

CIVIL ENGINEERING

ITI | DIPLOMA | DEGREE

CIVIL ENGINEERING ASSISTANT

स्थापत्य अभियांत्रिकी सहाय्यक

Useful For
PWD CEA

ZP CEA

WRD CEA

Other Competitive
Exam

संपूर्ण

तांत्रिक घटक

मार्गदर्शक

COVERED ALL TECHNICAL SYLLABUS

TCS | IBPS Pattern

-Language-

ENGLISH MEDIUM

Feature

- Strictly as per CEA Syllabus
- Topicwise Systematic Presentation
- Previous year MCQ and Practice Question
- Covered Complete Technical Part



CIVIL ENGINEERING

Degree/Diploma/ITI

संपूर्ण मार्गदर्शक

500⁺ PYQ's आणि अतिसंभाव्य प्रश्नांसह

- सर्व टेक्निकल विषयांचा समावेश
- स्थापत्य अभियांत्रिकी सहाय्यक पदांसाठी उपयुक्त
- सर्व विषयांचे वस्तुनिष्ठ बहुपर्यायी प्रश्न
- सर्व तांत्रिक विषयांचा समावेश
- उत्तम आकलनासाठी साध्या व सोप्या भाषेत मांडणी
- जलद उजळणी साठी उपयुक्त

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वितरणासाठी संपर्क

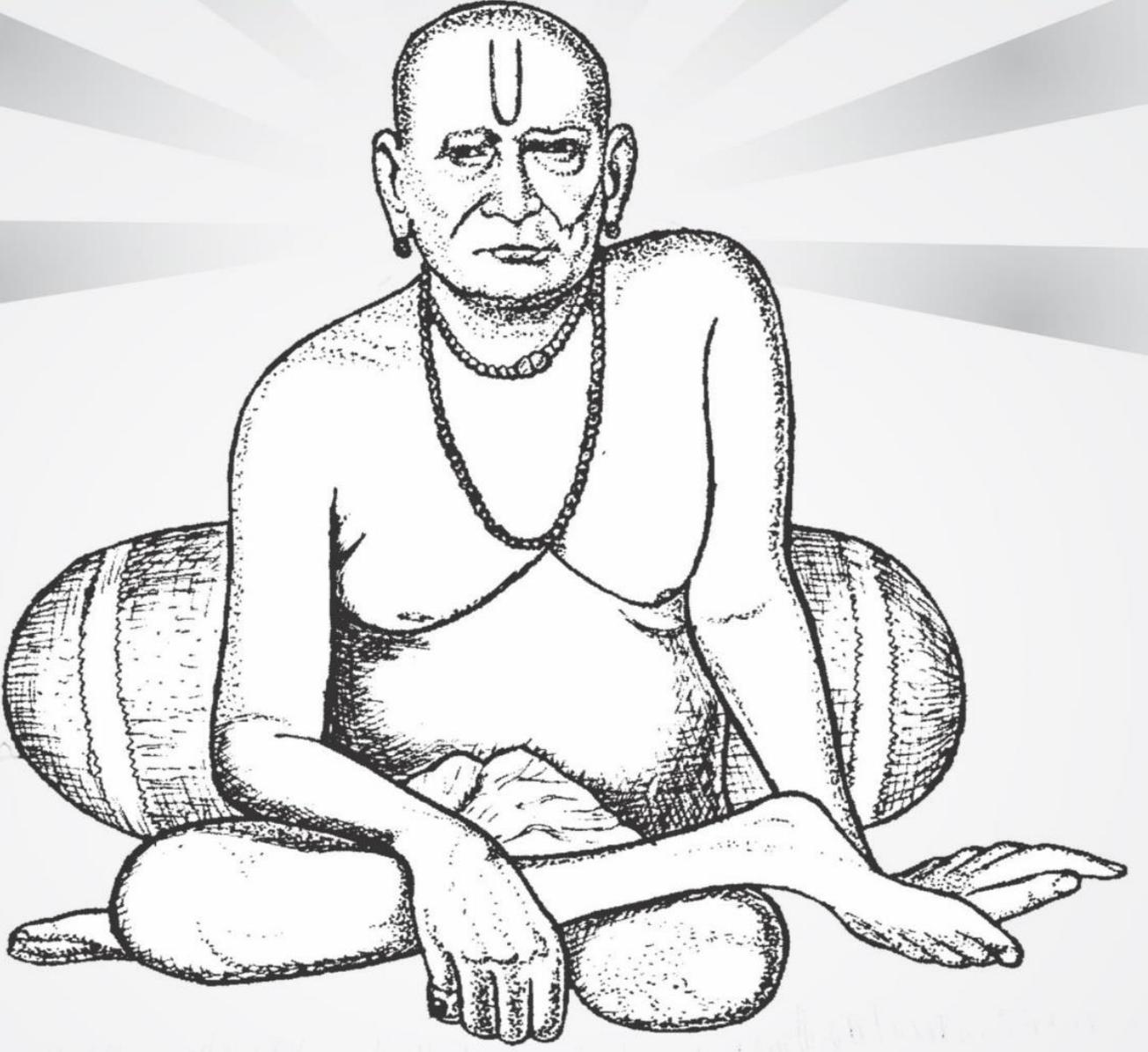
अक्षरजुळणी, सजावट व मुखपृष्ठ

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We Have made all possible effort to make this book error free however it is request to all students, if you find any error or want to give suggestions that we can incorporate into future editions, feel free Send us email girish@infinitycivilacademy.com

डिसक्लेमर : या पुस्तकाचे संपादन व मुद्रण करताना योग्य ती काळजी व खबरदारी घेतलेली आहे. अनावधानाने राहून गेलेल्या आणि अनावधानाने निर्माण होणाऱ्या चुकीबद्दल आम्ही दिलगिर आहोत .त्यासाठी लेखक, प्रकाशक किंवा मुद्रक यांची कुठलीही जबाबदारी नाही .संकलनातून निर्माण होणाऱ्या व त्याच्याशी संबंधित कुठल्याही प्रकारची देणी, नुकसानभरपाई यातून Infinity Publication मुक्त आहेत. सर्व पुणे न्यायालयाच्या कक्षेत



श्री स्वामी सम्पत्...

स्वामींच्या चरणी अर्पण ...

INDEX

CIVIL ENGINEERING ASSISTANT

1. BUILDING MATERIALS & CONSTRUCTION

1.1 BRICKS AND BRICK MASONRY.....	1
1.2 STONES AND STONE MASONRY.....	11
1.3 CONCRETE.....	21
1.4 PLASTER & POINTING.....	44
1.5 WOOD WORK & JOINERY.....	47
1.6 DOORS & WINDOWS.....	55
1.7 STAIRS.....	64
1.8. ROOF COVERING.....	66
1.9 FLOORING.....	70
1.10 BUILDING FINISHES.....	74
1.11 DOMESTIC SERVICES.....	84
1.12 STRUCTURAL STEEL WORK.....	88
1.13 FOUNDATION.....	99
1.14 PREVIOUS YEAR QUESTIONS.....	108
1.15 QUESTIONS FOR PRACTICE.....	114

2. ESTIMATION AND COSTING

2.1 ESTIMATION AND COSTING.....	126
2.2 RATE ANALYSIS.....	140
2.3 SPECIFICATION.....	144
2.4 CONTRACTS.....	154
2.5 TENDER.....	159
2.6 PAYMENT TO CONTRACTORS.....	176
2.7 PUBLIC WORK DEPARTMENT (PWD).....	179
2.8 PREVIOUS YEAR QUESTIONS.....	190
2.9 QUESTIONS FOR PRACTICE.....	190

3. SURVEYING

3.1 INTRODUCTION TO SURVEYING.....	196
3.2 MEASUREMENT OF DISTANCES.....	202
3.3 CHAIN AND COMPASS SURVEYING.....	210
3.4 PREVIOUS YEAR QUESTIONS.....	220
3.5 QUESTIONS FOR PRACTICE.....	223

BUILDING MATERIALS & CONSTRUCTION



The finished surface of third-class brickwork is rough and unsightly, requiring additional plastering or rendering.

