INSULATION OF A MIXED USE BUILDING WITH 7 STOREYS IN MUNICH WITH VIP

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Theme 3: VIPs in Practice - Industry Needs and Case Studies

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figure 1: The building from the Seitzstraße (Foto: Sascha Kletzsch, München)

Abstract:

The building in the Seitzstraße, Munich, is the first building over two storeys and also the first privately financed building to be insulated entirely with vacuum paneels. The high real estate prices in this part of Munich as well as the wish of the client to build to a very low energy standard made VIP economically advantageous. By combining 2cm VIP with a polyurethane render insulation system the thickness of insulation was reduced by half and 50 m² of useable floor area was gained. VIP was also used on the roof terraces to reduce the step between inside and outside. In some areas of the fenestration VIP was integrated between window panes, resulting in a very thin high performance facade. The building was completed in 2005 an has won the German Builing Physics Prize (Bauphysikpreis), the Bavarian Energy Prize and the Dena (German Energy Agency) Prize. Thermographic photographs taken recently show that to date none of the panels has been damaged.

This article focuses on the practical aspects and problems involved in the application of VIP in the building industry from the point of view of the user: the client, the architect and the building worker and with particualr reference to experience gathered on this project.

Decisive Factors in Choosing VIP:

Beyond the economic considerations and the maximisation of useable space, other less obvious factors played a surprisingly important role. These included psycholgical factors and idealism on the part of the client. Other potentially relevant factors include aesthetics, listed buildings, solar gain, and complex but energy saving building forms.

Economic Viability of VIP:
VIP is economically viable where a restriction on the building size and a good energy standard are paired with high real estate prices and/or building costs. This situation applies to ever more projects. The paper will present the cost/profit analysis for the project in the Seitzstraße

Construction System and Certification:
The main hurdle for planers is the lack of certified building systems for VIP and the difficulty of fixing the panels adequately. Here the construction with 2 cm VIP held by polyurethane battens and protected by 8 cm expanded polyurethane was developed from an existing certified system and tested for fire-proofing, structural security and heat transfer coefficient.

Planning and Building Process:
VIP lays heavy demands on planers and builders. Careful planning and detailing is necessary. On-site precautions and quality control of the panels are important.

1. INTRODUCTION

The office and apartment building at Seitzstrasse 23 in central Munich shows how an inner city development can save energy, almost reaching the passive house standard, while at the same time maximising the usable space on the site.

The building is particularly innovative in two ways:

- It is the first large building, and also the first privately financed building, to be insulated entirely with vacuum insulation panels (VIPs). These insulate up to 10 times as well as conventional materials. Using these, insulation thicknesses were reduced and the usable floor area was substantially increased.

- It is the first building in central Munich which, despite the shaded site, reaches the „Ultra-Low Energy Standard“ (Heating load 20 kWh/m²a). This far surpasses „low energy“ houses which reach values between 30 and 70 kWh / m²a as well as average Munich office and apartment buildings which use 200-300 kWh/m²a. The building would also reach the passive hosue standard in the UK, where the heating load over the year is approximately three quarters that in Germany.

1.1. Design Characteristics

The requirement for a low energy building proved to be the principal challenge on a site that is heavily overshadowed by tall buildings immediately to the south, east and west. The central idea of the design was to push a compact building form up to the northern edge of the site to free up the corners for long views and maximum solar gain. The architectural form is characterized by this: the lower floors have large corner windows while those on the shaded sides are smaller. The upper floors, with unrestricted solar gain, are freer in form, largely glazed and organized around roof terraces. A future extension on to the northern party wall will result in energy losses falling still further and in the attainment of the “passive house” standard.

The building is a mixed use development with a flexible floor layout. The first three floors are office use, above that residential. There are two underground parking levels. The units are zoned with the rooms on the outside wall grouped around a ring of core service spaces, which in turn are grouped around the two stairwells, one internal, one public.

