#6745

Insulation plays three key roles – curbing heat loss, muffling sound and retarding fire. Over the next eight pages* Building *looks at developments in each field.

SHADES OF GREEN

Which insulation is greenest? A material recycled from yesterday's paper or a longer lasting mineral fibre that needs more energy to manufacture? Erica Billingham *weighs up the choices.*

PROVIDERS OF social housing are striving to build more energy-efficient houses that are cheaper for their tenants to run.

Insulation is essential for conserving energy, and reduces the amount of carbon dioxide – the principal greenhouse gas responsible for global warming – released when fossil fuels are burned.

Last month, the Housing Corporation published a guide for housing associations called *Energy Efficiency in New Housing*. The Government is also encouraging local authorities to adopt energy-saving measures in their houses with another round of Green House grants this year.

Coupled with the move to energy-efficient housing, clients are now looking more closely at the properties of the insulating materials themselves and their potential impact on the environment.

Environmentally aware clients are avoiding insulants that are manufactured using ozone-depleting CFCs as the blowing agents. This rules out certain types of rigid polyurethane foams, extruded and expanded polystyrene foams and phenolic foams.

However, there seems to be no obvious choice between a variety of other insulants that are being sold on a green ticket. Materials included in this category include recycled paper, mineral fibres, foamed glass and non-CFC-blown expanded polystyrene.

"Some products are greener than others," says Keith Hall, co-author of the *Greener Building* products directory published by the Association for Environment Conscious Building.

He adds: "The problem is there are no strict criteria that any product has to surpass."

One south London housing association has opted for what could be considered the ultimate in green insulation – recycled oversupply newspaper. On the advice of London-based architect and energy consultant ECD, the South London Family Housing Association is insulating 28 new timber-framed homes in Surrey with recycled cellulose fibre as part of its pilot scheme to achieve a maximum energy rating on the Building Research Establishment Environmental Assessment Method.

"We build about 400 homes a year and felt we should be providing greener buildings," says SLFHA project director Paul Onwuanibe.

Green criteria

According to ECD partner Simon Burton, an insulant can be considered green if it satisfies three broad criteria:

- ☐ it must not contain CFC gases
- ☐ its embodied energy (the energy used during manufacture) must be low
- ☐ it must not harm building workers or occupants.

"Recycled paper wins on all counts," claims Burton. "It is CFC free; it has a low embodied energy because it is made from a recycled raw material; and there are no known health hazards. It also costs about the same as mineral fibre insulation."

But there is one major drawback. Recycled paper insulation only has a British Board of Agrément certificate for use in roof spaces. This means that the client – like the SLFHA – rather than the architect is taking the risk when using it to insulate walls.

The manufacturer claims recycled paper insulation is suitable for insulating walls in timber-framed houses, but it cannot be used to fill cavity walls.

"Recycled cellulose fibre is the most environmentally sensitive material," agrees Hall. "But its restricted use is a problem."

Durability is another major disadvantage, according to Hall. The material compresses when it absorbs water and has to be topped up as its thermal resistance decreases.

Cellular glass insulation, according to Hall, ranks second behind recycled paper as an environment friendly insulant. Glass is inert, has minimal effect on the environment and the insulation is expected to last for more than 40 years.

Manufacturers claim the insulation maintains its thermal resistance because it does not absorb any water. It is also fairly easy to dispose of when the building is demolished.

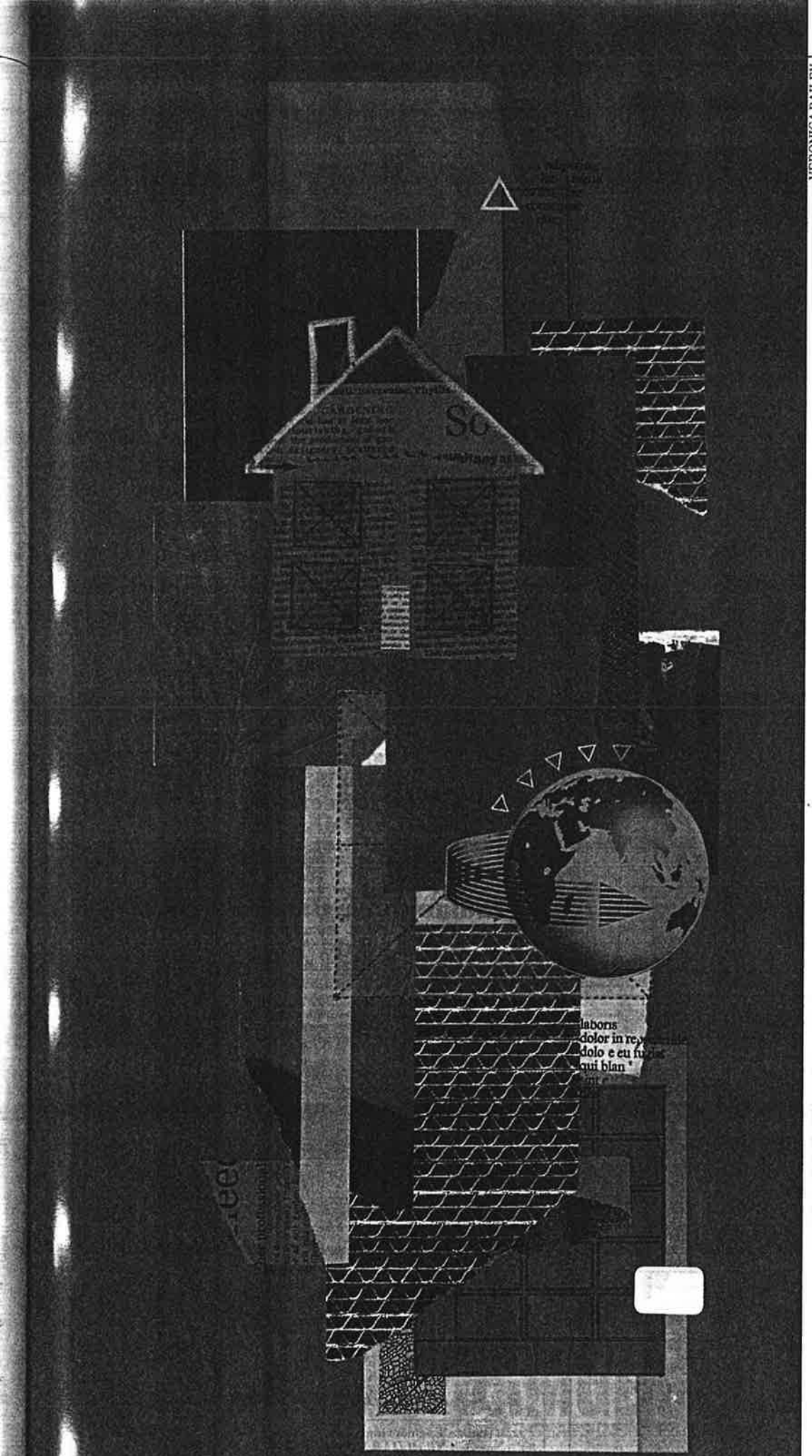
"The problem is its phenomenal cost," says Hall. This tends to limit its application to flat roofs although it is suitable for filling wall cavities.

