THERMAWRAP (TW) ARCHITECTURE IN KASHMIR

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Abstract: *The history of thermal insulation in Kashmir is as old as it's building activities. Kashmiris have always been innovative to deal with bone chilling cold of winters. They used materials known to them for construction. The geographical location of Kashmir and climatic conditions demand proper insulation methods. The technological advancement has in a way assisted a lot in dealing with harsh climate, but winter comes with lots of uncertainties as energy demands go up and energy generation goes down owing to the hydro dependent nature of the power plants. The lack of proper insulation in the present buildings has rendered majority of the houses ineffectual in dealing with the harsh winter. Known for it's traditional and conventional construction techniques, Kashmiris have stood out in developing various techniques to build houses with greater insulation and aesthetic properties. A walk through the lanes of the Old City typically demonstrates how traditional homes adapted to geography by utilizing mud, lime, timber, bricks and stones. With the onset of the modernization, Kashmiri homes got a new makeover as well which though provided more comfort in terms of circulation, compromised greatly on the insulation aspect of building construction which is a basic requirement in Kashmir. The paper is organized as follows. Firstly it sheds light on the traditional aspect of building insulation in the valley followed by the present day scenario of building insulation. Lastly we discuss the various modern alternatives that can be used to ensure proper building insulation. All in all the paper emphasizes on how Kashmir's vernacular construction practices need a comeback of course by incorporating modern construction materials, techniques and approach to develop houses with proper insulation and structural stability as well*

Key Words: **Insulation, R-value, Architecture, Solarium, Fiber glass, Cellulose, Spray foam**

1. INTRODUCTION

Kashmir lies between The Great Himalayas and The Pir Panjal Range with latitudes 32° and 36°N and longitudes 74° and 80°E.The valley experiences moderate climate but weather conditions are unpredictable. The winters are very harsh with the lowest temperature recorded being as low as -18°C. Under such circumstances, the need to keep oneself warm becomes more loud and pronounced. Kashmiris resort to many ways to keep themselves warm, be it clothing or food but building insulation is an important issue that is hardly taken care of in Kashmir now due to influence of architectural design of Indian plains.

Traditionally, Kashmiris took the climatic conditions more into account but with the advancement of new constructional techniques and architectural designs, it became a trend to ignore insulation and comfort as compared to the earlier concept of homes. According to a study titled "Financial Evaluation of Different Space Heating Options Used in the Kashmir Valley", published in the International Journal Of Ambient Energy, new buildings are not designed to meet heat conservation requirements. The study found that modern houses in the valley had, "poor insulation levels and loose-fitting doors and windows, thereby contributing to huge heat losses", in turn results in burden on already scarce electrical energy and natural resources.

Thus modern construction though was a right step as it provided structural stability but in a region like Kashmir it becomes more imperative to pay attention to insulation as well for reducing dependence on external source of energy. Hence, we need to find a way to combine modern and traditional architecture to make the houses warmer and provide structural stability as well.

2. TRADITIONAL BUILDING INSULATION METHODS

Building structures have existed since the beginning of human civilization and has influenced many aspects such as economy, politics, science and technology. Kashmiri houses have been known for their structural, aesthetic and thermal qualities since times immemorial. They are a manifestation of architectural systems continuously changing and adapting with regard to the local climate and frequently occurring natural disasters.

Being an epitome of architectural and aesthetic representation, Kashmiri houses were constructed in consonance with the availability of materials and climatic and geographical requirements. Due consideration was given to the location of windows with respect to sun as the direction of house is a natural heat regulator. Traditionally Kashmiris built houses with due consideration to the placement of doors and windows in order to trap maximum solar energy. The windows were

always placed to the south to allow maximum sunlight and block the north from where the cold winds usually blow (direction of winds in Kashmir being North- West).The houses usually had a single entrance and double shuttered windows. The double windows would trap the air column in between and create a barrier from the outside cold/heat.

The size of windows was kept small and the wooden window panels were provided with restricted glass panes in order to minimize the heat loss from the rooms.

