LEYCO-TILE

Thermal Insulation Tiles for Roofs and Walls

CONTENTS :

IMPORTANCE OF THE THERMAL INSULATION IN BUILDING

To improve the thermal behaviour of building and to save the consumption of the electrical energy used for cooling and heating . The roofs and the outside walls must be protected against the sun radiation and the variable climatic conditions by a suitable thermal insulation material .

The shaded air temperature reaches more than 42 ° C in summer and the sun's radiation on the horizontal surfaces reaches more than 1000 watt/m^2 in summer which makes the inside temperature uncomfortable.

The thin roofs and walls which are used in the majority of new buildings do not resist the flow of heat in summer and coolness in winter . This will cause the increase of the temperature during midday in summer and the decrease of the temperature during midnight in winter .

Due to the above reasons, the correct thermal conditions for the buildings must be taken into consideration by using suitable layers to ensure comfortable living conditions inside the building .

The thermal insulation materials give permanent protection to the buildings and increase its life . The harmful effect of the thermal cycling causes the formation of cracks, Specially between the reinforced concrete skeleton and the walls .

The thermal insulation materials decreases the need for using cooling and heating equipment . In case of using electrical cooling and heating equipment the heat insulation layers saves the consumption of electrical energy .

The heat insulation layers protect the waterproofing from extreme thermal cycling which causes deterioration .

TECHNICAL DESCRIPTION OF LEYCO-TILE :

TILE FOAM is an insulating tile made of high strength polymeric concrete laminated to extruded polystyrene foam (ADVE FOAM) .

The layer of foam which provides the insulation is characterised by its rigid and homogenous closed-cell structure which gives it the following advantages :

1) Extraordinarily high thermal properties which do not change with time .
2) High resistance to water absorption .
3) High compressive strength .
4) Long life .
5) Low flammability-(self-extinguishing) when the source of fire is removed .
6) Safe to use and it is not harmful to health .

Table (1) shows the technical properties of the ADVEFOAM board which are used in the production of LEYCO-TILE .

The protection layer consists of polymeric cementitious concrete produced from silicious aggregate, Portland cement . and admixtures to increase the strength and decrease the shrinkage and special polymeric materials . The cube compressive strength of this concrete reaches 600 Kg/cm^2 after 28 days .

The LEYCO-TILE is produced according to the following specifcatfons .

Dimensions	: 30 x 30 cm. (for roofs) .
	: 20 x 30 cm. (for walls) .
Thickness of foam layer (other thickness upon request)	:2cm.
Thickness of protection layer	: 1 cm. (other thickness upon request)
Surface texture	:- Plain
	:- Squared 0.5x1, 1x1, 2.5x2.5 and 10x1 Ocm.
	- Several decorative surfaces.
Colours	- Gray, beige , Yellow , brown.(Other colours upon request).

TABLE (1)

PROPERTIES OF EXTRUDED POLYSTYRENE BOARDS (ADVEFOAM)

PROPERTY	SPECIFICATION	UNIT	VALUE
Density		Kg/m^3	32 - 35
Thermal conductivity Value during manufacture 4.4 ° C	DIN 52612 ASTM - C 177-76	W/M.° C Kcal / M.h. ° C	0.016 0.014
Thermal conductivity Value in lab. 10 ° C	DIN 52612 ASTM - C 177-76	W/M.° C Kcal / M.h. ° C	0.027 0.023
Thermal conductivity Value after 5 years 24 ° C	DIN 52612 ASTM - C 177-76	W/M.° C Kcal / M.h. ° C	0.032 0.027
Compresside strength at 10% bending	DIN 53421	Kg/m^2	3.0
Immersed water absorption	DIN 53428	% Volume	0.2
Capillary water absorption	-	-	non
Flammability	DIN 4102	-	B2

COMPARISON BETWEEN CONVENTIONAL AND INVERTED ROOFING SYSTEMS :

When using thermal insulation materials which has high ability to absorb water, the waterproofing layer must be laid over the thermal insulation layer, this system is called conventional roofing system (see figure 2) .

