

UNIT 4

PRODUCTION COST ESTIMATION**Content 1:****Estimation of Different Types of Jobs:****COST ESTIMATION IN FOUNDRY SHOP**

Foundry is a metal casting process in which the metal is melted and poured into the moulds to get the components in desired shape and size. Castings are obtained from a foundry shop.

Generally a foundry shop has the following sections:

1. Pattern Making Section

In this section the patterns for making the moulds are manufactured. The machines involved in making the patterns are very costly and small foundries may not be able to afford these machines. In such cases the pattern are not made for outside parties who are specialists in pattern making. Patterns are made either from wood or from a metal.

2. Sand-mixing Section

In this section raw sand is washed to remove clay etc., and various ingredients are added in the sand for making the cores and moulds.

3. Core-making Section

Cores are made in this section and used in moulds to provide holes or cavities in the castings.

4. Mould Making Section

This is the section where moulds are made with the help of patterns. The moulds may be made manually or with moulding machines.

5. Melting Section

Metal is melted in the furnace and desired composition of metal is attained by adding various constituents. Metal may be melted in a cupola or in an induction or in an arc furnace. In some cases pit furnace is also used for melting the metals.

6. Fettling Section

The molten metal after pouring in the moulds is allowed to cool and the casting is then taken out of mould. The casting is then cleaned to remove sand and extra material and is shot blasted in fettling section. In fettling operation risers, runners and gates are cut off and removed.

7. Inspection Section

The castings are inspected in the inspection section before being sent out of the factory.

ESTIMATION OF COST OF CASTINGS

The total cost of manufacturing a component consists of following elements:

1. Material cost.
2. Labour cost.
3. Direct other expenses.
4. Overhead expenses.

Material Cost

(a) Cost of material required for casting is calculated as follows:

(i) From the component drawing, calculate the volume of material required for casting.

This volume multiplied by density of material gives the net weight of the casting.

(ii) Add the weight of process scrap *i.e.* weight of runners, gates and risers and other material consumed as a part of process in getting the casting.

(iii) Add the allowance for metal loss in oxidation in furnace, in cutting the gates and runners and over runs etc.

Note: The casting drawing is made by adding various allowances like shrinkage, draft and machining allowance, etc., to the dimensions of finished component.

(a) In addition to the direct material, various other materials are used in the process of manufacture of a casting. Some of the materials are:

(i) Materials required in melting the metal, *i.e.*, coal, limestone and other fluxes etc. The cost of these materials is calculated by tabulating the value of material used on per tonne basis and then apportioned on each item.

(ii) Material used in core shop for making the cores, *i.e.*, oils, binders and refractories etc.

The cost of core materials is calculated depending upon the core size and method of making the core. Similarly the cost of moulding sand ingredients is also calculated.

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ly expressed as per kg of casting weight and is covered under overhead costs.

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Labour Cost

Labour is involved at various stages in a foundry shop. Broadly it is divided into two categories:

- (i) The cost of labour involved in making the cores, baking of cores and moulds is based on the time taken for making various moulds and cores.
 - (ii) The cost of labour involved in firing the furnace, melting and pouring of the metal.
- Cleaning of castings, fettling, painting of castings etc., is generally calculated on the basis of per kg of cast weight.

Direct Other Expenses

Direct expenses include the expenditure incurred on patterns, core boxes, cost of using machines and other items which can be directly identified with a particular product. The cost of patterns, core boxes etc., is distributed on per item basis.

Overhead Expenses

The overheads consist of the salary and wages of supervisory staff, pattern shop staff and inspection staff, administrative expenses, water and electricity charges etc. The overheads are generally expressed as percentage of labour charges.

The cost of a cast component is calculated by adding the above constituents.

COST ESTIMATION IN WELDING SHOP

Gas welding:

The most commonly used gas welding is oxy-acetylene welding. The high temperature required for welding is obtained by the application of a flame from mixture of oxygen and acetylene gas.

The filler material is used to fill the gap between the parts to be welded. The welding technique used may be leftward welding or rightward welding.

Leftward welding : In this method, welding is started from right hand side of the joint and proceeds towards left. This method is used for welding plates upto 5 mm thick. No edge preparation is required in case of the plates of thickness upto 3 mm.

Rightward welding : This method is adopted for welding thicker plates. Welding proceeds from left to right. The flame is directed towards the deposited metal and rate of cooling is very slow.

The cost of welding depends on the welding process used, the type of joint, materials, and labour employed in making and inspecting the joint. Various types of welded joints are shown in Fig.

