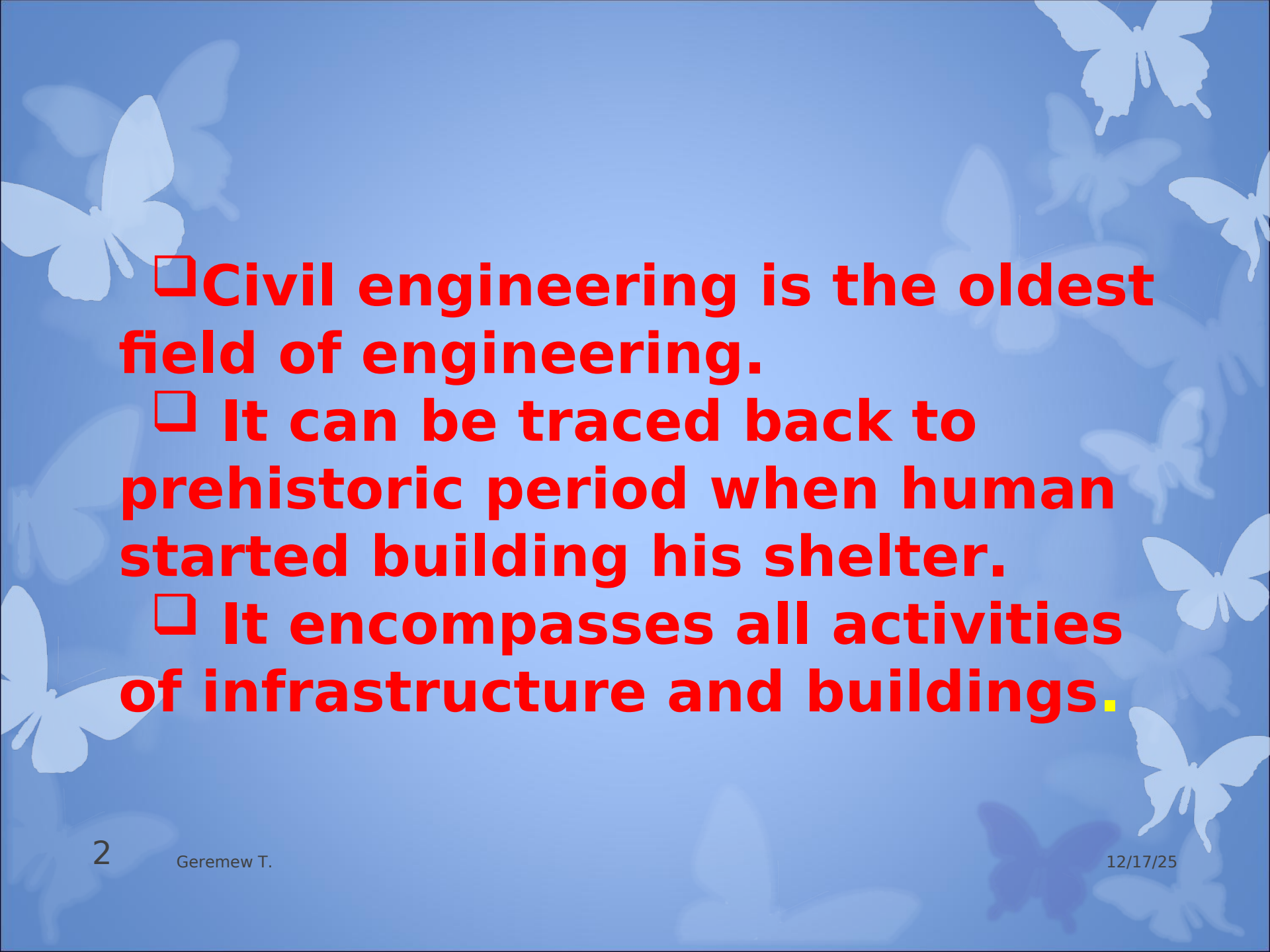


Introduction to Civil Engineering

- 
- ☐ **Civil engineering is the oldest field of engineering.**
 - ☐ **It can be traced back to prehistoric period when human started building his shelter.**
 - ☐ **It encompasses all activities of infrastructure and buildings.**

❑ Civil engineering deals with such topics as water engineering, structural engineering, geotechnical engineering, surveying and highway engineering, engineering materials, construction, etc.

❑ Even though they look different they have a common core of requirement for handling a civil engineering project efficiently.

❑ Even though the concepts we learn in civil engineering are simple, application of them to practical problems poses a great challenge due to different scenarios/ environment in different problems.

❑ Many simplifying assumptions are to be made to apply a concept and it demands “engineering judgment” on the part of engineer while applying solutions from those concepts to practical situation.

part of civil engineering is very vast and huge.

- ❑ More than 1/3 of the wealth creation of our globe is in the sector of construction.

- ❑ Investment in construction works all over the world exceeds 1 trillion dollars per annum. Construction sector is the biggest employer of manpower.

- ❑ Execution of construction is science, engineering, mathematics, management, sociology and politics.

It is a great deal of challenge, responsibility and power.

Geotechnical engineering

Soils

❑ What is the density of steel? It is 78.6 kN/CuM .

What is the density of mercury? It is 136 kN/CuM .

What is the density of soil?

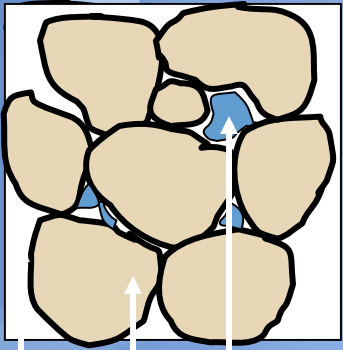
❑ probably we cant answer with out more information about it as to where it is, which type of soil it is, what is its condition- loose or dense, what is its water content and so on. This is because soil is not solid or liquid or gas completely but it is a system/composite of all the three.

❑ The density of soil depends on the proportion of these three components in it. The diagram below illustrates this. Also shown is the conceptual diagram of soil as three phase system.

□ It is clear now that soils have different densities. Also same soil can have different densities depending on its compactness and moisture content.

□ We define bulk density of soil (W/V), dry density of soil (W_{dry}/V), saturated density of soil ($W_{at Sr=100\%}/V$), submerged density of soil (W_{sub}/V) and insitu density of soil. We have to deal with soil as it exists in nature.

□ In situ density of soil is its weight per unit volume in its natural state.

