LABORATORY MANUAL

18MEL38B /18MEL48B FOUNDRY, FORGING AND WELDING LAB

2019-2020

DEPARTMENT OF MECHANICAL ENGINEERING
ATRIA INSTITUTE OF TECHNOLOGY
Adjacent to Bangalore Baptist Hospital
Hebbal, Bengaluru-560024

Department of Mechanical Engineering

Vision

To be a center of excellence in Mechanical Engineering education and interdisciplinary research to confrontreal world societal problems with professional ethics.

Mission

1. To push the frontiers of pedagogy amongst the students and develop new paradigms in research.

2. To develop products, processes, and technologies for the benefit of society in collaboration withindustry and commerce.

3. To mould the young minds and build a comprehensive personality by nurturing strong professionalswith human ethics through interaction with faculty, alumni, and experts from academia/industry.

FOUNDRY

A **foundry** is a factory that produces metal castings. Metals are cast into shapes by melting them into a liquid, pouring the metal into a mold, and removing the mold material after the metal has solidified as it cools. The most common metals processed are aluminum and cast iron. However, other metals, such as bronze, brass, steel, magnesium, and zinc, are also used to produce castings in foundries. In this process, parts of desired shapes and sizes can be formed.

ATRIA INSTITUTE OF TECHNOLOGY

LABORATORY CERTIFICATE

This is to certify that Mr. / Ms. ____

has satisfactorily completed the course of experiments in **Foundry, Forging & Welding Laboratory** bearing subject code **18MEL38B** prescribed by the Visvesvaraya Technological University, Belagavi of this Institute for the academic year 20 - 20 .

USN : ____

Branch : ______________________________________

Semester :________________Sec : _________________

MARKS	
Maximum Marks	Marks Obtained
40	

Signature of Faculty-In-Charge

Head of the Department

PREFACE

Foundry, Forging & Welding has been given considerable weightage in undergraduate Mechanical Engineering curriculum of all technological universities. This manual has been prepared to enlighten theory and methodology of performing experiments concerning to meet the growing needs of industry.

Foundry, Forging & Welding modules about testing of sand moulds, sand test, casting impart basic knowledge of various tools and their use in different sections of manufacture. This manual gives the perception to build technical knowledge by acting as a guide for imparting fundamental awareness. Numerous neatly drawn illustrations provided in the manual will help the students in understanding the subject, and the concepts related it, better. Sincere attempts have been made to present the contents in a simple language, supplemented with line diagrams, which are self-explanatory and easy to reproduce.

Based on my experience of teaching, I have endeavored to present a methodical explanation of the basic concept of the subject matter. Many viva voce questions are included in order to make the underlying principles more comprehensible.

It is hoped that the manual will also serve as a useful guide for the personnel already in the profession who may need to refresh their subject knowledge. It is further believed that the treatment of this manual is in harmony with the current trend towards a more practical approach to mechanical engineering education.

I wish to record my sincere thanks to Dr. M.S.Rajendrakumar, Head of Department, Atria Institute of Technology, Bangalore for their consistent support and encouragement extended to us.

I would appreciate receiving constructive suggestions and objective criticism from students and teachers alike with a view to enhance further the usefulness of this manual in the upcoming editions.

CHETAN C S

CONTENTS

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – III

FOUNDRY, FORGING AND WELDING LAB

Course Code	**18MEL38B/48B**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To provide an insight into different sand preparation and foundry equipment.
- To provide an insight into different forging tools and equipment and arc welding tools and equipment.
- To provide training to students to enhance their practical skills in welding, forging and hand moulding.
- To practically demonstrate precautions to be taken during casting, hot working and welding operations.

Sl. No	Experiments
	PART A
1	**Testing of Molding sand and Core sand.** **Preparation of sand specimens and conduction of the following tests:** 1. Compression, Shear and Tensile tests on Universal Sand Testing Machine. 2. Permeability test 3. Sieve Analysis to find Grain Fineness Number (GFN) of Base Sand 4. Clay content determination on Base Sand. **Welding Practice:** Use of Arc welding tools and welding equipment Preparation of welded joints using Arc Welding equipment L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats
	PART B
2	**Foundry Practice:** **Use of foundry tools and other equipment for Preparation of molding sand mixture.** **Preparation of green sand molds kept ready for pouring in the following cases:** 1. Using two molding boxes (hand cut molds). 2. Using patterns (Single piece pattern and Split pattern). 3. Incorporating core in the mold.(Core boxes). 4. Preparation of one casting (Aluminium or cast iron-Demonstration only)
	PART C
3	**Forging Operations:** Use of forging tools and other forging equipment. • Calculation of length of the raw material required to prepare the model considering scale loss. • Preparing minimum three forged models involving upsetting, drawing and bending operations.

Course Outcomes: At the end of the course, the student will be able to:

- Demonstrate various skills in preparation of molding sand for conducting tensile, shear and compression tests using Universal sand testing machine.
- Demonstrate skills in determining permeability, clay content and Grain Fineness Number of base sands.
- Demonstrate skills in preparation of forging models involving upsetting, drawing and bending operations.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

1. One question is to be set from Part-A : 30 marks
   (20 marks for sand testing+ 10 Marks for welding)
2. One question is to be set from either Part-B or Part-C: 50 Marks
3. Viva – Voce: 20 marks

COURSE OBJECTIVES

The objective of the course is to make the student aware of:

- Foundry practices like Moulding, Ramming, Shaping and Casting.
- Forging practices like Upsetting, Drawing and bending operations.
- Welding practices like V-joint, L-joint, Butt joint, Lap joint and T-joint.
- Foundry, Forging and Welding tools used to practice above operations.
- To provide training to students to enhance their practical skills.
- Safety precautions to be adopted while doing hot working operations.
- First aid in case of accidents.

COURSE OUTCOMES

At the end of the course, the student should be able to:

- Demonstrate various skills of sand preparation and moulding.
- Demonstrate various skills of forging operations.
- Analyze the time management in creating the moulds.
- Create various models with least material wastage.
- Interpret accuracy and precision in work.
- Work as a team keeping up ethical values.
- Weld various joints in the given object with the available work material

PREREQUISITES

The students should have the basic knowledge of the use of tools, equipments and precautions to be taken during hot working operations.

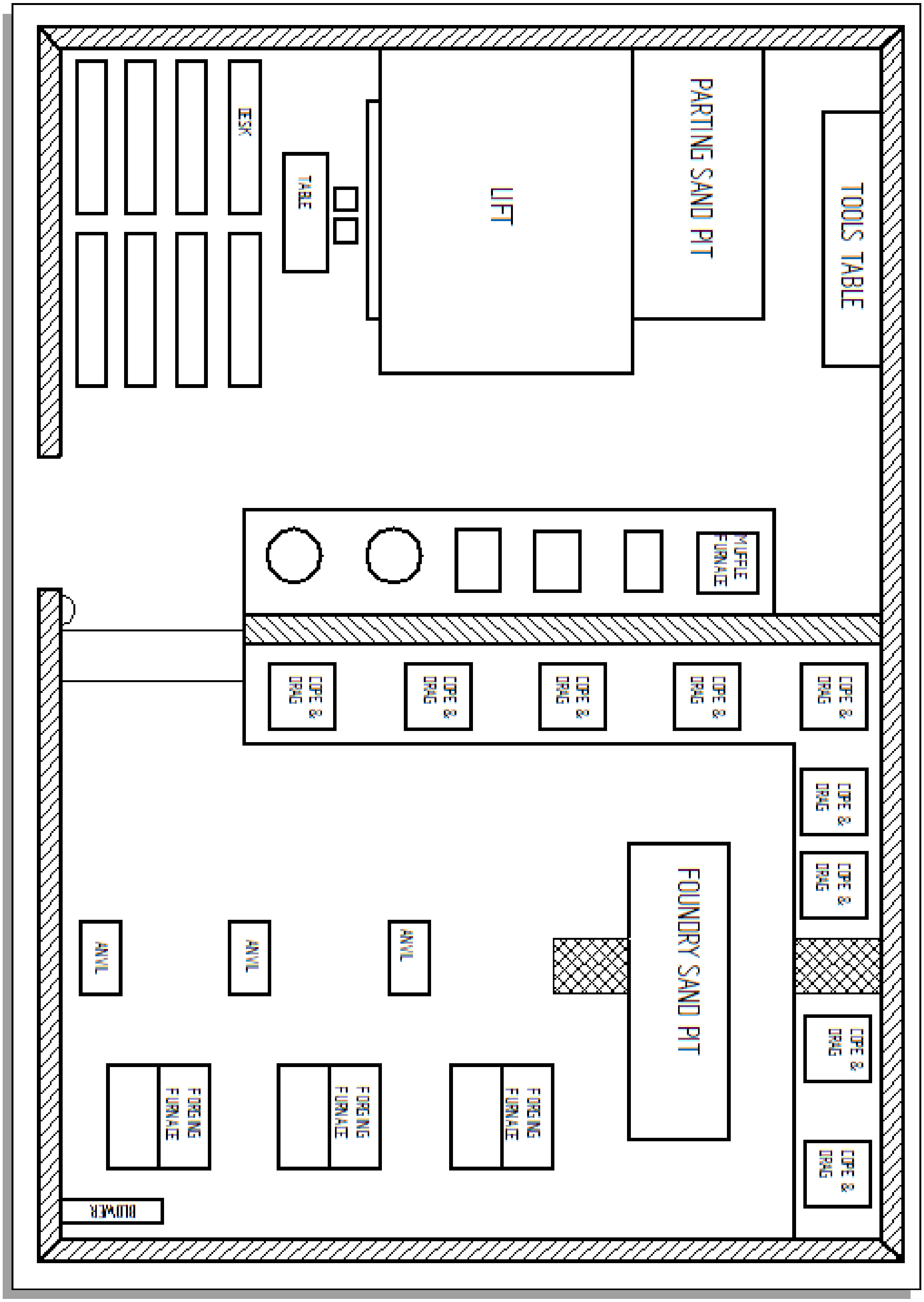
LABORATORY SAFETY PRECAUTIONS

- Laboratory uniform, shoes & safety glasses are compulsory in the lab.
- Do not touch anything with which you are not totally familiar. Recklessness may not only break the valuable equipment in the lab but may also cause severe injury to you and others in the lab.
- Please follow instructions precisely as instructed by your supervisor. Do not begin the experiment unless your setup is verified & approved by your supervisor.
- Do not leave the experiments unattended while in progress.
- Do not crowd around the equipment's & run inside the laboratory.
- During experiments material may fail and disperse, please wear safety glasses and maintain a safe distance from the experiment.
- If any part of the equipment fails while being used, report it immediately to your supervisor. Never try to fix the problem yourself because you could further damage the equipment and harm yourself and others in the lab.
- Keep the work area clear of all materials except those needed for your work and cleanup after your work.

INSTRUCTIONS TO THE CANDIDATES

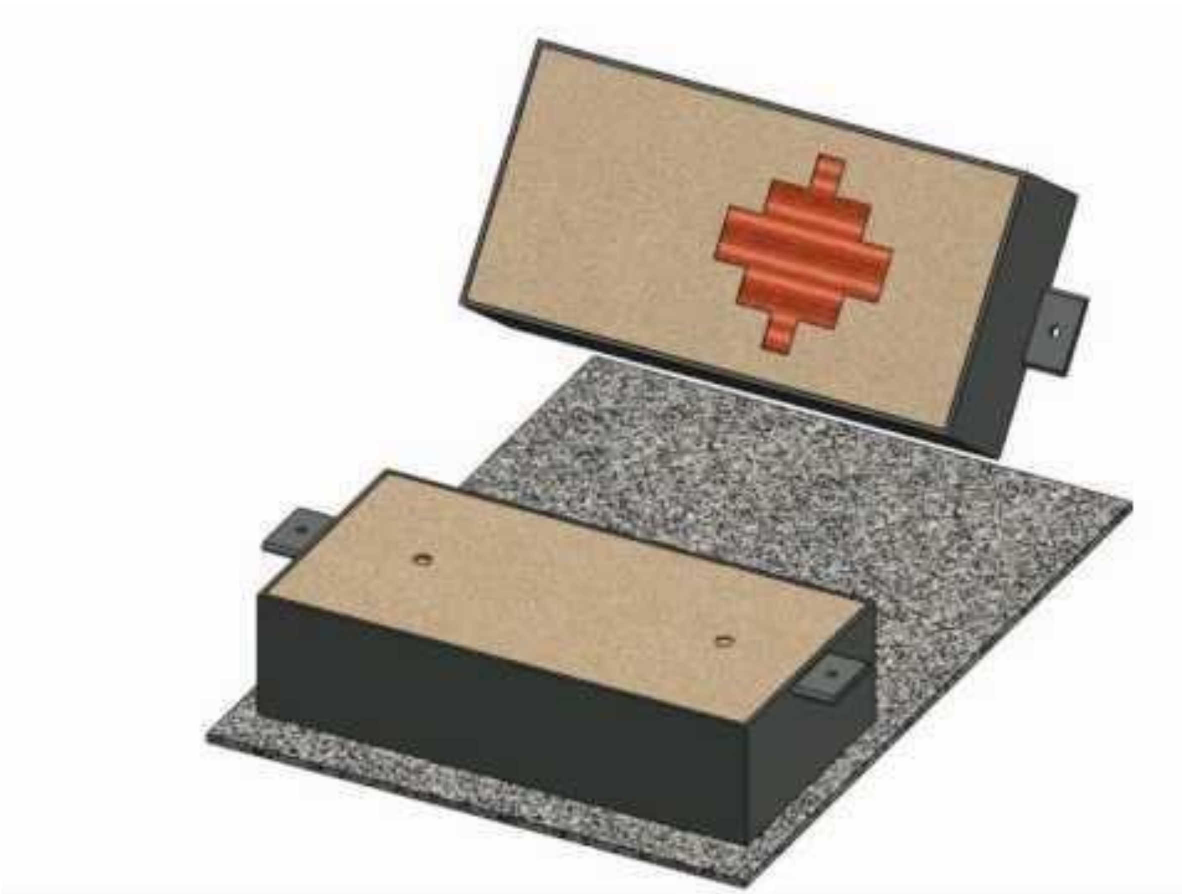
- Students should come with thorough preparation for the experiment to be conducted.
- Students will not be allowed to attend the laboratory unless they bring the practical record fully completed in all respects pertaining to the experiment conducted in the earlier class.
- Experiment should be started only after the staff-in-charge has checked the experimental setup.
- All the calculations should be made in the observation book. Specimen calculations for one set of readings have to be shown in the practical record.
- Wherever graphs are to be drawn, A-4 size graphs only should be used and the same should be firmly attached to the practical record.
- Practical record should be neatly maintained.
- They should obtain the signature of the staff-in-charge in the observation book after completing each experiment.
- Theory regarding each experiment should be written in the practical record before procedure in your own words.

Layout of Foundry & Forging Lab



1

TESTING MOULD / CORE SAND PROPERTIES



INTRODUCTION

Sand testing offers foundry men, the best way of measuring the various properties of foundry sand mixtures, before it is put into use. The moulding sand after it is prepared should be properly tested to see that require properties like compression strength, shear strength, permeability, fineness, Refractoriness, Hardness, Flow ability, Friability, etc. Good mould/core sand is evaluated in terms of these properties, and is found to have a favorable effect on the quality of the castings produced. Tests are conducted on a sample of the standard sand. The moulding sand should be prepared exactly as it is done in the shop on the standard equipment and then carefully enclosed in a container to safeguard its moisture content. A few properties as per the prescribed syllabus for 4th semester B.E., of VTU syllabus have been discussed under Part-A of this manual.

Before going on into the details of the testing procedures, it is essential to understand a few terms and concepts of foundry sand mixtures.

- **BASE SAND**

Sand, often referred as *base sand*, due to its high refractoriness and also being in expensive is the primary and basic material used for preparing moulds and cores. Nearly 90-95% of the moulding sand mixture is occupied by sand and the remaining being binder and additives. The common types of sand include: silica sand, olivine sand, chromite, and zircon. In our lab we will perform the experiments using silica sand.

- **BINDER**

The base sand is a loose sand (no cohesion between sand grains), and hence alone cannot be used for preparing moulds/cores. A binder is a material used to produce cohesion or bind the sand particles together in order to impart strength to the sand mixture. Clay binders (bentonites) are most frequently used for bonding sand grains together. It is important to note that clay activates or tends to bind the sand particles only in the presence of water (moisture). For good moulding sand, clay may vary from 4 - 12 %, and moisture from 3 - 6 %.

Apart from clay, various resins (thermoplastic or thermosetting) combined with hardeners and accelerators (chemicals) are also extensively used as binders for preparing moulds and cores.

- **ADDITIVES**

Additives are generally added to develop certain new properties, or to improve the existing properties of the mould/core sand. They do not form a compulsory constituent; however its addition improves the quality of the mould/core sand, and hence the casting. Additives include sea coal, silica flour, wood flour, iron oxide, graphite, pitch etc.

- **MOULDING SAND**

Moulding sand is a mixture consisting of base sand (silica sand), binder (clay or resin type), and one or more additives in suitable proportions. Moulding sand is used for preparing moulds and is also referred as *foundry sand.*

Foundry sand mixture = base sand (Example Silica sand) + binder + additives

- **CORE SAND**

Core sand is a mixture consisting of base sand, special binder and additives to prepare cores.

- **GREEN SAND**

Green sand is a mixture of silica sand, clay (binder), and moisture in suitable proportions. Moulds prepared with green sand mixture are called *green sand moulds.*

Note: The word *green* doesn't mean the color of the sand, but signifies that the moulding sand is in the moist condition at the time of molten metal pouring.

- **DRY SAND**

Dry sand is essentially the green sand, except that the sand mixture is dried or baked in an oven in order to remove the moisture present in them. This results in an increase in the strength of the moulds/cores.

- **NO-BAKE SAND**

A no-bake sand, also called as self-setting sand is one that does not require baking. It overcomes most of the disadvantages of green sand and dry sand. The main ingredients of no-bake sand are silica sand, binder (usually resin type), hardener, and a catalyst (if necessary). The bonding strength developed in moulds/cores is by means of a self-setting chemical reach on between the binder and the hardener. In some cases, a catalyst or accelerator is added to speed up the chemical reaction.

A few no-bake binder systems include: alkyd binder system (3-part system), phenolic urethane system, etc.

- **AFS**

AFS is a short name for American Foundrymen's Society.

- **AFS STANDARD SAND SPECIMEN**

In order to correlate the test results, standard procedures, specimen, and equipments must be used for testing. The AFS standard sand specimen for conducting various tests is a *cylindrically shaped* and exactly 50.8 *mm* diameter and 50.8 *mm* height, prepared using a standard sand rammer tool. A sample AFS sand specimen is shown in figure 1.1.

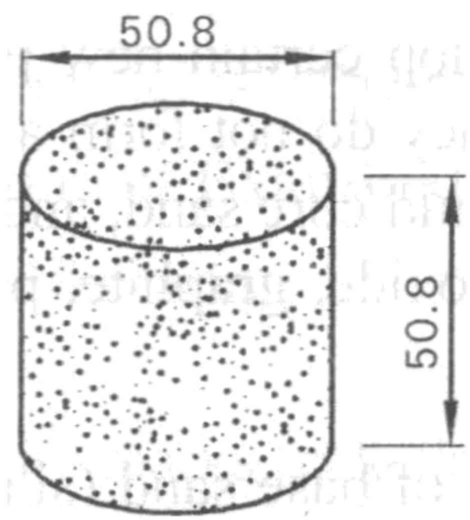


Fig.1.1 AFS Sand specimen

PROPERTIES OF MOULDING SAND

Good moulding sand must possess the following properties. The properties are determined by the amount of clay, moisture content and by the shape and size of the silica grain in the sand.

- **PERMEABILITY**

It is the ability of sand to allow the gasses to escape from the mould.

- **COHESIVENESS OR STRENGTH**

This is the ability of sand particles to stick together. Insufficient strength may lead to a collapse in the mould or its partial destruction during conveying turning over or closing.

- **ADHESIVENESS**

The sand particles must be capable of adhering to another body, i.e., they should cling to the sides of the moulding boxes.

- **PLASTICITY**

It is the property to retain it shape when the pressure of the pattern is removed.

- **REFRACTORINESS**

The sand must be capable of withstanding the high temperature of the molten metal without fusing.

- **BINDING**

Binder allows sand to flow to take up pattern shape.

- **CHEMICAL RESISTIVITY**

Moulding sand should not chemically react or combine with molten metal so that it can be used again and again.

- **FLOWBILITY:**

It is the ability of sand to take up the desired shape.

EXPERIMENT-1

COMPRESSION STRENGTH TEST

Aim

To determine green compression strength of the given specimen containing different percentages of clay and moisture.

Apparatus Required

Mixing jar, weighing machine, sand rammer, stripper, compression shackles, and universal sand testing machine.

Theory

A rigid mould is an essential requirement if a sound casting must be produced. When the molten metal is poured into the mould, it is subjected to various forces: *tensile, compressive,* and *shear,* the compressive force being the most important among them. The mould should be rigid enough or have sufficient strength to resist the compressive force (pressure) of the molten metal, and also it must retain its shape and size until the molten metal is solidified.

The compression strength test determines the holding power of the bonding material used in the sand mixture. The test is carried out on a universal sand testing machine, which determines the compressive stress in kgf/cm^2, necessary to cause rupture (break) the standard cylindrical sand specimen of 50.8 x 50.8 *mm.*

Note: Green sand mixture contains silica sand, clay and moisture (water) in suitable proportions. Variation in either clay or moisture content leads to change in the properties of the sand mixture. Hence the experiment is carried out in two parts: In the first part, the percentage clay is maintained constant, while the percentage moisture is being varied. In the second part, the percentage clay is varied while the moisture content is kept constant.

Procedure

a) Weighed proportions of silica sand & clay are dry mixed in a mixing jar for about 3 minutes.

b) Calculated amount of water is added to the mixture and mixed thoroughly for about 2 minutes to obtain a uniform green sand mixture

c) The green sand mixture of suitable weight is then filled into the specimen tube and rammed thrice using a sand rammer to obtain a standard cylindrical specimen of 50.8 x 50.8 *mm*.

d) The standard specimen is stripped from the specimen tube and then placed in between the compression shackles of the sand testing machine. Refer figure 1.2(a).

e) The hand wheel of the testing machine is rotated slowly to actuate the ram, which in turn applies hydraulic pressure axially against the plane surfaces of the specimen. Refer figure 1.3

f) The pressure is applied gradually and continuously till the specimen ruptures (breaks). At this instant, the compression strength reading (in kgf/cm^2) on the dial indicator is noted down.

g) The above steps are repeated for different percentages of clay and moisture.

Green compression strength implies that the compression strength test is carried out using the green sand mixture containing various percentages of clay and moisture.

