Noise Control NSV

ISO 9001/ISO 14001
OHSAS 18001
MADE IN KOREA

NOISE CONTROL

PRODUCT OVERVIEW

NOISE CONTROL

Information for prevention of noise

Definition of noise

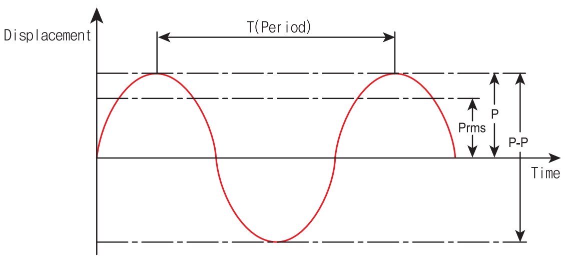
▶ **Sound**

Waves of varying pressure made by the vibration of propagation media particles, noticed by a human ear

▶ **Noise**

Noise is the name we collectively call what we feel is not good to hear. The NOISE AND VIBRATION CONTROL ACT defines it as"the strong sound generated by the use of machines, devices, facilities, and other materials."

Basics of sound



1) Wave length (λ, m)

The distance between the repeated pressure patterns in the space.

2) Period (T, sec)

The time taken for one repetition of the pressure pattern at a specific point.

3) Frequency (f, Hz)

The number of repetitions of the pressure pattern in a unit time period (one second).

4) Amplitude (P, m)

Maximum pressure variation from the reference pressure (atmospheric pressure).

5) Root Mean Square (Prms)

Root of the Mean of the Squares of the energy carried by a sound wave during one cycle.

6) Velocity of sound wave (C, m/s)

The distance the sound wave propagates during 1 second. It is constant in a uniform propagation medium.

$$C=\lambda \cdot f$$

In the air,

$$C \simeq 331.42+0.6t \simeq 20.06\sqrt{T}\ [m/s]$$

Where T is the absolute temperature.

1) dB(deciBel)

The unit and level of sound

The reaction of human ear or other sensing organs to the stimuli from outside is almost logarithmic. Therefore, by expressing the magnitude of the noise in logarithmic terms, dB, we can express it most closely to what humans feel regarding the degree of noise.

2) Sound Intensity Level (SIL)

$$SIL=10\log\left(\frac{I}{I_o}\right) dB$$

Where

I : Intensity of sound (w/m^2)

I_o : Intensity of the first audible sound (10^{-12}) w/m^2)

3) Sound Pressure Level (SPL)

The magnitude of the pressure slightly varying in the medium due to the propagation of the sound, expressed in terms of dB.

$$SPL=20\log\left(\frac{P}{P_o}\right) dB$$

Where

P : RMS value of the sound pressure under discussion (N/m^2)

P_o : RMS value of the minimum sound pressure (2×10^{-5} N/m^2)

4) Sound Power Level (PWL)

$$PWL=10\log\left(\frac{W}{W_0}\right) dB$$

Where

W : The sound power of the sound source under discussion

W_0 : Reference sound power (10^{-12} W)

5) Relationship between SPL and PWL

Sound Power Level (PWL) cannot be measured directly, and is calculated using the measured SPL and the formula shown below.

① In case of a non-directional point sound source in free space (r: clearance)

$$SPL = PWL - 20\log r - 11dB$$

② In case of a non-directional point sound source in semi-free space

$$SPL = PWL - 20\log r - 8dB$$

③ In case of a non-directional line sound source in free space

$$SPL = PWL - 10\log r - 8dB$$

④ In case of a non-directional line sound source in semi-free space

$$SPL = PWL - 10\log r - 5dB$$

6) Frequency Filter

For 1/1 octave band frequency analyzer,

$$\frac{f_u}{f_l} = 2,\ f_u = 2f_l$$

Center frequency $f_c = \sqrt{f_l \times f_u} = \sqrt{f_l \times 2f_l} = \sqrt{2}f_l$

Bandwidth $\mathrm{bw} = f_c\left(2^{\frac{n}{2}} - 2^{-\frac{n}{2}}\right) = f_c\left(2^{\frac{1}{2}} - 2^{-\frac{1}{2}}\right) = 0.707f_c$

or $\mathrm{bw} = f_u - f_l = 2f_l - f_l = f_l$

% bandwidth $\%\mathrm{bw} = \frac{\mathrm{bw}}{f_c} \times 100\%$

For 1/3 octave band frequency analyzer,

$$\frac{f_u}{f_l} = \sqrt[3]{2} = 2^{1/3},\ f_u = 1.26f_l$$

Center frequency $f_c = \sqrt{f_l \times f_u} = \sqrt{f_l \times 1.26f_l} = \sqrt{1.26}f_l$

$\mathrm{bw} = f_c\left(2^{\frac{1}{6}} - 2^{-\frac{1}{6}}\right) = 0.232f_c$

or $\mathrm{bw} = f_u - f_l = 1.26f_l - f_l = 0.26f_l$

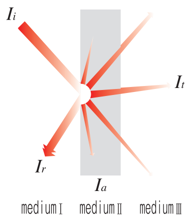
$\%\mathrm{bw} = \frac{\mathrm{bw}}{f_c} \times 100\%$

The upper end frequency, lower end frequency, and center frequency for respective frequency bands, 1/1 octave band and 1/3 octave band

Lower end frequency	Center frequency for 1/1 octave band	Upper end frequency	Lower end frequency	Center frequency for 1/3 octave band	Upper end frequency
f_l	f_c	f_u	f_l	f_c	f_u
			18	20	22
			22	25	28
23	31.5	45	28	31.5	35
			35	40	45
			45	50	56
45	63	90	56	63	71
			71	80	90
			90	100	112
90	125	180	112	125	141
			141	160	178
			178	200	225
180	250	355	225	250	282
			282	315	355
			355	400	450
355	500	710	450	500	560
			560	630	710
			710	800	890
710	1,000	1,400	890	1,000	1,120
			1,120	1,250	1,400
			1,400	1,600	1,780
1,400	2,000	2,800	1,780	2,000	2,240
			2,240	2,500	2,800
			2,800	3,150	3,550
2,800	4,000	5,600	3,550	4,000	4,470
			4,470	5,000	5,600
			5,600	6,300	7,080
5,600	8,000	11,200	7,080	8,000	8,900
			8,900	10,000	11,200
			11,200	12,500	14,130
11,200	16,000	22,400	14,130	16,000	17,780
			17,780	20,000	22,400
22,400	32,000	45,200	22,400	25,000	28,260
			28,260	32,000	35,560

1) Reflection, absorption, and permeation of sound

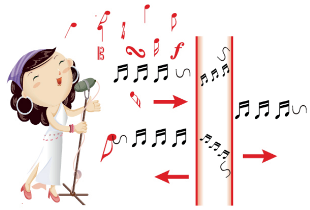
When sound meets an obstacle, portions of it are reflected, absorbed, and permeated.



I_i : magnitude of the incident sound
I_r : magnitude of the reflected sound
I_a : magnitude of the absorbed sound (absorption ratio)
I_t : magnitude of the transmitted sound

① Reflexibility (α)
The ratio of the reflected sound to the incident sound.

$$\alpha_r = \frac{I_i - I_r}{I_r}$$



② Acoustic absorptivity (α)
The ratio of the difference between the magnitudes of the incident sound and reflected sound, to the magnitude of the incident sound.

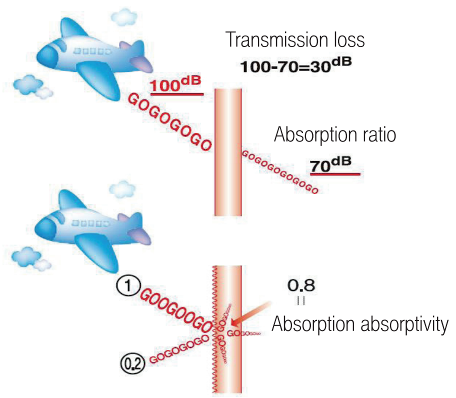
$$\alpha_r = \frac{I_i - I_r}{I_r} = 1 - \alpha_r$$

③ Transmission ratio (T)
The ratio of the magnitude of the transmitted sound to the magnitude of the incident sound.

$$\tau = \frac{I_t}{I_i}$$

Definition of the Transmission Loss, TL

$$TL = 10\log(\frac{1}{\tau})dB$$



Information for prevention of noise

2) Diffraction of sound

This is the characteristics that the sound reaches to the back of the obstacle in case the sound meets an obstacle in the course of propagation. As a typical case, the sound reaches the back side of the shielding wall from the viewpoint of the sound source. The longer the length of the wave, and the smaller the size of the obstacle, the more the sound diffracts

3) Attenuation of sound according to distance

① In case of a point sound source,

$$L_a = 20\log\left(\frac{r_2}{r_1}\right)dB \qquad L_a = SPL_1 - SPL_2$$

Where

SPL_1 : The level of the sound pressure at the place r_1 (m) apart from the sound source.

SPL_2 : The level of the sound pressure at the place r_2 (m, $r_2 > r_1$) apart from the sound source.

② In case of a line sound source,

$$L_a = 10\log\left(\frac{r_2}{r_1}\right)dB \qquad L_a = SPL_1 - SPL_2$$

③ In case of a rectangular plate sound source,

$$L_a = SPL_1 \quad SPL_2 = 0 \qquad \left(r < \frac{a}{3}\right)$$

$$L_a = 10\log\left(\frac{3r}{a}\right)dB \qquad \left(\frac{a}{3} < r < \frac{b}{3}\right)$$

$$L_a = 20\log\left(\frac{3r}{b}\right) + 10\log\left(\frac{b}{a}\right)dB \qquad \left(r > \frac{b}{3}\right)$$

(a: The length of the shorter side, b: The length of the longer side)

④ In case of a circular plate sound source,

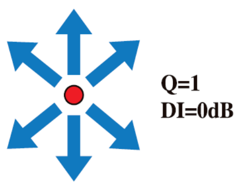
$$L_a = 20\log\left(\frac{a}{r}\right) - 3dB$$

(a: The radius of the circular sound source, in m)

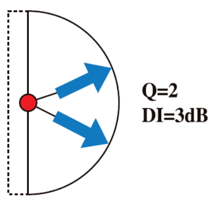
4) Directivity of sound

This is the characteristic that the intensity of sound varies depending on the direction, and the directivity factor DI is the value that expresses the directivity of a certain sound in dB.

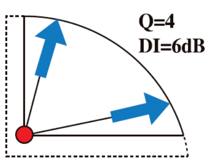
$$DI = 10\log Q$$



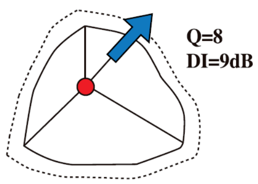
Free space



Semi-free space



The corner (line) where two planes meet



The corner (point) where three planes meet

Calculation of noise

1) Sum of dB(Decibel)s

$$SPL_T = 10\log\sum_{i=1}^{n} 10^{\frac{SPL_i}{10}}$$

$$= 10\log\left(10^{\frac{SPL_1}{10}} + 10^{\frac{SPL_2}{10}} + \cdots 10^{\frac{SPL_n}{10}}\right)$$

Where

SPL_T : Sound level of the composite sound

SPL_n : Sound level of the individual sound

2) Difference between dB (decibels)

$$\Delta SPL = 10\log\left(10^{\frac{SPL_1}{10}} - 10^{\frac{SPL_2}{10}}\right)$$

3) Compensation regarding background noise

The level of noise under discussion is obtained by calculating the difference between the measured noise level and the level of the background noise.

Difference between levels	3	4	5	6	7	8	9	≥10
Compensation value	–3	–2		–1				0

Counterplans for noise

1) Means for preventing noise

① Means related to the noise source: removing the noise source, installing a silencer, sound insulation box, prevention of vibration, etc.

② Means related to the propagation path: absorption, shield, shielding wall, attenuation by ensuring the distance, using directivity, etc.

③ Means on the receiving side: masking, earplug, double window, etc.

2) Absorption of sound

① Mean acoustic absorptivity: the sizes of each material and corresponding absorption ratios are used.

$$\bar{\alpha} = \frac{\sum S_i \alpha_i}{\sum S_i}$$

Where
S_i : the size of each material, α_i : absorption ratio

$$\bar{\alpha} = \frac{0.161\,V}{S\,T}$$

Where
S_i : volume of the room (m^3), T : reverberation time

*reverberation time: the time taken from turning off of the source of sound pressure to the time the level of the sound pressure has been reduced to 60dB.

② Noise Reduction Coefficient (NRC)
The arithmetic mean of the individual acoustic absorptivity measured for the frequency bands of which the center frequencies are 250Hz, 500Hz, 1000Hz, and 2000Hz, respectively, and the bandwidth is 1/3 octave.

$$NRC = \frac{\alpha_{250} + \alpha_{500} + \alpha_{1000} + \alpha_{2000}}{4}$$

3) Means for preventing noise

① Transmission loss at a single wall (principle of mass)
Transmission loss at a single wall depends on the surface density.

$$TL = 20\log(m \cdot f) - 43dB \quad \text{(vertical incident sound)}$$

$$TL = 18\log(m \cdot f) - 44dB \quad \text{(irregular incident sound)}$$

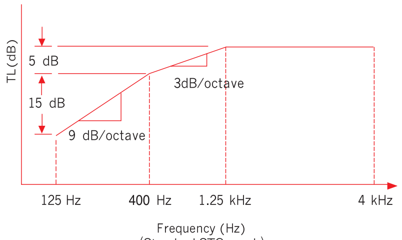
Where
m : surface density of the wall (kg/m^2), f : entering frequency (Hz)

② Total transmission loss

$$\overline{TL} = 10\log\left(\frac{1}{\bar{\tau}}\right) = 10\log\frac{\sum S_i}{\sum (S_i \tau_i)}\ dB$$

Where
S_i : size of each component of the wall (m^2)
τ_i : transmission rate of the wall

③ Sound Transmission Class (STC)
The value of the transmission loss at 500Hz. When compared to the standard STC graph, the following conditions need to be met.



(Standard STC graph)

- For the transmission losses measured for the center frequencies of frequency bands with 1/3 octave bandwidth, in the range of 125Hz ~ 4kHz,
- There should not be a value 8dB less than the corresponding value on the standard STC graph, or smaller value.
- The sum of the differences between the TL values that are smaller than the corresponding values on the STC graph and the corresponding values on the STC graph themselves should not be less than or equal to 32dB.

4) Transmission of sound in a room

$$SPL = PWL + 10\log\left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right), \quad R = \frac{S\bar{\alpha}}{1-\bar{\alpha}}$$

Where
Q: directivity coefficient, R: room constant (m^2)
S: size of the surface (m^2), α: mean of acoustic absorptivity

Effects of noise

1) **TTS (Temporary Threshold Shift):** temporary loss of hearing capability.
2) **PTS (Permanent Threshold Shift):** permanent loss of hearing capability.
3) **Occupational hearing-loss:** diseases found among the workers of the factories with high level of noises. The symptoms of losing hearing capability in this case occurs for sounds of high frequencies above or equal to 4000Hz at first.
4) **Presbycusis:** geriatric hearing loss. In this case, the symptom of losing hearing capability occurs for sounds of high frequencies above or equal to 6000Hz at first.
5) **Hearing loss:** if the average hearing loss for the center frequency range of 500~2000Hz is greater than or equal to 25dB, it is called hard of hearing or bradyacusia.

$$\text{Average hearing loss} = \frac{a+2b+c}{4}\ dB$$

Where
a : hearing loss at octave band of 500Hz
b : hearing loss at octave band of 1000Hz
c : hearing loss at octave band of 2000Hz

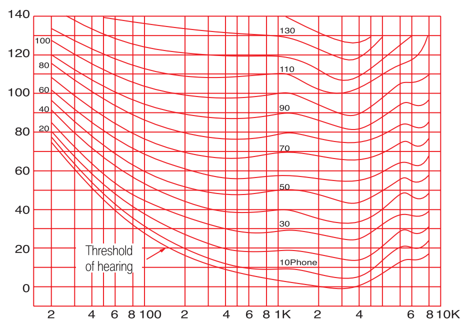
6) Masking effect

It is a phenomenon of hearing only a loud sound when hearing both a loud sound and a weak sound, and it is caused by interference of the sound waves.

Evaluation of the noise

1) Equal-loudness contour

The graph made by connecting the sound pressure levels the hearer with no hearing problem feels for sounds of various frequencies.



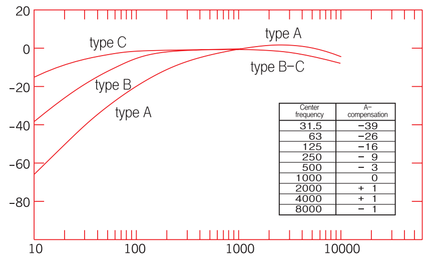
2) Loudness level (Phone)

The level of the sound pressure of certain sound expressed in terms of the level of sound pressure of 1000Hz sine wave felt, by normal young people without any problem hearing, the same as the level of the sound pressure under test.

3) dB(A)

A method of expressing the level of sound pressure which, by applying filters, reflects the hearing characteristics of a human ear regarding the frequency of the sound. Three types of filters, type A, B, and C, are used depending on the usage, for the audible frequency range of 20Hz ~ 20KHz. Among them, dB(A) filter is for reflecting the fact that the lower the frequency of the sound, the less sensitive the human ear is, for the moderate sound of less than 1000Hz.

Information for prevention of noise



Center frequency	A−compensation
31.5	−39
63	−26
125	−16
250	− 9
500	− 3
1000	0
2000	+ 1
4000	+ 1
8000	− 1

4) Loudness (Sone)

The unit for loudness is Sone, and the loudness corresponding to 1kHz, 40dB is defined as 1 Sone. The loudness felt by an audience as n times louder than 1 Sone is n Sone.

5) Energy Equivalent Sound Level, Leq

It is the method for evaluating the varying noise, and is used for the evaluation of the ambient noise and the evaluation of the accumulated effect of the noise.

$$L_{eq}=10\log\left(\sum_{i=0}^{n} f_i \times 10^{\frac{L_i}{10}}\right) dB(A)$$

Where

f_i : duration rate of specific sound pressure level

L_i : n_th sound pressure level

6) Percentage Noise Level, LN

The level of noise of which the sum of the occurred time exceeds N (%) of whole measuring time. For example, L_{10} refers to the level of noise occurred for over 10% of whole measuring time. The smaller the % value, the higher the noise level. There is the relationship, $L_{10} > L_{50} > L_{90}$.

7) Weighted Equivalent Continuous Perceived Noise Level, WECPNL

Aircraft noise evaluated around the airport.

$$WECPNL=\overline{dB(A)}+10\log(N_1+3N_2+10N_3)-27$$

Where

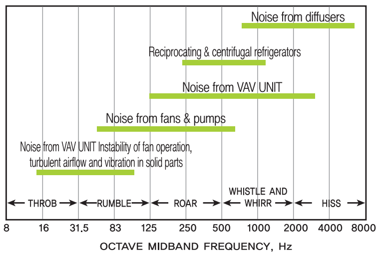
$\overline{dB(A)}$: average of the peak values of the aircraft noise during a day, in dB

N_1 : number of the arrived and departed airplanes during 07:00~19:00

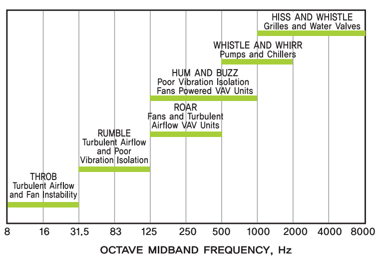
N_2 : number of the arrived and departed airplanes during 19:00~22:00

N_3 : number of the arrived and departed airplanes during 22:00~07:00

Frequency bands of HVAC noise sources



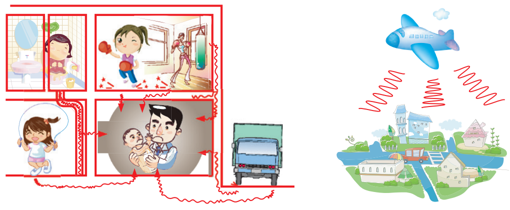
Frequency bands of the noise sources causing civil complaints



Frequency bands of the noise from various types of source

Means for preventing structure borne noise

The noise which is emitted to the air directly from the source and propagated through air, the medium, is called airborne noise, while in case the noise from the source is transmitted through solid materials and causes vibration of the ceilings, walls, etc., of buildings, and eventually makes sound in the air, it is called structure borne noise.

