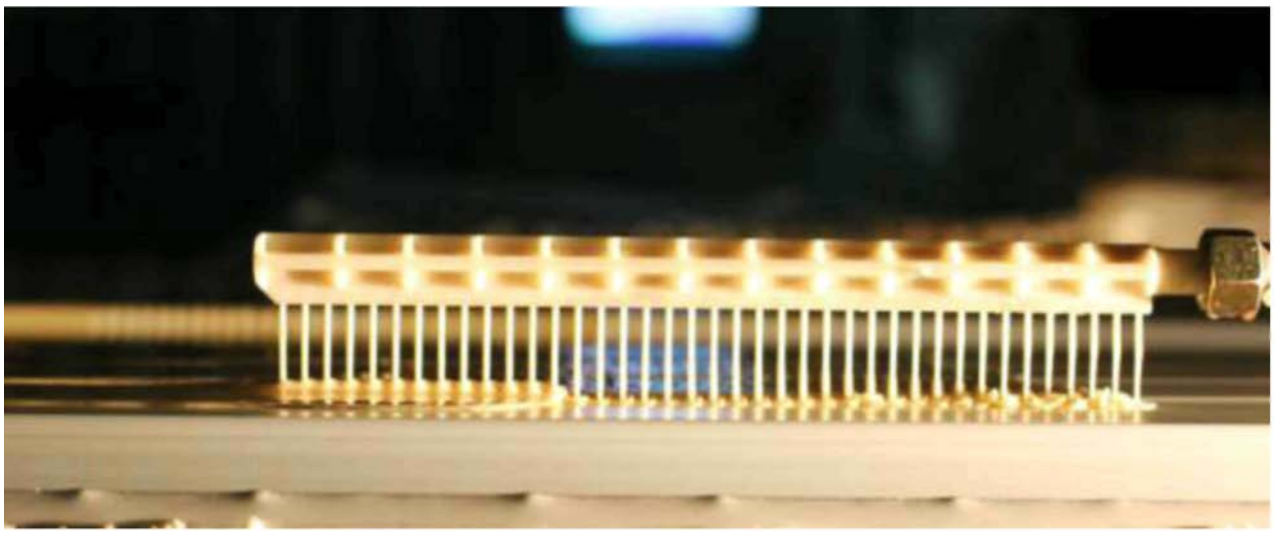
THERMAL INSULATION CALCULATION AT SANDWICH PANELS WITH POLYURETHANE



Calculation of Heat Loss on Walls

The thicknesses of the polyurethane foams in Sandwich Panels may vary according to the thermal insulation capacity, bearing capacity, conditions of the region and the utilization purpose of the building. The standard production is available at polyurethane thicknesses varying between 30 to 80 mm. While the polyurethane thickness is determined according to the thermal insulation capacity, the Thermal Transmittance Coefficient and Condensation values must also be taken into consideration.

Since the sandwich panels are the composite materials formed with polyurethane filling material between two metals, the contribution of the external metal surfaces having thermal conductivity in the thermal insulation is little if any. Therefore, the insulation values of the polyurethane, which is the filling material, are very important for the calculation of the thermal insulation.

Turkey has been divided into 4 regions in terms of Thermal Transmittance Coefficient "U" according to TS - 825, and it is required from all building components to be used in the buildings, to have maximum "U" values given in the **Table-1**. By taking λ = 0.022 W/mK polyurethane design value into consideration, the "U" values of all ASSAN PANEL products have been determined as can be seen in **Table-2**.

The thickness of polyurethane can be determined via **Table-1** and **Table-2**.

Table-1

	U WALL (W/m²K)	U CEILING (W/m²K)	U GROUND (W/m²K)	U WINDOW (W/m²K)
1. Region	0.80	0.50	0.80	2.80
2. Region	0.60	0.40	0.60	2.80
3. Region	0.50	0.30	0.45	2.80
4. Region	0.40	0.25	0.40	2.80