Third-class brickwork is typically used in areas where structural strength is the primary

consideration, and the visual appearance is of less importance, such as foundations or areas that will be concealed.

1.2 STONES AND STONE MASONRY

Introduction

Building stones are obtained from rocks occurring in nature.

It is estimated that three-fourthly of the land area of the globe is underlain in sedimentary rocks & remaining one-fourth by igneous & metamorphic rocks.

Stones has no definite shape or chemical composition.

These are the mixture of two or more minerals.

Classification of rocks:

1. Geological Classification:

a. Igneous rocks:

These rocks are formed due to solidification of molten mass laying below or above the earth surface. These are produced by volcanoes.

It has crystalline glossy or fused texture.

Ex: Granite, basalt, Trap, Dolerite.

b. Sedimentary rocks:

These rocks are formed due to gradual deposition of material like sand, clay etc. by setting water.

Also called "stratified rock" because these are formed in layers.

Ex: Sandstone, shale, slate, limestone, laterite, gypsum.

c. Metamorphic rocks:

These rocks are formed due to alteration of original structure under heat & excessive pressure.

Ex: Marble, Quartzite, slate, schist, laterite. (Granite → Marble, Sandstone → Quartzite, Shale → Slate, Basalt → Schist, Trap → laterite)

2. Physical classification:

A. Stratified rocks:

Stratified rocks are those which exhibits distance layer which can be separated.

Ex: Limestone, Slate & sandstone.

Sedimentary rocks are stratified rocks.

b. UnStratified rocks:

Those which do not show any sign of strata & cannot be easily split into slabs.

Igneous & metamorphic rocks are unstratified rocks

Ex: Granite & marble.

3. Chemical classification:

a. siliceous rocks:

Those which contain "silica" as main constituent.

Ex: Granite, gneiss, trap, basalt, sandstone, quartzite.

b. Argillaceous rocks:

Those which contain "clay or alumina" as main constituent.

Ex: Slate, laterite, kaolin.

c. Calcareous rocks:

Those which contain "lime or calcium carbonate" as main constituent.

Ex: Marble, limestone, dolomite.

Properties or requirements of good building stone:

- i. The crushing strength of good building stone should be more than $100N/mm^2$
- ii. A good building stone should have sufficient hardness it is (Co efficiency of hardness > 14).
- iii. High resistance to wear good fire resistance.
- iv. Specific gravity of good building stone should be more than 2.7.
- v. High impact value (i.e. toughness index > 13)



- vi. Low water absorption (i.e. percentage absorption after 24 hour less than 0.6).
- vii. Percentage of wear should be less than 3%.
- viii. Unit weight of stone = $2850 - 2960 \text{ kg/m}^3$

Note:-

Generally stones from igneous & metamorphic rocks are heavier and more durable than stones from sedimentary.

Quarrying of stones:

It is the art of extracting stones from natural rock beds for engineering purposes.

Sides of hills are most suitable sites for quarrying purpose as the rocks are of higher density & available at the surface.

Methods of quarrying:

1. Digging by hand tools:

This method is adopted when soft stones occur in the form of detached modules or blocks buried in earth.

2. Heating:

This method of splitting the rocks by heating is used when small blocks of more or less regular shape are desired.

This method is suitable when rock formation consist of horizontal layers of small thickness.

3. Wedging:

This method is adopted for quarrying sedimentary and soft rocks such as sandstone, limestone, marble, slates.

4. Blasting:

This method is adopted for quarrying hard and compact stones, having no fissures or cracks.

In this process explosives are used to convert rocks into small pieces of stones. Ex. 'Gun cotton' explosive commonly used blasting. (Also dynamite, nitroglycerine, blasting gelatin used).

'Dynamite' is generally used for this purpose being more powerful & suitable under both dry & wet condition.

Properties and uses of principle building stones:

1. Granite:

It is an igneous rock, plutonic in nature.

It is mainly composed of quartz, feldspar and mica.

Specific gravity = 2.64

Crushing or compressive strength = 770 to 1300 kg/cm^2

Uses:-

It suitable for works of importance such as bridge abutments piers etc. where weight & durability are essential.

2. Basalt and trap:

Igneous rock, volcanic in nature.

Specific gravity = 3.0

Crushing or compressive strength = 1530 to 1890 kg/cm^2

Uses:-

It is very hard, tough & compact hence expensive to work.

It is used in foundations of structures.

3. Sandstone:

It is composed of quartz, lime & silica.

Specific gravity = 2.65 to 2.95

Crushing or compressive strength = 650 kg/cm^2

Uses:-

It is very easy to dress & work.

Extensively used in general building constructions works and ornamental carving, mouldings, ashlar work etc.

4. Limestone:

Specific gravity = 2.00 to 2.75

Crushing or compressive strength = 550 kg/cm^2

Uses:-

Limestone slabs are used for flooring, paving & roofing.

Also used for general building purpose & manufacturing of lime.

5. Laterite:

IT is a sandy clay stone containing high percentage of iron-oxide.

Its Specific gravity varies from 2 to 2.2

Crushing strength = $1.8 \text{ to } 32 \text{ kg/cm}^2$

Uses:-

Laterite is used for inferior type stone masonry work.



6. Quartzite:

It has most weather resisting characteristics. Siliceous sand stone under the effect of metamorphic action.

Uses:-

It used for rubble masonry road metalling or railway ballast and also as aggregate for concrete.

7. Slates:

It is mainly composed of alumina mixed with sand or carbonate if lime.

Specific gravity=2.89

Crushing or compressive strength= 770 to 2110 kg/cm²

Uses:-

Slates are used as a roofing or flooring material also used for dado work, damp-proof materials & steps of stairs.

8. Marble:

It is a compact crystalline stone formed by metamorphic action.

It is one of the strongest & most durable varieties of timestone.

Specific gravity=2.65

Crushing or compressive strength= 720 kg/cm²

Uses:-

It is suitable for ornamental & superior type of building work.

Also suitable for flooring, veneer work, carving & decorative work.

9. Moorum:

It is decomposed laterite & has deep brown/red colour.

It is used in surfacing fancy paths & garden walks.

10. Gneisses:

These are metamorphic rocks, siliceous rock.

Mainly composed of quartz & felsper.

Specific gravity=2.69

Crushing or compressive strength= 2100 kg/cm²

Uses:-

It used for steel paving slabs & for rough stone masonry work.

11. Kankar:

It is limestone containing 30% of alumina % silica. Hard kankar is used for foundation of building.

Notes:-

The crushing strength of a stone depend upon its

i. Texture ii. Specific gravity.

The attrition test on stones is performed for determining the rate of wear of stone due to grinding action under traffic.

The dressing of stone is done immediately after quarrying.

12. Gypsum-

Chemically precipitated sedimentary rock.

STONE MASONRY

Definition

In a very strict sense, the term masonry is used to indicate the art of building the structures in stones. But broadly speaking, the term masonry is used to indicate the art of building the structures in either stones or bricks. The former type is called the stone masonry and the latter type is called the brick masonry.

The basic advantage of the masonry for the load bearing structures is that it performs a variety of functions like:

- (i) Affording architectural effect,
- (ii) Granting fire and weather protection,
- (iii) Providing acoustic and thermal insulation,
- (iv) subdividing space,
- (v) Supporting loads, etc.

Materials Required For Stone Masonry

For stone masonry, the following two materials are required:

- (1) Stones
- (2) Mortar.

