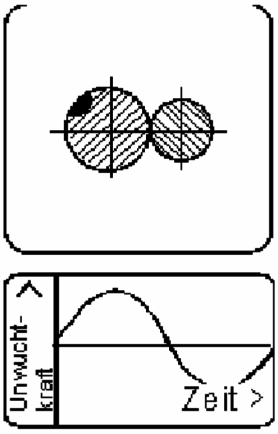
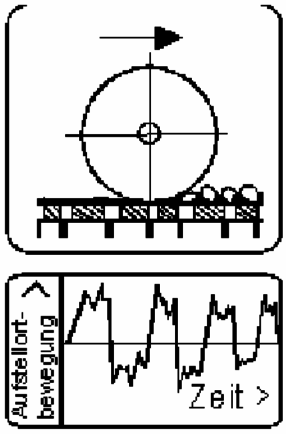
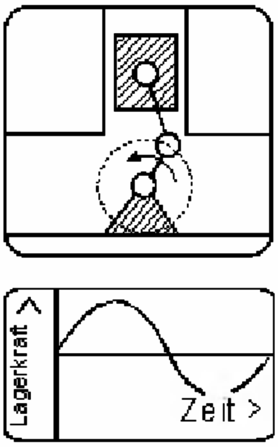


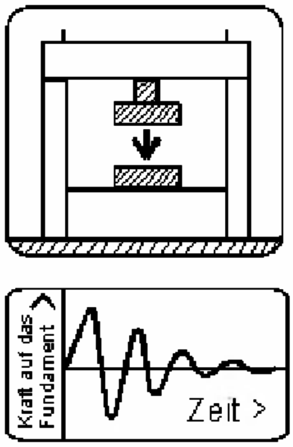
Unwuchten bei rotierenden Maschinenteilen in Getrieben, Lagern, Kupplungen



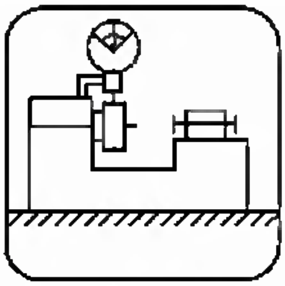
Regellose Stöße an Kollergängen und Mahlwerken



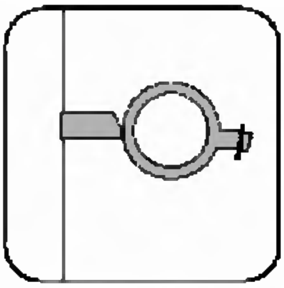
Hin- und hergehende Bewegungen in Maschinen



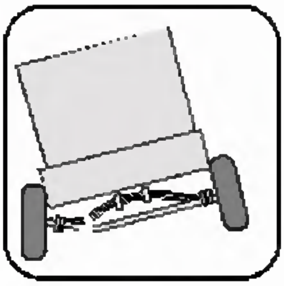
Stoßvorgänge an Pressen, Stanzen, Hämmern



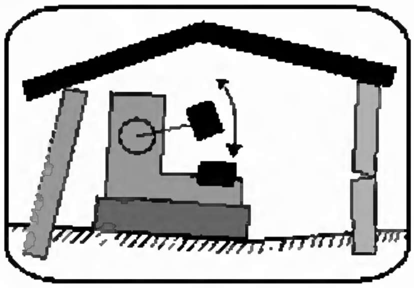
Funktionsstörungen durch zu große Bewegungen - Qualitätsminderung am Produkt



Dauerbrüche von Befestigungs-elementen -
Brüche von Rohrleitungen, Maschinenschäden



Brüche von Federn und Achsen bei selbstfahrenden Arbeits- und Transportmitteln



Formänderung und Brüche von Bauteilen und Bauwerksteilen

Sitzender Mensch	4-5 Hz
Magen	2-7 Hz
Nieren	3 Hz
Herz	4-6 Hz
Bauchhöhle	8 Hz
Schultergebiet	4-5 Hz
Kopf	20-30 Hz

Abb. 2/4: Eigenfrequenzen des Menschen und seiner Körperteile

In Abhängigkeit von der Erregerfrequenz kann es dabei zu verminderter Leistungsfähigkeit und zu Stressreaktionen kommen:

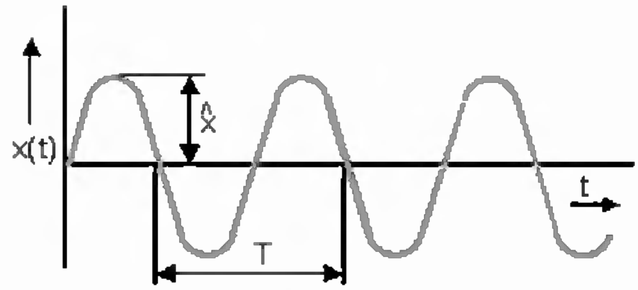
$1 < f < 4$ Hz: Beeinträchtigung der Atmung und des Sprechens

$2 < f < 16$ Hz: Beeinträchtigung der Geschicklichkeit;

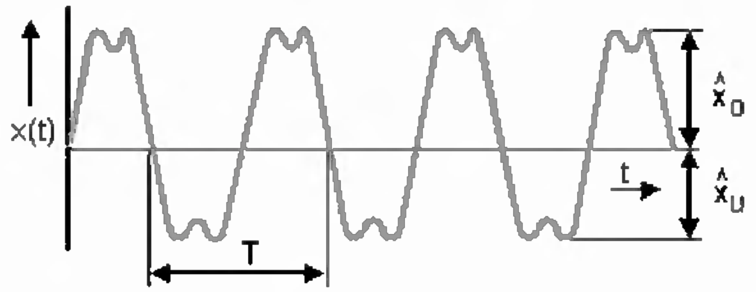
Gefahr: Führen eines Fahrzeugs kann erschwert werden.

$20 < f < 25$ Hz: Reizung der Augäpfel möglich.

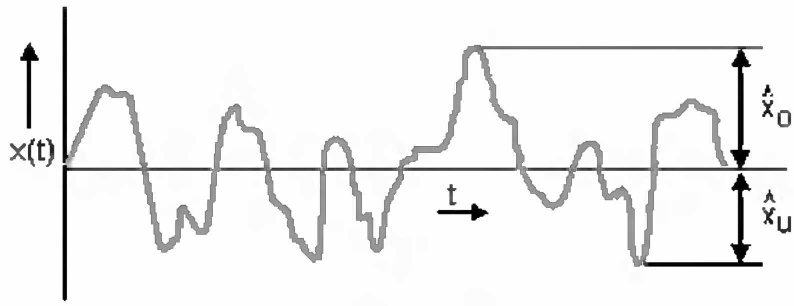
Gefahr: Minderung der Sehleistung.



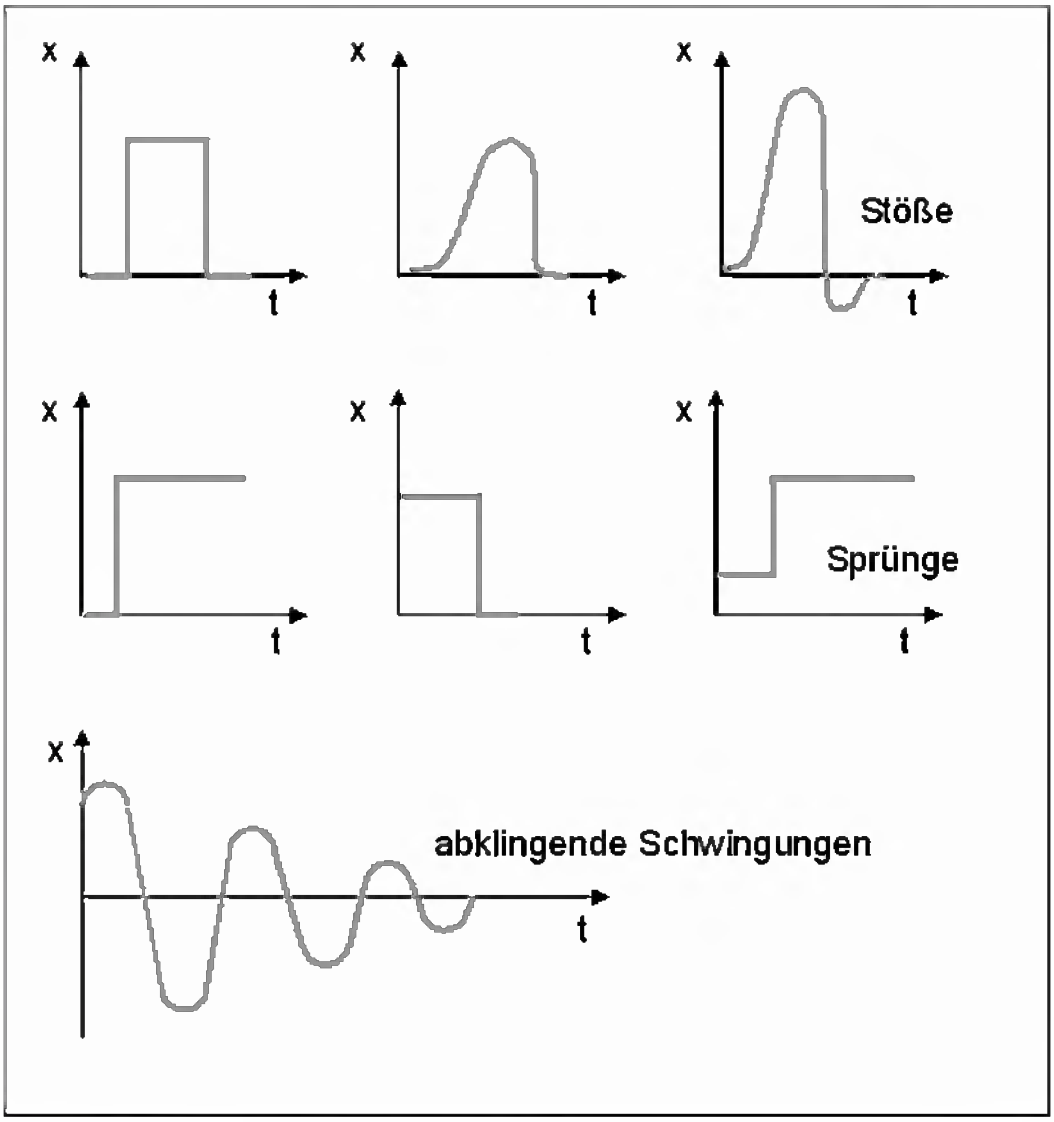
a) Harmonische Schwingung
(Sonderfall der periodischen Schwingung)

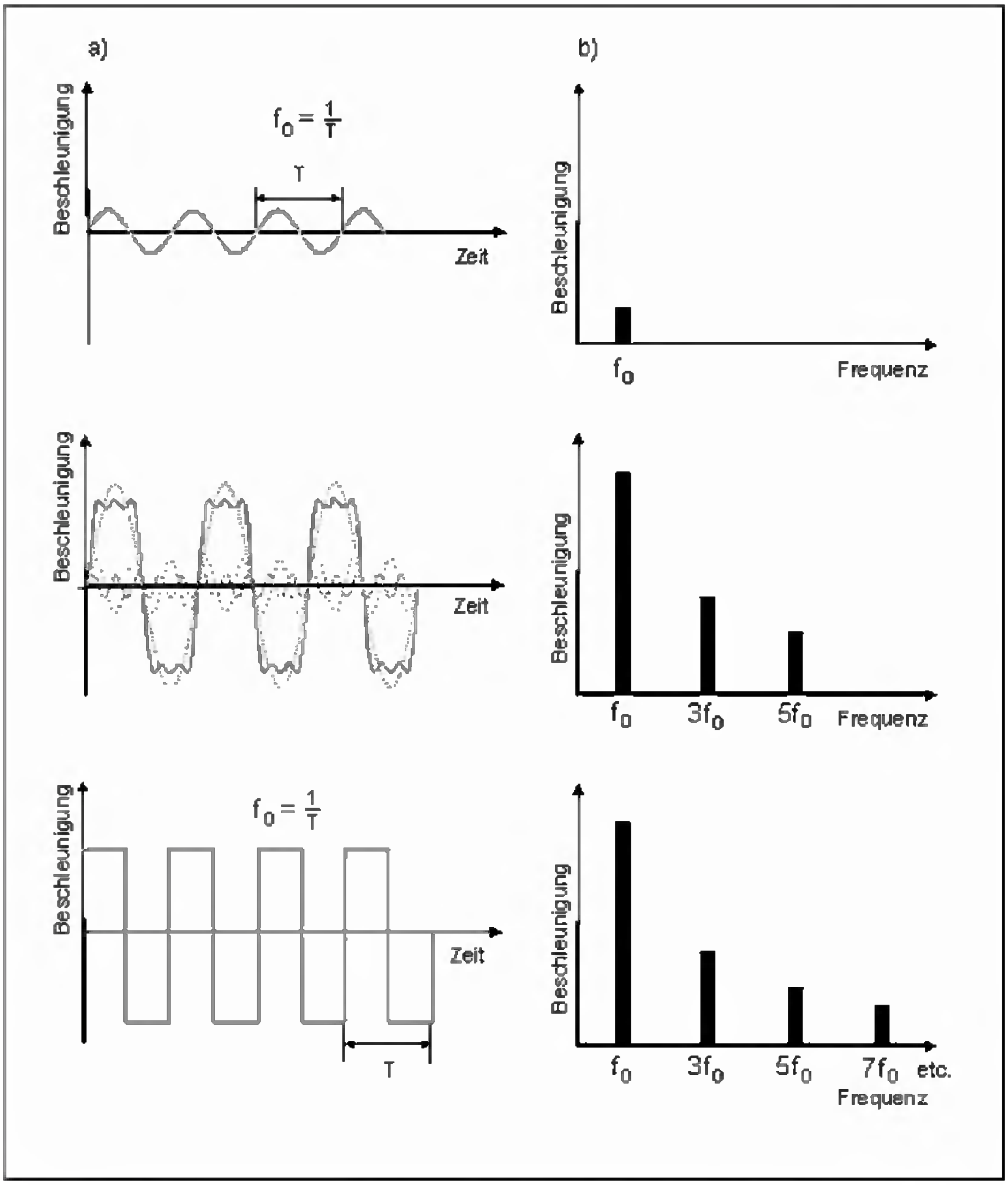


b) Periodische Schwingung



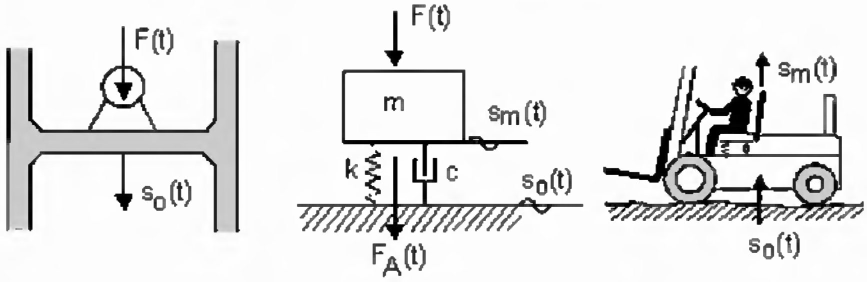
c) Regellose (stochastische) Schwingung


x
t
Stöße
Sprünge
abklingende Schwingungen


a)
b)
Beschleunigung
f0 = 1/T
T
Zeit
f0
3f0
5f0
7f0
etc.
Frequenz

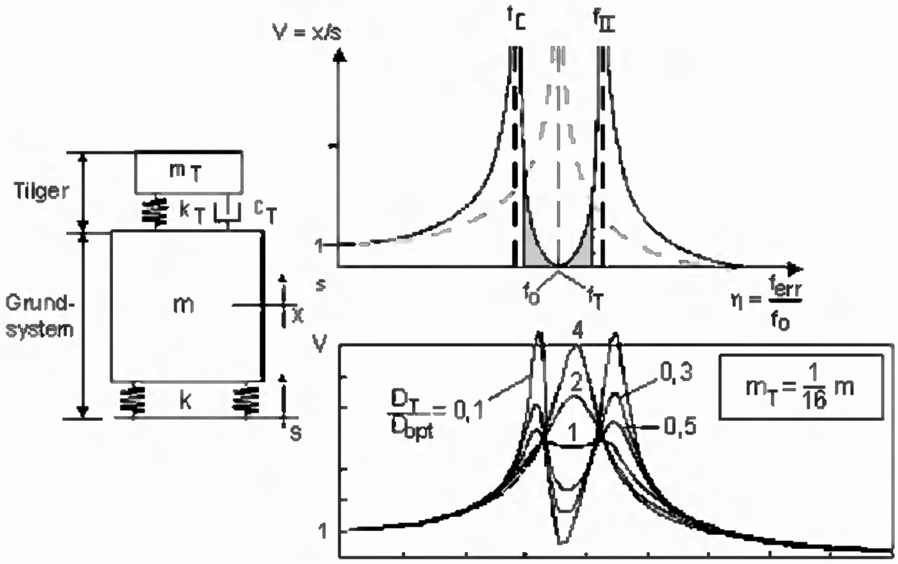
einfachstes Modell für

- Krafterregte Systeme
- über die Stützkonstruktion erregte Systeme



$m = m_{Maschine} + m_{Anteil\ Geschossdecke}$ | $m = m_{Bedienpersonal} + m_{Sitz}$

dynamische Erregung ➡ Modellierung ⬅ Kinematische Erregung



$f_0 = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ Eigenfrequenz des Grundsystems

$f_T = \frac{1}{2\pi}\sqrt{\frac{k_T}{m_T}}$ Kennfrequenz des Tilgers (Eigenfrequenz bei ideal starrem Aufstellpunkt)

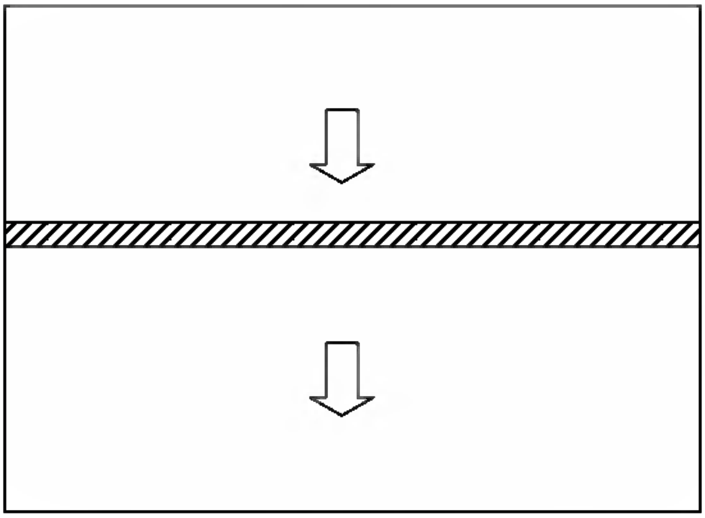
f_I, f_{II} Eigenfrequenzen des Grundsystems mit Tilger (ohne Dämpfung)

$D_T = \frac{c_T}{2m_T \cdot 2\pi f_T}$ Dämpfungsgrad des Tilgers

- - - - Übertragungsfunktion des Grundsystems

—— Übertragungsfunktion des Grundsystems mit Tilger

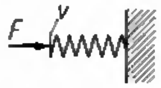
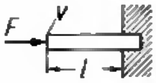
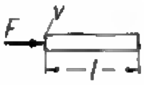
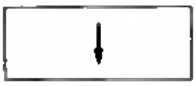
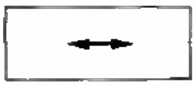
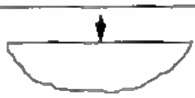
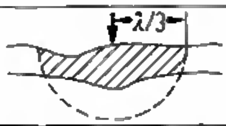
▬ Wirksamer Frequenzbereich des Tilgers



Μείωση έντασης δόνησης: $$R = 10 \cdot \log \frac{(Z_1 + Z_2)^2}{4 \cdot Z_1 \cdot Z_2}$$

όπου:
Z σύνθετη μηχανική αντίσταση σε κάθε μέσον

Tabelle 22.3. Zusammenstellung von Impedanzformeln

starre Masse		$Z = j\omega m$
masselose Feder		$Z = s/j\omega$
unendlich langer Stab, longitudinal		$Z = S\sqrt{E\varrho}$
kurzer Stab, longitudinal, starre Einspannung		$Z = -jS\sqrt{E\varrho}\,\cot(\sqrt{\varrho/E}\,\omega l)$
kurzer Stab, longitudinal, ohne Einspannung		$Z = jS\sqrt{E\varrho}\,\tan(\sqrt{\varrho/E}\,\omega l)$
unendlich langer Stab, Biegung		$Z = 2\varrho S c_B (1+j)$
unendlich langer Stab, Biegung		$Z = \frac{1}{2}\varrho S c_B (1+j)$
kurzer Stab, Biegung		$Z = \frac{B k_B^3}{j\omega}\,\frac{1+\cosh k_B l\,\cos k_B l}{\sin k_B l\,\cosh k_B l - \sinh k_B l\,\cos k_B l}$
unendlich große Platte, Biegung		$Z = 8\sqrt{D\varrho h} = 4h^2\sqrt{E\varrho/3}$
endliche Platte		$Z = \frac{\varrho h S_P}{4j\omega}\left\{\sum_n \frac{\varphi_n^2(x_0;y_0)}{\omega_n^2(1+j\eta_n)-\omega^2}\right\}^{-1}$
unendlich große Platte "inplane" Bewegung		$\frac{1}{Z} = \frac{\omega(3-\mu)}{16hG} + j\frac{\omega}{8\pi hG}\left[(1-\mu)\ln\frac{2c_L}{\omega a} + 2\ln\frac{2c_S}{\omega a}\right]$
elastischer Halbraum		$\frac{1}{Z} \approx 0{,}19(1-\mu)\frac{\omega^2}{G\sqrt{G/\varrho}} + j\frac{1-\mu}{\pi}\,\frac{\omega}{Ga}$
Faustformel		$\lvert Z \rvert \approx \omega m_\lambda$

Bemerkung: Dimension der Impedanz Ns/m = kg/s. S Balkenquerschnitt, S_P Plattenfläche, E E-Modul (bei verlustbehafteten Medien komplex, s. Gl. (13), B Biegesteife eines Stabes, D Biegesteife einer Platte, h Plattendicke, $k_B = \omega/c_B = (\omega^2\varrho S/B)^{1/4}$, G Schubmodul, μ Querkontraktions-zahl, c_L Dehnwellengeschwindigkeit, c_S Schubwellengeschwindigkeit, a Radius der angeregten Fläche ($a \ll \lambda$), η = Verlustfaktor, φ_n (x_0, y_0) Wert der Eigenfunktion an der Anregestelle, ω_n Eigenfrequenz s. Tabelle 1.7; m_λ Masse innerhalb eines Gebietes, das sich in einer Entfernung von weniger als $\lambda/3$ von der Anregestelle befindet. Dabei ist λ die kürzeste angeregte Wellenlänge (meist Biegewelle). Es wird auch vorausgesetzt, daß die lokale Elastizität (repräsentiert durch den Imaginärteil der Formel) für den elastischen Halbraum unberücksichtigt bleiben kann.

Type 1

Series "RD" Mountings

VMC Series R/RD neoprene isolators are molded in four sizes and can support up to 4000 lb. per isolator. They offer up to .5 inches of static deflection for excellent vibration isolation. All of our R/RD series isolators are molded completely in color for ease of identification, and all metal parts are completely embedded in neoprene for corrosion resistance. A tapped hole in the center of the mounting enables it to be securely bolted to the equipment. The mountings can also be furnished with a positioning pin (Series RP/RDP) for use with equipment that has inaccessible bolt holes.

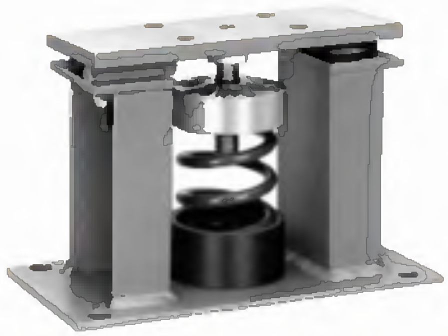
Type 2

Series "AC" Spring-Flex Mountings

VMC Series AC Spring-Flex mountings are free standing and laterally stable spring mountings. The coils are designed with an excellent ratio between the coil O.D. and operating height insuring lateral stability. In all of our designs, this ratio is a minimum of 0.80 and many have approximately a 1 to 1 ratio. In addition, our coils are designed with low operating stresses thus insuring a long operating life of the mounting. All of our open spring mounts have leveling capability and include a bolt hole in the bottom cup or a two hole rectangular baseplate for bolting to the structure. They are available with deflections up to 5 inches (127 mm) and are recommended for use directly under most HVAC equipment and in conjunction with structural steel bases and concrete inertia blocks.

Series "C" Spring-Flex Mountings

Recommended for applications requiring up to 1" of static deflection. Neoprene stabilizers provide lateral control without binding. All mountings have leveling bolts. Non-skid neoprene acoustical pad eliminates bolting.
Standard capacities 50 to 26,000 lbs..



Type 3

Series "AWRS" Spring-Flex Mountings

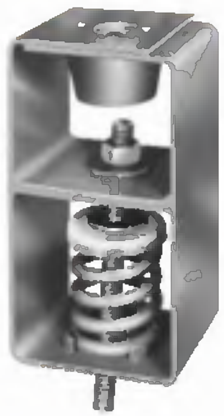
VMC Series AWRS Spring-Flex Mounts utilize our open spring isolators within a welded steel housing. The housing is designed to limit vertical movement when used under equipment with large variations in mass such as chillers, or to prevent excessive motion of outdoor equipment, such as cooling towers, due to high wind loads. The AWRS design also acts as a secure blocking during equipment installation and offers full leveling capability. These mountings are available with up to 5 inches of static deflection and can be designed to support virtually any load.

Type 4

Series "RSH" Spring-Flex Hangers

VMC Series RSH Spring Flex hangers provide optimum vibration isolation for suspended piping and equipment. They incorporate a color coded steel spring in series with a neoprene rubber element. This combination is excellent for critical applications where it is important to isolate both vibration and structure-borne noise. Load ranges from 21 lb. to 5000 lb. and up to 5 inches of static deflection offer a wide variety of choices to insure proper support.

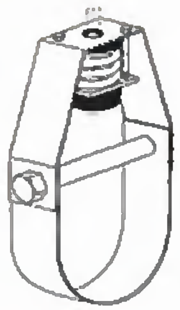
Series RSH-30A offers all of the above features plus the capability for the lower hanger rod to swing approximately 30° to compensate for rod misalignment. The 30° misalignment capability insures that the rod does not short circuit the hanger by coming in contact with the hanger box.



Type 5

Series "RSHP" Spring-Flex Hangers

To prevent load transfer to the equipment flanges when the piping system is filled, VMC has designed pre-positioning hangers which should be installed at the first three hanger locations adjacent to the equipment. Series RSHP incorporates a load bearing plate within the hanger box which keeps suspended piping at a fixed elevation during installation and start-up. Once the system is filled, the load is transferred from the plate to the spring insuring minimal movement in the piping. This design insures that the weight of the piping is kept off isolated equipment in order to maintain alignment, protect flexible connectors, and keep equipment isolators from becoming overloaded. Series RSHP is capable of supporting loads up to 5000 lbs. and offers up to 2 inches of static deflection.



Type 6

Series "CIH" Clevis Isolation Hanger

The VMC Series CIH, CIR, TIH, and TIR isolation hangers are revolutionary designs that incorporate a clevis or trapeze pipe support combined with vibration isolation **in one product.**

The built-in spring and neoprene pre-compression system coupled with flanged bushings on neoprene parts hold the isolation components into the pipe clevis assembly. You can now hang and pipe and isolate it in **one labor saving step.** Gone is the old method of hanging a pipe and then going back to cut the rod and install the isolation hanger.

Type 7

Series "RSHPR" or "RSHPR-30A" Spring-Flex Hangers

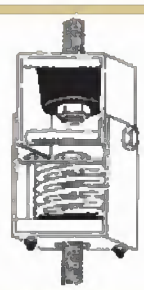
The RSHPR line of hangers offers a pre-compressed spring designed to keep suspended equipment and piping at a fixed elevation during installation.

Type 8

Series "SH" and "SHSC" Spring-Flex Hangers

VMC Series SH Spring-Flex hangers provide excellent vibration isolation for suspended piping and equipment. They incorporate a color coded steel spring for ease of identification in the field. Load ranges from 21 lb. to 5000 lb. and up to 5 inches of static deflection offer a wide variety of choices to insure proper support.

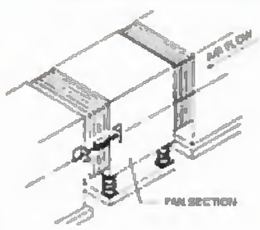
Series SH-30A offers all of the above features plus the capability for the lower hanger rod to swing approximately 30° to compensate for rod misalignment. The 30° misalignment capability insures that the rod does not short circuit the hanger by coming in contact with the hanger box.



Type 9

Series "SA" Spring-Flex Hangers

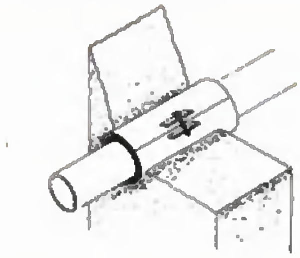
The SA hanger incorporates a color coded steel spring seated in a neoprene cup with an integral bushing to insulate the lower support rod from the hanger box. The hanger box is hinged to allow for a minimum of 30° misalignment between the rod attachment to the structure and the connection to the supported equipment.



Type 10

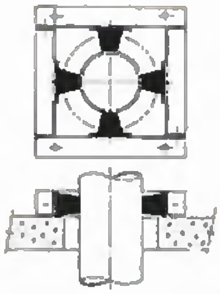
Series "HTR" Thrust Restraints

Excessive movement of air handling equipment can be controlled with our series HTR Horizontal Thrust Restraints. Motion resulting from high starting torque or air thrust will be limited to 1/4 inch.



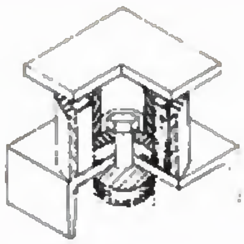
Type 11

Series "VCS" Sleeves
VMC Series VCS wall, floor, and ceiling sleeves provide an acoustical barrier that fits tightly around piping where it must penetrate floors, walls, or ceilings. If such penetrations are not properly sealed, they provide a path for airborne noise which can destroy the integrity of the occupied space.



Type 12

Series "RPG" Pipe Guides
Where vertical piping runs between support points, a resilient pipe guide should be provided. The guide consists of an angle frame and four double deflection neoprene mountings molded in specific colors for proper identification of rated load capacity.



Type 13

Series "MDPA" Pipe Anchors
VMC Series MDPA pipe anchors are designed to eliminate or guide pipe movement, and must be rigidly attached to the structure.

Type 14

Series "VMS", "VMT" & "VMU"
Quiet Sphere Flexible Connectors
Single-sphere (VMS), twin-sphere (VMT), and union (VMU) connectors are molded of neoprene and synthetic fiber and furnished with corrosion resistant floating steel flanges. Operating temperature to 240°F and operating pressure to 214 psi. Compensates for expansion, compression, transverse movement, and angular deflection. Reduces vibration and noise transmission. Size 1¼" to 20" I.D.

Type 15

Series "AEQM" Spring-Flex Mountings
Designed for seismic and restrained applications, these mountings are capable of withstanding a minimum of 1.0g accelerated force in all directions and provide static deflections up to 2" and loads to 2500 lbs. They also incorporate an all-directional neoprene grommet and an adjustable upward rebound plate. These mountings have been tested by an independent test laboratory and results are available on request.

Series "AWMR" Restrained Spring-Flex Mountings
The design incorporates a rugged welded steel housing with vertical and horizontal limit stops able to withstand a minimum of 1.0g accelerated force in all directions. Loads to 10,000 pounds and static deflections to 2". They are particularly recommended for equipment with differing installed and operating loads such as cooling towers and chillers or equipment subjected to severe wind loads.

Series "ASCM" Restrained Spring-Flex Mountings
Designed for seismic and restrained applications, these mountings when properly installed and adjusted will restrain mechanical equipment during a seismic event. For equipment that requires restrained isolators due to change in load, the ASCM incorporates a vertical limit stop to reduce motion.

Type 16

Series "SR" Seismic Restraints
Fabricated of welded steel components incorporating thick neoprene elastomer pads molded to Bridge Bearing quality specifications, the design of these restraints allows for the removal and replacement of the neoprene elements.
These restraints are designed for a minimum of 1.0g accelerated force in all directions. Series SR for loads from 250 to 12, 000 lbs.

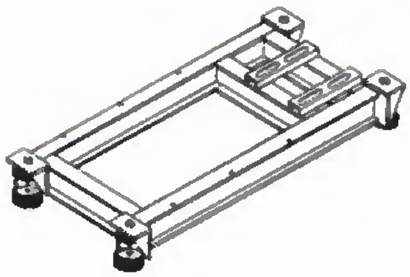
Type 17

Series "SCR" Seismic Cable Restraints
VMC Series SCR Seismic Cable Restraints are recommended for use to restrain suspended piping, equipment, and ductwork during a seismic event. Our cable restraint kits are manufactured from 7 x 19 galvanized aircraft cable, and are available in 1/8", 1/4", and 3/8" diameters.
One cable restraint kit consists of the following components: 2 cable lengths swaged at one end; 4- cable restraint angle brackets; 4- shackles; 4- cable clips; 2- thimbles.

Type 18

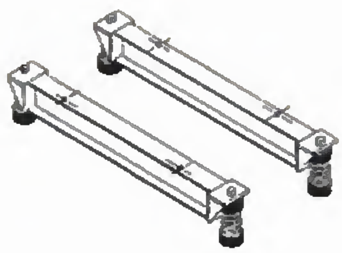
Series "RSM" Elastomer Mount
VMC Series RSM Elastomeric Seismic Mounts are available in two sizes and can handle loads from 60 lbs. to 1300 lbs. The rugged cast housing and high grade neoprene elastomer offers seismic restraint capability and vibration isolation in one complete mount.

The RSM Series is excellent for use under small mechanical equipment requiring seismic restraint.



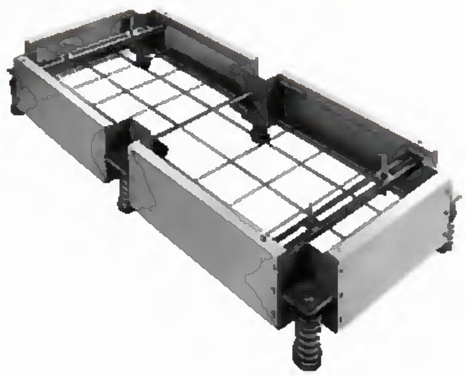
Type A

Type "WFB" Structural Steel Base
VMC manufactures a complete line of fan and motor bases which should be specified for all belt driven centrifugal fans that do not require a concrete inertia block. Available with an adjustable motor slide rail, VMC Series WFB bases are designed to maintain proper drive alignment and resist starting torque without the use of restraining snubbers.



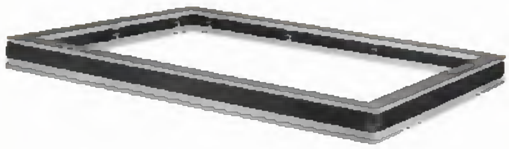
Type B

Series "WFR" Structural Steel Rails
Whenever mechanical equipment lacks the proper rigidity for point support, VMC Series WFR rails should be utilized. Like our bases, Series WFR rails are available in wide flange, angle, or channel steel and can be designed for use with any isolator in our product line.



