UNIT-IV
PRODUCTION COST ESTIMATION

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PRODUCTION COST ESTIMATION

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
- Insuch cases the pattern are got 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

1. 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.

(iv) Multiply the total weight by cost per unit weight of the material used.

(v)Subtract the value of scarp return from the amount obtained in step (*iv*), to get the direct material cost.

(b**) 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. The expenditure made on these materials is generally expressed as per kg of casting weight and is covered under overhead costs.

2. 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.

3. 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.

4. 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.

1.Calculate the total cost of CI (Cast Iron) cap shown in Fig. 5.1, from the following data :
Cost of molten iron at cupola spout = Rs. 30 per kg
Process scrap = 17 percent of net wt. of casting
Process scrap return value = Rs. 5 per kg
Administrative overhead charges = Rs. 2 per kg of metal poured.
Density of material used = 7.2 gms/cc

The other expenditure details are :

Process	*Time per piece*	*Labour charges per hr*	*Shop overheads per hr*
Moulding and pouring	10 min	Rs. 30	Rs. 30
Casting removal, gate cutting etc.	4 min	Rs. 10	Rs. 30
Fettling and inspection	6 min	Rs. 10	Rs. 30

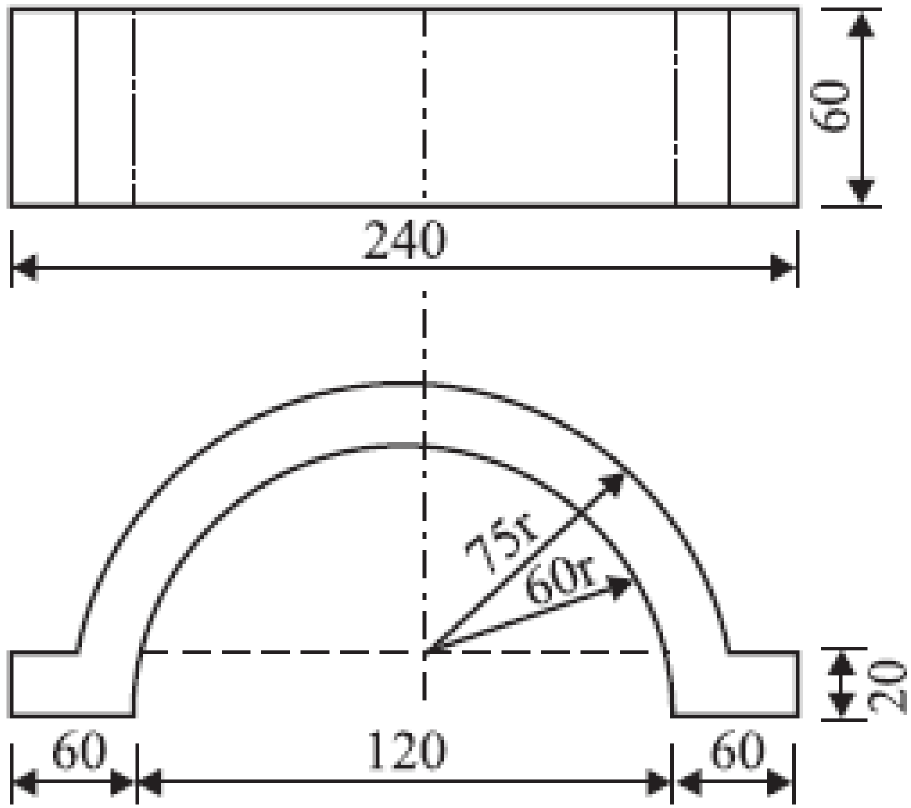


Fig. 5.1. All dimensions are in mm.

Solution:

$$\text{Volume of the component} = (2 \times 6 \times 2 \times 6) + \frac{1}{2} \times p\,[(7.5)^2 - (6)^2]\,6$$

$$= 335 \text{ cc}$$

$$\text{Net weight of the casting} = 335 \times 7.2$$

$$= 2{,}412 \text{ gms}$$

$$= 2.4 \text{ kgs}$$

$$\text{Process scrap} = 2.4 \times 0.17 = 0.4 \text{ kg}$$

$$\text{Metal required per piece} = 2.4 + 0.4 = 2.8 \text{ kgs}$$

$$\text{Material cost/piece} = 2.8 \times 30 = \text{Rs. } 84$$

$$\text{Process return} = 0.4 \times 5 = \text{Rs. } 2$$

$$\text{Net material cost per piece} = 84 - 2 = \text{Rs. } 82$$

(*ii*) Calculate Labour Cost and Overheads

Process	*Time per piece*	*Labour charges per piece (Rs.)*	*Shop overheads per piece (Rs.)*
Moulding and pouring	10 min	$\frac{10}{60} \times 30 = 5$	$\frac{30 \times 10}{60} = 5$
Casting removal, gate cutting etc.	4 min	$\frac{4}{60} \times 10 = 0.67$	$\frac{30 \times 4}{60} = 2$
Fettling and inspection	6 min	$\frac{6}{60} \times 10 = 1$	$\frac{30 \times 6}{60} = 3$
Total		**Rs. 6.67**	**Rs. 10**

