Glass fibre tape materials – the cost-effective solution to weld backing

For the majority of applications for fusion welded joints it is unnecessary to go to the trouble and expense of ensuring fully continuous transition of metal between parent materials. The fillet weld and the partial penetrating butt weld are thus adequate in many circumstances: employed intelligently they are capable of meeting many structural requirements and as a consequence are in widespread use throughout manufacturing engineering.

There remain nonetheless some demanding requirements where maximum joint strength is mandatory. Products subjected to mechanical fatigue, corrosion resistance or thermal cycling in end-user industries such as nuclear engineering, aerospace and power generation need joints of optimum quality in order to provide an acceptable level of insurance against service failure. For these critical applications the fully penetrating butt weld is essential.

The penetrating capability of the arc process determines whether or not a square edge preparation is adequate. With the MMA and TIG techniques the maximum material thickness which can be welded from one side is usually taken as about 3 mm. Using a high current MIG technique allows this thickness to be raised to around 6 mm. For thicker materials it becomes necessary to cut back the edges to provide access for the torch. The simplest preparation of this type is the single-V and the joint is filled using a multiple run with each pass fusing into the previous one and into the adjacent side walls. The first pass is referred to as the root run and it is the quality of this deposit which ultimately determines the overall quality of the finished joint. The fundamental requirement of the root run is to provide continuous fusion between the two materials along their length and this can be achieved in a number of different ways.

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The most direct technique is for the welder to exercise total control over the deposit, producing an acceptably smooth underbead of constant width with no significant surface oxidation products. The root gap plays an important part here in ensuring consistency of penetration; too wide and there will be over-penetration, too small and there will be inadequate penetration. Achieving consistency requires a level of skill on the part of the welder which is not always available.

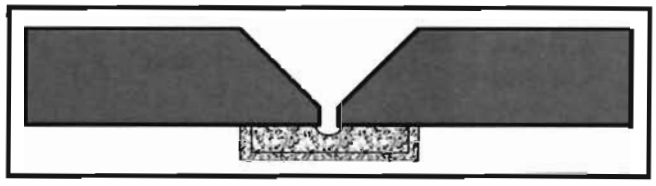

Fig. 1. *Ceramic tile backing.*

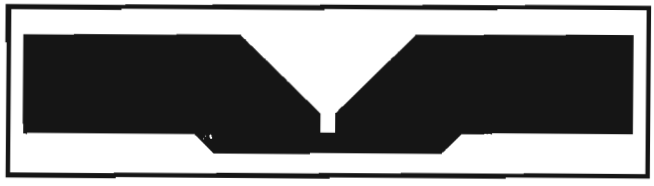

Fig. 2. *Permanent backing.*

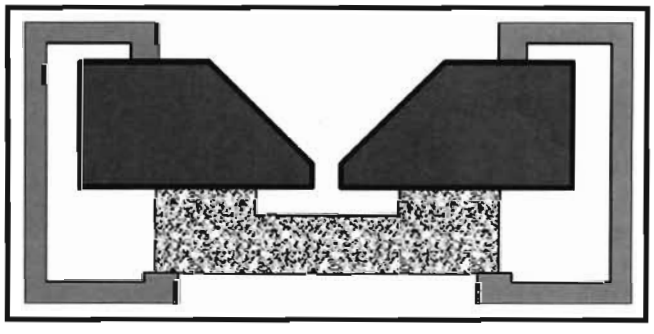

Fig. 3. *Temporary backing.*

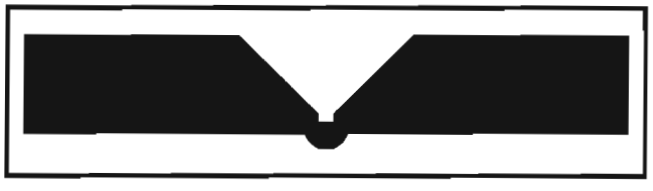

Fig. 4. *Consumable insert.*

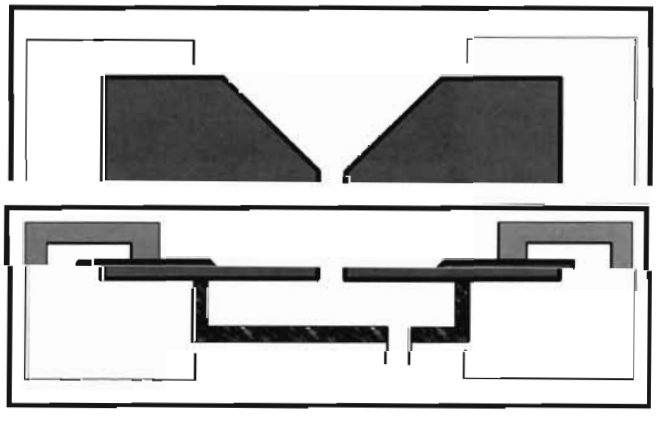

Fig. 5. *Gas purge backing.*

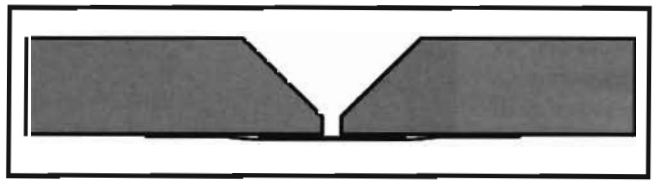

Fig. 6. *Tape backing.*

To counter this need for high levels of welder skill, mechanical methods of weld-bead control have been developed. In circumstances where access to the rear of the

