NO.86
(1989)

BUILDING RESEARCH ASSOCIATION OF NEW ZEALAND

REPRINT

Thermal Insulation and Contact Resistance in Metal-framed Panels

H. A. Trethowen

Reprinted from **Transactions, Vol 94, Part 2, Ashroe Annual Conference,** Ottawa, June 1988

BUILDING RESEARCH ASSOCIATION OF NEW ZEALAND

OT-88-15-4

THERMAL INSULATION AND CONTACT RESISTANCE IN METAL-FRAMED PANELS

H.A. Trethowen, P.E.
ASHRAE Member

ABSTRACT

This paper is concerned with the heat flows and thermal bridging in metal-framed structures and practical steps to minimize these. It arose from product development work to find economic solutions that meet specified insulation levels. Some strategies for counteracting thermal bridging have been found to be more effective than others. For example, the application of a complete layer of low conductivity material at the boundary of a bridged zone is usually much more effective than use of local thermal breaks. In some cases, the contact resistance between metal and other parts has been found to be a significant factor. Ways to increase these contact resistances have been tested, and these measurements have produced some features that are superficially anomalous but in fact entirely consistent. For example in some joints the insertion of a small thermal insulating break increases the heat flow, as a result of better contact with the metal outweighing the added thermal resistance of the insert. This paper discusses both the strategies for counteracting thermal bridging effects and the observed contact resistances of a range of real metal joints.

INTRODUCTION

The potential of thermal bridging to undermine the insulating value of metal-framed structures has been repeatedly cited (Sasaki 1971; Baktier and Larson 1983). But there are also cases where economical metal-framed structures have been found to produce a thermal performance that is not seriously undermined. This paper is concerned with strategies to reach this latter condition.

The pursuit of this target has indicated that there are at least some cases where the degree of contact resistance between metal parts, or between metal and nonmetal parts, can have a material influence on the overall thermal performance. This has, in turn, led to the realization that there is not a well-developed library of data on the thermal contact resistance of real joints with various inserts (washers, etc). This paper consists of a discussion of some real metal-framed panels and how their thermal performance has been modified. It presents results of a series of measurements of the apparent contact resistance of typical joints and comments on effective strategies for this type of structure.

There is a quite extensive literature on contact resistances between metals, and a particularly useful though older overview is given by Fried (1969). Unfortunately, much of this is not applicable here. For the most part, studies of contact resistance have considered the case of relatively well defined surfaces, usually machined and clean, and have then proceeded to find ways of minimizing the contact resistance. For our purposes, what is required is a relatively rough knowledge of the contact resistance in as-found condition and then to have information about how to maximize this resistance. In this respect, the term "contact resistance" is used with a different meaning than in previous literature.

H.A. Trethowen is Senior Research Engineer, Building Research Association of New Zealand, Wellington, New Zealand.

For practical application, it is also desirable to have some guidance on the degree of contact resistance that should be sought, if indeed it is of interest in a particular case.

CASE HISTORIES WITH METAL-FRAMED STRUCTURES

Five case examples, one with aluminium framing, the other four with steel, are discussed. The construction details are illustrated in Figures 2 to 6.

In each case the measured resistance Rm of the panels is compared to the potential unbridged resistance, called Ro. In most instances, when any insulating material as a complete layer is added in course of developmental trials, the value Ro itself changes, and so the reference condition is not entirely fixed. For convenience, the ratio Rm/Ro is called here the "efficiency" of the thermal break.

The measured thermal resistances of these panels are shown in Table 1. Results for Panel 1 are from Baktier and Larson (1983); all other results are presented here as new data. Panel 2 performance was determined from a scan of surface temperature measurements supplemented by heat flux sensors, with accuracy believed to be within 10%. Results for Panels 3-5 were obtained by guarded hotbox using a meterbox of 1 metre square, assessed as being within 3%. All values were obtained in test conditions close to 20°C warm side and 5°C cold side.

Panel 1. In the simplest form of steel stud shown in Figure 2, the measured R-value (Rm) reported[2] for this panel was 1.17 m^2.°C/W. The unbridged resistance Ro was reported as 2.09 m^2.°C/W . This indicates that the panel achieves an efficiency of 56% of the possible thermal resistance Ro.

Panel 2. The steel framed panel of Figure 3 has a rolled-steel Z-section joist, which also had a ridge formed at both contact edges between steel and facings. The reason for this was not primarily for insulation purposes but to give structural stiffness to the steel members.

The measured R-value (Rm) of Panel 2a was 1.2 m^2.°C/W, a thermal break efficiency of 55% compared to the calculated unbridged Ro of 2.2 m^2.°C/W, based on typical measured conductivity of 0.05 W/m.°C for the insulant. For Panel 2b the R-value increased to 1.85 m^2.°C/W with the addition of steel furring strips, and the thermal break efficiency increased to 77%. The Ro value was also a little higher, 2.4 m^2.°C/W , because of the additional air cavity. Note that the thermal break efficiency of 55% without furring strips is substantially the same as that for the simpler steel stud design of Panel 1.

Panel 3. The panel of Figure 4 was constructed with extruded aluminium framing, which could clip together to connect adjacent panels. The facings were 12 mm gypsum plaster on one side (k= 0.16 W/m.°C) and 6 mm cement board on the other (k= 0.25 W/m.°C), In its simplest form with no thermal break, it had a measured R-value (Rm) of 0.9 m^2.°C/W and a thermal break efficiency of 56% compared to the calculated unbridged Ro value of 1.61 m^2.°C/W.

Two variations of this panel were also examined, in a bid to reach a specified target of 1.5 m^2.°C/W. In one of these, a continuous 2.5 mm thick by 50 mm wide flexible butyl foam strip was placed between one face of the aluminium and the facing material. This raised the measured R-value to 1.1 m^2.°C/W and the thermal break efficiency to 65%. In another case, a complete layer of 12 mm EPS (expanded polystyrene foam) was placed over the outer face of aluminium and original insulant. This showed a larger increase of R-value to 1.4 m^2.°C/W and a thermal break efficiency of 72%.

Panel 4. Another steel stud system, Figure 5(a), in which a more complex frame member was used, achieved a measured initial R-value of 1.3 m^2.°C/W, a thermal break efficiency of only 50% . The facings were cement board of 0.25 W/m.°C conductivity, 6 mm thick, and there was a smaller than usual area of contact between steel and facings. When modified as in Figure 5(b) by insertion of a 6.5 mm square section flexible foam strip between steel and facings on one side, the measured R-value increased to 1.5 m^2.°C/W and the thermal break efficiency to 52%, compared to the increased Ro value of 2.9.

Panel 5. The final case considered here, in Figure 6(a), is that of a twin channel steel-frame system. The R-value of this panel was measured at 1.8 $m^2.^{\circ}C/W$. This panel, in fact, had a thermal break inherent in the design, and the thermal break efficiency was 58%.

This panel was examined in further detail, to shed more light on which of the thermal bridging processes was most important. First, 2.5mm wide cuts were made in the warm side facings, immediately adjacent to the edge of the steel. This would sharply reduce the lateral heat flow in the facing but in fact raised the R-value by only 8% to 1.95 $m^2.^{\circ}C/W$. In this case, it was also possible to test the panel with no steel present in the measurement zone, and the R-value (Rm=Ro) in this condition was found to be 3.1 $m^2.^{\circ}C/W$.

