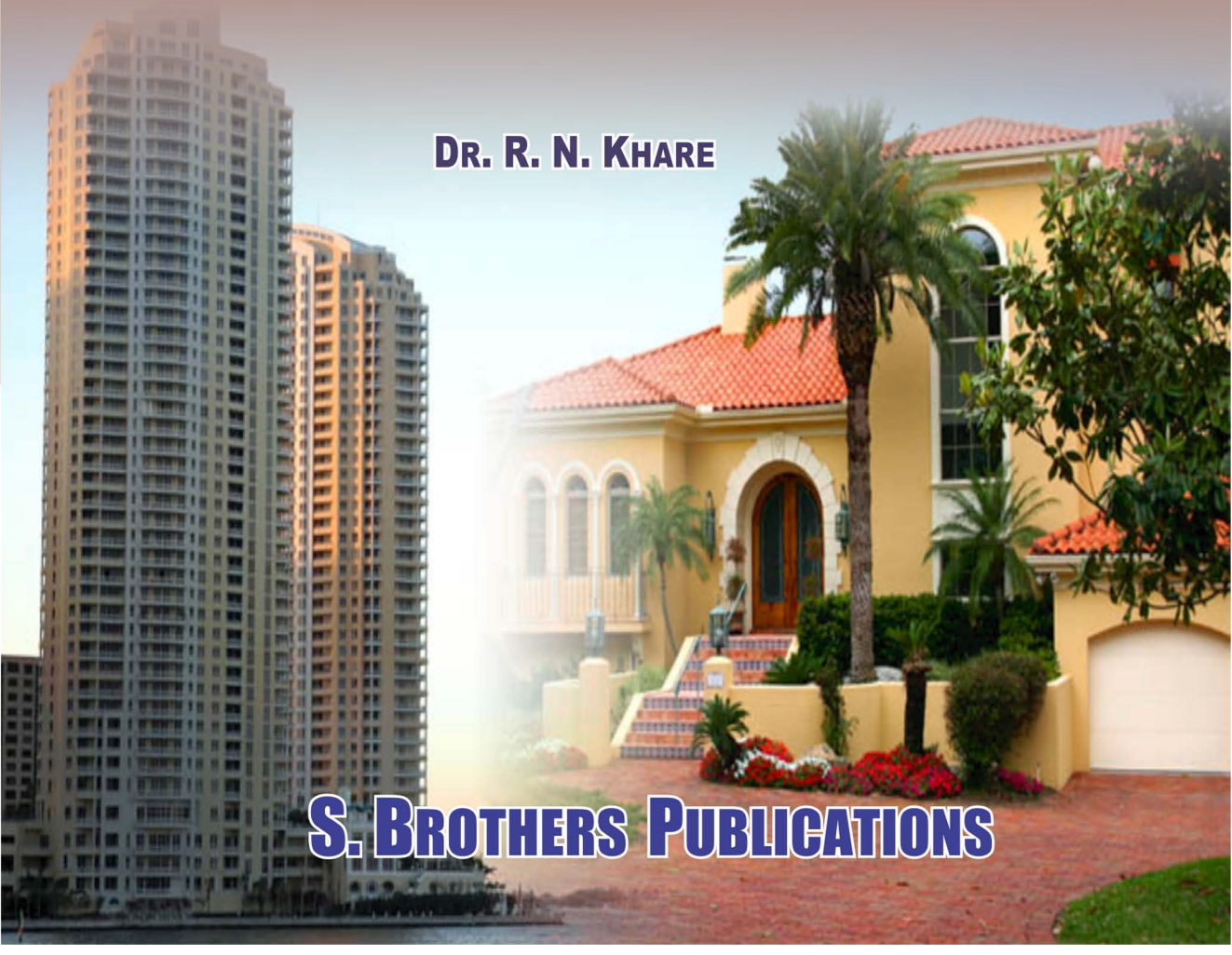
TEXT BOOK
OF

# BASIC CIVIL ENGINEERING

(Strictly as per C.S.V.T.U. Bhilai Syllabus)

