Insulation of House and Building

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Research Summary

Humans have developed a response to the environmental conditions surrounding him through long and continuous experiences in the practice of construction .they was able to recognize the characteristics of building materials to use them with maximum effectiveness to meet his needs and requirements. This development came in line with technological development and the urgent and rapidly growing needs of humans. However, this development was not without from the emergence of some obstacles, especially in the use of some building materials, including reinforced concrete, the use of these materials has been accompanied by some negatives related to their properties .reinforced concrete has the property of rapid conduction of heat and rapid loss of heat ,which makes its use in constructing buildings and designing their internal and exterior spaces without thermal insulators or air conditioning devices unsuitable comfortable for humans.

Insulating will add the comfortable to the building, create a healthier home environment, reduce the energy bills and have a positive environmental impact. Adding home insulation to an existing home will regulate the temperature, making the living environment more enjoyable, especially in places of extreme weather. With insulation the home will become more energy efficient. Insulation will keep the home cooler in the summer and warmer in the winter. This will reduce the amount of heating and cooling appliances that is needed to keep the house comfortable. Because of this, home insulation will reduce the energy ills and the costs of cooling and heating acoustic insulation will also enhance the sound control.

Insulation creates a sound barrier, keeping unwanted sounds out and protecting the privacy by keeping the sounds inside from being audible outside. Insulating at the home also creates a moisture barrier, keeping undesirable moisture out and offers much comfortable living environment inside.

Insulating the electrical outlets and the corresponding components will protect home against any electrical shocks.

The benefit of home insulation is not related to the occupants inside the house only but it is also extended to keep the environment out of pollutants .the insulation building will contribute to use less energy for air-conditioning .this will reduce the carbon footprint ,and also reduce the amount of chemicals released into the environment from air-conditioning units.

Therefore, insulation is a key element in the so-called "**Green Home Policy**".

- Introduction about Insulation Material

Insulation materials are made to maintain the building components and facilities as long as possible. There are many types of insulation materials according to the purpose and the structure.

The available insulating materials differ in their ability to conduct heat, and each material has a fixed value that we conclude from laboratory experiments the amount of heat transfer in it. This value is called the thermal conductivity coefficient. It is recommended to use materials with a low ability to conduct heat .the basic concept that must be remembered is that the higher the value of the thermal conductivity coefficient .the lower the heat gain o loss .in general ,building materials with cellular voids should be used due to its good thermal insulation (Porous Materials).

Safety: Some insulating materials could get hurt to human during storage, installation and usage. These may cause deformities in the human body poisoning, infections or allergies in the skin and eyes, which requires importance of knowing the chemical composition of the material and ability to interact with the environment and constitute a mold, germs and insects. There are some physical properties be considered like the ability of combustion and sublimation.

- Types of Insulation

A. Thermal Insulation

B. Acoustic Insulation

C. Waterproofing Insulation

D. Radiation Insulation

E. Electrical Insulation

- Thermal Insulation

Thermal insulation are those materials that prevent or reduce various from of heat transfer (conduction, convection and radiation).insulator resists the heat transfer from out to in or opposite direction whether the environment temperature is high or low, there are many advantages of thermal insulation that isolates the building from the heat and reduces the energy consumption as well as the cost of air-conditioning operation. Also it makes the indoor temperature of the building stable and non-volatile .to reduce the transmission of the heat; buildings must be isolated in order to protect it from heat loss in winter and heat gained in the summer. It is found that about **60%** of heat losses directly though the ceilings and walls of the building and that about **15%** through the glass and about **25%** of the heat infiltrates through cracks, openings and doors.

To make the thermal insulation of the building an economical process, the following factors should be chosen carefully:

A- The amount of insulation material and thickness.
B- The cost of insulation material and labor costs for installation.
C- The amount of energy saving and the reduction in greenhouse emissions.

By applying appropriate exterior designs and using good thermal insulation, it is possible reducing the electrical energy consumed due to air-conditioning loads through the use of thermal insulation of walls and ceilings and use of double glazing for windows maintains the temperature for the inner surface of the buildings walls.

- Advantage of Thermal Insulation

A. Reduce the amount of heat transmitted through the parts of the house or building.
B. Reduce the energy required for heating or cooling the house.
C. Make the internal temperature of the building stable, non-volatile.
D. Keep the temperature of the building elements stable thus long time life.
E. Reduce energy bills.
F. Reduce the burning of fuel in power plants.
G. Reduce the emission of greenhouse gases.