The brief conclusion of this rather limited but typical sample of structures suggests that in the real world, R-values of metal-framed panels without thermal breaks appear to reach thermal break efficiencies in the 50-60% range. With the addition of simple thermal break systems, the efficiency may rise above 60% if the facings are not strongly conductive or fall to 50% if they are strongly conductive. The use of furring strips produced a more effective thermal break efficiency of 77%. In other circumstances it has been noted that the use of transverse battens has a similar effect. This sort of relation would seem to make a useful rule of thumb in assessing the likely thermal performance of metal framed panels in the initial stages of development.

Although many of the attempts to introduce thermal breaks in these panels are relatively successful at raising the R-value, comparison of results in Table 1 shows that in some cases this is attributable mainly to raising the basic insulation level Ro, while in others it is attributable mainly to raising the "efficiency" of the thermal break system.

REFERENCE SCALE FOR THERMAL BREAKS

Thermal breaks are not easy to visualize quantitatively, mainly because some heat transfer paths are mainly one-dimensional, others are two- or three-dimensional. It is not easy to visualize how a thermal break of unit resistance of, say, 0.3 $m^2.^{\circ}C/W$ will compare with the fact that it may cover only 2% of the heat flow path. The arithmetic involved is often cumbersome.

In an attempt to give a visual scale, Figure 7 has been prepared using the method of isothermal planes as a model. The author's previous experience (Trethowen 1986), has indicated that, properly applied, this method is in fact quite successful in a wide variety of situations. The terms "area resistance", "line resistance", and "point resistance" are used below to emphasize different dimensions (see Figure 1).

We now consider a portion of structure in which there is thermal bridging between two planes. There are two situations to consider: first, bridging by a grid of point contacts; second, bridging by line contacts at intervals. For point contacts, take an insulating layer having thermal resistance, Ri, $m^2.^{\circ}C/W$. Through this layer there is a series of "point" thermal bridges, each having a point resistance, P, $^{\circ}C/W$. These points are on a grid of "a" metres by "a" metres, and there is, therefore, $1/a^2$ points per m^2. By adding the heat flows through the insulant to that in the thermal bridge point, then;-

$$\begin{aligned} q &= qo + \_T/(P.a^2) \\ q/qo &= 1 + \_T/(P.a^2.qo) \\ &= 1 + Ri/(P).a^2) \end{aligned} \qquad (1)$$

$$\begin{aligned} f &= q/qo - 1 \\ &= Ri/(P.a^2). \end{aligned} \qquad (2)$$

where:

q = mean heat flux, W/m^2
q_o = heat flux through insulant, W/m^2
T = temperature difference, $^{\circ}C$.
Ri = area thermal resistance of insulant, $m^2.^{\circ}C/W$.
P = point thermal resistance of each thermal bridge, $^{\circ}C/W$.
a = center spacing of thermal bridge point, m.
f = fractional loss of insulation = $(q-q_o)/q_o$.

For the line case, similarly-

$$f = Ri/(L.a) \tag{3}$$

where:

L = line thermal resistance of each thermal bridge, m.°C/W.

Now note that the series resistance through metal parts is extremely small, even when area-weighted, and it is not difficult for contact resistances to form the dominate part of the resistance of the thermal bridge.

As an example, consider a cavity where Ri is 1.0 m^2.°C/W. To keep the panel performance within 20% of that for the unbridged case, one would need (according to Figure 7) to have contact resistances exceeding 20°C/W for each point contact on a 0.5 m grid or 10°C.m/W for each line contact on 0.5 m centers. A higher insulation value (Ro) would need a higher thermal bridge resistance for a similar result. No joint in Table 2 shows high enough resistance, when tight, to achieve this figure.

For line contacts 25 mm width, a line contact resistance of 0.025 x 10 = 0.25 m^2.°C/W would typically be needed, i.e., more than 9 mm thickness of a highgrade insulant insert. The results in Table 1 may be compared with these expectations.

The corresponding point contact condition, requiring point resistance of 20°C/W, would require area resistance of only 0.013 m^2.°C/W for a 25mm square "point". It should be noted that "point contacts" often occur in association with some kind of line contact, and both must be considered. The use of furring strips as in panel 2(b) of Table 1, may be considered to be one where "point" contacts occur between studs and furring strips.

CONTACT RESISTANCE FOR TYPICAL JOINTS

Here we consider the contact resistances exhibited by typical joint types. Since in this case the intention is to characterize the resistance of real joints and then to explore ways of maximizing the resistance, these data are different to those for many existing publications on contact resistance, which usually seek the minimized, material-dependent part of the contact resistance.

It is useful to first consider the general behavior of heat transfer across air cavities. Referring to Figure 8, which is based on well- established sources (Robinson et al. 1957; ASHRAE 1985), it is evident that there are distinct conditions where radiation, conduction, and convection each affect the thermal resistance of air cavities in different ways. Above about 10 mm cavity width, radiation and convection dominate and the resistance is affected by both emittance and orientation. Below 10 mm, convection is suppressed and orientation becomes unimportant. But below about 2 - 3 mm cavity width, even radiation becomes unimportant and the resistance depends on cavity width only, with the heat transfer taking place principally by air conduction. Radiation still occurs but is outweighed by air conduction. This condition can be taken to apply right down to the point where solid contact becomes important. At small but nonzero cavity widths of 1-2 mm down to, say, 0.1 mm, the observed cavity resistance obtained by the method below can be compared to that from Figure 8, and the comparison is quite satisfactory.

Line Contacts

No testing was carried out in respect of line contacts.

In this group, we consider situations such as plaster or woodfiber board placed against a flange of metal. Presumably because both the board and the metal usually have rough and/or uneven surfaces, the heat transfer between them appears to follow the trends illustrated in Figure 8.

For this condition, we may therefore use an approximation derivable from Figure 8 that the contact resistance is about 0.04*b $m^2.^{o}C/W$, where b mm is the mean width of the contact gap between metal and board and must be less than about 2 mm. This value does not depend on the emittance of the metal, but the mean gap b will depend on the flatness of the materials. For example, if there is 0.1 mm mean gap between a steel flange and a plasterboard sheet, the line contact resistance will be about 0.04*0.1 =0.004 $m^2.^{o}C/W$. If the flange is 25 mm wide, then the line resistance will be 0.004/0.025=0.16 $m.^{o}C/W$.

Point Contacts

Tests were carried out as below to find the contact resistance for a number of "point" contacts.

The procedure, illustrated in Figure 9, involved the use of a small metal tank filled with fluid, usually water, and heated with a fixed heat input power. The metal was either galvanized mild steel or aluminium. Temperatures were measured with copper-constantan thermocouples, and input power was monitored by measuring input voltage and current to the heater. The tank surface and its entire fluid contents were required to be approximately uniform temperature. The internal tank temperatures were found to differ by less than 0.5°C from point to point, which was regarded as adequate.

The heat loss coefficient (C) of the tank had first to be determined. This was done by determining the equilibrium temperature the tank reached at a constant power input, with the patch that was later to be covered by the cooling fin insulated as thoroughly as possible. This coefficient was then used as below to separate the tank heat losses into one part lost directly from the tank and another part lost to the cooling fin, thus passing through the joint system.