$$
\begin{aligned}
\text{Labour charges} &= \text{Rs. } 6.67 \text{ per piece} \\
\text{Shop overheads} &= \text{Rs. } 10 \text{ per piece} \\
\text{Administrative overheads} &= 2 \times 2.8 = \text{Rs. } 5.6 \\
\text{Total cost per piece} &= 82 + 6.67 + 10 + 5.6 \\
&= \text{Rs. } 104.27
\end{aligned}
$$

2.A cast iron component is to be manufactured as per Fig. 5.2. Estimate the selling price per piece from the following data :

Density of material = 7.2 gms/cc

Cost of molten metal at cupola spout = Rs. 20 per kg

Process scrap = 20 percent of net weight

Scrap return value = Rs. 6 per kg

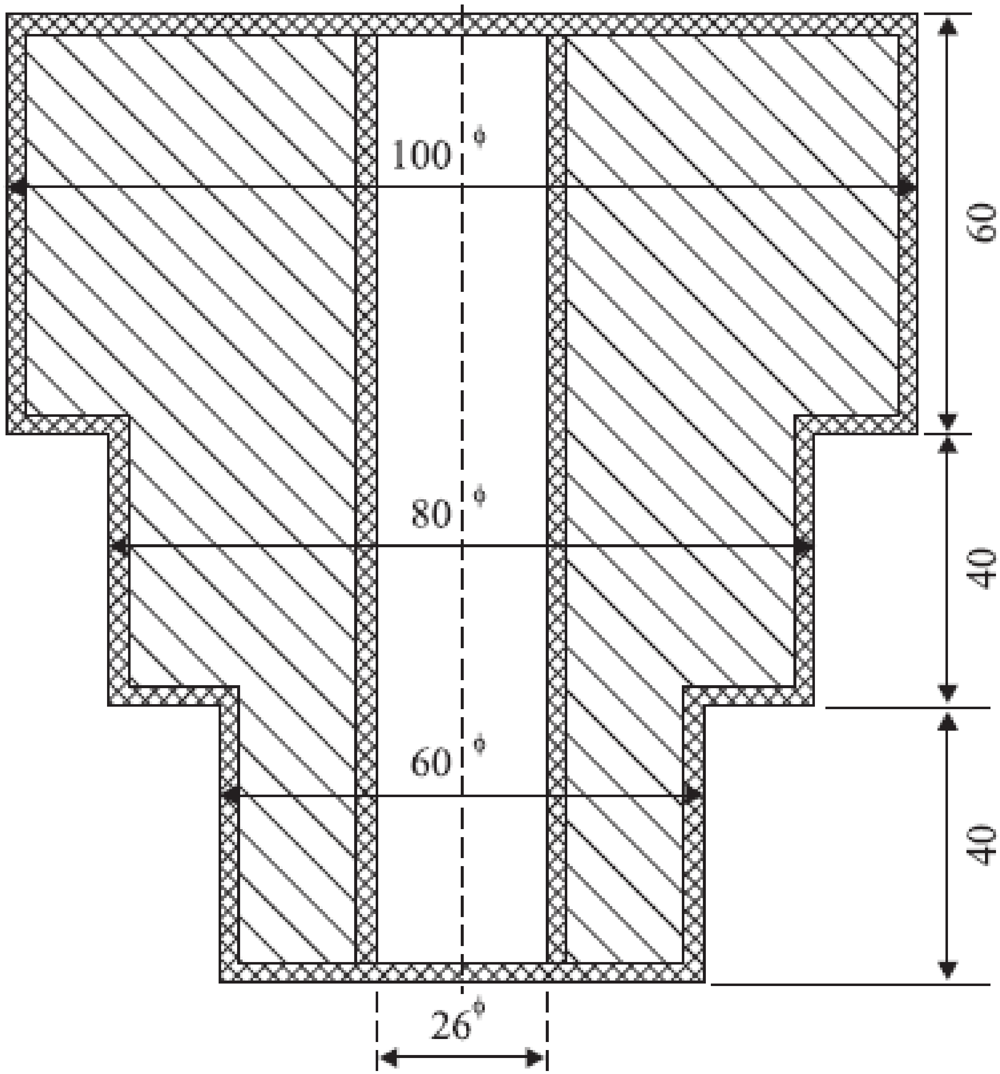
Administrative overheads = Rs. 30 per hour