1.2. Energy efficiency

Energy saving and sustainable elements of the design include:

Urban Design: High density development, inner city site and mixed usage allow for short distances between home and work and an increased efficiency / practicability of public transport. The closed block urban type reduces the surface areas for heat loss.

Building Form:The building is very compact and is zoned into warm and cold areas. The delineation between inside and outside spaces is clear and well insulated.

Solar gain: Where sunlight falls, the building fabric is opened up. Where the building is in shade, the window proportions are smaller.

Building fabric: The building is insulated on the walls and terraces with a VIP system. The windows are triple glazed with a special window frame detail. Cold bridges have been minimized.

Building Services: Ventilation is mechanical with heat exchanger. The air is tempered in summer and winter by ground water, which also cools the offices directly. Heat is provided by a small heat-led combined heat and power unit, the surplus electricity is fed into the grid and accounts for roughly a third of the building needs.

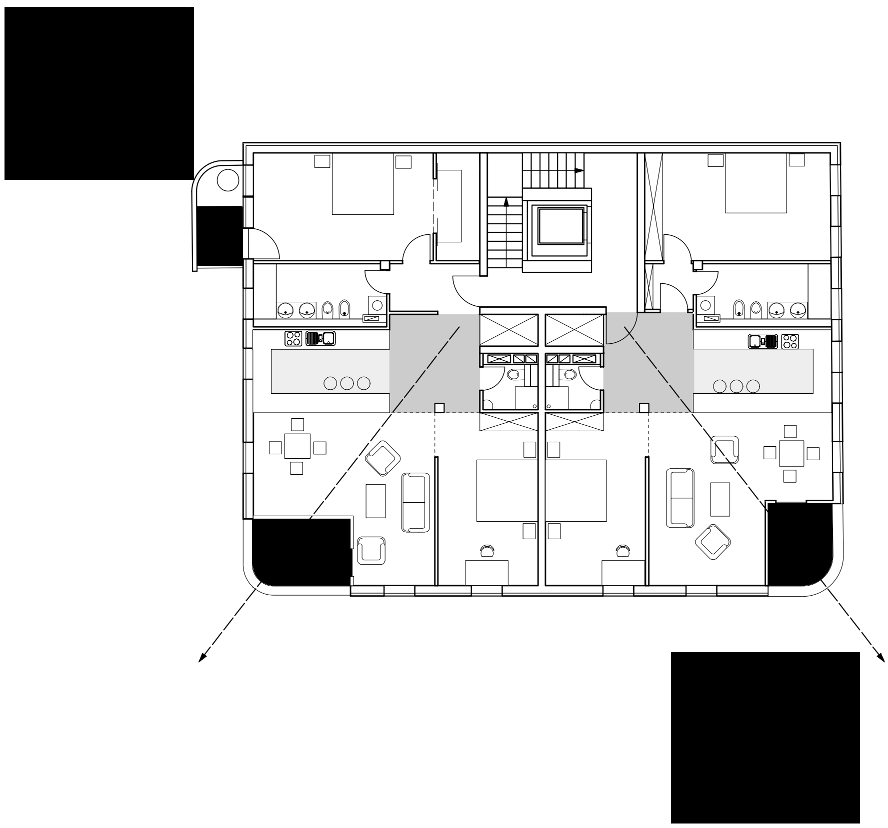

figure 2: The floor plan, apartment, level 3, showing the sight lines.

2. THE VIP SYSTEM

The project is almost entirely clad in vacuum insulation panels. These panels insulate 5 to 10 times better than comparable conventional types of insulation, allowing for much thinner walls on low energy buildings.

figure 3: Building in the vacuum insulation between the purenit battens (source: Hasit, Freising)

2.1. System Development and Certification

Because of the lack of proven systems for VIP, it was necessary to develop a unique and new system and have this certified. This process proved to be the main hurdle since buildings over 3 storeys fall under more demanding regulations. Simpler, more cost effective and more energy efficient systems that we conceived failed above all due to the stringent fireproofing conditions.

