External Thermal Insulation Composite System (ETICS) in Japan

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Energy saving is important to prevent global warming. Thermal insulation is a significant energy conservation measure in the construction field. A variety of insulation materials and methods are used for thermal insulation in buildings.
ETICS can be thought of as an excellent insulation method. However, it is widely misunderstood in our country, so its development has been slow. Guidelines for use of ETICS may be insufficient for general acceptance. The author will present some information about ETICS.

Introduction

In this paper the following items are presented.

1. A History of ETICS
2. Characteristics of ETICS
3. Outline of ETICS
4. ETICS in Japan

1. A History of ETICS

•ETICS was first developed in Germany.
•In the 1920s spraying of plaster began.
•In 1922, production of wood fiber insulation board began, and came to be used for external insulation. The thermal conductivity of this wood fiber insulation board was 0.065 ~0.090W/(m•K). The density was 360~600 kg/m^3.
•In 1938 standard DIN 1101 for wood fiber insulation board was established.
•In 1943 standard DIN 1102 for the usage method of wood fiber insulation board was established.
•In the 1950s plaster began to incorporate fibers to prevent cracking. It also began to contain reticulated fibers.
•In the 1950s ETICS became commonly used in silos to prevent dew condensation and to preserve the quality of stored items.
•In 1957, ETICS was applied to housing for the first time.
• In the 1960s, many companies joined the ETICS development industry. The company BASF led the way, with its insulation material, EPS. The thickness of its product was 25~ 50mm.
•In 1969, the standard DIN 4108 for thermal insulation in buildings was applied for the first time.
•In October 1973, the first oil crisis occurred.
• In the 1980s, in spite of encouragement from the government, the use of ETICS in new construction grew only moderately.
•In the 1990s, the advantages of ETICS were recognized and its use spread rapidly. The thickness of the insulation also increased.

2. Characteristics of ETICS

•ETICS developed as a method of covering the outside of a concrete building with thermal insulation material. Recently wood fiber has been added to the list of materials used.
It is as if a building is wearing a coat, so room air temperature won't cool down suddenly when internal heating is turned off. Similarly, the room air temperature won't increase when the air conditioner is turned off.
The fact that the concrete directly faces the room means that the temperature of the room does not fluctuate greatly. This leads to improved thermal comfort.
• In Japan thermal insulation materials have been conventionally used internally. With internal thermal insulation the building is not able to be fully covered. There is a gap where the outside walls and floor meet. This gap is called a thermal bridge and also exists where a veranda meets an outside wall. With the application of ETICS, such thermal bridge problems are solved. The phenomenon called "heat shock" is a harmful unevenness in temperature inside the building. In Japan it is customary to heat each room individually, so a living room or bedroom that is the current center of activity will have a large temperature difference from currently inactive rooms. It is well known that there is a high possibility of a cardiovascular problem caused by a sudden blood pressure change resulting from a sudden and large temperature difference. This situation most often occurs when an elderly person goes from a warm bedroom to an unheated toilet in the middle of the night. When the insulation is on the outside of the building, the building

surface is not directly exposed to the outside air. As a result, the building is protected from temperature changes, solar radiation, wind and rain, and the durability of the building is improved. When comparing the energy saving of ETICS to that of internal thermal insulation, there is the opinion that the heat transmission coefficient is the same by calculation, so there is no difference between them. However, not only heat but water vapor also moves through a building's walls and roofs, so this must be taken into account.

・By applying internal thermal insulation, sometimes vapor condensation occurs at the point of contact between concrete and thermal insulation material. Thermal insulation performance is lowered when the material gets wet.

・It is hot and humid in Japan during summer. In recent years, an increase in indoor humidity and resulting harm from fungi and ticks has been noticed, so there is an urgent need for updating building standards to include this factor.

In most of Europe, unlike Japan, there are no earthquakes. Thus, there are many examples of old buildings being refurbished and kept in use. Even for old buildings built in times when there was no thought of thermal insulation, they also use ETICS refurbishment to increase thermal comfort and extend their lives. In addition, as a secondary effect of adequate ETICS on the outer wall, the sound insulation of the building's outer skin can be dramatically improved. For example, the author of this article received the impression that "the sound of a stethoscope has become easier to listen to than before" from a doctor at a general hospital with ETICS construction.

・In the ETICS, indoor side finishing can be omitted. Because of this , it does not use the adhesive of the wallpaper, so it will not be harmed by volatile organic compounds (VOCs).

