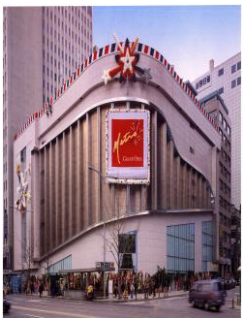
Panteon Building



HIVE ®

AL.HONEYCOMB PANEL

—Specification & Technical Data-

D S C ENGINEERING CORPORATION

CONTENTS

Introduction and Application

1. Introduction

Since 1976, **DSC (Former, Dongshin)** has been produced pre-coated metal and honeycomb panel were developed for new technologies and goods for construction material in 21C.

Especially, in case of AL. Honeycomb Panel, DSC is the only manufacturer in Korea which can supply pre-coated aluminum sheet, aluminum honeycomb core material and adhesive material by ourselves in one-stop basis.

This is frequently used as outstanding interior materials for buildings with high strength flatness and durability. Especially, in 1983, it was introduced to American military and acknowledged for its light weight and strength, and now is being used for a new building exterior materials with superiority. “HIVE Panel” is composition of Aluminum Honey-comb (Air97%+AL.3%) in core and surface AL. sheet, in a high density structure, with the best flatness and strength.

2. Application

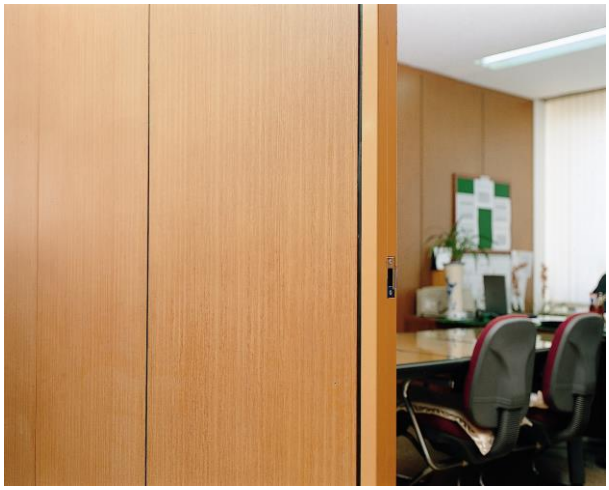
Curtain Wall

We, DSC, provide Aluminum or Stainless Steel faced panels for exterior and interior architectural applications. PVDF(Kynar 500) for exterior and High-durability polyester finishing are available in standard and custom colors. Especially, newly developed stone pattern and texture type patterns can extend client's color or pattern choice. Panels can be configured for glazed-in and other common methods of installation.

Building Exterior Wall Panel		Roofing

Displays & Exhibits

Aluminum Honeycomb panels can provide a lightweight, flat backing for client's graphics, decorative partitions, or signage. They are light, sturdy, and easy to transport.



Interior Partition

Clean-room Walls & Ceilings

For the special usage for System Ceiling and Clean-room, which requires anti-static treatment, we also provide aluminum honeycomb cored panels with conductive or anti-static coated coatings. Panels can be of any thickness to suit your framing system. Custom lengths are readily available.

Cleanroom	Ceiling

Others

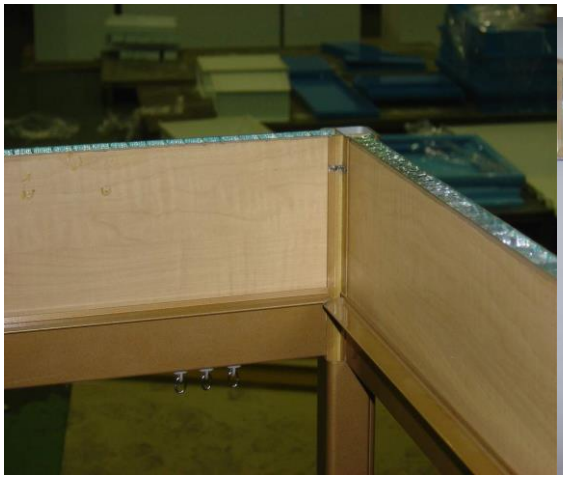
Except above usage, the HIVE can be act as special purpose of Interior Furniture, partition of Shipbuilding, Stone Composite Panel for Floor, Table, Elevator interior, Toilet Partition, Machinery Components, Instrument, Science projects and Aerospace.