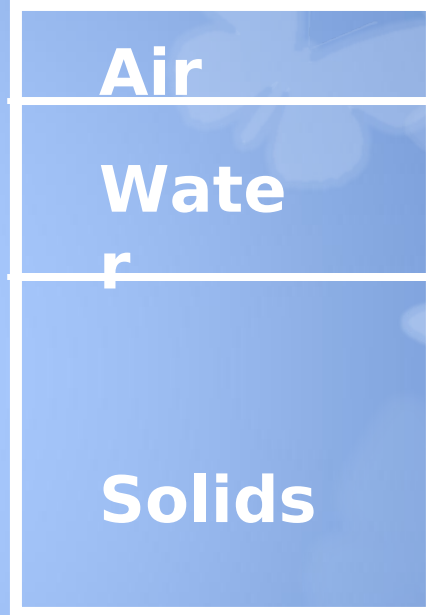


V



V

V_a
 V_w
 V_s



W_a
 W_w
 W_s

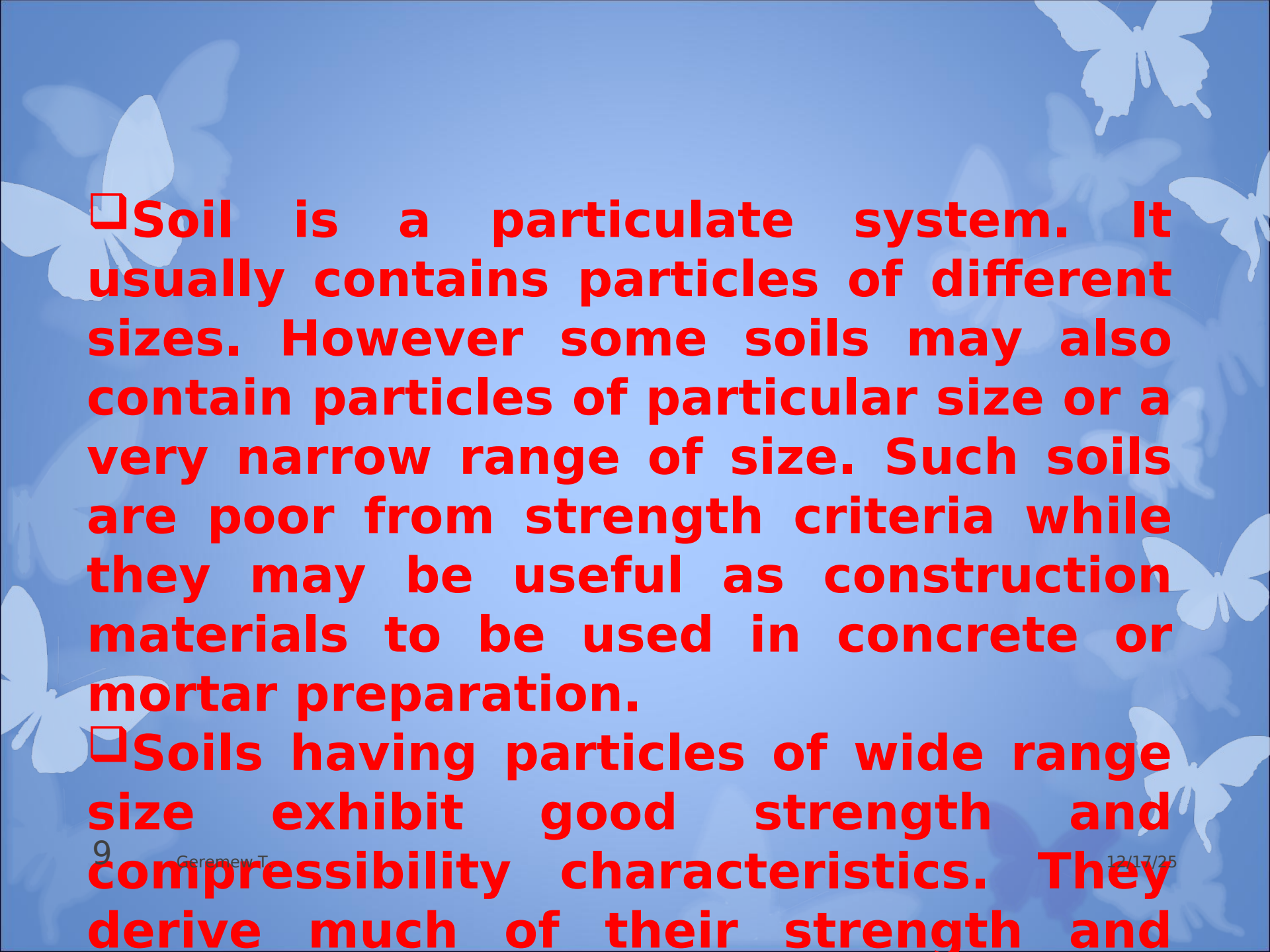
Water

Air

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solids



❑ Soil is a particulate system. It usually contains particles of different sizes. However some soils may also contain particles of particular size or a very narrow range of size. Such soils are poor from strength criteria while they may be useful as construction materials to be used in concrete or mortar preparation.

❑ Soils having particles of wide range size exhibit good strength and compressibility characteristics. They derive much of their strength and

Foundations

❑ The part of a structure that transmits load on to soil is termed as foundation or footing.

❑ Normally the material used in superstructure elements (Concrete, steel etc) are much stronger than soil. As such when elements are transferring load onto soil, a much weaker material, to reduce load per unit area the structural component is flared / enlarged to decrease the stress it transfers on to soil to a safe value so that soil can resist it safely.

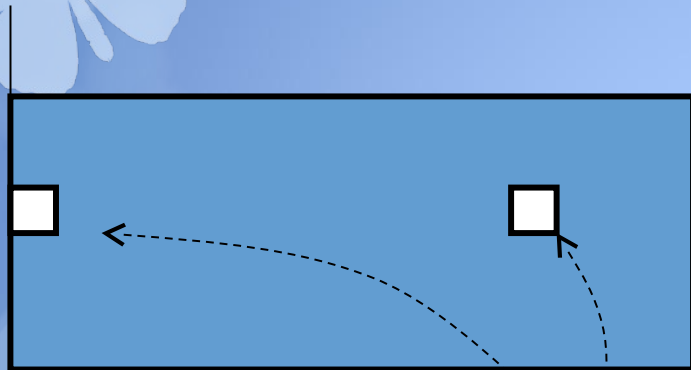
❑ For safety of structure soil should fulfil following two criteria.

- 1. It should not fail under the foundation load.**
- 2. It should not undergo considerable settlement under its load.**

❑ To fulfil the above criteria we should ensure that soil pressures are within allowable values and at those pressures the soil will not deform by a margin detrimental to structure.

❑ Column foundations of square and circular shape are widely used along with rectangular foundations.

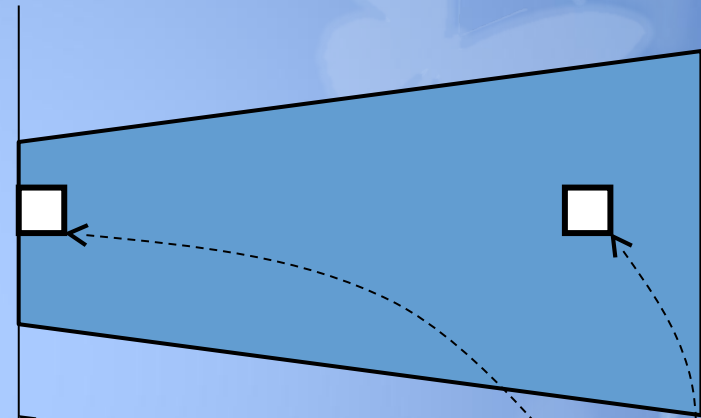
❑ Some times when a column has to be provided at the edge of property, the footings of those edge columns are combined with those of adjacent column, to achieve uniform pressure distribution beneath them. They are called combined or special footings. Some of them are shown in figure.



