

# THE USE OF ELASTIC INTERLAYERS FOR IMPROVING SOUND INSULATION IN ATTACHED DWELLINGS: FIELD STUDY RESULTS FROM TIMBER FRAME, MASONRY, AND STEEL FRAME APARTMENTS IN THE UK.

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## 1. INTRODUCTION

The benefit of using elastic interlayers for addressing flanking transmission at critical T-junctions has often been investigated over previous decades and continues today. Yet their use was never viable commercially for a mass housing market application, given standard UK wall and floor designs could meet the building regulation requirements, whilst still being the dominant pathway for acoustic transmission. When more stringent regulations were introduced, wall and floor flanking pathways began to dominate on-site performances, limiting potential improvements.

This paper outlines the development and field testing of two mass-market elastic interlayers, for walls and for floors. Both products have repeatedly turned what were adequately performance partitions into the highest performing mass-market walls and floors in the UK, and have acted as a robust safety net to prevent floors and walls that were compromised by poor workmanship from failing Building regulations. Each product has been shortlisted for the 'Housing Product of the Year' in 2009 and 2010.

## 2. BACKGROUND

### 2.1 Regulation changes

During the last ten years, sound insulation performance targets for residential partitions have steadily increased. In England and Wales, Approved Document Part E (ADE) of the Building Regulations 2003 (amended 2004) changed the calculation criteria for airborne measurement from the previous  $D_{nTw}$  criteria to  $D_{nTw} + C_{tr}$ , with minimum airborne levels set at 45 dB (43 dB for refurbishments). It was also stipulated that all new-build housing should have 10% of each site undergo pre-completion acoustic field testing (PCT) to ISO-140 Parts 4 and 7. However, home builders do not have to conduct PCT if they build to standardized 'Robust Detail' wall and floor designs. These have been proven to repeatably and reproducibly meet a minimum target of 48 dB, with a mean result of 50 dB from all 30 application tests, 5 dB above ADE 2003. Further the sustainability document 'the Code for Sustainable Homes' (CSH) introduced in 2006, required further increases in performance levels. To achieve the maximum 4 credits under the CSH, a minimum level of 53 dB must be achieved (for impact, 54 dB  $L'_{nTw}$ ). Although it was introduced initially for new-build social (public) housing, it may

become mandatory for all new-build private housing during the next decade.

### 2.2. Flanking transmission

Consistent achievement of these higher levels is difficult for current wall and floor constructions without the use of either independent linings, or thicker walls/floors than are currently standard constructions. Additionally, with higher partition insulation, flanking noise begins to influence or even become a dominant factor in controlling the achievable level of sound insulation. Previous studies have shown that elastic interlayers placed at wall-floor junctions reduce bending wave flanking transmission, albeit with varying results across the frequency range due to the wave type attenuated (Craik *et al.*, 1995, Crispina *et al.*, 2008). Ruff and Fischer showed that when bitumen-based membranes are used as isolation under lightweight gypsum walls, the wall achieved greater  $R_w$  levels than other elastic interlayers (Ruff *et al.*, 2009).

## 2. DESIGNING ELASTIC INTERLAYERS

Flanking noise accounts for 12 of the 13 basic transmission pathways between attached dwellings, taking place via structural junctions, cavities, or unintentional workmanship errors. Designing elastic interlayers for use in mass-market housing requires the products to meet certain criteria. Isolation solutions developed must firstly be effective, enabling improvements over current partition designs. However, they must be less expensive to the client than alternatives (such as independent wall linings) and readily compatible with current partition designs. Additionally, to maintain current build methods for apartments, any elastic interlayers must be thin, relatively incompressible, and not promote slippage. Finally, they should be sufficiently robust as to ensure correct installation.

## 3. WALL INTERLAYERS: BRIDGESTOP

Prior to 2008, it has not been possible to build lightweight cavity blockwork walls between attached dwellings off raft foundations, due to acoustic transmission flanking across the continual concrete raft. However 70% of all new builds in England & Wales are built using traditional blockwork construction, despite many new builds being built on brownfield sites which may require such raft foundations or gas barriers. As an alternative timber frame or solid walls were often built, which limit the attainable

acoustic performance and build options. Additionally, in attached houses that have continuous vertical cavities up three or more stories, a noticeable drop in wall acoustic performance can be observed from the 2<sup>nd</sup> floor to ground floor of up to 6 dB ( $D_{nT,w} + C_{tr}$ ), attributable to mortar collection on wall ties. Thus a combined effect of transmission through the raft and the mortar bridging can reduce the walls performance by up to 8 dB ( $D_{nT,w} + C_{tr}$ ).

