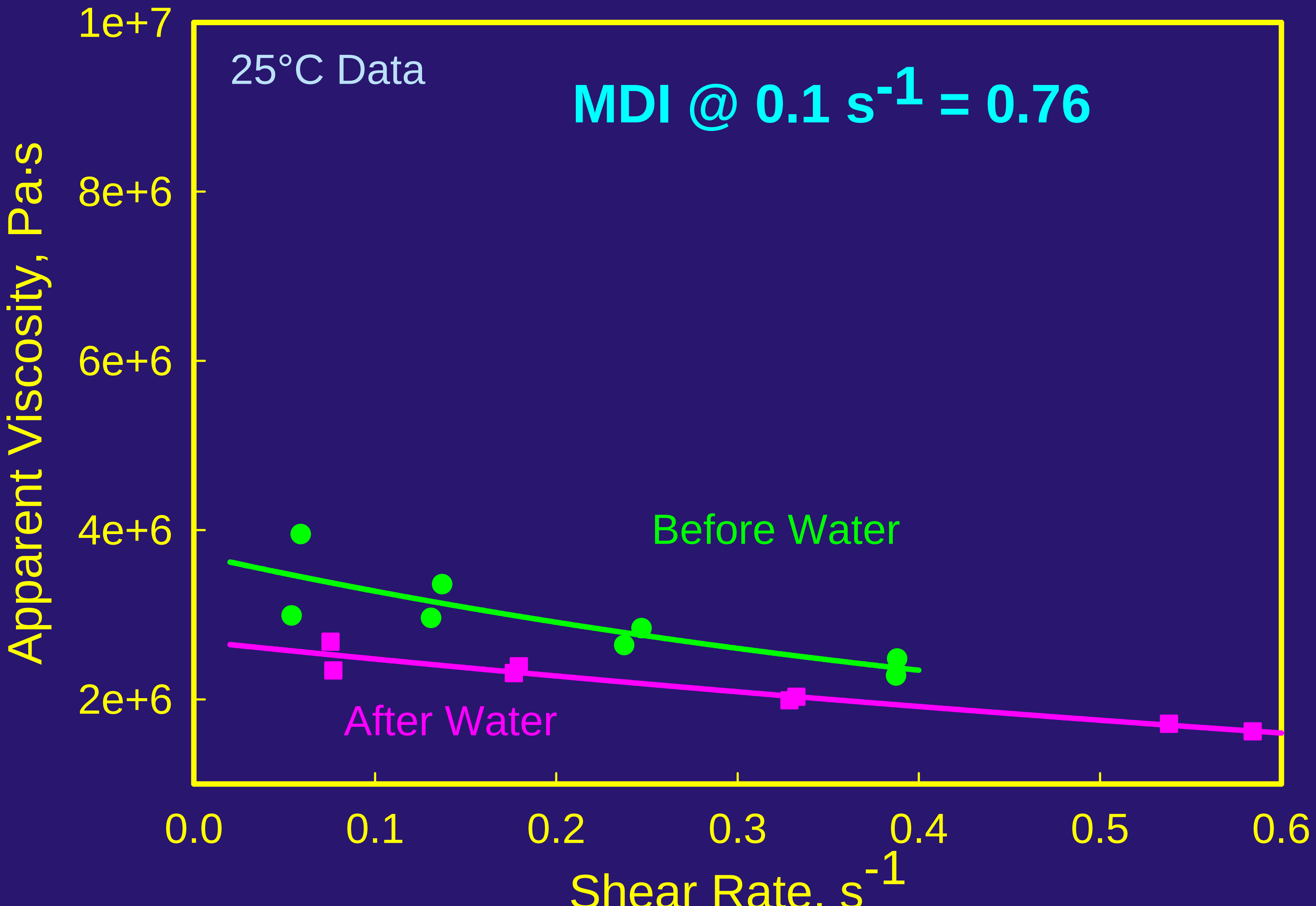


IMPACT OF WATER ON AAD-1/GRANITE (#325) ON GLASS PLATES @ 70 µm

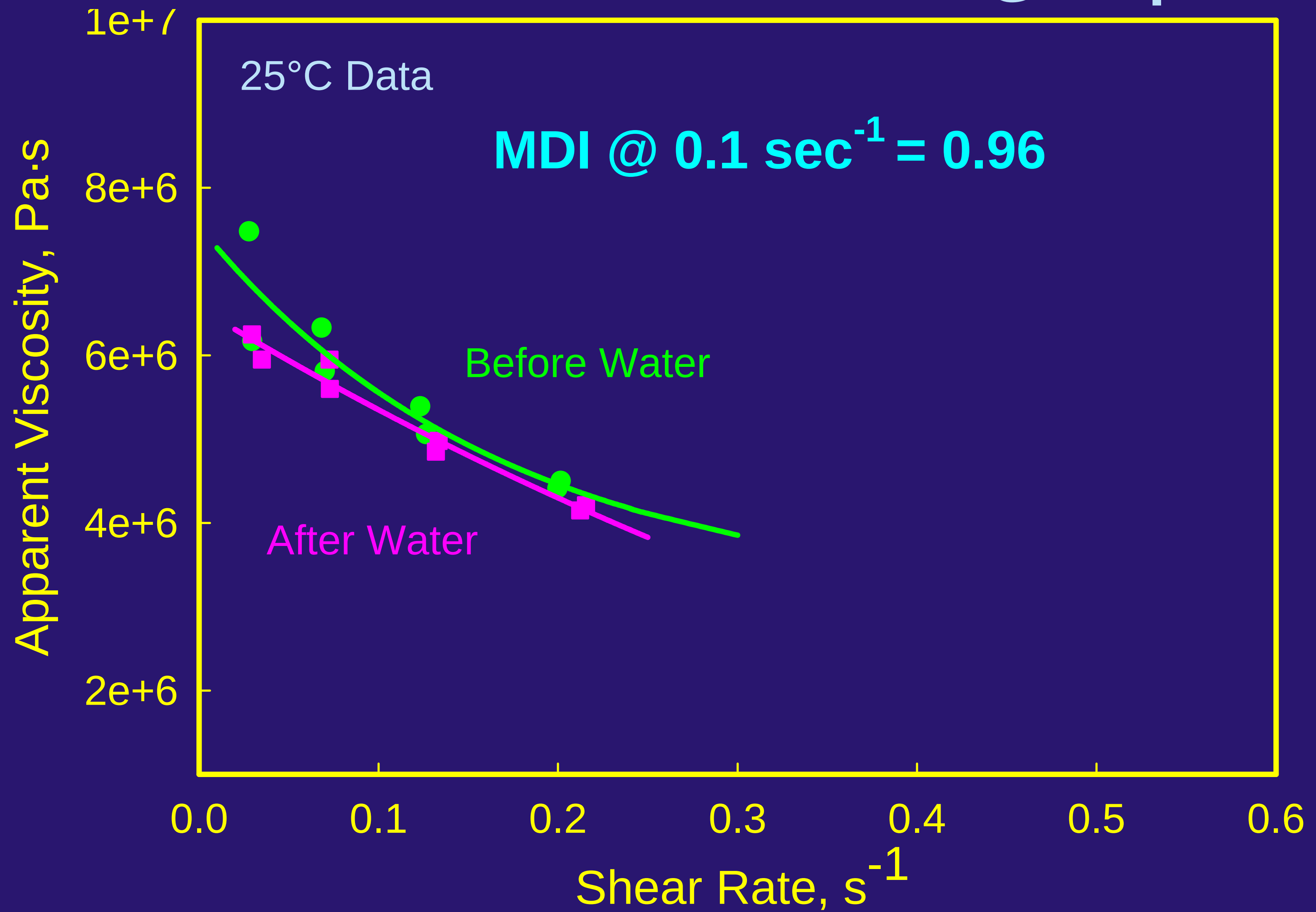
Moisture Damage Index

@ 0.1 sec^{-1} = 0.68

IMPACT OF WATER ON AAD-1/LIMESTONE (#325) ON GLASS PLATES @ 70 µm



IMPACT OF WATER ON AAD-1/ HYDRATED LIME ON GLASS PLATES @ 70 µm



CONCLUSIONS

- Polar asphalt components interacting with a mineral substrate induce multimolecular structuring in thin films producing an increase in viscosity.

- Interactions of asphalts with mineral surfaces have dramatic effects on thin-film viscosities. The interactions depend on asphalt composition and aggregate surface composition.

CONCLUSIONS

- The effects of aggregate surface-induced structuring on the rheological properties of asphalt binders in the thin film region at the asphalt-aggregate interface can be measured by the specially designed fixture.

- It appears that the specially designed fixture can also be employed to evaluate the effect of water on the rheological properties of thin films of asphalt.


QUESTIONS?
Thank You
LOW SHOULDER
LOOSE GRAVEL
DEEP GRAVEL
OPEN TRENCH
ROAD NARROWS
TRUCK LANE 500 FEET
SLOWER TRAFFIC USE TURNOUTS
PASSING LANE AHEAD
ROCK SLIDE AREA
NO PASSING ZONE
ROUGH ROAD