In each test, a constant power input was set up and temperatures recorded until equilibrium was established. This typically took 4-6 hours, but 9-15 hours was usually permitted. From the data observed, the input power was determined and the losses direct from the tank to ambient calculated using the coefficient C above. The difference between these must logically be the heat that passed through the joint to the cooling fin. Since the temperature of the tank and of the fin immediately adjacent to the joint were both measured, it was possible to determine a contact resistance of the joint. Temperatures further along the fin were also recorded and used in early trials to determine the likely error in fin temperature due to the need to displace the "joint" thermocouple slightly from its ideal position. This error was assessed as 7%, and the results in Table 2 are adjusted for it. This procedure is indicated algebraically below:

For equilibrium conditions:

If W = input power, W

Ta = ambient temperature, °C

Tt = tank temperature, °C

Tf = maximum fin temperature immediately adjacent to joint, °C

C = tank loss coefficient as above, W/°C.

Then:

	Tank heat loss	= C(Tt - Ta)	W
hence,	Heat flow through joint to fin	= W - C(Tt-Ta)	W
	Temperature difference across joint	= (Tf-Tt)	°C

$$\text{Joint Contact resistance} = \frac{(Tf-Tt)}{W - C(Tt-Ta)} \quad ^{o}C/W \qquad (4)$$

By differentiation of Equation 4 and inserting the expected measurement accuracy of each term, the overall accuracy of this procedure was assessed as within 10% for the higher contact resistances and 25% for the lower ones.

Note that the first three results in Table 2 have been overplotted onto Figure 8 and show a satisfactory agreement with the data in Figure 8.

Results

The main results are summarized in Table 2, and the observed contact resistances ranged from about 3 °C/W to over 30 °C/W.

As has been well established in previous investigations, the contact resistance decreased for higher contact pressures. As any joint was tightened, the contact resistance fell, but the decrease was commonly not linear. These data confirm that sufficient contact resistance to influence the overall R-value may not be easy to obtain with fully tightened joints.

Joints involving aluminium had slightly lower resistance than those with steel. This is attributed to the greater flatness of extruded aluminium and not to lower surface emittance, which should have little effect at these very small gap widths.

The results in Table 2 show some variability. For the "fingertight" cases, this presumably follows from variation in how tight "fingertight" is. Joints including more than one insert were more irregular in their behavior, both mechanically and thermally, the lower one contributing more resistance. The effect of an insert seemed to depend considerably on its thickness and also on the quality of contact the insert makes with the other surfaces. Consider the 10 mm O-ring, which may insert a resistance of several hundred °C/W, but this is simply bypassed. Its presence creates a gap of 1-2 mm, depending on bolt tightness, and therefore a resistance of 18-36 °C/W for the facing surface and fin. Additional heat flow through the bolt and its head is presumed to bring the final apparent contact resistance to its observed value, which would be almost unaffected by the conductivity of the O-ring. Star and spring washers performed almost as well as O-rings, presumably because they had poor surface contact with tank and fin. It was a feature of spring washer joints to show a sharp drop in resistance at the last stage of tightening.

One conclusion of this investigation is that the most important variable for the designer to manipulate is the area of joint components that are adjacent.

CONCLUSIONS

The measured thermal insulation values of five metal-framed panels with various details have been examined to show the effectiveness of different types of thermal break.

Without a thermal break, the "efficiency" (i.e., the ratio of measured to ideal unbridged R-value) was found to be typically 50% - 60%. The use of simple thermal breaks such as insert strips made rather limited improvement to the "efficiency" and often improvements in R-value could be attributed as much to extra insulation as to the thermal breaks.

Major improvements in the thermal break efficiency were only observed when rather complete breaks, such as by use of furring strips or transverse battens, were used. In this case the "efficiency" was seen to reach over 75%.

Particular values of thermal break properties have been briefly examined and indicate that inserts less than 10 mm thick for line contacts, even if of high-grade insulant, would commonly not be sufficient to prevent substantial loss of insulation value.

Approximate measured values of contact resistance for typical real bolted joints are reported for galvanized mild steel and aluminium with a number of different joint inserts and tightness. These showed joint resistances from 3 °C/W for direct joints to over 30 °C/W for joints with double inserts. Cases where metal parts were held 0.1 - 3 mm apart without physical contact were also measured and showed cavity resistance consistent with previous data. The argument that heat flow in these conditions will be dominated by air conduction seems to be supported, even when, as here, the "cavity" was open on four sides.

NOMENCLATURE

The following terminology has been used for this paper - see also Figure 1.

Ro, $m^2.{}^\circ C/W$, = The ideal thermal resistance that would be achieved for a panel if there were no thermal bridging.

Rm, $m^2.{}^\circ C/W$, = Actual (i.e., measured) average thermal resistance exhibited by a panel as built.

Rm/Ro = "Thermal break efficiency" - often cited as a percentage.

Ri, $m^2.{}^\circ C/W$, = "Area thermal resistance" is the normal thermal resistance term (equal to thickness/conductivity for a homogenous slab).

L $m^\circ.C/W$, = "Line thermal resistance" is used for elements (such as studs) that are long and narrow. It can be viewed as "area thermal resistance per unit width."

P $^\circ C/W$ = "Point thermal resistance" is used for elements (such as fasteners) that have little width in either direction.

thickness, depth = are in the direction of heat flow

width, length, height = are transverse to the direction of heat flow

contact resistance = refers to the apparent thermal resistance across a contact zone. It may include the effect of an insert.

REFERENCES:

ASHRAE. 1985. ASHRAE handbook -- 1985 fundamentals, p.23.4-23.5. Atlanta: American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

Baktier, F.; and Larson, D.C. 1983. Thermal performance of insulated wall systems with metal studs. Proc. 18th Intersociety Energy Conversion Eng. Conference, Orlando, Aug.

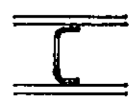
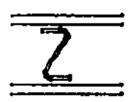
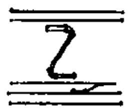
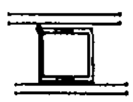
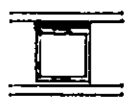
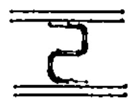
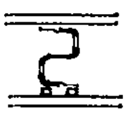
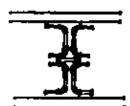
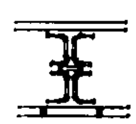
Fried, E. 1969. Thermal conduction contribution to heat transfer at contacts. Thermal Conductivity, Vol.2. Academic Press.

Robinson, H.E.; Cosgrove, L.A.; and Powell, F.J. 1957. Thermal resistance of air spaces and fibrous insulations bounded by reflective surfaces. National Bureau of Standards, Building Materials and Structures Report 151.

Sasaki, J.R. 1971. Thermal performance of exterior steel framed walls. National Research Council of Canada. DBR Building Research Note No.71.

Trethowen, H.A. 1986. R-values that are made-to-measure. ASHRAE Transactions, Vol. 91, Part 2, p.36-48.

