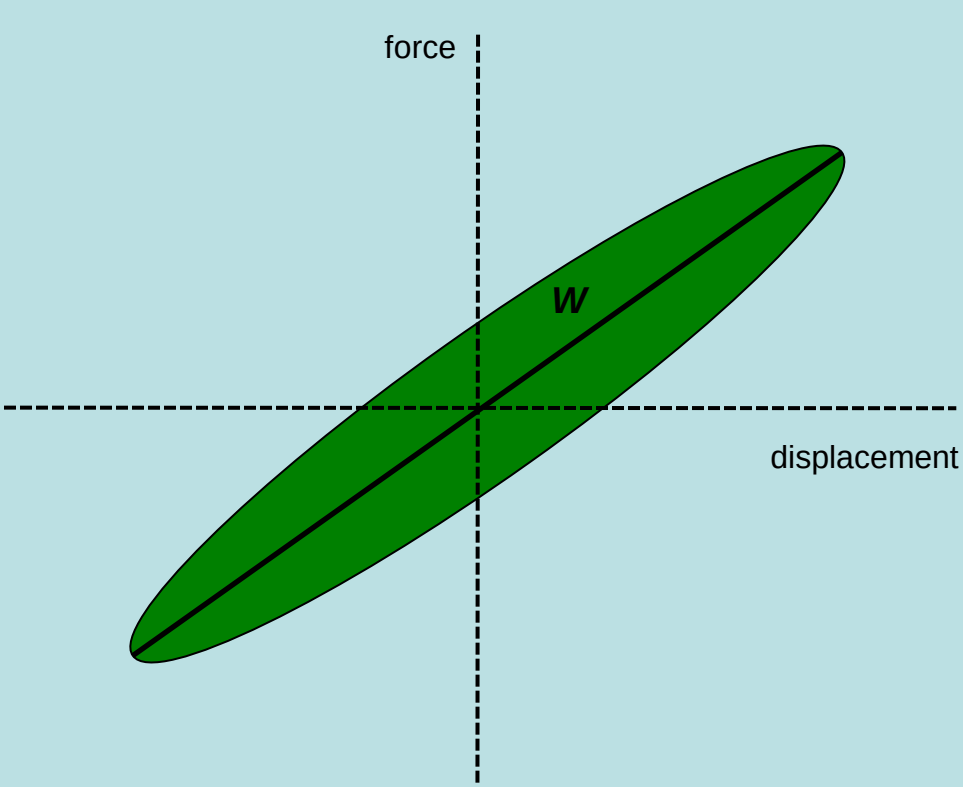
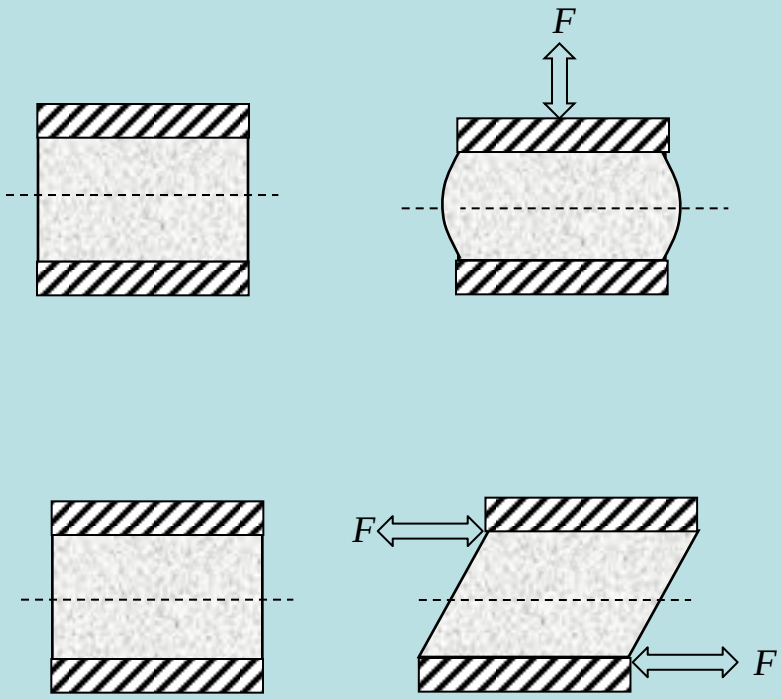
Novel Super-high Damping Natural Rubber

