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April 9<sup>th</sup>, 2008

For the attention of:

Termokir Industries (1980) Ltd.

**Subject: Thermal Calculations for a Residential House Insulated By Means of a Thermal Plaster System.**

The subject report refers to the calculation of the thermal insulation level of a standard residential house insulated by means of a thermal insulation system of the Termokir Industries (1980) Ltd. Company.

The calculations have been performed according to the B, C, D climate zones, according to Israeli Standard IS 1045.

The report includes:

1. The building's basic data.
2. The house's adaptation to the requirements of Israeli Standard IS 1045 "Thermal Insulation of Residential Buildings".
3. The house's adaptation to the requirements of Israeli Standard IS 5281 "Green Buildings".
4. Expenses on electrical heating by an air conditioning system in the winter period.
5. Expenses on electrical cooling by an air conditioning system in the summer period.
6. Expenses on electricity for an air conditioning system in the winter and the summer periods.
7. Conclusions.

**1. Calculation's basic data:**

- Ground floor, two storey residential house
- House area – 188 sq.m.
- House volume – 566 cbm.
- External wall built of 22.0 cm thick concrete blocks with five cavities
- Apartmental Protected Space's (APS) wall built of 25.0 cm thick concrete
- Top ceiling-roof built of 20.0 cm thick concrete
- Windows with ordinary glass

- External door – wooden door
- Thermal plaster system including:
  - 0.5 cm thick first layer
  - Thermal Insulation plaster layer with thickness as required by the standards (the report indicates the thermal plaster layer's thickness)
  - 0.5 cm thick protect layer
- There is an option of applying the thermal insulation plaster system on the wall's exterior or interior side, according to the design.

## **2. House adaptation to the requirements of Israeli Standard IS 1045.**

The thermal calculations have been performed according to the IS 1045 Part 1 Israeli Standard requirements "Thermal Insulation of Residential Buildings".

The calculation results of the typical thermal resistance of the house's external covering elements, with no addition of thermal plaster are detailed in Table Nr. 1.

Table Nr. 1.

Element's Type and Components	Typical Thermal Resistance "r" Sq.m. x °C / Watt					Compliance with the IS  1045
	Calculated		According to the IS for climate zones			
	Layer	Total	B	C	D	
<u>External wall</u>						
2.0 cm thick exterior render	0.014	0.403	0.5	0.7	0.9	Non standard
22.0 cm thick concrete block with 5 cavities	3					
1.5 cm thick interior plaster	0.372					
	3					
	0.017					
	2					

<u>Thermal bridge on the external wall – columns, belts, ceilings:</u>						
2.0 cm thick exterior render	0.014	0.636	0.5	0.7	0.9	Standard for climate zone B
2.0 cm thick F20 rigid foamed polystyrene board	3					
20.0 cm thick concrete	0.050					
1.5 cm thick interior plaster	0.104					
	8					
	0.017					
	2					
<u>The APS' external wall</u>						
2.0 cm thick exterior render	0.014	0.526	0.5	0.7	0.9	Standard for climate zone B
25.0 cm thick concrete	3					
4.5 cm thick Thermal Insulation Plaster 400 system (interior)	0.119					
	0.391					
	3					
<u>Top ceiling - roof</u>						
Bituminous sheets	0.029	0.716	0.6	0.8	1.3	Standard for climate zone B
5.0 cm thick light weight concrete (1200 kg/m <sup>3</sup> )	4					
2.0 cm thick rigid foamed polystyrene board	0.080					
20.0 cm thick concrete ceiling	6					
1.0 cm thick interior plaster	0.500					
	0.095					
	2					
	0.011					
	5					

The calculation results of the typical thermal resistance of the house's external covering elements, with the addition of thermal plaster in the climate zone B are detailed in Table Nr. 2.

Table Nr. 2.