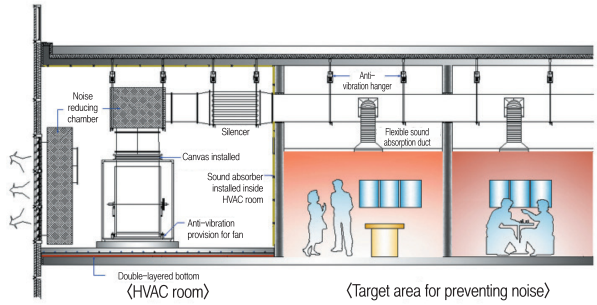


Structure borne noise

Airborne noise

1) Means to prevent structure borne noise

Regarding the prevention of structure born noise, there are three systems to consider, the generating system, vibration transmitting system, and sound emitting system. For the generating system, reducing the vibration given in the form of power energy, etc., is the first thing to take into account. The second is to lower the vibration frequency by increasing the mass of the machine, etc. The third is to suppress the transmission of the vibration by reducing the impedance at the supporting structure. As the means for the contacts between the generating system and the vibration transmitting system, absorption and prevention of vibration might be considered. The former is to use the soft elastic material or plastic material so that the impact time is extended, the maximum of the impact is suppressed and thus the natural frequency of the impact is lowered, and the input energy is reduced. The latter is to make the natural vibration system having lumped constants, and make the actual transmission of the exciting power reduced, due to the impedance difference. In addition, passive vibration reducers like oil damper, etc., or active vibration reducers utilizing the automatic control system are effectively used in low frequency range, but these are not practical for structure borne noise.



〈HVAC room〉 〈Target area for preventing noise〉

2) Materials for preventing structure borne noise, and systems being used

It is usual to add elastic elements to the mass of an ordinary transmission system, so it is also usual to think of springs when thinking about prevention of vibration. There are cases of adding mass of course, but there is no commercial product for that. So, the discussion here is also limited to elastic vibration preventing materials. There are various materials for preventing vibration depending on the use and purpose. Typical systems being used are:

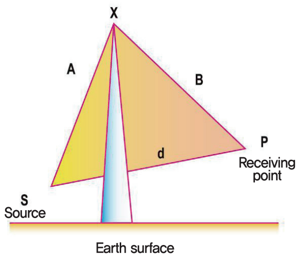
- Jack Up Floating Floor System (JUM)
- Plywood Panel System (NFM)
- Polyurethane Mat (PO−MAT)

Calculation of the noise reducing effect of shielding walls

In case there in no obstacle between the source of noise and the receiving point, sound is transferred from the source to the receiving point through the direct path. But if there is an obstacle between the source and the receiving point, the noise generated from the source is diffracted and reaches the receiving point over the upper part of the obstacle, and in the course of doing so, the noise is attenuated.

Attenuation achieved by using a shielding wall is about 10dB, and it is very difficult to obtain the attenuation of 15dB except in the case of making the wall such that it is very high and there is almost no gap or open part, and using a material with high transmission loss. The maximum attenuation that can be achieved by using a shielding wall is about 20dB so when more attenuation is required, we must consider other means. And without blocking the line of sight between the source of noise and the receiving point, we can scarcely obtain the noise reducing effect.

If the length of the shielding wall is infinite and the transmission loss of the wall is extremely high, the noise from the source is transferred to the receiving point over the upper part of the shielding wall, as shown in the figure below.

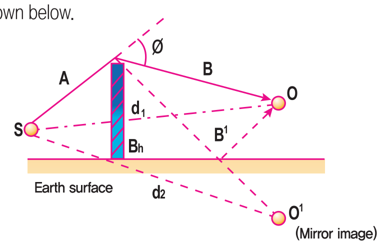


Where

X : summit of the wall
A : distance between the source and the summit of the wall
B : distance between the receiving point and the summit of the wall
d : direct distance between the source and the receiving point

A. Determination of diffraction attenuation

The noise reduction effect due to diffraction attenuation is determined by the difference between paths and the frequency (wave length) of the sound under discussion. Actual noise reducing effect of the wall is calculated by using the Fresnel Zone Number (N) considering the path difference and frequency of sound, as shown below.



1) Fresnel number for direct sound, N_1

$$N_1 = (A+B-d_1)\times\frac{2f}{340}$$

Where f: frequency of the diffracted sound under discussion, in Hz

2) Fresnel number for indirect sound, N_2

$$N_2 = (A+B-d_2)\times\frac{2f}{340}$$

3) Diffraction attenuation of direct and indirect sounds, L_{d1}, L_{d2}

$$L_d = 7.5+0.61\log N(dB),\quad 0 < N \leq 0.1$$
$$L_d = 10+3\log N(dB),\quad 0.1 < N \leq 0.8$$
$$L_d = 11+7\log N(dB),\quad 0.8 < N \leq 30$$
$$L_d = 12+6\log N(dB),\quad 30 < N \leq 60$$
$$L_d = 22(dB),\quad 60 < N$$

4) Diffraction attenuation due to shielding wall, ΔL_d

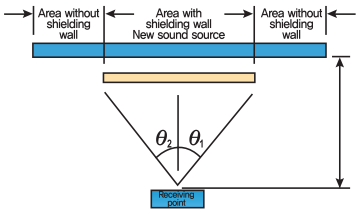
$$\Delta L_d = -10\log(10^{-\frac{L_{d1}}{10}} + 10^{-\frac{L_{d2}}{10}})$$

B. Determination of transmission loss, ΔL_t

$$\Delta L_t = 20\log(m\cdot f) - 47(dB)$$

Where m : surface density (kg/m^2)

C. Determination of attenuation of direct sound, ΔL_{in}



$$\Delta L_{in} = 10\log\left(\frac{2}{2-(\sin\theta_1+\sin\theta_2)}\right)dB$$

D. Determination of attenuation due to absorption, ΔL_α

In case of the absorption type shielding wall, additional attenuation due to the absorption is obtained.

$$\Delta L_a = \alpha^3\cdot(ø/30)dB,\quad ø \leq 120°$$

$$\Delta L_a = 1.1\alpha^3\cdot(ø/15)dB,\quad ø > 120°$$

E. Determination of insertion loss due to the use of finite shielding wall, ΔL_i

In case of using the absorption type shielding wall,

$$\Delta L_i = -10\log(10^{\frac{-\Delta L_d}{10}} + 10^{\frac{-\Delta L_t}{10}} + 10^{\frac{-\Delta L_{\in}}{10}}) + \Delta L_a\ [dB]$$

In case of using the reflection type shielding wall,

$$\Delta L_i = -10\log(10^{\frac{-\Delta L_d}{10}} + 10^{\frac{-\Delta L_t}{10}} + 10^{\frac{-\Delta L_{\in}}{10}})\ [dB]$$

Information for prevention of noise

A. Noise from fans, L_w

$$L_w = K_w + 10\log_{10}[\frac{Q}{Q_1}] + 20\log_{10}[\frac{P}{P_1}] + C + BFI$$

Where

L_w : level of the sound power from fans (dB)

K_w : reference value for noises from fans

Q : air volume from fans (CMH, CMM)

P : static pressure of fan outlet (mmAq)

Where

Q_1 : 1 cfm = 1.7 CMH

P_1 : 1 in. wg. = 25.4 mmAq

C : compensation for degradation in efficiency

BFI : compensation for frequency band of fan noise

B. Compensation for degradation in efficiency, C

$$\eta = \frac{Q \cdot P}{367{,}200 \cdot W}$$

Where

W : fan power (kW)

Ratio of efficiency η to the maximum efficiency of fan (%, PEAK)	Compensation for the degradation in efficiency (C, dB)
90 ~ 100	0
85 ~ 89	3
75 ~ 84	6
65 ~ 74	9
55 ~ 64	12
50 ~ 54	15

C. Compensation for frequency band of fan noise, BFI

Types of fan	Octave Band	Compensation (dB)
Centrifugal : Airfoil, Backward Curved, Backward Inclined	250 Hz	3
Forward Curved	500 Hz	2
Radial Blade, Pressure Blower	125 Hz	8
Vaneaxial	125 Hz	6
Tubeaxial	63 Hz	7
Propeller : General Ventilation & Cooling Tower	63 Hz	5

D. Reference value for fan noises, K_w

Types of fan		1/1 Octave Band Frequency (Hz, dB)							
		63	125	250	500	1K	2K	4K	8K
Centrifugal	Airfoil, Backward Curved, Backward Inclined Wheel Dia (mm)								
	over 900mm	40	40	39	34	30	23	19	17
	under 900mm	45	45	43	39	34	28	24	19
Forward Curved	All wheel Diameter	53	53	43	36	36	31	26	21
Radial Bladed	Low Pressure (1 to 2.5 kPa)	56	47	43	39	37	32	29	26
	Medium Pressure (1.5 to 3.7 kPa)	58	54	45	42	38	33	29	26
	High Pressure (3.7 to 15 kPa)	61	58	53	48	46	44	41	38
Axial Fans	Hub Ratio 0.3 to 0.4	49	43	43	48	47	45	38	34
Vaneaxial	Hub Ratio 0.4 to 0.6	49	43	46	43	41	36	30	28
	Hub Ratio 0.6 to 0.8	53	52	51	51	49	47	43	40
Tubeaxial	over 1000mm wheel diameter	51	46	47	49	47	46	39	37
	under 1000mm wheel diameter	48	47	49	53	52	51	43	40

(NOTE) NEBB National Environmental Balancing Bureau(1994)

Design data

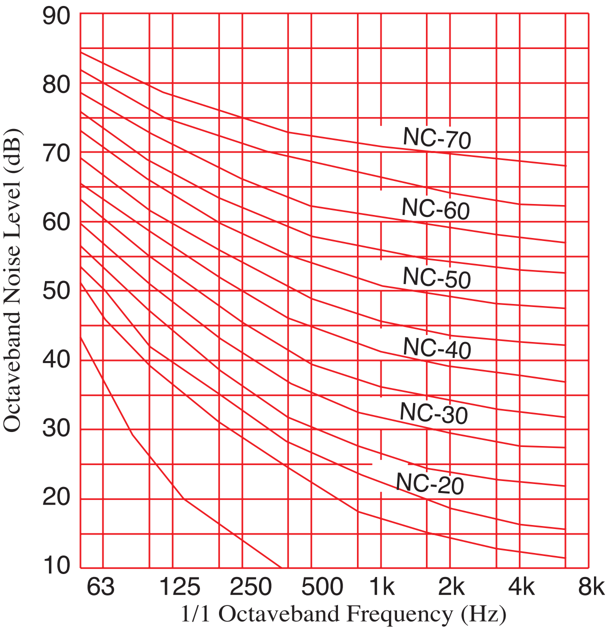
1. Recommendation regarding interior noise

A. Standards for interior noise (NC: Noise Criteria, RC: Room Criteria)

Room Types		Octave Band Analysis	Approximate Overall Sound Pressure Level	
		NC/RC	dBA	dBC
Rooms with Intrusion from Outdoor Noise Sources	Traffic noise Aircraft flyovers	N/A N/A	45 45	70 70
Residences , Apartments, Condominiums	Living areas Bathrooms, kitchens utility rooms	30 35 35	35 40 40	60 60 60
Hotels/Motels	Individual rooms or suites Meeting/banquet rooms Corridors and lobbies Service/support areas	30 30 40 40	35 35 45 45	60 60 65 65
Office Buildings	Executive and private offices Conference rooms Teleconference rooms Open-plan offices Corridors and lobbies	30 30 25 40 40	35 35 30 45 45	35 35 30 45 45
Courtrooms	Unamplified speech Amplified speech	30 35	35 40	60 60
Performing Arts Spaces	Drama theaters, concert and recital halls Music teaching studios Music practice rooms	20 25 30	25 30 35	50 55 60
Hospitals and Clinics	Patient rooms Wards Operating and procedure rooms Corridors and lobbies	30 35 35 40	35 40 40 45	60 60 60 65
Laboratories	Testing/research with minimal speech Communication Extensive phone use and speech communication Group teaching	50 45 35	55 50 40	75 70 60
Courtrooms	Unamplified speech Amplified speech	30 35	35 40	60 60
Churches, Mosques, Synagogues Schools	General assembly with critical music programs Classrooms Large lecture rooms with speech amplification Large lecture rooms without speech amplification	25 30 30 25	30 35 35 30	55 60 60 55
Libraries		30	35	60
Indoor Stadiums, Gymnasiums	Gymnasiums and natatoriums Large-seating-capacity spaces with speech Amplifications	45 50	50 55	70 75

Information for prevention of noise

B. Noise Criteria, NC



Noise Criteria Curves

▶Evaluation by Noise Criteria

It is the means to evaluate the interior noise such as the noise from HVAC by analyzing the noise using 1/1 octave band noise levels, following the steps below.

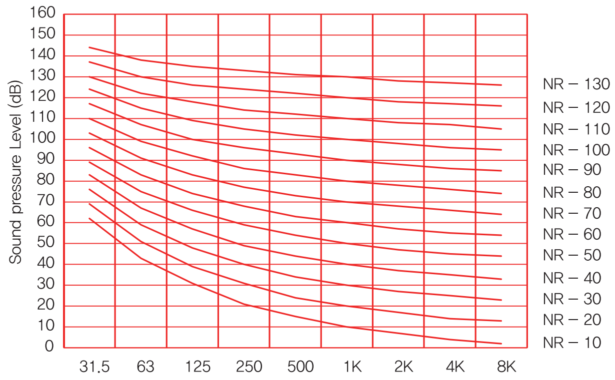
① Obtain the noise levels for the 8 octave bands, from 63Hz to 8000Hz.

② Mark the level for each octave band on the NC curves graph, and then connect them to make a line.

③ The NC Criteria Curve with the lowest number which is not touched by the line in the frequency range under discussion is the curve that represents the rating of the interior noise in this room. If the curve is NC–40, the room has NC40 rating, and the 1/1 octave band sound pressure level in this room should be under the level represented by the NC–40 curve at every frequency.

NC	Octave Band Center Frequency (Hz)							
	63	125	250	500	1K	2K	4K	8K
NC–65	80	75	71	68	66	64	63	62
NC–60	77	71	67	63	61	59	58	57
NC–55	74	67	62	58	56	54	53	52
NC–50	71	64	68	54	51	49	48	47
NC–45	67	60	54	49	46	44	43	42
NC–40	64	56	50	45	41	39	38	37
NC–35	60	52	45	40	36	34	33	32
NC–30	57	48	41	35	31	29	28	27
NC–25	54	44	37	31	27	24	22	21
NC–20	51	40	33	26	22	19	17	16
NC–15	47	36	29	22	17	14	12	11

C. Noise Rating, NR



NR	Octave Band Center Frequency (Hz)								
	31.5	63	125	250	500	1K	2K	4K	8K
NR 10	62	43	31	21	15	10	7	4	2
NR 20	69	51	39	31	24	20	17	14	13
NR 30	76	59	48	40	34	30	27	25	23
NR 40	83	67	57	49	44	40	37	35	33
NR 50	89	75	66	59	54	50	47	45	44
NR 60	96	83	74	68	63	60	57	55	54
NR 70	103	91	83	77	73	70	68	66	64
NR 80	110	99	92	86	83	80	78	76	74
NR 90	117	107	100	96	93	90	88	86	85
NR 100	124	115	109	105	102	100	98	96	95
NR 110	130	122	118	114	112	110	108	107	105
NR 120	137	130	126	124	122	120	118	117	116
NR 130	144	138	135	133	131	130	128	127	126

NR	Room Type
25	Concert halls, broadcasting and recording studios, cherches
30	Private dwellings, hospitals, theatres and cinemas, conference rooms
35	Libraries, museums, court rooms, schools, hospitals oprating
40	Halls, corridors, cloakrooms, restaurants, night clubs, offices, shops
45	Department stores, supermarkets, canteens, general offices
50	Typing pools, offices with business machines
60	Light engineering works
70	Foundries, heavy engineering works

D. Comparison of Sound Rating Methods

Items taken	Overview	Considers Speech Interference Effects	Evaluates Sound Quality	Components Presently Rated by Each Method
NC	Can rate components No quality assessment Does not evaluate low-frequency rumble	Yes	No	Air terminals Diffusers
RC	Used to evaluate systems Should not be used to evaluate components Can be used to evaluate sound quality Provides some diagnostic capability	Yes	Yes	-

2. Recommendation regarding environment noise

A. The recommendation of ISO on the criteria for environment [ISO recommendation R 1996 (Assessment of noise with respect to community response)]

Areas	Time of day (Leq, dB(A))		
	Day	Evening	Night
Residential only areas, hospitals and sanatoriums	45	40	35
Suburban residential areas, narrow road areas	50	45	40
City residential areas	55	50	45
Workshops, offices, neighbor of principal road	60	55	50
City areas, business areas, trade areas, administration areas	65	60	55
Dedicated industry areas (heavy industry)	70	65	60

B. EPA

The criteria is classified as Leq and Ldn based on regions and influencing factors.

[Standards for environmental noise in residential areas, specified by EPA]

Influence	Level	Area
Hearing-loss	Leq(24) ≤ 70dB	All areas
Interference in outdoor activities and disturbance	Ldn ≤ 55dB	Residential areas and outdoor areas in farms, other outdoor areas where people spend a lot of time, or other outdoor areas requiring quiet
	Leq(24) ≤ 55dB	Outdoor areas where people only stay for short periods, such as areas inside schools or playgrounds, etc.
Interference in indoor activities and disturbance	60Ldn ≤ 45dB	Indoor areas in residential areas
	Leq(24) ≤ 45dB	Other indoor areas such as schools where human activities take place

EPA, Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety

C. EU

Different limits of exposure to noise are suggested based on area class, and different standards are applied depending on the source of the noise and the time of exposure. [Limits of exposure to noise based on classification of areas in the EU]

Classification of areas	Limits of exposure to noise (dB(A))			
	Roads & railroads (Day/Night)	Airplanes	Industrial areas, military facilities, waterways, recre-ation facilities, etc. (Day/Night)	Sports areas (Day/Break time/ Night))
Residential only areas, hospitals and sanatoriums	64/54	62	60/45	60/55/45
Suburban residential areas, narrow road areas	59/49	62	55/40	55/50/40
City residential areas	59/49	62	50/35	50/40/35
Workshops, offices, neighbor of principal road	57/47	62	45/35	45/45/35

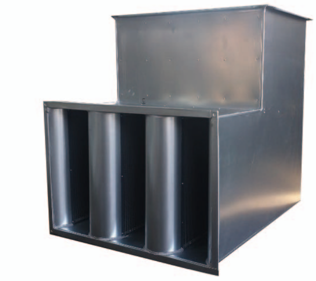
Noise Directive 2020/49/FC

ANOS10 Rectangular Type Sound Attenuator

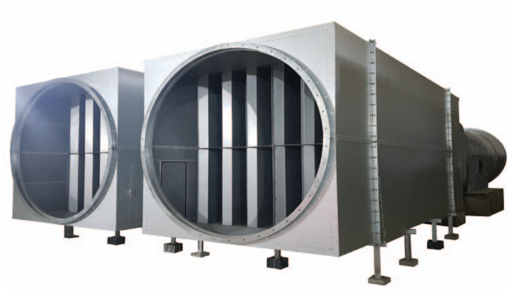
Features

ANOS10 is useful in reducing the noise transmission through the HVAC system and by adjusting air way gap between the splitters inside; the noise problem can be resolved. In general, it offers excellent sound attenuation in 500~8000Hz.

