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Drive to save energy is causing failures

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This has been done with the active participation of the Government, and there has been the launch recently of yet another *save it* type of advertising campaign urging industry and the public to do more to save energy. All timely and appropriate stuff, but the trouble is that the construction industry has not had the time or the money to research its subject nearly well enough. The result is that, far from reducing the number of incidents of building failures, this drive and the techniques which are being adopted to meet its ends, are in some cases causing greater problems for the designer than ever before.

Nor is it possible to obtain a great deal of assistance from the literature on the subject. Most of the construction handbooks and text-books were written before either the majority of buildings came to be heated, or before so much insulation was being added to retain this heat. Since the time of these changes not a lot has been published in the way of a compendium of techniques to cope with them which is not surprising, since much of the development work which has been done, has taken place on site or inside the buildings during the course of construction.

This is a far from satisfactory state of affairs and, in part, explains why the problems in the construction industry are at present undiminished, although we are as a nation constructing fewer new buildings today.

Looking farther afield a search of the literature from abroad is only partially helpful. It is true that the testing and investigation of materials and specifications on the continent is as a rule much more rigorous than that in the UK. (Compare DIN standards with British Standards for instance). But the continental climate is so different to the UK's, that the usefulness of these is somewhat questionable.

For instance being a northern European climate as opposed to a central European one, the wind velocities are considerably higher in the UK and although European winters are colder than ours, our maritime situation tends to ensure that the weather changes more rapidly here than in continental countries (and more rapidly than our buildings can keep up with). The end result is that they get out of step with these changes which leads to mist on the outside and condensation, (among other things), on the inside. Worse still, because of the presence of the insulation, the external envelope becomes more susceptible to the extremes of the weather since the insulation keeps the heat generated inside from leaking out, and helping to clear up the condensation, i.e. interstitial condensation in the internals of the construction, hidden away where it can cause acute problems, and yet not be visible to be corrected.

During the course of the last 20 years or so, two major conceptual changes have come about in the way we treat our buildings. One is that as a general rule, most buildings in the UK are now meaningfully heated, and the second is that having generated (and paid for) this heat, building owners are going to some considerable lengths to make the most of it; to preserve as much heat inside the buildings and to make it last as long as possible.

It is not inappropriate for a Scot to comment upon this since these conditions are a great deal worse in Scotland. (It costs on average 25 per cent more to heat the equivalent house in Scotland than one in the Home Counties). Thus problems are likely to be encountered much sooner north of the border, than in the south.

Real examples are not hard to find, university staff are in constant demand to help sort them out and they not only appear in nearly every form of construction but also in nearly every element: walls, floor, and roofs.

It is not necessary or even possible to generalise. The problems abound, which makes it all the more difficult to identify simple root causes, and thereby offer constructive advice.

To add to this catalogue of woe some construction systems manifestly cannot be guaranteed to be free from these problems – ever.

Examples of these are pitched roofs with insulation between ceiling joists only, and without insulation on the rear of the underslating felt. This frequently leads to quite severe condensation problems in Scotland. Venting the space can even make matters worse by introducing very cold air at eaves level.

Timber frame construction has come in for some very unfair treatment from the media recently. But there is as nearly always a grain of truth behind these attacks. In this case no matter what the designer does, interstitial condensation can always be predicted to occur in the midst of the insulation by a conventional dew point calculation. If this insulation is fibrous the moisture will be retained against the timber structure where it can do most damage.

Single membrane roofs are not free from this blight either. Early in their use, thin transparent sheets were installed, and looking down through these, drops of moisture have been observed forming on the underside. This gives rise to anxiety over newer roofs which are completely opaque and cannot be inspected so readily. Is the build-up of moisture saturating the insulation just underneath? This problem would be worse, if polystyrene bead board were specified here, since this will take up moisture under these conditions, and again the building owner may not be aware of the reduction in insulation performance until he gets his heating bill months later!

Similar problems in quantity have been experienced on the underside of transparent rigid plastic roofing systems, and metal roof sheets.

Much has recently been made of risk management in construction, mostly on matters of cost control, and professional indemnity. But many of the construction methods extolled in the high gloss trade literature are not capable of being built without considerable risk of interstitial condensation. One or two if used in buildings housing a "high risk" type of operation cannot be kept permanently condensation free. In itself this may not be calamitous but if the structure is not resistant to heavy wetting on the inside and worse still if the insulation is susceptible to saturation, the problem may rapidly become acute.