Property edge

Column

Rectangular combined footing

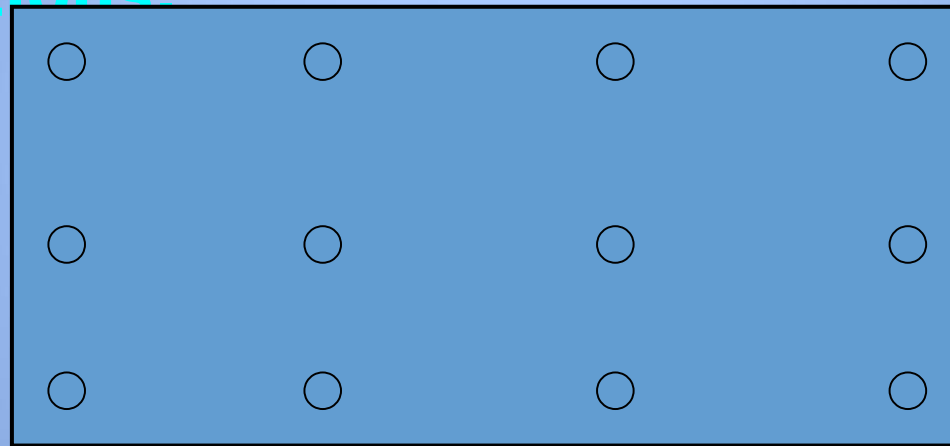


Property edge

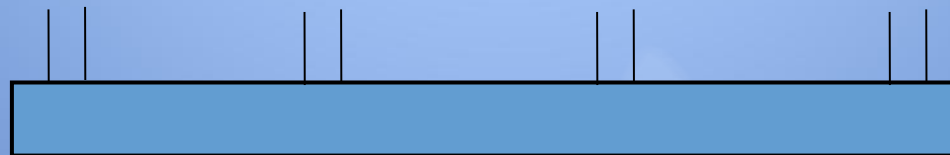
Column

Trapezoidal

When the soil is poor, its bearing capacity, q_a , will be very less and as such footing areas will be large. In such contexts and where foundations has to bridge over very poor soils a mat foundation covering the whole area of building is provided as shown in figure. Such footings are known as **mat or raft foundations**.



Plan

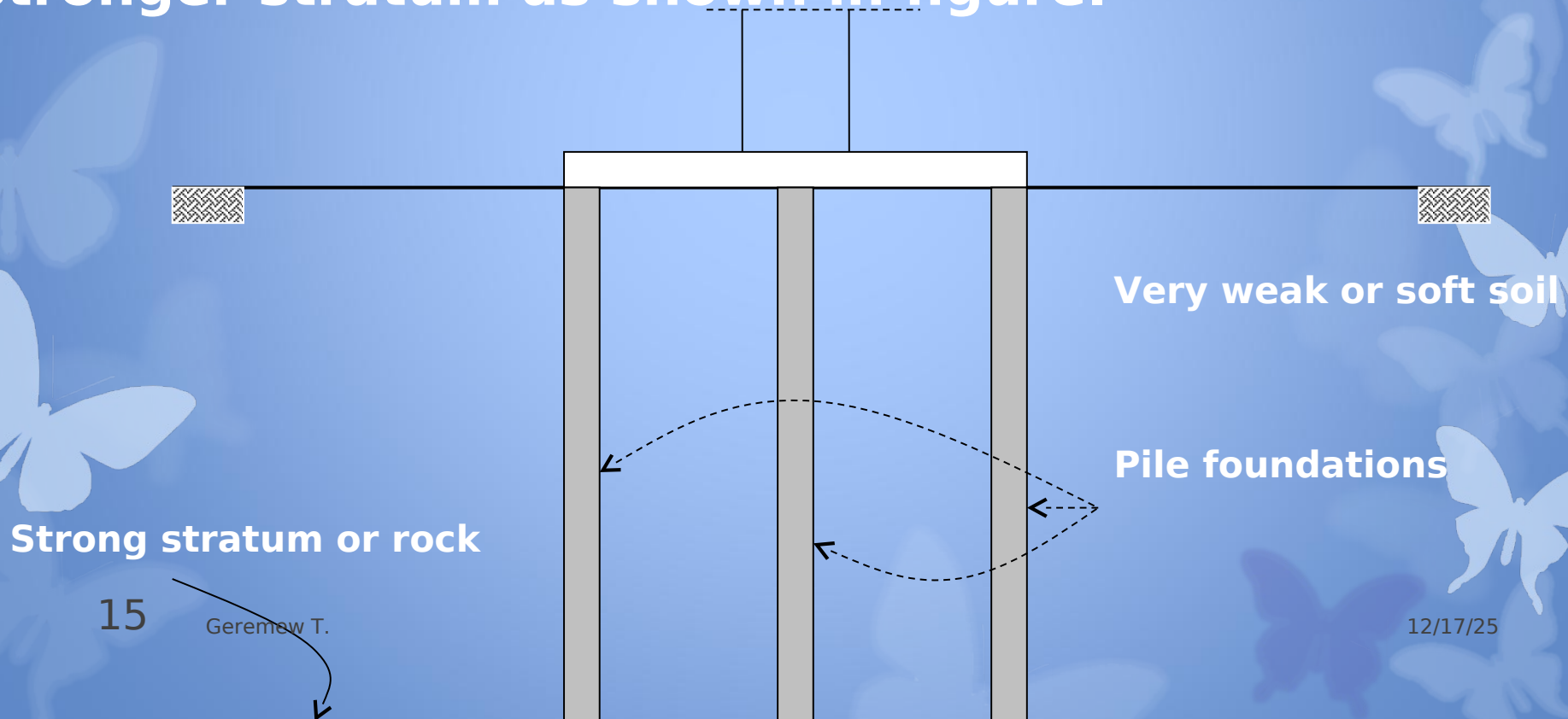


Section



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There may be also sites where the soil in top layer is very weak and extends to great depth. Resting of foundations of before discussed type may need large and impractical excavations. In such cases **pile / deep foundations** are used to transmit column load through weaker structures to deeply lying stronger stratum as shown in figure.



