Technical Paper – 1063

Mechanical weld backing methods for overcoming weld skill limitations

For most applications of 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 penetration butt weld usually are adequate, employed intelligently, they can meet many structural requirements. For this reason, they are in widespread use throughout the manufacturing industry.

For some demanding applications, however, maximum joint strength is mandatory. Products subjected to mechanical fatique, corrosion, or thermal cycling in end-user industries such as nuclear engineering, aerospace, and power generation need joints of optimum quality to provide an acceptable level of insurance against service failure. For these critical applications, a 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 manual metal arc (MMA) and gas tungsten arc welding (GTAW) techniques, the maximum material thickness that can be welded from one side usually is about 3 millimeters. Using a high-current gas metal arc welding (GMAW) technique allows this thickness to be increased to about 6 millimeters.

For thicker materials, the edges must be cut back to provide access for the torch. The simplest preparation if this type is the single V, and the joint is filled using multiple runs, with each pass fusing into the previous one and into the adjacent side walls.

The first pass is referred to as, a root run and the quality of this deposit ultimately determines the overall quality of the finished joint. It provides continuous fusion between the two materials along their length, and this can be achieved in a number of ways.

The most direct technique is for the welder to exercise total control over the deposit, producing an acceptable smooth underbead of constant width with no significant surface oxidation. The root gap

plays an important part here in ensuring consistency of penetration: too wide results in overpenetration, while too small causes inadequate penetration. Achieving consistency requires a level of skill on the part of the welder that is not always available.

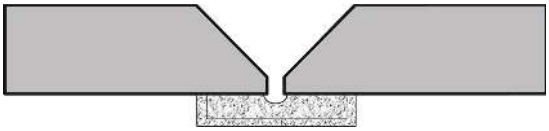
Weld Backing

To counter this need for a high level of welder skill, mechanical methods of weld-based control have been developed. If the rear of the joint can be accessed, the external bead profile can be machined or ground to an acceptable form – perhaps even to a smooth, flat, continuous surface. Alternatively, the bead can be deposited from the rear of the joint and the internal profile treated. If the rear of the joint cannot be accessed, a physical weld bead or backing support is the only alternative to allow the welder to be certain of producing a smooth, flat, coke-free weld that should not lead to corrosion or stress fracture. A number of backing methods for providing mechanical support and preventing contamination are available

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

Ceramic Tile Backing Strip

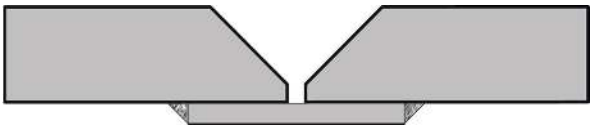
Ceramic tile backing (see fig.1) has been designed to meet the requirements of the slag processes submerged arc welding (SAW), fluxcored GMAW, and MMA welding.



The slag is contained within the tile recess below the weld and protects and shapes the external bead. Ceramic tiles usually are held on an adhesive tape that can be affixed to the backside of the weld.

Permanent Backing Bar

Protecting and shaping the weld bead by providing a permanently attached strip of material similar to that being welded is popular (see fig.2).

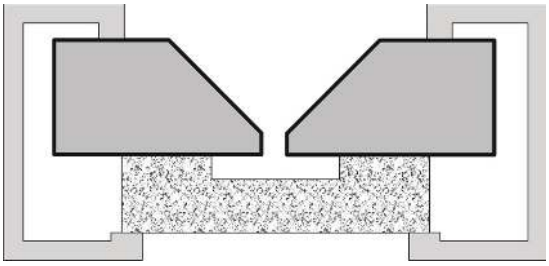


It is inexpensive, easily applied, and requires little special skill.

The backing bar becomes a permanent feature of the joint, which may be undesirable from an aesthetic point of view, depending on the part. It also presents a fatigue notch to the weld root. Once fabricated, the backing bar is tack welded into position. A permanent backing bar is unlikely to be used where a product or gases flow through pipework because of possible entrapment and flow disruption.

Temporary Backing Bar

Another type of backing bar support can be clamped in place for welding and removed after the joint has been completed (see fig.3)



To ensure the bar cannot be welded to the joint, this temporary support often is water-cooled and manufactured from copper.

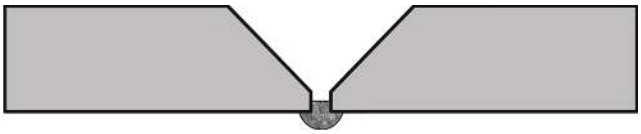
The manufactured temporary backing bar is held in place by a suitable tool or fixture that allows it to be removed easily after welding.

This application can be time-consuming for low-volume manufacturing because of the complexities of set-up and the need for removal after welding, bearing in mind that water cooling lines are attached.

