WHITE PAPER: Balconies and thermal bridging
Balconies and thermal bridging

Introduction
In the UK balconies are becoming a more common sight in new high rise developments. The move to higher housing densities and the increased use of brownfield sites has meant that many more apartments are built today than as little as four years ago. Over 40% of all new housing built in 2004 are apartments compared with only 17% in 1999.

With present day social and lifestyle changes this trend looks set to continue. However, due to our unique house and garden culture, there is still a desire for immediate access to outdoor space. One way that developers and designers have responded to improve the appeal of their apartments is to add balconies.

The development of balconies
Balconies have been a feature of apartments since multi-storey living first began. Before the widespread use of reinforced concrete, balconies were usually supported on brackets.

Georgian balcony supported on iron brackets
Edwardian balcony supported on large stone brackets
From the 1930s onwards, concrete was the material of choice for balconies. The projecting balcony was usually a direct extension of the floor slab.
Concrete continued to be the material of choice for balconies through the 1950s building boom, right up to the 1970s.

Typical local authority flats of the 1960s

One of the last large scale concrete balcony projects before thermal bridging became an issue
With the stepped improvement in insulation standards over the last 30 years and the increased need to avoid thermal bridging, balcony design has changed again. Some developers still prefer to use concrete due to its whole life durability, but have been deterred because of the previously unsurmountable thermal bridge issue. Many have therefore used steel as an alternative. This is largely a response to constructing balconies without continuous thermal bridging. Although steel conducts heat much more readily than concrete, individual steel sections bolted back to the structure create less of a thermal bridge than a continuous strip of reinforced concrete projecting through the insulation layer. It would be fair to add, however, that steel balconies come with their own set of issues, as shown on the right.

Some of the disadvantages of the metal balcony:
- clumsy detailing of metal support (top)
- corrosion and peeling paint on metalwork (above)
- perforated steel mesh and timber boarded decks (below)
Building Regulations and thermal bridging

The 2002 edition of Part L1 of the Building Regulations states in paragraph 1.30 that “The building fabric should be constructed so that there are no significant thermal bridges or gaps in the insulation layer(s) within the various elements of the fabric . . .”

Unfortunately, the standard reference on detailing to avoid thermal bridging, ‘Limiting thermal bridging and air leakage: Robust construction details for dwellings and similar buildings’ does not contain a balcony detail. However, the message from the Building Regulations is clear, do not bridge the insulation layer. As insulation standards continue to rise, the importance of eliminating thermal bridging becomes even greater.

Testing thermal performance

Various calculation methods are available to assess the performance of thermal bridging. These use finite element analysis to calculate the temperature gradient through a construction under ‘steady state’ conditions. In the UK, the set conditions are usually 20°C internally and 0°C externally. Where the internal surface falls below the dew point temperature there is a risk of condensation and mould growth during the colder months, given the humidity levels often occurring in UK housing.

Halfen has used the TRISCO computer program to develop and test the HIT system (see page 10). The diagrams below show the dramatic difference using the HIT system has on concrete balconies in both cavity insulated walls and externally insulated walls.

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Without balcony slab insulation

<table>
<thead>
<tr>
<th>Outside temperature</th>
<th>Room temperature + 20°C</th>
<th>Relative humidity in the room 60%</th>
<th>Below dew point!</th>
</tr>
</thead>
<tbody>
<tr>
<td>-15°C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With Halfen HIT system

<table>
<thead>
<tr>
<th>Outside temperature</th>
<th>Room temperature + 20°C</th>
<th>Relative humidity in the room 60%</th>
<th>Balcony slab insulation with HIT system reduces heat loss and prevents condensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>-15°C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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80 15 240 5 180 50 180 50

11.1°C

16.8°C

Below dew point!
The condensation risk

Designers and builders have learnt through experience that if the insulation layer is bridged by a projecting concrete balcony, the likely result is condensation and mould on the underside of the concrete slab.

This is an extract from an article by chartered surveyor Peter Fall in the Newcastle Journal:

“Our homeowner this week was suffering from a problem of constant dampness on the wall just below the ceiling above his “balcony” doors. He thought that the water must be leaking through the doorway of the flat above and down into his room. The problem was a little more complex than that. Having checked the doorway above and the upper balcony, we soon found that no matter how much water was played onto the surface of the door upstairs, none of it came through to the flat beneath.

The problem in this instance was the reinforced concrete cantilever balcony. This projected through to the inside face where the warm moist atmosphere of the living room condensed on the plaster finish to the cold reinforced concrete. The reinforced concrete balcony in effect bridged across the thermal insulation to the wall. Hence the expression ‘cold bridging’.

Other considerations

Drainage

Concrete balconies are normally finished with a waterproof membrane and water is usually then directed to a drainage outlet. Alternatively, for smaller balconies, rainwater is sometimes drained away by means of a small overflow pipe or discharged over the front edge.

Steel and timber balconies often have a permeable deck. The deck can be timber decking or steel mesh, which allows water to drip down onto the balconies directly below. This type of ‘open’ deck is unsatisfactory for balconies on lower floors. Not
**Marine environments**

It is no surprise that many coastal developments include balconies to make the most of the views. However, the salt spray in marine environments can be corrosive particularly to steel and, to a lesser extent, concrete.

