Introduction

As the name of this section suggests, it is meant for to recap the maximum part of the syllabus in minimum possible time. This is a part of GATE ARCHITECTURE 2018 complete set. It covers through short notes on different topics of the syllabus.

There is no limit on the discussion on the topic on General Aptitude. Scoring marks in this section depend on the intuition, clicks etc of the aspirants in the examination hall. However we have included ample examples with answer on Verbal Ability & Numerical Ability topic.

When it comes to the building services, it is essentially an engineering section. Even its topics (for example HVAC or Fire Fighting) comes from different departments. To solve a numerical from a particular topic, we need to understand the concept & theories behind it and knowledge of SI unit conversion to arrive at the precise answer. Here we have tried to introduce the topic through solved examples and derivation theories.

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BUILDING & CONSTRUCTION
Section 1: Architecture and Design
Visual composition in 2D and 3D; Principles of Art and Architecture; Organization of space; Architectural Graphics; Computer Graphics— concepts of CAD, BIM, 3D modeling and Architectural rendition; Programming languages and automation. Anthropometrics; Planning and design considerations for different building types; Site planning; Circulation- horizontal and vertical; Barrier free design; Space Standards; Building Codes; National Building Code.

Elements, construction, architectural styles and examples of different periods of Indian and Western History of Architecture; Oriental, Vernacular and Traditional architecture; Architectural developments since Industrial Revolution; Influence of modern art on architecture; Art nouveau, Eclecticism, International styles, Post Modernism, Deconstruction in architecture; Recent trends in Contemporary Architecture; Works of renowned national and international architects.

Section 2: Building Materials, Construction and Management
Behavioral characteristics and applications of different building materials viz. mud, timber, bamboo, brick, concrete, steel, glass, FRP, AAC, different polymers, composites.

Building construction techniques, methods and details; Building systems and prefabrication of building elements; Principles of Modular Coordination; Estimation, specification, valuation, professional practice; Construction planning and equipments; Project management techniques e.g. PERT, CPM etc.

Section 3: Building and Structures
Principles of strength of materials; Design of structural elements in wood, steel and RCC; Elastic and Limit State design; Structural systems in RCC and Steel; Form and Structure; Principles of Pre-stressing; High Rise and Long Span structures, gravity and lateral load resisting systems; Principles and design of disaster resistant structures.

Section 4: Environmental Planning and Design
Ecosystem- natural and man-made ecosystem; Ecological principles; Concepts of Environmental Impact Analysis; Environmental considerations in planning and design; Thermal comfort, ventilation and air movement; Principles of lighting and illumination; Climate responsive design; Solar architecture; Principles of architectural acoustics; Green Building- Concepts and Rating; ECBC; Building Performance Simulation and Evaluation; Environmental pollution- types, causes, controls and abatement strategies.

Section 5: Urban Design
Concepts and theories of urban design; Public Perception; Townscape; Public Realm; Urban design interventions for sustainable development and transportation; Historical and modern examples of urban design; Public spaces, character, spatial qualities and Sense of Place; Elements of urban built environment – urban form, spaces, structure, pattern, fabric, texture, grain etc; Principles, tools and techniques of urban design; Urban renewal and conservation; Site planning; Landscape design; Development controls – FAR, densities and building byelaws.

Section 6: Urban Planning and Housing
Planning process; Types of plans - Master Plan, City Development Plan, Structure Plan, Zonal Plan, Action Area Plan, Town Planning Scheme, Regional Plan; Salient concepts, theories and principles of urban planning; Sustainable urban development; Emerging concepts of cities - Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc.

Housing; Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing; Housing for special areas and needs; Residential densities; Standards for housing and community facilities; National Housing Policies, Programs and Schemes.

Section 7: Planning Techniques and Management
Tools and techniques of Surveys – Physical, Topographical, Landuse and Socio-economic Surveys; Methods of non-spatial and spatial data analysis; Graphic presentation of spatial data; Application of G.I.S and Remote Sensing techniques in urban and regional planning; Decision support system and Land Information System.

Urban Economics; Law of demand and supply of land and its use in planning; Social, Economical and environmental cost benefit analysis; Techniques of financial appraisal; Management of Infrastructure Projects; Development guidelines such as URDPFI; Planning Legislation and implementation – Land Acquisition Act, PPP etc.; Local self-governance.

Section 8: Services, Infrastructure and Transportation
Building Services: Water supply; Sewerage and drainage systems; Sanitary fittings and fixtures; Plumbing systems; Principles of internal and external drainage system; Principles of electrification of buildings; Intelligent Buildings; Elevators and Escalators - standards and uses; Air-Conditioning systems; Firefighting Systems; Building Safety and Security systems.


Process and Principles of Transportation Planning and Traffic Engineering; Road capacity; Traffic survey methods; Traffic flow characteristics; Traffic analyses and design considerations; Travel demand forecasting; Land-use – transportation - urban form inter-relationships; Design of roads, intersections, grade separators and parking areas; Hierarchy of roads and level of service; Traffic and transport management and control in urban areas.; Mass transportation planning; Para-transits and other modes of transportation, Pedestrian and slow moving traffic planning; Intelligent Transportation Systems. Principles of water supply and sanitation systems; water treatment; Water supply and distribution system; Water harvesting systems; Principles, Planning and Design of storm water drainage system; Sewage disposal methods; Methods of solid waste management - collection, transportation and disposal; Recycling and Reuse of solid waste; Power Supply and Communication Systems, network, design and guidelines.

General Aptitude
Section 2: Building Materials, Construction and Management

Behavioral characteristics and applications of different building materials

Timber

Introduction: The Mechanical properties and availability of wood have made it a natural material for building structures, furniture, tools, vehicles, and decorative objects. Worldwide it is used more than metal or plastic.

Wood is a natural product and when used responsibly is a sustainable resource which need not result in damage to the environment. Forests can be protected by recycling and reusing the wood, using less wood and by supporting sustainable forest management.

All wood is composed of cellulose, lignin, hemicelluloses, and minor amounts (5% to 10%) of extraneous materials contained in a cellular structure.

Wood comprises about 50% of cellulose which responsible for most of its mechanical properties.

Natural wood is generally composed of bundles of long fibres which are effectively water carrying tubes. These fibres are laid in the direction of the tree trunk or branch from which the wood is removed.

The strength of wood is highly dependent on the loading direction. Wood is strongest in tension along the fibres and is weakest in the radial and tangential direction. When loaded in its strongest direction (longitudinal along the grain - see figure below) wood can have a strength to weight ratio advantage relative to steel of 2:1. However when wood is loaded in other directions (radial and tangential to the grain- see figure below) this advantage disappears.

To use wood to its best advantage and most effectively in engineering applications, specific characteristics or physical properties must be considered.

Softwoods are one of the botanical groups of trees that has persistent needle-like or scale-like leaves; softwoods are evergreen and have longer-length fibers than hardwoods.

Softwood trees include pines, spruces, firs, cedars.

Hardwood trees are generally broadleaved trees. These tree species are deciduous, retaining their leaves only one growing season. The designation Hardwood trees does not necessarily relate to the hardness of the wood.. Hardwood trees are also called broad leaf trees or deciduous trees.

Typical hardwood trees include ash, elms, oak, maple, walnut, hickory, mahogany, and walnut. Woods grown in tropical climates are generally hardwoods. Hardwood have shorter fibers compared to softwood. Some hardwoods are evergreen.
**Plywood**

This is a product made from an odd number (three, five ...) of thin layers (veneers) of wood (generally hardwoods) bonded together by an adhesive. The alternate plies are at right angles thus ensuring that the resulting material has a high uniform strength in all directions.

Plywood does not split as easily as conventional wood and has a good dimensional stability under conditions of varying moisture conditions. Plywood will not easily split if a nail is close to any edges. Plywood can be considered as a high strength construction material used for internal and external load bearing panels.

Plywood is normally supplied as 1,2m x 2,4m sheets in thickness from 3 to 25mm thickness.

**Chipboard**

Chipboard is made from particles of wood bonded together with a synthetic resin and sometimes other binders. The panels are generally 2,4m x 1,2m with thicknesses from 3mm to 40mm. Larger sizes are available up to 5m x 1,5m. The particles are obtained from forest thinnings sawdust and small pieces of wood unsuitable for other uses are granulated to chips. The resin used is generally urea formaldehyde. Chipboard is normally only suitable for interior use in the manufacture of low cost furniture, wall panels and floor panels.

**MDF (Medium Density FibreBoard)**

There are different types fibreboard which differentiated by
..the size and type of wood fibres used
..the method of heating
..what type of bonding agent is used
..the method by which it is pressed into shape

Medium Density Fibreboard (MDF) is a wood substitute form which is made from fine wood fibres in a resin which is bonded under heat and pressure. It is manufactured by a dry process at a lower temperature than other fibreboards e.g hardboard. The natural glues and resins contained within the wood are not effective. MDF therefore uses artificial bonding agents / resins. The resin used is usually urea formaldehyde, but some fibreboard including exterior or marine quality board will use stronger glues such as phenol formaldehyde. MDF may be used instead of plywood or chipboard. It is dense, flat, stiff, has no knots and is easily machined. It is made up of fine particles and therefore does not have an easily recognisable surface grain.

MDF can be painted to produce a smooth quality surface. Because MDF has no grain it can be cut, drilled, machined and filed without damaging the surface. MDF may be dowelled together and traditional woodwork joints may even be cut. MDF may be glued together with PVA wood glue. Oil, water-based paints and varnishes may be used on MDF. Veneers and laminates may also be used to finish MDF.

**Safety:** It should be noted by anyone involved with MDF that there is an accepted risk that wood dust inhaled at certain level, is a carcinogen (cancer causing) and that formaldehyde is possibly carcinogenic to humans'. Exposure to formaldehyde by inhalation can cause irritation to the eyes, nose, throat and mucus membrane. Formaldehyde can also cause dermatitis. A number of countries have but legal limitations on the use of MDF.

**Strength of wood**

Wood is a natural product and its properties vary continuously throughout processing from when the tree is cut down. Green wood has high moisture content (generally) and this results in reduced strength. As it is dried it loses the moisture content and becomes stronger.

Wood may be described as an orthotropic material; that is, it has unique and independent mechanical properties in the directions of three mutually perpendicular axes: longitudinal, radial, and tangential. The longitudinal axis is assumed parallel to the fiber (grain); the radial axis is normal to the growth rings (perpendicular to the grain in the radial direction); and the tangential axis is perpendicular to the grain but tangent to the growth rings. (Think of the grain as the tree rings running up the trunk /branch - planks of wood are simply sections of the tree trunk (or branch).
10. A single tree can cool the summer heat for an entire day and night and is found better than 20 ACs running for 20 Hrs.
11. A hectare of trees produce about 10 times of O₂ (for 45 persons for 1 year)

<table>
<thead>
<tr>
<th>Item</th>
<th>Soft wood</th>
<th>Hard wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual rings</td>
<td>Distinct</td>
<td>Opposite</td>
</tr>
<tr>
<td>Color</td>
<td>Light</td>
<td>”</td>
</tr>
<tr>
<td>Fire resistance</td>
<td>Poor</td>
<td>”</td>
</tr>
<tr>
<td>Modular rays</td>
<td>Indistinct</td>
<td>”</td>
</tr>
<tr>
<td>Strength</td>
<td>Strong for direct pull and weak for resisting thrust or shear</td>
<td>”</td>
</tr>
<tr>
<td>Structure</td>
<td>Resinous and split easily</td>
<td>”</td>
</tr>
<tr>
<td>Weight</td>
<td>Light</td>
<td>”</td>
</tr>
</tbody>
</table>

12. Defects in timber
   a. Conversion
   b. Fungi
   c. Insects
   d. Natural forces
   e. Seasoning
FRP

Fiberglass Reinforced Plastic Panels (FRP) are modern composite materials that have become popular in the construction industry. These panels are made from a combination of glass fibers and plastics. The fibers act similar to beams in a house, reinforcing the structure of the polymer, making it more stable and strong. A fiberglass reinforced panel used in construction usually has the following components:

- A base polymer, usually, plastics like polyester
- A fiberglass reinforcement
- Other additives to improve desirable qualities like fire resistance, and opacity to UV rays
- Surface veils for a smooth finish and extra durability

Panels made from fiberglass reinforced plastics are lightweight, yet strong and flexible. They are quite superior to traditional building materials like wood and metal on several counts.

It offers the architect unlimited design flexibility due to its molded shape potential. From columns to cornices, Fiberglass (FRP) has been used around the world to add decorative dimensionality to projects while being a cost alternative to many traditional building materials.

Fiberglass reinforced polymers (FRP) is a lightweight, versatile and durable construction material for exterior architectural detailing. FRP is used to create columns, capitals, moldings, domes, decorative balustrades, pergolas, rafter tails, entablatures, pediments, rakes, brackets, quoins, window and door surrounds or any architectural feature you wish to create. fiberglass is extremely versatile. It can be molded and produced in practically any shape. FRP parts can be made on a radius or ellipse. You can have letters perform in the fiberglass parts to mimic the look of chiseled stone words on building facades.

There are great advantages to specifying and installing fiberglass on your construction project. Fiberglass is lightweight with strong and durable properties. Since it is lightweight, FRP enables the building design to require less structural load requirements, thus reducing costs for the project.

FRP can be supplied several ways. For many projects, FRP is supplied unpainted. This enables the installer to attach the FRP to the structure with the ability to countersink screws, patch the screw holes with body filler and sand the screw holes flush with the fiberglass surface. The entire project is then primed and painted giving the material a uniform, finished appearance.

FRP can also be supplied with a gel coated colored finish. Almost any color can be achieved. Some projects require that the FRP arrive to the jobsite with a finished coat. When specifying a finished FRP, there are certain things to take into consideration. Firstly, there needs to be strong communication between the architect, construction manager, supplier and installer. Prefinished FRP needs to handled and installed properly to protect the finish. Screws need to be strategically installed to minimize the number of exposed areas on the surface of the material.

A third process for producing fiberglass is with a simulated stone finish. This can give the FRP the appearance of limestone and other stone finishes. The same planning and care must be followed for handling and installation the stone finished FRP as with the gel coated colored FRP.

AAC Blocks
Principles of Modular Coordination;

Basic principles of modular coordination: a method of cost reduction in building through standardized dimensions and assembly methods / Housing and Home Finance Agency.

- Modular coordination is a concept of coordination of dimension and space in which buildings and components are dimensioned and positioned in terms of basic unit or module.

- It is internationally accepted by the International Standard Organization and many other countries

A module: a basic dimension which could for example form the basis of a planning grid in terms of multiples and submultiples of standard module.

Provide guide to building component sizing: this can reduce as much as possible the needs to further trim and shape the materials to fit together in construction thus, reducing wastage of labor and material.

Aims

To achieve dimensional compatibility between building dimensions, span, or spaces and the sizes of components or equipment by using related modular dimensions.

Making the planning simpler & clearer by distinct indication of location of the building component in the building, both in respect to each other & a modular grid.

Simplification of site work.

Limiting the member of sizes of building component so that the linkage is based on modular measurement.

Facilitating cooperation between designers, manufacturers, suppliers & builders.

Providing practical and logical construction methods for the coordination of the position & dimension of elements, components & spaces in a building design, which will contribute to first - increased design freedom. second - improve balance between quality and cost of the manufacturing the component.

Creating a basis for rationalization of both general & special building drawings for modular building components & assembling details.

Basics of Module: The basic module is known as 1M which is equivalent to 100mm.

There are three type of MODULE :-

(I) Basic Module (II) Multi Module (III) Sub Module

Basic Module: It is the fundamental unit of size in modular coordination and for general application to building & components. The size of basic Module is taken as 100mm denoted by “M”. It is considered to be large enough to effect some variety reduction in range of component size and is small enough to provide a flexible unit of measurement for the purpose of design.

Multi Module: Certain whole multiples of basic module usually expressed in as “M” with numeric prefix as 2M, 3M, 4M etc are referred to as multi module.

Sub Module: Certain submultiples of basic module which are whole simple fractions shall be chosen when absolutely necessary for an increment smaller than the basic module. For practical considerations, this sub modular increment shall be expressed as “M” with fractional prefix as 1/5M, 1/4M, 1/3M, etc.
Estimation, specification, valuation

Cost & Estimation

Types Of Estimates

The estimates may be divided in to the following categories:-

1. Preliminary or Approximate estimate
2. Rough cost estimate based on plinth area.
3. Rough cost estimate based on cubic contents.
4. Detailed estimate.
5. Annual repair estimate.
7. Revised estimate
8. Supplementary estimate.

1. Preliminary or Approximate estimate

This estimate is prepared to decide financial aspect, policy and to give idea of the cost of the proposal to the competent sanctioning authority. It should clearly show the necessity of the proposal and how the cost has been arrived at.

The calculations for approximate estimate can be done with the following data. The data can be had from a similar construction already complete in the nearby area, executed by the department.

For example: To calculate approximate estimate for a Hospital, per bed cost is calculated from the recent completed hospital and is multiplied with the number of beds required. Similarly for a house, per square metre plinth area is calculated and is multiplied with the proposed covered area. The specifications should also be same. For a road, expenditure of per kilometer length is taken, width also plays the role.

The following documents should be attached with it.

(a) Detailed report
(b) Site plan of the proposal
(c) It should also clearly mention about the acquisition of land, Provision of electric and water supply etc.

2. Plinth area Estimate (Based on Rough Cost)

Plinth area of a building means Length x Breadth (roofed portion only) excluding plinth offsets. The estimates are prepared on the basis of plinth areas of the various buildings proposed to be constructed. The rates are being arrived at the dividing the total cost of construction with its plinth area. For example if total cost of a building is Rs. 2 lac and its plinth area is 50 sq. m. then plinth area rate = 2,00,000 = Rs.4000/- per 50 sq.m. Using this rate as basis of the next construction, approximate or rough cost of the proposal can be arrived at by multiplying the plinth area of the proposed building with this plinth area rate.

The following documents are attached with the estimate.

(a) Line plan with brief specifications.
(b) Cost of various services added i.e. electric and water supply etc.
(c) North line should be shown clearly on line plan.

3. Cubic Contents Estimate (Based on Rough Cost)

The cubic contents of a building means plinth area x height of the building. The height is taken from top of floor level to top of roof.
The cubic contents of the proposed building are multiplied with cubic rates arrived at for the similar construction i.e. total cost of construction divided by cubic contents = cost per cubic metre.

4. Detailed Estimate

After getting Administrative approval on rough cost estimate, detailed estimates are prepared.

In this, the estimate is divided into sub-heads and quantities of various items are calculated individually.

In the end of the detailed quantities, an abstract of cost giving quantities of each item and rate of every item according to the sanctioned schedule of rates shall be attached. In case of non-schedule rates i.e. rates which are not given in the sanctioned schedule of rates, proper analysis of rates shall be attached. If however the work proposed to be constructed is located in a remote place, the provision for the carriage of the material shall be added in the estimate to avoid any excess over the administratively approved estimate later on. Detailed specifications & report should also be attached with the estimate. Technical sanction is given on detailed estimate.

The detailed estimate shall also provide for the cost of approach road, water supply, electric installations and acquisition of land etc, so as to call it a comprehensive estimate.