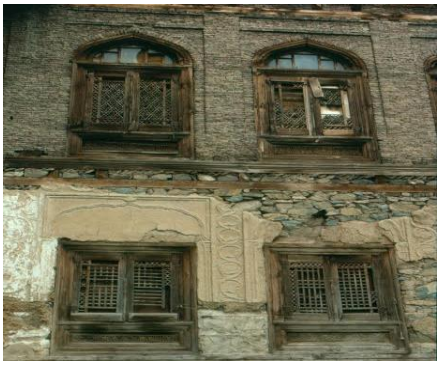

Fig - 1: Heat Loss Minimized By Small Sized Windows

The walls were usually mud plastered in two layers. The outer a few mm layer consisted of a mix of cattail fluff (*Kalrun*) and fine sieved clay (250g of cattail/10sqm) over a coarser base ,1'' thick, of chopped wheat fodder(*Praej)* and mud.[10 Kgs Busa (Chopped wheat fodder per 10 sqm)]

The cattail fluff provided excellent finish and has very good insulation properties.

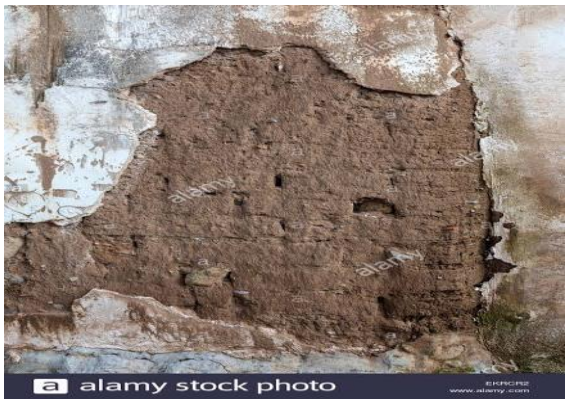

Fig - 2: Old Medieval Plaster

Traditionally the roofing material used was Birch bark provided with a layer of puddle clay above it and studded thickly with bulbs of tulips and lilies. The plants made the building more aesthetically pleasing and also drove away the rodents. In addition to that they would provide extra insulation thus reducing the amount of heating and cooling inside the building. A ceiling made of wood called the *Khatamband* was provided by fitting together precisely crafted small pieces of wood either Deodar or walnut in various geometrical patterns. It also imparted additional insulation to the building as it provided a double layer at ceiling level.

Fig - 3: Living Roofs Made of Birch

3. PRESENT DAY SCENARIO OF BUILDING INSULATION

With the advent of modern architecture and the influence of the Indian sub continental pattern of construction, Traditional Kashmiri architecture and construction techniques became obsolete. It became the order of the day to ignore insulation and take aesthetics more into account. Growing prosperity, showoff and exposure to the metropolitan world lead to Kashmiris demanding marble floors, open lobbies and large glazed windows.

The lobby system in Kashmir has been a complete failure in terms of insulation as there is no possible way to trap the heat. The open space acts as a large flue within a structure. This leads to an increase in demand of electrical heaters, *Kangris,* etc. which in turn leads to an overall increase in costs and puts a lot of pressure on our already scarce resources.

Verandahs have replaced the traditional *daeb* of the valley that used to be a wooden balcony that allowed more light, heat and air to flow in during summers.

The main roofing material that replaced the mud thatch is the Galvanized Iron (GI) sheets. It solves the problem of water proofing but at the cost of insulation.

The old small wooden windows have been replaced with large windows and we often come across houses with more than just one entrance. This leads to frequent heat loss from inside the homes.

4. FUTURE OF THERMAL INSULATION IN KASHMIR

It's the need of the hour to find ways to incorporate traditional techniques in the modern ways to build properly insulated and cost efficient buildings.

4.1. Mapping Out Heat Losses

- Roof /Attic : 25%
- (In house with open lobbies, it can go even upto 60%)
- Windows /Doors: 25%
- Walls : 35%
- Floor : 15%

By using the insulating material, the thermal performance of the building enhances thereby limiting the need for heating and cooling. The type of insulating material used depends on its R value which indicates the resistance to heat flow. The higher the R value the greater the insulating effectiveness.