Structures





17

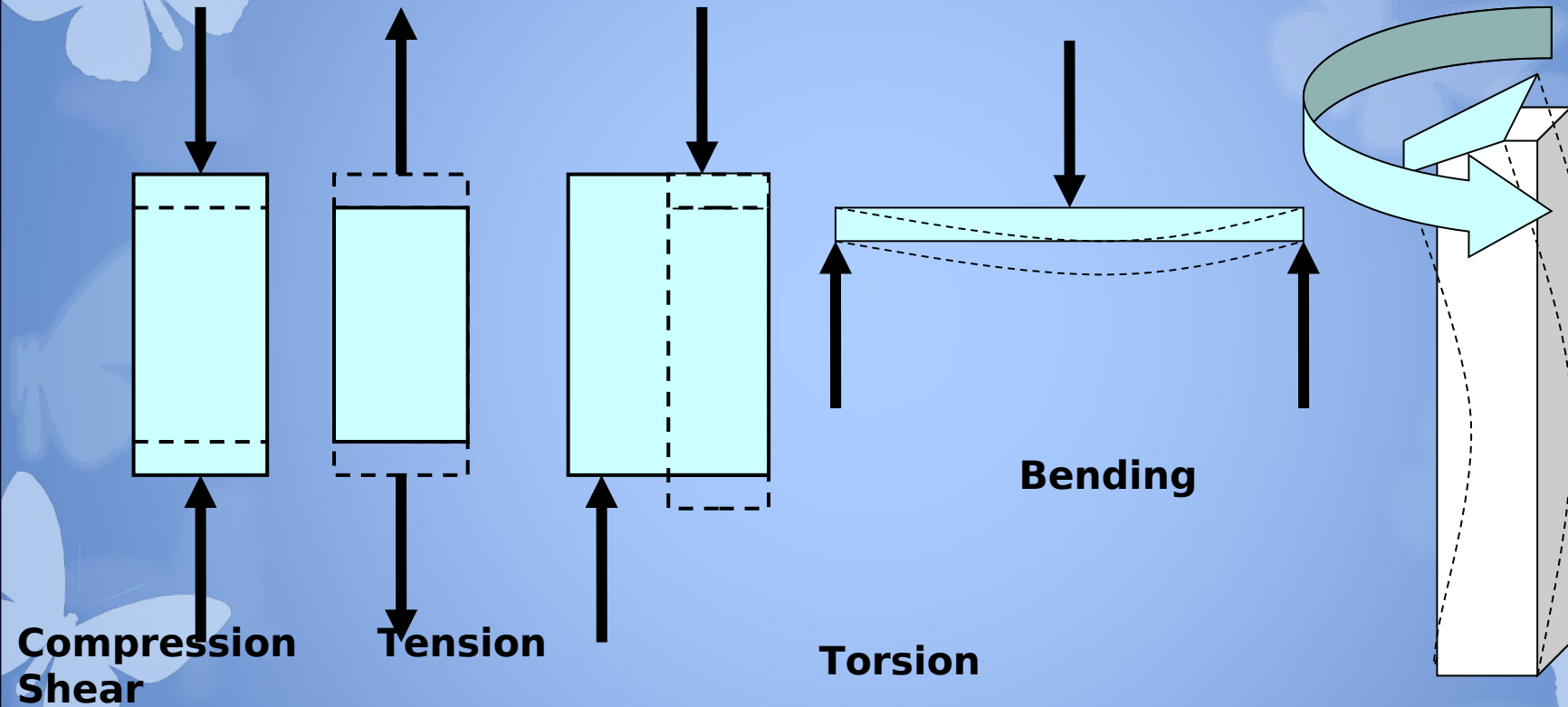
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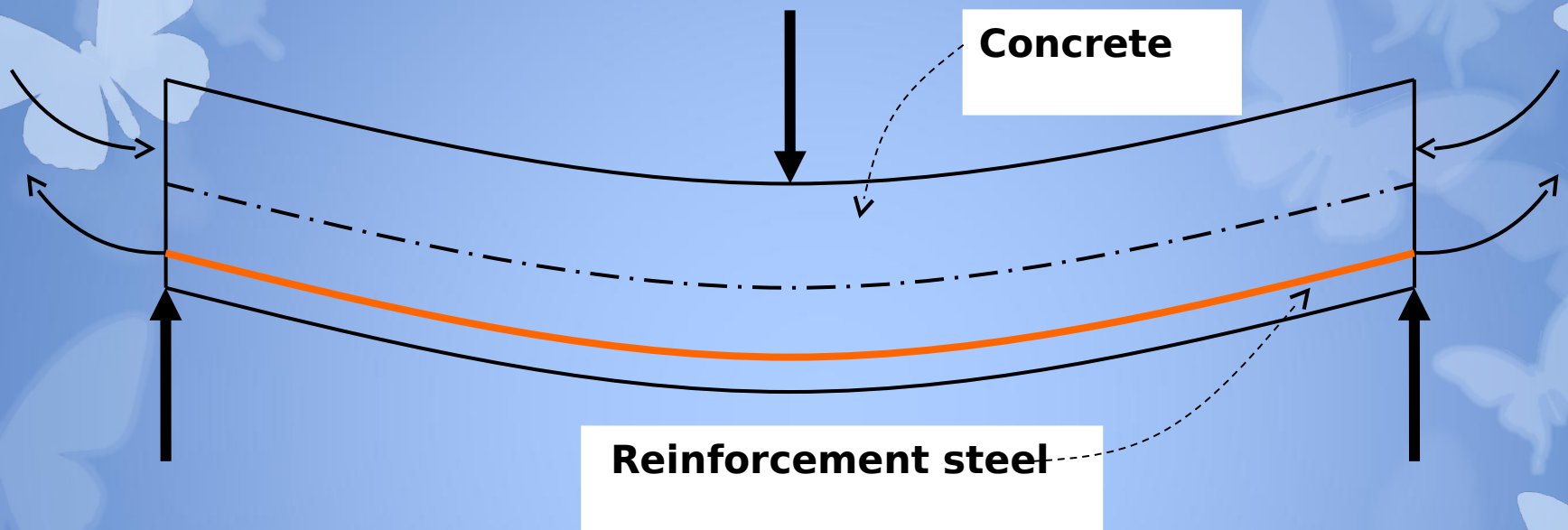
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Components of a civil engineering structure may be subjected to compression, tension, shear, bending, tension and any combination of these.



- ❑ Majority of the components usually will be subjected to combination of all these type of loads. Due to various factors most of the structural members other than those subjected to tension will also be subjected to bending.
- ❑ Bending strength of many naturally available materials are very less when compared to their compressive strength (Eg: Stone, Timber, etc).
- ❑ Plain concrete is strong in compression but weak in tension. Bending also produces compression and tension in structural members. Therefore using the properties of these two materials reinforced cement concrete is developed to resist bending where in, both compression and tension will come in a same member as shown in figure.