B. E. FIRST YEAR

DR. R. N. KHARE



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## TEXT BOOK OF

# BASIC CIVIL ENGINEERING

**Strictly as per Syllabus of C.S.V.T.U. BHILAI**

( For First Year Engineering Degree Students )

(Common for all Branches)


**By**

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**Bhilai (Chhattisgarh)**



Publisher

**S. BROTHER'S PUBLICATIONS**

**Bajrang Chowk, Santoshi Nagar**

**Raipur (C.G.) - 492001**

**Published by :**

**S. BROTHER'S PUBLICATIONS**
**Bajrang Chowk**
**Santoshi Nagar**
**Raipur (C.G.) - 492001**

**Phone No.:** **9893201011,**
**9630312324**



**First Edition - 2009**

**Price : Rs. 120/-**

**Note:** This book has been published strictly according to the syllabus. Care has been taken in all the respects during the publication of this book . The publisher will not be responsible for any controversy. All the legal disputes in this regard will be subjected to Raipur Jurisdiction only.

## ABOUT AUTHOR

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**Dr.R.N.Khare**, obtained his Bachelor's degree in Civil Engineering from Govt.Engineering College, Jabalpur and his M.Tech. Degree from D.A.V.V. Indore, He has done Ph.D. in Civil Engineering specialization in Geotechnical Engg from Rajiv Gandhi Technological University, Bhopal. In addition to this he has also in credit of other degree such as PGDPM in Personnel Management, Ph.D.(Hindi).

Dr. Khare was throughout topper and meritorious student of all classes, so he got merit scholarship from 5th standard to P.G.level. He stood first position in 12th board exam of M. P. Board Bhopal and so for this he has received Chief Minister Goldmedal award in 1988. He has awarded by various prizes like Shri Kishan Chitlangia Janseva Puraskar for best technical paper by Institution of Engineers (India), Appreciation Certificate by Engineer in Chief of PWD Department Govt. of Chhattisgarh for providing the research assistance for designing of high embankment against the erosion and Technical Excellence award by Lions Club Couple, Bhilai Chapter. His teaching experience spans over 17years.Previously he was Professor in Department of Civil Engineering, Bhilai Institute of Technology, Durg (C.G.).

Dr. Khare has published 2 books, 30 papers published in national journal, 18 papers published in international journal and 86 papers published in national and international conferences in his professional career. He is a member of various professional bodies like, member of Institution of Engineers, Chartered Engineer of Institution of Engineers, Indian Society for technical Education, Indian Geotechnical society, Indian Geotechnical society, Jabalpur Chapter, Indian Society for wind engineering, International Society for Soil Mechanics and Geotechnical Engineering, Indian Water Resources Society , Indian Society for Remote sensing, Biomedical Engg Society of India, National Institute of Personal Management and Geological Association of Research centre. He is in advisory board of C.G.. Government for CSEB and Creda etc. Presently he is working as Principal in Rawatpura Sarkar Institute of Technology, Raipur (C.G.).

# PREFACE

The present book entitled "Basic Civil Engineering" meant for the B.E. first year students of Chhattisgarh Swami Vivekanand Technical University, Bhilai (C.G.). The subject matter of this book have been written in strictly accordance with the latest syllabi. This book has its own identity because of the following features-

* This book covers the complete syllabus prescribed by Chhattisgarh Swami Vivekanand Technical University, Bhilai (C.G.) common to all branches of B. E. First year. .
* The subject matter has been written in a simple and lucid language, so that students can easily understand it.
* A large number of suitable diagrams, table and line diagrams are also given along with the subject matter.
* Each chapter is provided with exercise questions.
* While writting this book, the requirements of all the students regarding the latest trends of the examination, have been kept in view.
* At the end of each chapter, large number of exercise questions and numerical problems have been added for the students to solve them independently. Most of the quetions are selected from previous years examination papers. These questions also help the students to under stand the pattern of examination of the university.

The suggestions and healthy criticisms that could be helpful in mending and refining this book are heartedly welcomed.

We sincerely hope that the book will help the students to understand the subject matter in better way and it will prepare them for the exams they appear.