Type C

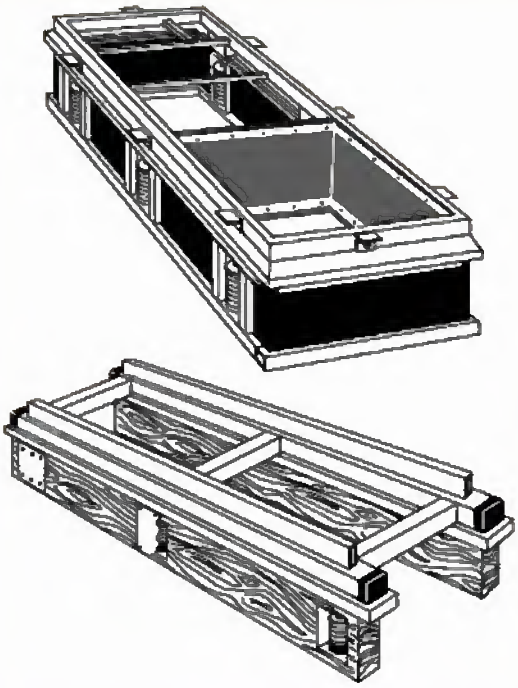
Types "MPF" and "WPF" Concrete Inertia Bases
Mechanical equipment requiring a concrete inertia base can now be quickly and economically installed using VMC's modular pouring forms. These sturdy lightweight bases, when filled with concrete, are an effective means to isolate vibration and limit motion of any equipment.
The added mass of WPF/MPF inertia bases lowers the center of gravity (Cg) of the equipment and allows a softer isolation system to be used. Greater isolation efficiencies can now be obtained while limiting the motion of supported equipment.



Type D

Type "AXR" Spring Isolation Base

Type AXR Spring-Flex Bases are designed to isolate curb mounted rooftop equipment from the building structure. The 'Unitized' base is fabricated from extruded aluminum upper and lower members, with electro- zinc plated springs designed for 1" static deflection. The springs are mechanically fastened, sized and positioned within the frame to ensure uniform deflection for the entire system. A continuous flexible "Hydro-Gard" seal is factory attached between the upper and lower members, and a continuous closed cell neoprene gasket bonded to the top and bottom surfaces provides an air and water-tight seal.



Type E

Type "P" Series Isolation Curbs
Type "R" Series Isolation Rails

VMC's "P" series curbs and "R" series rails are high quality, fully adjustable support systems specifically designed for rooftop unit vibration isolation and seismic/wind restraint. Each custom built unit incorporates both the roof curb and spring isolation into one complete structure. VMC engineers design each curb and rail to custom fit any rooftop mechanical equipment.

Spring deflections up to 3 inches can be specified to compensate for large floor spans, and spring pockets are positioned within the curb at the correct load points for proper support and seismic restraint.

All spring pockets incorporate a minimum 1/4" neoprene cup or pad in series with the spring to provide optimum isolation efficiency.

Type 19

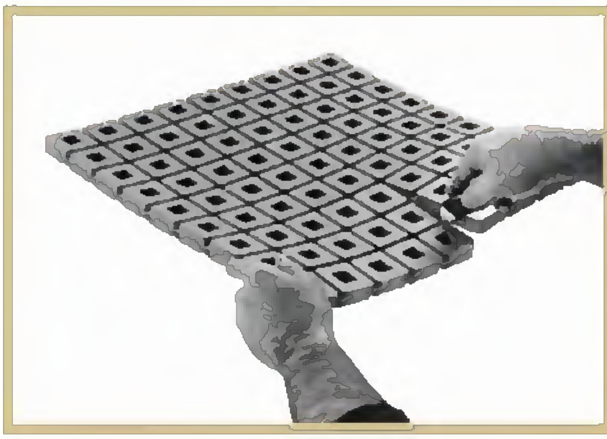
Series "VLM" Level-Flex Leveling Mounts

Series VLM Mountings utilize oil-resistant neoprene elastomers to provide effective shock and vibration control for all types of general metal working and processing machinery.

Built-in-Leveling feature provides height adjustment to compensate for unequal mounting deflection or floor irregularities.

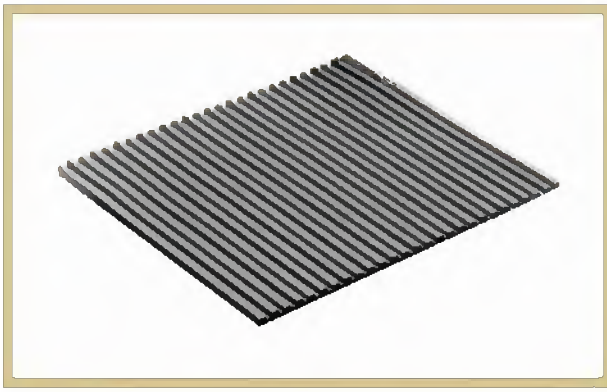
Ribbed design of mounting base provides non-skid surface, eliminating the need for bolting to floor. Cuts machine installation time from hours to minutes.

Four sizes provide load capacities up to 12,000 pounds.



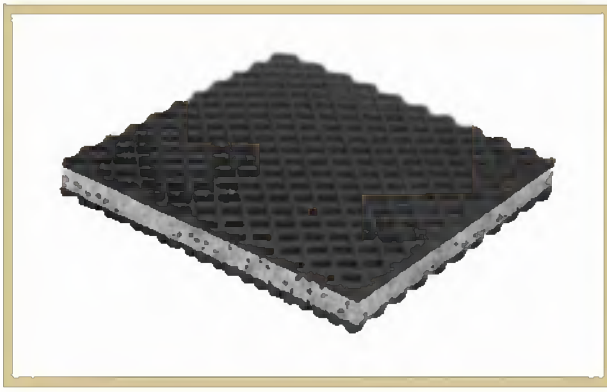
Type 20

Maxi-Flex "E-Z Cut" Neoprene Mounting Pads
VMC's Maxi-Flex Neoprene Pads are molded in standard size sheets — 18" x 18" x 3/4" thick (457 X 457 X 19mm) consisting of 81-2" (51 mm) square segments.
These segments are separated by a thin web that can easily be cut to fit required loading and shape of equipment base. They provide excellent high frequency sound attenuation and can be used effectively to prevent shock and vibration transmission in non-critical installations. Maxi-Flex Pads are available in four color coded loading types, which will satisfy a wide range of load/ deflection requirements.



Type 21

Shear Flex Pads
A resilient cross ribbed neoprene pad with an extremely high deflection rate. Alternately raised ribs, an exclusive VMC feature, provide effective vibration isolation in both high and low load ranges. May be used in multiple layers for greater deflection. Shear-Flex requires no bolting or cementing as gripping action of ribs prevents "walking". Maximum capacity 120 psi. Standard size sheets 18" x 18" x 3/8" and 18" x 36" x 3/8".

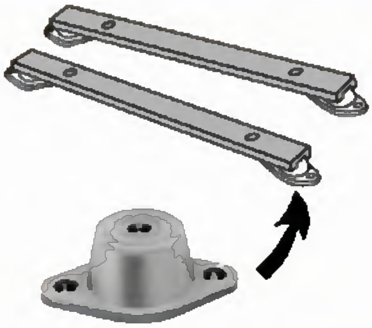


Type 22

Cork Rib Pads
Laminated isolation pad combining the effective qualities of neoprene and cork. Made by bonding 1/2" thick close grained cork core securely between two 1/4" thick layers of ribbed oil resistant neoprene to form an integral pad. Maximum load capacity 60 psi. Standard size sheet 36" x 36" x 1". Heavy Duty Cork-Rib also available for loads up to 120 psi.

Type 23

Series "RH" and "RHD" Neoprene Hangers
Rectangular steel housing incorporating neoprene element. Design permits installation in the hanger rods or at the ceiling. Four standard sizes and five durometers. Colored neoprene stocks identify capacity and simplify selections thereby avoiding installation errors. Load range 10 to 4,000 lbs. per hanger. Static deflections to 0.5".



Type 24

Type "DRB" Vibration Rails

Structural steel members with neoprene mountings as the isolating medium. Two or more rails used to support equipment such as pumps, cooling towers, compressors or other equipment which lack sufficient rigidity for point support.
Static deflections to 0.5".

Type 25

Type "ANFF" Neoprene Jack-up Mount

- Neoprene jack up floating floor system.
- Floor thickness from 3" to 24"
- Tested Long life neoprene elements
- VMC "easy lift" jacking mechanism accommodates air spaces from 1/4" to 4"
- Jacking design insures free floating resilient barrier
- Seismic capability to meet all building codes

Type 26

Type "ASFF" Spring Jack-up Mount

- Spring jack up floating floor system
- Floor thickness from 3" to 24"
- Housing design allows interchangeability between spring or neoprene elements
- Excellent for future building renovation
- Unique housing design allows for change in future space usage and occupancy for both frequency and load

Type 27

Type "QFFG" Glass Fiber Mount

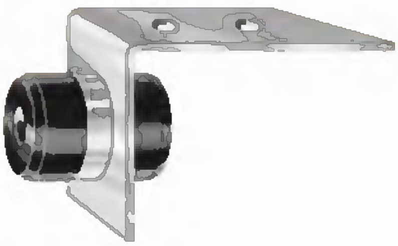
- Neoprene coated fiberglass floating floor system
- Low cost installation
- 1" to 4" air gap
- constant natural frequency over entire load range

Type 28

Type "QFFN" Neoprene Mount
- Neoprene floating floor system
- Low cost installation
- Tested long life neoprene elements
- Low natural frequency

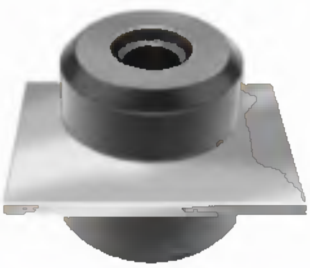
Type 29

Type "WAB" Wall Angle Brace
- Wall Support
- Eliminates acoustical flanking and noise path



Type 30

Type "WIB" Wall Isolation Brace
- Wall isolation brace
- Designed for compression, tension, or shear loading
- Simplified, inexpensive installation
- Strengthens the stud for drywall construction

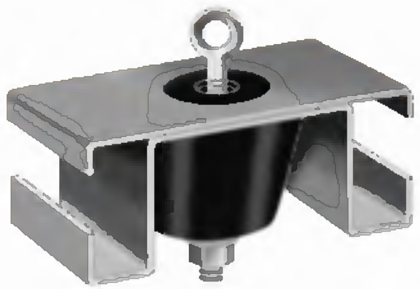


Type 31

Type "TMRB" Neoprene Isolation Mount
- Track mounted ring and bushing
- Isolates floating walls

Type 32

Type "MWIP" Masonry Wall Isolation Pad
- Isolates floating block walls
- Eliminates noise transmission

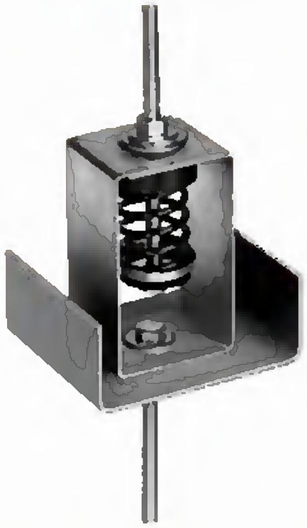


Type 33

Type "LPNH" Hanger
- Low profile neoprene hanger
- Installation requires NO INCREASE in airspace for standard drywall ceiling construction
- Full range neoprene elements for high frequency or impact attenuation applications
- Neoprene element design insures no metal to metal contact
- Saves installation time
- Ceiling can be leveled after 1st. layer of drywall is installed
- Suspend sound barrier ceiling and finish ceiling from same hanger
- VMC ECS (engineered ceiling system), all services (excluding fire protection) can be suspended from a common hanger

Type 34

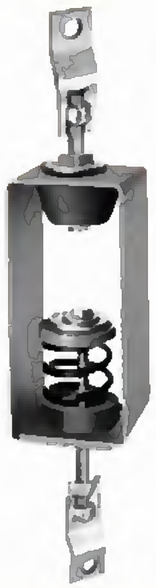
Type "LPRSH" Hanger
- Low profile combination neoprene and spring hanger
- Installation requires minimal increase in airspace above 1½" cold-rolled channel for standard drywall ceiling construction
- Full range neoprene elements combined with 1" or 2" deflection springs (pre-compressed as required) for low frequency attenuation applications
- Neoprene spring cup retainer insures no metal to metal contact
- Saves installation time
- Ceiling can be leveled after 1st. layer of drywall is installed
- Suspend sound barrier ceiling and finish ceiling from same hanger
- VMC ECS (engineered ceiling system), all services (excluding fire protection) can be suspended from a common hanger



Type 35

Type "LPSH" Hanger

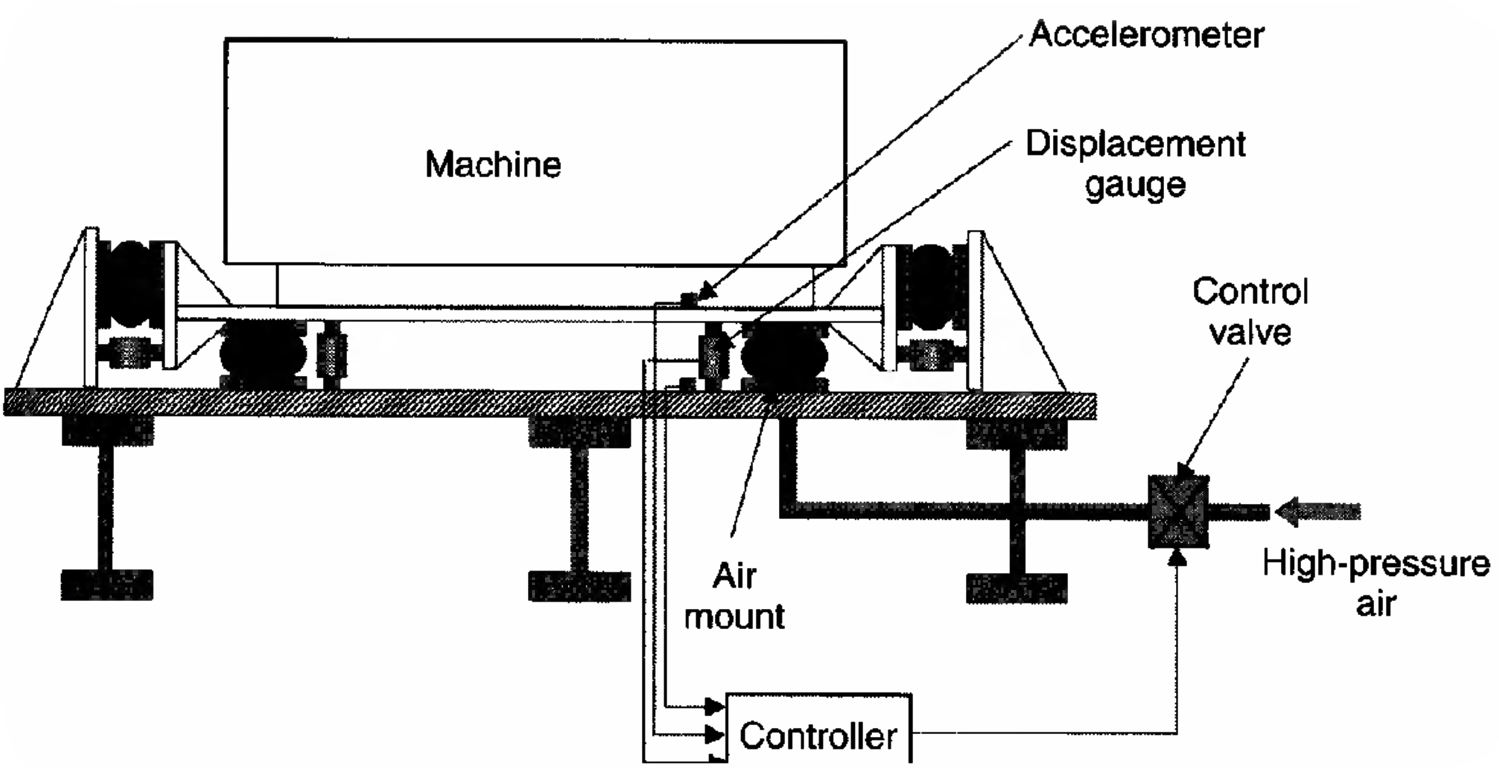
- Low profile spring hanger
- Installation requires minimal increase in airspace above 1½" cold-rolled channel for standard drywall ceiling construction
- 1" or 2" deflection springs (pre-compressed as required) for low frequency attenuation applications
- Neoprene spring cup retainer insures no metal to metal contact
- Saves installation time
- Ceiling can be leveled after 1st layer of drywall is installed
- Suspend sound barrier ceiling and finish ceiling from same hanger
- VMC ECS (engineered ceiling system), all services (excluding fire protection) can be suspended from a common hanger

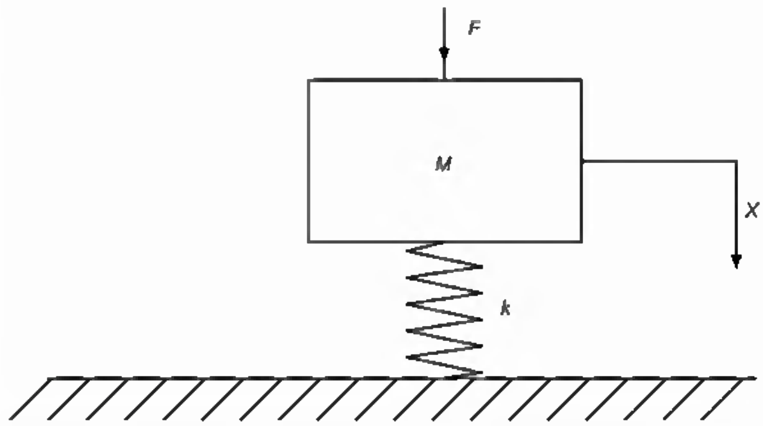


Type 36

Type "RSHSC"Hanger

When isolating ductwork and suspended ceilings, our standard hanger incorporates eye sockets to accommodate wire or duct strap.


Accelerometer
Machine
Displacement gauge
Control valve
Air mount
High-pressure air
Controller



$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \qquad f_{Feder} = \frac{5}{\sqrt{x_{(cm)}}} \qquad T = \left|\frac{1}{1-(f_d/f_n)^2}\right|$$

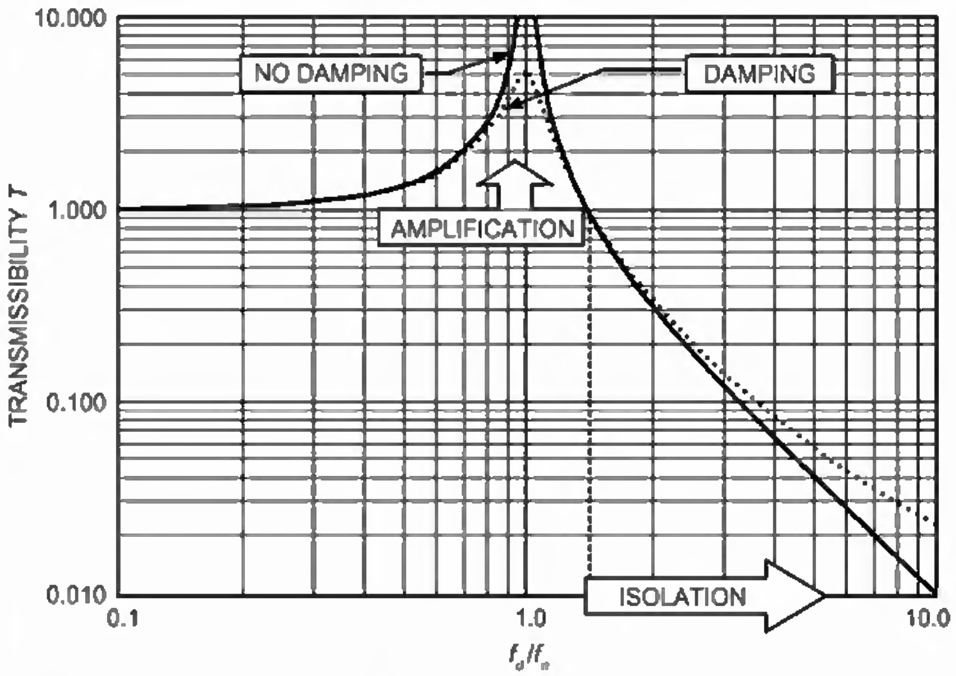


Fig. 11 Vibration Transmissibility T as Function of f_d/f_n

Εξίσωση κίνησης $$m\frac{d^2x}{dt^2} + kx = F\cos(\omega t)$$

Λύση $$x = \frac{F_0 / k}{1 - r^2}\sin\omega t$$

Συχνότητα συντονισμού $$f_0 = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Ικανότητα μετάδοσης $$\mathrm{T} = \frac{1}{1 - r^2}$$

όπου:

r $\quad r = \dfrac{f}{f_0}$

k σταθερά ελατηρίου

<u>Για ελαστομερή</u> $$k' = \frac{E \cdot S}{d}$$

όπου: E μέτρο ελαστικότητας
S επιφάνεια υλικού
d πάχος υλικού

Εξίσωση κίνησης $$m\frac{d^2x}{dt^2}+b\frac{dx}{dt}+kx=F\cos(\omega t)$$

Λύση $$x=\frac{F_0/k}{\sqrt{\left(1-r^2\right)^2+\left(2\zeta r\right)^2}}\cos\omega t$$

Συντελεστής απόσβεσης $$\zeta=\frac{b}{b_c}=\frac{b}{2m\omega_0}$$

Κρίσιμη αντίσταση $$b_c=2\sqrt{k\cdot m}$$

Παράγοντας απωλειών $$n=2\cdot\zeta$$

Συντελεστής ποιότητας $$Q=\frac{1}{n}$$

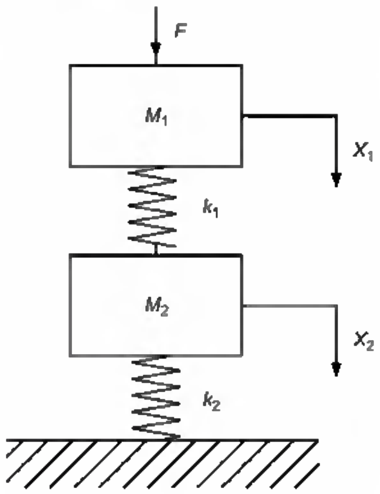
Συχνότητα συντονισμού $$f_d=f_0\sqrt{1-\zeta^2}$$

Ικανότητα μετάδοσης $$\mathrm{T}=\sqrt{\frac{1+\left(2\zeta r\right)^2}{\left(1-r^2\right)+\left(2\zeta r^2\right)}}$$

όπου:

r $r=\frac{f}{f_0}$

b Συντελεστής τριβής



$$T = \frac{1}{\left[1-\left(\frac{f_d}{f_{n1}}\right)^2\right] - \frac{1}{\left(\frac{f_{n1}}{f_d}\right)^2 \frac{k_2}{k_1} - \frac{M_2}{M_1}}}$$

$$f_{I,II}^2 = \frac{1}{2}\left[\left(f_1^2 + f_2^2 + f_3^2\right) \pm \sqrt{\left(f_1^2 + f_2^2 + f_3^2\right)^2 - 4 \cdot f_1^2 \cdot f_2^2}\right]$$

$$f_1 = \sqrt{\frac{k_1}{m_1}} \qquad f_2 = \sqrt{\frac{k_2}{m_2}} \qquad f_3 = \sqrt{\frac{k_1}{m_2}}$$

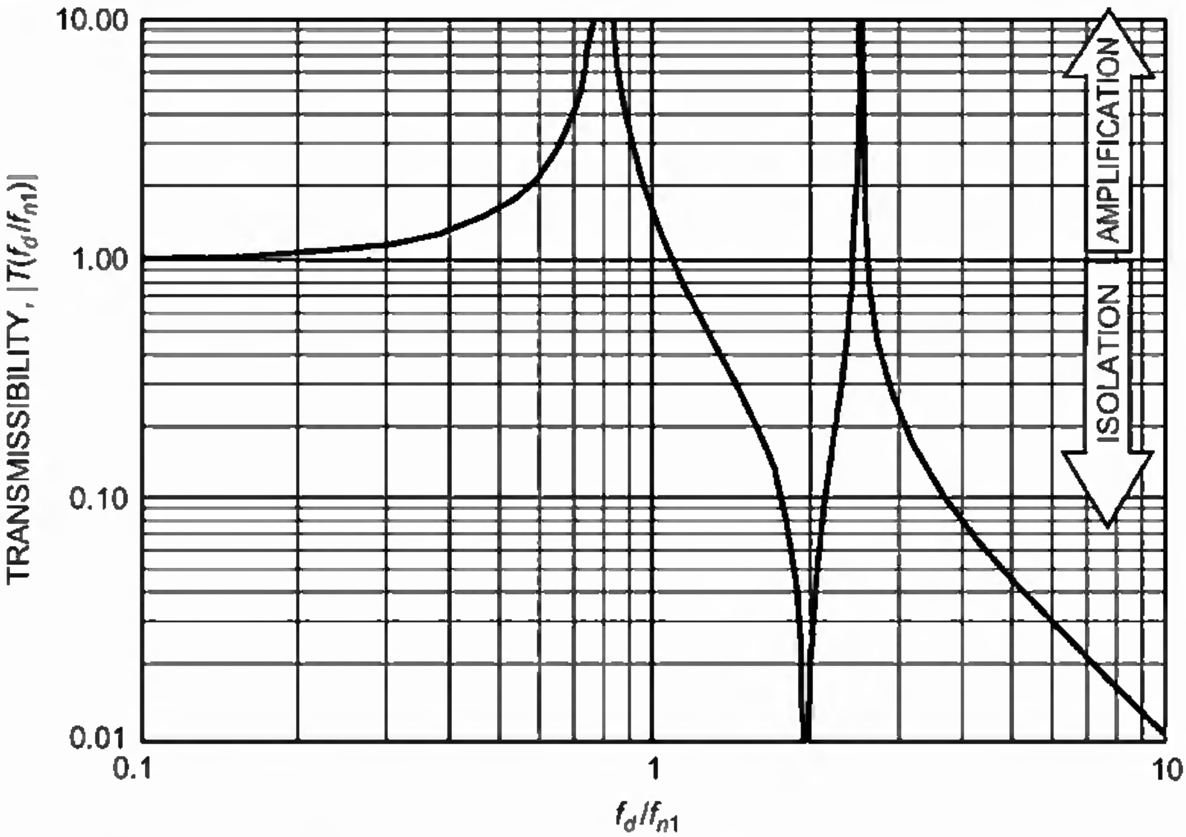
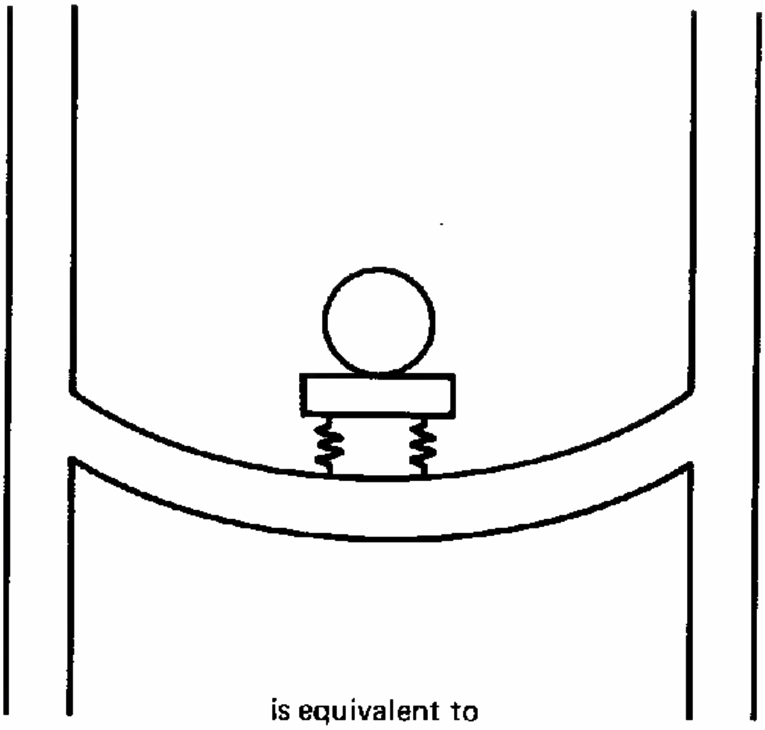
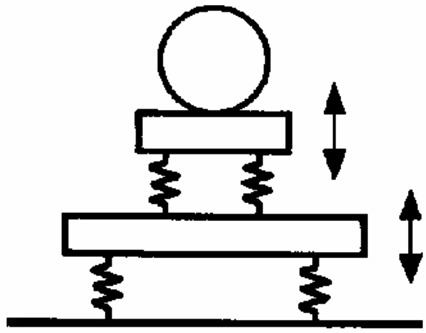
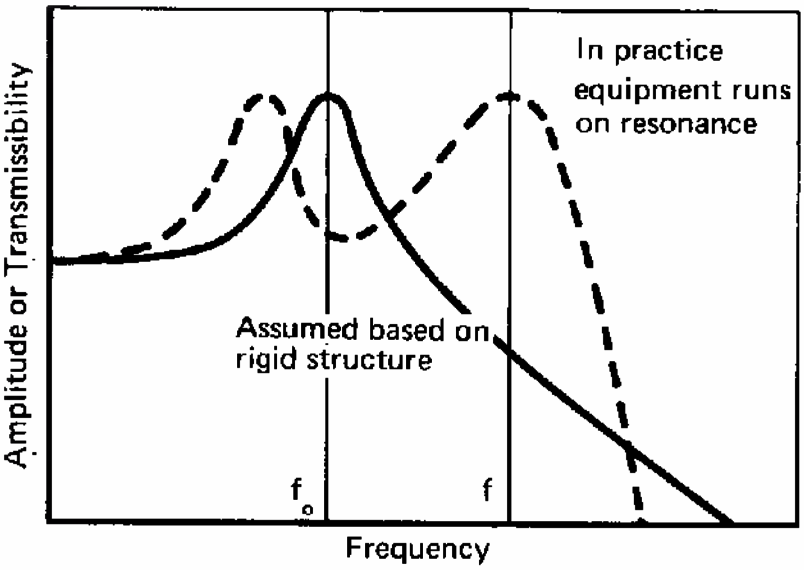
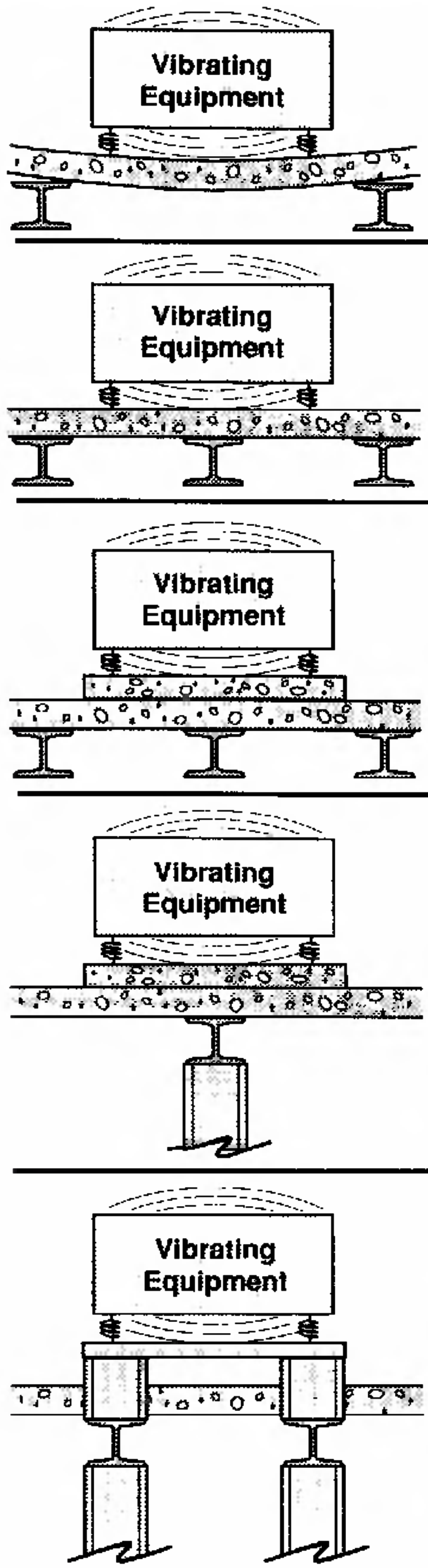


Fig. 14 Transmissibility T as Function of f_d/f_{n1} with $k_2/k_1 = 2$ and $M_2/M_1 = 0.5$


is equivalent to




In practice
equipment runs
on resonance
Assumed based on
rigid structure
Amplitude or Transmissibility
f_o
f
Frequency



Poor
Concentration of equipment weight between beams causes excessive roof deflection and vibration transmission, even for isolated equipment.

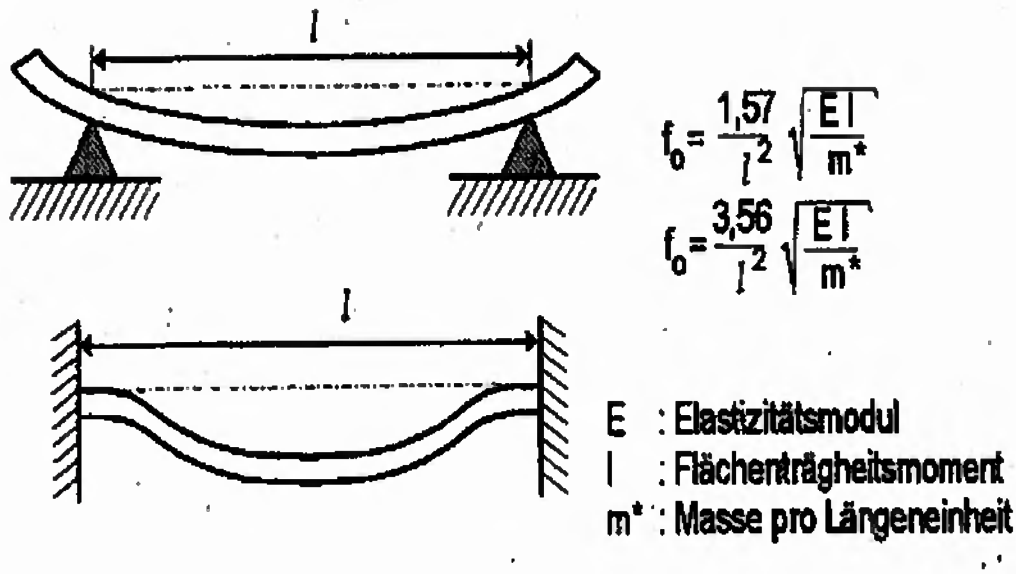
Fair
Additional beam under equipment stiffens roof.

Good
Further addition of housekeeping pad adds mass and stiffness to roof.

Very Good
A column directly under the equipment gives the roof a very high local stiffness, but some equipment vibration still enters the roof slab.

Best
Mounting equipment on a steel frame supported by column extensions keeps virtually all vibration out of the roof slab.