Mineral fibres, widely used as loft and cavity wall insulation, could pose a health risk when the building is demolished, according to some environmentalists. They claim the adhesive that holds the fibres together deteriorates with age and loose fibres could be released into the air.

"There is concern that when buildings with mineral wool or glass fibre cavity wall insulation are demolished there could be a problem of similar proportions to the asbestos problem," says Hall.

However, mineral fibre insulation manufacturers strongly refute this claim.

On the plus side, the raw



VERONICA BAILEY

materials used to make mineral fibres come from a plentiful – though non-renewable – source and the insulation can also double up as a fire barrier in cavity walls.

Embodied energy – the total amount of energy used to manufacture an insulant, from extracting the raw materials to installing the finished product on site – is another way of assessing a material's effect on the environment.

But measuring embodied energy is difficult since it depends to a large extent on how a material is used, which is why manufacturers often do not quote values for their products.

According to Nigel Howard, a research analyst at the Davis Langdon & Everest Consultancy Group, the embodied energy of recycled paper insulation is estimated to be about one tenth the value of mineral fibre. This, in turn, is generally lower than polymeric insulants, such as expanded polystyrene.

However, not many clients are as strict as the South London Family Housing Association when it comes to choosing insulation materials.

Ian Chapman, design manager at Leicester City Council's technical services department, believes it is important to weigh up the cost of an insulant and the amount of energy it will save against any potential environmental risks.

Last year the council, using a government Green House grant, installed non-CFC blown fibre insulation in the lofts and cavity walls of more than 5000 houses as part of its plan to halve the energy consumption of its entire housing stock by 2025.

The materials and installation used by the council cost about £120 per house.

PASSIVE RESISTANCE

Fire insulation will still be vital no matter how sophisticated active fire protection systems become. Tony Whitehead *looks at the latest developments.*

WITH A few exceptions, the materials used to insulate against fire have changed very little in recent years. Vermiculite cements and fireproof boards have been around since the beginning of the century, and intumescent paints for more than 20 years.

But the world of passive fire protection is not as quiescent as the term suggests.

Technical innovation abounds, though developments are more concerned with how existing materials may be used more effectively, and how their performance may be assessed.

The question of how such passive technology can be complemented by detector systems, sprinklers and other forms of active protection is also the subject of debate.

Most passive fire protection is concerned with structural steel, since concrete, and to some extent timber, structures have a natural fire resistance. Active systems can reduce the requirement for steel insulation from, say, a 40 mm thickness to 30 mm. One leading UK insulation manufacturer estimates that in recent years sales have declined 15% as a result.

Dr Gordon Cooke, of the BRE's Fire Research Station, says this trend is likely to continue – up to a point: "I don't think we will ever get to the stage when we can do away with passive protection. It often deals with a different stage of a fire. But as buildings are becoming larger, more complex and more densely occupied, the more we shall move away from simply prescribing insulation towards fire engineering."

Fire engineering can involve both active and passive protection to help control the course of a fire and the damage it can do. But this multi-faceted approach can place a greater burden on protecting insulation.

Says Cooke: "Buildings are becoming larger, and architecturally more open, so internally there is less compartmentation. That means the compartmentation you do have has to be very good. Fire stops and structural protection also have to be more effective. Passive protection remains vital no matter how sophisticated the building, or the approach to protecting it."

So is current insulation technology up to the job?

There have been some minor developments in the materials themselves, including a type of fireproof glazing made by sandwiching clear intumescent gel between two sheets of glass.