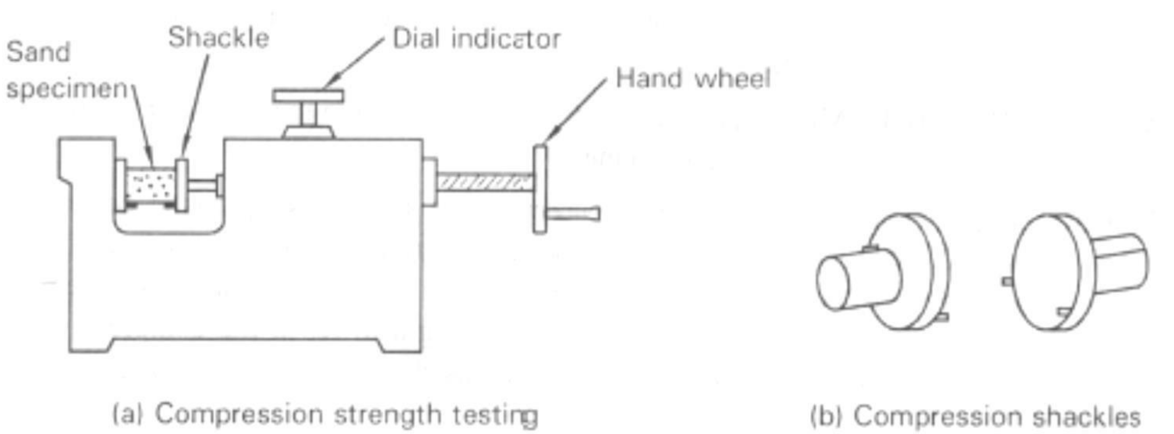


Fig. 1.2 Compression strength testing

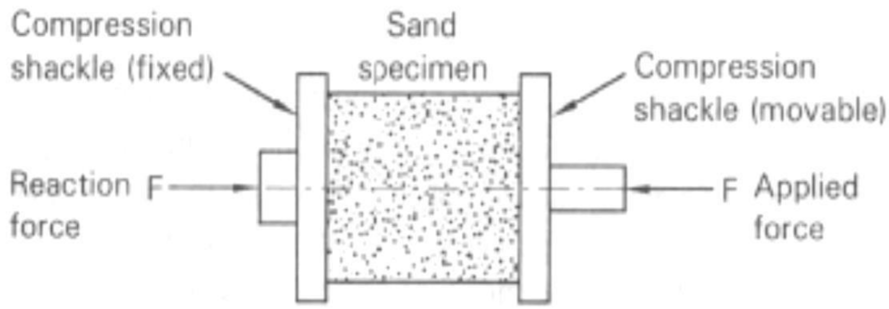


Fig. 1.3 Compressive force acting on the specimen

Tabular Column

Part - A Constant *clay* and varying *moisture* percentage

Sl. No.	Sand		Clay		Water		Compression strength (kgf/cm^2)
	%	gms.	%	gms.	%	cm^3	
l.							
2.							
3.							
4.							

Part - B Constant *moisture* and varying *clay* percentage

Sl. No.	Sand		Clay		Water		Compression Strength (kgf/cm^2)
	%	gms.	%	gms.	%	cm^3	
l.							
2.							
3.							
4.							

Graphs

a) Compression strength (y-axis) *vs* Percentage clay (x-axis)

b) Compression strength (y-axis) *vs* Percentage moisture (x-axis)

Results

The result of the experiment should be concluded from the graphs by analyzing the effect of clay and moisture content on the compression strength of the sand mixture.

EXPERIMENT-2

SHEAR STRENGTH TEST

Aim

To determine green shear strength of the given specimen containing different percentages of clay and moisture.

Apparatus Required

Mixing jar, weighing machine, sand rammer, stripper, shear shackles, and universal sand testing machine.

Theory

A rigid mould is an essential requirement if a sound casting has to be produced. When the molten metal is poured into the mould, it is subjected to various forces: *shear force* being one among them. The shear strength test determines the ability of the sand particles to resist the shearing forces resulting from the action of the molten metal. The test is carried out on a universal sand testing machine in a manner similar to the compression strength test, except that *shearing shackles* are used in place of *compression shackles.*

Procedure

a) Weighed proportions of silica sand and clay are dry mixed in a mixing jar for about 3 minutes.

b) Calculated amount of water is added to the mixture and mixed thoroughly for about 2 minutes to obtain a uniform green sand mixture

c) The green sand mixture of suitable weight is then filled into the specimen tube and rammed thrice using a sand rammer to obtain a standard cylindrical specimen of 50.8 x 50.8 *mm*.

d) The standard specimen is stripped from the specimen tube and then placed in between the shearing shackles of the sand testing machine. Refer figure 1.4(a).

e) The hand wheel of the testing machine is rotated slowly to actuate the ram, which in turn applies hydraulic pressure axially against the plane surfaces of the specimen. Refer figure 1.4(c).

f) The pressure is applied gradually and continuously till the specimen ruptures (breaks). At this instant, the shear strength reading (in kgf/cm^2) on the dial indicator is noted down.

g) The above steps are repeated for different percentages of clay and moisture.

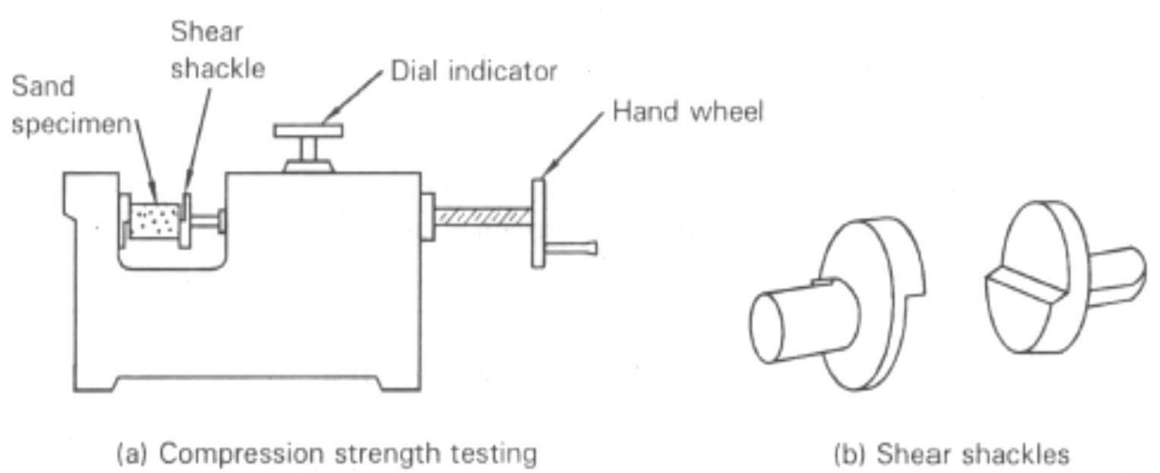


Fig.1.4 Shear strength testing

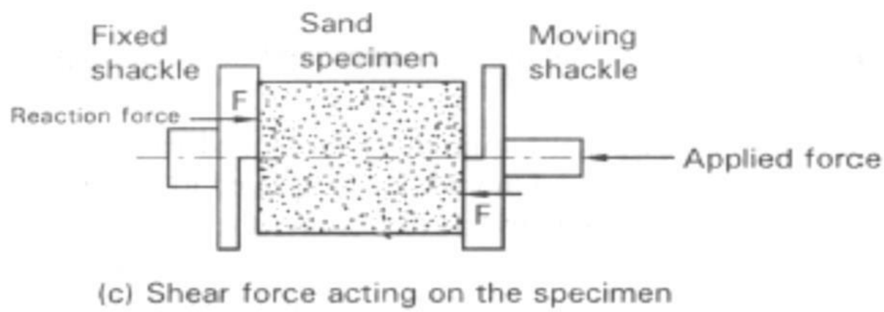


Fig.1.4 Shear strength testing

<u>Tabular Column</u>

Part - A **Constant *clay* and varying *moisture* percentage**

Sl. No.	Sand		Clay		Water		Shear strength (kgf/cm^2)
	%	gms.	%	gms.	%	cm^3	
1.							
2.							
3.							
4.							

Part - B **Constant *moisture* and varying *clay* percentage**

Sl. No.	Sand		Clay		Water		Shear strength (kgf/cm^2)
	%	**gms.**	%	**gms.**	%	cm^3	
1.							
2.							
3.							
4.							

<u>Graphs</u>

a) Shear strength (y-axis) *v/s* Percentage clay (x-axis)

b) Shear strength (y-axis) *v/s* Percentage moisture (x-axis)

<u>Results</u>

The result of the experiment should be concluded from the graphs by analyzing the effect of clay and moisture content on the shear strength of the sand mixture.

EXPERIMENT-3

TENSILE STRENGTH TEST

Aim

To determine the tensile strength of the given *core sand* specimen containing different percentage of binder.

Apparatus Required

Mixing jar, weighing machine, sand rammer, stripper, split core box, oven (for baking), tension shackles, and universal sand testing machine.

Theory

Moulds/cores should possess sufficient strength to resist the various forces resulting from the action of molten metal. Compression and shear strength tests are widely used when compared to the tensile strength test. However, tensile test is preferred for testing the baked or cured strength of mould/core sand mixture. According to AFS, the tensile strength of a baked sand mixture is the tensile stress necessary to rupture a test briquette of the standard dimensions as shown in figure 1.5. The standard specimen is made from a strong oil-sand mixture, for example with a 1:25 oil-sand ratio. A split core box is used for preparing the sand specimen. The oil which is used as binder hardens with the application of heat. The specimen is hence baked in an oven at a temperature and time sufficient to develop the properties of the binder employed. (The manufacturers' recommendations shall be followed for moulds/cores which are self-cured or air hardened with binders like alkyd binder, sodium silicate, etc.). After baking, the specimen must be cooled to room temperature, immediately after which the testing is carried out on the specimen using sand testing machine. The tensile testing attachment used for the purpose is shown in figure 1.6.

Procedure

a) Weighed proportions of silica sand and oil binder are mixed thoroughly in a mixing jar for about 2 minutes.

b) The sand mixture of suitable weight is then filled into the assembled split core box. The core box assembly is placed under the rammer and rammed three times to prepare a standard specimen as shown in figure 1.5.

c) The sides of the core box are tapped gently with a wooden piece, and the core box is removed from the core, leaving the core to remain on the core plate.

d) The specimen, along with the core plate is baked in an oven for about 15-30 minutes, and to a temperature of about 150 - 200°c.

e) The specimen is allowed to cool to room temperature. Meanwhile, the tension shackles are fixed on the universal sand testing machine, and once the specimen attains room temperature, it is placed in the jaws (shackles) of the testing equipment.

f) The load is applied gradually by rotating the hand wheel of the testing machine until the specimen breaks. At this instant, the corresponding tensile strength reading is noted down.

g) The above steps are repeated for different percentages of binder.

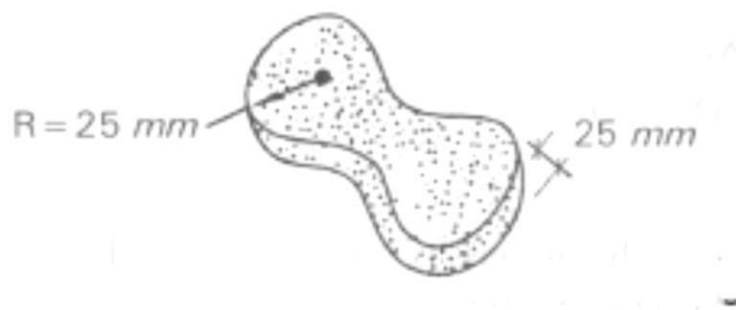


Fig.1.5 Tensile test specimen

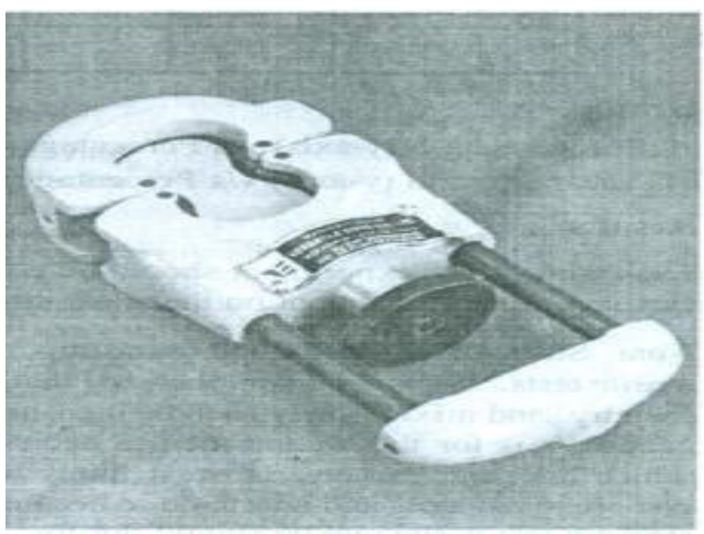


Fig.1.6 Tensile testing attachment

Tabular Column

Sl. No.	Sand		Oil Binder		Tensile strength (kgf/cm^2)
	%	gms.	%	gms.	
1.					
2.					
3.					

Graph

a) Tensile strength (y-axis) *v/s* Percentage binder (x-axis)

Results

The result of the experiment should be concluded from the graphs by analyzing the effect of binder content on the tensile strength of the sand mixture.

EXPERIMENT – 4

PERMEABILITY TEST

Aim

To determine the permeability of the given green sand mixture.

Apparatus Required

Mixing jar, weighing machine, sand rammer, universal sand testing machine, stop watch, and permeability meter.

Theory

During the filling of the mould with molten metal, gases are evolved from several sources like sand, binders, additives, etc., and these gases must be removed from the mould cavity, if the incoming liquid metal is to fill it completely. If the gases do not get a chance to escape completely from the mould cavity, it is in this period 'that defect in the form of incompletely filled moulds, gas holes, or pores, etc., result in the castings produced. The major sources of gas are as follows:

a) Gases produced from the decomposition of binders, and sand additives in moulds/cores.
b) Mould and core coatings, and
c) Air that is in the mould cavity before casting.

The reactions which evolve gases are dependent on heat, and will be most pronounced during and just after casting the metal.

A sand mould or core is made up of a permeable mass consisting of many grains of material with interconnected voids between them. The size of the voids, the degree of interconnection, and the distance through them, which the gas has to travel determines the rate of flow of gas through the mould; this venting property being termed as *permeability*.

In simple words, permeability is the physical property of the moulding sand, which allows the free escape of hot gases and water vapour through the pores between the sand grains. According to AFS, permeability is expressed as the volume of air in cubic centimeter that will pass per minute under a pressure of 1 gm/cm^2 through a standard cylindrical specimen having 50.8 *mm* diameter and 50.8 *mm* height. Numerically, permeability is given by the formula:

Permeability number, $$P_n = \frac{V.H}{P.A.T}$$

where,

V = Volume of gas passed through the specimen = 2000 cc

H = Height of the specimen in cm =5.08 cm

P = Air pressure (gm/cm^2) recorded by the manometer

A = Area of specimen in cm^2

T = Time in minutes, taken by 2000 cc of air to pass through the specimen.

Permeability is expressed as a number and is determined by a permeability meter. A higher permeability means, the sand allows more freely for the escape of hot gases and water vapour.

Procedure

a) Weighed proportions of silica sand and clay are dry mixed in a mixing jar for about 3 minutes.

b) Calculated amount of water is added to the mixture and mixed thoroughly for about 2 minutes to obtain a uniform green sand mixture.

c) The green sand mixture of suitable weight is then filled into the specimen tube and rammed thrice using a sand rammer to obtain standard cylindrical specimen of 50.8 x 50.8 *mm*.

d) The specimen tube with the sand specimen still inside the tube (sand specimen should not be stripped as is in the case of strength tests) is inverted so that the sand specimen will be at the upper end of the specimen tube.

e) The specimen tube is now placed on the rubber seal (mercury cup), as shown in fig 1.7.

f) The floating drum is lifted upwards so that the zero calibration mark on it just coincide the top level of water tank. The floating drum is allowed to settle in the water.

g) The initial reading on the manometer is noted down.

h) The valve is opened to allow the air (2000 *cc)* in the floating drum to flow through the sand specimen, and at the same time, a stop watch is started.

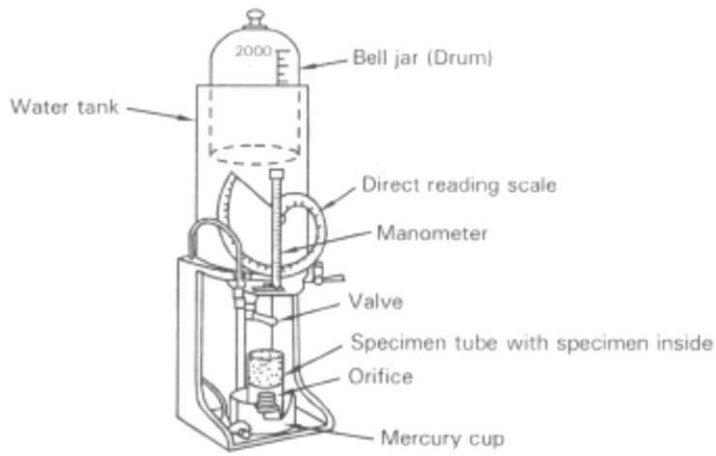
i) The time required for 2000 cc of air to pass through the specimen is noted down, and the final manometer* reading is recorded.

The permeability number is calculated using the formula, $P_n = \frac{V.H}{P.A.T}$

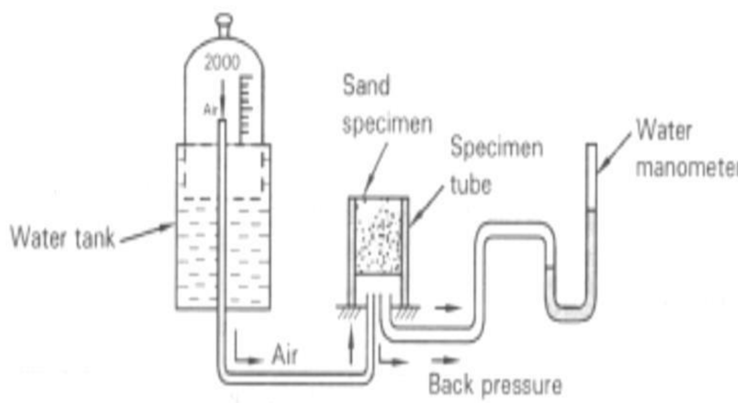
Tabular Column

Sl. No.	Sand		Clay		Moisture		Pressure (P) (gm/cm^2)			Time (T) minutes	Permeability Number Pn
	%	gms.	%	gms.	%	cc.	Initial manometer reading Pi	Final manometer reading Pf	Pressure Difference P = Pi - Pf		
1.											

** When the air is made to flow through the sand specimen, a back pressure is set up. This pressure is read with the help of water manometer. Refer figure 1. 7 (b).*



(a) Permeability meter (Mercury cup)



(b) Principle of permeability testing

Fig.1.7 Permeability testing

Results

The permeability number for the given sand mixture containing X % clay and Y % moisture is found to be ……

EXPERIMENT - 5

MOULD HARDNESS TEST

Aim

To determine the surface hardness of manually prepared green sand mould.

Apparatus Required

Weighing machine, sand mixer, single mould box, round rammer, wooden leveler, solid pattern, and sand mould hardness tester.

Theory

When a green sand mould is prepared manually by hand, the accuracy and uniformity in moulding varies due to non-uniform ramming of sand. The hardness to which a sand mould is rammed greatly influences the green strength, amount of sagging, permeability, and also surface finish of the casting. Casting defects, for example rough surface and penetration result from improper ramming. Further, the surface hardness of a mould largely determines how a mould will withstand the effects during its storage and handling.

The density of ramming of moulding sand is carried out by a surface hardness test, which makes use of a spring headed spherical indenter (1/2" dia. steel ball) as shown in figure 1.8(a). The indenter is made to penetrate into the sand surface, with the depth of penetration that has been calibrated in terms of hardness units, measures the hardness of the sand mould. The reading on the dial indicator usually ranges from 0 to 100. A mould which is more rigid and capable of completely preventing the steel ball from penetrating can be assumed to have a hardness value of about 100, while a mould which offers no resistance to the steel ball and allows it (ball to sink completely is considered to have a zero hardness value. For example, soft rammed sand moulds may have hardness value of approximately about 40, medium rammed moulds 50, hard rammed moulds 70, and very hard moulds about 85 - 90.

Procedure

a) The sand mixture for the given percentage of clay and moisture is prepared suitably.

b) A simple solid pattern is placed at the center of the mould box, and the green sand mixture is rammed around the pattern and till the top level of the mould box.

Note: For academic purpose, a single mould box is sufficient. It is advisable to use a pattern, because the extent of ramming will be similar to that when preparing a true mould.

c) Strike off the excess sand with a wooden leveler, and as soon as the process is completed, the hardness tester is placed vertically on the mould with the indenter pressed against the mould surface with sufficient force. Refer figure 1.8(b).

d) The ball is made to penetrate into the sand surface and the depth of penetration is indicated on a dial to read the hardness value directly.

e) The test is carried out at three different locations on the mould, and the average of the three readings is taken as the [mal value of mould hardness for the given percentage of clay and moisture.

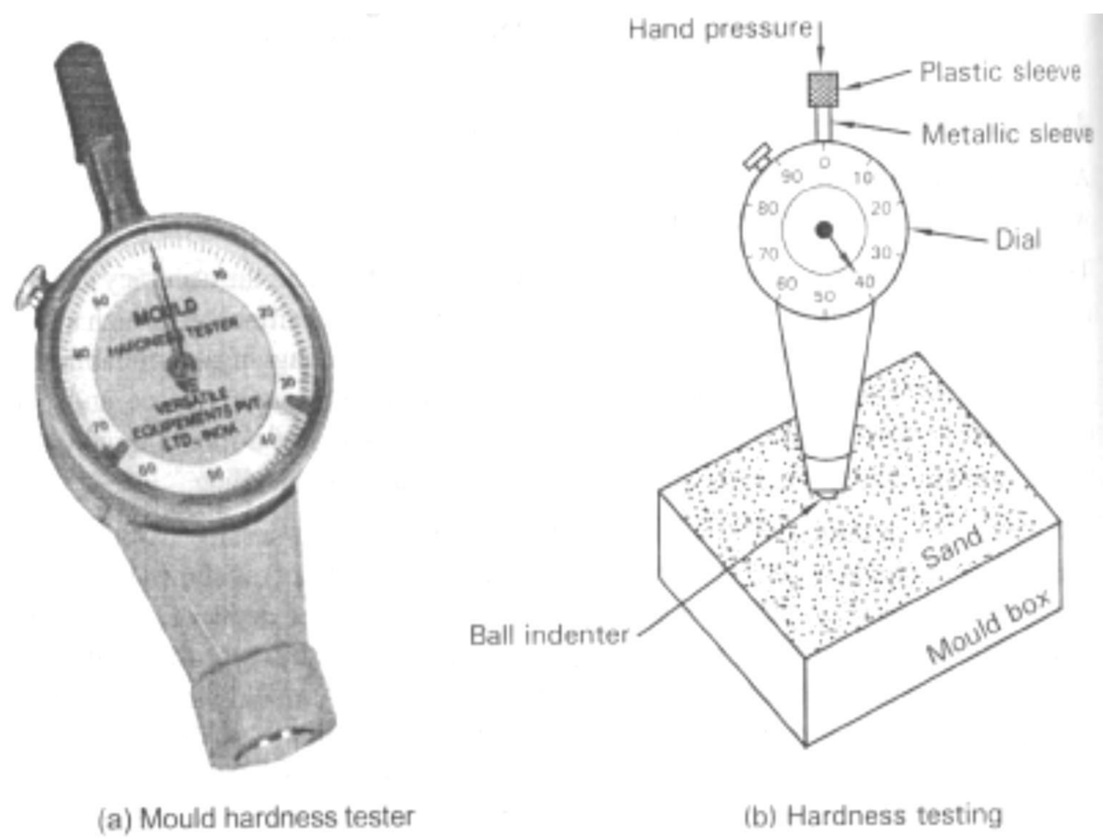


Fig.1.8 Mould hardness testing

Tabular Column

<table>
<tr><th rowspan="2">Sl. No.</th><th colspan="2">Clay</th><th colspan="2">Moisture</th><th colspan="3">Mould hardness test</th><th rowspan="2">Average mould hardness reading</th></tr>
<tr><th>%</th><th>gms.</th><th>%</th><th>cc.</th><th>Location 1</th><th>Location 2</th><th>Location 3</th></tr>
<tr><td>1.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Result

The surface hardness of the green sand mould containing X % clay and Y % moisture is found to be …………

EXPERIMENT - 6

SIEVE ANALYSIS OF BASE SAND

Aim

To find the average grain fineness number (GFN) of the given base sand.