3. Outline of ETICS According to European Guidelines

・The configuration of ETICS is shown in Figure 1.

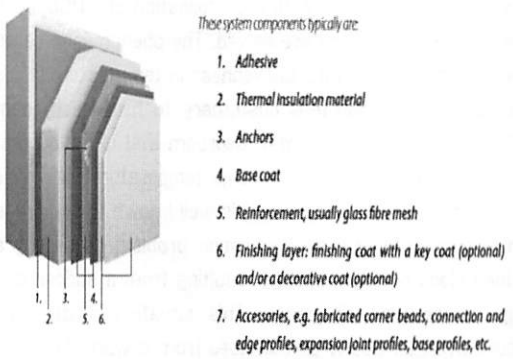


Fig.1 Configuration of ETICS[1)]

・In the corners of window and door apertures, diagonal reinforcements are necessary and should be embedded in the base coat before applying the surface reinforcement, and should be fixed so that the edge of the strip is applied directly to the corner at an angle of approximately 45 degrees . The dimension of the reinforcement strips are usually approximately 200mm X 300mm. Prefabricated mesh elements are also permitted. (Figure 2)

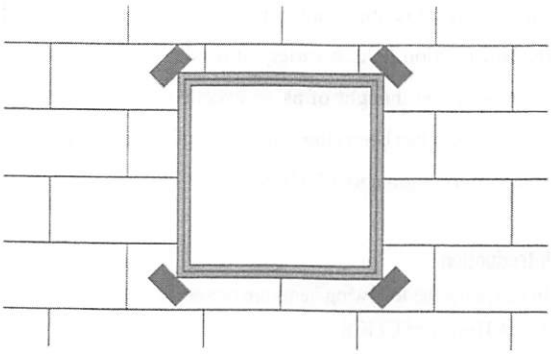
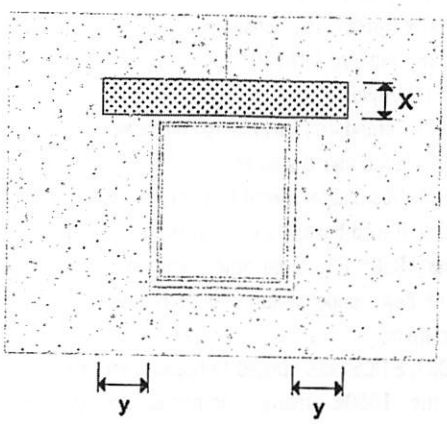


Fig 2 Window Corners[1)]

・To prevent an over flashed fire in a room from spreading to the outside wall, a fire protection transom should be installed. Figure 3 shows its position at the height of the window lintel.



x should be at least 200mm
y should be at least 300mm

Fig.3 Fire Protection Transom[1)]

4. ETICS in Japan

・The Sunshine Project

The author worked at Hermann Rietschel Institute at the Technical University of Berlin from 1971 to 1973. In October of 1973 the first oil shock occurred. The author returned to Japan and joined the "Sunshine Project" founded by the Japanese government. The purpose of this project was to find ways for Japanese people to be less dependent on oil. In the project, an experimental house was built that was able to be heated, cooled, and whose hot water could be supplied by solar energy. The house had to be built highly airtight and with good thermal insulation. The author applied the ETICS he learned while in Berlin to this house.

Fig.-4 shows the building site with ETICS. The thickness of the insulation materials is 10cm.

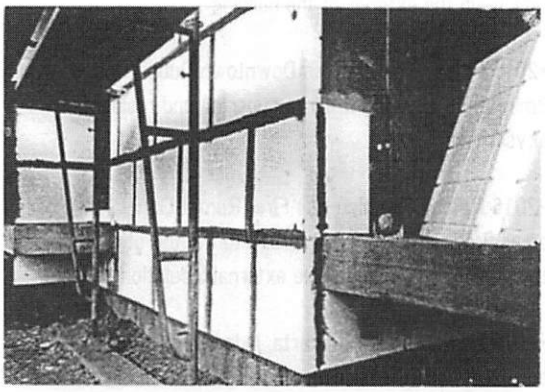


Fig. 4 ETICS for the Sunshine Project

・Tanaka Solar House

The author built a solar house for himself in Tokyo in 1980, applying the ETICS to it. He has lived in this house for more than 37 years without any complications or problems. This solar house is heated and has warm water supplied by solar energy.