Stone Honeycomb for Floor and Table

Furniture for Vessel

Cloth Chest for Vessel

Bedroom for Vessel



Honeycomb Application for Furniture

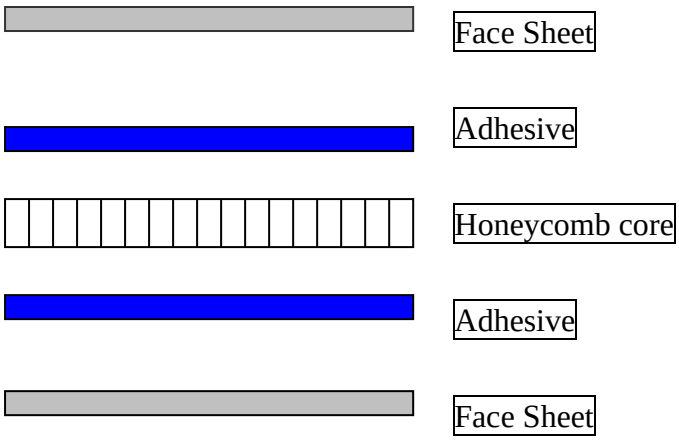
Toilet Door & Partition

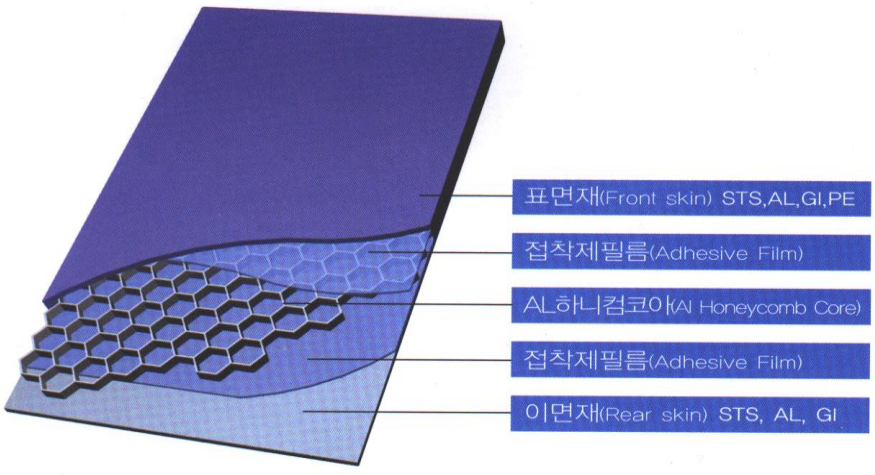
Specification

3. SPECIFICATION

3.1. STRUCTURE

It is a hexagonal structural type that is strongest and most safety structure among the all structure, it is used in aircraft field for a recent 50 years and honeycomb sandwich panel have applied in order to meet the demands of the time which light-weight and strong material for an application of high rise building.





3.2. Properties of facing materials

Alloy & Temper	Ultimate Tensile Strength (N/mm2)	Yield Strength (N/mm2)	Ultimate Shear Strength (N/mm2)	Modules of Elasticity (N/mm2)	λ(1-μ2)
Aluminum A3003 – H16	179	173	103	$6.^{89}$ X 10^4	0.89
A5052 – H34	262	214	145	$6.^{96}$ X 10^4	0.89

3.3. Chemical Composition Limits & Mechanical Properties

Composition		Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	other	Al
A3003	Max.	0.60	0.70	0.20	1.50	0.05	0.05	0.10	0.05	0.15	Rem
H16	Min.			0.05	1.0						97.919

Spec.	Tensile Strength (kgf/mm2)	Yield Strength (kgf/mm2)	Elongation (%)
Max.	21	15	3
Min.	17	13.8	1