When using extruded polystryrene (e.g. ADVEFOAM) which is distinguished by its high resistance to water absorption it become possible to lay the thermal insulation layer over the waterproofing layer (see figure 3). This system is called the inverted or the protected roofing system .

ADVANTAGES OF THE INVERTED ROOFING SYSTEM :

1) Protection of waterproofing layer from the effect of the temperature variation (from + 10 ° C. to + 60 ° C.) during one month and along the total year (see figure 4). In the case of the inverted roofing system this variation will reach ± *5 ° C.* during one year.

2) The waterproofing layer is laid directly on the concrete surface. Thus it will have higher efficiency.

3) The inclined cement screed, the water vapour barrier and the protection mortar layers are not essential to be used .

4) Few and simple installation steps .

5) Lower installation and maintenance cost .

INSTALLATION STEPS FOR THE CONVENTIONAL AND THE INVERTED ROOFING SYSTEM USNIG LEYCO-TILE :

Figure (5) shows the installation steps for the conventional roofing using the hot bitumeneous materials and the expanded polystyrene boards . These steps reach more than 8 steps which increase the time and the cost of installation .

The inverted roofing using the LEYCO-TILE consists two steps only :

1) Waterproofing layer from the bitumeneous emulsion materials LEYCOTEKT or LEYCOPLAST .
2) Layer from LEYCO-TILE bonded with cementitous mortar .
   This layer replaces the thermal insulation and the protection layers .

The bitumeneous emulsion Materials have the following advantages :

1) Are absolutely waterproof and having all the advantages of sheeting without the disadvantages .
2) Adheres firmly on all vertical , horizontal , dry and wet surfaces .
3) Easy to apply by brush, roller or sprayer .
4) Cold application .
5) Remains highly elastic and dries rapidly .
6) Saves considerable material and labour costs .

The LEYCO-TILE which is used as a thermal insulation layer
has the following advantages :

1) High thermal insulation efficiency which does not change with time.
2) The thermal insulation layer has high compressive strength and resistance to water absorption .
3) The concrete protection layer has high resistance to the mechanical stresses .
4) Lower total thickness and less total load per square metre .
5) Several surface textures .
6) Simple installation method .
7) Lower total cost .

ADVANTAGES OF THE INVERTED ROOFING SYSTEM IN WHICH BITUMENEOUS EMULSIONS AND LEYCO-TILE ARE USED :

Reducing the permanent loads for the roofing 200 - 300 Kg/m^2 in the conventional system to 40 Kg/m^2 for the inverted system .

Sparing the vapour barrier layers : The bitumeneous emulsions are permeable to water vapour and impermeable to water .

It is possible to spare also the inclined screed layer . The rain water outlets are laid at the same level of the waterproofing layer , thus it is possible to drain the rain water directly from the LEYCO-TILE surface or through the LEYCO-TILE joints .

Sparing the protection cement mortar layer which is laid under the waterproofing layer .

Sparing the sand and the protection layers .

Reliable guarantee for the efficiency of the protected water proofing layer .

Reliable guarantee for the efficiency of the thermal insulation which does not change with time .

Easy installation and maintenance procedure .

Possibility of changing the utilization of the roofs .

Possibility of fixing all roof installations and fittings without damaging the roofing layers .

Guarantee for the protection of the thermal insulation layer against the effect of U.V. radiation and mechanical stresses .

Guarantee for the protection of the waterproofing layer against deterioration , which results from the action of temperature variation .

Lower material and labour costs compared with the conventional roofing system.

MAJOR APPLICATIONS FOR LEYCO-TILE

Thermal insulation and protection layer for residential, public and industrial buildings .

Thermal insulation and final finishing layer for walls .

Thermal insulation layer for floors, walls and roofs of cold stores .

Upgrading of the thermal insulation layers of old roofs without removing the existing insulation layers .

Light weight thermal insulation layers for steel structures .

Final decorated tiles, in case a light weight tile is desired .

