

QMP 7.1 D/F



Channabasaveshwara Institute of Technology

(Affiliated to VTU, Belagavi & Approved by AICTE, New Delhi)

(NAAC Accredited & ISO 9001:2015 Certified Institution)

NH 206 (B.H. Road), Gubbi, Tumakuru – 572 216. Karnataka.



Department of Mechanical Engineering

**LAB MANUAL
(2025-26)**

MANUFACTURING PROCESS LABORATORY

(BME302)

III Semester

Name: _____

U.S.N: _____

Batch: _____ **Section:** _____



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Department of Mechanical Engineering

**MANUFACTURING PROCESS LABORATORY
(BME302)**

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C I T, Gubbi, Tumkur.

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COLLEGE VISION

To create centres of excellence in education and to serve the society by enhancing the quality of life through value based professional leadership.

COLLEGE MISSION

To provide high quality technical and professionally relevant education in a diverse learning environment.

1. To provide the values that prepare students to lead their lives with personal integrity, professional ethics and civic responsibility in a global society.
2. To prepare the next generation of skilled professionals to successfully compete in the diverse global market.
3. To promote a campus environment that welcomes and honours women and men of all races, creeds and cultures, values and intellectual curiosity, pursuit of knowledge and academic integrity and freedom.
4. To offer a wide variety of off-campus education and training programmes to individuals and groups.
5. To stimulate collaborative efforts with industry, universities, government and professional societies.
6. To facilitate public understanding of technical issues and achieve excellence in the operations of the institute.

DEPARTMENT VISION

To create state of the art learning environment to nurture the learning, blending human values, academic professionalism and research process in the field of mechanical engineering for the betterment of society.

DEPARTMENT MISSION

The mission of the department is to

1. Provide requisite foundation to our students in Mechanical Engineering
2. Provide cutting edge laboratory resources to bridge the gap between theoretical and practical concepts
3. Provide exposure to various mechanical industries through periodic industrial visits.
4. Enhance our students skill set and to make them industry ready by systematic skill development program

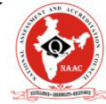


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B.E, MECHANICAL ENGINEERING Manufacturing Process Lab Syllabus (BME302)

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIE	
Spread Sheet For Engineers	BME302	04	3-0-2	50	50	3 Hrs

Course objectives:

1. To provide knowledge of various casting process in manufacturing.
2. To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys, also to provide detailed information about the moulding processes.
3. To acquaint with the basic knowledge on fundamentals of metal forming processes and also to study various metal forming processes.
4. To impart knowledge of various joining process used in manufacturing.
5. To impart knowledge about behaviour of materials during welding, and the effect of process Parameters in welding.

SI NO	Experiments
1	Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2	To determine permeability number of green sand, core sand and raw sand.
3	To determine AFS fineness no. and distribution coefficient of given sand sample.
4	Studying the effect of the clay and moisture content on sand mould properties
5	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
6	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).
7	Preparation of green sand molds kept ready for pouring in the following cases: 1. Incorporating core in the mold.(Core boxes).
8	Forging Operations: Use of forging tools and other forging equipment. Preparing minimum three forged models involving upsetting, drawing and bending operations.

Demonstration Exercises	
9	Demonstration of forging model using Power Hammer.
10	To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing
11	Mould preparation of varieties of patterns, including demonstration
12	Demonstration of material flow and solidification simulation using Auto-Cast software

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: **Describe** the casting process and learn different types of manufacturing process. Acquire knowledge on Pattern, Core, Gating, Riser system and some important moulding process.

CO2: **Compare** the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces. Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.

CO3: **Describe** the metal forming, metal working and other sheet metal process in manufacturing.

CO4: **Describe** the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes etc. used in manufacturing.

CO5: **Describe** the methods of different joining processes, thermal effects in joining process, Allied Processes & Advance welding processes.

CO6: **Demonstrate** various skills of sand preparation, molding & forging operations by use of foundry tools, forging tolls and other equipments.

Suggested Learning Resources:

Books

1. Ghosh, A. and Mallik, A. K., (2017), Manufacturing Science, East-West Press.
2. Parmar R. S., (2007), Welding Processes and Technology, Khanna Publishers.
3. Little R. L. – ‘Welding and Welding Technology’ – Tata McGraw Hill Publishing Company Limited, New Delhi – 1989.
4. Grong O. – ‘Metallurgical Modelling of Welding’ – The Institute of Materials – 1997 – 2nd Edition
5. Kou S. – ‘Welding Metallurgy’ – John Wiley Publications, New York – 2003 – 2nd Edition.



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COURSE OBJECTIVES:

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4. To impart knowledge of various joining process used in manufacturing.
5. To impart knowledge about behaviour of materials during welding, and the effect of process Parameters in welding.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

- CO1: Describe the casting process and learn different types of manufacturing process. Acquire knowledge on Pattern, Core, Gating, Riser system and some important moulding process.
- CO2: Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces. Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.
- CO3: Describe the metal forming, metal working and other sheet metal process in manufacturing.
- CO4: Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes etc. used in manufacturing.
- CO5: Describe the methods of different joining processes, thermal effects in joining process, Allied Processes & Advance welding processes.
- CO6: Demonstrate various skills of sand preparation, molding & forging operations by use of foundry tools, forging tolls and other equipments.



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Department of Mechanical Engineering

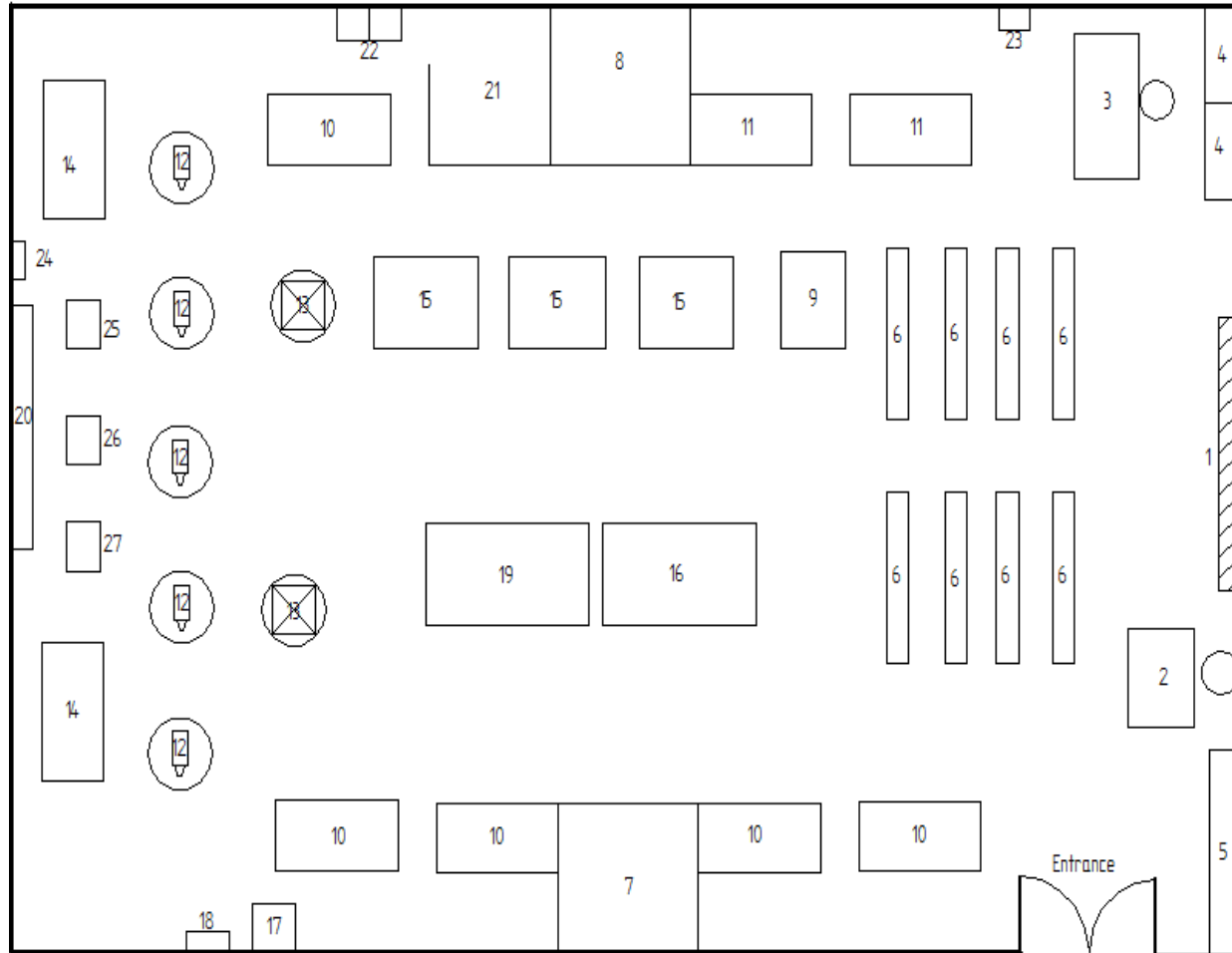
LABORATORY SAFETY PRECAUTIONS

1. Laboratory uniform, shoes & safety glasses are compulsory in the lab.
2. Do not touch anything with which you are not completely familiar. Carelessness may not only break the valuable equipment in the lab but may also cause serious injury to you and others in the lab.
3. Please follow instructions precisely as instructed by your supervisor. Do not start the experiment unless your setup is verified & approved by your supervisor.
4. Do not leave the experiments unattended while in progress.
5. Do not crowd around the equipment's & run inside the laboratory.
6. During experiments material may fail and disperse, please wear safety glasses and maintain a safe distance from the experiment.
7. 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.
8. Keep the work area clear of all materials except those needed for your work and cleanup after your work.

‘INSTRUCTIONS TO THE CANDIDATES’

1. Students should come with thorough preparation for the experiment to be conducted.
2. Students will not be permitted to attend the laboratory unless they bring the practical record fully completed in all respects pertaining to the experiment conducted in the previous class.
3. Experiment should be started only after the staff-in-charge has checked the experimental setup.
4. 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.
5. 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.
6. Practical record should be neatly maintained.
7. They should obtain the signature of the staff-in-charge in the observation book after completing each experiment.

DEPARTMENT OF MECHANICAL ENGINEERING



1. Green Board.
2. Staff Table.
3. Instructor Table.
4. Almerha.
5. Student Rack.
6. Students Desk.
7. Molding Sand Pit.
8. Silica Sand & Clay Pit.
9. Surface Plate.
10. Molding Practice Table.
11. Sand Testing Table.
12. Anvils.
13. Swage Blocks.
14. LPG Hearth Furnaces.
15. Fitting Tables.
16. Carpentry Tables.
17. Bench Drilling Machine.
18. Leg Vice.
19. Sheet Metal Stakes Table.
20. Forging Tools Display Board.
21. Welding Cabin.
22. Hand Wash Basin.
23. First Aid Box.
24. Fire Extinguisher.
25. Automated power Hammer.
26. Compression Moulding Machine
27. Induction Metal Melting Furnace

Total Area: $10.0 \times 19.95 = 199.5 \text{ M}^2$

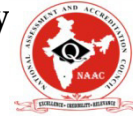


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DEPARTMENT OF MECHANICAL ENGINEERING

Manufacturing Process Lab Syllabus (BME302)

B.E, III Semester,

LIST OF EXPERIMENTS

PART-A TESTING OF MOULD AND CORE SAND, WELDING

- 01 Determination of Compression strength of moulding sand
- 02 Determination of Shear strength of moulding sand
- 03 Determination of Tensile strength of core sand
- 04 Determination of Permeability number of moulding sand
- 05 Determination of Core hardness and mould hardness
- 06 Sieve analysis to find grain fineness number of base sand
- 07 Determination of Clay content of base sand
- 08 Preparation of 3 welding models

PART-B FOUNDRY

- 01 Preparation of mould by using Solid Pattern
- 02 Preparation of mould by using Self Cored Pattern
- 03 Preparation of mould by Hand Cutting
- 04 Preparation of mould by using Stepped Cone Pulley with Core Print
- 05 Preparation of mould by using Split Pattern with Two Halves
- 06 Preparation of mould by using Loose Piece Pattern [additional]

PART-C FORGING

- 01 Preparation of Hexagonal Allen key
- 02 Preparation of Square section nail
- 03 Preparation of T-bolt (hexagonal headed bolt)

Staff In-Charge

HOD


DEPARTMENT OF MECHANICAL ENGINEERING
LECTURE PLAN
Faculty Name:
Sub.: Manufacturing Process
Sem. & Sec.: III & A
Sub. Code: BME302

Sl. No	Date	Lesson Plan No.	Topic	Remarks
Batch: ____				
1		LP.1	<ul style="list-style-type: none"> • Introduction: Introduction of Foundry, Practical Applications, Tools and Equipments. • Demonstration of preparing a Mould using Pattern. • Demonstration of preparing a Forging Job. • Moulding and Forging practice by students 	
2		LP.2	<ul style="list-style-type: none"> • Instructions: Welding introduction, Classification of foundries, Steps in Foundry process. • Compression strength of moulding sand by using UTM (Group-1) • Prepare of Molding using solid pattern (Group-2) • Prepare Forging Job(Allen Key) (Group-3) 	
3		LP.3	<ul style="list-style-type: none"> • Instructions: Patterns, and Types of Foundry Sand, Moulding Methods • Prepare of Molding using solid pattern (Group-1) • Prepare Forging Job(Allen Key) (Group-2) • Compression strength of moulding sand by using UTM (Group-3) 	
4		LP.4	<ul style="list-style-type: none"> • Instructions: Nomenclature of mould • Prepare of Molding using solid pattern (Group-3) • Prepare Forging Job(Allen Key) (Group-1) • Compression strength of moulding sand by using UTM (Group-2) 	

5		LP.5	<ul style="list-style-type: none"> • Instructions: Introduction to core and core making. • Prepare of Molding by Hand cutting method (Group-2) • Prepare Forging Job(Square section Nail) (Group-3) • Clay content test (Group-1) 	
6		LP.6	<ul style="list-style-type: none"> • Instructions: Working steps /sequence of operation in making the Mould using solid pattern ready to pour the molten metal • Prepare of Molding by Hand cutting method (Group-1) • Prepare Forging Job(Square section Nail) (Group-2) • Clay content test (Group-3) • Preparation of L Joint-All Groups 	
7		LP.7	<ul style="list-style-type: none"> • Instructions: Introduction to properties of Moulding sand and testing Equipments. • Prepare of Molding by Hand cutting method (Group-3) • Prepare Forging Job(Square section Nail) (Group-1) • Clay content test (Group-2) • Preparation of butt Joint-All Groups 	
1st LAB INTERNAL				
8		LP.8	<ul style="list-style-type: none"> • Instructions: Introduction of Forging, Practical applications • Prepare a Mould by using self core pattern (Group-2) • Prepare Forging Job(Bolt) (Group-3) • Conducting sieve analysis test (Group-1) • Preparation of Lap Joint-All Groups 	
9		LP.9	<ul style="list-style-type: none"> • Instructions: Forging Methods • Prepare a Mould by using self core pattern (Group-1) • Prepare Forging Job(Bolt) (Group-2) • Conducting sieve analysis test (Group-3) • Preparation of Tee Joint-All Groups 	
10		LP10	<ul style="list-style-type: none"> • Instructions: Forging Operations • Prepare a Mould by using self core pattern (Group-3) • Prepare Forging Job(Bolt) (Group-1) • Conducting sieve analysis test (Group-2) • Preparation of V Joint-All Groups 	
11		LP.11	<ul style="list-style-type: none"> • Instructions: Forging Tools and Equipments. • Prepare a Mould by using Stepped Cone Pulley With Core Print (Group-2) • Shear strength of moulding sand by UTM (Group-1) • Permeability test (Group-3) 	

12		LP.12	<ul style="list-style-type: none"> • Estimation of material cost • Prepare a Mould by using Stepped Cone Pulley With Core Print (Group-3) • Shear strength of moulding sand by UTM (Group-2) • Permeability test by Permeability Meter (Group-1) 	
13		LP.13	<ul style="list-style-type: none"> • Demonstration of Electric Arc Welding process, Soldering, Brazing and comparison. • Prepare a Mould by using Stepped Cone Pulley With Core Print (Group-1) • Shear strength of moulding sand by UTM (Group-3) • Permeability test by Permeability Meter (Group-2) 	
14		LP.14	<ul style="list-style-type: none"> • Prepare a Mould by using Split Pattern with Two Halves (Group-1) • Prepare a Mould by using Split Pattern with Two Halves (Group-2) • Prepare a Mould by using Split Pattern with Two Halves (Group-3) • Demonstration of preparation of a Mould by using Loose piece pattern (For all groups) [Additional work] 	
			2nd LAB INTERNAL	

EXTRA LAB TAKEN

Sl. No.	Month	Extra Lab	
		Date of Extra Lab Taken	LP. No.
1			
2			
1			
2			
1			
2			
1			
2			

Signature of staff

H O D

PART – A
**TESTING OF MOULDING SAND, CORE SAND AND
WELDING PRACTICE**

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 its 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.

SAND TESTING EXPERIMENTS

Periodic test are necessary to determine the essential qualities of foundry sand.

The most important tests to be conducted for any foundry sand are as follows.

1. Compression, shear and tensile strength test on universal sand testing machine.

Purpose:

- i) Moulding sand must have good strength otherwise it may lead to collapse of mould.
- ii) It must be retained when the molten metal enters the mould (bond strength)
- iii) To retain its shape when the patten is removed and movement of the mould.

2. Permeability test.

It is the property of moulding sand which allows gases to pass through easily in the mould.

3. Core and mould hardness test.

The hardness test is useful to find out the moulds surface uniformly.

4. Sieve analysis to find the grain fineness number of base sand.

To find the average grain fineness number for the selection of fine, medium, and course sand.

5. Clay content determination in base sand.

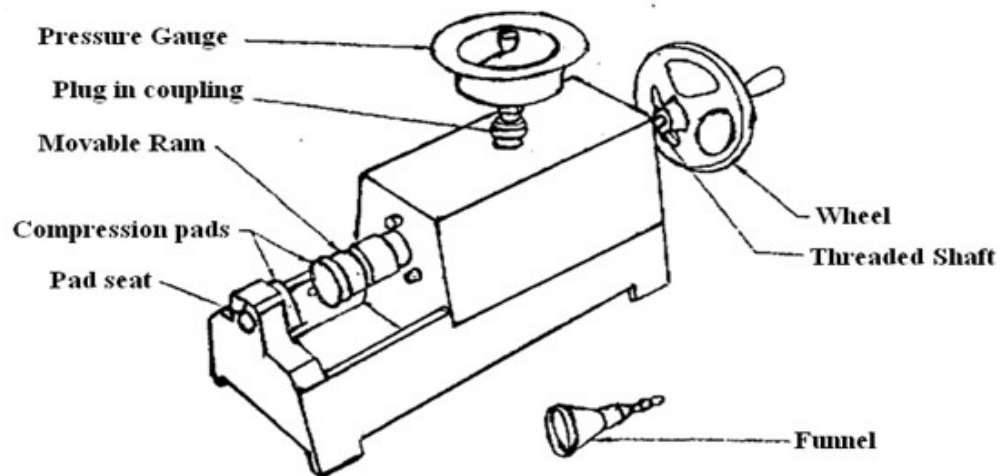
It is to find the % of the clay content in the base sand.

TABULAR COLUMN**1. VARYING THE % OF CLAY**

SL. NO	Percentage of sand	Percentage of clay	Percentage of water	compression strength gm/cm ²
1	91%(182gms)	4%(8gms)	5%(10gms)	
2	89%(178gms)	6%(12gms)	5%(10gms)	
3	87%(174gms)	8%(16gms)	5%(10gms)	

2. VARYING THE % OF WATER

SL. NO	Percentage of sand	Percentage of clay	Percentage of water	compression strength gm/cm ²
1	90%(180gms)	6%(12gms)	4%(8gms)	
2	88%(176gms)	6%(12gms)	6%(12gms)	
3	86%(172gms)	6%(12gms)	8%(16gms)	

UNIVERSAL STRENGTH MACHINE (Model-VUN)

Experiment No. 1**Date:** ___/___/____**COMPRESSION STRENGTH TEST FOR MOULDING SAND**

AIM: To find the green compression strength of the given specimen at different percentage of clay and moisture

Materials used: Base sand, clay, water,

Apparatus used: Sand Ramming machine (Rammer) with specimen tube with base, stripper, universal sand testing machine with Compression shackles, weighing pan, measuring jar, steel scale, Electronic weighing scale.

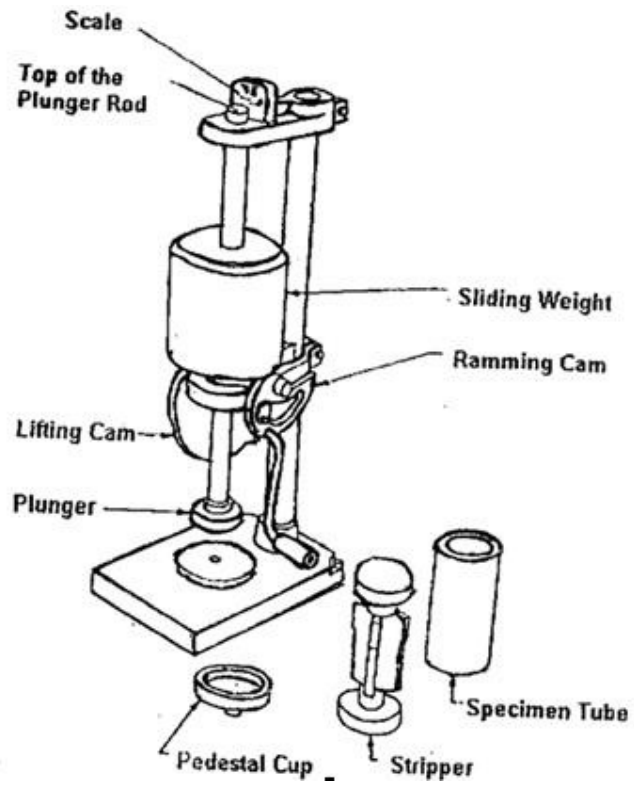
Theory:

1. Periodic tests are necessary to check the quality of foundry sand and compression strength test is one among them.
2. The constituents of moulding sand are silica sand, clay, water and other special additives.
3. Clay imparts the necessary bonding strength to the moulding sand when it is mixed with water etc. bentonite.
4. Compression test determines the bonding or adhesiveness power of various bonding materials in green sand.
5. The green compressive strength of foundry sand is the maximum compression strength a mixture is capable of developing when it is in most condition.