It is axiomatic, in this business that there is no point in heating a building unless it is insulated, and of course the corollary is also true, there is no point in insulating a building unless you are going to heat it. Designers who are not confident in this field should either stick to *tried* and *tested* traditional methods of construction, or put this area of their design work into the hards of a specialised consultant.

Although, as mentioned before nearly any method of construction and material is susceptible, there is one fairly general misunderstanding which can be discerned,

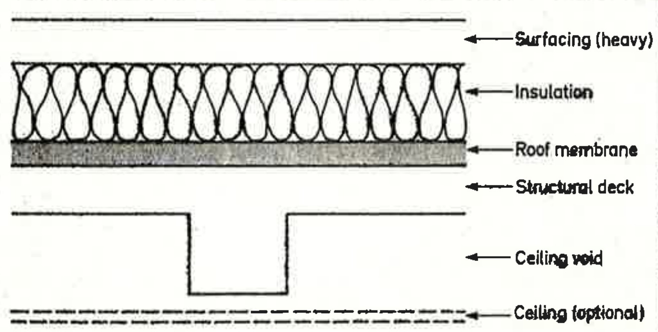

Fig.1. Inverted roof system

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and some advice can be given to help avoid the worst effects of the problem. Total elimination however cannot be guaranteed.

The main difficulty seems to centre upon the change which insulation brings about in the performance of the envelope to which it is attached. Insulation (if it is doing its job properly), will prevent heat from getting from the inside to the outside. (It will also prevent heat from the outside penetrating to the inside, but this is such a rare occurence in the UK that it is hardly worth discussing!). If heat is prevented from escaping to the exterior, the exterior will remain cold, and if that has been specified as on impervious sheet, like aluminium or steel, or similar impermeable skin (which will not let moisture in or out, be it a roof, or a wall or whatever), condensation will form.

Conventional wisdom says that condensation can be limited by introducing a vapour barrier or check, *on the warm side* and venting in between. But in many of these types of construction today, a vapour check is practically impossible to achieve on the warm side. Examples of this are systems where dry linings are held in place by spring clips, or screw fixings or pins or hangers or tee-bars or other similar devices. Dry linings which are not continuous therefore are virtually impossible to vapour check. In addition if the insulation behind is susceptible to moisture pick-up, then it will become very wet and cease to do its job at all.

This also calls into question the ability of the material to meet the function required of it as prescribed in the Building Regulations. Unhappily, they merely require a calculation to be presented or a thickness to be installed. There is no statutory necessity for insulation to continue to do its job throughout the life of the buildings. Thus the client or the building owner is not provided with any reassurance that the building will continuously perform as originally designed.

One bright spot on the horizon is that many authorities will shortly be equipped with the means to verify the continuing performance of thermal insulation. This can be done with thermal guns and imagers which can be used to scan over the building envelope, before an occupation certificate is issued, and again and again while the building is in use; all without having to take the building out of commission.

However, that won't help existing buildings or those at the design and construction stages at present.

Since certain types of construction are very condensation prone, the best advice at the moment is not to use them in buildings where there is likely to be a lot of water vapour or wet processes inside. If, on the other hand, wet processing is unavoidable then it would be better to use a more permeable type of construction, or one in which the dew point occurs right outside on the external face of the building. Examples of this are externally insulated walls or flat or pitched roof covers where the insulation covers or protects the construction, i.e., upside-down roofs. See Fig. 1.

Thin sheeted systems are vey difficult to keep condensation free in our climate, especially on low pitches or shallow roofs.

Vapour barriers

Interior dry lining systems puncture any vapour check wholesale on the inside, and placing them on the outside (where they may be more readily fixed) just behind the sheet only serves to cause condensation on the back of the vapour barrier instead. Ventilation may be of assistance, but not much since accelerating the rate of moisture movement up the back of, say, a steel sheet merely increases the amount of water vapour which is likely to form, and then trickle down. However, some ventilation should be provided because without it, any moisture which does form can only seep back down and escape inside as liquid water. A modicum of ventilation does offer some chance of water vapour escaping before it can do too much damage.

Alternatively, porous materials like brick or block or discontinuous systems like tiles or shiplap cladding not only allow water vapour to escape readily, but can hold on to a certain amount of moisture when the weather is cold and damp, and then let it breathe out again when the weather improves.

Insulation specified for these structures should also be selected with some discrimination. As with the previous systems discussed above it is always safest to use insulation which is not capable of taking up moisture, such as expanded extruded polystyrene. Then no matter how bad the conditions within the structure, at least the insulation will continue to function, and the building will remain warm. But positioning the insulation is not without difficulty either.