STEPS OF INSTALLATION :

1- ROOFING SYSTEM USING BITUMENOUS EMULSION AND TILE-FOAM.

Clean the concrete surface from dust, grease, oils and any foreign material .

Rain water outlets are to be laid at the level of the waterproofing layers (see figures 6.7) . The joint between the outlets and concrete slab are to be sealed with mastic material (CETOKOL 3000 or KEMFLEX 140).

To guarantee a perfect sealing between walls and floors, install 50 x 50 mm. triangular angle fillets at this connection .

The mortar for the angle fillet consists of cement, sand, water and LEYCOBOND 65 at a rate of 30 kg/m^3.

Apply a primer coat of LEYCO-PLAST or LEYCOTEKT diluted with water in the ratio 1:3 at a rate of 0.3 kg/m^2.

Apply 2-3 coats of LEYCO-PLAST or LEYCOTEKT at a rate of 0.5 - 0.7 kg/m^2.The total consumption will be not less than 2 kg/m^2.

Coarse grained sand layer is to be sprinkled on the final wet LEYCO-PLAST coat .

LEYCO-TILE is to be laid using cementiteous mortar consisting of 250 kg. cement / one cubic metre of sand and mixing water . To increase the bonding stress 30 kg LEYCOBOND 65 may be added to 1 m^3 of the mortar .

Surface slopes may be formed by the bonding mortar if required .

The joint between the tiles may be filled with cementiteous mortar .

3-5mm. joints must be installed between the tiles . In the case of large areas, expansion joints must be installed according to the specifications of laying the tiles .

2 - WALL INSULATION :

(See figure 8)

Clean the surface from dust, grease, oils and any foreign materials .

In the case of brick walls, the joint must be emptied to a depth of 1.0cm, and re-filled with cementiteous mortar containing LEYCOBOND 65 at a rate of 30 kg/m^3.

Apply a primer coat of LEYCOTEKT or LEYCO-PLAST diluted with water in the ratio 1:3 at a rate of 0.3 kg/m^2.

Apply two or more final coats of LEYCOTEKT or LEYCO-PLAST at a rate of 0.5-0.7 kg/m^2. The total consumption will be not less than 2.0 kg/m^2 .

Coarse grained sand layer is to be sprinkled on the final wet LEYCO-PLAST or LEYCOTEKT coat .

Apply a tie plastering coat (Tartsha) consisting of sand and cement in the ratio 1:1, the mixing water consists of water and LEYCOBOND 65 in the ratio 4:1.

LEYCO-TILE is laid using cementiteous mortar consisting of one cubic metre sand, 300 kg. cement, water and 40 kg. LEYCOBOND 65 .

The joints are to be filled with cementiteous mortar .

3 - UPGRADING OF EXISTING ROOFING .

(See figure 9)

Due to the reduced permanent load of the LEYCO-TILE roofing system the existing roofing can be upgraded without removing the old roofing layers . In this case the additional load will not be more than 40 kg/m^2.

In the case of cement tile roofs, the surface must be cleaned and the joint between the tiles must be filld with cementiteous mortar containing 30 kg. LEYCOBOND 65 / m^3 .

Install 50 x 50mm. triangular angle fillets in the connection between the walls and floors .

The mortar for the angle fillets consists of one cubic metre of sand. 300 kg. cement, water and 30 kg. LEYCOBOND 65 .

Apply a primer coat of LEYCO-PLAST diluted with water in the ratio 1:3 and 2-3 final coats of LEYCO-PLAST . The total consumption will be not less than 3 kg/m^2.

Coarse grained sand is to be sprinkled on the final wet LEYCO-PLAST coat .

LEYCO-TILE is to be laid using cementiteous mortar consisting of one cubic metre of sand, 250 kg. cement and mixing water . To increase the bonding stress 30 kg LEYCOBOND 65 may be added to 1 m^3 of the mortar .

The joints between the tiles may be filled with cementiteous mortar .