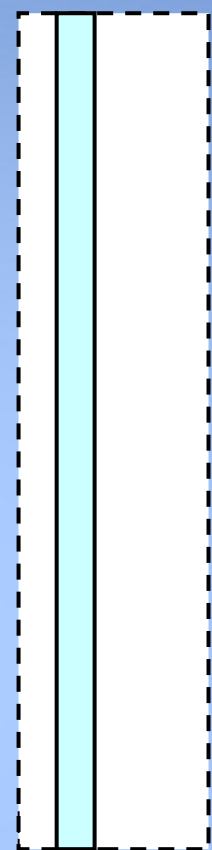
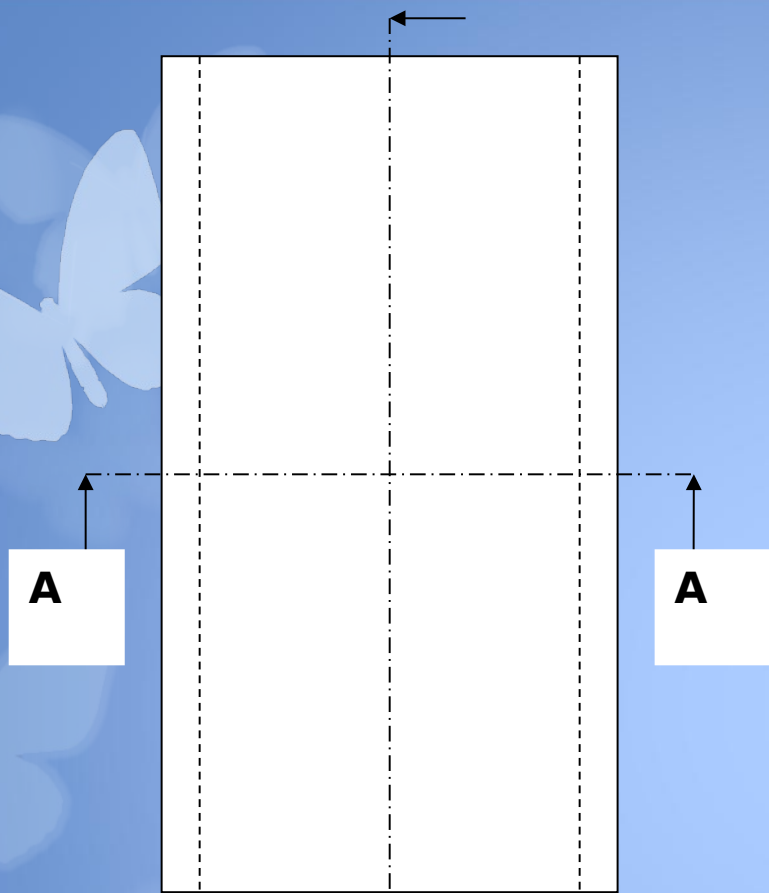
We can totally use a steel structural bending member, but it will be costly. As such it is used in tension zone of structural members.

Slabs

❑ Slabs and beams are the primary and secondary bending members in a structure, from the point of view of order of actual load transfer.

❑ Slabs are primary members which directly support live loads (movable loads). They transfer loads to beams. A slab supported over beams as shown in figure is designed as one way slab as bending occurs only in the direction shown in figure. The reinforcement in the direction of bending will be main reinforcement and in the other direction nominal distribution steel is provided.

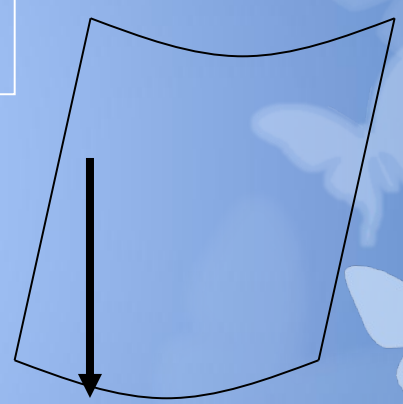
❑ The function of distribution steel is to transfer bending to main reinforcement steel which is provided at some spacing and to resist shrinkage and thermal stress in other direction.



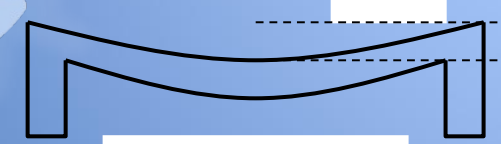
Section B-
B



**Before
loading**

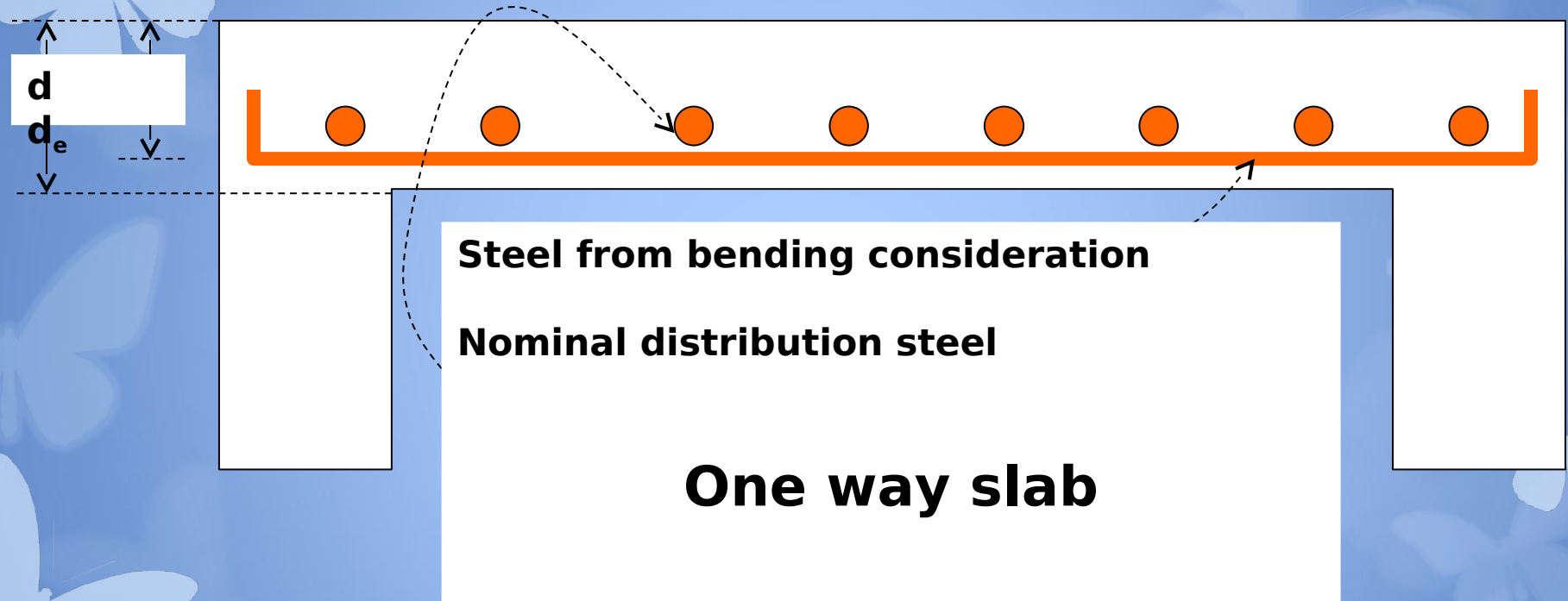


After loading



Section A-

A



☐ A slab supported over beam as shown in figure is designed as two way slab as bending occurs in both directions. Reinforcement in both directions is designed for respective bending.