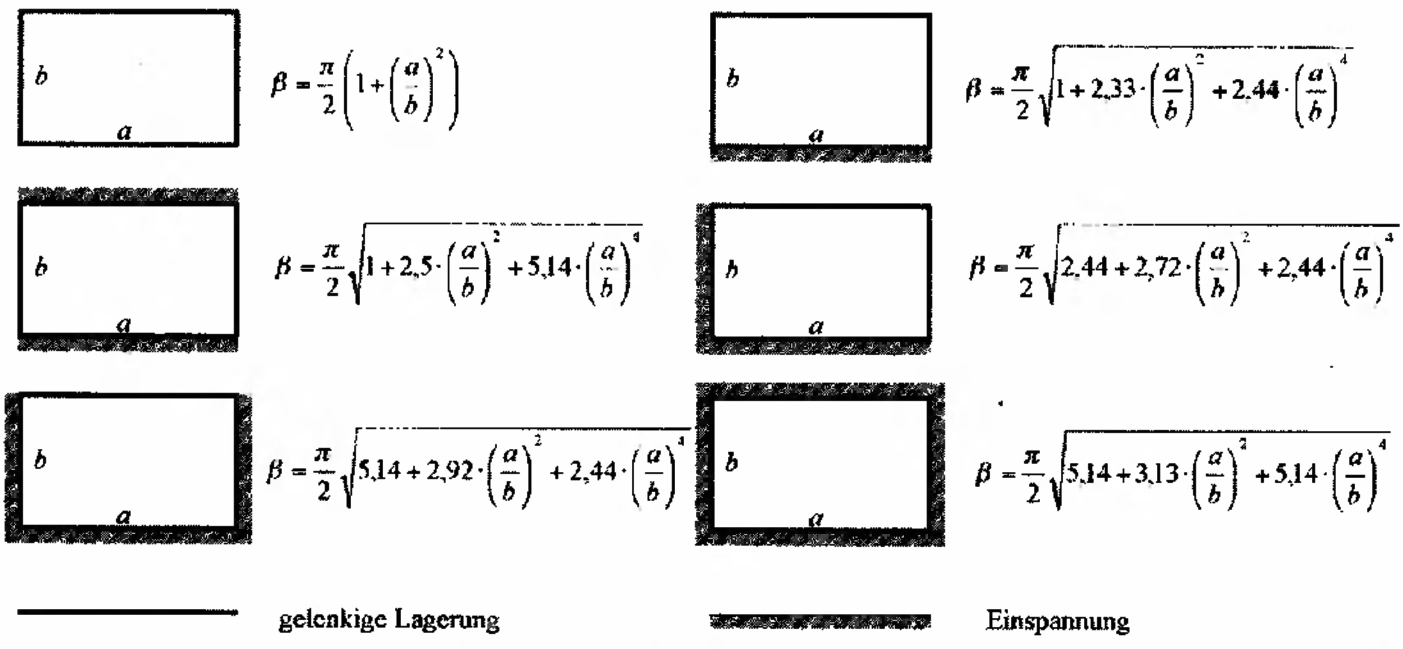
Figure 1-47 Structural support of rooftop equipment for vibration control



l
$f_0 = \frac{1{,}57}{l^2}\sqrt{\frac{E\,I}{m^*}}$
$f_0 = \frac{3{,}56}{l^2}\sqrt{\frac{E\,I}{m^*}}$
l
E : Elastizitätsmodul
I : Flächenträgheitsmoment
m* : Masse pro Längeneinheit

$$f_1 = \frac{\beta}{\alpha^2} \cdot \sqrt{\frac{E \cdot d^3}{12 \cdot (1-\nu^2) \cdot \mu}}$$

E μέτρο ελαστικότητας
d πάχος πλάκας
ν αριθμός Poisson
μ επιφανειακή μάζα (μαζί με όλα τα φορτία)



$$\beta = \frac{\pi}{2}\left(1+\left(\frac{a}{b}\right)^2\right)$$

$$\beta = \frac{\pi}{2}\sqrt{1+2{,}33\cdot\left(\frac{a}{b}\right)^2+2{,}44\cdot\left(\frac{a}{b}\right)^4}$$

$$\beta = \frac{\pi}{2}\sqrt{1+2{,}5\cdot\left(\frac{a}{b}\right)^2+5{,}14\cdot\left(\frac{a}{b}\right)^4}$$

$$\beta = \frac{\pi}{2}\sqrt{2{,}44+2{,}72\cdot\left(\frac{a}{b}\right)^2+2{,}44\cdot\left(\frac{a}{b}\right)^4}$$

$$\beta = \frac{\pi}{2}\sqrt{5{,}14+2{,}92\cdot\left(\frac{a}{b}\right)^2+2{,}44\cdot\left(\frac{a}{b}\right)^4}$$

$$\beta = \frac{\pi}{2}\sqrt{5{,}14+3{,}13\cdot\left(\frac{a}{b}\right)^2+5{,}14\cdot\left(\frac{a}{b}\right)^4}$$

Abb. 23.18 Koeffizient β zur Bestimmung der 1. Eigenfrequenz von Rechteckplatten

Το είδος και ο βαθμός της ενόχλησης από δονήσεις εξαρτάται από:

- το απόλυτο μέγεθος (ένταση) της δόνησης
- τον χώρο και την χρονική στιγμή, που λαμβάνει χώρα το συμβάν
- το φασματικό περιεχόμενο της δόνησης
- την διάρκεια του συμβάντος
- την συχνότητα εμφάνισης του συμβάντος
- το αν το συμβάν εμφανίσθηκε ξαφνικά ή βαθμιαία
- το είδος και τον τρόπο λειτουργίας της πηγής των δονήσεων
- την σωματική και ψυχολογική κατάσταση του ενοχλούμενου
- την δραστηριότητα του ενοχλούμενου κατά την στιγμή του συμβάντος
- το αν ο ενοχλούμενος έχει συνηθίσει την εμφάνιση του συμβάντος ή όχι
- την σχέση του ενοχλούμενου με την πηγή των δονήσεων (ιδιοκτησιακή κλπ.)
- το αν στον χώρο (οικιστικό περιβάλλον), που βρίσκεται ο ενοχλούμενος είναι αναμενόμενο να εμφανισθεί ένα παρόμοιο συμβάν ή όχι
- τα δευτερεύοντα φαινόμενα (συντονισμός υαλοπινάκων, επίπλων και αντικειμένων και εκπομπή θορύβου).

Επίσης:

- Η έκθεση των ανθρώπων σε δονήσεις γίνεται συνεχώς, χωρίς όμως να γίνεται πάντα αντιληπτό.
- Ο βαθμός της ενόχλησης εξαρτάται από υποκειμενικές και αντικειμενικές παραμέτρους.
- Η ενόχληση μπορεί μόνο να αποκλεισθεί, όταν οι δονήσεις δεν μπορούν να γίνουν αντιληπτές.
- Οι άνθρωποι δεν θα έπρεπε να εκτίθενται σε δονήσεις, που μπορούν να γίνουν αντιληπτές και που μπορεί να δημιουργήσουν ενόχληση. Αυτό το πράγμα όμως, ακόμα και με τις σημερινές τεχνικές δυνατότητες, δεν μπορεί να καταστεί δυνατό.

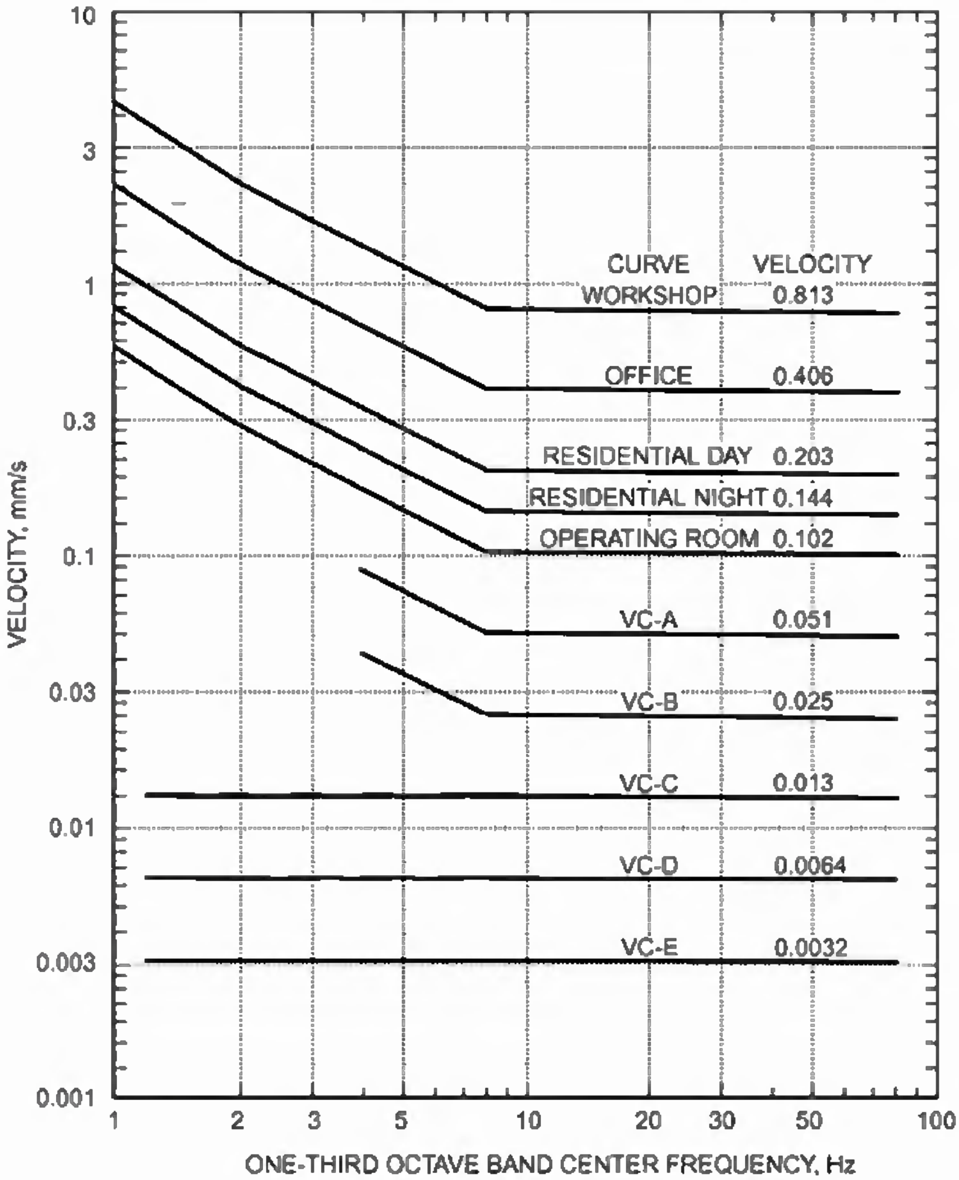


Fig. 37 Building Vibration Criteria for Vibration Measured on Building Structure

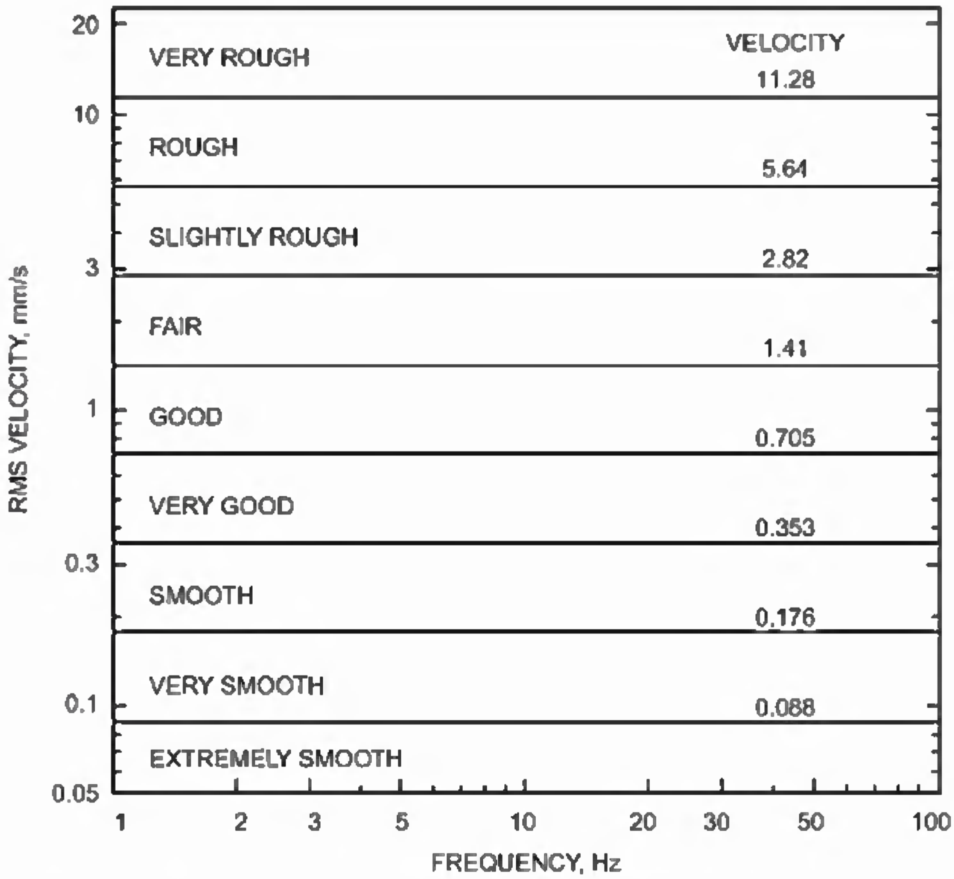


Fig. 38 Equipment Vibration Severity Rating for Vibration Measured on Equipment Structure or Bearing Caps

			Slab on Grade			Floor Span: Up to 6 m			Floor Span: 6 to 9 m			Floor Span: 9 to 12 m			
Equipment Type	Shaft Power kW and Other	RPM	Base Type	Isolator Type	Min. Defl., mm	Base Type	Isolator Type	Min. Defl., mm	Base Type	Isolator Type	Min. Defl., mm	Base Type	Isolator Type	Min. Defl., mm	Reference Notes
Refrigeration Machines and Chillers															
Reciprocating	All	All	A	2	6.4	A	4	19	A	4	38	A	4	64	2,3,12
Centrifugal, screw	All	All	A	1	6.4	A	4	19	A	4	38	A	4	38	2,3,4,12
Open centrifugal	All	All	C	1	6.4	C	4	19	C	4	38	C	4	38	2,3,12
Absorption	All	All	A	1	6.4	A	4	19	A	4	38	A	4	38	
Air Compressors and Vacuum Pumps															
Tank-mounted horiz.	≤7.5	All	A	3	19	A	3	19	A	3	38	A	3	38	3,15
	≥11	All	C	3	19	C	3	19	C	3	38	C	3	38	3,15
Tank-mounted vert.	All	All	C	3	19	C	3	19	C	3	38	C	3	38	3,15
Base-mounted	All	All	C	3	19	C	3	19	C	3	38	C	3	38	3,14,15
Large reciprocating	All	All	C	3	19	C	3	19	C	3	38	C	3	38	3,14,15
Pumps															
Close-coupled	≤5.6	All	B	2	6.4	C	3	19	C	3	19	C	3	19	16
	≥7.5	All	C	3	19	C	3	19	C	3	38	C	3	38	16
Large inline	3.7 to 19	All	A	3	19	A	3	38	A	3	38	A	3	38	
	≥22	All	A	3	38	A	3	38	A	3	38	A	3	64	
End suction and split case	≤30	All	C	3	19	C	3	19	C	3	38	C	3	38	16
	37 to 93	All	C	3	19	C	3	19	C	3	38	C	3	64	10,16
	≥110	All	C	3	19	C	3	38	C	3	64	C	3	89	10,16
Cooling Towers	All	Up to 300	A	1	6.4	A	4	89	A	4	89	A	4	89	5,8,18
		301 to 500	A	1	6.4	A	4	64	A	4	64	A	4	64	5,18
		500 and up	A	1	6.4	A	4	19	A	4	19	A	4	38	5,18
Boilers—Fire-tube	All	All	A	1	6.4	B	4	19	B	4	38	B	4	64	4
Axial Fans, Fan Heads, Cabinet Fans, Fan Sections															
Up to 560 mm diameter	All	All	A	2	6.4	A	3	19	A	3	19	C	3	19	4,9
610 mm diameter and up	≤500 Pa SP	Up to 300	B	3	64	C	3	89	C	3	89	C	3	89	9
		300 to 500	B	3	19	B	3	38	C	3	64	C	3	64	9
		501 and up	B	3	19	B	3	38	B	3	38	B	3	38	9
	≥501 Pa SP	Up to 300	C	3	64	C	3	89	C	3	89	C	3	89	3,9
		300 to 500	C	3	38	C	3	38	C	3	64	C	3	64	3,8,9
		501 and up	C	3	19	C	3	38	C	3	38	C	3	64	3,8,9
Centrifugal Fans															
Up to 560 mm diameter	All	All	B	2	6.4	B	3	19	B	3	19	C	3	38	9,19
610 mm diameter and up	≤30	Up to 300	B	3	64	B	3	89	B	3	89	B	3	89	8,19
		300 to 500	B	3	38	B	3	38	B	3	64	B	3	64	8,19
		501 and up	B	3	19	B	3	19	B	3	19	B	3	38	8,19
	≥37	Up to 300	C	3	64	C	3	89	C	3	89	C	3	89	2,3,8,9,19
		300 to 500	C	3	38	C	3	38	C	3	64	C	3	64	2,3,8,9,19
		501 and up	C	3	25.4	C	3	38	C	3	38	C	3	64	2,3,8,9,19
Propeller Fans															
Wall-mounted	All	All	A	1	6.4	A	1	6.4	A	1	6.4	A	1	6.4	
Roof-mounted	All	All	A	1	6.4	A	1	6.4	B	4	38	D	4	38	
Heat Pumps	All	All	A	3	19	A	3	19	A	3	19	A/D	3	38	
Condensing Units	All	All	A	1	6.4	A	4	19	A	4	38	A/D	4	38	
Packaged AH, AC, H and V Units															
All	7.5	All	A	3	19	A	3	19	A	3	19	A	3	19	19
	≤11 ≤1kPa SP	Up to 300	A	3	19	A	3	89	A	3	89	C	3	89	2,4,8,19
		301 to 500	A	3	19	A	3	64	A	3	64	A	3	64	4,19
		501 and up	A	3	19	A	3	38	A	3	38	A	3	38	4,19
	≤11, ≤1 kPa SP	Up to 300	B	3	19	C	3	89	C	3	89	C	3	89	2,3,4,8,9
		301 to 500	B	3	19	C	3	38	C	3	64	C	3	64	2,3,4,9
		501 and up	B	3	19	C	3	38	C	3	38	C	3	64	2,3,4,9
Packaged Rooftop Equipment	All	All	A/D	1	6.4	D	3	19	See Reference Note No: 17						5,6,8,17
Ducted Rotating Equipment															
Small fans, fan-powered boxes	≤300 L/s	All	A	3	12.7	A	3	12.7	A	3	12.7	A	3	12.7	7
	≥301 L/s	All	A	3	19	A	3	19	A	3	19	A	3	19	7
Engine-Driven Generators	All	All	A	3	19	C	3	38	C	3	64	C	3	89	2,3,4

Base Types:
A. No base, isolators attached directly to equipment (Note 27)
B. Structural steel rails or base (Notes 28 and 29)
C. Concrete inertia base (Note 30)
D. Curb-mounted base (Note 31)

Isolator Types:
1. Pad, rubber, or glass fiber (Notes 20 and 21)
2. Rubber floor isolator or hanger (Notes 20 and 25)
3. Spring floor isolator or hanger (Notes 22, 23, and 25)
4. Restrained spring isolator (Notes 22 and 24)
5. Thrust restraint (Note 26)

Notes for Table 48: Selection Guide for Vibration Isolation

These notes are keyed to the column titled *Reference Notes* in Table 48 and to other reference numbers throughout the table. Although the guide is conservative, cases may arise where vibration transmission to the building is still excessive. If the problem persists after all short circuits have been eliminated, it can almost always be corrected by increasing isolator deflection, using low-frequency air springs, changing operating speed, improving rotating component balancing, or, as a last resort, changing floor frequency by stiffening or adding more mass. Assistance from a qualified vibration consultant can be very useful in resolving these problems.

Note 1. Isolator deflections shown are based on a reasonably expected floor stiffness according to floor span and class of equipment. Certain spaces may dictate higher levels of isolation. For example, bar joist roofs may require a static deflection of 38 mm over factories, but 64 mm over commercial office buildings.

Note 2. For large equipment capable of generating substantial vibratory forces and structureborne noise, increase isolator deflection, if necessary, so isolator stiffness is less than one-tenth the stiffness of the supporting structure.

Note 3. For noisy equipment adjoining or near noise-sensitive areas, see the section on Mechanical Equipment Room Sound Isolation.

Note 4. Certain designs cannot be installed directly on individual isolators (type A), and the equipment manufacturer or a vibration specialist should be consulted on the need for supplemental support (base type).

Note 5. Wind load conditions must be considered. Restraint can be achieved with restrained spring isolators (type 4), supplemental bracing, snubbers, or limit stops. Also see Chapter 54.

Note 6. Certain types of equipment require a curb-mounted base (type D). Airborne noise must be considered.

Note 7. See section on Resilient Pipe Hangers and Supports for hanger locations adjoining equipment and in equipment rooms.

Note 8. To avoid isolator resonance problems, select isolator deflection so that resonance frequency is 40% or less of the lowest normal operating speed of equipment (see Chapter 7 in the 2005 *ASHRAE Handbook—Fundamentals*).

Note 9. To limit undesirable movement, thrust restraints (type 5) are required for all ceiling-suspended and floor-mounted units operating at 500 Pa or more total static pressure.

Note 10. Pumps over 55 kW may need extra mass and restraints.

Note 11. See text for full discussion.

Isolation for Specific Equipment

Note 12. Refrigeration Machines: Large centrifugal, hermetic, and reciprocating refrigeration machines may generate very high noise levels; special attention is required when such equipment is installed in upper-story locations or near noise-sensitive areas. If equipment is located near extremely noise-sensitive areas, follow the recommendations of an acoustical consultant.

Note 13. Compressors: The two basic reciprocating compressors are (1) single- and double-cylinder vertical, horizontal or L-head, which are usually air compressors; and (2) Y, W, and multihead or multicylinder air and refrigeration compressors. Single- and double-cylinder compressors generate high vibratory forces requiring large inertia bases (type C) and are generally not suitable for upper-story locations. If this equipment must be installed in an upper-story location or at-grade location near noise-sensitive areas, the expected maximum unbalanced force data must be obtained from the equipment manufacturer and a vibration specialist consulted for design of the isolation system.

Note 14. Compressors: When using Y, W, and multihead and multicylinder compressors, obtain the magnitude of unbalanced forces from the equipment manufacturer so the need for an inertia base can be evaluated.

Note 15. Compressors: Base-mounted compressors through 4 kW and horizontal tank-type air compressors through 8 kW can be installed directly on spring isolators (type 3) with structural bases (type B) if required, and compressors 10 to 75 kW on spring isolators (type 3) with inertia bases (type C) with a mass 1 to 2 times the compressor mass.

Note 16. Pumps: Concrete inertia bases (type C) are preferred for all flexible-coupled pumps and are desirable for most close-coupled pumps, although steel bases (type B) can be used. Close-coupled pumps should not be installed directly on individual isolators (type A) because the impeller usually overhangs the motor support base, causing the rear mounting to be in tension. The primary requirements for type C bases are strength and shape to accommodate base elbow supports. Mass is not usually a factor, except for pumps over 55 kW, where extra mass helps limit excess movement due to starting torque and forces. Concrete bases (type C) should be designed for a thickness of one-tenth the longest dimension with minimum thickness as follows: (1) for up to 20 kW, 150 mm; (2) for 30 to 55 kW, 200 mm; and (3) for 75 kW and up, 300 mm.

Pumps over 55 kW and multistage pumps may exhibit excessive motion at start-up ("heaving"); supplemental restraining devices can be installed if necessary. Pumps over 90 kW may generate high starting forces; a vibration specialist should be consulted.

Note 17. Packaged Rooftop Air-Conditioning Equipment: This equipment is usually on lightweight structures that are susceptible to sound and vibration transmission. The noise problem is further compounded by curb-mounted equipment, which requires large roof openings for supply and return air.

The table shows type D vibration isolator selections for all spans up to 6 m, but extreme care must be taken for equipment located on spans of over 6 m, especially if construction is open web joists or thin, lightweight slabs. The recommended procedure is to determine the additional deflection caused by equipment in the roof. If additional roof deflection is 6 mm or less, the isolator should be selected for 10 times the additional roof deflection. If additional roof deflection is over 6 mm, supplemental roof stiffening should be installed to bring the roof deflection down below 6 mm, or the unit should be relocated to a stiffer roof position.

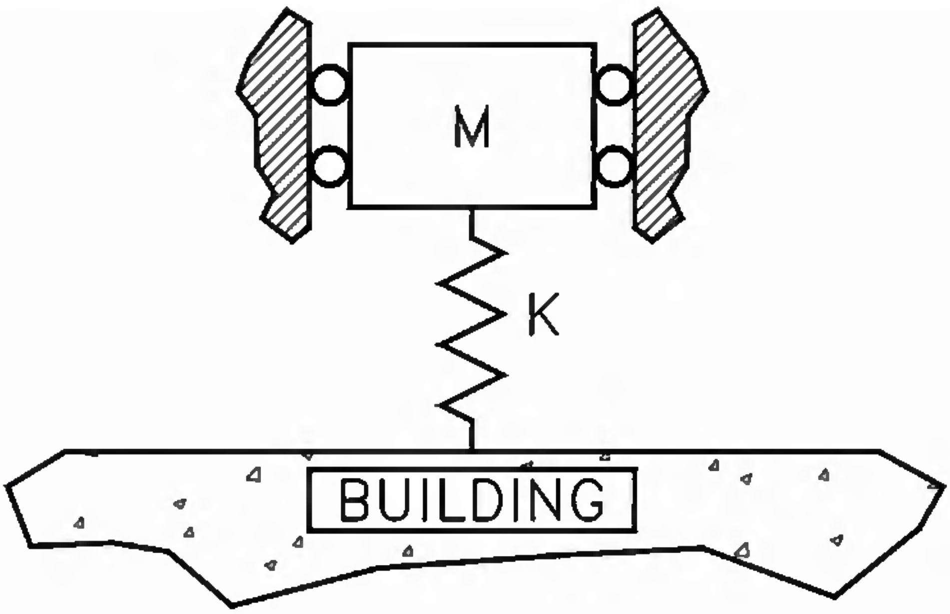
For mechanical units capable of generating high noise levels, mount the unit on a platform above the roof deck to provide an air gap (buffer zone) and locate the unit away from the associated roof penetration to allow acoustical treatment of ducts before they enter the building.

Some rooftop equipment has compressors, fans, and other equipment isolated internally. This isolation is not always reliable because of internal short-circuiting, inadequate static deflection, or panel resonances. It is recommended that rooftop equipment be isolated externally, as if internal isolation was not used.

Note 18. Cooling Towers: These are normally isolated with restrained spring isolators (type 4) directly under the tower or tower dunnage. High-deflection isolators proposed for use directly under the motor-fan assembly must be used with extreme caution to ensure stability and safety under all weather conditions. See Note 5.

Note 19. Fans and Air-Handling Equipment: Consider the following in selecting isolation systems for fans and air-handling equipment:

1. Fans with wheel diameters of 560 mm and less and all fans operating at speeds up to 300 rpm do not generate large vibratory forces. For fans operating under 300 rpm, select isolator deflection so the isolator natural frequency is 40% or less than the fan speed. For example, for a fan operating at 275 rpm, $0.4 \times 275 = 110$ rpm. Therefore, an isolator natural frequency of 110 rpm or lower is required. This can be accomplished with a 75 mm deflection isolator (type 3).
2. Flexible duct connectors should be installed at the intake and discharge of all fans and air-handling equipment to reduce vibration transmission to air duct structures.
3. Inertia bases (type C) are recommended for all class 2 and 3 fans and air-handling equipment because extra mass allows the use of stiffer springs, which limit heaving movements.
4. Thrust restraints (type 5) that incorporate the same deflection as isolators should be used for all fan heads, all suspended fans, and all base-mounted and suspended air-handling equipment operating at 500 Pa or more total static pressure. Restraint movement adjustment must be made under normal operational static pressures.


M
K
BUILDING

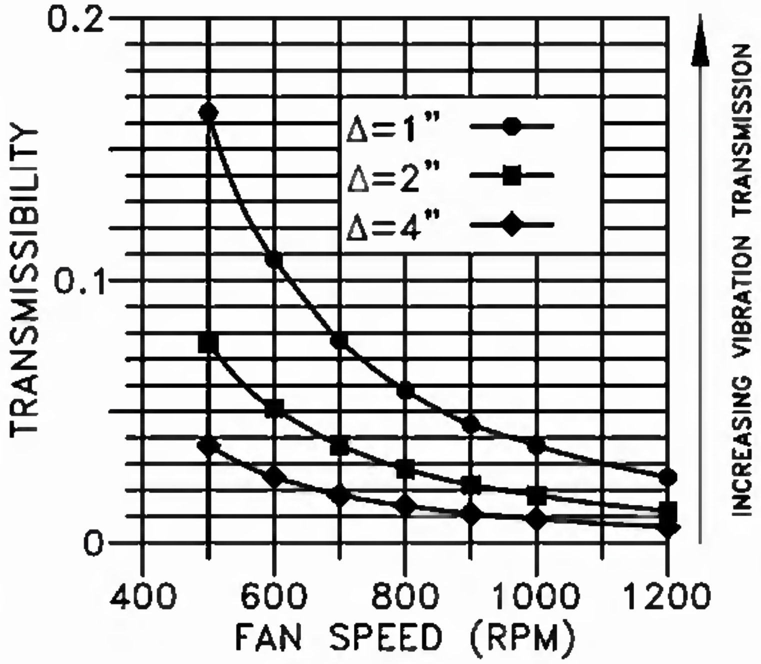

0.2
0.1
0
TRANSMISSIBILITY
Δ=1"
Δ=2"
Δ=4"
INCREASING VIBRATION TRANSMISSION
400
600
800
1000
1200
FAN SPEED (RPM)

Figure 2

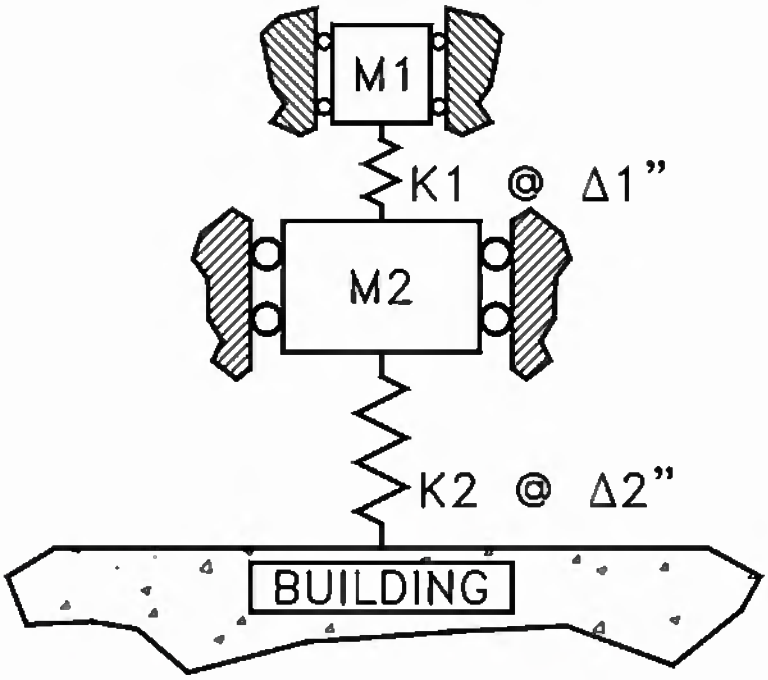


Figure 3

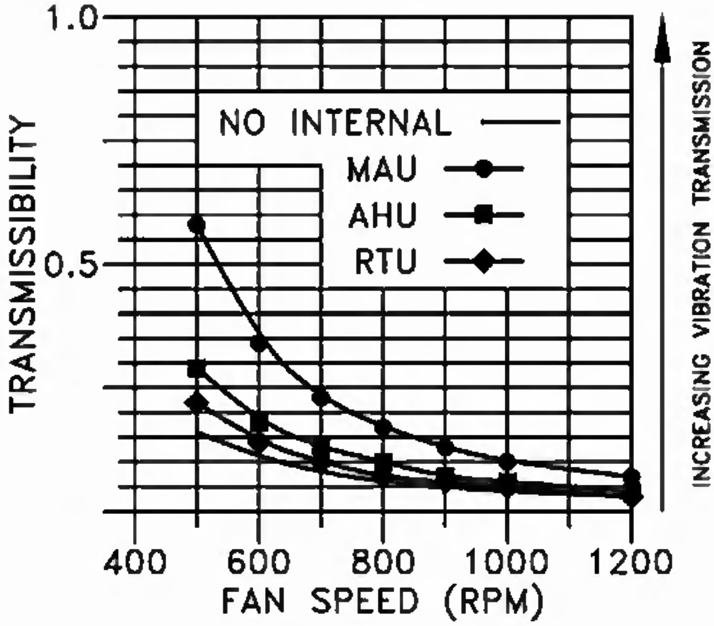


Figure 4 - Case No. 1

(2" Internal Springs & 1" External Springs)

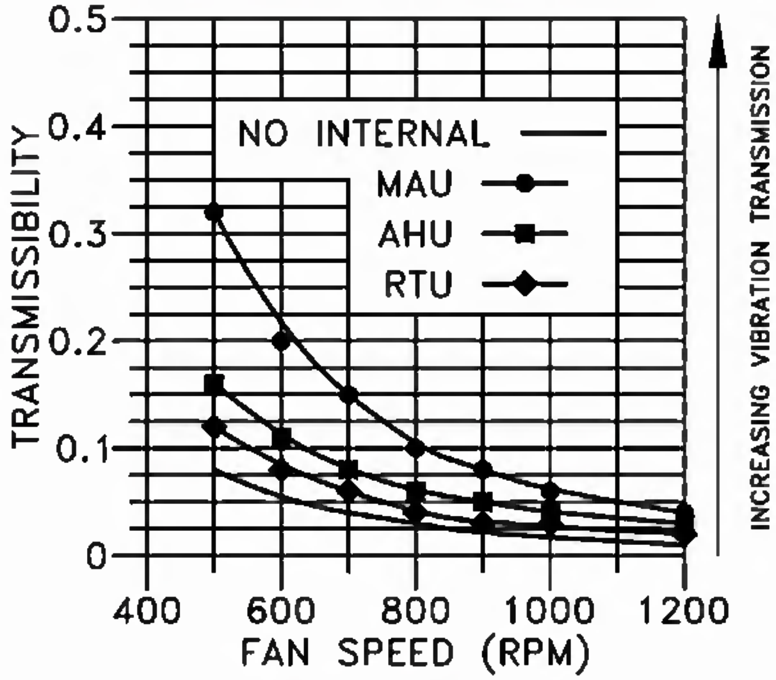


Figure 5 - Case No. 2

(2" Internal Springs & 2" External Springs)

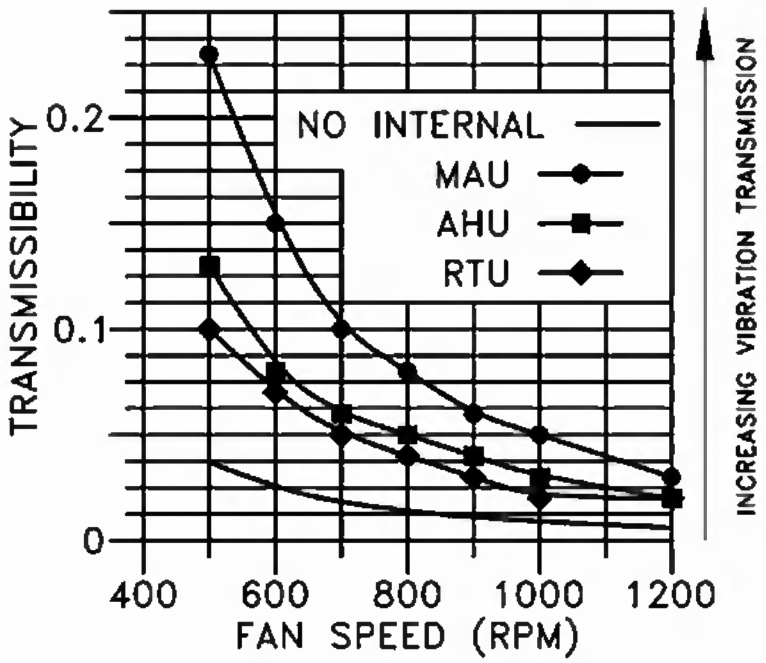


Figure 6 - Case No. 3

(2" Internal Springs & 4" External Springs)

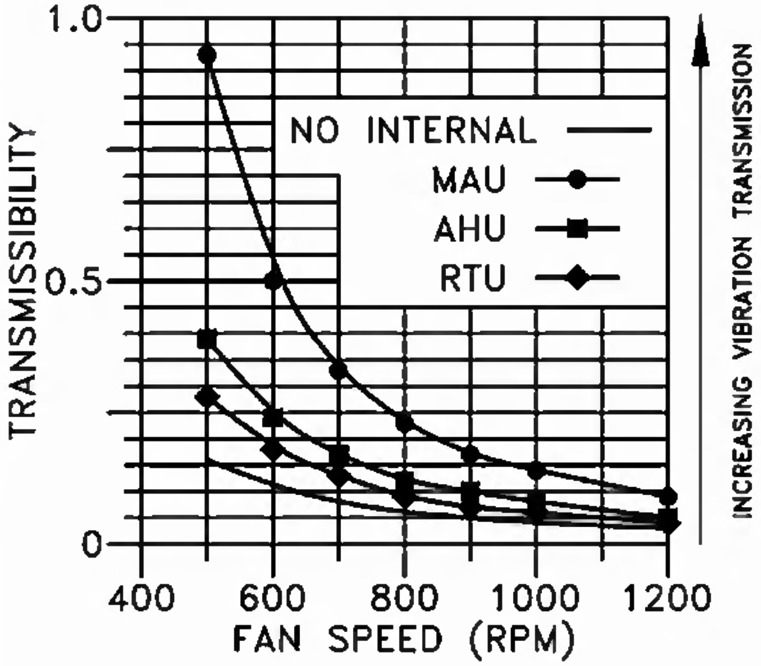


Figure 7 - Case No. 4

(1" Internal Springs & 1" External Springs)

