STRUCTURAL AND ARCHITECTURAL INTEGRATION OF TRANSPARENT INSULATION (TI) IN BUILDING RENOVATION

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ABSTRACT: Residential buildings are an important part of the existing building stock. Solar renovation strategies must cover this class of buildings in order to become successful. This paper summarises the study of Transparent Insulation (TI) for wall heating as a solar renovation strategy for such buildings. Detailed investigations of real renovation projects lead to the identification of structural consequences and to the design of workable solutions. The possibilities and variations for facade design with the latest TI wall heating systems are discussed. The conclusions show that further developments are required that must improve on the integration and renovation aspects, as well as lower the over all costs.
Keywords: TI, Retrofit, Facade integration, Solar wall

1. INTRODUCTION

1.1 Aim of the study

The use of Transparent Insulation (TI) is one more possibility to the thermal renovation concepts of buildings. It is important to find new solutions for this task because the stock of existing buildings is relevant to the energy consumption, and the investments for retrofit activities are rising.

This study has been worked out having in mind the goals of:

- expediting the use of TI in building renovation
- reducing the reservations of architects and owners by proposing possible solutions
- showing actual solutions concerning design and construction on behalf of two buildings
- identifying occurring problems and formulate questions to be followed up.

1.2 Content of the study

Existing residential buildings are the main objects of interest of this study. Conventional buildings have been selected to grant that the results being easily adaptable to many other objects with only slight modifications.

All considerations are made for TI application as solar wall heating systems.

The architectural aspects have been studied on the example of the residential building „Brugghof" in Niederurnen (CH). Some additional investigations in the field of building physics were performed for an apartment building in Hedingen (CH).

2. RESULTS

Different possibilities for the integration of TI were found. Some of the results are presented in a short summary.

2.1 Selection of the object

It is very important to investigate the suitability for TI application of the buildings to be renovated. By a list of criteria, inappropriate buildings can be identified at once. The following parameters have the main effects on the suitability:

- Location of the building
- Orientation of the facade
- Shading of the facade due to nearby objects
- Internal thermal loads
- Existing wall insulation
- Density of the outer wall

At the actual price level, the optimal solution is achieved with efficient systems on south oriented facades. Many of the residential buildings with east-west oriented main facades are suited for TI application on the (smaller) south facade. The integration of TI on south oriented main facade is often more difficult due to larger windows and balconies.

2.2 Design options

The TI wall elements leave a broad variety of options for colours and formal design. Different frame materials in every colour are possible and the colours of the absorbers can be varied within certain limits. However, an interesting facade design can be attained mainly by means of facade division.

Two different shading systems for overheating protection are available at the moment:

- Movable lamella or fabric blinds
- Fixed lamellas

The movable devices allow a maximum solar gain while fixed lamellas cause a loss of irradiation on the absorber of about 30 to 40 % during the heating season However, fixed lamellas are better suited for small areas and for window parapets.