Woothichai Thaijaroen
Pram Yodjun
Weenusarin Intiya

MTEC - Mahidol

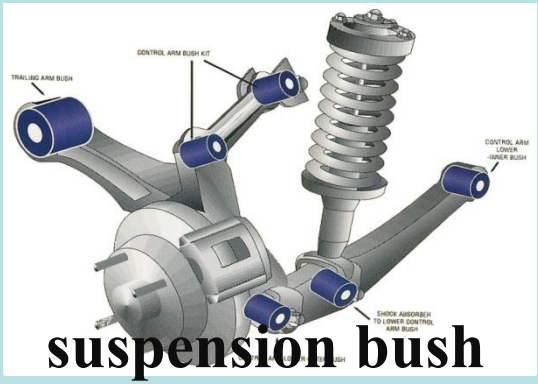
Rubber : Damping





bigger loop : higher damping : higher energy dissipation

Applications



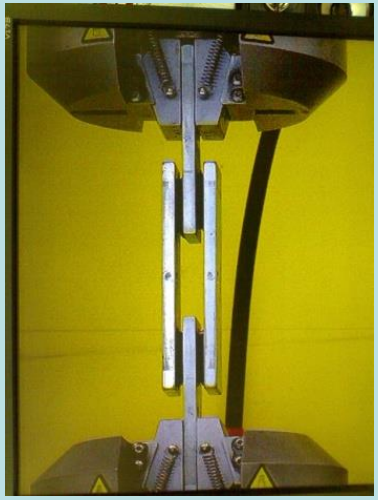
Damping ratio ≤ 10% : normal damping

10% < Damping ratio ≤ 15% : high damping

Damping ratio > 15% : super-high damping

Outline

New process



automotive suspension bush

Lemförder

Vibration attenuation

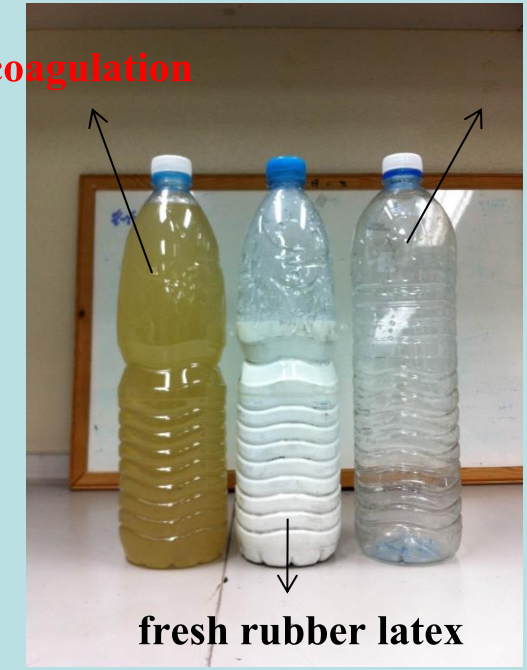
small shaking table

Shear modulus, damping ratio

Bridgestone, TARRC

New Process

acid coagulation



new process

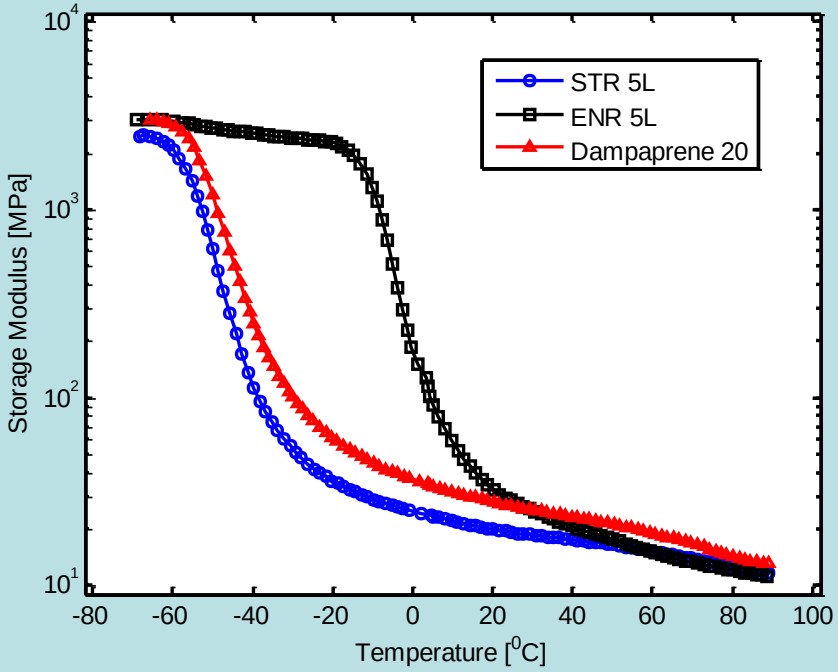
Green & Clean

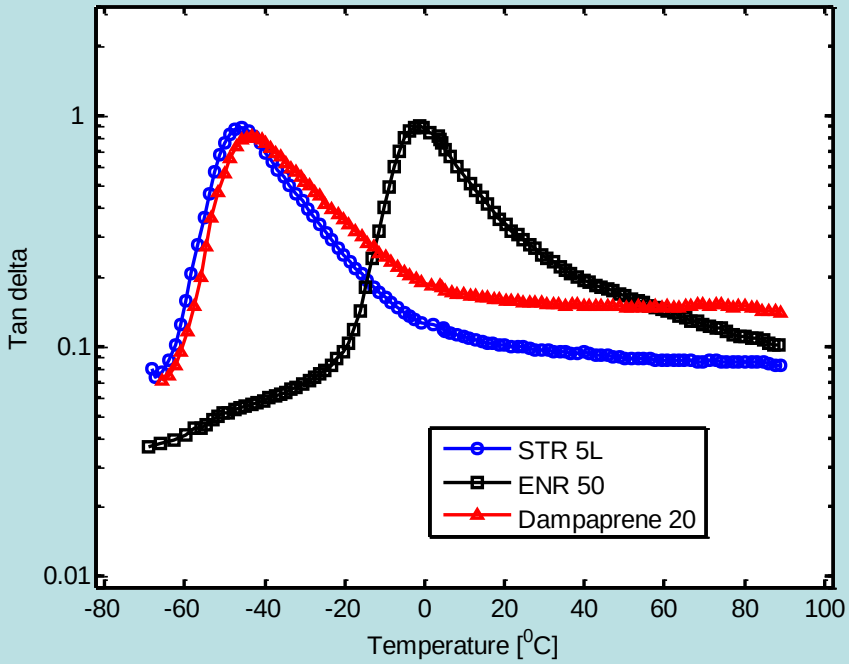
Dampaprene = high damping + polyisoprene