<b>Element's Type and Components</b>	<b>Typical Thermal Resistance "r" Sq.m. x °C / Watt</b>	<b>Compliance with the IS 1045</b>
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	Calculated		Per IS	
	Layer	Total		
<u>External wall</u> 2.0 cm thick Thermal Insulation Plaster 250 system (exterior) 22.0 cm thick concrete block with 5 cavities 1.5 cm thick interior plaster	0.250 0.3723 0.0172	0.639	0.50	Standard
<u>Thermal bridge on the external wall</u> – columns, belts, ceilings: 4.0 cm thick Thermal Insulation Plaster 250 system (exterior) 20.0 cm thick concrete 1.5 cm thick interior plaster	0.500 0.0952 0.0172	0.621	0.50	Standard
<u>The APS' external wall</u> 2.0 cm thick Thermal Insulation Plaster 250 system (exterior) 25.0 cm thick concrete 2.5 cm thick Thermal Plaster 400system (interior)	0.250 0.119 0.217	0.586	0.50	Standard
<u>Top ceiling - roof</u> Bituminous sheets 5.0 cm thick light weight concrete (1200 kg/m <sup>3</sup> ) 2.0 cm thick rigid polystyrene foam 20.0 cm thick concrete ceiling 1.0 cm thick interior plaster	0.0294 0.0806 0.500 0.0952 0.0115	0.716	0.60	Standard

The calculation results of the typical thermal resistance of the house's external covering elements, with the addition of thermal plaster in the climate zone C are detailed in Table Nr. 3.

Table Nr. 3.

Element's Type and Components	Typical Thermal Resistance "r" Sq.m. x °C / Watt	Compliance with the IS 1045
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	Calculated		Per IS	
	Layer	Total		
	<u>External wall</u> 3.0 cm thick Thermal Insulation Plaster 250 system (exterior) 22.0 cm thick concrete block with 5 cavities 1.5 cm thick interior plaster	0.375 0.3723 0.0172	0.7645	
<u>Thermal bridge on the external wall</u> – columns, belts, ceilings: 5.0 cm thick Thermal Insulation Plaster 250 system (exterior) 20.0 cm thick concrete 1.5 cm thick interior plaster	0.625 0.0952 0.0172	0.7374	0.70	Standard
<u>The APS' external wall</u> 3.0 cm thick Thermal Insulation Plaster 250 system (exterior) 25.0 cm thick concrete 3.0 cm thick Thermal Insulation Plaster 400system (interior)	0.375 0.119 0.260	0.754	0.70	Standard
<u>Top ceiling - roof</u> Bituminous sheets 5.0 cm thick light weight concrete (1200 kg/m3) 3.0 cm thick rigid foamed polystyrene board 20.0 cm thick concrete ceiling 1.0 cm thick interior plaster	0.0294 0.0806 0.750 0.0952 0.0115	0.9667	0.80	Standard

The calculation results of the typical thermal resistance of the house's external covering elements, with the addition of thermal plaster in the climate zone D are detailed in Table Nr. 4.

Table Nr. 4.

<b>Element's Type and Components</b>	<b>Typical Thermal Resistance "r" Sq.m. x °C / Watt</b>	<b>Compliance with the IS 1045</b>

	Calculated		Per IS	
	Layer	Total		
	<u>External wall</u>			
5.0 cm thick Thermal Insulation Plaster 250 system (exterior)	0.625	1.0145	0.90	Standard
22.0 cm thick concrete block with 5 cavities	0.3723			
1.5 cm thick interior plaster	0.0172			
<u>Thermal bridge on the external wall – columns, belts, ceilings:</u>				
7.0 cm thick Thermal Insulation Plaster 250 system (exterior)	0.8125	0.9249	0.90	Standard
20.0 cm thick concrete	0.0952			
1.5 cm thick interior plaster	0.0172			
<u>The APS' external wall</u>				
3.5 cm thick Thermal Insulation Plaster 250 system (exterior)	0.4375	0.9478	0.90	Standard
25.0 cm thick concrete	0.119			
4.5 cm thick Thermal Insulation Plaster 400 system (interior)	0.3913			
<u>Top ceiling - roof</u>				
Bituminous sheets	0.0294	1.4667	1.30	Standard
5.0 cm thick light weight concrete (1200 kg/m3)	0.0806			
5.0 cm thick rigid foamed polystyrene board	1.250			
20.0 cm thick concrete ceiling	0.0952			
1.0 cm thick interior plaster	0.0115			

### **3. The house's adaptation to the requirements of Israeli Standard IS 5281 "Green Buildings".**

The calculations have been made according to IS 5282 Part 1 "Grading Apartments According to Energy Consumption" (part of the requirements of Israeli Standard IS 5281).