(1) Stones: Depending upon the availability, the stones are selected. The stones to be used in the work should be hard, durable, tough and free from any defect such as shake, vent, mottle, etc.

(2) Mortar: The mortar is required to keep the stones in position. It is prepared by mixing lime or cement with sand and after adding water, it is placed



in the joints. The type of mortar to be used will depend on the strength required, load coming on the structure, resistance desired for weathering agencies, etc.

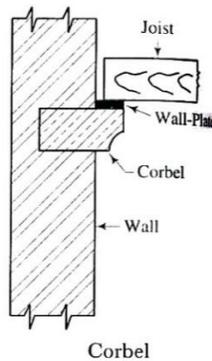
Some Definitions

The meanings, attached to some technical terms used in the masonry, are below for ready reference. Some of these terms are common in stonework as in brickwork. Technical terms are as follows:

(1) Natural bed: The building stones are obtained from rocks. These rocks have a distinct plane of division along which the stones can easily be split. This plane represents the natural bed and in stone masonry, the general rule to be observed is that the direction of natural bed should be perpendicular

(2) Sill: The bottom surface of a door or a window opening is known as a sill and the sill stones are so dressed that they prevent the entry of water to the interior of the building.

(3) Corbel:



A corbel is a projecting stone which is usually provided to serve as support for roof truss, beam, weather shed, etc., as shown in fig.. The corbels are generally moulded and given ornamental treatment. The corbels should extend at least two-third of their length into the wall.

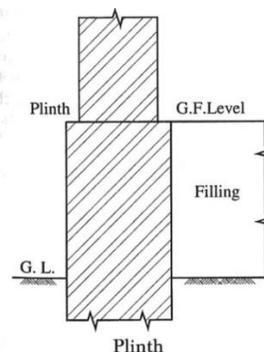
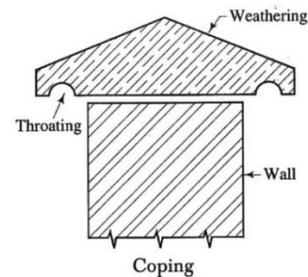
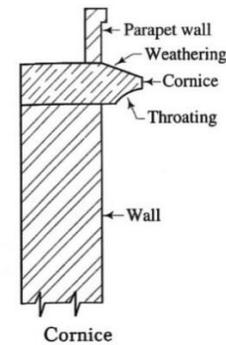
(4) Course: A layer of stones or bricks is known as a course and its thickness is generally equal to the thickness of a stone or a brick plus the thickness of one mortar joint.

(5) Cornice: A cornice is a course of stone provided at the top of wall as show in fig. It is generally moulded and given ornamental treatment. It is

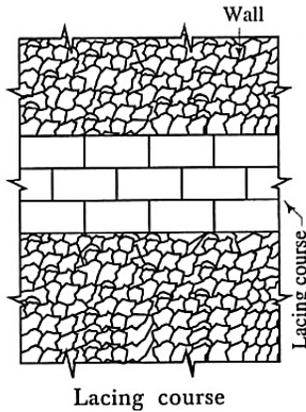
weathered and throated to dispose off rain water. In order to prevent the overturning of the cornice, sufficient bearing and extra weight at the top in the form of a parapet wall should be provided.

(6) Coping: A coping is a course of stone which is laid at the top wall so as to protect the wall from rain water. This course is generally provided at the top of a compound wall or a parapet wall and it is suitably weathered and throated as shown in fig.. Sometimes the term coping is used to refer to cutting of the stones by means of feathers, plugs and wedges.

(7) Weathering: The upper surface of stones used for sill, cornice and coping is dressed in a sloping way so that the water may flow off easily. This is termed as the weathering. The term weathering is sometimes used to denote the wearing of stone surfaces by the action of weather.



(8) Throating: A groove is provided on the underside of sill, cornice and so that the rain water can be discharged clear of the wall surface. This is known as the throating.



(9). Plinth -The projecting course at ground floor level is known as the plinth as shown in fig.. It is also used to indicate the height of ground floor level from ground level. The plinth course protects the interior of a building from rain, water, frost, etc. It is sometimes moulded and given ornamental treatment. The offset at plinth level is sometimes omitted for the architectural purpose.

(10) String course:

The horizontal course provided at suitable levels between the plinth and the cornice is termed as a string course. It breaks the monotony of a plane surface and it is sometimes moulded and given architectural treatment. The string course is suitably weathered and throated so as to throw off the rain water clear of the wall surface.

(11) Lacing course: The horizontal course provided to strengthen a wall of irregular small stones is known as a lacing course. It may be in the form of either ashlar masonry or coursed rubble masonry or brick masonry.

(12) Spalls: The chips of stones used to fill up the empty spaces in the stone masonry are known as the spalls or snecks. They are obtained as a result of reducing big blocks of stones into the regular stone blocks.

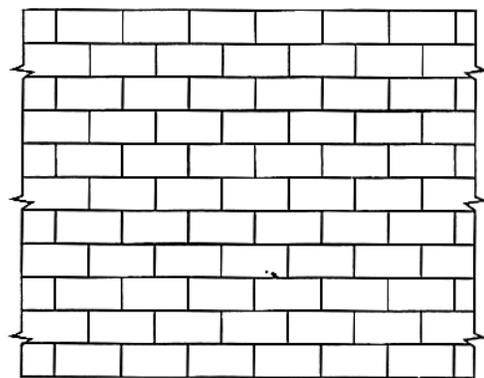
(13) Quoins: The external corners or angles of a wall surface are called the quoins and the stones or bricks forming the quoins are known as the quoin stones or

quoin bricks. The quoin stones are selected from large and sound stones and their beds are properly dressed.

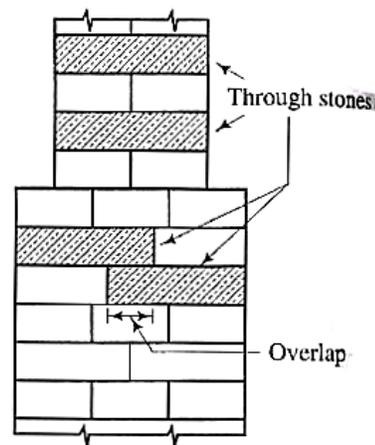
(14) Bond: A bond is an arrangement of layers of stones or bricks by which no continuous vertical joints are formed as shown in fig.. The bond distributes the load coming on the structure evenly and prevents the formation of a vertical crack.

(15) Through stone: In stonework, some stones at regular intervals are placed right across the wall as shown in fig.. Such stones are known as the through stoner or throughs or bond stones. If the wall is considerably thick, two through stones with an overlap are provided as shown in fig.

The area covered by the through stones should be about one-fourth to one-half of the area of the wall surface.



Bond



Through stone

The through stones should be non-porous so as to prevent the entry of moisture through the wall. They



Sand Blasting

Sand Blasting is technique to remove surface area in order to clean or etch it before painting. In this method very fine particles of an abrasive material at high velocity propell towards a surface need to prepared.

The sandblasting process knocks loose any paint, coating or debris so that the surface can be washed clean with ease, resulting in an extremely smooth surface.

Components Of Sandblasting

1. Abrasive
2. Air compressor
3. Blaster nozzle

Sand was once the most commonly used material in this technique. However, other materials are now commonly used in its place, such as:

- Steel grit
- Copper slag
- Walnut shells
- Powdered abrasives
- Coconut shell

There are two different processes for sandblasting:

- **Air-driven** - Best suited for metal surfaces, to avoid water intrusion into the surface or prevent moisture buildup
- **Water-driven** - Cools the surface to which it is applied, further reducing surface deterioration, most commonly used for brick and concrete surfaces

Green cutting

Green cutting is a popular method of roughening the concrete surface using a high-velocity water jet. It is possible to remove the top layer of cement paste using pressurized water when the concrete is still young.