Procedure:

1. Conduct the experiment in two parts:
 - a) Vary the clay content keeping the water content constant
 - b) Vary the water content keeping the clay content constant
2. Take weighed proportions of sand and clay and dry mix them together in a Muller for 3 minutes.
3. Adjust the weight (168gms) of the sand to get standard specimen.
4. Transfer the sand mixture into the specimen tube and ram it with the help of a sand rammer thrice.
5. Remove the standard specimen by the stripper and place it between shackles which are fixed in the sand testing machine.
6. Preliminary adjustments are made before applying the hydraulic pressure of the testing machine
7. Rotate the handle of the testing machine to actuate the ram. Thus hydraulic pressure is applied continuously till the specimen ruptures.
8. Read the compression strength from the gauge and record the same.
9. Conduct the experiment for the above said two cases and tabulate the result.

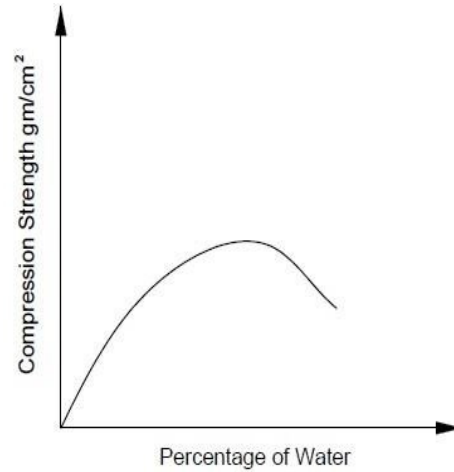
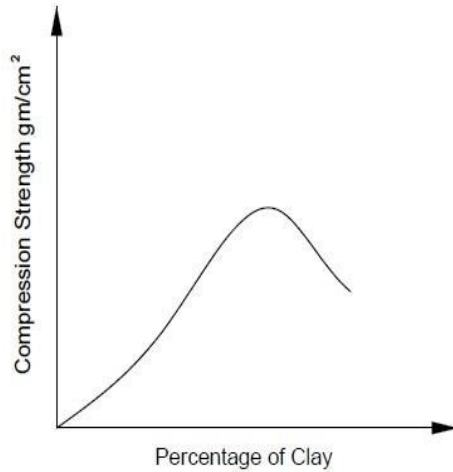
SAND RAMMER



Result and discussion

Plot the graphs with compression strength on y-axis & percentage clay on x-axis and the other with compression strength on y-axis v/s percentage water on x-axis.

Discuss the result with respect to the variation of percentage of clay on compression strength and percentage of water on compression strength.

Nature of graph

TABULAR COLUMN**1. VARYING THE % OF CLAY**

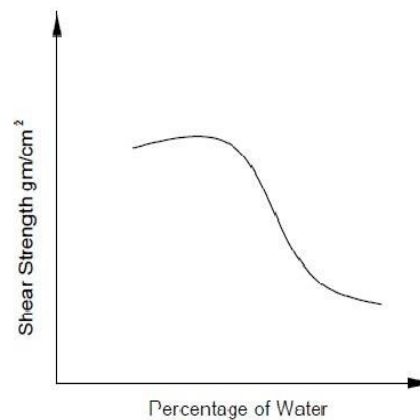
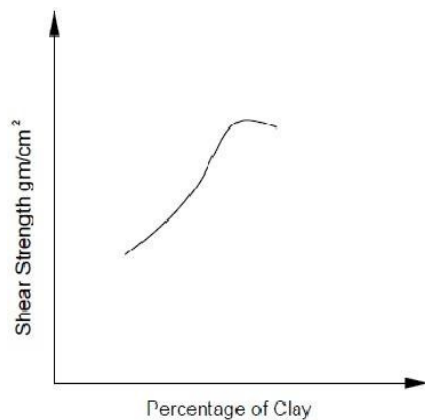
SL. NO	Percentage of sand	Percentage of clay	Percentage of water	Shear strength gm/cm ²
1	91%(182gms)	4%(8gms)	5%(10gms)	
2	89%(178gms)	6%(12gms)	5%(10gms)	
3	87%(174gms)	8%(16gms)	5%(10gms)	

2. VARYING THE % OF WATER

SL. NO	Percentage of sand	Percentage of clay	Percentage of water	Shear strength gm/cm ²
1	90%(180gms)	6%(12gms)	4%(8gms)	
2	88%(176gms)	6%(12gms)	6%(12gms)	
3	86%(172gms)	6%(12gms)	8%(16gms)	

Graphs:

- Shear strength (Y-axis) V/s Percentage of clay (X-axis).
- Shear strength (Y-axis) V/s Percentage of water (X-axis).



Experiment No. 2**Date:** ___/___/____**SHEAR STRENGTH TEST FOR MOULDING SAND**

AIM: To determine the green shear strength of the given specimen for different percentages of clay and moisture.

Materials used: Base sand, clay, water.

Apparatus used: Sand ramming machine (rammer), universal sand testing machine with attachments, weighing pan.

Theory:

1. Shear strength is the ability of sand particles to resist the shear stress and to stick together.
2. Insufficient Shear strength may lead to the collapsing of sand in the mould or its partial destruction during handling. The mould and core may also be damaged during flow of molten metal in the mould cavity.
3. The moulding sand must possess sufficient strength to permit the mould to be formed to the desired shape and to retain the shape even after the hot metal is poured into the mould cavity.
4. In shearing, the rupture occurs parallel to the axis of the specimen.

Procedure:

1. Conduct the experiment in two parts:
 - a) Vary the clay content keeping the water content constant
 - b) Vary the water content keeping the clay content constant
2. Take weighed amount of foundry sand (mixture of sand, clay & water as specified).
3. Transfer the sand mixture into the tube and ram it with the help of a sand rammer thrice.
4. Fix the shackles to the universal sand testing machine.
5. Remove the specimen from the tube with the help of a stripper and load it into the universal sand testing machine.
6. Preliminary adjustments are made before applying the hydraulic pressure of the testing machine
7. Apply the hydraulic pressure by rotating the handle of the universal sand testing machine continuously until the specimen ruptures.
8. Read the shear strength directly from the scale and tabulate the readings.

Results and Discussions:

The Graphs above reveal:

- a. With the increase in the percentage of water the shear strength of the specimen
.....

- b. With the increase in the percentage of clay the shear strength of the specimen
.....

Experiment No. 3

Date: __/__/____

TENSILE STRENGTH TEST OF CORE SAND

AIM: To determine the tensile strength of sand using two types of binders Viz. core oil binder and sodium silicate binder.

Materials used: Base sand, core oil, sodium silicate.

Apparatus used: universal sand testing machine, Split core box, Sand rammer, oven, tension shackles.

Theory:

1. A core is compacted sand mass of a known shape.
2. When a hollow casting (to have a hole – through or blind) is required, a core is used in the mould or when a complex contour is required a mould is created out of cores. This core has to be properly seated in the mould on formed impressions in the sand. To form these impressions extra projections called core points are added on the pattern surface at proper places.
3. Core boxes are used for making cores. They are either made single or in two parts. Their classification is generally according to the shape of the core or the method of making the core.
4. Split core box is very widely used and is made in two parts, which can be joined together by means of dowels to form the complete cavity for making the core.
5. The purpose of adding binder to the moulding sand is to impart strength and cohesiveness to the sand to enable it to retain its shape after the core has been rammed.
6. binders used can be
 - a) organic: ex. Dextrin, core oil
 - b) Inorganic: ex. Sodium silicate, Bentonite
7. Classification of binders:
 - a. Baking type: Binding action is realized in the sand after baking the sand mixture in an oven.
 - b. Gassing type: Binding action is obtained in the sand after passing a known gas through the sand mixture.
Ex. CO_2 gas passed through a mixture of sand and sodium silicate.
8. Core oil is used as binder that hardens with the addition of heat. The sand and binder is mixed and baked at a temperature of $250^\circ - 300^\circ \text{C}$ and binding action takes place within few hours.
9. Sodium silicate is a self setting binder and no external heat is required for the binding action which takes place at room temperature when CO_2 gas is passed.
10. During casting the core is placed inside the mould and the molten metal is poured in to the cavity. As the molten metal begins to cool, it begins to contract on the inner radius.

TABULAR COLUMN

SL. NO	Percentage of sand	Percentage of sodium Silicate or core oil	Tensile strength N/m ²	
1				
2				
3				
4				
5				
6				

Result and discussion:

Discuss the effect of variation of binder content on tensile strength.

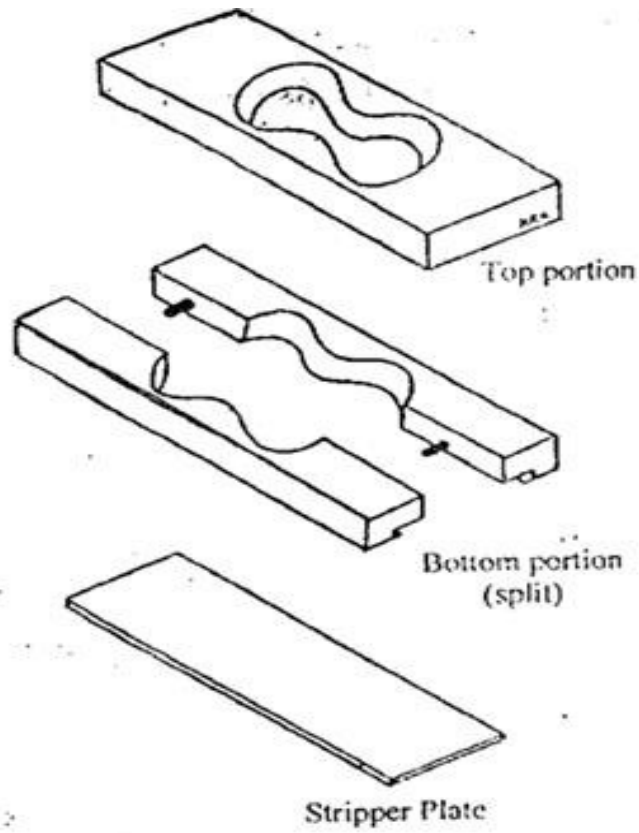
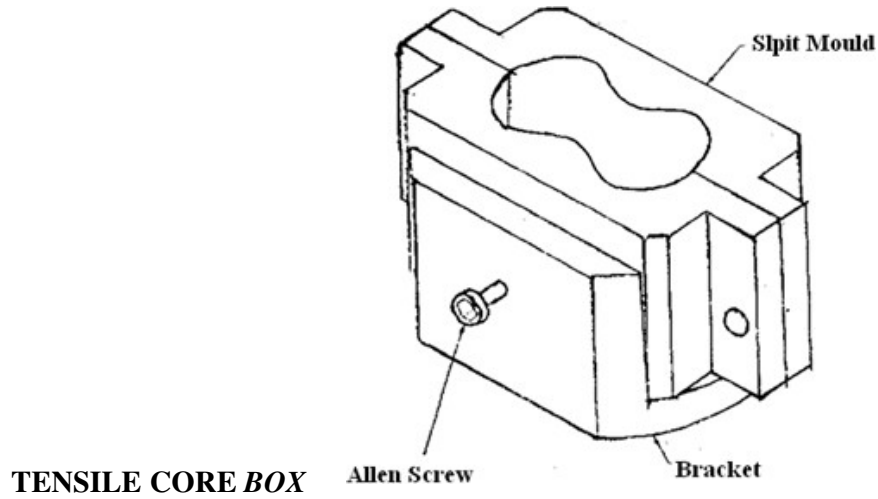
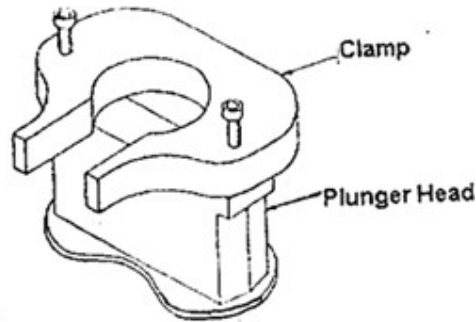


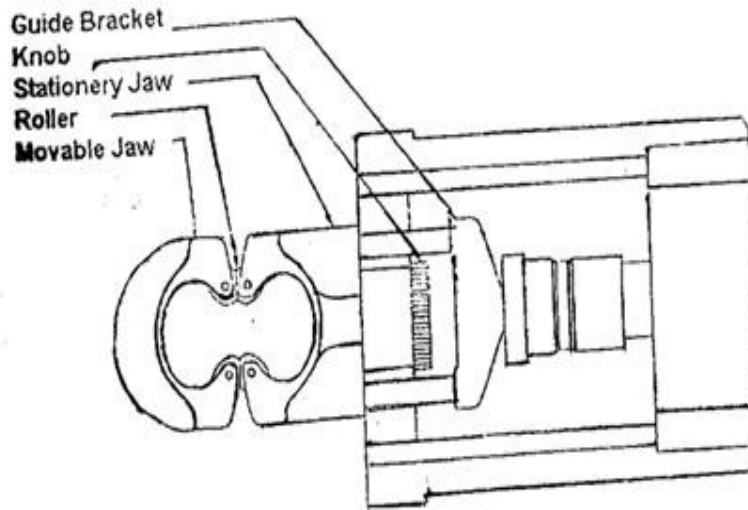
Fig. 1 – Split Core Box (Tensile)



TENSILE CORE BOX



Tensile strength attachment (Model-VAS)



well as the outer radius. Due to the contraction of the inner radius the core sand will be pulled outwards causing a tensile load around the core. Hence knowledge of tensile strength of core sand is important.

Procedure:

1. Conduct the experiment in two parts.
 - a. Using core oil as binder and
 - b. Using sodium silicate as binder.
2. Take proper proportions of base sand and binder then mix them together thoroughly.
3. Assemble the core box and fill the mixture into it.
4. Place the core box under sand rammer and ram the sand thrice.
5. Using a wooden piece tap the core box gently from sides. Remove the core box leaving the rammed core on a flat metal plate
6. Bake the specimen (which is on a plate) for about 30 minutes at a temperature of $150^{\circ} - 200^{\circ} \text{C}$ in an oven. (When the binder is core oil)
7. If the binder is sodium silicate, pass CO_2 gas for 5 secs. The core hardens instantly and the core can be directly used.
8. Fix the tension shackles on to the sand testing machine, and place the hardened specimen in the shackles.
9. Apply the load gradually by turning the hand wheel of the testing machine. Note down the readings when the specimen breaks.
10. Repeat the procedure for the different percentage of binder and tabulate the readings.

TABULAR COLUMN**1. Varying the percentage of Clay and keeping percentage of Water constant (5%).**

SL. NO	Percentage of Clay	Pressure gm/cm ²	Time in min.	P _N	
				Indicated	Calculated
1	4%(8gms)				
2	6%(12gms)				
3	8%(16gms)				

2. Varying the percentage of water and keeping percentage of Clay constant (6%).

SL. NO	Percentage of water	Pressure gm/cm ²	Time in min.	P _N	
				Indicated	Calculated
1	4%(8gms)				
2	6%(12gms)				
3	8%(16gms)				

Draw graph:

Permeability number v/s % of Clay

Permeability number v/s % of water

Discuss the effect of water and clay on Permeability

Experiment No. 4

Date: ___/___/____

PERMEABILITY TEST

AIM: To find the effect of water content, clay content on green permeability of foundry sand.

Materials used: Base sand, clay and water.

Apparatus used: Sand rammer, Permeability meter, Electronic weighing scale, stripper, stop watch, measuring jar, specimen tube, specimen tube cup.

Theory:

1. Molten metals always contain certain amount of dissolved gases, which are evolved when the metal starts freezing.
2. When molten metal comes in contact with moist sand, generates steam or water vapour.
3. Gases and water vapour are released in the mould cavity by the molten metal and sand. If they do not find opportunity to escape completely through the mould, they will get entrapped and form gas holes or pores in the casting. The sand must therefore be sufficiently porous to allow the gases and water vapour to escape out. This property of sand is referred to as permeability.
4. Permeability is one of the most important properties affecting the characteristic of moulds which depends upon the grain size, grain shape, grain distribution, binder content, moisture level and degree of compactness.
5. Permeability is a physical property of the physical sand mixture, which allows gases to pass through it easily.
6. The AFS (American Foundry Men Society) definition of permeability is –the number obtained by passing 2000cc of air through a standard specimen under a pressure of 10 gm/cm² for a given time in minutes.
7. The permeability number P_N can be found out by the equation

$$P_N = \frac{(VH)}{(PAT)}$$

Where

V = Volume of air passing through the specimen, 2000cc

H = Height of the specimen = 50.8 mm (standard value)

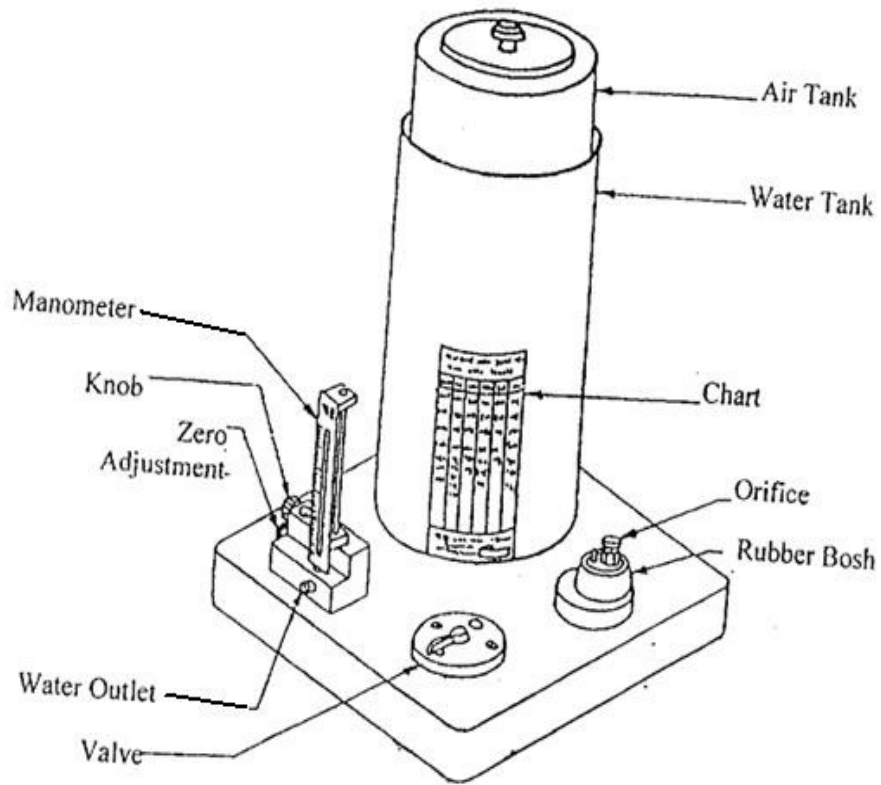
P = Pressure as read from the manometer in gm/cm²

A = Area of the specimen = $\pi d^2/4$

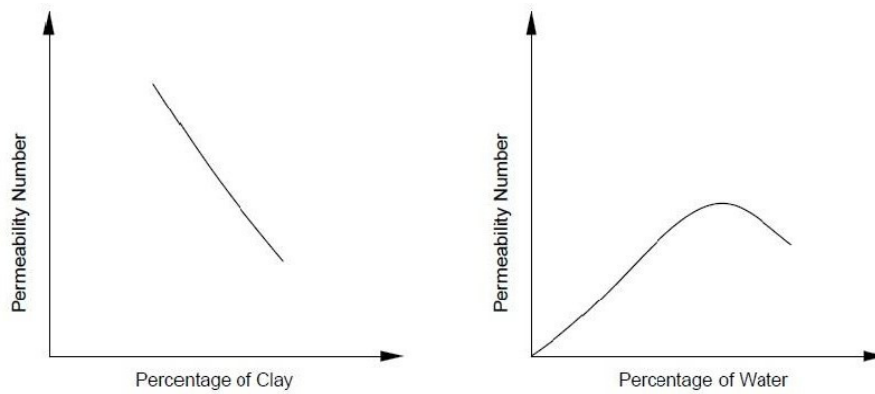
Where d = 50.8 mm (standard value)

T = time in minutes for 2000 cc of air passed through the sand specimen.

PERMEABILITY METER



Nature of graph



Experimental setup details:

Permeability meter has a cylindrical water tank in which an air tank is floating. By properly opening the valve, air from the air tank can be made to flow through the sand specimen and a back pressure is setup. The pressure of this air is obtained with the water manometer. The meter also contains the chart, which directly gives the P_N depending on pressure.