Splitter Type



Elbow Type



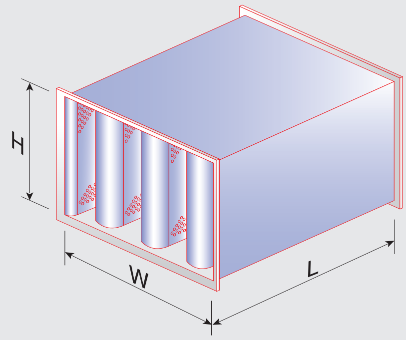
Tunnel Exhaust silencer

Model Denotation method

R □ □ – □ □ – □ × □ × □

① ② ③ ④ ⑤ ⑥ ⑦

① Splitter Shape
② Absorption Material Protection Method
③ Sound Attenuator Shape
④ Splitter Thickness / Air Way Area Ratio Type(S, L, M Type)
⑤ Sound Attenuator Width(mm)
⑥ Sound Attenuator Hight(mm)
⑦ Sound Attenuator Length(mm)

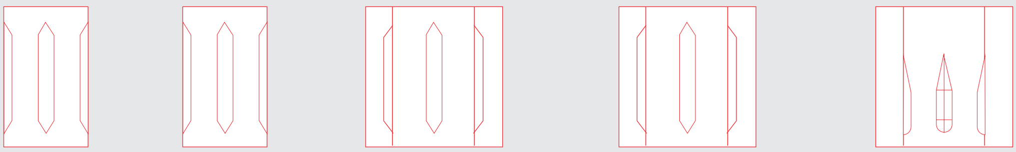


Splitter Shape

Absorption Material Protection Method

G : GLASS WOOL + GLASS CLOTH
P : GLASS WOOL + GLASS CLOTH + PERFORATED PLATE
F : GLASS WOOL + GLASS CLOTH + PE FILM + PERFORATED PLATE

Sound Attenuator Shape



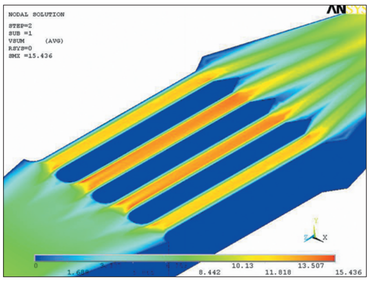
1 2 3 4 5

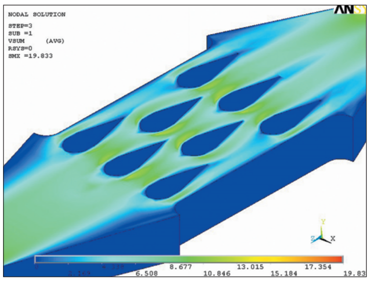
Splitter Thickness / Air Way Area

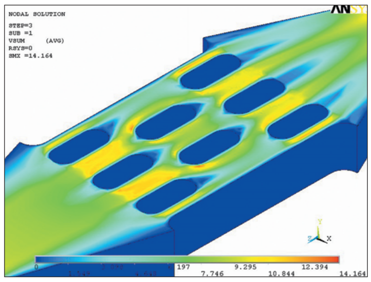
S Type : Large pressure loss and self noise and large amount of noise attenuation thru all of the frequency band.
L Type : Small pressure loss and self noise and large amount of noise attenuation for middle/high frequency band.
M Type : Middum amount of pressure loss and self noise and large amount of noise attenuation for 250Hz/500Hz.

ANOS10 Rectangular Type Sound Attenuator

■ Analysis Of Velocity Distribution Per Splitter Type







■ Sound Attenuator Calculation Sheet

Model	AHU–01(S)	Air Flow	20900 CMH(m^3/h)	DUCT SIZE	1400 X 600	Static Efficiency	90%
Project	Project Name			Service	Office	Quantity	1 SET
Location	–	Static Pressure	107 mmAq	Diffuser Type	SQUARE	Duct Airflow Velocity	6.9 m/sec

▶ INFORMATION OF EQUIPMENT & PROJECT

							OCTAVE BAND CENTER FREQUENCY(Hz)						
							63	125	250	500	1000	2000	4000
1. Fan Total Sound Power Level (PWL)			CODE	2	AIR FOIL								
1) Specific Sound Power Level (Kw)							45.0	45.0	43.0	39.0	34.0	28.0	24.0
2) Sound Level by Air Flow & Static Pressure (Mw)							53.4	53.4	53.4	53.4	53.4	53.4	53.4
3) Correction Factor by Efficiency (C)							0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) Blade Frequency Increments (BFI)							0.0	0.0	3.0	0.0	0.0	0.0	0.0
						(Total)	98.4	98.4	99.4	92.4	87.4	81.4	77.4
							Total Sound Power Level : 94.7dB(A)						
2. Attenuation of System													
1) Unlined Rectangular Sheet Metal Ducts													
a.Rectangular Duct			Width	Hight	P/A	Length							
Duct - 1			1.40	0.60	4.76	10	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Duct - 2			0.0	0.00	0.00	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
b.Circular Duct													
2) Insertion Loss of Elbow													
a.Square Elbow			Q'TY	0	Width	1.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0
b.Round Elbow			Q'TY	0	Width	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
c.Lined Elbow		0	Q'TY	0	Width	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) Chanber Attenuation (Non-Sound-Absorbing)	Q'TY	0	0	0	NRC	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) Chanber Attenuation			Inlet	0.0	Outlet	0.0							
(Sound-Absorbing)	Q'TY				Outlet	0.65	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5) Duct Branch Sound Power Division			Inlet	0.8	NRC	0.8							
6) Duct End Reflection Loss			Air Wolume		780	m^2/h	14.3	14.3	14.3	14.3	14.3	14.3	14.3
7) The Other Attenuation			Q'TY		N.D	0.25	16.0	11.0	6.0	2.0	1.0	0.0	0.0
(Total) : 1)+2)+3)+4)+5)+6)+7)							33.3	28.3	23.3	19.3	18.3	17.3	17.3
3. Sound Power Level in Room (PWL)			(Sum1 - Sum2)			Code	65.1	70.1	76.1	73.0	69.1	64.1	60.1
4. Noise Criteria in Room(SPL)						6	64.0	56.0	50.0	45.0	41.0	39.0	38.0
5. Correction by Diffuser Sound Pressure (-10log ne+10log ni) ne=0.23 ni=0.7							4.8	4.8	4.8	4.8	4.8	4.8	4.8
6. Attenuation to Room Absorption (Kr)			Width	5	α	0.01							
			Length	5	α	0.01							
			Hight	4.0	α (Ave)	0.01	-4.9	-4.9	-4.9	-4.9	-4.9	-4.9	-4.9
			Area(m^2)	130	Room Constan	1.31							
7. Allowable Sound Power Level at Outlet (PWL) : (4+5+6)							63.9	55.9	49.9	44.9	40.9	38.9	37.9
8. Generated Noise at Outlet (PWL)			*Sound Power Level (Before Atten.) : 74.4 dB(A)										
9. Allowable Sound Power Level in Room (PWL)							63.9	55.9	49.9	44.9	40.9	38.9	37.9
10. Additional Attenuation Required			(3-9)				1.2	14.2	26.2	28.2	28.2	25.2	22.2
11. Sound Attenuator			Model	Width	Hight	Length	*Air Velocity (Pass through Atten.) : 8.1 m/s						
(Insertion Loss)		5		1800	800	1500	7	8	14	23	31	33	17
Pressure Drop	3 mmAq	7		1800	800	1800	7	11	16	26	37	37	20
		9		1800	800	2100	8	11	19	30	43	41	24

▶ SELF GENERATED NOISE DATA

▶ NATURAL ATTENUATION DATA (Noise attenuation by Duct, Elbow, Chamber and Distribution etc.)

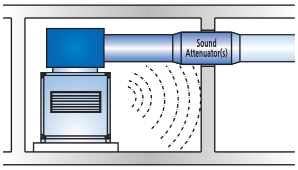
▶ Selection of standard noise level on room

▶ Radiation Coefficient (Considering the area and absorption ratio of room)

▶ SELLECTION OF SOUND ATTENUATOR SIZE (Considering required attenuation, velocity and static pressure drop etc.)

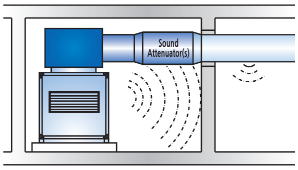
ANOS10 Rectangular Type Sound Attenuator

■ Sound Trap Sound Attenuator Placement On AHU Room



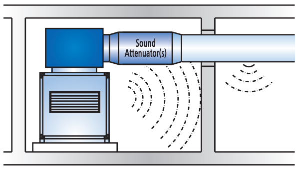
BEST

Controls ductborne noise and mechanical room noise that "breaks into" duct.



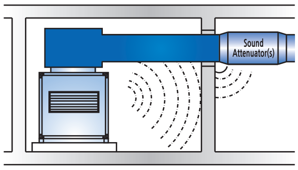
VERY GOOD

Practical alternate where fire damper is required at wall.



FAIR

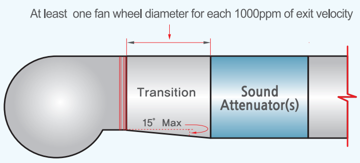
Michanical room noise "break into" duct without reduction through sound attenuator



POOR

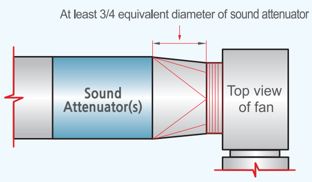
All noise in duct "breaks out" over occupied space before being reduced by sound attenuator

■ Guidelines for sound attenuator placement near fans and duct fittings

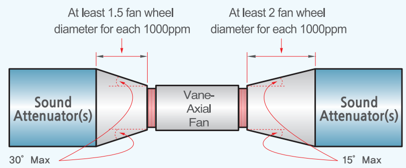


At centrifugal fan discharge

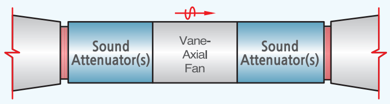
Note : Sound attenuator baffles should be perpendicular to fan shaft



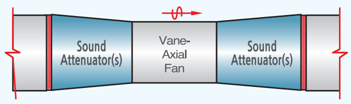
At centrifugal fan inlet



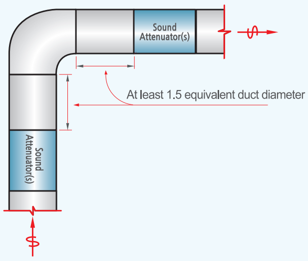
Rectangular sound attenuator at vane axial fan inlet and discharge
<Subway, Tunnel>



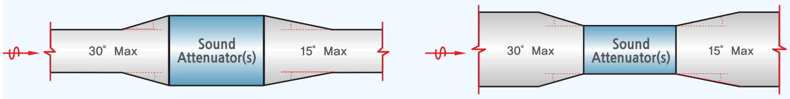
Circular sound attenuators attached directly to vane axial fans



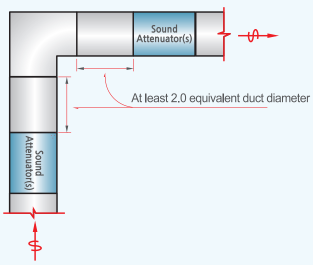
Circular sound attenuators attached directly to vane axial fans



At radius turns and square turns with turning vane
(Note : Sound attenuators baffles should be parallel to the elbow cheeks)



Upstream and downstream of transitions
(Note:Transition angle should be Max. 30°,
before sound attenuator and Min. 15° after transition)

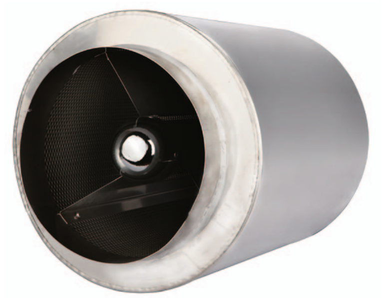


At square turns without turning vanes
(Note : Sound attenuators baffles should be parallel to the elbow cheeks)

■ Installation features

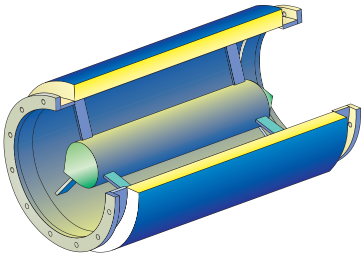



ANOS20 Circular Type Sound Attenuator

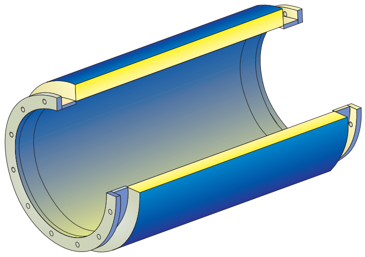


Features

The ANOS20 is used for HVAC systems and industrial machines. There are two types : one with a sound-absorbing material attached inside the attenuator and the other one with sound-absorbing cone mounted inside.



TYPE-1

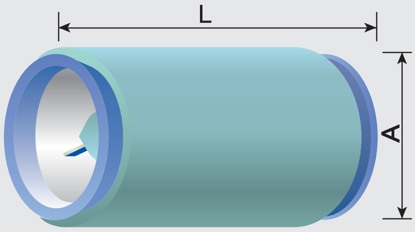


TYPE-2

Model denotation method

C □□ − □ × □ × □
① ② ③ ④ ⑤

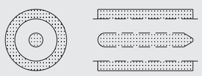
① Absorption Material Protection Method
② Sound Attenuator Shape
③ Splitter Thickness / Air Way Extention Type
④ Sound Attenuator Diameter(Ø):A
⑤ Sound Attenuator Length(mm):L



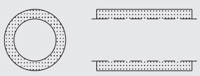
Absorption Material Protection Method

G: GLASS WOOL + GLASS CLOTH
P: GLASS WOOL + GLASS CLOTH + PERFORATED PLATE
F: GLASS WOOL + GLASS CLOTH + PE FILM + PERFORATED PLATE

Sound Attenuator Shape



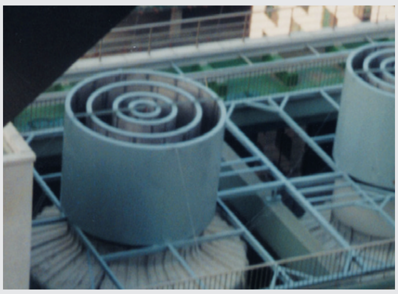
1

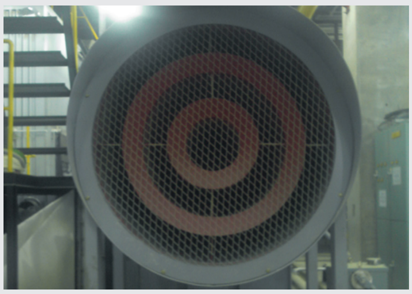


2

Splitter thickness/Air Way Extention

S Type : Large pressure loss and self noise and large amount of noise attenuation thru all of the frequency band.
L Type : Small pressure loss and self noise and large amount of noise attenuation for middle/high frequency band.





SC Sound Attenuating Chamber

Features

It is installed on the outlet or inlet of the air conditioner and fan to control turbulent flow and reduce noise. The SCF type is used for low-speed ducts, the SCP type for high-speed ducts and SCF type for clean rooms. An angle bracket is installed for robust structures and convenience. It is designed to use different interior material and installation methods depending on the main frequency of the air conditioner and fan. The noise attenuation of the sound chamber is in proportion to the sound-absorption rate of the interior material and installation area, but is in inverse proportion to the area of duct exit. It offers excellent sound attenuation in a medium/high frequency range.

Model denotation method

SC □ − □ X □ X □ X □
① ② ③ ④ ⑤

① Sound Absorption Material Protection Method
② Sound Absorption Material Thickness(mm)
③ Sound Attenuating Chamber Width(mm)
④ Sound Attenuating Chamber Hight(mm)
⑤ Sound Attenuating Chamber Length(mm)

Sound Attenuating amount(R)

$$R=10log\left\{\frac{1}{S_e\left(\frac{COS\theta}{2\pi d^2}+\frac{1-\overline{\alpha}}{\overline{\alpha}S_W}\right)}\right\}=10log\left\{\frac{A}{S_e}\right\}$$

Here $\overline{\alpha}$:average absorption of the plenum lining
S_e :plenum inlet or exit area(m^2 or ft^2)
Sw :plenum Wall area(m^2 or ft^2)
d :distance from input to output(m^2 or ft^2)
θ :$(w-\ell)^2+h^2$(m^2 or ft^2)
A :h/d

SE Sound Attenuating Elbow

Features

The sound attenuating elbow is installed in a right-angled corner to reduce noise and turbulent flow. The elbow interior material is attached only on the sides. Its thickness should be about 10% of the breadth of the duct with the length at least twice as as the duct. Sometimes, the turning vane is installed to reduce turbulent flow. In general, it works better in the medium/high frequency range, offering attenuation of up to 10dB in 500~1000Hz.

Model denotation method

SE □ − □ X □
① ② ③

① Sound Aborption Material Protection Method
② Sound Attenuating Elbow Width(mm)
③ Sound Attenuating Elbow Hight(mm)

Absorption Material Protection Method

G : GLASSWOOL + GLASS CLOTH
P : GLASSWOOL + GLASS CLOTH + PERFORATED PLATE
F : GLASSWOOL + GLASS CLOTH+ PE FILM + PERFORATED PLATE

Insertion Loss of Elbows

Elbow Type / Application	Square Elbow				Round Elow
	Without Turning vanes		With Turning vanes		Without Turning vanes
	Unlined Elbows	lined Elbows	Unlined Elbows	lined Elbows	Unlined Elbows
*fw<48	0	0	0	0	0
48≤fw<96	1	1	1	1	1
96≤fw<190	5	6	4	4	2
190≤fw<380	8	11	6	7	3
380≤fw<760	4	10	4	7	3
Fw≥760	3	10	4	7	3

* fw = f(Center Frequency:kHz) X w(Elbow Width:㎜)

AL-A/B Acoustic Louver

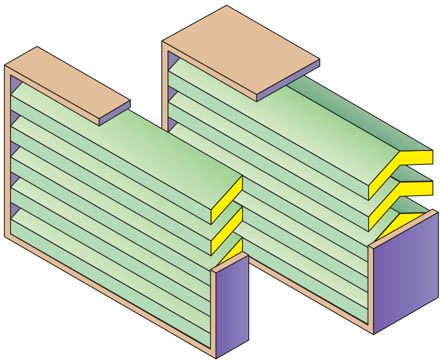
Features

The acoustic louver is installed in a place having enough area for ventilation where the rectangular sound attenuator is not available, but needs to be soundproofed. The casing is made of a galvanized steel plate with the thickness of 1.0~2.3 mm, and the inside of the louver splitter is filled with sound-absorbing material. It can prevent damage against the air current speed of 30M/S and the size of the acoustic louver splitter should be at least 150 mm.