More recently, the US-based Grace Group has launched Monokote in this country, a gypsum-based fireproofing material which contains expanded polystyrene balls. In the event of fire these vaporise leaving voids which boost the material's thermal insulation capacity.

But Cooke believes the biggest changes over the next few years will be the ways in which existing materials are put together: "For instance, steelwork is often sprayed on site which is a messy business. Why should it not be sprayed, with intumescent paint or whatever, in the factory?

"There is scope also for much more prefabrication of composites. Pre-assembled clip-together panels would be faster and easier than turning up on site with mineral wool and protective board."

Cooke also highlights recent design innovations in steel frame construction which can virtually eliminate the need for extra insulation for much of the structural element. Systems like those offered by ConstrucThor and British Steel incorporate precast flooring panels within the structural depth of the steel beams. "This allows the panels themselves to act as a heat sink, preventing the steel becoming hot enough to fail," explains Cooke.

More important perhaps than any single development is

Fire walls that don't bow in an inferno

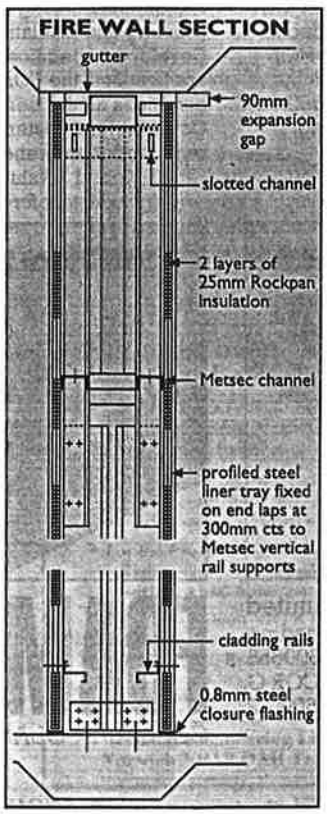
THE GRATTAN warehouse in Bradford is one of the largest in Europe and despite early detection and sprinkler systems, it presented designer Singleton Architects with a particularly challenging fire insulation problem.

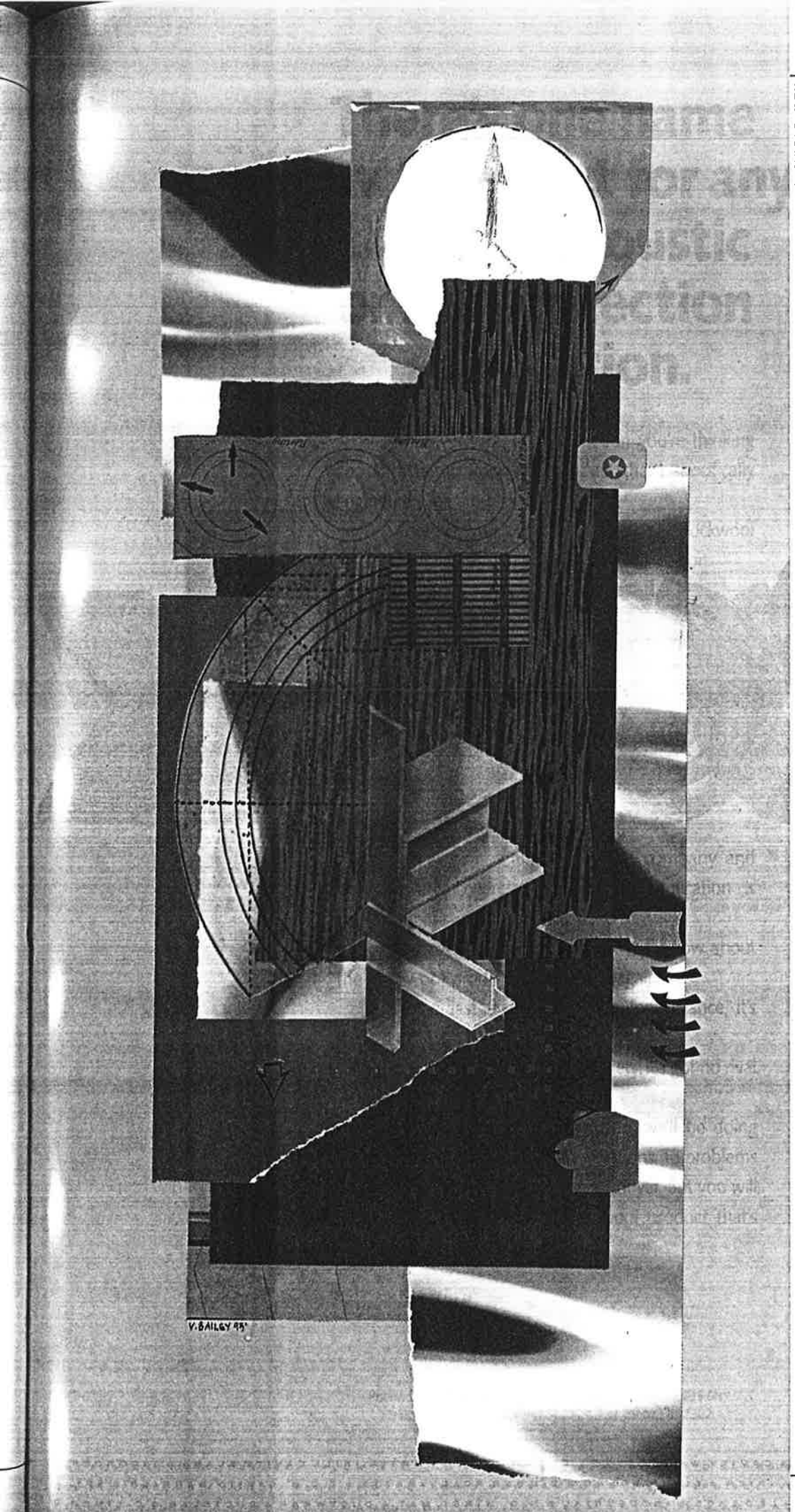
The main building is an 11 m high steel frame construction covering more than 8 ha, and capable of storing goods worth more than £100m. Ideally, warehouses feature large open spaces through which goods can flow, but an easy route for goods tends to mean a similarly easy route for fire. The designer's answer was a new kind of compartment wall.