Procedure:

1. Conduct the experiment in two parts. In the first case vary water percent keeping clay percent constant. In the second case vary clay percent and keep water percent constant.
2. Take weighed proportions of sand dry mix them together for 3 minutes. Then add required proportions of water and wet mix for another 2 minutes, to get a homogeneous and mixture. Take the total weight of the mixture between 150-200 grams. The correct weight has to be determined by trail and error method.
3. Fill the sand mixture into the specimen tube and ram thrice using sand rammer. Use the tolerance limit provided at the top end of the rammer for checking the specimen size. If the top end of the rammer is within the tolerance limit, the correct specimen is obtained. If it lies below the limit, increase the weight of sand mixture and prepare a new specimen. The specimen conforming to within limits represent the standard specimen required.
4. Now the prepared standard specimen is having a dia.50.8mm and height 50.8mm.
5. Place the standard specimen along with the tube in the inverted position on the rubber seal or on the mercury cup (specimen in the top position in the manometer reading).
6. Operate the valve and start the stop watch simultaneously. When the zero mark on the inverted jar just touches the top of water tank, note down the manometer reading.
7. Note down the time required to pass 2000cc of air through the specimen. Calculate the permeability number by using the formula given.

Direct scale reading:

The permeability can also be determined by making use of the graduated marker provided near the manometer.

Procedure to be followed:

- Coincide the graduations on the transparent scale with the meniscus of the manometer liquid.
- Note the reading of the scale.
- This reading represents the permeability number of the sand.

Tabular column for Core Hardness Test

SL. NO	% of Sand	% of sodium silicate	Core Hardness Number
1			
2			
3			

Tabular column for Mould Hardness Test

SL. NO	% of Sand	% of Water	Mould hardness Number
1			
2			
3			

Experiment No. 5

Date: __/__/____

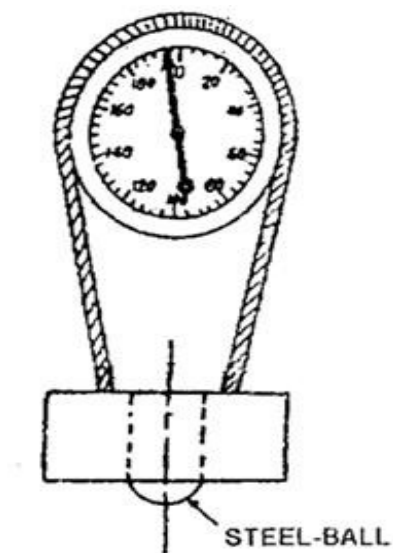
CORE HARDNESS AND MOULD HARDNESS TEST

Mould and core hardness can be found out by the hardness – tester which is base on the same principle as Brinell hardness tester. A steel ball of 50 mm diameter weighing 237 gm is pressed on the mould surface. The depth of penetration of steel ball will give the hardness of mould surface on the direct reading dial. This hardness test is useful in finding out the mould uniformity

The following are the moulding hardness numbers for

Moulding sand (1 number = 1/100 mm) Soft rammed moulds = 100 Medium rammed moulds = 125

Hard rammed mould = 175



Mould hardness tester

Tabular Column:

Total weight of sand taken = 100g.

SL. NO	(a) Sieve NO in Microns	(b) Weight in grams		(c) % Retained	(d) Multiplying factor	(e) Product $\Sigma e = c \times d$
		Empty Sieve W_1	Sieve with Sand W_2			
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	
11	Sieve pan				300	

$$P = \Sigma c$$

$$Q = \Sigma e$$

(Calculate the average GFN using the formula as shown below.)

$$\% \text{ Retained } C = \frac{\text{Weight of sand in each sieve}}{\text{Total weight of sand}} \times 100$$

$$\text{Calculation: AFS grain number} = Q (\text{sum}) / P (\text{total})$$

Results: The average grain fineness number is =

Experiment No. 6**Date:** ___/___/____**SIEVE ANALYSIS TO FIND GRAIN FINENESS NUMBER OF BASE SAND**

AIM: To find the distribution of sand grains using a set of sieves and to find the average grain fineness number.

Materials used: Base sand- Silica sand.

Apparatus used: Electronic weighing scale, stop watch, sieve shaker.

Theory:

1. The base sand is a mixture of grains having a variety of shapes such as
a) Round b) sub-angular c) angular d) compounded grains.
Base sand is relatively free from any binder or additives.
2. Depending on the average size of the grains, the sand can be grouped into: a) Fine
b) Medium and c) Coarse grains.
3. The shape and size of grains has a large influence on the permeability of sand mix as well as on the bonding action.
4. The shape and size of grains determine the possibility of its application in various types of foundry practice.

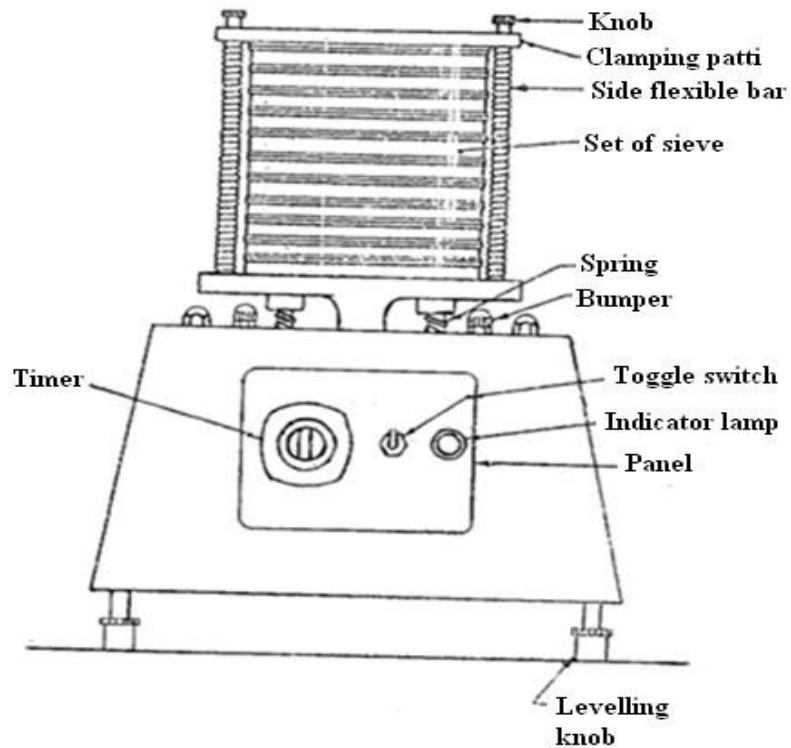
Ex: Fine grain sand results in good surface, on the casting but gases cannot escape out of the mould made from it. Coarse grain sand allows gases to escape out easily but the casting surface will be very rough. Hence grain size should select appropriately.

5. The given size of sand grains is designated by a number called grain fineness number that indicates the average size of grains in the mixture.
6. The size is determined by passing the sand through sieves having specified apparatus which are measured in microns.
7. The sieve number designates the pore size through which the sand grains, may pass through it or retained in it.
8. Average grains fineness number can be found out by the equation

$$GFN = Q/P$$

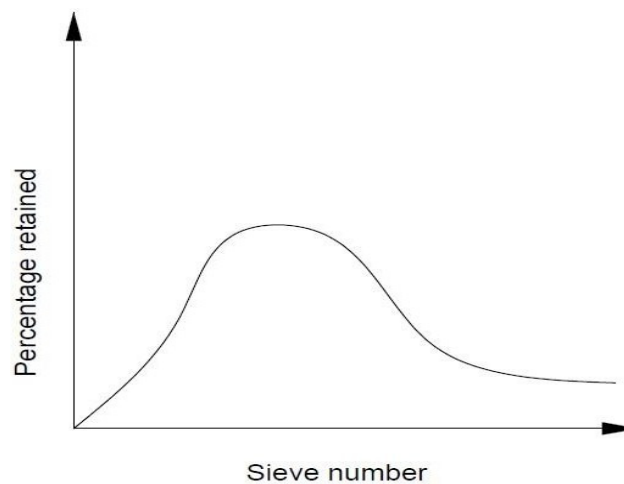
Where Q = sum of product of percentage sand retained in sieves and
Corresponding multiplier.

P = sum of percentage of sand retained in sieves.

SIEVE SHAKER

Graph: Percentage of sand retained v/s sieve number

Nature of graph



Procedure:

1. Take 50 gm or 100 gm of dry sand and place in the top sieve of a series and close the lid.
2. Place the whole assembly of sieves on the vibratory sieve shaker and clamp it.
3. Switch on the motor and allow the sieve assembly to vibrate for 5 minutes. Then switch off the motor.
4. Collect the sand particles retained in each of the sieve separately and weigh in Electronic weighing scale and enter into the tabular column. Calculate the percentage weight retained by each of the sieves. Multiply this value with the multiplier for each sieve.

Calculations

Weight of sand $W_1 = 100$ gms

Weight of dried sand $W_2 = \text{-----}$ gms

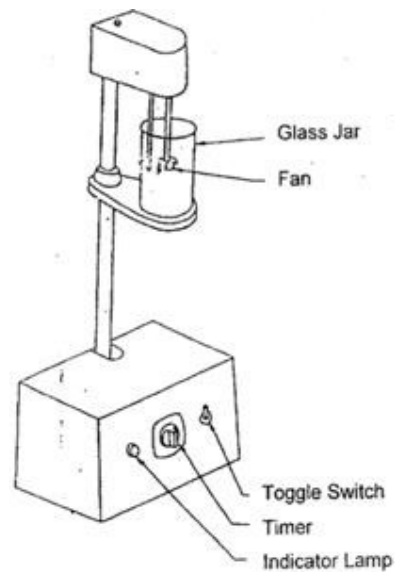
$$\% \text{ of clay} = \frac{(W_1 - W_2) \times 100}{100}$$

Results and discussion:

The percentage of clay is = _____ %

Discuss whether the % of clay is present is high or low and whether this % is enough to act as binder in the sand.

CLAY WASHER



Experiment No. 7**Date:** ___/___/___**CLAY CONTENT TEST****AIM:** To determine the percentage of clay present in base sand.**Materials used:** Base sand, 5 % NaOH solution and water.**Apparatus used:** Wash bottle, measuring jar, mechanical stirrer and siphon tube.**Theory:**

1. Clay can be those particles having less than 20 microns size. Moulding sand contains 2 to 50 percent of clay. When mixed with water it imparts, binding strength and plasticity.
2. Clay consists of two ingredients a) Fine silt and b) True clay. Fine silt as no binding power where as true clay imparts the necessary boundary strength to the moulding sand; thereby the mould does not loose its shape after ramming.
3. Clay also can define as those particles which when mixed with water, agitated and then made to settled, fails to settle down at the rate of 1l/mm.
4. The particles of clay are plate like from and have a very large surface area compared to its thickness and therefore have a very high affinity to absorb moisture.
5. Clay is the main constituent in a moulding sand and mixture other than sand grains. Clay imparts binding action to the sand and hence the strength.
6. Clay is of mineral origin available in plenty on earth. It is made of alumina silicate. The types of clay are a) montmorillonite b) Kaolinite and c) illite the first type is generally referred to as Bentonite.
Clay is the main constituent in a moulding sand mixture other than sand grain. Clay help impart binding action to the sand and hence strength to the sand.

Procedure:

1. Take 100g of base sand in a wash bottle and add 475ml of distilled water and 25ml of NaOH solution to it.
2. using the mechanical stirrer, stir the mixture for about 5 minutes add distilled water to make up the level to 6" height. Stir the mixture again for 2 minutes. Now allow the content of the bottle to settle down.
3. Siphon out 5l level of unclean water using a standard siphon.
4. Add distilled water again up to 6" height and stir the content again. Allow the mixture to settle down for 5 minutes.
5. Siphon out 5l level of water from the bottom of the bottle
Repeat the above procedure for 3-4 times till the water becomes clear in the wash bottle.
6. Transfer the wet sand from the bottle in to a tray and dry in it in an oven at 110 ° C to remove moisture. Note down the dry sand weight accurately. Using the calculations find percentage of clay.

WELDING PRACTICE

It is a process of joining two pieces of metal by heating them to a suitable temperature with additions of filler metal or with application of pressure is called welding.

Practical application of welding:

Welding is extensively used in the following fields

- 1) Automobile industries
- 2) Aircraft industries
- 3) Railway Industries
- 4) Ship building industries
- 5) Machine tool industries, structural works, Repair works, thermal power plants, fabrication of metal structures etc.

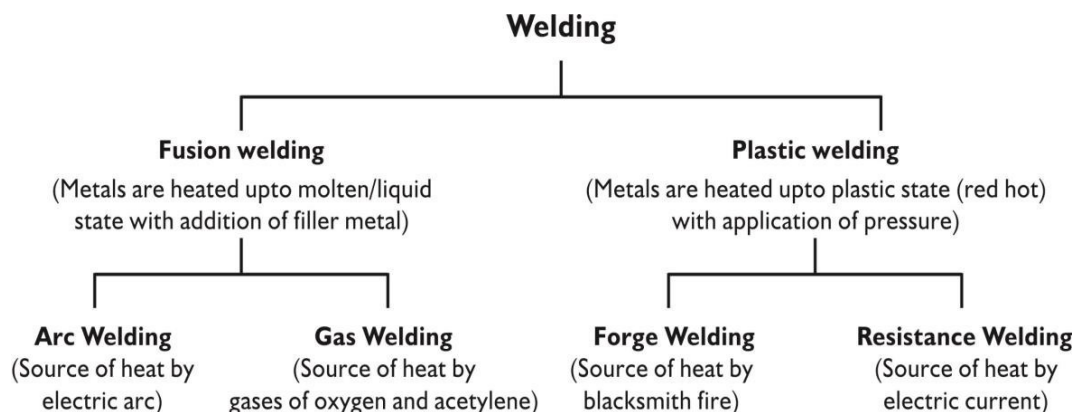
Now a day there is no industry which is not using welding process in the fabrication of its products in some form or the other.

Advantage of welding process.

Welding is the most acceptable method of fabrication for the following reasons

1. This is the most rapid and easiest way of fabrication and assembly of metal parts.
2. 10 to 40% material can be saved and weight reduction.
3. This process having more than 100% strength of the joint.
4. Greater flexibility in fabrication and erection.
5. Repair and maintenance is easier.
6. Better integrity of components.

Classification of welding:



ARC WELDING: The pieces of metal to be joined are heated to molten or liquid state by an electric arc with using flux coated consumable electrode. The intense heat of the electric arc will melt the work pieces and electrode. This molten pool will make a welding joint after solidification. This process of is mostly used for welding ferrous metals.

GAS WELDING: The pieces of metal to be joined are brought to melting temperature from OXY-acetylene flame and then weld is completed by addition of filler metal (Gas welding rods). The process of welding is used for joining non-ferrous metal and small / thin sections.

FORGE WELDING: The pieces of metal to be joined are heated to plastic state from coal/leco/charcoal/ in hearth or forge then pressing together by hand power hammering. This is the oldest method of welding. This process is used in block smith shop for joining wrought iron and low Carbon Steel.

RESISTANCE WELDING:

In resistance welding a heavy electric current is passed through the metal to be joined over a limited area causing them to be locally heated up to. Plastic state and weld is completed by the application of pressure for a prescribed period of time. No addition of filler metal is required.

Resistance welding is employed mainly for mass production. This is the only process where heat can be controlled and which permits a pressure action at the weld. The operation is extremely rapid and simple. E.g. Spot welding, Butt Welding, Seam welding etc.

Arc Welding and its equipments:

When two conductor of an electric circuit of very high current and low voltage (approximately 200 amps, 20 Volts) are connected with one to flux coated consumable electrode and other one to work piece are brought nearer touch and separated in a small distance of about 4 mm an electric arc is formed. The electric arc is protected from out side atmosphere with gaseous shield around the arc from flux-coated electrode. The temperature of arc is about 3000 to 4000°C. The heat of an electric are will melt the work pieces and electrode. This molten pool will make a welding joint after solidification from the atmosphere. Ensure safety apparel is worn.

Arc welding equipments:

- 1) AC or DC machines
- 2) Welding cable and its connectors
- 3) Electrode holder
- 4) Earthling clamps
- 5) Face shield or helmet
- 6) Goggles and spectacles.
- 7) Leather hand gloves.

- 8) Apron.
- 9) Chipping hammer and wire brush
- 10) Tongs.

Safety precautions in Arc Welding:

Because of the intensity of heat and light rays from the electric arc the operator hands, face, and eyes are to be protected while the arc is in use. Leather hand gloves are worn and a hand shield or a helmet with a window of colored glass should be used to protect the face and eyes from the glaring effect of the arc rays. Also the space for the electric arc welding should be screened off from the rest of the building to safe guard other workmen from the glare of arc.

Related applications of AC and DC welding:

AC Welding	DC Welding
Ac welding is a low cost efficient performance and popular to weld heavy gauge steel finds maximum use.	DC welding is best suitable for thinner, sheet metals and non-ferrous metals.
Best suitable for flat and horizontal position of welding	DC welding has a greater use in overhead and vertical position.
The biggest advantages in AC welding <ol style="list-style-type: none"> i) Complete absence of magnetic arc blow (deflection arc is called arc blow) ii) Arc is forceful and produces good penetration. (Pierce or deep in sight) 	TIG and MIG welding etc. It is easier to strike and maintain a stable arc. Polarity can be changed to +ve and -ve to electrode Base wire and light coated electrode can be easily used.

Skill Information required to perform various functions in an Electric Arc Welding to produce good Arc welding joints.

1. Setting of arc welding plant.
2. Setting of welding current and selection of electrode according to plate thickness.
3. Strike and maintain the arc.
 - i. Scratching method.
 - ii. Tapping method
4. To deposit straight bead in a flat position.
 - i. Electrode position.
 - ii. Depositing straight beads by maintaining;
 - a. Correct arc length.
 - b. Correct travel speed.
 - c. Correct angle of electrode.
- 5 Clean the weldment and inspect for faults.
 - i. Remove the slag using chipping hammer and wire brush.
 - ii. Inspect the deposited bead.

1. Setting of arc welding plant.

- Check the working of power source for the welding machine.
- Remember electricity is a good servant but a bad master.
- Call an electrician for solving any electrical problems.
- Connect the welding cables with the welding machines.
- Ensure that the cable connections are clean, dry, tight and are attached to the proper terminals of the machine.
- Attach tightly the earth cable with the welding table at the proper place.
- Keep the electrode-holder at a safe place.
- If the machine is on D.C. power connect the cables in correct polarity.
- Polarity means changing of +ve and -ve to the electrode is called polarity.

Setting of Arc-Welding Plant

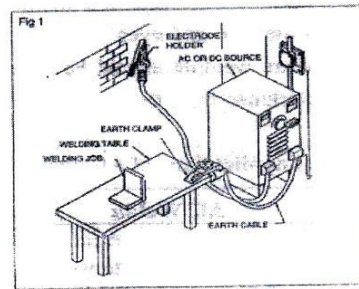
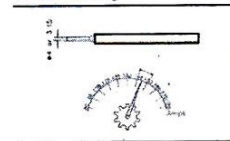


Plate thickness in mm	Electrode size ϕ mm	Current range amperes
1.6	1.6	40 – 60
2.5	2.5	50 – 80
4.0	3.2	90–130
6.0	4	120–170
8.0	5	180–220
25.0	6	300–400

2. Current setting & selection of electrode according to the thickness of plate to be joined.

- Set the welding current and select the electrode as per the thickness of the metal to be welded ref table.
- Use alternative electrodes of nearest size in the case of non-availability of the exact size of electrodes.
- The electrode diameter should not be more than the thickness of the metal to be welded.
- Set the current on the welding machine 120-130 amps for 3.15mm M.S. electrode. If the thickness of metal to be welded is 5mm. Always follow the current range chart for the electrodes in use.

Current setting



Set the current on the welding machine, 140-150 amps for ϕ 4mm M.S. Electrode.

Always follow the current range chart for the electrodes in use

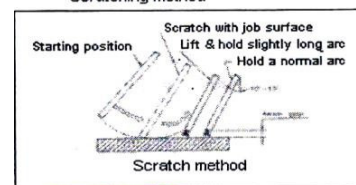
3. Striking and maintaining an Arc.

Striking an arc is a basic operation in arc welding. It will occur every time the welding is to be started. It is an essential basic skill to learn in arc welding.

i) Scratching method:

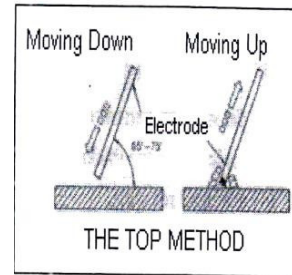
- Hold the electrode about 25 mm above the job piece at one end perpendicular to surface
- Bring the welding screen in front of your eyes.
- Ensure safety apparatus is worn.
- Strike the arc by dragging the electrode quickly and softly across the welding job, using wrist movement only.
- Withdraw the electrode approximately 6 mm from the surface for a few seconds and then lower it to (approximately) 4mm distance.
- If the arc has been properly struck, a burst of light with a steady sharp crackling sound will be produced.

Striking and maintaining an arc
Scratching method



ii) Tapping method:

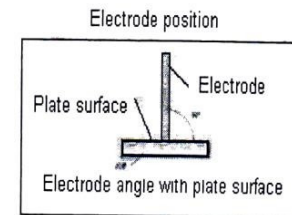
- Strike the arc by moving the electrode down to touch the job surface lightly.
- Move the electrode slowly up approximately 6mm for a few seconds and then lower it to approximately 4 mm from the surface.
- The tapping method is generally recommended as it does not produce pit marks on the job surface

**4. To deposit straight bead in a flat position.****i. Job setting**

- * Set the job in a flat position on the welding table.
- * Ensure there is good electrical contact between the job and the welding table.

ii. Electrode position

- * Hold the electrode at an angle of 70° - 80° with the weld line and 90° with the adjoining plate surface.