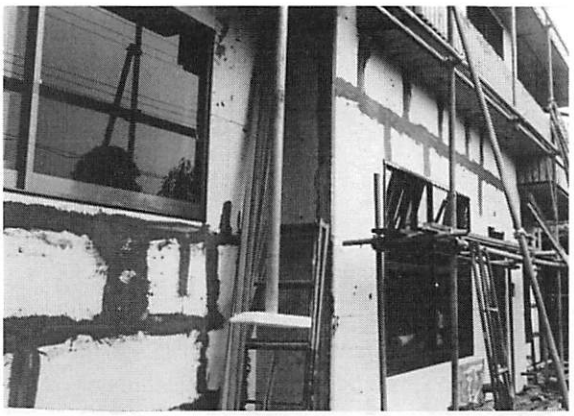


Fig 5 ETICS for a Tanaka Solar House

・ETICS with wooden fiber

The author built a highly airtight and well thermally insulated house in Tokyo in 2015.

High density wooden panels were attached to the external walls.

They were also insulated by an external thermal composite system. The thick wooden fiber boards were attached directly to the outside wall using 70 mm metal nails. Furring strips were not used to attach insulation board. The surface of the wooden fiber boards was coated with a thin adhesive mortar. To prevent cracks, alkali-resistant glass fiber mesh was inserted in the mortar layer. Finally, the surface of the mortar layer was coated with plaster (stucco). Wooden fiber boards were connected by shiplap. This was so that when it rained at the construction site, rainwater could not enter the walls and roof. The corners of the outside walls were covered by plastic profiles to prevent scuffing, such as from bicycle handles.

During production, most building materials, such as plastics, steel, aluminum, glass, and cement discharge a great amount of CO_2. However wood absorbs CO_2 while growing in a forest.

Table 1 Monthly Electric Power Consumption (JAN-JUL 2017)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
Days	31	29	31	30	33	28	30
Elec. Power Consumption (kWh)	444	502	484	376	248	292	358

Table 2 Estimated Monthly Cooling & Heating Power Consumption (JAN-JUL 2017)

C. & H. Power Consumption (kWh)	196	254	236	128	0	44	110
Avg. outside temp. (℃)	5.8	6.9	8.5	14.7	20.0	22.0	27.3
Avg .outside rel. Hum. (%)	53	49	60.	66	72	73	78

Fig.-6 ETICS using Wooden Fiber

Wooden materials, such as wooden fiber board, return to the earth when the house becomes unused. Therefore the application of wooden material is environmentally friendly. In the future, the author believes wood materials must become more common in the construction of houses.

In this house, heating and cooling radiator panels were installed. These do not generate airflow in a room, so this heating and cooling method is more comfortable.

Table-1 shows the power consumption for heating and cooling of this house.

In May there was no heating or cooling consumption. Therefore, this month was used as the baseline of electrical consumption for heating and cooling in other months. Using new heating and cooling technology, the electricity cost became lower.

Conclusion

ETICS also has a large energy saving effect, extending the life of the building. Furthermore, it maintains the comfort of the room. Unfortunately, in Japan the development has been slow. The author hopes that the development of ETICS will be accelerated.

Afterthoughts

There is an alternative construction method that has an aeration layer in the external insulation. In this method, the air layer can create a chimney effect, which is very dangerous in the event of a fire.

It was reported that an external insulation building with an air layer caused a recent fire to get out of control.

・2012 Tamweel Tower Fire (Dubai United Arab Emirates) – The fire spread across dozens of floors via flammable aluminum cladding.

・2014 Lacrosse Tower Fire (Melbourne, Australia) –The fire started on an eighth-floor balcony and took just 11 minutes to travel up 13 floors to the building's roof, spreading via the same type of aluminum composite cladding as was used in the ill-fated Grenfell Tower in London

・2015 Fire at The Marina Torch (Dubai, United Arab Emirates) – a fire spread up the cladding of several dozen stories from the 50th floor to the top of the building. A second fire occurred on 4 August 2017, again spreading rapidly up the exterior of the building

・2015 Fire at The Address Downtown Dubai (United Arab Emirates) – cladding fire in a supertall and residential skyscraper.

・2016 Ramat Gan high-rise Fire (Ramat Gan, Israel) – a small fire in a flat quickly spread to the top of a 13-storey tower block via combustible external insulation paneling

・2016 Neo Soho Fire (Jakarta, Indonesia) – the fire occurred while the building was still under construction and spread rapidly up dozens of floors via flammable cladding.

・2017 The Grenfell Tower Fire (London UK) broke out at the 24-storey apartment building, causing 71 deaths.

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