Table - 1: R Values of Different Insulation Materials

INSULATION VALUES	per 50mm (Approximate value)
INSULATION MATERIAL	**R-VALUE METRIC**
Loose fill	
Fiberglass	0,9
Cellulose	1,2
Mineral/Rock Wool	1,1
Batts	
Fiberglass Standard	1,2
Fiberglass Med High Density	1,4
Mineral /Rock Wool	1,1
Rigid Foam boards	
Expanded Polystyrene	1,4
Extruded Polystyrene	1,7
Isocyanurate	2,4
Spray Foams	
Polyurethane low density	1,3
Polyurethane high density	2,3
Polysocyanurate	2,3
SIP (Structural Insulated Panels)	Per panel
71/2SIP Polystyrene	10,0
81/2SIP Polystyrene	10,0

The lack of proper insulation in the present houses has rendered majority of the buildings in Kashmir deficient in countering the harsh winter. A major source of heat loss from a house is through the roof which is often ignored. The easiest and most cost efficient way to insulate an attic is to add insulating material at the purlin level to stop heat escape through the roof space. Multiple slope roofs need to be analysed as so many failures have occurred in the recent past. The pitch of the roof needs to be steeper in order to permit little accumulation of snow to avert any structural failures.

The other insulation options for an attic include cellulose, fiberglass or spray foam. Cellulose is primarily made of recycled newsprint or denim. It can be either installed as loose fill on the attic floor or as a blown-in material. Cellulose insulation in attic is cheap as compared to other materials. The thermal conductivity of loose-fill cellulose is approximately 40 MW/M·K (R-value: metric R2.6 per 100 mm; imperial R3.8 per inch)}. The thermal conductivity of loose-fill cellulose is approximately same or slightly better than glass wool and rock wool. The University of Colorado School of Architecture and Planning did a study that compared two seemingly identical test structures, one insulated with cellulose and the other with fiberglass. The cellulose insulation lost 26.4% less heat energy over time compared to the fiberglass insulation.

Spray foam insulation, also called spray foam or spray polyurethane foam (SPF) is liquid foam which is sprayed into position and sets into an insulating layer. It can be used to insulate roof, loft, walls, floors, etc.

Spray foam is also class one fire rated for the attic, which means it won't serve as a catalyst if there is a fire. It also doesn't retain water, so it won't promote mildew growth.

The downside of spray foam insulation is that it is more expensive than the other insulation options. There are two types of spray foam:

- Closed cell spray foam
- Open cell spray foam

Open cell foam is lightweight, pliable, and easy to work with, whereas closed cell foam is rigid and very dense. Closed cell spray foam tends to be a better insulator than open cell spray foam. This is because when it sets, it contains lots of separate pockets of gas which slow down the movement of heat through it.

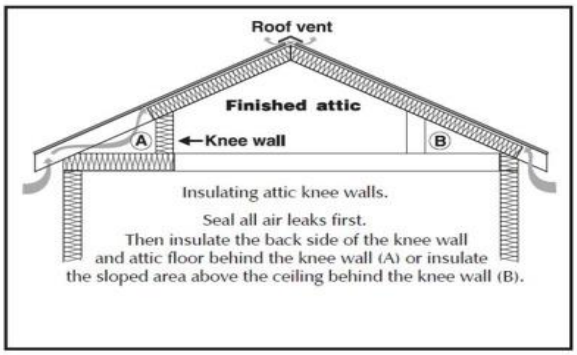

Fig - 3: Insulation Material: Cellulose **Fig- 4:** Diagrammatic Representation Of Roof Insulation

Fig. 5: Attic Insulation by Spray Foam

Walls account for 35% of the total heat loss from the building. There are different ways to insulate the walls. Mud plaster may be applied over the existing walls to increase thermal insulation. Air can be an excellent insulator, that is, to have cavity wall construction. A lot of buildings have been constructed with the masonry brick walls with an air gap of about 25mm-50mm, which provides good insulation.

Wooden panelling / Gyp board incorporated with the insulating material such as thermocol, Styrofoam can also provide excellent insulation. A Recent study conducted by Sikora P. *et al* shows that use of magnetite powder in concrete increases its thermal properties.