5. Annual repair estimate

In order to keep building and roads in perfect condition, annual repairs should be carried out as follows:

(i) In case of a building-white washing, oiling and painting of doors and windows, cement plaster repairs (inside & outside), repairs of floors etc. In no case this annual repair amount should increase more than 11/2% to 2% of the capital cost of the building.

(ii) In case of a road-filling patches, maintenance of berms etc.

6. Special repair estimate

If the work cannot be carried out of the annual repair funds due to certain reasons resulting in the genuine increase in cost, then special repairs estimate is to be prepared.

The reason of increase may be:

(i) In case of a building-opening of new doors, change of floors, replastering walls etc.

(ii) In case of roads-if the whole surface is full of corrugation & patches, then the total surface is to be scarified. The old metal is taken out, consolidation by adding more metal is done and top surface is repainted.

7. Revised estimate

When the sanctioned estimate exceeds by 5% either due to the rate being found insufficient or due to some other reasons, a fresh estimate is prepared which is called a Revised Estimate. A comparative statement on the last page of the estimate is attached giving there in the reasons of the increase of cost in case of each item.

8. Supplementary Estimate

This is fresh detailed estimate in addition to the original sanctioned estimate prepared when additional works are deemed necessary during the progress of a work to supplement the original works. The abstract of cost should show the amount of the original sanctioned estimate as well as the supplementary amount of the original sanctioned estimate as well as the supplementary amount for which sanction is required.

Methods of Taking out Estimates

The calculations of quantities of materials can be done using various methods of estimates. The application of an individual method depends upon the design and shape of the building. The different methods are as under:

1. Centre line method.
2. Crossing method.
3. Out to out and in to in method.
5. Service unit method.
1. Centre line method

This method is suitable only if the offsets are symmetrical and the building is more or less rectangular in shape. The centre line of the building is determined carefully after doing deductions for repeated measurements (as explained in the next problem). This centre line acts as length for the complete calculations of the estimate. If the deduction is not cared for the results of estimates may be wrong. All the walls should have the same section.

2. Crossing Method

In this method, lengths and breadths of the masonry walls at plinth level are taken (internal dimension of the room + thickness of the walls) for calculating quantities. The symmetrical offsets are a must as in the case of centerline method.

3. Out to out & in to in Method

This method is most practicable under all circumstances and is generally followed in the P.W.D. for computing the quantities of various items. The estimation in this book has been done using this method.

4. Bay Method

This method is useful and is generally followed in case of building having several bays. The cost of the one class room is worked out and then multiplied by the number of bays in that building. The extra cost of the end walls and difference in framing. If there is any, should be made, so as to arrive at the correct cost.

5. Service Unit Method.

This method is followed in cases such as school building where there are so many class rooms. The cost of one class room us worked out and then multiplied by the number of class rooms to be constructed. In case of Hospitals, the service unit is a bed, in case of Water Tank, it is a litre and in case of Cinema Hall, the service unit is a seat.

Example:

Calculate the quantities of the following items from the given figure upto G.L., using

(a) Centre line method

1. Excavation for foundations.
2. Cement Concrete in foundations.
3. Brick work in cement mortar (1:4)

Solution:

Figure: Calculate quantities
GENERAL SPECIFICATIONS

General specifications give the idea and class of work in general terms and are generally attached with the rough cost and detailed estimates.

1. GENERAL SPECIFICATIONS OF FIRST CLASS BUILDINGS

Foundation and Plinth: Shall be of first class burnt bricks in lime or cement mortar (1:6) over a bed of cement concrete. (1:6:12 or 1:8:16)

Superstructure: Shall be of first class burnt brick work in lime or cement mortar (1:6)

Damp Proof Course: Shall be of a cm thick cement concrete (1:2:4) with an outer layer of bitumen laid hot or any other specified water proof material.

Roofing: Shall be of R.C.C. slabs (1:2:4) covered with two coats of bitumen and a layer of lime or cement concrete 8 cm. thick over it with a tile flooring with cement flush with cement flush pointed on the top.

Flooring: Shall be of TERRAZO in drawing, dining, bath and W.C., 4 cm thick plain conglomerate polished floors in bed rooms and in other rooms.

Doors and Windows: Doors and windows shall be of teak wood, paneled or paneled and glazed with gauze shutters to outer doors and fixed wire gauze to windows and ventilators. Fittings shall preferably of brass or good quality metal.

Finishing: The inside and outside walls shall have 1.25 cm. thick cement plaster. Drawing, dining and bed rooms inside of walls shall have two coats of distemper and other rooms shall have three coats of white washing. The outside of the wall shall have two coats of colour washing over one coat of white washing.

Painting: Doors and windows shall be given three coats of white lead where exposed and white zinc or cream or grey silicate paint elsewhere.

Miscellaneous:

First class buildings shall be provided with first class sanitary and water supply fittings and electrical installations. A plinth protection 1.50 m. wide of bricks sloped away from the building shall be provided all round the building.

Plinth Area Rate: Rs. 4500.00 to Rs. 5,500 per sq. meter. (Rates variable)

DETAILED SPECIFICATIONS

Detailed specifications give the method of constructions and specify the nature of work.

1. EXCAVATION OF FOUNDATIONS

Equality of pressure should be aimed at in designing foundations. The foundation

Trenches shall be taken down to the exact width of the widest part of the foundation. The trenches where possible shall always be taken down to a few cms into good hard soil. In order to ascertain the nature of the soil, it is essential to dig trial pits at each of the four corners of the proposed site of a building before starting the construction.

The bottoms of all trenches shall be well watered and rammed. The soft and defective place shall be filled with concrete or with any other hard material as directed by the Engineer-in-charge.

If, however, rocky surface is met, it shall be made as leveled as possible and any small in equalities shall be filed with concrete.

Foundation in bad soil

Where great depths of bad soil are met with, such as black cotton soil, it may be necessary to resort to piles which may be of wood, steel or reinforced concrete. Where the depth of the bad soil is not excessive, the foundations may consist of beams or concrete arches of concrete pillars.
The pillars being taken down into good soil. In some cases the structure may be built on a raft of concrete reinforced with a grillage of R.s Beams.

2. EARTH FILLING

Earth used for filling shall be free from salt peter and white ants and only foamy and clayey soil free from clods shall be used. It shall be laid in 15 cm layers and each layer shall be well watered and rammed with iron rammers. In case of high embankments, the layers shall not exceed 30 cm depth and the settlement allowances shall be made @ 10% of the height of uncomapacted fills.

3. Concrete in foundations

Lime concrete or cement concrete shall be used in foundations to be a base for the super structure.

3.1. LIME CONCRETE

Ingredients

Lime, Surkhi, Sand, Brick ballast or stone ballast and water.

3.1.1. Lime

Lime is always used as putty lime of class „B” [semi – hydraulic or quick lime form] and Class „C” [Non- hydraulic in hydrated or quick lime form], shall be used as directed by the Executive Engineer.

The hydrated lime used should be thoroughly mixed with water in suitable container. It shall then be stirred into thick consistency and left undistributed for not less than 36 hours. Extra water should be drained out and putty should be bused. Similarly quick lime should be converted into putty. The volume of lime putty shall be taken as equal to the volume of dry slaked lime.

3.1.2 surkhi

Surkhi shall be obtained by pounding fully bricks or bats. It shall be free from admixture of clay, dust or foreign matter. No un burnt bricks or bats shall, be used for grinding in to surkhi.

3.1.3 Aggregate

The brick aggregate shall be broken from first class or second class bricks or their bats, or from dense over burnt bricks. The gauge of the ballast shall be 2 cm to 4 cm.

The stone aggregate shall consist of good hard tough broken stone, gravel or shingle of the gauge specified. It shall free from dirt, leaves or any other organic, or admixture of soft or decayed stone.

3.1.4 Water

Water used in construction shall be clean, free earthly, vegetable or organic impurities, like alkalis, salts etc. which cause efflorescence and affect setting time of mortar.

4. Mixing And Laying

The aggregate previously well soaked, shall be measured and laid on a clean platform of brick layout or wood. The platform shall be sufficient size to give ample room for mixing 23 to 28 cub.m. of concrete. Lime and surkhi shall be measured and laid on the aggregate. The whole dry and wet mix is then turned over three or four times so that it shall be thoroughly mixed concrete shall be laid slowly and gently in layer of 15 cm (not thrown from a height) and thoroughly consolidated with 5.5 kg. Rammers shall be used for consolidating the edges.

5. Tests

The consolidation of a concrete is said to be complete if (a) a stick end ways from a height of I m rebounds with ringing sound. (b) The second test is by digging a hole in the concrete and pouring water in the hole. If the consolidation in complete, the water shall not be absorbed in the.

6. Curing
VALUATION

Valuation means fixation of cost or return expected of a building, engineering structure project (Govt. or private), at present rates. The value of a structure may be more or less depending upon the present utility of a structure. For example, a house having a number of rooms but smaller in size will fetch less value than a house, may be smaller in area but having well planned and proper sized of rooms.

Necessity of Valuation

The following reasons necessitates the valuation of property:
(i) Rent fixation. It is generally taken as 6% of the valuation of the property.
(ii) For buying and selling.
(iii) Acquisition of property by Govt.
(iv) To be mortgaged with bank or any other society to raise loan.
(v) For various taxes to be given and fixed, by the Municipal Committee.
(vi) Insurance: For taking out on insurance policies.

Role of an Architect and Engineer

Valuation is felt when an building structure is to be valued, if and when it is:
(a) To be acquired
(b) To be divide
(c) To be allotted to a claim holder.

The following factors require consideration for valuation:
(i) Locality:
In case a building is located in such an area, where there is easy access to market, schools and is located on road side. The Orientation of the building is according to Engineering rules. It will fetch more cost than a building which is in a neglected condition and is locate at unhealthy site.

(ii) Structure:
The structure of a building is also an important consideration while evaluating a building. Workmanship I attractive and the building is properly maintained, it will fetch more cost than the building in a neglected form with poor quality of material used.

According to specifications a building is divided in four classes:

- First Class
- Second Class
- Third Class
- Fourth Class

For Details, see chapter on specifications

Value: Present day cost of a Engineering structure (Saleable value)

Cost: Original cost of construction. It is used to find out the loss of value of property due to various reasons.

Net Income: Total amount of the income received from a property during the year, without deducting outgoing.

Gross Income: Total amount of the income received form a property during the year, without deducting outgoing.

Net income: An amount left at the end of the year after deducting all usual outgoings.

Out goings: These are expenses which are incurred on a building so that it may give back revenue. The following are various outgoings.
(i) **Taxes:** These are annual taxes paid by the owner, such as wealth tax, property tax and municipal taxes (varies from 10% to 25% of net income).

(ii) **Management:** Upto 10% of the gross revenue is kept aside for this expenses. This includes, *chowkidar*, *sweeper* etc. this is applicable only for big buildings or apartments.

(iii) **Repairs:** For this 1 ½ % of the total construction is set aside for annual repairs of the building. These repairs are must to maintain the building. It is also calculated as 10% of the gross income.

(iv) **Sinking fund:** This is also taken as outgoings (For details see definition).

(v) **Miscellaneous:** This is again suitable for big buildings. Lighting of common place, expenditure of liftman etc. are to be paid by the owner.

(vi) **Loss of Rent:** This is also an outgoing in case a building in not fully occupied by the tenants. This has to be deducted from gross income.

(vii) **Insurance:** Premium given against fire or for theft policy.

**Obsolescence:** The value of property decreases if its style and design are outdated i.e. rooms not properly set, thick walls, poor ventilation etc. the reasons of this is fast changing techniques of construction, design, ideas leading to more comfort etc.

**Free hold Property:** Any property which is in complete possession f the owner is known as free hold property. The owner can use the property in an way he likes. But he will have to follow constraints fixed by town planners or Municipality before doing any construction.

**Lease hold:** If a property is given to some person on yearly payment basis by the free holder, then the property is called „lease hold property” and the person who take s the property is called Lease holder. In case of building, the lease is for 99 years to 9 years.

**Easement:** An owner getting over the property of another person, the following faculties is known as easements.

(i) Facility of running water and sewer pipes through other’s land.
(ii) Facility of air and light.
(iii) Facility of drainage of rain water.
(iv) Facility of access.

The owner who gives facilities is known as Servant owner and who enjoys facilities is called Dominant owner.

**Scrap Value:** If a building is to be dismantled after the period of its utility is over, some amount can be fetched from the sale of old materials. The amount is known as Scrap Value of a building. If varies from 8% to 10% of the cost of construction according to the availability of the material.

In case where Wood & Steel are available, the scrap value is more than as R.C.C structure, as in the latter case, the material has less reuse value.

**Salvage Value:** If property after being discarded at the end of the utility period is sold without being broken into pieces, the amount thus realized by sale is known as its Salvage Value.

For example, railway sleepers can be re-used as posts and even old iron rails taken out can be used as beams in a roof or sheds of a building.

**Building Cost Index:**

A building cost index indicates the increase and decrease of the cost above the cost at a certain base year and is expressed by a percentage rise & fall. For instance taking 1960 as abase year, the present 1980 as Building Cost Index may be taken 1.25% to 150% above the cost during the year 1960.

This index depends upon cost of material, labour, transport etc.
Capitalized value:- It is defined as the amount of money whose annual interest at the highest prevailing rate will be equal to the net income received from the property. To calculate the capitalized value, it is necessary to know highest rate of interest prevailing on such properties and net income form the property.

Sinking Fund:- A fund which is gradually accumulated and aside to reconstruct the property after the expiry of the period of utility is known as

sinking Fund. The sinking funds may be found out by taking a sinking fund policy with any insurance company or depositing some amount in the bank. Generally while calculating the sinking fund, life of the building is considered. 90% of cost of construction is used for calculations & 10% is left out as scrap value.

The formula used to find out the annual sinking fund is

\[ I = \frac{St}{(1+i)^n - 1} \]

Where

\[ I = \text{Annual installment required} \]
\[ N = \text{Number of years required to creat sinking fund.} \]
\[ I = \text{Rate of interest expressed in decimal i.e. 5% as .05}. \]
\[ S = \text{Amount of sinking fund}. \]

Example: A printing machine is to be installed at a cost of 30000/- in a press. Assuming the life of the machine as 20 years. Calculate the amount of annual installment of sinking fund to be deposited to accumulate the whole amount of 5% compound interest.

The annual sinking fund

\[ I = \frac{30000 \times 0.05}{(1 + 0.05)^{20} - 1} = \text{Rs. 906.30} \]

The owner will have to deposit Rs. 906.30 per year in 5% compound interest for 20 years to accumulate Rs. 30,000/-. 

Note: In certain cases, old buildings are purchased and in that case scrap value into be deducted from the amount spent so as to calculate the amount of Sinking fund.

Example: An old shop in the main market has been purchased by a person as a cost of Rs. 20000/-. Work out the amount of annual sinking fund at 3% interest assuming future life of the building as 15 years and scrap value of the building as 10% of the cost of purchase.

Solution:

Cost of the shop = Rs. 20000/-

Less scrape value = Rs. 2000/-

Net Rs. 18000/-

Amount of sinking fund to be accumulated after 15 years = Rs. 18000/-

Annual instalment of sinking fund.

\[ I = \frac{St}{(1+i)^n - 1} \]

\[ = \frac{18000 \times 0.03}{(1 + 0.03)^{15} - 1} = \text{Rs. 971.20} \]
**Excavators**

Excavators are heavy construction equipment consisting of a boom, stick, bucket and cab on a rotating platform (known as the "house").

The house sits atop an undercarriage with tracks or wheels.

Excavators are also called diggers

Excavators are used in many ways:

- Digging of trenches, holes, foundations
- Material handling
- Brush cutting with hydraulic attachments
- Forestry work
- Demolition
- General grading/landscaping
- Heavy lift, e.g. lifting and placing of pipes
- Mining, especially, but not only open-pit mining
- River dredging
- Driving piles, in conjunction with a pile driver

![Figure: Excavators](image)

**Loader**

A **loader** is a heavy equipment machine often used in construction, primarily used to load material (such as asphalt, demolition debris, dirt, snow, feed, gravel, logs, raw minerals, recycled material, rock, sand, and woodchips) into or onto another type of machinery (such as a dump truck, conveyor belt, feed-hopper, or railcar).

![Figure: Loader](image)

**Skid steer loaders**

A **skid loader** or **skid-steer loader** is a small rigid frame, engine-powered machine with lift arms used to attach a wide variety of labor-saving tools or attachments.

Though sometimes they are equipped with tracks, skid-steer loaders are typically four-wheel vehicles with the wheels mechanically locked in synchronization on each side, and the left-side drive wheels can be driven independently of the right-side drive wheels.

![Figure: Skid steer loaders](image)
Graders

A grader, also commonly referred to as a road grader, a blade, a maintainer, or a motor grader, is a construction machine with a long blade used to create a flat surface.

Typical models have three axles, with the engine and cab situated above the rear axles at one end of the vehicle and a third axle at the front end of the vehicle, with the blade in between.

In civil engineering, the grader's purpose is to "finish grade" (refine, set precisely) the "rough grading" performed by heavy equipment or engineering vehicles such as scrapers and bulldozers.

Graders are commonly used in the construction and maintenance of dirt roads and gravel roads.

In the construction of paved roads they are used to prepare the base course to create a wide flat surface for the asphalt to be placed on. Graders are also used to set native soil foundation pads to finish grade prior to the construction of large buildings.

Crawler Loaders

The crawler loader combines the stability of the crawler tractor with the abilities of a wheel loader.

However, to construct a reliable crawler loader it requires more than simply attaching a loader bucket onto a crawler tractor. It must be designed with its specific purpose in mind to ensure it has the strength to withstand heavy excavating.

The introduction of hydraulic excavators diminished the market for the crawler loader because it was unable to match the excavator's lifting power and flexibility.

However, crawler loaders are capable of maneuvering across the entire construction site under its own power, whereas most hydraulic excavators require towing or transport. While crawler tractors are still being manufactured today for niche markets, they reached their peak of popularity in the 1960s.

Backhoe

A backhoe, also called a rear actor or back actor, is a piece of excavating equipment or digger consisting of a digging bucket on the end of a two-part articulated arm. They are typically mounted
1. INTRODUCTION

Basically, CPM (Critical Path Method) and PERT (Programme Evaluation Review Technique) are project management techniques, which have been created out of the need of Western industrial and military establishments to plan, schedule and control complex projects.

1.1 Brief History of CPM/PERT

CPM/PERT or Network Analysis as the technique is sometimes called, developed along two parallel streams, one industrial and the other military.

CPM was the discovery of M.R.Walker of E.I.Du Pont de Nemours & Co. and J.E.Kelly of Remington Rand, circa 1957. The computation was designed for the UNIVAC-I computer. The first test was made in 1958, when CPM was applied to the construction of a new chemical plant. In March 1959, the method was applied to a maintenance shut-down at the Du Pont works in Louisville, Kentucky. Unproductive time was reduced from 125 to 93 hours.

PERT was devised in 1958 for the POLARIS missile program by the Program Evaluation Branch of the Special Projects office of the U.S.Navy, helped by the Lockheed Missile Systems division and the Consultant firm of Booz-Allen & Hamilton. The calculations were so arranged so that they could be carried out on the IBM Naval Ordinance Research Computer (NORC) at Dahlgren, Virginia.