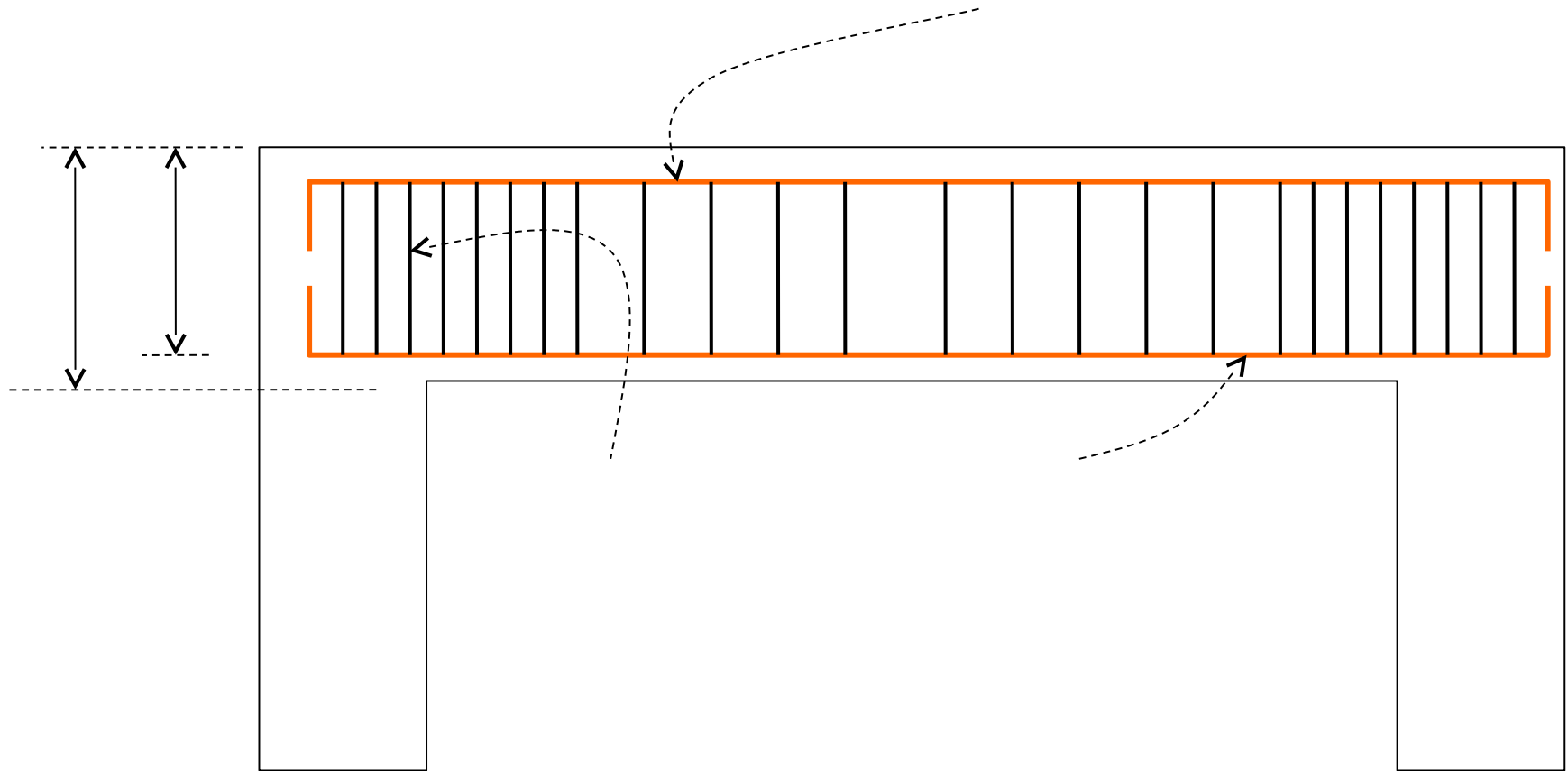
☐ Slabs may also be continuous over several beams. Then pattern of their bending is as shown in figure.

☐ In these continuous slabs, at beams tension will develop at top while at mid span tension will develop at bottom of slab. Slabs are designed as

Beams

☐ The same design applies for beam as well, but they are of definite width. They are designed for their particular width. Also slabs are safe against shear as more section is available to resist shear and as they carry less load.

☐ Beams carry more load and are of less cross sectional area, as such they are provided with steel to resist shear as well, in the form of vertical stirrups as shown in figure.



❑ In civil engineering we come across many more structural elements viz. plate girder, lattice girder, arches, frames, domes, shells, water tanks, suspension bridges etc, which are more complicated.

❑ Apart from the complexity of structural behaviour estimating the loads coming on them, like in case of bridges adds to complexity.

Performance of structures of RCC or otherwise also depends on environment and maintenance.

Surveying



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Surveying a railway track

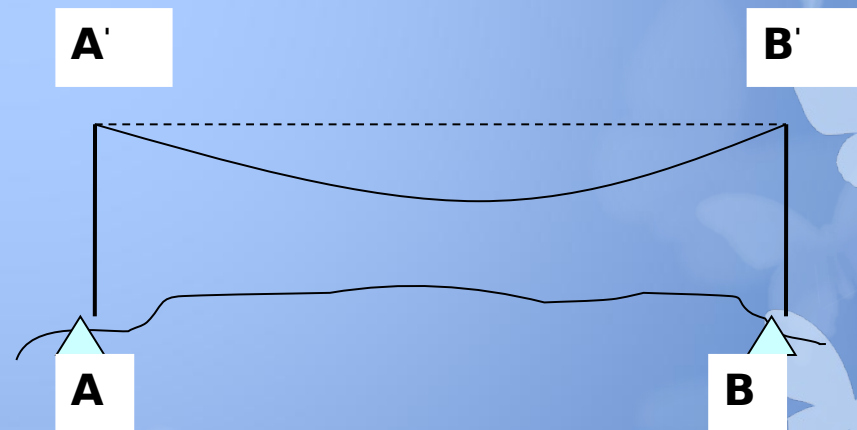
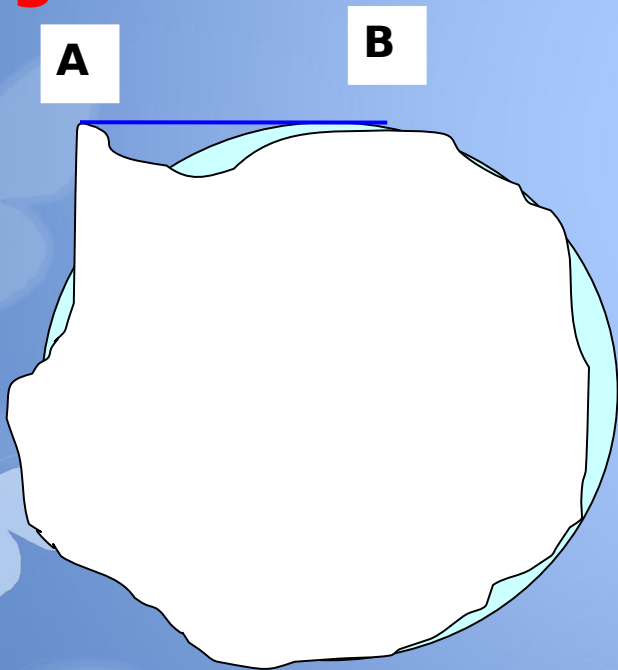
❑ Surveying is the science of fixing up the relative positions of points in space.

❑ For various purposes it is required in civil engineering, it may be for aligning an highway, it may be fixing the position of a building in ones property, it may be estimating the reservoir capacity and so on.