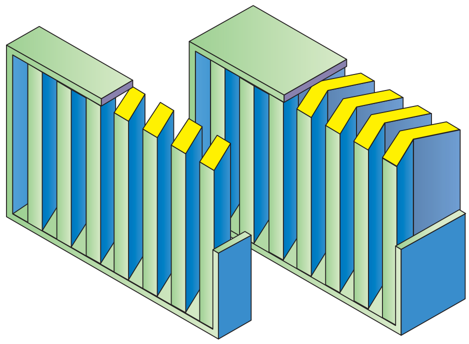
Specification

Item	Name of Components	Thickness	Remark
Outer Plate	Galvanized Steel Plate	1.0~2.3㎜	–
Splitter	Punching Plate	Over 0.8㎜	Ø5 x 7P, 46%
	Glass Cloth	0.12㎜	18 strands/25㎜
	Glass Wool	Over 50㎜	Over 40K
	Glass Cloth	0.12㎜	18 strands/25㎜
	Punching Plate	Over 0.8㎜	Ø5 x 7P, 46%

Types of Acoustic Louver



-Horizontal splitter-



-Vertical splitter-

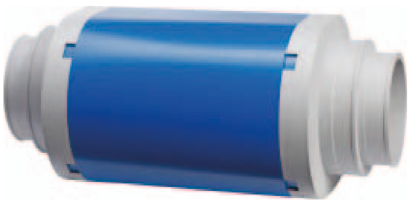
Installation features

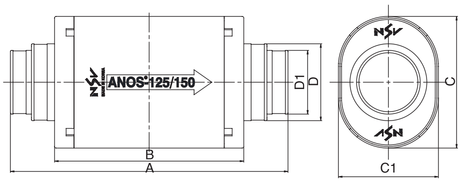
ANOS50 Hybrid Type Silencer (Resonance+Expansion Type Silencer)

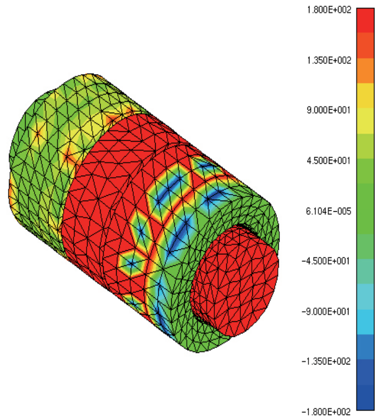
■ Why ANOS50 is needed

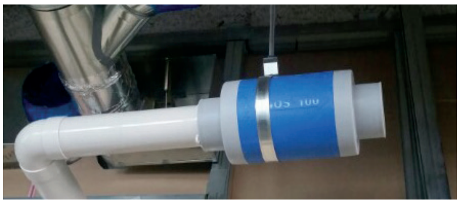
- To improve the quality of living – quiet and pleasant living environment
- Noise is the main cause of conflicts between neighbors
- Because ventilation pipes/ducts in the bathroom of an apartment or house are connected, noise is transferred next door, and therefore it is difficult to protect one's privacy.

■ ANOS50–125L/150L Specification









■ Specification

Model	Dimension(mm)						Type
	A	B	C	C1	D	D1	
ANOS50–100A	325	227	Ø150	–	Ø97	–	Circular
ANOS50–125A ANOS50–150A	528	360	250	190	Ø145	Ø121	OVAL

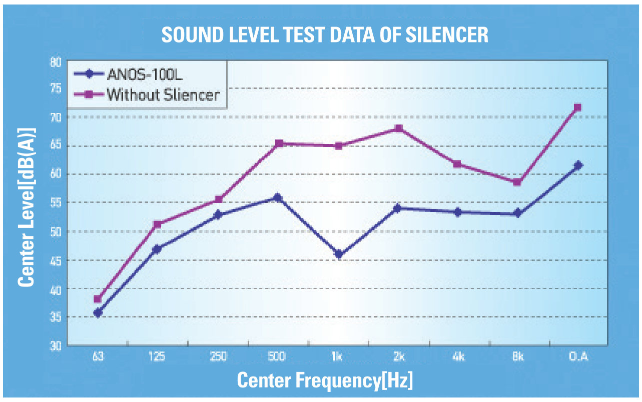
(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

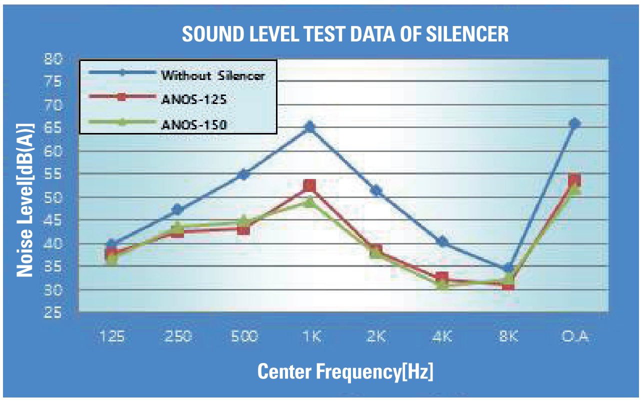
■ Characteristic

Details		Specification
Attenuation Performance		Greater than10dB(A) for dailylife noise in apartment
Ventilation Specification	Pressure Loss	0.3mmAq(based on Air flow speed of 5m/s in silencer)
	Ventilator Air Volume	2.0 CMM(120CMH)
	Bathroom Air Circulation	Air circulation count 15 times/hr base(volume 8.0m^3)
Material [polypropylene(PP)]		Material that is used to manufacture cooking ware harmless to human
		Rrecyclable and eco-friendly material
		When in combustion, no noxious gases are generated
Product Structure		Assembly design that is easy to install and perform maintenance

ANOS50 Hybrid Type Silencer (Resonance+Expansion Type Silencer)

ANOS50 Noise Level Test Data





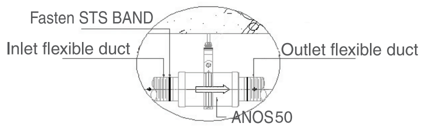
Effectiveness of ANOS50

- Reduces the level of noise generated in the bathroom down to that of background noise
- Excellent noise attenuation especially in 1~2KHz, which affects humans
- Protects privacy and maintains a quiet, pleasant living environment
- Helps avoid neighborly disputes and allows for the respect of privacy of one another

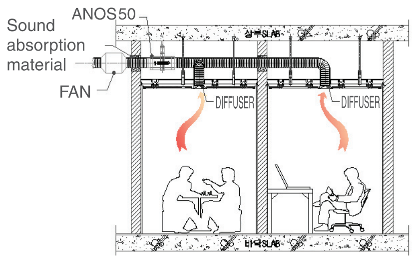
ANOS50 installation

- It can be installed on a ceiling and/or wall regardless of vent type
- It is easy to connect regardless of vent fan type
- It has a wide use of application, including kitchen hoods
- Its simple structure makes it easy to install, use and maintain

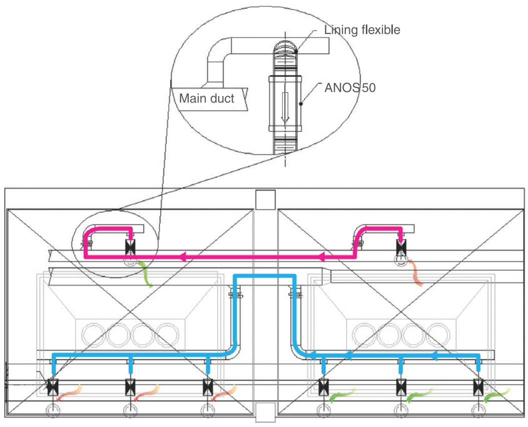
Bathroom Detailed drawing for ANOS50 installation



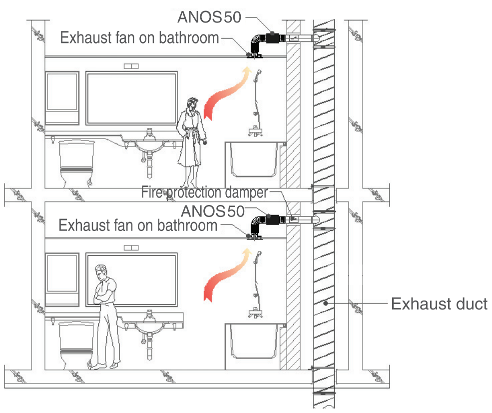
ANOS50 installation detail drawing



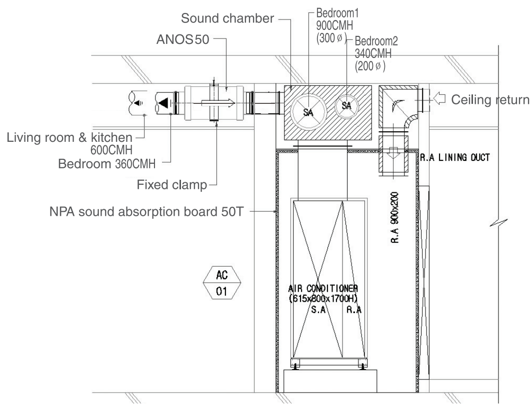
Detail drawing applied to A/C room



Noise block detail drawing between each

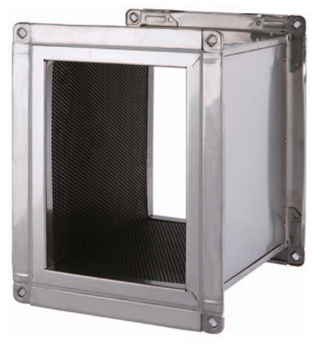


ANOS50 installation detail drawing on bathroom



office exhaust fan & ANOS50 installation detail drawing

SD Sound Absorbing Duct



■ Features

It is installed on the outlet or inlet of the air conditioning units and fan, and in a place where soundproofing equipment such as sound arrester and sound chamber are not available because its installation is not constrained by space. It is easy to install and useful in reducing noise inside ducts and subsequent noise as well.

■ Model denotation method

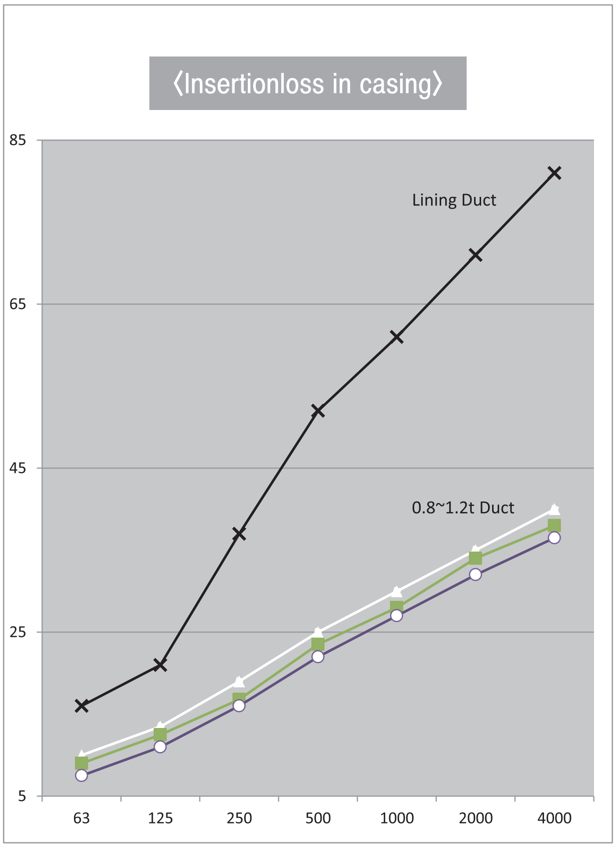
SD ① – ② X ③

① Method of protecting the sound-absorbing material
② Width of sound-absorbing duct(mm)
③ Height of sound-absorbing duct(mm)

■ Comparison of the sound-absorbing ducts' external insertion loss

Dimensions	63	125	250	500	1000	2000	4000
Lined Duct 25t	13	17	21	33	47	63	71
Lined Duct 50t	14	18	21	40	55	64	74
0.8t Unlined Duct	9	12	17	21	27	32	37
1.0t Unlined Duct	11	14	18	23	28	34	38
1.2t Unlined Duct	12	15	20	25	30	35	39
1.6t Unlined Duct	14	18	22	27	32	37	42
2.0t Unlined Duct	16	20	24	29	34	39	43

■ Comparison of the sound-absorbing ducts' external insertion loss



■ Sound attenuation amount of sound-absorbing duct (dB/m)

Dimensions, mm	Insertion Loss(dB/m), Octave Band Center Frequency(Hz)					
	125	250	500	1000	2000	4000
150 X 150	2.0	4.9	8.9	19.0	24.3	14.1
150 X 250	1.6	3.9	7.9	16.7	20.0	12.1
150 X 300	1.6	3.9	7.5	16.4	19.0	11.8
150 X 460	1.6	3.3	7.2	15.4	17.1	10.8
200 X 200	1.6	3.9	7.5	16.4	19.0	11.8
200 X 300	1.3	3.3	6.9	14.8	16.1	10.5
200 X 460	1.3	3.0	6.6	14.1	14.8	9.8
200 X 610	1.3	2.6	6.2	13.1	13.5	9.2
250 X 250	1.3	3.3	6.9	14.4	15.4	10.2
250 X 410	1.3	2.6	6.2	13.1	13.1	8.9
250 X 510	1.0	2.6	5.9	12.5	12.1	8.5
250 X 760	1.0	2.3	5.6	11.8	10.8	7.9
300 X 300	1.3	2.6	6.2	13.1	13.5	9.2
300 X 460	1.0	2.3	5.6	12.1	11.5	8.2
300 X 610	1.0	2.0	5.6	11.5	10.5	7.5
300 X 910	1.0	2.0	5.2	10.8	9.5	7.2
380 X 380	1.0	2.3	5.6	11.8	10.8	7.9
380 X 560	1.0	2.0	5.2	10.8	9.5	7.2
380 X 760	1.0	1.6	4.9	10.2	8.5	6.6
380 X 1140	0.7	1.6	4.6	9.5	7.9	6.2
460 X 460	1.0	2.0	5.2	10.8	9.5	7.2
460 X 710	0.7	1.6	4.6	9.8	7.9	6.2
460 X 910	0.7	1.6	4.7	9.2	7.2	5.9
460 X 1370	0.7	1.3	4.3	8.9	6.6	5.6
610 X 610	0.7	1.6	4.6	9.2	7.2	5.9
610 X 910	0.7	1.3	3.9	8.5	6.2	5.2
610 X 1220	0.7	1.3	3.9	7.9	5.6	4.9
610 X 1830	0.7	1.0	3.6	7.5	5.2	4.6
760 X 760	0.7	1.3	3.9	8.2	5.9	5.2
760 X 1140	0.7	1.0	3.6	7.5	5.2	4.6
760 X 1520	0.7	1.0	3.6	7.2	4.6	4.3
760 X 2290	0.3	1.0	3.3	6.9	4.3	3.9
910 X 910	0.7	1.0	3.6	7.5	5.2	4.6
910 X 1370	0.3	1.0	3.3	6.9	4.3	3.9
910 X 1830	0.3	1.0	3.3	6.6	3.9	3.9
910 X 1830	0.3	0.7	3.0	6.2	3.6	3.6
1070 X 1070	0.7	1.0	3.3	6.9	4.6	4.3
1070 X 1630	0.3	1.0	3.0	6.2	3.9	3.6
1070 X 2130	0.3	1.7	3.0	5.9	3.6	3.6
1070 X 3200	0.3	1.7	3.0	5.6	3.3	3.3
1220 X 1220	0.3	1.0	3.3	6.6	3.9	3.9
1220 X 1830	0.3	0.7	3.0	5.9	3.3	3.3
1220 X 2440	0.3	0.7	2.6	5.6	3.3	3.3
1220 X 3660	0.3	0.7	2.6	5.2	3.0	3.0

IS Industrial Silencer

■ Features

When high-pressure fluid is released from the safety valve, the pressure control valve and relief valve release into the atmosphere, and the speed of running fluid changes into the speed of sound and produces friction with the surrounding air and swirl, which results in the generating of loud noise. In general, high-frequency noise is generated from the outlet and low-frequency noise is generated from a short distance away, and the result is noise which frequency components show the mixed form of high frequency and low frequency. In order to reduce such noise, it is required to find the frequency that has the lowest noise level.

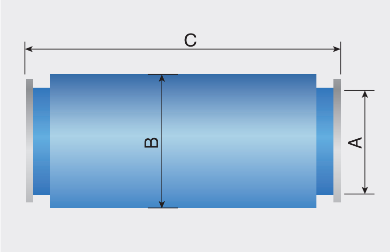
■ Specification

It is effective in attenuating the sound of the audible frequency and noise generated when high-pressure gas or steam is released into the atmosphere. It consists of the diffuser that directs low-frequency sound toward high-frequency sound, the expansion chamber is for low-frequency noise control, the acoustic tube is for high frequency noise control and shell.

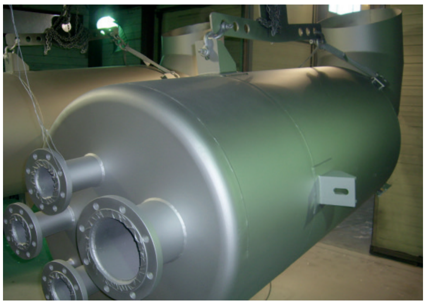
■ Model denotation method

I □□ – □ × □ × □
① ② ③ ④ ⑤

① Sound Attenuator Type : I/IN-LINE TYPE, V/VENT TYPE
② Sound Attenuator Form : H/HORIZONTAL, V/VERTICAL
③ Diameter of the connecting hole(mm) A
④ Sound Attenuator Diameter(mm) B
⑤ Sound Attenuator Length(mm) C



■ Steam vent silencer






SPR Soundproof Room

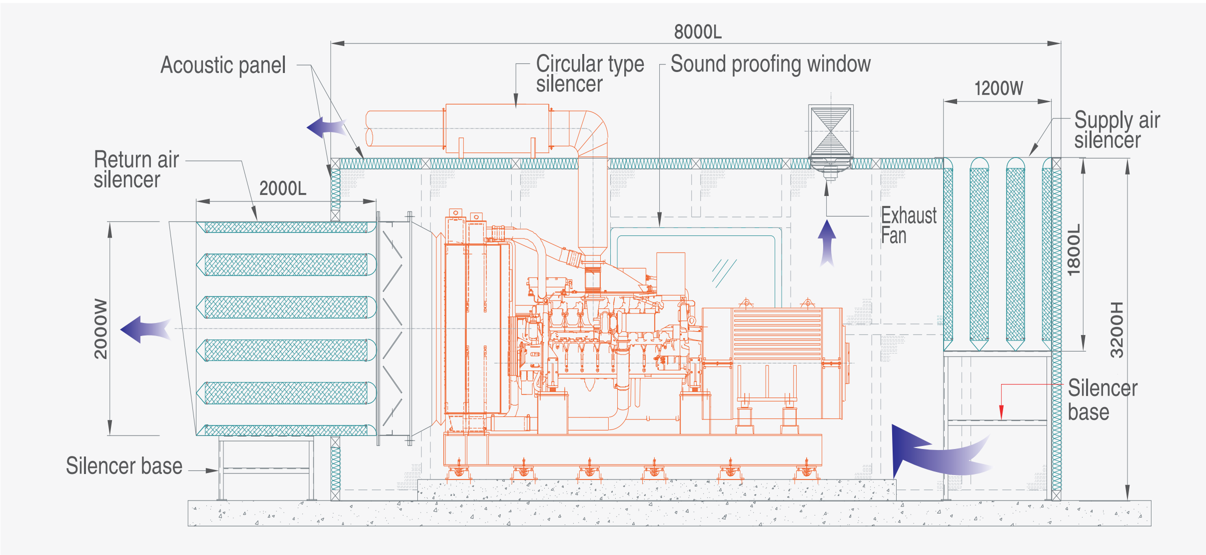
Soundproof Room

It is to make the noise-generating industrial facility into a room using sound absorbing/insulation panels in whole or in part. NSV plans the sound attenuation target in light of installation and surrounding conditions and designs, makes and installs the room to ensure performance.

Considerations in soundproof design

· Data of noise generated per frequency from the target facilities
· Location of the sound pick-up point and allowable noise level
· Ventilation and open-part soundproof depending on increase in indoor temperature
· Opening/closing plan and installation structure for maintenance
· Installation of door/window with the flow of human traffic in mind
· Location of electrical units, enclosing of penetration and drain

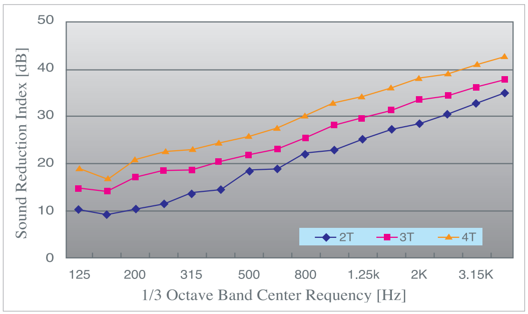
A Soundproof Room Structure Drawing








NDP Damping Sheets



■ Features

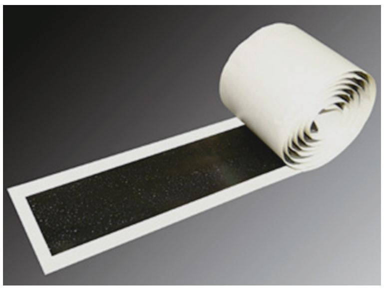
It is a viscoelastic material having a relatively high damping loss. It converts vibrational energy into thermal energy through internal viscous damping and friction. It is used to reduce the sound energy generated when a panel shakes due to vibration, resonance amplitude and vibration on joint parts.

