NOENE®

SHOCK TECHNOLOGY

SWISS MADE
UNDER ISO 9001 & 14001

TECHNICAL DATAS

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is a registered brand
& secret formula owned by

MEDIADEM S.A.M.
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MC 98000 MONACO

NOENE: A NEW VIBRATION ABSORBER ELASTOMER

Vibrations and their effects

When machines are working, they vibrate, causing impairment to their parts, to their supporting structures and to the quality of production.
The vibrations, propagated through the structures, are harmful to people working nearby.
The vibrating structures create noise, which in turn becomes a source of disturbance.

What is NOENE

NOENE is a new member of the rubber family, but with substantially different characteristics to those of traditional elastomers.
The word NOENE is an acronym of the italian NO-Energia-NEgativa, which means *No Negative Energy.*
It has the elasticity of a good rubber, but it also has unusual damping capacity: by deformation it absorbs energy, being an elastic material; as a damper, it dissipates the energy absorbed.
One part of the energy is converted into heat, while the other part is returned so slowly as to have practically no dynamic effects.
In solid form, NOENE can be used to reduce shock and impact stress effects as a vibration damper.
Foamed, NOENE finds use with specific, not-too-heavy loads.

Shocks and impact vibrations

Compare what happens when a small metal ball is dropped on a slab of NOENE and on a slab of some other elastic material.
The elastic material is compressed and "energized". This given energy is at once returned to the ball, which then bounces.
But NOENE is slow in neutralizing the impact-induced deformation and returns to its original shape with no bounce action; the impact energy is "digested" inside NOENE.
The absorbed energy is not given back to the ball and is, in fact, also filtered out from affecting the underlying surface.
Test enough, surely, to prove NOENE's claims to reduce shock effects and to attenuate impact vibrations generated by the repeated blows of metal on metal.

Shock absorption

A salient feature of NOENE is its shock-absorbing capacity.
NOENE is a material par excellence for use where shock vibration is added to constant vibrations.

Continouous vibrations

As a rule, machines are insulated from their base plates by vibration-damping supports.
The machine-plus-support system has a natural frequency of oscillation determined by the mass of the machine and the elasticity of the supports.
In operation, the machine vibrates at a frequency depending, in rotatory mechanism, on the speed of rotation.
If the vibration frequency is higher than the natural frequency, NOENE absorbs the energy and decidedly cuts down the transmission of vibration to the base-plate.
When the vibration frequency is near the natural frequency, as it is, for example, in the start-up and stopping stages of the machine, NOENE acts as a true and proper shock absorber, limiting machine oscillation.

Vibration of metal panels

It often happens that machine-made vibrations are transmitted to the metal covering panels, which then act as sounding boards. Noise attenuation is had by damping the vibrations with suitable material on panels, in such a way that the mechanical energy associated with the vibrations is converted into heat and so dissipated.
A sheet of foamed NOENE on the metal is the answer.
A metal-panel sandwich with NOENE filling is an excellent noise-deadening arrangement.

Were NOENE can be used

NOENE is a positive solution in conquering vibration problems in a large number of machines. Major application sector are those of machines with metal hammering on metal, with reciprocating parts, and precision machines where protection mast be provided against vibrations emanating from neighbouring mechanism.
The human body, too, can draw benefit from the use of NOENE: as insert in gloves for workers using vibratory tools; as insert in footwear, for absorption of the negative energy discharded on to the lower limbs when the foot strikes the ground.

APPLICATIONS OF NOENE

Industrial Sector:
Vibration deadening in rotatory and reciprocating machines, linings for hoppers and containers suffering shock from falling materials, vibratory separators, metal panel deadening, handgrip covers, portable machine tool uncouplers.

Motor Vehicles:
Linings and covers, rebound bumpers, racing car interiors.

Railwais Superstructure:
Rail chairs, superstructure platform supports, signalling and shunting box connexions.

Building:
Slab supports, bearings, joints, floating floors.

Electronics and Precision Instrumentation:
Coverings, equipment supports and fixings.

Hi-Fi:
Coverings, supports and fixings for soundboxes and record-players.

Hydraulics:
Piping anchorage, pump uncouplers, joint seals.

Sport:
Shoe inserts, saddles, equipment handgrips, shockproof inserts.

Accident Prevention:
Shoes, gloves, protective clothing shockproof inserts.

Office Machines:
Supports and base plates for printers and computers.

Aeronautics:
Helicopter landing platforms.

Orthopaedics:
Corrective and restful inner soles.