❑ Relative position of a point with respect to others may be fixed by measuring distances to other points or angles and distance as shown in figure.

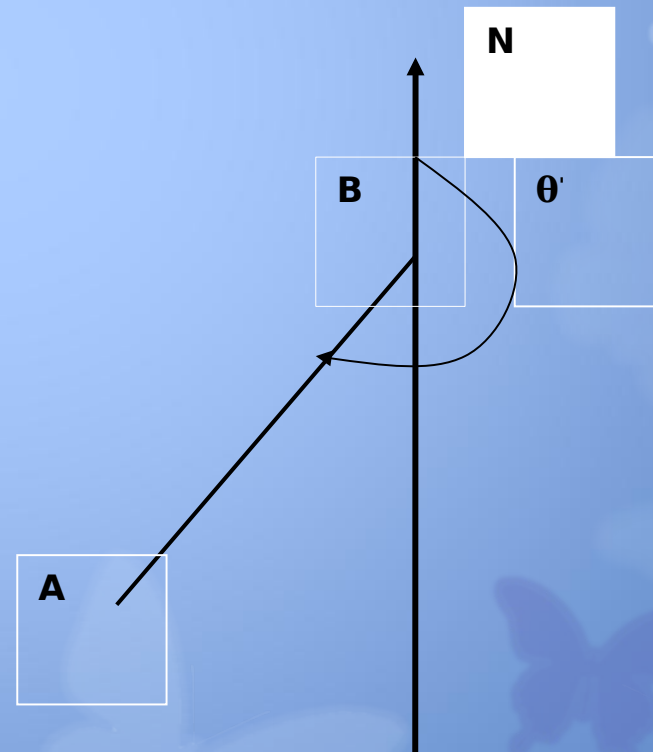
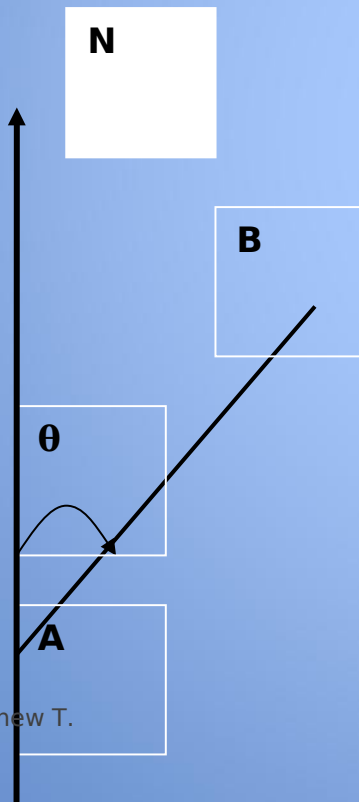
Linear measurement

- ❑ Distance between points A & B can easily be measured by tape stretching it between them.
- ❑ Suppose two points are ground surface, can we stretch the tape on ground surface and measure the distance. It will be erroneous most of the times as ground is not level as shown in figure.



Angle measurement

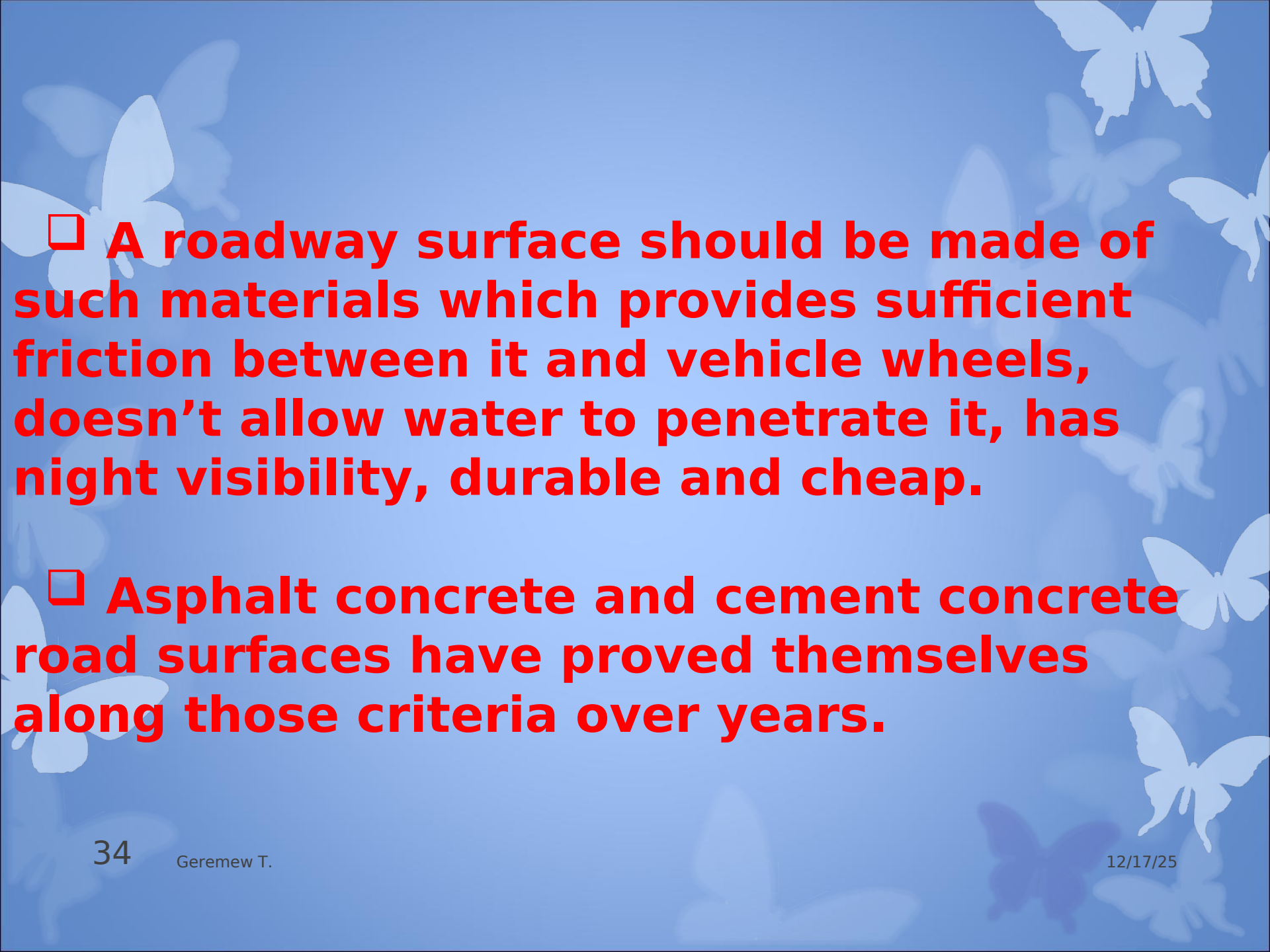
The angle a line makes with a reference line is known as bearing of the line. In surveying reference line is usually magnetic meridian. The bearing of a line AB is ' θ ' as shown in figure measured clockwise from magnetic north.