Physical and Mechanical properties

Properties	STR 5L	ENR 50	Dampaprene 20
Mooney (ML 1+4) 100 ^{0}C	77 ± 2	69 ± 2	65 ± 2
Hardness (Shore A)	68 ± 1	69 ± 1	69 ± 1
Tensile strength (MPa)	27.5 ± 0.4	26.5 ± 0.6	24.5 ± 0.6
Elongation at break (%)	537 ± 9	503 ± 13	528 ± 10
100% Modulus (MPa)	3.6 ± 0.1	3.7 ± 0.1	3.4 ± 0.1
300% Modulus (MPa)	15.6 ± 0.2	16.0 ± 0.2	14.5 ± 0.2
Tear strength (N/mm) die B	173 ± 4	98 ± 4	151 ± 3

Dynamic Properties





ENR : high temperature dependence : inapplicable

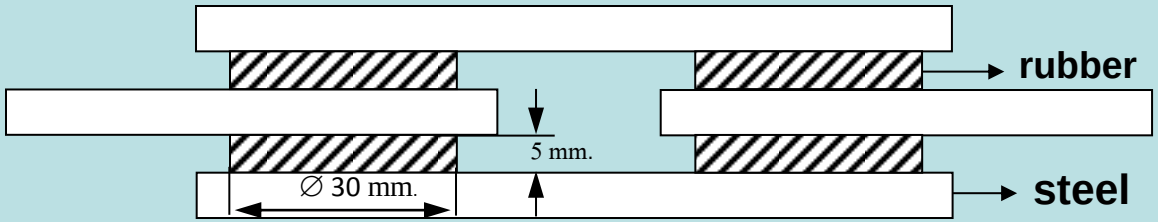
STR 5L and Dampaprene 20 : Low temperature dependence: applicable

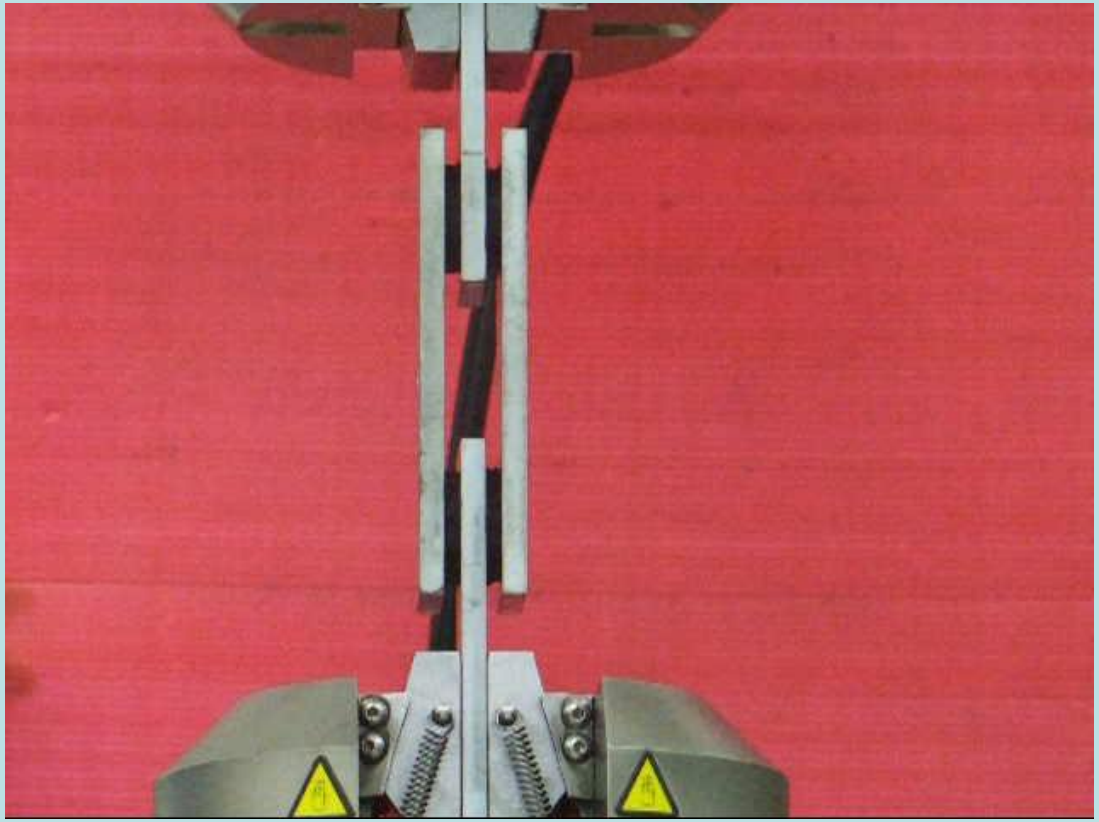
2. Shear modulus & damping ratio : ISO 22762

Bridgestone and TARRC high damping compounds

	low modulus	high modulus
references	Bridgestone Chang, Y.W. and Seidensticker, R.W., Argonne National Laboratory, ANL/RE-93/7 (1993)	TARRC Tun Abdul Razak Research Centre Burtscher, S.L. and Dorfmann A., *Engineering Structures*, 26 (2004), 1979-1991
developed compounds	Dampaprene low-modulus [60 Shore A]	Dampaprene high-modulus [73 Shore A]