Green cutting is commonly used in mass concrete constructions like dams, bridges, large foundations, and retaining walls.

Advantages of green cutting

1. Speed: With proper equipment & skilled operators, green cutting can cover 5 to 10 times more area than chiseling.
2. Less human resources
3. Better quality surface: Concrete green cutting is more of washing the top cement paste layer.
4. Improve working environment: Green cutting won't bring up any dust like in chiseling. It's easier for the laborers. Also, it is easier to chip and clean the areas close to reinforcement using the water jet.
5. Uniform surface quality: With chiseling, the surface roughness can vary over the area. Different workers will chip the surface differently. But with concrete green cut, you can achieve more uniform surface quality regardless of the uneven concrete surface.



Exposed concrete surface after green cutting

Admixtures

Functions of Admixtures

1. Admixtures are used to accelerate the rate of hydration.
2. Used to reduce the initial setting time.
3. Used to increase the strength of concrete.
4. Used to improve the workability.
5. Reduces the heat of hydration.
6. Helps in improving the durability of concrete.
7. Help in controlling shrinkage, creep, and swelling of concrete.
8. Increases the impermeability of concrete.
9. Improves the pumpability of concrete.



They are provided with rollers at bottom and top to roll on rails when they open or collapse. These doors work without hinges and can be opened or closed by a slight pull or push.

These doors are extensively used for residential buildings. Public buildings, sheds, schools, god owns, etc.

vii) Rolling Steel Shutter Doors.

These doors are capable of being rolled up at the top easily and cause no obstruction either in the opening or in the floor space.

These are commonly used these days for the main entrance of shops, garages, god owns, show. Windows, show-room openings and doors, etc.

These doors are sufficiently strong and offer proper safety to glass and the interior when closed. They also provide safety against fire and burglars.

Depending upon the area of the opening, the rolling shutter are classified into two types in respect of their operation:

i) Pull-push types.

When area of the opening is less than 10 sq.m., then the shutters are operated simply by applying pull or push.

ii) Mechanical gear types.

When area of the opening is greater then 10sq.m., the shutters are operated by a reduction gear, connecting rod and winding handle or by means of chain pulley blocks.

viii) Block board shutters

Block board, the main material used in these shutters, is a type of engineered wood. It consists of a core made of wooden strips or battens sandwiched between two layers of veneer. The core is usually made of softwood strips, while the veneer layers can be made of hardwood or softwood.

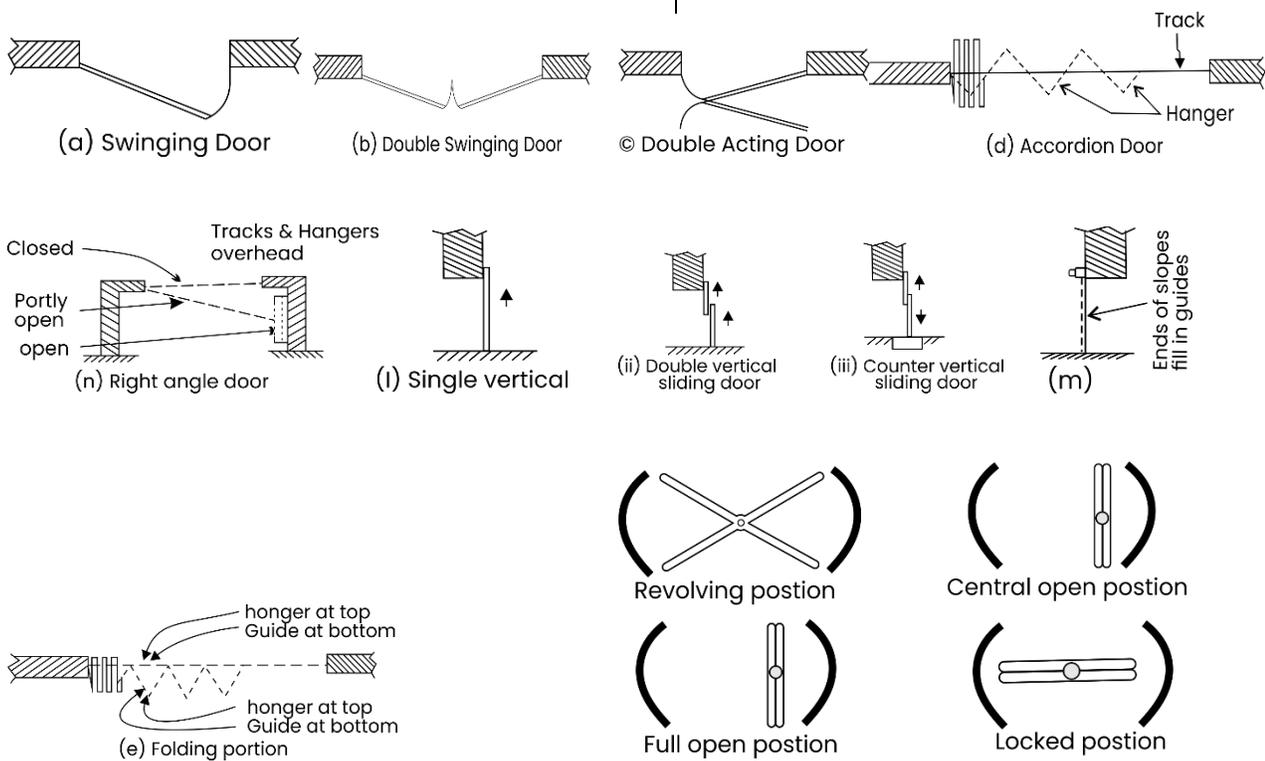


Fig. Types of Doors



15. As the cube size increases the strength of concrete (Nanded ZP 2014)

- A. decreases B. remains constant
C. increases D. insufficient data

16. A concrete cube of 15cm and a cylinder of 150mm diameter and 300 mm height are tested for compressive strength, the strength of cube compared to cylinder will be.(Nanded ZP 2014)

- A. higher B. lower
C. equal D. difficult to assess

17. The ratio of 7 days and 28 days cube strength is (Nanded ZP 2014)

- A. 0.5 B. 0.6 C. 0.75 D. 0.85

18 The characteristic strength of the concrete is (Nanded ZP 2014)

- A. higher than the average cube strength
B. lower than the average cube strength
C. same as the average cube strength
D. higher than 90% of the average cube strength

19. Which of the following is a rock? (Nanded ZP 2014)

- A. quartz B. mica
C. gypsum D. none of the above

20. Which of the following stone has more fire resisting characteristics?(Nanded ZP 2014)

- A. marble B. lime stone
C. compact sand stone D. granite

21. Excess of alumina in brick earth makes the brick (Nanded ZP 2014)

- A. impermeable
B. brittle and weak
C. to loose cohesion
D. to crack and warp on drying

22 According to IS specifications, the compressive strength of ordinary Portland

cement after three days should not be less than (Nanded ZP 2014)

- A. 7 Mpa B. 15 Mpa C. 16 Mpa D. 21 Mpa

23. With increase in moisture content the bulking of sand(Nanded ZP 2014)

- A. Increases
B. Decreases
C. First increases to a certain maximum value and then decreases
D. First decreases to a certain minimum value and then increases

24 The most common admixture which is used to accelerate the initial set of concrete is (Nanded ZP 2014)

- A. Gypsum B. Calcium chloride
C. Calcium carbonate D. None of the above

25. The most commonly used retarder in cement is (Nanded ZP 2014)

- A. Gypsum B. Calcium chloride
C. Calcium carbonate D. None of the above

26. Which of the following gradients exerts maximum influence on properties of steel? (Nanded ZP 2014)

- A. iron B. carbon
C. manganese D. sulphur

27. Minimum thickness of Wall where single flemish bond can be used is (Nanded ZP 2014)

- A. Half brick thick B. one brick thick
C. one and a half bricks thick D. two bricks thick

28. The type of footing which is used to transmit heavy loads through steel column is (Nanded ZP 2014)

- A. raft foundation B. grillage foundation
C. well foundation D. isolated footing

ESTIMATION COSTING AND VALUATION



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2.1. ESTIMATION AND COSTING

What is an Estimate?