Separation using four-hour resistance walls was demanded by the building's insurers to limit financial loss in any one compartment to £10m. Block walls, the obvious solution, were not feasible as the subsoil conditions required prohibitively expensive piled foundations.

The solution was a tall, twin-skin lightweight fire wall specially developed for the warehouse by Singleton in conjunction with Dr Ian Smith, of Cox Turner Morse and Partners. It comprises Metsec Z sections spanning 11 m from floor to roof, supporting two layers of 25 mm rockboard with staggered joints. Both faces have corrugated metal cladding and the skins enclose columns and trusses supporting the wall.

Because the hot face of a restrained wall will tend to bow towards a fire, slotted holes fixing the Metsec sections to the roof provide a sliding joint. By significantly reducing restraint, thermal bowing is minimised.





VERONICA BAILEY

the increasing influence of an analytical approach.

He explains that this will be facilitated in part by the advent of structural Eurocodes.

"Currently, UK manufacturers have to test a range of insulation thicknesses on a range of steel sections in a furnace to discover the duration and quality of the protection afforded," says Cooke.

"However, structural Eurocodes will allow insulation thicknesses to be calculated for any section from a knowledge of the basic thermal properties of the insulation involved. It is a more flexible approach, in that answers to unusual section sizes or insulating requirements can be easily calculated. But it means that producers will have to give much more technical information about products."

The prospect of fire protection being determined more by mathematics and less by practical testing has caused alarm among some. But Cooke points out the limitations of existing tests: "Furnace tests follow a standard temperature curve, but real fires follow their own, individual and entirely different curves. In any case, the analytical approach tends to be on the side of safety, more often resulting in thicker, not thinner protection."

Cooke says the approach could be extended to cover the question of whether insulation stays on the structure it is protecting during a fire. He says: "At the moment nobody tries to analyse test results in terms of the expansion and contraction of materials involved. But I think it is possible to calculate the non-compatibility of deformation of materials in a fire – that is whether gaps or cracks will open up in insulation used in certain ways."

WALL OF SOUND

Is fighting sound with sound the future for noise control? James Macneil *hears how active noise technology is slowly being fine-tuned for commercial use.*

NOISE control has traditionally been a passive affair with engineers relying on stiff or absorbent construction materials to stop the passage of sound through buildings.

So it may come as a surprise that engineers are turning to a method that, at its most sophisticated, involves getting structures to vibrate.

Active noise control turns traditional passive acoustic principles on their head. Instead of trying to deaden the sound, it fights fire with fire, cancelling out offending sound with more noise.

To date it has been applied to ships, submarines and sports cars. In construction it has been used to dull sound from generators and fans coming through ducts, but researchers are laying grander plans to use it to stop noise entering through curtain walls.

The theory behind active noise control is simple – fight noise with anti-noise. Sound travels in waves which are a series of air pressure fluctuations. A pressure wave that is the exact opposite to the one creating the sound will cancel it out (see diagram below). A peak in one is cancelled by a trough in the other and vice versa.

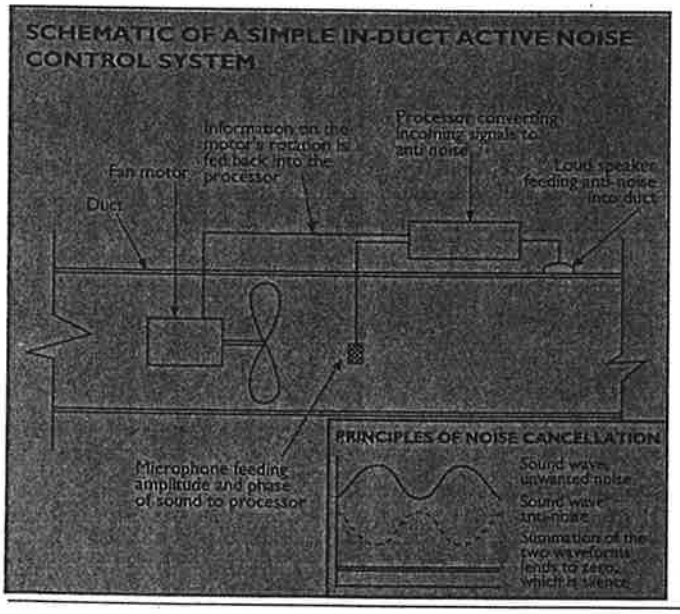
Building acoustics experts have been toying with the idea for 30 years. Says Arup Acoustics' Dr Raf Orlowski: "The reason it didn't take off is because the electronics were not sophisticated enough to produce the anti-sound signal."