Shear modulus and damping test



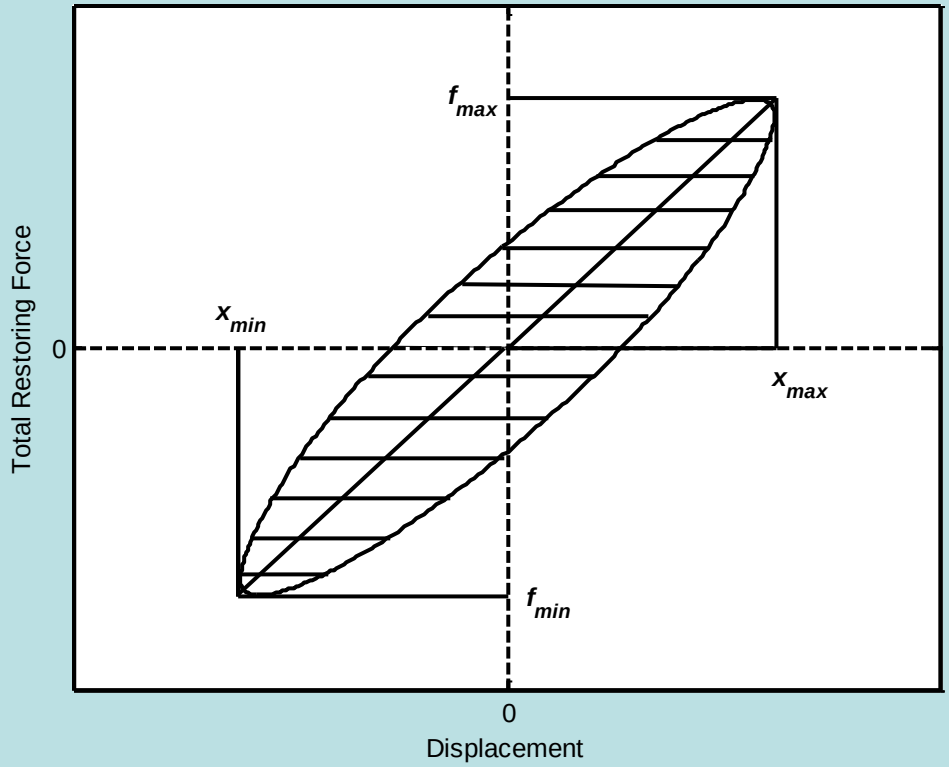


ISO 22762

0.5 Hz

2-300% strain

Definition of Stiffness, Shear Modulus, and Damping Ratio



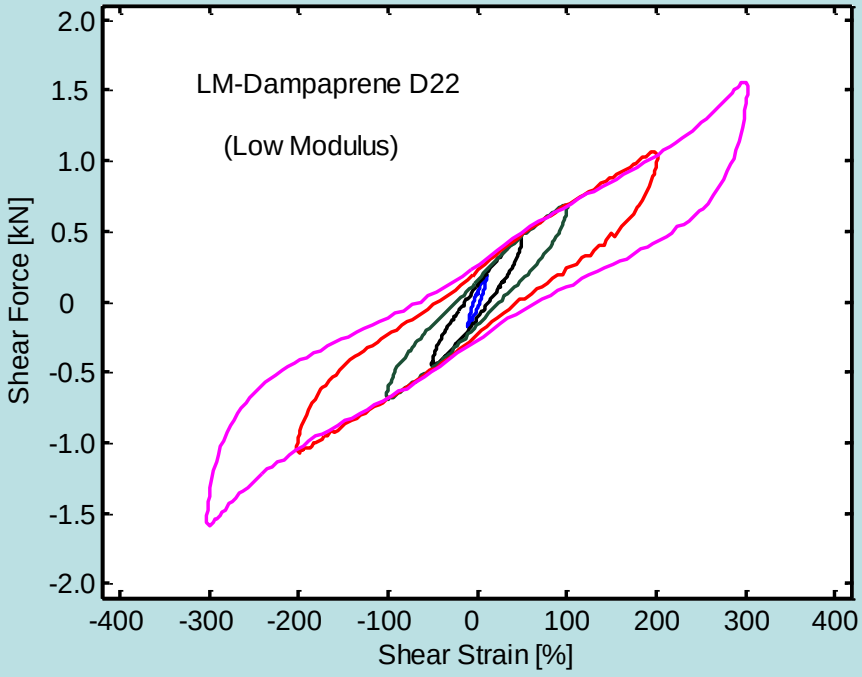
W = area within the loop

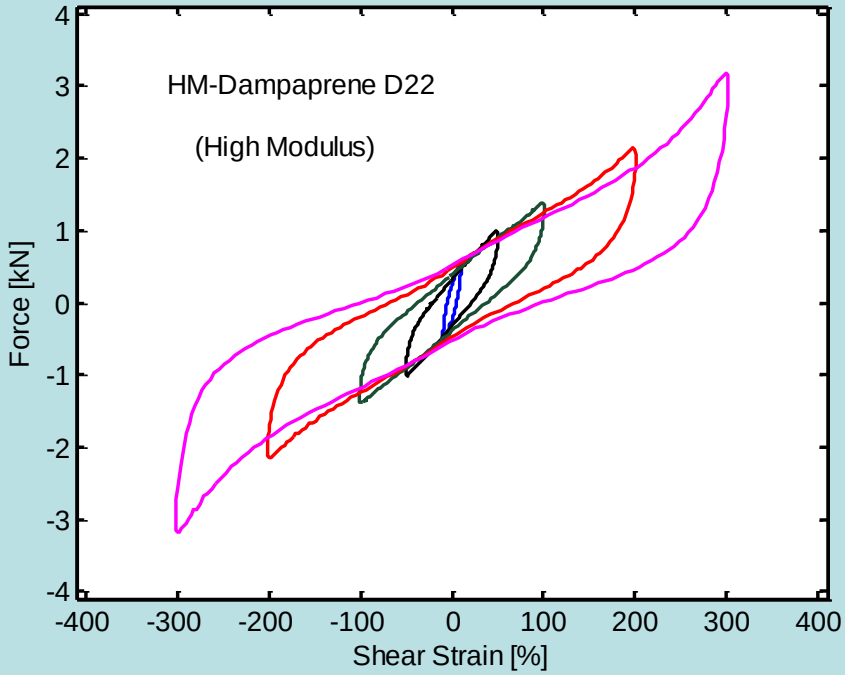
$$\text{Stiffness } K = \frac{f\text{max} - f\text{min}}{x\text{max} - x\text{min}}$$