KS D6701(Related to JIS H4000, ASTM B209)

3.4. Properties of Aluminum Honey-comb Core

Properties		Values			
		1/4”	3/8”	1/2”	3/4”
Density(kg/m3)	60 micron	70	46	35	23
	65 micron	76	50	38	25
	70 micron	81	54	41	27
	75 micron	87	58	44	29
Flammability		Non-Combustible			
Alloy & Temper		A3003 H16, A3104 H18			
Foil Treatment		Chromated for anti-Corrosion Perforated(Option)			

3.5. Panel Coating Finish

Test Type		Testing Conditions		Quality standards		Remarks
				High Durability P.E	P.V.D.F	
Color		1.By eye 2.Color difference-meter		O.K within range Δ E = 1.0 or less	O.K within range Δ E = 1.0 or less	
Gloss		GLOSS METER(60)	Full light	70% or more	Not Applicable	
			Half light	20~70% or less	Not Applicable	
			No light	20% or less	30% or less	
Pencil Hardness		MITSUBISHI UNI – PENCIL		H or harder	H or harder	
Coating Thickness	TOP SIDE	ELCOMETER		25±3㎛	25±3㎛	
	BACK SIDE			5±2㎛	5±2㎛	
1st Adherence Test	ERICHSEN	1mm spacingxH100 CROSS-CUTXERICHSEN 6mm		100/100	100/100	Forced/Natural Abrasion (max score:100)
	IMPACT	C 1/2"X1kgX50cm		No abrasion of the coat	No abrasion of the coat	
2nd Adherence Test	ERICHSEN	ERICHSEN 6mm after 1mm spacingxH100 CROSS-CUT		100/100	100/100	Forced/Natural Abrasion (max score:100)
	IMPACT	C 1/2"X1kgX50cm		No abrasion of the coat	No abrasion of the coat	
MEK Rubbing		Rub twice with MEK Soaked piece of cloth		30 times or more	30 times or more	
Heat Resistance		170℃x1hour		Δ E = 1.5 or less	Δ E = 1.5 or less	
Bending		25±5℃x180° BENDING		6T NO CRACK	5T NO CRACK	
Stain Resistance	Monamioil Magicink #300	BLACK	Removed with acetone after piece 24hours exposure(20±2℃)	Easily removable with no traces.	Easily removable with no traces	
		BLUE				
		RED				
	LIPSTIC					
Chemical Resistance	5% CH3COO	Washing and Drying after 20±2℃ X Spot Test		No changes to coat	No changes to coat	P/E:24hour High Durability P.E:48hr P.V.D.F.:72hr
	5%HCL					
	5%NAOH					
	TOLUENE					
	XYLENE					
Corrosion Rosistance (Salt spray)		35±2℃2x5% Nacl Continuous Spray(Edge sealed)		No blister at 2mm Or deeper from the Cross cut	No blister at 2mm Or deeper from the Cross cut	P/E:500hour High Durability P.E:1000hr P.V.D.F:1000hour
Weather Resistance (Q-UV Test)		DEW CYCLE (1CYCLE) (UV-test(60℃)4hour+(50℃)4hour condensation)x3		Δ E = 3.0 or less (white color)	Δ E = 5.0 or less (white color)	P/E:500hr High Durability P.E:1000hr P.V.D.F:5000hr
Base Metal		-		AL	AL	
Usage		-		Construction material	Construction material	-

3.6. Properties of Adhesive

Adhesive Properties

Epoxies are the strongest and most versatile structural rigid adhesives.
They also offer superior electrical properties, very high heat and chemical resistance, dimensional stability and durability.
They are unsurpassed for bonding metals, for laminating and filling fiberglass, assembling circuit boards, composite structures, for maintenance repairs, patching applications, etc.

Chemical and Water Resistance

Chemical and Water Resistance of Epoxies is among the widest ranging, as it includes inertness to strong alkalis, acids, fuel oils, food chemicals, many solvents and agents that attack other materials.