Sales overheads = 20 percent of factory cost

Profit = 20 percent of factory cost

Other expenditures are :

Operation	*Time (min)*	*Labour cost/hr (Rs.)*	*Shop overheads/hr (Rs.)*
Moulding and pouring	15	20	60
Shot blasting	5	10	40
Fettling	6	10	40



(a)

(*i*) *Material cost :*

$$\text{Net volume of cast component} = \frac{\pi}{4}\left(10^2 \times 6 + 8^2 \times 4 + 6^2 \times 4 - 2.6^2 \times 14\right)$$

$$= 711 \text{ cc}$$

$$\text{Net weight of cast component} = 711 \times 7.2 = 5117 \text{ gms}$$

$$= 5.117 \text{ kg}$$

$$\text{Process scrap} = 20 \text{ percent of } 5.117 \text{ kg}$$

$$= 0.2 \times 5.117 = 1.02 \text{ kg}$$

$$\text{Total metal required per component} = 5.12 + 1.02 = 6.14 \text{ kg}$$

$$\text{Cost of metal poured} = 6.14 \times 20 = \text{Rs. } 122.8$$

$$\text{Process return value} = 1.02 \times 6 = \text{Rs. } 6.12$$

$$\text{Material cost per component} = 122.8 - 6.1 = \text{Rs. } 116.7$$

(ii) *Labour cost and factory overheads :*

Labour cost = Rs. 6.83

Shop overheads = Rs. 22.33

Process	*Time per piece (Minutes)*	*Labour cost per piece (Rs.)*	*Shop overheads per piece (Rs.)*
Melting and pouring	15	5.00	15.00
Shot blast	5	0.83	3.33
Fettling	6	1.00	4.00
Total	**26 min**	**6.83**	**22.33**

$$(iii) \quad \text{Factory cost per component} = 116.70 + 6.83 + 22.33 = \text{Rs. } 145.86$$

$$(iv) \quad \text{Administrative overheads} = \frac{30 \times 26}{60} = \text{Rs. } 13$$

$$(v) \quad \text{Sales overheads} = 0.2 \times 145.86 = \text{Rs. } 29.17$$

$$(vi) \quad \text{Profit} = 0.2 \times 145.86 = \text{Rs. } 29.17$$

$$\begin{aligned}\text{Selling price per component} &= \text{Factory cost} + \text{Administrative overheads} \\ &\quad + \text{Sales overheads} + \text{profit} \\ &= 145.86 + 13 + 29.17 + 29.17 \\ &= \text{Rs. } 217.2\end{aligned}$$

COST ESTIMATION IN WELDING SHOP

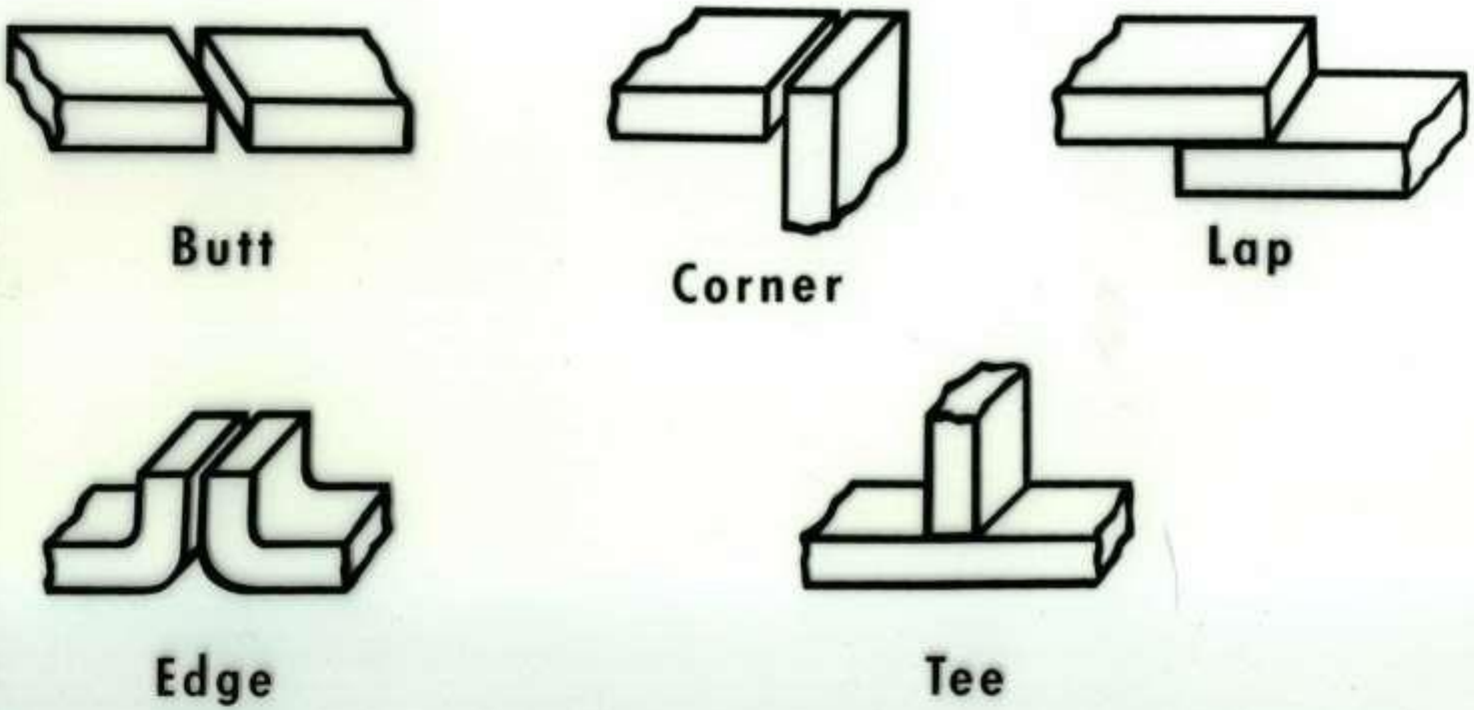
Gas welding :

