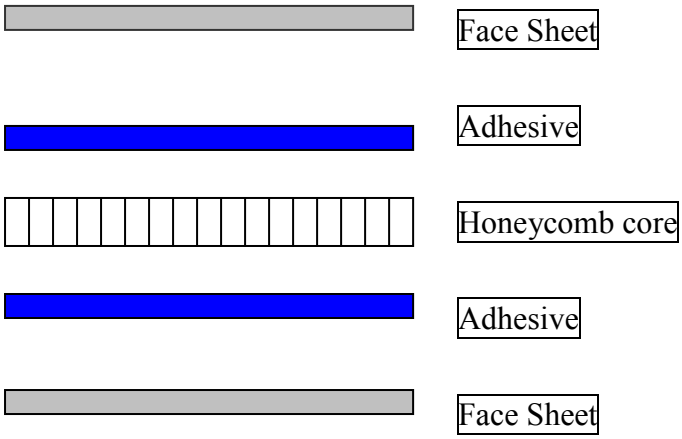
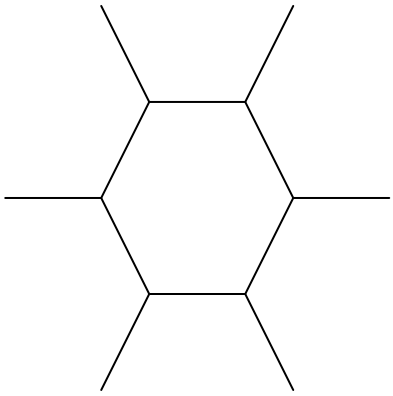
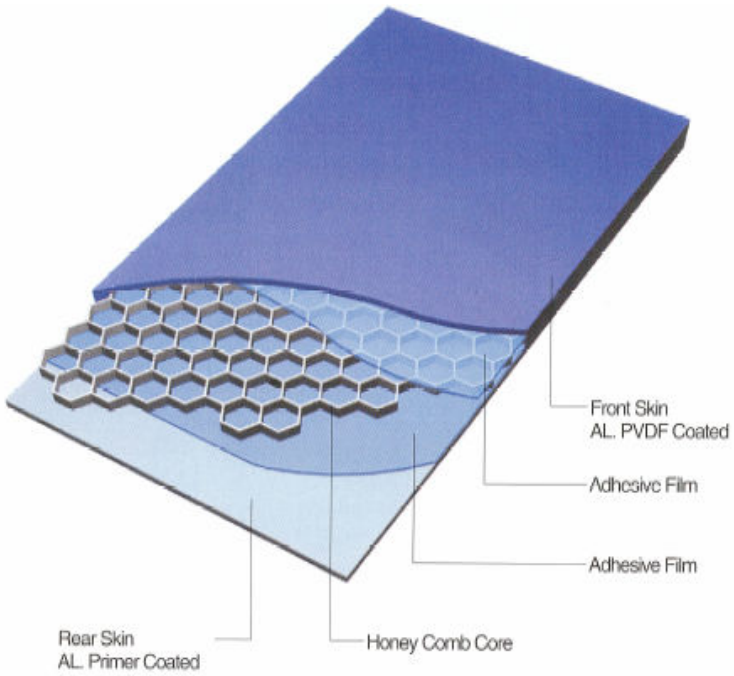
1. SPECIFICATION

1.1. 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.







Facing Materials	Yield Strength (Kg/cm2)	Modules of Elasticity(Kg/cm2)	λ(1-μ2)
Aluminum A3003 – H16 A5052 – H34	 1266 1687	 $7.^{03}$ X 10^5 $7.^{10}X10^5$	 0.89 0.89
Stainless Steel 304 316	 2461 2461	 $1.^{97}X10^6$ $1.^{97}X10^6$	 0.94 0.94
Pine plywood Lauan plywood Hard wood	211 158 253	$1.^{27}X10^5$ $1.^{27}X10^5$ $4.^{56}X10^4$	0.99 0.99 0.99