Apparatus Required

Weighing machine, stop watch, sieve shaker set-up, etc.

Theory

Base sand (silica sand) consists of sand grains of various sizes like *fine*, *medium*, or *coarse*. The size of the sand grains has a direct effect on the various properties of the sand like strength, permeability, workability, and also on the surface finish of the castings. For example, fine grain sand results in good surface finish on the casting, but does not perm it easily for the escape of the gases through them (poor permeability). On the other hand, coarse grain sand allows easily for the escape of gases through them, but gives a rough surface finish on the casting.

The size of the sand grains is designated by *Grain Fineness Number (GFN),* which indicates the average size of the grains of sand present in the base sand. The size is determined by passing the sand through a number of standard sieves (mesh with specific openings) mounted one above the other, and on a power driven shaker. Refer figure 1.9 (a). The top most sieve is the coarsest, and the bottom most sieve is the finest of all the sieves. The sieves in between the top and bottom are placed in the order of fineness. Refer figure 1.9 (b). The shaker vibrates the sieves, and the sand placed on the top sieve gets screened (filtered) and collect on different sieves depending upon the various sizes of grains. The GFN is then calculated numerically by weighing the sand retained in all the sieves.

Note: The grain fineness number unfortunately does not give much information regarding the size distribution of the grains. Thus, two sands from different origin might have the same GFN, but differ widely in their distribution. Further, two sand with the same GFN might differ in their properties because of differences in shape* of the sand grains.

Procedure

a) The sieves of the sieve tester are thoroughly cleaned from any dust or retained sand particles.

b) Dry silica sand weighing 100 *grams* is placed in the top most sieve of the standard set of sieves, and the lid is closed.

c) The sieve stack is mounted on the sieve shaker and rigidly clamped.

d) The motor is switched ON, which causes the sieve assembly to vibrate resulting in screening (filter) of sand particles.

e) After duration of about 15 *minutes*, the motor is switched OFF, and the amount of sand particles retained in each of the sieves are weighed separately and tabulated.

f) The percentage weight retained by each sieve is calculated, and this quantity is multiplied by the multiplier (factor) for the sieve.

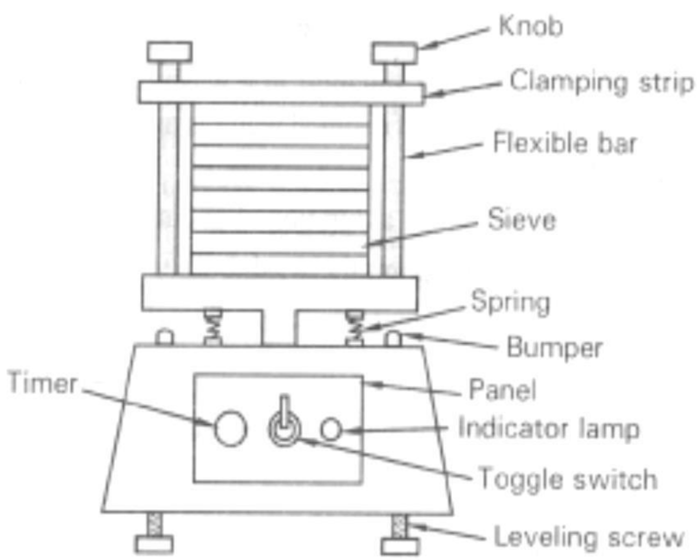
g) The average GFN is calculated using,

$$GFN = \frac{Y}{X}$$

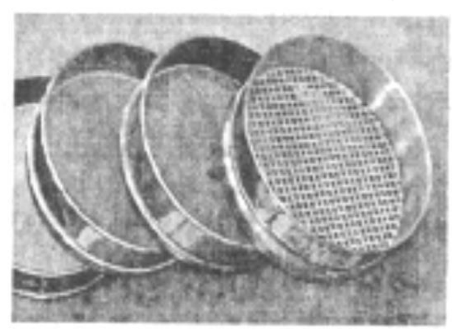
where, X = sum of percentage of sand retained in the sieve, and

Y = sum of product of percentage sand retained in the sieve and the corresponding multiplier.

* *The shape of the sand grains may be either round, sub-angular, angular, or compound grains.*



(a) Sieve tester



(b) Sieve

Fig.1.9 Details of sieve testing

Tabular Column

Sl. No.	Sieve Number	Wt. of the sieve before test	Wt. of the sieve after test	Weight of sand retained (gms)	% of sand retained (R)	Multiplier (M)	Product (RxM)
1.	1700					5	
2.	850					10	
3.	600					20	
4.	425					30	
5.	300					40	
6.	212					50	
7.	150					70	
8.	106					100	
9.	75					140	
10.	53					200	
Total					$X = \sum R$		$Y = \sum (R \times M)$

$$\text{Average GFN} = \frac{Y}{X}$$

Result

The average grain fineness number of the given base sand is found to be……….

EXPERIMENT - 7

CLAY CONTENT DETERMINATION TEST

Aim

To determine the percentage of clay present in the given base sand sample.

Apparatus Required

Weighing machine, stop watch, flat tray, oven, clay content tester (wash bottle, siphon, and stirrer driven by motor), etc.

Theory

Clay, in the presence of water helps to bind the sand particles together, thereby imparting sufficient strength to the moulding sand mixture. In some mineral deposits, clay and sand occur mixed in suitable proportions, so that the sand can be mined and used directly for moulding. This type of sand is referred to as *natural moulding sand*. In other sands, clay will be present in very small amounts, and should be added externally to the silica sand in suitable proportions to develop adequate strength and plasticity. According to AFS, clay content in the moulding sand includes very fine material, fine silica or slit, as well as the clay mineral present, and the total percentage of all these particles is called the AFS clay content of the sand.

According to standard testing procedure, the AFS clay in a moulding sand is defined as *particles which when suspended in water, fail to settle at the rate of* **1** *inch per minute*. The clay content in the base sand can be determined by *dissolving* or washing *it* off the sand.

Procedure

a) Take 50 grams of dry silica sand (if not dry, bake in oven suitably) in a wash bottle, to it add 475 *ml* of distilled water and 25 *ml* of NaOH solution. (If distilled water is not available, ordinary water can be used). Refer figure 1.1O.

b) The mixture is thoroughly stirred by a mechanical stirrer for duration of about 5-minutes.

c) Add distilled water up to the 6 inch level graduation mark on the wash bottle.

d) The mixture is now left undisturbed for duration of 10 minutes so as to allow the contents of the bottle to settle down.

Note: By doing so, the sand settles at the bottom while the clay particles washed from the sand will be floating in the water,

e) Siphon out the water up to l-inch level mark* using a standard siphon.

f) Allow the contents to settle down for 5 minutes and thereafter siphon out the water up to the l-inch level mark.

g) Add distilled water again up to 6 inch level mark and stir the contents for duration of about 2-minutes.

h) Repeat steps (f) and (g) to about 3 to 4 times till the water above the sand level becomes clear. This indicates all the clay in the base sand has been removed.

i) The sand settled in the wash bottle is removed and dried in an oven to about 110^0C.

j) The weight of the dried sand (Wd) is noted down and the percentage clay is calculated using,

$$\% \text{ clay} = \frac{(50-Wd)}{50} \times 100$$

** Some wash bottles are not marked with inches, instead with milliliters. Testing with such bottle have to be done suitably, i. e., the water in the wash bottle is siphoned off to a depth of exactly* 5 *inches below the level to which it had been filled thereby leaving a minimum depth of at least J inch of water in the bottom of the wash bottle.*

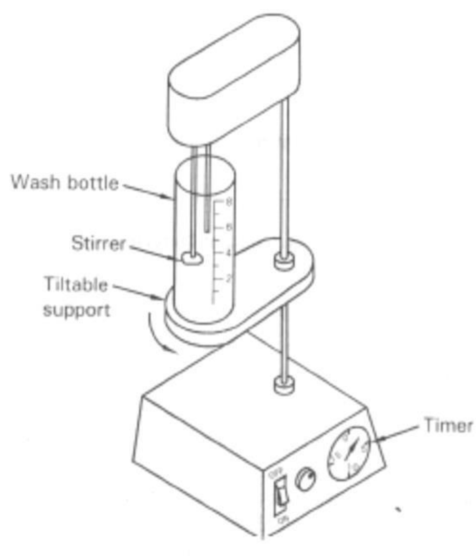


Fig. 1.10 Clay content tester

Result

The percentage clay in the given base sand is found to be …………

2

FOUNDRY PRACTICE

USE OF FOUNDRY TOOLS & MOULD PREPARATION

INTRODUCTION

Founding or Casting is a process of producing metallic objects by pouring molten metal into a preformed mould having the desired shape of the metallic object, and then allowing the molten metal to solidify in the mould. The solidified metal is known as *casting.*

A rigid mould is one among the various factors for producing a sound casting. Moulds are usually classified into two types as given below:

Temporary moulds

Usually made from refractory sand *(example* silica sand), however wax, plaster of Paris, or ceramic materials can also be used.

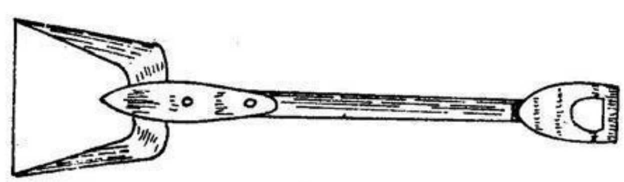
Permanent moulds

Made from ferrous metals like steel, gray cast iron, etc.

When compared to permanent moulds, temporary moulds (especially refractory sand moulds) can cast high melting point metals and large size objects with minimum cost, whereas permanent moulds are used for low melting point materials and small sized objects that require quality and dimensional accuracy. Sand moulds can be prepared either manually by hand, or by using machines. In machine moulding, various moulding operations like sand ramming, withdrawing pattern, etc., are done my machines, whereas in manual moulding, the various operations are carried out with specific tools and equipments by the moulder. A few commonly used manual tools and equipments are discussed briefly below.

- **Shovel**

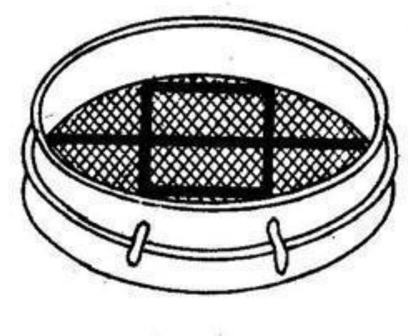
A shovel as shown in figure is used to transfer the sand from pile to the place of use.
It is also used to mix and temper the moulding sand.



Showel

- **Hand riddle**

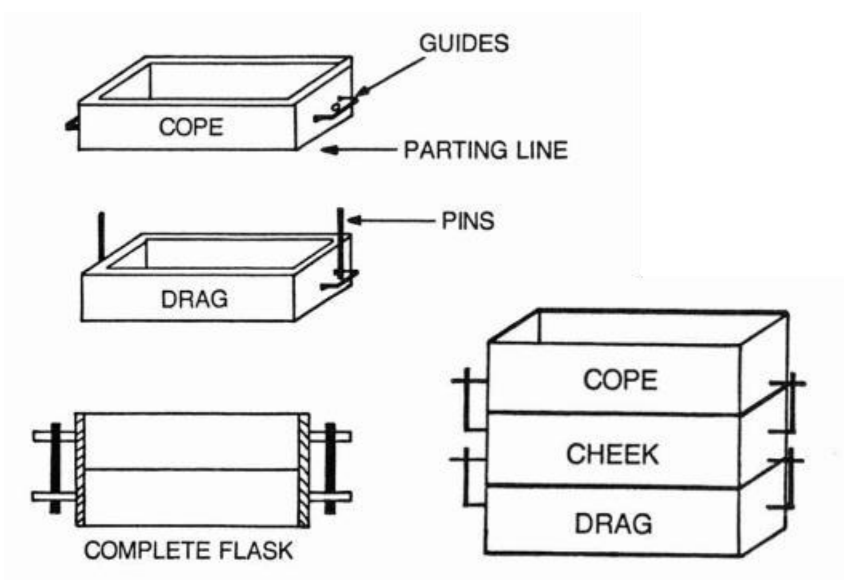
Hand riddle consists of a wire mesh fitted into a circular wooden frame as shown in figure. It is used for cleaning or removing unwanted material like lumps, stones, splinters, nails, etc., from the moulding sand.



Riddle

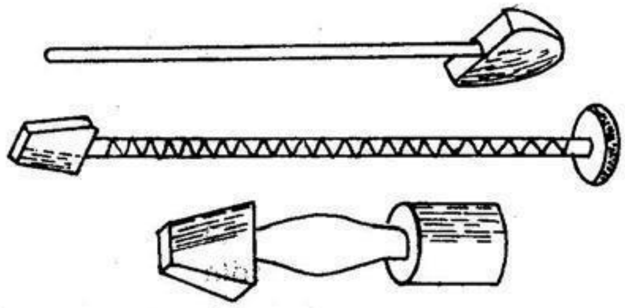
- **Mould box**

A mould box or flask as shown in figure is a container which holds the moulding sand during ramming and until the molten metal has been solidified. A mould box may be 2 or 3 in numbers. The top box is called *cope*, the bottom *drag*, and the middle box *cheek*.



- **Rammer**

A rammer is used for ramming or packing the sand into the mould box. The different types of rammer are shown in figure. The wedge or peen shaped part of the rammer is used for ramming sand in pockets and comers where there is space restriction for a round shaped rammer.



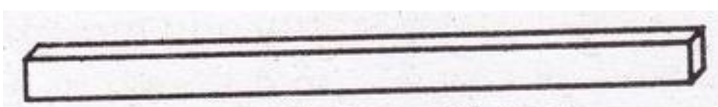
Rammers

- **Brush**

A brush is used to sweep away the dust and other particles from the pattern, bottom board or floor, etc., so as to make it clean for use. Refer figure.

- **Wooden leveler**

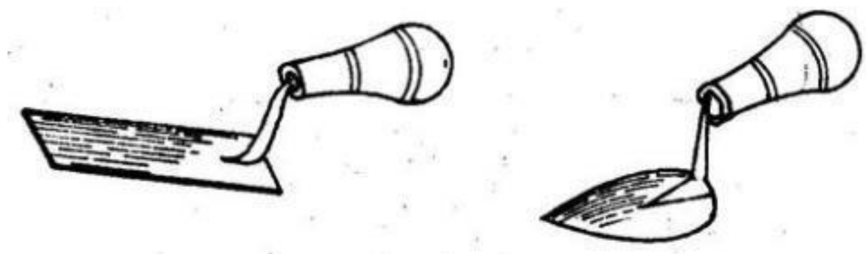
A wooden leveler or strike-off bar is used to remove excess sand from the top of the rammed sand so as to provide a plane level surface.



Strike off bar

- **Trowel**

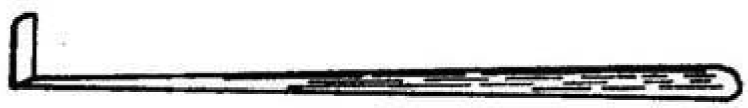
A trowel consists of a metal blade of different shapes with a wooden handle as shown in figure. It is used for smoothing and finishing the mould surface, and also for repairing the damaged portions of the mould.



Trowels

- **Lifter (Cleaner)**

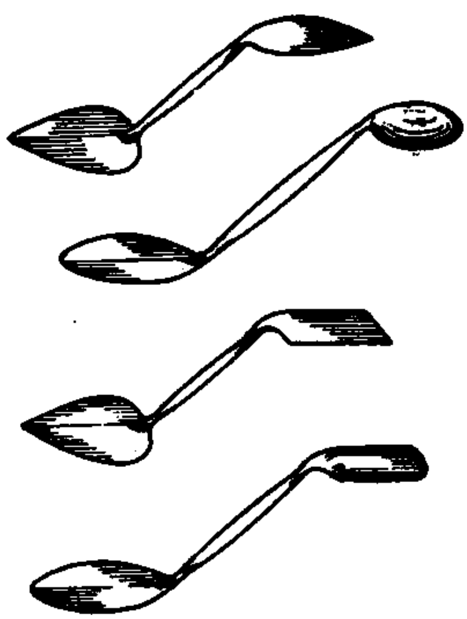
A lifter, also called cleaner, is used to lift dirt or loose sand from the mould. It is also used for repairing and finishing thin sections, deep and narrow openings in the mould.



LIFTER

- **Smoothers and corner slick**

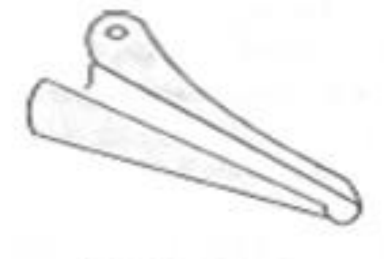
A smoother & comer slick as shown in figure are used to repair and finish comers, edges, round and flat surfaces of the mould.



(i) Smoother & corner slic

- **Gate cutter**

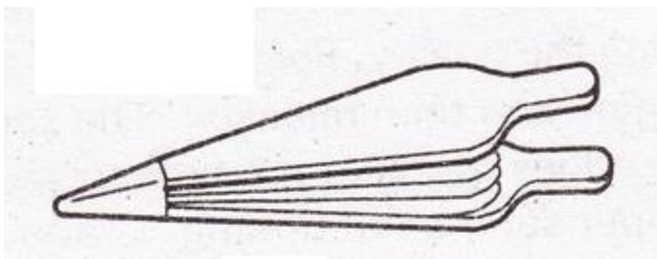
A gate cutter as shown in figure is a shaped piece of metal used to cut the gate, i.e., an opening which connects the runner and the mould cavity.



(g) Gate cutter

- **Bellow**

A bellow as shown in figure is used to blow off loose particles of sand and other foreign particles from and around the pattern and the mould cavity.



Bellow

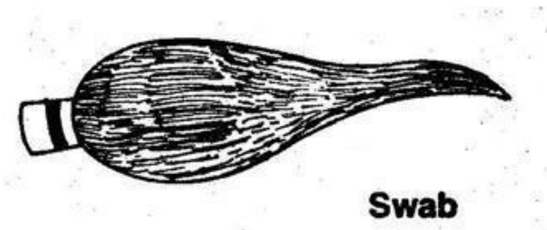
- **Vent wire**

A vent wire as shown in figure is a sharp tool used for piercing holes in the rammed sand of the cope box. These holes permit gases to escape easily from the mould.

Vent wire

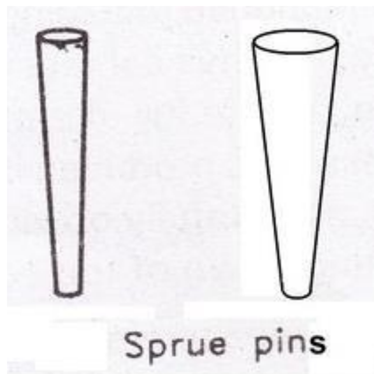
- **Swab**

It is a hemp fiber brush used for moistening the edges of sand mould, which are in contact with the pattern surface, before withdrawing the pattern. It is also used for coating the liquid blacking on the mould faces in dry sand moulds.



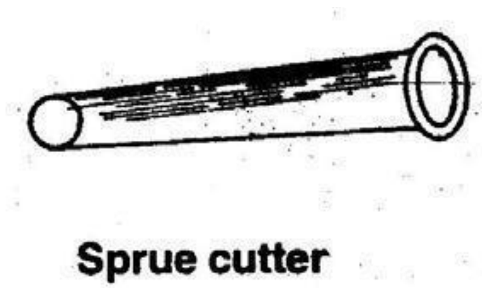
- **Sprue Pin**

It is a tapered rod of wood or iron, which is embedded in the sand and later withdrawn to produce a hole, called runner, through which the molten metal is poured into the mould.



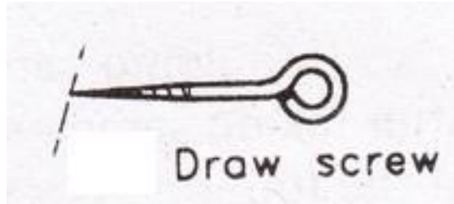
- **Sprue Cutter**

It is also used for the same purpose as a sprue pin, but there is a marked difference between their use in that the cutter is used to produce the hole after ramming the mould. It is in the form of a tapered hollow tube, which is inserted in the sand to produce the hole.



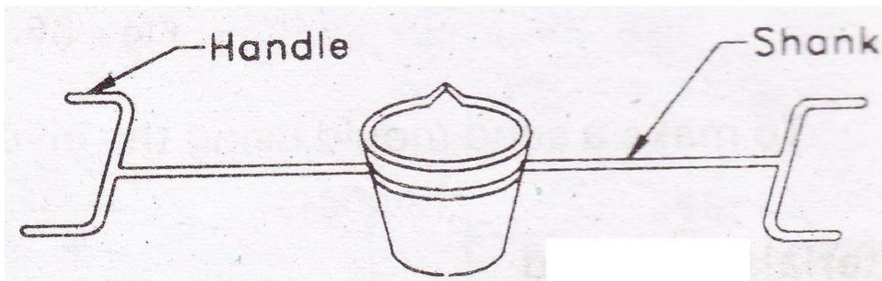
- **Draw Spike**

Draw spike are used to lift the pattern from the sand mould. Two types of draw spike are shown in the figure. Draw pin is inserted into a wooden pattern while thread end of draw spike screws into a wooden pattern draw plate fastened to the large wooden plate or tapped hole of metal pattern.



- **Ladle**

Ladle is used to collect the molten metal from the furnace and to pour the metal in the mould cavity. It is made up of sheet metal and is coated with refractory material inside to withstand the temperature of molten metal.



FUNDAMENTALS OF MOULD PREPARATION

The basic terms involved in preparation of moulds are illustrated & discussed briefly in Fig.1.12.

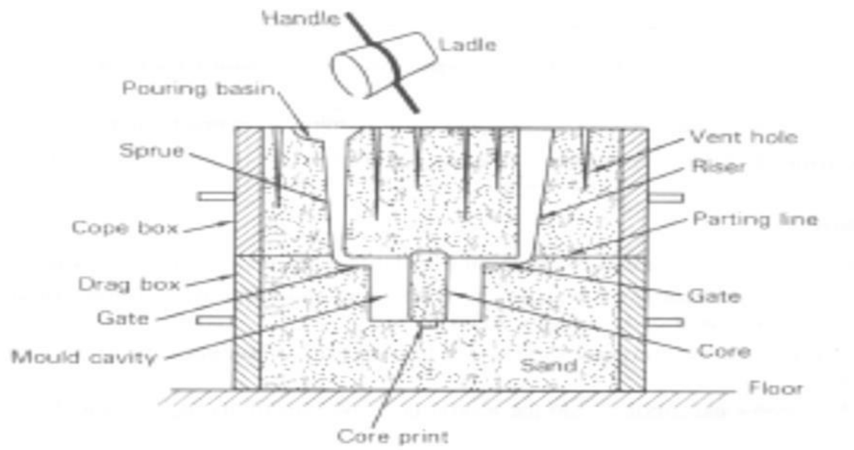


Fig 1.12 Basic terms in moulding

- **Parting line:** Also called parting surface, it is the zone of separation between cope and drag portions of the mould in sand casting.
- **Sprue:** It is a vertical passage through which the molten metal will enter the gate, and then into the mould cavity
- **Pouring basin:** It is the enlarged portion of the sprue at its top into which the molten metal is poured.
- **Gate/Ingate:** It is a short passageway which carries the molten metal from the runner/ sprue into the mould cavity.
- **Riser:** A riser or feed head is a vertical passage that stores the molten metal and supplies (feed) the same to the casting as it solidifies
- **Mould cavity:** The space in a mould that is filled with molten metal to form the casting upon solidification.
- **Core:** A core is pre-formed (shaped) mass of sand placed in the mould cavity to form a hollow cavity in castings.
- **Core print:** It is a projection attached to the pattern to help for support and correct location of core in the mould cavity.
- **Ladle:** It is usually made from graphite or silicon carbide, and is used to hold molten metal during pouring.