- 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.

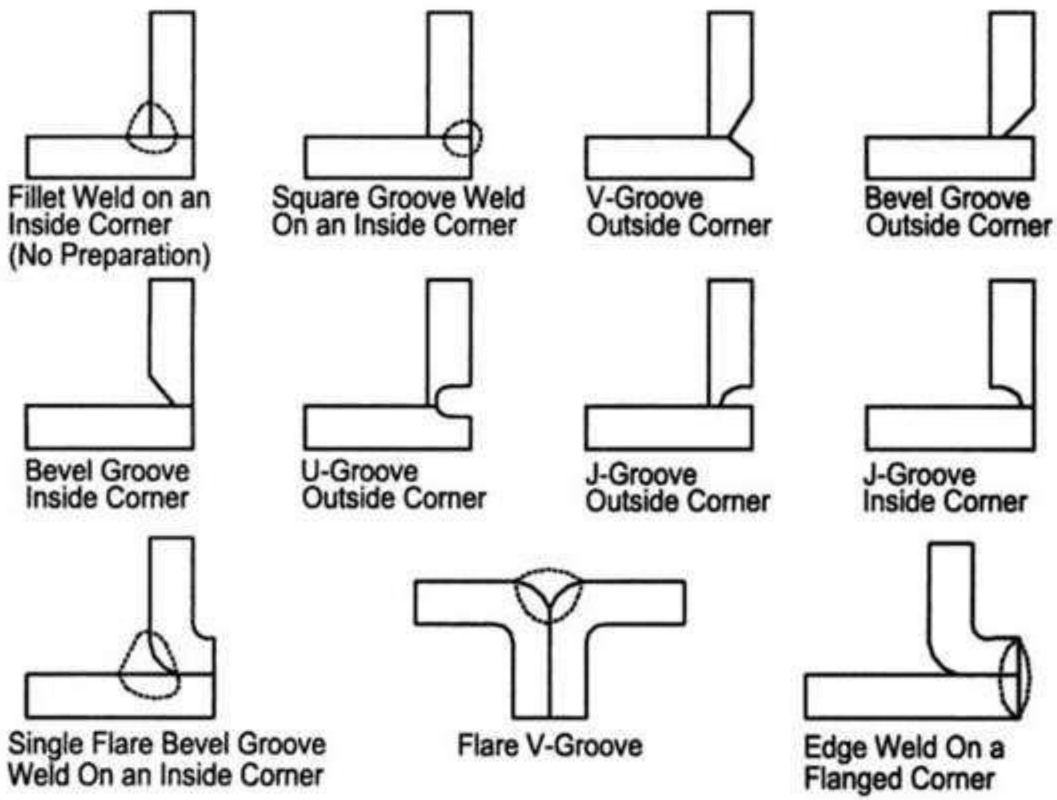
Leftward welding : In this method, welding is started from right hand side of the joint and proceeds towards left. This method is used for welding plates upto 5 mm thick. No edge preparation is required in case of the plates of thickness upto 3 mm.

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

TYPES OF JOINTS



Corner Joints - Edge Preparation & Weld Types



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 × 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 :

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

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.

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.