The system which in the end was chosen was an adaptation of a render insulation system already certified for timber buildings. This was changed to accept VIP panels and had to be test for fireproofing, structural security and for thermal qualities. Developing an entirely new system would be too expensive and time consuming for use on one single building.

2.2. System Description (The Render Façade)

The final construction was as follows:
VIP with thickness 2 cm in standard sizes 45 x 200 cm, were placed between battens of Purenit (recycled Polyurethane). These were screwed through the vapour barrier into battens laid into the main concrete wall. The covering of 8 cm of Polyurethane insulation was fixed onto the battens and finished with a seamless render façade. The construction thickness is 12 cm, half of an equivalent conventional façade. The system was developed together with the building firm and the product suppliers.

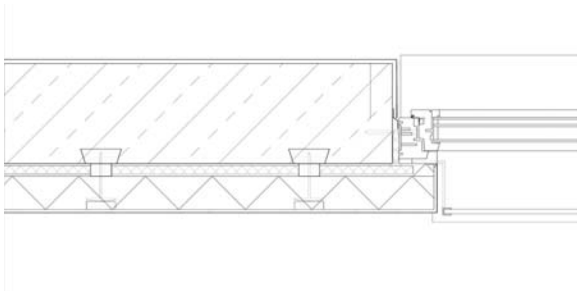

figure 4 Façade construction with insulation at window joint

The decision to cover the VIP with an additional 8 cm of insulation stemmed in part from uncertainty about the life of the VIP elements and in part from practical considerations. As well as being the render carrier, the PUR provides insulation for those cold bridges which are difficult to solve with any discrete panel insulation: the fixings, the joints (especially at windows, see fig.4) and other problem points. In the case of vacuum loss, the panels serve as backup insulation and provide supplementary mechanical fixing for the panels. The PUR lengthens the life of the panels, protecting them from the elements, from thermal strain and mechanical damage.

2.3. System Description (The Window System)

VIPs were also integrated at certain places into the window panels. VIPs were placed between two enamelled glass panes which were then held in a slightly modified timber window frame. At these points the facade has a passive house standard and is merely 3 cm thick.

Figure 5: The project in context (Foto: Sascha Kletzsch, München)

3. RESONS FOR USING VIP

The obvious advantages of these panels are countered by many difficulties, which explain why VIP has not yet found a wider market. Which arguments are decisive will be examined here, with reference to the real design process on this project.

3.1. Economic Factors: Wall

Certainly the main reason for the use of VIP is the maximisation of useable floor area on cramped sites. This is shown impressively in this project. Buildings with the energy standard of this project typically have insulation thicknesses of 25cm. That translates to 1 m² ground area for every 4 m of façade. The façade length here, measured over all upper floors, is around 500 m. The ground area taken up by insulation would thus be around 125 m². This is 10% of the useable floor area or roughly one half of one floor. With a VIP insulation system of theoretically 4cm, virtually all this space can be regained.

The use of VIP has clear economic advantages. These are however subject to a number of restrictions. VIP is viable when:

- The absolute size of the building is limited, e.g. by planning concerns. This is for example less likely to be the case on a green field site. On buildings which are particularly contentious, skyscrapers for example, this is all the more important.

- The energy standard is good enough. The gain in space through a reduction of the insulation of 25 cm is likely to make VIP viable. If however the energy standard only requires 10 cm of insulation, the scope for space gain is going to be much smaller.

- The real estate prices are high enough. Using VIP costs more than conventional insulation. This is paid back by the amount of space gain multiplied by the selling price per square metre.

The cost calculation runs as follows: VIP is viable when

Real Estate Costs / m² Floor Area >

(Extra Cost of VIP/m² Façade) x (Height of one Storey) / (Reduction of Façade Thickness)

This calculation is also dependent on three further factors:

- By how much can façade thickness be reduced? Can the façade be reduced from 25 cm to 4 cm? Or, as in the case of the Seitzstraße, for reasons explained, can it only be reduced to 12 cm? This depends on the technologies available.
- How much does VIP cost me? The material itself costs, say, 100,-€ / m². This will no doubt come down somewhat in the future. The extra cost for fixing the insulation can be, we found, over twice this. With the development of patent systems, this is where the big savings will be made.
- How “long” is the façade? Less compact buildings have a proportionately longer façade. Possible savings are larger here.