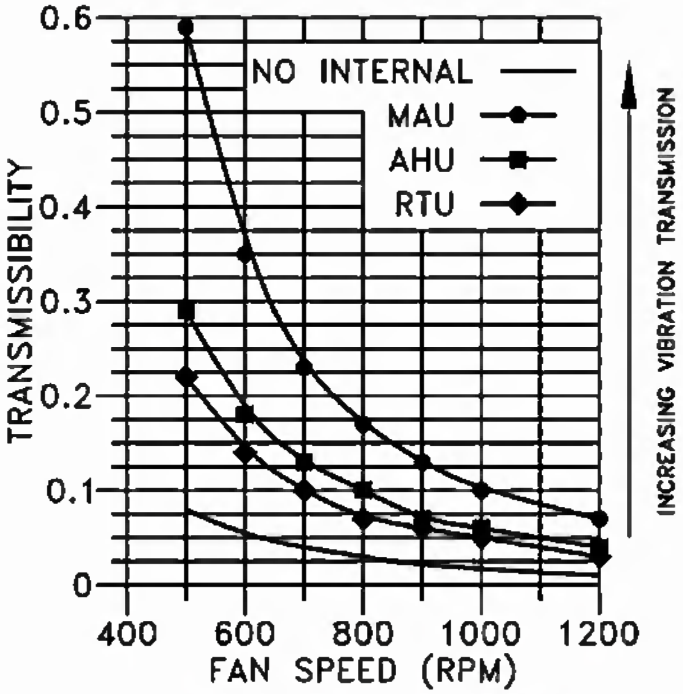


Figure 8 - Case No. 5

(1" Internal Springs & 2" External Springs)

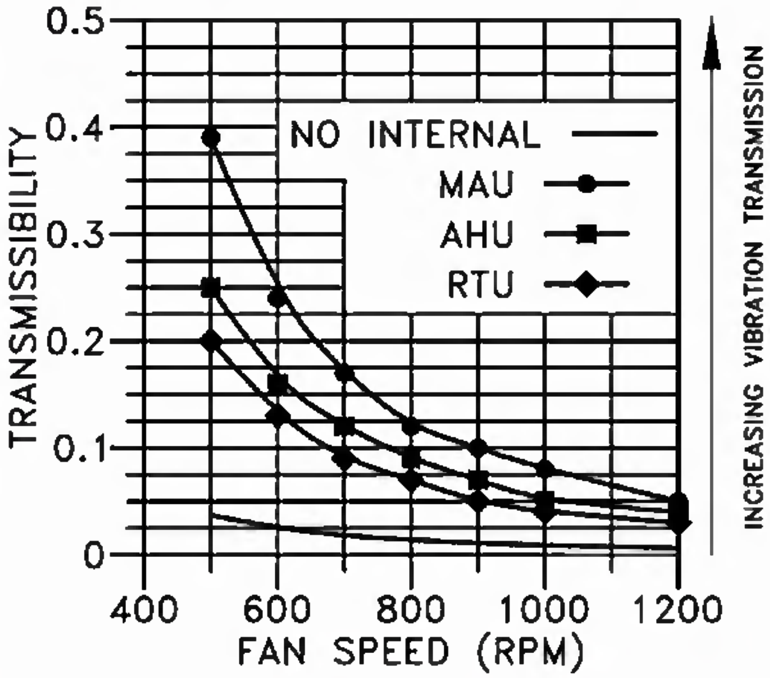


Figure 9 - Case No. 6

(1" Internal Springs & 4" External Springs)

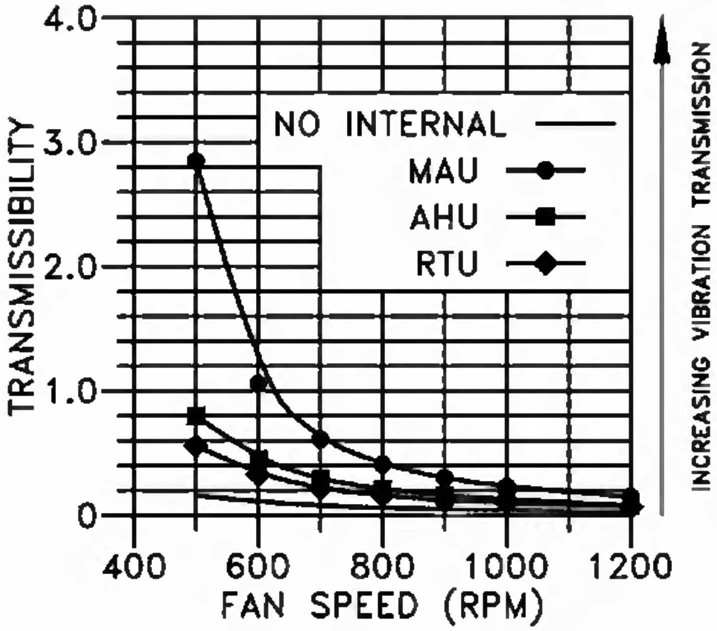


Figure 10 - Case No. 7

(0.5" Internal Springs & 1" External Springs)

Conclusions:

1.) In all cases investigated, equipment that had external isolation only had lower transmissibility values than equipment with both internal and external isolation.
2.) The harmful effects of using both internal and external isolation are amplified as the operating speed of the internally isolated components decreases. The reason for this is shown in the low natural frequencies indicated in Table 2.
3.) As the mass of the internally isolated components increases relative to the mass of the entire unit, the harmful effects of the internal and external isolation become more pronounced. When the mass of the internally isolated components becomes a significant percentage of the whole mass of the unit, the use of internal and external isolation could have disastrous results when combined with the lower fan speeds.
4.) In some of the cases in Table 2, the first natural frequency of the internally and externally isolated equipment approached the natural frequency of some buildings. In these cases, significant transmission of low frequency noise and vibration could be expected.
5.) Any condition that moves the C.G. of the internally isolated components and/or the entire piece of equipment off of the geometric center of the equipment will introduce additional degrees of freedom to the system. This will result in additional natural frequencies, resonance conditions, which must be avoided. Thus it behooves the owner to reduce the number of resonance conditions by eliminating the internal or the external isolation. However, as demonstrated above, external isolation performs better than internal isolation.
6.) If both internal and external isolation are specified, choose external isolation springs with either a 2" or 4" static deflection based on the entire mass of the equipment. The external isolation springs with the 4" static deflection are preferable.
7.) If the equipment installation is sensitive to the transmission of vibration and noise, internal isolation should not be used. The use of external isolation alone always produces better results than the use of both internal and external isolation. With external isolation, springs with 3" or 4" static deflections may be used. Springs with such high static deflections are not readily available for use as internal isolation.

Εξειδικευμένες υπηρεσίες και προϊόντα στον τομέα του ελέγχου των θορύβων και των δονήσεων

- Αρχική
- Εταιρεία
- Δραστηριότητες
- Έργα
- Νέα
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Αρχική

Διοργάνωση Ημερίδας με θέμα:"Παρουσίαση Συστημάτων Μόνωσης Δονήσεων και Στερεόφερτου Θορύβου σε Μέσα επί Σταθερής Τροχιάς 18/11/2009

Την Πέμπτη 12 Νοεμβρίου 2009 διοργανώθηκε Ημερίδα στον 9ο όροφο του Μεγάρου του ΟΣΕ με θέμα:"Παρουσίαση Συστημάτων Μόνωσης Δονήσεων και Στερεόφερτου Θορύβου σε Μέσα επί Σταθερής Τροχιάς"

Περισσότερα

Δελτίο Τύπου Sylomer SR -Παρουσίαση εξέλιξης από Sylomer σε Sylomer SR 10/9/2009

Από το Σεπτέμβριο του 2009, ξεκινά η διάθεση της νέας σειράς Sylomer SR με στόχο τη βελτιωμένη κάλυψη των αναγκών μόνωσης δονήσεων.

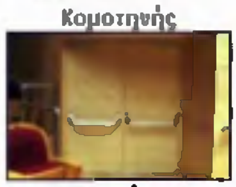
Περισσότερα

Τελευταία Έργα

Πλωτή πλάκα σε ελατήρια GERB στο ΣΠΚ Ηρακλείου

Περισσότερα

Ηχομονωτικές θύρες SANCO στο ΣΠΚ Κομοτηνής



Περισσότερα

Πανόρμου 71-73, 115-24 Αθήνα
Τηλ: 210 6980601, 210 6912306
Fax: 210 6914421
E-mail: info@ergoakoustiki.gr

Overview Sylomer®

by getzner
sylomer®

Material:
mixed cell polyurethane (PUR) with combined spring and dampening properties

Standard delivery specifications:
Thickness: 12.5 mm / 25 mm
Rolls: 1.5 m wide, 5.0 m long
Strips: up to 1.5 m wide, up to 5.0 m long
Other dimensions (including thickness), stamped components and moulded components available on request.

Material type:

Properties	Test procedures	SR 11	SR 18	SR 28	SR 42	SR 55	SR 110	SR 220	SR 450	SR 850	SR 1200
Color		yellow	orange	blue	pink	green	brown	red	grey	turquoise	violet
Static range of use [N/mm²]**		0.011	0.018	0.028	0.042	0.055	0.110	0.220	0.450	0.850	1.200
Load peaks [N/mm²]**		0.5	0.75	1.0	2.0	2.0	3.0	4.0	5.0	6.0	6.0
Mechanical loss factor	DIN 53513*	0.25	0.23	0.21	0.16	0.17	0.13	0.13	0.11	0.12	0.09
Static shear modules [N/mm²]	DIN ISO 1827*	0.03	0.05	0.07	0.08	0.13	0.22	0.35	0.58	0.8	0.9
Dynamic shear modulus [N/mm²]	DIN ISO 1827*	0.1	0.12	0.15	0.17	0.26	0.42	0.64	1.0	1.4	1.6
Min. tensile stress at rupture [N/mm²]	DIN EN ISO 527-3/5/100*	0.3	0.35	0.4	0.5	0.6	0.8	1.2	1.8	2.5	2.7
Min. tensile elongation at rupture [%]	DIN EN ISO 527-3/5/100*	300	300	250	250	250	220	200	170	170	160
Abrasion [mm³]***	DIN 53516	1400	400	1300	1200	1100	1100	1000	400	300	350
Static E-modulus [N/mm²] (at the upper limit of the static range of use)**	DIN 53513*	0.061	0.097	0.166	0.282	0.367	0.87	1.44	3.30	7.2	10.4
Dynamic E-modulus [N/mm²] (at the upper limit of the static range of use)**	DIN 53513*	0.172	0.280	0.437	0.611	0.753	1.36	2.54	5.04	11.1	16.4
Resistance to strain at 10 % deformation [N/mm²]		0.012	0.020	0.031	0.047	0.061	0.12	0.22	0.42	0.86	1.08
Operating temperature [°C]		-30 to +70									
Temperature peak [°C]	short term****	+120									
Inflammability	DIN 4102 EN ISO 11925-2	B 2 B, C and D									

* Measurement procedure similar to the relevant standard
** Data valid for a form factor of q=3, material thickness 25 mm
*** Measurement of abrasion depends on density with varying testing parameters
**** Depending on application

All information and data is based on our current knowledge. The data can be applied for calculations and as guidelines, are subject to typical manufacturing tolerances, and are not guaranteed. We reserve the right to amend the data.

Data sheets on the various material types and special specifications available on request.

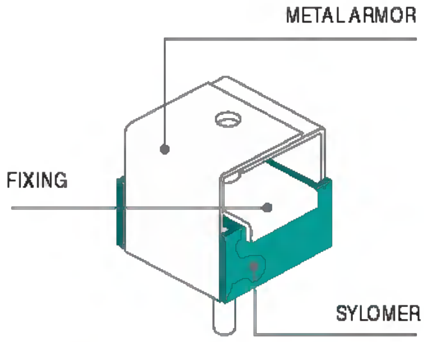
Akustik + Sylomer®: Models and dimensions

PRODUCT DESCRIPTION

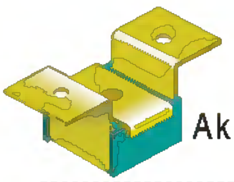
These antivibration mounts have been conceived for suspension from false ceilings, vibrating pipelines and machinery that has to be suspended.

The excellent properties of the Sylomer® microcelular polyurethane achieve elevated isolation values as opposed to other mounts using rubber or cork, or a combination of both. These antivibration mounts are manufactured in two special mixes of Sylomer® to adapt better to the load of each application.

A great variety of fixing metal armors and elements facilitate installation and adapt better to each type of job. Their rugged metal parts withstand can tensile stresses from 650 kg to 1000 kg. They are supplied with an anticorrosive treatment that can withstand the toughest environments.

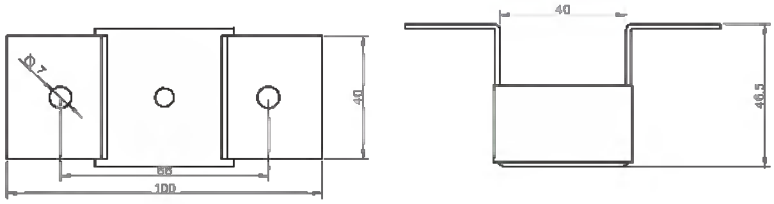


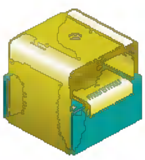
TYPE OF metal armor



Akustik 1

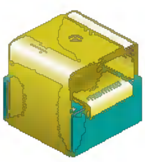
It is secured directly to the ceiling by means of two holes.





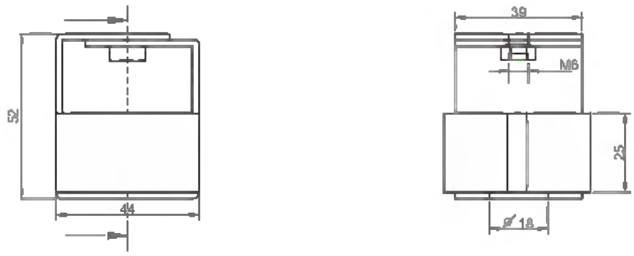
Akustik 3

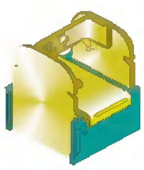
It is secured directly to the ceiling with a screw and locking nut.



Akustik 4

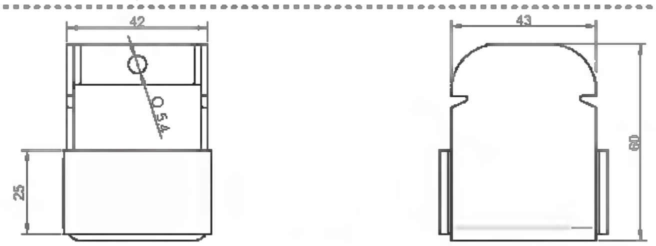
It is secured with a screw via a nut welded to the metal armor.

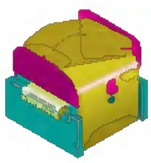




Akustik Rapid

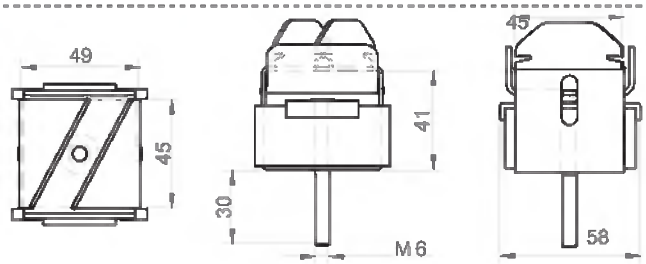
Designed to be secured to most profiles on the market. Its design makes for easy and safe installations.





Akustik Safety

Its gravitational system guarantees correct installation and offers greater safety, preventing elements from becoming detached.
Thanks to its design, the mount will not attach to the profile if it is not installed properly. It prevents possible slip-ups. Its 45º forked design makes installation and removal easy and safe.



REINICKE
Schwingungssysteme

ISOTOP® DSD

Steel spring vibration isolators with integrated high-performance damping element

Design

ISOTOP® DSD steel spring vibration isolators consist of two spring plates with M10 internal thread and a cylindrical screw spring designed according to DIN EN10270-1: 2001. All DSD elements are cataphoresis coated, which guarantees high corrosion resistance. The core piece of these elements is the damping medium of special Sylomer®-HD material, which is exactly matched to the relevant characteristic curve of the spring. The material is permanently elastic and break-proof.

Field of application

ISOTOP® DSD steel spring vibration isolators are used for source and receiver isolation of all impact type machines, as well as for machines of which the operating point is within the resonance range or which can start rocking when traversing the resonance.

Examples:

- Block-type thermal power stations
- Compressors
- Rotating machines, motors, turbines
- Mobile equipment, emergency power units
- Centrifuges, pumps
- Plan tables, test beds, scales
- Vibrating tables, conveyors
- Transport storage of delicate goods

Required data for selection

- Total weight to be absorbed (operational weight)
- Number and location of points of support
- Centre of gravity
- Structural shape of the device (dimensions)
- Load direction (vertical - horizontal)
- Lowest parasitic frequency (rotational speed or number of strokes)
- Start-up behaviour of the motor (run-up time)

Advantages

- Construction height, diameter and connection thread are identical for all types, which guarantees exchangeability.

ISOTOP® DSD, KTL

- As a result of the open construction, the source is connected to the foundation point only via the spring. The spring element can oscillate in the horizontal plane without restriction.
- The spring is clearly visible, which allows checking of its condition without dismantling. The distance between spring coils is visible under load.
- Accessories, base plate and height adjustment are universally applicable for all types.
- The damping core is permanently elastic and break-proof
- High corrosion resistance is accomplished with cataphoresis coating

Our service

Make use of our know-how on questions about vibration technology. We will gladly consult you and will calculate tailor-made solutions for vibration isolation.

Reinicke GmbH
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Telefax +49 7141 7917911

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www.reinicke-gmbh.de

Reinicke® creates silence.

ISOTOP® DZE
Multi-part element

Design

ISOTOP® DZE is a multi-part element consisting of grey cast iron (GGG) and two different insulation materials: Sylodyn® and Sylomer®. Combined they are resilient to pressure and tensile loading.
Due to the spring/damper combination the transmission of vibration can be isolated precisely and effectively and strong amplitudes will be debilitated.
The continuous steel axis with its welded-on baseplate endures strong horizontal forces as well as massive negative impulses like e.g. windloads.
Corrosion protection: powder-coating

ISOTOP® DZE

Field of application

ISOTOP® DZE elements can be adjusted individually up to a resonance frequency of approx. 7 Hz, depending on the load and disturbance frequency.
Various applications, for example elastic isolation of:

- Compressors
- Pumps
- Cooling towers
- Fast rotating machines
- HVAC
- Roof-top devices
- Emergency power units
- Vibration isolation of all kinds

Advantages

- Different combinations of spring/damper elements depending on the load of the device allow ideal frequency tuning.
- Premounted elements ensure fast assemblage
- Demolition-proof – especially advisable for narrow and tall devices or mobile applications
- Long durability
- Low resonant frequency
- Low construction height

Required data for selection

- Total weight to be absorbed
- Number and location of points of support
- Centre of gravity
- Structural shape of the device
- Direction of load
- Lowest parasitic frequency (rotational speed or number of strokes)

Our service

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Spring element for building isolation.

Vibro
VIBRATION CONTROL PRODUCTS
Home Page
About us
Products
News
Certificate
Contact
HIGHLIGHTED VIBRATION CONTROL PRODUCTS
EP
Antivibration Elastic Pad
3D
Multidirectional Antivibration Mount
JS
Jack-Up Antivibration Mount for Concrete Floating Floors
Home Page | About us | Products | News | Certificate | Contact
ALPHA ACOUSTIKI
ALPHA ACOUSTIKI LTD Kambouroglou 19 Street, Athens, Greece P.C. 11525 Tel.:+30 2106779875 , Fax:+30 2106779269
Web Design & Web Development

Vibration Insulation

Over

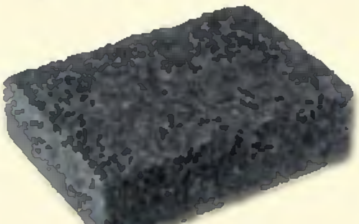
2 ways
1 goal

Regupol®

Rubber product range


Regupol® 6010BA


Regupol® 6010SH


Regupol® 6010PL


Regupol® 6010HT


Regupol® 5010XHT

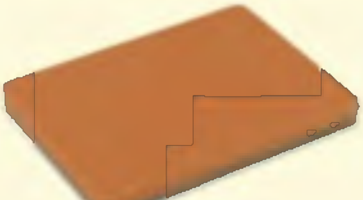

Regupol® 6010MF

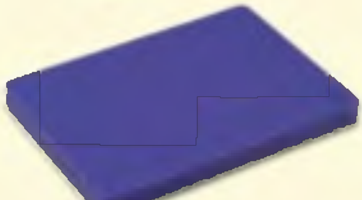
Optimal vibration absorption and insulation of structure-borne sound

Regupol®, the high-grade rubber product and Regufoam®, the high-grade PUR product, supplement each other perfectly and guarantee versatile, specific solutions for all tasks in the civil engineering and construction industries requiring effective insulation.

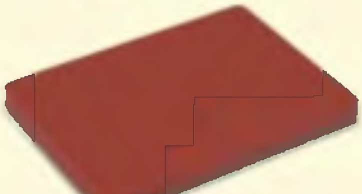
Regufoam®

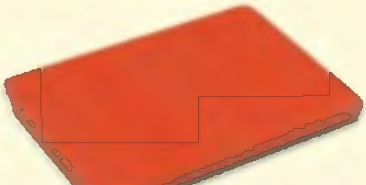
PUR product range


Regufoam® 150


Regufoam® 220


Regufoam® 300


Regufoam® 400


Regufoam® 510

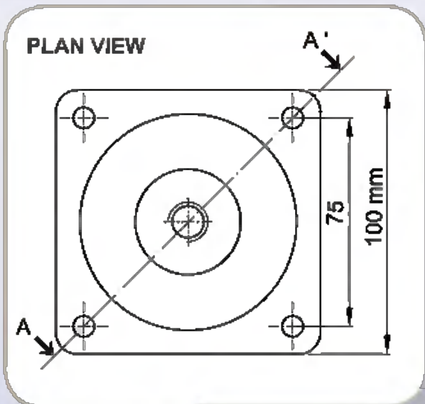

Regufoam® 680

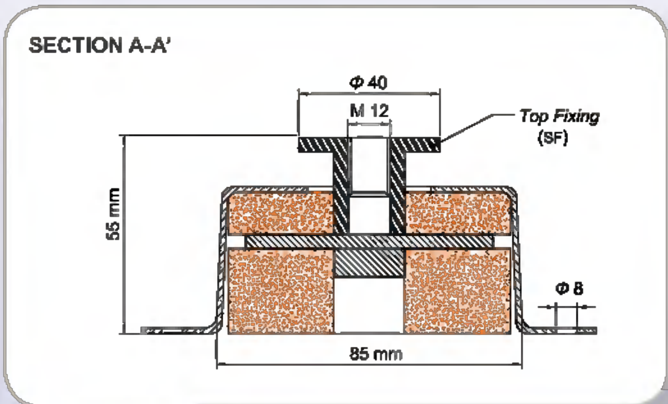
The printing technique used may lead to deviations in colour tone. Unfortunately this cannot be avoided.

MULTIDIRECTIONAL ANTIVIBRATION MOUNT

APPLICATIONS

- Suspension of exhaust gas pipes.
- Marine & aviation applications .
- Support of freon cooling pipelines.
- Mounting of high RPM engines.
- Mounting of electronic devices.
-Suspension & on-wall fastening of loudspeakers.
- Anti-seismic protection of machines.





The new antivibration mount **Vibro-*3D*** is one of the few antivibration mounts that can support vibration of every direction (x,y,z).

Vibro-*3D* is also designed to sustain impulsive loads in all the three axis, so its capable to receive high vertical or lateral shocks with minimum danger of destruction.

The main internal elastic material is high technology polyurethane foam with semi closed cells, with the trademark ***Regufoam***®. Full range of its mechanical behavior diagrams, are available on request.

Vibro-3D selection table

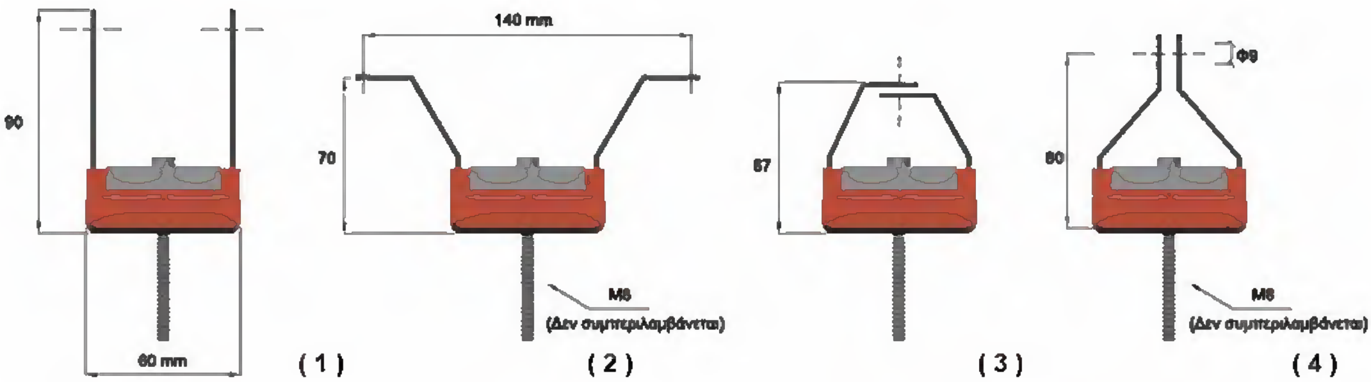
TYPE OF ELASTIC PART	COLOR	USE	Max STATIC LOAD (dN)	DYNAMIC LOAD (dN)
R	Brick red	Mounting (B)	**35**	50
		Suspension (H)	***29***	*43*
R	Orange	Mounting (B)	**70**	100
		Suspension (H)	***58***	*85*
R	Brown	Mounting (B)	**140**	210
		Suspension (H)	***115***	*170*
E	Black	Mounting (B)	**280**	380
		Suspension (H)	***200***	*280*

Different static loads available on request

Vibro®
CH-R

ANTIVIBRATION HANGER

WITH *Regufoam*®



*** *1 part 4 uses***
*** *4 forms in 1 suspension***

APPLICATIONS

* Antivibration suspension of machinery (ventilators, air conditioning e.t.c.) * Suspension of sound insulation false ceiling (gympumboard). * Antivibration suspension of pipes, air – ducts.

DESCRIPTION

The frame of ***Vibro* CH-R** is galvanized metal. The precisely designed incisions provide easy bending of its frame, at certain shapes, that can be achieved by the force of a single hand. Thus ***Vibro* CH-R** can be easily transformed, very easy, into 3 different shapes in order to help the installer to use it in the most favorable form.

It can be used in the following forms:

- Pattern (1) screwed on both sides of the metal suspension's profile.
- Pattern (2) is fixed with 2 anchors on the ceiling.
- Pattern (3) is fixed with 1 anchor on the ceiling.
- Pattern (4) hanged up with a hook or other proper device.

The elastic element of the hanger is high quality polyurethane foam, with semi-closed cells, manufactured by the German company BSW with the trademark ***Regufoam***®. Full range of its mechanical behavior diagrams and certificates, conducted in the University of Dresden, are available on request.

***Vibro* CH-R** is available with two different thicknesses of its elastic pad.

- *12 mm (the economical solution)*
- *24 mm (better vibration control).*

LOAD OF SUSPENSION

10-20 dN* for every suspension.
**(1N = 10Kp)*

*Our products are designed and manufactured according to the quality assurance system: **ISO 9001.2000***

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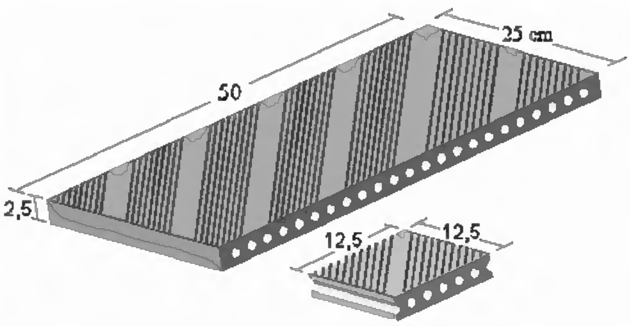
ANTIVIBRATION ELASTIC PAD



- **VIBRATION CONTROL**
- **PASSIVE MACHINERY PROTECTION**
- **EASY TO INSTALL**
- **SUITABLE FOR LARGE LOADS**

APPLICATIONS

ANTIVIBRATION SUPPORTS:

Air-compressors - Air conditioner units – Pumps – Fans – Generator sets – Cutting machines etc.

FLOATING SUPPORTS:
Industrial floors – Elevators – Printing machines – Testing machines etc.

DIMENSIONS	TYPE
50 x 25 x 2,5 cm 12,5 x 12,5 x 2,5 cm 6 x 6 x 2,5 cm	- Elastomeric special rubber compound (***grey - blue - red***) - Neoprene: (**beige** - ***green - yellow***)

COMPOSITION MATERIAL

VIBRO-EP is a product of specialized research and is produced in this form since 1989, made from excellent quality elastomeric material mixed with special substances for its further improvement.

Its longitudinal holes increase the provided compression and improve vibration absorption. They can be used in multiple layers with the use of steel plate in between *in order to reduce the natural frequency down to **4 Hz***.

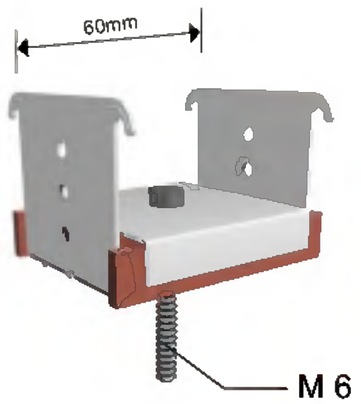
LOAD RANGE

VIBRO-EP	DIMENSIONS (cm)	MAXIMUM LOAD (dN)*	LOAD (dN/cm^2)
Grey or Beige	50x25 12,5x12,5	3.800 400	2 - 3 1,8 - 2,5
Blue or Green	50x25 12,5x12,5 6x6	2.500 280 60	1,5 - 2 1- 1,8 —
Red or Yellow	50x25 12,5x12,5 6x6	1.800 180 40	1 – 1,5 0,8 – 1,2 —

**(1dN = 1Kg)*

The Quality Assurance System in use complies with **ISO 9001-2000.**

ANTIVIBRATION
HANGERS for GYPSUMBOARD CEILINGS
with Regufoam ®



Vibro - QH-R

APPLICATIONS

- SOUND INSULATION for FALSE CEILINGS

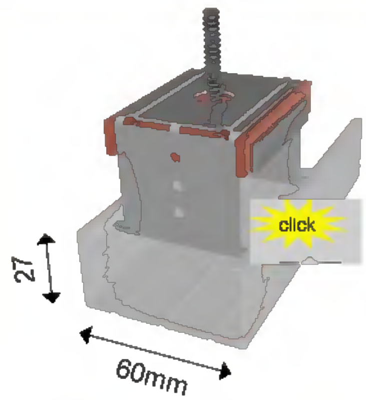
- QUICK & EASY CQNNECTIQN with the metal profile of gypsumboard ceiling systems.

DESCRIPTION

***Vibro* QH-R** consist of a specially design galvanized metal suspension hanger, which has grabbling nebs for *QUICK AND EASY* connection with the standard ceiling profiles with dimensions 60x27 mm (for false ceilings) according to DIN 18182-1.

Therefore the working cost is decreased and it also facilitates the work of the installer.

The elastic element of the ***Vibro* QH-R** hanger is high technology polyurethane foam, with semi-closed cells, with the trademark ***Regufoam*®**. Full range of its mechanical behavior diagrams and certificates, conducted in the University of Dresden, are available on request.



EXAMPLE OF APPLICATION with METAL PROFILE

***Vibro* QH-R** is available with two different thickness of its elastic pad.

- *12 mm (the economical solution).*
- *24 mm (better vibration control).*

LOAD RANGE

10 - 20 dN per mounting point.

Our products are designed and manufactured according to the quality assurance system: ***ISO 9001.2000***

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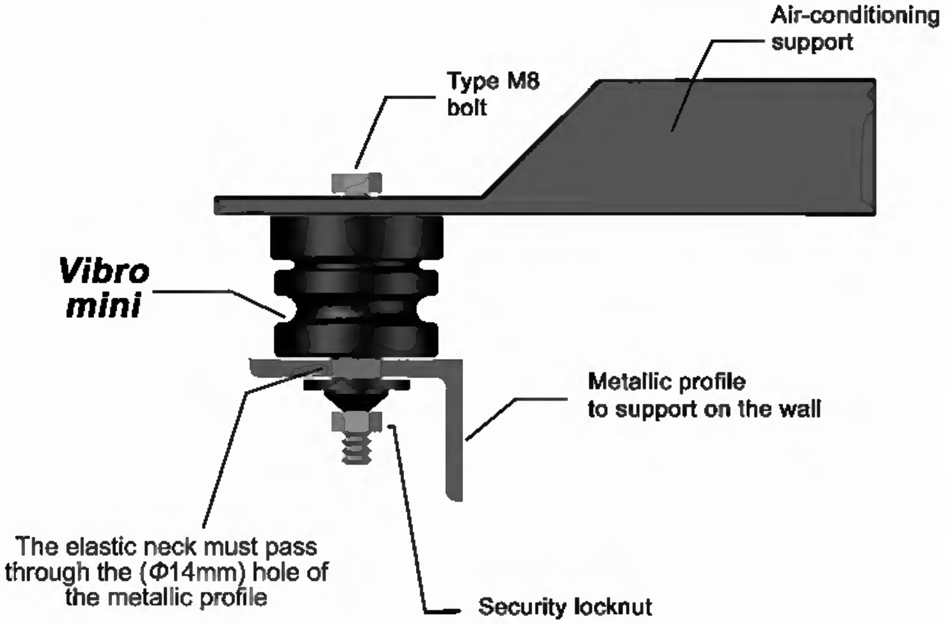
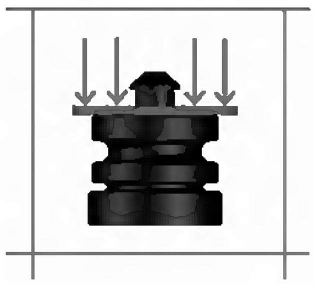
Application example for *Vibro-mini*

Vibration control of Air-conditioning unit





Maximum static load: ***20 kg***

Attention:

Do not screw the pass-through bolt excessively.

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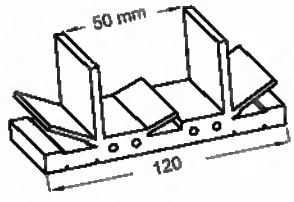
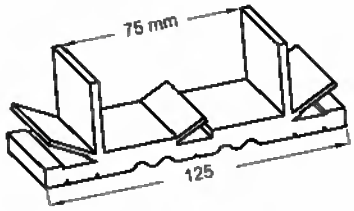
email: info@vibro.gr

Vibro WS

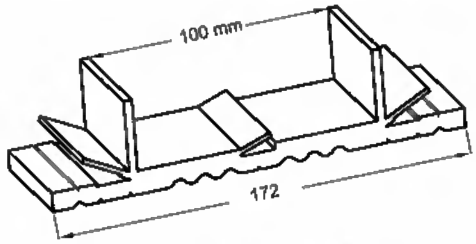
ANTIVIBRATION SUPPORTS For GYPSUMBOARD PARTITIONS



Vibro - WS.50



Vibro - WS.75



Vibro - WS.100

Vibro-WS is specially designed homogeneous elastomeric support systems for gypsumboard partitions. The semi-cylindrical modulation at their base (for WS.75 & 100) and the transversal holes (for WS.50), provides the necessary space for the rubber expansion, increases the deflection and consequently the vibration insulation. The inclined flaps of **VIBRO-WS** cover the fixing bolts on the base and prevent possible contact with gypsumboard.