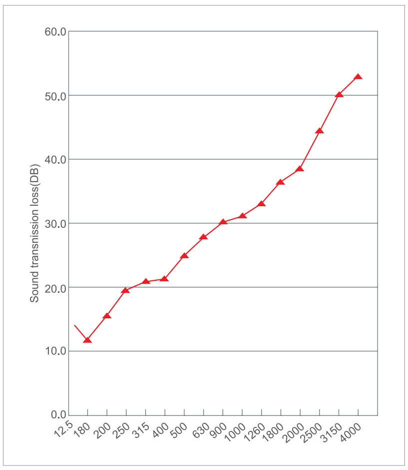
■ Dimension(size 1000x1000mm)

Type	Material	Thickness	Usage	Features
NDP-F	EVA+Film+Asphalt+Other Compound	2.0~4.0mm	AHU Room, Mechanical Room	Good for Sound Insulation and Dust Proofing

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

NDT Damping Tape





■ Features

The main material is butyl synthetic rubber, which is a tape-shaped material excellent in vibration control. It improves the loss factor from noise and vibration sources to reduce problematic vibration. With the mix of highly-functional additives and high molecules having excellent weather-resistance and viscosity, it offers excellent soundproof effects.

■ Specification

Type	NDT
Material	BUTYL
Thickness	3.2mm
Width	20~80mm
Length	10m

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

PO-MAT® Polyurethane Mat

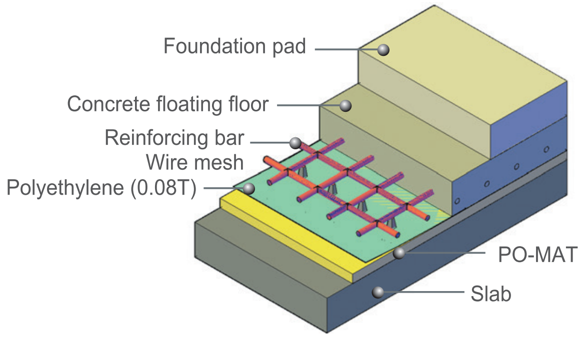
■ Features

Microcellular Polyurethane Mat is elastic and capable of supporting a wide range of dynamic loads owing to micro-sized air gap inside. In particular, the thickness of the Floating Slab can be reduced as the load is distributed evenly over the surface. Because Mat itself maintains elasticity and isolates noise, extra Floating Slab lifting is not required. It comes in different colors depending on its density, which makes it easier to select, handle and install.

■ Specification

Model	A25	B25	C25	D25	E25	F25	G25	H25
Color	Green	Yellow	Blue	Pink	Brown	Red	Gray	Black
Thickness	25T							
Density(kg/㎥)	150± 20%	220± 20%	300± 20%	400± 20%	500± 20%	600± 20%	800± 20%	1000± 20%
Rated Load(N/㎟)	0.01± 20%	0.03± 20%	0.05± 20%	0.10± 20%	0.15± 20%	0.40± 20%	1.50± 20%	5.00± 20%
Rated Def. (mm)	6.0						3.0	1.5
Size	1000mmX1000mmX25T							

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.



■ PO–MAT Durability Test Data

PO-MAT Model	Density (kg/㎥)	Lifetime (room temperature:20℃)	Activation Energy (kJ/mol)
A–25	150	612Years	200
B–25	220	630Years	207
C–25	300	644Years	206
D–25	400	652Years	185
E–25	500	660Years	219
F–25	600	675Years	193

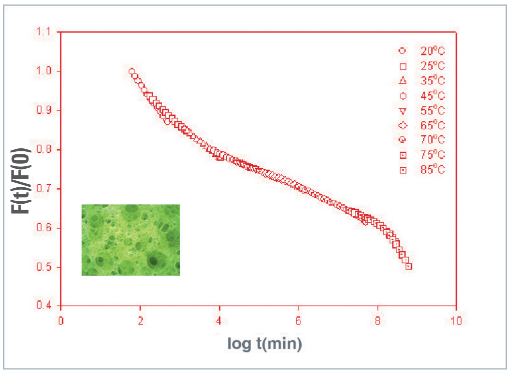
■ Test Equipment(DMA 2980, TA Instrument)

– The data above is the result of the test performed upon request by the Department of Chemical Engineering at Hanyang University. The test was conducted to predict durability using Time Temperature Superposition (TTS) and observe stress–relaxation under constant compression strain.

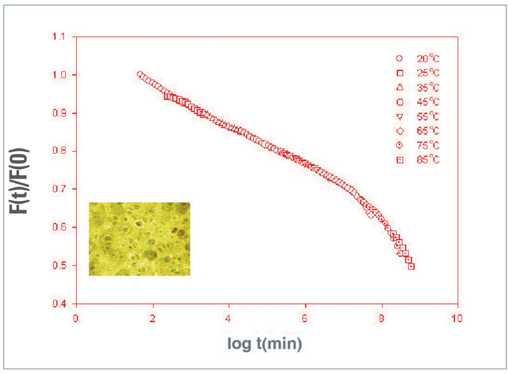
★ TTS : The higher the temperature, the less time is required for stress–relaxation; this principle is used to predict changes in mechanical behavior over time at a given temperature when temperature is changed within a measurable time range.

PO-MAT® Polyurethane Mat

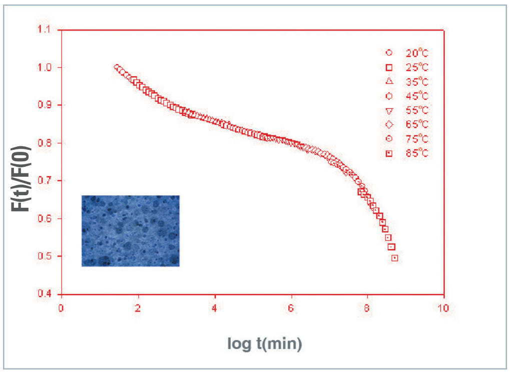
■ The PO–MAT Durability Test Resulting Graph



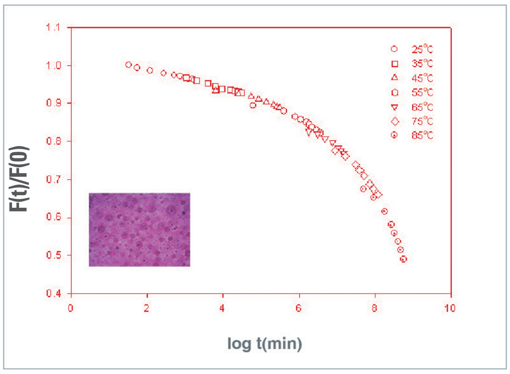
- Sample A : Green
- Density : 150Kg/㎥
- Durability : Durabity 612yrs(20°C)



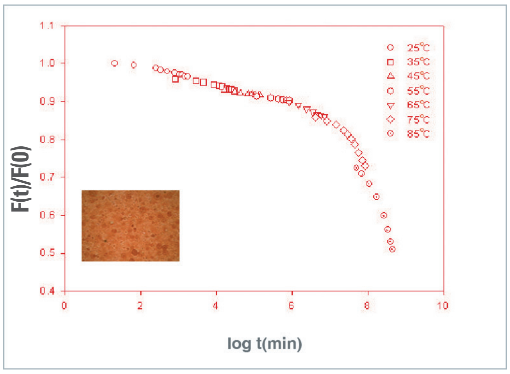
- Sample B : Yellow
- Density : 220Kg/㎥
- Durability : Durabity 630yrs(20°C)



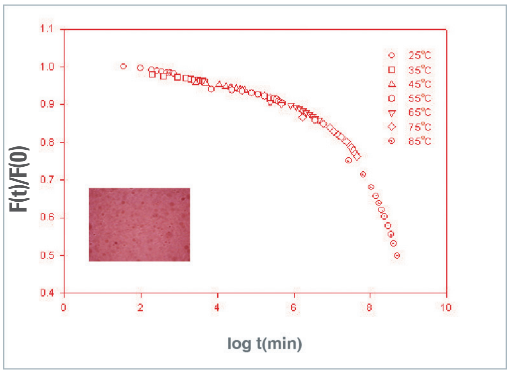
- Sample C : Blue
- Density : 300Kg/㎥
- Durability : Durabity 644yrs(20°C)



- Sample D : Pink
- Density : 400Kg/㎥
- Durability : Durabity 652yrs(20°C)



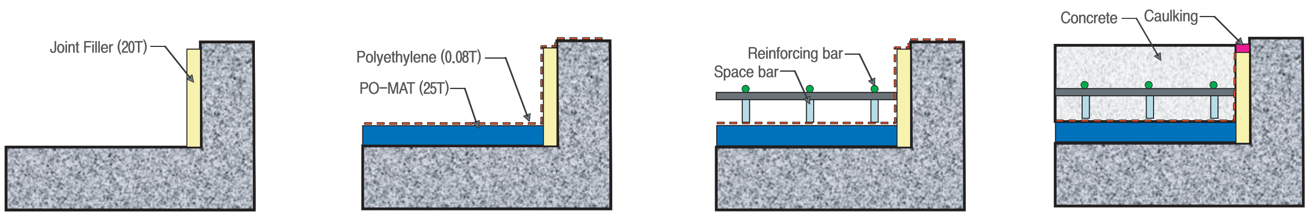
- Sample E : Brown
- Density : 500Kg/㎥
- Durability : Durabity 660yrs(20°C)



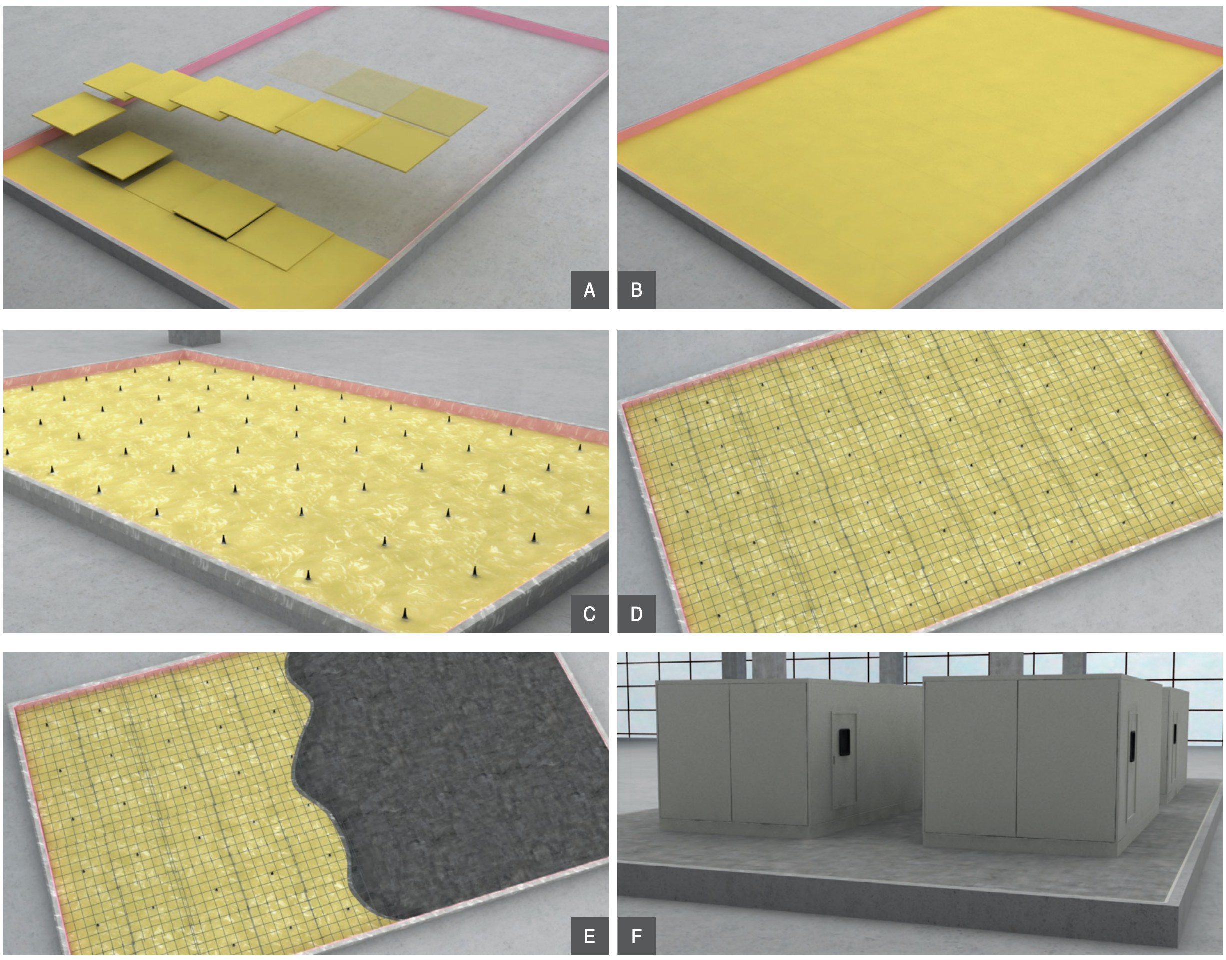
- Sample F : Red
- Density : 600Kg/㎥
- Durability : Durabity 675yrs(20°C)

PO-MAT® Polyurethane Mat

■ PO–MAT Installation Order

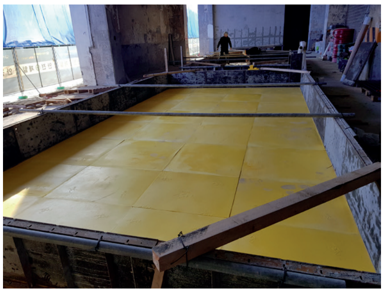


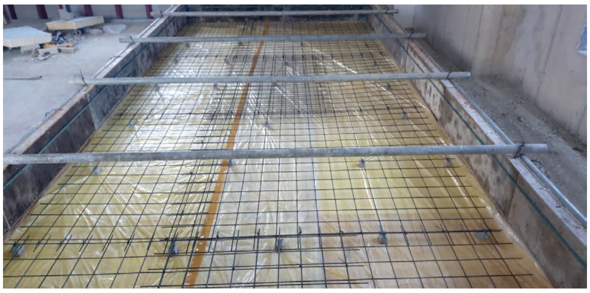
1. Clean the floor where the PO MAT is to be installed, keep level and install the MAT when the floor is dried.
2. Cover drain, vertical pipes, ducts and electric line–passing parts with joint filler and/or heat insulating materials.
3. Attach joint filler on surrounding walls and pillars that come in contact with double–bottomed slab.
4. Install the PO–MAT according to the approved drawing, in a way that manufacturer's name and model comes on top.
5. Install 2 layers of 0.08 mm–thick polyethylene (PE) plastic on top of the PO–MAT and attach using the OPP adhesive tape.
6. Install a wire mesh or steel reinforcement as shown in the approved drawing. Be cautious not to damage the plastic.
7. Place concrete and then leave it for curing. (According to the construction specification standard)
8. Then, do the caulking with 10mm–thick sealant.

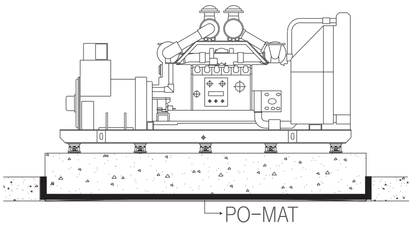


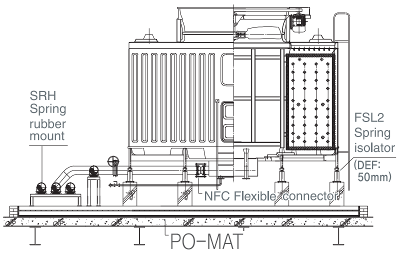
PO-MAT® Polyurethane Mat

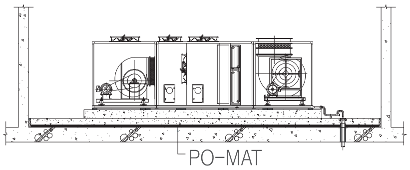
■ PO–MAT Construction Method



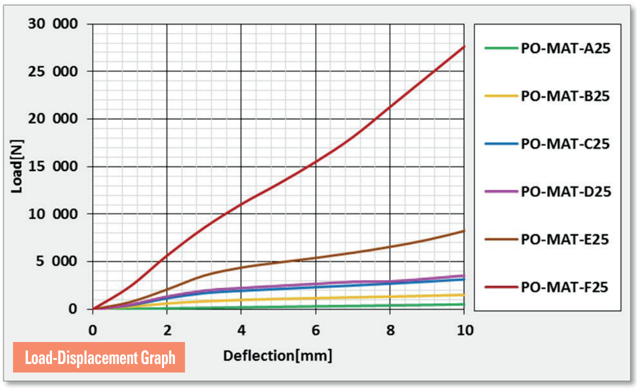




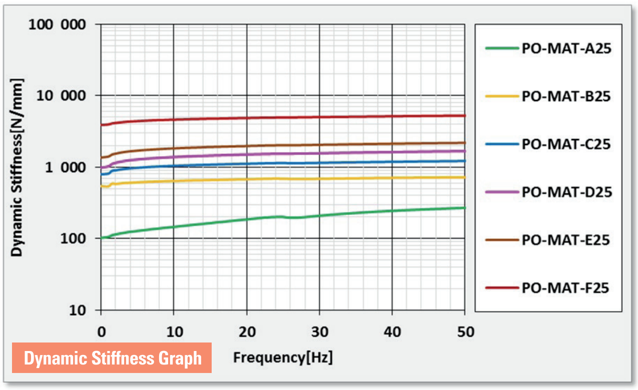




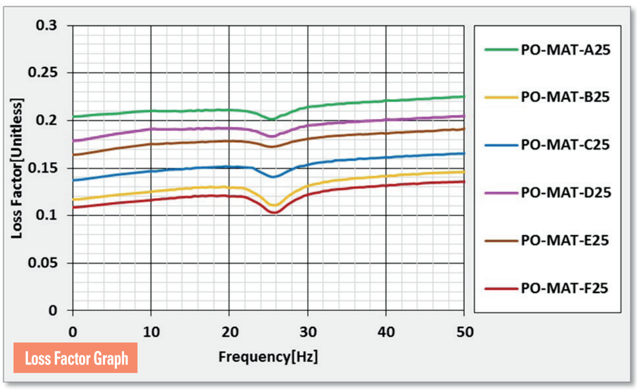
■ 25T Test Data



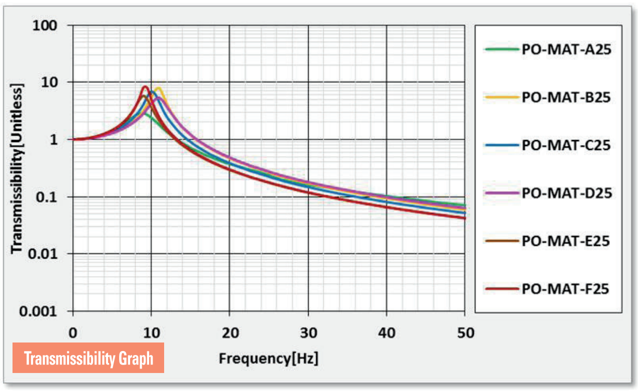
Load-Displacement Graph



Dynamic Stiffness Graph



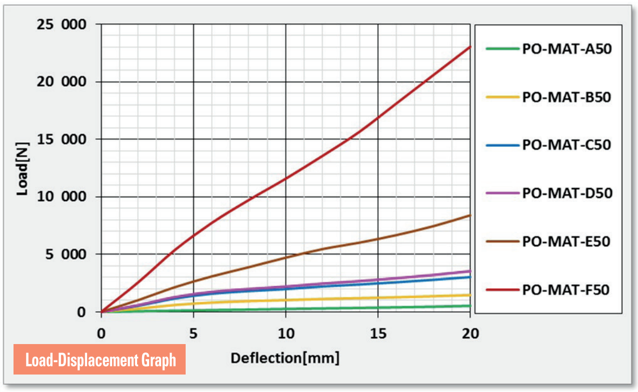
Loss Factor Graph

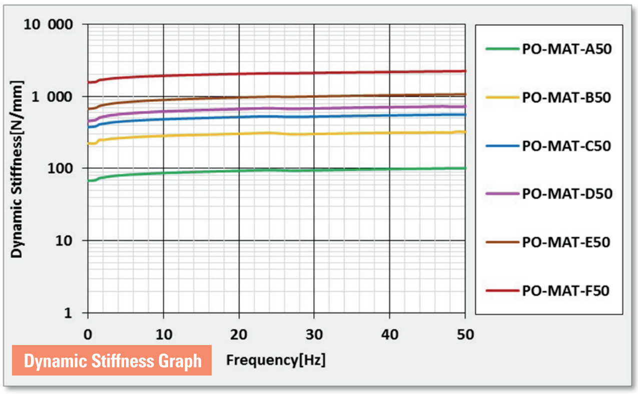


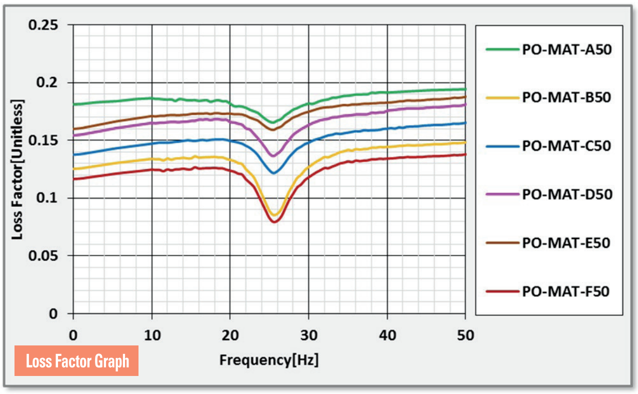
Transmissibility Graph

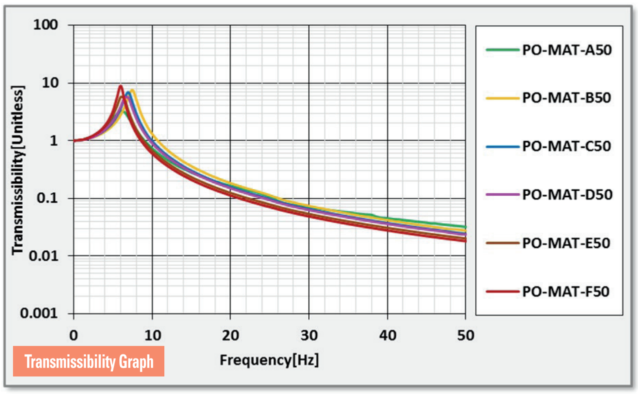
PO-MAT® Polyurethane Mat

50T Test Data









Explanation(Commonness)