Lowest Shrinkage

Among plastics, this unique property is not only decisive in electrical applications, but essential in exact reproductions of shapes, designs, sizes and details, in casting patterns, models, sculptures, scientific details, in analytical, geological, artistic and other applications.

Properties

Features	Typical cure cycles	Momo service Temp(c)
● Modified Epoxy film type ● High compressive strength ● Excellent elevated temperature properties ● Excellent hot/wet properties	150℃/60min	150

3.7. Product Dimension and Tolerance

* Panel thickness and weight

PANEL THICK		WEIGHT(kg/m2)		
		1/4”(6.3mm)	3/8”(9.5Mmm)	1/2”(12.7mm)
6mm	Front : 1.0t Back : 0.5t	4.95	4.84	4.80
10mm	Front : 1.0t Back : 0.5t	5.21	4.99	4.93
15mm	Front : 1.0t Back : 0.5t	5.53	5.19	5.09
20mm	Front : 1.0t Back : 1.0t	7.21	6.76	6.63
25mm	Front : 1.0t Back : 1.0t	7.54	6.96	6.78
30mm	Front : 1.0t Back : 1.0t	7.85	7.16	6.93

* Standard Panel Size
  Width : 1250mm, 1,550mm
  Length : Max. 5,000mm

* Tolerance
  Width : +/-2mm
  Length : +/-4mm
  Thickness : +/-0.2mm

3.8. General data on Perforated Aluminum Honeycomb Panel

3.8.1. Aluminum Honeycomb panel shall be composed of perforated Aluminum honeycomb core of alloy A3104,H18(or A3003,H16), cell size 3/8” with Al.foil thickness 60micron/70micron duly anti-corrosion coated(chromated) and micro-perforated. The honeycomb core is sandwiched between two skins of perforated Aluminum sheets in 1.0mm thickness for the front skin and 0.5mm thickness for rear skin.

3.8.2. Basic Sandwich Composition

- Front Skin : 0.8/1.0mm thick Aluminum sheet (A3003, H16), The surface is PVDF coated Kynar 500 over 70%, 25+/-5micron coating thickness.
- Rear Skin : 0.4/0.5mm thick Aluminum sheet (A3003, H16), The surface is Primer or Epoxy service coated, 3~5micron coating thickness
- AL. H/C Core : Aluminum Honeycomb Hexagonal & Hollow Core of 8.5mm thickness, made of Alloy A3104, H18(A3003, H16), cell size 3/8” with Al. foil thickness 60~70micron duly anti-corrosion surface coating(Chromated) should be perforated for breathing & air-circulation.

3.8.3 Mechanical properties of AL Honey-Comb Core

Properties	Values					
	1/8”	1/4"	3/8"	1/2"	3/4"	1"
Density(kg/m^3)	141	83	54	42	29	21
Compression Strength Stabilized (MPa)	8.8	4.6	2.5	1.5	0.9	0.57
Compression Module Stabilized (MPa)	2,860	1,000	540	275	165	103
Plate Shear Strength/L-Direction (MPa)	6.9	2.4	1.4	0.9	0.65	0.43
Plate Shear Module/L-Direction (MPa)	1,010	440	260	220	110	83
Plate Shear Strength/W-Direction (MPa)	3.9	1.5	0.85	0.5	0.4	0.3
Plate Shear Module/W-Direction (MPa)	385	220	130	100	64	48

(A 3003 H18/ A3104 H18 – 70Micron)

3.8.4 Bonding & Lamination

Aluminum Honeycomb panel should be made by machine laminated at factory to obtain a distortion free flat panel in which the Honeycomb core is bonded hot melted(150℃/curing time-60min) to front and rear skins of Aluminum sheets by modified Epoxy system .

3.8.5 Modified Epoxy Film

The epoxy adhesive film should be structurally rigid with very high heat and chemical resistance, dimensional stability and durability besides having high chemical and water resistance that includes inertness to strong Alkali, Acid, Fuel oils, Food Chemicals, Solvents and agents that attack other material.