The application of Vibro-WS in floating gypsumboard partitions:

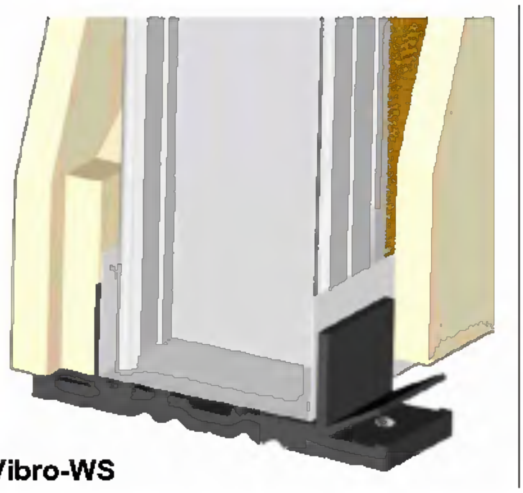
- Decreases the flanking noise transmissions.
- Interrupts heat-bridges and coming up moisture between humid floor and wall.

INSTALLATION

Vibro-WS is installed on floor or ceiling metal profiles (U-runner with width 50, 75 or 100mm) in correspondence to the C-studs or could also be installed unified, under the U-runner. They can be fixed on the profiles with bolts and on floor or ceiling with expansion bolts.

The free spaces must be filled with sound absorption material (e.g. rockwool).

Part or all of base's lateral flaps, of **Vibro-WS**, can be cut easily due to its incisions, for applications with smaller thickness (e.g. single gypsumboard) than the flap's length.



Vibro-WS

GYPSUMBOARD FLOATING WALL

ATTENTION:

*In every fixed point **metal washer** must be also used.*

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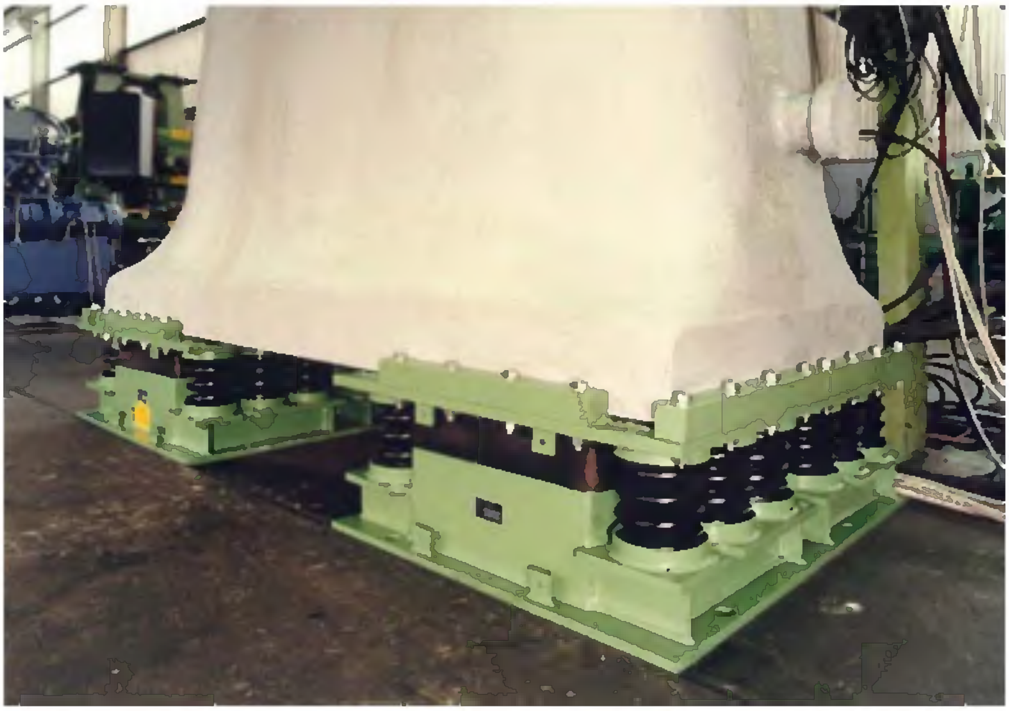
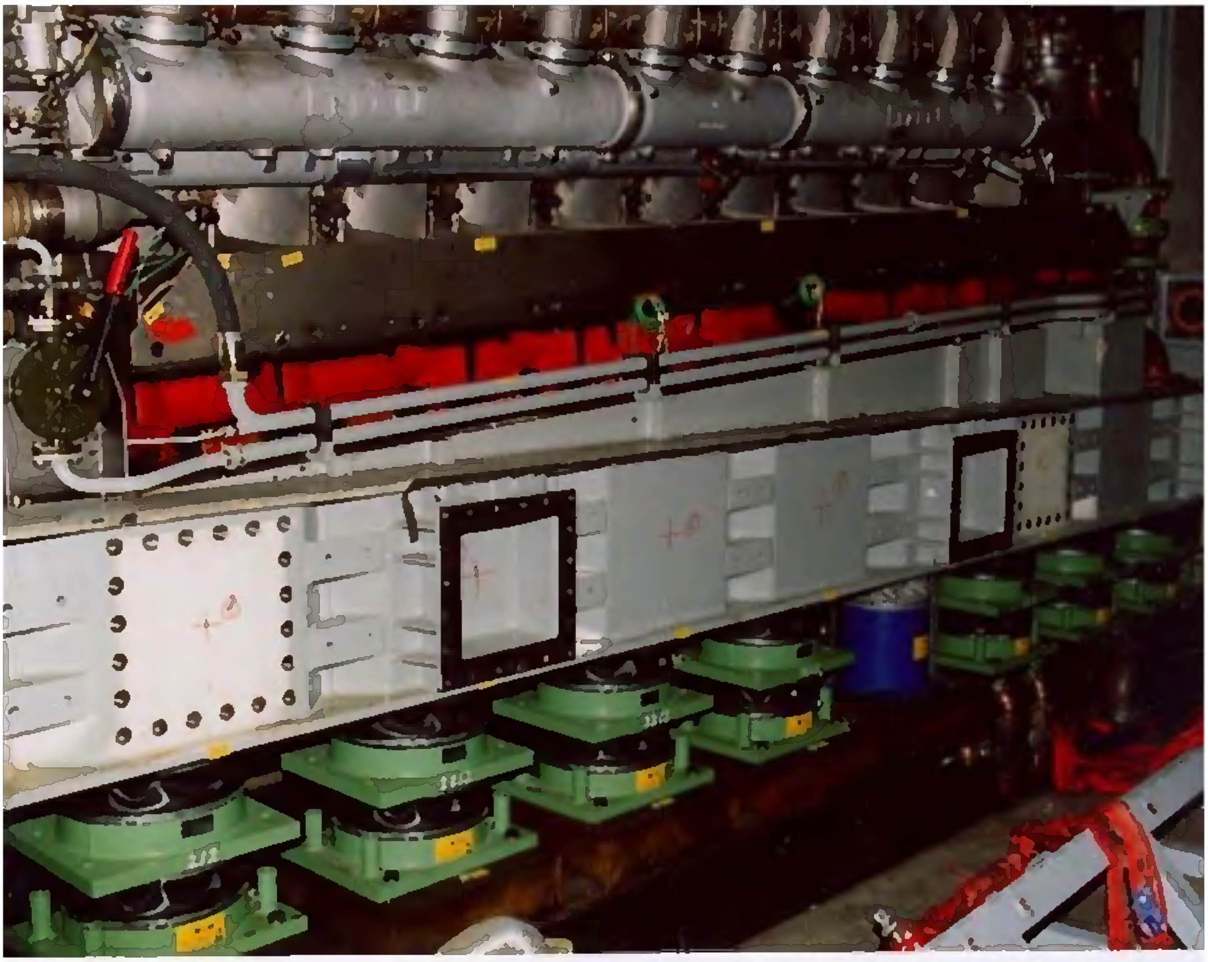
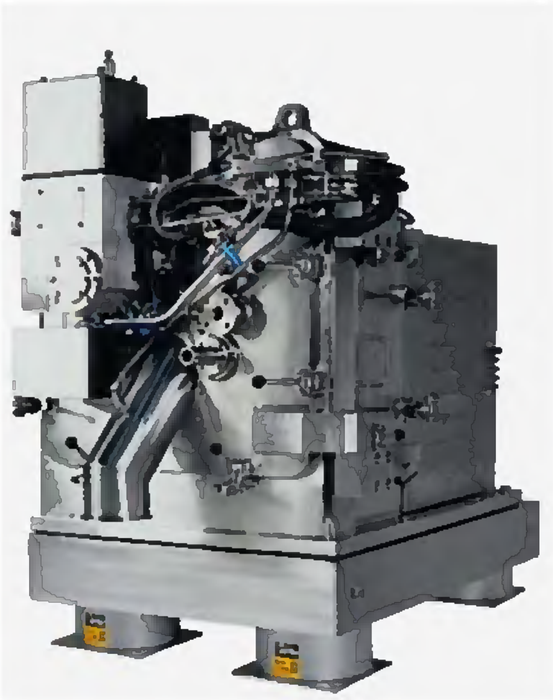
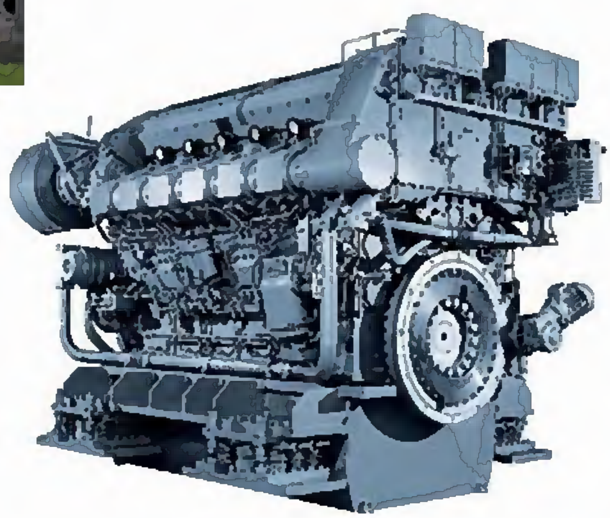
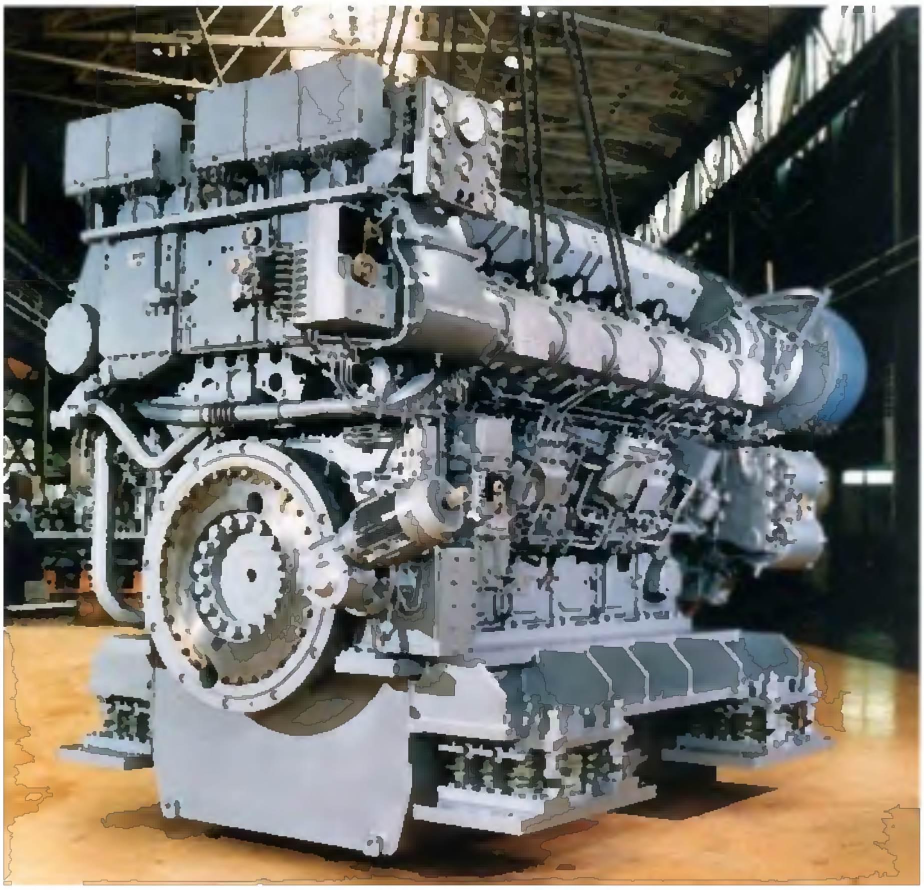


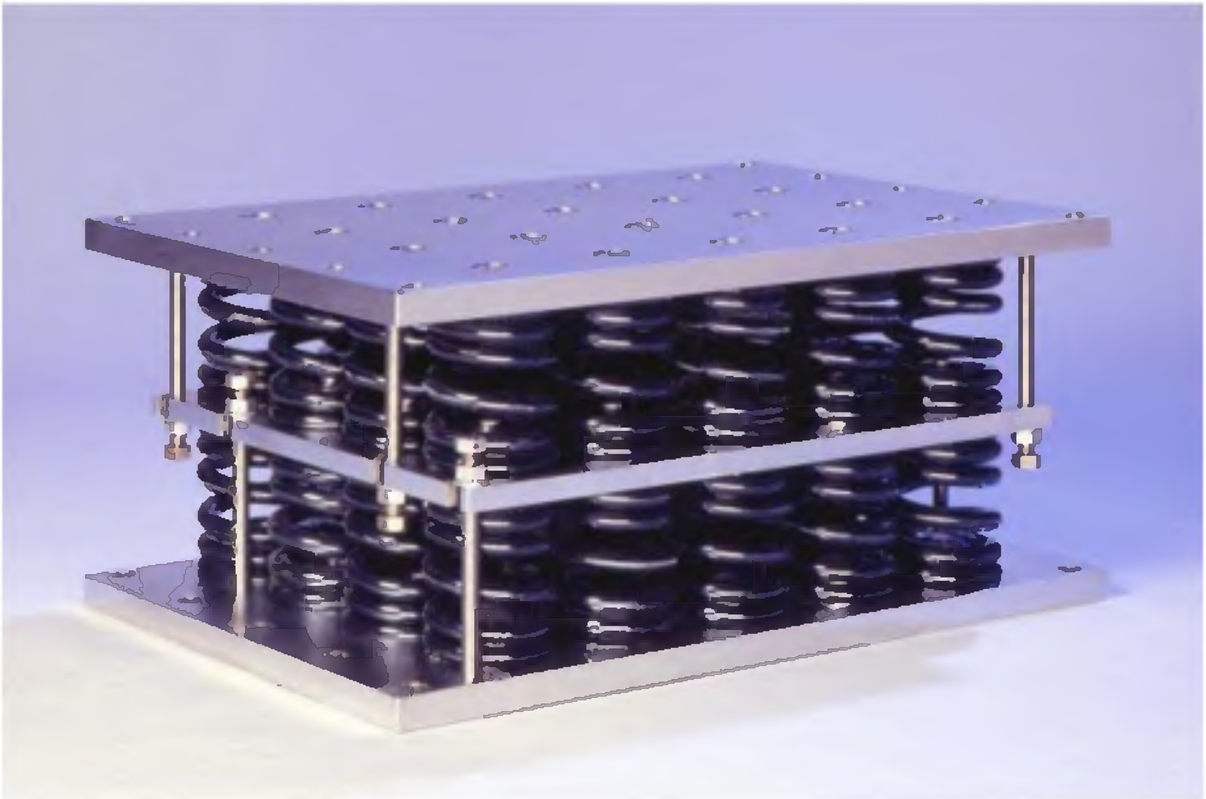


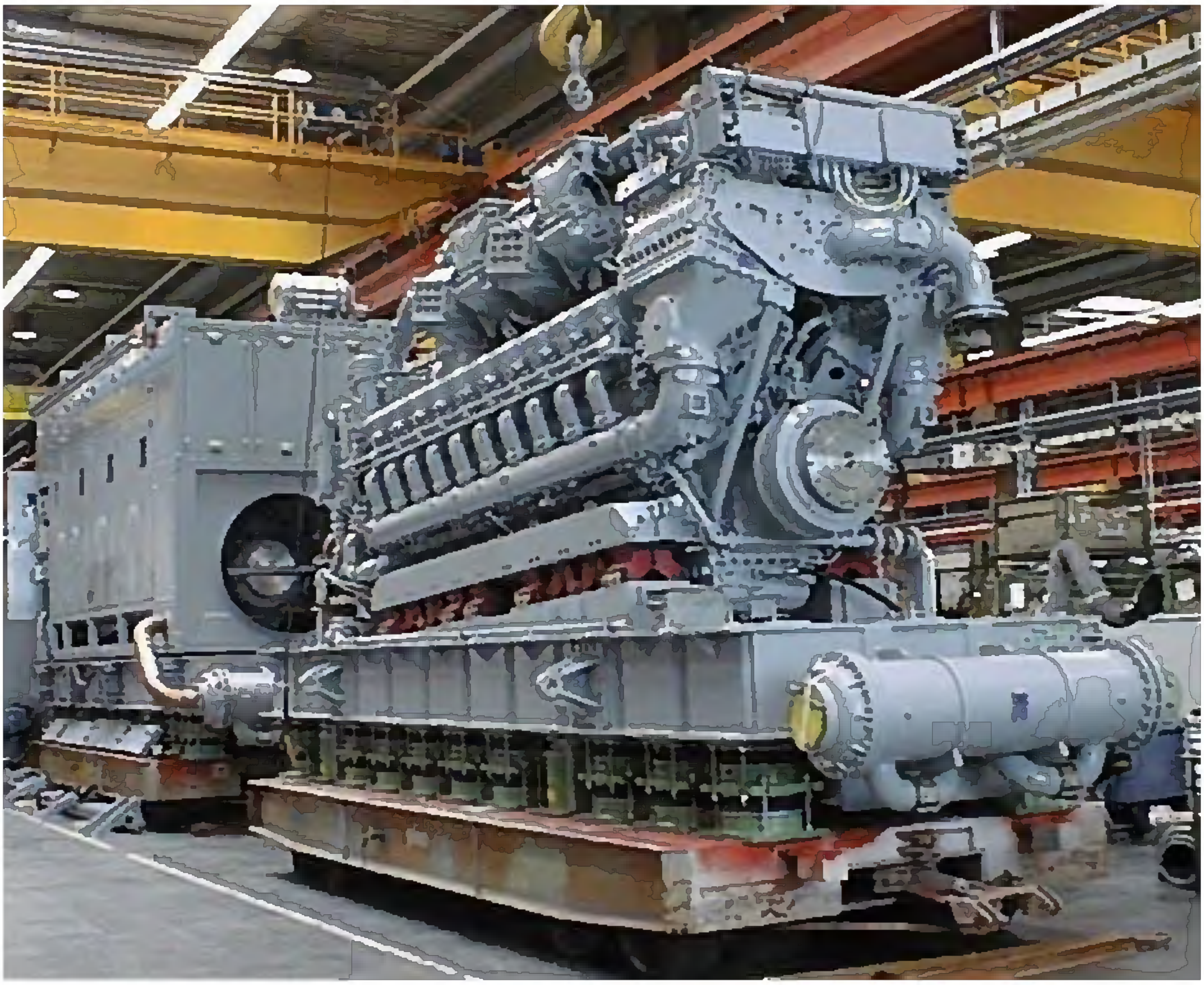

BÊCHÉ

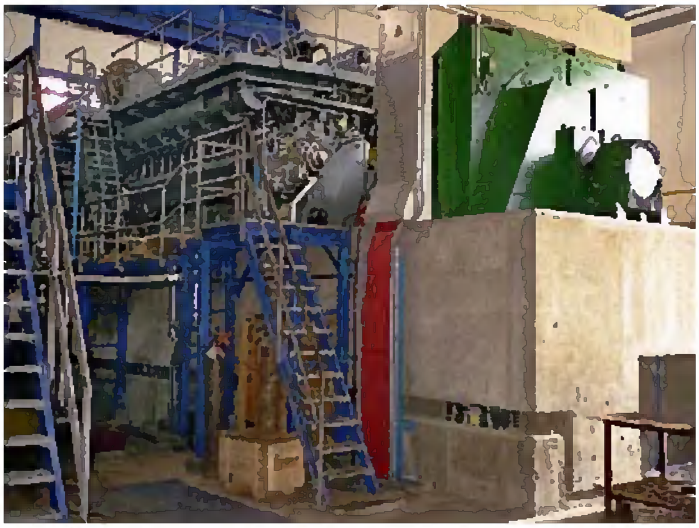


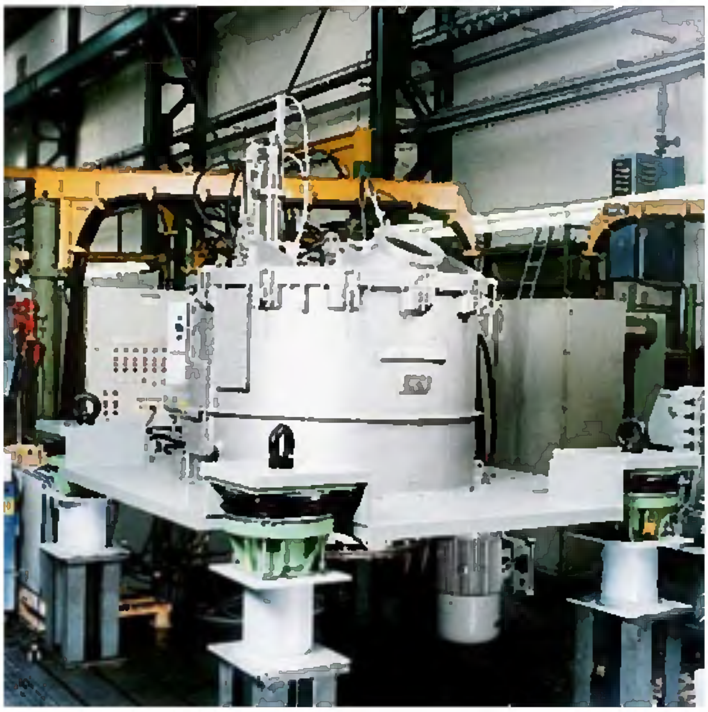


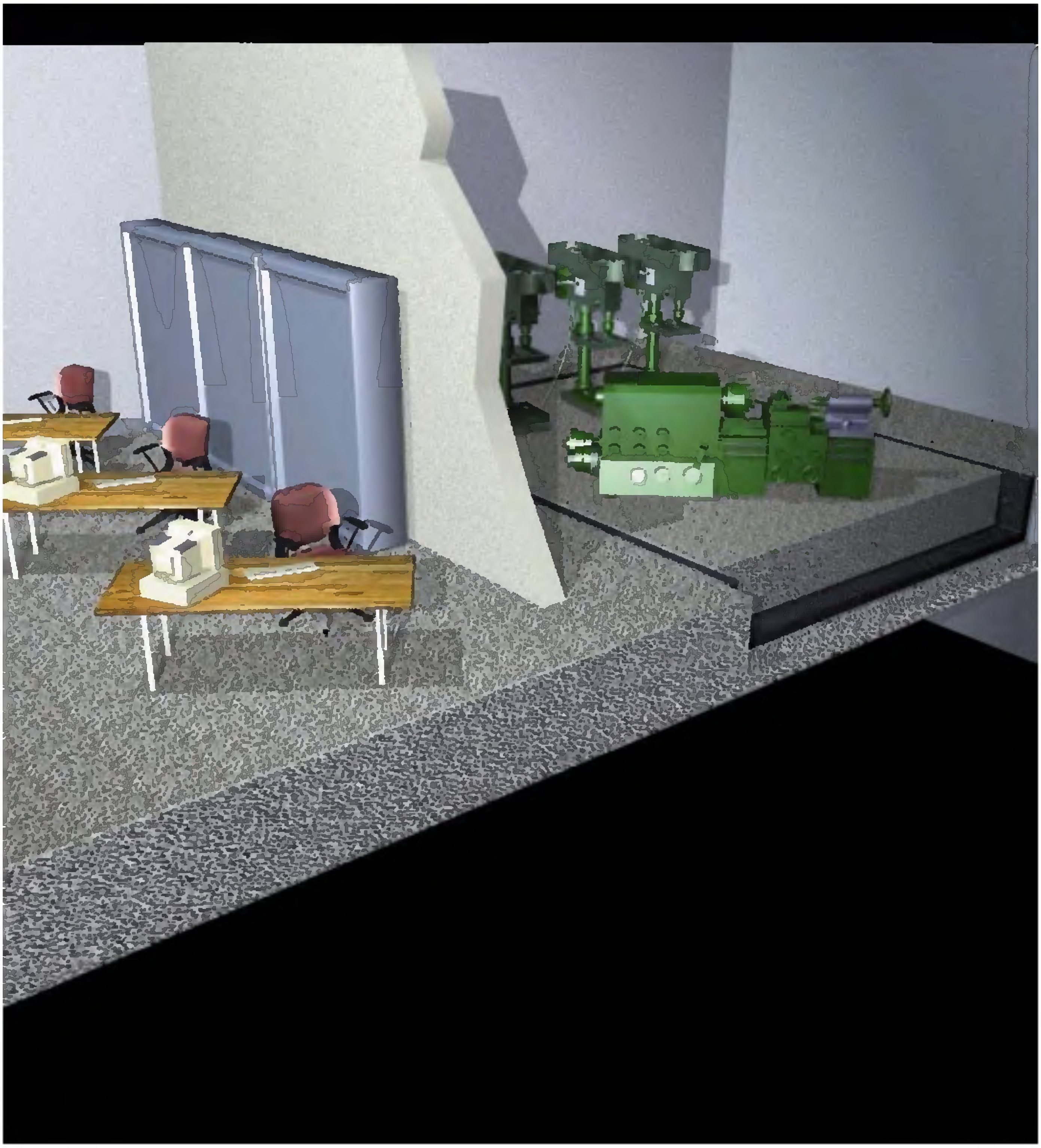




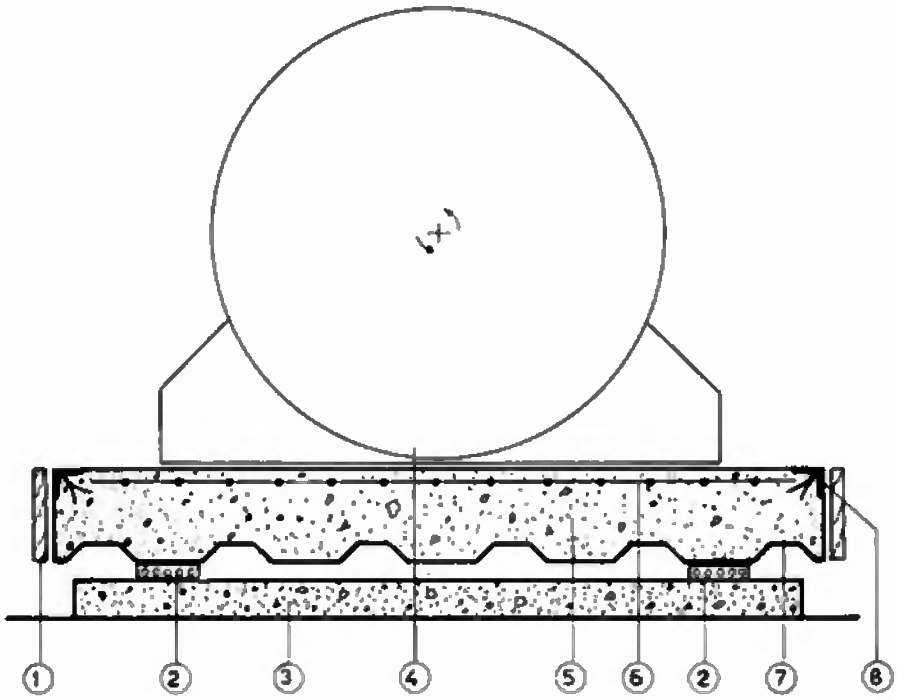




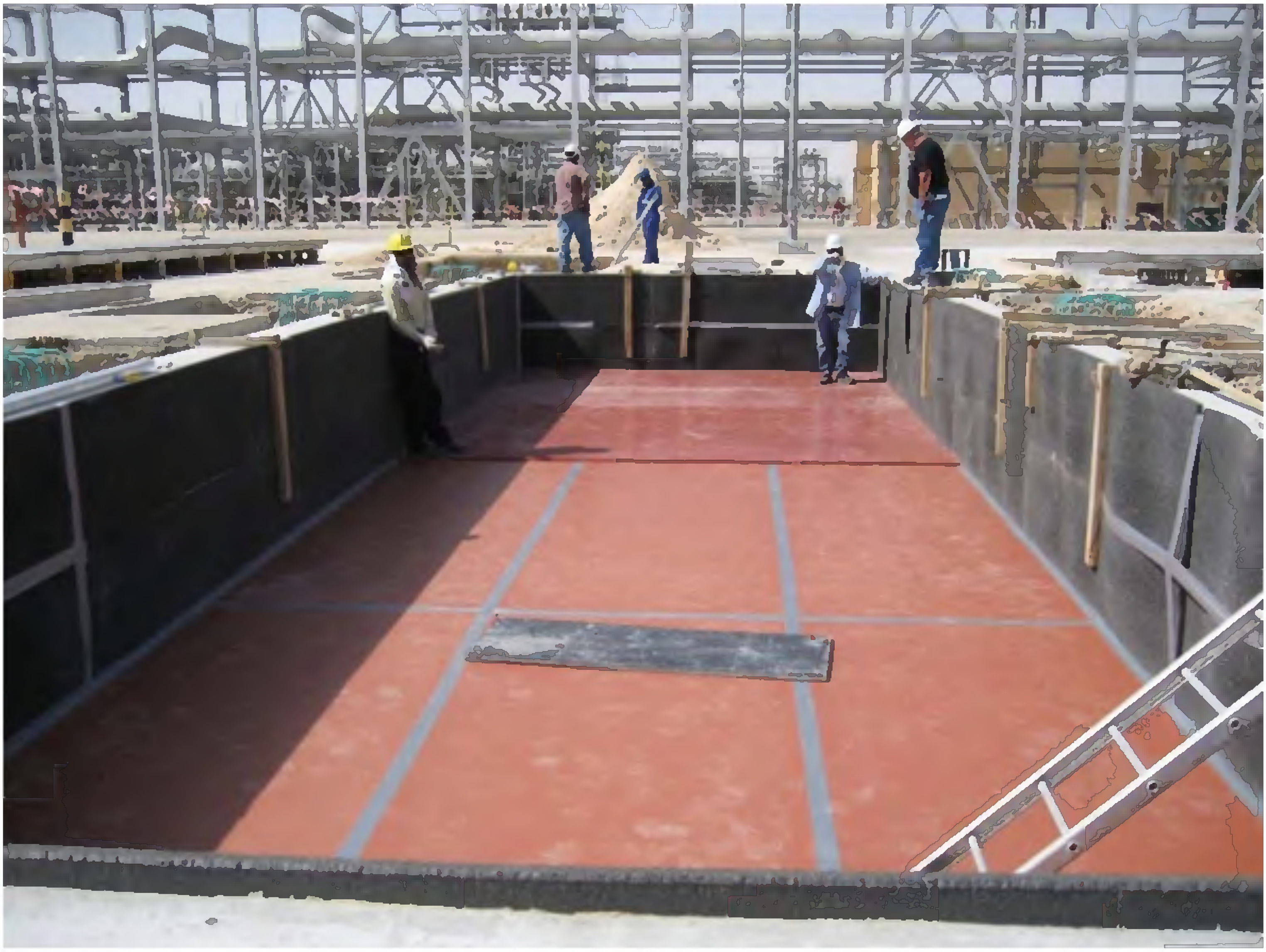




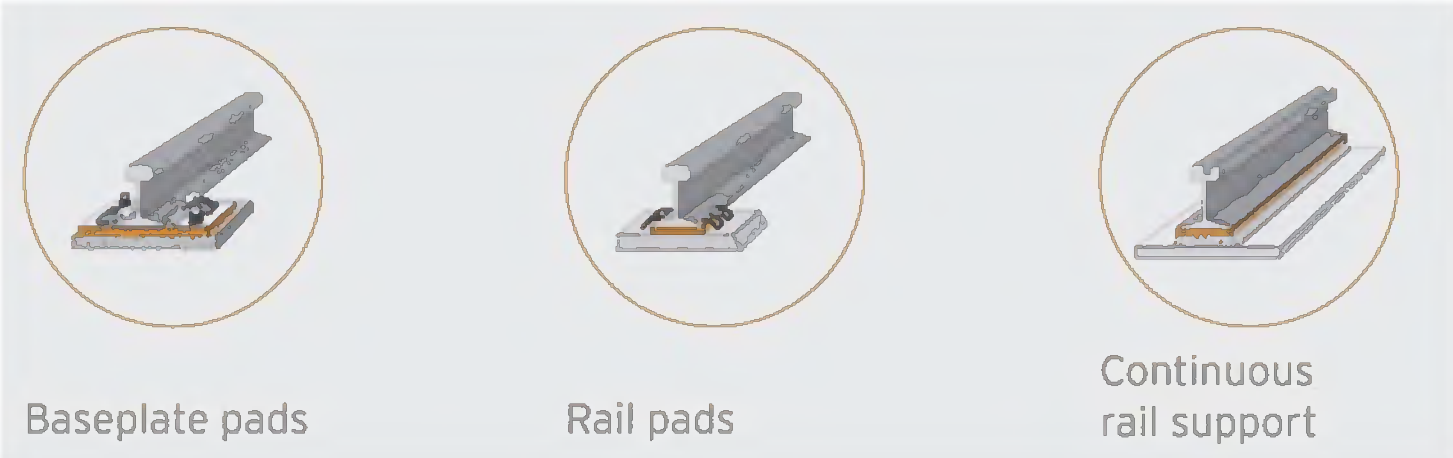
ΑΝΤΙΚΡΑΔΑΣΜΙΚΗ ΕΔΡΑΣΗ ΜΗΧΑΝΗΜΑΤΟΣ
ΜΕ ΑΝΤΙΚΡΑΔΑΣΜΙΚΑ ΕΦΕΔΡΑΝΑ
VIBRO-EP



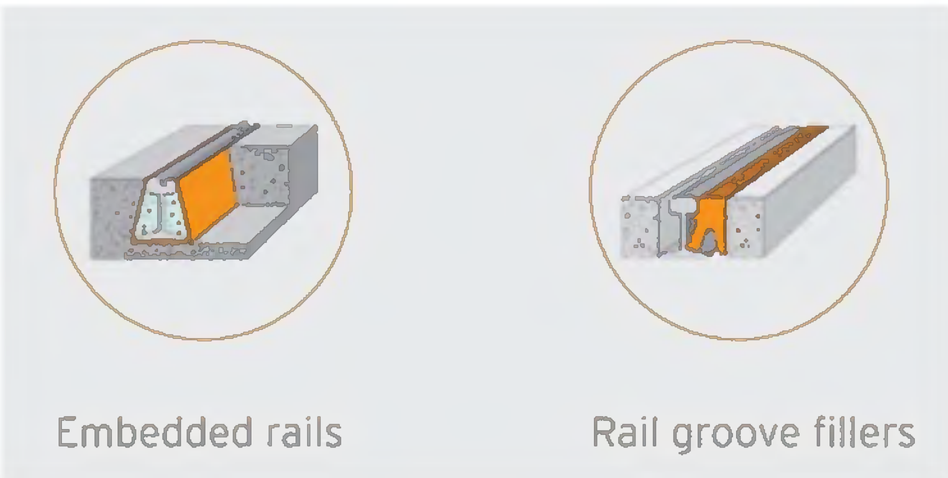
1. Αφαιρούμενος ξυλότυπος
2. **VIBRO-EP**
3. Beton (για προστασία από λάδια, νερά κ.λ.π.)
4. Μηχανήματα με κραδασμούς
5. Beton
6. Οικοδομικό πλέγμα (ΔΑΡΙΓΚ)
7. Ξυλότυπος (Betoform, MDF, λαμαρίνα κ.λ.π.)
8. Σιδηρογωνιά περιμετρικά 50x5 mm με ανάλογα τζινέτια