- An estimate for any construction work may be defined as the process of calculating the quantities and costs of the various items required in connection with the work.
- It is prepared by calculating the quantities, from the dimensions on the drawings for the various items required to complete the project and multiplied by unit cost of the item concerned.
- To prepare an estimate, drawings consisting of the plan, the elevation and the sections through important points, along with a detailed specification giving specific description of all workmanship, properties and proportion of materials, are required.

Purpose of Estimating

Estimate for a work or project is necessary mainly for the following purposes:-

1. To ascertain the necessary amount of money required by the owner to complete the proposed work. For public construction works, estimates are required in order to obtain administrative approval, allotment of funds and technical sanction
2. To ascertain quantities of materials required in order of programme their timely procurement. to procure controlled materials, if any, like cement, steel, etc.; quantities of such materials are worked out from the estimate of the work and attached with the application for verification.
3. To calculate the number of different categories of workers that are to be employed to complete the work within the scheduled time of completion.

4. To assess the requirements of Tools, Plants and equipment required to complete the work according to the programme.
5. To fix up the completion period from the volume of works involved in the estimate.
6. To draw up a construction schedule and programme and also to arrange the funds required according to the programming.
7. To justify the investment from benefit cost ratio. (For ideal investment, this ratio should be more than one).
8. To invite tenders and prepare bills for payment.
9. An estimate for an existing property is required for valuation.

Different Types of Estimates

There are different types of estimates and they are as follows:

Preliminary or approximate or rough Estimate

- This is an approximate estimate to find out an approximate cost in a short time and thus enables the authority concerned to consider the financial aspect of the scheme, for according sanction to the same.
- Such an estimate is framed after knowing the rate of similar works and from practical knowledge in various ways for various types of works such as:
 - (i) Plinth area or square-metre method
 - (ii) Cubic rate or cubic metre method
 - (iii) Service unit or unit rate method
 - (iv) Bay method
 - (v) Approximate quantities with bill method
 - (vi) Cost comparison method
 - (vii) Cost from materials and labour

Plinth area method



The cost of construction is determined by multiplying plinth area with plinth area rate. The area is obtained by multiplying length and breadth (outer dimensions of building). In fixing the plinth area rate, careful observation and necessary enquiries are made in respect of quality and quantity aspect of materials and labour, type of foundation, height of building, roof, wood work, fixtures, number of storeys etc.,

As per IS 3861-1966, the following areas include while calculating the plinth area of building.

- a) Area of walls at floor level.
- b) Internal shafts of sanitary installations not exceeding 2.0m^2 , lifts, airconditioning ducts etc.,
- c) Area of barsati at terrace level:

Barsati means any covered space open on one side constructed on one side constructed on terraced roof which is used as shelter during rainy season.

- d) Porches of non cantilever type. Areas which are not to include

- a) Area of lofts.
- b) Unenclosed balconies.
- c) Architectural bands, cornices etc.,
- d) Domes, towers projecting above terrace level.
- e) Box louvers and verticalsunbreakers.

Cubical Contents Method

This method is generally used for multistoreyed buildings. It is more accurate than the other two methods viz., plinth area method and unit base method. The cost of a structure is calculated approximately as the total cubical contents (Volume of buildings) multiplied by Local Cubic Rate. The volume of building is obtained by Length x breadth x depth or height. The length and breadth are measured out to out of walls excluding the plinth offset. The cost of string course, cornice, carabelling etc., is neglected. The cost of building = volume of buildings x rate/ unit volume.

Unit Base Method

According to this method the cost of structure is determined by multiplying the total number of

units with unit rate of each item. In case schools and colleges, the unit considered to be as 'one student' and in case of hospital, the unit is 'one bed'. the unit rate is calculated by dividing the actual expenditure incurred or cost of similar building in the nearby locality by the number of units.

Quantity Estimate or Quantity Survey:

- This is a complete estimate or list of quantities for all items of work required to complete the concerned project.
- The quantity of each individual item of work is worked out from respective dimensions on the drawing of the structure.
- To find the cost of an item its quantity is multiplied by the rate per unit for that item.
- The purpose of the Bill of quantities is to provide a complete list of quantities necessary for the completion of any engineering project and when priced gives the estimated cost of the project.

Revised Estimate

- A revised estimate is a detailed estimate for the revised quantities and rates of items of works originally provided in the estimate without material deviations of a structural nature from the design originally approved for a project.
- It is accompanied with a comparative statement abstract form showing the probable variations for quantity, rate and amount for each item of work of the project as compared with the original estimate side by side stating the reasons of variations.
- A revised estimate is prepared and submitted for fresh technical sanction. It is required to be prepared for the following reasons:-
 - a. When a sanctioned estimate is likely to exceed by more than 5% either from the rates being found insufficient or from any cause whatsoever except important structural alterations.
 - b. When the expenditure of work exceeds or is likely to exceed by more than 10% of the administrative approval.

- c. When there are material deviations from the original proposal but not due to material deviation of a structural nature.
- d. When it is found that the sanctioned estimate is more than the actual requirement.

Supplementary Estimate

- While a work is in progress, some changes or additional works due to material deviation of a structural nature from the design originally approved may be thought necessary for the development of a project.
- An estimate is then prepared to include all such works. This is known as a supplementary estimate.
- The method of preparation of a supplementary estimate is the same as that of a detailed estimate and it should be accompanied by a full report of the circumstances which render its necessity.
- The abstract must show the amount of the original estimate and the total of the sanction required including the supplementary amount.

Combination of Revised and Supplementary Estimate

- During execution of a project it may be necessary to revise the original estimate due to increased volume of original proposed work and at the same time sanction of supplementary works.
- For such a case a revised estimate is prepared for the increased volume of original work and -a detailed estimate for the supplementary works not included in the original schedule.
- The amount of supplementary estimate is added to the revised estimate, showing the amount separately.
- Thus the total amount of the revised estimate includes the amount for supplementary works also.

Complete Estimate

- this is an estimated cost of all items which are related to the work in addition to the main contract or to the "detailed estimate".

- One may think that an estimate of a structure includes only the cost of land and the cost of the main contracts or labour, materials and supervision.

Annual Maintenance or Repair Estimate

(A.M. or A.R. Estimate):

- After completion of a work it is necessary to maintain the same for its proper function and for the same, an estimate is prepared for the items which require renewal, replacement, repairs etc. in the form of a detailed estimate.
- For buildings, such items of work like white washing, colour washing and painting of doors and windows etc., quantities are based on the previous measurements recorded in the Measurement books as Standard Measurement books.
- For petty works such as replacement of glass panels, repairs of floors, patch repairs to cement plaster to walls and changing of roof tiles or similar nature of works whose repairs cannot be estimated in the beginning, only lumpsum provision is made for different items in the estimate.
- An idea of the amount to be provided is taken from the actual figures of expenditure incurred during the last year.
- The total estimated cost of maintenance of a structure is generally kept within the prescribed limits on percentage basis (variable according to the 'importunacy of the structure) of the cost of the construction of the structure and its importance.