LEYCO-TILE TEST RESULTS

STUDY OF THE ROYAL SCIENTIFIC SOCIETY, JORDAN

THERMAL INSULATION OF HOLLOW BLOCK ROOFS .

Figure (10) shows a section in the tested roof . The test results are given in table (2) and figure (11).

The thermal transmittance value of the insulated roof is much smaller than the value of the non-insulated roof, and consequently its ability for thermal insulation increases due to the increases of the foam layer thickness .

The percentage of saving of thermal energy lost through the roof is between 47.1% and 72.4%, when selected foam layer of 1 cm, 3 cm. thickness respectively .

The thermal transmittance value stipulated in thermal insulation code is reached in tiles containing a foam layer not less than 1.5 cm.

THERMAL INSULATION OF A TRADITIONAL EXTERNAL WALL .

Figure (12) shows a section in the tested wall .

The test results are given in the table (3), figure (13).
In the case of traditional walls without windows, the thermal transmittance values decrease from 3 W/M^2 x ° C. to 0.939 W/M^2 x ° C. and 0.697 W/M^2 x ° C. if the thicknessess of the foam are 2cm, 3cm respectively .

It is possible to save 68.8%, 76.8% of the thermal energy in this case.

In the case of walls containing 18% aluminium windows, it is shown that the thermal transmittance value stipulated in the thermal insulation code for walls including wall (1.8 W/M^2 x ° C) can be achieved when the foam layer is 2 cm. Thick or more .

In this case the saving of the thermal energy reaches 48.7% and increases to 54.4% if using 3 cm. thick foam .

THERMAL INSULATION OF HOLLOW BRICK WALL .

Figure (14) shows a section in the tested wall .

The test results are given in table (4) and figure (15) .

The thermal transmittance decreases from 2.35 W/M^2 x ° C. in the case of solid walls and from 2.935 W/M2 $_x$ ° C. to 1.544 W/M^2 x ° C. in the case of the walls containing 18% windows . This is accomplished when the thickness of foam is 3 cm.

The thermal transmittance value stipulated in the code for walls including windows is achieved by using a 2 cm. thick foam layer or more.

When the thickness of the foam is 3 cm, the saving of the thermal energy reaches 47.4% for walls with 18% windows and 72.2% for walls without windows .

STUDY OF THE GENERAL ORGANISATION FOR HOUSING, BUILDING AND PLANNING RESEARCH. CAIRO. EGYPT.

A complete study for the thermal behaviour and properties of TILE-FOAM was carried out in the General Organisation for Housing., Building and Planning Research. The summary of the study is as follows :

1 - The Thermal insulation tiles " LEYCO-TILE " which are produced by Chemicals For Modern Building " C.M.B " consists of a closed cell extruded polystyrene foam layer, laminated to a polymeric concrete facing layer .

2 - The Co-efficient of thermal conductivity (See table 5)
for the LEYCO-TILE is as follows :
For the polymeric concrete facing - 0.850 W/M^2 x ° C.
For the extruded polystryene layer - 0.031 W/M^2 x ° C.
For both materials together - 0.061 W/M^2 x ° C.

3 - The field investigations for the insulated wooden test boxes show the importance of the insulation layer for decreasing the inside surface temperature, the test results were as follows :
Decreasing of the thermal decrement factor from 50% to 17% .
Increasing the time lag by 6 hours .
The inside surface temperature decreases by 7 ° C.
Thermal limit from 15 ° C. to 3 ° C.

4 - Field investigations were carried out for 3 test rooms of the dimensions 3.40 x 3.15 x 2.70m.

Each room having 1x 1m. window and 1 x 2 m. door and having the following specifications

ROOM I : Comparative test room 25 cm. brick walls, 18 cm. R. C. roof .

ROOM II : The same as Room I, the walls and roof were insulated by 2&3 cm. LEYCO-TILE .

ROOM III : The same as ROOM II but having hollow brick walls .