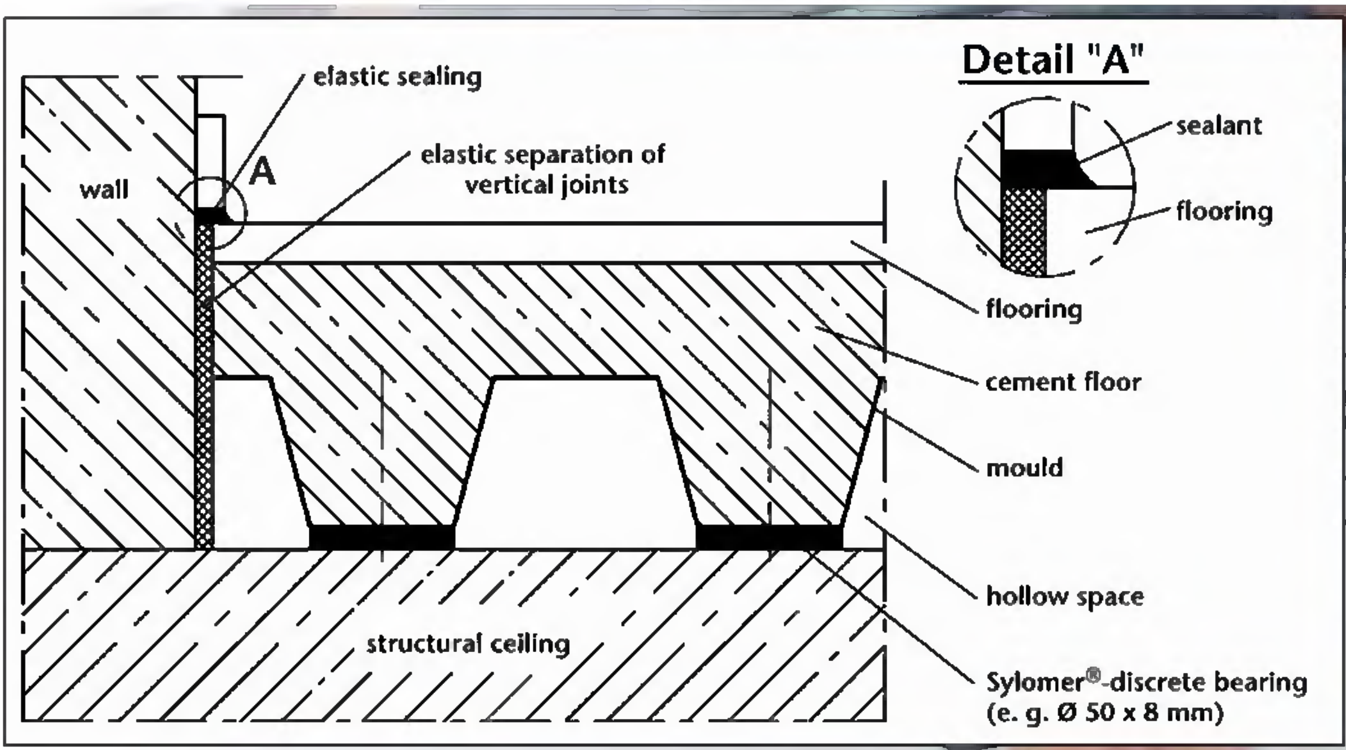
Sub-ballast mats
Insertion plates for sleeper boots
Sleeper pads



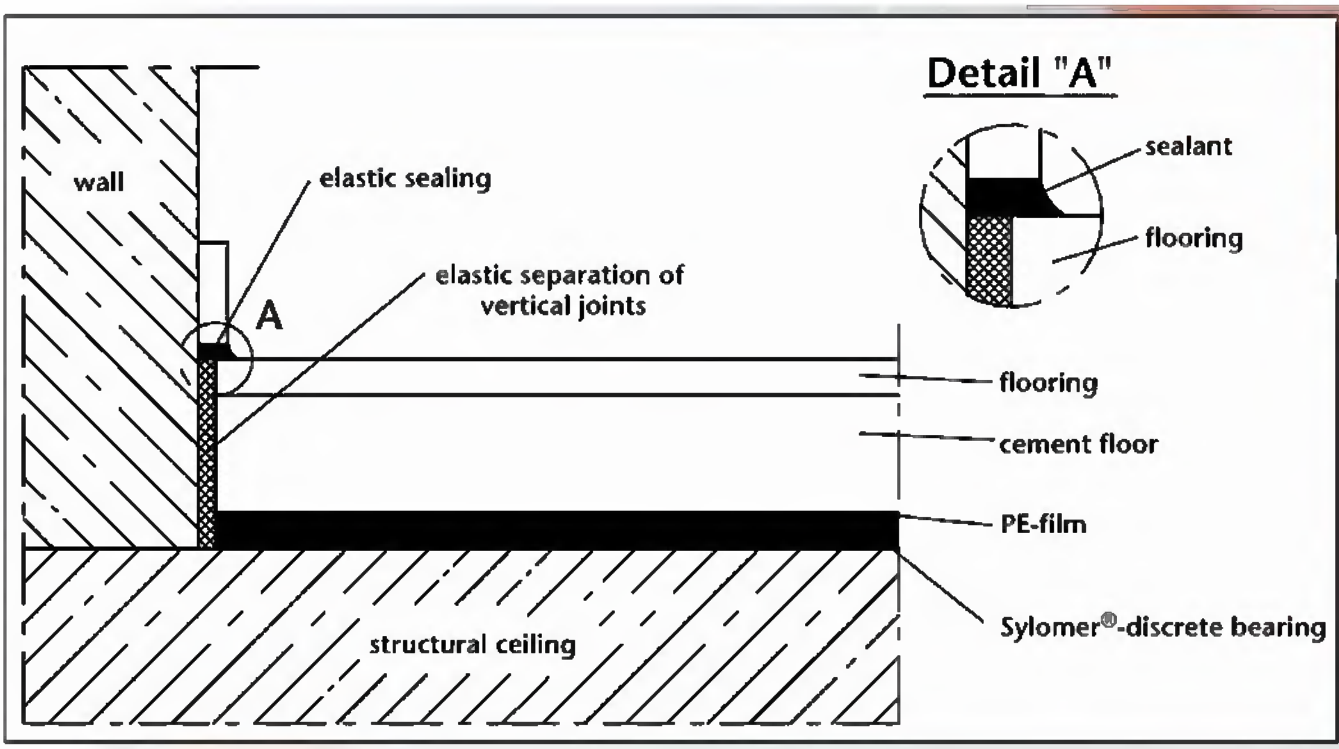
Baseplate pads
Rail pads
Continuous rail support



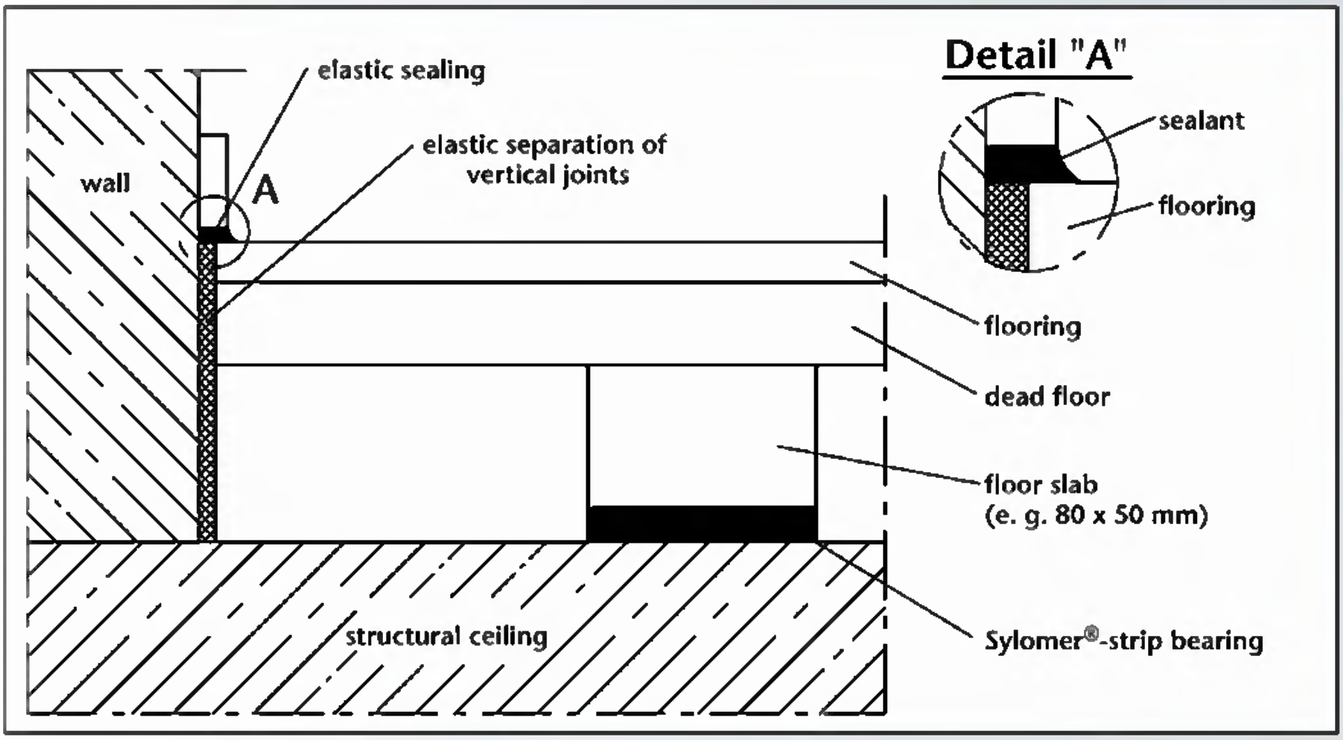
Embedded rails
Rail groove fillers



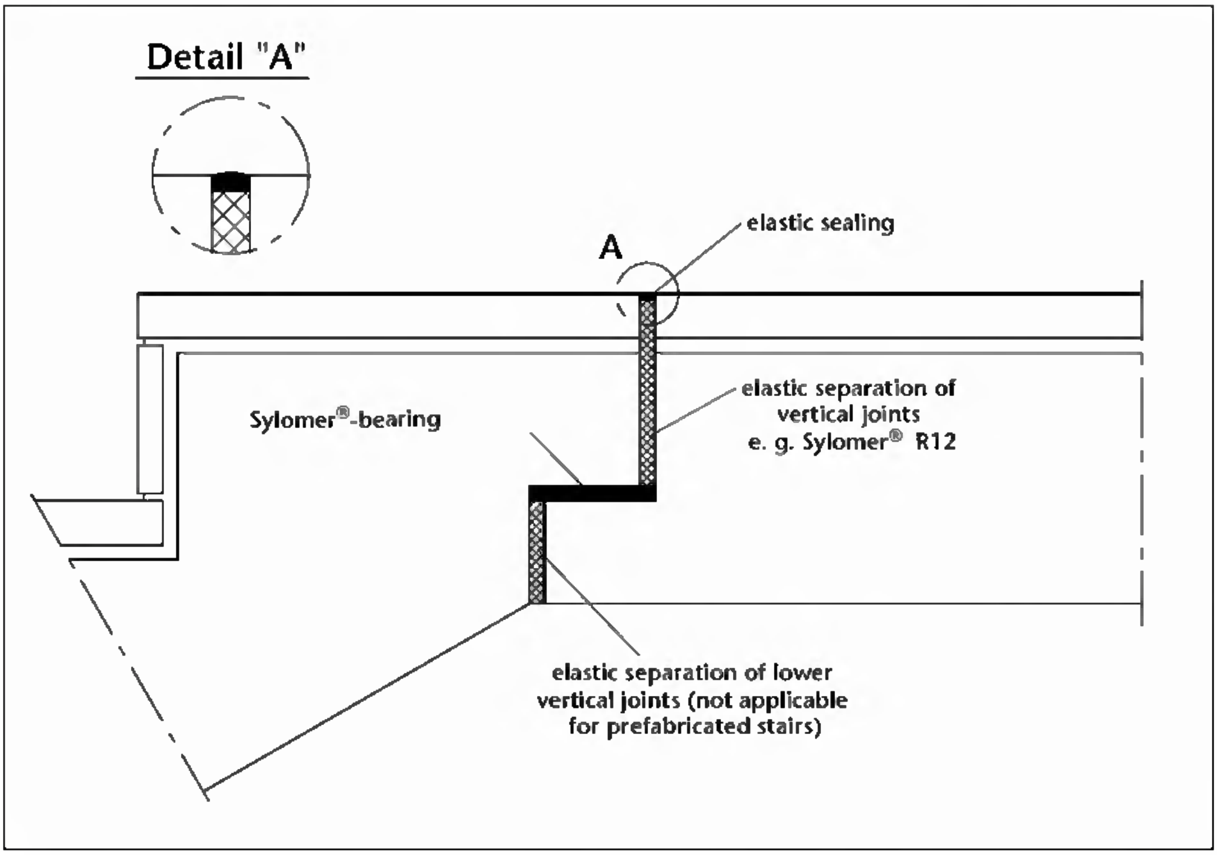
discrete bearing

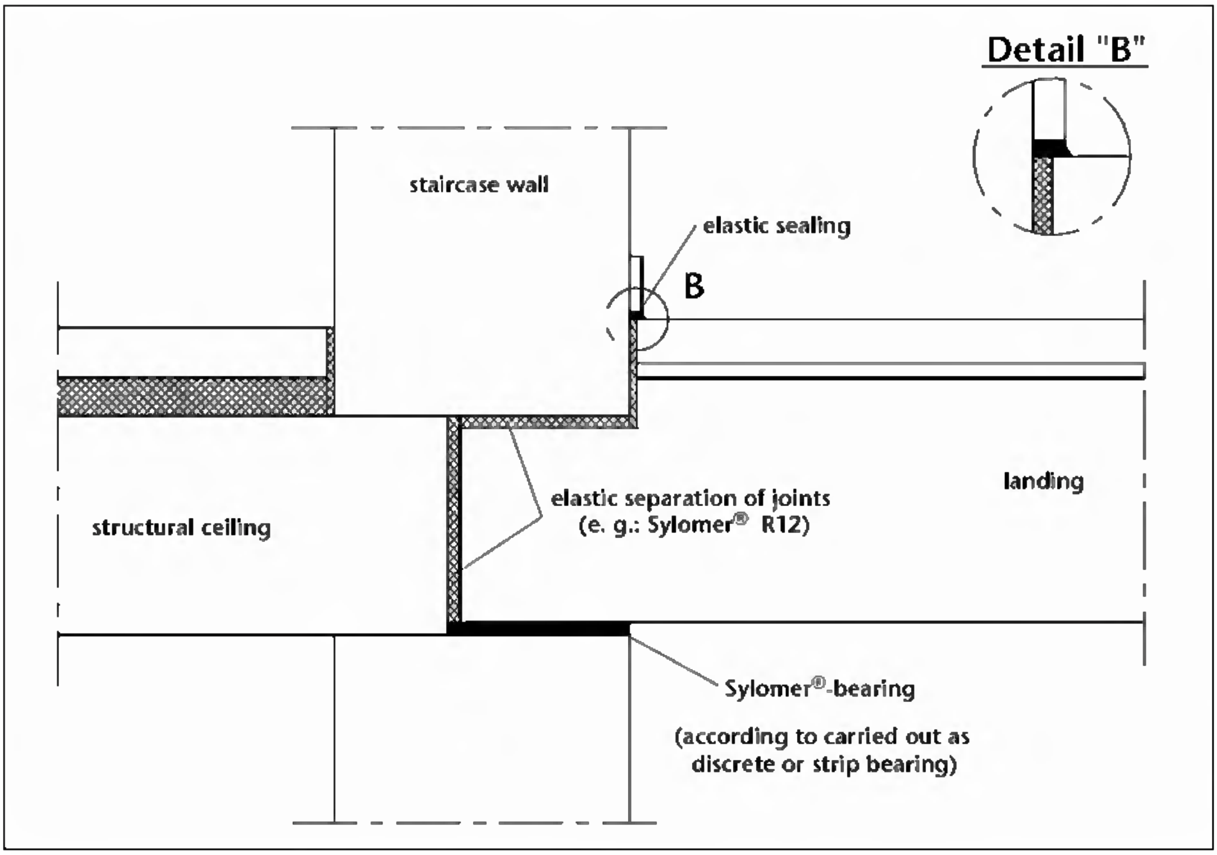


full surface bearing

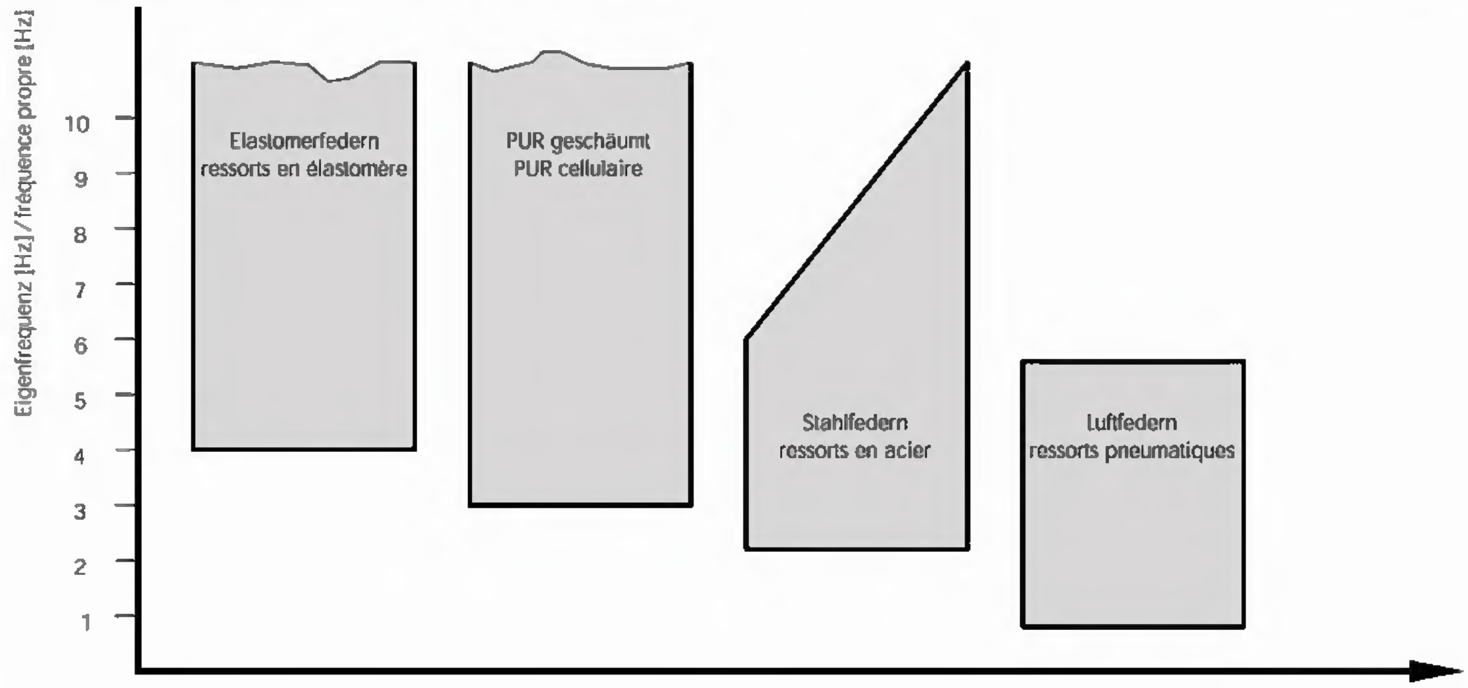


strip bearing

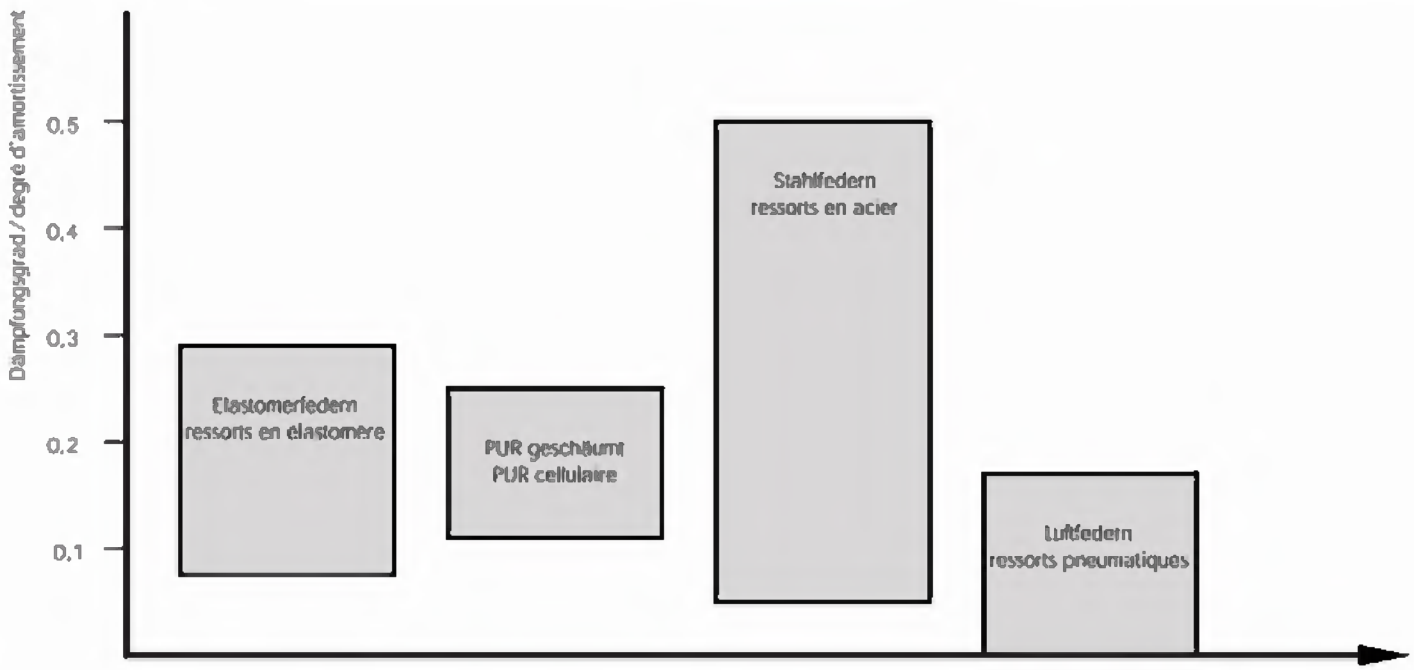

Detail "A"
A
elastic sealing
Sylomer®-bearing
elastic separation of
vertical joints
e. g. Sylomer® R12
elastic separation of lower
vertical joints (not applicable
for prefabricated stairs)


Detail "B"
staircase wall
elastic sealing
B
landing
structural ceiling
elastic separation of joints
(e. g.: Sylomer® R12)
Sylomer®-bearing
(according to carried out as
discrete or strip bearing)

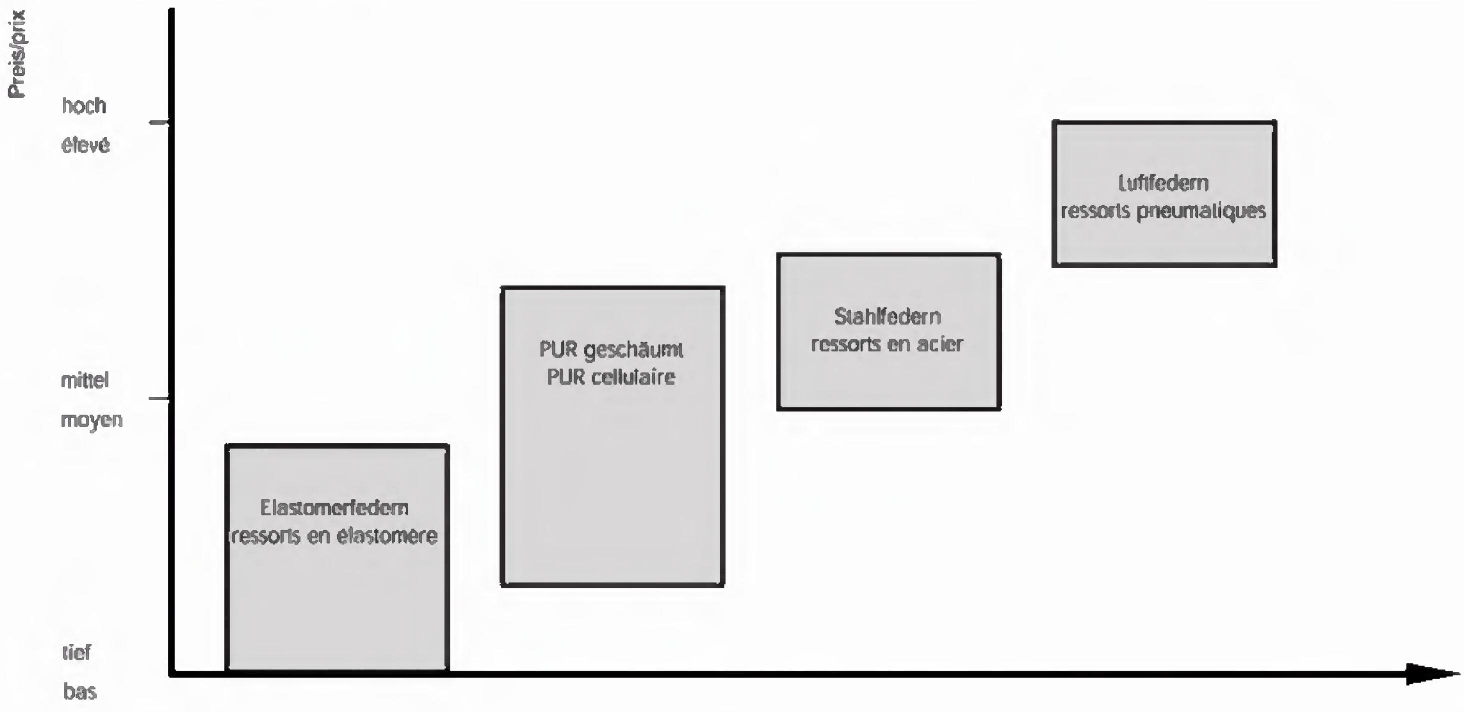
Ως προς την ιδιοσυχνότητα



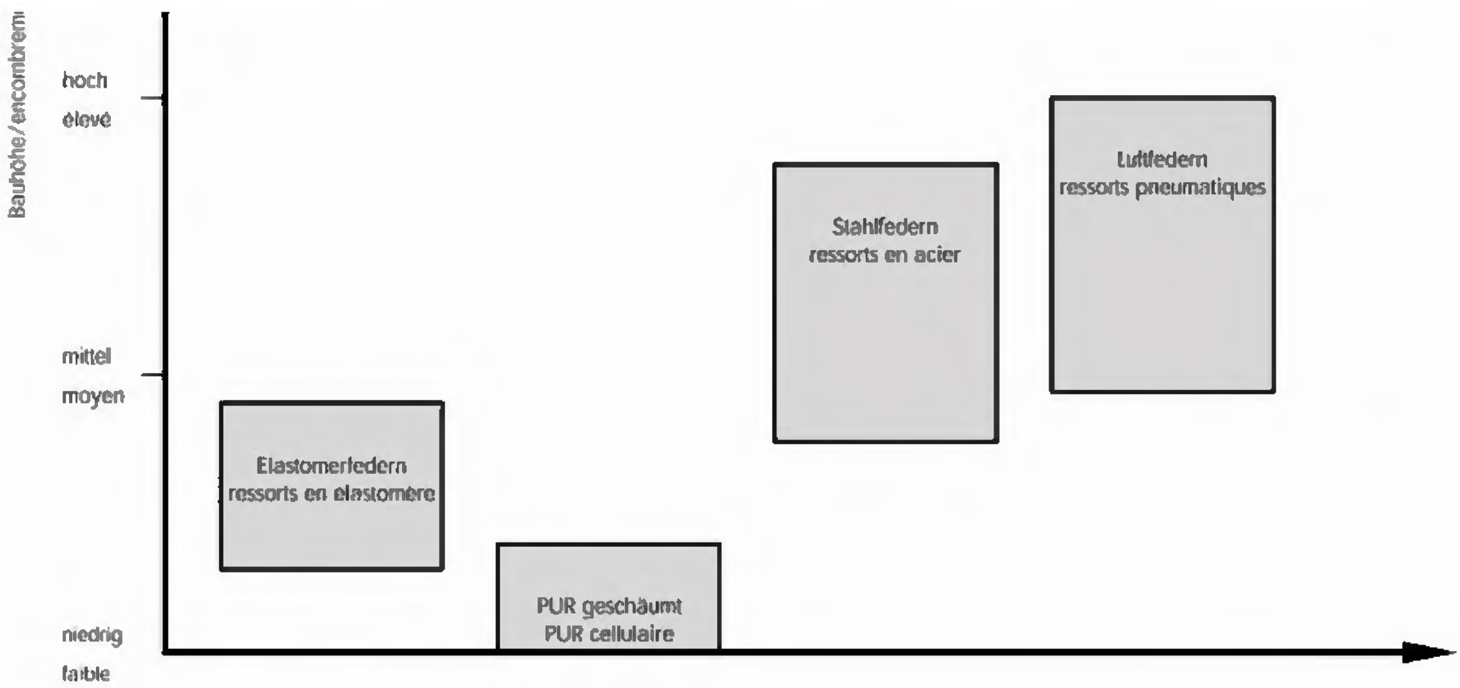
Ως προς την απόσβεση



Ως προς το κόστος



Ως προς το ύψος



1. Αποφασίζουμε την αναγκαία ικανότητας μετάδοσης, που πρέπει να έχει η έδραση, ώστε να τηρηθούν τα όρια προστασίας, ανάλογα με την περίπτωση.
2. Επιλέγουμε το είδος της βάσης πάνω στην οποία θα τοποθετηθεί το μηχάνημα.
3. Προσδιορίζουμε την θέση του κέντρου βάρους.
4. Ελέγχουμε την ευστάθεια ως προς το ύψος του κέντρου βάρους.
5. Προσδιορίζουμε το φορτίο για κάθε έδρανο ανάλογα με την θέση του κέντρου βάρους.
6. Επιλέγουμε το κατάλληλο υλικό ή συνδυασμό υλικών.
7. Φροντίζουμε ώστε οι συνδέσεις (σωληνώσεις, καλώδια κλπ) να είναι τοποθετημένα έτσι, ώστε να μην αναιρούν την έδραση του μηχανήματος.

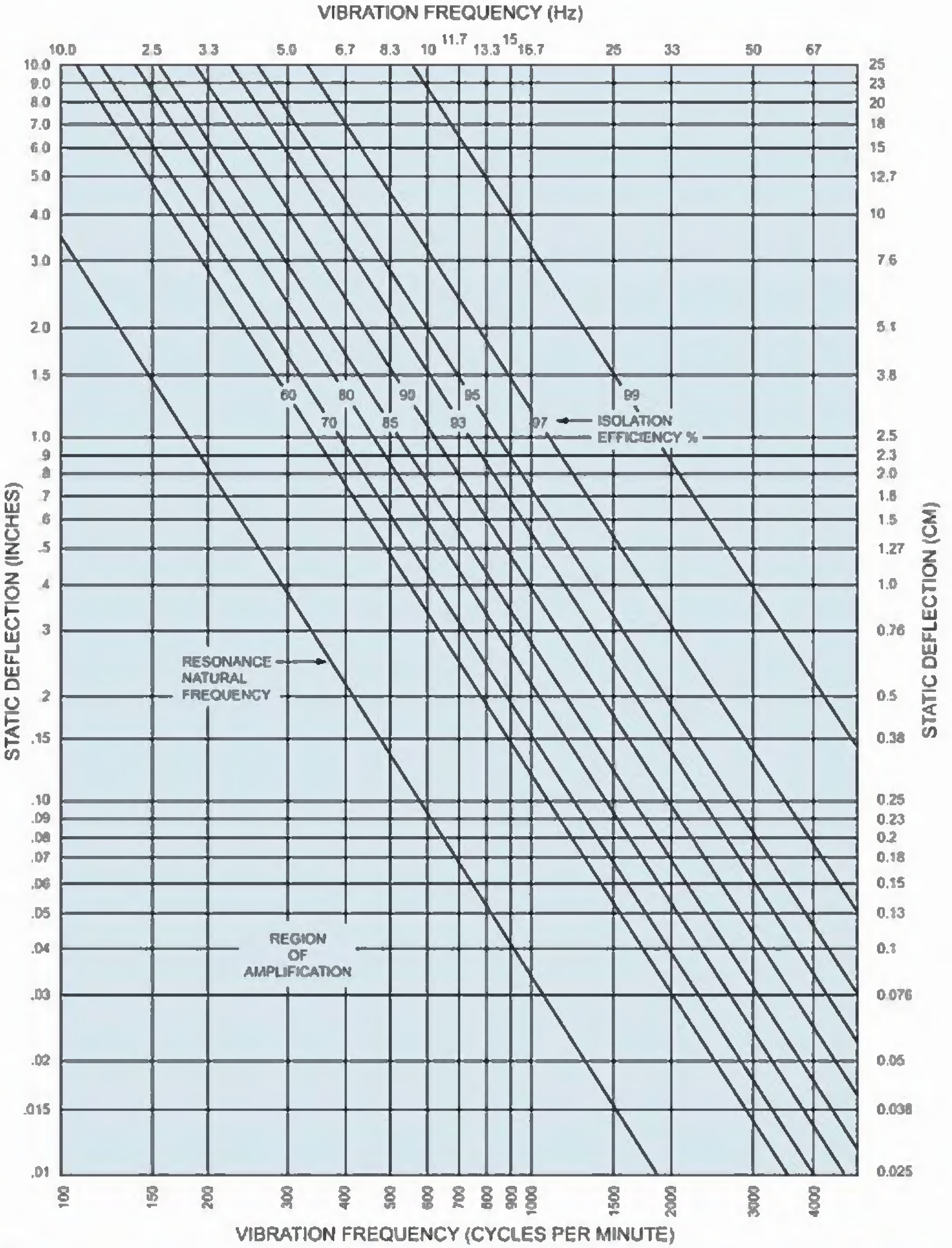
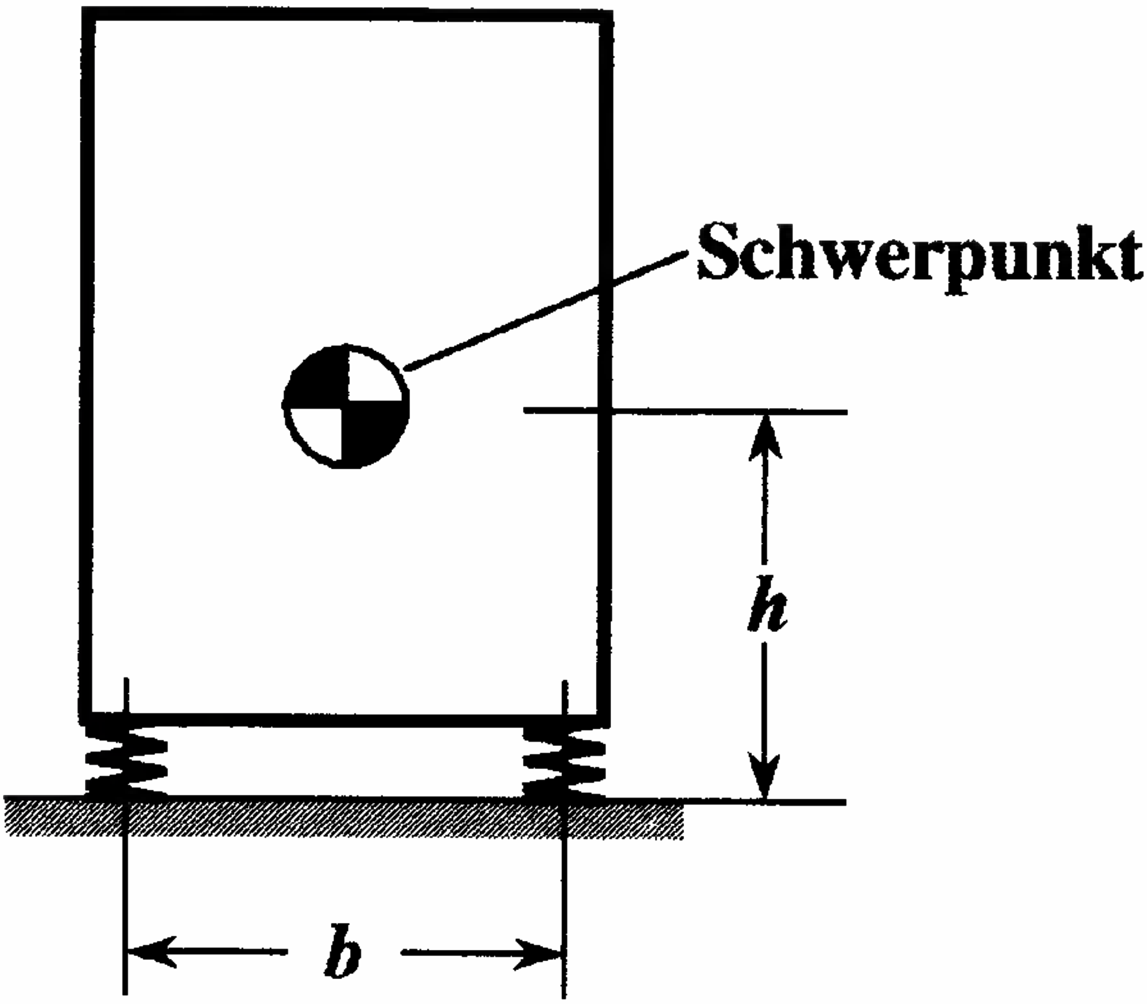


Figure 12 Vibration Frequency vs Static Deflection of Isolators vs Isolation Efficiency

1. Αύξηση της στατικής σταθερότητας.
2. Μετατόπιση του κέντρου βάρους χαμηλότερα.
3. Ομαλοποίηση της κατανομής βάρους σε κάθε έδρανο.
4. Ελαχιστοποίηση της επίδρασης εξωτερικών δυνάμεων.
5. Αύξηση της ακαμψίας της συνολικής κατασκευής.
6. Μείωση προβλημάτων, λόγω συζευγμένων μορφών ταλάντωσης.
7. Μείωση της πιθανότητας αστοχίας, σε περίπτωση λανθασμένου προσδιορισμού του κέντρου βάρους του μηχανήματος.
8. Λειτουργεί σαν τοπικό ηχοπέτασμα.



$$b > \sqrt{40 \cdot h \cdot \delta_{stat}}$$

If the flatness tolerance is assumed to be 5% of x_{st}, then it can be realized only for small objects mounted on flat tables, especially for higher f_n.