**BRIEF PROCEDURE FOR ARC WELDING**

1. Set the arc welding plant by one cable connection to electrode with electrode holder another connection for workpiece with earthing clamp.
2. Set the current range & electrode according to plate thickness.
Ex: 6mm plate i) Current range 120Amps
ii) Electrode size 3.2mm Dia or 10G
3. Set the workpiece for tack weld by fixing with C Clamp using suitable tack welding fixture.
4. Tack the pieces at both ends by scratching or tapping method.
5. Place the tack weld unit to full bead welding fixture as provided in working table.
6. Deposits full bead weld with correct i) Arc lengths 3 to 5mm ii) Electrode angle 70° to 80° iii) Travel speed 150mm/min iv) uniform Movement v) Direction towards your end.
7. Reverse the joint to perform full bead on other end.
8. Chip off all slag, remove spatters with using white spectacles
9. Clean the bead by wire brush with using white spectacles.
10. Inspect the weld bead.

Why Electrodes are coated?

During welding, the work pieces melts and at the same time, the tip of electrode also melts. As the globules of molten metal pass from the electrode to the work piece, they absorb Oxygen and Nitrogen from the atmospheric air. This causes the formation of some non-metallic constituents that are trapped in the solidifying weld metal thereby decreasing the strength of the welded joint. In order to avoid this, a flux is coated on the metallic wire. During welding, the flux vaporizes and produces a gaseous shield around the molten weld

pool. The flux also performs a variety of functions depending on the constituents from which it is made.

Advantages of coated electrodes:

- 1 Stabilizes the arc.
2. Prevents oxidation of molten metal
- 3 Helps in removal of oxides and other undesirable substances present on the surface of the work piece.
4. Chemically reacts with the oxides and forms a slag. The slag floats and covers the top portion of the molten metal thereby preventing it from rapid cooling.

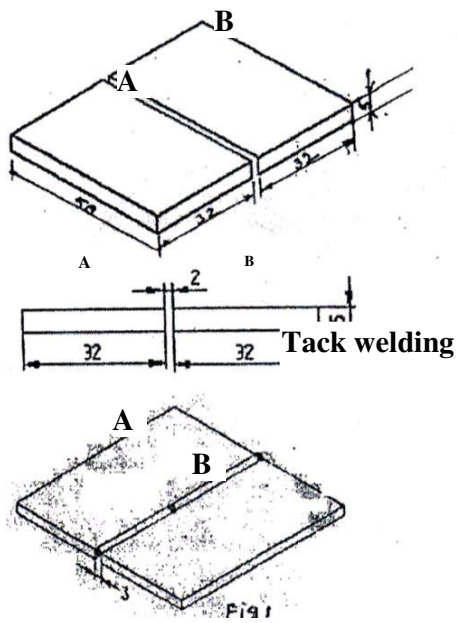
Sequence of operation and methods for preparing Electric Arc Welding joints, (Step by Step Procedure)

SI. No.	Sequence of Operation	Method/ System adapted	Tools/ Equipments required to perform the operation
1	Sketching / Drawing	Orthographic : 2D Isometric : 3D	Using all conventions, notations and symbolic representations.
2	Set the Arc welding plant	i) connect one cable to workable it proper place ii) Another cable for electrode holder	i) A.C. step down transformer (air cooled) or D.C. generator I rectifier. (connect the cable to correct polarity) ii) Welding cable, iii) Electrode holder iv) Earthling clamp.
3	Set welding current and selection of electrode according to plate thickness	i) set the current on welding machine ii) Select electrode fit with electrode holder	Ref to Chart for selection of current range in amperes and electrode size. Ex.: 6 mm thick plate / 90 — 130 amps I 3.2 mm
4	Clean and set the work pieces for tack weld Tack the pieces at both ends by holding by _C' clamp	Obtain the arc by Scratching or tapping method	i) Use suitable tack weld fixture as available. ii) _C' clamp iii) Face shield and spectacles iv) Chipping hammer v) Wire brush and tong vi) Use safety apparels
5	Check the alignment and reset if necessary. Place the tack weld joint in a		Select suitable fixture for fun bead weld. (Butt, Lap, _T' and _L' joint)

	fixture in flat position provided on the worktable		
6	Deposit full bead with correct arc length, electrode angle, travel speed and movement	<ul style="list-style-type: none"> i) Arc length: 4 mm ii) Electrode Angle: 70° - 80° iii) Travel Speed: 150 mm / mm Movement: more uniform and consistency to your end	Use all safety apparels
7	Reverse the joint, deposit full bead if necessary .	<ul style="list-style-type: none"> i) Arc length: 4 mm ii) Electrode angle:70°-80° iii) Travel Speed: 150 mm/mm Movement: more uniform and consistency to your end	Use all safety apparels
8	Chip off all slag, remove spatters, clean the bead by brushing		Tong, chipping hammer, wire brush, white glass spectacles, chisel and hammer.
9	Inspect the wd:	<ul style="list-style-type: none"> i) To ensure uniform and correct reinforcement ii) To ensure that weld face is free from porosity, Slag inclusion, unfilled creator, over lap, insufficient throat 	

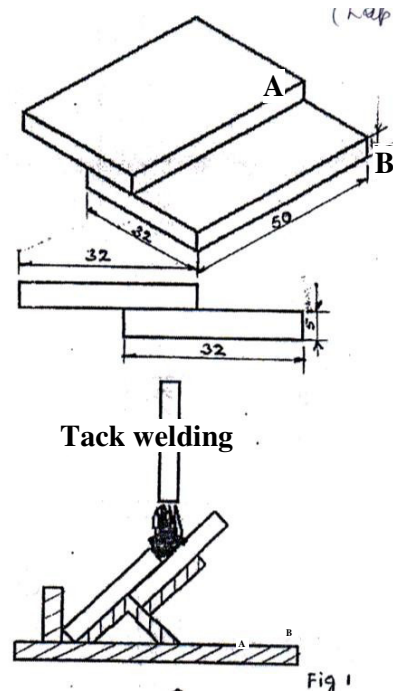
Experiment No: - 1

Butt Joint

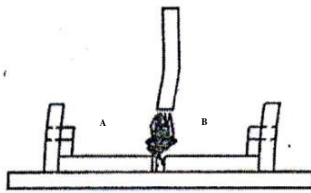


Experiment No: - 2

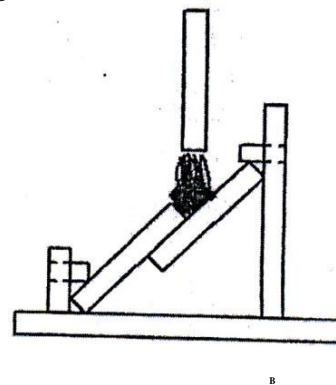
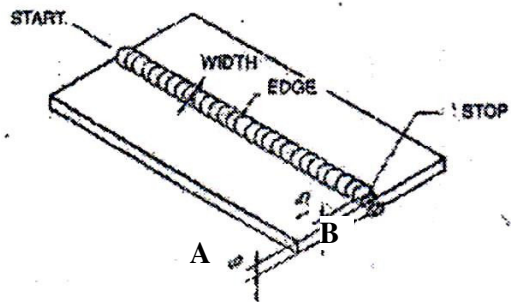
Lap Joint



Full Bead welding

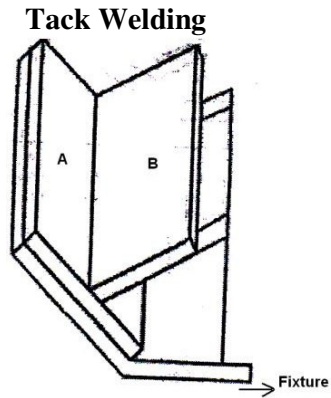


Full Bead welding

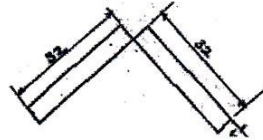
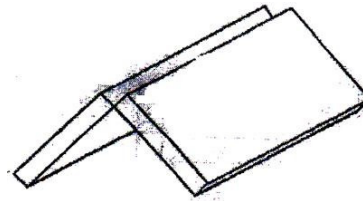
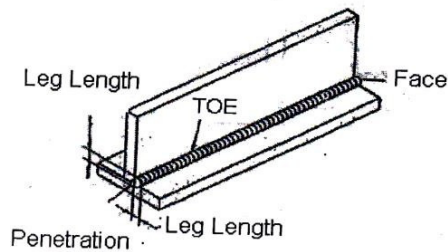
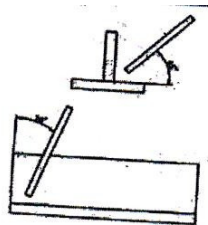
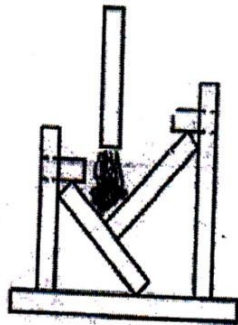


Experiment No: - 3
Tee Joint

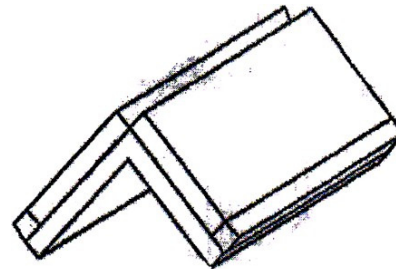
Experiment No:-4
V Joint & L Joint



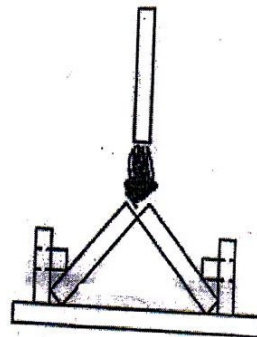
Full Bead Welding



Tack Welding



Full Bead Welding



PART – B
FOUNDRY

FOUNDRY

Introduction:

Foundry is a process of shaping the metal components in their molten stage. It is also called as metal casting the shape and size of the metal casting is obtained depends on the shape and size of the cavity produced in sand mould by using wooden/ metal pattern.

Practical application

1. Casting is the cheapest and most direct way of producing the shape of the component
2. Casting is best suited to work where components required is in low quantity.
3. Complicated shapes having internal openings and complex section variation can be produced quickly and cheaply by casting since liquid metal can flow into any form/ shape.

Example: 1. Outer casing of all automobile engines.

2. Electric motor housing

3. Bench vice, Irrigation pumps etc.

4. Heavy equipment such as machine beds of lathe, milling machine, shaping, drilling planing machine etc. can be cast/easily
5. Casting is best suited for composite components

Example.1. steel screw threads in zinc die casting

All conductors into slot in iron armature for electric motor.

Steps in foundry process

The Foundry process involves three steps.

- (a) Making the required pattern
- (b) Moulding process to produce the cavity in sand using pattern.
- (c) Pouring the molten metal into the cavity to get casting.

Classification of foundries

- Steel foundry
- C.I foundry
- Light alloy foundry
- Brass foundry
- Shell moulding foundry

- Die casting foundry (using permanent metal or dies for high volume of low and pressure die)

Pattern:

A pattern is normally a wooden/ metal model or thermosetting plastic which is facsimile of the cast product to be made, there are many types of pattern and are either one piece, two piece or three piece, split pattern, loose piece pattern, Gated and match plate pattern etc.

Pattern size: Actual casting size +shrinkage allowance +shake allowance +finish allowance

1. Shrinkage allowance: The liquid metal shrinks during solidification and its contraction to its room temperature, so that the pattern must be made larger than the casting to provide for total contraction.
2. Finishing allowance: The casting is to be machined at some points then the casting should be provided with excess metal for machining.

Types of foundry sand

1. **Natural sand:** Sand containing the silica grains and clay bond as found. It varies in grain size and clay content. Collected from natural sources.
2. **Synthetic sand:** It is an artificial sand obtained by mixing relatively clay free sand, binder (water and bentonite). It is better moulding sand as its properties can be easily controlled.
3. **Facing sand:** It is the fine grade sand used against the face of the pattern and finally governs the surface finish of the casting.
4. **Parting sand:** It is fine dry sand + brick dust used to preserve the joint face between the cope and the drag.

Natural Green sand= sand + clay + moisture
(10 to 15%) (7 to 9%)

Synthetic Green sand= sand + clay + moisture
(5 to 7%) (4 to 8%)

5. **Green sand:** mouldings is the most common moulding process

Dry sand mould: Dry sand mould refer to a mould which is artificially dried before the molten metal is poured into it. Dry sand moulds are costly, stronger, used for complicated castings, i.e. avoid casting defects, casting gets smoother surface.

Moulding methods:

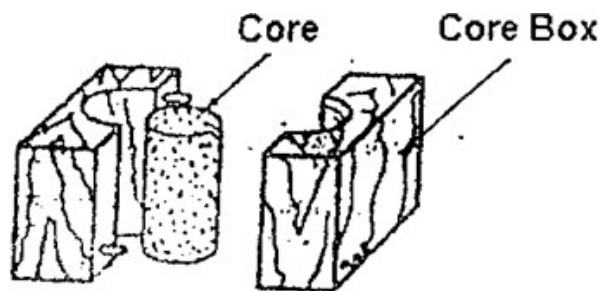
- **Bench moulding:** In this method the moulding is carried out on convenient bench and moulds are relatively small.
- **Floor mouldings:** In this method the mouldings is carried out in medium and large moulds are carried out on the floor.
- **Plate mouldings:** For large quantity production and for very heavy casting two plates may be used with pattern.
- **Pit moulding:** In this method the moulding is carried out in the pits and generally very large moulds are made.
- **Machine mouldings:** A machine is used to prepare moulds of small and medium. This method is faster and gives uniform mouldings.

CORE AND CORE MAKING

CORES: Cores are sand blocks they are used to make hollow portion in a casting. It is placed in a mould so that when molten metal is poured into the mould. This apart of mould will remain vacant i.e. the molten metal will not fill this part of the mould. So when the mould is broken and the castings removed a hollow portion will result in the casting.

Core sand= Moulding sand+ binders (ABC core oil) or sodium silicate

Core making: Cores are made separately in a core box made of wood or metal.



CORE MAKING

Core binders

1. Water soluble binders (2 to 4% by weight)
2. Oil binders (1-3% by weight)
3. Pitch and resin binders (1-3% by weight)

The sand is treated with binder to achieve cohesion

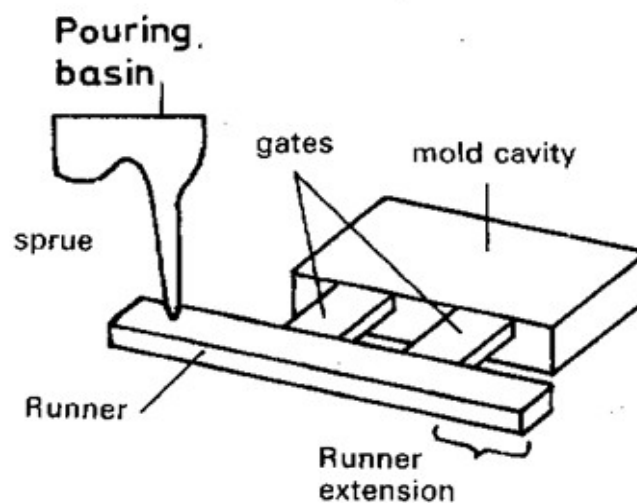
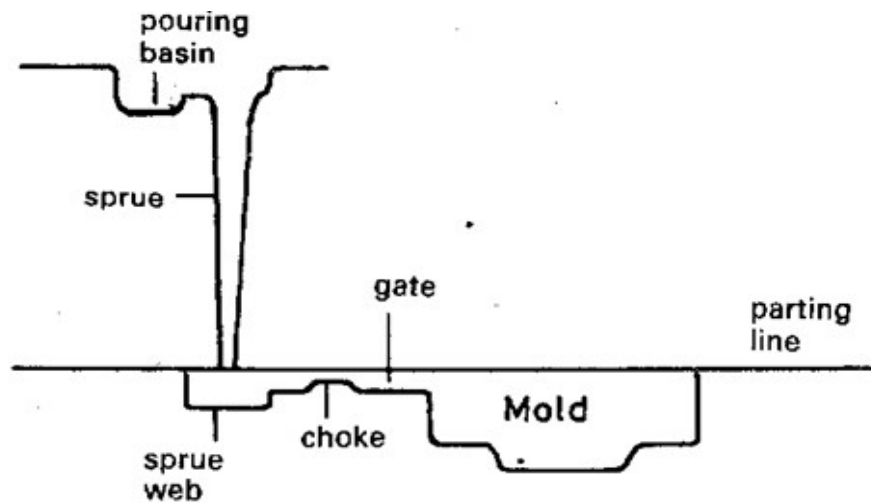
Core Baking

The core is baked (hardened) by heating at 150°C depends on core size in oven.

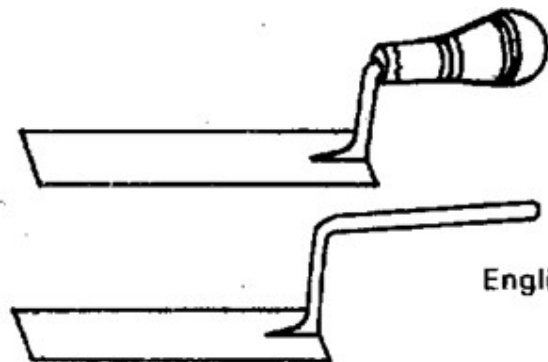
This hardening of the core helps to handle and to place the core in the mould.

The core is supported in the mould by projection known as core prints.

NOMENCLATURE OF A MOULD



MOULDING TOOLS & EQUIPMENTS



English trowels



Long heart trowel



Broad heart trowel



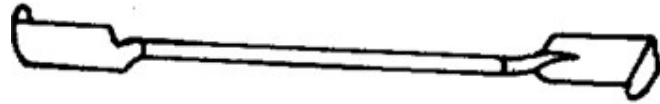
Taper trowel



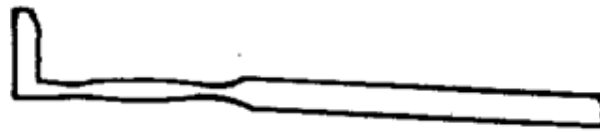
Heart and square trowel



Flange bed



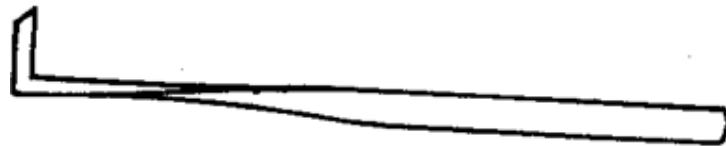
Boss tool



scoth cleaner



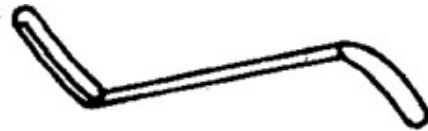
straight bead



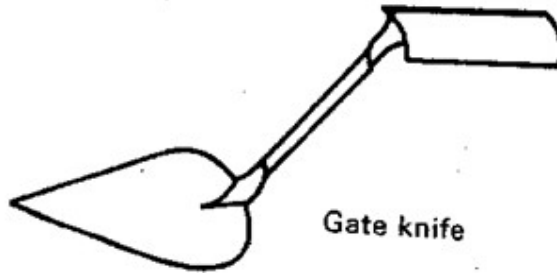
English cleaner



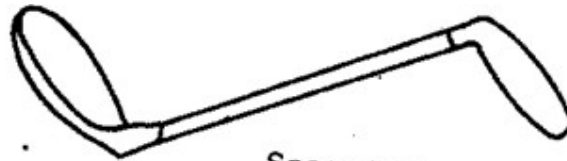
girdar tool



fluted bead



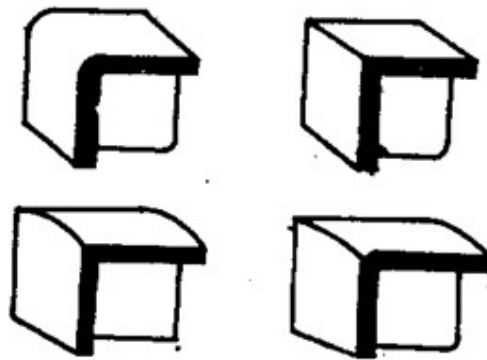
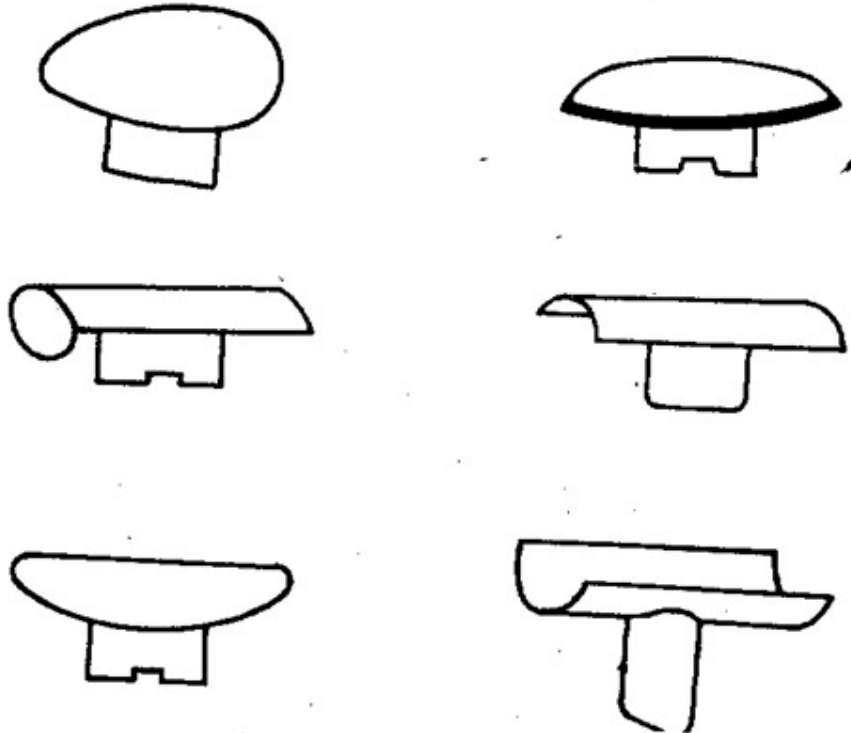
Gate knife