1.2. Properties of facing materials

1.3. Properties of Aluminum Honey-comb Core

Properties	Values			
	1/4”	**3/8”**	**1/2”**	**3/4”**
Density(kg/m3)	80	54	38	29
Compression Strength Unstabilized(kg/mm2)	0.46	0.25	0.14	0.09
Compression Strength Stabilized(kg/mm2)	0.48	0.27	0.15	0.095
Compression Module Stabilized(kg/mm2)	108	67	29	17
Crush Strength(kg/mm2)	0.18	0.087	0.044	0.032
Plate Shear Strength/L-Direction(kg/mm2)	0.25	0.16	0.09	0.07
Plate Shear Module/L-Direction(kg/mm2)	0.05	0.03	0.02	0.014
Plate shear Strength/W-Direction(kg/mm2)	0.15	0.03	0.02	0.014
Plate shear Module/L-Direction(kg/mm2)	0.027	0.015	0.009	0.008
Bonding Strength between foil(kg/mm2)	35	27	23	20
Flammability(kg/mm2)	Non-Combustible			

(A3003-H18 75□)

1.4. 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:48hour P.V.D.F.:72hour
	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:1000hour 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:500hour High Durability P.E:1000hour P.V.D.F:5000hour
Base Metal		-		AL	AL	
Usage		-		Construction material	Construction material	-

1.5. 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)
● 1component Epoxy film type ● high compressive strength ● excellent elevated temperature properties ● excellent hot/wet properties	150□/60min	150

1.6. 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)
5mm	Front : 0.8t Back : 0.4t	3.78	3.68	3.62
10mm	Front : 1.0t Back : 0.5t	4.98	4.75	4.62
15mm	Front : 1.0t Back : 0.5t	5.38	5.02	4.81
20mm	Front : 1.0t Back : 1.0t	7.10	6.63	6.34
25mm	Front : 1.0t Back : 1.0t	7.50	6.90	6.53

* Standard Panel Size
  Width : 1250mm, 1500mm
  Length : Max. 4,000mm

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

2.1.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.

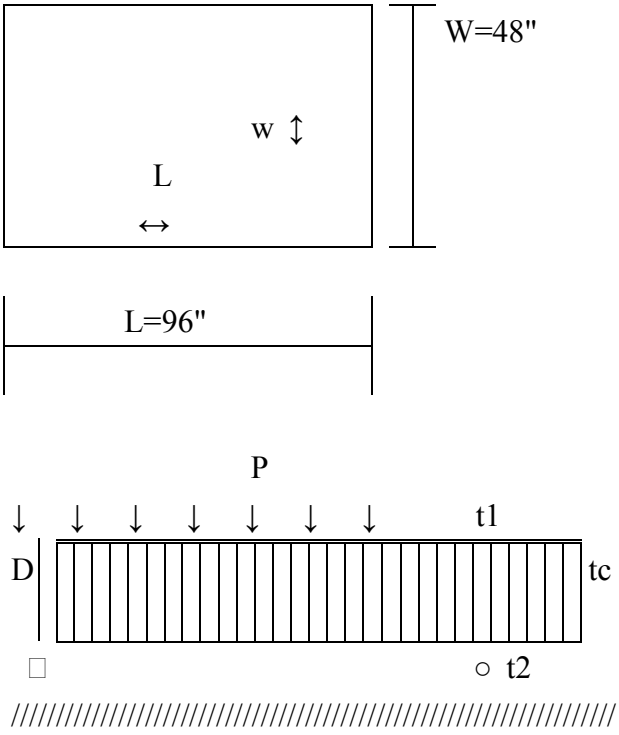
Stiffness

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 - μ2(μ=Facing Poisson's Ratio)

Fs = Facing Stress

Cs = Core Shear Stress

Check Panel Deflection

$$\Delta = \frac{2C1PW4\lambda}{E\,t1\,d2} = \frac{2(0.0105)(0.139)(48)^4(0.89)}{(10 \times 10^6)(0.039)(0.364)^2} = 0.27"$$