1. Vibration Transmissibility(T_r)

   Vibration Transmissibility is the amplitude ratio of Output to Input.

$$T_r = \frac{Output\ Amplitude}{Input\ Amplitude} = \sqrt{\left(\frac{1}{1-\eta^2}\right)^2}\ ,\eta = \frac{Disturbing\ Frequency\ of\ the\ equipment}{Natural\ Frequency\ of\ the\ Isolator(\ Damping(c) = 0\ )}$$

2. Natural Frequency(F_n) of Vibration Isolation System

   The mass and spring stiffness dictate a natural frequency of the system.

$$F_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

3. Isolation Efficency(E)

   Isolation Efficiency in percent transmission is related to Vibration Transmissibility $E = 100(1 - T_r)$

   ex) Disturbing Frequency of the equipment=100 Hz,

   Natural Frequency of the isolator=10Hz

$$T_r = \sqrt{\left(\frac{1}{1-\eta^2}\right)^2} = \sqrt{\left(\frac{1}{1-\left(\frac{100}{10}\right)^2}\right)^2} = 0.101 \quad E = 100(1 - T_r) = 100(1-0.101)=99(\%)$$

4. Loss Factor(ζ)

   ① Loss Factor is the double damping ratio on natural frequency of Vibration Isolation System $\eta = 2 \times \zeta(Damping\ Ratio)$

   ② The damping ratio is a dimensionless measure describing how oscillations in a system decay after a disturbance.

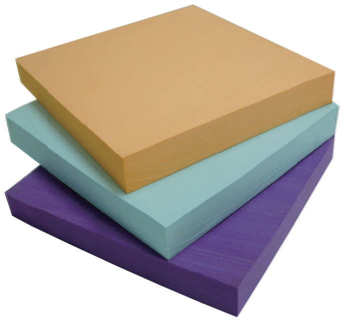
$$\zeta = \frac{Actural\ Damping}{Critical\ Damping}$$

5. Dynamic Stiffness(k_d)

   The dynamic stiffness is the frequency dependant ratio between a dynamic force and the resulting dynamic displacement.

$$k_d = \frac{Force(Frequency)}{Vibration\ Response}$$

HD-MAT High-Damping Mat



■ Features

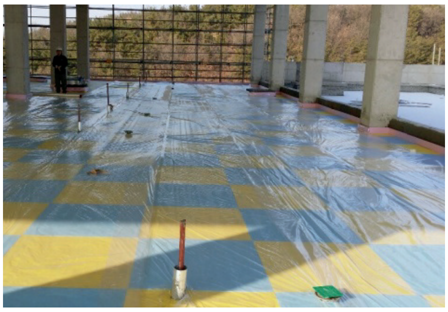
It is a highly-molecular copolymer formed through the foaming of HSBR (Hydrogenated SBR) blended with EVA (Ethylene Vinyl Acetate). Because it has adequate elasticity compared to the conventional foam and excellent damping properties against external exciting force and impulsive load, it can be converted into a static state in a short space of time.

■ Specification

Model	A25	A50	B25	B50	C25	C50
Color	Orange		Sky Blue		Purple	
Thickness	25	50	25	50	25	50
Density(kg/㎥)	100±20%		150±20%		200±20%	
Tensile Strength(MPa)	Over 1.3		Over 1.8		Over 2.0	
Coefficient of Extension(%)	Over 220		Over 220		Over 220	
Rated Load(N/㎟)	0.08±20%		0.17±20%		0.20±20%	
Rated Def.(mm)	8	16	8	16	8	16
Natural Freq.(Hz)	Under 12	Under 8	Under 12	Under 8	Under 12	Under 8
Rebound Resilience(%)	Under 25		Under 25		Under 25	
Loss Factor(tanδ)	Over 0.3	Over 0.27	Over 0.3	Over 0.27	Over 0.3	Over0.27
Dynamic Modulus of Elasticity(N/㎟)	Under 1.6	Under 2.0	Under 1.6	Under 2.0	Under 1.6	Under 2.0
Compression Set ((23±2)℃, 22h)	Under 5.0		Under 5.0		Under 5.0	
Water Absorption Ratio (g/㎤)	Under 0.005		Under 0.003		Under 0.003	
Size(W x H x T)	1000mmX1000mmX25mm, 1000mmX1000mmX50mm					

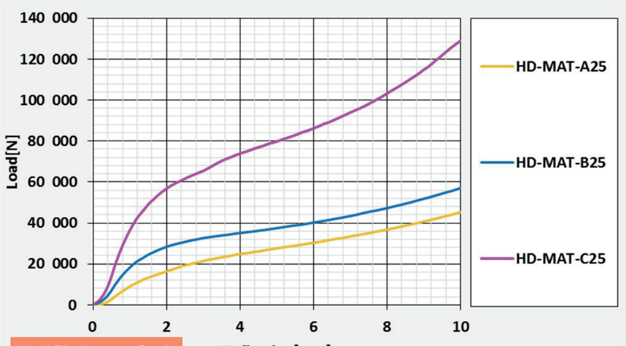
(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

■ Installation features

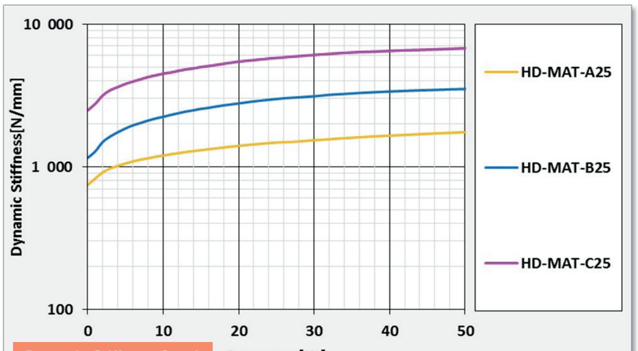


HD-MAT High-Damping Mat

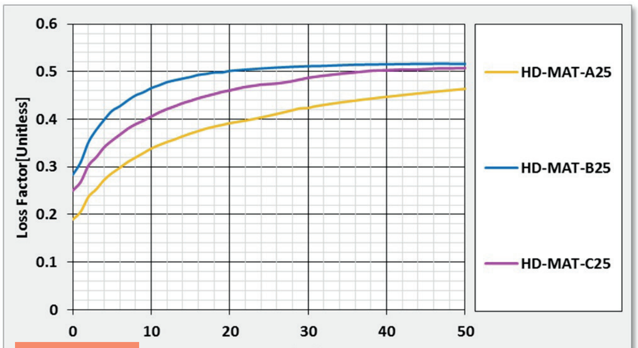
■ 25T Test Data



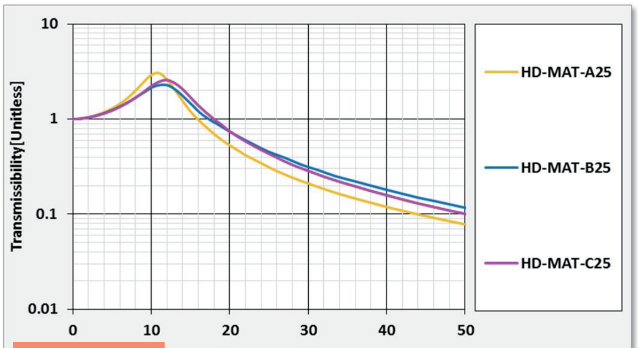
Load-Displacement Graph



Dynamic Stiffness Graph

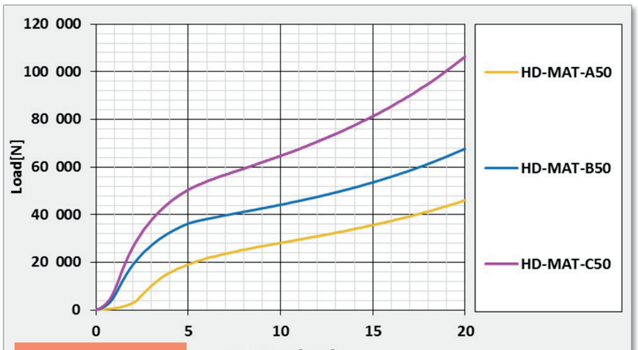


Loss Factor Graph

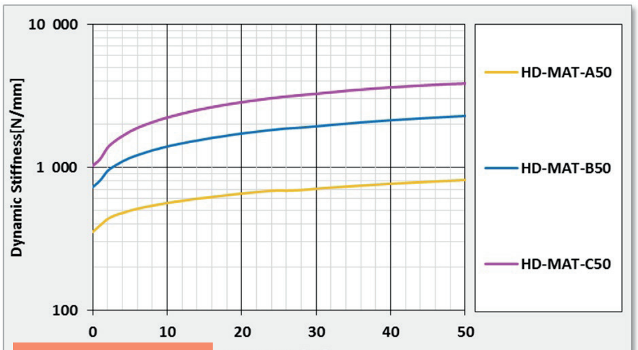


Transmissibility Graph

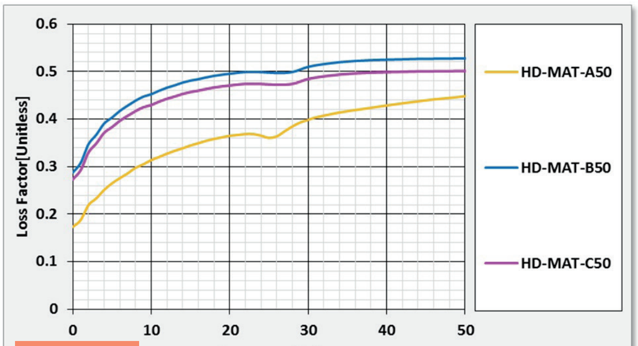
■ 50T Test Data



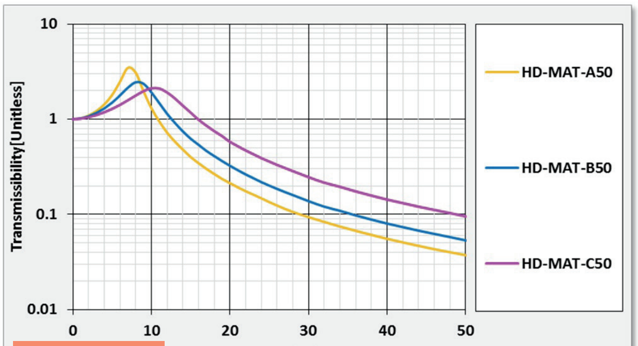
Load-Displacement Graph



Dynamic Stiffness Graph

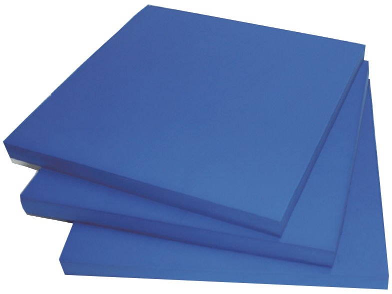


Loss Factor Graph



Transmissibility Graph

HE-MAT High-Elasticity Mat



■ Features

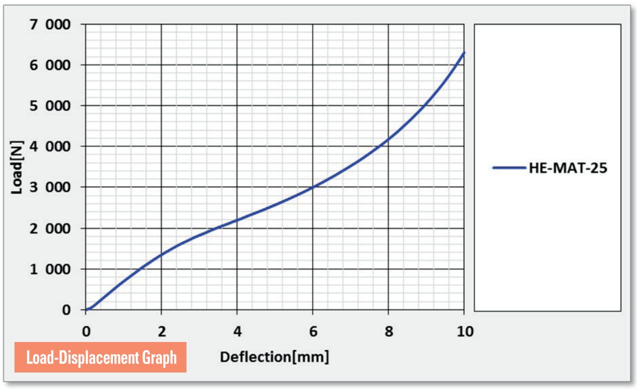
It is a highly-molecular copolymer formed through the foaming of high-elastic ethylene olefin blended with styrene copolymer. It has a higher elasticity than that of common foam and outstanding glutinous properties. Plus, it can be used as an alternative to the anti-vibration system for the floating floor of structure under concentrated load/distributed load and anti-vibration rubber material used for construction facilities as it can control the dynamic range of compressive load depending on the specific gravity and has a good resistance to compressive deformation.

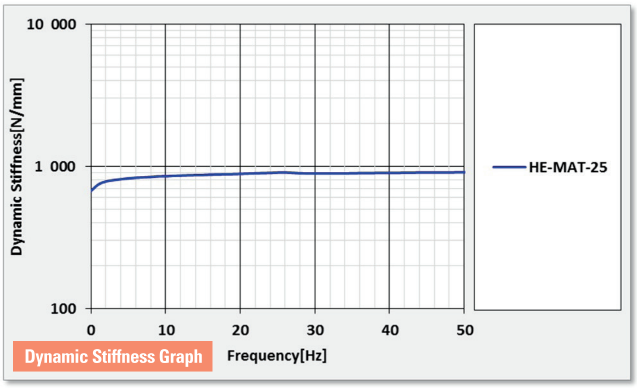
■ Specification

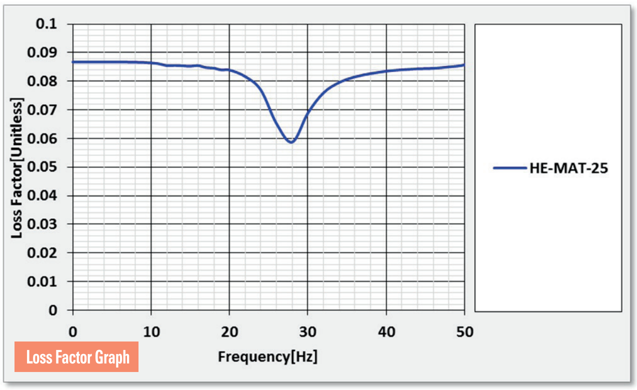
Model	HE-MAT 25	HE-MAT 50
Color	Blue	
Thickness	25	50
Density(kg/㎥)	270±20%	
Tensile Strength(MPa)	Over 1.3	
Coefficient of Extension(%)	Over 200	
Rated Load(N/㎟)	0.11±20%	
Rated Def.(mm)	6	12
Natural Freq.(Hz)	Under 10	Under 8
Rebound Resilience(%)	Over 80	
Dynamic Modulus of Elasticity(N/㎟)	Over 5	Over 5
Compression Set ((23±2)℃, 22h)	Under 3	
Water Absorption Ratio(g/㎤)	Under 0.003	
Size(WxHxT)	1000mm X 1000mm X 25T	

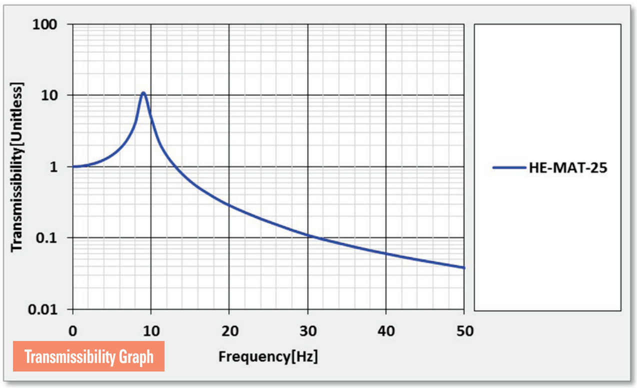
(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

■ HE-MAT Test Data









NP-MAT Neoprene Mat

■ Features

The NP-MAT is made of neoprene rubber (CR:Crichloroprene Rubber) with excellent durability and relatively stable oil, heat and chemical resistance that is foamed and shaped with high density. The close-cell structure inside the mat helps absorb shock, vibration and noise without volumetric displacement.

■ Intended use

· Double bottom of air conditioning rooms and machine rooms
· Shock-absorbing material for machines
· For the isolation of buildings from a vibration-generating subway
· Base vibration and noise control in a special area
· For the floor of sports facilities

■ Physical properties

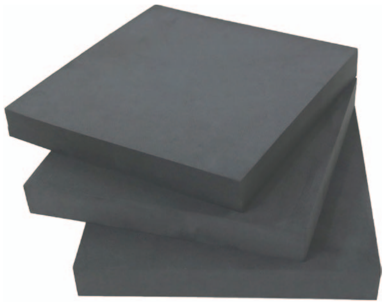
· Damp proof property (absorption rate : less than 0.5g/㎠)
· Insulation : Thermal conductivity (0.036W/m.K at 20℃)
· No environment pollutant contained and harmless to human
· Non-combustible

■ Dimension & Selection Guide

Model	Color	Density(kg/㎥)	Rated Def.(mm)	Coefficient of Extension(%)	Size(mm)
NP-B25	Black	200±20%	8	Over 250	1000X1000X25
NP-B50			16		1000X1000X50
NP-C25		300±20%	8		1000X1000X25
NP-C50			16		1000X1000X50

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

EP-MAT EVA Mat



■ Features

EVA (Ethylene Vinyl Acetate) resin is copolymer produced through the polymerization of ethylene monomer and VAM (Vinyl Acetate Monomer) in autoclave reactors, which is used to produce LDPE (Low Density Polyethylene) with as much VAM as VA in content. Because it has excellent elasticity and flexibility, it is suitable as a buffer to alleviate the transfer of structure-borne shock and vibration through neighboring rooms on lower and upper floors. It is mostly used as the base pad for air conditioning rooms and machine rooms.