- Types of Thermal Insulating Materials and Methods of Manufacturing

* Thermal insulation materials classification according to the structure

A. **Organic materials**; such as cotton, wool, cork, ruber and cellulose.
B. **Inorganic materials**; such as glass, asbestos, rockwool, perlite, vermiculite and calcium silicate.
C. **Metallics**; such as aluminum foils and tin reflectors.

* Thermal insulation materials classification according to the shape

A. **Rolls**; vary in the degree of flexibility and the ability to bend or pressure. They could be fastened by nails like glass wool, rock wool, polyethylene and foil-ceramic rolls.

B. **Sheets**; there are specific dimensions and thicknesses such as polyethylene layer, polystyrene, cork and cellulose.

C. **Liquid or gaseous fluids**; poured or sprayed on to form the desired dielectric layer, such as polyurethane foam and epoxy.

D.**Grains**; a powder or granules are usually placed in the spaces between the walls and it can also be mixed with some other materials .examples of such materials granulated cork and polymers.

The most common insulators materials are:

A. **Glass wool**: are widely used to insulate building, as well as boilers and reservoirs.
B. **Rock wool**: this material is used to isolate the buildings and storages.
C. **Cellulose**: which is made from wood or recycled paper and is characterized by its susceptibility to water and dust absorption.

D. **Cork**: this is taken from cork tree. It could be made industrial from petroleum product which is called the expanded polystyrene

E. **(EPS).** it is found in the form of panels and used as thermal and acoustic insulators.

F. **Polyurethane**: usually uses as insulated panel or foam to fill the cracks.

G. **Polystyrene cork**: both types, EPS and XPS.

H. **Astrofoil (XPE) layers**: consist of two aluminum foils and including air bubbles which are made of polyethylene material. the aluminum layers reflect the solar radiations in summer while the air bubbles reduce the heat transfer through the walls because of high air isolation .this material is a good insulator against the water and air leaks.

I. **Polycarbonate panels**: these sheets are lightweight panels, and are composed of several layers to be able to withstand the shocks with the presence of air cavities for the purposes of thermal insulation.

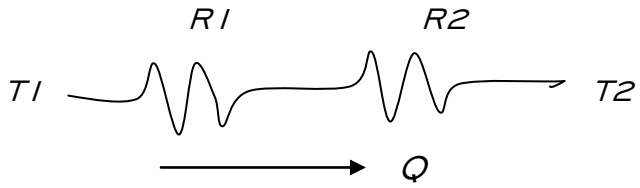
J. **Reflective materials**: such as aluminum panels, alu-cobond and reflective paints. These materials are used to reflect solar radiation on the exterior walls.

- Thermal Insulation Expression

There are some concepts must be defined before entering to the design, such as:

Thermal resistance: it is the susceptibility of the material to resist the heat .thermal resistance has inverse relation with the coefficient of thermal conductivity. To find out the total resistance of the wall or ceiling ,the collection of resistors for all materials should be included as well as the convection resistance adjacent to the external surface .dealing with these resistors exactly like that used with electrical resistors ,they are either parallel or series. Resistance also called **R** – value. It is worth nothing that the US **R** – Value is about six times the the SI **R** – Value due to the different standards.

Using the resistance concept,

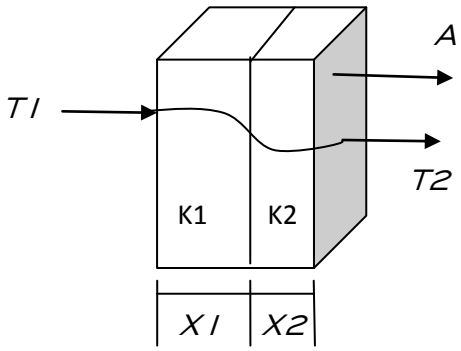


$R1 = X1 / K1$

$R2 = X2 / K2$

In case of convection resistance,

$RC = 1 / h$



Composite wall

Over Heat Transfer Coefficient: it is a factor used to determine the optimum thickness of the insulation material in buildings. It is also called **U** – value .and it can be calculated from the following relationships:

$U = 1 / (R1 + R2)$

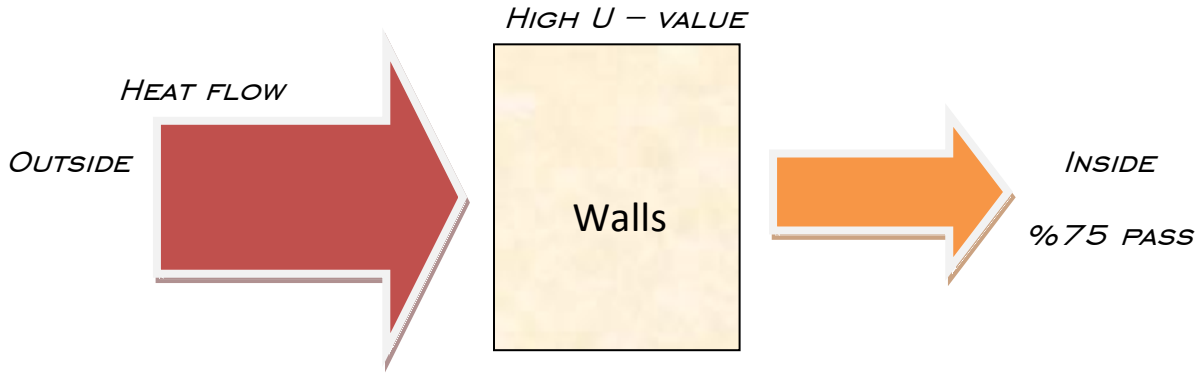
Then calculated the amount of heat transfer through the wall by the following relationships:

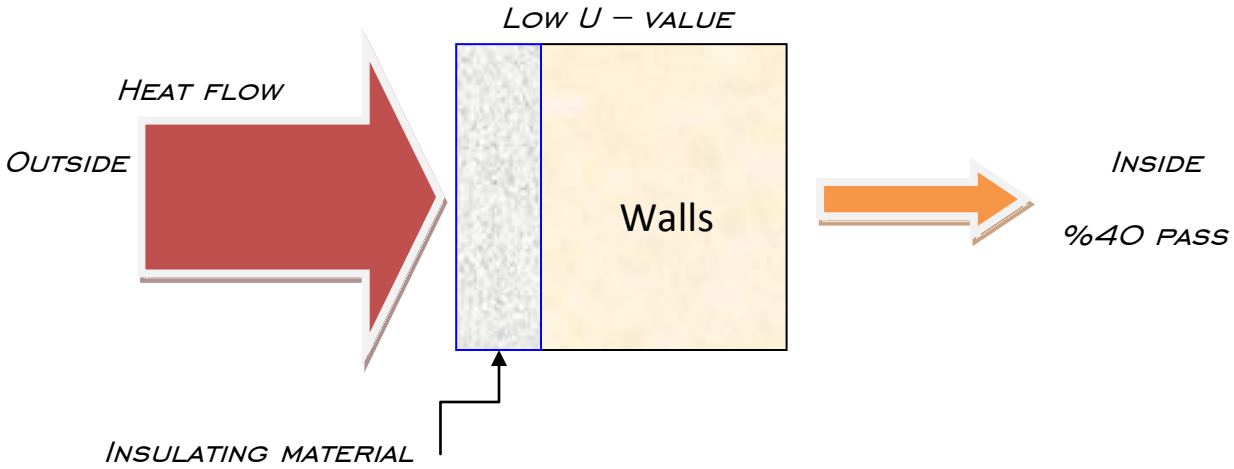
$Q = U A (T1 - T2)$

Where **T** is the temperature of the surface and **A** is the surface area

The unit of **U** – Value is $(W/M^2.K)$.

The **U** –Value of uninsulated wall is high up (1 – **5**),while the **U** – value of insulated wall is less than (1),while for super-insulation wall is less than (**0.2**).the world is moving to standardize the **U** – value for residential buildings as minimum as possible toward satisfying the **ZERO** energy building .