MODEL-1

MOULD PREPARATION USING SOLID PATTERN

Aim

To prepare green sand mould using solid pattern of stepped bar profile.

Tools Required

Shovel, mould box (2 nos.), rammer, strike-off bar, trowel, lifter, gate cutter, vent rod, etc.

Procedure

a) Prepare a green sand mixture containing suitable amounts of clay and moisture.

b) Place drag box on the floor in its inverted position, and keep the solid pattern at the center of the drag box as shown in figure l.13 (a).

c) Sprinkle parting sand around the pattern to avoid the moulding sand from sticking to the pattern

d) Fill the green sand mixture into the mould box and ram till its top level without disturbing the pattern.

e) Remove excess sand using strike-off bar and now turn the drag box upside, so that the pattern faces at the top as shown in figure 1.13 (b).

f) Sprinkle parting sand over the drag top surface and place the cope box on top of it.

g) Place the sprue and riser at suitable position as shown in figure1.13(c).

h) Holding the sprue and riser pin firmly in their position, fill the cope box with green sand and ram the mixture to obtain a rigid mould.

i) Strike off excess sand from top of the cope and remove the sprue and riser pin by rapping them with slight pressure.

j) Vent the cope with a vent wire and roll over the cope box on the floor.

k) Eject the pattern by rapping it with low pressure and cut the gate connecting the sprue and the mould cavity.

l) Repair the mould if any, using trovel and blow-off sand particles from the mould cavity using a bellow.

m) Place the cope over drag and make the mould ready for pouring as shown in figure1.13 (d).

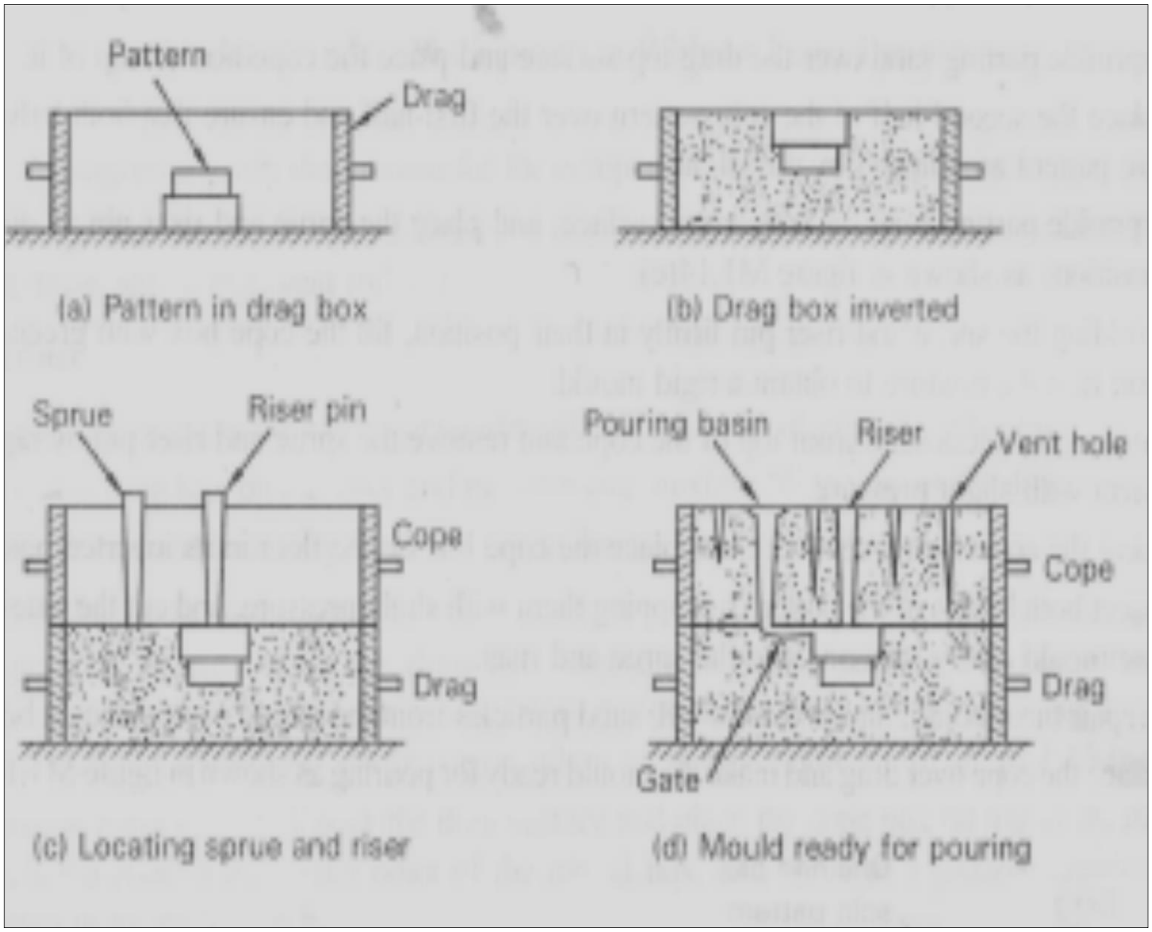


Fig.1.13 Mould preparation using solid pattern

Result

The mould cavity for the stepped shaped bar is prepared and made ready for pouring.

MODEL- 2

MOULD PREPARATION USING SPLIT PATTERN

Aim

To prepare a green sand mould using split pattern of dumbbell shape.

Tools Required

Shovel, mould box (2 nos.), rammer, strike-off bar, trowel, lifter, gate cutter, vent rod, etc.

Procedure

a) Prepare a green sand mixture containing suitable amounts of clay and moisture

b) Place the drag box on the floor in its inverted position and place the flat surface of one-half of the split pattern on the floor as shown in figure1.14 (a).

c) Sprinkle parting sand around the pattern to avoid the moulding sand from sticking to the pattern.

d) Fill the green sand mixture into the mould box and ram till its top level without disturbing the pattern

e) Remove excess sand using strike-off bar and now turn the drag box upside, so that the pattern faces at the top as shown in figure 1.14(b).

f) Sprinkle parting sand over the drag top surface and place the cope box on top of it.

g) Place the second-half of the split pattern over the first-half and ensure that both halves of pattern are aligned by dowel pins.

h) Sprinkle parting sand on the pattern surface, and place the sprue and riser pin at suitable positions as shown in figure 1.14(c)

i) Holding the sprue and riser pin firmly in their position, fill the cope box with green sand and ram the mixture to obtain a rigid mould.

j) Strike off excess sand from top of the cope and remove the sprue and riser pin by rapping them with slight pressure.

k) Vent the cope with a vent wire and place the cope box on the floor in its inverted position.

l) Eject both halves of the pattern by rapping them with slight pressure, and cut the gate from the mould cavity to connect to the sprue and riser.

m) Repair the mould if any, and blow-off sand particles from the mould cavity using a bellow.

n) Place the cope over drag and make the mould ready for pouring as shown in figure 1.14(d).

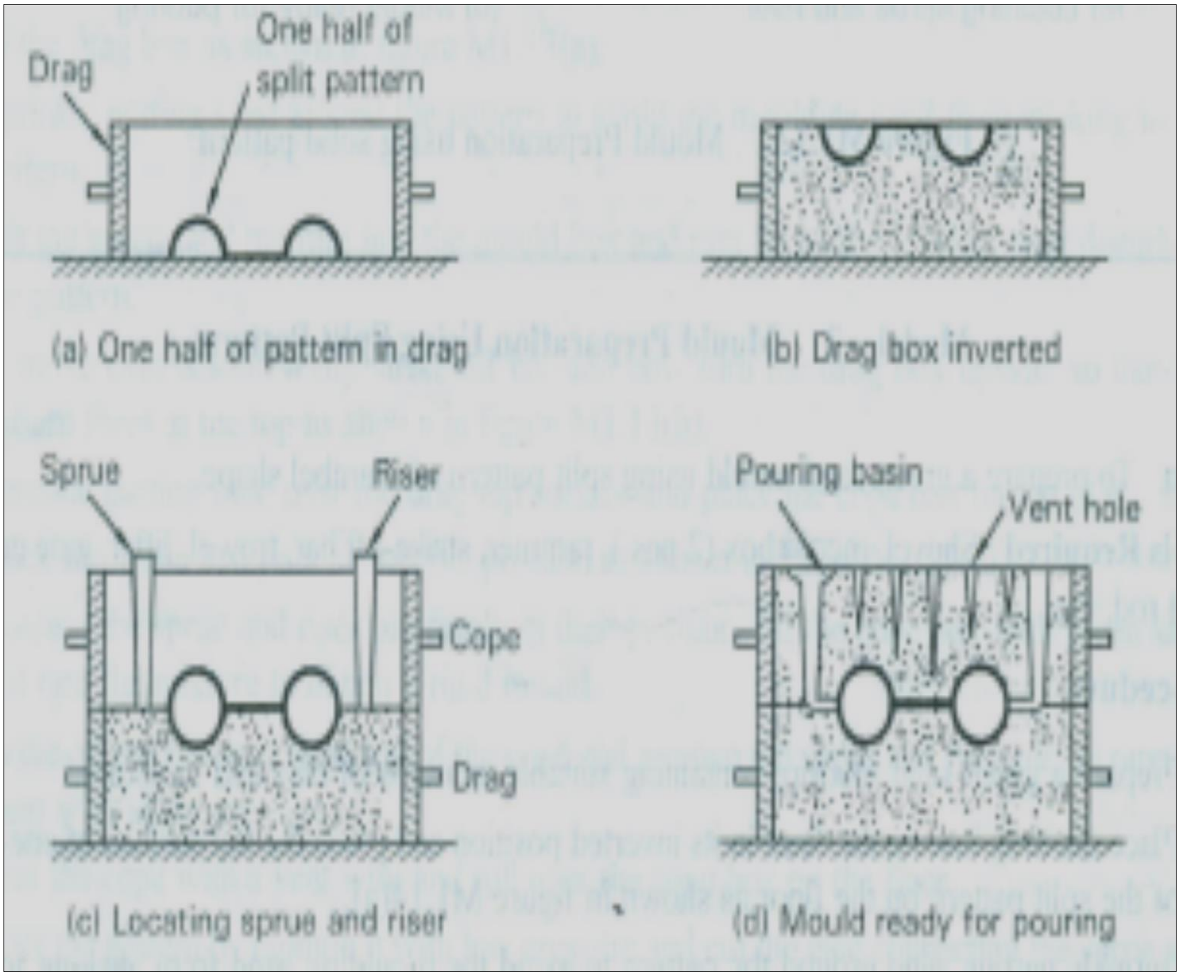


Fig.1.14 Mould preparation using split pattern

Result

The mould cavity for the dumbbell shaped part is prepared and made ready for pouring.

MODEL-3

MOULD PREPARATION WITHOUT USING PATTERN

Aim

To prepare a green sand mould for the component shown in figure l.15.

Tools Required

Steel rule, spring divider, shovel, mould box (2 nos.), rammer, strike-off bar, trowel, lifter, gate cutter, vent rod, etc.

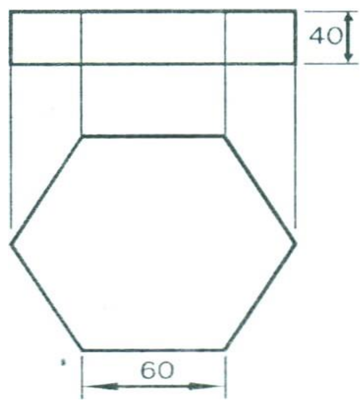


Fig.1.15 Front and Top views of component for Model 3

Procedure

a) Prepare a green sand mixture containing suitable amounts of clay and moisture.

b) Place the drag box on the floor and ram the sand mixture till the top of the drag box.

c) Remove excess sand using strike-off bar to form a flat level surface.

d) Finish the top surface using a trowel.

e) Using a sharp tool or vent rod, draw two diagonals on the top surface of the drag box to locate the center point of the drag box. With this point as center and using spring divider, draw a circle of radius 60 *mm* (hexagon side is 60 *mm)* as shown in figure l.16 (a).

f) Sprinkle parting sand all over the drag surface and place the cope box on top of the drag. Place the riser at the center point of the mould box, and sprue at a suitable location as shown in figure 1.16 (b).

g) Holding the sprue & riser pin in position, ram the sand mixture till the top of the cope box.

h) Strike-off excess sand from top of the cope and remove the sprue and riser pin by rapping them with slight pressure.

i) Vent the cope with vent wire and lift the cope and keep it in inverted position.

j) With the center point of the circle marked in the drag box, construct a hexagon of sides *60mm.*

k) With the help of knife tool and lifter, remove the sand to a depth of 40 *mm* to obtain a hexagon shaped cavity as shown in figure l.16(c).

l) Cut the gate connecting the sprue and the hexagonal shaped cavity and finish the mould to make it ready for pouring.

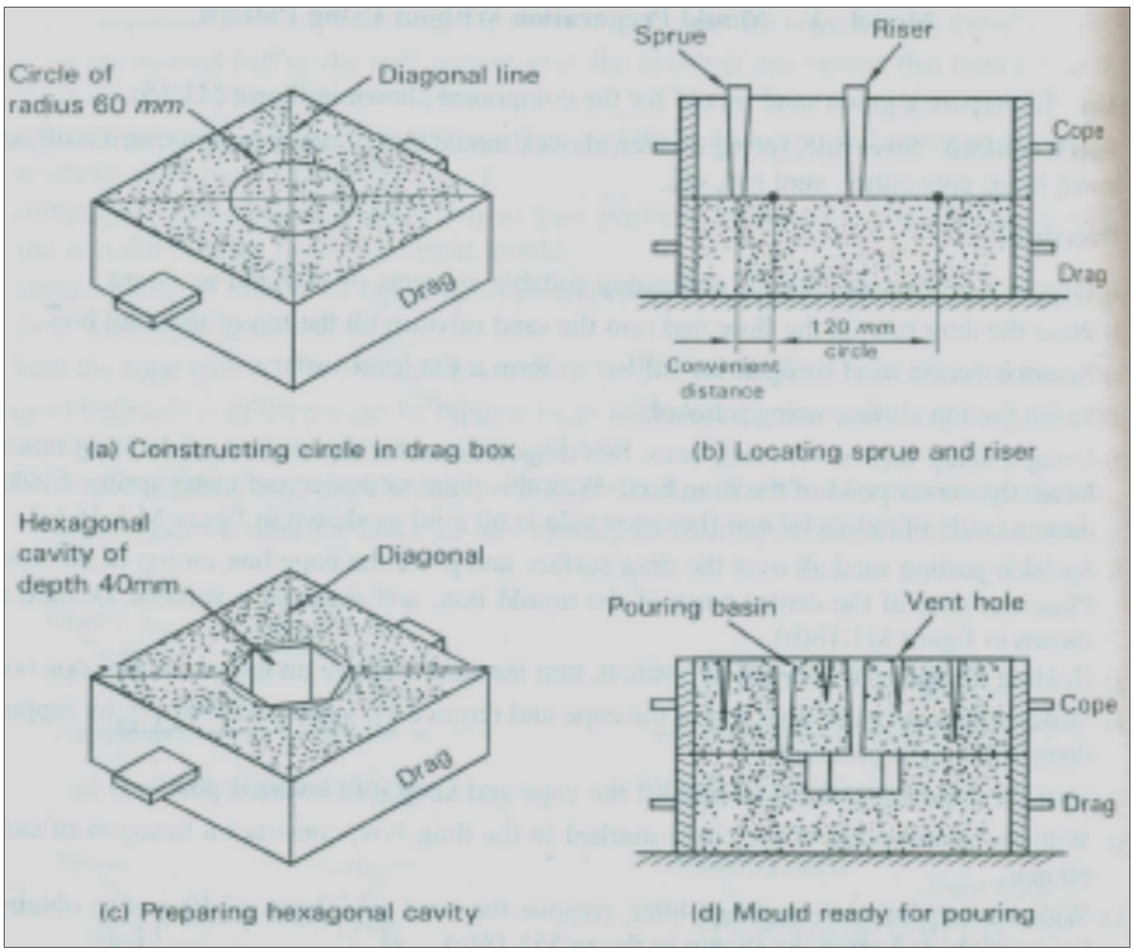


Fig.1.16 Mould preparation for model 3

Result

The mould cavity for the given component is prepared and made ready for pouring.

3

FORGING OPERATIONS

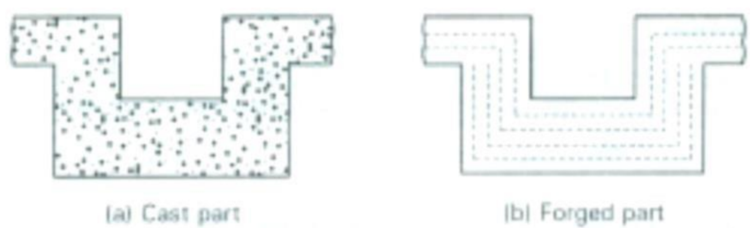
INTRODUCTION

Forging is a type of manufacturing process, wherein a metal is heated to its plastic state and then deformed to the desired shape and size by the application of compressive force through a hammer, press, or rolls. If the compressive force is exerted manually by using specific tools, it is called *hand forging*, and if the compressive force is exerted using machines, it is called *power forging.*

Forging versus Casting

There are many factors to consider whether a component is to be cast or forged. However, if a component can be produced either by casting or forging, the advantages for preferring forging can be ascertained due to the grain flow in forged parts. Figure1.17 shows the grain flow in a cast and forged part.

Fig.1.17 Grain flow in casting and forged part



On comparison, it can be seen in the forged part, the fiber like grain flow lines being continuous and following the contour of the part, whereas there is no grain flow in the cast component. The cast part is made up of grains with random orientation and exhibits uniform properties in all directions. However, in a forged part, the directions of the fibrous structure can be controlled to develop the maximum mechanical properties for applications where shock and fatigue are encountered. Forging leads to a re-arrangement of the fibers and makes the grain size finer. High-strength-to-weight ratio, greater toughness, elimination of internal defects such as crack and porosity are a few major properties that make forging better than casting.

HAND FORGING TOOLS

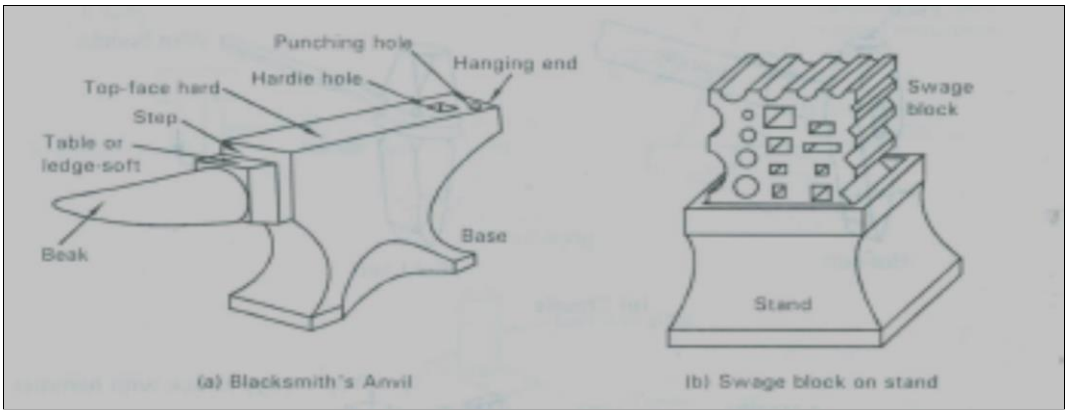
A few commonly used hand forging tools (Blacksmith's tools) are discussed briefly below:

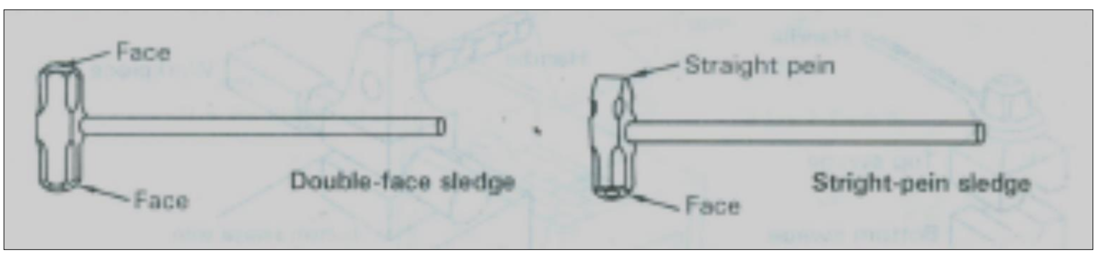
- **Anvil**

An anvil shown in figure 1.18 (a) forms a support for the work while it is being hammered. The *body* of the anvil is made of cast steel or mild steel with a hardened top face welded on.

The *beak* or *horn* is soft and with an increasing diameter of cross-section, is used for bending the metal or forming curved profiles. The *ledge* between the beak and the anvil face is soft, and can be used as a base for cutting operation with hot chisels.

The anvil bas a square hole called *Hardie hole* that is used to hold a square shank of various hand tools, while the circular hole called *punching hole* or *pritchel hole* is used for punching operations. The holes can also be used to bend the work piece by inserting the work piece into them and hammering it to the desired shape. The end of the anvil opposite to the horn is made rectangular for bending work pieces at right angles.





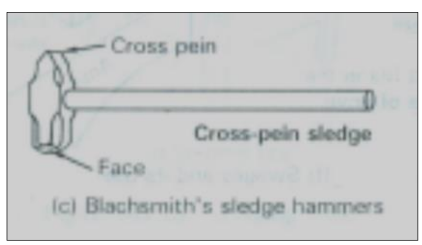


Fig.1.18 Forging tools

- **Swage Block**

The swage block as shown in figure 1.18 (b) is a rectangular block made from cast steel, and can be placed either in a vertical or horizontal position. The swage block consists of varying sizes of Vee and half-round grooves on its edges, and round, square and rectangular through holes on its face. The grooves on the edges are used for accommodating works of various sizes, while the holes on the face are used for punching and bending operations.

- **Sledge Hammer**

A sledge hammer is a very heavy hammer with a long handle. It is used for striking the hot work piece so as to give it, the desired shape. Sledge hammer comes in various shapes as shown in figure l.18 (c).

- **Tongs**

Tongs are used to hold hot work pieces during hammering. They are usually made from mild steel and come in different shapes and sizes so as to hold work pieces of corresponding shapes and sizes. Refer figure 1.18 (d).