$$G = Kt/A$$

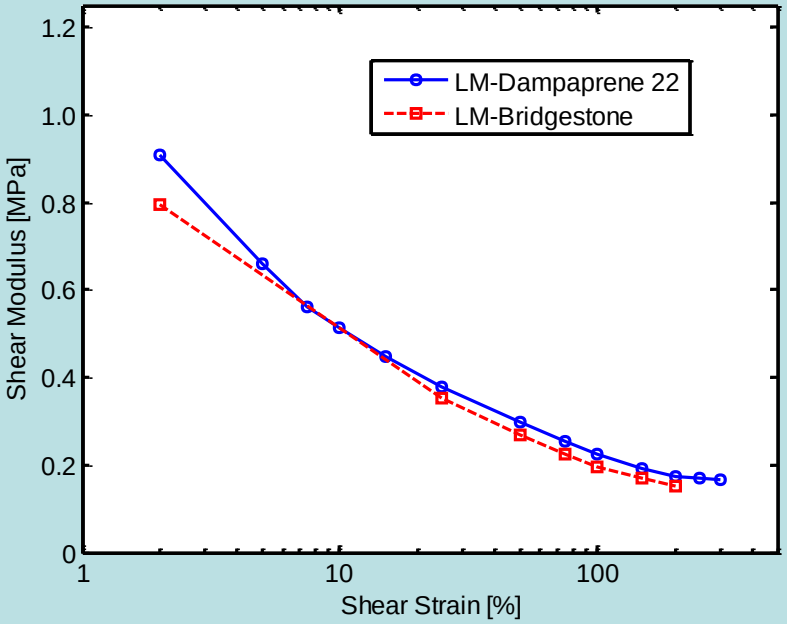
$$\text{Damping ratio} = \frac{W}{2\pi(K\text{d}^2)}$$