NOENE AND THE ABSORPTION OF SHOCK ENERGY

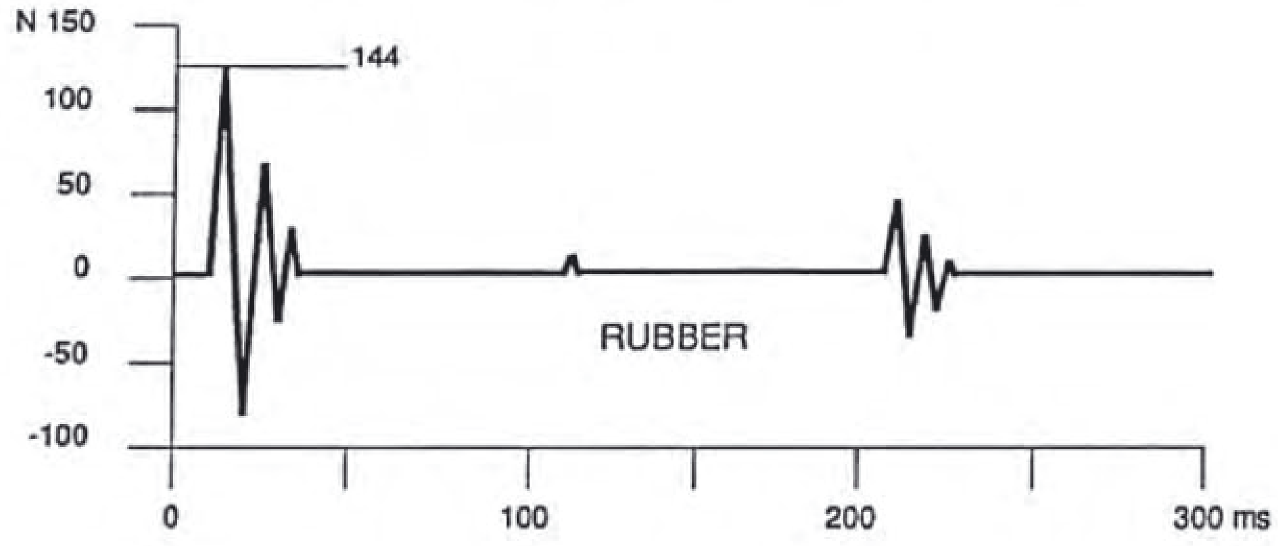
The graphs on page 5 illustrate the force transmitted by a free-falling steel ball on a load cell.
Between the ball and the instrument there have been put test pieces of natural rubber, ethyl-vinyl-acetate (E.V.A.) and NOENE.
It can be seen that under equal conditions of drop and test piece geometry NOENE absorbs the shock energy almost completely (there is no second or rebound shock) and reduces the transmitted force peak.
The values found were:

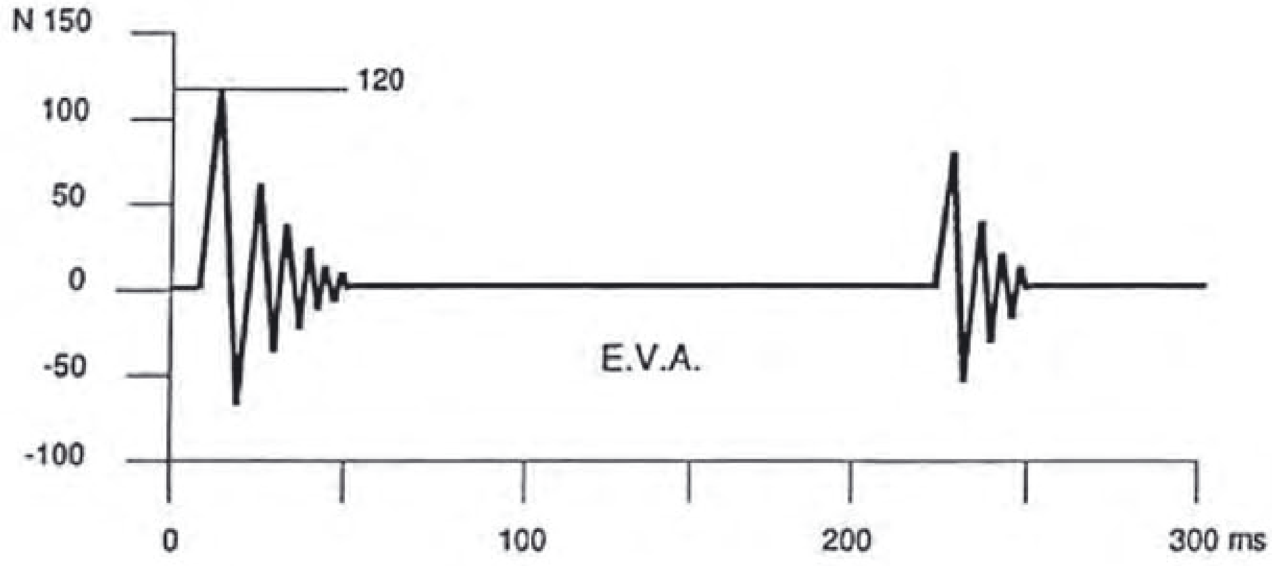
Rubber	144
E.V.A.	120
NOENE	100

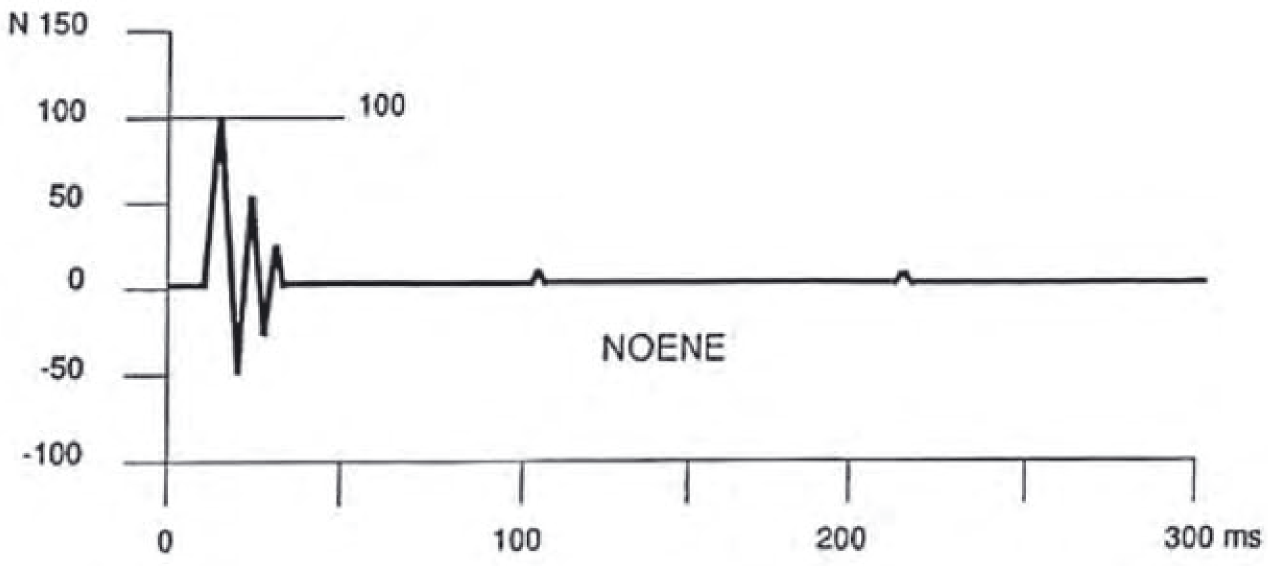
NOENE REBOUND ELASTICITY

One of the major characteristic differentiating NOENE from other good quality elastomers is its rebound elasticity.
This quantity is a parameter expressing the capacity of the material to dissipate mechanical energy. It is measured by means of an instrument called the *Rebuond Pendulum* wich measures how much mechanical energy is put back into a steel ball falling from a specific height on to a test piece of the material under examination.
With NOENE, for temperatures between 0° and 30°C, less than 5% of the ball's prefall potential energy is is put back into the ball. The remaining 95% is dissipated by the NOENE.
On page 6 NOENE's rebound elasticity is graphed in comparison with that of other common elastomers, as a function of temperature.
In the range of temperature from -20° to +60°C, which includes most normal applications, the rebound elasticity of NOENE is decidedly lower than that of all other elastomers.

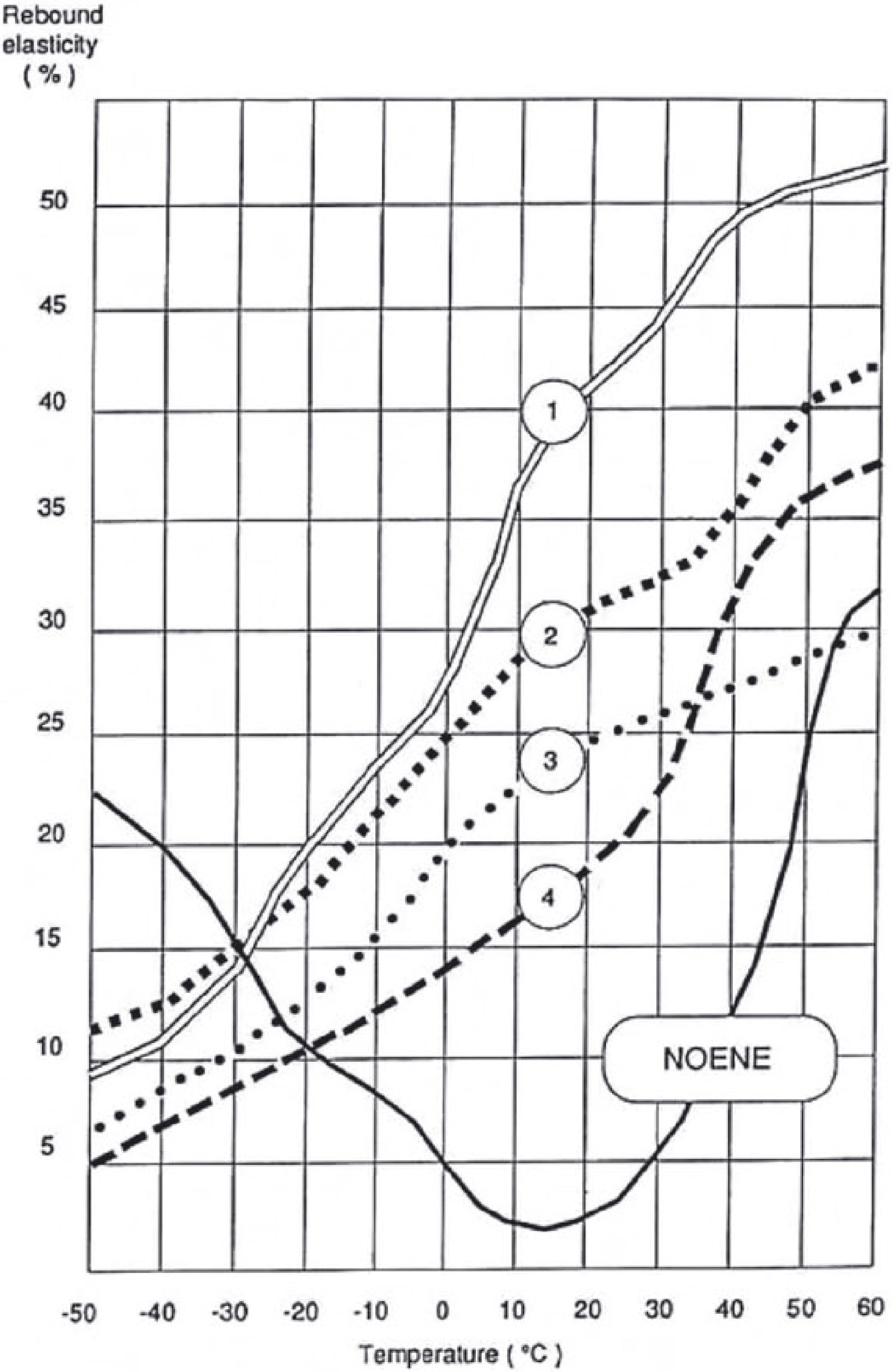
GRAPHS ILLUSTRATING THE FORCES TRANSMITTED BY A FREE-FALLING STEEL BALL TO A LOAD CELL WITH INTERPOSED TEST PIECES OF RUBBER, ETHIL-VINYL-ACETATE AND NOENE