1.2 Planning, Scheduling & Control

Planning, Scheduling (or organising) and Control are considered to be basic Managerial functions, and CPM/PERT has been rightfully accorded due importance in the literature on Operations Research and Quantitative Analysis. Far more than the technical benefits, it was found that PERT/CPM provided a focus around which managers could brain-storm and put their ideas together. It proved to be a great communication medium by which thinkers and planners at one level could communicate their ideas, their doubts and fears to another level. Most important, it became a useful tool for evaluating the performance of individuals and teams. There are many variations of CPM/PERT which have been useful in planning costs, scheduling manpower and machine time. CPM/PERT can answer the following important questions:

- How long will the entire project take to be completed? What are the risks involved?
- Which are the critical activities or tasks in the project which could delay the entire project if they were not completed on time?
- Is the project on schedule, behind schedule or ahead of schedule?
- If the project has to be finished earlier than planned, what is the best way to do this at the least cost?

1.3 The Framework for PERT and CPM

Essentially, there are six steps which are common to both the techniques. The procedure is listed below:

I. Define the Project and all of it’s significant activities or tasks. The Project (made up of several tasks) should have only a single start activity and a single finish activity.

II. Develop the relationships among the activities. Decide which activities must precede and which must follow others.

III. Draw the “Network” connecting all the activities. Each Activity should have unique event numbers. Dummy arrows are used where required to avoid giving the same numbering to two activities.

IV. Assign time and/or cost estimates to each activity

V. Compute the longest time path through the network. This is called the critical path.

VI. Use the Network to help plan, schedule, monitor and control the project.

The Key Concept used by CPM/PERT is that a small set of activities, which make up the longest path through the activity network control the entire project. If these “critical” activities could be identified and assigned to responsible persons, management resources could be optimally used by concentrating on the few activities which determine the fate of the entire project.

Non-critical activities can be replanned, rescheduled and resources for them can be reallocated flexibly, without affecting the whole project.

Five useful questions to ask when preparing an activity network are:

- Is this a Start Activity?
- Is this a Finish Activity?
- What Activity Precedes this?
- What Activity Follows this?
What Activity is Concurrent with this?

Some activities are serially linked. The second activity can begin only after the first activity is completed. In certain cases, the activities are concurrent, because they are independent of each other and can start simultaneously. This is especially the case in organisations which have supervisory resources so that work can be delegated to various departments which will be responsible for the activities and their completion as planned. When work is delegated like this, the need for constant feedback and co-ordination becomes an important senior management pre-occupation.

1.4 Drawing the CPM/PERT Network

Each activity (or sub-project) in a PERT/CPM Network is represented by an arrow symbol. Each activity is preceded and succeeded by an event, represented as a circle and numbered.

At Event 3, we have to evaluate two predecessor activities - Activity 1-3 and Activity 2-3, both of which are predecessor activities. Activity 1-3 gives us an Earliest Start of 3 weeks at Event 3. However, Activity 2-3 also has to be completed before Event 3 can begin. Along this route, the Earliest Start would be 4+0=4. The rule is to take the longer (bigger) of the two Earliest Starts. So the Earliest Start at event 3 is 4.

Similarly, at Event 4, we find we have to evaluate two predecessor activities - Activity 2-4 and Activity 3-4. Along Activity 2-4, the Earliest Start at Event 4 would be 10 wks, but along Activity 3-4, the Earliest Start at Event 4 would be 11 wks. Since 11 wks is larger than 10 wks, we select it as the Earliest Start at Event 4. 

We have now found the longest path through the network. It will take 11 weeks along activities 1-2, 2-3 and 3-4. This is the Critical Path.

1.5.3 The Backward Pass - Latest Finish Time Rule

To make the Backward Pass, we begin at the sink or the final event and work backwards to the first event.

At Event 3 there is only one activity, Activity 3-4 in the backward pass, and we find that the value is 11-7 = 4 weeks. However at Event 2 we have to evaluate 2 activities, 2-3 and 2-4. We find that the backward pass through 2-4 gives us a value of 11-6 = 5 while 2-3 gives us 4-0 = 4. We take the smaller value of 4 on the backward pass.

1.5.4 Tabulation & Analysis of Activities

We are now ready to tabulate the various events and calculate the Earliest and Latest Start and Finish times. We are also now ready to compute the SLACK or TOTAL FLOAT, which is defined as the difference between the Latest
15. sanitary fitting used to receive the human excreta directly from user is called water closet
16. Appliances used to flush water closets, urinals are flushing cisterns.
17. The pipe that conveys the discharge of water closets or fixtures is called soil pipe.
18. The water seals in the trap are prevented from braking by means of the ventilating pipe.
19. All drainage pipe should be covered with a G.I wire dome.
20. Minimum self cleaning velocity for house drains 0.75 m/sec.

Hierarchy of roads and levels of services

1. Classification of urban roads
   a. Express ways
      i. for motor traffic with full or partial control of access
      ii. provided with grade separation at intersections
      iii. to provide for movement of heavy volumes at high speeds
      iv. free flow conditions
      v. connect major points of traffic generation
      vi. to serve trips of medium and long lengths between res, ind, comm., CBD areas
   b. Arterial streets
      i. thorough traffic usually on continuous route
      ii. between CBD to resi, sub urbans
      iii. generally spaced at less than 1.5 kms in CBDs 8 kms in developed urban fringes
      iv. parking, loading etc are regulated
   c. Sub-arterial streets
      i. access to adjoining areas
      ii. parking, loading etc are regulated
      iii. generally spaced at less than 05 kms in CBDs, 3-5 kms in developed urban fringes
   d. Collector streets
      i. collection and distribution of traffic
      ii. in resi, ind, neighborhoods
      iii. few parking restrictions except during peak hours
   e. Local streets
      i. access to resi, business, etc
      ii. Allows loading, pedestrians, parking etc.

2. Classification of rural roads
   a. National highways
      i. connects ports, foreign highways, capital of states
   b. State highways
      i. connects national headquarters and important cities
      ii. same standard as national highways
   c. District roads
      i. serves areas of production and marketing
      ii. Capable of taking traffic into the heart of rural areas.
   d. Village roads
      i. connects villages with nearest national, state or railways

Intersection and parking areas

1. Intersection – the general area where 2 or more ways join or across
2. Half of the fatal and serious road accidents in built up areas occur at junctions.
3. Principles in a good design
   a. The number of intersections should be kept a minimum. If necessary some minor roads may be connected with each other before joining the major road.
   b. Hazardous movements by drivers are eliminated by various techniques such as channelizing and staggering.
   c. The design should permit the driver to discern quickly either from the layout or traffic signs
   d. Layout should follow natural vehicle paths
Traffic density
Traffic density is the number of vehicles occupying a unit length of lane of roadway at a given instant, usually expressed as vehicles per kilometer. Traffic volume is the product of the traffic density and traffic speed. The highest traffic density will occur when the vehicles are practically at a stand still on a given route, and in this case traffic volume will approach zero.

Traffic capacity
Traffic capacity is the ability of a roadway to accommodate traffic volume. It is expressed as the maximum number of vehicles in a lane or a road that can pass a given point in unit time, usually an hour, i.e., vehicles per hour per lane or roadway. Capacity and volume are measures of traffic flow and have the same units. Volume represents an actual rate of flow and responds to variations in traffic demand, while capacity indicates a capability or maximum rate of flow with a certain level of service characteristics that can be carried by the roadway.

Passenger Car Unit (PCU)
Different classes of vehicles such as cars, vans, buses, trucks, auto rickshaw, motor cycles, pedal cycles, bullock carts, etc. are found to use the common roadway facilities without segregation on most of the roads in developing countries like India. The flow of traffic with unrestricted mixing of different vehicle classes on the roadways forms the heterogeneous traffic flow or the mixed traffic flow. It is rather difficult to estimate the traffic volume and capacity of roadway facilities under mixed traffic flow, unless the different vehicle classes are converted to one common standard vehicle unit. It is common practice to consider the passenger car as the standard vehicle unit to convert the other vehicle classes and this unit is called Passenger Car Unit or PCU. Thus in mixed traffic flow, the traffic volume and capacity are generally expressed as PCU per hour or PCU/lane/hour and the traffic density as PCU per kilometer length of lane.

Tentative equivalency factors or PCU values suggested by the IRC (Indian road congress)

<table>
<thead>
<tr>
<th>S.no</th>
<th>Vehicle class</th>
<th>Equivalency factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Passenger car, tempo, auto rickshaw, agricultural</td>
<td>1.0</td>
</tr>
<tr>
<td>2.</td>
<td>Bus, truck, agricultural tractor-trailer unit</td>
<td>3.0</td>
</tr>
<tr>
<td>3.</td>
<td>Motor cycle, scooter and pedal cycle</td>
<td>0.5</td>
</tr>
<tr>
<td>4.</td>
<td>Cycle rickshaw</td>
<td>1.5</td>
</tr>
<tr>
<td>5.</td>
<td>Horse drawn vehicles</td>
<td>4.0</td>
</tr>
<tr>
<td>6.</td>
<td>Small bullock cart and hand cart</td>
<td>6.0</td>
</tr>
<tr>
<td>7.</td>
<td>Large bullock cart</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Patterns of physical form of cities in terms of transportation.

<table>
<thead>
<tr>
<th>Form of Network</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>Easy flow of traffic is maintained</td>
<td>Monotony of drivers as all crossings look similar</td>
</tr>
<tr>
<td>Grid-iron</td>
<td>Regular plot sizes are got, Easy flow of traffic is maintained</td>
<td>Monotony of drivers as all crossings look similar, Close placement of roads creates too many intersections</td>
</tr>
<tr>
<td>Radial</td>
<td>City gets prominent center, It gives a direction growth of the city, Easy connection between radials</td>
<td>Trapezoidal plots are got, Through traffic is increased, Connections of the radials are felt necessary as the distance from one road to other goes on increasing</td>
</tr>
<tr>
<td>Regular and diagonal</td>
<td>Monotony is broken, Landmarks and nodes are created</td>
<td>Plot sizes becomes irregular</td>
</tr>
</tbody>
</table>
BUILDING SERVICES
Introduction
to
Building Services

GATE Syllabus related to Building Services: Water supply; Sewerage and drainage systems; Sanitary fittings and fixtures; Plumbing systems; Principles of internal and external drainage system; Principles of electrification of buildings; Intelligent Buildings; Elevators and Escalators - standards and uses; Air-Conditioning systems; Firefighting Systems; Building Safety and Security systems.

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3. Soil and waste systems .......................................................(page BS16)
4. Surface-water drainage ....................................................(page BS22)
5. Lighting .............................................................................(page BS27)
6. Electrical installations .......................................................(page BS36)
7. Room acoustics .................................................................(page BS45)
8. Fire protection ...................................................................(page BS51)
9. Mechanical transportation ...................................................(page BS56)

This study manual is prepared from different source books & references on advance level building services. It’s been trimmed down to restrict around GATE syllabus. However to maintain the coverage of topic, some discussions may have exceeded the syllabus. The aim of this manual is to introduce the concept of derivations and basic engineering.

Some topics on building services that may not be discussed here are better discussed in question-bank. You are suggested to read this section along question-bank as complementary.
Introduction

Building Services are the electrical, plumbing, and mechanical systems in a building. For this reason they are also called MEP services, for mechanical, electrical, and plumbing.

A comprehensive list of services that could be provided in a building follows:

Mechanical Services
1. Firefighting Systems
2. Elevators & Escalators
3. HVAC Systems (heating, ventilation, and air-conditioning systems)
4. Gas Supply Systems (such as for heating and cooking in residential buildings, or oxygen and nitrogen in hospitals)
5. Compressed Air Systems used in industries

Electrical Services
1. Power Supply
2. Backup Power (such as diesel generators)
3. Emergency Power (such as battery-based uninterrupted power supply)

Plumbing Systems
1. Water Supply
2. Drainage of Wastes
3. Water Recycling Systems (these allow you to recover the water from your waste and re-use that water for low-grade applications such as flushing)
4. Rainwater Harvesting
5. Storm Water Drainage

Data based Systems or Low-Voltage Systems
1. Security Systems
2. Fire Alarm Systems
3. Building Management Systems
4. Public Address Systems
5. Cable TV Systems
6. Data Networks
7. Voice Networks
1. Heating System

Thermal resistance of materials

The thermal resistance of a slab of homogeneous material is calculated by dividing its thickness by its thermal conductivity:

\[ R = \frac{l}{\lambda} \]

where \( R \) is the thermal resistance (m\(^2\)K/W), \( l \) is the thickness of the slab (m) and \( \lambda \) is the thermal conductivity (W/mK). Resistance to heat flow by a material depends on its thickness, density, water content and temperature. The latter two parameters result from the material’s location within the structure. Insulating materials are usually protected from moisture and the possibility of physical damage as they are of low density and strength. The thermal conductivity of masonry can be found from the bulk dry density and the moisture content, which depends on whether it is exposed to the climate or is in a protected position.

\[ \lambda = 0.62 \text{ W/mK (given)} \text{ and } l = 0.11 \text{ m.} \]

\[ R = \frac{l}{\lambda} = \frac{0.11}{0.62} = 0.1774 \text{ m}^2\text{K/W} \]

Example 1.1 Find the thermal resistance of a 110 mm thickness of brickwork inner leaf.

Given, \( \lambda = 1.63 \text{ W/mK for the heavyweight concrete block and } \lambda = 0.6 \text{ W/mK for the fiberboard.} \)

\[ R \text{ (concrete)} = 0.200 / 1.63 \]
\[ R \text{ (fiberboard)} = l / 0.06 \]

So, for the same resistance,
\[ 0.200 / 1.63 = l / 0.06 \]

Hence,
\[ l = 7.4 \text{ mm Answer.} \]

Thermal transmittance (\( U \) value)

Thermal transmittance is found by adding the thermal resistances of adjacent material layers, boundary layers of air and air cavities, and then taking the reciprocal. Boundary layer or surface film thermal resistances result from the near-stationary air layer surrounding each part of a building, with an allowance for the radiant heat transfer at the surface. Heat transmission across cavities depends upon their width, ventilation and surface emissivities. The external surface resistance depends upon the building’s exposure.

Example 1.3 An external wall consisting of 105 mm brick, 50 mm unventilated cavity, 105 mm brick and 13 mm dense plaster has a severe exposure. Find its \( U \) value.
3. Soil and waste systems

Introduction

The terminology of drainage systems is outlined and then the characteristic flow within the pipework is explained. Understanding how fluid flows through waste and drain pipework is fundamental to correct design. The potential for water seal loss in traps beneath sanitary fittings and the deposition of solids in long sloping drains is examined.

Various standard pipework layouts for above-ground systems are shown. The fluid flow through drain pipes is subject to diversity in timing and duration, as are the hot- and cold-water supplies to the same appliances. However, the characteristic flows into and out of the appliance are not the same, and the use of discharge units for drains is explained.

The materials and jointing methods used for pipework are demonstrated, as are the testing and maintenance procedures.

Definitions

The following terms are used.

**Bedding:** material around a buried pipeline assisting in resisting imposed loads from ground and traffic.

**Benching:** curved smooth surfaces at the base of manholes, which assist the smooth flow of fluids.

**Combined system:** a drainage system in which foul and surface-water are conveyed in the same pipe.

**Crown:** the highest point on the internal surface of a pipe.

**Discharge stack:** vertical pipe conveying foul fluid/solid.

**Foul drain:** a pipe conveying water-borne waste from a building.

**Foul sewer:** the pipework system provided by the local drainage authority.

**Invert:** the lowest point on the internal surface of a pipe.

**Manhole:** an access chamber to a drain or sewer.

**Separate system:** a drainage system in which foul and surface-water are discharged into separate sewers or places of disposal.

**Stack:** vertical pipe.

**Subsoil drains:** a system of underground porous or un-jointed pipes to collect groundwater and convey it to its discharge point.

**Surface-water drain:** a pipe conveying rain water away from roofs or paved areas within a single cartilage.

**Surface-water sewer:** the local authority pipework system.

**Waste pipe:** pipe from a sanitary appliance to a stack.

Fluid flow in waste pipes

Flows in waste pipes occur as surges, or plugs of fluid, which last for a short time. The pipe flows full at some time and a partially evacuated space appears towards the end of discharge. Separation between the water attempting to remain in the P-trap and the plug falling into the soil stack causes an air pocket to form. The static pressure of this air will be subatmospheric. Air from the room and the ventilated soil stack bubbles through the water.
to equalize the pressures and a noisy appliance operation results. The inertia of the discharge may be sufficient to syphon most of the water away from the trap, leaving an inadequate or non-existent seal. The problem is avoided by using 32 mm basin waste pipes when the length is restricted to 1.7 m at a slope of 20 mm/m run, about $1^\circ$.

The sloping waste pipe can be up to 3 m long if its diameter is raised to 40 mm after the first 50 mm of run. This allows aeration from the stack along the top of the sloping section. Longer waste pipes with bends and steeper or even vertical parts have a 25 mm open vent pipe.

Vertical soil and vent stacks are open to the atmosphere 900 mm above the top of any window or roof-light within 3 m. Underground foul sewers are thus atmospherically ventilated. Water discharged into the stack from an appliance entrains air downwards and establishes air flow rates of up to a hundred times the water volume flow rate. Air flow rates of 10–150 l/s have been measured. The action of water sucking air into the pipe lowers the air static pressure, which is further reduced by friction losses.

Water enters the stack as a full-bore jet, shooting across to the opposite wall, falling and establishing a downward helical layer attached to the pipe surface. Restricted air passageways at such junctions further lower the air static pressure by their resistance to flow. Atmospheric pressure will be re-established at the base of the stack because of the flow of air into the low-pressure region. The falling fluid tends to fill the pipe near the base and positive air static pressures can be generated. Appliances connected to such a region may have their water seals intermittently forced out.

Following figure shows the principle of operation of an anti-syphon trap. When excessive suction pressure occurs in the waste pipe, some of the water in the trap is syphoned out. When the central ventilation passage becomes uncovered, it connects the inlet and outlet static air pressures. This returns the waste pipe to atmospheric pressure and the syphonage ceases. Sufficient water remains in the trap to maintain a hygienic seal.
5. Lighting

Artificial illumination for both functional and decorative purposes is a major consumer of primary energy, and developed civilizations have become used to very high illumination standards with consequently high electricity consumption. The use of daylight is encouraged in order to reduce fuel consumption for lighting but this occurs at the expense of heating and cooling energy consumption at the building outer envelope, which is in contact with the external environment. A compromise solution is inevitable, and the building services engineer is at the centre of the calculations needed to minimize total energy consumption for all usages.

The factors involved in determining illumination requirements are discussed in relation to lighting levels for various tasks and the possible use of daylight. Lighting terms are introduced as are glare considerations. The lumen design method is demonstrated for office accommodation. Lamp colour-rendering is discussed, and the use of luminaires with air-conditioning systems. Lamp types, their uses and control arrangements are explained.

Natural and artificial illumination

Natural illumination by penetration of direct solar and diffuse sky visible radiation requires correctly designed passive architecture. Large glazed areas may provide sufficient day lighting at some distance into the building but can also cause glare, overheating and high heating and cooling energy costs.

The other extreme of vertical narrow slot windows limits energy flows while causing very unequal lighting levels near the room’s perimeter. Reflected illumination from other buildings, particularly from those having reflective glazing or metallic architectural features, may cause annoyance. A careful consideration of all the, largely conflicting, variable elements is necessary if a comfortable internal environment is to be produced.