1. Leftward Welding

Thickness of plate (mm)	*Consumption of Oxygen and Acetylene (m^3/hr)*	*Diameter of filled rod used (mm)*	*Rate of welding (meters/hrs)*	*Filler rod used per meter of weld (meters)*
1.0	0.035 – 0.072	1.0	6.0 – 8.0	1.00
1.5	0.06 – 0.09	1.5	7.5 – 9.0	1.75
2.0	0.075 – 0.125	2.0	6.0 – 7.5	2.50
2.5	0.093 – 0.155	2.5	6.0 – 8.0	2.75
3.0	0.14 – 0.19	2.5	5.5 – 6.0	1.65
4.0	0.20 – 0.30	3.0	4.5 – 5.5	2.10
5.0	0.30 – 0.37	3.0	3.5 – 4.5	4.80

2. Rightward Welding

Thickness of plate (mm)	*Consumption of O_2 and C_2H_2 (m^3/hr)*	*Diameter of filler rod used (mm)*	*Rate of welding (meters/hr)*	*Filler rod used per meter of weld (meters)*
5	0.37 – 0.52	2.5	3.6 – 4.5	3.40
6	0.50 – 0.70	3.0	3.0 – 3.6	3.40
7	0.65 – 0.80	3.5	2.5 – 3.1	3.40
8	0.71 – 0.86	4.0	2.1 – 2.4	3.40
9	0.95 – 1.20	4.5	1.9 – 2.2	4.00
10	1.00 – 1.30	5.0	1.7 – 2.0	4.50
12	1.25 – 1.40	6.0	1.3 – 1.5	4.75
15	1.55 – 1.65	6.0	1.2 – 1.3	6.75
20	1.70 – 2.00	6.0	0.9 – 1.0	9.75
25	2.00 – 2.5	6.0	0.6 – 0.7	16.5

Example 3 : A lap welded joint is to be made as shown in Fig. 5.4.

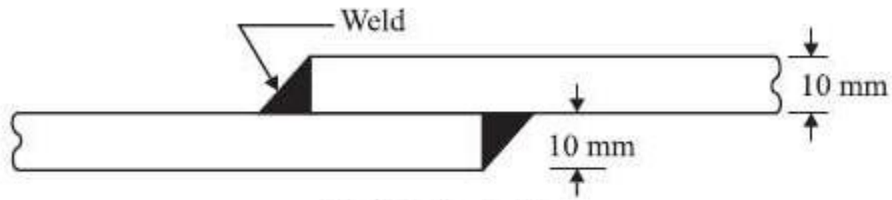


Fig. 5.4. Lap joint

Estimate the cost of weld from the following data :

Thickness of plate	=	10 mm
Electrode diameter	=	6 mm
Minimum arc voltage	=	30 Volts
Current used	=	250 Amperes
Welding speed	=	10 meters/hour
Electrode used per meter of weld	=	0.350 kgs
Labour rate	=	Rs. 40 per hour
Power rate	=	Rs. 3 per kWh
Electrode rate	=	Rs. 8.00 per kg
Efficiency of welding m/c	=	50 percent
Connecting ratio	=	0.4
Overhead charges	=	80 percent of direct charges
Labour accomplishment factor	=	60 percent

Solution :

$$\text{Time per meter run of weld} = \frac{1}{10} \text{ hrs} = 6 \text{ minutes.}$$

$$\text{Cost of power consumed per meter run of weld} = \text{Rs. } \frac{V \times A}{1{,}000} \times \frac{t}{60} \times \frac{1}{E} \times C \times \frac{1}{r}$$

$$= \text{Rs. } \frac{30 \times 250}{1{,}000} \times \frac{6}{60} \times \frac{1}{0.5} \times 3 \times \frac{1}{0.4}$$

$$= \text{Rs. } 11.25$$

$$\text{Cost of labour per meter of weld length} = \frac{\begin{array}{c}\text{Cost of labour}\\ \text{per hour}\end{array}}{\begin{array}{c}\text{Welding speed}\\ \text{in m/hr}\end{array}} \times \frac{1}{\begin{array}{c}\text{Labour accomplishment}\\ \text{factor}\end{array}}$$

$$\text{Cost of labour} = \frac{40}{10} \times \frac{100}{60}$$

$$= \text{Rs. } 6.66\text{/meter of weld length}$$

= Rs. 6.66/meter of weld length

$$\text{Cost of electrodes per meter of weld} = 0.350 \times 8$$

$$= \text{Rs. } 2.80$$

$$\text{Total direct cost per meter of weld} = \text{Rs. } 11.25 + 6.66 + 2.80$$

$$= \text{Rs. } 20.71$$

$$\text{Overhead charges per meter of weld} = \text{Rs. } \frac{20.71 \times 80}{100}$$

$$= \text{Rs. } 16.60$$

$$\text{Total charges for welding one meter length of joint} = \text{Rs. } 20.71 + 16.60$$

$$= \text{Rs. } 37.31$$

$$\text{As this is a double fillet weld, lap joint length of weld} = 1.5 \times 2 = 3 \text{ meters}$$

$$\text{Total charges of making the welded joint} = \text{Rs. } 37.31 \times 3$$

$$= \text{Rs. } 112$$

Example 6 : A container open on one side of size 0.5 m × 0.5 m × 1 m is to be fabricated from 6 mm thick plates Fig. 5.5. The plate metal weighs 8 gms/cc. If the joints are to be welded, make calculations for the cost of container. The relevant data is :