Detailed Estimate

- This includes the detailed particulars for the quantities, rates and costs of all the items involved for satisfactory completion of a project.
- Quantities of all items of work are calculated from their respective dimensions on the drawings on a measurement sheet.
- Multiplying these quantities by their respective rates in a separate sheet, the cost of all items of

- They should not break when two bricks in two hands are struck together or when dropped from breast height on the ground.
- Bricks should be of standard dimensions as per *I.S.I. (19cm X 9cm X 9cm)* or as prescribed by the Public Works Department.

Cement

- The cement used for reinforced concrete works shall be ordinary Portland cement or rapid—hardening Portland cement conforming to *I.S. 269* up-to-date or blast furnace slag cement conforming *I.S. 455 – 1962* or high alumina cement of approved specifications.
- The minimum compressive strength of ordinary Portland cement as per *I.S. 269* should be 175 kg/cm^2 after 7 days and the minimum tensile strength after 7 days should be 25 kg/cm^2 .
- The initial setting time should not be less than 30 minutes and the final setting time should not be more. Than 10 hours.

Sand

- The fine aggregate (sand) shall conform to either *I.S. 383 – 1963* or *I.S. 515* up-to-date.
- It shall be clean, sharp, heavy and gritty to touch.
- Sand should be free from clay, mica, vegetable and organic matter and any other foreign matter.
- River and pit sand should be used as this does not contain common salt in large quantities.
- Sand must be cleaned by screening before its use. If a sample of sand contains more than 4 to 6 percent of clay, it should be washed thoroughly.
- Sand should be perfectly dry before it is used. Otherwise the bulking effect of sand must be taken into account.
- Sand for all cement concrete works must be coarse. It should not pass through *I.S. sieve No. 480* (approximately 4.75 mm) and retain on *No. 15 sieve* (5.5 mm).
- The fineness modulus of coarse sand shall be determined by taking 500gms of it from a representative sample of sand and passing it successively through *IS. sieves* No. 480 No.240 No. 120 No.60 No. 30 and No. 15.

- Medium sand may be used in cement mortar for masonry, plastering, and pointing etc. and bituminous works of road.
- Sand fining in plinth, where specified may be done with fine sand. The fineness modulus of fine sand should not be less than one.

Water

- In concrete works the water used for both mixing and curing shall be free for amounts of deleterious materials.
- Potable water is generally considered satisfactory for mixing and curing concrete.

Lime

Quick-lime or white-lime:

- This should be obtained by burning pure limestone, chalk or sea-shells, in a kiln.
- The burning should be done with coal, charcoal or firewood as fuel, but it should not be with cow-dung.
- After burning, the pieces of stones should be picked up to exclude ash and over or under-burnt pieces Lime which has been damaged by rain, moisture, dirt etc. shall not be used.
- The lime should be slaked thoroughly on a brick platform.
- Unslaked lime must be kept in air tight vessels. Slaked lime should be packed in gunny bags, and stored in dry places so that this may not absorb moisture from the air.
- All lime that has been damaged by rain or moisture or dust should be rejected. Unslaked white lime weighs 214 kg/cu m .
- The tensile strength of briquettes after 24 hours curing by immersion in water should be 12.8 kg/sq cm .

Reinforcement: -

- The reinforcement shall be of mild steel and medium tensile steel wire conforming to *I.S. 432 – 1960* or cold twisted steel bars conforming to *I.S. 1786 – 1961* or deformed steel bat



• Work may be executed departmentally by employing daily labours such as masons, carpenters, labours etc.

The work is executed under the direct supervision of the sectional officer or junior engineer.

• The materials such as cement, sand, bricks etc. are supplied by the department through store or directly purchased from market. These are directly charged to the works.

The attendance of labours employed is recorded in daily muster roll, Form No. 21 by the sectional officer or by his authorised agent, such as supervisor or technical assistant.

The attendance of labours is checked and initialled by assistant engineer or executive engineer during their inspection.

• The labours are paid weekly, fortnightly or monthly according to the requirement.

• When the muster roll is closed for payment, the works are measured, attendance of different categories of labours and their respective total wages are worked out.

• The muster roll is then submitted to assistant engineer or executive engineer who checks the muster and passes it for payment.

The muster roll being an important document, all precautions should be taken.

• The executive engineer issues the muster roll and blank inner sheets to the assistant engineer as per the necessity.

Then the assistant engineer issues the muster to the sectional officer for engaging the labours.

A separate register muster roll form is maintained in executive engineer's office and assistant engineer's office, showing the date of issued muster numbers and to whom issued.

Register of Muster Roll Forms

Date of issue	SI. no. of muster roll	No. of inner sheets	Name of work	Dated initials of issuing officer
1	2	3	4	5

Division Signature of issuing officer and designation	Voucher and Date	Dated initial of Divl. A/c./or sub-divisional clerk	Remarks
6	7	8	9

The muster roll Form No. 21 consists of two parts:

Part I is called a nominal roll and

Part II wherein details of quantity of work done, unpaid wages are kept.

Part I:

In this part, there are columns for category of labour, Name, Father's name, dates of attendance, rates, total amount due, signature of person taking attendance and signature of officer making payment. Fines, if imposed on labours, are recorded in this part. The names of the labours are grouped according to the category.

Part II:

The details of measurement of the work done by the labours engaged on muster are recorded in

measurement book and item-wise abstract is prepared. This abstract is recorded in part II giving reference of M.B. number and page etc.

Unpaid wages are recorded in a register of unpaid wages-maintained in the subdivision office.

Whenever, the payment of these unpaid wages is made, it is made on hand receipt, Form No. 28.

Rules for Writing Muster Roll:

1. The sectional officer or his authorised agent, to whom the muster is issued, should take the attendance daily at the time of roll call.

2. Assistant engineer and executive engineer should conduct a surprise check to ensure that the entries for workers in the muster rolls are actually employed on the work or not.



3. After closing the muster roll, the sectional officer or his authorised agent should complete all the entries and payment should be made as early as possible.
4. Details of unpaid wages should be recorded in the register of unpaid wages.
5. Duplicate muster rolls should not be maintained. Muster rolls lost or destroyed should be immediately

reported to higher authorities. The superintending engineer can write off the lost or destroyed muster. Form No. 21 - Muster Roll
Cash book voucher No. ... Date
Name of work...
Part I - Nominal Roll

Category of labour	SI. No.	Name	Father's name	Date ... Month						Total	Rate ₹ P.	Amount ₹ P.	Dated initial of paying officer
				1	2	3	4	5	6				
Daily Total													
Initial of person marking daily attendance													
Initial of inspecting officer													

Passed for ₹ ... (Rupees ...)

Grand total of muster roll ...

Deduct - payment not made as per details

Transferred to register of arrears -

Total amount paid in words rupees

Date Signature Rank

Signature ... Rank ...

₹ P. P.

.....

.....

.....

Table: Form No. 21

Preparation of NMR : To prepare a Nominal Muster Roll (NMR), we require various details of working. Let us take the following example.

Consider that a NMR was maintained for a certain Government work for a period from 5th April, 2020

to 14th April, 2020. Details regarding labourers employed on this NMR, their categories, rates of daily wages, attendance are as under :

Name	Category	Rate of daily wages ₹ P.	Attendance details	Remarks
Dashrath Nana	Mason	250	Absent on 18 th morning and 13 th evening	NMR was checked by Asst. Engr. On 12 th April, 2020
Pandu Raoji	Carpenter	350	Absent on 7 th morning and afternoon	
Bhima Shankar	Mazdoor	150	Absent on 11 th afternoon	
Kisan Nathu	Mazdoor	150	Employed from 7 th April, 2020	



Let us rule out a page of Part I of NMR, enter the date given above and find out the amounts of individuals payments and the total amount of payment.