* 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

Pressure Panel Thk	10 psf	20 psf	30 psf	40 psf
0.236"(6mm)	0.41"(10.41mm)	0.82"(20.82mm)	1.236"(31.39mm)	1.644"(41.75mm)
0.393"(10mm)	0.13"(3.3mm)	0.27"(6.85mm)	0.403"(10.23mm)	0.536"(13.61mm)
0.787"(20mm)	0.03"(0.76mm)	0.06"(1.52mm)	0.092"(2.34mm)	0.123"(3.12mm)
1.181"(30mm)	0.013"(0.33mm)	0.027"(0.68mm)	0.04"(1.01mm)	0.053"(1.35mm)

- Cell Size : 1/4" cell
- Upper skin : 0.039"
- Lower skin : 0.02"
- Panel Size : 48" x 96"

Check Facing Stress

$$FS = \frac{C_2 P W^2}{d t_1} = \frac{0.103 \times 0.139 \times (48)^2}{0.364 \times 0.039} = 2.324 \text{ ps} = 38{,}000/2{,}324 = 16.35$$

Check Core Shear Stress

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

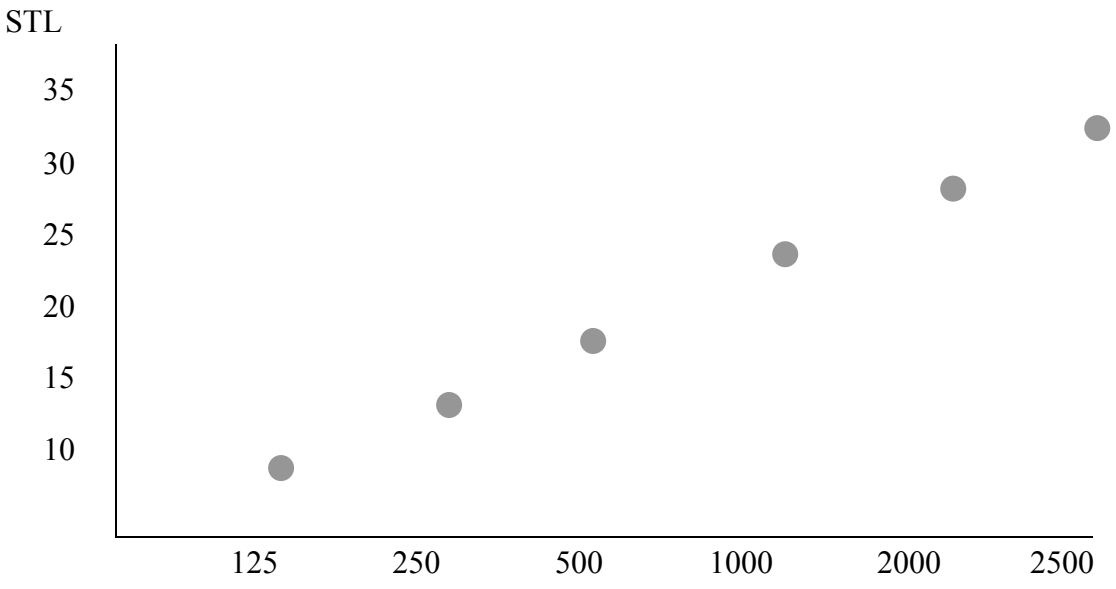
$$F.S = \frac{85(0.93)}{6.78} = 11.66$$

2.2. Sound Transmission

Ex.) 10mm THK Hive Panel Sound Transmission

* 1.0 THK – 1/4” Core – 0.5 THK

HZ	125	250	500	1000	2000	2500
STL	7.56	13.58	19.60	25.62	31.65	33.58



* The calculating method is based on Mass Law

2.3.Thermal Expansion

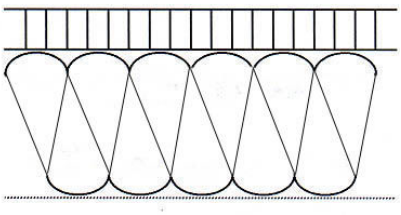
Ex.)10mm THK Hive Panel Thermal Expansion

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})

2.4. 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.