One of the main advantages of active noise control is that it is effective with low frequency sounds, such as the deep throb of generators and rotary engines, which are hardest to control with passive techniques. "If you are trying to match a low frequency sound you have a long, well-defined wave length and you can create a clear cancelling signal," says Orlowski.

At higher frequencies the signal is harder to contradict. "The danger with active noise control is that if the anti-noise signal is not exactly the equal and opposite of the noise you will amplify the sound."

The simplest way to produce the opposite pressure pattern is to use a speaker to produce anti-noise. A microphone is placed near the sound source and the signal it receives is sent to a processor. The processor analyses the sound and produces an exact opposite through a speaker further down the noise's path.

This approach has been successfully used where the direction of the sound can be defined. Applications include dulling exhaust, engine and fan noise in confined spaces such as ducts. Alan Fry, technical director of the Salex Group which manufactures active noise control systems through its subsidiary Contranoise, explains: "Dealing with a pure tone on a predictable repetitive basis is quite easy."



Good vibrations

Researchers see potential for active noise control to prevent noise passing through thin walls, such as curtain walling. This requires more sophisticated technology which can cancel out sound waves arriving from more than one direction by vibrating the panel in the right place at the right time to counteract any sound waves hitting it. This would allow noise control without significantly increasing the mass of the cladding.

Researchers at a US university have achieved sound reductions of up to 20 dB in an experimental system. With passive systems the thickness of the wall needs to be doubled for a 5 dB reduction. In this experimental system at the Virginia Polytechnic Institute and State University, vibrations are picked up by sensors built into the panels. The sensors relay information to a computer processing unit which then operates the transducers – the electronic devices that cause the panels to vibrate at the required frequency to cancel the sound.

"With this system all the electronics can be contained within the panel. This is a positive step towards linking it in a building," says Orlowski.

The trick is in the speed with which the vibration is measured and the response calculated. The latest signal processors are fast enough to respond to the wave they measure. But before this can be applied to a building, extremely sophisticated electronics will have to be developed to cope with random traffic noise.

Orlowski expects the system is between five and 10 years away from a commercial application. But it remains to be seen whether an industry that has trouble successfully erecting a standard curtain wall can cope with one that is stacked with sophisticated electronics.

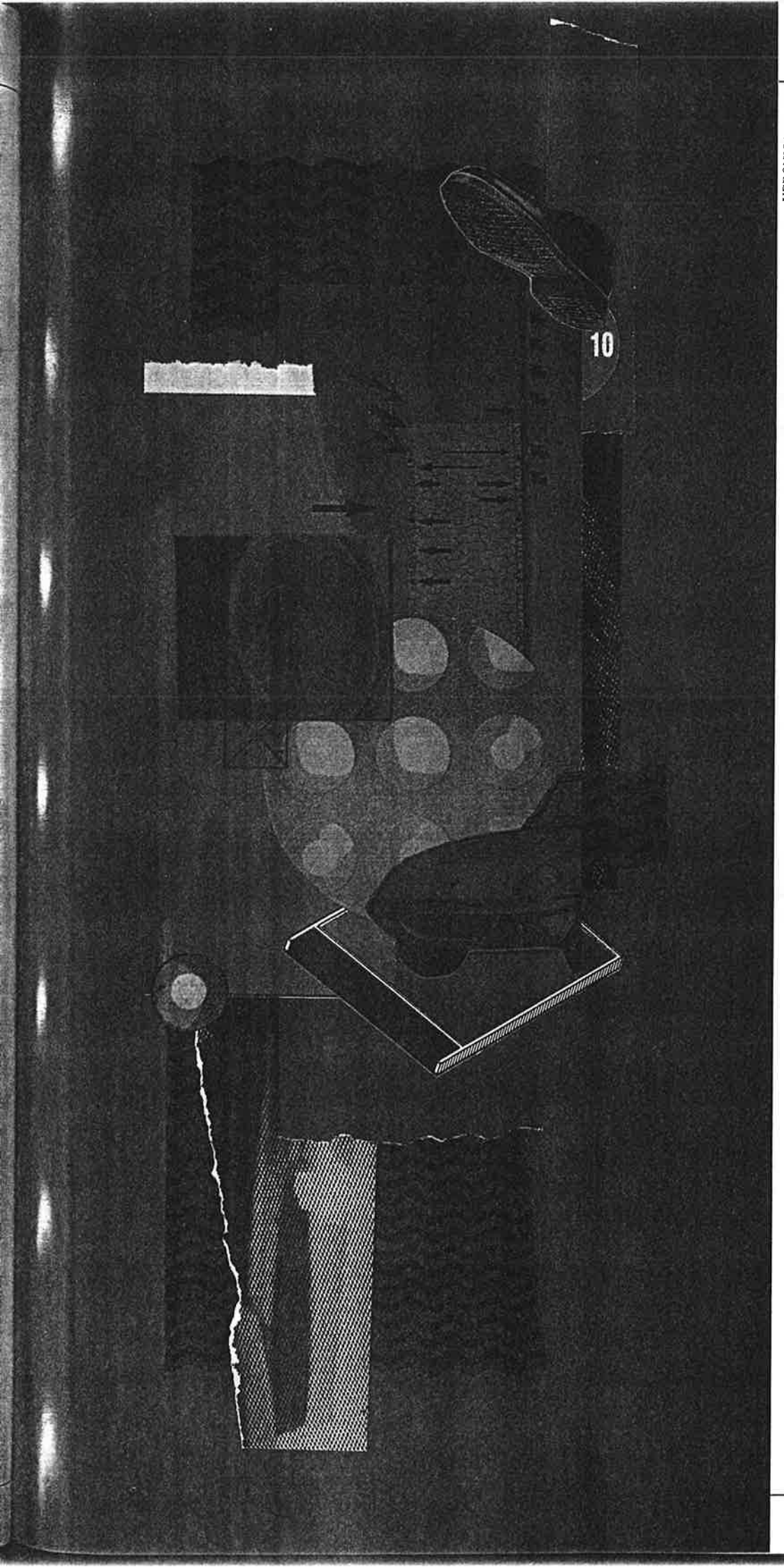
According to Fry, the main application for active noise control will be in remedial works where passive systems have not performed as expected.