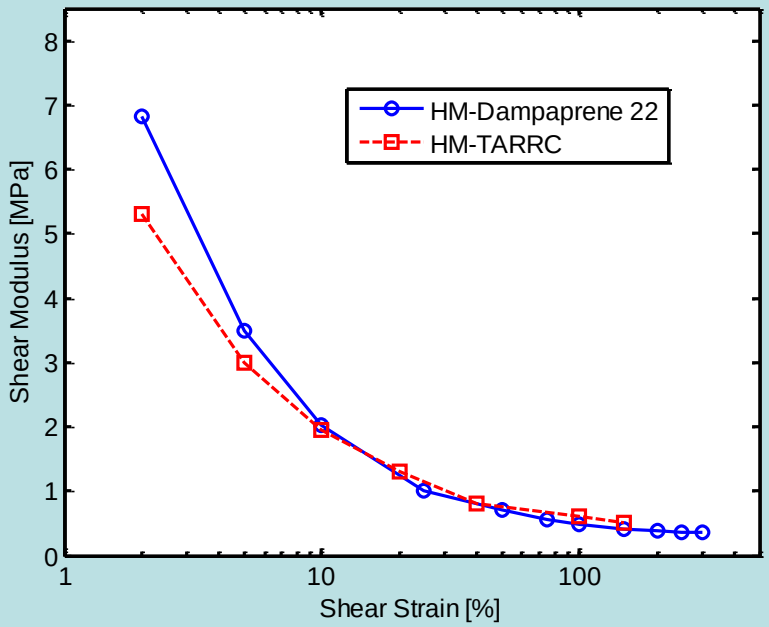
Hysteresis Loops

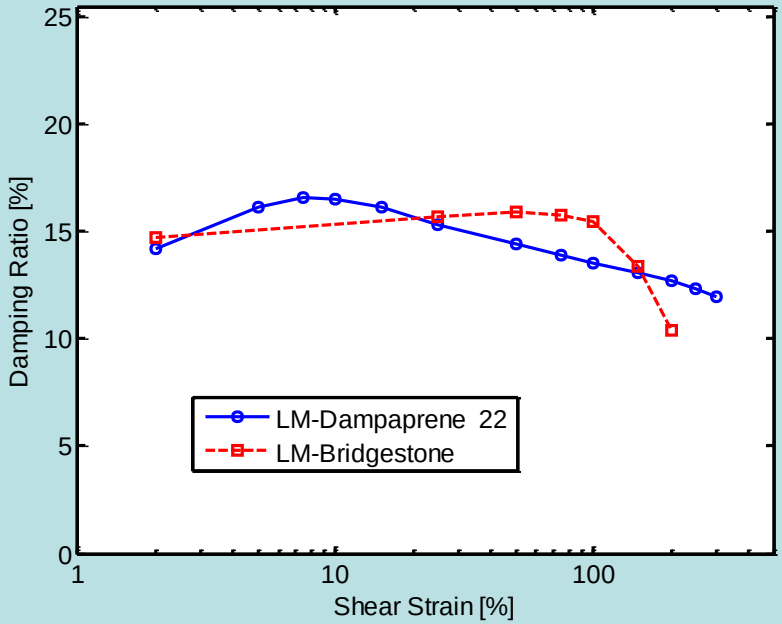


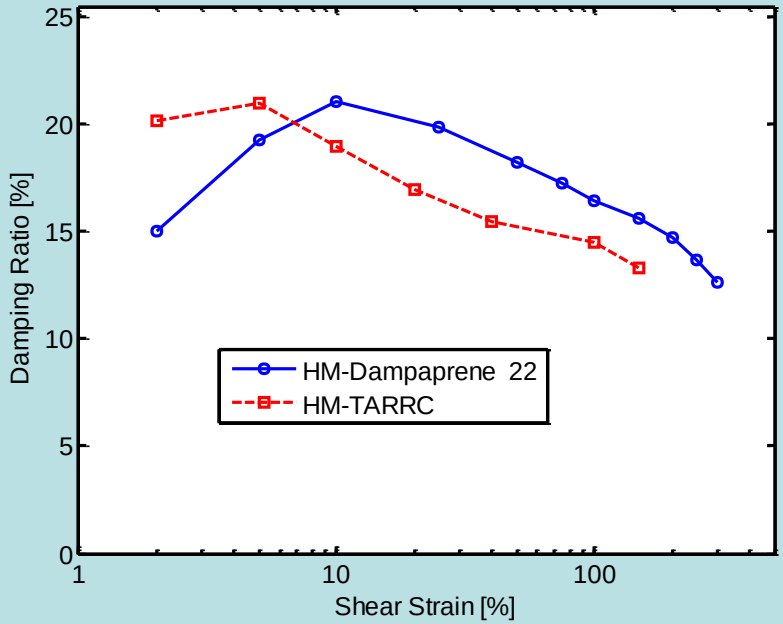


Shear Modulus and Damping Ratio



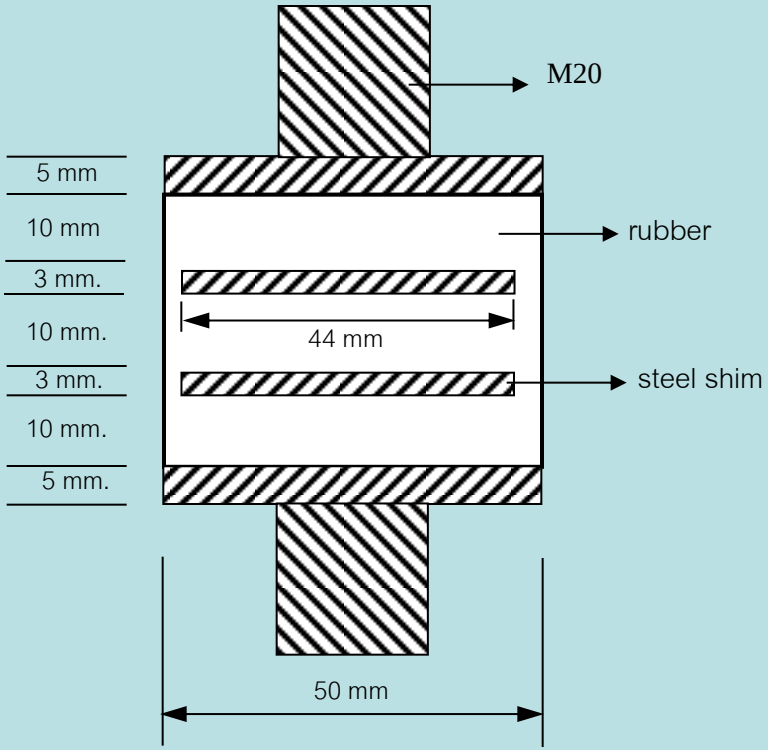






3. Vibration attenuation test : cylindrical isolators

small shaking table (laboratory scale)