With the assumption of perfectly flat mounting surfaces, load distribution between mounting points is given below for some basic object configurations.

In the case of a fully symmetrical four-point mounting system in Figure 30, the static load at each support point is equal to the total system weight (W) divided by the number of mounts (4). Thus,

$$P_1 = P_2 = P_3 = P_4 = \frac{W}{4} \tag{24}$$

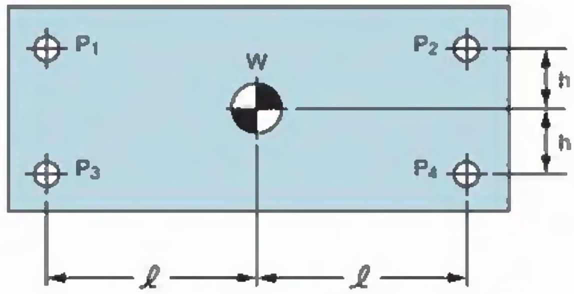


Figure 30 Symmetrical Four-Point Mounting System

NOTE: It is assumed for the purpose of Figures 30, 31 and 32, that the loaded surface as supported by the points P_1, P_2, P_3, P_4, P_5 and P_6, is in the horizontal plane.

Figure 31 describes a four-point mounting system where the C.G. is not at the geometric center. The static load for each of the four mounting points is:

$$\left.\begin{aligned} P_1 &= \left[\frac{BD}{AC}\right] W & P_3 &= \left[\frac{(C-D)\,B}{AC}\right] W \\ P_2 &= \left[\frac{(A-B)\,D}{AC}\right] W & P_4 &= \left[\frac{(A-B)\,(C-D)}{AC}\right] W \end{aligned}\right\} \tag{25}$$

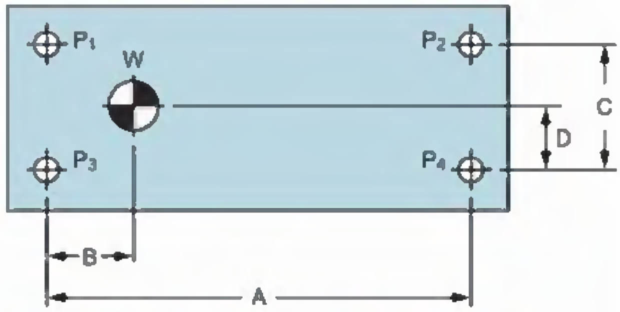


Figure 31 Nonsymmetric Four-Point Mounting System

Figure 32 illustrates a system which is symmetrical about one plane and the C.G. is offest from the geometric center on that plane. In such a system pairs of diagonals will carry equal loads. The static loading is given by the following equations:

$$\left.\begin{aligned} (P_1 + P_6) = (P_4 + P_3) &= \frac{W}{3} \\ (P_1 + P_2 + P_3) = (P_4 + P_5 + P_6) &= \frac{W}{2} \end{aligned}\right\} \tag{26a}$$

$$\left.\begin{aligned} \text{where: } P_1 = P_4 &= \left[\frac{2C - 3A + D}{6C}\right] W \\ P_3 = P_6 &= \left[\frac{3A - D}{6C}\right] W \\ P_2 + P_5 &= \frac{W}{3} \\ \text{and} \quad P_2 = P_5 &= \frac{W}{6} \end{aligned}\right\} \tag{26b}$$

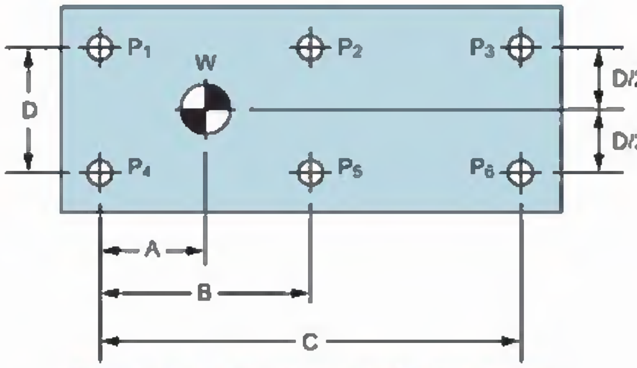
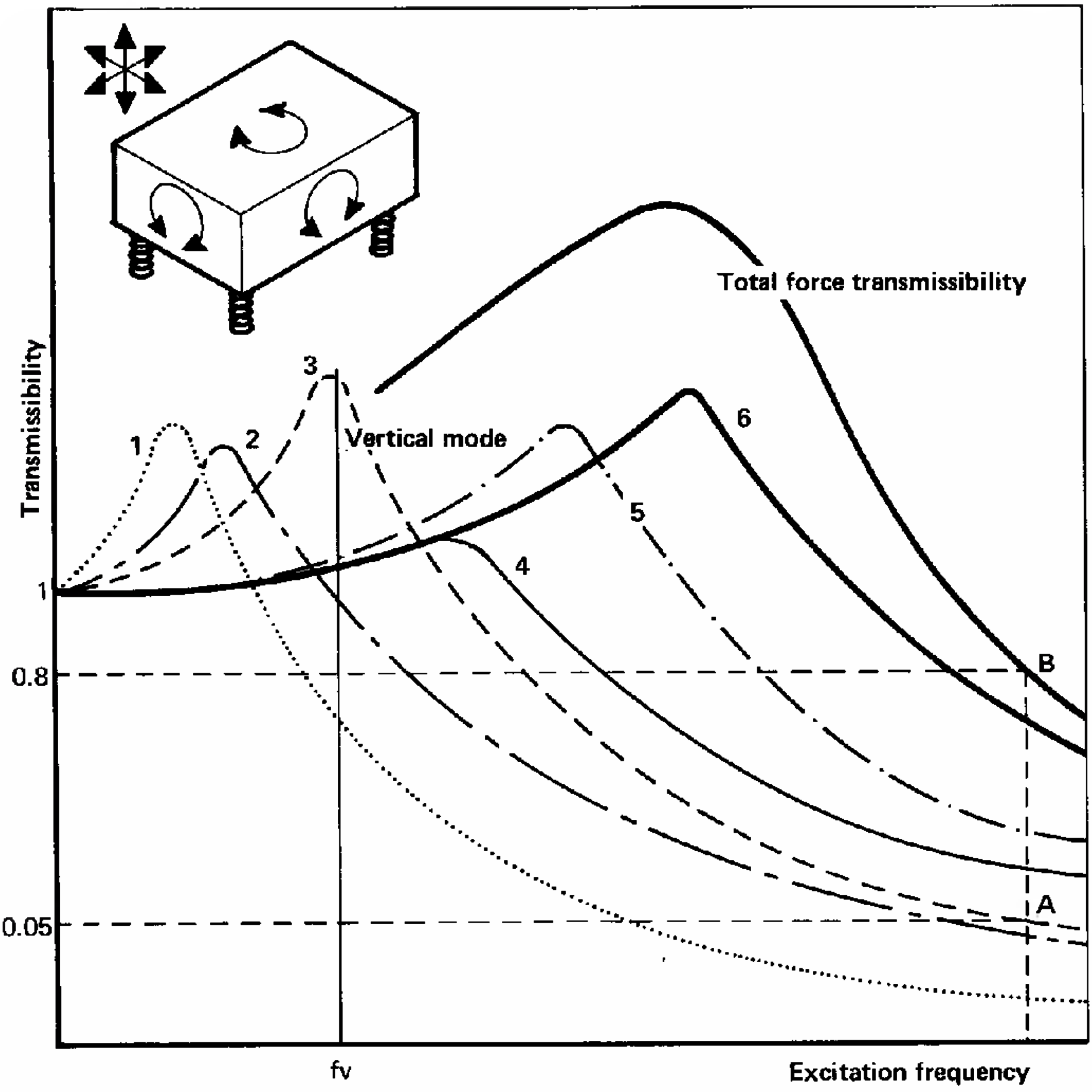


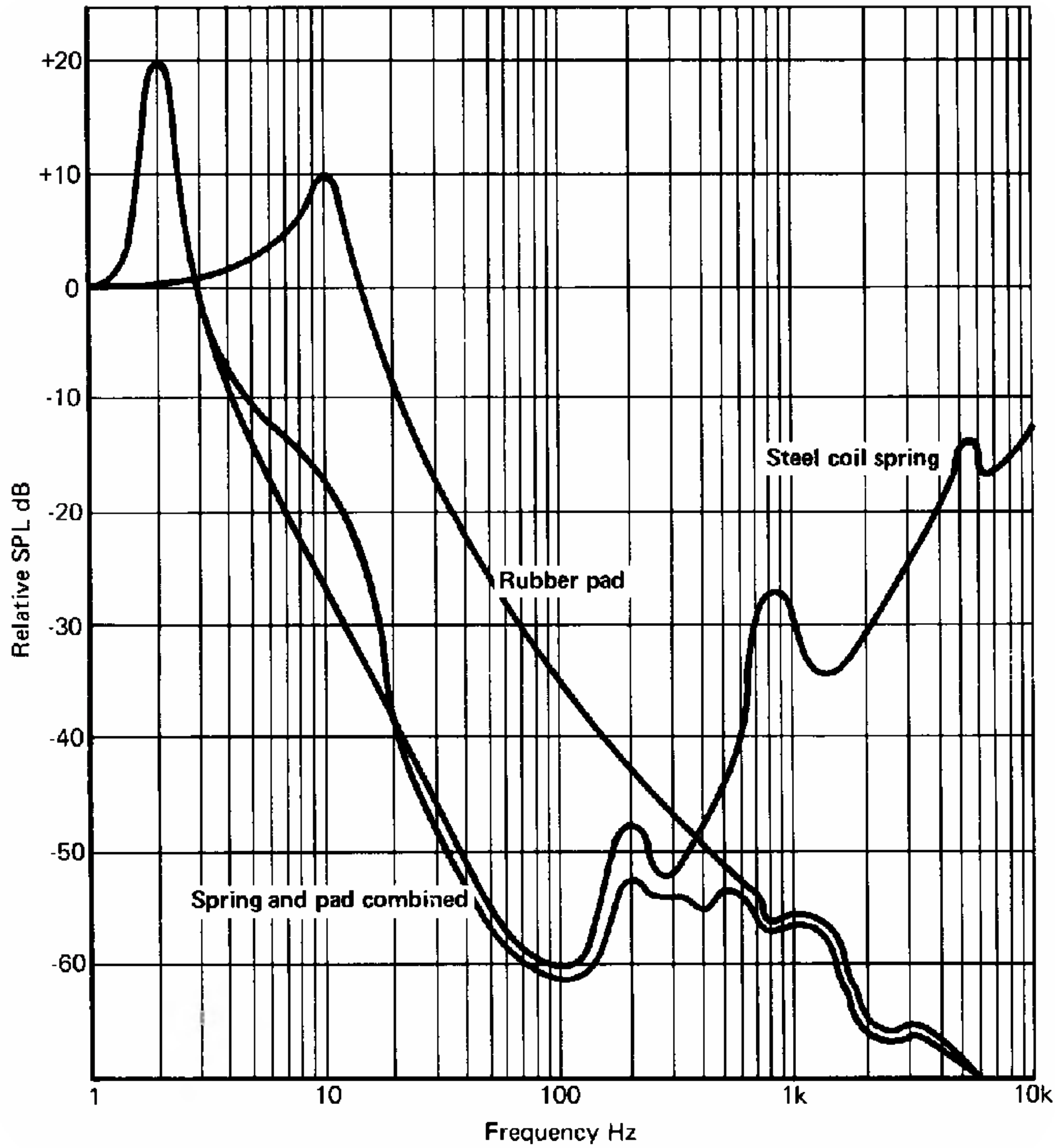
Figure 32 Nonsymmetric Six-Point Mounting System

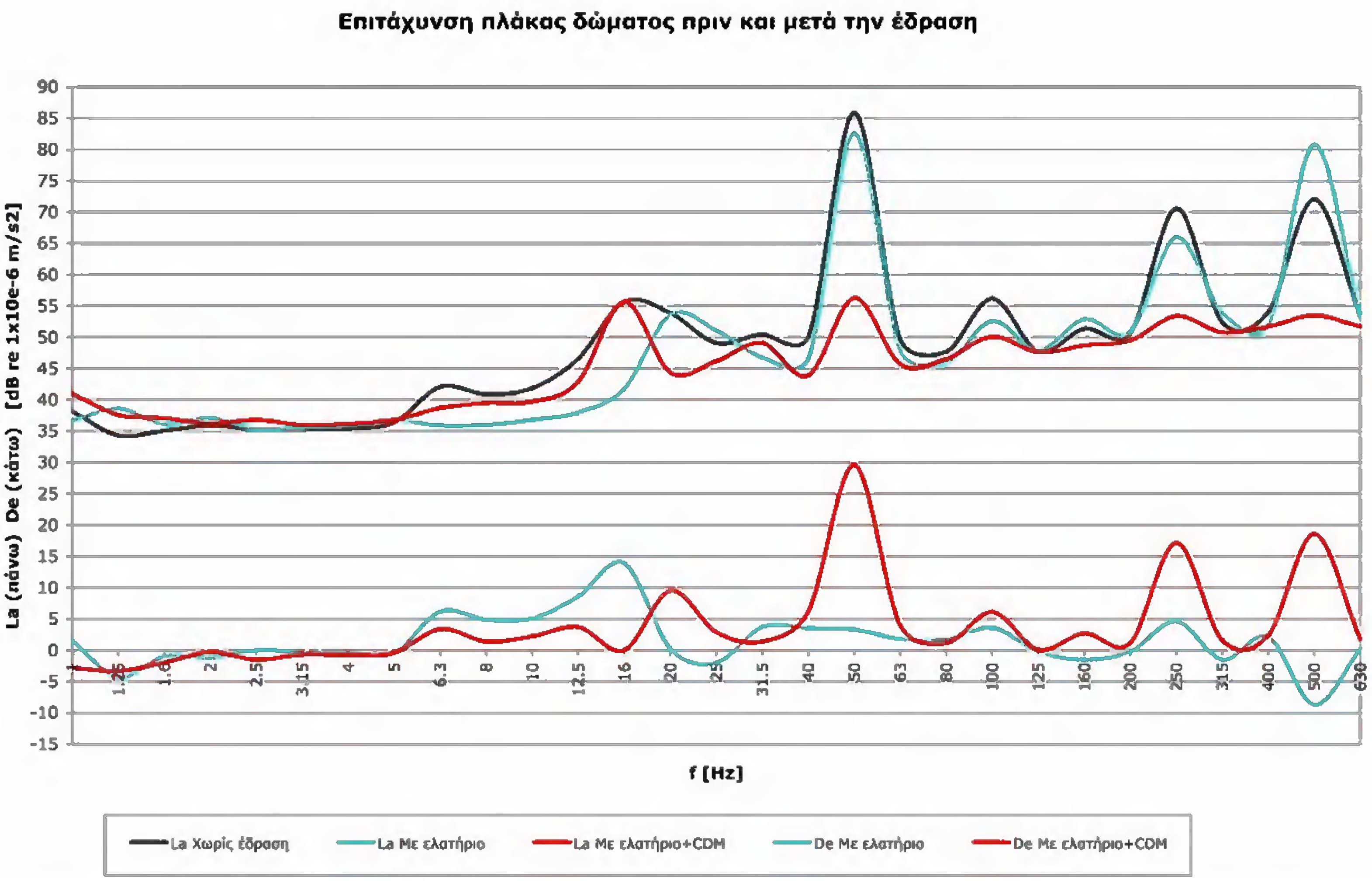


fv = Natural frequency of vertical mode alone

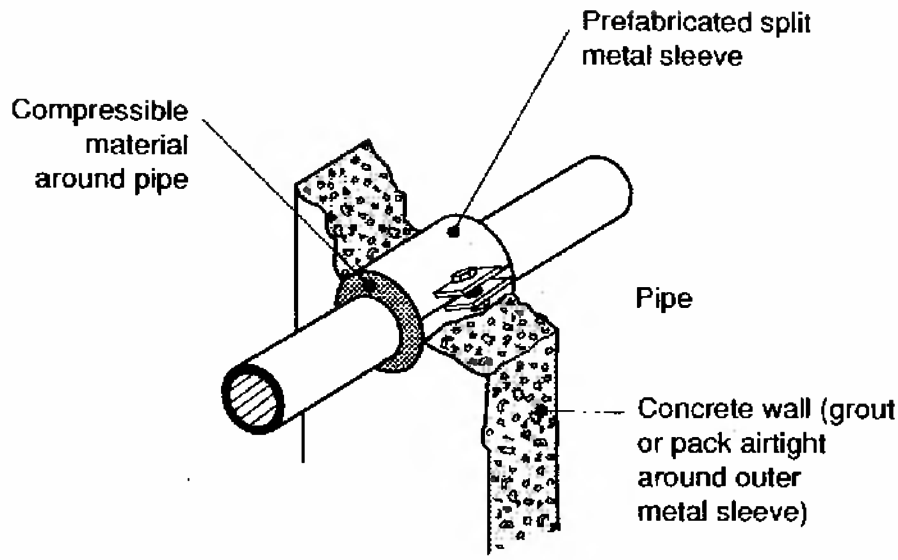
A = Expected transmissibility 5% from pure vertical motion

B = Actual transmissibility 80% from the combined coupled motions

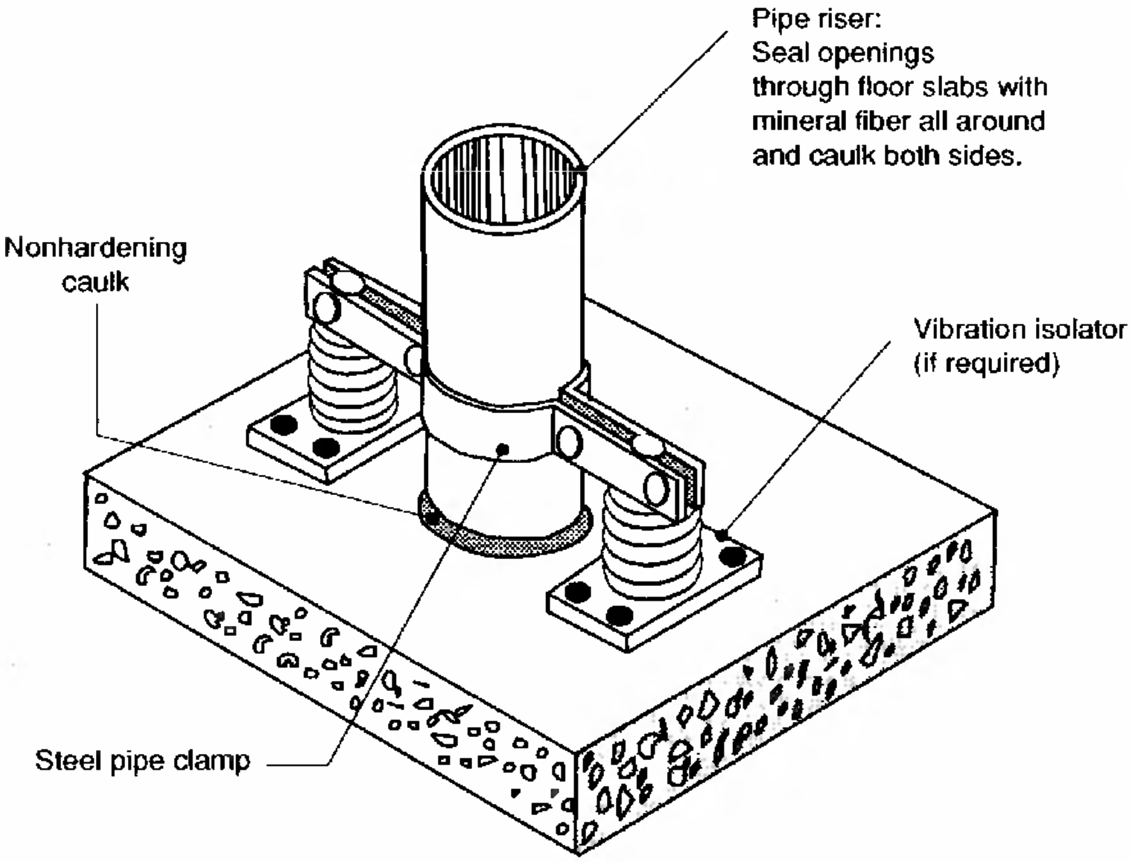

+20
+10
0
-10
-20
-30
-40
-50
-60
Relative SPL dB
Steel coil spring
Rubber pad
Spring and pad combined
1
10
100
1k
10k
Frequency Hz



Επιτάχυνση πλάκας δώματος πριν και μετά την έδραση
La (πάνω) De (κάτω) [dB re 1x10e-6 m/s2]
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
1.25
1.6
2
2.5
3.15
4
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
f [Hz]
La Χωρίς έδραση
La Με ελατήριο
La Με ελατήριο+CDM
De Με ελατήριο
De Με ελατήριο+CDM



Horizontal Penetration



Vertical Penetration

Figure 1-54 Sealing pipe penetrations for sound isolation

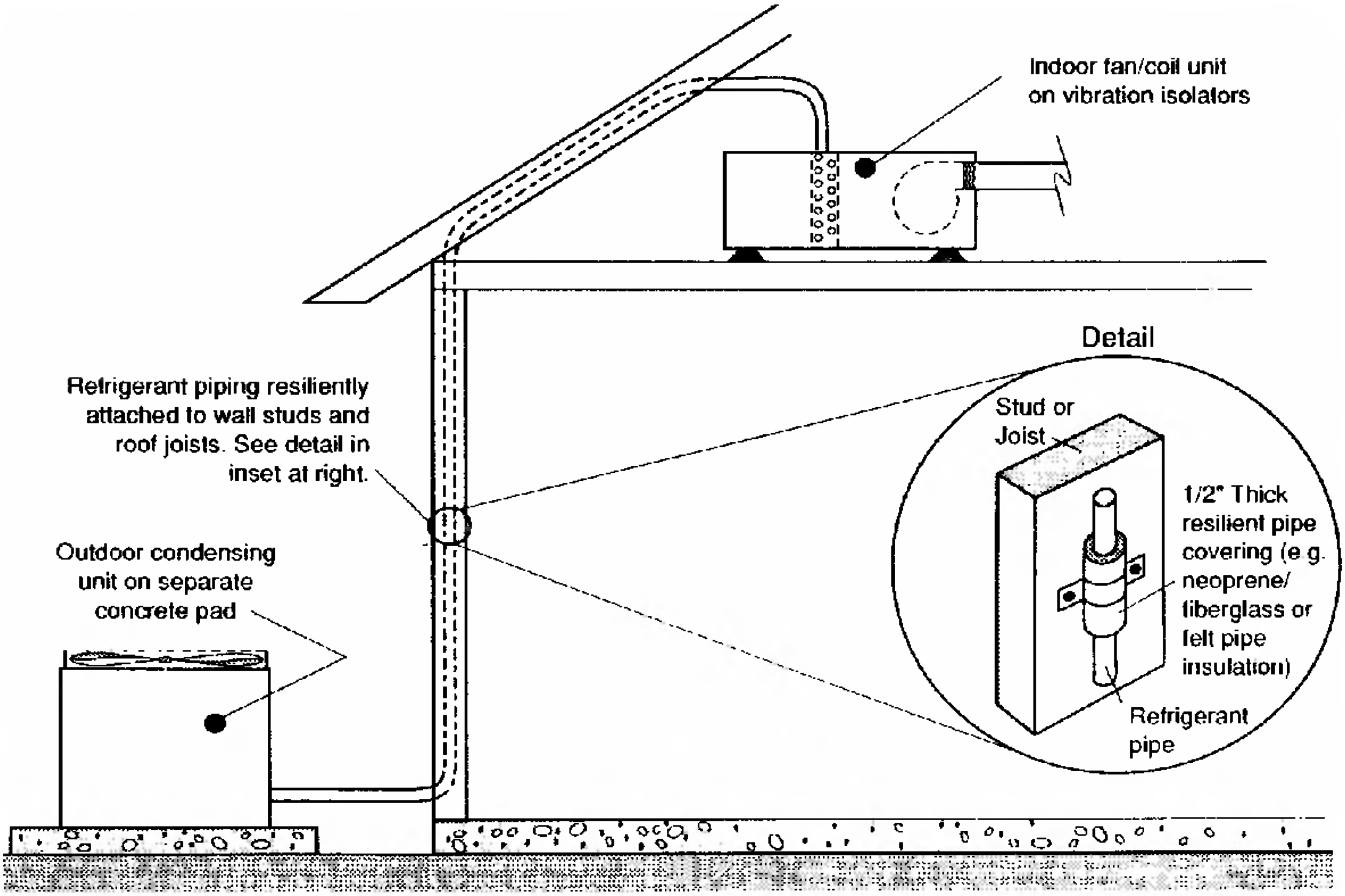


Figure 1-77 Guidelines for vibration isolation of split systems

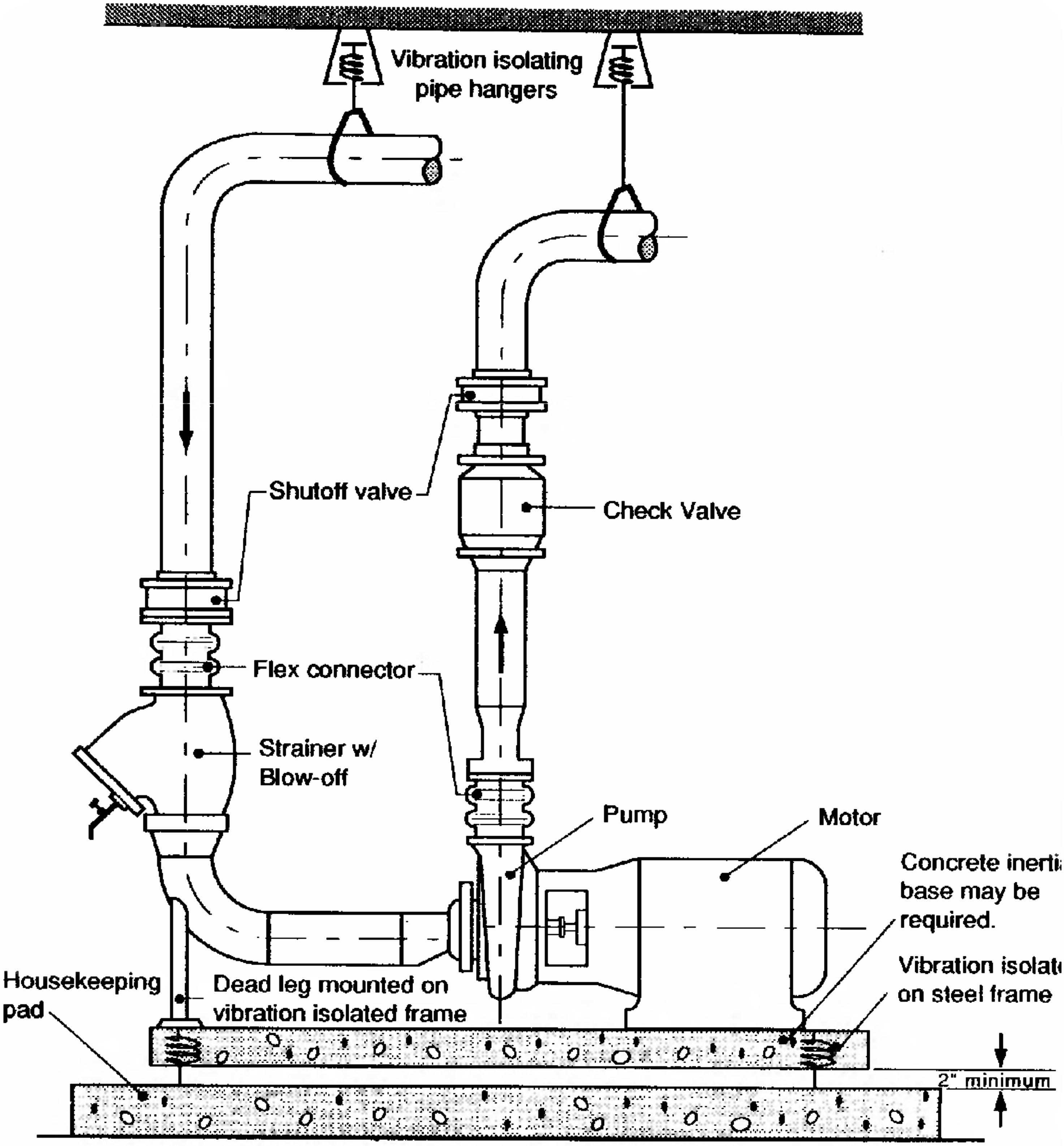


Figure 1-49 Guidelines for end suction pump installation

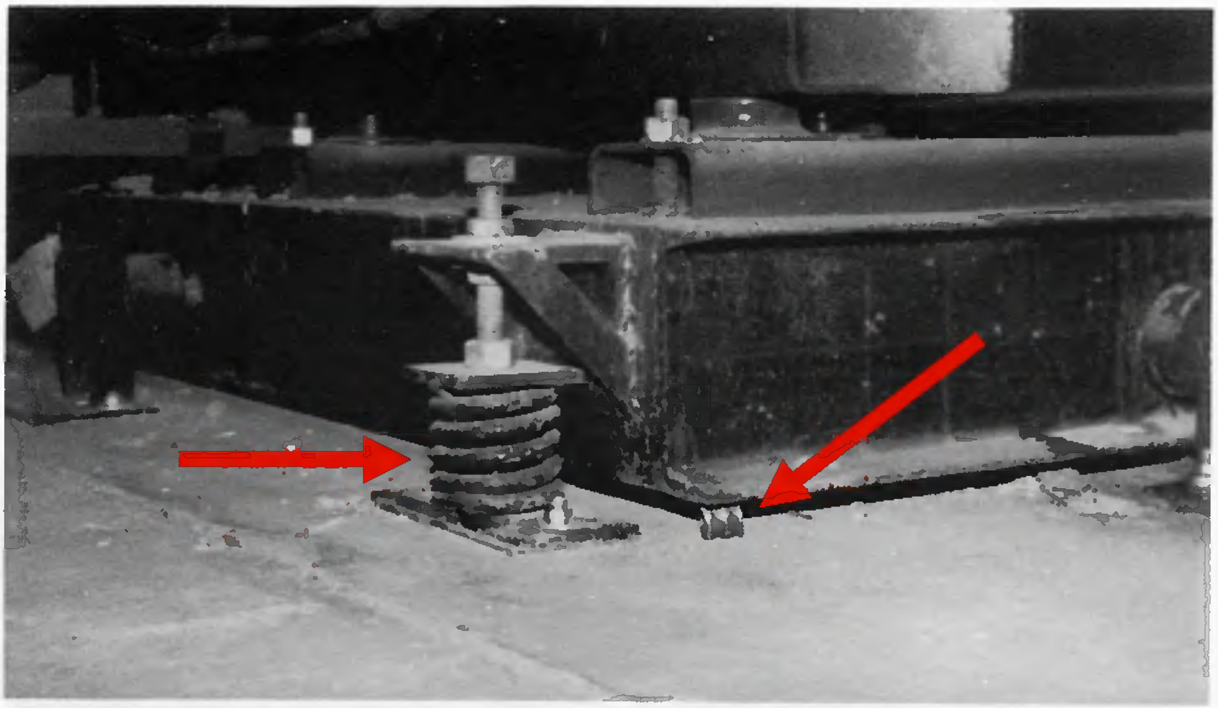


Figure 2-7 Construction debris short-circuiting isolator effectiveness. The small piece of flexible conduit forms a rigid contact path between the equipment frame and the slab, allowing equipment vibration to bypass the spring. Also note that the spring is overloaded and should be replaced with one that can accommodate a heavier load.

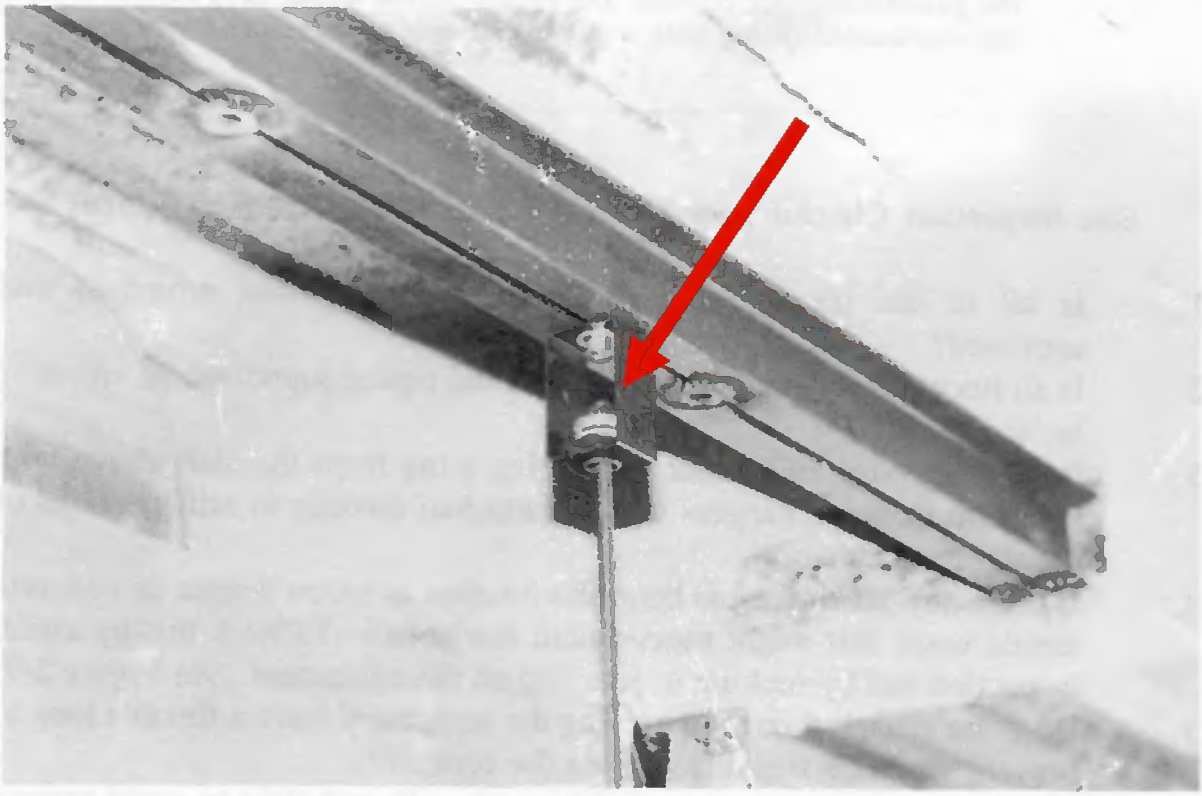


Figure 2-8 Overloaded spring hanger. Note the overcompression of the spring coils.