On the Seitzstraße project the façade is economically viable as long as the saleable square metre costs more than 3.500 €. In principle, well tested and certified facades can, especially on smaller buildings, be much cheaper than this, making VIP also viable in smaller city centres.

3.2. Economic Factors: Roof

VIP is in its element in the horizontal. It can take pressure, and is fixed by its own weight. It also has an economic advantage: a gain of 25 cm on a 5 storey building will increase room height by 5 cm per floor.

VIP is also used on the Seitzstraße to reduce the step out onto the roof terraces. On low enery buildings this can easily reach 30 cm. Here it was reduced to 12 cm.

3.3. Psychological factors:

Often it is less the hard factors that sway decisions in one direction or the other, but “softer” factors. These were absolutely decisive in the decision to opt for VIP in the Seitzstraße.

Many clients (and architects) do not like the feeling that they are packed in too much insulation. The feeling of “wearing wool in summer” or “living in a thermos flask” is unpleasant. They want to live in a “building that breathes”, even if no modern building actually “breathes”, insulation or not. Thin walls alleviate this feeling.

Also very relevant to the decision in the Seitzstrasse were idealistic factors. The clients were building for themselves and wanted to use the upper floors for their retirement. The decision to build sustainably was essentially an idealistic one, an idea that had been instigated originally by one of their sons. Part of that idealistic vision was not only to save energy with their building, but also, in their willingness to use VIP, to promote future technolgies so that these may come onto the market sooner rather than later.

3.4. Other Factors

Other uses include: insulating cold bridges (eg roll blinds, window reveals), increasing solar gain by minimising window reveals and maintaining the appearance of existing buildings with minimal insulation thicknesses. Finally, the excellent insulation properties of VIP could potentially see a move away from the compact box architecture of the last years towards buildings with complexer forms for closer interaction between inside and outside spaces. This would make high rise accommodation more attractive by offering terraces within taller buildings and by consequence promote a more sustainable, denser urban development. (Pool 2005)

4. OBSTACLES TO VIP

The buidling industry is traditionally slow-moving, conservative and risk-averse. The lack of certified construction systems means that VIP is rarely taken into consideration.

4.1. Certification and Liability

Wtihout certified, that is to say, tested and authorized, construction systems, the planner takes on a lot of extra risk and a lot of extra work. VIP has a limited proven track record and is fragile. Subject to normal building practices, VIP would be punctured before it was built in. It also exacerbates physical problems (eg interstitial condensation) and is itself particularly vulnerable to their consequences. Since certified systems are at present unavailable, planers and builders must, in the absence of other incentives, think carefully about whether they want to take on this uncalculable risk.

4.2. Time and Cost

In the absence of proven systems, clients and planers face uncertain cost and time scales. In the case of the Seitzstraße, passing the necessary tests and getting authorisation took several months and was expensive. The system which had originally been envisaged fell through weeks before the ground floor concrete was to be poured. It was uncertain whether the walls would have to be moved inwards to make place for conventional insulation. These are conditions which would hardly be acceptable on a normal commercial speculative building.

4.3. Local Frameworks

Local frameworks influence the relevance of VIP drastically. In China for example, accomodation is sold as a function of gross area (that is, measured to the outside walls). Here, thinner walls do not mean more saleable area.

5. MAKING THE DECISION FOR VIP

At the end of the day, it is the architect who specifies this or that insulation, just as he might specify this or that waterproof sealing. The client usually has little preference in this matter. Furthermore, since VIP has a big influence on wall thickness and thus on the entire design, VIP must be integrated into the design process very early. The decision for VIP must be made at around the same time as the decisions: steel or concrete, frame or wall building. This differentiates VIP from almost all other building products.