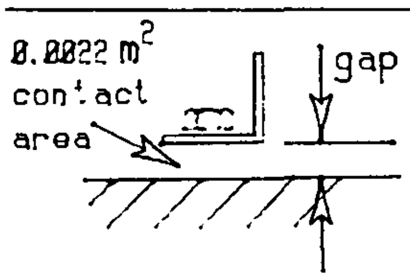
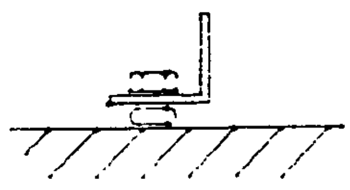
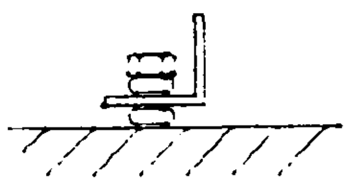
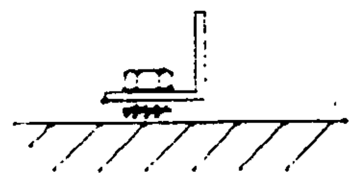
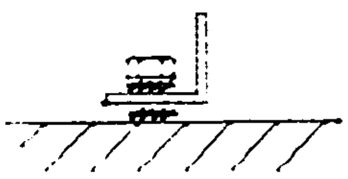
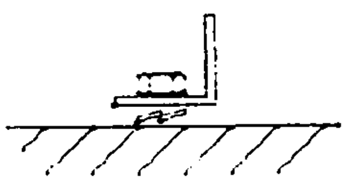
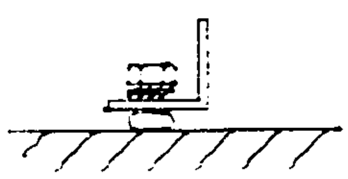
TABLE 1
Summary of Effect of Various Thermal Breaks
on Five Metal-Framed Panels

	Panel Ref		Description	Thermal Resistance m^2°C/W measured (R)	ideal (Ro)	%eff
	1		Simple 0.51mm steel U-channel @ 410mm centres. Fibreglass insulation See Fig. 1	1.17	2.09	56%
	2	a	Z-section 0.91mm steel studs @ 410mm centres. Fibreglass insulation. See Fig. 2(a)	1.20	2.2[1]	55%
		b	- as 2a, except that gypsum board facing separated from steel studs by steel furring strip. See Fig. 2(b)	1.85	2.4[1]	77%
	3	a	Extruded 2mm aluminium frame @ 800 mm centres. EPS insulation. See Fig. 3(a)	0.90	1.61[2]	56%
		b	- as 3a, except for addition of 50 x 2.5mm adhesive foam strip between aluminium and facing. See Fig. 3(b)	1.10	1.7[2]	65%
		c	- as 3a, except for addition of a complete 12mm layer of EPS between aluminium and cladding. See Fig. 3(c)	1.40	2.04[2]	72%
	4	a	Rolled 1.65mm steel frame @ 900mm centres. PU foam insulation, 50mm. See Fig. 4(a)	1.3	2.6[3]	50%
		b	- as 4a, except for addition of 6.5mm square flexible foam strips between steel and cladding, and consequent thickening of insulation to 56mm. See Fig. 4(b)	1.5	2.9[3]	52%
	5	a	Twin steel channels of 1.2mm steel. PU foam insulation, 62mm. The twin steel channels were separated by 6mm PVC insert. See Fig. 5.	1.8	3.1[4]	58%
		b.	Panel 5 with 2.5mm slots cut entire length of one face, each side of steel	1.95	3.1[4]	63%

1. Calculated using k = 0.05 W/m°C for fibreglass density 10 kg/m^3.
2. Calculated using k = 0.035 W/m°C for EPS density.
3. Calculated using k = 0.021 W/m°C from Panel 5 for similar foam.
4. Measured from panel 5 reassembled with no steel near measurement zone.

TABLE 2

Contact Resistance of Metal Joints with Inserts

Joint	Description	Joint Resistance °C/W Galvanised Mild Steel Bolt dia 10mm	6mm	Aluminium Bolt dia 10mm
	Joint with gap 1.6mm	- 35	-	- 32
	0.6mm	- 15	-	- 12
	0.3mm	- 8	-	- 6
	No gap, with or without bolt	- 6	-	- 4
	Fully tightened bolt	3-4	-	- -
	O-ring under fin			
	Fingertight	20	16	13
	Fully tight	10	12	4
	O-rings over & under fin			
	Fingertight	21	15	33
	Partlytight (Fingertight and 1 turn)	18	-	18
	Star washer under fin			
	Fingertight	16	15	15
	Fully tight	12	10	3
	Star washers over & under fin			
	Fingertight	25	25	-
	Fully tight	6	5	-
	Spring washer under fin			
	Fingertight	27	17	16
	Fully tight	9	9	4
	O-ring under, star washer over fin			
	Fingertight	-	-	43
	Fully tight	-	-	9