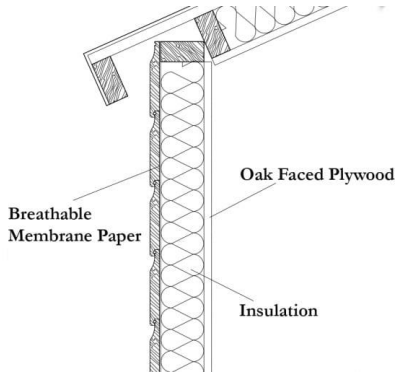

Fig - 6: Diagrammatic Representation of Wall Insulation

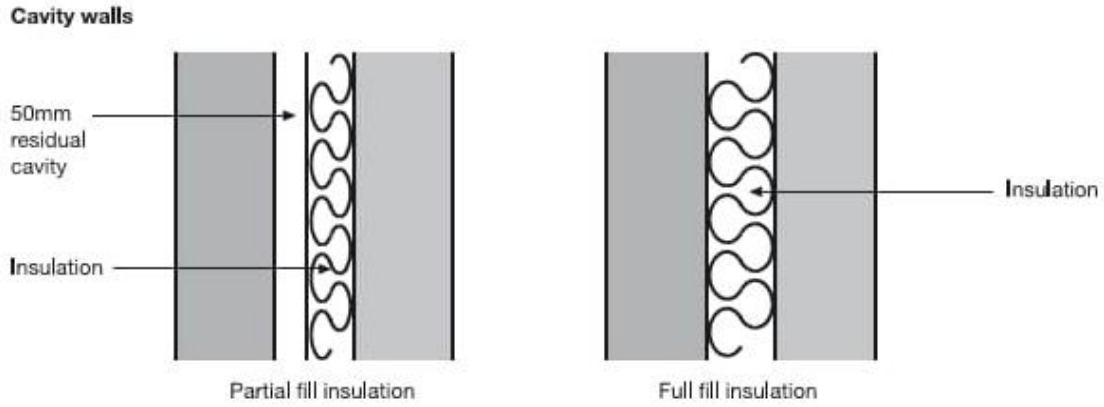

Fig - 7: Cavity Wall Insulation

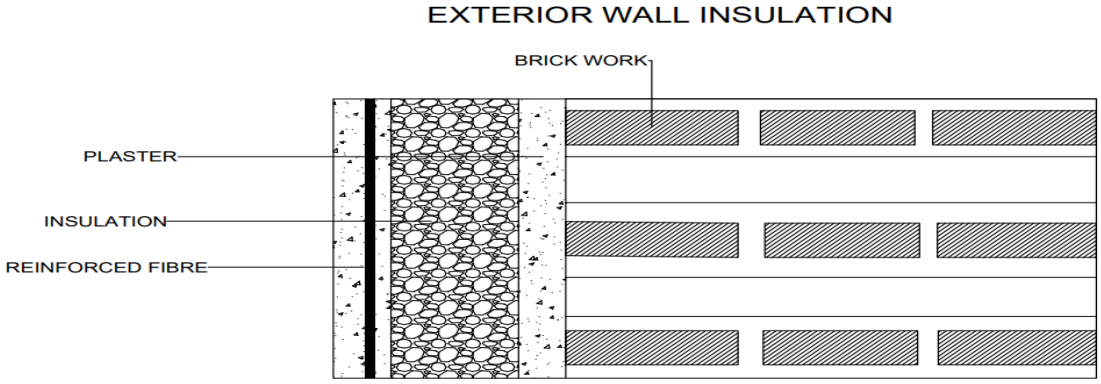

Fig - 8: Diagrammatic Representation of Exterior Wall Insulation

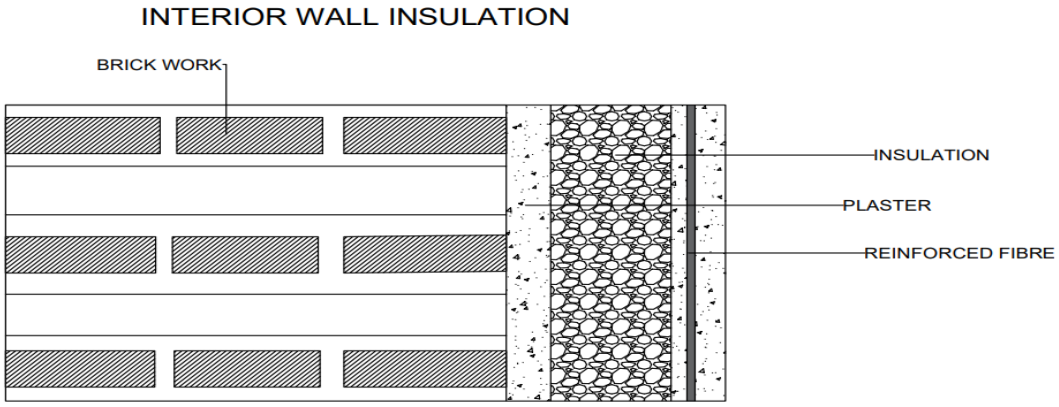

Fig - 9: Diagrammatic Representation of Interior Wall Insulation

Floor accounts for 25% of the heat losses. The insulation material mostly thermocol can be provided below the flooring which enhances the thermal resistance. Floor accounts for 25% of the heat losses. The insulation material mostly thermocol can be provided above the DPC which enhances the thermal resistance.