Technical Data

4.1. Structural Considerations

Fatigue

Since fatigue failures are rare in bonded honeycomb sandwich system, general fatigue data for honeycomb cores and specific core/facing combinations are not published. If fatigue does become a consideration in a sandwich design the problems usually will occur around a mechanical fastener or stress concentration area.

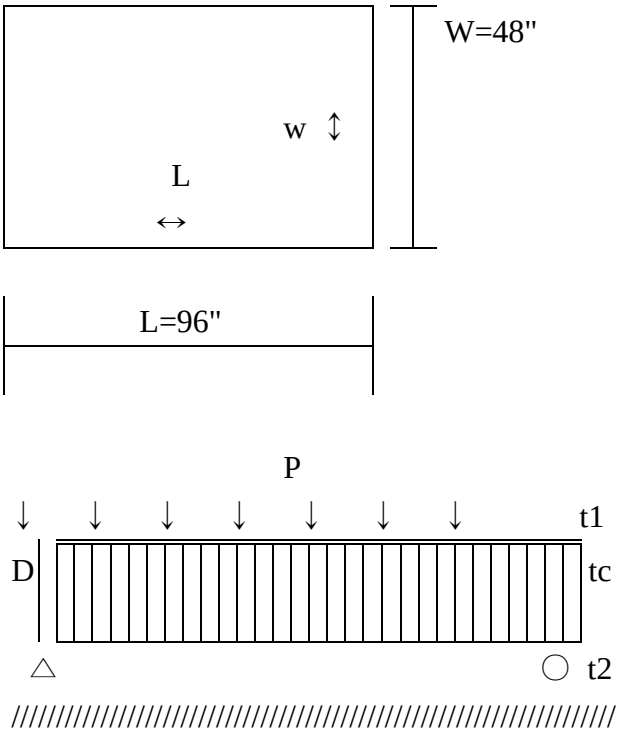
Stiffness

Sandwich structures are frequently used to maximize stiffness at very low weights. Because of the relatively low shear modules of most core materials. However, the deflection calculations must allow for shear deflection of the structure in addition to the bending deflections usually considered.

Panel Deflection

Sandwich Honeycomb Panel Design

The following data are mechanical characteristics and type of stress on surface materials and honeycomb core for HIVE PANEL design. Moreover, the example practice of design is shown for more useful application.



Simple supported all four edges

W/L = 48/96 = 0.5

L = Longside Panel Length

W = Shorter side Panel Length

Δ = Deflection

P = Pressure

E = Facing Modulus

λ = 1 - $\mu 2$(μ=Facing Poisson's Ratio)

Fs = Facing Stress

Cs = Core Shear Stress

Check Panel Deflection

$$\Delta = \frac{2K1PW4\lambda}{E\ t1\ d2} = \frac{2(0.0105)(0.139)(48)^4(0.89)}{(10 \times 10^6)(0.039)(0.364)^2} = 0.27"$$

* W/L = 48/96 = 0.5

$$R = G_w / G_L = 70{,}000 / 38{,}000 = 1{,}842$$

$$V = \frac{\pi^2 E\ t1\ d^2}{2\ ^{W2}d\ G_w\ \lambda} = \frac{(3.14)^2(10x10^6)(0.039)(0.364)^2}{2(48)^2(0.364)(38{,}000)(0.89)} = 0.009$$

