13 Inspection and Testing of Iron Castings

13.1 INTRODUCTION

In iron foundries, quality control systems are designed to ensure that castings are produced with a certain level of quality that is acceptable to both the customer and the supplier. At various stages during the manufacturing and particularly on the finished castings, some inspection is required to see that the specifications of casting quality are being maintained. Castings with obvious visible defects are quickly rejected. However, castings which are dimensionally or metallurgically defective may require special measurements or tests before they are detected.

Inspection of iron castings normally consists of checking for shape and dimensions, coupled with aided and unaided visual inspection for external discontinuities and surface quality. Various kinds of tests performed for mechanical properties along with chemical analyses are supplemented by those of nondestructive inspection including leak testing and proof loading and all these are used to ensure the soundness of the castings. Since these various inspection procedures add to the cost of the product, a prior consideration is required to determine the amount of the inspection needed to maintain adequate control over the quality required. In some cases, full inspection of each individual casting may be required where as in other cases, sampling procedures may be sufficient to maintain the quality of the casting.

13.2 TYPES OF INSPECTION

The inspection procedures adopted for quality testing of castings may be classified as follows.[99-106]

finished product heavier than permissible. The various methods of inspection and testing adopted for detecting casting defects and properties can be broadly grouped into following categories:

1. Methods for Detection of Surface Defects
2. Methods for Detection of Internal Defects
3. Methods for Measurement of Properties.

13.3.1 Detection of Surface Defects

All the methods in this category require clean and relatively smooth surfaces of the casting for effective results of examination.

13.3.1.1 Visual Examination

This is most important test adopted for iron castings which is closely followed by measurement of vital dimensions. Various kinds of aids to such inspection are adopted which include adequate illumination of the areas under inspection and use of necessary gigs and fixtures for checking measurement. Such visual inspection will be able to eliminate castings with major surface imperfections such as misruns, cross-joints and blowholes. The areas of the castings from where risers have been removed should be carefully examined for presence of any defect.

13.3.1.2 Magnetic Crack Detection or Magnetic-Particle Inspection

This method is frequently used in iron foundries to detect presence of smaller cracks on the surface or slightly sub-surface defects which may not be detected by visual examination. In this technique, a magnetic field is set-up in the casting or in the part of the casting being examined either by passing a heavy electric current through the casting or immersing the casting in the magnetic field set-up by a coil carrying electric current or by a permanent magnet. If any crack is present in the casting and interrupt the magnetic field in the casting, there will be a magnetic flux leakage at the position of the crack and this leakage will be defected by magnetic particles applied as a dry powder or in a suspension in a liquid applied as magnetic ink. For best sensitivity, the magnetic particles are covered during manufacture to form a proprietary fluorescent magnetic ink and the casting is viewed under an ultraviolet light.

4. Can risers, gates, and chills, etc. be positioned properly to ensure casting soundress?
5. Are the section size and configuration of the casting such as to cause undue stresses in the casting and consequent tearing or fracture of the casting?
6. Is it possible to establish and control directional solidification needed for casting soundness?
7. Can the model making be an aid in the desired casting design?

The last factor is an important consideration in case of complicated castings. In such cases, it is often desirable to make a model of the desired casting to determine accurately whether standard moulding methods can be adopted and whether it is possible to obtain sound metal in all critical areas.

Both the trouble and money could be saved, if an accurately scaled wood or plastic model can be made because even with the very competent foundry and/or design engineer, it is possible to miss many of important details as outlined above of the design when all that he sees is a blueprint of the design.

Many costly design changes and casting repairs can be avoided by making and studying a model of the job to be done. Areas of potential shrinkage defects, hot tearing can be predicated, gates and riser positions can be judiciously decided without trial and error and more serious changes in the casting design can be spotted before final working patterns are made.

For above modeling work, transparent plastics are excellent materials. Modeling clay can be also used to simulate padding and other features needed

14.3 SEQUENCE OF CASTING DESIGN

For very intricate castings and even for the simple castings, it is preferred to adopt the following design sequence:[111-112]

1. Establish the service conditions for casting from the layout and otherall specifications of the casting design.
2. Determine the static and dynamic forces and other critical requirements.
3. Layout the structural skeletons.
4. Decide the suitable composition of the iron to be used.

these areas and hence will reduce the size of the defect formed or may eliminate its formation. But it is a doubtful solution. A solid casting without formation of any such defect is obtained by designing the section at the junction slightly smaller than of the straight arms and using an adequate inside radius. The above principles have been used in the design of the junctions formed as shown in Fig. 14.2. In the case of X-type junctions, off-setting one arm is the worse design as too rapid heat transfer between the junctions will occur which will increase the size of the defect formed. Therefore, the two arms should be offset considerably which can permit the use of chills and/or decrease in the size of the junction effectively to produce the solid casting. There has to be an optimum distance between the junctions formed by offsetting the arms as shown in the example of design of X-junction.

It should be emphasized that even if the designer is unable to design a joint which will not be free of shrinkage cavity, but he can design it such that it will have smallest possible defect formed and with such a design, the foundryman can easily apply his various methods of chilling, padding, directional solidification to produce a solid section. Thus, in general, out of all above 5 types of junctions of uniform sections, one should follow:

1. To attempt to limit such junctions formation;
2. To select the least difficult one and
3. To attempt to put minimum number of sections together.

14.5.2.2 Design of Junctions of Unequal Sections and Sharply Differing Cross Sections

Joints of dissimilar sections also produce shrinkage defects and contraction stresses like junctions of uniform sections but the contractions stresses formed at the junctions of unequal sections are of greater magnitude than in the cases of similar sections which cool relatively evenly. The stresses may be so severe that they can cause ruptures at these junctions.

The usual remedy for the feeding problem is taken care by placing riser at one end of the thick section and section proportioning for regulating solidification of the junction from where the thinner section can draw its feed metal. It is also advisable to incorporate a gradual increase in the thickness of the thinner section so that it is almost equal in thickness with the