Table Nr. 5.

Climate Zone	The external wall's total thermal conductivity – "U" (°C x sq.m. / Watt)		Adaptation conditions to "Green Buildings" requirements
	As per IS 5282 for class 1	Calculated	
A, B	1.05	0.953	<u>Ordinary external wall</u> 4.0 cm thick Thermal Insulation Plaster 250 system (exterior) 22.0 cm thick concrete block with 5 cavities 1.5 cm thick interior plaster
	1.05	1.004	<u>APS' external wall</u> 4.0 cm thick Thermal Insulation Plaster 250 system (exterior) 25.0 cm thick concrete 2.5 cm thick Thermal Insulation Plaster 400 system (interior)
C, D	0.70	0.70	<u>Ordinary external wall</u> 7.0 cm thick Thermal Insulation Plaster 250 system (exterior) 22.0 cm thick concrete block with 5 cavities 1.5 cm thick interior plaster
	0.70	0.70	<u>APS' external wall</u> 6.0 cm thick Thermal Insulation Plaster 250 system (exterior) 25.0 cm thick concrete 4.5 cm thick Thermal Insulation Plaster 400 system (interior)

#### **4. Expenses on electrical heating in the winter period.**

The calculation of heating expenses was made assuming that the house is heated in the heating period by means of an air conditioning system.

The calculation of energy consumption for heating is based on parameter "G" – the house's volume thermal conductivity.

The results of "G" calculation - the house's volume thermal conductivity in different conditions are detailed in Table Nr. 6.

Table Nr. 6.

<b>The house's condition</b>	<b>The house's volume thermal conductivity – "G" (°C x cu.m. / Watt)</b>
According to the data detailed in Table Nr. 1: House with no addition of thermal insulation plaster	1.470
According to the data detailed in Table Nr. 2: House with the addition of thermal insulation plaster according to the requirements of IS 1045 for climate zone B	1.189
According to the data detailed in Table Nr. 3: House with the addition of thermal insulation plaster according to the requirements of IS 1045 for climate zone C	1.081
According to the data detailed in Table Nr. 4: House with the addition of thermal insulation plaster according to the requirements of IS 1045 for climate zone D	0.954
External walls according to the data detailed in Table Nr. 5 Roof with the addition of 6.0 cm thick F30 rigid foamed polystyrene board according to the IS 5282 standard for climate zone B	0.939
External walls according to the data detailed in Table Nr. 5 Roof with the addition of 7.0 cm thick F30 rigid foamed polystyrene board according to the IS 5282 standard for climate zone C	0.837
External walls according to the data detailed in Table Nr. 5 Roof with the addition of 6.0 cm thick F30 rigid foamed polystyrene board according to the IS 5282 standard for climate zone D	0.848

The results of the calculation of energy consumption for heating, and electricity costs during the heating season for the house in different conditions are detailed in Table Nr. 7.

Table Nr. 7.

<b>The house's condition</b>	<b>Electrical consumption for</b>	<b>Electricity cost per heating</b>
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	<b>heating KWH / Season</b>	<b>season NIS / Season</b>
House with no addition of thermal insulation plaster in climate zone B	4,260	2,170
House insulated according to IS 1045 in climate zone B	3,430	1,750
House insulated according to IS 5282 in climate zone B	2,700	1,370
House with no addition of thermal insulation plaster in climate zone C	9,150	4,660
House insulated according to IS 1045 in climate zone C	6,730	3,420
House insulated according to IS 5282 in climate zone C	5,210	2,650
House with no addition of thermal insulation plaster in climate zone D	1,170	590
House insulated according to IS 1045 in climate zone D	760	390
House insulated according to IS 5282 in climate zone D	670	340

The price of a KWH is 0.5086 NIS including AVT (to April 1<sup>st</sup>, 2008).

Comparison of electricity costs on an air-conditioning system during the heating season in a residential house built in the climate zone B.

Table Nr. 8.

<b>The house's condition</b>	<b>Air condition system's electrical consumption during the heating period (KWH / Season)</b>	<b>Heating cost (NIS / Season)</b>
House with no addition of thermal insulation plaster	4,260	2,170
House built according to IS 1045	3,430	1,750
House built according to IS 5282	2,700	1,370

Energy saving in a house built according to IS 1045 compared with a house built without the addition of thermal insulation plaster is 830 KWH / Season or 420 NIS. Energy saving is approximately 25%.