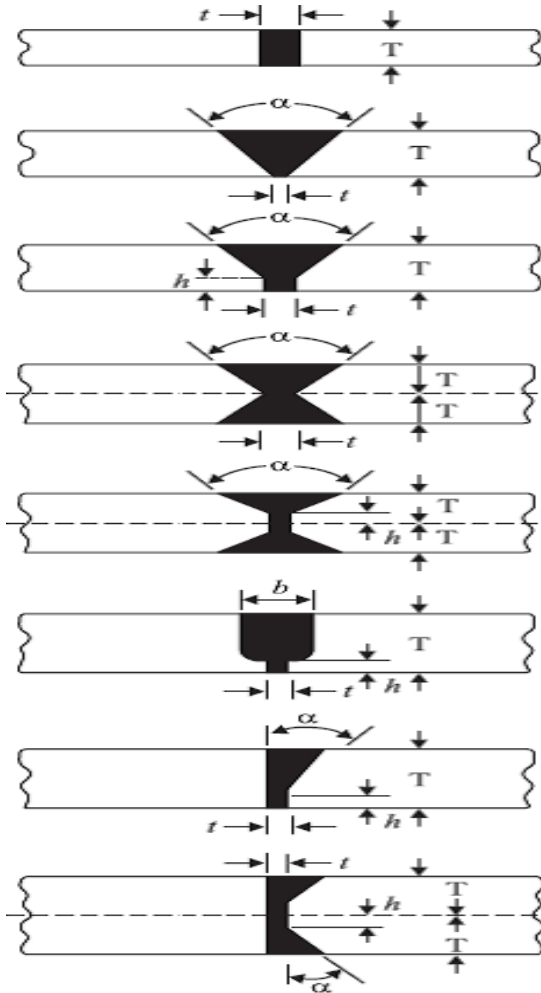


Fig. 5.3. Types of Welded Joints.

Estimation of Cost in Welding

The total cost of welding consists of the following elements:

1. Direct material cost.
2. Direct labour cost.
3. Direct other expenses.
4. Overheads.

1. Direct Material Cost

The direct material cost in a welded component consists of the following:

- (i) Cost of base materials to be welded *i.e.*, sheet, plate, rolled section, casting or forging. This cost is calculated separately.
- (ii) Cost of electrodes/filler material used. The electrode consumption can be estimated by using the charts supplied by the suppliers. Another way to find the actual weight of weld metal deposited is to weigh the component before and after the welding and making allowance for stub end and other losses during welding.

Also the weight of weld metal = Volume of weld \times Density of weld material

2. Direct Labour Cost

The direct labour cost is the cost of labour for preparation, welding and finishing operations.

Preparation or pre-welding labour cost is the cost associated with preparation of job for welding, *i.e.*, the edge preparation, machining the sections to be welded etc. If gas is used in cutting/preparation of edges, its cost is also taken care of.

Cost of labour in actual welding operation is calculated considering the time in which arc is actually in operation.

The cost of labour for finishing operation is the cost of labour involved in grinding, machining, sand or shot blasting, heat treatment or painting of welded joints.

3. Direct Other Expenses

The direct other expenses include the cost of power consumed, cost of fixtures used for a particular job etc.

Cost of power: The cost of power consumed in arc welding can be calculated from the following formula:

$$\text{Power cost} = \frac{V \times A}{1,000} \times \frac{T}{60} \times \frac{1}{E} \times \frac{1}{r} \times C$$

Where,

V = Voltage

A = Current in Amperes

t = Welding time in minutes

E = Efficiency of the welding machine

= 0.6 for welding transformer

= 0.25 for welding generator

r = Ratio of operating time to connecting time taken by the operator

C = Cost of electricity per kWh *i.e.*, Unit.

In case of gas welding, the cost of gas consumed is calculated by taking the values from Tables 5.1 and 5.2. Cost of welding fixtures is apportioned on the total number of components that can be manufactured using that fixture.

4. Overheads

The overheads include the expenses due to office and supervisory staff, lighting charges of office and plant, inspection, transport, cost of consumables and other charges. The cost of equipment is also apportioned to the individual

components in the form of depreciation.

COST ESTIMATION IN FORGING SHOP

Forging is the process of forming a metal into desired shape and size by the application of localized compressive forces. The component may be forged in cold or hot condition. In case of hot forging the metal is heated to a high temperature below its melting point and is pressed into shape by the application of compressive forces by manual or power hammers, presses or special forging machines.

Forging Processes

Forging processes can be divided into following categories:

- 1. Smith forging:** In smith forging, also known as hand forging, the component is made by hammering the heated material on an anvil. The hammering may be done by hand or machine.
- 2. Drop forging:** The forging is done by using the impressions machined on a pair of die blocks. The upper half of the die is raised and allowed to drop on the heated metal placed over the lower half of the die. The metal is thus squeezed into required shape.
- 3. Press forging:** In this method the metal is squeezed into desired shape in dies using presses. Instead of rapid impact blows of hammer, pressure is applied slowly. This method is used for producing accurate forgings.
- 4. Machine forging or Upset forging:** In machine forging or upset forging the metal is shaped by making it to flow at right angles to the normal axis. The heated bar stock is held between two dies and the protruding end is hammered using another die. In upset forging the cross-section of the metal is increased with a corresponding reduction in its length.
- 5. Roll forging:** Roll forging is used to draw out sections of bar stock, *i.e.*, reducing the cross-section and increasing the length. Special roll forging machines, with dies of decreasing cross-section are used for roll forging.