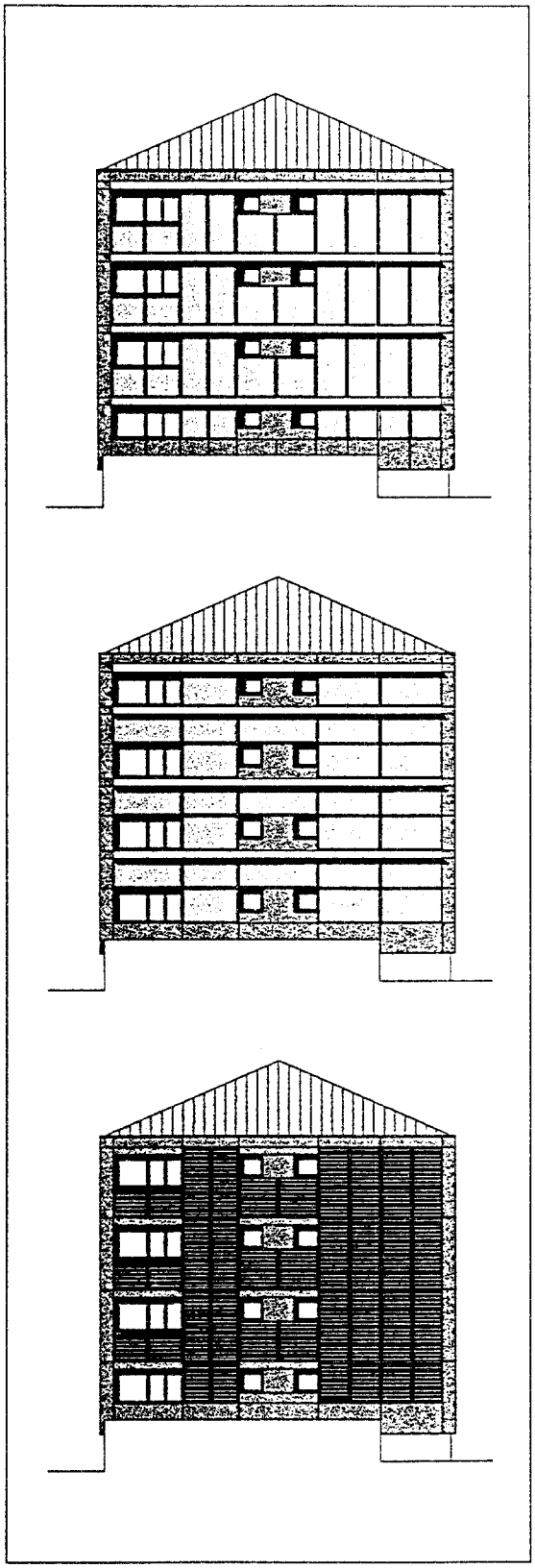

Figure 1: Examples of facade design

2.3 Constructional details

The constructional details are primarily influenced by:

- Shading device
- Fraction of TI on the facade area (whole facade, small parties,...)
- Integration of the windows (window plane, joint to the soffit)

Figure 2 shows an example on how to integrate a window in a TI facade with movable shading.

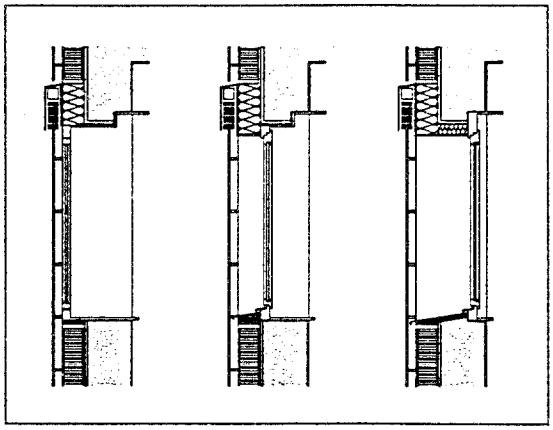

Figure 2: Variant studies of window plane

2.4 Energy and building physics

The analysis of monitoring and simulation results show, that in the Swiss midland a net energy of 250 to 350 MJ/m^2 per heating season can be expected.

However, this study is not concerned with the system aspects but with the effects of construction and design on buildings. The important points that need detailed consideration from the building physics point of view are:

- Crack occurrence in the wall due to thermal stress that effects the interior.
- Lacking dilatation in cavity brick walls or other thermally fast responding outer walls.

For regular facades, TI wall elements with integrated absorber result in an increase of temperature swing of only about 10°K compared to the bare wall. The maximum surface temperature rises, in fact, but so is the minimum temperature. It is important however, that the whole facade (that is transparent and opaque parts) is insulated at the same time to prevent higher thermal gradients.

3. NEED FOR FURTHER INVESTIGATIONS

3.1 System development

Today, the TI wall element system SolFas from Eternit AG/Ernst Schweizer AG is available. First projects with the composite insulation system from STO AG will be realised in Switzerland, soon.

To achieve a dissemination of the technology and to widen the design options, it is necessary to have different products of several companies on the market.

For further development, the following aspects seem important:

- More cost effective TI wall systems (that is by use of other materials or material combinations, e.g. wood/metal frame systems).

- Additional work at the building site must be taken more into account in systems developments and have to be standardised.
- Energy pay back time has to be considered more.
- Other ways for the overheating protection, especially for small areas (e.g. window parapets) have to be investigated (e.g. by ventilation of air void).

3.2. Planing

For an efficient planning, easy to use tools are required. Complicated building simulation is too expensive and too time consuming to be used as a standard planning tool. Therefore it is important that:

- Buildings with TI application will be evaluated and that the results will be made available to potential users.
- The impact on energy savings from TI wall heating should be integrated in a simple way in the standardised calculations of energy consumption (e.g. SIA 380/1 for Switzerland).

3.3 User's influence

Today's experiences with TI applications in Switzerland are more or less restricted to small buildings inhabited by interested persons. To expand the application of TI in Switzerland considerably, it is compulsory to realise apartment building projects. The inhabitants of these buildings, however, may not be interested in energy issues at all. Therefore, it is important to know more about the acceptance of TI wall heating systems in practice. Knowledge can be gained by monitoring realised objects and by survey the attitudes of the inhabitants of such buildings.

Key questions are how inhabitants use the improved comfort (higher wall surface temperatures), the position of furniture, the individual thermostat setting, the ventilation strategy and the operation of the window-combined TI wall shading systems.

4. REFERENCES

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