Thermal Insulation in Residential Buildings

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Abstract— The interior walls of all buildings in general and the external walls in particular performs a major role in buildings, both in financial point of view and in the role they play in daily habits. External walls must provide acoustical and thermal comfort, protection and security and must be long-lasting and meet the all requirements. Brick masonry has been the elected material for the execution of external walls as it has paid an important role in buildings since first civilizations. Nowadays, most external walls are built with double wall layers with an inner thermal insulation and ventilation space. Certainly, the complexity that involves a building of this kind of walls increases the possibility of several changes. As a matter of fact, the normal evolution of the buildings outside should involve the use of simple layers. It means a lower complexity in execution and less time waste which leads to economical savings as far as workmanship is concerned.

Key words: Thermal Insulation, R-Value, Foundation Insulation, Basement Wall Insulation, Floor Insulation

I. INTRODUCTION

The term thermal insulation can refer either to materials used to reduce the rate of heat transfer, or the methods and processes used to reduce heat transfer. Heat energy can be transferred by conduction, convection, radiation. Thermal insulation prevents heat from escaping a container or from entering a container. In other words, thermal insulation can keep an enclosed area such as a building warm, or it can keep the inside of a container cold. Insulators are used to minimize that transfer of heat energy. In home insulation, the R-value is an indication of how well a material insulates. The flow of heat can be reduced by addressing one or more of the three mechanisms of heat transfer and is dependent on the physical properties of the material employed to do this.

II. R-VALUE

The R-value is the reciprocal of the amount of heat energy per area of material per degree difference between the outside and inside. The R-value is proportional to the thickness of the material. For example, if you doubled the thickness, the R-value doubles." It is also referred to as the thermal resistance or thermal rating of an insulating material. This is the parameter which is used to rate the thermal ability of an insulation. It determines the amount of resistance offered by the material to heat flow or transfer of heat energy. A higher R- value is usually preferred for better insulation.

A. All insulating materials should satisfy following major requirements

They need to maintain their shape and strength under all conditions. They should have adequate durability and robustness. Also, they should be impervious to the attack of mould and parasites. They should be able to meet the safety criteria for protection against fire.

B. Some important facts concerning insulation materials are mentioned below

The less dense the material, the better insulator it is. This is due to the fact that atoms in highly dense materials are bound closer to each other which results in an effectual transfer of energy from one atom to another. Liquids are considered to be better insulators than solids but not better than gases. A perfect insulating material which provides poor conduction of heat always happens to be a poor conductor of electricity also. For example, wood which is a non-conductor of electricity provides better insulation than copper.

III. PURPOSE OF INSULATION

A thermal insulator is a poor conductor of heat and has a low thermal conductivity. Insulation is used in buildings and in manufacturing processes to prevent heat loss or heat gain. Although its primary purpose is an economic one, it also provides more accurate control of process temperatures and protection of personnel. It Prevents condensation on cold surfaces and the resulting corrosion. Such materials are porous, containing large number of dormant air cells. Thermal insulation delivers the following benefits:

- Reduces over-all energy consumption
- Offers better process control by maintaining process temperature.
- Prevents corrosion by keeping the exposed surface of a refrigerated system above dew point
- Provides fire protection to equipment
- Absorbs vibration

A. Types of Insulation by Technique

1) Foundation Insulation

- Slab-on-Grade Insulation
- Foundation Wall Insulation
- Foundation Vents

B. Basement Wall Insulation

- Interior Foam Wall Insulation
- Interior Framed Wall
- Integrated Foam and Concrete Wall Systems

C. Floor Insulation

- Insulating Under Floors
- Insulating Crawl Space Walls Rather Than Floors
- Attic Floor Insulation Techniques

1) Foundation Insulation

a) Slab-on-Grade Insulation

Many of homes have slab-on-grade floors for the first story of conditioned space. Slab insulation is not recommended anywhere in the state by the IRC due to problems with termites, which can tunnel undetected through the foam to gain Access to the wood framing in the walls. Because of the severity of the problem, this publication does not recommend foam slab insulation in homes.

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b) Foundation Wall Insulation

Foundation walls and other masonry walls are usually built of concrete blocks or poured concrete. Insulating concrete block cores Builders can insulate the interior cores of concrete block walls with insulation such as:

- Vermiculite – R-2.1 per inch
- Polystyrene inserts or beads – R-4.0 to 5.0 per inch
- Polyurethane foam – R-5.8 to 6.8 per inch

Unfortunately, the substantial thermal bridging in the concrete connections between the cores depreciates the overall R-value. Thus, this approach is only a partial solution to providing a quality, well-insulated wall.