**Author**
**& Publisher**

# SYLLABUS

Chhattisgarh Swami Vivekanand Technical University ,

Bhilai

( B. E. First Year )

(Common for all Branches)

**M.M. : 80** **Total Periods : 40**

**Total Tutorial Periods : 40**

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**UNIT-I**

**Brick:** Nomial and actual dimensions of modular and traditional bricks,Frog, Good brick earth, moulding, characteristics of good bricks, compression test and absorption test, classification of bricks.

**Cement:** Raw materials, wet process for manufacture of Portland cement, Initial and final setting time, use of Vicat needle apparatus, distinction between ordinary Portland cement, Pozzolana cement and slag cement, grades of cement, uses of white cement.

**Stone:** Geological, physical and chemical classification of stone, important uses of stone.

**Steel:** Differece between cast iron, wrought iron and steel, mild steel and tor steel.

**No. of Pds. 8+2**

**UNIT-II**

**Mortor :** Proportion of cement mortor for various uses.

**Concrete:** Ingredients of concrete, Meaning of M-10, M-15, and M-20 grades and nominal mix proportions for them. Common w/c ratio. Workability, Slump test, compression test, Curing.

**Aggregate:** Coarse and fine aggregates, grading curve and fineness moulds.

**Building plans:** Reading and comprehending a building plan and section. Convention if assuming the cutting plane at window sill level. Conventional symbols for represent doors etc. and electrical and sanitary fittings. Identification of footing, plinth, lintel, slab, chajjaetc. on a given cross section.

**No. of Pds. 8+2**

**UNIT-III**

**Chain survey:** Inctrument used, Selection of survey station, chain lines, off-sets, oblique off-sets, tie lins, check lines, ranging, field book, plotting, survey of India toppo sheets. their scales and conventional symbols.

**Compass Syrvey:** The prismatic campass, definition and types of meridian,

Dip and Declination, Whole circle bearing, Fore bearing and Back bearing, Local attraction. calculation of included angles for closed and open travers.

**No. of Pds. 8+2**

**UNIT-IV**

**Levelling :** Various parts of a Dumpy level, Temporary adjustment, interrelationship of Bubble tube Axis, Line of collimation and Vertical Axis, Levelling staff, Thechnocal terms used in levelling, Fly levelling, Profile levelling, Level field book, Arithmetical cecks and problem on levelling.

**Contours:** Definition, contour value, identification of ridge, valley and other geographical features on a contour plan.

**No. of Pds. 8+2**

**UNIT-V**

**Bearing capacity:** Necessity of foundation, definition of safe bearing capacity, Ultimate bearing capacity and factor of safty, Consideration of failure of soil and settlement of foundation for deciding ultimate bearing capacity.

**Load bearing and framed construction:** Load bearing wall type and framed type of constructions.

**Types of foundations:** Sketches of spreads footing for walls, rectangular R.C.C. footing for columns and raft foundations for a group of columns.

**Foundation Soils:** Black cotton soil, its expansion and shrinkage, building cracks due to it, use of framed construction or under- reamed pile for B. C. coil, Good soils for foundation viz. moorum, yellow soil or silt and rock.

**No. of Pds. 8+2**

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This Book

is

Dedicated

to

Our

Respected Teachers

&

Parents

# CONTENTS

UNIT-1
BUILDING MATERIAL

# 1 BRICKS

**Concepts:** **Bricks:** Nominal and actual dimensions of modular and traditional bricks. Good brick earth, moulding, Frog. Characteristics of good bricks, com pression test and absorption test, classification of bricks.

Bricks are artificial stones usually made of clay. It is one of the most popular and leading construction material because of cheap, durable and easy to handle and work with. Bricks are usually made of clay. These are used in building construction and for ornamental purposes. These are one of the basic materials used for wall construction. These are easily available, cheap and light weighted. They can be mould into required shape and size. The properly manufactured bricks are nearly as strong as stone. Different type of bricks can be manufactured from different materials, such as mud bricks, refractory bricks, silica bricks, cement sand bricks, fire bricks.