REBOUND ELASTICITY OF ELASTOMERS AS A FUNCTION OF TEMPERATURE



Compounds of:

1. Chloroprene (CR)
2. Acrylonitrile (NBR)
3. Etylene-Propylene (EPDM)
4. Isoprene-Styrene-Butadiene (NR/SBR)

NOENE DAMPING PROPERTIES

NOENE's capacity in extensively damping both impulse and transitory vibrations as well as stationary and pseudostationary dynamic actions is apparent in its hysteresis behaviour.
Take test pieces of various materials and subject them to a squash s (t) of unit amplitude (1 cm), varying according to harmonic law (with pulsation w).
Then

$$s(t) = (1\ \text{cm}) \sin(wt).$$

Graph the relationship between the squash (s) and the force (F) required to produce the desired displacement.
A list of symbols is given on page 9.

The behaviour shown in the first figure on page 10 refers to a perfectly elastic material, such as steel.
The relationship between (s) and (F) is a straight line whose slope (K) represents the elastic stiffness of the sample.

$$F(t) = K s(t) = K((1\ \text{cm}) \sin(wt))$$

The elastic energy (E_e) required to cover the load-phase (half circle)

$$E_e = 1/2\, K (2\ \text{cm})^2$$

is given back in total in the unload phase.

The behaviour of the elasomers, shown in the other figures on page 10, diverges from that of the steel in that the straight lines of steel becomes an s/F closed curve and represents the hysteresis cycle of the material.
The area enclosed by the curve is a mesure of the hysteresis energy (E_i) expended in one cycle of the system.
The ratio (R_i) between hysteresis energy (E_i) and the energy associated with the elastic half-cycle (E_e) is an index of the material's hysteretic dissipative capacities:

$$R_i = E_i / E_e$$

The hysteresis properties of materials are expressed in terms of hysteretic stiffness (C), or hysteretic damping coefficient, wich has the same dimensions as elastic stiffness (K), and therefore the total force (F) to be applied to the sample to produce the cycle is given by

$$F(t) = (K + iC)\, x(t) = K\,(1\ cm)\, \sin(wt) + C\,(1\ cm)\, \cos(wt)$$

The ratio ($2\,n_I$) between the two stiffnesses expresses the loss factor or hysteresis damping factor.

The parameter

$$n_I = C / (2K)$$

is connected to the energy ratio (R_I) by the formula

$$R_I = (3.14)\, n_I$$

In the examples given on page 10, the different cycles for different values of the hysteresis factor are shown:

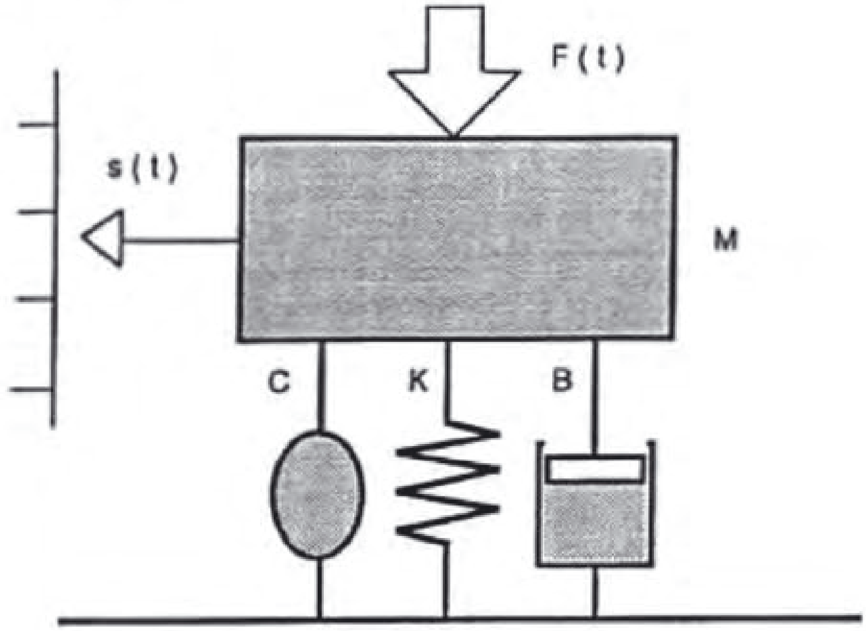
STEEL:	n_I = 0 %	R_I = 0 %
RUBBER:	n_I = 30 %	R_I = 94 %
NOENE:	n_I = 60 %	R_I = 188 %

The greater the hysteresis capacity for dissipating mechanical energy, the fatter is the cycle shape.