■ Dimension & Selection Guide

Model	Measure	EP-10	EP-20	EP-25	EP-30	EP-50
Thickness	mm	10	20	25	30	50
Density	Kg/㎥	100±20%				
Tensile Strength	MPa	Over 1				
Coefficient of Extension	%	Over 85				
Hardness of spring	-	Over 45				
Rebound Resilience	%	Over 35				
Compression Set((23±2)℃, 22h)	%	Under 5				
Size (W x H x t)	mm	900mm x 1800mm x 10mm, 20mm, 25mm, 30mm, 50mm				

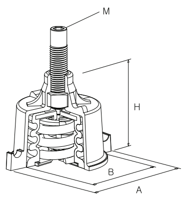
(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

JUM-10000/20000/30000/40000 Jack Up Mount

Features

The jack-up system absorbs and insulates noise, impulsive vibration, as well as impulsive noise generated in problematic areas, such as air conditioning rooms, machine rooms and bowling alleys. It has at least a 50 mm-deep air layer and a 100mm-thick ferroconcrete slab using the neoprene mount on top of the slab. It increases transmission loss of noise in the double slab (floating floor) and prevents the transfer of vibration and primary structure-borne nose in the neoprene mount. the jack screw bolt should be on the top to lift the slab after installation and the support fixture should be on both sides for the distribution of steel reinforcements. Plus, the neoprene mount must have a steel plate within in order to handle a dynamic load.

JUM-10000 (Deflection : 17mm)

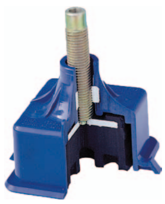


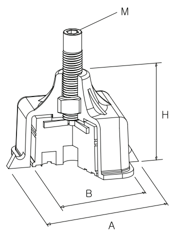
Dimension & Selection Guide

Model	Capacity (kgf)	Deflection (mm)	Hardness (Hs)	Dimension				Others	
				A	B	H	M	Air Gap(mm)	Slab Thickness(mm)
JUM-10200	200	17	65±5	130	94	100	M20	50~100	100~150
JUM-10300	300								
JUM-10400	400								
JUM-10500	500								
JUM-10600	600								
JUM-10700	700								
JUM-10800	800								

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

JUM-20000 (Deflection : 8mm)



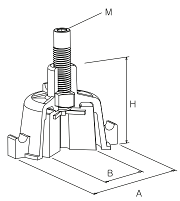


Dimension & Selection Guide

Model	Capacity (kgf)	Deflection (mm)	Hardness (Hs)	Dimension				Others	
				A	B	H	M	Air Gap(mm)	Slab Thickness(mm)
JUM-20200	200	8	65±5	136	86	100	M20	50~100	100~150
JUM-20300	300								
JUM-20400	400								
JUM-20500	500								
JUM-20650	650								
JUM-20800	800								

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

JUM-30000 (Deflection : 8mm)

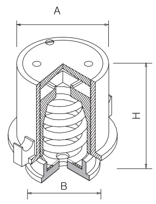


Dimension & Selection Guide

Model	Capacity (kgf)	Deflection (mm)	Hardness (Hs)	Dimension				Others	
				A	B	H	M	Air Gap(mm)	Slab Thickness(mm)
JUM-30200	200	8	65±5	154	116	100	M20	50~100	100~150
JUM-30300	300								
JUM-30500	500								
JUM-30650	650								
JUM-30800	800								

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

JUM-40000 (Deflection : 50mm)



Features

It is mostly applied when vibration is a bigger problem than the noise (for example, air conditioning rooms and machine rooms where the vibration frequency is less than 20Hz or the vibration is less than 30Hz with broad amplitude is generated). When the spring jack up system is used to form the double bottom, it is best to maintain the natural frequency of the whole system between 3.6Hz and 4.0Hz using an anti-vibration spring mount with a static deflection of 20~50mm. At this point, the diameter of the spring should be about 80% of the spring height under static loading. (With a reserve more than 50% of the static load)

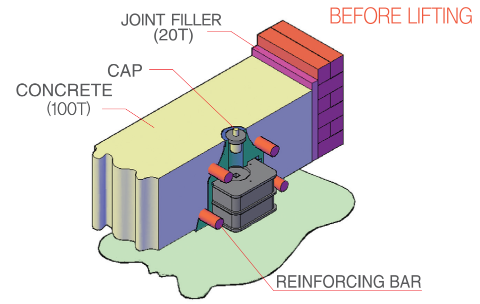
Dimension & Selection Guide

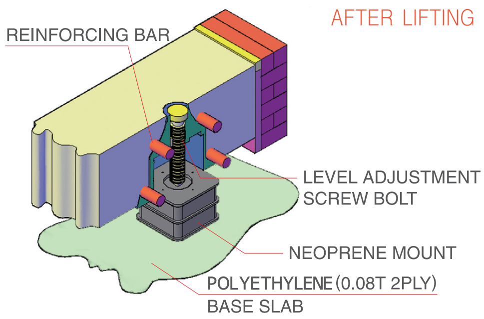
Model	Color	Capacity(kgf)	Deflection(mm)	Dimension			Others	
				A	B	H	Air Gap(mm)	Slab Thickness(mm)
JUM-40200	White	200	50	180	95	150	50	150~120
JUM-40300	Orange	300						
JUM-40400	Pink	400						
JUM-40500	Green	500						
JUM-40600	Blue	600						
JUM-40750	Black	750						

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

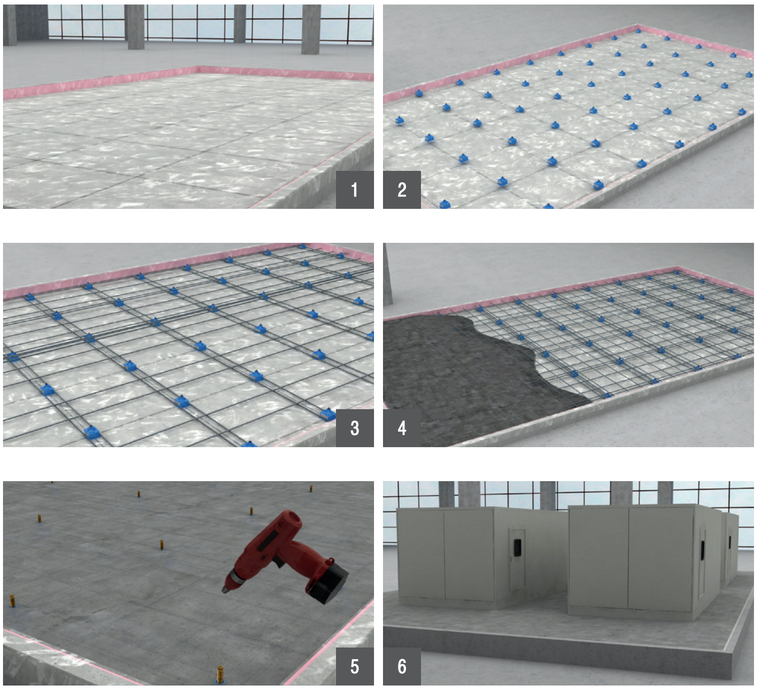
JUM-10000/20000/30000/40000 Jack Up Mount

■ Jack-up system before/after lifting

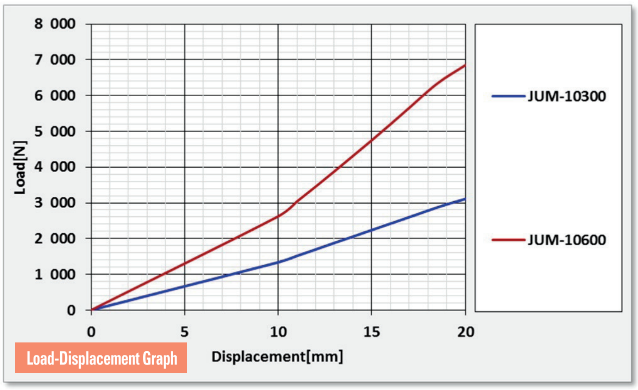


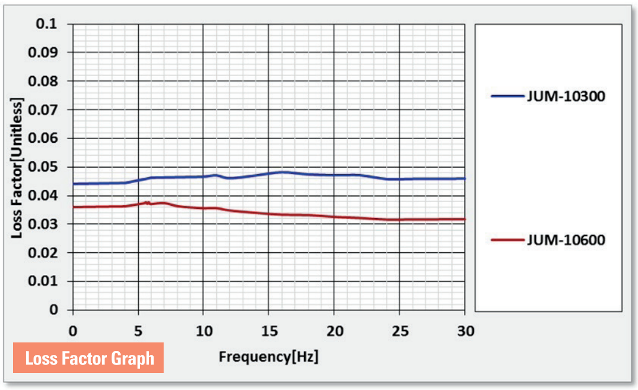


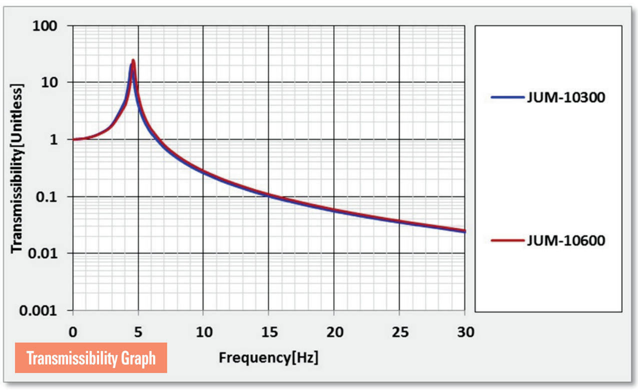
■ Jack-up system Installation Order

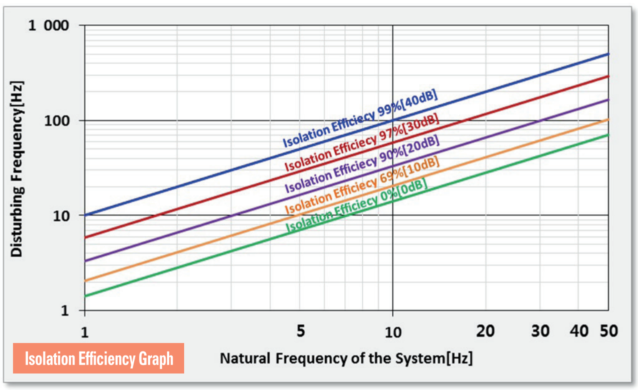


■ JUM-10000 Test Data



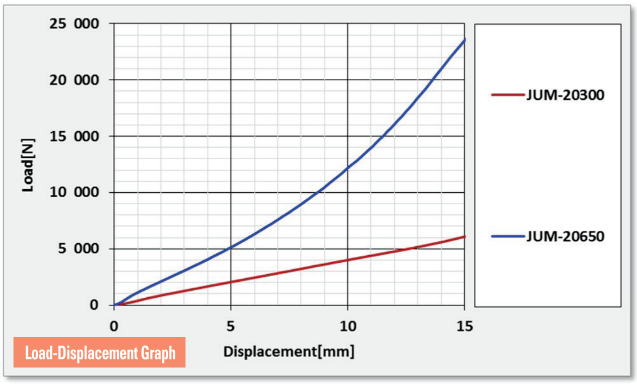


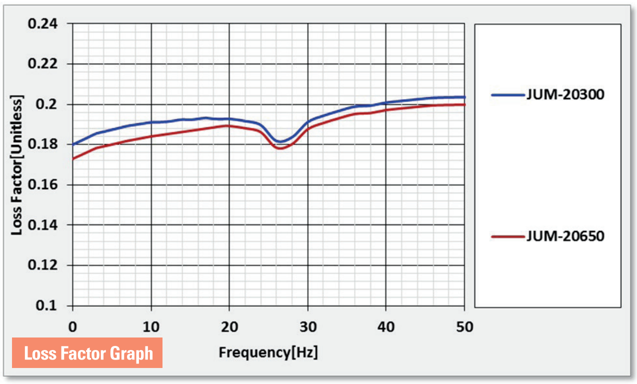


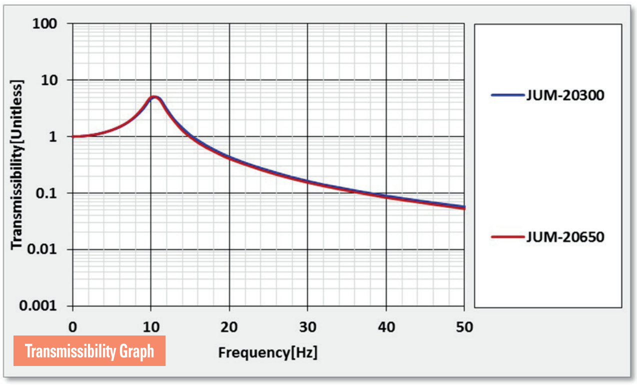


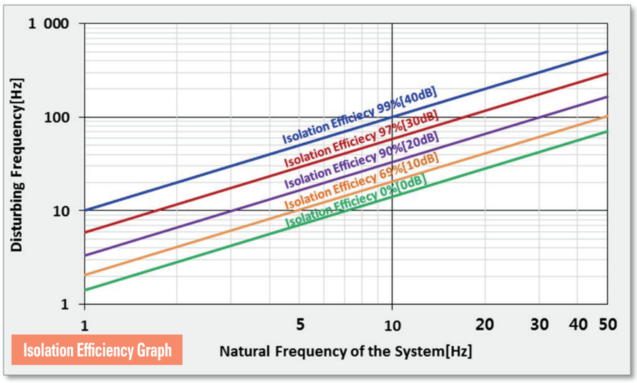
JUM-10000/20000/30000/40000 Jack Up Mount

■ JUM–20000 Test Data

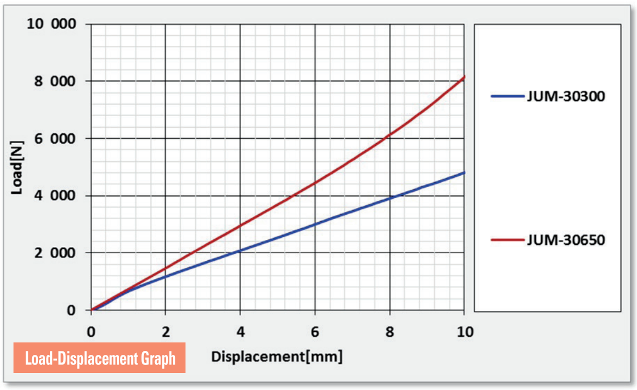


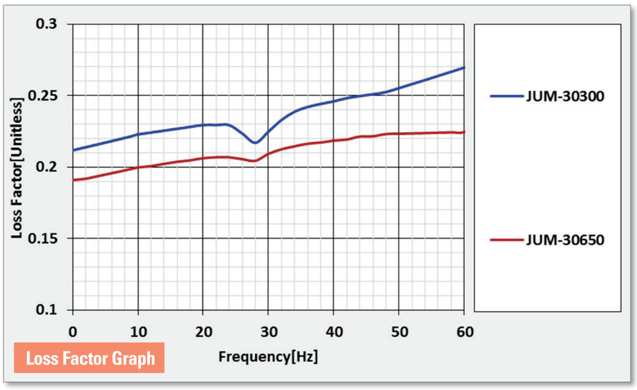


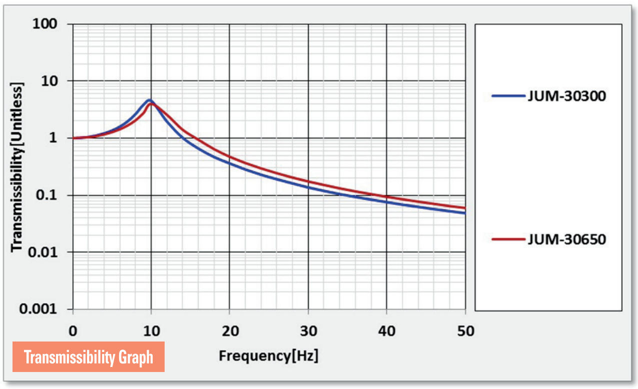


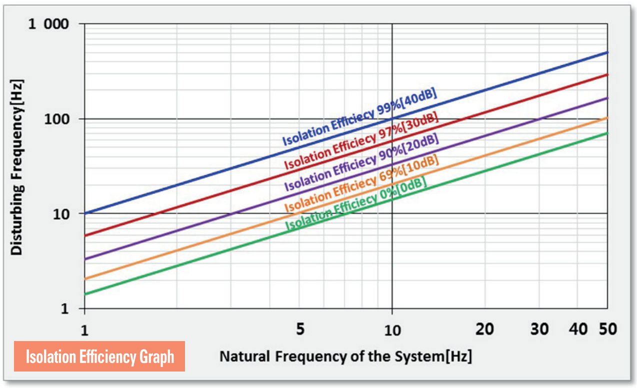


■ JUM–30000 Test Data



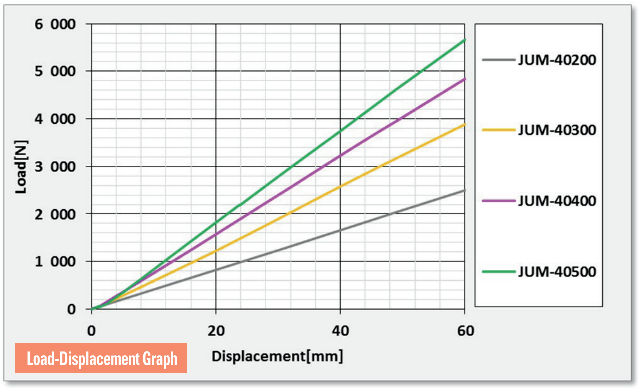




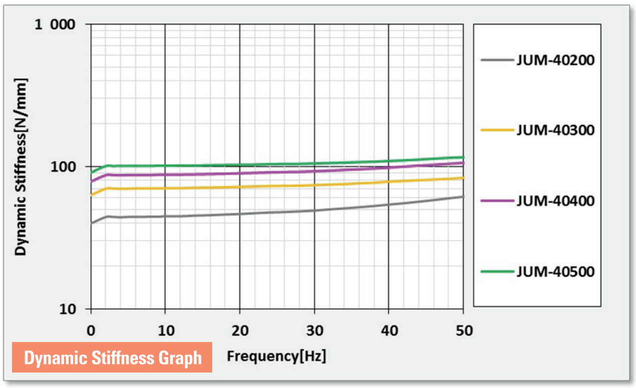


JUM-10000/20000/30000/40000 Jack Up Mount

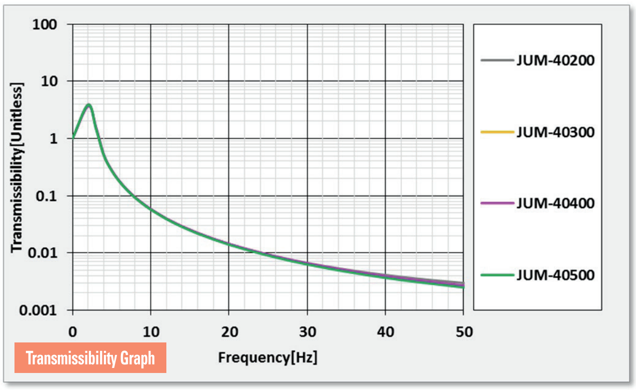
■ JUM−40000 Test Data



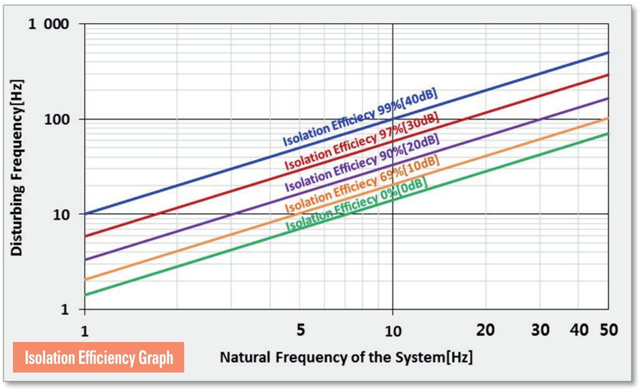
Load-Displacement Graph



Dynamic Stiffness Graph



Transmissibility Graph



Isolation Efficiency Graph

■ Explanation(Commonness)

1. Vibration Transmissibility(T_r)

Vibration Transmissibility is the amplitude ratio of Output to Input.

$$T_r = \frac{Output\ Amplitude}{Input\ Amplitude} = \sqrt{\left(\frac{1}{1-\eta^2}\right)^2}\ ,\eta = \frac{Disturbing\ Frequency\ of\ the\ equipment}{Natural\ Frequency\ of\ the\ Isolator(\ Damping(c) = 0\ )}$$

2. Natural Frequency(F_n) of Vibration Isolation System

The mass and spring stiffness dictate a natural frequency of the system.

$$F_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

3. Isolation Efficency(E)

Isolation Efficiency in percent transmission is related to Vibration Transmissibility $E = 100(1 - T_r)$

ex) Disturbing Frequency of the equipment=100 Hz,

Natural Frequency of the isolator=10Hz

$$T_r = \sqrt{\left(\frac{1}{1-\eta^2}\right)^2} = \sqrt{\left(\frac{1}{1-\left(\frac{100}{10}\right)^2}\right)^2} = 0.101 \qquad E = 100(1 - T_r) = 100(1-0.101)=99(\%)$$

4. Loss Factor(ζ)

① Loss Factor is the double damping ratio on natural frequency of Vibration Isolation System $\eta = 2 \times \zeta(Damping\ Ratio)$

② The damping ratio is a dimensionless measure describing how oscillations in a system decay after a disturbance.