## USES OF BRICKS

1. First and second class bricks are used in construction work of buildings, dam, bridges, piers and abutments.
2. It is also used in sewers, roads, tunnels, lining and pitching work of water structures.
3. First class bricks are used for architectural and ornamental purposes, and also for face work of the structure.
4. First and second class bricks are used in construction of permanent character.
5. Third class bricks should not be used in the places of heavy rains and moisture. These should not be used in cold places and cold climate. These are generally used in construction of temporary character.
6. Zhama bricks are used as road metal and as aggregates in foundation concrete.

## SIZES OF BRICKS

**( Nominal and actual dimensions of modular and traditional bricks.)**

Bricks are made up of different sizes according to traditions of the country and requirement of the consumer. The size of bricks should be such that they can be easily lifted and placed wherever required and can be burnt up to the core of the brick. Dimensions of the Bricks are according to the BIS which is given in table 1.1. The mass of the brick normally varies from 3 to 3.5 KG..

**Table 1.1: Nominal and actual dimensions of modular and traditional bricks**

| S.N. | Type of Brick | Actual Size of the Brick | Nominal Size of the Brick |
|---|---|---|---|
| 1. | Modular Brick | 190mm x 90mm x 90mm | 200mm x 100mm x 100mm |
| 2. | Traditional Brick | 210mm x 100mm x 75mm | 230mm x 114mm x 76mm |

## CONSTITUENTS OF GOOD BRICKS EARTH

The chief constituents of good earth are as follows-

**1. Alumina: It** is the chief constituent of every kind of clay. A good brick earth should contain about 20% to 30% of Alumina. This constituent imparts plasticity to earth so that it can be moulded. If Alumina is present in excess, with inadequate quantity of sand, the raw bricks shrink and wrap during drying and burning and become too hard when brunt.

**2. Lime: A** small quantity of lime not exceeding 5 percent is desirable in good brick earth. It should be present in a very finely powdered state because even small particles of the size of a pinhead cause flaking of the bricks. The lime prevents shrinkage of raw bricks. The sand alone is infusible. But slightly fuses at kiln temperature in presence of lime. Such fused sand works as a hard cementing material for brick particles. The excess of lime causes the brick to melt and hence its shape is lost. The lumps of lime are converted into quick lime after burning and this quick lime slakes and expands in presence of moisture. Such an action results in splitting of bricks into pieces.

**3. Magnesia:** A small quantity of magnesia in brick earth imparts yellow tint to bricks and decreases shrinkage. But excess of magnesia leads to the decay of bricks.

**4. Oxide of iron:** A small quantity of oxide iron to the extent of about 5 to 6 percent is desirable in good brick earth. It helps as lime to fuse sand. It also imparts red colour to bricks. The excess of oxide of iron makes the bricks dark blue or blackish. If, on the other hand, the quantity of iron oxide is comparatively less the bricks will be yellowish in colour.

**5. Silica:** It exists in clay either as free of combined. As free sand, it is mechanically mixed with clay and in combined form; it exists in chemical composition with Alumina. A good brick earth should contain about 50% to 60% of silica. The presence of this constituent prevents cracking, shrinking and wrapping of raw brick. It thus imparts uniform shape to the bricks. The durability of bricks depends on the proper proportion of silica in brick earth. The excess of silica destroys the cohesion between particles and the bricks become brittle.

## HARMFUL CONSTITUENTS OF BRICKS EARTH

A variety of other ingredients are also present in brick earth which render the resulting brick unstable for construction. These are-

1. **Pebbles of Stones and Gravels:** The stones and gravels present in brick earth does not allow the clay to be mined thoroughly which results in porous and weak bricks.
2. **Vegetation and Organic Matter:** The presence of vegetation and organic matter helps in burning of bricks. But if it is in the excess then it burnt to make the bricks porous due to evolution of $CO_2$.
3. **Alkali:** Alkalis present in brick lower the fusion point of clay. They cause the brick to fuse twist and coarp during burning. Alkalis absorbs the moisture from atmosphere and create damped conditions leaving behind grayish white deposit on drying of bricks. This property is also called efflorescence.

