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WELDING OF STEEL CASTINGS

INTRODUCTION:

Welding is used popularly to repair the casting defects in new steel castings, old steel castings and also for joining them to wrought products like plates etc. Though welding of castings is not difficult, it is different from welding of plates and requires special considerations because of the fact that

- Most of the time the casting defects are irregular in shape and size and so filling them up produces multi-directional shrinkage stress which can lead to distortion and or cracking
- Section thicknesses are usually very high which increase the cooling rate and tend to produce hard metallurgical phases and cracks
- In complex castings, some sections will be heavy and some will be thin. Since heavy sections cool faster than thin sections, residual stresses may result during welding
- The metallurgical condition of the casting and the cast structure many time have poor ductility which can lead to cracking
- There can be compositional differences between the casting and the weld metal
- The ultimate heat treatment the casting has to undergo may be markedly different from the one to which the weld metal is normally tested

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All the above factors make the welding of castings an interesting subject and calls for a good understanding of the metallurgical aspects involved in welding to select a consumable, assess its properties, qualify a welding procedure and adopt the correct welding practices to produce a defect free casting. In this article, we highlight the various important considerations in welding of castings which will be of use for welding personnel to get a better understanding of the subject and produce good welds.

Selection of Welding Process

Though welding processes like GMAW, GTAW, PAW, FCAW can be used for welding of steel castings, most of the time SMAW is the most preferred process because of its many inherent advantages like accessibility, positional welding, easy availability of specific compositions, ability to deposit weld metal in small as well as large quantum, in-situ operations etc. So, many applications use SMAW and selection of process is virtually not there.

Base material considerations

The chemical composition, mechanical properties of the steel casting are very important for selecting the right weld metal. Apart from these, the condition of the casting on which welding has to be done is also very important. If the casting is in hardened condition, then welding becomes very difficult. Normally welding is done in the as-cast condition before any heat treatment but there may be requirements in which welding may have to be done after some heat treatment, particularly in the case of large and intricate castings. Since the metallurgical condition of the casting affects the ductility of the base material which directly influences the ability of the material to withstand shrinkage stresses, welding procedures may require modifications to ensure defect free welds.

Selection of electrodes

This step is an important step in the successful accomplishment of sound welds that will perform well in service. The following points are noteworthy during selection of weld metals

- In general the weld metals have lower carbon content as compared to the castings and hence higher alloying additions may be required to achieve the properties equal to that of the castings
- The weld metal properties are normally declared after a stress relief heat treatment but some castings, under certain conditions (when the weld metal volume is more), may call for a different combination of heat treatments. In such cases the repaired casting has to undergo the complete heat treatment

once again. In such cases the weld metal also should be capable of producing properties with the changed heat treatment cycles

Matching the major alloying elements, matching the impact properties, matching the strength and other properties are some of the usual techniques adopted for selecting the electrodes. Table 1 gives details of the suggested electrode for various castings. It should be noted that these recommendations assume that the weld metal is normally subjected to the usual heat treatment cycles and for special heat treatments their usage should be confirmed after consultations.

Forming and qualifying the welding procedure

Just similar to the welding of plates, pipes etc. a WPS and a PQR has to be established before starting the welding of steel castings. ASTM A 488 details this procedure which is similar to the ASME section IX. It groups casting in to various categories (as indicated in Table 1) just like P number, filler metals in F number and weld metals in A number. There are essential variables and procedures that have to be qualified when they are altered.

While qualifying a procedure care should be exercised to ensure that the procedure covers all the practical requirements including the post weld heat treatments. It is preferable to qualify the procedure with a full heat treatment of the casting so that in case required, the same procedure can be used.

Actual welding

Use the established procedure and consumables during actual welding. Ensure that proper pre-heat, inter-pass temperatures are maintained. In many cases, suitable sequencing and bead laying procedures may have to be adopted to ensure that the shrinkage stresses are limited to the minimum. The use of a production coupon also can be made which can be subsequently tested destructively to ensure that everything is alright. The following additional welding procedural points should be of use.

- In general, a low hydrogen (basic coated) electrode is used
- Normally DC+ current is used
- Use proper techniques like grinding, brushing etc to expose a defect free clean surface for welding
- All the defects should be ground off and removed completely. Ensure their complete detection and removal using a D.P.Test.
- Pre-heat and inter pass temperatures are to be continuously checked using thermal chalks
- Avoid air blasts which can lead to fast cooling during welding.

- After welding allow the castings to cool slowly, particularly the low alloy and carbon steel castings

Conclusions

Welding of steel castings is not a difficult task since it is very similar to the welding of similar wrought products but requires only some special considerations to take care of finer aspects that can lead to defects in the finished welds.

Table 1:

Category as per A 488	ASTM specification	Grade	Suggested AWL electrodes
1	A27	U60/30, 65/35	SUPERBOND / SUPERBOND-S
		70/36,70/40	SUPABASE X PLUS
	A216	WCA	SUPERBOND / SUPERBOND S
		WCB	SUPABASE X PLUS
	A352	LCB/LCC	TENALLOY Z PLUS / TENALLOY HH SPL
		LCA	SUPABASE X PLUS
	A757	A1Q	TENALLLOY Z PLUS
2	A216	WCC	TENALLOY Z PLUS / TENALLOY 55
	A352	LCC	TENALLOY Z PLUS / TENALLOY 55
3	A732	4A/5N	TENALLOY 65
4	A217	WC1	MOLYTEN
		WC6	CROMOTEN
		WC9	CROMOTEN C
	A352	LC1	TENALLOY 70C
		LC2	TENALLOY 70B
	A356	2	MOLYTEN
5	A217	C5	CROMOTEN D
		C12	CROMOTEN 9
		C12A	CROMOTEN 9M
	A356	10	CROMOTEN C
	A487	4A	TENALLOY 70
6	A148	105-85	TENALLOY 80
	A487	2B	TENALLOY 70
8	A217	CA15	BETACHROME 13CR / BETANOX D
	A352	CA6NM	BETACHROME 13/4

9	A351/743/744	CF3/3A	SUPERINOX 1C
		CF3M/3MA	SUPERINOX 2C
		CG3M	SUPERINOX 2D
10	A351	CF8	SUPERINOX 1A
		CF8M	SUPERINOX 2A
		CH8	BETANOX D
11	A351	CF8C	SUPERINOX 1B
		CK20	BETANOX C
		CN7M	BETANOX 20/30
	A743	CN7MS	BETANOX 20/25/5Cu
12	A351	CD4MCu	BETANOX 2553
13	A747	CB7Cu1	SUPERINOX 630

To know more about electrodes detailed in Table 1, please click on the name of electrode. Please contact us at cmo@adorians.com or visit www.adorwelding.com for assistance in ensuring defect free welding of steel castings.

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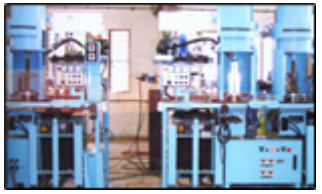

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