***U values recommended according to the regions (TS 825)**

Table-2

	Pur (mm)	Upper sheet (mm)	Lower sheet (mm)	U Thermal Transmittance (W/m^2K)	U Thermal Transmittance ($Kcal/m^2hC$)
Master Panel R2	30	0.5	0.4	**0.677**	**0.582**
Master Panel R2	40	0.5	0.4	**0.523**	**0.450**
Master Panel R2	50	0.5	0.4	**0.426**	**0.366**
Master Panel R2	60	0.5	0.4	**0.359**	**0.309**
Master Panel R2	70	0.5	0.4	**0.311**	**0.267**
Master Panel R3	30	0.5	0.4	**0.678**	**0.583**
Master Panel R3	40	0.5	0.4	**0.523**	**0.450**
Master Panel R3	50	0.5	0.4	**0.426**	**0.366**
Master Panel R3	60	0.5	0.4	**0.359**	**0.309**
Master Panel R3	70	0.5	0.4	**0.311**	**0.267**
Master Panel R4	30	0.5	0.4	**0.675**	**0.580**
Master Panel R4	40	0.5	0.4	**0.521**	**0.448**
Master Panel R4	50	0.5	0.4	**0.425**	**0.365**
Master Panel R4	60	0.5	0.4	**0.358**	**0.308**
Master Panel R4	70	0.5	0.4	**0.310**	**0.266**
Master Panel R7	30	0.5	0.4	**0.588**	**0.506**
Master Panel R7	40	0.5	0.4	**0.468**	**0.402**
Master Panel R7	50	0.5	0.4	**0.389**	**0.334**
Master Panel R7	60	0.5	0.4	**0.332**	**0.286**
Master Panel R7	70	0.5	0.4	**0.290**	**0.249**
Master Panel R7M	30	0.5	1.2	**0.588**	**0.505**
Master Panel R7M	40	0.5	1.2	**0.468**	**0.402**
Master Panel R7M	50	0.5	1.2	**0.388**	**0.334**
Master Panel R7M	60	0.5	1.2	**0.332**	**0.285**
Master Panel R7M	70	0.5	1.2	**0.290**	**0.249**
Master Panel W	45	0.5	0.4	**0.518**	**0.446**
Master Panel W	50	0.5	0.4	**0.470**	**0.405**
Master Panel W	60	0.5	0.4	**0.397**	**0.342**
Master Panel CS	80	0.5	0.5	**0.247**	**0.212**
Master Panel CS	100	0.5	0.5	**0.199**	**0.171**
Master Panel CS	120	0.5	0.5	**0.167**	**0.144**
Master Panel CS	150	0.5	0.5	**0.134**	**0.116**

***ASSAN PANEL Products Thermal Transmittance Values (U) (Prepared according to TS 14509)**

Perspiration on Walls and Controlling the Perspiration

Besides the data provided above, the utilization purpose of the building, the indoor-outdoor temperatures and the indoor humidity rate data are also effective on the calculation of the polyurethane thickness. In a comfortable area, it is required to have maximum 3 ºC temperature difference between the indoor temperature and external inner surface. Within this respect, the most effective polyurethane thickness can be determined for the project by making the necessary calculations by means of providing the following information in order to avoid the condensation of the water steam within the building after contacting with the inner surface of the panel as well as to avoid perspiration-dripping.

The polyurethane thickness necessary to avoid the condensation can be determined with the formula given below;

$$S = \frac{\lambda\,(T_i - T_o)}{\alpha_i (T_i - T_c)}$$

S = Thickness of the insulation material (m)
λ = Polyurethane thermal transmission coefficient 0.022 (W/mK)
α_i = Internal surface thermal convection coefficient (ave. 5)
α_e = External surface thermal convection coefficient (ave. 20)
T_i = Indoor temperature (ºC)
T_o = Outdoor temperature (ºC) (See: **Table-4)**
T_c = Condensation temperature limit. T_c is calculated through superposing the humidity rate given in the following **Table-3** and the environmental temperature.

Table-3

		Humidity rate %													
		30%	**35%**	**40%**	**45%**	**50%**	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**	**85%**	**90%**	**95%**
Indoor temperature ºC	**10**	-6.0	-4.2	-2.6	-1.2	0.1	1.4	2.6	3.7	4.8	5.8	6.7	7.6	8.4	9.2
	11	-5.2	-3.4	-1.8	-0.4	1.0	2.3	3.5	4.7	5.8	6.7	7.7	8.6	9.4	10.2
	12	-4.5	-2.6	-1.0	0.4	1.9	3.2	4.5	5.7	6.7	7.7	8.7	9.6	10.4	11.2
	13	-3.7	-1.9	-0.1	1.3	2.8	4.2	5.5	6.6	7.7	8.7	9.6	10.5	11.4	12.2
	14	-2.9	-1.0	0.6	2.3	3.7	5.1	6.4	7.5	8.6	9.6	10.6	11.5	12.4	13.2
	15	-2.2	-0.3	1.5	3.2	4.7	6.1	7.3	8.5	9.6	10.6	11.6	12.5	13.4	14.2
	16	-1.4	0.5	2.4	4.1	5.6	7.0	8.2	9.4	10.5	11.6	12.6	13.5	14.4	15.2
	17	-0.6	1.4	3.3	5.0	6.5	7.9	9.2	10.4	11.5	12.5	13.5	14.5	15.3	16.2
	18	0.2	2.3	4.2	5.9	7.4	8.8	10.1	11.3	12.5	13.5	14.5	15.4	16.3	17.2
	19	1.0	3.2	5.1	6.8	8.3	9.8	11.1	12.3	13.4	14.5	15.5	16.4	17.3	18.2
	20	1.9	4.1	6.0	7.7	9.3	10.7	12.0	13.2	14.4	15.4	16.4	17.4	18.3	19.2
	21	2.8	5.0	6.9	8.6	10.2	11.6	12.9	14.2	15.3	16.4	17.4	18.4	19.3	20.2
	22	3.6	5.9	7.8	9.5	11.1	12.5	13.9	15.1	16.3	17.4	18.4	19.4	20.3	21.2
	23	4.5	6.7	8.7	10.4	12.0	13.5	14.8	16.1	17.2	18.3	19.4	20.3	21.3	22.2
	24	5.4	7.6	9.6	11.3	12.9	14.4	15.8	17.0	18.2	19.3	20.3	21.3	22.3	23.1
	25	6.2	8.5	10.5	12.2	13.9	15.3	16.7	18.0	19.1	20.3	21.3	22.3	23.2	24.1
	26	7.1	9.4	11.4	13.2	14.8	16.3	17.6	18.9	20.1	21.2	22.3	23.3	24.2	25.1
	27	8.0	10.2	12.2	14.1	15.7	17.2	18.6	19.9	21.1	22.2	23.3	24.3	25.2	26.1
	28	8.8	11.1	13.1	15.0	16.6	18.1	19.5	20.8	22.0	23.2	24.2	25.2	26.2	27.1
	29	9.7	12.0	14.0	15.9	17.5	19.0	20.4	21.7	23.0	24.1	25.2	26.2	27.2	28.1
	30	10.5	12.9	14.9	16.8	18.4	20.0	21.4	22.7	23.9	25.1	26.2	27.2	28.2	29.1