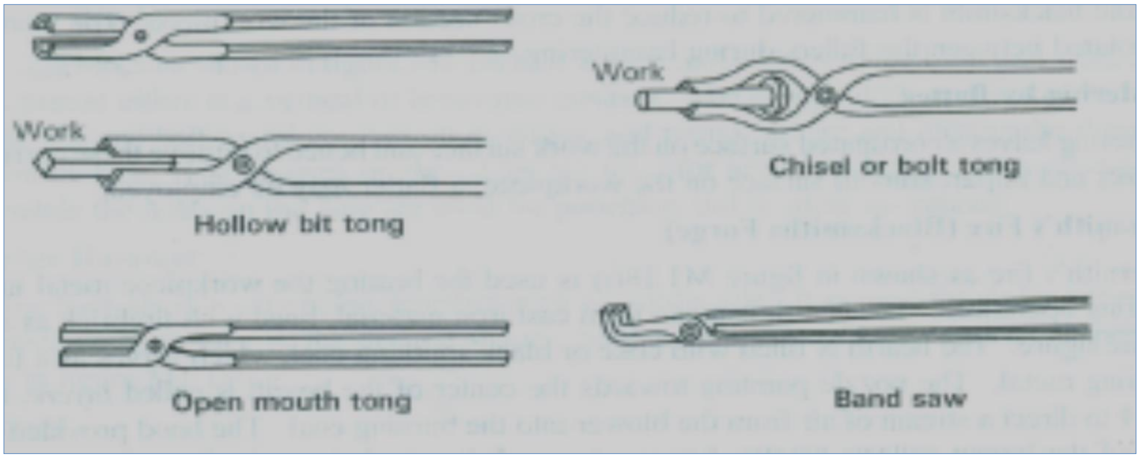


Fig.1.18 (d) Tongs

- **Chisels**

Chisels are cutting tools used for cutting metals which are in hot or cold condition. Figure l.18 (e) shows the two types of chisels: *hot* and *cold* chisels. The difference between the two types arrives because of the chisel edge. The edge of a cold chisel is hardened and tempered with edge angle varying from 45° to 60°, whereas the edge of a hot chisel need not be hardened, and the edge angle varies from 30° to 35°. It should be noted that during cutting hot metal, the edge of the hot chisel must be frequently cooled, otherwise which might become soft and useless.

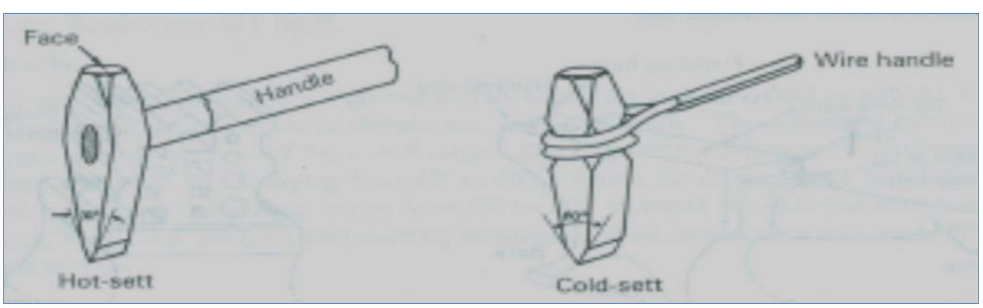


Fig.1.18 (e) Chisels

- **Swages**

Swages as shown in figure 1.18(f) are used in pairs, and are employed to reduce or finish the job to size and shape. They are usually available in circular and hexagonal shapes. Figure1.18 (f) shows the use of swages in producing a part. The bottom swage having a square shank is fixed in the Hardie hole of the anvil. The top swage carries a handle, and is held rigidly by the operator (blacksmith). Between the top and bottom swage is the work piece, which is rotated by the blacksmith while the top swage is being hammered by another blacksmith.

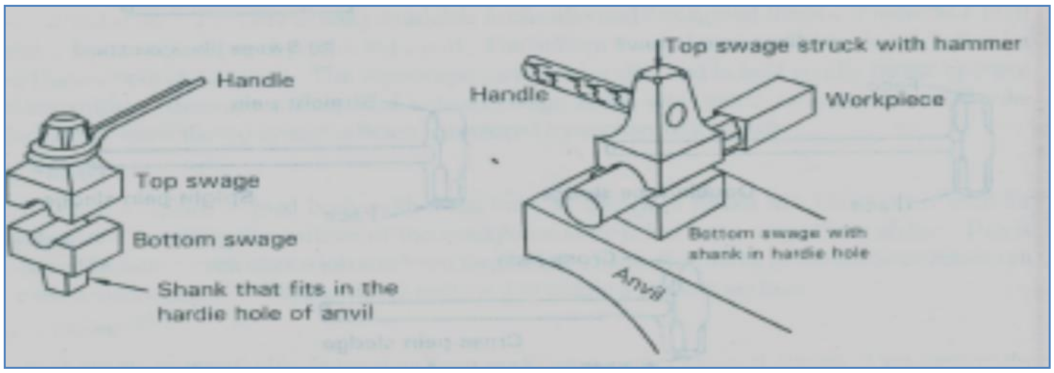


Fig.1.18 (f) Swages and its use

- **Flatter**

A flatter is a square shaped body with a flat base as shown in figure 1.18(g). It is used for leveling and finishing the surface of the work piece after it has been forged into shape. This is required because, even after a job has been forged into shape, the marks of the hammer remain on the work surface, and hence should be removed to obtain a smooth surface.

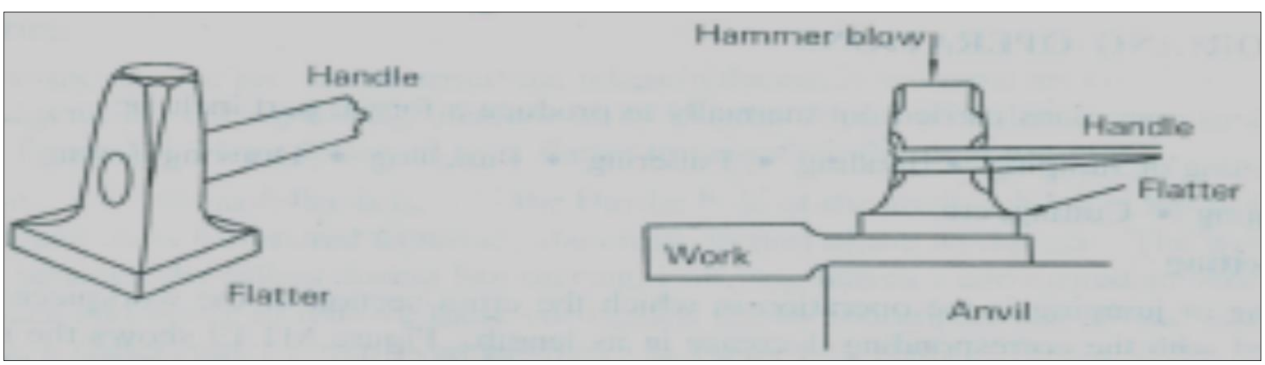


Fig.1.18 (g) Flatter and its use

- **Fullers**

Fullers are blunt nosed chisels used to form necks or groove on work pieces. They spread the metal and reduce the cross-section of the work piece. Figure 1.18(h) shows the fullering operation. The bottom fuller is held in the Hardie hole of the anvil, *while* the top fuller held by the blacksmith is hammered to reduce the cross-section of the work piece. The work piece is rotated between the fullers during hammering.

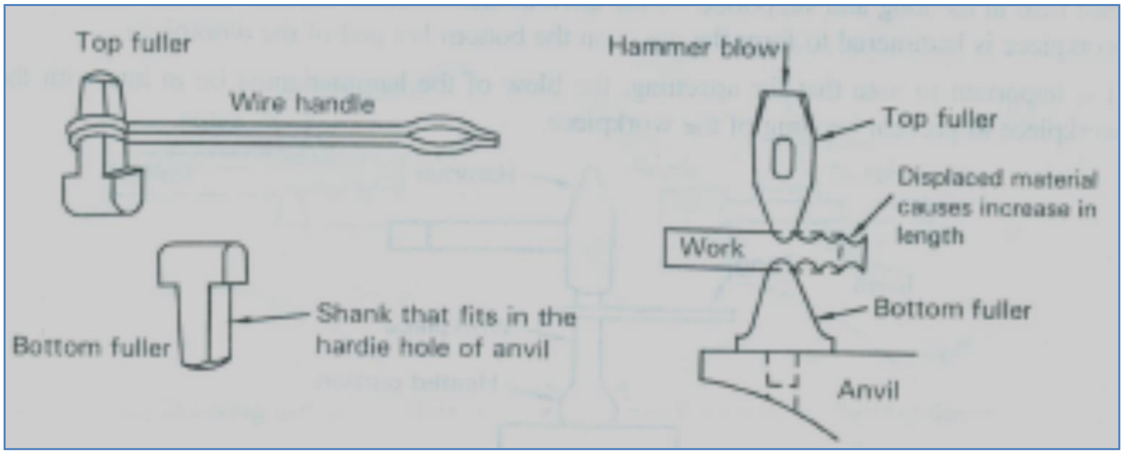


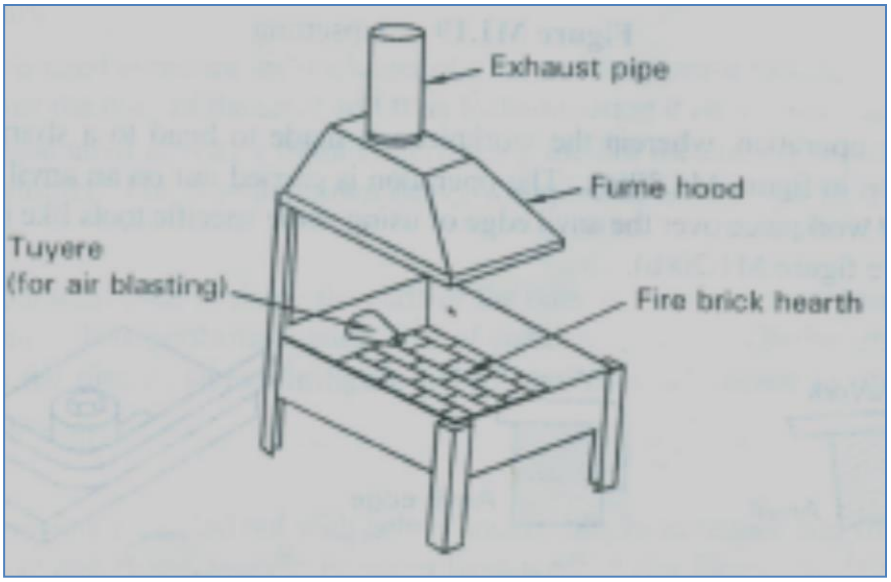
Fig.1.18 (h) Fullering

Fullering by flatter

Fullering leaves a corrugated surface on the work surface and hence to remove these corrugated marks and impart smooth surface on the work piece, a flatter may be employed.

- **Smith's Fire (Blacksmiths Forge)**

A Smith's fire as shown in figure 1.18 (i) is used for heating the work piece metal in hand forging operations. The hearth is made from cast iron material, lined with firebrick as shown in the figure, The hearth is filled with coke or black smithing coal, which serves as a fuel for heating metal. The nozzle pointing towards the center of the hearth is called *tuyere*, and is used to direct a stream of air from the blower into the burning coal. The hood provided at the top of the hearth collects smoke, fumes, etc., and directs them away from the work place, through the chimney. The ash and other impurities resulting from burning coal is collected from the bottom of the smiths fire.



Figre1.18 (i) Smith's fire

FORGING OPERATIONS

The various operations carried out manually to produce a forged part include:

- Upsetting or Jumping
- Bending
- Fullering
- Punching
- Drawing down
- Swaging
- Cutting, etc.

a) Upsetting

Upsetting or jumping is the operation in which the cross-section of the work piece metal is increased with the corresponding decrease in its length. Figure 1.19 shows the upsetting process. In operation, the portion of the metal to be upset is heated suitably; the work piece is then held in the tong and supported on the anvil as shown in the figure. The top edge of the work piece is hammered to form the upset on the bottom hot end of the work piece.

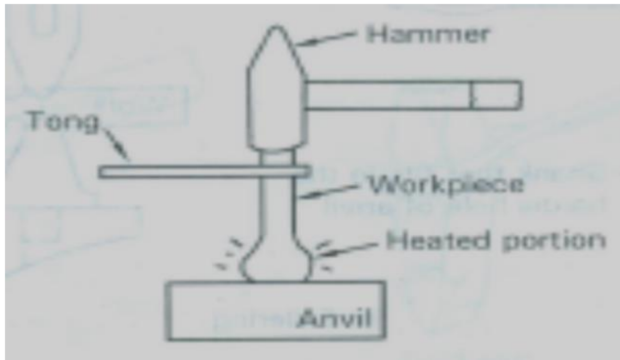


Fig.1.19 Upsetting

b) Bending

Bending is the operation, wherein the work piece is made to bend to a sharp angle or to a radius as shown in figure 1.20(a). The operation is carried out on an anvil by heating and hammering the work piece over the anvil edge or using some specific tools like jigs and fixtures as shown in the figure 1.20(b).

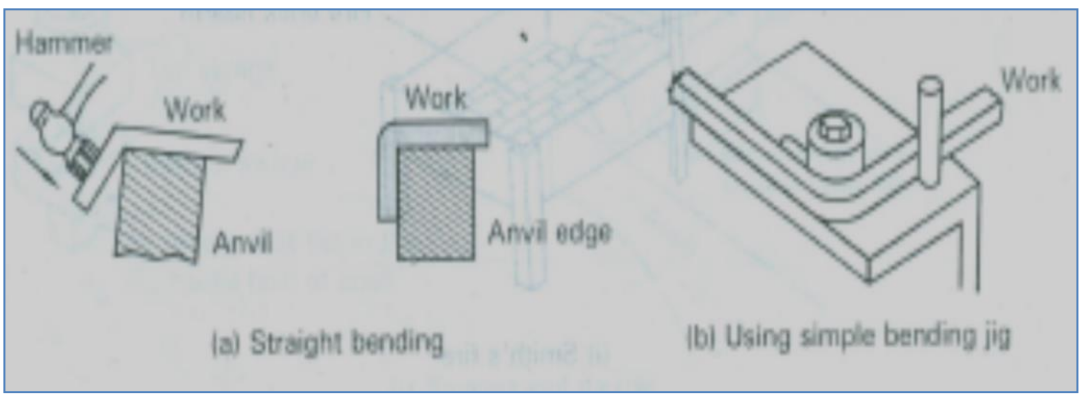


Fig.1.20 Bending

c) Fullering

Fullering is the reverse process of upsetting, wherein the cross-sectional area of the work piece is reduced with the corresponding increase in .its length. A pair of fullers is initially used as shown in figure 1.21(a), followed by a flatter to smoothen the final product.

In operation, the bottom fuller is held in the Hardie hole of the anvil, while the top fuller held by the blacksmith is hammered to reduce the cross-section of the work piece. The work piece is rotated between the fullers during hammering. Fullering leaves a corrugated surface on the work surface and hence to remove these corrugated marks and impart smooth surface on the work piece, a flatter may be employed as shown in figure 1.21(b).

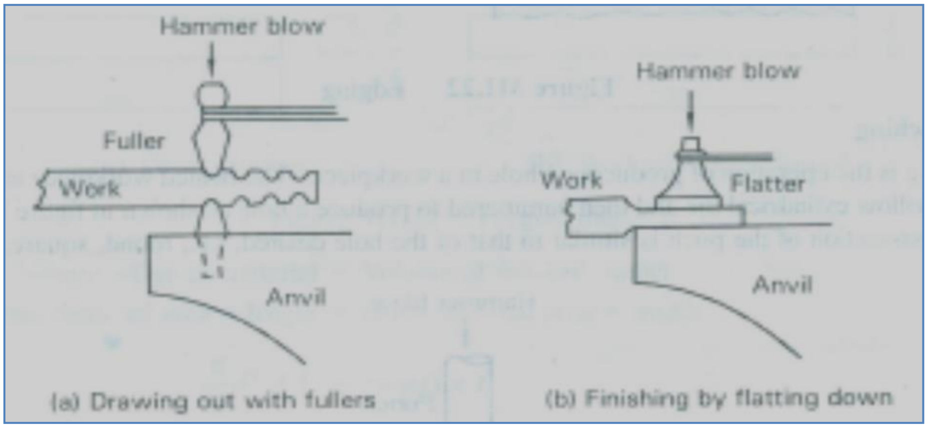


Figure 1.21 Fullering

d) Drawing Down

Drawing Down is used to reduce the thickness of a bar and to increase its length. The operation is carried out over the horn of the anvil and then by hammering it on the anvil face. The round shaped horn of the anvil acts as a blunt edge forcing the hot metal to flow lengthwise when struck by the hammer. For drawing down heavy work pieces, fullers may be used.

e) Edging

Edging is the operation used to shape the ends of the bars in order to collect more material for further operations. It is performed using dies of suitable cavities. The heated work piece is placed between the dies as shown in figure 1.22 and then hammered to obtain a specific shape called *edge.*

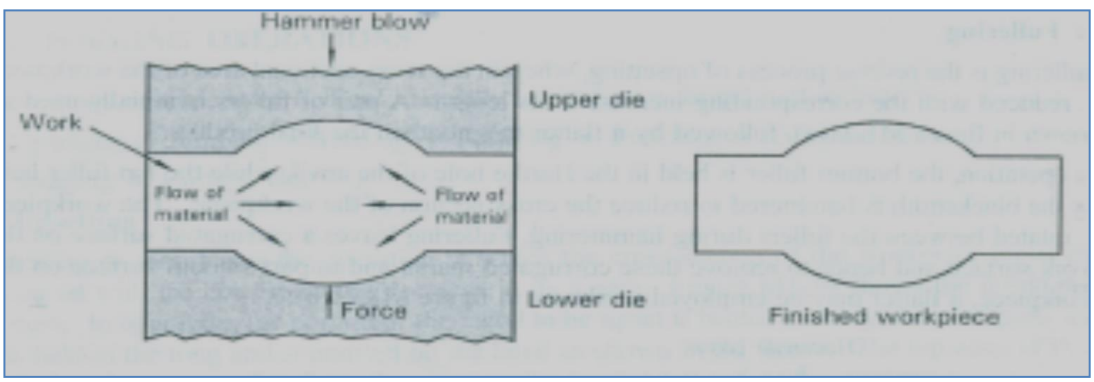


Fig.1.22 Edging

f) Swaging

Swaging is the operation carried out with help of swage blocks to reduce and finish work piece to the desired size and shape, usually round or hexagonal. Refer figure l.18 (f).

g) Punching

Punching is the operation of producing a hole in a work piece. The heated work piece is placed over a hollow cylindrical die and then hammered to produce a hole as shown in figure 1.23. The cross-section of the punch is similar to that of the hole desired, i.e., round, square, etc.

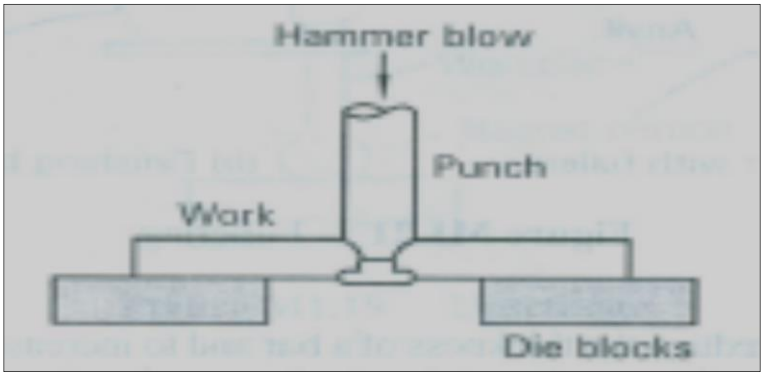


Fig.1.23 Punching

MODEL - 1

FORGING SQUARE SHAPED BAR

Aim

To forge a square shaped bar from a given cylindrical rod

Tools Required

Steel rule, caliper, anvil, sledge hammer, flat tong, flatter, etc

Procedure

a) The final length of the model to be forged is calculated suitably. Refer figure 1.24

b) Ignite the coal in the furnace. Switch on the blower and charge sufficient coal into the furnace

c) The given cylindrical shaped work piece is placed in the hearth and heated to red hot temperature.

d) Draw down the heated work piece to the calculated length with the help of hammer, tongs and anvil. The process is carried out appropriately until the circular rod is transformed into square shape of the desired dimensions

e) With the help of flatter, finish the work piece to the final dimensions and surface finish

f) The specimen is allowed to cool in air.

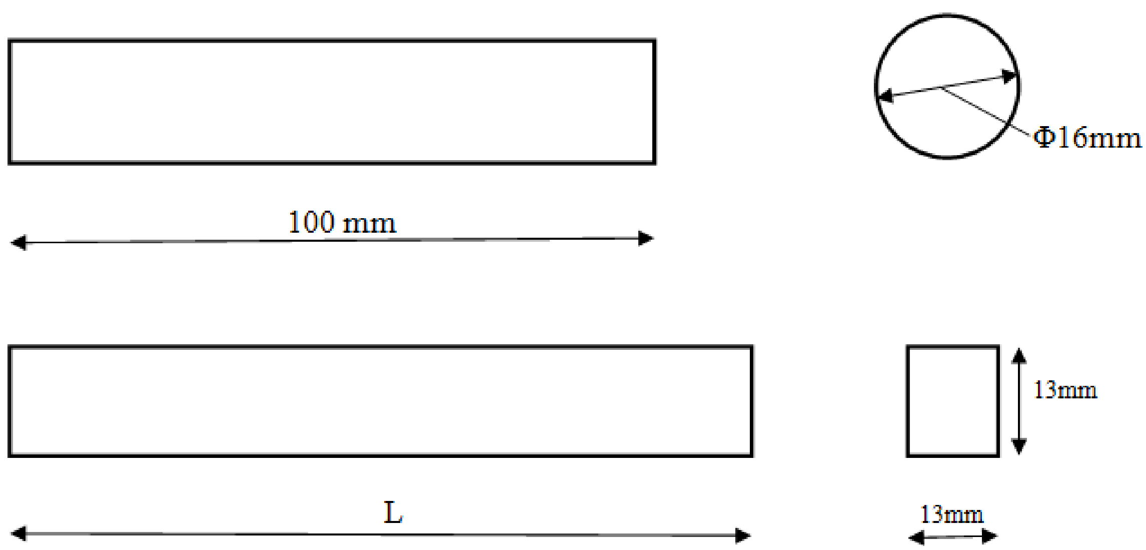


Fig. 1.24 Forging Square Shaped Bar

Specimen calculation

Volume of given material = Volume of finished model

or

Cross-sectional area x length = cross-sectional area x length

$$\frac{\pi}{4} D^2 \, l = L \times b \times h$$

$$\frac{\pi}{4} \times 16^2 \times 100 = L \times 13 \times 13$$

Length of square rod = L = 119 mm

Compensating 6 % wastage for loss in material during forging, we get

$$\text{Wastage} = \frac{6}{100} \times 119$$

Wastage = 7 mm

Final length of square specimen = L = 119 - 7 = **112 mm**

Thus, if the specimen is drawn suitably to a length of 112 mm, a circular rod of 16 mm can be shaped to a square rod of sides 13 mm.

Result

The given circular rod is forged to a square shaped model.

MODEL - 2 FORGING

L-SHAPED BAR

Aim

To forge a L-shaped Bar of square cross-section shown in figure 1.25

Tools Required

Steel rule, caliper, anvil, sledge hammer, flat tong, flatter, etc.

Procedure

a) The final length of the model to be forged is calculated suitably.

b) Ignite the coal in the furnace. Switch on the blower and charge sufficient coal into the furnace.

c) The given cylindrical shaped work piece is placed in the hearth and heated to red hot temperature.

d) Draw down the heated work piece to the calculated length with the help of hammer, tongs and anvil. The process is carried out appropriately until the circular rod is transformed into square shape of the desired dimensions.

e) The work piece is heated locally at the location where it has to be bent, and further upset suitably.

f) Bending is carried out on the anvil edge, or with the help of Hardie hole.

g) With the help of flatter, finish the work piece to the final dimensions and surface finish.

h) The specimen is allowed to cool in air.