Artificial lighting is provided to supplement daylight on a temporary or permanent basis. Local control of lights by manual and/or automatic switches aids economy in electricity consumption. The colours rendered by objects on the working plane should match the colours under daylight. The working plane may be a desk, drawing board or display area.

Illumination intensity, illuminance, measured in lux on the working plane, is determined by the size of detail to be discerned, the contrast of the detail with its background, the accuracy and speed with which the task must be performed, the age of the worker, the type of space within which the task is to be performed and the length of time continuously spent on the task. The working plane is the surface being illuminated. Other areas are lit by overspill from it and by reflections from other room surfaces.

Higher levels of illuminance may be provided for particularly fine detail tasks at the area of use by local, or task, illumination: for example, up to 3000 lx for inspection of small electronic components and 50 000 lx on a hospital operating table. Bright sunlight provides up to 100 000 lx. Local spot lighting for display purposes and exterior illumination are used to accentuate particular features of the working plane.

Permanent supplementary artificial lighting of interiors (PSALI) has become common in modern office accommodation, shops and public buildings.

![Typical values of illuminance](image)

Typical value of illuminance

The heat generated by permanent lighting can be extracted from the light fitting (luminaire) by passing the ventilation extract air through it, thus raising the air temperature to 30–35°C, and then supplying this heated
6. Electrical Installations

Introduction

The safe and economical use of electricity is of paramount importance to the building user and the world as it is the most highly refined form of energy available. Electricity production consumes up to three times its own energy value in fossil fuel, and electricity in its distributed form is potentially lethal.

In this chapter the handling methods and safety precautions for utilizing electricity are explained and a range of calculations, which can easily be performed by the services designer or constructor prior to employing specialist help, is introduced.

Electricity distribution

The electrical power-generating companies supply electrical power into the national 400 kV grid system of overhead bare wire conductors. This very high voltage is used to minimize the current carried by the cables over long distances. Step-down transformers reduce the voltage in steps down to 33 kV, when it can be supplied to industrial consumers and to other transformer stations on commercial and housing estates.

The electricity-generating alternator rotates at 50 Hz (3000 rev/mm) and has three coils in its stator. The output voltages and currents from each coil are identical but are spaced in time by one-third of a revolution, 120°. Each coil generates a sine wave or phase voltage that has the same heating effect as a 240 V continuous direct current supply. This is its root mean square (RMS) value. The RMS value of the three phases operating together is 415 V.

Various circuits of different voltages are supplied from the incoming mains. Equal amounts of power are fed into each phase, and so it is important that power consumption within a building is equally shared by each line.

The neutral wire is a live conductor in that it is the return path to the alternator for the current which has been distributed.

\[
\text{RMS} = \sqrt{\frac{\sum V_n^2}{n}}
\]

where \( V \) is the voltage at each of \( n \) measurements, say at 15° intervals.

A balanced load, such as a three-phase electrical motor driving an air-conditioning fan, water pump or lift motor, does not produce a current in the neutral wire. This is because an alternating current flows alternately in the forward and backward directions along the line wire. The overall effect of three driving coils in the motor is a balance in the quantity and direction of the current taken from the line conductors. There is no net return current in the neutral wire from such a balanced load. Single-phase electrical loads, which are not in balance, produce a net current in the neutral conductor.

The casings of all electrical appliances are connected to earth by a protective conductor, the earth wire, connected to the earthed incoming service cable of the electricity supply authorities or an earth electrode in the ground outside the building. Gas and water service pipes are bonded to the earth by a protective conductor.
Introduction to Building Services

Sound power and pressure levels

Sound power and pressure levels are measured over a range of frequencies that are representative of the response of the human ear to sounds. The unit of measurement of sound is the Bel (B). The smallest increment of sound that the human ear can detect is one-tenth of a Bel, one decibel (dB). This means that the smallest change in sound level that is perceptible by the human ear is 1 dB, so any decimal places that are produced from calculations using sound power or pressure level are not relevant. A calculated sound level of 84.86 can only be 84 dB as the 0.86 decimal portion is not detectable by the ear. The ‘A’ scale of measurement gives a weighting to each frequency in the range 20 Hz to 20 kHz in the same ratio as can be heard. For example, the human ear is more sensitive to sounds at 1000 Hz than at higher frequencies.

The acoustic output power of a machine is termed its sound power level, SWL dB. Think of SWL as the sound watts level of the acoustic output power of the machine. The value of acoustic power in watts from building services plant is very small, much less than 1 watt of power. The word level is used because it is not the actual value of the number of watts that is normally used; it is the sound level produced in acoustic units of measurement, dB, that are taken for practical use. The manufacturer of the plant provides the sound power levels produced by a particular machine from test results and predictions for known ranges of similar equipment. The sound power level of a machine at the range of frequencies from 125 to 8000 Hz is required by the building services design engineer in order to assess the acoustic affects upon the occupied spaces of the building. The overall sound power level for a range of frequencies is also quoted by the manufacturer of a machine.

Sound pressure level

A sound field is created by the sound power output from a machine within a plant room. It is made up of a direct sound field, that is, directly radiated sound, and a reverberant sound field, that is, general sound that reflects uniformly from the hard surfaces around the room. The direct sound field reduces with the inverse square of the distance from the sound source and is not normally of importance as it only applies to very short distances from the sound source. The reverberant sound field results from the average value of the sound pressure waves passing around the room. These waves try to escape from the plant room and find their way into the occupied spaces where the air-conditioning engineer is attempting to create a quiet and comfortable environment. The sound pressure level, SPL dB, of the total sound field, direct plus reverberant, that is generated within a room from a sound source of sound power level SWL dB, is found from

\[ SPL = SWL + 10 \times \log \left( \frac{Q}{4 \times \pi \times r^2} + \frac{4}{R} \right) \text{ dB} \]

where,

- \( SPL \) = sound pressure level produced in room dB
- \( SWL \) = sound power level of acoustic source dB
- \( \log \) = logarithm to base 10 dimensionless
- \( Q \) = geometric directivity factor dimensionless
- \( r \) = distance from sound source to the receiver m
- \( R \) = room sound absorption constant \( m^2 \)

Logarithms to base 10, \( \log_{10} \), are used throughout the calculation of acoustic values. A sound source that radiates sound waves uniformly in all directions through unobstructed space will create an expanding spherical sound field and have a dimensionless geometric directionality factor \( Q \) of 1. A sound source that is on a plane surface radiates all its sound energy into a hemispherical sound field moving away from the surface. This has a directionality factor \( Q \) of 2, that is, twice the sound energy passes through a hemisphere. Similarly, if the sound source occurs at the junction of two adjacent surfaces that are at right angles to each other, such as the junction of a wall and ceiling, \( Q \) is 4. When there are three adjacent surfaces at the

![Sound level meter device.](image-url)
8. Fire protection

Introduction

The systems required to meet the needs of tackling small fires, evacuation and major fire-fighting both by the occupants and then the Fire Service are outlined. Building management systems under computer monitoring and control will incorporate such systems, together with security functions. Integration of such equipment with the architecture, decor and other services is planned from the earliest design stage.

Fire classification

A fire is supported by three essential ingredients: fuel, heat and oxygen. The absence of any one of these causes an established fire to be extinguished. The fire-fighting system must be appropriate to the location of the fire and preferably limited to that area in order to minimize damage to materials, plant and the building structure. Radiation from a fire may provoke damage or combustion of materials at a distance. Structural fire protection can include water sprays onto steelwork to avoid collapse, as used in the Concorde aircraft production hangar.

The system of fire-fighting employed depends upon the total combustible content of the building (fire load), the type of fire risk classification and the degree of involvement by the occupants. Fire escape design where children, the elderly or infirm are present needs particular care so that sufficient time is provided in the fire resistance of doors and partitions for the slower evacuation encountered.

Smoke contains hot and unpleasant fumes, which can be lethal when produced from certain chemicals and plastics. Visual obstruction makes escape hazardous and familiar routes become confused. Packaging materials, timber, plastics, liquefied petroleum gas cylinders and liquid chemicals must not be stacked in passageways or near fire exits in completed or partially completed buildings.

Regular fire drills are conducted by the safety officer and employees are clearly notified of their responsibilities in an emergency. Staff duties will be to shepherd the public, patients or students out of the building to the rendezvous, while maintenance personnel may be required to operate fire-fighting equipment while awaiting the fire brigade.

Portable extinguishers

Portable extinguishers are manually operated first-aid appliances to stop or limit the growth of small fires. Staff are trained in their use and the appliances are regularly maintained by the suppliers. Fire blankets are provided in kitchens where burning pans of oil or fat need to be covered or personnel need to be wrapped to smother ignited clothing.

Water

A 9 l water extinguisher is installed for each 210 m² floor area, with a minimum of two extinguishers per floor. A high-pressure CO₂ cartridge is punctured upon use and a 10 m jet of water is produced for 80 s. Water must not be used on petroleum, burning liquids or in kitchens as it could spread the fire.
BEAM MECHANICS
Shear Force and Bending Moment Diagram:

Introduction:

The advantage of plotting a variation of shear force F and bending moment M in a beam as a function of 'x' measured from one end of the beam is that it becomes easier to determine the maximum absolute value of shear force and bending moment.

Further, the determination of value of M as a function of ‘x’ becomes of paramount importance so as to determine the value of deflection of beam subjected to a given loading.

Construction of shear force and bending moment diagrams:

A shear force diagram can be constructed from the loading diagram of the beam. In order to draw this, first the reactions must be determined always. Then the vertical components of forces and reactions are successively summed from the left end of the beam to preserve the mathematical sign conventions adopted. The shear at a section is simply equal to the sum of all the vertical forces to the left of the section.

When the successive summation process is used, the shear force diagram should end up with the previously calculated shear (reaction at right end of the beam. No shear force acts through the beam just beyond the last vertical force or reaction. If the shear force diagram closes in this fashion, then it gives an important check on mathematical calculations.

The bending moment diagram is obtained by proceeding continuously along the length of beam from the left hand end and summing up the areas of shear force diagrams giving due regard to sign. The process of obtaining the moment diagram from the shear force diagram by summation is exactly the same as that for drawing shear force diagram from load diagram.

It may also be observed that a constant shear force produces a uniform change in the bending moment, resulting in straight line in the moment diagram. If no shear force exists along a certain portion of a beam, then it indicates that there is no change in moment takes place. It may also further observe that dm/dx = F therefore, from the fundamental theorem of calculus the maximum or minimum moment occurs where the shear is zero. In order to check the validity of the bending moment diagram, the terminal conditions for the moment must be satisfied. If the end is free or pinned, the computed sum must be equal to zero. If the end is built in, the moment computed by the summation must be equal to the one calculated initially for the reaction. These conditions must always be satisfied.

Illustrative problems:

In the following sections some illustrative problems have been discussed so as to illustrate the procedure for drawing the shear force and bending moment diagrams

1. A cantilever of length carries a concentrated load ‘W’ at its free end.

Draw shear force and bending moment.

Solution:

At a section a distance x from free end consider the forces to the left, then F = -W (for all values of x) -ve sign means the shear force to the left of the x-section are in downward direction and therefore negative

Taking moments about the section gives (obviously to the left of the section)

M = -Wx (-ve sign means that the moment on the left hand side of the portion is in the anticlockwise direction and is therefore taken as –ve according to the sign convention)

so that the maximum bending moment occurs at the fixed end i.e. M = -Wl

From equilibrium consideration, the fixing moment applied at the fixed end is Wl and the reaction is W. the shear force and bending moment are shown as,
2. Simply supported beam subjected to a central load (i.e. load acting at the mid-way)

By symmetry the reactions at the two supports would be \( \frac{W}{2} \) and \( \frac{W}{2} \). Now consider any section X-X from the left end then, the beam is under the action of following forces.

So the shear force at any X-section would be \( = \frac{W}{2} \) [Which is constant upto \( x < \frac{l}{2} \)]

If we consider another section Y-Y which is beyond \( \frac{l}{2} \) then

\[
S.F_{Y-Y} = \frac{W}{2} - W = \frac{-W}{2}
\]

for all values greater \( = \frac{l}{2} \)

Hence S.F diagram can be plotted as,
The bending moment diagram is partly positive and partly negative. If we plot the deflected shape of the beam just below the bending moment.

![Bending Moment Diagram](image)

This diagram shows that L.H.S of the beam ‘sags’ while the R.H.S of the beam ‘hogs’.

The point C on the beam where the curvature changes from sagging to hogging is a point of contraflexure.

OR

It corresponds to a point where the bending moment changes the sign, hence in order to find the point of contraflexures obviously the B.M would change its sign when it cuts the X-axis therefore to get the points of contraflexure equate the bending moment equation equal to zero. The fibre stress is zero at such sections.

Note: there can be more than one point of contraflexure.
GENERAL APTITUDE
GATE SYLLABUS 2018: General Aptitude (15 marks)

Numerical Ability: Numerical computation, numerical estimation, numerical reasoning and data interpretation.

Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.

Numerical Ability Questions:

In the exams, you may encounter challenging numerical reasoning questions. Such challenging numerical reasoning questions require problem-solving heuristics (set of rules) in addition to the four basic operations (addition, subtraction, multiplication and division). Below are the 11 useful heuristics you can adopt to solve difficult questions.

1. Use Diagrams / Models
2. Act it Out
3. Use Before & After
4. Use Systematic Listing
5. Look for Patterns
6. Work Backwards
7. Use Guess & Check
8. Simplify the Problem
9. Make Supposition
10. Solve Part of the Problem
11. Paraphrase the Problem

1. In the first 10 overs of a cricket game, the run rate was only 3.2. What should be the run rate in the remaining 40 overs to reach the target of 282 runs?

A. 6.25  
B. 6.5  
C. 6.75  
D. 7

Answer: Option A

Explanation:

\[
\text{Required run rate} = \frac{282 - (3.2 \times 10)}{40} = \frac{250}{40} = 6.25
\]

2. The captain of a cricket team of 11 members is 26 years old and the wicket keeper is 3 years older. If the ages of these two are excluded, the average age of the remaining players is one year less than the average age of the whole team. What is the average age of the team?

A. 23 years  
B. 24 years  
C. 25 years  
D. None of these

Answer: Option A

Explanation: Let the average age of the whole team by \( x \) years.

\[
\therefore 11x - (26 + 29) = 9(x - 1)
\]
\[
\Rightarrow 11x - 9x = 46
\]
\[
\Rightarrow 2x = 46
\]
\[
\Rightarrow x = 23.
\]
So, average age of the team is 23 years.

3. The average age of husband, wife and their child 3 years ago was 27 years and that of wife and the child 5 years ago was 20 years. The present age of the husband is:

A. 35 years  
B. 40 years  
C. 50 years  
D. None of these

Answer: Option B

Explanation: Sum of the present ages of husband, wife and child = (27 x 3 + 3 x 3) years = 90 years.
<table>
<thead>
<tr>
<th>Word</th>
<th>Meaning</th>
<th>Synonyms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peevish</td>
<td>Easily irritated, testy or annoyed</td>
<td>Cranky, fractious, grumpy, snappy, waspish</td>
</tr>
<tr>
<td>Adage</td>
<td>A proverb or byword</td>
<td>Axiom, maxim, dictum, aphorism, precept</td>
</tr>
<tr>
<td>Machination</td>
<td>To plot evilly for personal gain</td>
<td>Conspiracy, skulduggery, scheme, ruse, manoeuvre</td>
</tr>
<tr>
<td>Mountebank</td>
<td>Someone who deceives others especially to rob them of their money</td>
<td>Fraudster, impostor, hoaxer, trickster, charlatan</td>
</tr>
<tr>
<td>Apocryphal</td>
<td>Something whose authenticity is questionable irrespective of its wide circulation</td>
<td>Debatable, fabricated, fictitious, dubious, unsubstantiated</td>
</tr>
<tr>
<td>Ersatz</td>
<td>An artificial substance used as a substitute to a natural one, often inferior</td>
<td>Adulterated, fabricated, spurious, unnatural, synthetic</td>
</tr>
<tr>
<td>Archetype</td>
<td>A model on which all others in the same category are based</td>
<td>Epitome, prototype, standard, exemplar, paradigm, paragon</td>
</tr>
<tr>
<td>Hyperbole</td>
<td>An extravagant statement not meant to be taken literally</td>
<td>Amplification, exaggeration, embellishment, magnification, overstatement</td>
</tr>
<tr>
<td>Redundant</td>
<td>Surplus, more than what is required</td>
<td>Disposable, dispensable, superfluous, inessential, expendable</td>
</tr>
<tr>
<td>Hermit</td>
<td>One who has withdrawn to a solitary life or religious seclusion</td>
<td>Ascetic, saint, austere, puritanical, abstinent</td>
</tr>
<tr>
<td>Cajole</td>
<td>To persuade by buttering up or making promises</td>
<td>Flatter, tempt, beguile, sweet-talk, compliment</td>
</tr>
<tr>
<td>Espionage</td>
<td>The act of spying (by the government or otherwise)</td>
<td>Intelligence, surveillance, reconnaissance, spying, tailing</td>
</tr>
<tr>
<td>Restive</td>
<td>Unable to remain still, especially because of boredom or dissatisfaction</td>
<td>Agitated, anxious, fidgety, jittery, impatient, restless</td>
</tr>
<tr>
<td>Brazen</td>
<td>Shameless or impudent</td>
<td>Blatant, unashamed, unabashed, barefaced, unrepentant</td>
</tr>
<tr>
<td>Accolade</td>
<td>Any honour</td>
<td>Acclaim, award, commendation, laurel, laudation</td>
</tr>
<tr>
<td>Harbinger</td>
<td>A person or thing which signals the approach of another</td>
<td>Announcer, forerunner, forewarning, herald, prelude</td>
</tr>
<tr>
<td>Bizarre</td>
<td>Very strange or unusual</td>
<td>Eccentric, aberrant, ludicrous, peculiar, weird, odd</td>
</tr>
<tr>
<td>Parochial</td>
<td>Having a limited or narrow outlook</td>
<td>Conservative, myopic, intolerant, narrow-minded, illiberal</td>
</tr>
<tr>
<td>Sanguine</td>
<td>Cheerfully positive and confident</td>
<td>Buoyant, enthusiastic, optimistic, animated, hopeful</td>
</tr>
<tr>
<td>Magnanimous</td>
<td>Large-hearted or forgiving</td>
<td>Altruistic, generous, bounteous, philanthropic, liberal</td>
</tr>
<tr>
<td>Sublime</td>
<td>Extreme and unparalleled</td>
<td>Elevated, exalting, magnificent, resplendent, splendid</td>
</tr>
<tr>
<td>Restraint</td>
<td>A measure to keep something/someone under control</td>
<td>Constraint, inhibition, judiciousness, prohibition, temperateness</td>
</tr>
<tr>
<td>Trepidation</td>
<td>Tremulous fear or agitation</td>
<td>Alarm, apprehension, foreboding, consternation, discomposure</td>
</tr>
<tr>
<td>Imperturbable</td>
<td>Incapable of being upset or agitated</td>
<td>Nonchalant, phlegmatic, relaxed, tranquil, undisturbed</td>
</tr>
<tr>
<td>Congenial</td>
<td>Agreeable and pleasing in nature or character</td>
<td>Comradely, friendly, companionable, hospitable, favourable</td>
</tr>
<tr>
<td>Strident</td>
<td>Making or having a harsh sound</td>
<td>Discordant, rasping, raucous, vociferous, clamorous, loud</td>
</tr>
<tr>
<td>Egalitarian</td>
<td>Asserting equality for all people</td>
<td>Democratic, classless, equalitarian, unrestricted, uncensored</td>
</tr>
<tr>
<td>Confluence</td>
<td>The place where two or more water bodies meet</td>
<td>Conflux, convergence, junction, meeting, union</td>
</tr>
<tr>
<td>Diabolic</td>
<td>Having the qualities of the devil</td>
<td>Demonic, devilish, fiendish, infernal, satanic, evil</td>
</tr>
<tr>
<td>Lavish</td>
<td>Occurring or happening in profusion</td>
<td>Expensive, extravagant, luxuriant, opulent, prodigal</td>
</tr>
<tr>
<td>Insolent</td>
<td>Boldly rude or disrespectful</td>
<td>Abusive, audacious, discourteous, offensive,</td>
</tr>
</tbody>
</table>
Introduction

This is a part of GATE ARCHITECTURE 2018 complete set. It covers the topic on history & architecture. The section on history of architecture plays a significant role in scoring a good marks and so this dedicated section is included. It has three broad topics. Indian history of architecture, world history of architecture & contribution of architects & planners. If you remember of the compilation of Sir Banister Fletcher, you may aware that how vast this topic is itself. Here we have tailored the coverage to the syllabus and questions asked in GATE exams in past years. The topics that are extensively covered through the Question Bank, are escaped here. However, some common topics are discussed here to complement the syllabus.