Deflection Vs Load

Thk / Pressure	6 mm	10 mm	15 mm	20 mm	30 mm
10 psf(488 pa)	0.41"(10.41mm)	0.13"(3.3mm)	0.056"(1.42mm)	0.03"(0.76mm)	0.013"(0.33mm)
20 psf(976 pa)	0.82"(20.82mm)	0.27"(6.85mm)	0.112"(2.85mm)	0.06"(1.52mm)	0.027"(0.68mm)
30 psf(1464 pa)	1.236"(31.39mm)	0.403"(10.23mm)	0.169"(4.29mm)	0.092"(2.34mm)	0.04"(1.01mm)
40 psf(1952 pa)	1.644"(41.75mm)	0.536"(13.61mm)	0.225"(5.72mm)	0.123"(3.12mm)	0.053"(1.35mm)
50 psf(2,440 pa)	2.05”(52.0mm)	0.67”(17.0mm)	0.281”(7.14mm)	0.153”(3.8mm)	0.066”(1.6mm)
60 psf(2,928 pa)	2.46”(62.4mm)	0.804”(20.4mm)	0.337”(8.56mm)	0.184”(4.6mm)	0.079”(2.0mm)
70 psf(3,416 pa)	2.87”(72.8mm)	0.938”(23.8mm)	0.393”(9.98mm)	0.215”(5.4mm)	0.092”(2.3mm)
80 psf(3,904 pa)	3.28”(83.3mm)	1.072”(27.2mm)	0.449”(11.4mm)	0.246”(6.2mm)	0.106”(2.7mm)
90 psf(4,392 pa)	3.69”(97.7mm)	1.206”(30.6mm)	0.506”(12.9mm)	0.276”(7.0mm)	0.119”(3.0mm)
100psf(4,880 pa)	4.1”(104.1mm)	1.34”(34.0mm)	0.562”(14.3mm)	0.3”(7.6mm)	0.13”(3.3mm)

▶ Cell Size : 1/4” Cell Hexagonal type

▶ Upper Skin : 0.039” thick(1mm) Aluminum Sheet

▶ Lower Skin : 0.02” thick(0.5mm) Aluminum Sheet

▶ Panel Size : 48” x 96”

▶ 4 Side Supported, Edges fixed.

Check Facing Stress

$$FS = \frac{C_2 P W^2}{d t_1} = \frac{0.103x0.139x(48)^2}{0.364 \times 0.039} = 2.324 \text{ ps} = 38{,}000/2{,}324 = 16.35$$

Check Core Shear Stress

$$CS = \frac{C_3 P W}{d} = \frac{0.37 \times 0.139 \times 48}{0.364} = 6.78 \text{ psi}$$

$$F.S = \frac{85(0.93)}{6.78} = 11.66$$

4.2. Sound Transmission

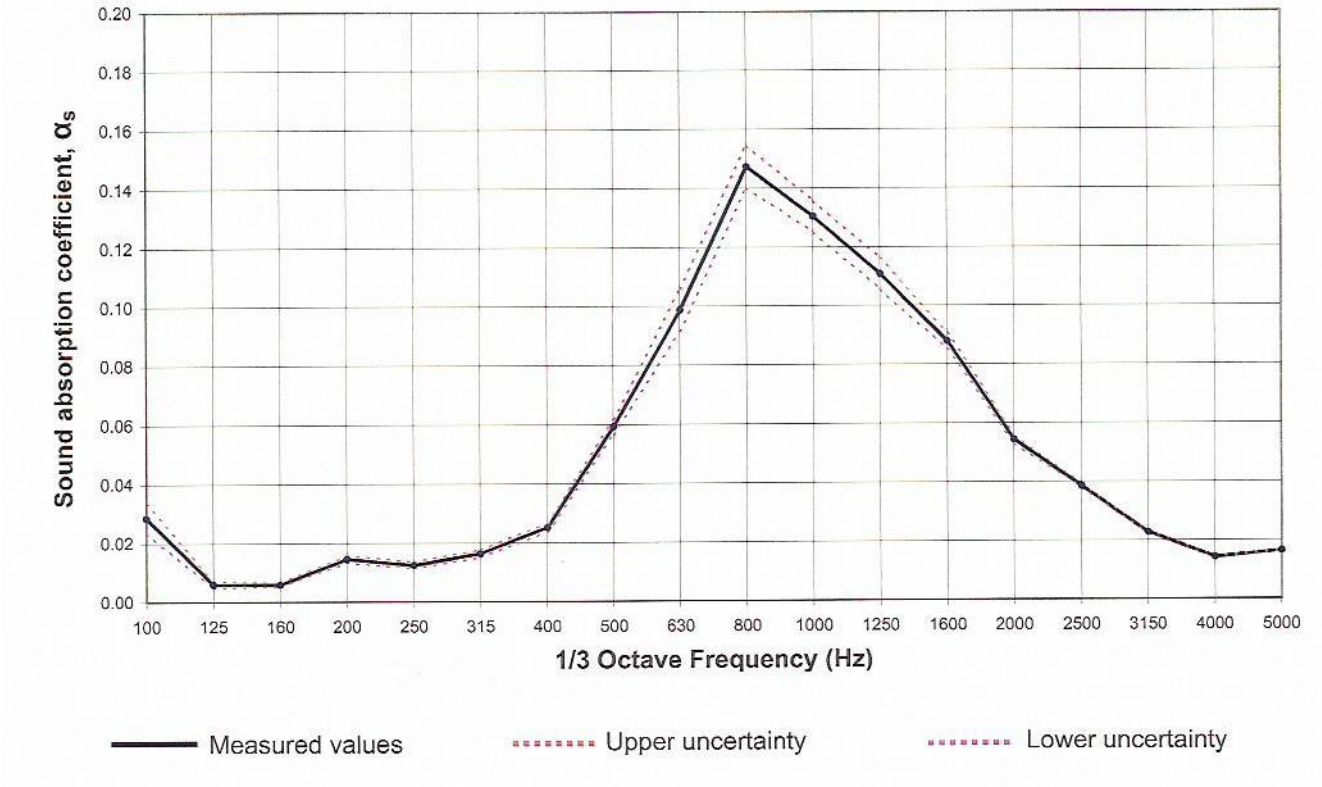
Ex.) 10mm THK Hive Panel Sound Transmission