Cost of plate	=	Rs. 10 per kg
Sheet metal scarp (wastage)	=	5 percent of material
Cost of labour	=	10 percent of sheet metal cost
Cost of welding material	=	Rs. 20 per meter of weld.

Solution :

(*i*) To calculate material cost :

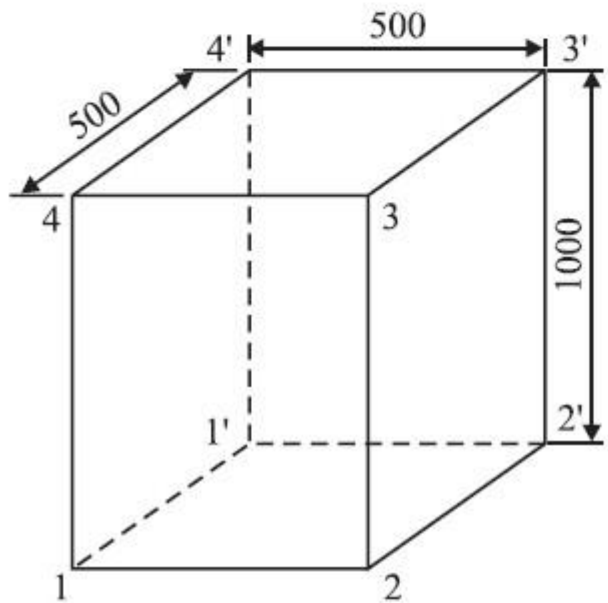


Fig. 5.5. Welded water tank

$$\text{Net volume of material used} = (4 \times 50 \times 100 \times 0.6) + (50 \times 50 \times 0.6)$$
$$= 13{,}500 \text{ cc}$$
$$\text{Net weight of container} = \text{Volume} \times \text{density of material}$$
$$= 13{,}500 \times 8$$
$$= 1{,}08{,}000 \text{ gm}$$
$$= 108 \text{ kgs}$$

$$\text{Sheet metal scrap} = 5 \text{ percent of net weight}$$

$$= \frac{108 \times 5}{100} = 5.40 \text{ kgs}$$

Total weight of sheet metal required for fabrication of one container

$$= 108 + 5.4$$

$$= 113.4 \text{ kgs}$$

$$\text{Cost of sheet metal per container} = 113.4 \times 10$$

$$= \text{Rs. } 1134$$

(*ii*) To calculate labour charges :

$$\text{Cost of labour} = 10 \text{ percent of sheet metal cost}$$

$$= \frac{1134 \times 10}{100} = \text{Rs. } 113$$

(*iii*) To calculate cost of welding material :

$$\text{Length to be welded} = (4 \times 50) + (4 \times 100)$$

$$= 600 \text{ cm} = 6 \text{ meters}$$

$$\text{Cost of welding material} = 6 \times 20$$

$$= \text{Rs. } 120$$

(*iv*) Cost of container = Cost of sheet metal material + Cost of labour + Cost of welding material

$$= 1134 + 113 + 120$$

$$= \text{Rs. } 1367$$

COST ESTIMATION IN FORGING SHOP

Forging is the process of forming a metal into desired shape and size by the application of localised 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.

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.

$$\text{Net weight} = \text{Volume of forging} \times \text{Density of material}$$

(*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.

$$\text{Gross weight} = \text{Net weight} + \text{Material loss in the process}$$

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

$$\text{Direct material cost} = \text{Gross weight} \times \text{Price per kg}$$

2. Cost of Direct Labour

Direct labour cost is estimated as follows :

$$\text{Direct labour cost} = t \times l$$

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

$$\text{Let cost of Die} = \text{Rs. X}$$

$$\text{No. of components that can be produced using this die (i.e., die life)} = \text{Y components}$$