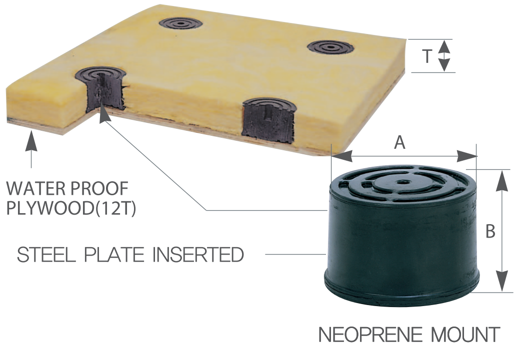
$$\zeta = \frac{Actural\ Damping}{Critical\ Damping}$$

5. Dynamic Stiffness(k_d)

The dynamic stiffness is the frequency dependant ratio between a dynamic force and the resulting dynamic displacement.

$$k_d = \frac{Force(Frequency)}{Vibration\ Response}$$

NFM Plywood Floating Floor System



■ Features

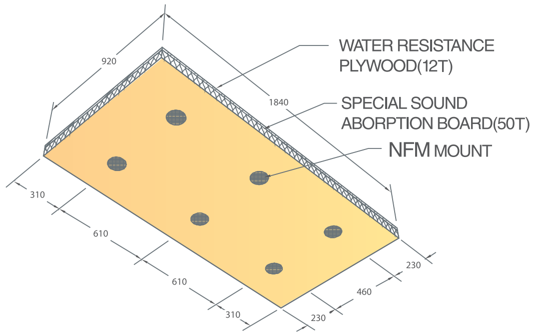
As a kind of form work floor system, it absorbs noise, shock and vibration generated in air conditioning rooms, machine rooms and other special facilities like the jack-up system does. But, unlike the jack-up system, it is easier to install as it requires no floating floor to be lifted. In particular, the high-density glass wool inside the product helps work better than the jack-up system in all ranges of frequency. It is designed according to the waterproof plywood standards to keep the mounts at regular intervals when installed next to each other in a horizontal position.

■ Dimension & Selection Guide

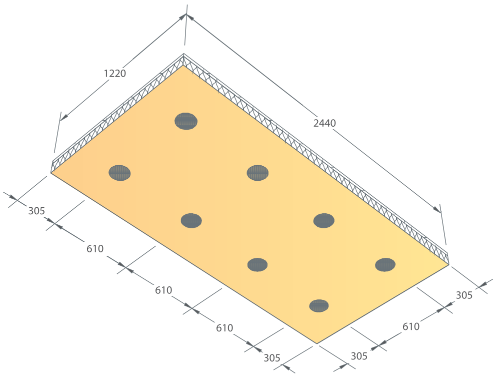
Model	Capacity (kgf)	Deflection (mm)	Hardness (Hs)	Dimension(mm)		Others	
				A(mm)	B(mm)	Absorption material T(mm)	SLAB Thickness(mm)
NFM-250	250	8	55±5	60	50	50	100~150
NFM-500	500	8	55±5	80	50	50	100~150
NFM-1000	1000	8	55±5	80	50	50	100~150

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.

■ NFM Plywood Panel Configuration

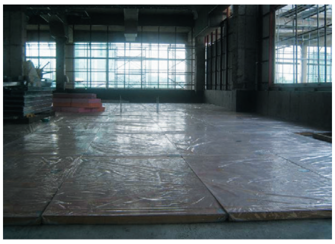


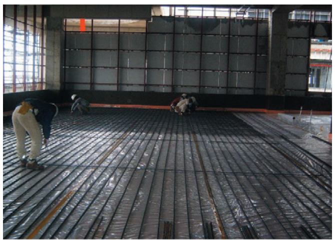
3′×6′ SIZE



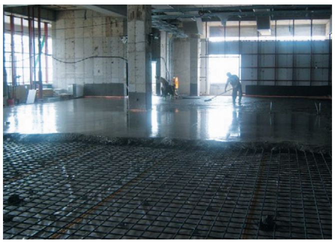
4′×8′ SIZE

■ NFM Plywood Panel Installation features

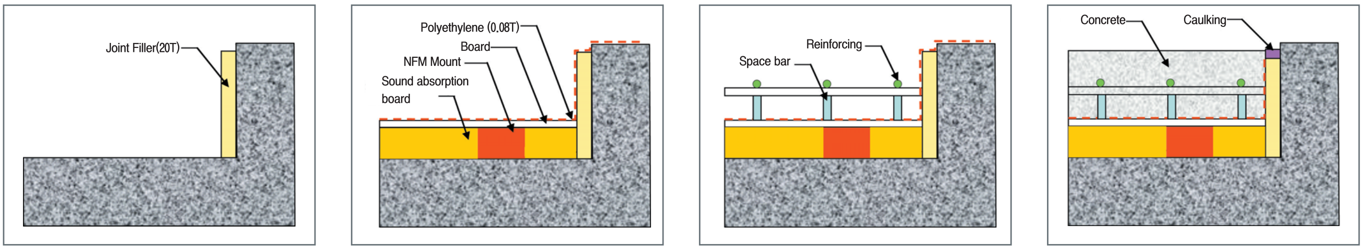






NFM Plywood Floating Floor System

NFM plywood panel Installation Order



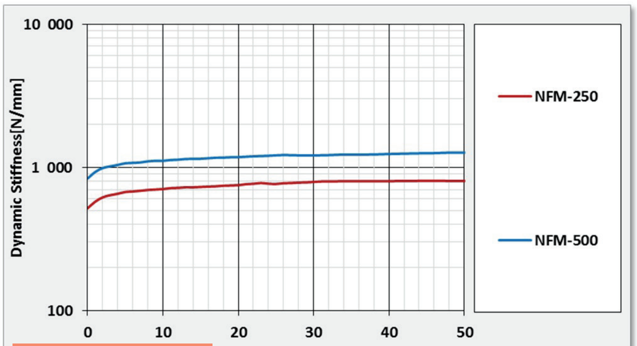
1. Clear the surface of the floor where nfm mount is to be installed, maintain a level surface and keep it dry.
2. Fix the drain, vertical pipes and ducts.
3. Insert the spool pipe seal on the general pipe or electric pipe.
4. Attach the joint filler on the wall or pillar that will come in contact with the slab of plywood panel system.
5. Install nfm plywood panel according to the approved drawing.
6. Spread two layers of 0.08mm-thick polyethylene (PE) over the panel and then attach it using the waterproof tape. The plastic sheet should be large enough to cover the top of the iso pink.
7. Install the steel reinforcement as shown in the approved drawing. At this point, be cautious not to damage the plastic sheet.
8. Pour the concrete at once, so that it can have the strength of 3000 psi.
9. Leave it for curing.
10. Once the floor is completely cured, remove the plastic sheet and then do the caulking with 10mm-thick sealant.

NFM Plywood Panel System Transmission Loss DATA

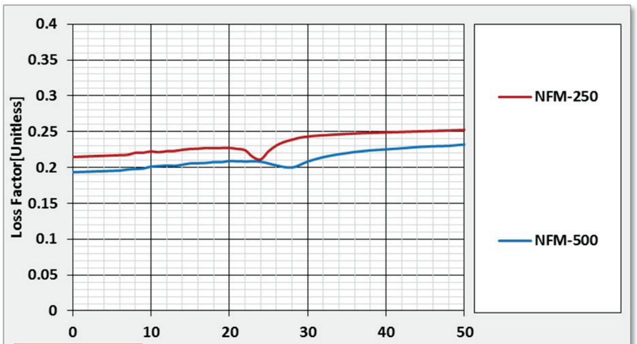
Frequency(Hz)	63	125	250	500	1000	2000	4000
Transmission Loss(dB)	54	59	73	83	89	97	106

Performance Test Data

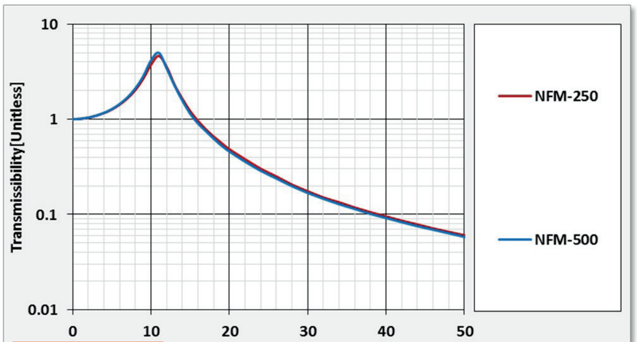
Load-Displacement Graph



Dynamic Stiffness Graph

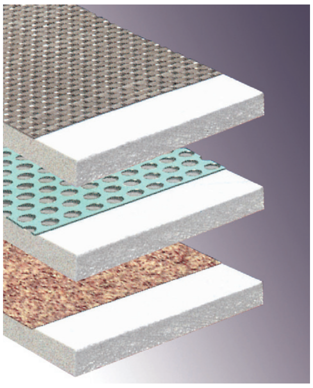


Loss Factor Graph



Transmissibility Graph

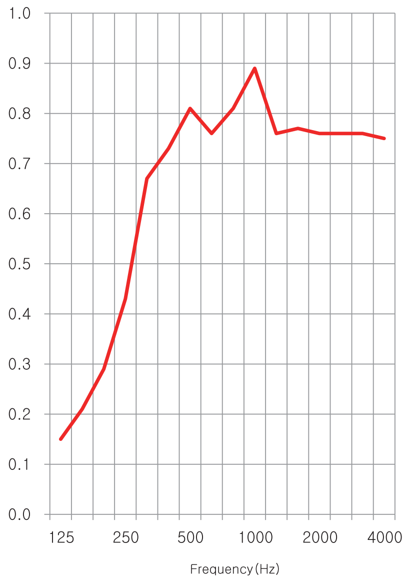
NFA Fiber Glass Sound Absorbing Board



Features

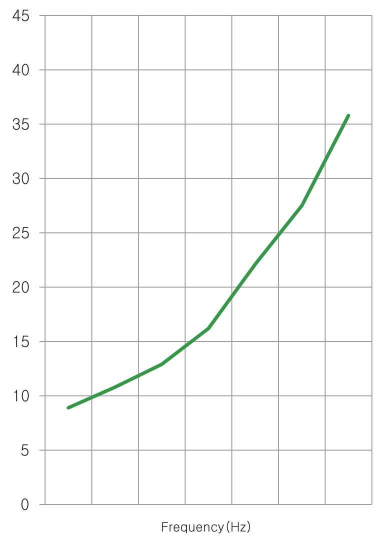
The NFA board is the perfect non combustible sound absorbing material treated with GlassCloth and Fabric using an E-glass fiber needle mat. It offers higher sound absorbing power compared with other products of the same thickness. Plus, it is the first sound absorbing material in Korea that is treated with the Roving Cloth, which made it last longer and look beautiful outside.

Sound Absorbing Coefficient (Reverberation Method)



Hz	α
125	0.15
160	0.21
200	0.29
250	0.43
315	0.67
400	0.73
500	0.81
630	0.76
800	0.81
1000	0.89
1250	0.76
1600	0.77
2000	0.76
2500	0.76
3150	0.76
4000	0.75

Transmission Loss (NFA Sound Absorbing Board 25T)



Frequency(Hz)	63	125	250	500	1000	2000	4000
25T board	8.9	10.8	12.9	16.2	22.1	27.5	35.8

NFA-GC TYPE

As the sound-absorbing material for construction and industrial fields, NFA-GC is made of an E-glass fiber needle mat covered with Glass Cloth. It is the most efficient sound absorbing material that copes with medium/high frequency range.

Usage

Used for sound absorption in power generator rooms, air conditioning rooms and industrial facilities

Size

1000X1000X20mm, 25mm/THK

NFA Merit

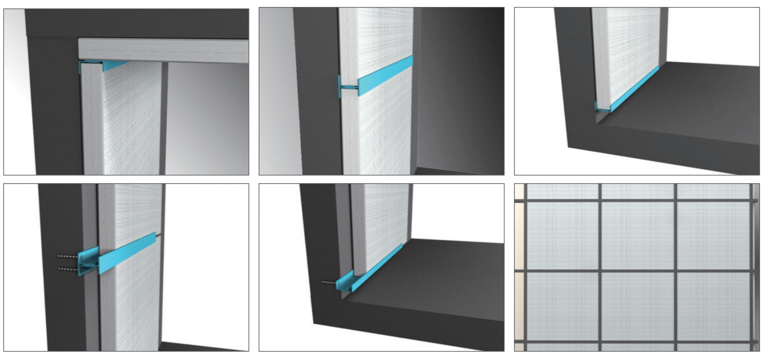
1.Excellent noise attenuation
The NFA sound absorbing board with a density higher than 160Kg/㎥ has higher sound absorbing coefficient compared to other products of the same thickness. Because three different medium are stacked up, it copes better with physical properties of sound. Plus, it has a high transmission loss, which provides excellent noise attenuation when installed.

2.Made up of perfect non-combustible natural mineral material, it lasted 2 hours in the level 1 fireproof construction test.

3.It is light, economical, easy to handle and install and moreover, generates less dust.

4.Because it is made up of E-glass fiber, which is natural mineral having excellent durability and safety, it has a chemical resistance with a high durability. And it has a low thermal expansion coefficient, which means it is unlikely to contract and expand as it is almost never affected by temperature and humidity.

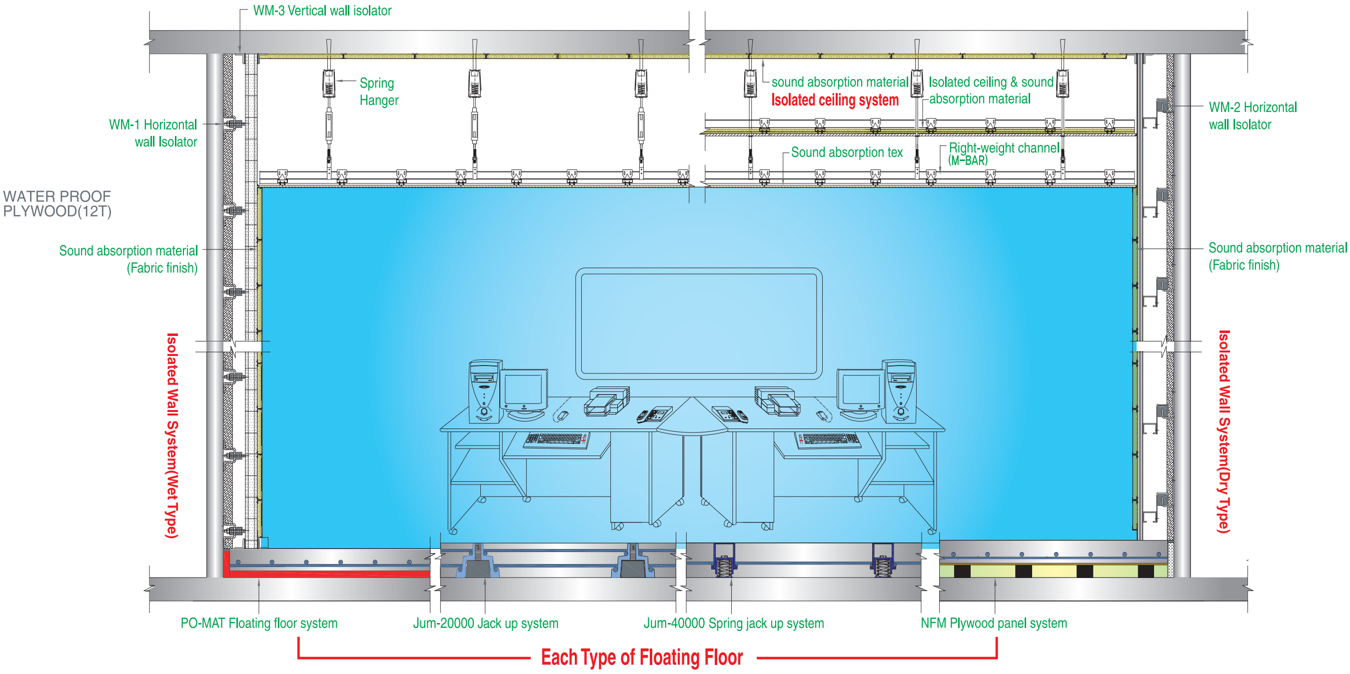
NFA sound absorbing board installation



WM1 / WM2 / WM3 Isolated Stud Neoprene Mount

■ Suspended ceiling

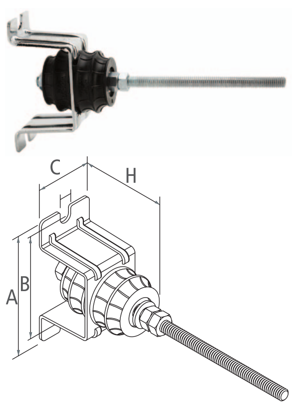
The aerial density of a suspended ceiling is much lower than the hardness of the floor SLAB and in this regard, noise is absorbed by in-between space (usually 30mm deep) rather than the ceiling itself. To block the transfer of vibration to the ROADBAR through the structure and control resonance of the ceiling, a rubber or hybrid spring hanger is used.



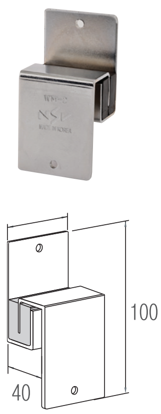
■ Double-wall

To maintain quiet indoors, architectural soundproofing structures are as important as soundproofing using building equipment. The double-wall works as a vibration insulator to prevent the vibration of the wall by sound pressure from passing through the building structure. This double-wall system can be applied on both wet and dry walls. The transmission loss of the double wall is determined based on the structure of the air layer and its aerial density.

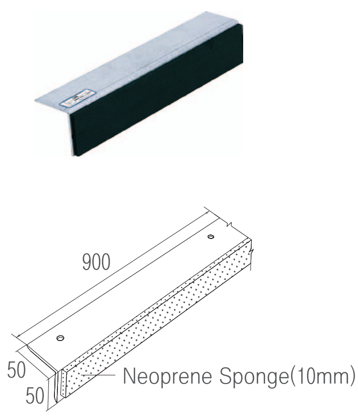
WM1



WM2



WM3



■ Dimension & Selection Guide

Model/Capacity	Dimension				
	A(mm)	B(mm)	C(mm)	D(mm)	AH(mm)
WM1-50	108	95	50	11	86
WM1-150	148	124	70	13	114

(NOTE) The mentioned size and scale can be altered to improve the quality performance and capacity of the product without any notice.