Effect of U – Value in reducing the heat transfer

- Tables

-Thermal Conductivity for Common Insulators

Item	Material	Thermal conductivity(W/m.k)
1	Astro – foil(XPE)	0.08
2	Asbestos	0.12
3	Asphalt	0.69
4	Alucobond	0.15
5	Acrylic	0.20
6	Aerogel	0.02
7	Bitumen	0.17
8	Calcium silicate	0.05
9	Cellulose	0.08
10	Coal	0.24
11	Cotton	0.04
12	Cork(EPS)	0.05
13	Ceramic fiber	0.08
14	Engine oil	0.15
15	Epoxy	0.35
16	Glass fiber	0.03
17	Glass wool	0.04
18	PVC	0.2
19	Paraffin wax	0.25
20	Plywood	0.13
21	Polycarbonate	0.19
22	Perlite	0.05
23	Polystyrene(XPS)	0.08
24	polyurethane	0.02
25	Rubber	0.35
26	Vacuumed panel	0.007
27	Vermiculite	0.06
28	Wool	0.05

-Thermal Conductivity for Common Construction Materials

Item	Material	Thermal conductivity(W/m.k)
1	Basalt	2.3
2	Block(hollow) 20 cm	0.5
3	Block(hollow) 15 cm	0.6
4	Block (hollow) 10 cm	0.7
5	Block (solid)	0.9
6	Brick(cavity)	0.4
7	Brick(solid)	0.5
8	Concrete(reinforcedO	2
9	Concrete(not reinforced)	0.8
10	Cement plaster	1
11	Clay	1.2
12	Dry wall 10cm	0.3
13	granite	3
14	Gypsum	0.8
15	GRC	0.9
16	Glass	1
17	Limestone	1.2
18	Mica	0.7
19	Marble	2.2
20	Porcelain	1.5
21	Sandstone	1.5
22	Sandwich panel- 10cm	0.04
23	Sandwich panel -5cm	0.05
24	Thermostone-20cm	0.3
25	Thermostone-10cm	0.4
26	Wood	0.15

-Thermal Conductivity for Common Metals

Item	Material	Thermal conductivity(W/m.k)
1	Aluminum(AL)	200
2	Bronze	110
3	Copper(Cu)	400
4	Iron(Fe)	80
5	Lead(Pb)	35
6	Silver(Ag)	450

-Thermal Conductivity for Common Gases

Item	Material	Thermal conductivity(W/m.k)
1	Air	0.025
2	Argon	0.015
3	Bromine	0.04
4	Caron dioxide(CO2)	0.014
5	Helium	0.15
6	Methane	0.03

- *Project of Construction Building Directorate General of Investment / Sulaimanyah*

Establishment of the general director building for sulaimanyah investment authority, the project is being implemented by ***BALLA*** *general contracting company, the project consists of (****4 floors****) and with a full parking floor in the basement, the conference and event hall is approximately* ***200*** *square meters on the ground floor.*

I am working on this project as a civil engineer and general supervisor by the directorate of construction and housing of sulaimanyah supervising the project, and now the project is in its final stages.

Many materials are used in this building for thermal insulation, and Waterproofing insulation, the most important of which is thermal insulation of the exterior walls and Roofs of the building structure, it is necessary to use external insulation materials for this building to save electricity (heating and cooling) energy.

Insulating materials used in the building and their locations:

1 - ***Concrete foundation and retaining walls of basement****: using the* ***cold bitumen*** *materials used to protect the reinforced concrete of foundation from moisture and materials that affect the reinforced concretes from the gaps, cracks and pores.*

2- **Exterior walls insulation :**

a.**Thermostone**, we used a **20cm** thermostone unit to build an external walls because it is a resistant material for thermal insulation.

B.**Cement plastering**, cement rendering with a thickness **2.5cm** using a Turkish rendering method.

C. **Styroboard Expanded Polystyrene (EPS)**, fix the EPS panels to the walls by plastic screws.

D.**Geotextile sheet**, using a geotextile sheets 1.5mm thick over EPS to prevent moisture and water.

E.**Aluminum honeycomb panel**. Construction structures to install Final layers are honeycomb core **23mm** thick compound materials for thermal insulation.

3.**Acoustic Insulation** ; used for interior walls of conference and event halls by using the Rockwool **10cm** thick ,and use of soundproof wooden panels **2.5cm** thickness.

4. **External roof insulation**: the most important place for insulation is the external roofs and is composed as follows.