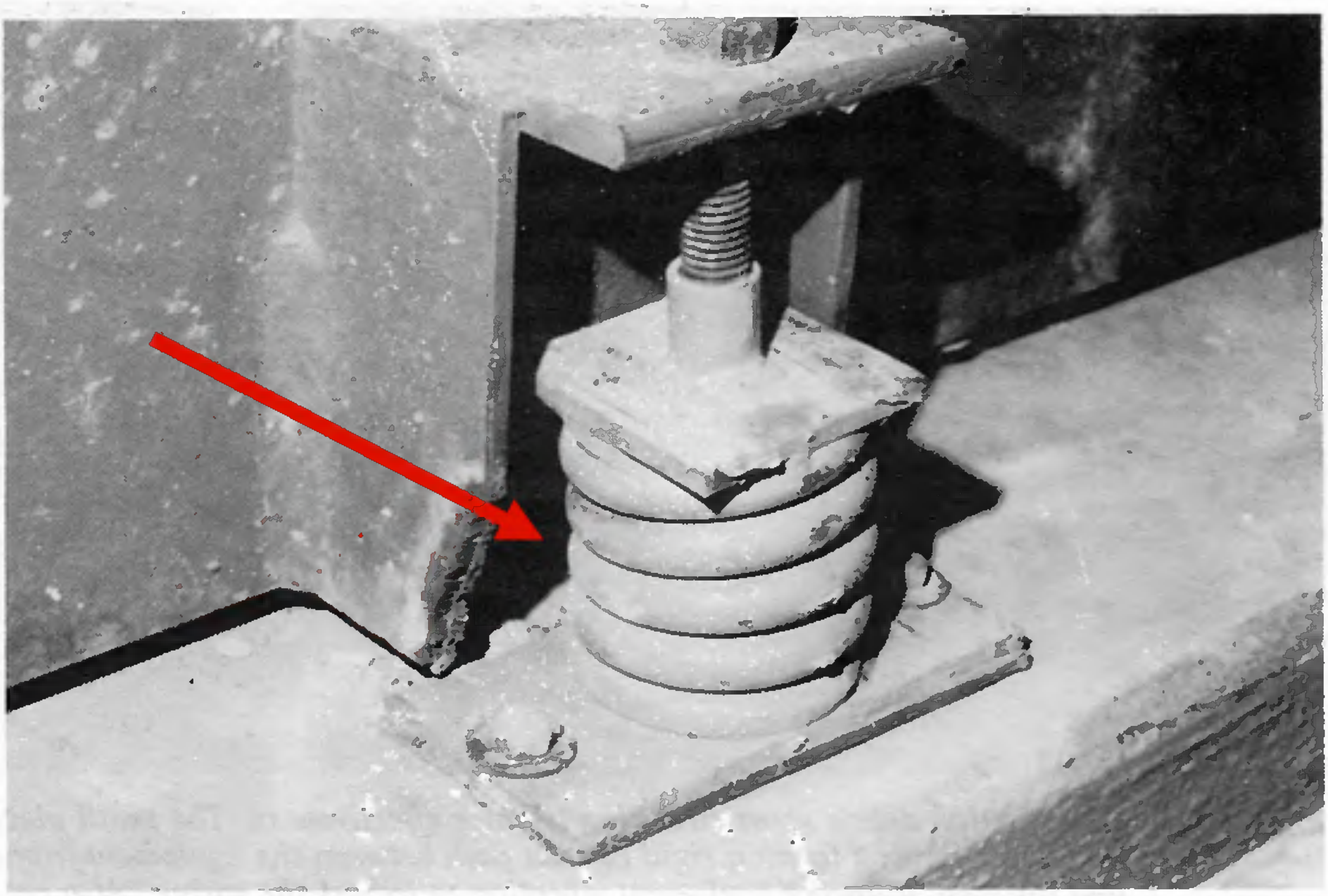


Figure 2-9 *Overloaded freestanding isolator. The overloading allowed the gussets welded to the side of the equipment frame to rest on top of the isolator baseplate. The lower right corner of the gusset was burned off to eliminate the gusset/baseplate contact. The proper action would have been to replace the overloaded spring with a stiffer one able to carry the heavy load.*

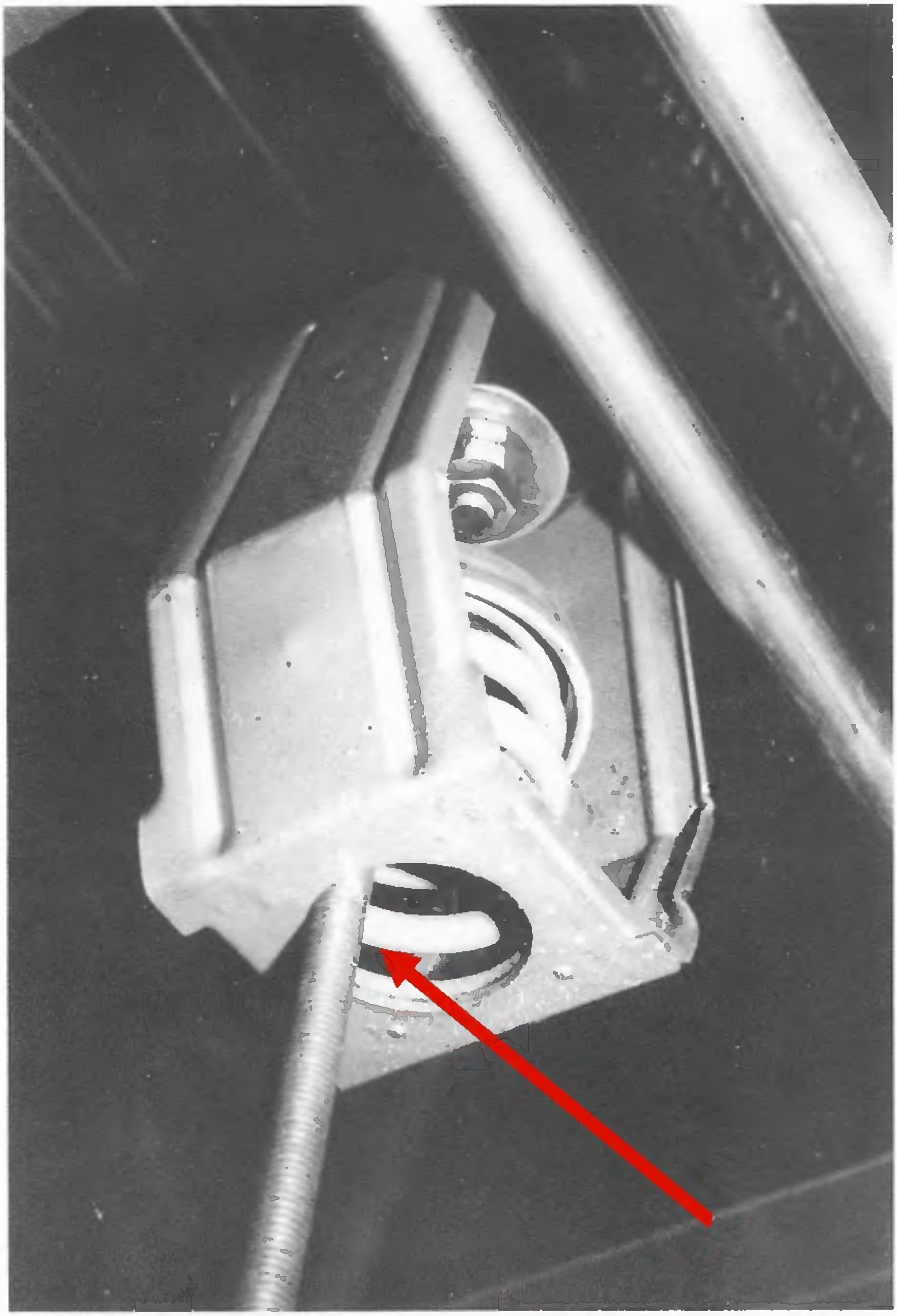


Figure 2-10 Faulty spring hanger installation. The hanger rod touches the side of the hole in the bottom of the hanger box. This allows pipe vibration to bypass the spring and enter the building structure above.

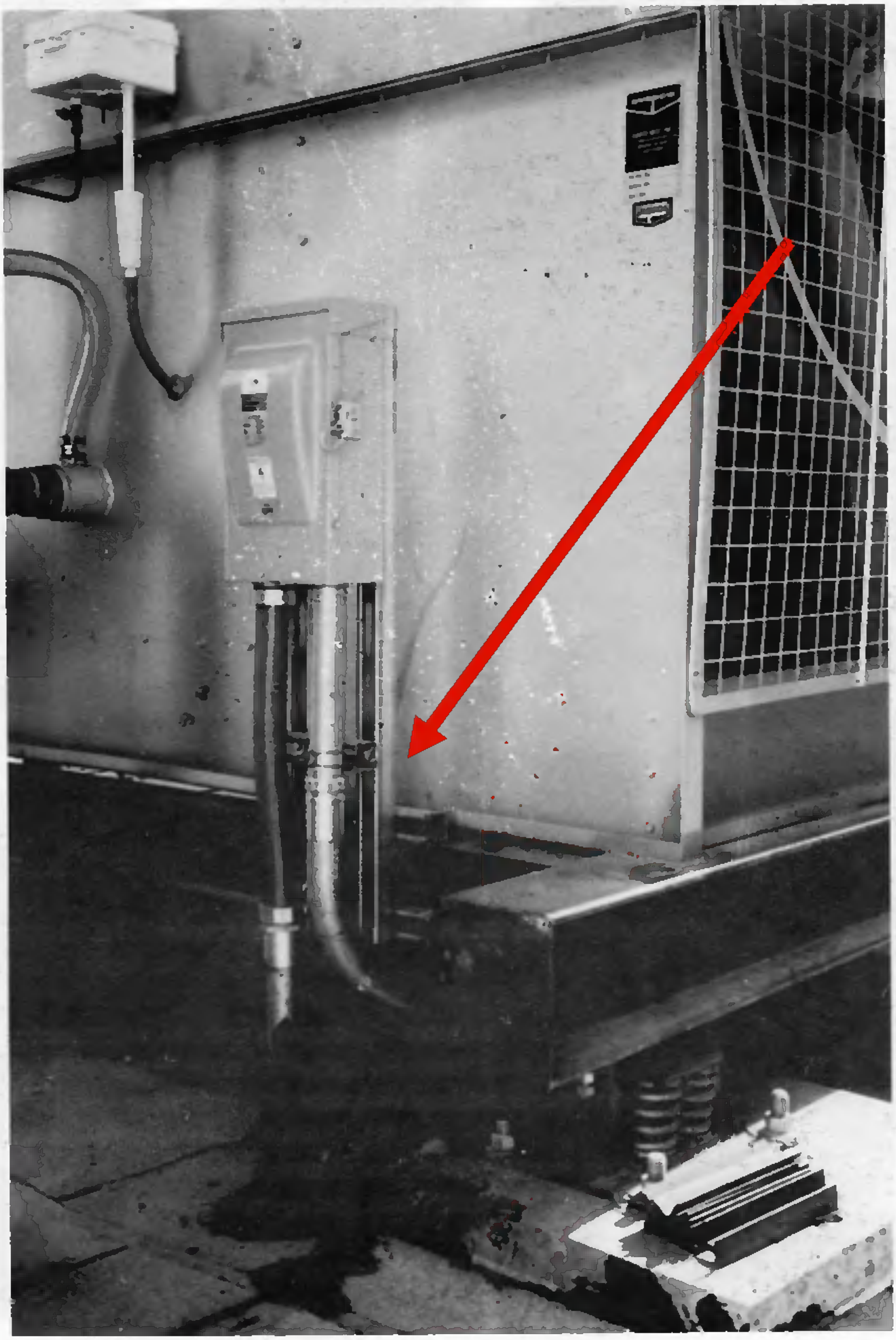


Figure 2-11 *Taut outdoor "flexible" conduit forms a vibration short-circuit at cooling tower. The grillage under the cooling tower is resting on spring isolators, but the short conduit between the disconnect and the roof penetration transmits tower vibration into the roof.*

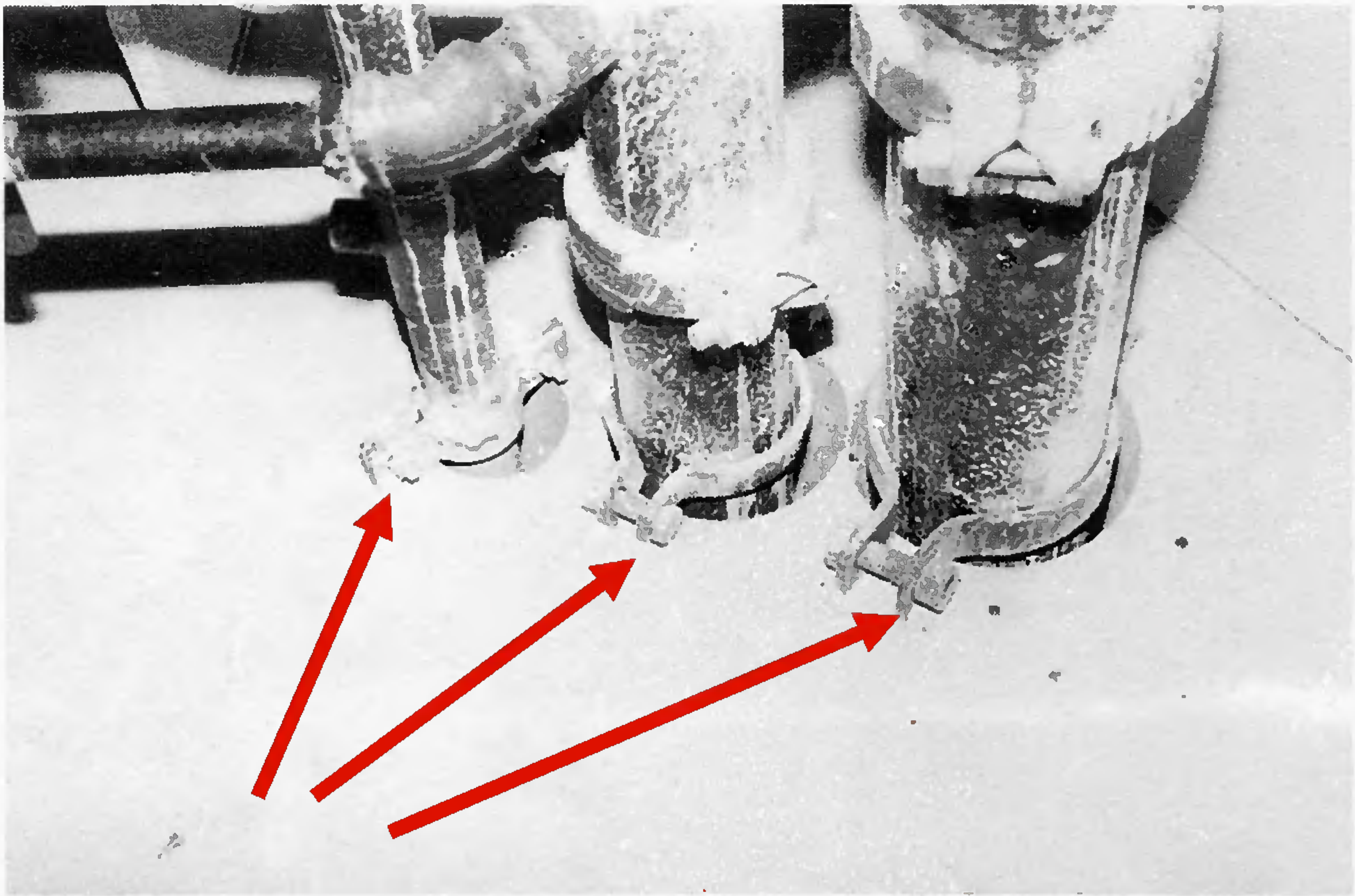


Figure 2-12 *Pipe risers without vibration isolation. The pipe clamps transmit pipe vibration to the slab.*

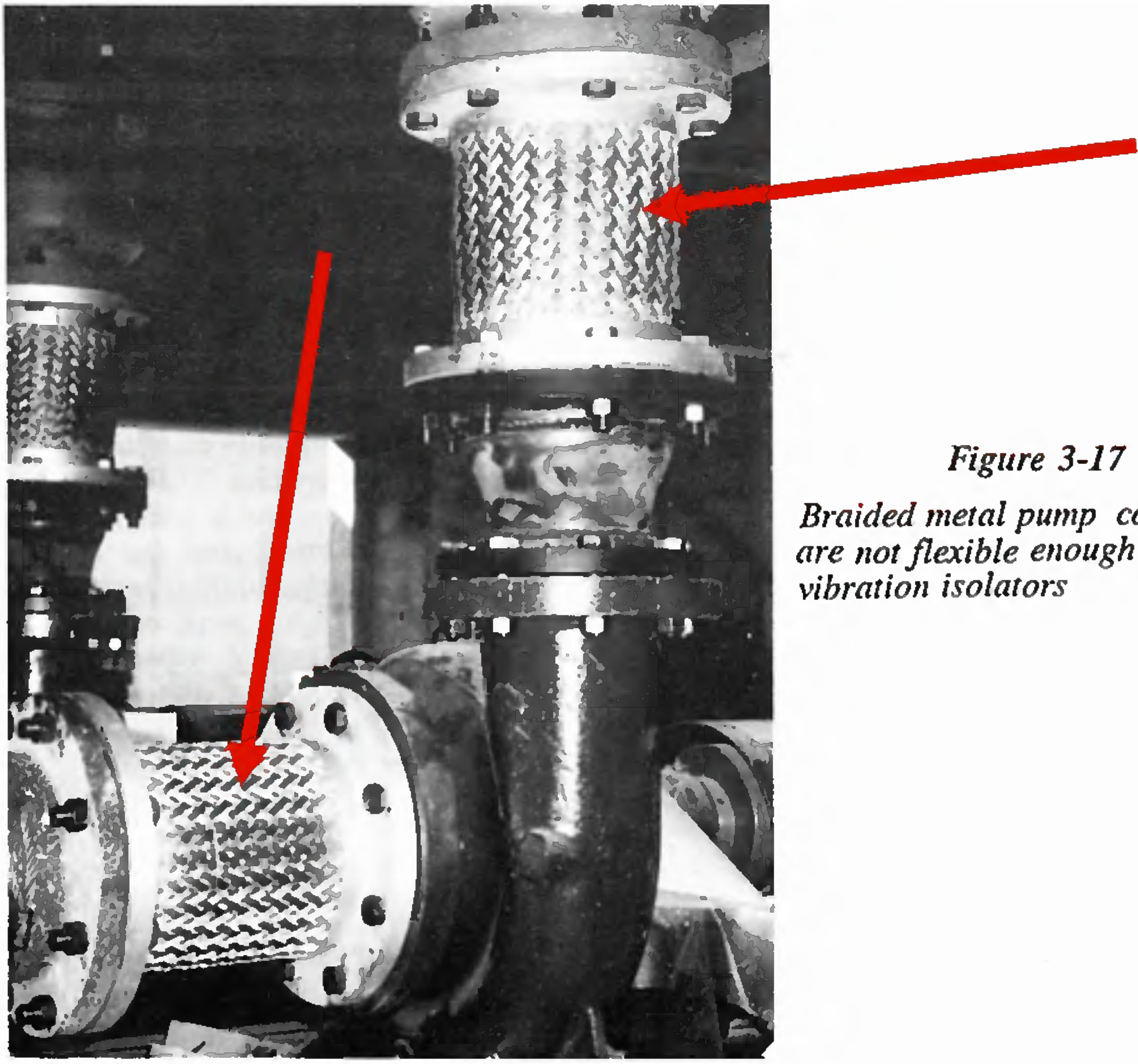


Figure 3-17

Braided metal pump connectors are not flexible enough to act as vibration isolators

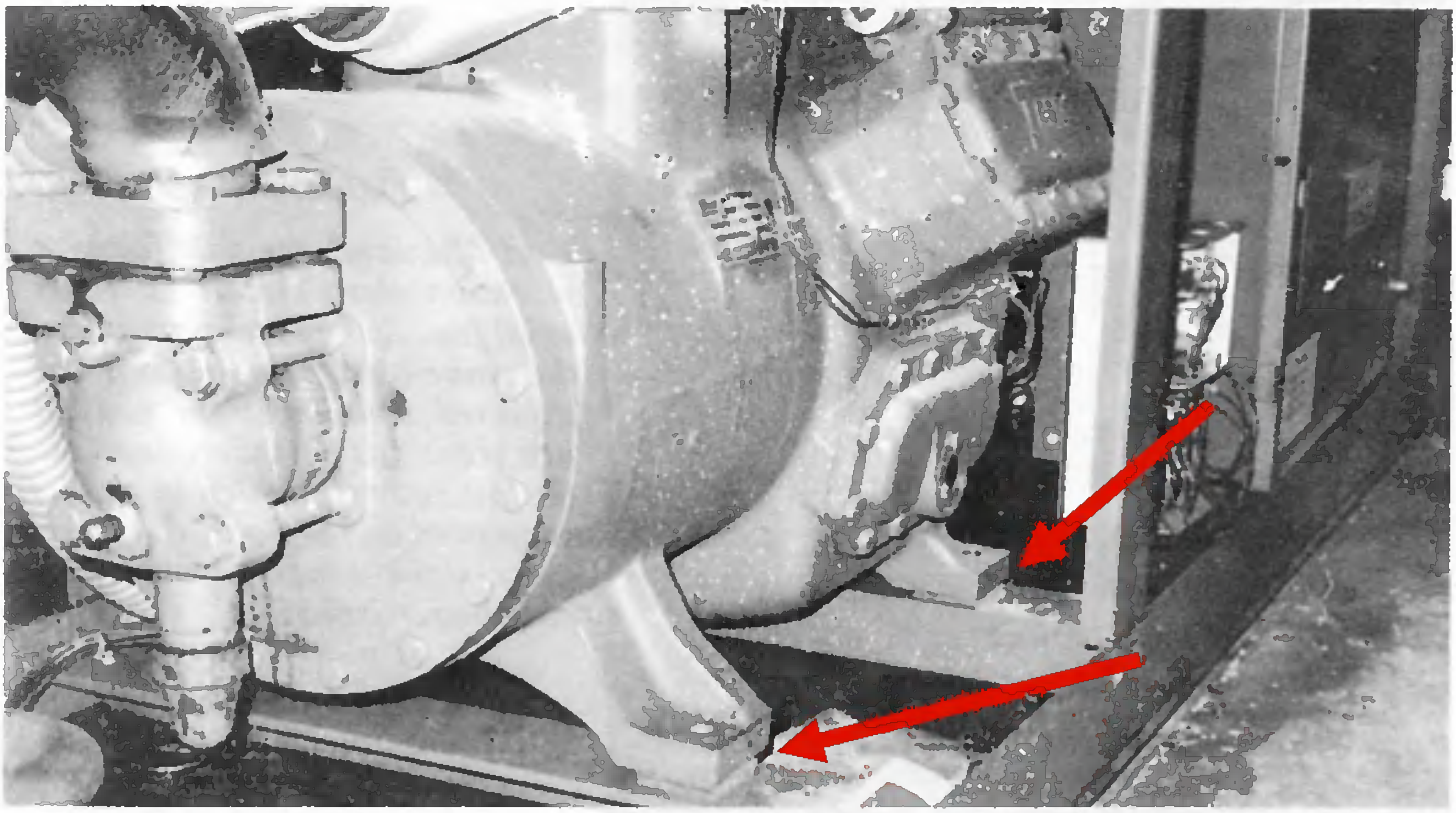


Figure 3-19 Compressor with insufficient vibration isolation. The small neoprene pad beneath the mounting foot was the only isolation between the compressor and the floor slab. Additional spring isolators supporting the entire unit were required for proper isolation.

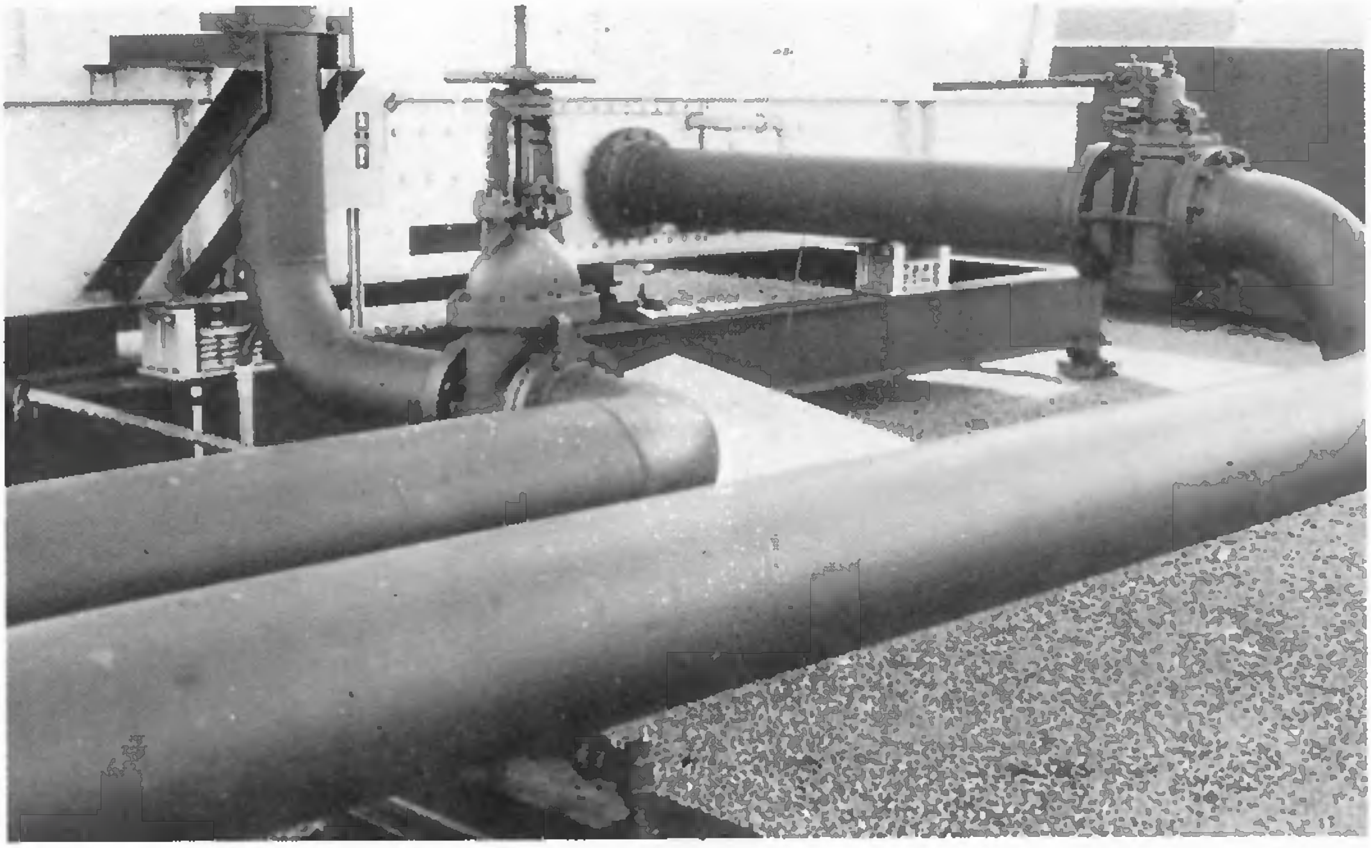


Figure 3-20 *Incomplete vibration isolation at cooling tower. Even though the tower is isolated, the condenser water pipe supports are mounted rigidly to the roof. This allows some tower vibration to enter the roof structure.*

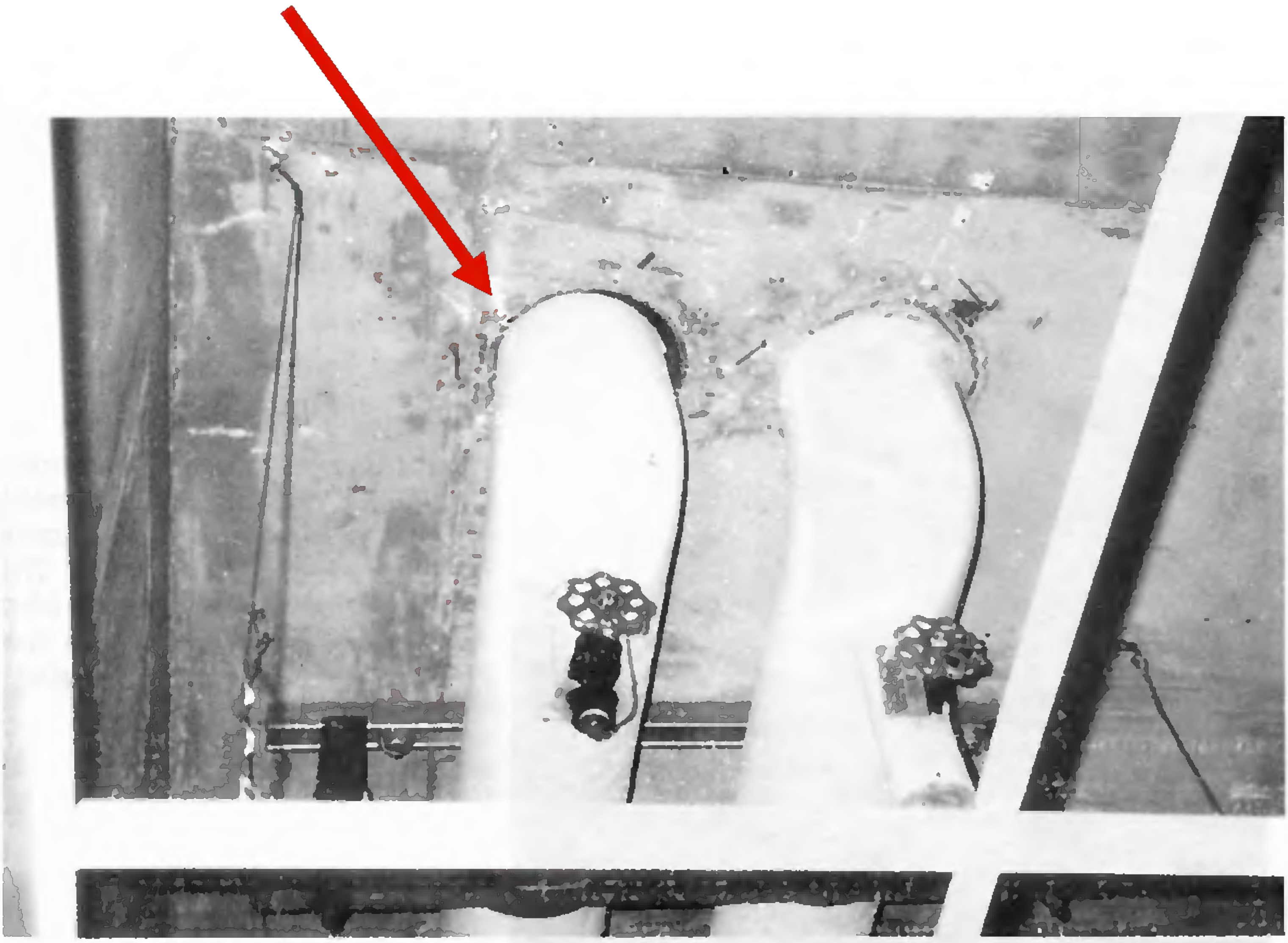


Figure 3-23 *View of pipe penetration from below roof. The pipe on the right is contacting the left edge of its penetration. This installation allowed pipe vibration to excite the roof slab, which radiated the energy as noise.*

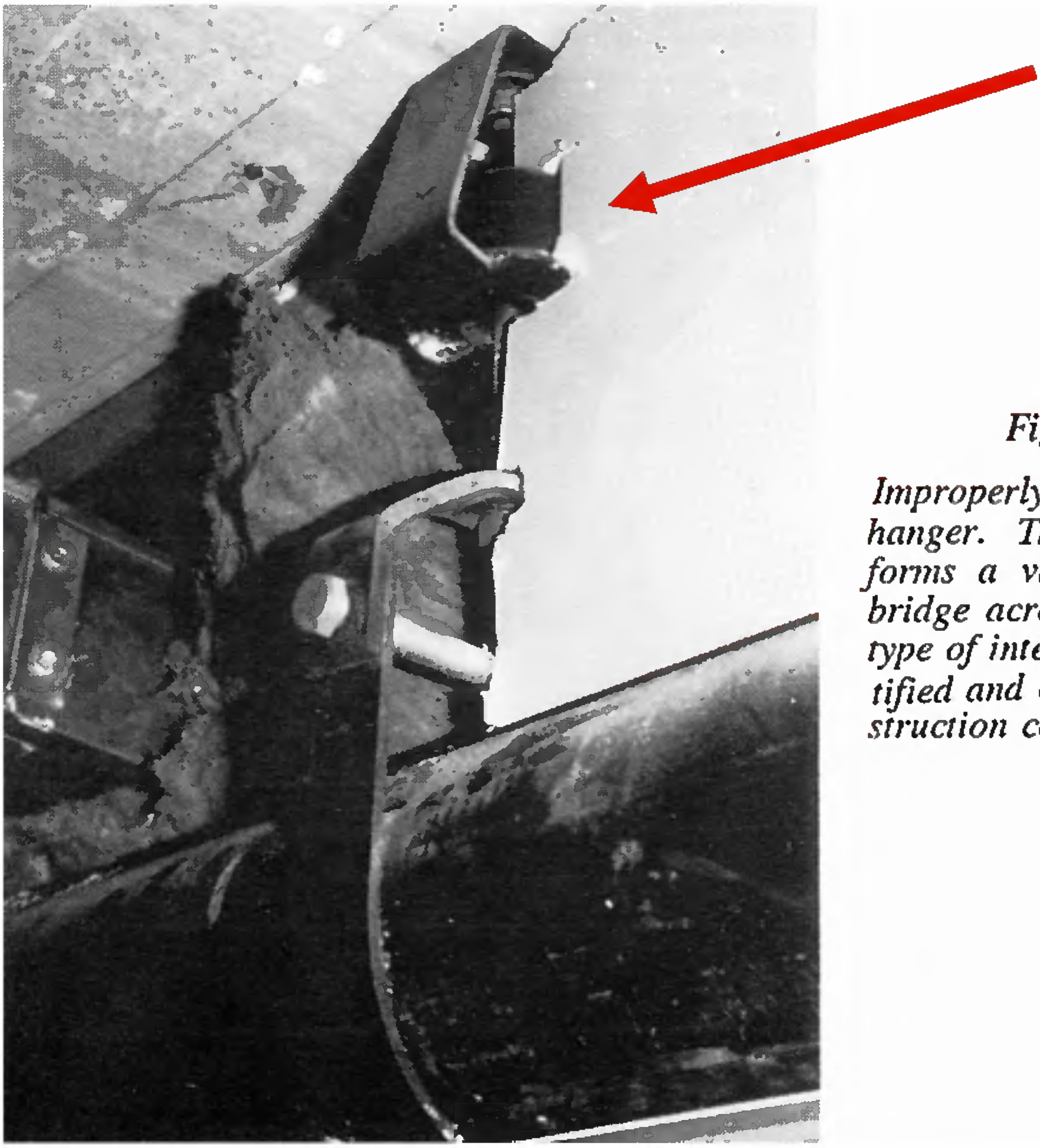


Figure 3-25

Improperly placed neoprene hanger. The drywall assembly forms a vibration transmission bridge across the isolator. This type of interference can be identified and corrected in pre-construction coordination meetings.