$$\text{Cost of die/component} = \text{Rs. X/Y}$$

Apportioning of Machine (Press) Cost

$$\text{Let cost of press} = \text{Rs. A}$$

$$\text{Life of press} = n \text{ years}$$

$$= n \times 12 \times 4 \times 5 \times 8 = 1920n \text{ hours}$$

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

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

$$\text{No. of components produced per hour} = N$$

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

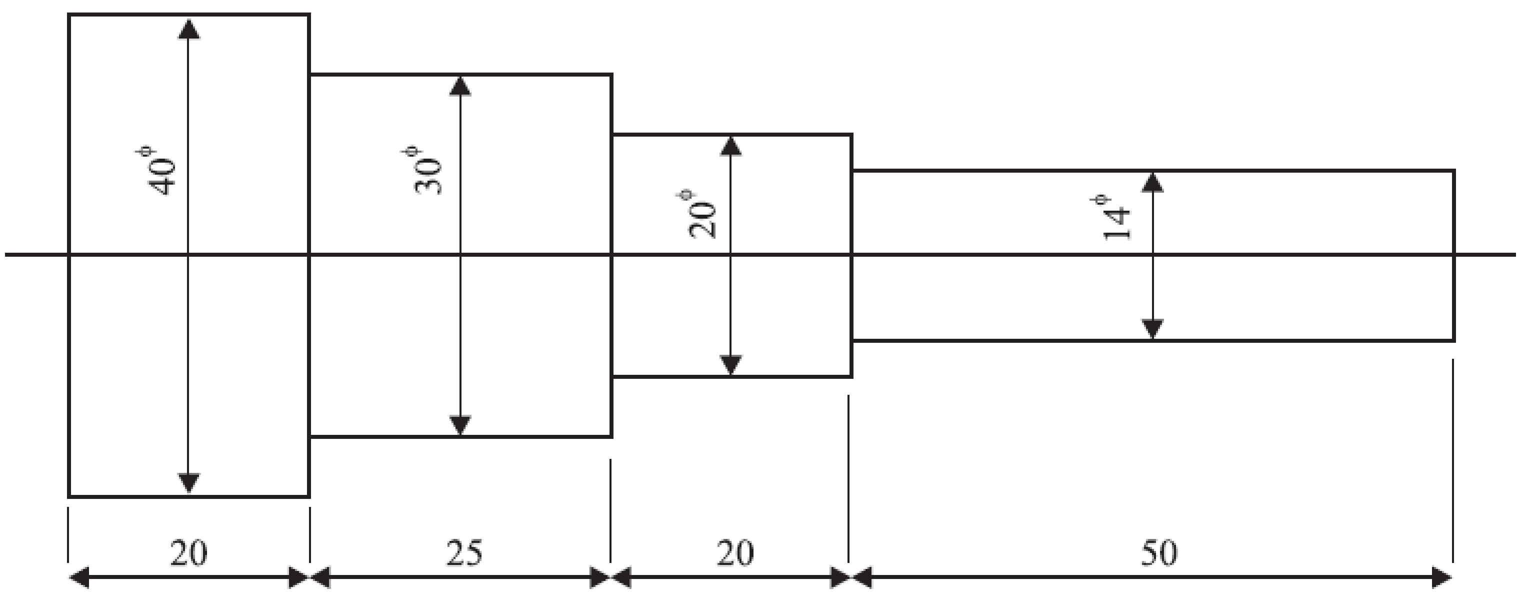
This excludes cost of power consumed and cost of consumables, if any.

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.

Example 9 : Calculate the net weight and gross weight for the component shown in Fig. 5.7. Density of material used is 7.86 gm/cc. Also calculate :



(*i*) Length of 14 mm dia bar required to forge one component.

(*ii*) Cost of forging/piece if :

Material cost = Rs. 80 per kg

Labour cost = Rs. 5 per piece

Overheads = 150 percent of labour cost.

Solution :

$$\text{Net volume of forged component} = \frac{\pi}{4}\left[(4)^2 \times 2 + (3)^2 \times 2.5 + (2)^2 \times 2 + (1.4)^2 \times 5\right]$$

$$= \frac{\pi}{4}(72.3) = 56.76 \text{ cc}$$

$$\text{Net weight} = 56.76 \times 7.86 = 446 \text{ gms}$$

***Losses* :**

Shear loss = 5 percent of net weight

$$= \frac{5}{100} \times 446 = 22.30 \text{ gms}$$

Scale loss = 6 percent of net weight

$$= \frac{6}{100} \times 446 = 26.76 \text{ gms}$$

$$\text{Taking flash width} = 20 \text{ mm}$$

$$\text{Flash thickness} = 3 \text{ mm}$$

$$\begin{aligned}
\text{Flash loss} &= (\text{periphery of parting line}) \times 2 \times 0.3 \times 7.86 \\
&= [2\,(2 + 2.5 + 2 + 5) + 1.4 + (2 - 1.4) + (3 - 2) + (4 - 3) + 4] \times 2 \times 0.3 \times 7.86 \\
&= 31.0 \times 2 \times 0.3 \times 7.86 = 146 \text{ gms}
\end{aligned}$$