4. **Excess of Lime:** Excess of lime results in melting of bricks and brick loose their shape. Lime also absorbs moisture from the atmosphere and increases the volume of bricks causing weaking and disintegration of bricks.
5. **Iron Pyrites:** Iron pyrites decomposes, oxidizes and finally crystallize in the brick causing the bricks to split into pieces.
6. **Carbonaceous Matters:** It causes different colours in the interior and exterior of the plaster by discoloration.

## CHARACTERISTICS OF A GOOD BRICK
## (Characteristics of First Class Brick For masonry work)

The masonry brick which are to be used for the construction of buildings and other structure should possessing the following characteristics-

1. The brick should be preferably table moulded
2. A good brick should have uniform deep red, cherry or copper colour. The colour should be uniform and bright.
3. It should have even surfaces, sharp edges and compact structure.
4. It should be uniform in shape and of standard size.
5. It should have fine, compact and uniform texture and should uniform in shape and size.
6. It should well burnt in kilns, free from cracks, flows, loose material., nodules of free lime and any other defect.
7. Crushing strength of brick should be 105 kg/cm2.
8. The brick should be moulded from a good brick earth which is free from vegetable matter, stones, saltpetre, harmful salts, acids and other organic matters as well as from fumes and oxides of irons.
9. It should be so hard so that finger nails should not be able to make any impression on it surface, when stretched.
10. When two first class bricks are struck with each other, metallic ringing sound should be emitted.
11. A good brick should not absorb more than 20% water of its dry weight when kept immersed for 24 hours.
12. It should not break when dropped on hard ground from a height of about one meter.
13. Good brick should able to resist atmospheric actions.
14 .The crushing strength of the brick should be above 55kg/cm$^2$.

## MANUFACTURE OF BRICKS

A good brick earth contains 50 to 60 % of silica, 20 to 30 % of alumina and the remaining constituents being line, magnesia, sodium, potassium, manganese and oxide of irons. The chief constituents of brick earth are alumina and silica i.e. mixture of clay and sand. The clay having size of 0.02 to 0.002 mm should be 20 to 30 % by weight. The sand having size of less than 2 mm should by weight and silt of 0.2 to 0.02 mm size should by 20 to 35 % by weight.

The brick earth should not contain any type of vegetable matter as well as coarse sand, gravel, lime and kankar. Soluble matter which are present in water

should not exceed 1% by weight, calcium oxide and magnesium oxide should not exceed 1% by weight.

The manufacture of bricks involves the following operations –

1. Selection of site
2. Selection of brick earth
3. Preparation of brick earth
4. Moulding of bricks
5. Drying of moulded bricks
6. Burning of bricks
7. Removal and transportation of bricks

**1. Selection of Site:** The site should be easy approachable from the city. The water should be easily available on the site.

**2. Selection of good Brick Earth** : A good brick earth contains 50 to 60 % of silica, 20 to 30 % of alumina and the remaining constituents being line, magnesia, sodium, potassium, manganese and oxide of irons. The chief constituents of brick earth are alumina and silica i.e. mixture of clay and sand. The clay having size of 0.02 to 0.002 mm should be 20 to 30 % by weight. The sand having size of less than 2 mm should by weight and silt of 0.2 to 0.02 mm size should by 20 to 35 % by weight.

The brick earth should not contain any type of vegetable matter as well as coarse sand, gravel, lime and kankar. Soluble matter which are present in water should not exceed 1% by weight, calcium oxide and magnesium oxide should not exceed 1% by weight.

**3. Preparation of Brick Earth** :The pebbles, vegetable matters coarse sand, gravel, lime kanker etc. are removed out from the soil.

Following are well defined operations involved in preparing earth to be used for the manufacture of the bricks.

(i). Unsoiling
(ii). Digging
(iii). Cleaning
(iv). Weathering
(v). Blending
(vi). Tempering or pugging

**(i). Unsoiling:** This process consists of scraping of top layer of soil (about 150 to 250 mm depth). The top soil may contain a number of impurities including waste disposal materials which are harmful for bricks therefore it is rejected and thrown away. Top soil is also cleared of all vegetation, bushes etc.

**(ii). Digging:** After unsoiling, the brick earth is then dug out of the ground either manually or with the help of power excavators. The dug soil is spread on a levelled ground.