With the test, the difference between the behaviours of NOENE and other elastomers can be quantified.
Given that all good quality rubbers have respectable hystereris damping factors (n_I), NOENE's is particularly high.

PARAMETERS	RUBBER	NOENE
Rebound elasticity at 20°C	from 20 % to 40 %	from 2 % to 5 %
Loss factor: $2\,n_I = C / K$	from 10 % to 30 %	from 120 % to 180 %
Hysteresis factor: $n_I = C / (2K)$	from 5 % to 15 %	from 60 % to 90 %
Energy ratio: $R_I = E_I / Ee$	from 16 % to 47 %	from 188 % to 283 %

Given an oscillator



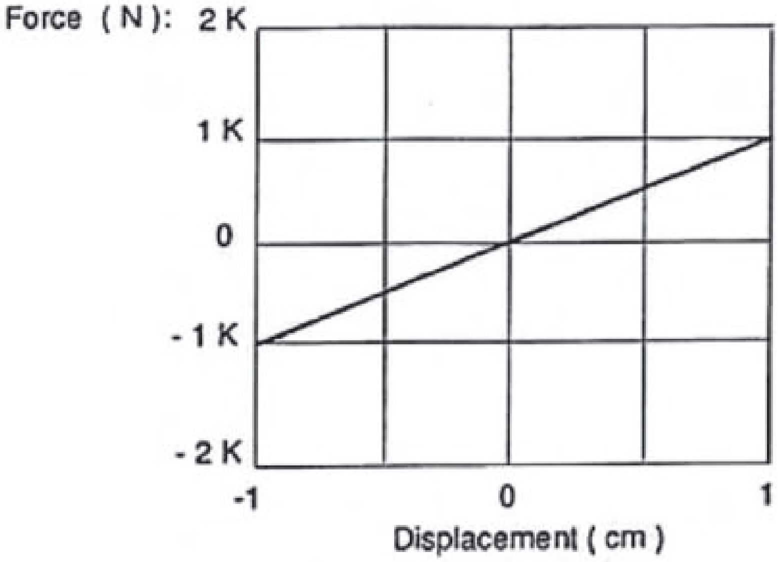
where:

time	t	s
frequency	f	Hz
pulsation	w=6.28 f	rad / s
displacement	s (t)	m
speed	v (t) = ds (t) / dt	m / s
acceleration	a (t) = dv (t) / dt	m / s / s
force	F (t)	N
mass	M	kg
elastic stiffness	K	N / m
viscous damping	B	N / (m / s)
hysteresis stiffness	C	N / m
imaginary unit	i	
viscous damping factor	$n_v = B / (2\ Sqr\ (K / M))$	ad
hysteresis damping factor	$n_i = C / 2 K$	ad
natural pulsation	$w_o = Sqr\ (K / M)$	rad / s
natural frequency	$f_o = (1 / 6.28)\ Sqr\ (K / M)$	Hz
natural period	$T_o = 1 / f_o$	s
natural damping factor	$n_o = n_v + n_i$	ad

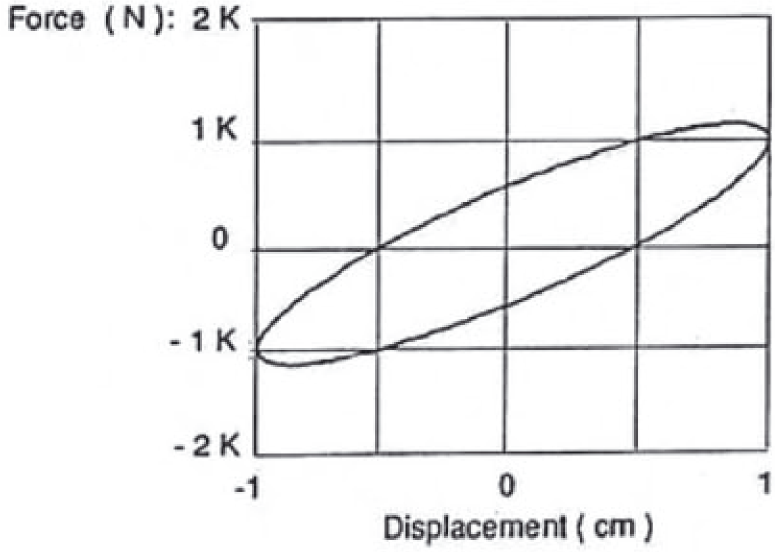
The equation of motion is:

$$F(t) = M\,a(t) + B\,v(t) + (K + iC)\,s(t)$$

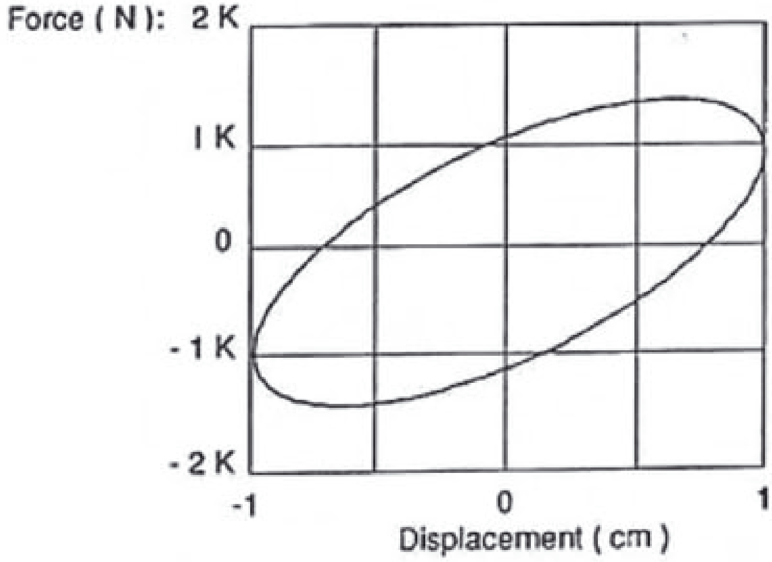
THE HYSTERESIS OF STEEL, RUBBER AND NOENE



STEEL
$n_i = 0\%$



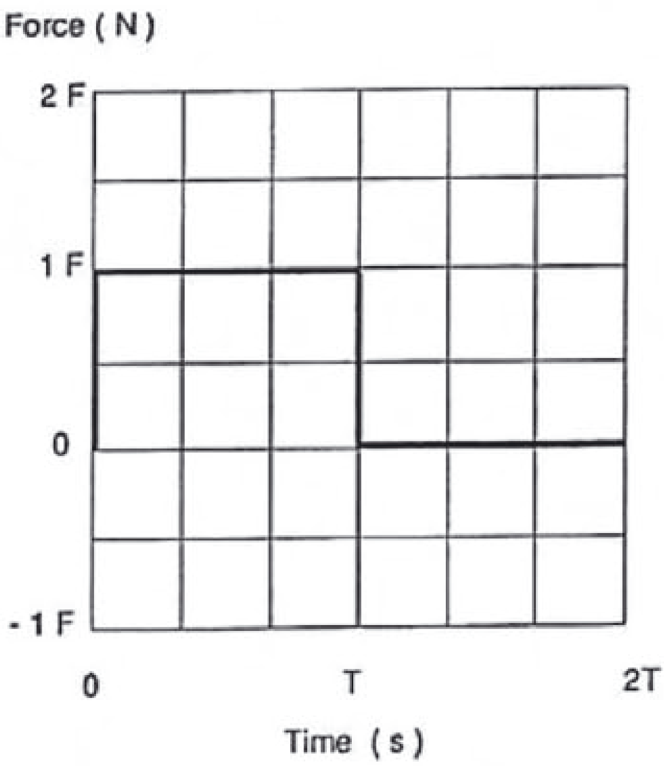
RUBBER
$n_i = 30\%$



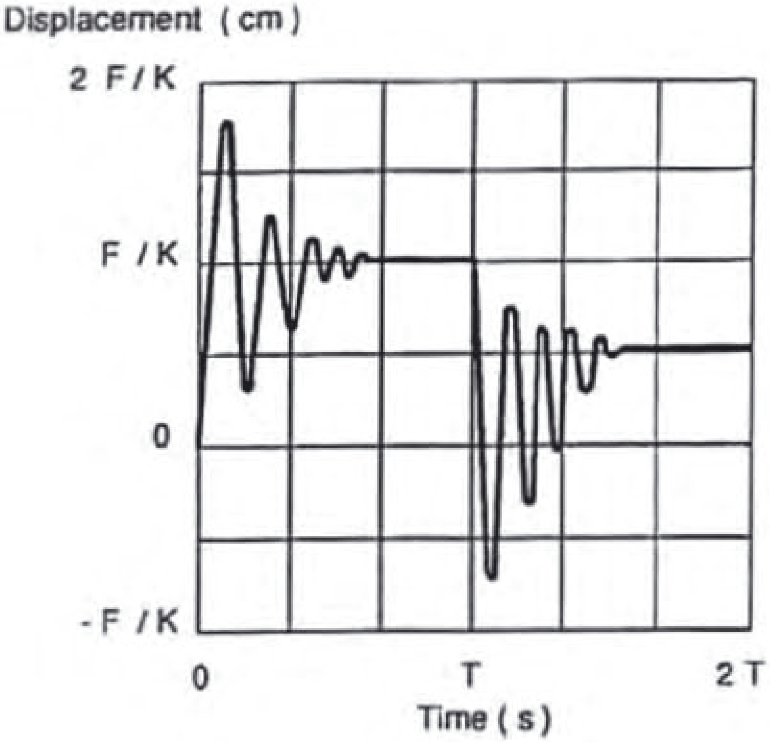
NOENE
$n_i = 60\%$

NOENE AND TRANSITORY PHENOMENA

Transitory phenomena have their origin in events which last only for a very short time.
A theoretical example, schematically very simple, is the rectangular impulse illustrated in the figure, resulting from the application of a load (F) which remains constant for a period of time (T).
In actual fact the response of the mechanical systems is usually characterized by complex oscilllatory phenomena during the loading phase , in passing from (0) to (F). These phenomena disappear the more rapidly the higer is the natural damping factor (n_0) of the system.
The diagrams on pages 12 and 13 evidence the differences in behaviour between an ordinary rubber (n_0 = 30 %) and NOENE (n_0 = 60 %).
The extent of displacement depends upon the stiffness (K) of the system.
Response oscillation amplitude a (t) is inversely proportional to the mass (M).
The diagrams confirm that favourable and significant effects are obtained through the use of NOENE insofar as the transitory phenomena caused by the system's free oscillations are concerned, both in the loading phase and in the unloading phase.
The shorter oscillation damping time also reduces the risk of dangerous synchronisations due to the superimposing of return waves on the outgoing waves.