Windows contribute 25% of the heat loss in our houses. Windows can be insulated using double glasses that will trap the heat. Size and number of windows need to be selected judicially. Fitting of joinery needs to be taken into account while construction.

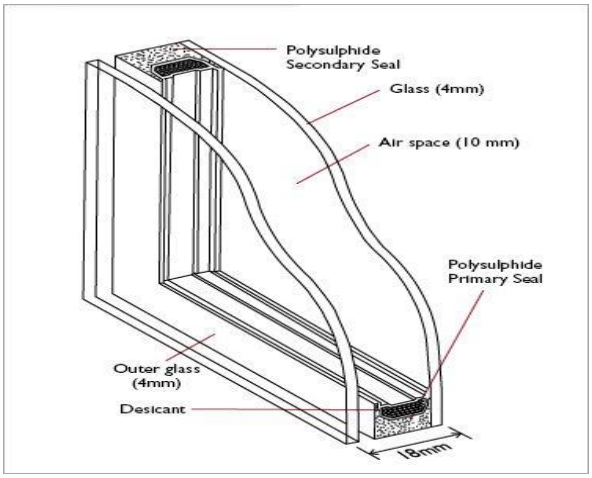

Fig -10: Double Glazed Glass Panel

The verandas can be replaced by Solarium also known as Green House that is a type of sun roof which is made of glass. The main objective is to trap as much sunlight as possible. It stays hot for long hours with good selection of flooring material and wall insulation.

Another way of trapping the solar energy is the Trombe Wall. It consists of south facing masonry wall painted in black to which a glass cover has been added. Solar heat is absorbed by the black surface and it gets into the building slowly through the masonry wall. The vents are provided in the masonry wall to allow circulation of air between the cavity and the room, thus bringing heat into the room during the day.