***TS 825**

The thermal insulation must not be considered only for protection from cold. The thermal insulation is very important in hot regions. The insulated wall will not let the heat in at the hot regions and will enable the areas to be cool during summer. Otherwise, the hot wall will continuously spread heat to indoor and cause the area to be blistered. Even when there is cooling installation at the hot regions, heat insulation must still be performed.

Table-4

LOWEST ANNUAL TEMPERATURE VALUES AT THE CITIES AND REGIONS					
CITY	**°C**	**Region No**	**CITY**	**°C**	**Region No**
Adana	-8.4	I	**Kocaeli**	-18	II
Adıyaman	-9.6	III	**Konya**	-28.2	II
Afyon	-27.2	III	**Kütahya**	-28.1	III
Ağrı	-46.6	IV	**Malatya**	-25.1	III
Amasya	-20.4	III	**Manisa**	-17.5	I
Ankara	-24.9	II	**K. Maraş**	-9	III
Antalya	-4.6	I	**Mardin**	-14	II
Artvin	-16.1	IV	**Muğla**	-12.6	I
Aydın	-11	I	**Muş**	-34.4	III
Balıkesir	-21.8	I	**Nevşehir**	-23.6	II
Bilecik	-16	III	**Niğde**	-27	II
Bingöl	-23.2	IV	**Ordu**	-7.2	III
Bitlis	-21.3	IV	**Rize**	-7	IV
Bolu	-34	III	**Sakarya**	-14.5	III
Burdur	-16.7	II	**Samsun**	-7	III
Bursa	-25.7	II	**Siirt**	-19.3	II
Çanakkale	-11.5	I	**Sinop**	-8.4	III
Çankırı	-25	III	**Sivas**	-34.6	III
Çorum	-25.6	II	**Tekirdağ**	-13.5	II
Denizli	-11.4	II	**Tokat**	-23.4	III
Diyarbakır	-24.2	II	**Trabzon**	-7.4	IV
Edirne	-22.2	III	**Tunceli**	-30.3	IV
Elazığ	-22.6	III	**Ş. Urfa**	-12.4	I
Erzincan	-32.5	III	**Uşak**	-24	II
Erzurum	-35	IV	**Van**	-28.7	IV
Eskişehir	-26.3	II	**Yozgat**	-24.4	III
Gaziantep	-17.5	III	**Zonguldak**	-8	III
Giresun	-9.8	IV	**Aksaray**	-22.4	II
Gümüşhane	-25.7	III	**Bayburt**	-22.5	III
Hakkari	-22	IV	**Karaman**	-26.8	II
Hatay	-14.6	I	**Kırıkkale**	-31.3	II
Isparta	-21	II	**Batman**	-30.3	II
İçel	-6.6	I	**Şırnak**	-39.8	IV
Istanbul	-16.1	II	**Bartın**	-14.5	III
Izmir	-8.2	I	**Ardahan**	-11	IV
Kars	-39.6	IV	**Iğdır**	-18.6	IV
Kastamonu	-26.9	III	**Yalova**	-26.4	II
Kayseri	-32.5	II	**Karabük**	-12	III
Kırklareli	-15.8	II	**Kilis**	-15.1	II
Kırşehir	-28	II	**Osmaniye**	-8.4	III

Reference: 1. Assan Panel Studies 2. TSE 825/April 1999 3. Ode Teknik Yayınlar- 1999 4. TSE EN 14509/08.01.2009 5. Lightweight Sandwich Construction, J.M. Davies 6. Sandwich Panel Construction, Rolf Koschade 7. İzoder Yayınları