But he points out: "It is rarely used in building services. It is still cheaper to incorporate passive techniques in the first instance."

And it is not possible to build an off-the-shelf system. "It has to be sold on a project-by-project basis as each system has to be tailored to its particular application," says Fry. In remedial uses it has the advantage of being able to be fitted without shutting down the equipment generating the noise.

Trying to control noise in larger spaces such as rooms is also still beyond the capabilities of the technology because it is so difficult to predict the passage of the sound waves.

"The sound can go anywhere and it will not necessarily be repetitive or predictable," says Orlowski. Although not commercially viable in large rooms, systems have been developed for more compact areas such as sports cars (see opposite).



VERONICA BAILEY

Ships to sports cars

ACTIVE NOISE control has its origins in maritime engineering. When dual propeller ships were introduced, an engineer came up with the bright idea of turning the engines in the opposite direction. By doing this the vibrations from one engine effectively cancelled those generated by the other, as long as their operation was synchronised.

The MOD has worked on its own active system primarily for submarines. Vibrations from the hull of a submarine can be detected by enemy sonar and researchers have tested active noise control systems as a way of damping vibration beneath the waves. Unfortunately the results of this research are not available to civilian exponents of active noise control.

One glamorous application is using the method to dull engine noise entering the interior of performance cars. Although it is difficult to predict the behaviour of sound waves in a large space, the cabin of a car is small enough for effective noise control.

By careful computer analysis, engineers design an anti-noise pattern which will cancel sound waves arriving in the spaces occupied by the driver's and passenger's heads when they are seated.

A firm called Contranoise worked with a US partner on a system that plays anti-noise through the car stereo system. Lotus uses this to dull the throb of its sports car engines. The rights to the idea have been sold to a Japanese electronics firm.

LOFT INSULATION

Eezi Fit is a range of expanded polystyrene insulation boards designed to speed the decking of loft floors. Based on a 40 mm thick, 900 by 600 mm high density EPS board, the boards from Cemoss are offered in three facing materials: plasterboard, plywood or chipboard. All are rebated and tongued and grooved on two adjacent faces to allow easy fitting between ceiling joists. North London-based Cemoss claims that by using the boards a loft floor can be decked and insulated in less than a day.
Cemoss
► ***Enquiries: 9401***

WARM FLOOR

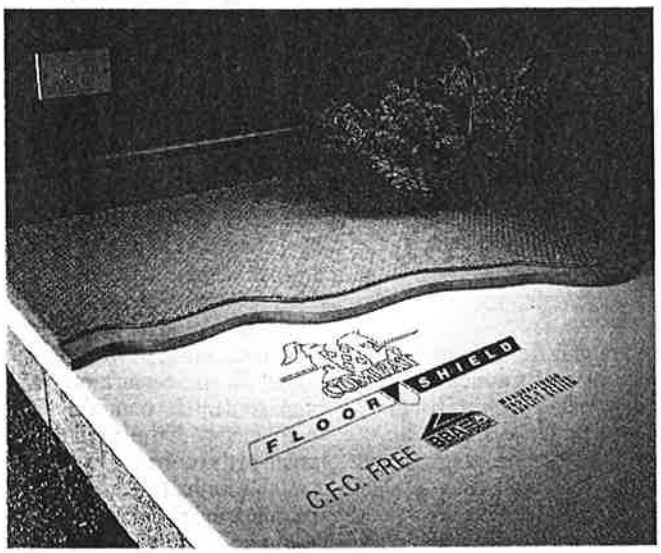
Combat Polystyrene claims its CFC-free Floorshield thermal insulation boards are suitable for a variety of new build and refurbishment applications. The boards can be used over a concrete slab with an intervening dampproof membrane and chipboard or floating screed overlay. Or the dampproof membrane can be laid under the slab with a vapour check between the slab and the boards, which are overlaid with chipboard.
Combat Polystyrene
► ***Enquiries: 9402***