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GATE SYLLABUS 2018 [Contents covered in this section are highlighted]

**Section 1: Architecture and Design** Visual composition in 2D and 3D; Principles of Art and Architecture; Organization of space: Architectural Graphics; Computer Graphics-- concepts of CAD, BIM, 3D modeling and Architectural rendition; Programming languages and automation. Anthropometrics; Planning and design considerations for different building types; Site planning; Circulation- horizontal and vertical; Barrier free design; Space Standards. Building Codes; National Building Code.

Elements, construction, architectural styles and examples of different periods of Indian and Western History of Architecture; Oriental, Vernacular and Traditional architecture; Architectural developments since Industrial Revolution; Influence of modern art on architecture; Art nouveau, Eclecticism, International styles, Post Modernism, Deconstruction in architecture; Recent trends in Contemporary Architecture; Works of renowned national and international architects.

**Section 2: Building Materials, Construction and Management** Behavioral characteristics and applications of different building materials viz. mud, timber, bamboo, brick, concrete, steel, glass, FRP, AAC, different polymers, composites.

Building construction techniques, methods and details; Building systems and prefabrication of building elements; Principles of Modular Coordination; Estimation, specification, valuation, professional practice; Construction planning and equipments; Project management techniques e.g. PERT, CPM etc.

**Section 3: Building and Structures** Principles of strength of materials; Design of structural elements in wood, steel and RCC; Elastic and Limit State design; Structural systems in RCC and Steel; Form and Structure; Principles of Pre-stressing; High Rise and Long Span structures, gravity and lateral load resisting systems; Principles and design of disaster resistant structures.

**Section 4: Environmental Planning and Design** Ecosystem- natural and man-made ecosystem; Ecological principles; Concepts of Environmental Impact Analysis; Environmental considerations in planning and design; Thermal comfort, ventilation and air movement; Principles of lighting and illumination; Climate responsive design; Solar architecture; Principles of architectural acoustics; Green Building- Concepts and Rating; ECBC; Building Performance Simulation and Evaluation; Environmental pollution- types, causes, controls and abatement strategies.

**Section 5: Urban Design** Concepts and theories of urban design; Public Perception; Townscape; Public Realm; Urban design interventions for sustainable development and transportation; Historical and modern examples of urban design; Public spaces, character, spatial qualities and Sense of Place; Elements of urban built environment – urban form, spaces, structure, pattern, fabric, texture, grain etc; Principles, tools and techniques of urban design; Urban renewal and conservation; Site planning; Landscape design; Development controls – FAR, densities and building byelaws.

**Section 6: Urban Planning and Housing** Planning process; Types of plans - Master Plan, City Development Plan, Structure Plan, Zonal Plan, Action Area Plan, Town Planning Scheme, Regional Plan; Salient concepts, theories and principles of urban planning; Sustainable urban development; Emerging concepts of cities - Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc.

Housing; Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing; Housing for special areas and needs; Residential densities; Standards for housing and community facilities; National Housing Policies, Programs and Schemes.

**Section 7: Planning Techniques and Management** Tools and techniques of Surveys – Physical, Topographical, Landuse and Socio-economic Surveys; Methods of non-spatial and spatial data analysis; Graphic presentation of spatial data; Application of G.I.S and Remote Sensing techniques in urban and regional planning; Decision support system and Land Information System.

Urban Economics; Law of demand and supply of land and its use in planning; Social, Economical and environmental cost benefit analysis; Techniques of financial appraisal; Management of Infrastructure Projects; Development guidelines such as URDPFI; Planning Legislation and implementation – Land Acquisition Act, PPP etc.; Local self-governance.

**Section 8: Services, Infrastructure and Transportation** Building Services: Water supply; Sewerage and drainage systems; Sanitary fittings and fixtures; Plumbing systems; Principles of internal and external drainage system; Principles of electrification of buildings; Intelligent Buildings; Elevators and Escalators - standards and uses; Air-Conditioning systems; Firefighting Systems; Building Safety and Security systems.


Process and Principles of Transportation Planning and Traffic Engineering; Road capacity; Traffic survey methods; Traffic flow characteristics; Traffic analyses and design considerations; Travel demand forecasting; Land-use – transportation - urban form inter-relationships; Design of roads, intersections, grade separators and parking areas; Hierarchy of roads and level of service; Traffic and transport management and control in urban areas.; Mass transportation planning; Para-transits and other modes of transportation, Pedestrian and slow moving traffic planning; Intelligent Transportation Systems. Principles of water supply and sanitation systems; water treatment; Water supply and distribution system; Water harvesting systems; Principles, Planning and Design of storm water drainage system; Sewage disposal methods; Methods of solid waste management - collection, transportation and disposal; Recycling and Reuse of solid waste; Power Supply and Communication Systems, network, design and guidelines.

**General Aptitude**
Elements & Principles of Art Design

Elements of design are the parts. They structure and carry the work. Principles of design are concepts. They affect content and message.

**Elements of Design**: Line, Form, Space, Texture, Shape, Color, Value  
**Principles of Design**: Emphasis, Movement, Unity, Rhythm, Contrast, Variety

Order and Composition  
Composition is the organization of the elements of design into a unified whole. “It is the organization of the whole out of its parts - the conception of single elements, the interrelating of these elements, and the relating of them to the total form. It means ‘putting together’, and can apply to any work of art, from music to writing to architecture, that is arranged or put together using conscious thought.”

It basically refers to the placement or arrangement of conceptual elements (point, line, plane, volume, form, shape, space) and visual elements (color, texture, size and shape) in a work of art according to some (consciously or unconsciously used) compositional principles. “In the visual arts, composition is often used interchangeably with various terms such as design, form, visual ordering, or formal structure, depending on the context.”

In architectural design, the architect creates an ordered expression through the process of composition by using the raw materials of architectural form, which are basically the mass and the space. In this process, the material forms (masses) and spaces are arranged into the final composition, of the definitive design. At this stage each element ends up in its proper place according to the principles of composition. Without this ordering process the result would be chaos. The method of ordering and the concept employed ultimately dictate the character, appearance and style of a design.”

---

**Frank Lloyd Wright, Johnson and Wax Building**

Some compositional principles might be used (such as unity, balance, hierarchy, scale, dominance, similarity, contrast, rhythm, repetition, symmetry) to create this order. The way the formal and spatial elements are arranged through these principles creates the order of composition in architecture.

These organizational principles of composition are like the grammar of a language. The use of these principles over the visual and conceptual elements of design is like using a visual grammar. It is like speaking and writing in the language of architectural design. Visual and conceptual elements are the materials (words) of design and the principles are the ways to work with and arrange the elements (grammar). However it is also true that there is not such a thing that these principles should be obeyed.
Principles of visual composition

1. Important factor to be considered in Urban Design – Arrangement of spaces
   Good composition
   Orderly and pleasing
   Pleasure follows order

2. principles of composition –
   - **Unity** –
     - Oneness and brings harmony with the surroundings.
     - Similar forms give coherence to the parts and integrity to the whole.
     - An urban form so planned and created will create a single picture of unity.
     - Dissimilar forms, texture, color lack unity.
   - **Segregation** –
     - Composition should form an independent unit by separating from others by enclosing masses.
     - It can be made up neutral forms, average textures or subdued colors of building masses.
   - **Coherence** –
     - Complicated compositions lack coherence.
     - Too many sorts of buildings, elements, and accessories result in lack of coherence.
   - **Balance** –
     - **Symmetrical balance** – Balance means equality and it can be easily obtained by symmetrical type of plants or features on either side of the central axis of composition. Balance should be dynamic, vital hence it should be rhythmic.
     - **Asymmetrical or Occult balance** – Too unequal masses on either side of the central axis form asymmetrical balance. Meticulously arranged occult balance adds softness and freedom to the composition.
   - **Scale** –
     - The building or group of buildings must be in scale with its surroundings.
     - The parts of the composition in relation to each other should exhibit their true size.
   - **Rhythm and reputation** –
     - It is a devise to give continuity to the design.
     - It develops rhythmic sequence producing a coherent effect.
     - Use distinctive elements for a rhythmic arrangement (columns, openings like windows), to hold together and carry the eye from part to the other.
   - **Color** –
     - Select paints for long color effects.
     - A feeling of coherence in design is achieved by color as well or by simple repetition of the same color at regular intervals.
   - **Texture** –
     - It is the surface quality which give a textile sensation when touched, such as soft cum hard, smooth, rough etc.,
     - Sandstone – course.
     - Marble – translucent and soft
   - **Light and Shade** –
     - Occasional Shades cast by large openings produce a pictorial effect.
     - Columns and arcades throw shadows in the morning and evening producing a constant change of light and shade.
     - Quality of color also changes according to the intensity of light.

3. Visual aspect of plan arrangement –
   - **View**: is a scene observed from a given place.
   - **Vista**: is a confined view to a dominant feature. Each vista has a viewing station. A well conceived vista has the balance and rhythm.
   - **Axis**: is a linear element connecting two or more elements such as a drive, a street or a park way. It is directional, orderly, dominating.

4. Color theory
   - **Primary hues**: RED, YELLOW, BLUE
   - **Complementary colors**: Red and Green
   - **Harmonizing colors**: hues adjacent on the color wheel.
   - **Hue** – (first dimension), by definition it is pure color, containing no white, black or grey.
Site Planning:

Site Planning is defined by Kevin Lynch as “the art of arranging structures on the land and shaping the spaces between; an art linked to architecture, engineering, landscape architecture and city planning.” (Site Planning)

Harvey M. Rubenstein defines it as "the art and science of arranging the uses of portions of land. These uses are designated in detail by selecting and analyzing sites, forming land use plans, organizing vehicular and pedestrian circulation, developing visual form and materials concepts, readjusting the existing landforms by design grading, providing proper drainage, and developing the construction details necessary to carry out the projects”. (A Guide to Site and Environmental Planning, 1980)

In site planning, as in other forms of problem-solving, the critical thinking process of research, analysis and synthesis makes a major contribution to the formation of design decisions.

- Research material may be gathered from existing projects, books photographs, or experiments. A program is then formulated and the elements required to develop the project is listed.
- Analysis of the site shall consider all existing features, both natural and man-made in order to determine those inherent qualities that give a site its ‘personality’. A topographical analysis is mandatory. Emphasis should be made on the site’s relationship with the total environment and its special values or potentials.

There are two methods of establishing a SITE:

1. SITE SELECTION PROCESS
   This process selects from a list of potential sites one that suits best the given use and requirements of the project.
2. DEVELOPMENT SUITABILITY PROCESS
   This process selects the best possible use and development suited for a given site.

SITE ANALYSIS involves the study of the site in terms of the following:

Natural factors:

1. Geology
2. Geomorphology – physiography, landforms, soils, drainage, topography and slopes, and soil erosion
3. Hydrology – surface and ground water
4. Vegetation – plant ecology
5. Wildlife – habitats
6. Climate – solar orientation, wind, and humidity.

Cultural factors:

1. Existing land use – ownership of adjacent property, off-site nuisances
2. Traffic and transit – vehicular and pedestrian circulation on or adjacent to site
3. Density and zoning – legal and regulatory controls
4. Socio-economic factors
5. Utilities – sanitary, storm-water, water supply, power supply, and communications.
6. Historic factors – historic buildings, landmarks, and archeology

Aesthetic factors:

1. Natural features
2. Spatial patterns – spaces and sequences
3. Visual Resources – views and vistas

GEOLOGY is the natural science that studies the Earth – its composition; the processes that shaped its surface; and its history. Earth is made up of rocks (including soil, sand, silt and dust); rocks are composed of minerals; minerals are made up of atoms:

Igneous Rocks – rocks produced by crystallization from a liquid.

Sedimentary Rocks – when igneous rocks are exposed to surface and weathering reduces them to particles, these particles are moved by erosional process and deposited in layers into rivers and oceans.
Metamorphosed Rocks – when sedimentary rocks are pushed to deeper levels of the earth, they transform into metamorphosed rocks due to changes in pressure and temperature.

GEOMORPHOLOGY - is that branch of Geology that deals with the origin, nature and distribution of landforms.

Physiography – refers to the description of landforms.
Landforms – are irregularities on the earth’s surface. They are derived from volcanic, glacial, or erosional processes.

When designing a piece of property for architectural, landscape architectural and engineering usage, it is essential for the designer to first confront the nature of the land, particularly its form, its slopes, and its inherent capabilities for surface and subsurface discharge of water, for supporting vertical and horizontal structures, and for resisting erosion. This exercise requires four basic geomorphologic information such as:

- Soil Properties – Composition and Soil Texture
- Drainage
- Topography and Slopes
- Soil Erosion

In site planning, it is important to establish the relationship between soil composition and land uses (other than agriculture). Soil surveys help guide in site selection for residential, industrial, and other forms of development that involve surface and subsurface structures.

Several features, or properties, are used to describe soil for use in site design. Of these ---

1. COMPOSITION
2. TEXTURE

are generally the most meaningful; from them we can make inferences about bearing capacity, internal drainage, erodibility, and slope stability.

SOIL PROPERTIES:
1. COMPOSITION refers to the material that makes up soil; mineral particles, organic matter, water and air.
   a. Mineral Particles comprise 50% to 80% of the volume of the soil and form the all important skeletal structure of the soil. Sand and gravel particles provide for the greatest stability, usually yield a relatively high bearing capacity,
   b. Organic Matter varies radically in soils and usually imposes a limitation to any building structure. Organic matter is important only for soil fertility, moisture absorption and retention and for landscaping.
   c. Water content varies with particle sizes, local drainage, topography and climate. Most water occupies the spaces between particles; only in organic soils do the particles themselves actually absorb measurable amounts of water.
   d. Air is what occupies remaining space that is not occupied by water. In layers where groundwater is formed by gravity water in the subsoil and underlying rock, there is absence of air.

2. TEXTURE - is the term used to describe the composite sizes of particles in a soil sample.
   There are 12 basic terms for texture, at the center of which is Class LOAM, which is an intermediate mixture of 40% sand, 40% silt and 20% clay.

DRAINAGE:
GOOD DRAINAGE refers to the soil’s ability to transfer gravity water downward through:

1. Infiltration - the rate at which water penetrates the soil surface (usually measured in cm or inches per hour);
2. Permeability - the rate at which water within the soil moves through a given volume of material (also measured in cm or inches per hour)
3. Percolation - the rate at which water in a soil pit or pipe within the soil is taken up by the soil (used mainly in wastewater absorption tests and measured in inches per hour)

POOR DRAINAGE - means that gravity water is not readily transmitted by the soil and soil is frequently or permanently saturated and may have water standing on it caused by:
   1. The local accumulation of water;
   2. A rise in the level of groundwater within the soil column;
   3. The size of the particles in the soil being too small to transmit infiltration water.

TOPOGRAPHY AND SLOPES:

SLOPE ANALYSIS -- Understanding slope forms for site design requires understanding of local geologic, soil, hydrologic, and vegetative conditions.

SLOPE FORM -- is expressed graphically in terms of a slope profile, a silhouette of a slope drawn to known proportions with distance on the horizontal axis and elevation on the vertical axis.

Four basic slope forms are detectable on contour maps:

<table>
<thead>
<tr>
<th>straight</th>
<th>S - shape</th>
<th>concave</th>
<th>convex</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Straight Shape" /></td>
<td><img src="image2" alt="S-Shape" /></td>
<td><img src="image3" alt="Concave Shape" /></td>
<td><img src="image4" alt="Convex Shape" /></td>
</tr>
</tbody>
</table>

ANGLE OF REPOSE -- angle at which soil can be safely inclined and beyond which it will fail.
ARCHITECTS & WORKS
**Pritzker Prize Winners**

To honor a living architect or architects whose built work demonstrates a combination of those qualities of talent, vision, and commitment, which has produced consistent and significant contributions to humanity and the built environment through the art of architecture.

The international prize, which is awarded each year to a living architect/s for significant achievement, was established by the Pritzker family of Chicago through their Hyatt Foundation in 1979. It is granted annually and is often referred to as “architecture’s Nobel” and “the profession’s highest honor.”

The award consists of $100,000 (US) and a bronze medallion. The award is conferred on the laureate/s at a ceremony held at an architecturally significant site throughout the world. *(Source: pritzkerprize.com)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Laureate</th>
<th>Example work (year completed)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>Philip Johnson (United States)</td>
<td>Glass House (1949)</td>
<td>American architect Philip Johnson was honored with the first Pritzker Architecture Prize in recognition of &quot;50 years of imagination and vitality embodied in a myriad of museums, theaters, libraries, houses, gardens and corporate structures.*</td>
</tr>
<tr>
<td>1980</td>
<td>Luis Barragán (Mexico)</td>
<td>Torres de Satélite (1957)</td>
<td>Mexican architect Luis Barragán was a minimalist who worked with light and flat planes.</td>
</tr>
<tr>
<td>1981</td>
<td>Sir James Stirling (United Kingdom)</td>
<td>Seeley Historical Library (1968)</td>
<td>Sir James Stirling worked in many styles during his long and rich career.</td>
</tr>
<tr>
<td>Year</td>
<td>Architect</td>
<td>Work Description</td>
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<tr>
<td>1982</td>
<td>Kevin Roche (Ireland)</td>
<td>Critics praised Irish-American architect Kevin Roche for his innovative work in glass.</td>
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</tr>
<tr>
<td></td>
<td>Knights of Columbus Building (1969)</td>
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<tr>
<td>1983</td>
<td>Ieoh Ming Pei (United States)</td>
<td>Chinese-born architect I.M. Pei tends to use large, abstract forms and sharp, geometric designs. His glass clad structures seem to spring from the high tech modernist movement. However, Pei is more concerned with function than theory.</td>
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<tr>
<td></td>
<td>National Gallery of Art, East Building (1978)</td>
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<tr>
<td>1984</td>
<td>Richard Meier (United States)</td>
<td>A common theme runs through Richard Meier's striking, white designs. The sleek porcelain-enamed cladding and stark glass forms have been described as &quot;purist,&quot; &quot;sculptural,&quot; and &quot;Neo-Corbusian.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Museum of Art (1983)</td>
<td></td>
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<tr>
<td>1985</td>
<td>Hans Hollein (Austria)</td>
<td>Based in Vienna, Austria, Hans Hollein became known for postmodernist building and furniture designs.</td>
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<td></td>
<td>Abteiberg Museum (1982)</td>
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Philip Johnson, Glass House Architect

Philip Johnson was a museum director, writer, and, most notably, an architect known for his unconventional designs. His work embraced many influences, from the neoclassicism of Karl Friedrich Schinkel and to the modernism of Ludwig Mies van der Rohe.