It is, therfore, up to the architect (in Britain also the quantity surveyor) to sell VIP to the client, and this at the beginning of the design process. Up to now there been no incentive to do so.

The VIP industry must work to remove these main disincentives:

- Liability: Reduce the planner's risk by offering a range of certified systems, with technical support and guarantees, in much the same way as the rendered insulation industry does.
- Ensure that VIP does not mean more work for the planner. Firms must provide detail solutions, specifications and accompany the building through the building process. Alternatively, the planner must be in a position to ask for more fees for the extra work, arguing that this is minor price compared to the client advantage..
- Provide more information. Only a small minority of architects have heard of VIP, let alone know the arguments.

6. BUILDING WITH VIP

Building with VIP will take two paths. The one sees VIP hermetically packed into foolproof systems more or less independent of all other built elements. Sandwich panels in curtain walls are a good example of this. The other path sees small well trained specialist firms working flexibly in the context of existing buildings or other trades. (Bindel 2008)

The latter was the case in the Seitzstraße, where the façade was fitted directly on to the concrete core, with all its imperfections. This type places heavy demands on the planning and running of such a building site:

- That the façade had been drawn onto a grid of 1 x 1 m for the purposes of proportion proved a lucky coincidence, since this reduced the number of different panel formats required considerably.
- Extra precision was required on the building core: low tolerances on dimensions and wall straightness.
- Prepararing the concrete core proved to be particularly laborious. The battens which had been lain into the concrete had to be set free, and all irregularities had to be sanded down.

- The façade firm made an accurate survey of the building core as built with a drawing and catalogue of each panel.
- The building itself was protected from the elements during the building process by a light mesh over the scaffolding.
- The panels were delivered well packed and stored awaiting construction in ship containers.
- In the case of the unexpected, panels had to be made to order and shipped quickly to site.
- Each panel was checked with a sensor (va-Q-vip) for loss of vacuum and catalogued electronically before being covered with the protective PUR layer. Virtually no panels were found to have an imperfect vacuum.
- Thermographic studies taken last year show that none of the panels have been damaged, (ZAE 2008)

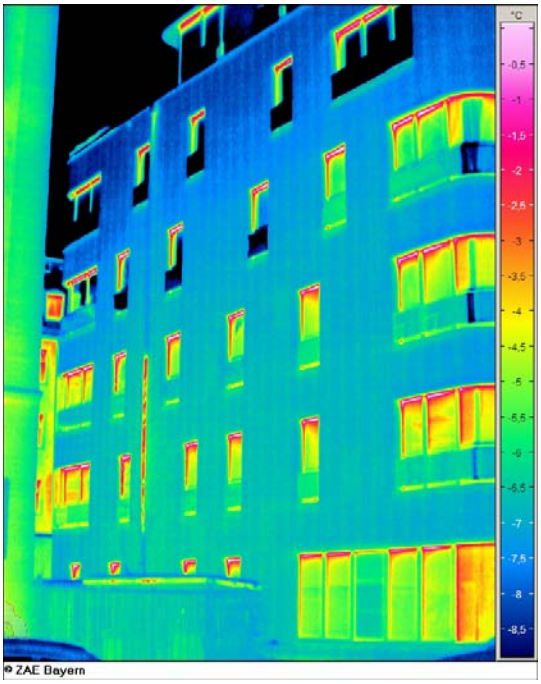

figure 6: Thermography of the building (copyright: ZAE Bayern 2008)

7. CONCLUSION

The project in the Seitzstraße was possible due to an unusual combiation of conditions. In order to reach a wider market, VIP is still too little known. Architects must be persuaded that, for them, VIP does not mean more work and more risk.

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Source: ZAE 2008, The thermographic picture was taken as part of the project VIP-PROVE, Fkz: 0327321 N, sponsored by the German Federal Ministry of the Economy and Technology (BMWi). Copyright ZAE Bayern