**(iii). Cleaning and powdering:** The brick earth is cleared of grass, roots of plants, gravels, pebbles, kankar and other undesirable things. The evacuated lumps of soil are broken so as to reduce them in powder form. If the clay is hard and full of lumps, it is ground in to powder by passing it between cast iron or stone rollers .The rollers may be rotated mechanically.

**(iv). Weathering:** The process of softening and mellowing of dug out clay by adding little water and exposing it in to the atmosphere is known as weathering. The clean and powdered soil then mixed with a little water and is left in heaps to weather for a suitable period. Weathering improves the plasticity and strength of the brick earth. During the entire period of weathering, the soil is kept slightly wet

by spraying water from time to time and by turning over the heap.

**(v). Blending:** During the weathering period, the excavated earth is tested for its suitability. For small scale work, only field test are sufficient, but for large scale manufacture, scientific test are conducted to find out the deficient constituents. After the weathering is over, the earth is thoroughly broken and mixed with sandy soil or other deficient constituents. The whole mass is mixed up thoroughly with spades, and reasonable amount of water is added if needed.

**(vi). Tempering and Pugging:** This process render the clay fit for moulding. This process is done by thoroughly brokening and adding adequate quantity of water and the whole mass is kneaded well under the feet of men or cattle (or by mechanical means) so as to obtain a homogeneous mass of uniform consistence. This process is known as **tempering or pugging**. For large scale manufacturing work, this is done in **pug mills.**

**Pug Mill**

A pug mill consists of following parts-

**1. Conical iron tub:** It is an iron tub whose height is 1 m to 1.8 m and top and bottom diameters are 1.25 m and 0.75 m respectively .This tub is sunk 0.6 m below the ground level.

**2. Vertical iron shaft :** It is fixed in the centre of the shaft and is provided with **horizontal arms** with **knives or cutting blades**.

**3. Long wooden arm :** It is a lon horizontal wooden arm whose one end is fixed to the top of the shaft. This arm is meant for rotating the shaft by bullocks yoked at its free end. The shaft can also be rotated by mechanical power.

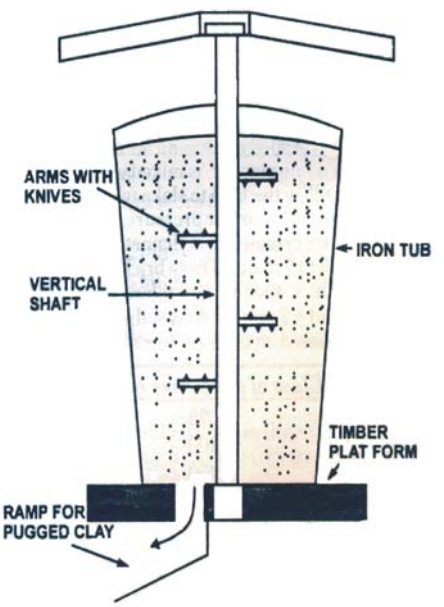



**Fig. 1.1. Pug mill**

**4. Timber base :** The mill is fixed on a pair of square timber log of size 0.2 m x 0.2 m in section.

The pug mill has provisions made both at the top and bottom to feed and collect the clay. The mixture of clay (blended brick earth) and water is fed into the pug mill from the top. Now the shaft is rotated so that the cutting blades fixed at various levels kneads the mixture thoroughly. The pugged clay is then taken out through the outlet provided at the bottom of the mill.

**4. Moulding of Bricks:** After preparation (pugging) the pugged clay is placed in to moulds made of wood or steel to give it proper shape.

When the brick earth is prepared, it is moulded by hand or by machine.

**(i). Hand Moulding:** This is opted when breaks are to be manufacture in small scale and when manpower is cheap and is readily available. The moulds are rectangular boxes, which are open at top and bottom. They may be wood or steel.

They shrink during drying and burning. The moulds are made 8 to 10% larger in all directions than the actual size of a burnt bricks.