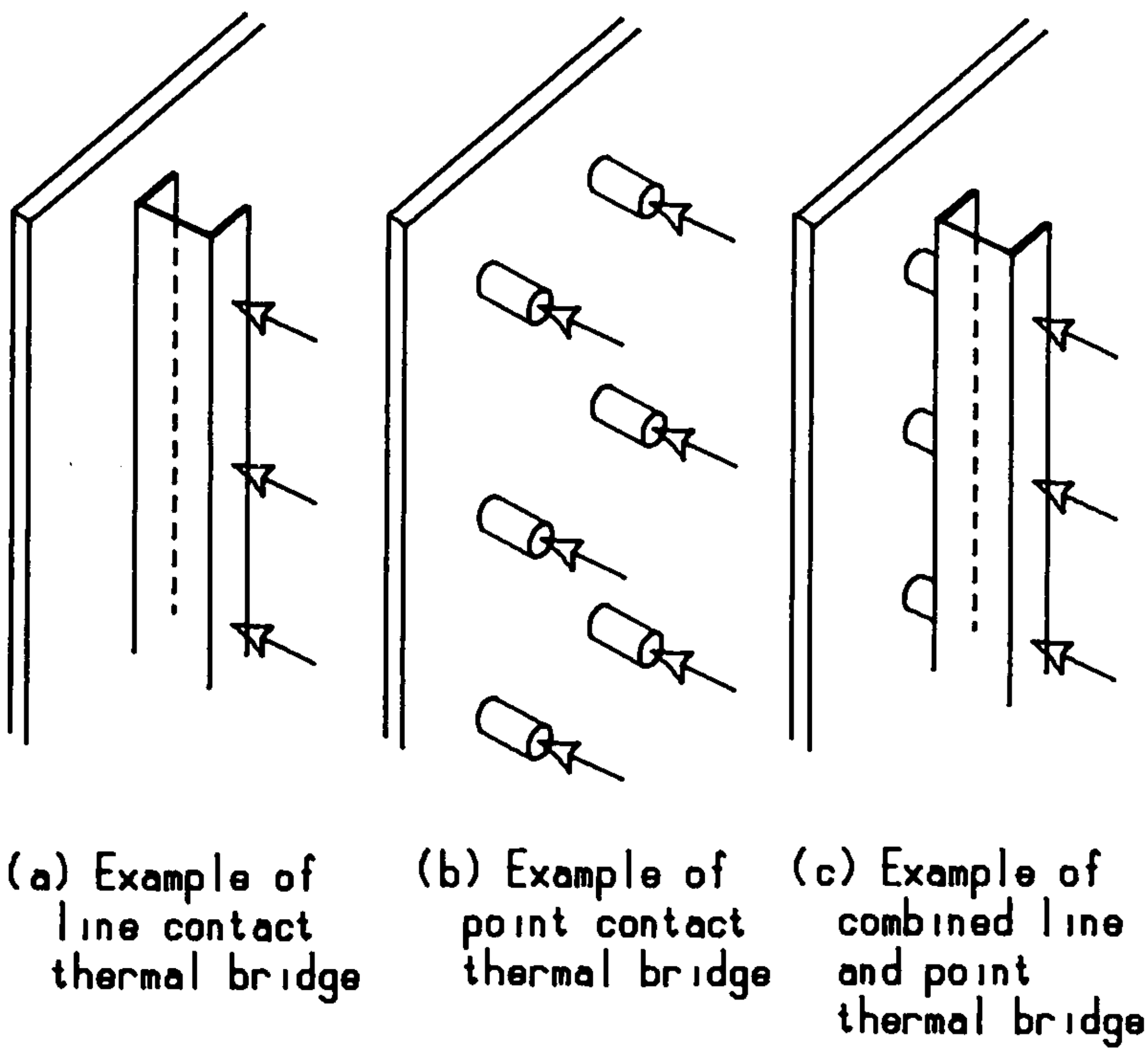


Figure 1 Illustration of terminology used

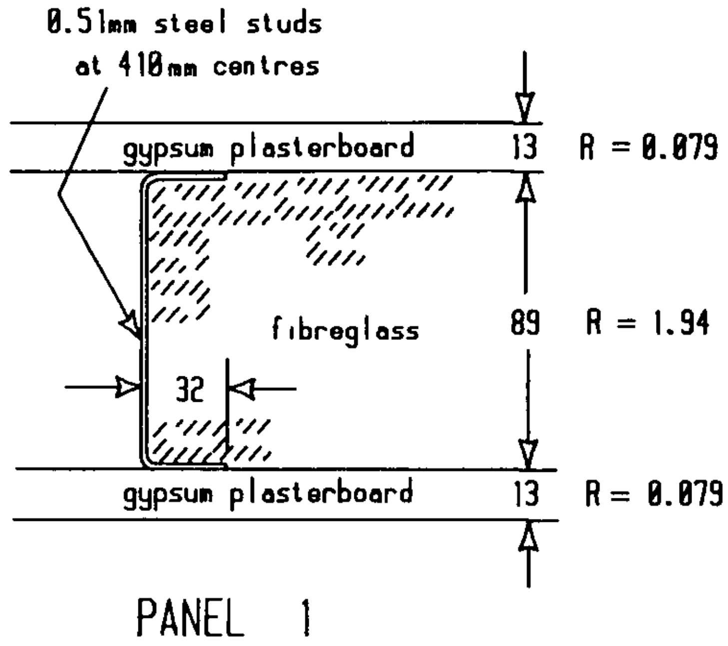


Figure 2

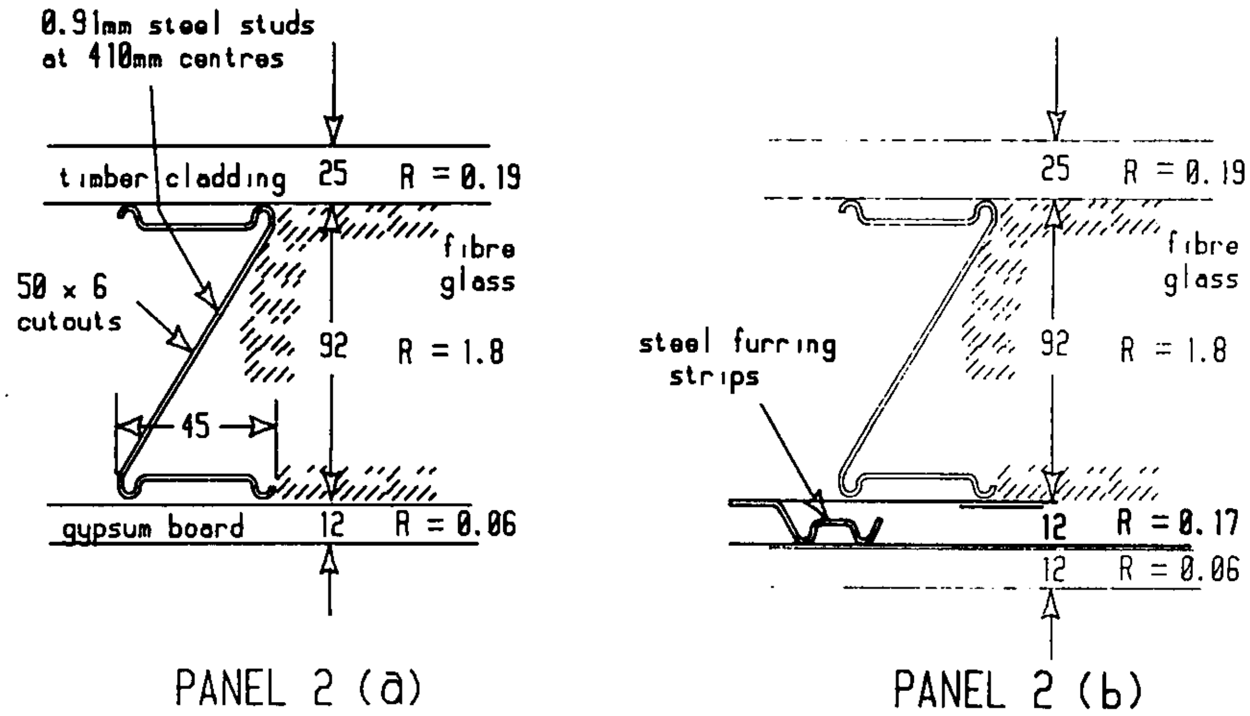


Figure 3

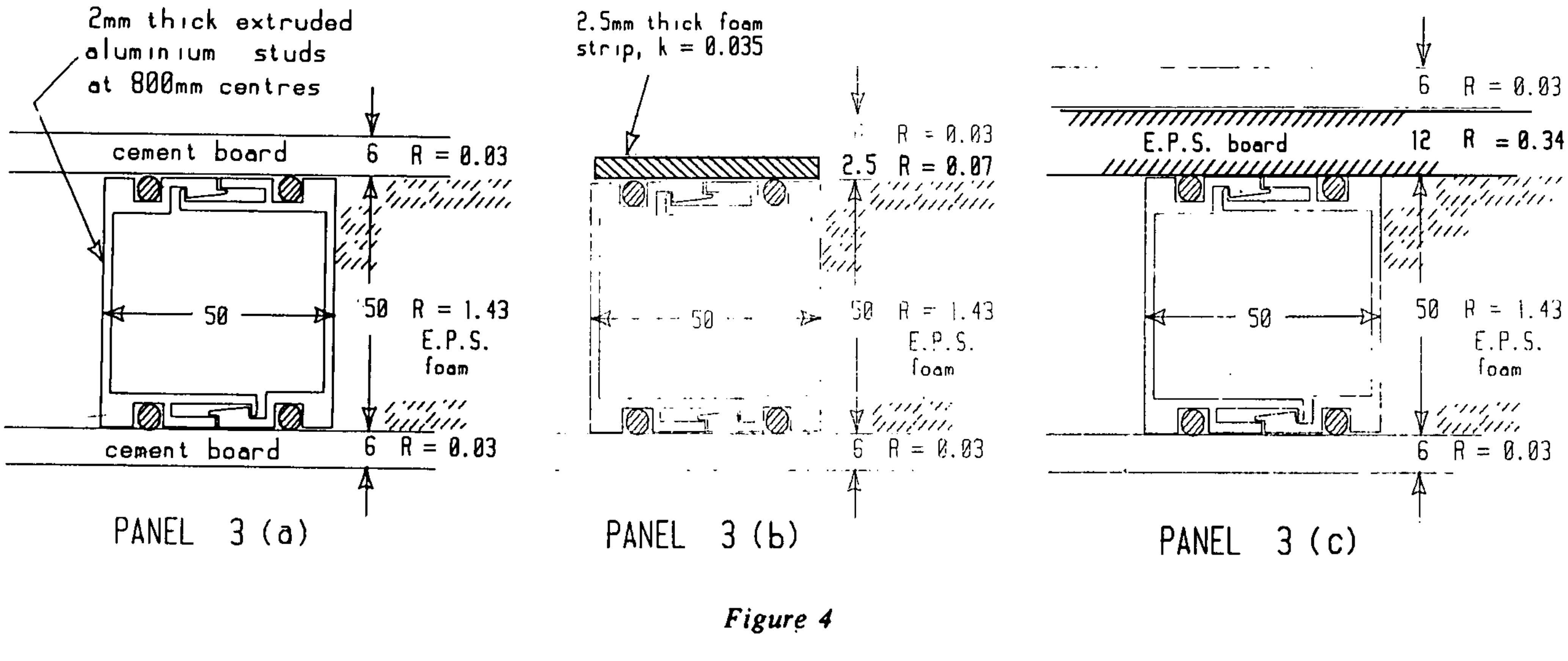


Figure 4

Details of metal framed panels

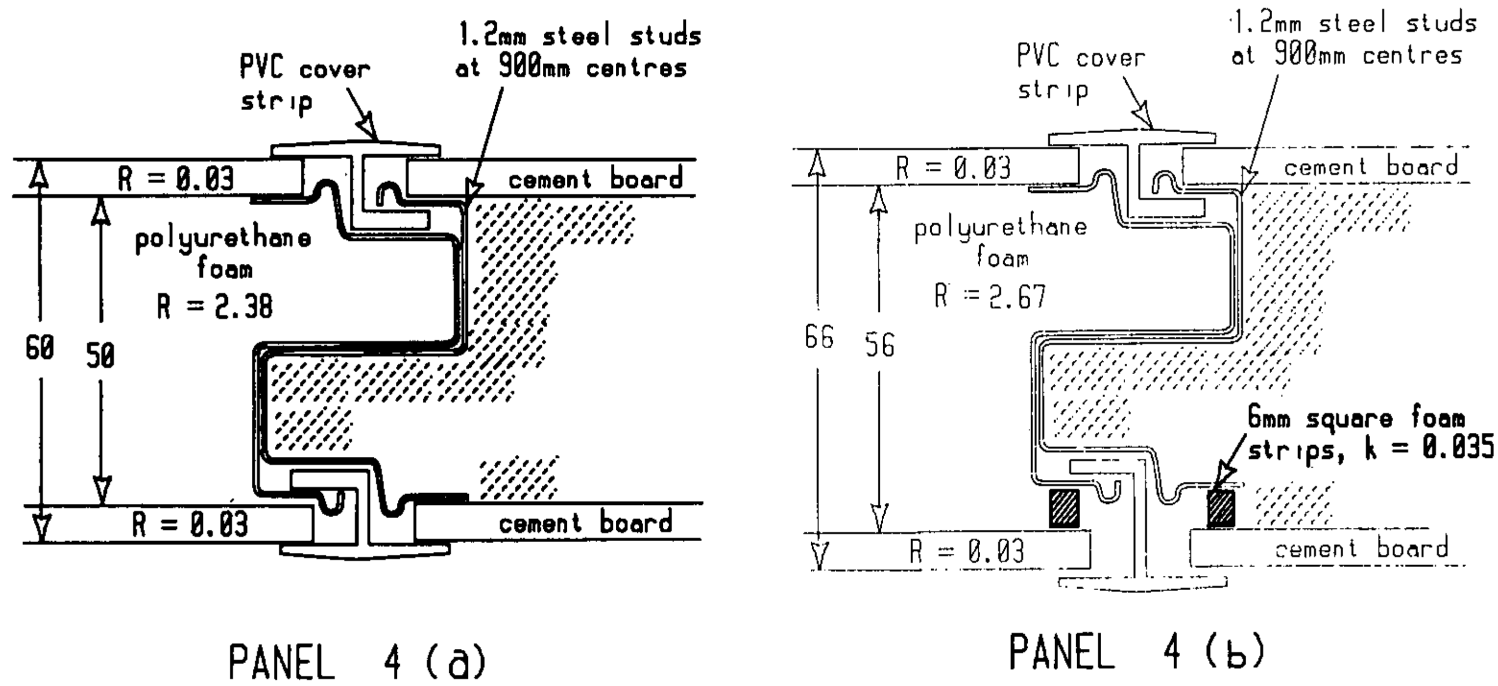


Figure 5

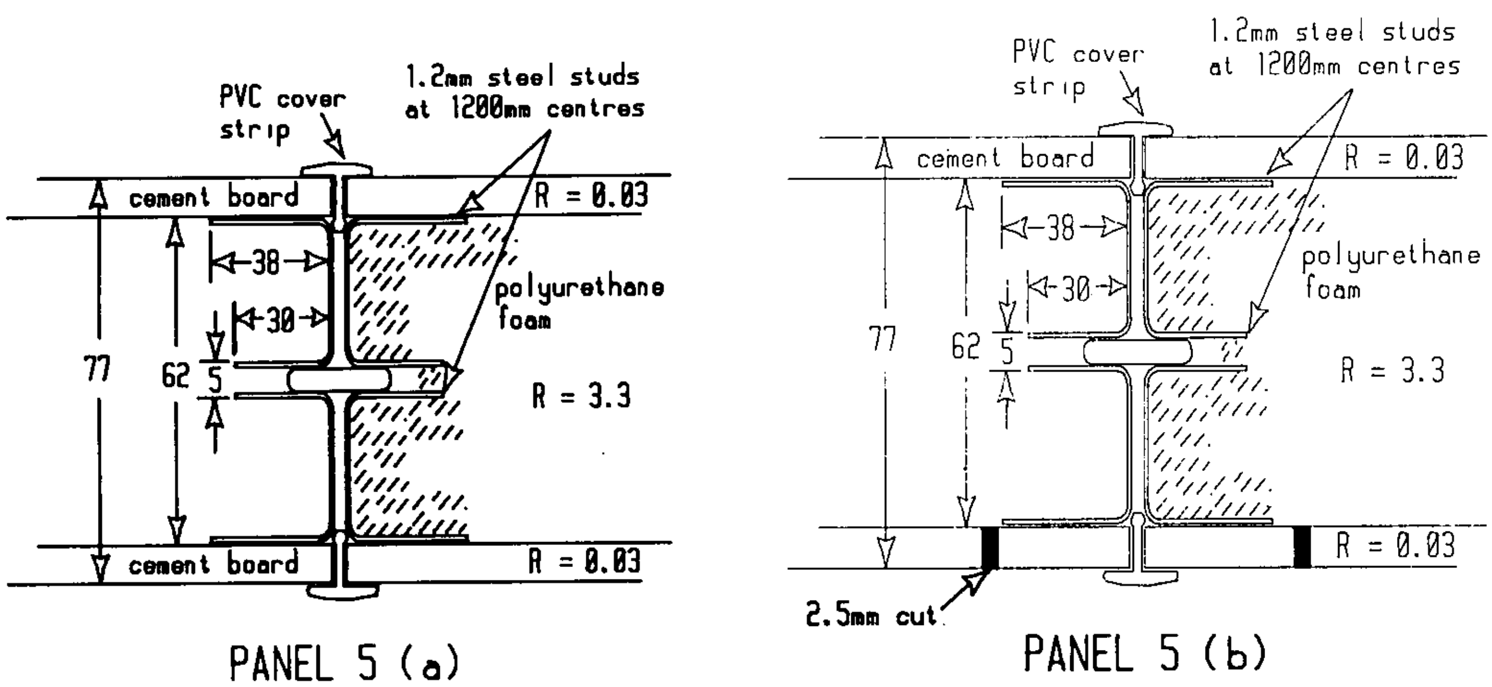


Figure 6

Details of metal framed panels

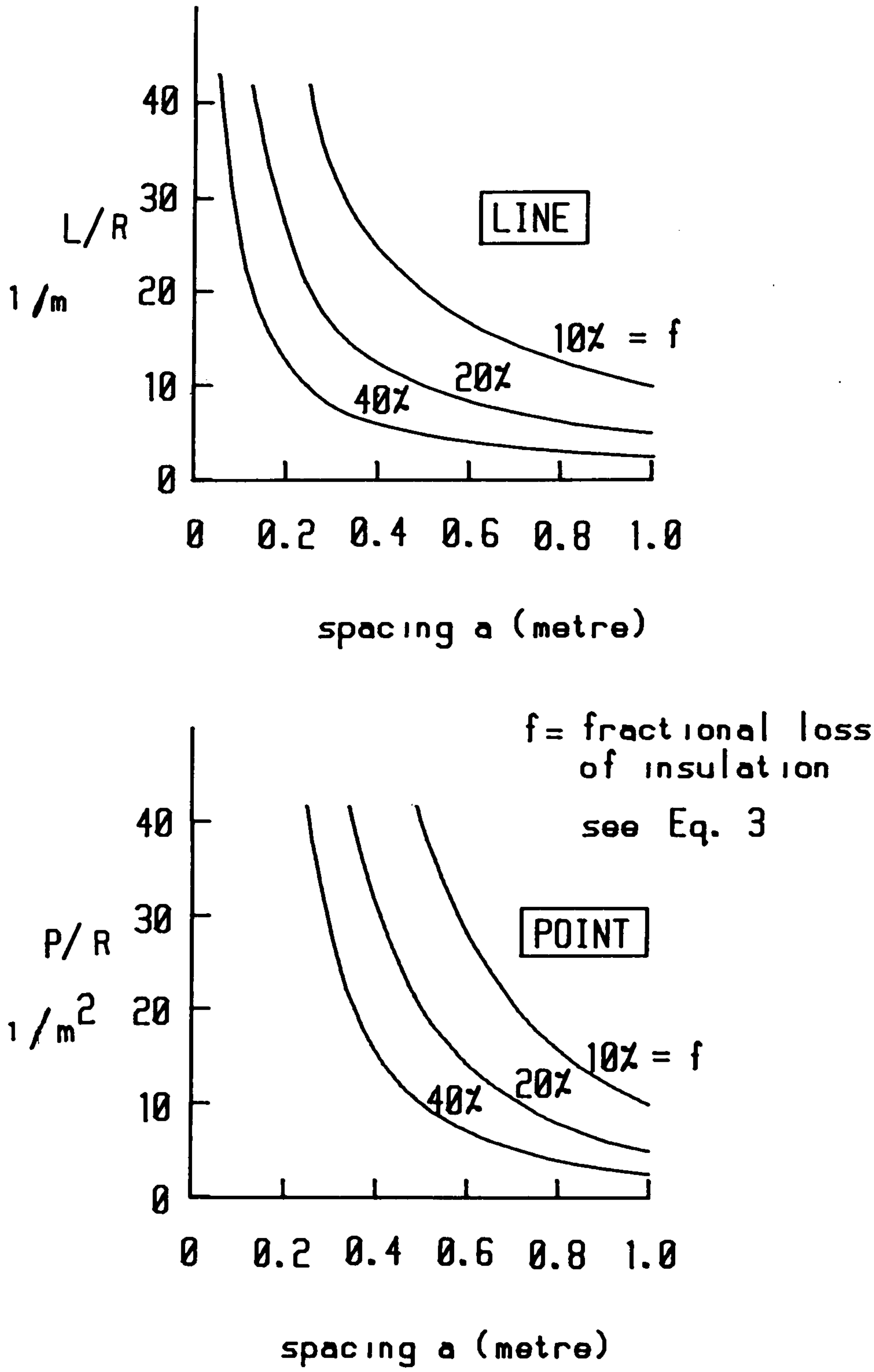


Figure 7 Joint resistance corresponding to various loss of insulation

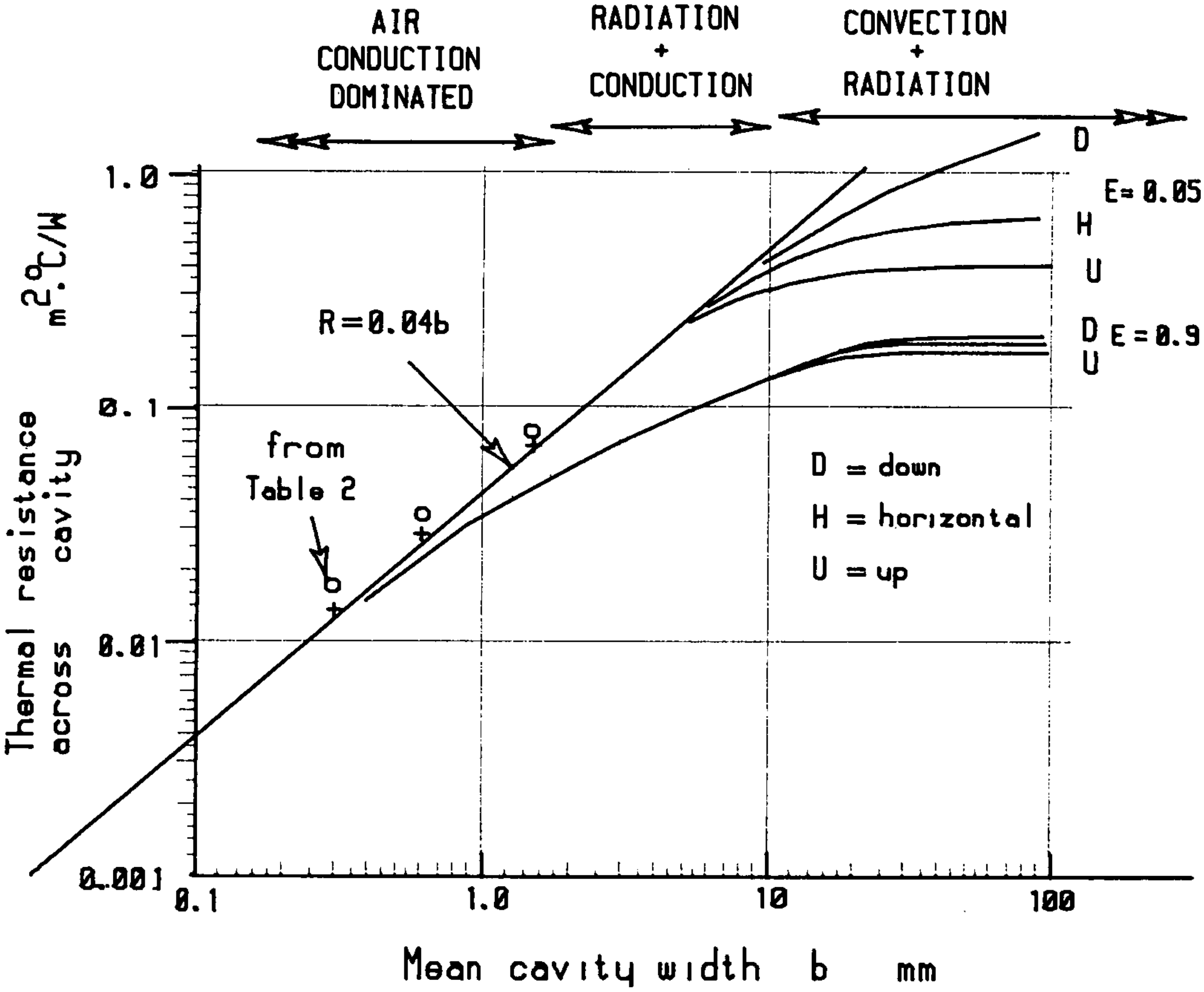


Figure 8 Thermal resistance across small cavities

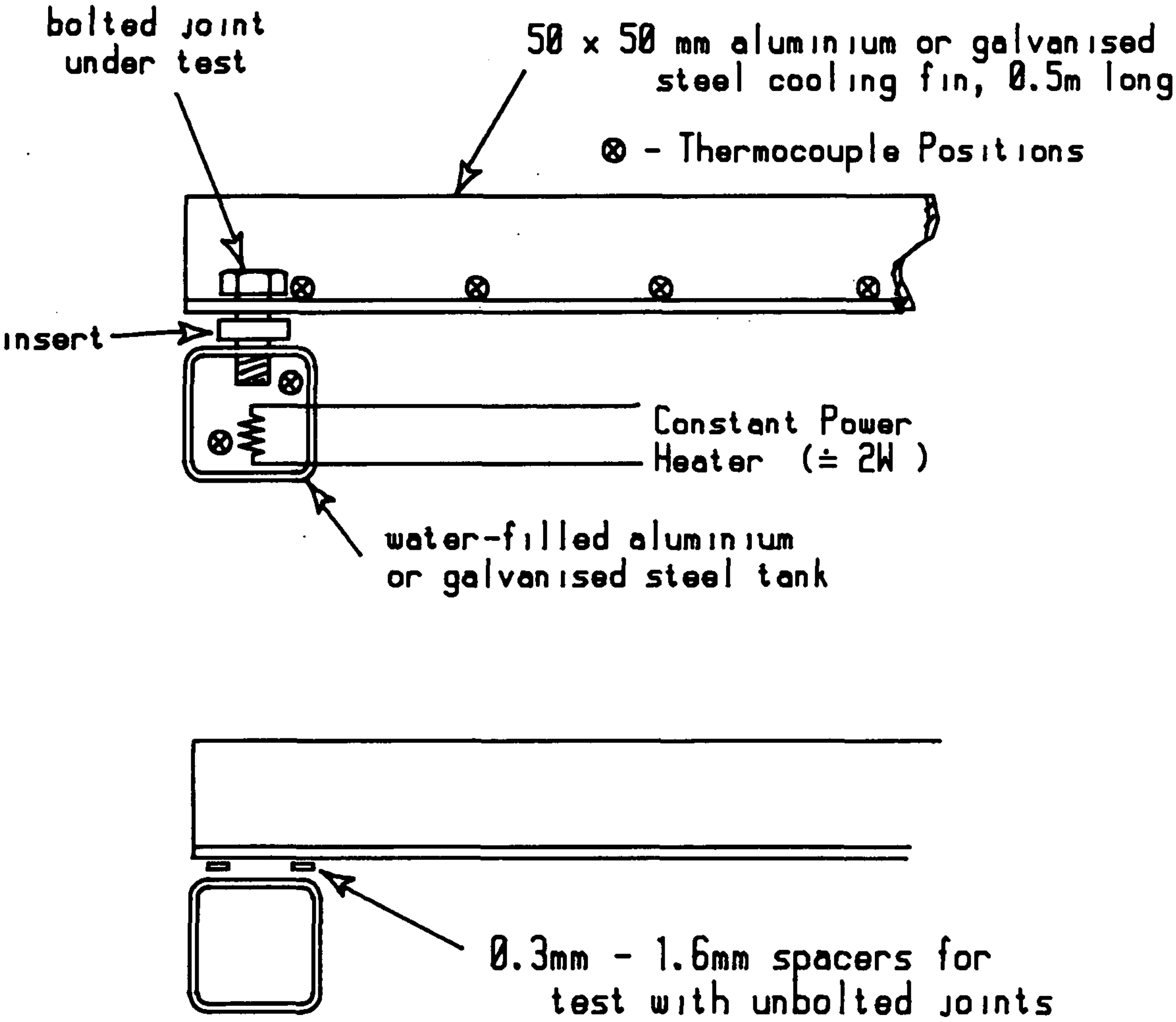