- 1.0 THK – 1/4" Core – 0.5 THK

Sound Absorption Coefficients of Aluminum Honeycomb Panel

1/3 Octave Frequency(Hz)	Sound absorption coefficient, αs
	Type A mounting
	Honeycomb Panel
100	0.03 ± 0.00
125	0.01 ± 0.00
160	0.01 ± 0.00
200	0.01 ± 0.00
250	0.01 ± 0.00
315	0.02 ± 0.00
400	0.03 ± 0.00
500	0.06 ± 0.00
630	0.10 ± 0.01
800	0.15 ± 0.01
1000	0.13 ± 0.01
1250	0.11 ± 0.01
1600	0.09 ± 0.00
2000	0.05 ± 0.00
2500	0.04 ± 0.00
3150	0.02 ± 0.00
4000	0.01 ± 0.00
5000	0.02 ± 0.00
Noise Reduction Coefficient, NRC	**0.06**
Sound Absorption Average, SAA	**0.07**

Figure 1 : Sound absorption performance of 10mm thick aluminium honeycomb panel



4.3. Thermal Expansion

Ex.)10mm THK Hive Panel Thermal Expansion

The condensations of Hive Panel under the Temperature and humidity condition are as follow;

ΔL	10	15	20	25	30	40	50	
(ΔL) 10 T Hive	0.235	0.355	0.471	0.590	0.709	0.945	1.180	L=1000mm basis
(ΔL) 10 T Hive	0.385	0.58	0.77	0.965	1.159	1.545	1.929	L=1635mm basis

* Above mentioned table was calculated as below ;

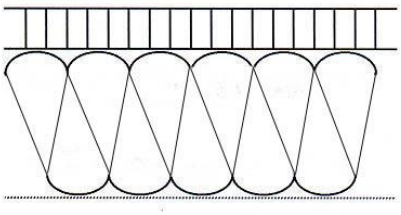
ΔL = L X ΔL X CE

L=Panel Length

ΔL = A gap of the Temperature

CE = Rate of Thermal Expansion (AL = 23.60 X 10^{-6})

4.4. 10mm THK Hive Panel Thermal Conductivity



1.5 W/m^2k for Hive

Required ability of insulation will be decided according to the rate of the insulation material. Therefore, thermal conductivity of Hive panel has not priority