joint is possible, the external bead profile can be machined or ground to an acceptable form - perhaps even to produce a smooth, flat continuous surface. Alternatively the bead can be deposited from the rear of the joint and the internal profile treated. Where access to the rear of the joint is not possible, recourse to physical weld bead or backing support is the only alternative. The following represents the range of backing solutions available:

1 Ceramic tile backing strip
2 Permanent backing bar
3 Temporary backing bar
4 Consumable inserts
5 Inert gas
6 Glass reinforced fibre tape.

Ceramic tile backing strip

This technique has been designed to meet the requirements of the slag processes, submerged arc, flux cored MIG and MMA welding. The slag is contained within the tile recess below the weld and protects and shapes the external bead. The ceramic tile method is relatively expensive and not widely used.

Permanent backing bar

Protecting and shaping the weldbead by providing a permanently attached strip of similar material to that being welded is popular. It is cheap, easily applied and needs little specialist skill. It does, however, present the potential drawback of becoming a permanent feature of the joint which may be undesirable from an aesthetic point of view: it also presents an undesirable fatigue notch at the weld root.

5 Inert gas
6 Glass reinforced fibre tape.

Temporary backing bar

To overcome the disadvantages of the integrated backing bar a support can be clamped in place and removed after the joint has been completed. To avoid the possibility of welding the bar to the joint these temporary supports are often water cooled and manufactured from copper. The supports are expensive to produce and the application is time-consuming, particularly for low volume manufacture.

Consumable inserts

Shaped inserts are available in a range of materials designed to be metallurgically compatible with the weld metal. During deposition of the root bead, the insert is melted into the weld pool. This solution is capable of producing a consistent root profile but is expensive and is available only in a limited range of materials.

Inert gas

Although originally intended to be used in the butt welding of tube using the TIG process, inert gas backing has been extended to linear butt welds. By providing nominal gas sealing at the ends of the joint seam it is possible to create a gas pressure under the bead sufficient to provide protection from contamination and support for the molten metal. Inert gas backing is expensive but, well applied, capable of producing good root profiles.

Glass reinforced tape

Self-adhesive, thermally stable and inert tape is simply applied to the underside of materials designed to be metallurgically compatible with the weld metal. During deposition of the root bead, the insert is

of the joint. The tape provides good mechanical support to the weld and prevents contamination. It is easy to use, requiring no special skills. This tape solution remains surprisingly underused and relatively unknown.

One example of the fibre tape is provided by the "Argweld" product manufactured by Huntingdon Fusion Techniques. "Argweld" is suitable for most common materials such as carbon, alloy and stainless steels, cast iron and for copper, nickel and titanium alloys and it can be used in conjunction with the MMA, TIG and MIG processes. The standard product can be used up to 80 A and heavier tapes are available for application up to 160 A and beyond. "Argweld" is essentially a 75 mm wide strip of adhesively-backed aluminium foil centrally overlaid with a 25mm band of woven continuous filament glass fibre cloth and is supplied in 12.5 m lengths. The tape is simply cut to length and stuck to the underside of the joint to be welded. The thermally stable woven fibre prevents overpenetration of the fusion zone but shapes the underbead to produce a positive reinforcement which is continuous and uniform and which blends smoothly to the parent material on each side. The tape can be removed by peeling it away from the weld zone.

Technical data

Composition of fibre: oxides of silicon, aluminium, calcium, boron and magnesium fused in an amorphous vitreous form. Fibre diameter: filament diameters between 6 and 25 microns; boiling point used up to 80 A and heavier tapes are available for application up to 160 A and beyond. "Argweld" is essentially a 75 mm 800°C; non-flammable and non-burning; non-carcinogenic.

Commercial data

Cost savings are well illustrated by comparing tape products with gas purging on a circumferential weld in a 3 m diameter tank 5 m long. The minimum recommended purge would consume double the tank volume in gas at 70 l/min. The purge process would thus take 16 hours and the gas alone would cost in excess of Euro 600. The cost of "Argweld" tape for this requirement would be Euro 30.

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Table 1. *Characteristics of backing methods.*

Illustration	3	4	5	6	7	8
Additional Machining	none	none	Groove in strip	None	None	Gas containment
Special Requirements	purchase ceramic tiles, clamping	tack welding	Clamping	Purchase inserts, location	Purchase tape	Clamping
Time Utilisation*	4	2	5	3	1	6
Welder skill Level*	4	1	5	3	2	6
Cost of Materials*	5	1	4	3	2	6
Overall cost*	5	2	4	3	1	6

*1 to 5, low to high