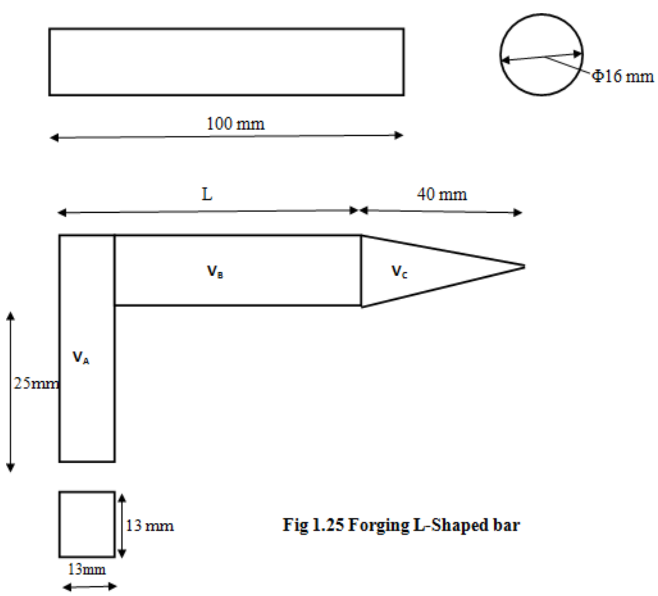


Fig 1.25 Forging L-Shaped bar

Specimen calculation

Volume of round bar = $\frac{\pi}{4} D^2 l$

$= \frac{\pi}{4} x\ 16^2\ x100$

Volume of round bar (V) = 20106 mm^3

Volume of Square bar V_A = b x h x l

= 13 x 13 x 25

Volume of Square bar V_A= 4225 mm^3

Volume of Square bar V_B = 13 x 13 x L

Volume of Square bar V_B = 169 x L mm^3

Volume of Square pyramid, $V_C = \frac{b\ x\ h\ x\ l}{3}$

$= \frac{13\ x\ 13\ x\ 40}{3}$

Volume of Square pyramid V_C = 2253.33 mm^3

$V = V_A + V_B + V_C$

20106 = 4225 + 169 x L + 2253.33

L = 80.63 mm

Result

The given circular rod is forged to L-shaped bar of square cross-section.

4

WELDING

Welding is the metallurgical process of joining two pieces of metals by the application of heat and with or without the application of pressure and filler material.

Applications of Welding

The chief application of welding is in making bridges and buildings. Pressure vessels, tanks, boilers, hull structures, pipelines and machinery components are usually welded.
Automobile industry, Aircraft industry, Railway industry and Ship Building industry use large amounts of welding.

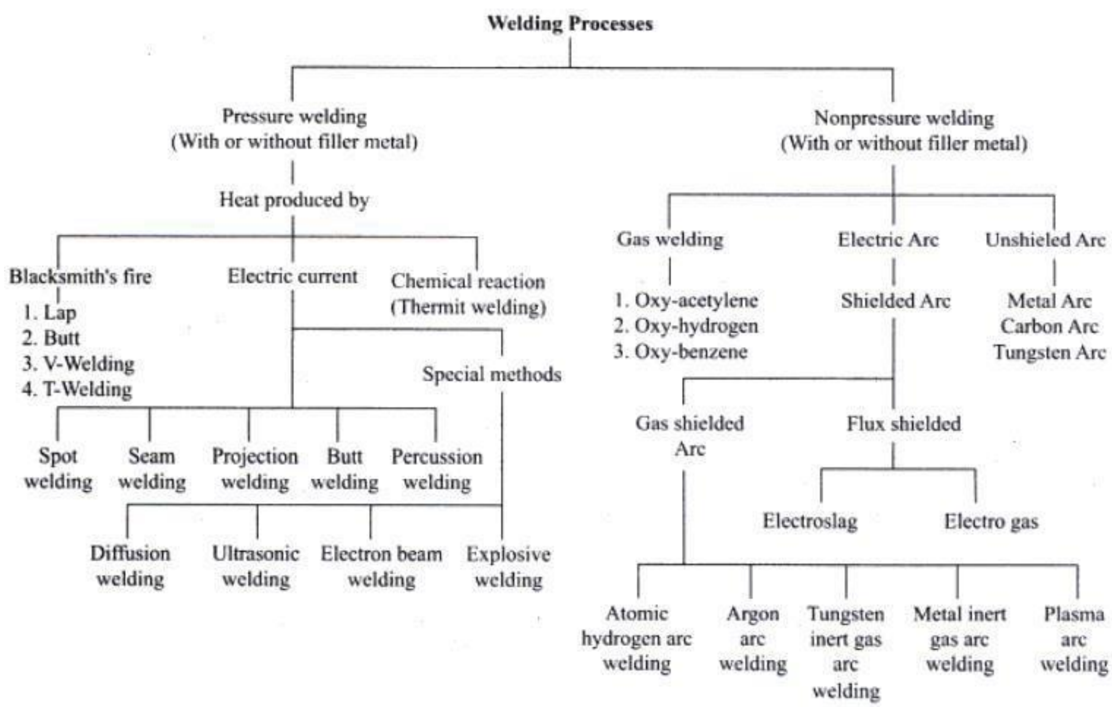
Classification of Welding Processes

Welding processes may be classified into two types:

- Plastic welding or Pressure welding
- Fusion welding or Non-pressure welding

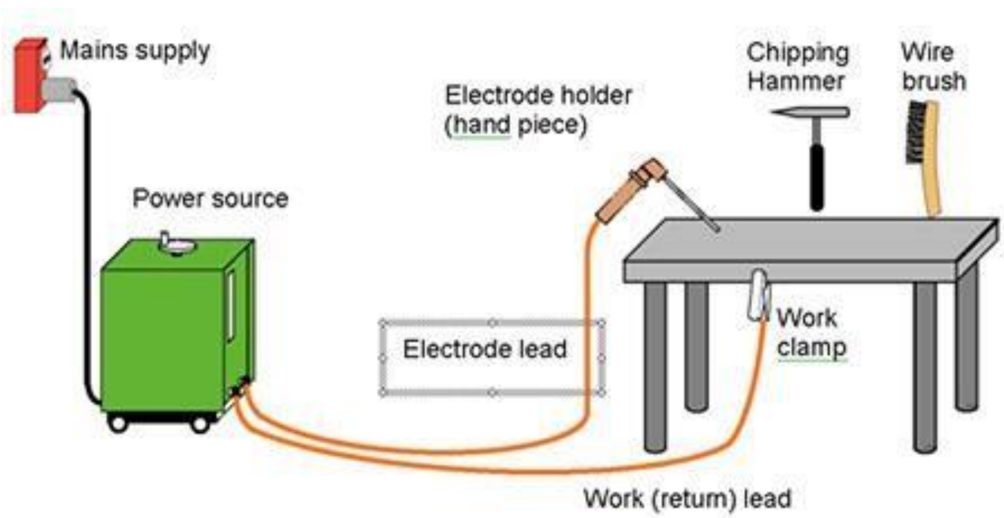
Plastic welding is a type of welding process, where the metal pieces to be joined are heated to a plastic state and then joined together by the application of external pressure without the addition of filler material. Resistance welding, Forge welding, Thermit welding are few examples of this type.

Fusion welding is a type of welding process, where the metal pieces to be joined are heated to molten state at the joint and allowed to solidify without the application of pressure with the addition of filler material. Gas welding, Arc welding are few examples of this type.



ELECTRIC ARC WELDING

Arc welding is the welding process, in which heat is generated by an electric arc struck between an electrode and the work piece. Electric arc is luminous electrical discharge between two electrodes through ionized gas.



Any arc welding method is based on an electric circuit consisting of the following parts:

- Power supply (AC or DC);
- Welding electrode;
- Work piece;
- Welding leads (electric cables) connecting the electrode and work piece to the power supply.

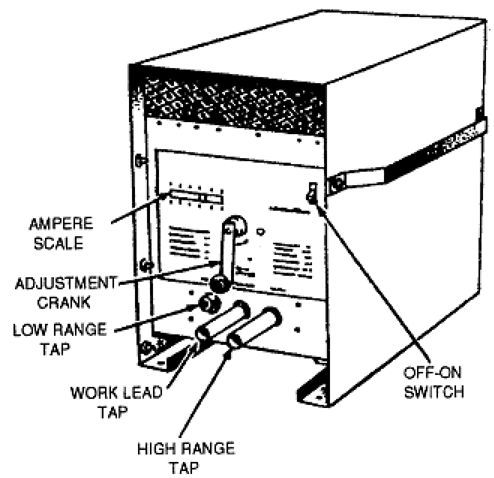
Electric arc between the electrode and work piece closes the electric circuit. The arc temperature may reach 10000°F (5500°C), which is sufficient for fusion the work piece edges and joining them. When a long joint is required the arc is moved along the joint line. The front edge of the weld pool melts the welded surfaces when the rear edge of the weld pool solidifies forming the joint.

Transformers, motor generators and rectifier sets are used as arc welding machines. These machines supply high electric currents at low voltage and an electrode is used to produce the necessary arc. The electrode serves as the filler rod and the arc melts the surface so that, the metals to be joined are actually fixed together.

Sizes of welding machines are rated according to their approximate amperage capacity at 60% duty cycle, such as 150,200,250,300,400,500 and 600 amperes. This amperage is the rated current output at the working terminal.

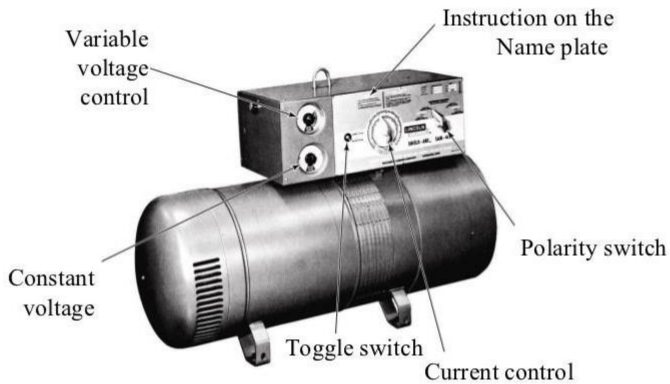
Transformers

The transformers type of welding machine produces A.C current and is considered to be the least expensive. It takes power directly from power supply line and transforms it to the voltage required for welding. Transformers are available in single phase and three phases in the market.



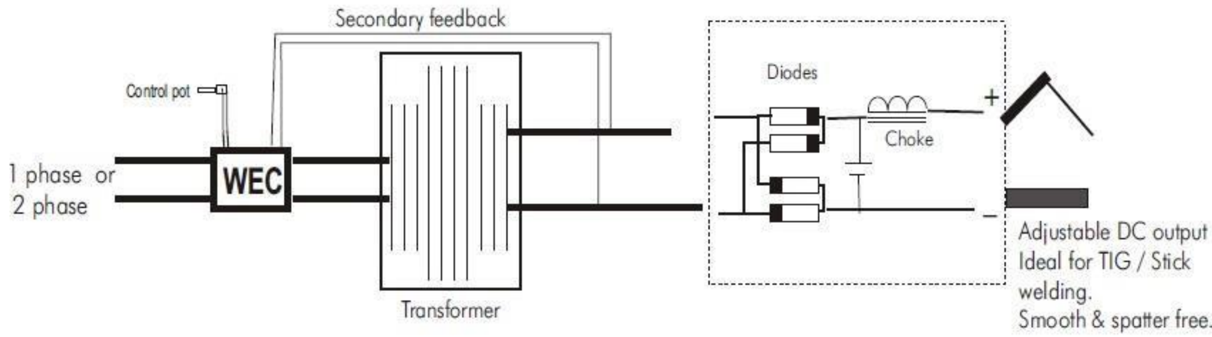
Motor generators

These are D.C generators sets, in which electric motor and alternator are mounted on the same shaft to produce D.C power as pert the requirement for welding. These are designed to produce D.C current in either straight or reversed polarity. The polarity selected for welding depends upon the kind of electrode used and the material to be welded.



Rectifiers

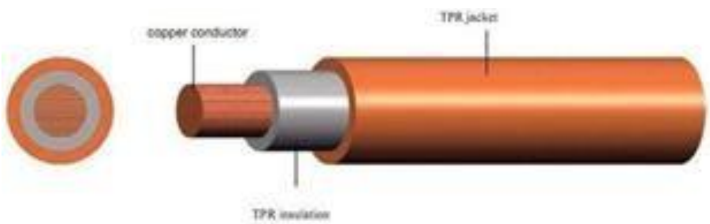
These are essentially transformers, containing an electrical device which changes A.C into D.C by virtue of which the operator can use both types of power (A.C or D.C, but only one at a time).In addition to the welding machine, certain accessories are needed for carrying out the welding work.

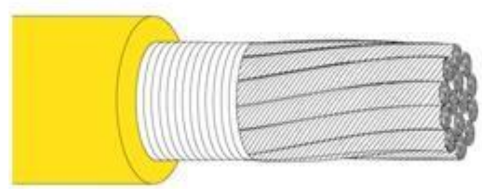


Single phase welding rectifier Circuit

Welding cables

Two welding cables are required, one from machine to the electrode holder and the other, from the machine to the ground clamp. Flexible cables are usually preferred because of the case of using and coiling the cables. Cables are specified by their current carrying capacity, say 300 A, 400 A, etc.

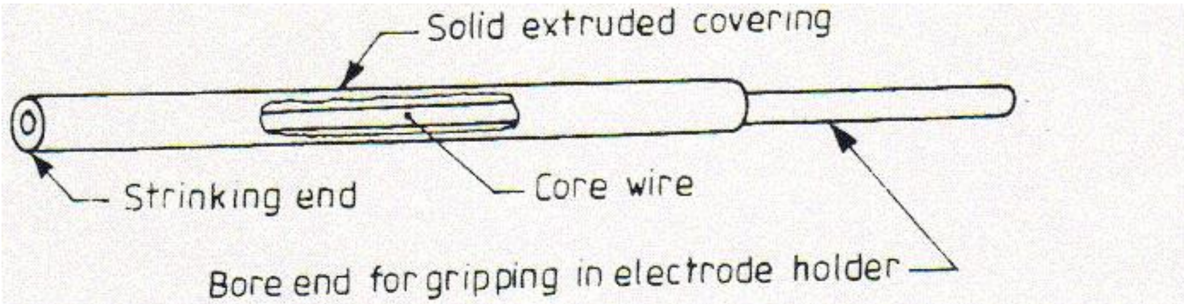




Electrodes

Filler rods are used in arc welding are called electrodes. These are made of metallic wire called core wire, having approximately the same composition as the metal to be welded. These are coated uniformly with a protective coating called flux. While fluxing an electrode; about 20mm of length is left at one end for holding it with the electrode holder. It helps in transmitting full current from electrode holder to the front end of the electrode coating. Flux acts as an insulator of electricity.

Figure shows the various parts of an electrode.



In general, electrodes are classified into five main groups; mild steel, carbon steel, special alloy steel, cast iron and non-ferrous. The greatest range of arc welding is done with electrodes in the mild steel group.

Various constituents like titanium oxide, potassium oxide, cellulose, iron or manganese, Ferro-silicates, carbonates, gums, clays, asbestos, etc., are used as coatings on electrodes. While welding, the coating or flux vaporizes and provides a gaseous shield to prevent atmospheric attack. The size of electrode is measured and designated by the diameter of the core wire in SWG and length, apart from the brand and code names; indicating the purpose for which there are most suitable.

- **Electrodes may be classified on the basis of thickness of the coated flux as**

1. Dust coated or light coated
2. Semi or medium coated and
3. Heavily coated or shielded

- **Electrodes are also classified on the basis of materials, as**

1. Metallic and
2. Non-metallic or carbon

- **Metallic arc electrodes are further sub-divided into**

1. Ferrous metal arc electrode (mild steel, low/medium/high carbon steel, cast iron, Stainless Steel, etc)
2. Non-ferrous metal arc electrodes (copper, brass, bronze, aluminum, etc).

In case of non-metallic arc electrodes, mainly carbon and graphite are used to make the electrodes.

WELDING TOOLS

Electrode holder

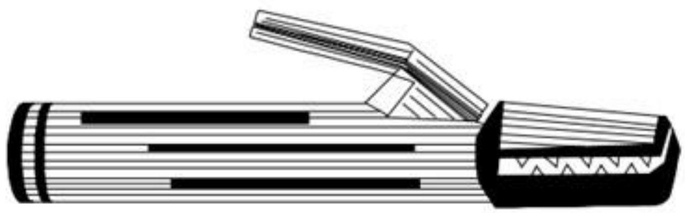


Fig. Electrode holder

Electrode holder is used for holding the electrode manually and conducting current to it. These are usually matched to the size of the lead, which in turn matched to the amperage output of the arc welder. Electrode holders are available in sizes that range from 150 to 500 Amps.

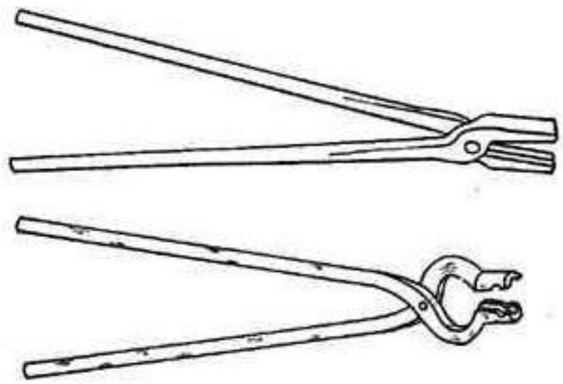
Ground clamp

It is connected to the end of the ground cable and is clamped to the work or welding table to complete the electric circuit. It should be strong and durable and give a low resistance connection.

Wire brush

A wire brush is used for cleaning and preparing the work for welding. It is made up of steel wires embedded in wood.

Tongs



Tongs are used to hold and to turn the workpiece during welding. Tongs are usually made of mild steel and are available in various shapes for holding different cross sections. A flat tong is most commonly used in welding to hold flat plates and bars.

Chipping hammer

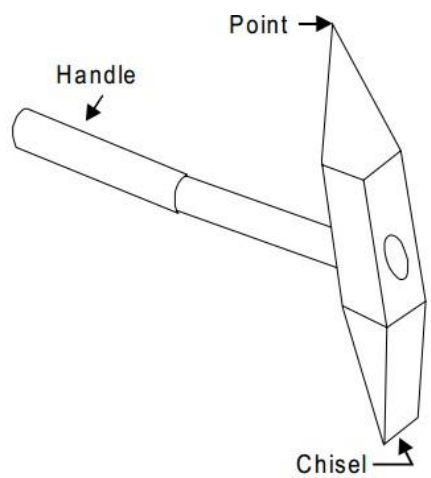


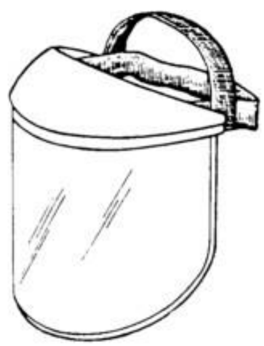
Fig. Chipping and hammer

A chipping hammer is used for removing slag formation on welds. One end of the head is sharpened like a cold chisel and the other, to a blunt, round point. It is generally made of tool steel. Molten metal dispersed around the welding heads, in the form of small drops, is known as spatter. When a flux coated electrode is used in welding process, then a layer of flux material is formed over the welding bead which contains the impurities of weld material. This layer is known as slag. Removing the spatter and slag formed on and around the welding beads on the metal surface is known as chipping.

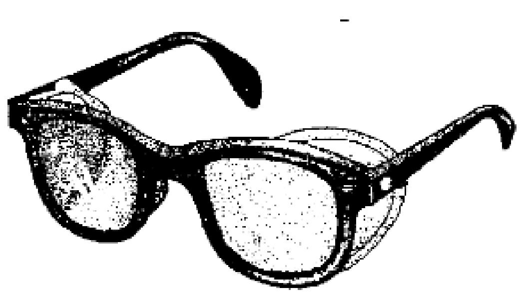
Welding table and cabin

It is made of steel plate and pipes. It is used for positioning the parts to be welded properly. Welding cabin is made-up by any suitable thermal resistance material, which can isolate the surrounding by the heat and light emitted during the welding process. A suitable draught should also be provided for exhausting the gas produced during welding.

Face shield and Goggles



CLEAR FACE SHIELD

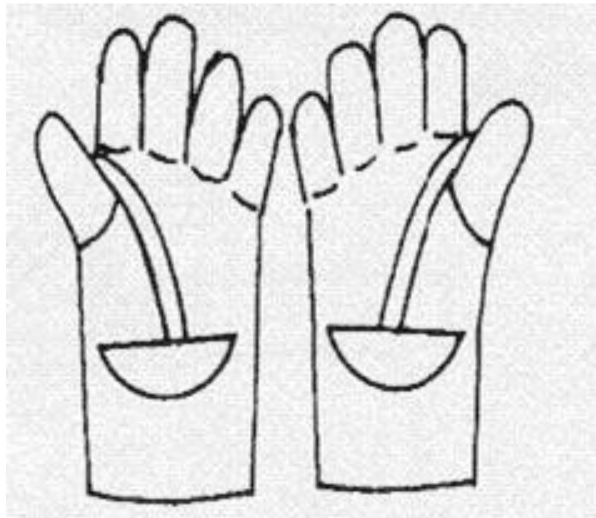


HAND-HELD SHIELD

A face shield is used to protect the eyes and face from the rays of the arc and from spatter or flying particles of hot metal. It is available either in hand or helmet type. The hand type is convenient to use wherever the work can be done with one hand. The helmet type though not comfortable to wear, leaves both hands free for the work. Goggles are the simplest form and are most convenient to wear at the time of welding.

Shields and goggles are made of light weight non-reflecting fiber and fitted with dark glasses to filter out the harmful rays of the arc. In some designs, a cover glass is fitted in front of the dark lens to protect it from spatter.

Welding Gloves



These are used to protect the hands from electric shocks and hot spatters at the time of welding.

TECHNIQUES OF WELDING

Preparation of work

Before welding, the work pieces must be thoroughly cleaned of rust, scale and other foreign material. The piece for metal generally welded without beveling the edges, however, thick work piece should be beveled or veed out to ensure adequate penetration and fusion of all parts of the weld. But, in either case, the parts to be welded must be separated slightly to allow better penetration of the weld.

Before commencing the welding process, the following must be considered

- Ensure that the welding cables are connected to proper power source.
- Set the electrode, as per the thickness of the plate to be welded.
- Set the welding current, as per the size of the electrode to be used.

Table Electrode current Vs electrode size Vs plate thickness.

Plate thickness, mm	Electrode size, mm	Electrode current range, amp
1.6	1.6	40-60
2.5	2.5	50-80
4.0	3.2	90-130
6.0	4.0	120-170
8.0	5.0	180-270
25.0	6.0	300-400

NOTE: While making butt welds in thin metal, it is a better practice to tack-weld the pieces intervals to hold them properly while welding.

Striking an arc

The following are the stages and methods of striking an arc and running a bead

- Select an electrode of suitable kind and size for the work and set the welding current at a proper value.
- Fasten the ground clamp to either the work or welding table.
- Start or strike the arc by either of the following methods.

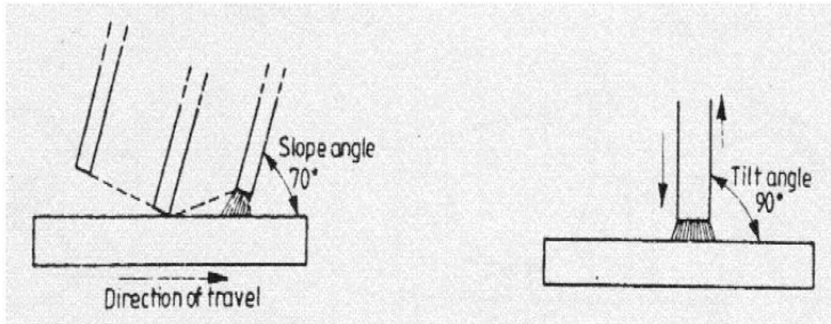
Strike and withdraw

In this method the arc is started by moving the end of the electrode onto the work with a slow sweeping motion, similar to striking a match.