Spoon tool



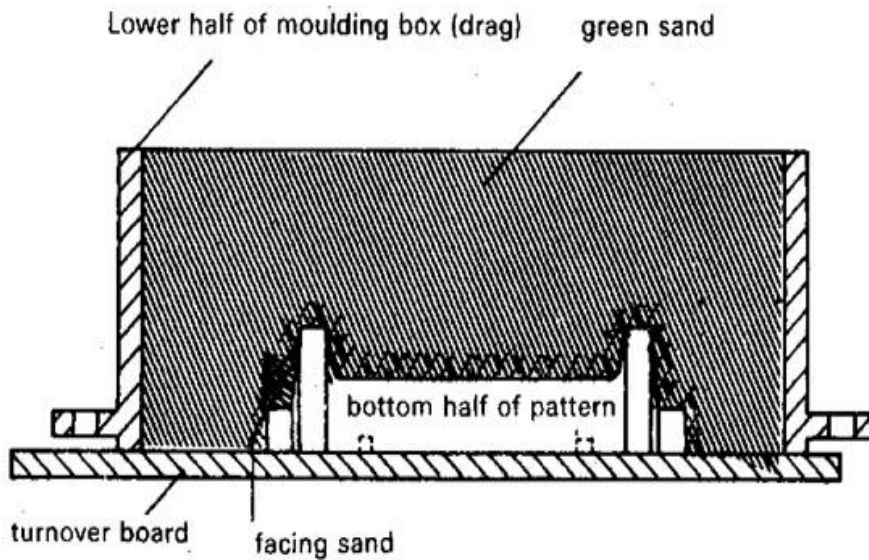
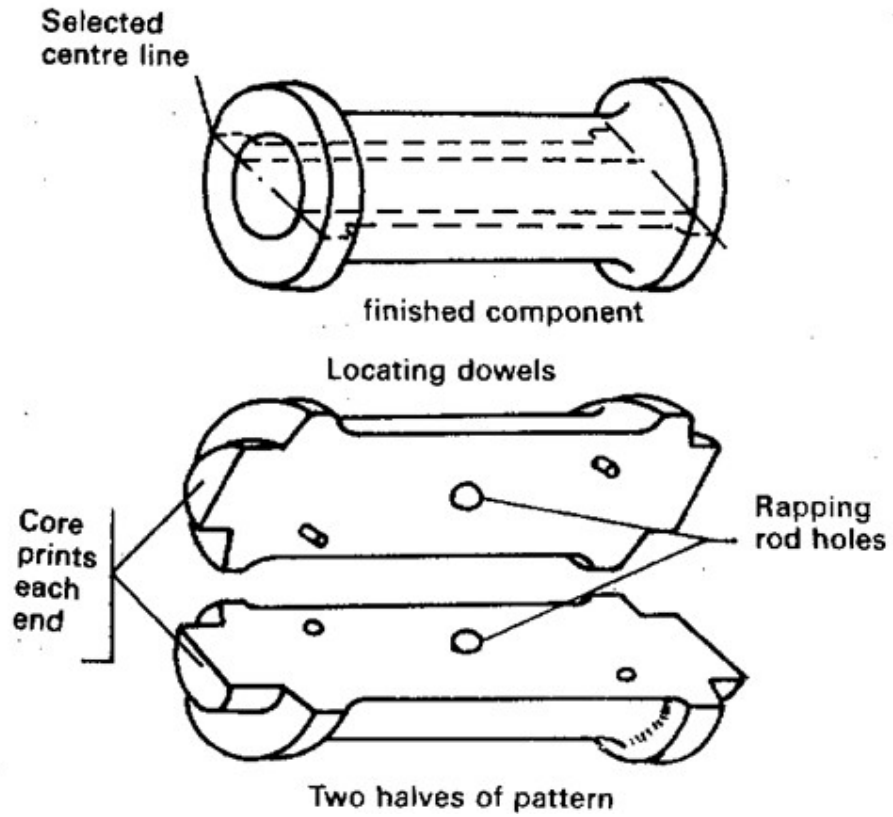
Safe edge heart and upset

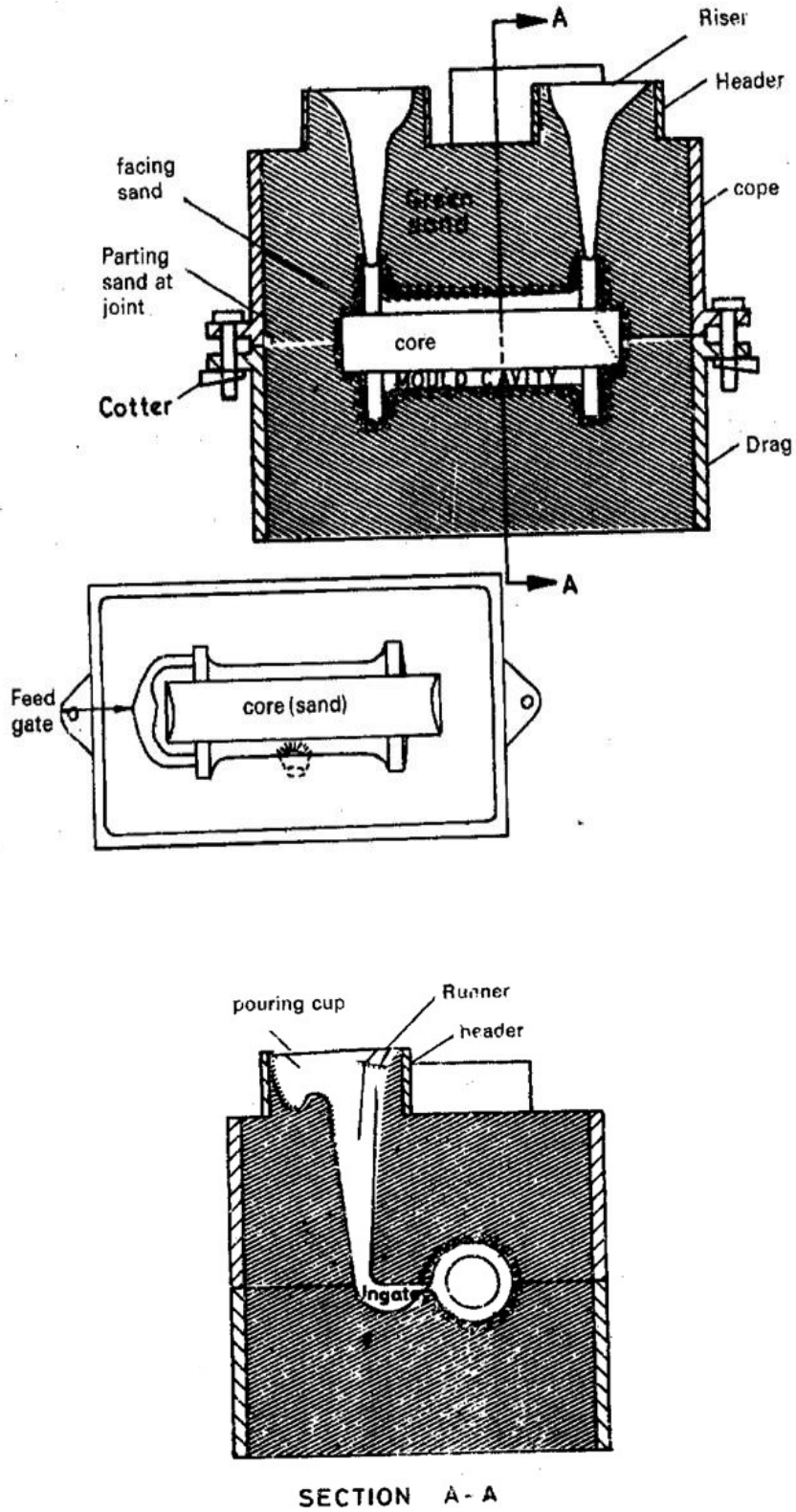


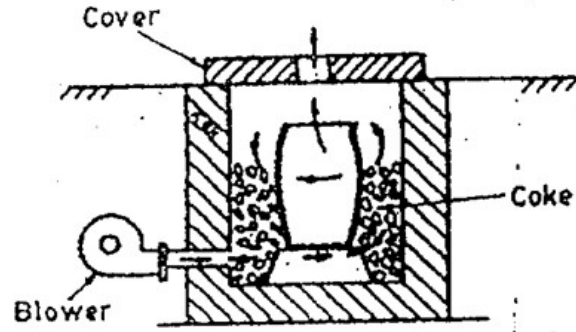
Smoothers



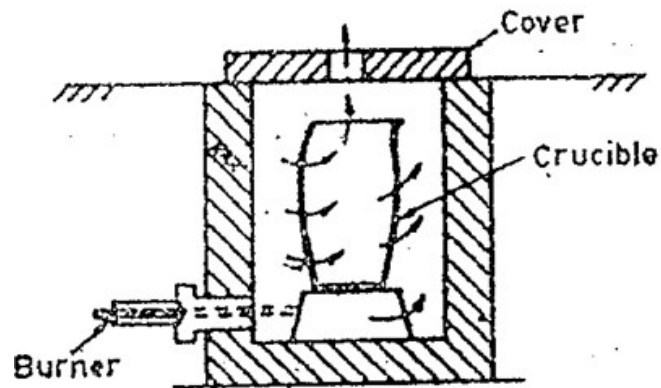
Bellows



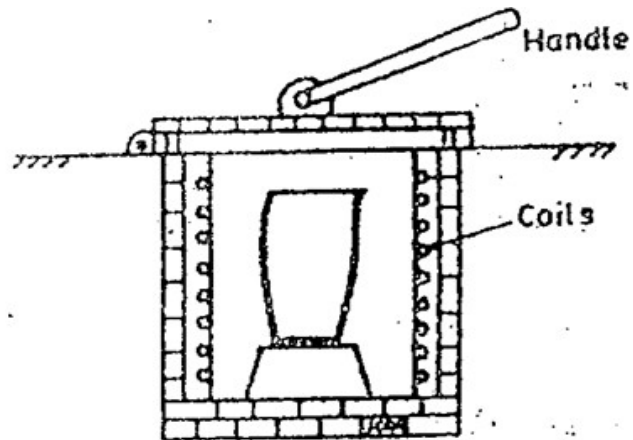




(a) Coke fired



(b) Oil/Gas fired



(c) Resistance type

Pin Type Furnaces

Trowels: These are used for working up into a square corner.

Taper trowel: It is more useful for working along the curved edges of a pattern. Trowels are measured by the length and width of the blade.

Slicks: Use for repairing and slicking of small surfaces. They are named according to the shape of the blade and measured at the widest part of the blade.

Lifters and Cleaners: They are used to clean & finish the bottom and sides of deep narrow openings.

Gate Knife: is for cutting the channel from the mould to the bottom of the runner or riser.

Spoon tool: is convenient for cutting the pouring basin.

Corner Slicks: are, as the shape implies, for finishing off fillets and corners of moulds.

Draw Spike: is a spike for knocking into the wooden pattern in order to withdraw it.

Draw Screw: is for the same purpose as the draw spike; the end is threaded to screw into the rapping plate.

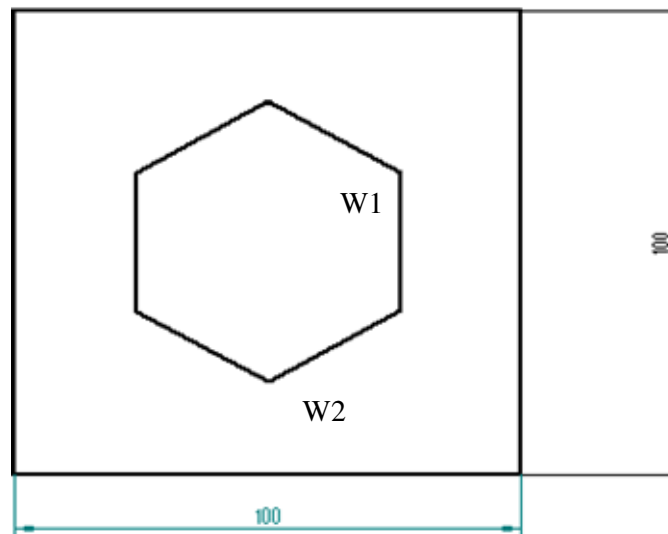
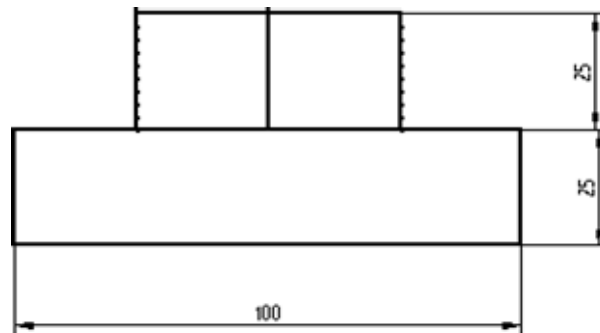
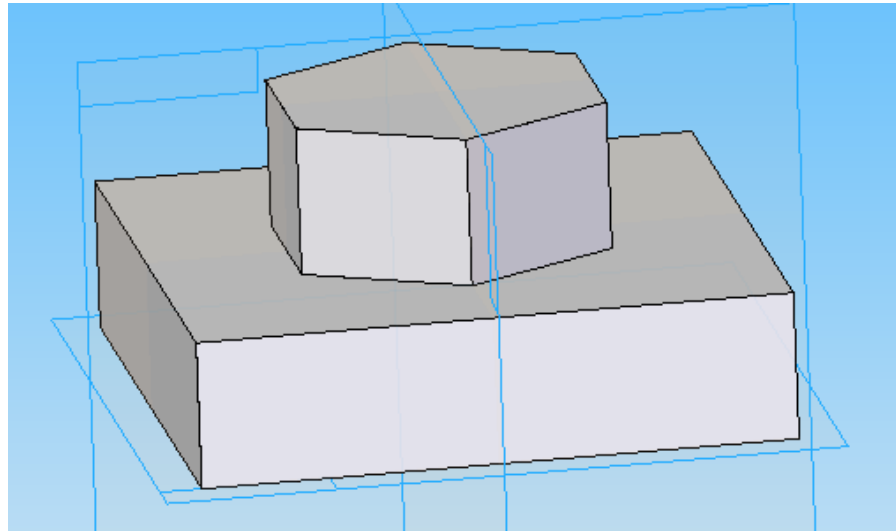
Swap: is a soft – pointed brush for moistening the edges of the mould before lifting the pattern. The angle at which it is held will decide the area to be covered. Care must be taken not to get the sand too damp.

Bellows: are used for blowing out loose sand from the completed mould; they must be used gently; too vigorous use will damage the mould.

Working steps in making the sand casting

- Place the pattern on the turn over board.
- Place the drag around the pattern with upside and sprinkle the parting sand at the bottom.
- Fill the Moulding sand over the pattern pack, Ram with ramming tools.
- Level the bottom drag surface by leveller & turn over the drag.
- Sprinkle the parting sand, place the cope on the drag to suit the drag slot.
- Select the in and out gate in the drag, Place the sprue pins.
- Fill the moulding sand around the sprue pins pack, Ram with ramming tools.
- Make vent holes on both the boxes with the help of vent wire.
- Remove the sprue pin & Separate cope from drag.
- Remove the pattern carefully with the help of draw pin, Cut gate ways to flow the molten metal.
- Make the funnel shape on runner & riser, to pour the molten metal on the top of the cope box.
- Join the two boxes with clamps, now the mould is ready to pour the molten metal.

Solid Pattern



All dimensions are in mm

Experiment No. 1

Date: ___/___/_____

PREPARATION OF A MOULD BY SOLID PATTERN

AIM: To prepare a required mould by using a solid pattern and green moulding sand by bench moulding method.

Materials/Tools required: Flasks, solid pattern, moulding sand, Trowels, Rammers, Lifter, Smoothners, Bellows, Levellers, Sprue pins, Draw spike and Vent wire etc.,

Product material- Aluminium

Calculation for solid Pattern

***Product material- Aluminium**

W= Total weight of the Product

w1=Weight of the Hexagonal prism

w2= Weight of the Square

W=w1+w2

$$\begin{aligned} w1 &= \text{Volume} \times \text{Density} \\ &= (2.6 \times a^2 \times h) \rho \\ &= (2.6 \times 3^2 \times 2.5) 2.70 \\ &= 157.95 \text{gms} \end{aligned}$$

$$\begin{aligned} a &= 30 \text{mm} = 3 \text{cm} \\ h &= 25 \text{mm} = 2.5 \text{cm} \\ \rho &= 2.70 \text{ gm/cm}^3 \text{ (Density of Aluminium)} \end{aligned}$$

$$\begin{aligned} w2 &= \text{Volume} \times \text{Density} \\ &= (l \times b \times h) \rho \\ &= (10 \times 10 \times 2.5) 2.70 \\ &= 675 \text{gms} \end{aligned}$$

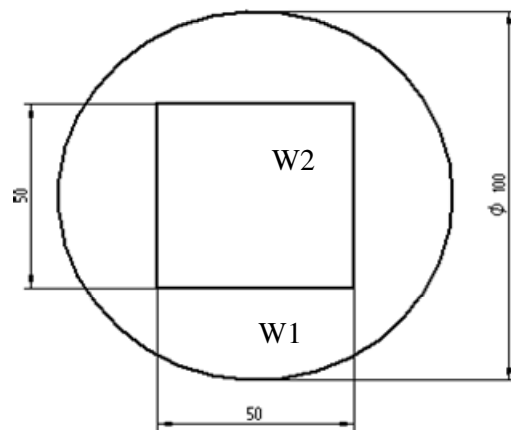
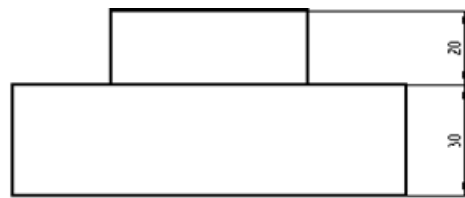
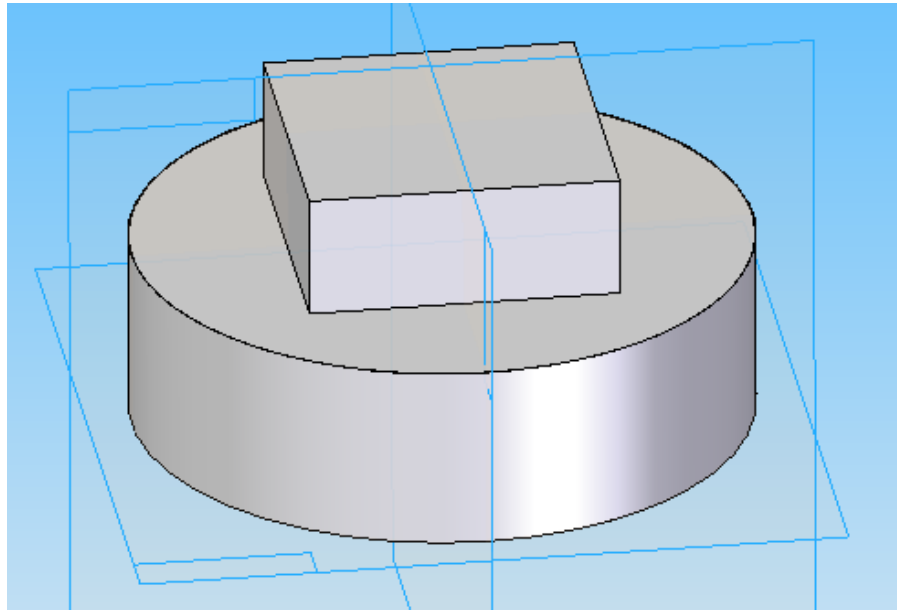
$$\begin{aligned} l &= 100 \text{mm} = 10 \text{cm} \\ b &= 100 \text{mm} = 10 \text{cm} \\ \rho &= 2.70 \text{ gm/cm}^3 \\ h &= 25 \text{mm} = 2.5 \text{cm} \end{aligned}$$

$$\begin{aligned} W &= w1 + w2 \\ &= 157.95 + 675 \\ &= 832.95 \text{gms} \end{aligned}$$

$$\begin{aligned} \text{Add 30\% Extra casting allowances} &= 832.95 \times 0.3 = 249.89 \\ &= 832.95 + 249.89 \\ &= 1082.84 \text{gms} \end{aligned}$$

Weight of Aluminium product is= **1082.84gms**

Hand Cutting



All dimensions are in mm

Experiment No. 2

Date: ___/___/____

PREPARATION OF A MOULD BY HAND CUTTING TOOLS

AIM: To prepare a required mould by hand cutting tools and green moulding sand by bench moulding method.