Not everybody is sufficiently experienced to grapple with the complexities of external insulation systems. When placed in a traditional cavity wall the dew point falls somewhere within the outer leaf, which although not as safe as construction where the dew point falls outside the wall altogether, may nevertheless be acceptable.

When the insulation is placed on the inside, this must either be extruded expanded polystyrene, or must contain a vapour check, since the inner leaf of the cavity may become damp due to the action of interstitial condensation. Material which requires an extra vapour check is suspect because its fixings usually puncture the whole sandwich in several dozen places. And if they don't, light switches, conduit boxes and service pipes certainly will. Thus once more, the only safe specification is expanded extruded polystyrene adhered to the back of the lining. Only this material is inherently vapour resistant. The grade is important as some formulations have greater densities than others, so be careful to specify the higher vapour resistant variety, somewhere of the order of 800 MNs/gm to be sure of maximum vapour protection.

There are many variants of the thin sheeted system mentioned above, offered by a large number of manufacturers. But the designer would do well to examine a number of successful installations in the following categories:–

(a) for the building type which he is designing;

(b) in a building housing the same kinds of operations which he is contemplating;

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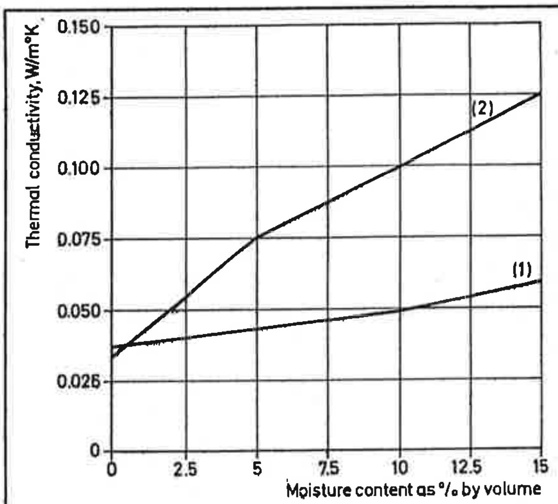

Fig.2.

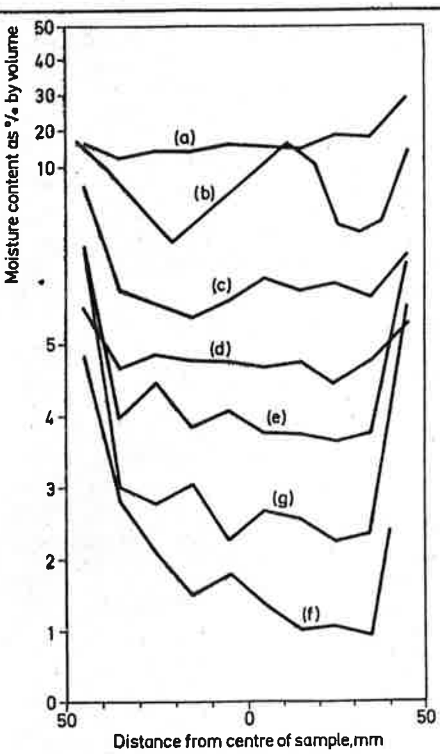

Fig.3. Edge distribution in all materials after 10 freeze-thaw cycles

Key to figure 3
(a) Phenolic foam, 40 kg/m^3
(b) Polyurethane foam, 33.6 kg/m^3
(c) Expanded polystyrene, 14.4 kg/m^3
(d) Expanded polystyrene, 20 kg/m^3
(e) Polyisocyanurate, 49 kg/m^3
(f) Extruded polystyrene, 29.3 kg/m^3
(g) Glass fibre reinforced polyurethane, 41.5 kg/m^3

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(e) in the same local climate and exposure situation which his building is to experience and

(d) in a building utilising a similar heating regime to that which he is planning.

Typical offerings currently are metal clad structures with plasterboard linings laid into some sort of T-bar arrangement and with mineral fibre insulation sandwiched between. The system may or may not contain a vapour check.

It is inevitable, if water vapour is created in any quantity, that the mineral fibre will become wet from the condensation on the inside of the external metal sheet. The presence of a vapour barrier or metal tray or panel will only serve to contain this water for a short while, and the suspension system must be designed to take the extra weight. While all this may not become immediately apparent, Fig. 2 shows that the insulation is not particularly effective during this time. Moisture levels of 14, 18 and 34 per cent have been measured in shallow pitched roofs of this description. These problems were not totally relieved by the introduction of ventilation slots to BS 5268.