RESIN INTERLAYER

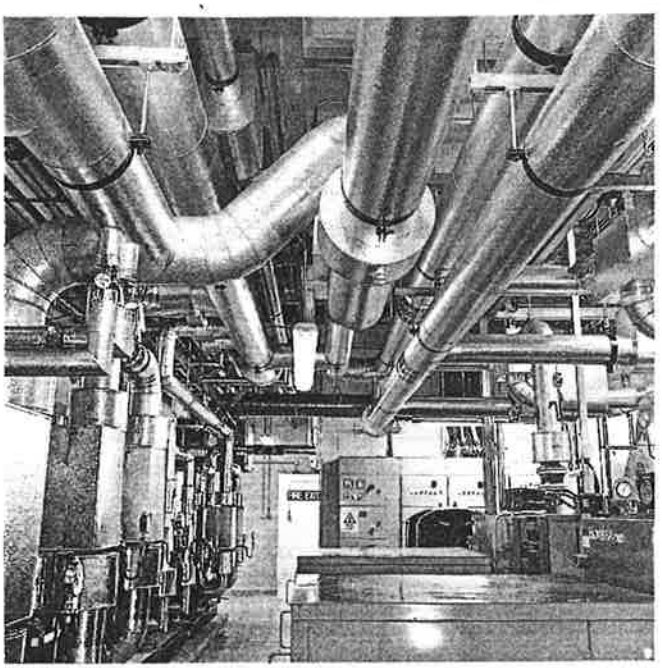
A laminated glass with a special noise-reducing resin interlayer has been added to Glaverbel's acoustic glazing. The product, called GH-PHON, can be used in internal partitions or supplied as doubled-glazed sealed units, where it is said to be ideal for windows or curtain walling in built-up areas. When thermal insulation is a high priority the glazing can be used with a low-emissivity glass.
Glaverbel UK
► ***Enquiries: 9403***

LIGHT TOUCH

Finnish-made Paroc fire proof panels are being introduced to the UK by Hemsec. The lightweight insulation panels were developed by Finnish firm Partek in conjunction with the Technical Research Centre of Finland. The panels can be used in wall, ceiling and roofing applications and consist of a structural mineral wool core between two plastic-coated galvanised steel sheets. Hemsec claims that the modular design will reduce construction time. The Liverpool-based company intends to set up a specialist technical service for architects and specialist contractors.
Hemsec
► ***Enquiries: 9404***



Combat Polystyrene's thermal insulation boards for concrete slabs.



COOL PIPING: Kooltherm Insulation Products has supplied approximately 10 000 m of CFC-free pipe insulation for the Alliance & Leicester IT Centre at Narborough, Leicester. The closed cell, rigid phenolic foam has a k value of 0.02 W/m°C. Kooltherm has completed its range of environment friendly products with K7, a foil-faced sarking board. ***Kooltherm Insulation Products*** ► ***Enquiries: 9405***

HOT AND COLD PIPES

Improved thermal conductivity is claimed for Kingspan's elastomeric pipe insulation. Polyflex Classic is made from an extruded polyethylene foam material which can be used within a temperature range of -50°C to +95°C. It achieves a K value of 0.035 W/mK.
Kingspan
► ***Enquiries: 9406***

KEEP THE WATER OUT

Armstrong World Industries has improved the water resistance of its Class 0 Armaflex CFC-free, flexible, closed cell, elastomeric insulation. It is designed for hot and cold water services, chilled water lines, heating systems, air-conditioning ductwork and refrigerated pipework operating in a -40°C to 105°C temperature range.
Armstrong
► ***Enquiries: 9407***

ROCKWOOL MUFFLERS

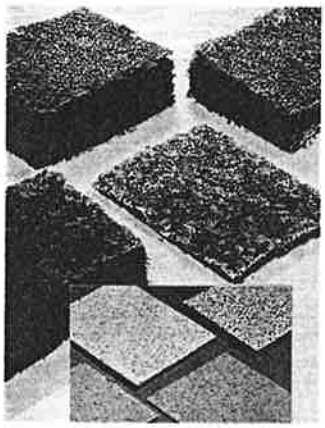
A range of fire protection and noise absorption products fabricated from mineral wool has been introduced by Pyracoustics. Roof and wall barriers, fire stops and cavity barriers are manufactured to specific profiling. The noise absorption products can, claims the firm, achieve any practical acoustic requirements and are available as panels, screens, trough infills and wall lining systems.
Pyracoustic
► ***Enquiries: 9408***

CFC-FREE BOARDS

CFC-free polyurethane foam-based insulation boards called Tempchek have been launched by manufacturer Celotex. Products are available in the range for roofing, wall and floor insulation.
Celotex
► ***Enquiries: 9409***

APERTURE SEAL

Graphite-based intumescent sheet materials for fireproofing pipes, doors and other building elements are available from Tenmat. Included in the selection is a flexible sheet material from 3 to 12 mm thick that can seal apertures left by PVC pipe and cable tray penetrations. Another product, Firefly 102, can be used to produce thin door and jamb sealing strips for timber and steel doors. The seals are waterproof and do not need encasing in PVC sheathing.
Tenmat
► ***Enquiries: 9410***



Tenmat, before and after fire.