Part I : NMR

Part I : Nominal Muster Roll (NMR)

Designation	No.	Name grouped according to classes	Father's name	From 5/4/20 to 14/4/20	Total days	Rate ₹	Amount ₹	Dated initial of paying officer
1. Mason	2	Dasharath	Nana		8	250	2000	xyz
2. Carpenter	5	Pandu	Raoji		8	350	2800	xyz
3. Mazdoor	7	Bhima	Shankar		8 ½	150	1275	xyz
4. Mazdoor	7	Kisan	Nathu		7	150	1050	xyz
Initial of person marking daily attendance xyz								
Initial of Inspection officer xyz								

Signature - xyz rank - Deputy Engineer

Measurement Book (M.B.)

• It is the book in which measurement of all works and supplies are recorded in the measurement book form no. 23, and payment of all works is made on the basis of measurement recorded.

It is a very important account record. Entries are made by J.E. and certified by S.D.O. or A.E.

All pages of this book are numbered serially and a register is maintained in Divisional Office, showing Sr. No. of each book, name of sub-division, date of issue, date of return and remark. A similar register is maintained in sub-divisional office showing name of officers to whom issued, date of entry, date of return. Following points should be followed in relation with M.B.:

1. The calculations of periodical works are certified.
2. Measurements are taken accurately, preferably with steel tape.
3. All entries are recorded in ink directly in M.B.
4. No entry is allowed to be erased.

5. If any correction is required, it must be initialled by the officer who made the measurement.

6. Measurements are taken in the presence of contractor, and his signature is taken in M.B.

7. This forms a basis of payments of all items of work which can be measured.

8. It gives original record of all works.

9. Entries should be recorded continuously and no blank pages left or turn off. Any pages left blank should be cancelled by diagonal lines and signed by authority.

10. It is an auditable document.

11. Loss of measurement book is a very serious matter and should be immediately reported to higher authorities.

12. The M.B. contains name of work, name of contractor, date of measurement, location, date of work order, number of measurements.

Sample page of measurement book:

Date of commencement :

Date of completion :

Date of measurement :

SURVEYING



infinity[®]
Engineering Academy



3.1. INTRODUCTION TO SURVEYING

Introduction to Surveying

- Surveying is the science and art of determining the relative positions of various points above, on or below the surface of the earth.
- The relative positions are determined by measuring horizontal distances, vertical distances (elevations), horizontal angles and vertical angles accurately using various surveying instruments.

Primary classification of surveying

- The Primary division of surveying is made on the basis whether the curvature of the earth is considered or whether the earth is assumed to be a flat plane.
- The actual shape of the earth is an oblate spheroid. The length of the pole axis, is about 12713.168 km and that of the equatorial axis is about 12756.602 km.
- Thus the polar axis is shorter than the equatorial axis by about 43.434 km.
- On the basis of whether the curvature of the earth is taken into account or not, surveying can be divided into two main categories

Plane surveying

- Plane surveying is the type of surveying where the mean surface of the earth is considered as a plane. All angles are considered to be plane angles.
- For small areas less than 250 km² plane surveying can safely be used. For most engineering projects such as a canal, railway, highway, building, pipeline etc. constructions, this type of surveying is used.
- It is worth noting that the difference between an arc distance of 18.5 km and the subtended chord lying in the earth's surface.
- Also the sum of the angles of a plane triangle and the sum of the angles in a spherical triangle differ

by 1 second for a triangle on the earth's surface having an area of 196 km²

Geodetic surveying

- It is the type of surveying in which the curvature of the earth is taken into consideration, and a very high standard of accuracy is maintained.
- The main object of geodetic surveying is to determine the precise location of a system of widely spaced points on the surface of the earth.
- The points so located are used as control station of the primary surveys. The secondary surveys of less precision are connected to these control stations.
- For large area more than 250km², geodetic surveying is used

Functional classification

Control Surveying.

- It consists of establishing the horizontal and vertical positions of widely spaced control points using the principles of geodetic surveying.
- In India, control surveying is done by the Survey of India

Land Surveying:

- Land surveys are conducted to determine the boundaries and areas of tracts of land.
- These also known as property surveys

City Surveys.

- These surveys are conducted within the limits of a city for urban planning.
- These are required for the purpose of layout of streets, buildings, sewers, pipes, etc

Topographical Surveys: -

- These surveys are required to establish horizontal locations of the various points as well as their vertical locations, to show the natural features of the country.



Route Surveying.

- These surveys are special types of topographical surveys conducted along a proposed route for a highway, railway, sewer line, etc. The route survey is done along a wide strip.

Mine Surveys.

- These surveys are conducted to determine the relative positions and elevations of mines, shafts, adits, bore holes, etc. for underground works.

Hydrographic Surveys.

- These surveys are conducted on or near the body of water, such as lakes, rivers, bays, harbours, Marine surveys are the special type of hydrographic survey.
- The hydrographic surveys consists of locating shorelines, estimation of water flow, and determination of the shape of areas beneath the water surface.
- It also includes the determination of channel depth, location of locks, sand bars, buoys, etc.

Engineering Surveys.

- Engineering surveys are conducted to collect data for the designing and planning of engineering works
- such as building, roads, bridges, dams, reservoirs, sewers, and water supply lines These surveys generally include land surveys, city surveys, topographical surveys and route surveys discussed above.

Astronomic Surveys.

- These surveys are conducted for the determination of latitudes, longitudes, azimuths, local time, etc. for various places on the earth by observing heavenly bodies (the sun or stars).
- The absolute locations of various points on the earth are obtained by astronomic surveys

Satellite Surveys.

- These surveys are conducted to obtain intercontinental, inter datum and interisland geodetic ties all the world over by artificial earth satellites.
- These surveys are done by space agencies

Geological Surveys.

- Geological surveys are conducted to obtain information about different strata of earth's surface for geological studies.
- Geological maps are prepared to depict the details of the strata

Construction Surveys.

- All the above-mentioned surveys are conducted to obtain information required for preparation of maps, plans, sections, etc.
- After the plans have been prepared and the structures designed, the construction surveys is conducted.
- The points and lines are established on the ground, and the layout plan of the structure is marked on the ground.
- Stakes are driven for setting out. Thus construction surveys are the reverse of engineering surveys

Miscellaneous Surveys

- Archaeological surveys. These are done to unearth relics of antiquity.
- Military surveys. These are conducted to determine the routes and points of strategic importance.
- Gravity surveys. These are conducted to measure the intensity of the gravitational force at various points
- General surveys. These are used to acquire and accumulate qualitative information and quantitative data for a specific purpose by observing, counting, classifying and recording according to the need. For example, soil survey and traffic survey.

Classifications based on instrument used

a) Chain Survey.

- Here, only the linear measurements are made with a chain (or a tape) and no angular measurements are made.
- This survey is of limited use, since it requires clear ground without any obstruction like intervening trees, buildings, rivers etc.
- This survey is particularly useful for laying of sewer lines, water supply lines, construction of roads etc.

- The permanent adjustments of a prismatic compass are similar like a surveyor's compass, but they are much simpler. The following differences should be noted.

1. Adjustments of levels: In a prismatic compass, there are no level tubes hence, there is no adjustment of levels.
2. Adjustments for sight vanes: Sight vanes in a prismatic compass are not adjustable.
3. Adjustments of the needle and pivot. Needle in a prismatic compass cannot be straightened.

Errors And Measurements:

Errors of measurement are of three kinds:

Mistakes:-

1. Systematic errors
 2. Accidental errors
 3. Natural errors
- Mistakes are errors that arise from inattention, inexperience, carelessness and poor judgment or confusion in the mind of the observer.