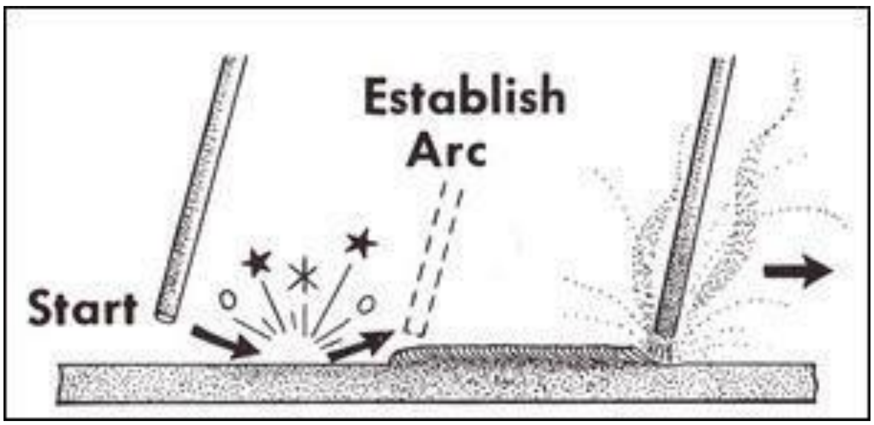
Touch and with draw

In this method, the arc is started by keeping the electrode perpendicular to the work and touching or bouncing it lightly on the work. This method is preferred as it facilitates restarting the momentarily broken arc quickly. If the electrode sticks to the work, quickly bend it back and forth, pulling at the same time. Make sure to keep the shield in front of the face, when the electrode is freed from sticking.

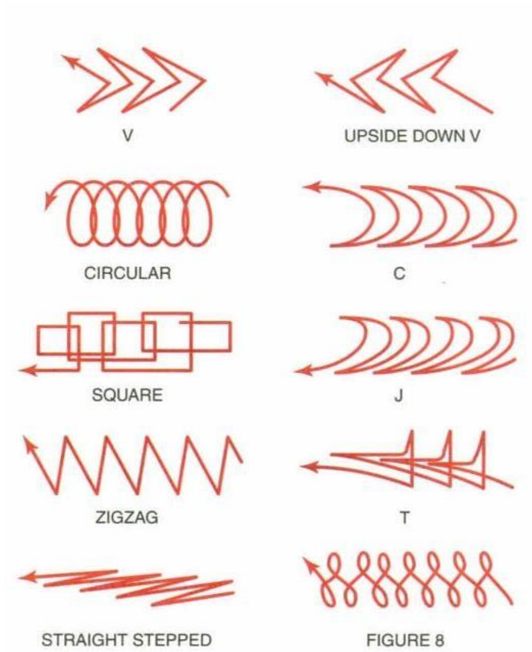
- As soon as the arc is struck, move the electrode along, slowly from left to right, keeping at 15^{o} to 25^{o} from vertical and in the direction of welding.



Strike and withdraw　　　　Touch and withdraw



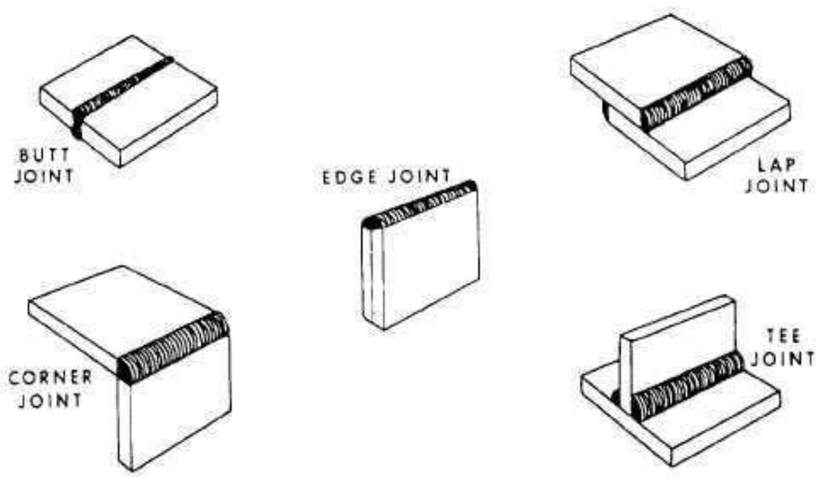
WEAVING


V
UPSIDE DOWN V
CIRCULAR
C
SQUARE
J
ZIGZAG
T
STRAIGHT STEPPED
FIGURE 8

A steady, uniform motion of the electrode produces a satisfactory bead. However, a slight weaving or oscillating motion is preferred, as this keeps the metal molten a little longer and allows the gas to escape, bringing the slag to the surface. Weaving also produces a wider bead with better penetration.

TYPES OF JOINTS

Welds are made at the junction of the various pieces that make up the weldment. The junctions of parts, or joints, are defined as the location where two or more numbers are to be joined. Parts being joined to produce the weldment may be in the form of rolled plate, sheet, pipes, castings, forgings, or billets. The five basic types of joints are listed below.

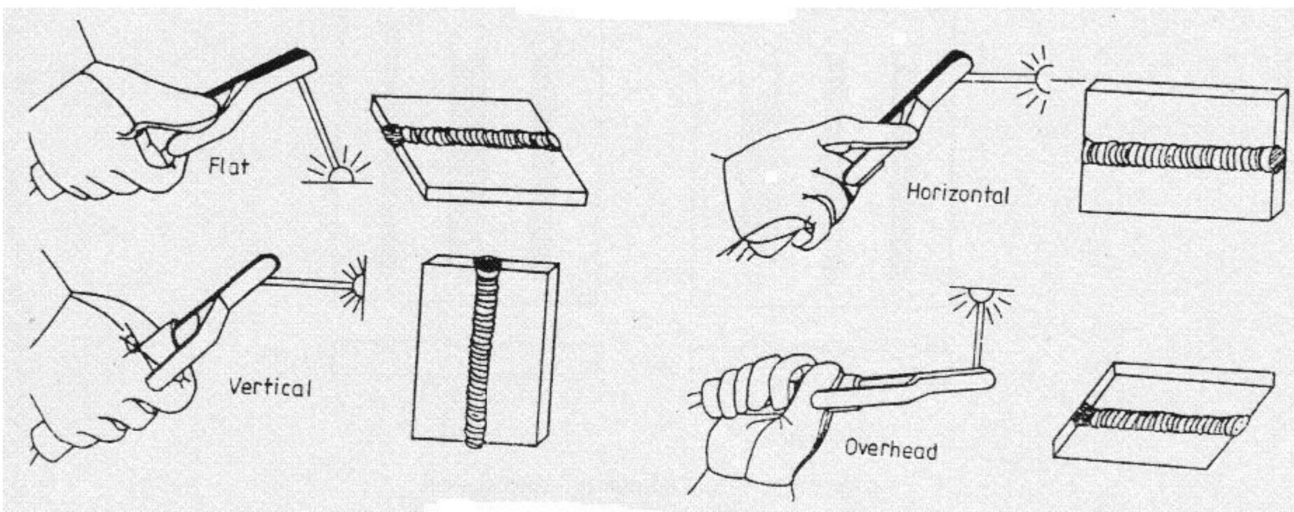


- A butt joint is used to join two members aligned in the same plane. This joint is frequently used in plate, sheet metal, and pipe work. A joint of this type may be either square or grooved.
- Corner and tee joints are used to join two members located at right angles to each other. In cross section, the corner joint forms an L-shape, and the tee joint has the shape of the letter T. Various joint designs of both types have uses in many types of metal structures.
- A lap joint, as the name implies, is made by lapping one piece of metal over another. This is one of the strongest types of joints available; however, for maximum joint efficiency, you should overlap the metals a minimum of three times the thickness of the thinnest member you are joining. Lap joints are commonly used with torch brazing and spot welding applications.
- An edge joint is used to join the edges of two or more members lying in the same plane. In most cases, one of the members is flanged, as shown in figure. While this type of joint

has some applications in plate work, it is more frequently used in sheet metal work. An edge joint should only be used for joining metals 1/4 inch or less in thickness that are not subjected to heavy loads.

WELDING POSITIONS

Depending upon the location of the welding joints, appropriate position of the electrode and hand movement is selected. The figure shows different welding positions.



- **Flat position welding**

In this position, the welding is performed from the upper side of the joint, and the face of the weld is approximately horizontal. Flat welding is the preferred term; however, the same position is sometimes called down hand.

- **Horizontal position welding**

In this position, welding is performed on the upper side of an approximately horizontal surface and against an approximately vertical surface.

- **Vertical position welding**

In this position, the axis of the weld is approximately vertical as shown in figure.

- **Overhead position welding**

In this welding position, the welding is performed from the underside of a joint.

ADVANTAGES & DISADVANTAGES OF ARC WELDING

Advantages

- Welding process is simple.
- Equipment is portable and the cost is fairly low.
- All the engineering metals can be welded because of the availability of a wide variety of electrodes.

Disadvantages

- Mechanized welding is not possible because of limited length of the electrode.
- Number of electrodes may have to be used while welding long joints.
- A defect (slag inclusion or insufficient penetration) may occur at the place where welding is restarted with a fresh electrode.

HINTS ON WELDING

- Adequate ventilation in the work area is a prime requirement.
- The welding machine must be grounded.
- The ground cable must have a firm grip.
- The floor area and the work area must be dry.
- Select the correct electrode for the given job.
- Wear head shield and gloves.
- Stand on a dry wooden plank or on rubber mat.
- Wear safety shoes.

SAFETY PRECAUTIONS

Welding Shop

1. Check workspaces and walkways to ensure that no slip/trip hazards are present
2. Check switchgear and cable are in sound condition
3. Check for the dryness of the workspace.
4. Check electrode points are in good condition and meet exactly
5. Ensure electrodes are securely mounted and clean from contaminants
6. Gloves should be used to position and hold work.
7. Before arc welding or cutting, ground the electrical equipment to reduce the risk of the transformer causing a fire by triggering the electrical supply circuit protection.
8. Always turn off the machine when leaving the work.
9. Apply eye drops after welding is over for the day, to relieve the strain on the eyes.
10. While welding, stand on dry footing and keep the body insulated from the electrode, any other parts of the electrode holder and the work.
11. Chip only with appropriate chipping hammer and in such a ways that the chips flow away from the persons.
12. Never touch the hot job with hands. Always use a pair of tongs for this purpose.

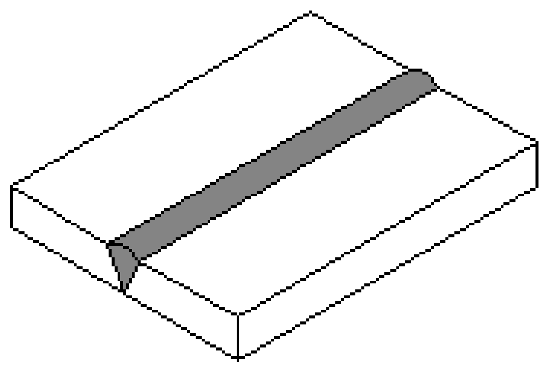
SINGLE V- BUTT JOINT

AIM: To make a single V-butt joint (60º), using the given two M.S pieces and by arc welding.

MATERIAL USED: Mild Steel Plate, L=25mm, W=25mm, T=5mm, 2 Nos.

TOOLS & EQUIPMENTS USED:

Rough and smooth files, Arc welding machine (transformer type), Mild Steel electrode and electrode holder, Ground clamp, Tongs, Face shield/Goggles, Anvil and Chipping hammer.



WELDING PROCEDURE

1. The given M.S pieces are thoroughly cleaned of rust and scale.
2. One edge of each piece is beveled, to an angle of 30º, leaving nearly ¼th of the flat thickness, at one end
3. The two pieces are positioned on the welding table such that, they are separated slightly for better penetration of the weld.
4. The electrode is fitted in the electrode holder and the welding current is set to a proper value.
5. The ground clamp is fastened to the welding table.
6. Wearing the gloves and using the face shield, the arc is struck and holding the two pieces together, first run of the weld is done to fill the root gap.
7. Second run of the welding is done with proper weaving and with uniform movement, during the process of welding, the electrode is kept at 15º to 25º from vertical and in the direction of welding.
8. The scale formation of the weld is removed by using the chipping hammer.
9. Filling is done to remove any spatter around the weld.

RESULT

The single v-butt joint is thus made, using the tools and equipment as mentioned above.

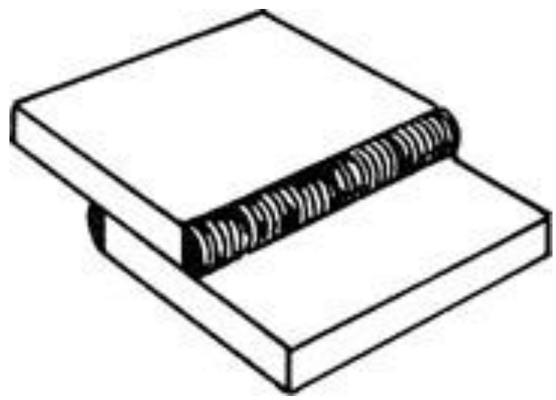
LAP JOINT

AIM: To make a lap joint using the given two M.S pieces and by arc welding.

MATERIAL USED: Mild Steel Plate, L=25mm, W=25mm, T=5mm, 2 Nos.

TOOLS & EQUIPMENTS USED:

Rough and smooth files, Arc welding machine (transformer type), Mild Steel electrode and electrode holder, Ground clamp, Tongs, Face shield/Goggles, Anvil and Chipping hammer.



WELDING PROCEDURE

1. Take the two mild steel pieces of given dimensions and clean the surfaces thoroughly from rust, dust, particles, oil and grease.
2. Remove the sharp corners and burrs by filing or grinding and prepare the work pieces.
3. The work pieces are positioned on the welding table, to form a lap joint with the required over lapping.
4. The electrode is fitted in to the electrode holder and the welding current is set to a proper value.
5. The ground clamp is fastened to the welding table.
6. Wearing the hand gloves, using the face shield and holding the over lapped pieces the arc is struck and the work pieces are tack-welded at the ends of both the sides
7. The alignment of the lap joint is checked and the tack-welded pieces are reset, if required.
8. Welding is then carried out throughout the length of the lap joint, on both the sides.
9. Remove the slag, spatters and clean the joint.

RESULT

The lap joint is thus made, using the tools and equipment as mentioned above.

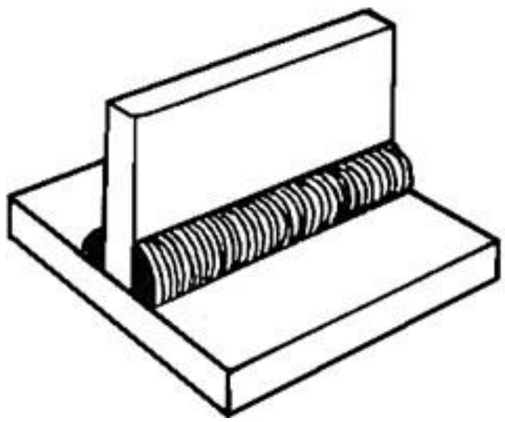
‘T’ JOINT

AIM: To make a ‘T’ joint using the given two M.S pieces and by arc welding.

MATERIAL USED: Mild Steel Plate, L=25mm, W=25mm, T=5mm, 2 Nos.

TOOLS & EQUIPMENTS USED:

Rough and smooth files, Arc welding machine (transformer type), Mild Steel electrode and electrode holder, Ground clamp, Tongs, Face shield/Goggles, Anvil and Chipping hammer.



WELDING PROCEDURE

1. Take the two mild steel pieces of given dimensions and clean the surfaces thoroughly from rust, dust particles, oil and grease.
2. Remove the sharp corners and burrs by filing or grinding and prepare the work pieces.
3. The work pieces are positioned on the welding table such that, the T shape is formed.
4. The electrode is fitted in to the electrode holder and the welding current is set to a proper value.
5. The ground clamp is fastened to the welding table.
6. Wearing the apron, hand gloves, using the face shield and holding the pieces the arc is struck and the work pieces are tack-welded at both the ends.
7. The alignment of the T joint is checked and the tack-welded pieces are reset, if required.
8. Welding is then carried out throughout the length of the T joint as shown in the figure.
9. Remove the slag, spatters and clean the joint.

RESULT

The ‘T’ joint is thus made, using the tools and equipment as mentioned above.

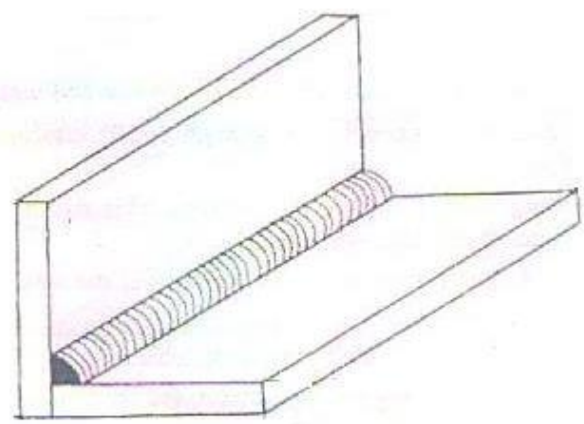
‘L’ JOINT / CORNER JOINT

AIM: To make ‘L’ joint / Corner joint using the given two M.S pieces and by arc welding.

MATERIAL USED: Mild Steel Plate, L=25mm, W=25mm, T=5mm, 2 Nos.

TOOLS & EQUIPMENTS USED:

Rough and smooth files, Arc welding machine (transformer type), Mild Steel electrode and electrode holder, Ground clamp, Tongs, Face shield/Goggles, Anvil and Chipping hammer.



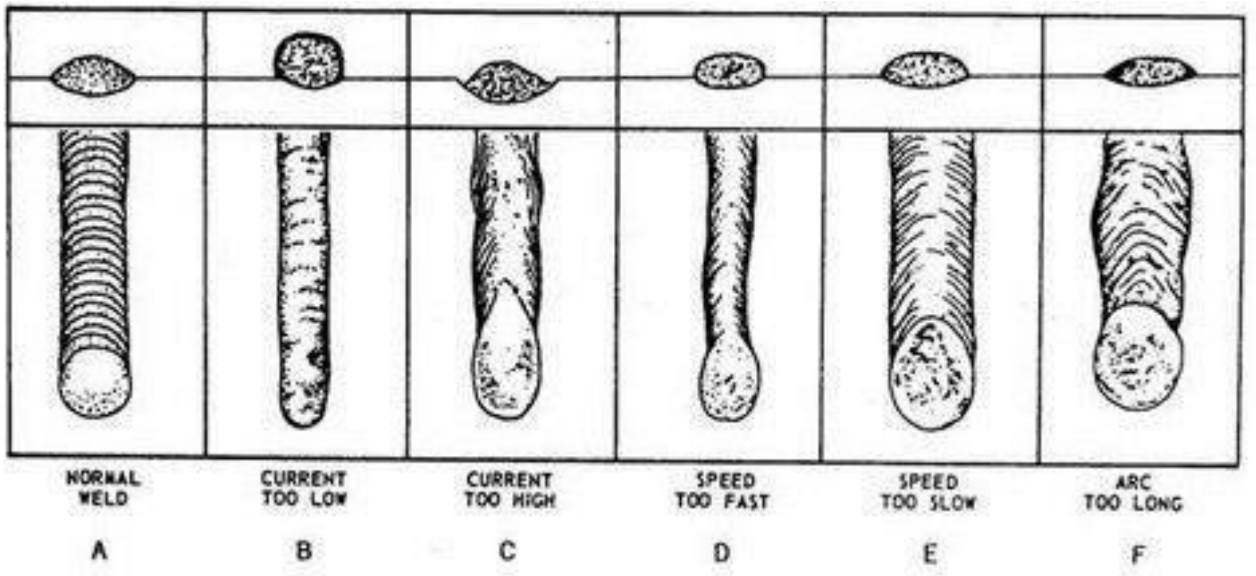
WELDING PROCEDURE

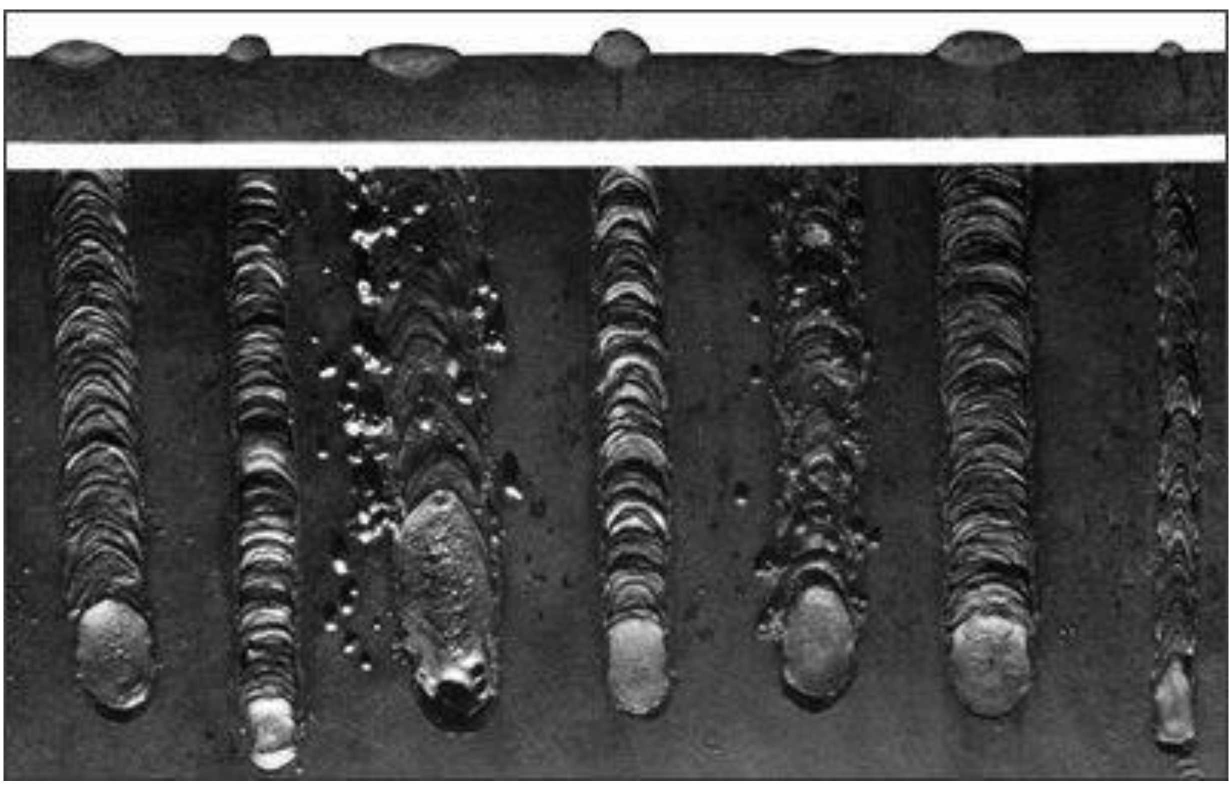
1. Take the two mild steel pieces of given dimensions and clean the surfaces thoroughly from rust, dust particles, oil and grease.
2. Remove the sharp corners and burrs by filing or grinding and prepare the work pieces.
3. The work pieces are positioned on the welding table such that, the L shape is formed.
4. The electrode is fitted in to the electrode holder and the welding current is set to a proper value.
5. The ground clamp is fastened to the welding table.
6. Wearing the apron, hand gloves, using the face shield and holding the pieces the arc is struck and the work pieces are tack-welded at both the ends.
7. The alignment of the corner joint is checked and the tack-welded pieces are reset, if required.
8. Welding is then carried out throughout the length.
9. Remove the slag, spatters and clean the joint.

RESULT

The ‘L’ joint/Corner joint is thus made, using the tools and equipment as mentioned above.