Materials/Tools required: Flasks, moulding sand, Trowels, Rammers, Lifter, Smoothers, Bellows, Levellers, Sprue pins, Draw spike and Vent wire etc.,

Product material- Aluminium

Calculation for Hand Cutting

W= Total weight of the Product

w1=Weight of the Cylinder

w2= Weight of the Square

W=w1+w2

w1=Volume x Density

w1= (A x L) ρ

= (πd²/4 x L) ρ

= (π10²/4 x 3) 2.7

=636.17gms

d=100mm=10cm

l= 30mm=3cm

ρ= 2.70 gm/cm³

w2=Volume x Density

= (l x b x h) ρ

= (2 x 5 x 5) 2.70

=135gms

l=20mm=2cm

b=50mm=5cm

ρ=2.70 gm/cm³

h=50mm=5cm

W=w1+w2

=771.17gms

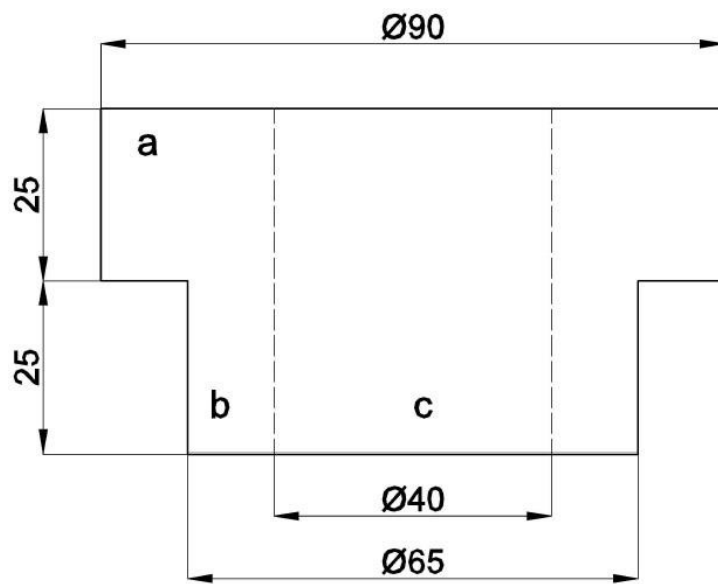
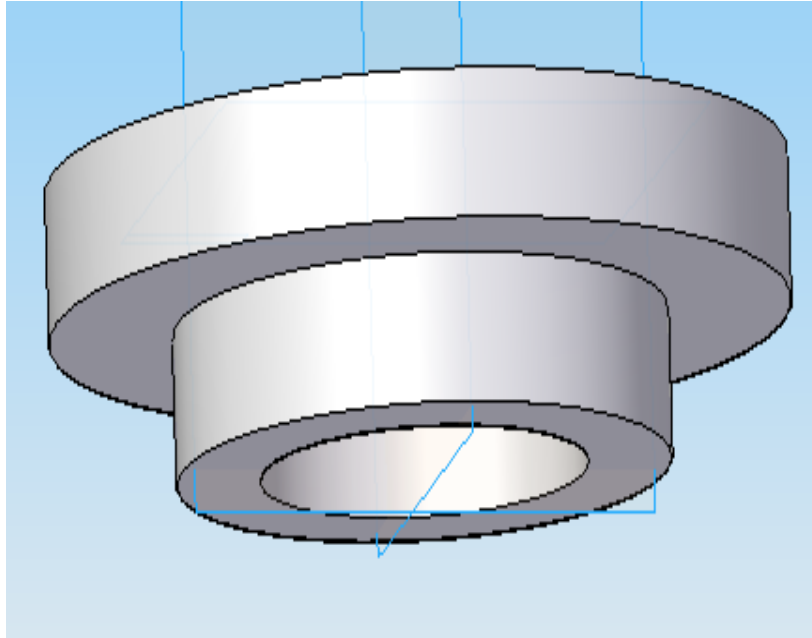
Add 30% Extra casting allowances =771.17x0.3= 231.35gms

=771.17+231.35

=1002.52gms

Weight of final product is **1002.52gms**.

Self Cored Pattern



All dimensions are in mm

Experiment No. 3

Date: ___/___/___

PREPARATION OF A MOULD BY SELF CORED PATTERN

AIM: To prepare a required mould by using a self cored pattern and green moulding sand by bench moulding method.

Materials/Tools required: Flasks, self cored pattern, moulding sand, Trowels, Rammers, Lifter, Smoothners, Bellows, Levellers, Sprue pins, Draw spike and Vent wire etc.,

Product material- Aluminium

Calculation for Self Cored Pattern

W= Total Weight of the Product

w1=Weight of the Cylinder (a)

w2= Weight of the Cylinder (b)

w3= Weight of the Cylinder (c)

$$W=w1+w2-w3$$

w1=Volume x Density

$$w1= (A \times L) \rho$$

$$= (\pi d^2/4 \times L) \rho$$

$$= (\pi (9)^2/4 \times 2.5) 2.7$$

$$=429.42\text{gms}$$

$$d=90\text{mm}=9\text{cm}$$

$$L= 25\text{mm}=2.5\text{cm}$$

$$\rho=2.70 \text{ gm/cm}^3$$

W2=Volume x Density

$$W2= (A \times L) \rho$$

$$= (\pi d^2/4 \times L) \rho$$

$$= (\pi (6.5)^2/4 \times 2.5) 2.7$$

$$=223.98\text{gms}$$

$$d=65\text{mm}=6.5\text{cm}$$

$$L= 25\text{mm}=2.5\text{cm}$$

$$\rho=2.70 \text{ gm/cm}^3$$

W3=Volume x Density

$$W3= (A \times L) \rho$$

$$= (\pi d^2/4 \times L) \rho$$

$$= (\pi (4)^2/4 \times 5) 2.7$$

$$=169.65\text{gms}$$

$$d=40\text{mm}=4\text{cm}$$

$$L= 50\text{mm}=5\text{cm}$$

$$\rho=2.70 \text{ gm/cm}^3$$

$$W= (w1+w2)-w3$$

$$= (429.42+223.98)-169.65$$

$$=653.4-169.65$$

$$= 483.75\text{gms}$$

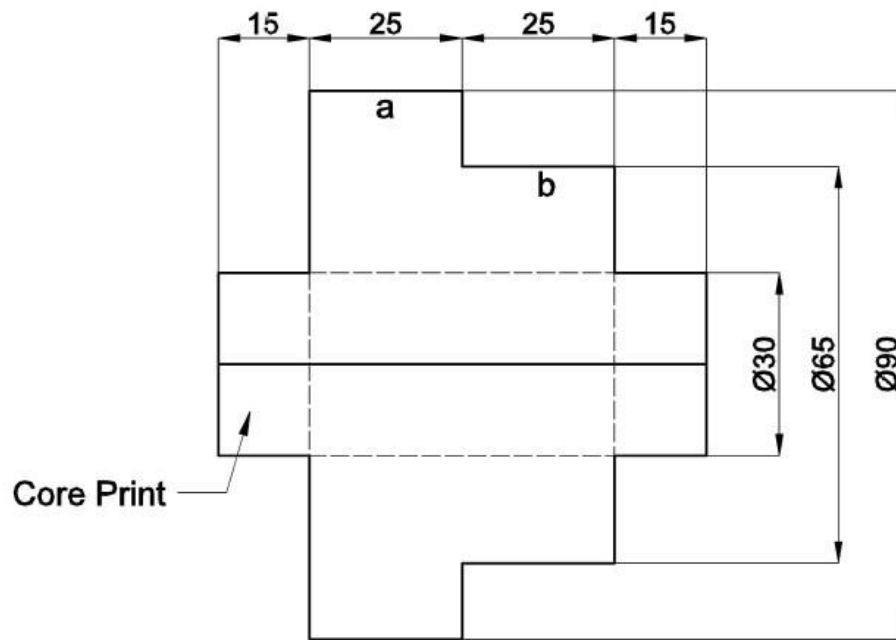
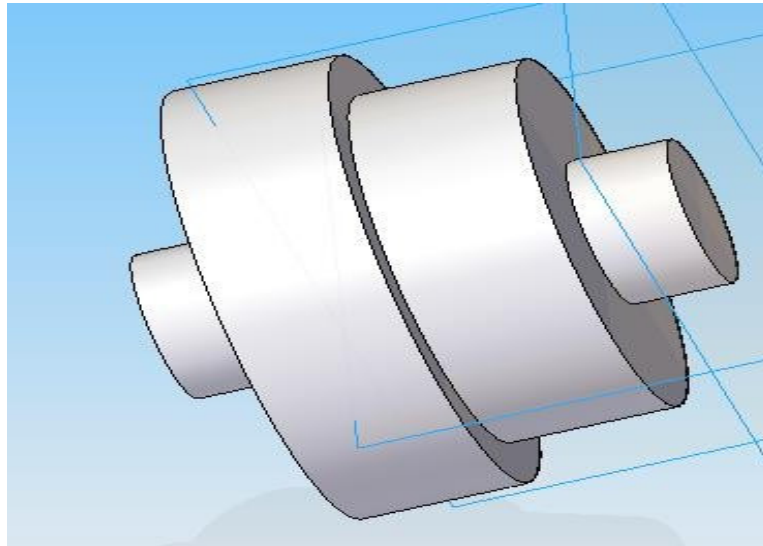
$$\text{Add 30\% Extra casting allowance } =483.75 \times 0.3= 145.13$$

$$=483.75+145.13$$

$$=628.88\text{gms}$$

Weight of final product is **628.88** gms

Stepped Cone Pulley With Core Print



All dimensions are in mm

Experiment No. 4

Date: ___/___/___

PREPARATION OF A MOULD BY STEPPED CONE PULLEY WITH CORE PRINT

AIM: To prepare a required mould by using a Stepped cone pulley with core print pattern and green moulding sand by bench moulding method.

Materials/Tools required: Flasks, Stepped cone pulley with core print Pattern, moulding sand, Trowels, Rammers, Lifter, Smoothners, Bellows, Levellers, Sprue pins, Draw spike and Vent wire etc.,

Product material- Aluminium

Calculation for stepped cone pulley with core print pattern.

W= Total Weight of the Product

w1=Weight of the Cylinder (a)

w2= Weight of the Cylinder (b)

w3= Weight of the Cylinder (c)

$W = (w1+w2)-w3$

w1=Volume x Density

$w1 = (A \times L) \rho$

$= (\pi d^2/4 \times L) \rho$

$= (\pi (9)^2/4 \times 2.5) 2.7$

$= 429.42 \text{gms}$

d=90mm=9cm

L= 25mm=2.5cm

$\rho = 2.70 \text{ gm/cm}^3$

w2=Volume x Density

$w2 = (A \times L) \rho$

$= (\pi d^2/4 \times L) \rho$

$= (\pi (6.5)^2/4 \times 2.5) 2.7$

$= 223.98 \text{gms}$

d=65mm=6.5cm

L= 25mm=2.5cm

$\rho = 2.70 \text{ gm/cm}^3$

w3=Volume x Density

$w3 = (A \times L) \rho$

$= (\pi d^2/4 \times L) \rho$

$= (\pi (3)^2/4 \times 5) 2.7$

$= 95.43 \text{gms}$

d=30mm=3cm

L= 50mm=5cm

$\rho = 2.70 \text{ gm/cm}^3$

$W = (w1+w2)-w3$

$= (429.42+223.98)-95.43$

$= 653.4-95.43$

$= 557.97 \text{gms}$

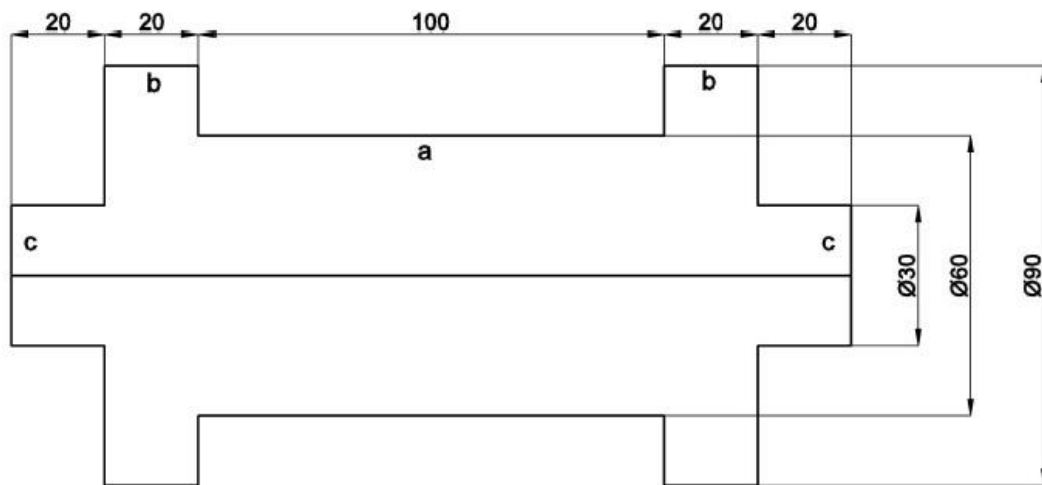
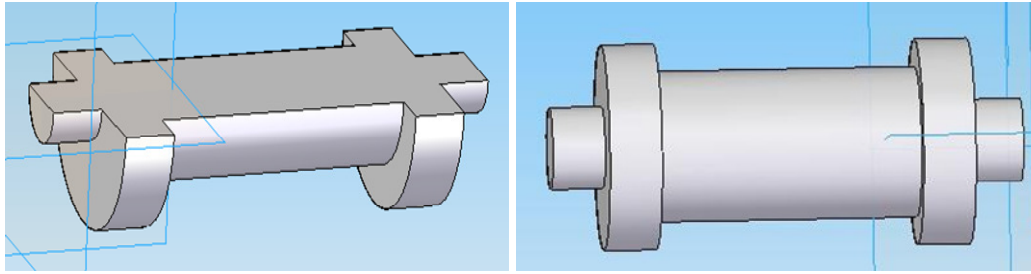
Add 30% Extra casting allowance $= 557.97 \times 0.3 = 167.4$

$= 557.97 + 167.4$

$= 725.37 \text{gms}$

Weight of final product is **725.37** gms

Split Pattern with Two Halves



All dimensions are in mm

Experiment No. 5

Date: ___/___/___

PREPARATION OF A MOULD BY SPLIT PATTERN WITH TWO HALVES

AIM: To prepare a required mould by using a split pattern with two halves pattern and green moulding sand by bench moulding method.

Materials/Tools required: Flasks, split pattern with two halves pattern, moulding sand, Trowels, Rammers, Lifter, Smoothers, Bellows, Levellers, Sprue pins, Draw spike and Vent wire etc.,

Product material- Aluminium

Calculation for stepped cone pulley with core print pattern.

W= Total Weight of the Product

w1=Weight of the Cylinder (a)

w2= Weight of the Cylinder (b)

w3= Weight of the Cylinder (c)

$$W = w1 + w2 + w3$$

w1=Volume x Density

$$w1 = (A \times L) \rho$$

$$= (\pi d^2/4 \times L) \rho$$

$$= (\pi (6)^2/4 \times 10) 2.7$$

$$= 763.4 \text{gms}$$

$$d = 60 \text{mm} = 6 \text{cm}$$

$$L = 100 \text{mm} = 10 \text{cm}$$

$$\rho = 2.70 \text{ gm/cm}^3$$

W2=Volume x Density

$$W2 = (A \times L) \rho$$

$$= (\pi d^2/4 \times L) \rho$$

$$= (\pi (9)^2/4 \times 4) 2.7$$

$$= 687 \text{gms}$$

$$d = 90 \text{mm} = 9 \text{cm}$$

$$L = 40 \text{mm} = 4 \text{cm}$$

$$\rho = 2.70 \text{ gm/cm}^3$$

W3=Volume x Density

$$W3 = (A \times L) \rho$$

$$= (\pi d^2/4 \times L) \rho$$

$$= (\pi (3)^2/4 \times 4) 2.7$$

$$= 76.34 \text{gms}$$

$$d = 30 \text{mm} = 3 \text{cm}$$

$$L = 40 \text{mm} = 4 \text{cm}$$

$$\rho = 2.70 \text{ gm/cm}^3$$

$$W = w1 + w2 + w3$$

$$= 763.4 + 687 + 76.34$$

$$= 1526.74 \text{gms}$$

$$\text{Add 30\% Extra casting allowance} = 1526.74 \times 0.3 = 458.02$$

$$= 1526.74 + 458.02$$

$$= 1984.76 \text{gms}$$

Weight of final product is **1984.76** gms

Estimation of Material Costs

In this chapter the material cost means the direct material cost. The frequently used materials are: Aluminum, Copper, Gunmetal, Brass, Iron, Tin, Magnesium, Mild steel, Alloy steel & Lead etc.

The generalized procedure to calculate the Material Cost:

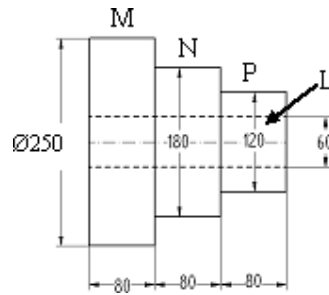
1. Observe the component drawings, break up the drawing into simple parts as per convenience.
2. Using formulae calculate area & Volume of each part. Scrap should be taken into account while calculating the volume.
3. Add the Volume of all the parts.
4. Multiply the component volume & density of material. It will be weight of the component. Density X Volume = Weight.
5. Multiply the weight of the component with the cost of material per unit weight.

The following table gives the densities of various materials:

No.	Material	Density Gm/cc	No.	Material	Density Gm/cc
1	Aluminum Cast	2.70	2.	Al-wrought	2.681
3.	Cast Iron	7.209	4.	Wrought-Iron	7.707
5.	Steel	7.868	6.	Mild Steel	7.2
7.	Brass-Cast	8.109	8.	Brass-Wire	8.382
9.	Bronze	8.7	10.	Gun Metal	8.735
11.	Zinc-Cast	6.872	12.	Zinc Sheet	7.209
13.	Copper	8.622	14.	Gold	19.316
15.	Lead	11.368	16.	Tin	7.418

Solved Examples: Stepped Pulley:

QNo 1. A Cast-Iron Step cone pulley is shown in the following Figure. The Density of the C.I. is 7.209 gm/cc, Material Cost is Rs.20/ kg. Calculate the weight and material cost.

Solutions:

Let L, M, N, P are the different parts of the fig shown.

Total Length of the Fig.=80+80+80 = 240 mm

Now calculate the volume of Each Part:

a) Volume of hole i.e., Part L'

$$V_L = \frac{\lambda}{4} \times d^2 \times l = \frac{\lambda}{4} \times 60^2 \times 240 = 678584 \text{ mm}^3 = 678.584 \text{ cm}^3$$

b) Volume of part M':- $V_M = \frac{\lambda}{4} \times d^2 \times l = \frac{\lambda}{4} \times 250^2 \times 80 = 3926990 \text{ mm}^3 = 3926.99 \text{ cm}^3$

c) Volume of part N':- $V_N = \frac{\lambda}{4} \times d^2 \times l = \frac{\lambda}{4} \times 180^2 \times 80 = 2035752 \text{ mm}^3 = 2035.72 \text{ cm}^3$

d) Volume of part P':- $V_P = \frac{\lambda}{4} \times d^2 \times l = \frac{\lambda}{4} \times 120^2 \times 80 = 904778.68 \text{ mm}^3 = 904.778 \text{ cm}^3$

The volume of the fig= (b + c + d) – a

$$= (3926.99 + 2035.72 + 904.778) - 678.584 = 6188.904 \text{ cm}^3$$

Total weight of the fig.= Volume of the fig. X Density of the CI Material

$$= 6188.904 \times 7.209 = 44615.809 \text{ gm.} = 44.615 \text{ kg}$$


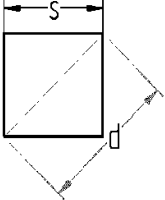
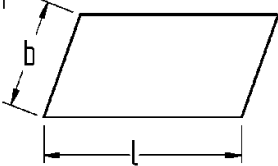
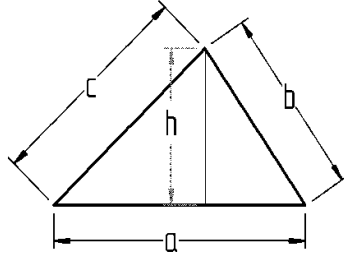
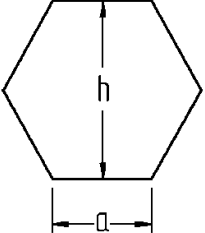
Assume the Rate of CI = Rs. 75/-

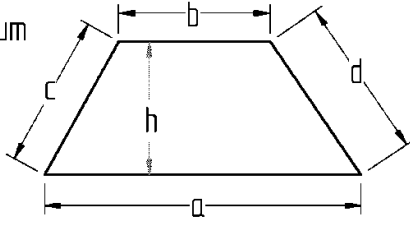
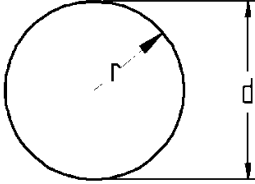
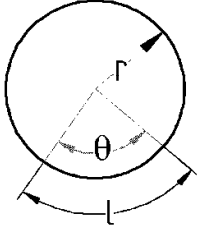
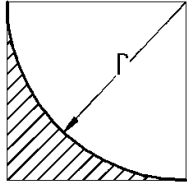
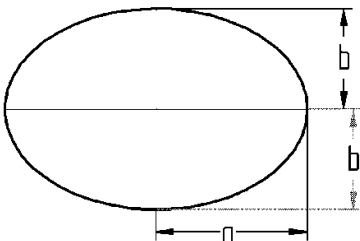
Cost of the Material Required = Weight X Cost

$$= 44.615 \times \text{Rs. } 75 = \text{Rs. } 3346.125$$

ESTIMATION

Some of the important formulae regarding Planes and Solids are given below

<p>1 Rectangle</p>		<p>l = length of rectangle b = breadth of rectangle ∴ Area = l × b, Perimeter = 2 × (l + b)</p>
<p>2 Square</p>		<p>s = length of each side of square d = length of diagonal ∴ Area = s^2 or $\frac{d^2}{2}$, Perimeter = 4s</p>
<p>3 Parallelogram</p>		<p>l = length of one side of parallelogram b = length of another side h = height of parallelogram ∴ Area = l × h, Perimeter = 2(l + b)</p>
<p>4 Triangle</p>		<p>h = height of A from BC Area = $\frac{1}{2} \times a \times h = \frac{1}{2} \times \text{base} \times \perp^r \text{ height}$ Perimeter = a + b + c = 2s</p>
<p>5 Hexagon</p>		<p>a = length of each side; h = height Area = $\frac{3\sqrt{3}}{2} a^2$ Perimeter = 6a, h = $\sqrt{3}a$</p>

<p>6 Any Regular Polygon</p>	<p>Let n = no of sides; a = length of each side Perimeter = n x a Area = $\frac{1}{2}$ x perimeter x inner radius</p>
<p>7 Trapezium</p> 	<p>a, b, c, d are the lengths, h = distance between parallel sides Area = $\left(\frac{a + b}{2}\right)h$ perimeter = a + b + c + d</p>
<p>8 Circle</p>	 <p>r = radius, d = dia Area = $\frac{\pi d^2}{4} = \pi r^2$ Perimeter = $\pi d = 2\pi r$</p>
<p>9 Sector</p>	 <p>r = radius, θ = angle in radius, l = length of arc, $l = r \times \theta$, Area = $\frac{\theta}{2\pi} \times \pi r^2 = \frac{\theta r^2}{2}$</p>
<p>10 Fillet</p>	 <p>Area of fillet = $r^2 - \frac{\pi}{4} r^2 = r^2 \left(1 - \frac{\pi}{4}\right) = 0.215r^2$</p>
<p>11 Ellipse</p>	 <p>a = Semi major axis b = Semi minor axis area = $\pi \times a \times b$ Perimeter = $\pi (a + b)$</p>

PART – C
FORGING

FORGING

Introduction:

Forging is a process of shaping the metal components in cold or hot condition by the application of impact or pressure but the primary difference between various forging methods is the rate which the energy is applied to the work piece.