Systematic error:-

- A systematic error is an error that under the same conditions, will always be of the same size and sign. A systematic error always follows

Accidental error:-

- Accidental errors are those which remain after mistakes and systematic error have been eliminated and are caused by a combination of reasons beyond the ability of the observer to control.
- They tend sometimes in one direction and some times in the other, i.e., they are equally likely to make the apparent result too large or too small.
- An accidental error of a single determination is the difference between (1) the true value of the quantity and (2) a determination that is free from

mistakes and systematic error. Accidental error represent the limit of precision in the determination of a value.

- They obey the laws of chance and, therefore, must be handled according to the mathematical laws of probability.

Natural errors

- Such errors may be occur due to:
 1. Variation in declination
 2. Local attraction
 3. Magnetic changes in the atmosphere due to clouds and storms
 4. irregular variations due to magnetic storms

Bowditch's method (Compass rule)

- This method is used to balance a traverse where linear and angular measurements are of equal precision.
- It is based on the errors in the linear measurements are proportional to \sqrt{l} and the angular measurements are inversely proportional to \sqrt{l}

where l = length of a line,

- Correction to latitude (Departure) of any side of traverse line

$$= \frac{\text{Total error in latitude}}{\text{(Departure)}} \times \frac{\text{length of that side}}{\text{perimeter of traverse}}$$

$$C_L = -\sum L \times \frac{L}{P} \text{ \&}$$

$$C_D = -\sum D \times \frac{L}{P}$$

where L = length of a that side

P = Perimeter of Traverse



Fieldbook

CLOSE TRAVERSE SURVEY BY PRISMATIC COMPASS

Line	Dist (M)	Reduced Length In CM (Scale: 1CM to10 M)	Bearing Observed In Degree		Difference In Degree	Error In Degree	0.5×Error	Corrected Bearing In Degree	
			FB	BB				FB	BB
PQ									
QR									
RS									
ST									



3.4 PREVIOUS YEAR QUESTIONS

1. An obstacle which obstructs chaining but not ranging may be a _____ (Nagpur ZP 2015)

- A. Building B. Lake
C. Hillock D. Electric pole

2. If the end stations of a line are free from local attraction then the difference in between fore and back bearing of that should be (Nagpur ZP 2015)

- A. 180° B. 120° C. 360° D. 90°

3. The temporary adjustment of a prismatic compass is _____. (Nagpur ZP 2015)

- A. Centering B. Adjustment of levels
C. Adjustment of needle D. Adjustment of vane

4. Accurate centering of a plane table is done by (Nagpur ZP 2015)

- A. Spirit level B. Plumbing fork
C. Alidade D. Ranging rod

5. The maximum tolerance in 20 m chain is (Nagpur ZP 2015)

- A. $\pm 2\text{mm}$ B. $\pm 3\text{mm}$ C. $\pm 5\text{mm}$ D. $\pm 8\text{mm}$

6. A total station is an instrument consisting of combination of (Jalgaon ZP 2015)

- A. Prismatic compass, theodolite and dumpy level
B. Auto level, tacheometer and compass
C. Electronic theodolite and electronics distance meter
D. Digital plainimeter with auto level.

7. A contour is a line joining points having (Jalgaon ZP 2015)

- A. Equal evaporation line

- B. Equal barometric line
C. Same elevation
D. Equal rainfall depth in a given duration

8. The curvature of earth is taken into account when the extent of survey is more than: (Jalgaon ZP 2015)

- A. 1001cm' B. 160km² C. 2001cm' D. 260km²

9. When the bubble of the level tube of a level remains central: (Jalgaon ZP 2015)

- A. Line of sight is horizontal
B. Axis of telescope is horizontal
C. Line of collimation is horizontal
D. Geometric axis of the telescope is horizontal

10. The zero of the graduated circle of a prismatic compass is located at (Jalgaon ZP 2015)

- A. North end B. East End
C. South End D. West End

11. The method of finding out the difference in elevation between two points for eliminating the effect of curvature and refraction is known as: (Jalgaon ZP 2015)

- A. Reciprocal levelling B. Precise levelling
C. Differential leveling D. Flying levelling

12. Satellites move around the earth due to: (Jalgaon ZP 2015)

- A. Gravitational Force B. Centripetal Force
C. Centrifugal Force D. Electromagnetic Force

13. In centesimal system circumference is divided into (Parbhani ZP 2015)

- A. 400 parts B. 360 parts

No.1 INSTITUTE for MPSC CIVIL ENGINEERING
HIGHEST NO. OF SELECTIONS ALL OVER MAHARASHTRA



- स्पर्धा परीक्षेमधील 7 वर्षांहून अधिक अग्रगण्य नाव
- महाराष्ट्र अभियांत्रिकी सेवा (MES)
स्थापत्य / विद्युत / यांत्रिकी साठी
पूर्व + मुख्य + मुलाखत या तिन्ही टप्प्याची तयारी करवून घेणारी
महाराष्ट्रातील नं 1 अकॅडमी
- 3500+ अधिकारी घडविणारी संस्था
- OFFLINE व ONLINE माध्यमातून मार्गदर्शन

महाराष्ट्र शासनामधील विविध विभागातील होणाऱ्या सरळसेवा भरती परीक्षांची तयारी करून घेणारी संस्था. कनिष्ठ अभियंता / अभियांत्रिकी सहाय्यक / नगर रचनाकार सहाय्यक या परीक्षांसाठी (टेक्निकल + नॉन टेक्निकल) विषय तज्ञ अनुभवी मार्गदर्शकांकडून शिकवले जातात.



सर्व स्पर्धा परीक्षेची तयारी करवून घेण्यासाठी इन्फिनिटी अकॅडमी मध्ये तज्ञ शिक्षक वर्ग आहेत.

विविध विषयासाठी (टेक्निकल + नॉन टेक्निकल) DEDICATED अनुभवी शिक्षक वर्ग असल्यामुळे स्पर्धा परीक्षेतील प्रत्येक विषयाला योग्य न्याय दिला जातो व तो विषय उत्तमप्रकारे शिकवले जातो.

विद्यार्थ्यांची स्पर्धा परीक्षेमार्फत शासनात निवड हे एकमेव ध्येय इन्फिनिटीच्या अनुभवी शिक्षकांचे आहे

No.1 INSTITUTE for MPSC CIVIL ENGINEERING
HIGHEST NO. OF SELECTIONS ALL OVER MAHARASHTRA



AEE (CIVIL) 2023

RUSHIKESH RAOSAHEB DHAMNE

MES RANK 1 MECHANICAL



PRATIK AGAWANE



MES RANK 1 ELECTRICAL



SANKET SHINDE



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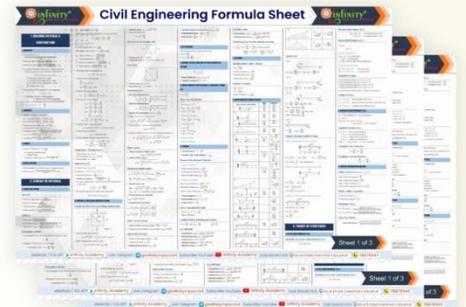
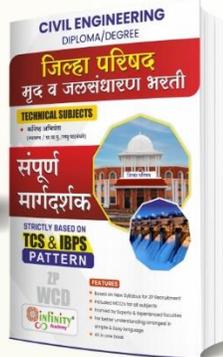
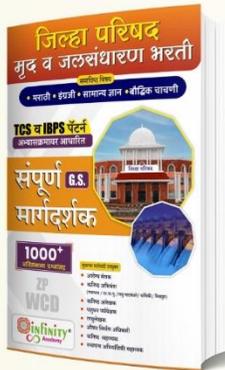
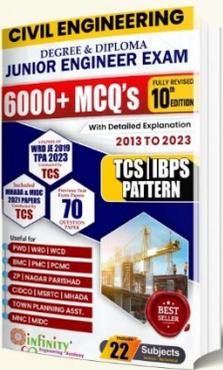
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