WELD BEAD TYPES





VIVA QUESTIONS

1. Define Hand Forging.

When the forging process is done by means of hand tools, it is called as hand forging.

2. Define Power Forging.

When forging is done with the help of power hammers, it is known as Power forging.

3. Small components are forged by which method?

Hand forging is employed for relatively small components, Machine forging for medium sized and large components are forged by Drop forging method.

4. What are the advantages of forging?

- It refines the structure of the metal.
- It renders the metal stronger by setting the direction of the grains.
- It effects considerable saving in time, labour and material.

5. Mention the tool and equipment used in hand forging.

Smith's forge or hearth, Anvil, Swage block, Hammers, Tongs, Chisels, Punches, Fullers, Flatters,

6. Mention the types of fire prepared in smith's forge.

- Open fire.
- Stock fire.

7. What do you mean by Open fire?

Open fire is prepared by covering the previously burnt coal by fresh coal in front of the tuyere. As combustion of fresh coal takes place and fire expands outwards, the coal from top and sides moves towards the centre f the hearth, and more fresh coal are added over the fire after removing the ash and clinkers etc. left behind by the previous fire.

8. What is meant by stock fire?

Stock fire is prepared for prolonged heating, for large components.

9. Mention the role of Anvil during forging?

Act as a supporting device for the components for which forging operation is carried out and is capable of withstanding heavy blows rendered to the job.

10. Body of anvil is made of which material?

Body is generally made of cast steel, wrought iron, mild steel provided with a hardened top, about 20 to 25mm thick.

11. What is the use of Horn in Anvil?

Horn is used in bending the metal or forming curved shapes. The flat step provided, between the top and the horn is used to support jobs during cutting and is known as chipping block.

12. What is Swage Block?

It carries a number of slots of different shapes and sizes along its four side faces and through holes from its top face to bottom face, which also vary in shapes and sizes.

13. What is the function of Swage Block?

Used as a support in punching holes and forming different shapes. The job to be given a desired shape is kept on the similar shape slot.

14. Swage Block is made from which material?

Usually a block of cast steel or cast iron.

15. What is the function of Hammers?

Hammers are used to give heavy blows to the job or component to be forged.

16. From which material Hammers are made?

Generally Forged Steel

17. List the classification of hammers.

- Hand or Smith's hammers
- Sledge hammers
- Power hammers

18. Mention the major parts of a Hammer.

Pein, Eye, Cheeks and face are the major parts of any hammer.

19. Which is called as a Smith's hammer?

Ball pein hammer or a straight pein sledge type hammer of relatively small size is called as Smith's hammer.

20. What is the weight of a Ball Pein hammer?

Its weight normally varies between 1 kg – 1.8kg.

21. What is a Ball Pein hammer?

Is used for all general work and its pein is employed when slight blows at a faster speed are needed such as in fullering a rivet head in a countersunk hole.

22. What are Sledge Hammers?

Sledge Hammers are comparatively 3 to 4 times heavier than the hand hammers. They are available in varying sizes and weights from 3 kg – 8 kg.

23. When we need a Sledge Hammer?

When heavy blows are needed in forging and other operations done on heavy jobs.

24. List the classification of Sledge Hammer.

- Straight pein hammer
- Cross pein hammer
- Double faced sledge hammer.

25. What is the function of Tongs?

They are used to hold the jobs in position and turning over during forging.

26. From which material Tongs are made?

They are made of Mild Steel.

27. Mention the size of Tongs used during forging?

Sizes of the tongs vary according o the size and shape of the job to be held, but the commonly used lengths of the tongs in hand forging vary from 40 to 60cm with the jaws opening ranging from 0.6 to 5.5 cm.

28. List the types of Tongs?

They are Close flat tong, Side bit tong, Pincer tong, Chisel or belt tong, Round hollow tong, square hollow tong, Pickup tong.

29. What is the function of Chisels?

Chisels are used to cut metals in hot or cold state. Those which are used for cutting the metal in hot state are termed as hot chisels. When used for cutting in cold state is known as cold chisels.

30. What is the difference between Hot & Cold chisel?

The main difference between these chisels is in the included angle at the cutting edge.

31. What is the included angle for cold chisel?

A cold chisel carries an included angle of 60 degree at the cutting edge.

32. What is the included angle for hot chisel?

A hot chisel carries an included angle of 30 degree at the cutting edge

33. Mention the materials from which cold & hot chisels are made?

Cold chisels are made from High carbon steel, where as Hot chisels are made from Medium carbon steel

34. What are punches?

Punches are tapered tools made in various shapes and sizes. They are used for producing holes in red hot jobs.

35. What is the role of Fullers?

They employed for making necks by reducing the cross-section of a job and also in drawing out.

36. Mention the material of Fullers.

Fullers are made from High carbon steel.

37. What is the function of Flatters?

They are used for leveling and finishing a flat surface after drawing out or any other forging operation.

38. List types of furnaces used in forging.

- Smith's forge
- Closed blacksmith's hearth
- Gas fired hearths
- Gas and oil fired flame furnace.

39. Which is the most widely used furnace for industrial application?

Gas and oil fired flame furnaces are widely used for heating the jobs for hammer forging.

40. What is the advantage of Gas & Oil fired furnace?

They prove quite economical and facilitate better temperature and atmosphere control.

41. Give the classification of Gas & Oil fired furnace.

- Box type
- Semi-continuous or batch type
- Continuous furnace.

42. Mention the fuels used in furnaces.

- Solid fuels: Eg. Coal, coke & charcoal etc.
- Liquid fuels: Eg. They include different types of fuel oils
- Gaseous fuels: Eg. Natural gas and producer gas.

43. Mention the forging temperature.

Temperature generally ranging from 1200 – 1350 degree C.

44. What is the use of blowers in forging?

Efficient and adequate supply of air at proper pressure is always a vital necessity for combustion of the fuel.

45. Which type of Blowers is widely used?

Roots blowers and centrifugal blower are widely used.

46. Mention the forgeable materials

Aluminum & Magnesium alloys, Copper, Brass & Bronze, Mild steel, Wrought iron, Medium & High carbon and d alloy steel, Stainless steels.

47. Mention forgeable materials temperature?

Material	Temperature ^{0}C	Material	Temperature ^{0}C
Aluminum &Magnesium alloys	350-500	Mild steel	750-1300
Copper, Brass &Bronze	600-950	Medium carbon steel	750-1250
Wrought Iron	900-1300	Stainless steels	940-1180

48. List forging operation.

Upsetting, drawing out, cutting, Bending, Punching, Setting down and finishing, Welding.

49. What do you mean by Upsetting or Jumping?

Upsetting or Jumping is the forging process through which the cross-section of a metal piece is increased with a corresponding reduction in its length.

50. What is drawing out?

Drawing out is also known as drawing down. It is exactly a reverse process to that of upsetting or jumping. Thickness is reduced with the increase in length.

51. What if setting down & finishing in forging?

Setting down is the operation through which the rounding of a corner is removed to make it square, by means of set hammer.

52. What do you mean by Welding in forging?

Welding in smithy is an important Operation carried out in this shop. Two pieces of the same metal which are to be joined together age heated in the hearth to the proper temperature. When they have acquired the welding heat they are withdrawn from the furnace and joined together by the application of external pressure, generally Hammering.

53. What main considerations will you make in designing a forging?

- The forged component should ultimately be able to achieve a radial flow of grains or fibers.
- As far as possible, the parting line of a forging should lie in one plane.
- Sufficient draft on surfaces should be provided to facilitate easy removal of forgings from the dies.
- High & thin ribs should not be designed.
- Too thin sections should be avoided to facilitate an easy flow of metal.

54. Mention the furnaces for heat treatment.

- Hearth type
- Bath type

55. What is the purpose of heat treatment?

To impart certain desired properties to metal so as to render it suitable for a particular use.

56. What is Hardening?

To harden the metal to make it wear resistant and render it capable of cutting other metals.

57. What is the purpose of Annealing?

To softening the metal.

58. What is tempering?

Generally followed after hardening to reduce brittleness, particularly in case of cutting tools.

59. Mention the function of Normalizing?

For refining the structure of the metal after cold working.

60. What is case hardening?

For making a metal to have a hard outer surface with a comparatively soft but tough core.

61. List the tools and equipment used in foundry.

They are Hand tools, Containers, Mechanical tools, Sand testing & conditioning equipment, Metal melting equipment, Fettling & finishing equipment.

62. List the Hand tools used in Foundry.

Shovel, Hand riddle, Rammers, Strike off bar, Towels, Slicks, Lifters or cleaners, Drag Spike, Draw screws and rapping plate, Smoothers and corner slicks, Mallet, Swab, Sprue pin, Sprue cutter, Goggers, Bellow

63. What are Power hammers?

The blows obtained by hand hammering will not be sufficient enough to affect the proper plastic flow in medium or heavy forging. For this a power hammer is usually employed.

64. What is the weight of these power hammers?

200 kg hammer will be one of which the falling weight is 200kg. The heavier these parts and greater the height from which they fall, the higher will be intensity of blow the hammer will provide.

65. List the common Power hammers in use.

Spring power hammers, Pneumatic power hammers, Steam hammers and Drop or Forge hammers.

66. What do you mean by Press forging?

Forging of parts by presses involves slow squeezing of plastic metal in closed impression dies, instead of applying repeated severe blows by hammers.

67. Mention the types of Press forging.

- Hydraulic press
- Mechanical press

68. Give an example to roll forging.

This process is employed for producing long slender forged components.

Eg. Axles & Leaf springs.

69. Why forging defects occurs?

- Improper heating of component for forging
- Faulty die design
- Improper placement of metal in the die
- Forging operation not carried out properly
- Faulty forging design.

70. Why the forged parts are heat treated?

- To relieve internal stresses set up during working and cooling
- to normalize the internal structure of the metal
- To improve its Machinability
- To improve hardness, strength and other mechanical properties.

71. Mention common heat treatments given to forged components.

Annealing, Normalizing and Tempering. Are the common heat treatments given to forged components.

72. What main considerations will you make in designing a forging?

- The forged component should ultimately be able to achieve a radial flow of grains or fibers.
- As far as possible, the parting line of a forging should lie in one plane.
- Sufficient draft on surfaces should be provided to facilitate easy removal of forgings from the dies.
- High & thin ribs should not be designed.
- Too thin sections should be avoided to facilitate an easy flow of metal.

73. Mention the furnaces for heat treatment.

- Hearth type
- Bath type

74. What is the purpose of heat treatment?

To impart certain desired properties to metal so as to render it suitable for a particular use.

75. What is Hardening?

To harden the metal to make it wear resistant and render it capable of cutting other metals.

76. What is the purpose of Annealing?

To softening the metal.

77. What is tempering?

Generally followed after hardening to reduce brittleness, particularly in case of cutting tools.

78. Mention the function of Normalizing?

For refining the structure of the metal after cold working.

79. What is case hardening?

For making a metal to have a hard outer surface with a comparatively soft but tough core.

80. List the tools and equipment used in foundry.

They are Hand tools, Containers, Mechanical tools, Sand testing & conditioning equipment, Metal melting equipment, Fettling & finishing equipment.

81. List the Hand tools used in Foundry.

Shoel, Hand riddle, Rammers, Strike off bar, Towels, Slicks, Lifters or cleaners, Drag Spike, Draw screws and rapping plate, Smoothers and corner slicks, Mallet, Swab, Sprue pin, Sprue cutter, Goggers, Bellow.

82. What is the function of Hand riddle?

Used for hand riddling of sand to remove foreign material from it.

83. What is a Rammer?

Rammers are used for striking the sand mass in the moulding box to pack it uniformly around the pattern.

84. Give the classification of Rammer.

- Peen rammer
- Hand rammer
- Floor rammer

85. What is the use of Vent wire in foundry?

It is a thin steel rod. After ramming and striking off the excess sand it is used to make small holes, called vents, in the sand mould to allow the exit of gases and steam during casting.

86. What is a Mallet?

In foundry work it is used for driving the draw spike into the pattern and the rapping it.

87. What is a Swab?

It is a hemp fiber brush used for moistening the edges off sand mould, which are in contact with the pattern surface, before withdrawing the pattern.

88. What is the use of Sprue cutter?

It is used to produce the hole after ramming the mould. It is in the form of a tapered hollow tube.

89. What are Goggers?

Bent of pieces wires and rods which are used for reinforcing the downward projecting sand mass the cope.

90. What is the use of Bellow?

Used to blow but the loose or unwanted sand from the surface and cavity of the mould.

91. Mention the use of Trowels?

Used for finishing flat surfaces and joints in a mould.

92. What are Slicks?

They are used for repairing & finishing the mould surfaces & edges after

93. Which is the commonly used Slick?

The commonly used slicks are Heart & Leaf, Square & Heart, Spoon & Bead, and Heart & Spoon.

94. List the containers used in foundry.

- Moulding boxes or flasks
- Ladles
- Crucibles.

95. Mention the material of moulding boxes.

Made of Wood, Cast iron or steel.

96. Why Dry sand moulds always require metallic boxes?

Because dry sand moulds are heated for drying.

97. Why the Ladles are used?

They are used to receive molten metal form the melting furnace and pour the same into the mould.

98. What is the capacity of ladles?

Its capacity ranges from 30 kg – 1000 kg.

99. Why we required Crucibles?

They are similar in shape to the ladles. They are used as metal melting pots.

100. Define Moulding Machines.

Is device which, by means of large number of correlated internal parts and mechanisms, transmits & directs various forces & motions in required directions so as to help the preparation of a sand mould.

101. What are the Functions of moulding machines?

- Ramming of moulding sand
- Rolling over or inverting the mould
- Rapping the pattern.
- Withdrawing the pattern from the mould.

102. Mention the types of moulding machines.

- Jar / Jolt machine
- Squeezer machine
- Jolt – Squeezer machine
- slinging machines or sand slingers.
- Diaphragm moulding machine

103. Where we get the foundry sand?

The common sources of collecting foundry sand are rivers, lakes, sea and deserts.

104. Give the main group of foundry sand.

- Natural sand
- Silica sand

105. What are the constituent of Natural sand?

It contains sufficient amount of binding clay.

106. What is silica sand?

It is a type of sand which do not possess the clay content and need addition of a suitable binder to make them usable for foundry work.

107. Which is called as Sharp sand?

Silica sand is called as sharp sand.

108. Mention the common colours of sands used in foundry work.

They are White, Yellow, Brown, Grey & Red.

109. Mention the common sources of foundry sands in India?

- Damodar & Barkar ares & Raj mahal hills in Bihar
- Batala in Punjab
- Bhavnagar & satara in Maharashtra
- Avadi & Veeriyambkkam in Madras
- Hoogli in Bengal
- Rourkela in Orissa

110. List the characteristics of Foundry sand.

- Refractoriness
- Permeaability
- Flowability or plasticity
- Adhesiveness
- Cohesiveness
- Collapsibility

111. Explain Refractoriness of foundry sand?

It is that property of the moulding sand which enables it to withstand high temperatures of the molten metal without using thus facilitating a clean casting.

112. Define Permeability of foundry sand.

It is also termed as porosity. It is the property of the sand which allows the gases and steam to escape through the sand mould.

113. What do you mean by Flowability or plasticity?

It is that property of the sand due to which it flows during ramming to all portions of the moulding flask. This increases with the addition of clay and water content and reduction of green strength and grain size.

114. What is Adhesiveness of foundry sand?

It is that property of the sand due to which it is capable of adhering to the surfaces of other materials.

115. Define Cohesiveness of foundry sand?

It is that property of the sand due to which its rammed particles bind together firmly and the patterns withdrawn from the mould without damaging the mould surfaces and edges.

116. What is collapsibility of foundry sand?

It is the property due to which the sand mould automatically collapses after solidification of the casting to allow a free contraction of metal.

116. Mention the Terminology of foundry sand.

- Green sand
- Dry sand
- Facing sand
- Parting sand
- Floor. Black or baking sand
- Core sand
- Oil sand

117. What is Green sand?

It is also known as tempered sand. This contains just enough moisture to give it sufficient bond. Moulds in this sand are known as green sand moulds.

118. What is Dry sand?

It is moulding sand which was originally having excess moisture content but the same has been evaporated from it by drying its mould in a suitable oven.

119. What is the use of facing sand?

This forms the face of the mould, i.e., rammed around the pattern surface. It is nothing but the fresh prepared and well tempered foundry sand.

120. What is parting sand?

This sand is sprinkled on the pattern and the parting surfaces of the mould so that the sand mass of one flask does not stick to that of the other or the pattern.

121. What do you mean by Baking sand?

It is the used sand which is left on the floor after the castings have been removed from the mould

122. What is Core sand?

The sand which carries high silica content and is used for making cores is known as core sand.

123. What is Molasses sand?

It is sand which carries molasses as binder.

124. Mention the advantage of Molasses sand.

It is very useful for making moulds of small castings having intricate shapes and thin sections.

125. Which sand is called as Fat sand?

Facing sand is called as Fat sand.

126. What is the effect of sand grains on foundry sand?

A sand grain has a remarkable effect on the physical properties of the foundry sand.

127. Mention the types of sand grain surfaces.

Smooth, Conchoidal / rough surfaces.

128. Why the Smooth sand grain surface is preferred?

Because such a surface renders higher permeability, sinter point and plasticity to the sand mass & the percentage of binder required is also equally high.

129. What are the different shapes of sand grains?

The commonly formed shapes are rounded, sub – angular, angular and compound.

130. For light castings which type of foundry san d is preferred?

Light or fine grained sand is used.

131. For bench work which type of foundry sand is preferred?

Medium grained sand is preferred.

132. For large iron and steel castings which type of foundry sand is used?

Heavy or close sand is used. This sand should carry a high silica content, strong bond and low proportion of time.

133. What is the purpose of adding Binders to the foundry sand?

The purpose of adding a binder to the moulding sand is to impart it sufficient strength and cohesiveness so as to enable it to retain its shape after the mould has been rammed and the pattern withdrawn.

134. Name the common binders used in foundry?

- Organic binders
- Inorganic binders.

135. List the commonly used Organic binders.

- Dextrin
- Molasses
- Linseed oil
- cereal binders
- Resins, like phenol and urea formaldehydes.

136. List the commonly used inorganic binders

- Bentonite
- Kaoloite
- Limonite
- Ball clay
- Fire clay
- Fuller’s earth.

137. Which are the most widely used inorganic binders?

Bentonite is the most widely used inorganic binder.

138. What are Additives related to foundry?

Additives are those materials which are added to the moulding sand to improve upon some of its existing properties or to impart certain new properties to it.

139. List commonly used Additives.

- Coal dust
- Sea coal
- Cereals or cornflour
- Silica flour
- Wood flour
- Pitch
- Dexirin and molasses
- Fuel oil

140. Where Coal dust additives are used?

It is mainly used in the sand used for grey iron and malleable iron castings.

141. Mention the main purpose of using coal dust additives?

Its main purpose is to react chemically with the oxygen present in the sand pores and, thus, produce a reducing atmosphere at mould – metal interface & prevent oxidation of the metal

142. What is Sea coal?

It is a finely ground soft coal.

143. What is the nature of Sea coal?

It restricts the mould wall movement and improves surface finish. It reduces permeability and hot strength of the mould and requires a higher percentage of water in the sand.

144. What are Pitch additives?

It is used to improve hot strength and surface finish on ferrous castings.

145. What is the role of Water on foundry sand?

Clay content added to the foundry sand will not give the required strength and bond until a suitable quantity of water is added to it.

146. Mention the quantity of water added to foundry sand.

Quantity of water varies from 2 – 8% according to different requirements.

147. What is the necessity of testing Foundry sand?

The moulding sand is expected to have good properties. These properties depend upon the size and shape of sand grains, their distribution and the amount of the other constituents added to the sand. In order to control these factors effectively a number of tests are performed.

148. Name the Sand testing Equipments used in foundry laboratory.

- Laboratory Balance
- Sand Rammer
- Drying Oven
- A sieve shaker.

149. Name the commonly performed tests on foundry test.

- Grain fineness test
- Moisture content test
- clay content test
- Test for permeability
- Refractoriness test
- Strength test

- Mould harness test
- Core hardness test
- Compacting factor test.

150. Why Grain fineness test is conducted?

The grain size of the moulding sand provides a significant effect on its permeability. Grains of similar or uniform sizes increase permeability whereas those of different size increase compactness, i.e., reduce the permeability. The grain size should therefore, by properly controlled through adequate testing of the sand before use

151. Mention the methods used to test grain fineness?

- Boswell method
- Mechanical Sieve shaker method.

152. Why Moisture content test is necessary?

Excess moisture reduces permeability and too low moisture content reduces strength. Also many other defects in castings may occur on account of unbalanced proportion of moisture content or its uneven distribution. As such the testing of moisture content is invariably a must to control the same.

153. Why Clay content test is essential?

Clay is the principal binder used in most foundry sands. It may be present in the natural sands or may bead to it. It considerably affects the strength and other properties and hence the determination of its quantity present in the sand is necessary.

154. Name the equipment used to conduct Moisture content test.

A very simple type of instrument, offered by M/s Metrimpex, Budapest, called a Rapid Moisture teller.

155. Name the equipment used to conduct Clay content test.

The apparatus used for this purpose is Mud / Clay content tester.

156. Why Permeability test is essential?

In order to allow the escape of steam and gases formed inside the mould when molten metal is poured into the latter. Permeability depends on the shape & size of sand grains, moisture content and clay content of the sand. It is also affected by the degree of ramming of the mould sand.

157. Name the equipment used to conduct Permeability test.

Apparatus called as Permeability meter or Permeability test.

158. Give the formulae used to determine Permeability number.

$$P = \frac{V.h}{p.a.t}$$

Where, P = Permeability number V = Volume in cc of the air passing through the specimen, h = Height of specimen in cm, p = Air pressure, a= Area of cross-section of the specimen in sq.cm, t = Time in minutes, taken by the air to pass.

159. Why Refractoriness test is necessary?

The extent to which this property is required in a moulding sand depends on the pouring temperature of the molten metal and the wall thickness of the casting to be made. The refractoriness of particular sand is determined by its sintering temperature.

160. What do you mean by Strength test of Moulding sand?

Moulding sands are usually tested for their shear strength, tensile strength, compression strength and bending strength. A well designed apparatus, called the strength tester, is used to perform these tests.

WELDING

1. Define Welding?
2. What is the classification of Welding?
3. Name applications of welding processes.
4. What do you mean by electric arc welding?
5. What is Pressure welding?
6. Give some examples of pressure welding processes.
7. What is the other name for pressure welding process?
8. What is Fusion welding?
9. Give some examples of fusion welding processes.
10. What is the other name for fusion welding process?
11. Which welding process is most commonly used at present?
12. Name the different types of welding joints.
13. Define fusion welding.
14. Differentiate between gas welding and arc welding.

15. What is the minimum gap that should be maintained between electrode and workpiece for striking an arc?
16. What is the amount of current used in arc welding?
17. What is the amount of voltage used in arc welding?
18. What type of transformer used in arc welding process?
19. What is the function of step down transformer?
20. What is the temperature developed in the arc welding process?
21. What is an electrode?
22. Name the parts of an electrode.
23. What is the classification of electrodes?
24. What do you mean by coated electrode and un-coated electrode?
25. What are the functions of flux on flux coated electrode?
26. Differentiate between consumable and non-consumable electrode.
27. What is the material of flux used in the electrode?
28. What is the use of chipping hammer?
29. What is the use of electrode holder?
30. What is the use of wire brush?
31. What is the use of tong?
32. What is the use of ground clamp?
33. What is the use of goggles?
34. What is the use of C-clamp?
35. What is the use of hand shields?
36. What is the difference between welding and soldering?
37. Define edge preparation?
38. Define weld bead?
39. What is Anvil?
40. What is the use of anvil?
41. From which material, the anvil is made of?