Practical Application:

Forging is generally used for those components which require high strength and resistance to shock or vibration sudden impact of load and uniform properties

Example: Automobiles	(1) chassis of all vehicles
	(2) Front and Rear axel
	(3) Wheel drums
	(4) Spring blades
	(5) Rocker arm
	(6) Gear shifter
	(7) Connecting rod etc.
Railways	(1) Railway wheels
	(2) Railway tracks
General	(1) D. E. Spanners
	(2) Ring Spanner
	(3) Wrenches
	(4) Cutting Pliers
	(5) Hammers etc.

FORGING METHODS

- (1) Hand forging
- (2) Drop forging
- (3) Press forging
- (4) Roll forging

Hand forging: Hand forging is made by heating the metal until it is plastic state in an open hearth furnace and there by hammering is done on anvil by smith/sledge hammer with use of open face dies to get the desired shape and size by judgment of an individual.

Drop forging: In this process of forming the desired shape by placing a heated bar or billet on the lower half of the forging die and hammering the top half of the die into the metal by means of a power hammer by repeated blows the impact of which compel the plastic metal to conform the shape of the die. This method is used to produce large number of small and medium sized forging of similar parts.

Press forging: In this process the heated billet is squeezed between die. The pressure is applied by the forging press which completes the operation in a single stroke. Large forging are generally shaped by thin method.

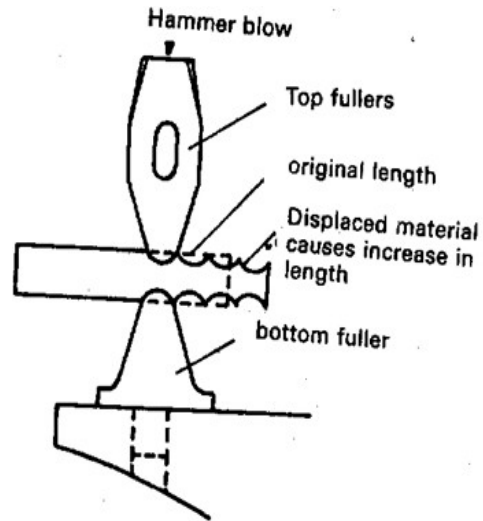
Roll forging: Rolling involves the passing of a heated bar between revolving rolls that contains an impression of the required shape. It is used to reduce short thick section to long slender pieces.

FORGING operations;

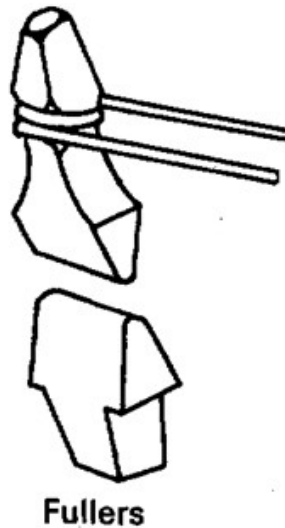
- (1) Drawing down
- (2) Up setting
- (3) Punching
- (4) Bending
- (5) Welding
- (6) Cutting

Drawing down:

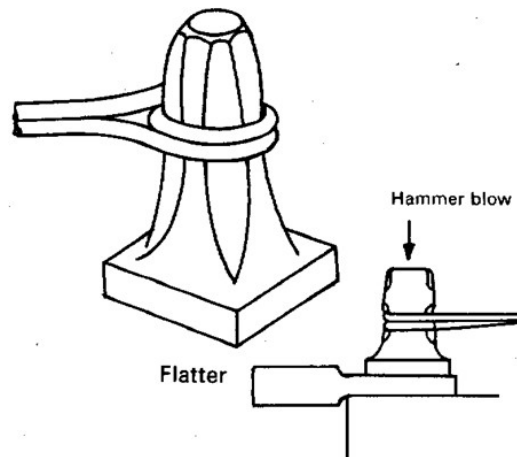
The operation of spreading or thinning action and is accomplished by striking the work piece with flat dies. Due to impact of die on metal its thickness is reduced and length is increased‘



Fullers: are blunt nosed chisel and are used to reduce the thickness of hot metal. They may be held with hand fitted with a rod handle. Bottom fullers may be inserted in the square hole of the anvil.



Flatters: this is used to flatten and smoothen metal flatters are used under a sledge hammer to flatten the metal particularly after its thickness has been reduced using fullers.



Upsetting: This is just opposite to drawing and involves increasing of the cross sectional area usually by pressing or hammering in the direction parallel to the original in got axis. Only the part to be upset is heated to forging temper and the bar or work is then struck at the end, usually between the hammer and the axis as shown in figure.

Punching: It is the process of producing hole generally cylindrical by using a hot punch over a cylindrical die.

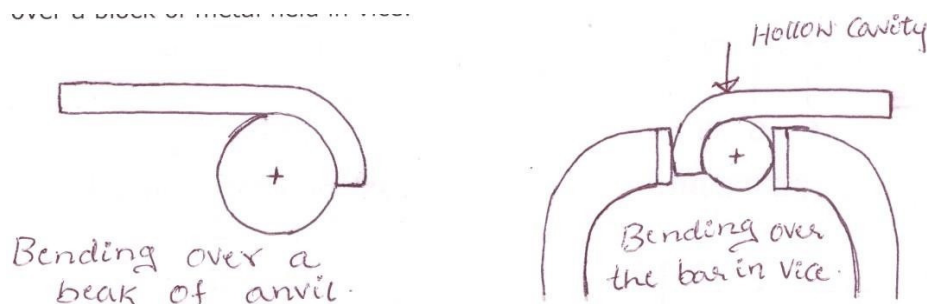
Drifting: It is the opening out of holes previously punched.

Bending: It is one of the most important processes of forging and is very frequently used.

Bends may be classified a sharp cornered bends or more gradual bends.

The operation is performed by hammering the metal over the edge of the anvil or over a block of metal held in vice.

over a block of metal held in vice



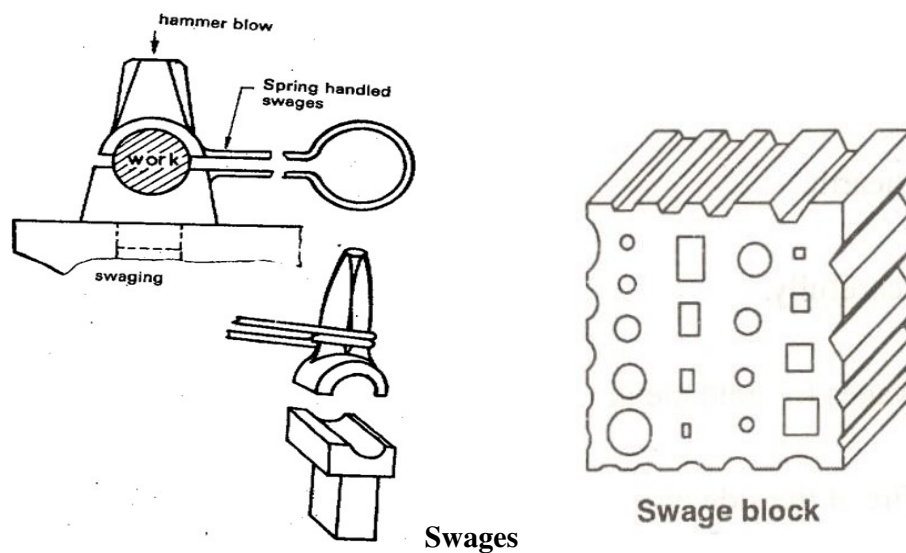
When the metal is bending by hammering, the outer and inner surface does not remain same. The inside surface is shortened while the outer surface is stretched which causes bulging of the side at the inner surface and a radius on the outer surface of a sharp corner is required an additional metal is required at the place where the bend occur in order to permit stretching of metal at outer surface.

Welding: Metal like wrought iron and steel are welded by pressing or hammering together surface after they have been raised to the correct welding temperature at 1350°C

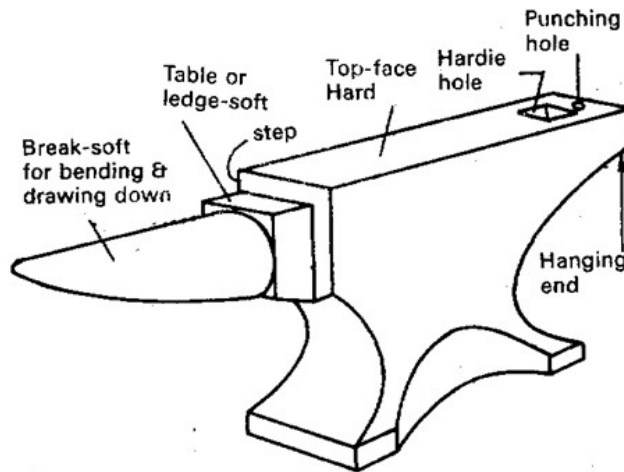
when the metal is white hot. The operation of such a type of welding is performed in forge shop. And hence is also called forge welding.

Cutting: In order to perform a rapid cutting operation by chiselling, the metal is heated in black smith fire to a temperature of 850-900°C and then hammer blows are directed on the chisel head. If the thickness of metal to be cut is more then two notched or grooves are made 180° apart.

Swaging: it is a process of finishing a round or hexagonal section of bar between a pair of swages of the appropriate size. These may be separate tools for top and bottom or these may be held together by a long spring handle as shown in figure.

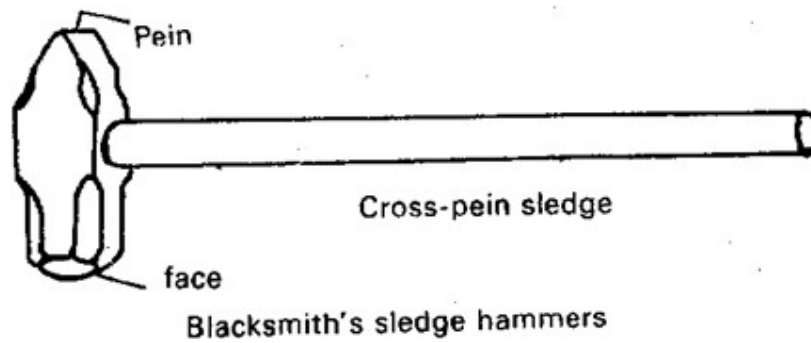
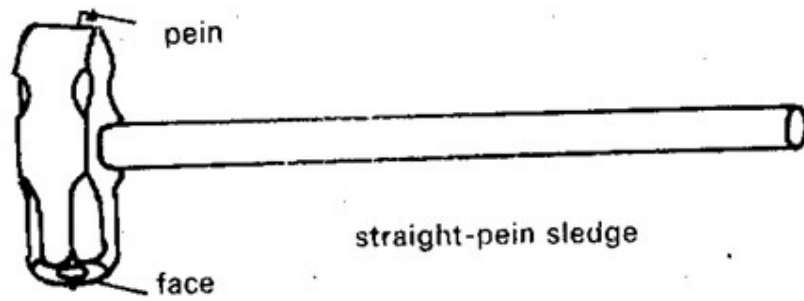
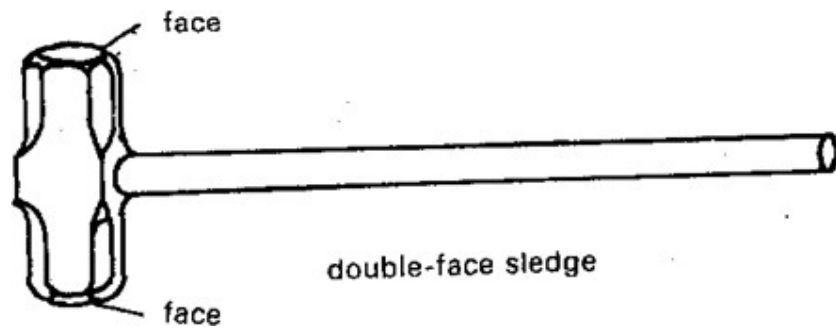


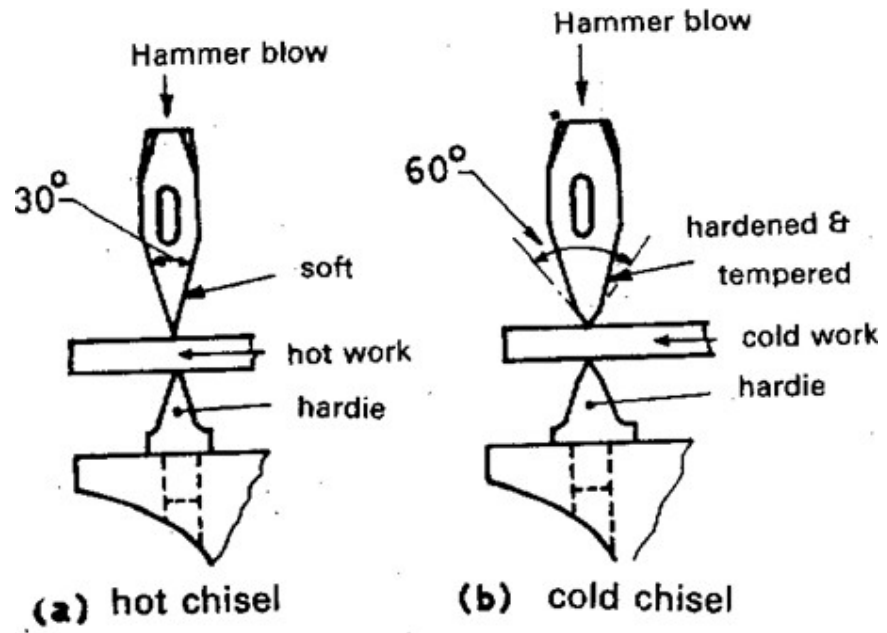
TOOLS & EQUIPMENTS REQUIRED FOR FORGING.



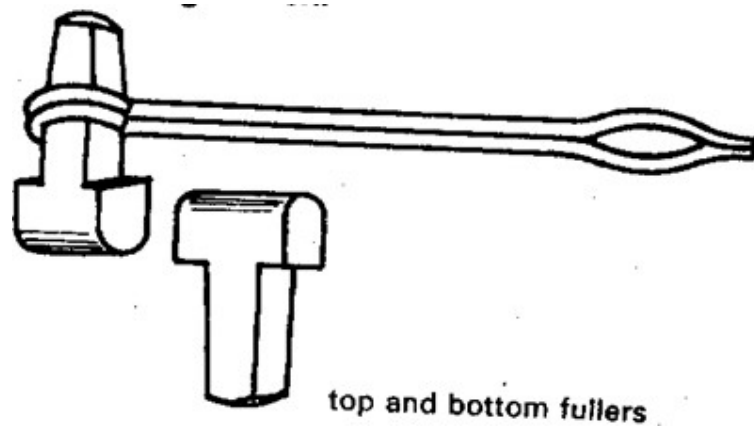
A SMITH'S ANVIL

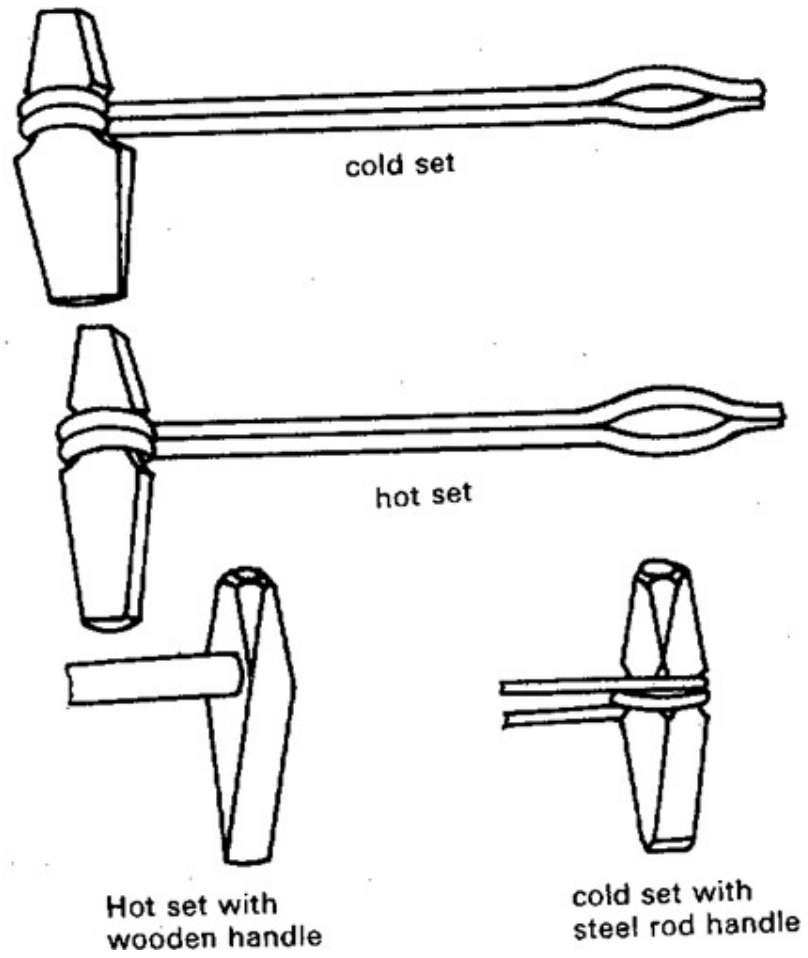






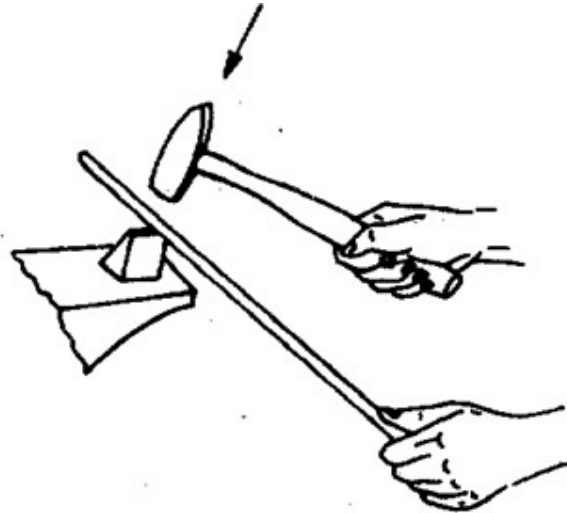
Use of chisels in forging



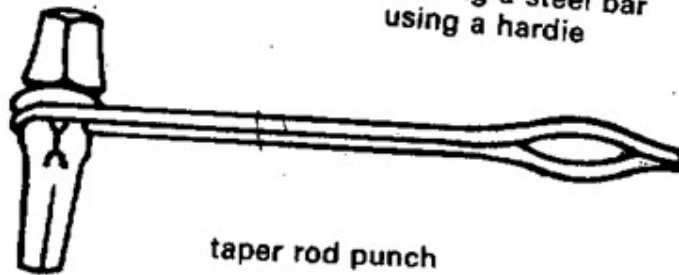




hardie



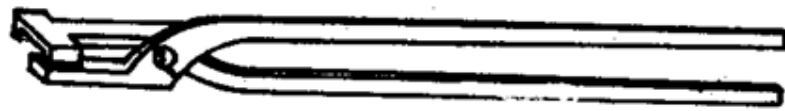
Cutting a steel bar
using a hardie



taper rod punch



top and bottom swages



Flat mouth



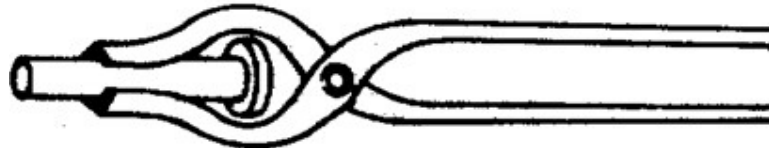
Open mouth



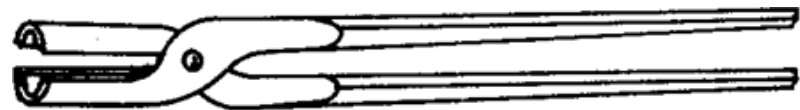
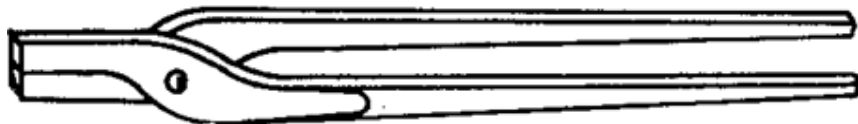
Chisel or bolt



close mouth

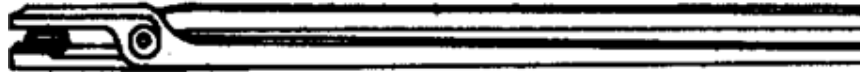


hollowbit

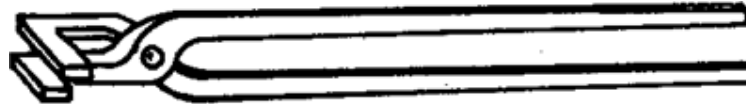




Double hollow bit



Square mouth



side mouth



Band saw

Anvil: It is used as a mount for pairs of tools between which the work is forged by hammer blows. The main body of the anvil is made of mild steel with a hardened top face welded on. The beak is soft and with an increasing diameter of cross section. Beak is useful for producing bends of different radii. The ledge between the beak and the anvil face is soft and can be used as a base for cutting operation with hot chisels.