$$\begin{aligned}
\text{Tonghold loss} &= 2 \times \text{Area of cross-section of bar} \times 7.86 \\
&= 2 \times \frac{\pi}{4}(1.4)^2 \times 7.86 = 24.22 \text{ gms}
\end{aligned}$$

$$\text{Sprue loss} = 7 \text{ percent of net weight}$$

$$= \frac{7}{100} \times 446 \text{ gms}$$

$$= 31.22 \text{ gms}$$

$$\text{Total material loss} = 22.3 + 26.8 + 146 + 24.22 + 31.22$$

$$= 250 \text{ gms}$$

$$\text{Gross weight} = \text{Net weight} + \text{Losses}$$

$$= 446 + 250 = 696 \text{ gms}$$

(*i*) New length of 14 mm f bar required per piece

$$= \frac{\text{Volume of forging}}{\text{Area of X – Section of bar}}$$

$$= \frac{56.76}{\frac{\pi}{4}(1.4)^2} = 36.86 \text{ cm}$$

$$\text{Direct material cost} = \frac{696}{1,000} \times 8$$

$$= \text{Rs. } 5.57$$

$$\text{Direct labour cost} = \text{Rs. } 5 \text{ per piece}$$

$$\text{Overheads} = 150 \text{ percent f labour cost}$$

$$= 1.5 \times 5 = \text{Rs. } 7.5$$

$$\text{Cost per piece} = 5.57 + 5 + 7.5$$

$$= \text{Rs. } 18$$

Rs. 18

Example 10 : 150 components, as shown in Fig. 5.8 are to be made by upsetting a f 20 mm bar. Calculate the net weight, gross weight and length of f 20 mm bar required. The density of material may be taken as 7.86 gms/cc.

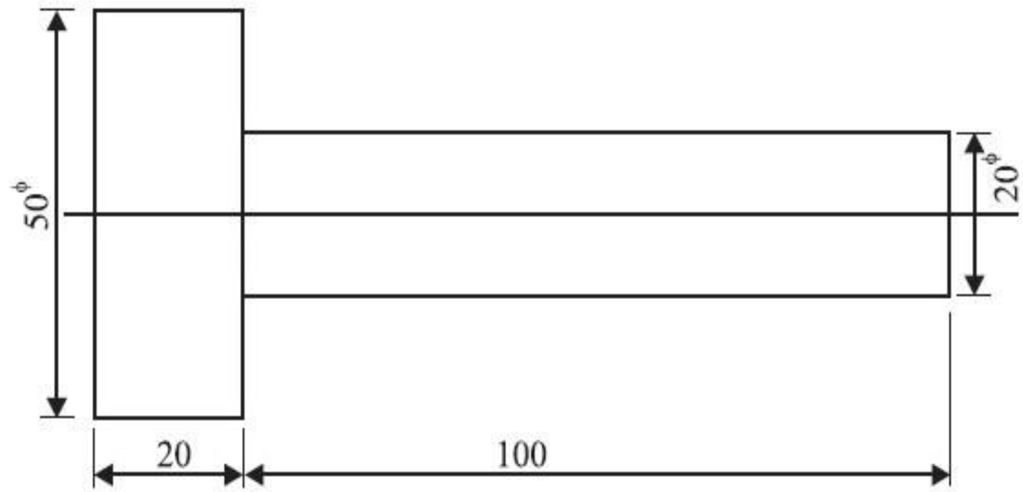


Fig. 5.8

Solution :

$$\text{Net volume of material} = \frac{\pi}{4}\,[(5)^2 \times 2 + (2)^2 \times 10]$$

$$= \frac{\pi}{4}\,(50 + 40) = 70.72 \text{ cm}^3$$

$$\text{Net weight per component} = 70.72 \times 7.86 = 556 \text{ gms}$$
$$\text{Net weight for 150 components} = 556 \times 150 = 83{,}400 \text{ gms}$$
$$= 83.4 \text{ kgs}$$

Losses :

$$\text{Shear loss} = 5 \text{ percent of net weight}$$
$$= \frac{5}{100} \times 556 = 27.8 \text{ gms}$$
$$\text{Scale loss} = 6\% \text{ of net weight}$$
$$= \frac{6}{100} \times 556 = 33.4 \text{ gms}$$
$$\text{Gross weight/component} = 556 + 27.8 + 33.4$$
$$= 617 \text{ gms}$$
$$\text{Gross weight for 150 components} = 617 \times 150 = 92{,}550 \text{ gms}$$
$$= 92.550 \text{ kgs}$$
$$\text{Length of 20 mm f bar required} = \frac{92550}{\frac{\pi}{4}(2)^2 \times 7.86}$$
$$= 3744 \text{ cms} = 37.44 \text{ meters.}$$