Figure 9 Sketch of equipment for test of contact resistance of joints

DISCUSSION

D. Stephenson, Ottawa, Ontario, Canada: Did you investigate the improvements that could be achieved by using nylon bolts rather than steel to attach cladding to the metal studs?

H.A. Trethowen: Nylon bolts were not examined, but this would be a useful area to explore.

W.E. Murphy, Associate Professor, University of Kentucky, Lexington: Did you happen to look at a double-stud wall construction where two rows of studs are used in a staggered arrangement, and, if so, how did that influence the insulation efficiency?

Trethowen: No staggered-stud constructions were encountered in any of the cases we were asked to examine.

Murphy: Could you speculate on its performance since it would represent the ultimate in a thermal break?

Trethowen: One would speculate that a staggered-stud construction would contain only limited thermal bridging. There should be no direct bridging between the two sets of studs, but each set may protrude into the common cavity with some loss of performance.

Figure 1   Illustration of terminology used

Figure 2

Figure 3

Figure 4

Details of metal framed panels

Figure 5

Figure 6

Details of metal framed panels

Figure 7   Joint resistance corresponding to various loss of insulation

Figure 8   Thermal resistance across small cavities

Figure 9   Sketch of equipment for test of contact resistance of joints

Thermal insulation and contact resistance in metal-framed panels

BUILDING RESEARCH ASSOCIATION OF NEW ZEALAND INC.
HEAD OFFICE AND LIBRARY, MOONSHINE ROAD, JUDGEFORD.

The Building Research Association of New Zealand is an industry-backed, independent research and testing organisation set up to acquire, apply and distribute knowledge about building which will benefit the industry and through it the community at large.

Postal Address BRANZ, Private Bag, Porirua

branz

ISSN 0111–7459