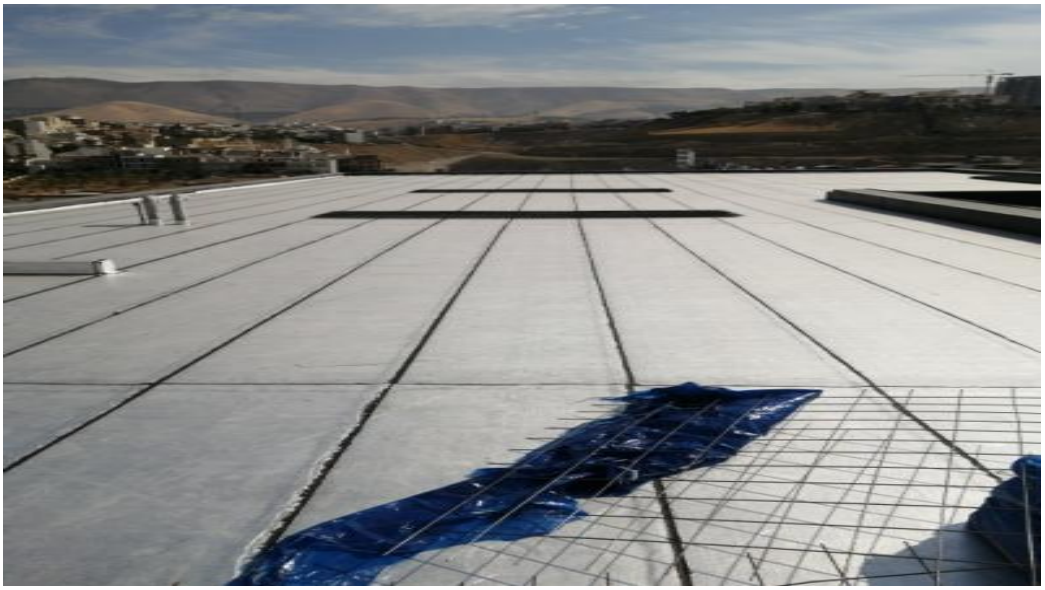
A- Treating roofs from cracks and gaps using special treatment materials.

B- Stick a layer of isogam material 6mm thick.

D- Styroboard Expanded Polystyrene (EPS).stick the layer of EPS **5cm** over the isogam.

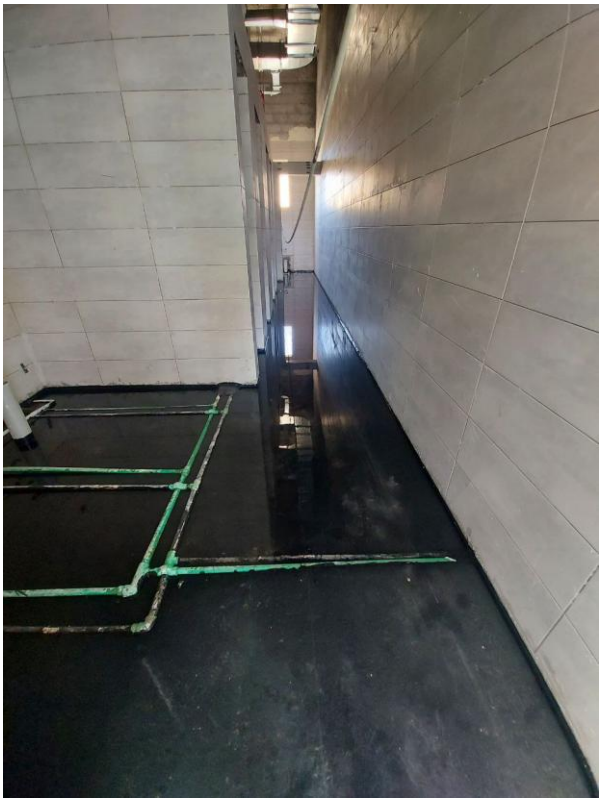
E- Geotextile sheet, layer of geotextile sheets **1.5mm** thick over EPS layer.

F- Reinforced concrete, the last layer we used **10cm** thick of reinforced concrete to save the layers.



5-**Windows and Skylight**, used the aluminum curtain wall windows with two layers of glasses that reflect **40%** of sunlight.

6- **Waterproofing Insulation**, use materials to treat floors in wet areas such as toilets and any other wet areas.



Finally;

The engineer must be take care to the external insulation work in the building. The engineer must also pay attention to the types of building structure in terms of the buildings earthquake resistance, add the new code for earthquake force calculations, and use good quality reinforced concrete. The engineer also pays attention to the good quality used materials in the finishing works. Increasing the percentage of green areas in our projects and reducing the percentage of poisonous gases in the environment, such as CO2 gas, means that the building we build will use less electricity and fuel, and the environment inside will be clean and more suitable for life and human health..

Good luck.....

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