Born: July 8, 1906 in Cleveland, OH
Died: January 25, 2005
Full Name: Philip Cortelyou Johnson

Education:
- 1930: Architectural History, Harvard University
- 1943: Architecture, Harvard University

Famous Buildings:
- 1949: Glass House, New Canaan, CT
- 1958: Seagram Building (with Mies van der Rohe), New York
- 1962: Kline Science Center, Yale University, New Haven, CT
- 1964: NY State Theater, Lincoln Center, New York
- 1972: Boston Public Library addition
- 1980: Crystal Cathedral, Garden Grove, CA
- 1984: AT&T Headquarters, New York City
- 1984: Pittsburgh Plate Glass Company, Pittsburgh, PA
- 1984: Transco Tower, Houston, TX

Important Ideas:
- International Style
- Neoclassicism

Quotes:
- Create beautiful things. That’s all.
- Architecture is surely not the design of space, certainly not the massing or organizing of volumes. These are auxiliary to the main point, which is the organization of procession. Architecture exists only in time.
- Architecture is the art of how to waste space.
- All architecture is shelter, all great architecture is the design of space that contains, cuddles, exalts, or stimulates the person in that space.
- Why reinvent the spoon?
- The only test for architecture is to build a building, go inside and let it wrap itself around you.

More About Philip Johnson:

After graduation from Harvard in 1930, Philip Johnson became the first Director of the Department of Architecture at the Museum of Modern Art, New York (1932-1934 and 1945-1954). He coined the term International Style and introduced the work of modern European architects such as Ludwig Mies van der Rohe and Le Corbusier to America. He would later collaborate with Mies van der Rohe on what is considered the most superb skyscraper in North America, the Seagram Building in New York City (1958).

Johnson returned to Harvard University in 1940 to study architecture under Marcel Breuer. For his master degree thesis, he designed a residence for himself, the now famous Glass House (1949), which has been called one of the world's most beautiful and yet least functional homes.

Philip Johnson's buildings were luxurious in scale and materials, featuring expansive interior space and a classical sense of symmetry and elegance. These same traits epitomized corporate America's dominant role in world markets in
## Buildings and Projects by Jean Nouvel

Defying expectations, Pritzker-prize winning architect Jean Nouvel experiments with light and shadow. His works have been called exuberant, imaginative, and experimental. This photo gallery presents some highlights of Nouvel's prolific career.

<table>
<thead>
<tr>
<th>Building/Project</th>
<th>Location</th>
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<tbody>
<tr>
<td>Nemausus I public housing in Nimes, France</td>
<td></td>
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<tr>
<td>Agbar Tower in Barcelona, Spain</td>
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<tr>
<td>World Institute in Paris, France</td>
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<tr>
<td>Arab Wall With Metal Lenses at the Arab World Institute</td>
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<tr>
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<td>View of Metal Lenses at the Arab World Institute</td>
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<tr>
<td>Cartier Foundation for Contemporary Art in Paris, France</td>
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<tr>
<td>Guthrie Theater in Minneapolis, Minnesota</td>
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<tr>
<td>Quai Branly Museum in Paris, France</td>
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<tr>
<td>Tour de Verre in New York City</td>
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<tr>
<td>40 Mercer Street, New York City</td>
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</tbody>
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## Alvar Aalto: Buildings and Projects:

Alvar Aalto is known as the father of modern Scandinavian design, and also became famous for his furniture and glassware. His works are modernist and functional, yet classically-inspired.

<table>
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<tr>
<td>Aalto: Headquarters for the White Guards</td>
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<tr>
<td>Aalto: Baker House at MIT</td>
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<tr>
<td>Aalto: Lakeuden Risti Church</td>
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</tr>
<tr>
<td>Aalto: Enso-Gutzeit Headquarters</td>
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<tr>
<td>Aalto: Seinajoki Town Hall</td>
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<tr>
<td>Aalto: Finlandia Hall</td>
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<tr>
<td>Aalto: Otaniemi Technical University</td>
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</tbody>
</table>
Georgian Architecture
1720 to 1800 AD Georgian was a stately, symmetrical style that dominated in Great Britain and Ireland and influenced building styles in the American colonies.

Neoclassical / Federalist / Idealist
1730 to 1925 AD A renewed interest in ideas of Renaissance architect Andrea Palladio inspired a return of classical shapes in Europe, Great Britain and the United States.

Greek Revival Architecture
1790 to 1850 AD These classical buildings and homes often feature columns, pediments and other details inspired by Greek forms. Antebellum homes in the American south were often built in the Greek Revival style.

Victorian Architecture
1840 to 1900 AD Industrialization brought many innovations in architecture. Victorian styles include Gothic Revival, Italianate, Stick, Eastlake, Queen Anne, Romanesque and Second Empire.

Arts and Crafts Movement in Architecture
1860 to 1900 AD Arts and Crafts was a late 19th-century backlash against the forces of industrialization. The Arts and Crafts movement revived an interest in handicrafts and sought a spiritual connection with the surrounding environment, both natural and manmade. The Craftsman Bungalow evolved from the Arts and Crafts movement.

Art Nouveau Architecture
1890 to 1914 AD Known as the New Style, Art Nouveau was first expressed in fabrics and graphic design. The style spread to architecture and furniture in the 1890s. Art Nouveau buildings often have asymmetrical shapes, arches and decorative surfaces with curved, plant-like designs.

Beaux Arts Architecture
1895 to 1925 AD Also known as Beaux Arts Classicism, Academic Classicism, or Classical Revival, Beaux Arts architecture is characterized by order, symmetry, formal design, grandiosity, and elaborate ornamentation.

Neo-Gothic Architecture
1905 to 1930 AD In the early twentieth century, medieval Gothic ideas were applied to modern skyscrapers.

Art Deco Architecture
1925 to 1937 AD Zigzag patterns and vertical lines create dramatic effect on jazz-age, Art Deco buildings.

20th Century Trends in Architecture
1900 to Present. The century has seen dramatic changes and astonishing diversity. Twentieth century trends include Art Moderne and the Bauhaus school coined by Walter Gropius, Deconstructivism, Formalism, Modernism, Structuralism, and Postmodernism.

The Impact Of The Garden City Concept

Ebenezer Howard’s Garden City concept had a profound influence on urban planning. Many plans have attempted to directly emulate Howard’s original ideas, while others have been revised over the past one hundred years. Two major modifications of Howard’s ideas, Perry’s “Neighbourhood Unit” design and Stein and Wright’s plans for “New Towns,” involve the modification of Howard’s ideas regarding the design of residential areas so as to accommodate the growing influence of the automobile. Together, the Garden City concept, the notion of the Neighbourhood Unit, and the “New Town” idea, influence urban planning to this day. The integration of town and country, the separation of conflicting land uses and modes of travel, and the ideas of growth management are all elements of the Garden City concept that have made their way into plans of most major Western cities.

EBENEZER HOWARD AND THE GARDEN CITY CONCEPT

Ebenezer Howard introduced the Garden City Concept in an 1898 book entitled, Tomorrow: A Peaceful Path to Real Reform. Howard’s motivation for developing this scheme was primarily the deterioration of living conditions in the urban and rural areas of England. In urban areas, Howard was concerned about the increasing prominence of
INDIAN HISTORY
Section 1: Architecture and Design
Visual composition in 2D and 3D; Principles of Art and Architecture; Organization of space; Architectural Graphics; Computer Graphics – concepts of CAD, BIM, 3D modeling and Architectural rendition; Programming languages and automation. Anthropometrics; Planning and design considerations for different building types; Site planning; Circulation- horizontal and vertical; Barrier free design; Space Standards; Building Codes; National Building Code.

Elements, construction, architectural styles and examples of different periods of Indian and Western History of Architecture; Oriental, Vernacular and Traditional architecture; Architectural developments since Industrial Revolution; Influence of modern art on architecture; Art nouveau, Eclecticism, International styles, Post Modernism, Deconstruction in architecture; Recent trends in Contemporary Architecture; Works of renowned national and international architects.

Section 2: Building Materials, Construction and Management
Behavioral characteristics and applications of different building materials viz. mud, timber, bamboo, brick, concrete, steel, glass, FRP, AAC, different polymers, composites.

Building construction techniques, methods and details; Building systems and prefabrication of building elements; Principles of Modular Coordination; Estimation, specification, valuation, professional practice; Construction planning and equipments; Project management techniques e.g. PERT, CPM etc.

Section 3: Building and Structures
Principles of strength of materials; Design of structural elements in wood, steel and RCC; Elastic and Limit State design; Structural systems in RCC and Steel; Form and Structure; Principles of Pre-stressing; High Rise and Long Span structures, gravity and lateral load resisting systems; Principles and design of disaster resistant structures.

Section 4: Environmental Planning and Design
Ecosystem- natural and man-made ecosystem; Ecological principles; Concepts of Environmental Impact Analysis; Environmental considerations in planning and design; Thermal comfort, ventilation and air movement; Principles of lighting and illumination; Climate responsive design; Solar architecture; Principles of architectural acoustics; Green Building- Concepts and Rating; ECBC; Building Performance Simulation and Evaluation; Environmental pollution-types, causes, controls and abatement strategies.

Section 5: Urban Design
Concepts and theories of urban design; Public Perception; Townscape; Public Realm; Urban design interventions for sustainable development and transportation; Historical and modern examples of urban design; Public spaces, character, spatial qualities and Sense of Place; Elements of urban built environment – urban form, spaces, structure, pattern, fabric, texture, grain etc; Principles, tools and techniques of urban design; Urban renewal and conservation; Site planning; Landscape design; Development controls – FAR, densities and building byelaws.

Section 6: Urban Planning and Housing
Planning process; Types of plans - Master Plan, City Development Plan, Structure Plan, Zonal Plan, Action Area Plan, Town Planning Scheme, Regional Plan; Salient concepts, theories and principles of urban planning; Sustainable urban development; Emerging concepts of cities - Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc.

Housing; Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing; Housing for special areas and needs; Residential densities; Standards for housing and community facilities; National Housing Policies, Programs and Schemes.

Section 7: Planning Techniques and Management
Tools and techniques of Surveys – Physical, Topographical, Landuse and Socio-economic Surveys; Methods of non-spatial and spatial data analysis; Graphic presentation of spatial data; Application of G.I.S and Remote Sensing techniques in urban and regional planning; Decision support system and Land Information System.

Urban Economics; Law of demand and supply of land and its use in planning; Social, Economical and environmental cost benefit analysis; Techniques of financial appraisal; Management of Infrastructure Projects; Development guidelines such as URDPFI; Planning Legislation and implementation – Land Acquisition Act, PPP etc.; Local self-governance.

Section 8: Services, Infrastructure and Transportation
Building Services: Water supply; Sewerage and drainage systems; Sanitary fittings and fixtures; Plumbing systems; Principles of internal and external drainage system; Principles of electrification of buildings; Intelligent Buildings; Elevators and Escalators - standards and uses; Air-Conditioning systems; Firefighting Systems; Building Safety and Security systems.

Urban Infrastructure – Transportation, Water Supply, Sewerage, Drainage, Solid Waste Management, Electricity and Communications. Process and Principles of Transportation Planning and Traffic Engineering; Road capacity; Traffic survey methods; Traffic flow characteristics; Traffic analyses and design considerations; Travel demand forecasting; Land-use – transportation - urban form inter-relationships; Design of roads, intersections, grade separators and parking areas; Hierarchy of roads and level of service; Traffic and transport management and control in urban areas.; Mass transportation planning; Para-transits and other modes of transportation, Pedestrian and slow moving traffic planning; Intelligent Transportation Systems.

Principles of water supply and sanitation systems; water treatment; Water supply and distribution system; Water harvesting systems; Principles, Planning and Design of storm water drainage system; Sewage disposal methods; Methods of solid waste management - collection, transportation and disposal; Recycling and Reuse of solid waste; Power Supply and Communication Systems, network, design and guidelines.

General Aptitude
Timeline: Indian History of Architecture

Indian History of Architecture

Introduction

- A bronze age civilization - Also known as harappan civilization (2600-1900 BC)
- Thrived in the basins of Indus river profiting from the fertility of the land
- Had a population of 5 million at its peak
- People were mostly tradesmen or artisans
- Known for
  - futuristic urban planning
  - astonishing architecture
  - remarkable handicrafts
  - work in the field of metallurgy

Regional Spread

- Sites cover most of the modern Pakistan and northwestern India
- Area covered is about 1.3 million square miles
- The largest among the old world civilizations
- Over 1050 sites; scattered across the area.

Architecture

- The cities are build on numerous mounds (elevated grounds)
  - Advanced architecture
    - Impressive
- Dockyards
- Graneries
- Warehouses
- Walled city (protection from flood water)
- Well planned streets
- Proper sanitation and drainage system
- Baked brick houses
Indian History of Architecture

Buddhist Architecture

- Principal place of early Buddhist worship is the stupa. Mound shaped shrine with no interior.
- A stupa is a reliquary and worshipers gain spiritual merit through being in close proximity to its contents.
- Buddhists pray while walking around stupa in an easterly direction (direction of sun’s course).
- Central mast at top of stupa with 3 umbrella shapes (Chatras). Symbolizes three jewels of Buddhism (Buddha, Law, and the community of monks).

Buddhism

Buddhism is a path of practice and spiritual development leading to Insight into the true nature of reality. Buddhist practices like meditation are means of changing yourself in order to develop the qualities of awareness, kindness, and wisdom. The experience developed within the Buddhist tradition over thousands of years has created an incomparable resource for all those who wish to follow a path — a path which ultimately culminates in Enlightenment or Buddhahood. An enlightened being sees the nature of reality absolutely clearly, just as it is, and lives fully and naturally in accordance with that vision. This is the goal of the Buddhist spiritual life, representing the end of suffering for anyone who attains it.

Because Buddhism does not include the idea of worshipping a creator god, some people do not see it as a religion in the normal, Western sense. The basic tenets of Buddhist teaching are straightforward and practical: nothing is fixed or permanent; actions have consequences; change is possible. So Buddhism addresses itself to all people irrespective of race, nationality, caste, sexuality, or gender. It teaches practical methods which enable people to realise and use its teachings in order to transform their experience, to be fully responsible for their lives.

Stupas—great stupa at sanchi

- Sanchi is a small village in Raisen district of Madhya Pradesh. It is 46 km NE of Bhopal, Capital of Madhya Pradesh. It is famous for it houses Buddhist monuments called "Stupas" dating to 3rd century BCE. "Stupa" in Sanskrit stands for "heap". Stupas are large hemispherical domes or mound like structure containing a central chamber, in which the relics of the Buddha were placed.
- A circular tumuli of earth covered with stone or brick which propagates the ‘Doctrine’
- Also known as ‘Relic Shrines’

Spherical dome symbolises the infinite sky, the abode of God. Top of dome is a small decorative balcony called ‘Harmika’. At top is a rainvase or ‘Varsha sthala’. The reconstruction of the stupa was started in as early as 150 B.C., when the existing stupa was enlarged nearly twice its previous size.
Mahabodhi Temple, Bodh Gaya, Bihar

The magnificent *Maha Bodhi temple* in Bodh gaya is an architectural amalgamation of many cultures. Originally believed to be a small shrine erected by Emperor Asoka in the 3rd century B.C., temple was later restored in the 11th and 18th centuries. The temple bears the stamp of the architecture of the Gupta Dynasty and subsequent ages. On the walls of the temple, one sees Buddha carved in different aspects, and in the sanctum sanctorum, a colossal Buddha, is seen touching the ground, which has mythological significance in the Buddhist lore. The temple has a 54 meters high pyramidal spire and an ornamental archway at the entrance. The temple carries inscriptions recording the visits of pilgrims from Sri Lanka, China, and Mayanmar in the 7th and 10th Centuries A.D. Hieun Tsang, the Chinese traveller, also visited the temple in the 7th Century.

The Mahabodhi temple has a 150 feet high tower, and it contains a gilded image of Buddha. The original shrine here is believed to have been raised by Emperor Ashoka. The temple has a beautiful stone railing around it. Depicted on the walls of the temple are scenes from Buddha's life. A museum in the vicinity has gold, bronze and stone images of Buddha.

The Vajrasana-platform where Buddha performed his penance is located below the Bodhi tree, and this spot is described as the center of the Universe. The spots where he spent seven weeks have seven shrines, built by devout Buddhists from several countries.

Several Buddhist relics have been unearthed in this area. Other places of interest here include the Tibetan, Japanese and Burmese monasteries. The Tibetan monastery houses the massive Dharma Chakra or the wheel of law. Millions visit Buddha Gaya from all over the world.

The basement of the present temple is 15m square, 15m in length as well as in breadth and its height is 52m which rises in the form of a slender pyramid tapering off from a square platform. On its four corners four towers gracefully rise to some height. The whole architectural plan gives pose and balance to the observers.

Inside the temple there is a colossal image of the Buddha in the "touching the ground pose", bhumisparsa mudra. This image is said to be 1700 years old and is facing east exactly at the place where the Buddha in meditation with his back to the Bodhi tree was enlightened.

**Bodhi Tree**

The original 'Bodhi tree' or Pipal (Ficus religiosa) - the tree of awakening; was said to have been destroyed by Mauryan emperor

Figure: Mahabodhi Temple, Bodh Gaya.

Figure: Mahabodhi Temple Inside Picture

Figure: The Bodhi Tree of Mahabodhi Temple
Meenakshi Temple, Madurai

The temple complex is dedicated to Shiva, known here as Sundareshvara and his consort Parvati or Meenakshi. The temple complex is within a high-walled enclosure, at the core of which are the two sanctums for meenakshi and Sundareshvara, surrounded by a number of smaller shrines and grand pillared halls. Especially impressive are the 12 gopuras. Their soaring towers rise from solid granite bases, and are covered with stucco figures of dieties, mythical animals and monsters painted in vivid colours.

Gopura

Pyramidal gates(gopuras) rise to a height of more than 50m. These towering gateways indicate the entrance to the temple complex at the four cardinal points, while lesser gopuras lead to the sanctums of the main dieties.

Stucco Work

The figures of dieties on the tower are repaired, repainted and ritually reconsecrated every 12 years.

