Welding Job Knowledge

Welding costs - Part 2

Previous articles dealt with the mechanics of costing a weld: how to calculate the weld volume and how to calculate the amount of welding consumables required to fill a weld preparation.

The final step in costing a weld is to determine the length of time to deposit this weight of weld metal. This is obviously a function of the deposition rate of the process. The deposition rate is generally expressed as kgs/hr or lbs/hr deposited at a given welding current, welding continuously and without any breaks for electrode changing or deslagging.

Flux-cored arc welding

The deposition rate will be affected by many factors and it will not be possible within the limitations of these articles to list the precise deposition rates for any specific process or welding current. Such data can be found in publications referenced below or by a web search. The ranges of approximate deposition rates for the commoner arc welding processes are listed in Table 1.

Table 1 Indicative deposition rates - arc welding processes

Welding Process	Deposition Rate kgs/hr	
	min	max
MMA	0.4	5.5
MAG	0.6	12
FCAW	1.0	15
Single wire SAW	3	16

To obtain an accurate figure for the specific parameters to be used is a relatively simple exercise. Weighing a plate, depositing weld metal using the required parameters on this plate for a fixed time and then re-weighing the plate will give an accurate figure that may be used for estimating purposes.

There is one golden rule for minimising the cost of making a weld and, whilst this may seem to be self-evident, it is worth repeating: deposit the minimum amount of the highest quality weld metal with the largest gauge electrode or wire at the highest current in the shortest possible time. This is obviously the ideal and can seldom be achieved in practice because of limitations on heat input, access etc.

The implications of applying the golden rule are:

1. To deposit the minimum amount of weld metal the designer, aided by the welding engineer, must select the smallest weld preparation that is capable of providing the required weld quality. If the included angle is too narrow then lack of side wall fusion is a possibility with the consequent costs of repair; too wide an angle is wasteful in terms of deposited weld metal. Remember, though, that the cost of providing a weld preparation (by flame-cutting, edge planning, milling *etc*) must also be included in any costing exercise as must the cost of assembly. Machined weld preparations are more accurate than flame cut edges and this may result in faster set-up times and a reduced weld repair rate. It may be possible to use a square edge preparation by using the deep penetration characteristics of some of the welding processes; electron beam and laser welding are the best examples of this technique. Plasma-TIG and activated flux TIG can penetrate up to 10mm in a single pass; the 'finger' penetration of spray transfer MAG welding can penetrate up to 6mm and a submerged arc weld can penetrate up to 15mm. There is also the benefit when using a square edge preparation in that the consumption of filler metal is substantially reduced, the bulk of the weld metal being provided by the parent material. The final option on reducing costs when butt welding is for the designer to specify a partial penetration joint. The most expensive weld pass in any full penetration butt weld is the root pass and if this can be eliminated by using partial penetration joints then substantial savings can be made. However, the decision to use partial penetration welds should not be taken lightly but only if service conditions permit the presence of a large crevice at the weld root. The designer will therefore need to consider whether fatigue, creep, corrosion etc are likely to occur and must clearly specify where the joints are permitted and the minimum acceptable weld throat.

2. Depositing the highest quality weld metal infers that the weld repair rate will be reduced. Repair weld metal is very costly, particularly if the unacceptable defects are detected late in the fabrication programme; perhaps after final assembly where access is difficult or after post weld heat treatment. Accurate weld preparations and fit-up, easy access for the welder, welds made in the flat position and well trained welders will all help to minimise the weld repair rate.

3. Depositing weld metal with the largest electrode or wire at the highest current will obviously give the highest weld deposition rate and shortest joint completion time. The deposition rate figures in *Table 1*give the minimum and maximum deposition rates at minimum and maximum welding currents. As an example, a 1.2mm diameter MAG wire at 120amps will deposit around 1.2 kgs/hr, at 380amps around 8 kgs/hr. To enable high welding currents to be used the item must be placed in the flat position and there must be easy access for the welder. One benefit of using the high welding currents is that the number of weld runs to fill the joint will be reduced and this, in most circumstances, will result in less distortion than a large number of low current weld passes. Remedial work to correct distortion can therefore be reduced. A further benefit when welding the ferritic steels is that high current and therefore high heat input may allow any preheat to be reduced or eliminated entirely.

However, there are limitations to this approach to improving productivity. If achieving high toughness is a factor then it is likely that heat input will need to be controlled when welding the ferritic steels, placing a limit on the welding current and travel speed. High welding currents also imply a large, fluid weld pool and it may not be possible to control this pool when welding in any other than the flat position - for example, MAG welding cannot be performed using spray transfer (high welding current) in the vertical position due to the absence of a flux to hold the pool in place. Using a manual process at such high currents also results in increased welder fatigue resulting in a reduced duty cycle. A solution to this problem is to mechanise or automate the process.

To achieve the most cost effective solution to producing a welded structure is therefore not simply to increase duty cycle or deposition rate but to consider all aspects of fabrication from the design stage to final inspection, involving all members of the team from designer to welder.

This article was written by **Gene Mathers**.

References:

Procedure Handbook of Arc Welding, Publication - Lincoln Co.

Standard Data for Arc Welding, Publication - TWI (out of print)

Welding Handbook Vol 2 Welding Processes, Publication - American Welding Society