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 technique produces a consistent root profile and is available in a limited range of materials, Standard insert material includes the common grades of stainless steel, but some of the nickel alloys, such as MONEL® alloy, INCONEL® alloy, and HASTELLOY®, may not be available in the form required.

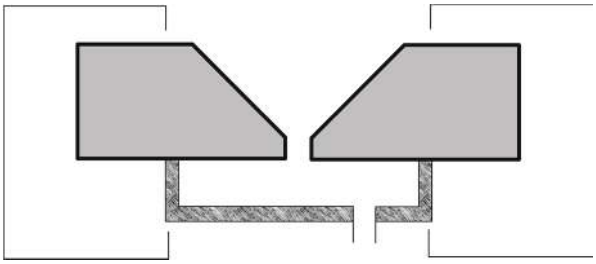
Typical inserts are known as A shape, EB-, J_, and K-type inserts (see fig.4)**.**



Availability of these inserts depends on the availability of the raw materials in the form required for the insert material.

Inert Gas

Although originally intended to be used to butt weld tube with the GTAW process, inert gas backing has been extended to linear butt welds (see fig.5).

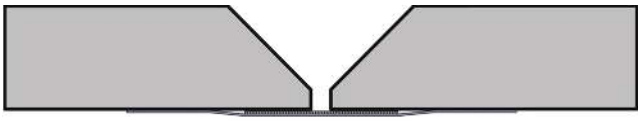


When nominal gas sealing is provided at the ends of the joint seam, a gas pressure is created under the bead that is sufficient to provide protection from contamination and act as support for the molten metal. Inert gas backing produces good root profiles.

Argon is the most common inert gas for backing, and where there is no metallurgical or chemical restriction, nitrogen also can be used. Helium often is used as a backing gas in the US, because of its relatively low cost, while argon with a 2 to 7 percent hydrogen content can be used for oxide reduction purposes, assuming the hydrogen content has no detrimental metallurgical effects on the weld.

Glass-reinforced tape

In another technique, self-adhesive, thermally stable, inert tape is applied to the underside of the joint (see fig.6).



The tape is aluminium foil centrally overlaid with a band of woven, continuous-filament glass fibre cloth. It is cut to length and stuck to the underside of the joint to be welded.

The fibre prevents overpenetration of the fusion zone but shapes the underbead to produce a positive, continuous reinforcement that blends to the parent material on each side (see fig.7).

After the welding, the tape is removed from the weld zone by peeling. The tape typically is suitable for use on most common materials such as carbon, alloy, and stainless steels cast iron and copper, nickel and titanium alloys. It is used in conjunction with the MMA,GTAW, GMAW processes.

Two standard versions of tape are readily available – light-duty for use up to 80 Amps and heavy-duty for up to 160 Amps. An extra heavy duty version is available for use up to 240 Amps, but above that, ceramic tiles are necessary.

Light weight
80 Amps

Middle weight
160 Amps

Heavy weight
240 Amps

Conclusion

The use of backing gas, tiles, and bars is necessary in many situations, but glass fibre backing tape is an alternative from which many operations could benefit. It is designed to allow weld roots to be cast directly onto the fibre, and it helps produce flat, slag-free welds eliminate the need for grinding and backgouging and minimize the risk of weld failures.

Examples of Backing Tape being used in welding.

Extending the Argweld® range of purging products, Huntingdon

Fusion Techniques HFT® provides an economical non metallic weld backing system for the backing of welds, where purging is required but not easily achieved, for quality and for supporting weld roots to improve weld bead profiles.

Typically for the welding of thin wall stainless steel sheet and vessels from one side only, the backing tape can be attached to the backside of the weld, to support the weld pool, keep the argon from the weld torch surrounding the weld pool and eliminate the need to back purge, while giving a consistent high quality underbead profile.

For purging large vessels the tremendous savings of purge gas and waiting time, pays for the use of the backing tape many times over.

The high temperature heat resistant adhesive aluminium backing foil is 75 mm (3”) wide and in the centre is a heat resistant band of woven glass fibre cloth 25 mm (1”) wide.

The glass fibre cloth has a weight of 1000 grams per square metre.

The 80 Amps Tape comes in rolls of 25 m (80”) length and the 160 and 240 Amps tape rolls are 12.5 m (40”) long.

With the thickest cloth Argweld® **Backing Tape™** will support single pass welding at weld currents up to 240 Amps, without change to the chemistry or metallurgy of the weld.

Features:

- Speeds up production
- Provides back purge facility
- Ideal for stainless steel and alloyed metals
- Saves cleaning costs
- Massive purge gas savings
- Eliminates weld defects
- Suitable for sheet, plate, pipes, vessels
- For horizontal or vertical welding
- No gouging or grinding
- No re-welding or rework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