Sledge hammer: It is a very heavy hammer with a long handle. It may weigh from 4 to 16 kg. These are used for heavy work. The length of the handle increases with the weight.

Chisel: It is fitted with a long handle. The chisel is held on the work and struck with a hammer.

Cold chisel: It is used for cutting cold metal.

Hot chisel: It is used for cutting hot metal.

Hardie: This is a chisel fitted in to a hole in the anvil with its cutting edge at the top. There is usually one for hot and another for cold use.

Swages: These are used in pairs to shape hot metal. They are supplied in pairs, top and bottom.

Fullers: These are blunt nosed chisels and are used to reduce the thickness of hot metal. They may be held with hand or fitted with a rod handle. Bottom fullers may be inserted in the square hole of the anvil .For occasional use, fullers can be improvised from round mild steel bar.

Flatter: This is used to flatten and smooth the metal. It is used under a sledge hammer to flatten and smoothen the metal, particularly after its thickness has been reduced using fullers.

Tongs: These are used to hold hot metal pieces. Various shapes of blacksmith's tongs are available.

Types of Tongs:

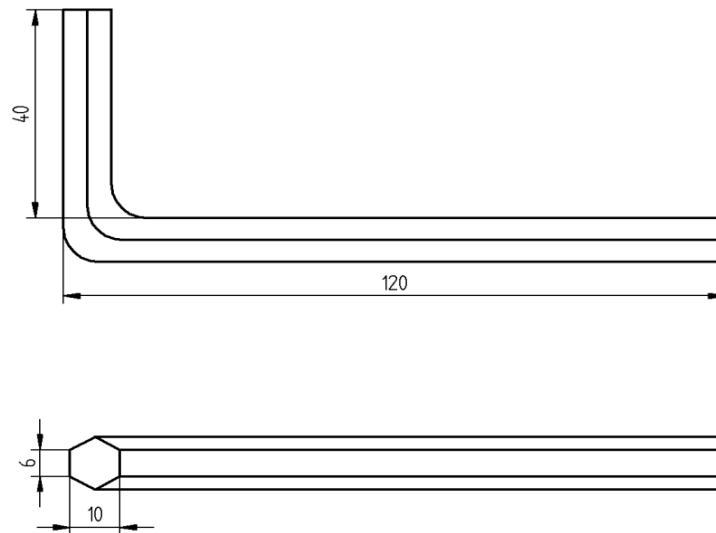
Single pick up tong: It is used to pick up either flat work or round work.

Curved lip tong: This is also called as chisel or bolt tong. It is used to hold round work.

Straight lip tong: It is also called as flat-jawed or flat mouth tong. It is used to hold flat work.

Double hollow bit: It is used to pick up either flat work or round work.

HEX ALLEN KEY 10A/F



All dimensions are in mm

Calculation of length of the raw material required to do the component

W= Total weight of the finished product

Hexagon = Volume x Density

$$= (2.6 \times a^2 \times L) \rho$$

$$= (2.6 \times 0.6^2 \times 16) 7.2$$

W = 107.8 gms

a= 6mm=0.6cm

(Where **a** is side of hexagon)

$\rho = 7.2\text{gm/cm}^3$ (ρ is Density of mild steel)

L=160mm=16cm

To find length of the raw material required

Total weight of the finished product (W) =weight of the raw material given (12mm MS Bar)

Weight of bar = Volume x Density

$$W = (A \times L) \rho$$

$$107.8 = (\frac{\pi d^2}{4} \times L) \rho$$

$$107.8 = (\frac{\pi (1.2)^2}{4} \times L) 7.2$$

$$107.8 = 8.14L$$

L= 13.25cm

L =?

d=12mm=1.2cm

$\rho=7.2\text{gm/cm}^3$

w=107.8

Add extra 10 % forging allowance =13.25x0.1=1.32cm

=13.25+1.32

Length of the raw material required =14.57cm

Experiment No. 1**Date:** ___/___/___**HEX ALLEN KEY****AIM:** To prepare a Hex Allen key model by hot forging method.**Material used:** mild steel bar of 12mm diameter**Equipments/Tools required:** LPG Hearth furnace, Anvil, Vice, Flatters, Swage block, Tongs and Hammers.

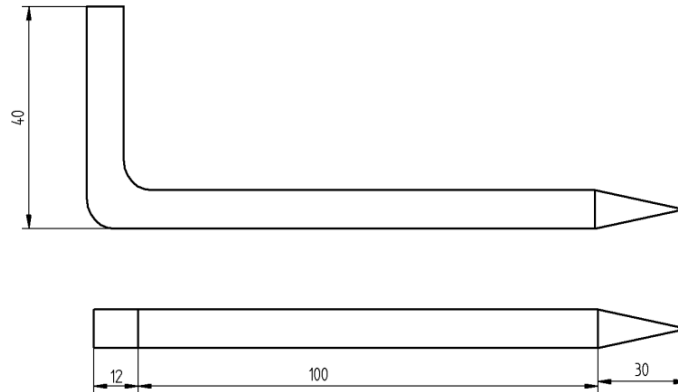
Hex Allen key: A **hex key**, **Allen wrench** or **Allen key**, is a simple tool used to drive bolts and screws with hexagonal sockets in their heads. The tool is usually formed of a single piece of hexagonal rod of hard steel, with blunt ends that are meant to fit snugly into the screw's socket, bent in an "L" shape with unequal arms. The tool is usually held and twisted by the long arm, creating a large torque at the tip of the short arm. Reversing the tool lets the long arm reach screws in hard-to-reach places.

Each key is meant to be used with screws of a specific socket size, with rather tight tolerances; so the tool is commonly sold in kits that include half a dozen or more keys of different sizes. Usually the size of the key increases with the size of the socket, but not necessarily in direct proportion.

Working steps in making the Forging Job

1. Calculate the final length of the model to be forged of the given round rod of 12mm diameter.
2. Place the given round rod in the LPG Hearth furnace in suitable place.
3. Switch on the blower and set the temperature range up to 900-1000⁰C in control panel.
4. The job is heated to red hot temperature.
5. Place the heated job in between open faced Bottom & Top Die, Which is set on Anvil.
6. Draw down the heated work piece to calculated length with the help of hammer, tong & flatter.
7. The process is carried approximately until the circular rod is transformed into desired shape and with desired dimensions.
8. The work piece is re-heated to carry out bending operation.
9. Bending is carried out on Leg vice as per dimensions.
10. With the help of flatter, open faced dies finish the work piece to the final dimension and surface finish; cool the specimen by dipping in water.

SQUARE SECTION NAIL



All dimensions are in mm

Calculation of length of the raw material required to do the component

W = Total weight of the finished product

$W = w_1 + w_2$

$$\begin{aligned} w_1 &= \text{square prism} = \text{volume} \times \text{density} \\ &= (L \times b \times h) \rho \\ &= (14 \times 1.2 \times 1.2) 7.2 \\ &= 145.15 \text{gms} \end{aligned}$$

$$\begin{aligned} L &= 140 \text{mm} = 14 \text{cm} \\ b &= 12 \text{mm} = 1.2 \text{cm} \\ h &= 12 \text{mm} = 1.2 \text{cm} \\ \rho &= 7.2 \text{gm/cm}^3 \end{aligned}$$

$$\begin{aligned} w_2 &= \text{Square Pyramid} = \left(\frac{1}{3} \times a^2 \times h\right) \rho \\ &= \left(\frac{1}{3} \times 1.2^2 \times 3\right) 7.2 \\ &= 10.36 \text{gms} \end{aligned}$$

$$\begin{aligned} a &= 12 \text{mm} = 1.2 \text{cm} \\ h &= 30 \text{mm} = 3 \text{cm} \\ \rho &= 7.2 \text{gm/cm}^3 \end{aligned}$$

$$\begin{aligned} W &= w_1 + w_2 = 145.15 + 10.36 \\ &= 155.51 \text{gms} \end{aligned}$$

W = weight of the raw material MS round

Weight = Volume \times Density

$$155.51 = \left(\frac{\pi}{4} d^2 \times L\right) \rho$$

$$155.51 = \left(\frac{\pi}{4} (1.6)^2 \times L\right) 7.2$$

$$L = 10.74 \text{cm}$$

L = ?

$$d = 16 \text{mm} = 1.6 \text{cm}$$

$$\rho = 7.2 \text{gm/cm}^3$$

Add extra 10 % forging allowance = 1.07 cm

$$= 10.74 + 1.07$$

Length of the raw material required = 11.81 cm

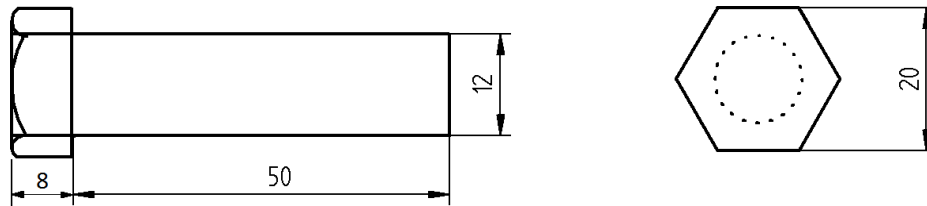
Experiment No. 2**Date:** ___/___/____**SQUARE SECTION NAIL****AIM:** To prepare a square section nail model by hot forging method.**Material used:** mild steel bar of 16mm diameter.**Equipments/Tools required:** LPG Hearth furnace, Anvil, Vice, Flatters, Swage block, Tongs and Hammers.

Square section Nail: A **nail** is a small object made of metal which is used as a fastener, as a peg to hang something, or sometimes as a decoration. Generally, nails have a sharp point on one end and a flattened head on the other, but headless nails are available. Nails are made in a great variety of forms for specialized purposes..

Nails are typically driven into the work piece by a hammer or pneumatic nail gun. A nail holds materials together by friction in the axial direction and shear strength laterally. The point of the nail is also sometimes bent over or clinched after driving to prevent pulling out.

Working steps in making the Forging Job

1. Calculate the final length of the model to be forged of the given round rod of 16mm diameter.
2. Place the given round rod in the LPG Hearth furnace in suitable place.
3. Switch on the blower and set the temperature range up to 900-1000⁰C in control panel.
4. The job is heated to red hot temperature.
5. Place the heated job in between open faced Bottom & Top Die, Which is set on Anvil.
6. Draw down the heated work piece to calculated length with the help of hammer, tong & flatter.
7. The process is carried approximately until the circular rod is transformed into desired shape and with desired dimensions.
8. The work piece is re-heated to carry out bending operation.
9. Bending is carried out on Leg vice as per dimensions.
10. With the help of flatter, open faced dies finish the work piece to the final dimension and surface finish; cool the specimen by dipping in water.

T-BOLT (HEXAGONAL HEADED BOLT)

All dimensions are in mm

Calculation of length of the raw material required to do the component

W= weight of the finished product

$$W=w_1+w_2$$

$$\begin{aligned} w_1 &= \text{Hexagon prism} = (2.6 \times a^2 \times L) \rho \\ &= (2.6 \times 1.2^2 \times 0.8) 7.2 \\ &= 21.56 \text{ gm} \end{aligned}$$

$$\begin{aligned} a &= 12 \text{ mm} = 1.2 \text{ cm} \\ &\text{(Where } a \text{ is side of hexagon)} \\ \rho &= 7.2 \text{ gm/cm}^3 \\ L &= 8 \text{ mm} = 0.8 \text{ cm} \end{aligned}$$

$$\begin{aligned} w_2 &= \text{Round} = \left(\frac{\pi d^2}{4} \times L \right) \rho \\ &= \left(\frac{\pi (1.2)^2}{4} \times 5 \right) 7.2 \\ &= 40.71 \text{ gm} \end{aligned}$$

$$\begin{aligned} d &= 12 \text{ mm} = 1.2 \text{ cm} \\ L &= 50 \text{ mm} = 5 \text{ cm} \\ \rho &= 7.2 \text{ gm/cm}^3 \end{aligned}$$

$$\begin{aligned} W &= w_1 + w_2 = 21.56 + 40.71 \\ &= 62.27 \text{ gm} \end{aligned}$$

W = wt of the raw material MS Round

$$\begin{aligned} 62.27 &= \left(\frac{\pi d^2}{4} \times L \right) \rho \\ 62.27 &= \left(\frac{\pi (1.2)^2}{4} \times L \right) 7.2 \\ 62.27 &= 8.14L \\ L &= 7.65 \text{ cm} \end{aligned}$$

$$\begin{aligned} d &= 12 \text{ mm} = 1.2 \text{ cm} \\ L &=? \\ \rho &= 7.2 \text{ gm/cm}^3 \end{aligned}$$

$$\begin{aligned} \text{Add extra } 10\% \text{ forging allowance} &= 7.65 \times 0.1 = 0.76 \text{ cm} \\ &= 7.65 + 0.76 \\ &= 8.41 \end{aligned}$$

Length of the raw material required = 8.41 cm

Experiment No.3**Date:** ___/___/____**T-BOLT (HEXAGONAL HEADED BOLT)****AIM:** To prepare a hexagonal headed bolt model by hot forging method.**Material used:** mild steel bar of 12mm diameter.**Equipments/Tools required:** LPG Hearth furnace, Anvil, Vice, Flatters, Swage block, Dies, Tongs and Hammers.

Hexagonal Headed Bolt: Bolts are for the assembly of two unthreaded components, with the aid of a nut. Bolts are often used to make a bolted joint. This is a combination of the nut applying an axial clamping force and also the shank of the bolt acting as a dowel, pinning the joint against sideways shear forces. For this reason, many bolts have a plain unthreaded shank (called the grip length) as this makes for a better, stronger dowel. The presence of the unthreaded shank has often been given as characteristic of bolts vs. screws, but this is incidental to its use, rather than defining.

Working steps in making the Forging Job

1. Calculate the final length of the model to be forged of the given round rod of 12mm diameter.
2. Place the given round rod in the LPG Hearth furnace in suitable place.
3. Switch on the blower and set the temperature range up to 900-1000⁰C in control panel.
4. The job is heated to red hot temperature.
5. Place the heated job in between open faced Bottom & Top Die, Which is set on Anvil.
6. Upset the heated work piece to calculated length with the help of hammer, Dies & flatter.
7. The process is carried approximately until the circular rod is transformed into desired shape and with desired dimensions.
8. The work piece is re-heated to carry out forging operation to make hexagonal head of required size and shape.
9. With the help of flatter, finish the work piece to the final dimension and surface finish; cool the specimen by dipping in water.

Viva Question with answers

1. What is core sand?
Sand that prepared by mixing a special binder such as core oil with sand, that develop high strength.
2. What are the properties of good moulding sand?
 - Permeability
 - Cohesiveness or Strength
 - Adhesiveness
 - Plasticity
 - Refractoriness
 - Binding
 - Chemical resistivity
 - Flowbility.
3. What is molding sand?
Its prepared by using a mixture of base sand, binder, additives and with or without water. The mixture of sand is referred to as moulding sand.
4. What is a binder?
it is a material, which imparts the necessary binding action to the sand, a binder holds the sand grains together and induces strength and other properties to the moulds
5. What is green sand?
-Containing 5-7% water and 6-10% clay it's the cheapest of sand mix.
6. What is permeability?
- The ability of sand to allow the gasses to escape from the mould
7. What is clay?
-its most common binder system used in foundries, it's a product of silicious rocks, containing hydro silicates of alumina (Al_2O_3).
8. What is the importance of GFN? Explain how GFN affects the properties of sand and casting.
-Grains fineness number Fine grain sand result in good surface, on the casting but gases cannot escape out of the mould made from it. Coarse grain sand allows gases to escape out easily but the casting surface will be very rough. Hence grain size should select appropriately.
9. What are the different types of patterns used in foundry?
 - Solid pattern
 - Split pattern
 - Cope and Drag pattern
 - Loose piece pattern
 - Gated Pattern

- Match plate pattern
- Follow board pattern
- Skeleton pattern
- Sweep pattern.

10. What are the different methods of preparing moulds?

- open mould
- Pit mould
- Loma mould
- Sweep mould
- Core sand mould
- Cement bonded mould
- Plaster mould
- CO₂ Sand mould
- Shell mould.

11. What is a dry sand mould? Why binder is used.

- its refers to sand mould in the dried condition when there is no moisture in the mould, Dextrin is used up to 2% with clay as Binder.

12. What are the different types of furnaces used for melting?

- Crucible Furnace
- Coke Fired Furnace
- Gas or oil Fired Furnace
- Resistance Furnace
- Electric Arc Furnace
- Induction Furnace
- Cupola Furnace.

13. What are the different tools used for making moulds in the foundry?

- Round Rammer
- English Trowels
- English cleaner
- Spoon tool
- Smoother
- Bellows.

14. What is pattern allowance? Why it is required.

- Pattern has the same shape as that of the casting but the dimensions will be generally than that of the casting. This extra dimensions or deviations from the required value, given on the pattern are referred to as pattern allowance.

15. Name different allowances given for the pattern.

- Shrinkage allowances

- Draft allowances
 - Machining allowances
 - Scale & grinding allowances
 - Distortion allowances
16. What are the different patterns materials used in foundry?
- Wood
 - Metal
 - Plastic
 - Wax
 - Plaster of Paris.
17. What is cope and Drag?
- The upper part of mould is cope and lower part of mould is drag.
18. What is foundry?
- Shaping the metal components in their molten stage is known as Foundry.
19. Name different additives used in foundry practice.
- Cereal husks
 - Sea Coal
 - pitch
 - wood flour
 - Silica flour
 - Iron oxide
 - Dextrin
 - Molasses.
20. What is casting?
- Casting is a manufacturing process by which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process.
21. Name the different casting processes.
- Sand Casting
 - Permanent Mold Casting
 - Low Pressure Casting
 - Die Casting (high pressure)
 - Direct Squeeze Casting
 - Continuous Casting
 - Investment Casting
 - Shell mould casting
 - Vacuum Casting

- Investment (top) and Conventional Castings
- Lost Foam Casting
- Centrifugal Casting

22. What is a Core?

- Core is sand blocks they are used to make hollow portion in a casting.

23. How a core is made?

- Core is made separately in a core box made of wood or metal.

24. What is Sprue?

- it is taper shaped vertical component in the system. It will help transfer of molten metal from the pouring cup into the runner.

25. What is Runner and Riser?

- it is a long horizontal channel which carries molten metal and distributes it to the ingates or gates. It will ensure proper supply of molten metal to the cavity so that proper filling of the cavity takes place.
- Riser is to supply the molten metal to the solidifying casting and eliminate shrinkage cavity and should permit easy escape of air and gases.

26. Name some of the Common casting defects.

- Porosity/Holes
- Shrinkage cavity
- Inclusions
- Hot Tears
- Scab, Rat tails
- Sand burn-on/sand fusion
- Cold shut
- Core shift/Mould shift

27. What is gating?

- Molten metal is conveyed into the mould cavity and the mould gets completely filled up. After solidification, the solid metal represents casting, For conveying the molten metal into the mould cavity components referred to as Gating system.

28. What is forging?

- The process of shaping the metal components in cold or hot condition by the application of impact or pressure but the primary difference b/w various forging method is the rate which the energy is applied to the work piece.

29. What is welding?

- It is a process of joining two pieces of metal by heating them to a suitable temperature with additions of filler metal or with application of pressure is called welding.

30. What are the types of Welding?

- Fusion welding: The pieces of metals to be joined are heated to molten/liquid state with addition of filler metal used during welding process and allowed to solidify. Eg. Arc welding, Gas welding.

Plastic welding :The pieces of metal to be joined are heated to plastic// red hot! state with application of pressure. E.g. Forge welding, Resistance welding.

31. What are advantages of welding compare to other joining process?

- This is the most rapid and easiest way of fabrication and assembly of metal parts.
- 10 to 40% material can be saved and weight reduction.
- This process having more than 100% strength of the joint.
- Greater flexibility in fabrication and erection.
- Repair and maintenance is easier.
- Better integrity of components.

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32. What are the advantages of coated electrodes?

- Stabilizes the arc.
- Prevents oxidation of molten metal
- Chemically reacts with the oxides and forms a slag. The slag floats and covers the top portion of the molten metal thereby preventing it from rapid cooling.
- Reduces weld metal porosity.
- Helps to produce minimum spatter adjacent to the weld

Experiment Questions

1. Find the green compression strength of the given specimen at different percentage of clay and water.
2. Determine the green shear strength of the given specimen for different percentage of clay & moisture.
3. Determine the tensile strength of sand using 2 types of binder's viz. core oil binder & sodium silicate binder
4. Find the effect of water content, clay content on green permeability of foundry sand
5. Find the distribution of sand grains using a set of sieve & to find the average GFN.
6. Determine the percentage of clay present in the base sand
7. Find the core hardness & mould hardness.
8. Prepare the mould using single piece pattern.
9. Prepare the mould using split pattern
10. Prepare the mould using match plate pattern.
11. Prepare the forged model which involves upsetting, drawing & bending operation
12. Prepare the forging model using Power hammer.

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