RUBBER FLOOR

Sound Service (Oxford) has developed a floating floor insulation material made from recycled vulcanised rubber. Called Isolgomma, it can be used for floors and walls.
Sound Service (Oxford)
Polystyrene
► ***Enquiries: 9411***

NOT BAFFLED

Acoustic baffles from Rockfon have become easier to install since all the fixings have been integrated into the end of the baffle. The new Multi-flex mounting system allows the integration of the baffle on 24-50 mm grids. The baffle can be easily adapted to crosswise and chess-board patterns.
Rockfon
► ***Enquiries: 9412***

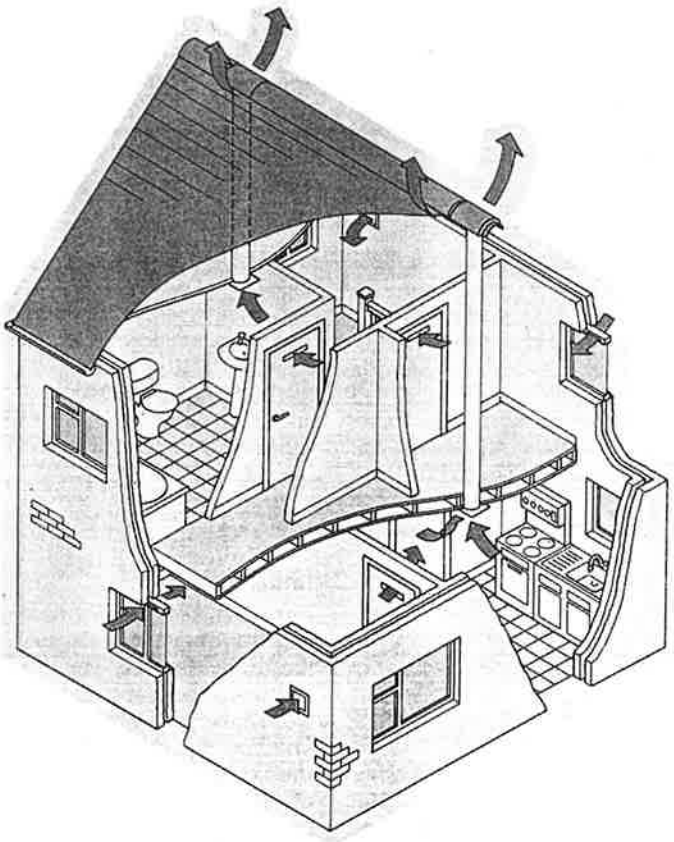
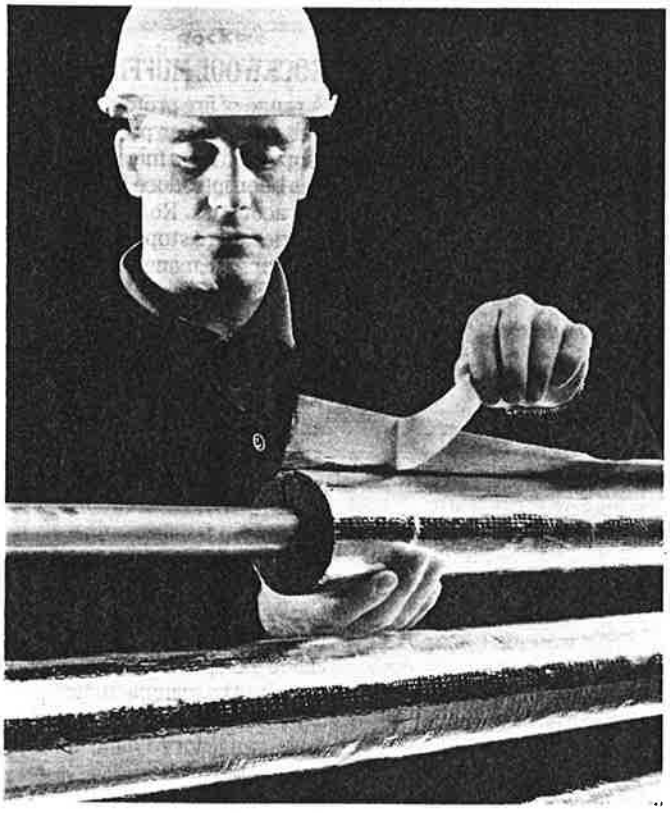


Diagram showing air flow through a house fitted with Willan ventilators.



Rocklap pipework insulation from Rockwood.

FOILED AGAIN

Insulating pipework is said to be simpler and faster using Rocklap 800 H&V Pipe Section from Rockwool. Designed to provide thermal and acoustic insulation for heating, ventilation and air-conditioning pipework, Rocklap comprises a high density Rockwool mineral wool core covered in puncture resistant foil. Rockwool has added Conlit Firestop Systems to its fire protection range. Three stops are available for various joint thicknesses in brickwork and metal profiles.
Rockwool
► ***Enquiries: 9413***

ALL SORTS

Moy Insulation offers a range of insulation products for industrial, commercial and domestic applications. Products for fire, thermal and acoustic insulation are available in any size.
Moy Insulation
► ***Enquiries: 9414***

AIRY BUT QUIET

Willan Building Services' Passivent Acoustically Treated Wall Ventilators can satisfy potentially conflicting sets of regulations on noise insulation and whole house ventilation. The acoustically treated inlets and exhaust pipes can provide air changes required by the Building Regulations without admitting traffic and other external noise.
Willan Building Services
► ***Enquiries: 9415***

CORK AND FOAM BOARD

Korkplus is a composite roof insulation material from Euroroof. It combines natural corkboard locked by impregnation to polyurethane foam. The mechanical strength imparted by the bonding combined with the insulation value of the polymer makes it suitable for high performance roofings and mastic asphalt.
Euroroof
► ***Enquiries: 9416***