Hand moulding may be done either on ground or on table, where man power is cheap. Types of hand moulding are:

(i). Ground Moulding (ii). Table Moulding

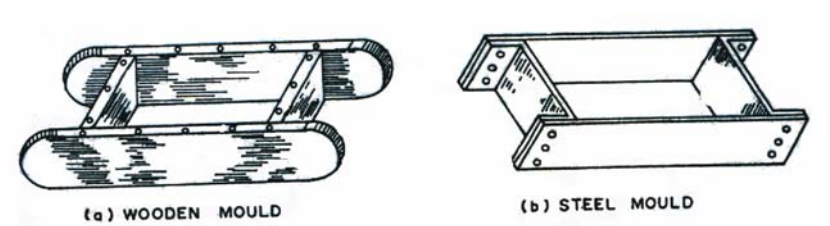



**Fig. 1.2. Moulds for brick moulding**

**(ii). Ground Moulding:** The ground area where moulding is done is first prepares by levelling, sweeping and plastering smooth. It is then sprinkled over by fine sand. The mould is dipped in water and placed over the ground. Then the lump of tempered clay is pressed or forced in the mould in such a way that, it fills all the corners of mould. The extra or surplus clay is removed with the help of wooden strike or metal plate strike or with a wired frame. The mould is then removed vertically and the moulded brick is left on the ground. The process is repeated till the ground is filled with raw moulded bricks. Brick molder can mould 750 bricks per day when such bricks become sufficiently day, they are carried and placed in drying shed.

Bricks prepared by dipping mould in water every time are known as **slop moulded bricks.** Fine sand or ash may be sprinkled on inside surface of mould instead of water such bricks are known as **sand moulded bricks.**

**(ii). Table Moulding:** It is more or less similar to that of ground moulding but in this method stock board and pallet boards are made use of. This process is carried out on a moulding table of about 1m x 2 m size.

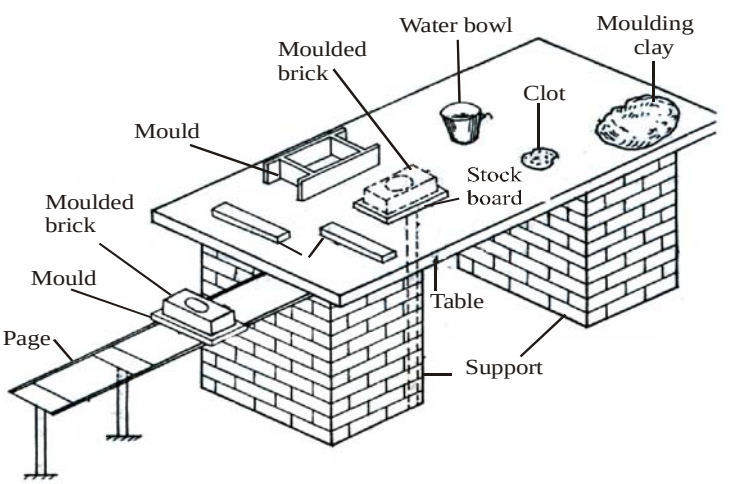
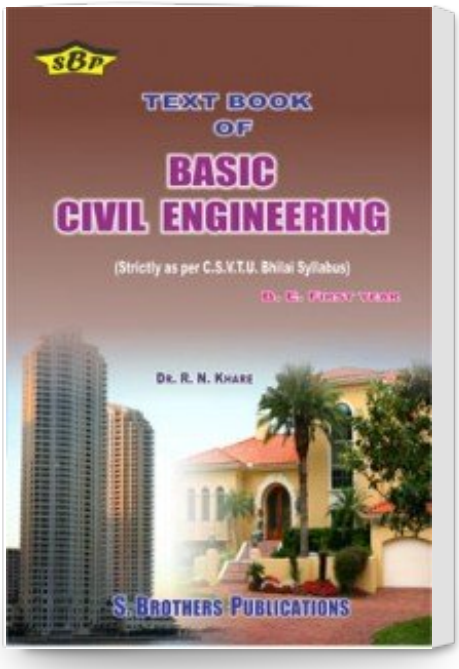



**Fig. 1.3. Table moulding of bricks**

# Basic Civil Engineering




Publisher : S Brothers Publication

Author : Dr. R. N. Khare

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