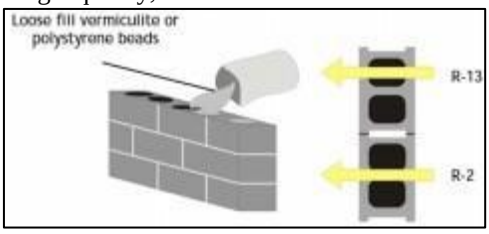

Fig. 1: Insulating Concrete Block Cores

2) Basement Wall Insulation

a) Interior Foam Wall Insulation

Foam insulation can be installed on the interior of basement walls; however, it must be covered with a material that resists damage and meets local fire code requirements. Half-inch drywall will typically comply. Furring strips will need to be installed as nailing surfaces. Furring strips are usually installed between sheets of foam insulation. To avoid the direct, un-insulated thermal bridge between the concrete wall and the furring strips, a continuous layer of foam may be installed underneath the nailing strips.

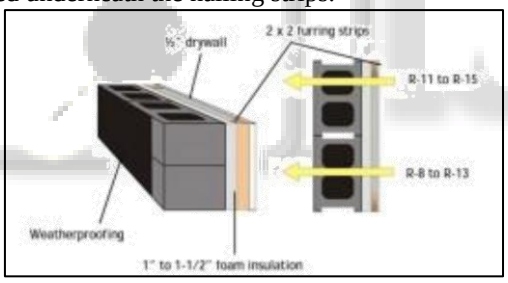

Figure 2: Interior Foam Wall Insulation

b) Interior Framed Wall

In some cases, designers will specify a framed wall on the interior of a masonry wall. Standard framed wall insulation and air sealing practice can then be applied.

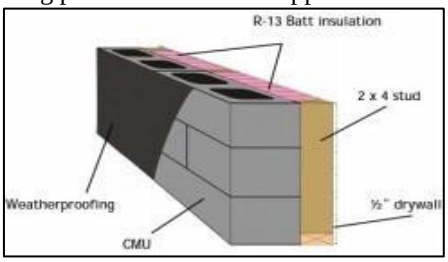

Fig. 3: Interior Framed Wall

3) Floor Insulation

a) Insulating Under Floors

Many homes have floor structures consisting of 2x10 or 2x12 wood joists, wood I beams, or trusses over unconditioned crawl spaces or basements. Insulation should be installed underneath the subfloor between the framing members. Most builders use insulation bats with an attached vapor barrier for insulating framed floors. The bats should be installed flush against the subfloor without any gaps, which may serve as a passageway for cold air between the insulation and floor. Special rigid wire supports called "tiger teeth" hold the insulation in place.

Run wiring, plumbing, and ductwork below the bottom of the insulation so that the continuous layer can be installed. Be certain to insulate all plumbing and ductwork in the unconditioned spaces such as crawl spaces, basements, and attics.

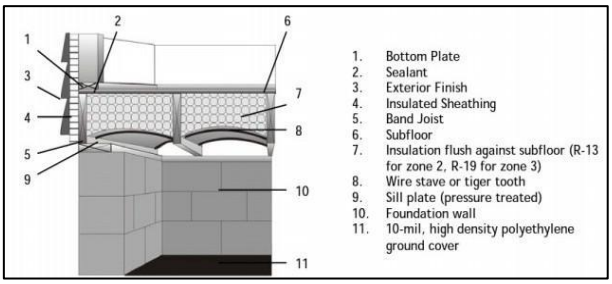

Fig. 4: Insulated Wood Framed Floors

b) Insulating Crawl Space Walls Rather Than Floors

For years, building professionals have assumed the optimal practice for insulating floors over unheated areas was to insulate underneath the floor. However, studies performed in Tennessee several years ago found that insulating the walls in well-sealed crawl spaces and unconditioned basements can be an effective alternative to under-floor insulation. While the annual heating bills in the homes tested was one to three percent higher than those with under floor insulation, the cooling bills dropped by approximately the same amount. Because the crawl space remains cool in summer, the home can conduct heat to the crawl space if there is no insulation under the floor.

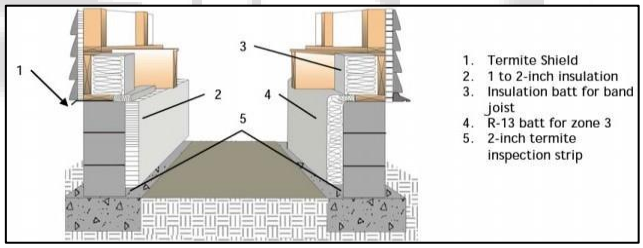

Fig. 5: Insulated, Sealed Crawl Space Walls

D. Crawl Space Wall Insulation Requirements

- Cover the entire earth floor with 6- to 10-mil polyethylene (recommended in all homes)
- A one- or two-inch gap should be left at the bottom of the insulation to serve as a termite inspection strip.
- Insulate the band joist area in addition to the foundation wall.
- The crawl space or basement must have an airtight barrier to the house.
- Review plans for the insulation with local building officials to ensure code compliance

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