Energy saving in a house built according to IS 5282 compared with a house built according to IS 1045 is 730 KWH / Season or 380 NIS. Energy saving is approximately 21%.

Energy saving in a house built according to IS 5282 compared with the house built without the addition of a thermal insulation plaster system is 1560 KWH / Season or 800 NIS. Energy saving is approximately 37%.

Comparison of electricity expenses on an air-conditioning system during the heating season in a residential house built in the climate zone C.

Table Nr. 9.

<b>The house's condition</b>	<b>Air condition system's electrical consumption during the heating period (KWH / Season)</b>	<b>Heating cost (NIS / Season)</b>
House with no addition of thermal insulation plaster	9,150	4,655
House built according to IS 1045	6,730	3,420
House built according to IS 5282	5,210	2,650

Energy saving in a house built according to IS 1045 compared with a house built without the addition of a thermal plaster system is 2420 KWH / Season or 1235 NIS. Energy saving is approximately 26%.

Energy saving in a house built according to IS 5282 compared with a house built according to IS 1045 is 1520 KWH / Season or 770 NIS. Energy saving is approximately 22%.

Energy saving in a house built according to IS 5282 compared with the house built without the addition of a thermal insulation plaster system is 3940 KWH / Season or 2005 NIS. Energy saving is approximately 43%.

Comparison of electricity expenses on an air-conditioning system during the heating season in a residential house built in the climate zone D.

Table Nr. 10.

<b>The house's condition</b>	<b>Air condition system's electrical consumption during the heating period (KWH / Season)</b>	<b>Heating cost (NIS / Season)</b>
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House with no addition of thermal insulation plaster	1,165	590
House built according to IS 1045	760	390
House built according to IS 5282	670	340

Energy saving in a house built according to IS 1045 compared with a house built without the addition of thermal insulation plaster is 405 KWH / Season or 200 NIS. Energy saving is approximately 35%.

Energy saving in a house built according to IS 5282 compared with a house built according to IS 1045 is 90 KWH / Season or 50 NIS. Energy saving is approximately 11%.

Energy saving in a house built according to IS 5282 compared with the house built without the addition of a thermal insulation plaster system is 495 KWH / Season or 250 NIS. Energy saving is approximately 42%.

### **5. Calculation of electricity expenses on cooling in the summer period.**

The results of the calculation of energy consumption by an air condition system in the cooling period and electricity costs in the cooling period for the house in different conditions are detailed in Table Nr. 11.

Table Nr. 11.

<b>The house's condition</b>	<b>Electrical consumption for cooling KWH / Season</b>	<b>Electricity cost per cooling season NIS / Season</b>
House with no addition of thermal insulation plaster system in climate zone B	7,780	3,960
House insulated according to IS 1045 in climate zone B	5,880	2,990
House insulated according to IS 5282 in climate zone B	4,480	2,280
House with no addition of a thermal insulation plaster system in climate zone C	4,310	2,190
House insulated according to IS 1045 in climate zone C	2,860	1,450
House insulated according to	2,100	1,070

IS 5282 in climate zone C		
House with no addition of a thermal insulation plaster system in climate zone D	17,420	8,860
House insulated according to IS 1045 in climate zone D	9,690	4,930
House insulated according to IS 5282 in climate zone D	8,660	4,400

Comparison of electricity expenses on an air conditioning system during the cooling period in a residential house built in the climate zone B.

Table Nr. 12.

<b>The house's condition</b>	<b>Air conditioning system's electrical consumption during the cooling period (KWH / Season)</b>	<b>Cooling cost (NIS / Season)</b>
House with no addition of thermal insulation plaster	7,780	3,960
House built according to IS 1045	5,880	2,990
House built according to IS 5282	4,480	2,280

Energy saving in a house built according to IS 1045 compared with the house without the addition of thermal insulation plaster is 1900 KWH / Season or 970 NIS. Energy saving is approximately 24%.

Energy saving in a house built according to IS 5282 compared with a house built according to IS 1045 is 1400 KWH / Season or 710 NIS. Energy saving is approximately 24%.

Energy saving in a house built according to IS 5282 compared with the house built without the addition of a thermal insulation plaster system is 3300 KWH / Season or 1680 NIS. Energy saving is approximately 42%.