To try and address these issues, a research project was carried out via a joint venture between Icopal Ltd. and the Building Performance Centre (BPC) at Edinburgh Napier University. Early on in the design process, it became apparent that a 3mm bitumen-aluminium composite interlayer alone satisfied the above criteria for mass-market housing. The Icopal Bridgestop system (Figure 1) acts both as an isolator at lower frequencies and as an acoustic dampener for high frequencies. By placing the continuous isolator under each leaf (simplifying installation), there is a doubled isolation effect between wall leaf and support and wall leaf to wall leaf. The issue of mortar droppings forming a bridging pathway between leafs at the base of the cavity is also addressed by a 10 mm recycled foam quilt fixed at the base of the cavity to isolate any mortar accumulation.

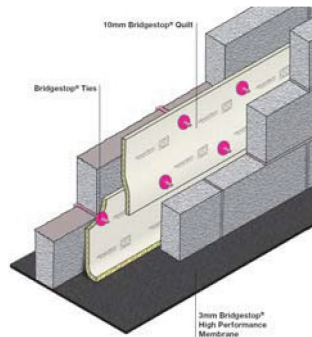


Figure 1 The Bridgestop system

Figure 2 shows the airborne sound insulation results from identical masonry cavity blockwork walls built with Bridgestop (57 dB) and without (49 dB) on a set of row housing in England.

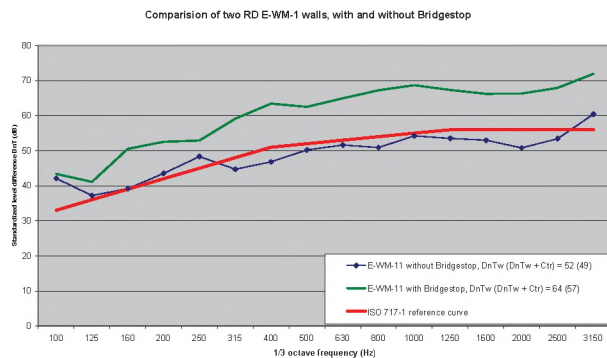


Figure 2 100mm cavity block walls with and without Bridgestop

Early field testing showed that the use of Bridgestop improved airborne sound insulation by an average of ~8 dB ( $D_{nT,w} + C_{tr}$ ) for cavity walls.

After 30 further results, Bridgestop was awarded its own Robust Detail, and became the first wall type to consistently meet the maximum performance targets of the CSH. It also allowed, for the first time since the publication of ADE, the building of cavity blockwork walls of raft foundations, resulting in a groundworks saving to the contractor of ~19%. However, the issue of flanking transmission between partition floors still remained.

#### 4. FLOOR INTERLAYERS: WALL CAP

The Wall Cap membrane used similar Bridgestop technology to isolate the critical acoustic junction between each load-bearing wall head and the separate floor structure. This reduces eight of the twelve acoustic flanking pathways. For the heat-retaining benefits of effectively edge-sealing the cavity from heated air convection, the Wall Cap 400 is fixed to both leaves across the cavity wall and over non-party wall heads.

It has been now been site tested on masonry and steel frame constructions, and laboratory testing for timber frame. For masonry, two clear benefits have been seen. Firstly, direct benefits to airborne and impact sound insulation can be seen on identical-construction plots (150 mm pre-cast concrete slab, 150 mm metal frame ceiling, 40 mm screed), four with Wall Cap and without three without Wall Cap. The plots without Wall Cap got a mean result of 49 dB ( $D_{nT,w} + C_{tr}$ ) and 53  $L'_{nT,w}$ . The plots with Wall Cap got a mean result of 54 dB ( $D_{nT,w} + C_{tr}$ ) and 49  $L'_{nT,w}$ . Secondly, In several separate apartments where the screed had clearly breached through the underscreed to the walls, an event which would normally see a floor failing impact tests, the floors still passed the building regulations of ADE 2003. For Steel Frame, on the eight tests conducted so far on steel-concrete composite RD E-FS-1 floors, which would typically get a mean result < 53 dB ( $D_{nT,w} + C_{tr}$ ), mean airborne results were 58 dB, and mean impact results 45 dB ( $L'_{nT,w}$ ). Its use in steel frame to date has achieved Candidate Robust Details Stage A status. Timber frame sites are still being sought.

#### REFERENCES

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