Ashta Shakthi Mandapam

A visitor who enters the temple through the eastern gateway, first enters this Mandapam(Hall). In this hall food was once distributed to the devotees who came from far off places. Next to this hall is the
Jali Work, Sidi Sayyid Mosque, Ahmedabad, Gujarat

The Islamic monuments of Bengal are not much different from such buildings elsewhere in plan and in design, but the use of a different building material and the execution of details inspired by local traditions have made them quite distinct. The so-called "Bengal" roof with sloping cornices, which originated from the bamboo-construction, was adopted by the Muslims and later it spread widely, even in other regions. Brick was the chief building material in the alluvial plains of Bengal from early times and remains so even now, the use of stone being limited largely to pillars which were mainly obtained from demolished temples. The pillars in Bengal, even when constructed with brick, are generally short and square and the opening is usually accurate, for trabeate construction normally called for the use of stone. Covered brick and glazed tiles were usually pressed into service for decoration.

At Gaur the earliest building representing the constructional and ornamental methods of this style, is the Dakhil Darwaja built by Barbak Shah (1959-74) as a ceremonial gateway in front of the citadel. With a tall arched entrance between vertical pylons on either side and tapering towers on the corners, it is an imposing structure.

The walls of Sidi Said Mosque, Ahmedabad, built in 1572 consist substantially of perforated screens. It has become world famous on account of perforated screens, some of them representing the "palm and parasite" motif, which occurs also in the Darsbari Masjid in Bengal. It has the delicate quality of filigree work.

Golgombaz, Bijapur, Karnataka

Figure: Jali Work, Sidi Sayyid Mosque.

Figure: Golgombaz, Bijapur.
Modern Architecture In India

No doubt we have a great architectural heritage of temples, mosques, palaces and forts. So much so that whenever architecture is thought of in conjunction with India, images of the Taj Mahal, Fatehpur Sikri and South Indian temples are conjured up in our minds.

Do we have anything today as representative of Modern Architecture which could be compared with our old buildings? Or in even simpler terms - 'what represents Modern Architecture in India'?

The question which is difficult to answer - demands more than skin deep analysis of modern architecture in the context of India.

The answer to this question also depends on the spirit behind it. If the curiosity behind the question concerns the quantum of construction done in post-independence years, the answer can be one impressive list of statistical figures, a fine achievement for building science and technology.

But, if on the other hand the questioning mind is concerned about new architectural and planning thought generated in the same post-independence years, which have resulted in buildings and cities suited to our socio-economic, cultural and climatical circumstances, our achievements are not very impressive so far. But considering the fact that formation of thoughts and ideas, in this relatively young field, has been going for only the last quarter of century and with the limited resources that we have, it is evident that we are on the verge of making a break-through.

It is not out of context here to go into details how things have been happening in the field of architecture in years preceeding the following independence.

Architecture traditionally, i.e., before the arrival of British on the Indian soil, was from the social point of view, a creation of spectacular sculptural forms hewn out of stone. Architectural material was stone; tools, chisel and hammer, and the aim was glorification. In contrast, the every-day needs of a common man were ruthlessly neglected. Then the British arrived on the scene, it was through them that the first introduction to elementary modern building construction and planning was introduced into India. Their aim, however, was to house their organisations, and their people and whatever was necessary to control an empire as big as India. Apart from self-serving military cantonments and civil lines, they also left the basic problems well alone. It was no intention of the British to educate Indians in the art and science of architecture. Consequently Indian minds, during the British reign, were completely out of touch with the progressive thinking taking place in the rest of the world. The most significant architectural phenomenon that took place during the first half of this century in this country was building of Imperial Delhi. This was an anachronism of the highest order, because, while at that time contemporary Europeans were engaged in most progressive thinking in architecture, Sir Edward Lutyen's was a masterpiece in high renaissance architecture, the result of a way of thinking typical of the early nineteenth century in Europe. It is interesting to note that at the same time as the construction of Delhi, Europe was having "Heroic period of modern architecture" in such schools of thought as "Bauhaus".

Independence woke us to a changed situation. "Time had moved on. In place of religion or royal concern with architectural immortality, this situation demanded attention to those problems that had so far been ruthlessly neglected. The ordinary man, his environment and needs became the centre of attention. Demand for low cost housing became urgent.
Introduction

One of the major reasons to score low in GATE exam for B.Arch students is that few are fully aware that GATE AR is for both of B.Arch & B.Plan. So, a quite well number of questions would be asked in exam covering B. Planning section.

This is a reason you have this booklet. Please note that we have covered in depth the section about town planners, theories and their contribution in Question-Bank itself. Therefore we have minimized those sections here.

Urban planning and design more of theories, stories, concepts etc. We have randomly selected topics from the syllabus and put into concise and bullet form as far as possible.

You should read this booklet as a complementary to the complete set.

GATE SYLLABUS 2018 [Contents covered in this section are highlighted]

Section 5: Urban Design Concepts and theories of urban design; Public Perception; Townscape; Public Realm; Urban design interventions for sustainable development and transportation; Historical and modern examples of urban design; Public spaces, character, spatial qualities and Sense of Place; Elements of urban built environment – urban form, spaces, structure, pattern, fabric, texture, grain etc; Principles, tools and techniques of urban design; Urban renewal and conservation; Site planning; Landscape design; Development controls – FAR, densities and building byelaws.

Section 6: Urban Planning and Housing Planning process; Types of plans - Master Plan, City Development Plan, Structure Plan, Zonal Plan, Action Area Plan, Town Planning Scheme, Regional Plan; Salient concepts, theories and principles of urban planning; Sustainable urban development; Emerging concepts of cities - Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc.

City Planning

Housing: Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing; Housing for special areas and needs; Residential densities; Standards for housing and community facilities; National Housing Policies, Programs and Schemes.
Urban Design

What is urban design?

Unfortunately, there are no hard and fast rules related to urban design. A structural beam in a building must meet certain requirements for that building to stand. A road must be built in a certain way to avoid future potholes.

Urban design, however, is not a series of rules and standards. Rather, it is a group of concepts that, once understood, can lead to a fresh way of perceiving streets, buildings, and spaces -- and insights into why certain places are appealing and others are not. With urban design concepts in mind you should be able to better question architectural presentations and consider the impact of development proposals on your town's character.

Introduction to urban design

When walking down the street you see a place that appears interesting and inviting. Across the street you glance at another area but it looks unappealing and uncomfortable. Which place would you rather be? That’s easy to answer. The more difficult question is: Why? What is it that creates a place that people like and use? Understanding some of the ideas of urban design can help us better answer this question. Urban design does not have to be a mystery. Knowing a few important concepts can make it easier for you to observe what works – and what doesn’t – as you stroll through your town, or as you review a project application.

Urban design is concerned with the arrangement, appearance and function of our suburbs, towns and cities. It is both a process and an outcome of creating localities in which people live, engage with each other, and engage with the physical place around them.

Urban design involves many different disciplines including planning, development, architecture, landscape architecture, engineering, economics, law and finance, among others.

Urban design operates at many scales, from the macro scale of the urban structure (planning, zoning, transport and infrastructure networks) to the micro scale of street furniture and lighting. When fully integrated into policy and planning systems, urban design can be used to inform land use planning, infrastructure, built form and even the socio-demographic mix of a place.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Architecture</th>
<th>Urban Design</th>
<th>Urban Planning</th>
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<tbody>
<tr>
<td>Scale</td>
<td>Individual building</td>
<td>Space between buildings:</td>
<td>Whole neighborhood,</td>
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<td></td>
<td></td>
<td>Street, park, transit shop</td>
<td>districts &amp; cities</td>
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<tr>
<td>Orientation</td>
<td>Aesthetic and functional</td>
<td>Aesthetic and functional</td>
<td>Unity</td>
</tr>
<tr>
<td>Treatment of space</td>
<td>2D &amp; 3D</td>
<td>3D</td>
<td>Predominantly 2D</td>
</tr>
<tr>
<td>Time frame</td>
<td>No definite time frame</td>
<td>Short Term (&lt; 5 years)</td>
<td>Long term (5 to 20 years)</td>
</tr>
</tbody>
</table>
available building materials. Even the absence or removal of distracting or jarring features, such as overhead utility lines, can help bring a sense of unity to a town.

**Sustainable approaches to urban design**

One should first avoid the misconception that dealing with the environment is merely ‘an engineering problem’ to be overcome by technology; and second, that designing to meet people’s social needs is appropriate at the expense of the natural environment. Unfortunately, in the presence of cheap energy, theorists have long argued that the urban environment is being shaped by a technology whose goals are economic rather than environmental or even social. The result has been the alienation of city from the country through a misuse of urban and rural resources and an alienation of urban dwellers from the natural processes which in earlier times dictated so much of the flux of life.

Following are commonly agreed tenets that underpin notions of sustainable development:

- **Futurity** - because we owe future generations an environment at least as rich and opportunities at least as good as those available today;
- **Environmental diversity** - because maintenance and enhancement of various forms of natural capital underpin notions of sustainability;
- **Carrying capacity** - because by remaining within the carrying capacity of environments, activities can be accommodated in perpetuity;
- **The precautionary principle** - because environmental impacts are by their nature uncertain and because prevention is better than cure;
- **Equity / quality of life** - because sustainability extends to the needs of people in that environment which fail to meet human needs and in which resources are poorly shared are unlikely ever to be sustainable;
- **Local empowerment** - because sustainability is a process as much as an objective, requiring the acquiescence and preferably the active involvement of communities;
- **The polluter pays** - because those responsible should pay for the consequences of their actions.

(Source: [http://discovery.ucl.ac.uk/92934/7/Carmona_Sustainabilitypaper1.pdf](http://discovery.ucl.ac.uk/92934/7/Carmona_Sustainabilitypaper1.pdf))

**ELEMENTS OF URBAN DESIGN**

This diagram shows the approximate hierarchical relationship between the elements of urban design, followed by a brief definition of each of the elements. The section below provides basic explanations for terms that are commonly used for urban design.

**URBAN STRUCTURE**

The overall framework of a region, town or precinct, showing relationships between zones of built forms, land forms, natural environments, activities and open spaces. It encompasses broader systems including transport and infrastructure networks.

**URBAN GRAIN**

The balance of open space to built form, and the nature and extent of subdividing an area into smaller parcels or blocks. For example a ‘fine urban grain’ might constitute a network of small or detailed streetscapes. It takes into consideration the hierarchy of street types, the physical linkages and movement between locations, and modes of transport.

**DENSITY + MIX**

The intensity of development and the range of different uses (such as residential, commercial, institutional or recreational uses).
Principles of landscape design and site planning

1. Landscape is a reflection of dynamic natural and social systems.
2. Landscape theory - natural process, social processes, methodology, and technology of values.
3. Goals of art of landscape - Surprise, variety, concealment, the development of idyllic prospects, line of beauty, manipulation of nature undulating contours, elimination of visual break between garden and landscape.
4. Landscape design deals with - surfaces, edges and joints, steps and ramps, connecting specific differences in elevation, paving and drainage.
5. Trees act as ‘scale transition’ from the multiple building to the individual.
6. BEAUTY – the evident harmonious relationship of all sensed components.
7. VIEW – A scene observed from a fine vantage point, Is a theme that may suggest and give added meaning to will related functions.
8. VISTA – An unframed segment of view, Is a function of axis.
9. AXIS – a linear plan element connecting two or more points.
10. HEIGHT – connects attainment, potential, expansion, exhilaration, inspiration, the sublime and release.
11. DEPTH – connects regression, concentration, confinement, shelter, the profane and weight of pressure.
12. SEQUENCE – a succession of perception having counting.
13. The best source of design criteria is field observation.
14. The best test of design is performance.

15. stages of landscape planning -
   ▪ Survey and analysis: classification of landscape types
   ▪ Evaluation
   ▪ Policy or design solution
   ▪ Implementation

16. Trees – entrapment, scale induction, backdrop, ornamentation, noise abatement, and shade ground space.  
17. trees are the basis
18. Group trees to stimulate natural stand
19. Use canopy trees to unify the site
20. Install intermediate trees for understudy screening, wind break, and visual interest.
21. Shrubs for supplementary low level baffles and screens.
22. Treat vines as nets and draperies.
23. Install ground covers on the base plane to retain soils.
24. Soil moisture, define paths, and use areas and provide turf where required.
25. Choose as a dominant theme tree a type that indigenous, moderately fast growing and able to thrive with little care.
26. Exotic species to be limited to areas of high reinforcement.
27. Use trees to sheathe traffic ways.
28. Give emphasis to traffic ways node.
29. Keep the sightless clear at road way intersections.
30. Arrange the tree groupings to provide views and expansive open species.
31. Use plantings to reinforce the alignment of paths and road ways.
32. Concealing unwanted areas, unpleasant views, eliminate glare and reduce noise levels.
33. Provide evolving sequences of space to enclose and link the various site use areas.
34. Strengthen the protruding points of mass planting with dominant plants.
35. Establish vegetation along the malls and water ways.
36. Complement the topographical form.
37. Use plants as space defines.
38. Create a harbor like entrance portal to each neighborhood.

39. Site planning procedure
   ▪ Definition of intent
   ▪ Procurement of topographical survey
   ▪ Program development
PLANNING PROCESS:

All stages of actions from defining the objectives till implementation and review of any planning project in the planning process. In plan preparation, the physical planning should associate with the socio-economical, geographical, political factors, for achieving the objective in desired direction. The various stages of planning process is as follows:
1. Identification and definition of problems
2. Defining the objectives
3. Studies and survey
4. Analysis of data and preparation of study maps
5. Fore-casting
6. Design
7. Fixation of priorities
8. Implementation
9. Review, evaluation and feedback

MULTILEVEL PLANNING IN INDIA
The concept of multi level planning incorporates the principle that proper decision making is possible at any level if the strategy at each level is determined after a careful consideration of the potentials, needs and limitation at the next higher as well as the next lower levels of planning Multi level planning is two-way approach, requiring many preparatory efforts from both ends. The higher level gives macro framework indicators and guideline for planning. The lower levels must feed the higher level with information and has to prepare from below. The various processes involved in multi-level planning are
- Determination of approach levels of decision making with reference to various activities
- Organizing interaction between different levels in terms of exchange of information and interactive consultations of different stages of plan formulation and appraisal
- ‘Nesting of plans’ at different levels and integrating them into a unified frame work. Nesting implies securing both the balances within the plans drawn up for different levels and also their harmonization. Securing integration within plans at different levels implies achieving balance at three levels i.e., sectoral, spatial and operational

COMPREHENSIVE COMMUNITY PLANNING

The purpose of community planning is to anticipate the physical environment that will best serve the needs of the people living and working in an urban area, and then to make plans for achieving this environment. It is continuing process of developing a comprehensive programme to guide urban growth and renewal. There are six minimum planning requirements, which are backbone of any programme.

1. The Land use plan
2. The thoroughfare plan
3. The community facilities plan
4. The public Improvement programme
5. The zoning ordinance and map
6. The subdivision regulations

CENTRAL PLACE THEORY by CHRISTELLER Comprehensive approach of the system

Basic elements are
- A central good
- A central place
- A complimentary region

1. A region can be served by goods of various types if central places producing different ranges of goods are evenly distributed
2. Central places will be regularly spaced clusters located with in hexagonal trading areas and will together for triangular lattices
3. Lower order centers will be located at the gravity centers of the triangles formed by next higher order centers
4. Distances separating the centers will be greater in case of higher order centers and proportionally less for lower order centers
5. All the central places constitute a hierarchy of the smallest villages to the largest town of national importance

SETTLEMENT PATTERN
Census of India defines an Urban Area as
(i) all places with a municipality, corporation, cantonment board or notified town area committee;  
(ii) all other places which has features as  
   (1) a minimum population of 5000;  
   (2) at least 75% of the male working population engaged in non- agricultural pursuits and  
   (3) a density of population of at least 400 persons per sq. km.  
Apart from urban area & urban agglomeration rest is considered as Rural Area.

Census Classification of Cities and Towns:

<table>
<thead>
<tr>
<th>Class of Cities/Towns</th>
<th>Range of Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>100,000 and above</td>
</tr>
<tr>
<td>Class II</td>
<td>50,000 to 99,999</td>
</tr>
<tr>
<td>Class III</td>
<td>20,000 to 49,999</td>
</tr>
<tr>
<td>Class IV</td>
<td>10,000 to 19,999</td>
</tr>
<tr>
<td>Class V</td>
<td>5,000 to 9,999</td>
</tr>
<tr>
<td>Class VI</td>
<td>Below 5,000</td>
</tr>
</tbody>
</table>

Source: Report of National Commission on Urbanization

LAND USE AND LAND UTILISATION
At any particular point of time, a parcel of land put to some use is landuse. This concept is a dynamic phenomenon as the use of a vacant land may be converted to residential or commercial.

Need for ‘land use’
- To guide the use of land to promote the advantages of development of the community
- Curb misuse of land i.e. increased intensity of development, encroachment of open space
- Prevent abuse of land i.e. prevent formation of slums, squatters
- Regulate the nonuse or misuse of land i.e. land being used for speculation, without development
- To guide the re-use of land i.e. conservation

Land use plan
Land use plans show us the various kinds of activities that are carried out in the different location of the city. There are various types of landuses in a city.
Transit Oriented Development

Transit Oriented Development is the exciting fast growing trend in creating vibrant, livable, sustainable communities. Also known as TOD, it's the creation of compact, walkable, pedestrian-oriented, mixed-use communities centered around high quality train systems. This makes it possible to live a lower-stress life without complete dependence on a car for mobility and survival.

Transit oriented development is regional planning, city revitalization, suburban renewal, and walkable neighborhoods combined. TOD is rapidly sweeping the nation with the creation of exciting people places in city after city. The public has embraced the concept across the nation as the most desirable places to live, work, and play. Real estate developers have quickly followed to meet the high demand for quality urban places served by rail systems.

Transit oriented development is also a major solution to the serious and growing problems of climate change and global energy security by creating dense, walkable communities that greatly reduce the need for driving and energy consumption. This type of living arrangement can reduce driving by up to 85%.

Rationale

Transit-oriented development is a response to current conditions:
- Rising energy prices
- Road congestion
- Climate change
- Shrinking household sizes
- Increasing demand for urban living
- Interest in green building and walkable neighborhoods

Homebuyers, renters and employers are increasingly drawn to areas with convenient access to transit and other urban amenities such as neighborhood shopping and services.

Factors Driving The Trend Toward TOD

- Rapidly growing, mind-numbing traffic congestion nation-wide
- Growing distaste for suburbia and fry-pit strip development
- Growing desire for quality urban lifestyle
- Growing desire for more walkable lifestyles away from traffic
- Changes in family structures: more singles, empty-nesters, etc
- Growing national support for Smart Growth
- New focus of Federal policy

"Traffic congestion has increased so much in virtually every metropolitan area that two-hour commutes now are routine. Attempts to alleviate the problem by constructing more highways almost always have led to more sprawl and, eventually, more congestion."