Other solutions currently available are the twin metal sheets with polyurethane foam sandwiched in the middle. As Fig. 3 shows, the polyurethane is only effective as long as it remains dry. Should moisture penetrate the system at the edges or ends or through fixings, the urethane will absorb the moisture. This is likely then to become a permanent state of affairs since the metal facings will prevent the urethane from ever drying out.

Similar problems will occur with flat roofing systems which do not have insulation on the top side of the membrane, but which have absorbent insulation on the underside. A vapour proof layer below this insulation must be an effective barrier or the condensation risk will be acute. Care should also be taken to ensure that there is some drainage provision within this sandwich or the whole layer could fill up with water.

There are other questions still surrounding the long term effectiveness of urethane. Insulants like expanded extruded polystyrenes on the other hand have been manufactured in large quantities since the end of the Second World war, and only when urethanes have been in service for a comparable length of time to extruded polystyrene will many of these outstanding queries be satisfactorily answered. □

Condensation and its consequential problems of mould growth persist. Is the builder to blame? The industry may be tired of hearing and reading about it. T builder may be irritated by others blaming him for it. Despite all the words writ and advice given, occupiers continue to experience the unsightliness and distre of mould growth, an inevitable result of continuous condensation. The main culprit currently is said to be the builder. Assuming, fairly or unfairly, that thi so, what can he do to offset this criticism? This article gives some practical remedies both for the builder and user.

Condensation: is the builder to blame?

by Bill Humphreys, ARICS

First, it would be useful to examine the suggestion being canvassed that in new housing the Building Regulations themselves are a contributory factor, and that by compliance the builder introduces conditions conducive to mould growth.

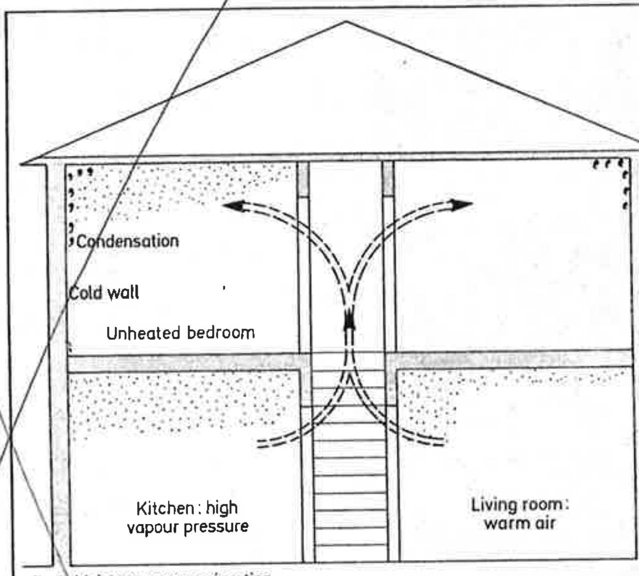

Fig.1. Moisture vapour migration

We are familiar with the changes in traditional construction since the Second World War, but we tend to overlook the consequential changes in the way a structure interacts with the atmosphere. Suspended floors, flues or airbricks in all habitable rooms, and unstripped doors and windows provided ample, if not excessive ventilation in a poorly heated and badly insulated structure. Today the reverse applies – insufficient ventilation in a well insulated structure with adequate heating facilities, even though these are not always fully used. Comfort levels are higher but the penalty is entrapment of large quantities of moisture vapour.

Looking specifically at the Building Regulations 1985, F1 covers 'Means of Ventilation' and is applicable to walls and roofs. F2 covers 'Condensation' but significantly is applicable only to roof voids. Thus the regulations require positive steps to be taken in roof design whereby "reasonable provision shall be made to prevent excessive condensation in a roof void above an insulated ceiling". This requirement is in pitched roofs for exampl cross-ventilation at eaves This recognises that once ventilation is built in, over the occupier does not have trol, it is unlikely to be inter with if only because it doe affect personal comfort level

There is no such requireme deal with condensation withi habitable rooms of a dwelli is required only that "there be means of ventilation so th adequate supply of air ma provided for people in the ing". Adequate means of ve tion, however, does not that the occupier will use because what is provided often consists only of sidehu pivot hung casements. Thes excellent in summer but una able in winter. Facilities fo trolling the amount of venti are usually crude, draughts discomfort result, and in event such windows are lik

About 1.25 million homes in the UK suffer from mould patches like this as a result of persistent condensation.

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