Material Losses in Forging:

While calculating the volume of material to be used for a component an allowance is made for wastage of metal due to various factors. Various allowances to be taken into account are discussed below:

(i) Shear loss: The blank required for forging a component is cut from billets or long bars.

The material equal to the product of thickness of sawing blade and cross-section of bar is lost for each cut. Similarly, if the small pieces left at the end are not of full length, these also go as waste. Shear loss is generally taken as 5 percent of net weight.

(ii) Tonghold loss: Drop forging operations are performed by holding the stock at one end with the help of tongs. A small length, about 2.0 – 2.5 cm and equal to diameter of stock is added to the stock for holding.

$$\text{Tonghold loss} = \text{Area of X-section of bar} \times \text{Length of tonghold}$$

(iii) Scale loss: As the forging process is performed at very high temperature, the Oxygen from air forms iron oxide by reacting with hot surface. This iron oxide forms a thin film called scale, and falls off from surface at each stroke of hammer. Scale loss is taken as 6 percent of net weight.

(iv) Flash loss: When dies are used for forging, some metal comes out of the die at the parting line of the top and bottom halves of the die. This extra metal is called flash. Flash is generally taken as 20 mm wide and 3 mm thick. The circumference of component at parting line multiplied by cross-sectional area of flash gives the volume of flash. The flash loss in weight is then calculated by multiplying the volume of flash by density of the material.

(v) Sprue loss: When the component is forged by holding the stock with tongs, the tonghold and metal in the die are connected by a portion of metal called the sprue or runner. This is cut off when product is completed. Sprue loss is taken as 7 percent of net weight.

4.2 Estimation of Cost of Forgings

The cost of a forged component consists of following elements:

1. Cost of direct materials.
2. Cost of direct labour.
3. Direct expenses such as cost of dies and cost of press.
4. Overheads.

1. Cost of Direct Material

Cost of direct material used in the manufacture of a forged component is calculated as follows:

(i) Calculate the net weight of forging: Net weight of the forged component is calculated from the drawings by first calculating the volume and then multiplying it by the density of material used.

Net weight = Volume of forging \times Density of material

(ii) **Calculate the gross weight:** Gross weight is the weight of forging stock required to make the forged component. Gross weight is calculated by adding material lost due to various factors discussed above, to the net weight.

Gross weight = Net weight + Material loss in the process

In case of smith or hand forging, only scale loss and shear loss are to be added to net weight but in case of die forging all the losses are taken into account and added to net weight.

(iii) **Diameter and length of stock:** The greatest section of forging gives the diameter of stock to be used, and

$$\text{Length of stock} = \frac{\text{Gross weight}}{\text{X-sectional area of stock} \times \text{Density of material}}$$

(iv) The cost of direct material is calculated by multiplying the gross weight by price of the raw material

Direct material cost = Gross weight \times Price per kg

2. Cost of Direct Labour

Direct labour cost is estimated as follows:

Direct labour cost = $t \times l$

where

t = time for forging per piece (in hours)

l = labour rate per hour.

It is very difficult to estimate the exact time to forge a component. In practice the forging time per component is estimated based on the total production of eight hours or a day.

3. Direct Expenses

Direct expenses include the expenditure incurred on dies and other equipment, cost of using machines and any other item, which can be directly identified with a particular product. The method of apportioning die cost and machine cost is illustrated below: *Apportioning of Die Cost*

Let cost of Die = Rs. X

No. of components that can be produced using this die (i.e., die life) = Y
components Cost of die/component = Rs. X/Y

Apportioning of Machine (Press) Cost

Let cost of press = Rs. A

Life of press = n years

= $n \times 12 \times 4 \times 5 \times 8 = 1920 n$ hours

(Assuming 8 hours of working per day, 5 days a week and 4 weeks a month in 12 months of year).

$$\text{Hourly cost of press} = \frac{A}{1920 \, n}$$

No. of components produced per hour = N

$$\text{Cost of using press per component} = \text{Rs.} \frac{A}{1920 \, n \, N}$$

This excludes cost of power consumed and cost of consumables, if any.

4. Overheads

The overheads include supervisory charges, depreciation of plant and machinery, consumables, power and lighting charges, office expenses etc. The overheads are generally expressed as percentage of direct labour cost.

The total cost of forging is calculated by adding the direct material cost, direct labour cost, direct expenses and overheads.