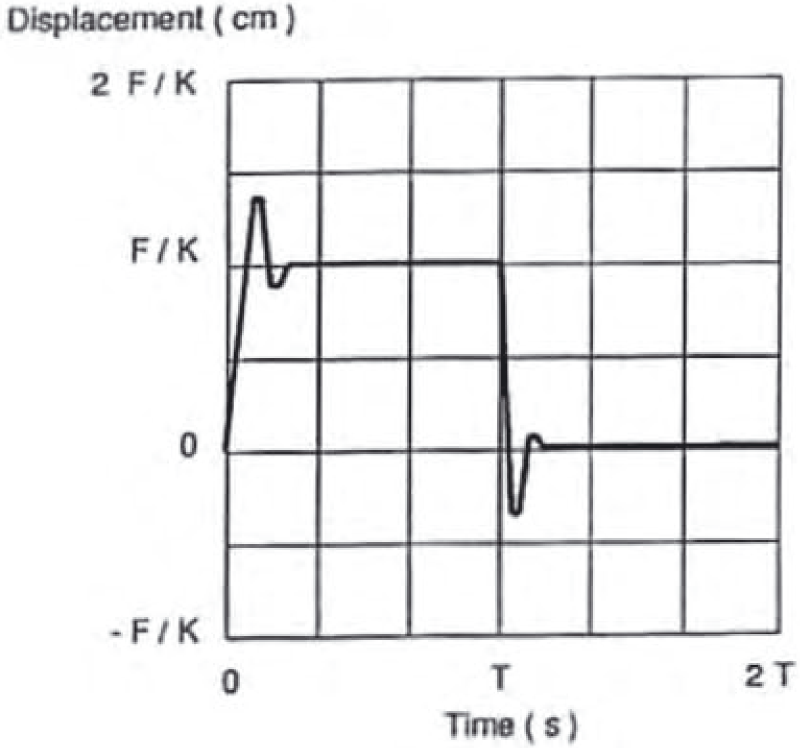


RESPONSE TO TRANSITORY PHENOMENA: DISPLACEMENTS



RUBBER

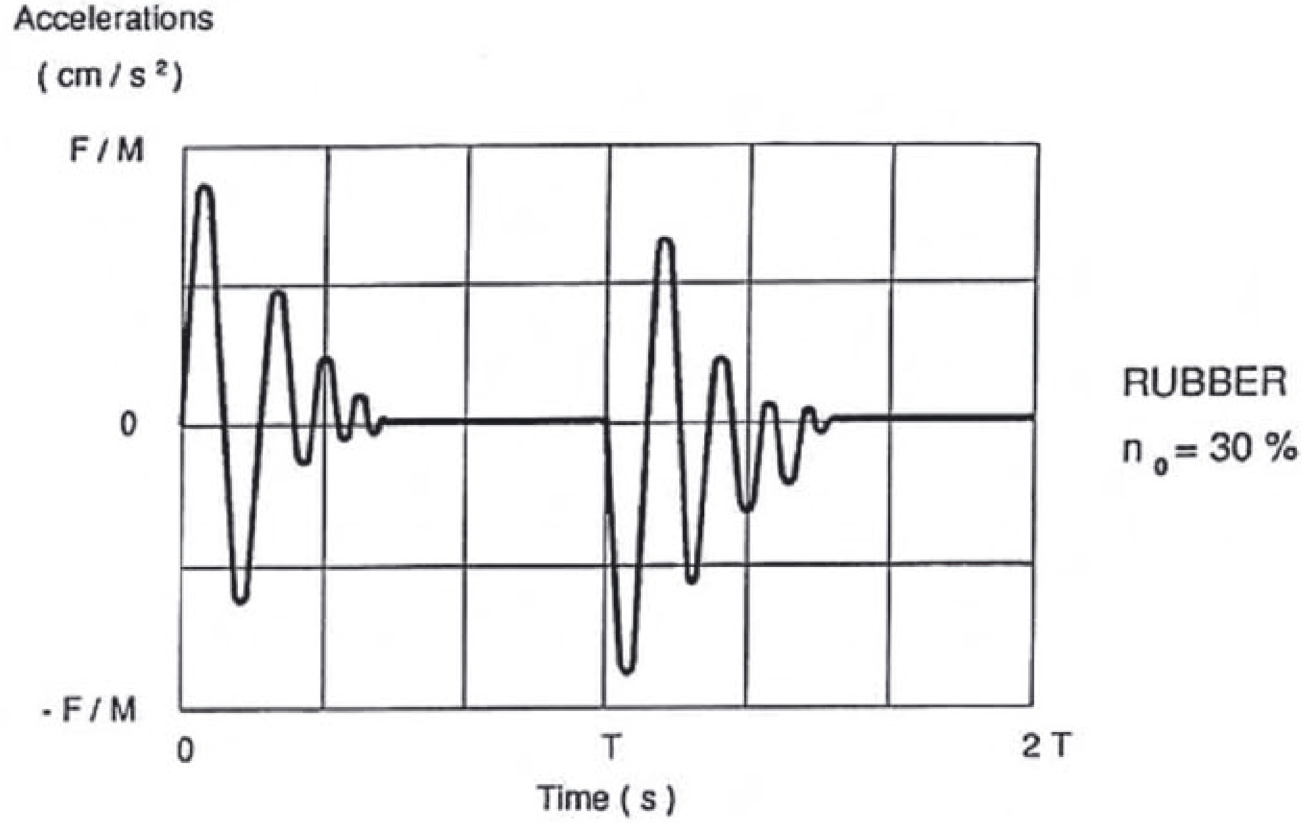
$n_0 = 30\ \%$

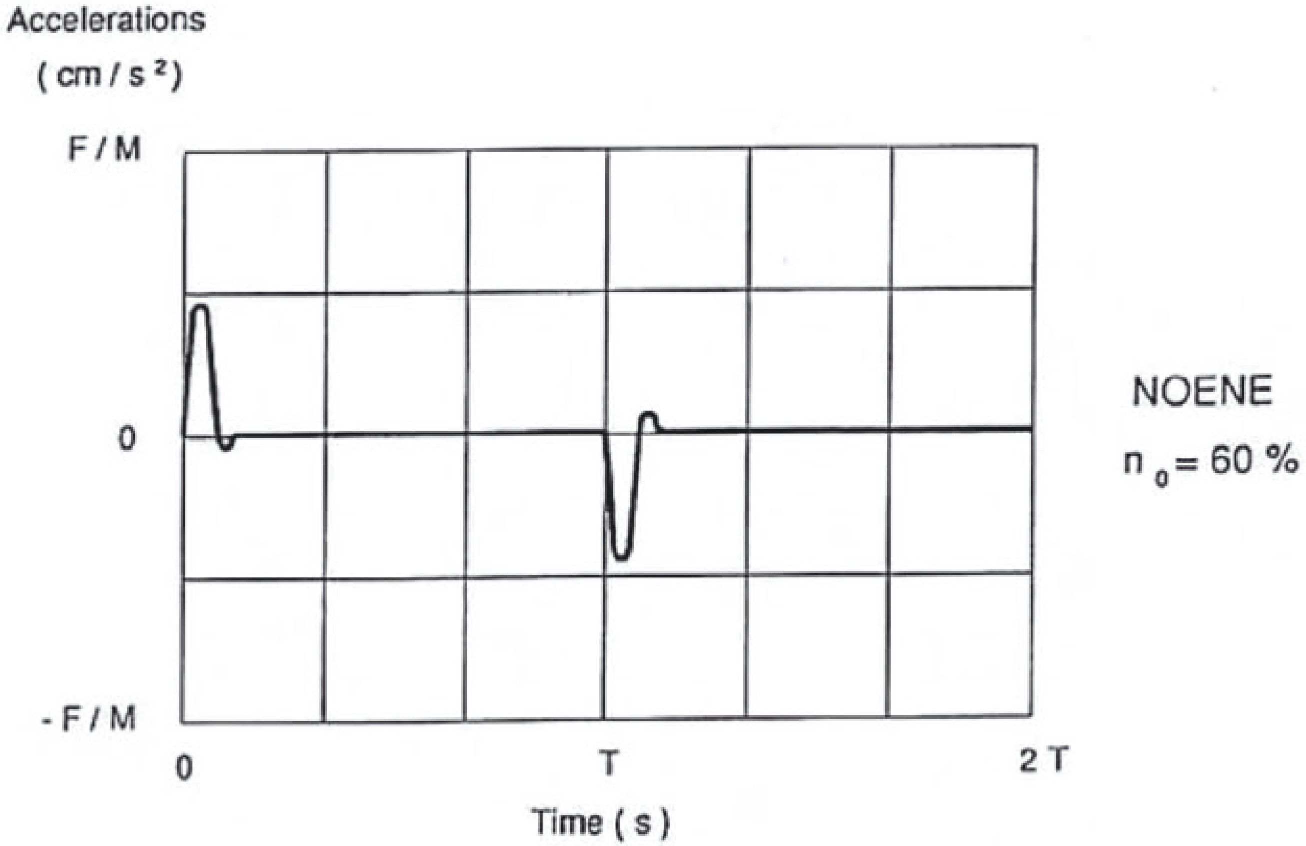


NOENE

$n_0 = 60\ \%$

RESPONSE TO TRANSITORY PHENOMENA: ACCELERATIONS





NOENE IN FOOTWEAR

At the University of Brussels Biomechanics Laboratory the forces transmitted to a person running and walking, due to the foot striking the ground, have been measured.

These measurements were made by means of sensors inserted into the footwear and analyzed with the help of a Light Electronic Gait Analyser.

Comparison was made between the use of conventional footwear and footwear in which a 2 mm thick NOENE foam plantar had been inserted.

The test dynamic conditions were: a frequency of 70 steps per minute, corresponding to a cycle of 860 msecs. The time during which the return forces act is about one third of the cycle.

The graph shows the measurements made at the heel, where are the lateral and medial tubercles, which is the part of the foot receiving the first and major shock.

It will be observed that the maximum response pressure is 7.6 N/mm^2 with ordinary footwear and 6.4 N/mm^2 with NOENE insert footwear.

Return force duration is reduced by 20% with NOENE inserts.

The total force exerted, that is the product of the momentary forces and their duration time, is reduced by 40%.

The use of NOENE in footwear reduces fatigue and the risk of those microtraumas on the osteocartilage structures wich are the cause of tendinitis and periostitis.