STR 5L, ENR, Dampaprene

shape factor ≈ 1.1

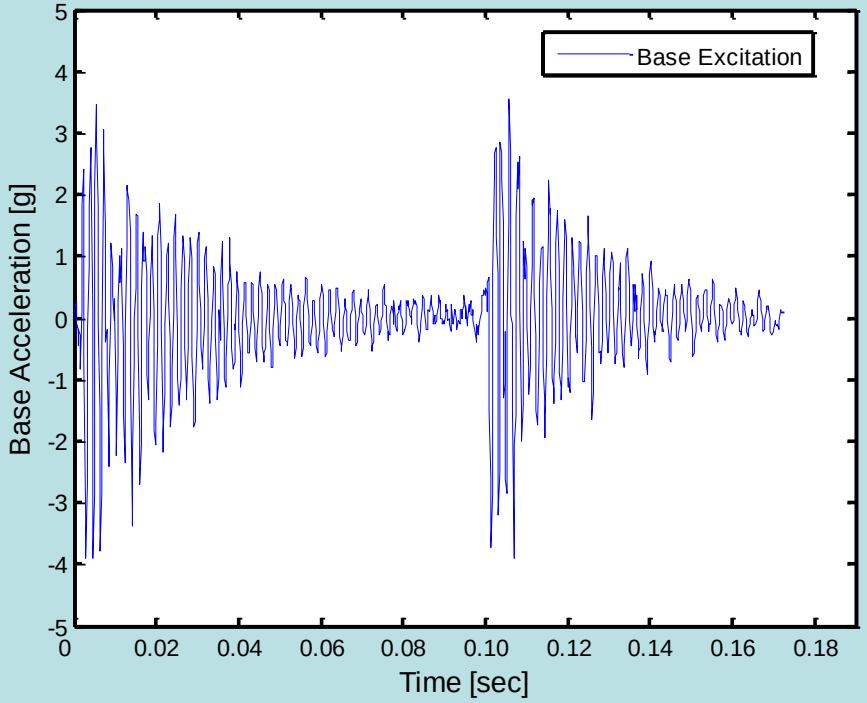
Isolators and shaking table

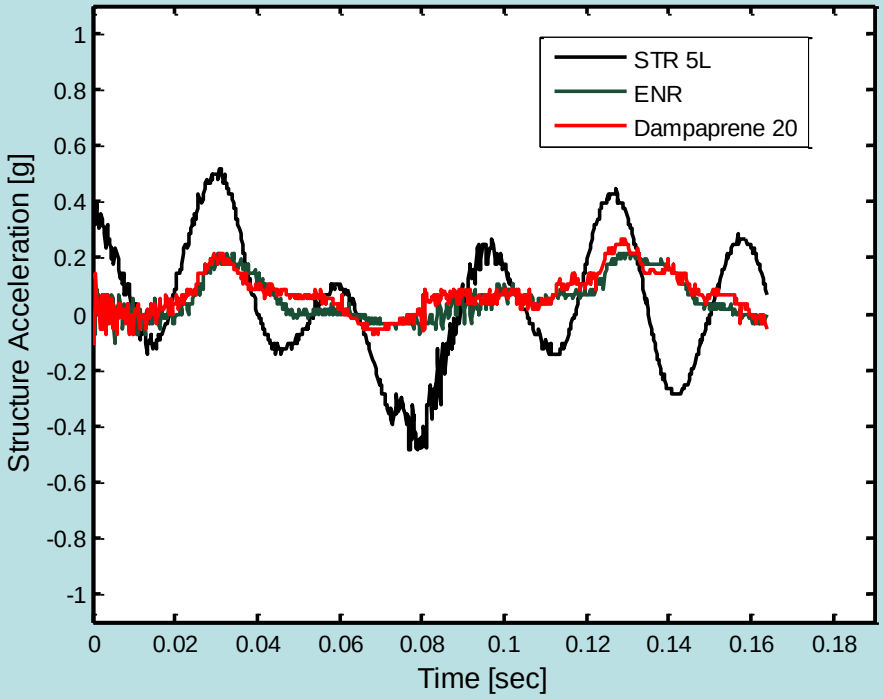
5 Hz,

stroke 15 mm,

load 200 kg

Excitation and response signals





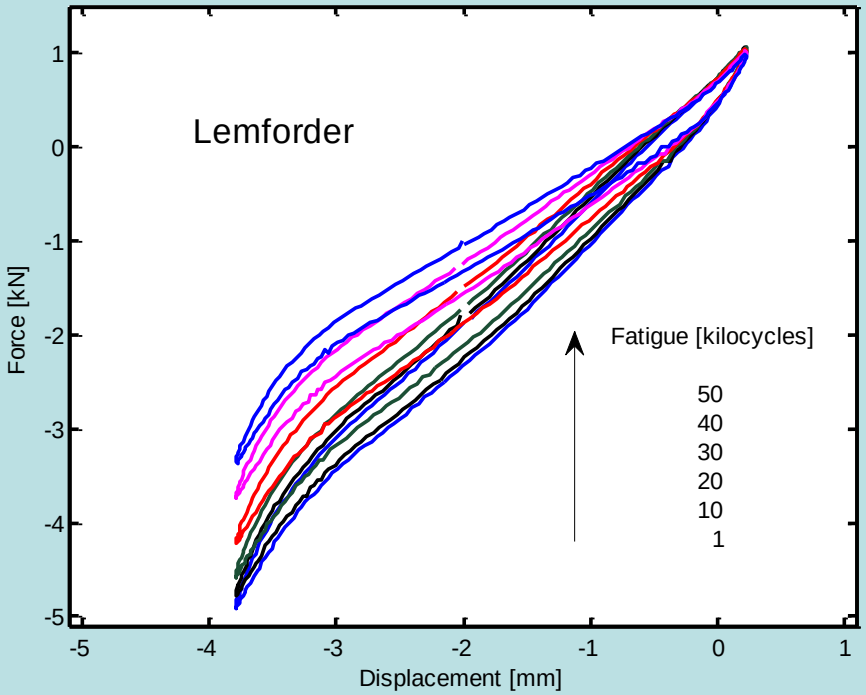
4. Fatigue test : suspension bush : Lemförder