COMPONENTS OF TRANSIT ORIENTED DEVELOPMENT

- Walkable design with pedestrian as the highest priority
- Train station as prominent feature of town center
- Public square fronting train station
- A regional node containing a mixture of uses in close proximity (office, residential, retail, civic)
- High density, walkable district within 10-minute walk circle surrounding train station
- Collector support transit systems including streetcar, light rail, and buses, etc
- Designed to include the easy use of bicycles and scooters as daily support transport
- Large ride-in bicycle parking areas within stations
- Bikeshare rental system and bikeway network integrated into stations
- Reduced and managed parking inside 10-minute walk circle around town center / train station
- Specialized retail at stations serving commuters and locals including cafes, grocery, dry cleaners
Transit-oriented development, or TOD, is an approach to development that focuses land uses around a transit station or within a transit corridor. Typically, it is characterized by:

- A mix of uses
- Moderate to high density
- Pedestrian orientation/connectivity
- Transportation choices
- Reduced parking
- High quality design

The rule of thumb is that TOD occurs within one-quarter mile, or a five to seven minute walk, of a transit station.
Smart City

The first question is what is meant by a ‘smart city’. The answer is, there is no universally accepted definition of a smart city. It means different things to different people. The conceptualisation of Smart City, therefore, varies from city to city and country to country, depending on the level of development, willingness to change and reform, resources and aspirations of the city residents. A smart city would have a different connotation in India than, say, Europe. Even in India, there is no one way of defining a smart city.

Some definitional boundaries are required to guide cities in the Mission. In the imagination of any city dweller in India, the picture of a smart city contains a wish list of infrastructure and services that describes his or her level of aspiration. To provide for the aspirations and needs of the citizens, urban planners ideally aim at developing the entire urban eco-system, which is represented by the four pillars of comprehensive development-institutional, physical, social and economic infrastructure. This can be a long term goal and cities can work towards developing such comprehensive infrastructure incrementally, adding on layers of ‘smartness’.

In the approach of the Smart Cities Mission, the objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of ‘Smart’ Solutions. The focus is on sustainable and inclusive development and the idea is to look at compact areas, create a replicable model which will act like a lighthouse to other aspiring cities. The

Smart Cities Mission of the Government is a bold, new initiative. It is meant to set examples that can be replicated both within and outside the Smart City, catalysing the creation of similar Smart Cities in various regions and parts of the country.

The core infrastructure elements in a smart city would include:

i. adequate water supply,
ii. assured electricity supply,
iii. sanitation, including solid waste management, iv. efficient urban mobility and public transport,
v. affordable housing, especially for the poor, vi. robust IT connectivity and digitalization,
vii. good governance, especially e-Governance and citizen participation, viii. sustainable environment,
ix. safety and security of citizens, particularly women, children and the elderly, and
x. health and education.

As far as Smart Solutions are concerned, an illustrative list is given below. This is not, however, an exhaustive list, and cities are free to add more applications.

Accordingly, the purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes. Area-based development will transform existing areas (retrofit and redevelop), including slums, into better planned ones, thereby improving liveability of the whole City. New areas (greenfield) will be developed around cities in order to accommodate the expanding population in urban areas. Application of Smart Solutions will enable cities to use technology, information and data to improve infrastructure and services. Comprehensive development in this way will improve quality of life, create employment and enhance incomes for all, especially the poor and the disadvantaged, leading to inclusive Cities.

Figure: What it takes to be a Smart City
Eco City

The term ‘eco-cities’ is synonymous with urban areas that, at scale, promote environmental preservation. However, decorating cities with boulevards and green buildings, as well as adopting energy- and waste-efficient technologies, are merely small parts of the modern eco-city.

The concept of making cities environmentally sustainable is nothing new. In Europe and the US, the Garden City movement of the 1890s and the post-World War II New Town phenomenon were based on the idea of creating urban areas that merged contemporary and spacious housing with modern infrastructure and greenery. Both were seen as attempts to reinvent the city in the post-industrial era.

The term ‘eco-city’ surfaced in the 1970s, when a US-based movement known as Urban Ecology first used it. Founded in California, the group launched the journal, The Urban Ecologist. “An eco-city is an ecologically healthy city. That also means the city design is strongly informed by knowledge of ecology and its design principles,”

However, many claim the term today depicts a city that adheres to the three core pillars of sustainability: environmental stewardship, social equality and economic prosperity.

Today we know much more about designing and building eco-cities than we did in the 1990s. At that time sustainability was more or less about being environmentally sustainable. Today, however, sustainability is much more recognised and mainstream.”

“We have come to recognise that sustainability has three dimensions: environment and resources; social and cultural cohesion; and economic and financial dimension. We have also realised that we should aim for creating cities for people – cities that are designed and built for the human scale and are vibrant,” he adds.

Eco-cities come in all shapes and sizes. Research conducted in 2011 by the International Eco-Cities Initiative claims there are more than 170 such places globally, with this number set to rise over the next decade. Furthermore, the size, scale and types of eco-cities vary widely. In the developing world, for instance, purpose-built eco-cities are being built at breakneck pace, whereas in the West, urban regeneration is more common.

“Greenfield development and retrofitting both have their advantages and disadvantages. In the developed world of Europe, the US and Japan, greenfield is becoming rarer, so in these regions it is more about retrofitting. In the developing world of Asia and Latin America, greenfield development is happening in many places,”.

The urbanist names the IBA Hamburg project in Germany and Masdar City in the UAE. It is said that the former exemplifies a hybrid model that mixes retrofitting with building on new land, while the latter demonstrates the ability to build a sustainable city in a harsh desert climate.

Drivers of today’s eco-cities

It is widely accepted among urbanists that in order to be referred to as an eco-city, cities must embrace the three core pillars of sustainability.

However, behind these principals, a host of other factors influence the modern eco-city. Affordability and demand on the parts of the general public and government policymakers are two notable factors, as are energy-and resource-efficiency and land conservation.

“People want eco-cities only if they can choose freely and can afford to pay for them. Wise politicians and business people listen to their constituents and clientele, and strive to deliver what the people want. As energy prices go up eco-cities will become more competitive. In addition, land scarcity is also driving up prices on building rights, making the densification process unavoidable,”.
Master Plan

A Master plan is a comprehensive long term perspective plan intended for guiding the sustainable planned development of city.

- It creates a vision that is supported by policies, guidelines and priorities.
- It is a policy based document, it does not, nor can regulate land use.
- **lays down** the planning guidelines, policies, development code and space requirements for various socio-economic activities supporting city population during plan period.
- **It is based on**
  - public input,
  - surveys,
  - planning initiatives,
  - existing development,
  - physical characteristics, &
  - socio-economic conditions.

- It includes analysis, recommendations, and proposals for:
  - population,
  - economy,
  - housing,
  - transportation,
  - community facilities, &
  - land use.

- It is the basis for all infrastructure requirements.
- To guide development of a city is an orderly manner so as to improve the quality of life of the people
- Organize and coordinate the complex relationships between urban land uses
- Chart a course for growth and change, be responsive to change and maintain its validity over time and space, and be subject to continual review

- Direct the physical development of the city in relation to its social and economic characteristics based on comprehensive surveys and studies on the present status and the future growth prospects; and

- Provide a resource mobilization plan for the proposed development works.

City Development Plan?

A City Development Plan is a comprehensive document outlining the vision and development strategy for future development of the city, prepared in consultation with a wide range of stakeholders to identify the thrust areas to be addressed on priority basis in order to achieve the objectives and the vision. It thus provides the overall framework within which projects are identified and put forward in a City Investment Plan.

Key features of a CDP

1. Presents current stage of city’s development – where are we now?
2. Projects aspirations of the city – what/where do we want to be?
3. Attempts a Resource Based Planning – is city planning inclusive of all resources; social, economic, natural and
4. Identifies the thrust areas – what are the sectors we need to address on a priority basis?

5. Sets goals for different sectors – inter sectoral and intra sectoral - what specific goals should be targeted?

6. Suggests alternative routes, strategies – what are the practical and implementable approaches to achieve the goals?

7. Identifies specific interventions and their resource requirements – what are the specific projects and initiatives to be undertaken, and what will be the investment needs?

8. Adopts a transparent and consistent framework and prioritizes these interventions - collectively what do we agree are the priorities?

9. Identifies a financial plan that can be operationalised at the institutional level and then as an aggregate at the city level – how do we balance the resource availability (social, economic, cultural and natural) with the requirements of the plan for the medium term? Can the internal resources finance priority investments? Are there other options for leveraging finances?

10. Identifies the actions for developing institutional synergy, drawing on resources from private sector and the civil society, and build the organizational capacity to meet the challenges of implementing these plans – what are the resources we need to put together to be able to implement these plans?

11. Ensures that focused strategies and plans are evolved to address issues of urban poverty - how do we ensure that the goals, strategies and plans promote inclusive growth, and provide the environment to alleviate poverty?

12. Evolves through a process of participatory planning with involvement of all stakeholders – how do we ensure that the CDP has collective ownership and reflects the voice of all sections of society?

**CDP as a Living Document**

The CDP has to be looked at in a context of the dynamic nature of the issues involved. The timelines and processes for changes and mid-term course correction related to varying aspects of the CDP have to be dynamic, to reflect the changing physical as well as policy environment. The CDP should also integrate developments in the ULBs with its immediate spatial continuum extending to the peri-urban ULBs and panchayats. In context of urban agglomerations, the CDP could be for the Metropolitan Planning Area. This could also help in expediting the creation of MPCs. Thus the CDP becomes a comprehensive and implementable document including a long term Vision of the city, short term sectoral plans defining specific projects and annual Financial Operating Plan (FOP). Since a CDP is both a perspective and a vision for the future development of a city, it should not limit itself only to provide for existing and projected shortfalls but to provide for better quality of services, infrastructure and built environment. All the three aspects of curative, preventive and betterment approaches have to be part of a comprehensive and inclusive planning for an enhanced quality of life of the citizens.

**Structure Plan**

The Structure Plan is the main document of the entire planning process. It is a legal document, binding for all further planning and investment procedures at a more detailed level. Local Plans for example have to follow the Structure Plan, so do permits.

**Most Structure Plans will be at the scale of 1:25,000.**

**The Structure Plan map should include identification of main land uses:**
- Present
- Proposed
- ‘White land’
- Main trunk infrastructure (roads, water, drainage, sewage, electricity)
• Major Government Housing Finance Bodies
  - National Housing Bank
  - HUDCO

**Role of State Governments:**
• State and City Level Authorities

**Major Acts and Regulations:**
• GoI, in the constitutional Amendment Act 73 and 74 gave power of housing to local government agencies.
• Housing a state centric subject
• Centre gives policy guidelines, implementation is on state

**National Level acts and regulations**

(A) Laws relating to ownership of land for development.

1. *Urban Land Ceiling and Regulation Act, 1976 (ULCRA)*
   • Implemented in 1976
   •Implemented to facilitate availability of urban land for MIG and LIG
   •Ceiling on ownership & possession of vacant land
   •Acquisition of excess land for common good
   •Payment of compensation for acquire land

ULCRA failed to achieve its objectives

• Instead of facilitating it lead to artificial scarcity
• High Land prices
• Central Govt. Repeal the Act by Passing UL (C&R) Repeal Act, 1999

2 *Registration Act, 1908*
• Purpose is to conserve evidence, assurance of title, publication of documents and prevention of fraud

3 *Stamp Act*
• Stamp Duty needs to be paid on all documents
• Rate of duty varies from state to state
• High stamp duties are cited as a key reason for avoidance of registration
• Calculated on the basis of the market value of property as quoted in the agreement

4 Transfer of Property Act, 1872 5 Indian Contract Act, 1972

(B) Laws Relating to nature of development

1 *Coastal Regulation Zone Notification*
HOUSING

Gross residential density
No. of persons per acre over the whole of a defined area including public buildings, large open space and half the width of surrounding roads

Net residential density
No. of persons per acre of residential area including small garden patches, internal roads, half the width of surrounding roads up to 6m.

Overall density
No. of persons per acre over a large area of town affecting the general economy

Town density
No. of persons per acre over the entire town area including residential, industrial, commercial, educational, recreational, transportation unusable areas like river beds, quarry pits, streams, lakes, military land

Importance of housing
- A place where one can take rest, sleep and cook food. House is a part and parcel of man's life and substantial part of man's lifetime is spent in his house.
- The economic importance of housing is also very significant. It contributes to national income, national wealth and national employment. It also serves as a good source of revenue for central state and local governments.
- In general, it can be stated that housing has potentiality to great extent in promoting human welfare, social life, economic growth, health of community and various other related aspects of human life.

Role of Architect / Planner in Housing Design
- Generate no social pollution due to lack of privacy, group interaction, separation (class segregation) of income groups
- Plot distribution must be maintainable i.e, eliminate the concept of no man's land
- Means to combat natural and unnatural hazards
- Ensure efficient network and services for easy maintenance
- A close knit for optimum density pattern
- Maintain desired level of privacy
- Guarantee acceptable - safety and standard of physical health

Factors governing design of housing
- Clients brief
- Site
- Climatologic
- Development control parameters
- Budget
- Technology
- Social, economic and cultural content of the community

Housing and Urban policy in India

In the First Five Year Plan (1951-56), the emphasis was given on institution building and on construction of houses for Government employees and weaker sections. The Ministry of Works & Housing was constituted and National Building Organisation and Town & Country Planning Organisation were set up. A sizeable part of the plan outlay was spent for rehabilitation of the refugees from Pakistan and on building the new city of Chandigarh. An Industrial Housing Scheme was also initiated. The Centre subsidised Scheme to the extent of 50% towards the cost of land and construction.
SURVEY METHODS

TYPES OF SURVEYS
Surveys can broadly be divided into two categories depending on the area upon which they are to be conducted. They are:

REGIONAL SURVEYS
They are those surveys, which are done over a region dealing with
- PHYSICAL FACTORS like topography, physically difficult land, geology, landscape etc.
- PHYSICAL ECONOMIC FACTORS like agricultural value of the land, mineral resources and water gathering lands, areas with public services, transportation linkages etc.
- SOCIAL ECONOMIC FACTORS like areas of influence of towns and villages, employment, population changes etc.

TOWN SURVEYS
They are done at much small scale and apart from the above data collected from the regional surveys it also includes
- LANDUSE SURVEYS
- DENSITY SURVEYS
- SURVEYS FOR THE AGE AND CONDITION OF THE BUILDINGS
- TRAFFIC SURVEYS
- OTHER SOCIAL SURVEYS

For conducting proper survey, primarily relevant enquiries should be framed in the form of questionnaires for presentation, when required.

TECHNIQUES OF SURVEYS
Of the various techniques of surveys that are followed, the four listed below are most prominent
1. self surveys (i.e. mailing questionnaires to the persons to be surveyed )
2. interviews (i.e. by asking questions to the people to be surveyed)
3. direct inspection (i.e. when the surveyor himself inspects the situations concerned)
4. observers participation (i.e. when the observer himself participate in acquiring the data required)

SCALES FOR STRUCTURING QUESTIONNAIRES
The questions that are asked in the questionnaires formed for doing the surveys can be of various types. Some of the asks for general things, some asks for some order of preferences or some give stress to the time interval between two incidents. Thus the scales of the questionnaires are fixed, which can be described as follows

NOMINAL where there is no ordering, like asking of sex, age, employment in any particular service etc.
ORDINAL where there is a specific order of choices like asking of priorities, housing conditions, climate etc.
INTERVAL where an interval of time is given importance like time taken to shift from LIG housing to MIG housing, time interval to change from two wheelers to four wheelers etc. this provides an yardstick of measurements

SELECTION OF SAMPLES
For conducting surveys, it is not always possible to ask each person about his or her opinion. Hence, certain numbers of persons are selected for conducting the surveys and these selected persons are known as ‘samples’ of surveying. The selection of the number of samples is of utmost importance. The basic rules for selection of sample size are as follows:
1. MORE DISASTROUS THE RESULTS OF POOR INFORMATION, LARGER SAMPLE SIZE IS REQUIRED. That is if the information got are poor (both qualitatively and quantitatively) the analysis done from them will be wrong. Thus, if getting incorrect results have a very disastrous effect on the
# PLANNING STANDARDS

## 1. Civic amenities and community facilities

<table>
<thead>
<tr>
<th>Educational facilities</th>
<th>Population per unit</th>
<th>Number of pupils</th>
<th>Area in hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery school (age group of 3 to 6 years)</td>
<td>1,500</td>
<td>80</td>
<td>0.2 (including play ground)</td>
</tr>
<tr>
<td>Basic primary school (age group of 6 to 14 years)</td>
<td>3,500</td>
<td>400</td>
<td>1.0 (including play ground)</td>
</tr>
<tr>
<td>Higher secondary school (age group of 14 to 17 years)</td>
<td>3,500</td>
<td>400</td>
<td>1.0 (including play ground)</td>
</tr>
<tr>
<td>Colleges</td>
<td>50,000</td>
<td>2,000</td>
<td>3 to 4 (including play ground)</td>
</tr>
<tr>
<td>Technical institution</td>
<td>50,000</td>
<td>1,000</td>
<td>5.0</td>
</tr>
<tr>
<td>University campus</td>
<td>---</td>
<td>20,000</td>
<td>500.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medical facilities</th>
<th>Population per unit</th>
<th>Number of beds</th>
<th>Area in hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispensary</td>
<td>5,000</td>
<td>---</td>
<td>0.1</td>
</tr>
<tr>
<td>Health centre (0.5 bed per 1,000 population)</td>
<td>20,000</td>
<td>15</td>
<td>0.4 (including staff quarters)</td>
</tr>
<tr>
<td>Hospital (2 bed per 1,000 population)</td>
<td>50,000</td>
<td>100</td>
<td>2 (including staff quarters)</td>
</tr>
<tr>
<td>District tuberculosis centre</td>
<td>1.0 to 2.0 million</td>
<td>100</td>
<td>2</td>
</tr>
</tbody>
</table>

## Other amenities

<table>
<thead>
<tr>
<th>Other amenities</th>
<th>Population per unit</th>
<th>Area in hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post and telegraph office</td>
<td>10,000</td>
<td>0.1 (including staff quarters)</td>
</tr>
<tr>
<td>Telephone exchange (10,000 lines)</td>
<td>1,000,000</td>
<td>0.2</td>
</tr>
<tr>
<td>Electricity substation</td>
<td>50,000</td>
<td>0.2</td>
</tr>
<tr>
<td>Police station</td>
<td>10,000</td>
<td>0.2</td>
</tr>
<tr>
<td>Police station (major)</td>
<td>50,000</td>
<td>0.8 (including staff quarters)</td>
</tr>
<tr>
<td>Fire station</td>
<td>50,000</td>
<td>0.8 (including staff quarters)</td>
</tr>
<tr>
<td>Cinema theatre</td>
<td>20,000</td>
<td>0.25</td>
</tr>
<tr>
<td>Community hall and library</td>
<td>25,000</td>
<td>0.75</td>
</tr>
<tr>
<td>Swimming pool</td>
<td>1,000,000</td>
<td>0.8</td>
</tr>
<tr>
<td>Stadium</td>
<td>1,000,000</td>
<td>3</td>
</tr>
<tr>
<td>Open air theatre</td>
<td>50,000</td>
<td>0.8</td>
</tr>
<tr>
<td>Religious building</td>
<td>3,000</td>
<td>0.1</td>
</tr>
<tr>
<td>Auditorium</td>
<td>20,000</td>
<td>0.4</td>
</tr>
<tr>
<td>Filling station</td>
<td>15,000</td>
<td>0.05</td>
</tr>
<tr>
<td>Filling-cum service-station</td>
<td>25,000</td>
<td>0.1</td>
</tr>
</tbody>
</table>
That's it folks! End of preview!

Let's be honest. We have tried to cover most of the syllabus, but it's incomplete. You must read this part along with the provided question-bank to get most out of it. Even though many topics might be missing, you can score well. All the best!

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The most important thing, don't forget to like us on our Facebook page!