Comparison of electricity expenses on an air condition system during the cooling period in a residential house built in the climate zone C.

Table Nr. 13.

<b>The house's condition</b>	<b>Air conditioning system's electrical consumption during the cooling period</b>	<b>Cooling cost (NIS / Season)</b>
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	<b>(KWH / Season)</b>	
House with no addition of thermal insulation plaster	4,310	2,190
House built according to IS 1045	2,860	1,450
House built according to IS 5282	2,100	1,070

Energy saving in a house built according to IS 1045 compared with the house without the addition of thermal plaster is 1450 KWH / Season or 740 NIS. Energy saving is approximately 33%.

Energy saving in a house built according to IS 5282 compared with the house built according to IS 1045 is 760 KWH / Season or 380 NIS. Energy saving is approximately 26%.

Energy saving in a house built according to IS 5282 compared with the house built without the addition of a thermal plaster system is 2210 KWH / Season or 1120 NIS. Energy saving is approximately 51%.

Comparison of electricity expenses on an air condition system during the cooling period in a residential house built in the climate zone D.

Table Nr. 14.

<b>The house's condition</b>	<b>Air condition system's electrical consumption during the cooling period (KWH / Season)</b>	<b>Cooling cost (NIS / Season)</b>
House with no addition of thermal insulation plaster	17,420	8,860
House built according to IS 1045	9,690	4,930
House built according to IS 5282	8,660	4,400

Energy saving in a house built according to IS 1045 compared with the house without the addition of thermal insulation plaster is 7730 KWH / Season or 3930 NIS. Energy saving is approximately 44%.

Energy saving in a house built according to IS 5282 compared with the house built according to IS 1045 is 1030 KWH / Season or 530 NIS. Energy saving is approximately 11%.

Energy saving in a house built according to IS 5282 compared with the house built without the addition of a thermal insulation plaster system is 8760 KWH / Season or 4460 NIS. Energy saving is approximately 50%.

## **6. Electricity expenses on an air conditioning system in the heating season and in the cooling season.**

The results of the calculation of annual electrical consumption and the expenses on electricity of an air conditioning system in the heating season and in the cooling season are detailed in Table Nr. 15.

Table Nr. 15.

Climate zone	Electrical consumption of an air conditioning system during a year in a house built according to the requirements (KWH / Year)			Expenses on electricity of an air condition system during a year in a house built according to the requirements (NIS / Year)		
	House with no thermal insulation plaster addition	According to IS 1045	According to IS 5282	House with no thermal plaster addition	According to IS 1045	According to IS 5282
B	12,040	9,310	7,180	6,120	4,740	3,650
C	13,460	9,590	7,310	6,845	4,880	3,720
D	18,585	10,450	9,330	9,450	5,320	4,740

## **Conclusions.**

1. The thermal insulation of a residential house by means of thermal plaster renders significant energy saving in the use of air-conditioning systems during the house's heating season and cooling season.
2. The external walls insulated by means of thermal plaster as detailed in Table Nr. 5 comply with the requirements of "Green Buildings".
3. Energy saving in the various climate zones is detailed in Table Nr. 16.

Table Nr. 16.

Climate zone	House's condition (Comparison of the various options)	Energy saving (%)
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B	The house built according to the requirements of IS 1045 compared with the house built with no thermal insulation plaster system's addition	22.6
B	The house built according to the requirements of IS 5282 compared with the house built according to IS 1045	22.8
B	The house built according to the requirements of IS 5282 compared with the house built with no thermal insulation plaster system's addition	40.3
C	The house built according to the requirements of IS 1045 compared with the house built with no thermal insulation plaster system's addition	28.8
C	The house built according to the requirements of IS 5282 compared with the house built according to IS 1045	20.5
C	The house built according to the requirements of IS 5282 compared with the house built with no thermal insulation plaster system's addition	45.7
D	The house built according to the requirements of IS 1045 compared with the house built with no thermal insulation plaster system's addition	43.8
D	The house built according to the requirements of IS 5282 compared with the house built according to IS 1045	10.7
D	The house built according to the requirements of IS 5282 compared with the house built with no thermal insulation plaster system's addition	49.8

Very respectfully

Eng. Goldin Roza