Certain grades of stainless steel are specified for their corrosion resistance. These are mainly used for balustrading and fixings, but the high cost normally prohibits their use for the structural components of a balcony. Galvanising and other protective coatings are available for structural steel, but most require regular maintenance in order to retain their original appearance.

*Extensive paint peeling on galvanised steel balcony*

In general all concretes for use in a marine environment should be designed to be impermeable with low water cement ratios and be able to withstand the aggressive environment to which they will be subjected. Pulverised Fuel Ash is commonly mixed with Portland Cement in marine specification concretes to produce a more durable concrete that is better able to resist the ingress of chlorides. There is also a wide range of admixtures available for concrete. The effect of the additives and Polyvinyl Acetate (PVA) is to block the large capillary pores in the concrete resulting in lower permeability and a greater resistance to corrosion-inducing chlorides.

**Structural support**

As well as ‘pure’ cantilever balconies, there are many hybrid designs. These include:

- propped balconies, where part of the support is provided by a structurally independent column or wall
- inset balconies, where the balcony has structural support on three sides
- partially inset balconies, where the sides of the balcony are partially supported and partially project from the main facade

It will normally be the overall design and appearance of the building that will dictate the choice of structural design for the balcony.

*Above: a ‘propped’ steel balcony*

*Below: an inset concrete balcony*
Preservation of view
One of the main purposes of a balcony is to take advantage of the view. In order to preserve ‘the view’ from inside the dwelling, the balustrading should offer the minimum of obstruction. Clear glass is an obvious choice where enjoyment of the view is important. Vertical metal balustrading is also commonly used. Horizontal metal framing should not be used because it is too easy to climb.

In all cases the balustrading must comply with the requirements of Building Regulation Approved Document K2: Protection from falling. This sets a minimum height of 1100mm for all ‘guarding’. The guarding must be able to resist a minimum force of 0.74 kN/m at the top edge.

In addition the balustrading must be able to resist a point load equivalent to 50 kgs applied through a 25mm square indent, when applied to the most vulnerable point.
The Halfen HIT system

The Halfen HIT insulated balcony connection is delivered to site, ready assembled in one metre and 200mm long units. The red arrows point to the balcony slab.
The Halfen HIT system – overview

Halfen have developed the HIT insulated balcony connection to enable concrete cantilever balconies to be constructed whilst virtually eliminating thermal transfer.

The drawing below sets out the main components of the HIT system and the site installed reinforcement (shown in pink). In the HIT system, stainless steel reinforcement is shown in green and carbon steel reinforcement is shown in blue.

The compressive, tensile and shear forces of the Halfen HIT insulated balcony connection are carried by the purpose designed steel reinforcement, through the 80mm thick polystyrene ‘thermal break’, back to the main concrete structure of the building.

All the steel reinforcement that passes through the insulation is stainless steel. Not only does this avoid the risk of corrosion from any water draining down the cavity, but the thermal conductivity of stainless steel is about a quarter that of carbon steel. The heat loss through the reinforcement is therefore greatly reduced.

The HIT balcony connection has the following additional benefits:

• Can be used with pre-cast or in-situ concrete balconies
• Suitable for cantilevers of up to 2.5m
• Metre wide units with 200mm wide make-up pieces can be combined to form any length of balcony
• Economic and elegant solution with no waste
Typical balcony options with the HIT system

This page shows simple cantilever balconies. For propped cantilevers or other designs, please consult Halfen Limited.

Stepped threshold, sloping outward, level soffit

Stepped threshold, sloping outward with margin, level soffit

Stepped threshold, sloping inward with margin, stepped and rebated soffit

Stepped threshold, sloping outward, downstand beam with brick shelf angle

Note: In the above illustrations site reinforcement in both balcony and floor slab is omitted for clarity.
Typical balcony detail

Cross section through balcony doors

- **Halfen cast-in channels** provide fixings for balustrading
- **Double glazed door** gives access to balcony
- **Halfen HIT system**
- **‘Soft’ joints**
- **Floating floor** to comply with Approved Document E
- **Suspended ceiling** to comply with Approved Document E
- **Continuity of wall insulation**

Isometric of balcony

- **Floor slab**
- **Balcony slab**

Isometric of metre long HIT unit

- **Polystyrene insulation**
- **Tension bars**
- **Pressure pads**
- **Shear reinforcement**
Installation

In-situ balcony

Installation sequence:
1 site reinforcement placed on formwork - note: longitudinal bars and links are essential
2 HIT elements placed in position - note: tension bars are placed above top steel in slab
3 balcony top steel placed under HIT top steel
4 concrete poured to floor slab and balcony

Pre-cast balcony

Installation sequence:
1 floor slab reinforcement placed on formwork - note: longitudinal bars and links are essential
2 pre-cast balcony placed in position with HIT elements projecting
3 concrete poured to floor slab
Case study – Richmond Gate, Bournemouth

Above: Halfen HIT system and main reinforcement in place

Right: Main slab cast, Halfen HIT polystyrene and balcony slab reinforcement visible

Left: The completed building

Below: Detail of balcony

Structural engineer: Reuby & Stagg
Main contractor: Taylor Woodrow
RC contractor: Byrne Brothers
References

Building Regulations
Approved Document K, Protection from falling, collision and impact
Approved Document L, Conservation of fuel and power

British Standards
BS 6180: 1995 Code of practice for protective barriers in and about buildings