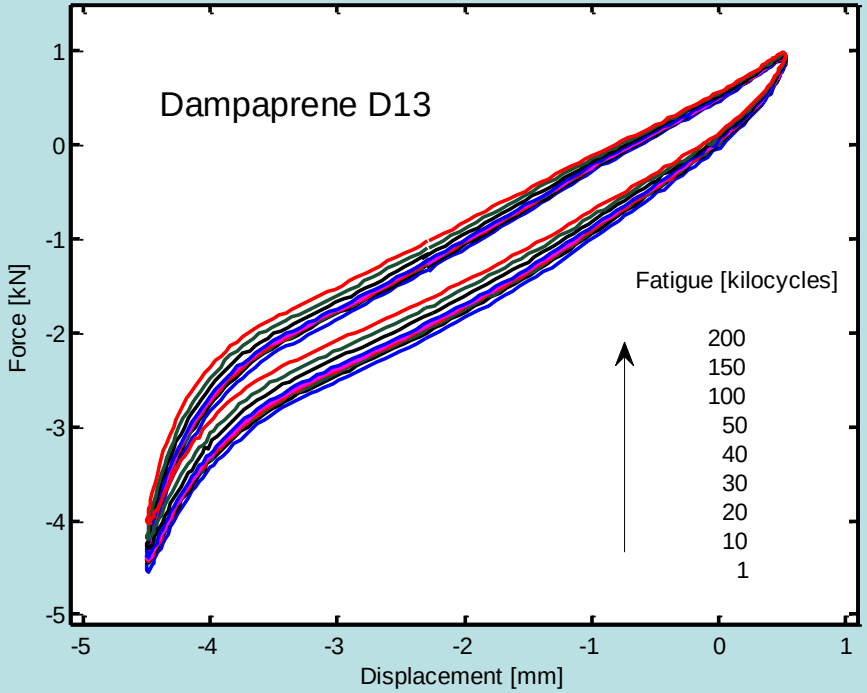
genuine part **copied part**

Lemförder **Dampaprene D13**

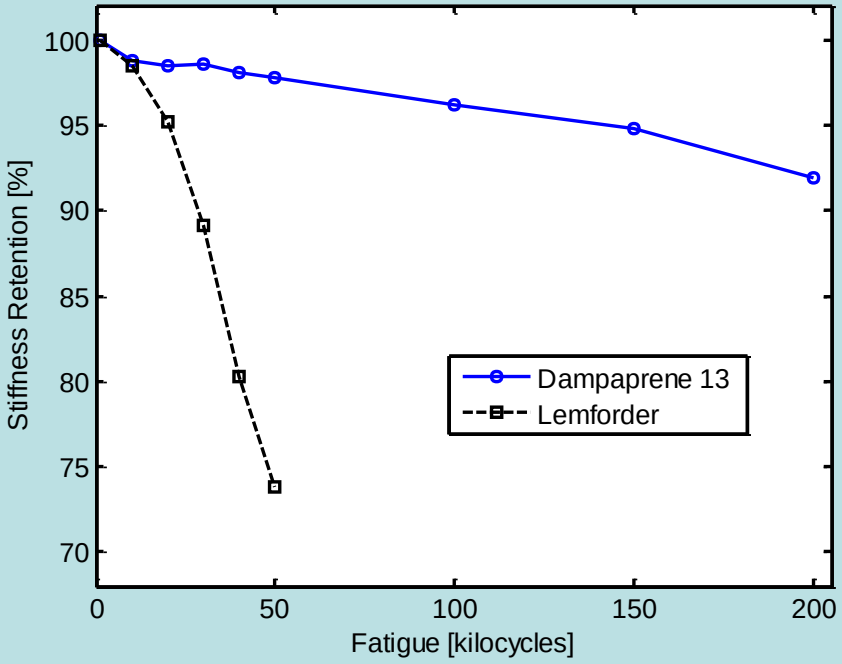
Changes in Hysteresis Loops with Cycles of Oscillation

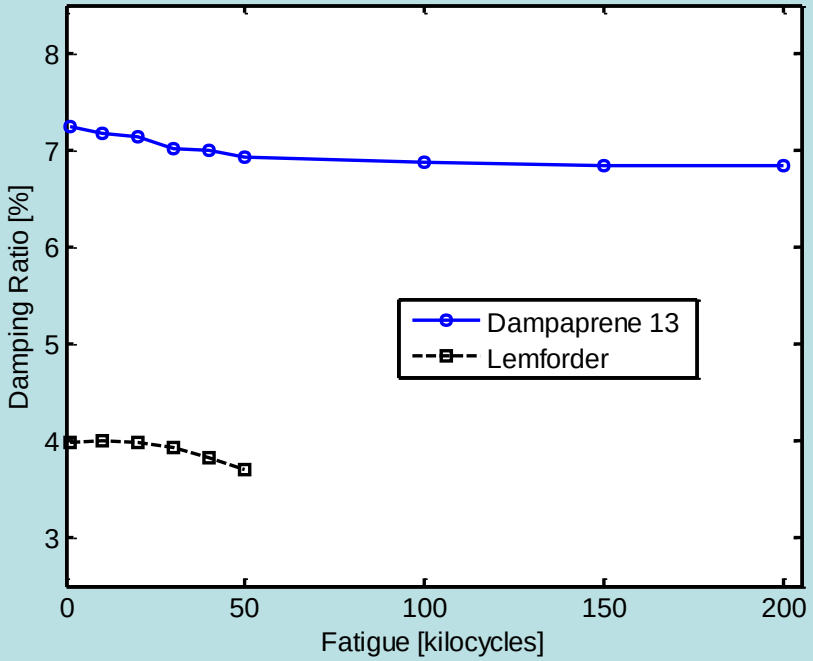
Fatigue : Stiffness, Damping





Fatigue : Stiffness, Damping





Dampaprene Suspension bush : workable

Conclusions

acid coagulation

limitations / normal practices

green clean process

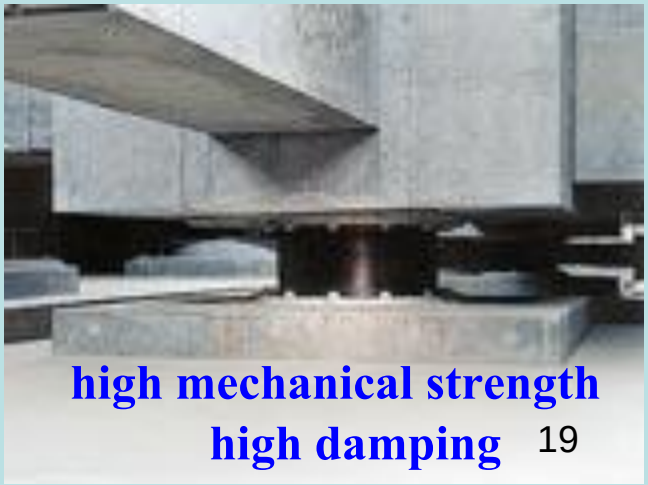
Bridgestone

TARRC

good mechanical strength

low temperature dependence

high damping



high mechanical strength

high damping

Thank you

?