The test results show that the LEYCO-TILE improves the thermal behaviour of the insulated room as follows :

Decreasing the temperature vibration for inside air and increasing the time lag . Table (6) shows the test results for the insulated walls and roofs .

Decreasing the max-inside room temperature by 5 ° C and 11 ° C in comparison with the non-insulated rooms and outside air temperature respectively see figure (16) .

5 - Air conditioning sets were installed in the testrooms No I and No II . The use of LEYCO-TILE saves about 11% of the consumption of the electrical energy and decreases the inside room temperature in the range of 5 to 10 ° C . Table (7) shows the thermal properties for the non-insulated and the insulated air conditioned rooms .

6 - According to the test results of this study, we recommend to use LEYCO-TILE as thermal insulation material to save the consumption of the electrical energy and to improve the thermal behaviour and internal environment inside the buildings .

TABLE (2)

THERMAL INSULATION PROPERTIES FOR HOLLOW BRICK ROOFS

VAULE OF THERMAL TRANSMITTANCE ($W/M^2X^\circ C$) OF A ROOF INSULATED WITH LEYCO-TILE						
ROOF		THICKNESS OF THE THERMAL INSULATING LAYER USED IN (CM)				
		1	1.5	2	2.5	3
THERMALLY INSULATED WITH LEYCO-TILE	With a sloping area	1.239	1.008	0.849	0.734	0.646
	Without a sloping area	1.296	1.045	0.876	0.753	0.660
WITHOUT THERMAL INSULATION	With a sloping area	2.342				
JORDANIAN CODE REQUIREMENT 1.0 (Max value as given in the Jordanian code)						
PERCENTAGE OF SAVING IN THE LOST THERMAL IN THE CASE OF INSULATION						
THERMALLY INSULATED WITH LEYCO-TILE	With a sloping area	47.1	57.0	63.7	68.7	72.4
	Without a sloping area	44.7	55.4	62.6	67.8	71.8

TABLE (3)

THERMAL INSULATION PROPERTIES FOR TRADITIONAL WALLS

THERMAL TRANSMITTANCE VAULES ($W/M^2X^\circ C$) OF TRADITIONAL EXTERNAL WALLS THERMALLY INSULATED BY LEYCO-TILE						
External walls		THICKNESS OF THE INSULATED LAYER IN THE TILE (CM)				
		1	1.5	2	2.5	3
Thermally insulated	Walls without openings	1.440	1.137	0.939	0.800	0.697
	Walls with windows	2.189	1.940	1.778	1.664	1.581
Without Insulation	Walls without openings	3.005				
	Walls with windows	3.464 (18% Aluminium windows)				
Requirements of the thermal insulation code for extermal walls without windows		The maximum value of thermal transmittance stipulated in the code is : 1.80				
PERCENTAGE OF SAVING IN THE THERMAL ENERGY LOST THROUGH AN INSULATED WALL (%)						
A wall without openings		52.1	62.2	68.8	73.4	76.8
A wall with openings		36.8	44.0	48.7	52.0	54.4

TABLE (4)

THERMAL INSULATION PROPERTIES FOR HOLLOW BRICK WALLS

THERMAL TRANSMITTANCE VAULE ($W/M^2X^\circ C$) OF EXTERNAL WALL BUILT OF HOLLOW CEMENT BRICK THERMALLY INSULATED WITH LEYCO-TILE						
External walls		THICKNESS OF THE HEAT INSULATING LAYER IN THE TILE (CM)				
		1	1.5	2	2.5	3
Thermally insulated	Walls without windows	1.270	1.028	0.864	0.745	0.654
	Walls with windows	2.049	1.851	1.716	1.619	1.544
Without heat insulation	Walls without openings	2.350				
	Wall with windows	2.935 (18% Aluminium windows)				
Thermal insulation code requiement for external walls with windows		The maximum transmittance value stipulated in the code is : 1.80				
PERCENTAGE OF SAVING OF LOST THERMAL ENERGY IN THE CASE OF INSULATED WALL (%)						
Walls without openings		46.0	56.3	63.2	68.3	72.2
Walls with openings		30.2	36.9	41.5	44.8	47.4