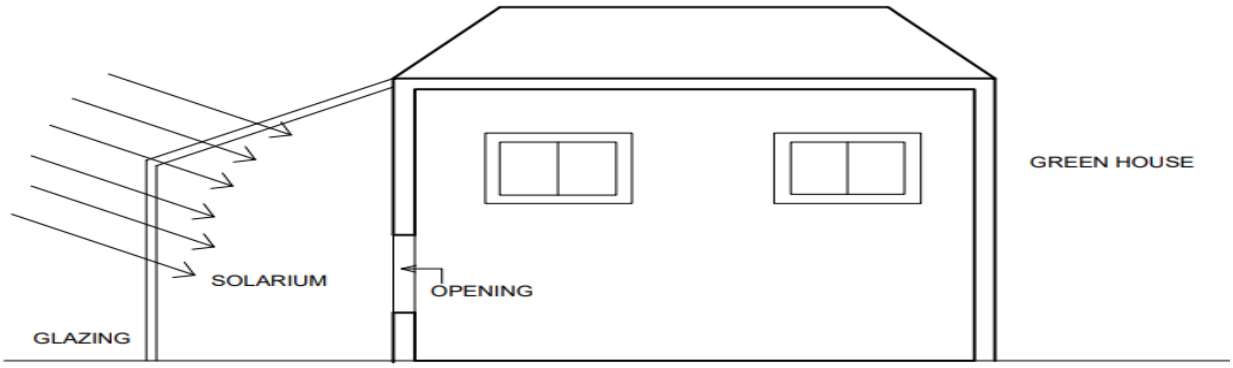

Fig - 11: Solarium

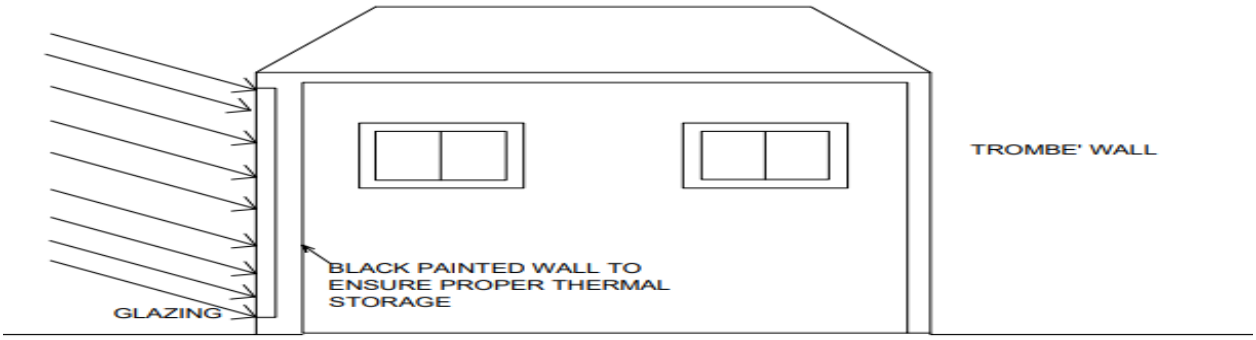

Fig -12: Trombe Wall

Another material that can be used as an insulating material is the Fiberglass, which consists of extremely fine glass fibers. It is available in various size, shapes and types that works best for our homes. Choice should be made such that R-Value is 49 or more. In addition to providing thermal insulation, it also provides fire resistance and acoustic insulation.

Despite its efficient contribution towards insulation, its use is few and far between in Kashmir. One of the reasons for this could be people are less acquainted with this concept. But it's use is spotted in hotels build in Gulmarg, Pahalgam and other regions that entice tourists.

Fig - 13: Insulating Material: Fiberglass

4.2. Solar Energy as the New Energy Proxy

The energy sector is going through different challenges which will get worse with time. J&K, according to the state's economic survey, is presently energy deficient and has to rely on power purchases from outside to meet its requirement. This is particularly true of the winter season, when the demand goes up and generation goes down. The valley gets most of its power from hydropower projects. With the region's rivers at their lowest ebb in winter, the electricity generation also takes a hit. Right now, one of the most significant trends in the energy sector is solar power. It is not only an excellent source of energy but also sustainable and renewable too. It should be known that the efficiency of solar panels is not affected by external temperature. The only thing solar panels require is sunlight. In fact, solar panels seem to perform even better in colder climates. Cold weather prevents solar panels from heating up. However, solar energy remained underutilised in Kashmir. To generate electricity installing solar panels on the rooftops of the houses, Union Ministry Of New And Renewable Energy (MNRE) is providing 40% and 20% subsidy upto 3KW and 10KW respectively. This form of energy, used minimally by residents for heating water, must be popularised in Kashmir because of intensive consumption during the winter season.

Solar water heating uses the radiation from the sun to heat water in a panel often sited on the roof which in turn can supply the heat as hot water. Solar panels should be sited on south facing pitched roof, towards the sun at an angle of 20 to 50 degrees. Automatic adjustable solar panel can be used to trap maximum solar energy in different seasons {Model patented by Main Danish from NIT Hazratbal Srinagar}. Solar collectors have evacuated tubes each with a liquid filled copper conductor inside. A liquid heats up, it rises to the top of the tube where the heat is transferred to the water from cylinder.

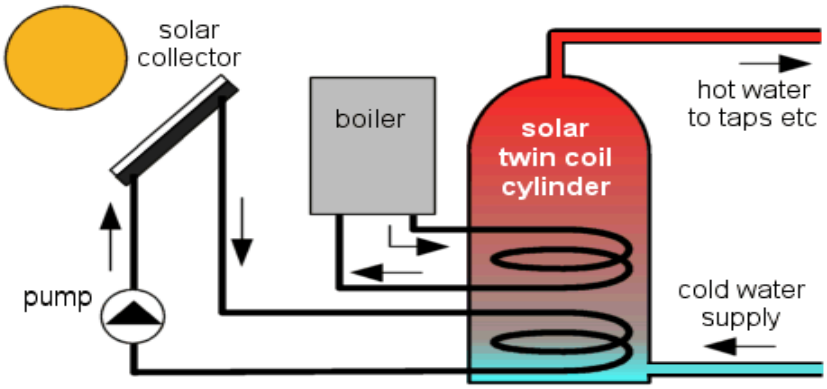

Fig- 14: Solar Water Heater

5. CONCLUSION

To sum up, there is a dire need for improvement in building insulation methods in Kashmir. Strategic construction practices wherein incorporation of tradition and modernity is upheld, needs to be called upon by the Engineers and architects by methods stated. Thus it is concluded by sharing a vision for houses constructed in a way that they are thermally better insulated; so as to result in comfort to the users on one hand and relief to already scarce sources of energy on the other and shall prove economic in the long run as well.

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