TABLE (5)

LABORATORY TESTS FOR DETERMINATION OF THERMAL AND PHYSICAL PROPERTIES

NO. SAMPLE	THICKNESS L (mm)	CO-EFFICIENT OF THERMAL CONDUCTIVITY K ($W/M^2.^\circ C$)		DENSITY ρ (Kg/m^3)	THERMAL RESISTANCE R = L/K ($M^2.^\circ C/W$)
		HOTWIRE : METHOD	THERMAL FLOW MEASUREMENT		
1 ADVEFOAM	20	0.034	0.031	34.8	0.6
2 ADVEFOAM	30	0.036	0.033	35.1	0.9
3 ADVEFOAM	50	0.034	0.033	34.1	1.5
4 CONCRETE LAYER	10	1.28	0.850	2200	0.008
5 LEYCO-TILE Hot surface in contact with solid surface	40		0.0617	857	0.64
6 LEYCO-TILE Hot surface in contact with insulating material	40		0.0403	857	0.99

TABLE (6)

THERMAL PROPERTIES FOR NON INSULATED AND INSULATED WALLS AND ROOFS

THERMAL PROPERTIES	RED BRICK WALL		CEMENT BRICK WALL		CONCRETE ROOF	
	NON - INS.	INS.	NON - INS.	INS.	NON - INS.	INS.
THERMAL TRANSMITTANCE (U. VALUE) ($W/m^2.\ ^\circ C$)	1.65	0.79	2.75	0.96	3.02	0.77
THERMAL TIME CONSTANT (Hour)	23.4	90.6	11.7	81.8	9.5	128.5
TIME LAG (Φ Hours)	9.42	11.96	6.74	9.41	6.04	8.96
THERMAL DECREMENT %	0.17	0.03	0.36	0.04	0.43	0.03

TABLE (7) COMPARISONS OF THERMAL PROPERTIES BETWEEN INSULATED AND NON-INSULATED CONDITIONED ROOMS

THERMAL PROPERTIES	TESTING ROOM (RED BRICKS) NON-INSULATED				INSULATED RED BRICK	INSULATED HOLLOW CEMENT BLOCK
	NON-COND.	MORNING PERIOD OPERATING	NOON PERIOD OPER.	NIGHT PERIOD OPER.		
THERMAL DECREMENT FACTOR (λ)	0.321	0.44	0.294	0.163	0.084	0.095
TIME LAG (Φ Hours)	3	7	7	12	8	8
CO-EFFICIENT OF THERMAL DAMPING (Ds %)	68 %	56 %	71 %	68 %	92 %	90.5 %

REFERENCE LIST OF SOME PROJECTS WHERE LEYCO-TILE WAS USED.

HOTELS AND TOURIST VILLAGES

Semiramis Intercontenental

Meridian Heliopolis

Maraqia Tourist Village

Sidi Abdel Rahman Hotel (El - Alamain Hotel)

HOSPITALS

Artificial Kidney Centre

Kasr El Aini Renovation

Social And Preventive Medicine (Abou El Reech)

Police Hospital

El - Haram Hospital

Suez General Hospital

Dr. Osman Hospital

INDUSTRIAL BUILDINGS

H.V.A. Cheese Factory

Swiss Pharmacy Factory

Power Sub-Station Assuit

Kanater Research Institute

Alexandria Local Broadcasting Station

Greater Cairo Waste Water Project (21/22)

Petro-Balaim Company (SUEZ)

INSTITUTIONAL BUILDINGS

Cairo University - Faculty of Pharmacy

El Menia University

Cairo University - Faculty of Engineering

The French Embassy In Cairo

The German Embassy In Cairo

The American Embassy In Cairo

Heliopolis CLUB

Durg Reinforcement Department Ministry of Interior

Vegetable Cold Stores

Freezing refrigeration

Enpi Office Building

Capco Office Building

S.O.S. Village

World Trade Centre

Luxor Airport

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