□ Highway Engineering

□ A contour map is a map depicting lines of equal elevation. Nearer the contours, steeper is the natural slope between them. Farther are the successive contours gentle is the natural slope between them.

□ Roadways have to be aligned keeping in mind the maximum gradient a vehicle can traverse comfortably. Also highways are taken along the path where natural slope available is around the above said comfortable gradient to minimise the cut and fill, a measure to economise road construction. This is done using a contour map.

- 
- ☐ **A roadway surface should be made of such materials which provides sufficient friction between it and vehicle wheels, doesn't allow water to penetrate it, has night visibility, durable and cheap.**
 - ☐ **Asphalt concrete and cement concrete road surfaces have proved themselves along those criteria over years.**

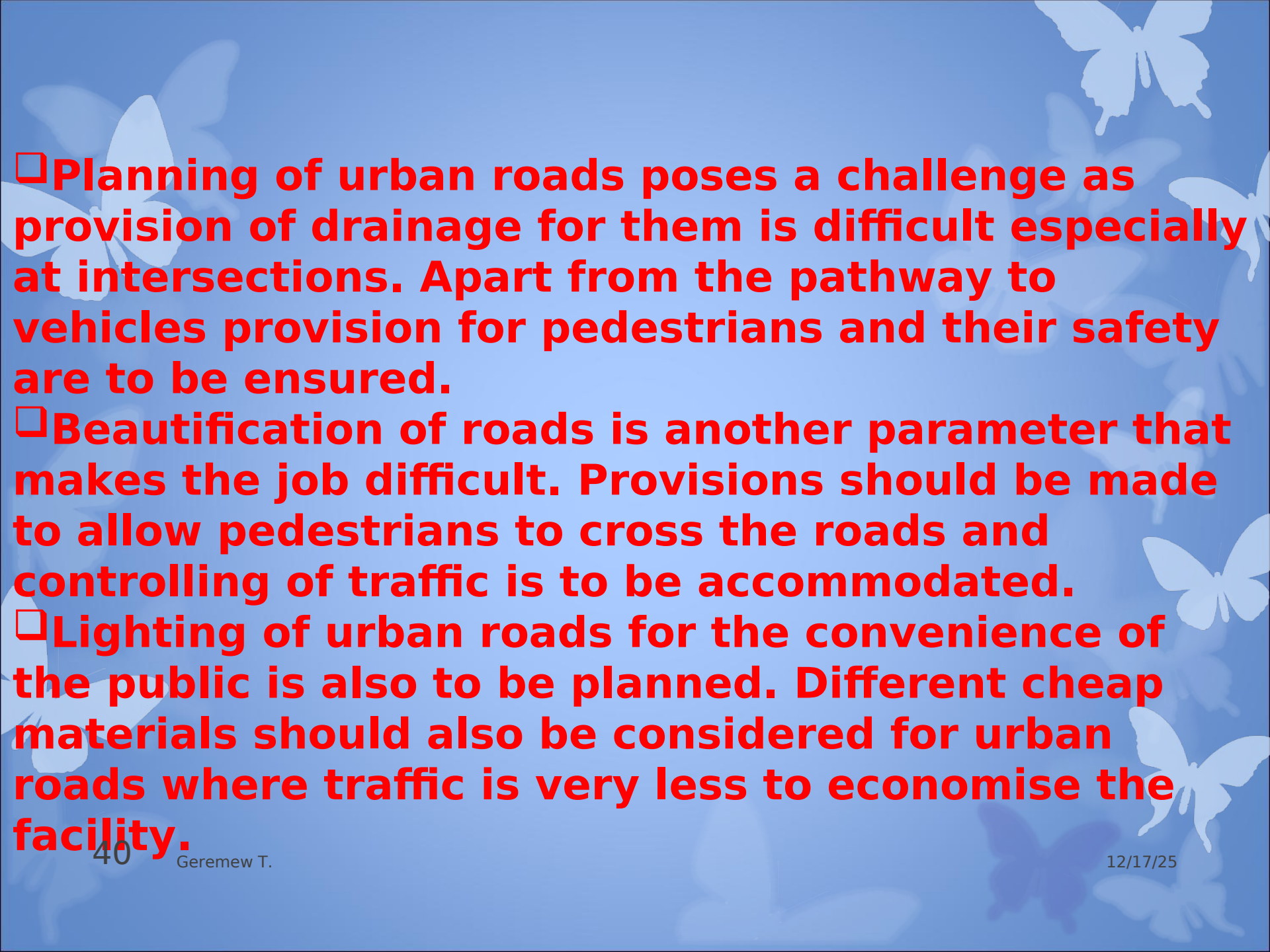










- 
- ❑ Planning of urban roads poses a challenge as provision of drainage for them is difficult especially at intersections. Apart from the pathway to vehicles provision for pedestrians and their safety are to be ensured.**
 - ❑ Beautification of roads is another parameter that makes the job difficult. Provisions should be made to allow pedestrians to cross the roads and controlling of traffic is to be accommodated.**
 - ❑ Lighting of urban roads for the convenience of the public is also to be planned. Different cheap materials should also be considered for urban roads where traffic is very less to economise the facility.**

Construction

❑ Construction Materials

- ❑ Construction industry is a big consumer of wide range of materials. It utilise natural as well as manufactured materials.**
- ❑ Civil engineering has developed methods to utilise abundantly available materials like stones, soil, sand etc. it also uses cement, glass, steel, PVC, HDPE, Epoxies, Resins, Enamels etc.**



Glass, Stone, Cement, Aluminium, Steel, Resins, Epoxies are extensively used in modern buildings

❑ Cement is a building material which has vast applications in construction. It is used in concrete, mortar and decorative finishing, in manufacturing of hollow concrete blocks, paving blocks, electric poles, and pipes and so on.

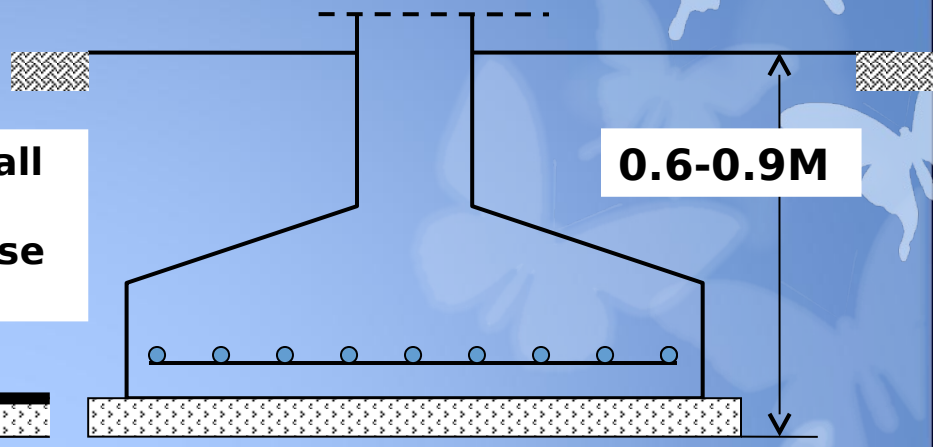
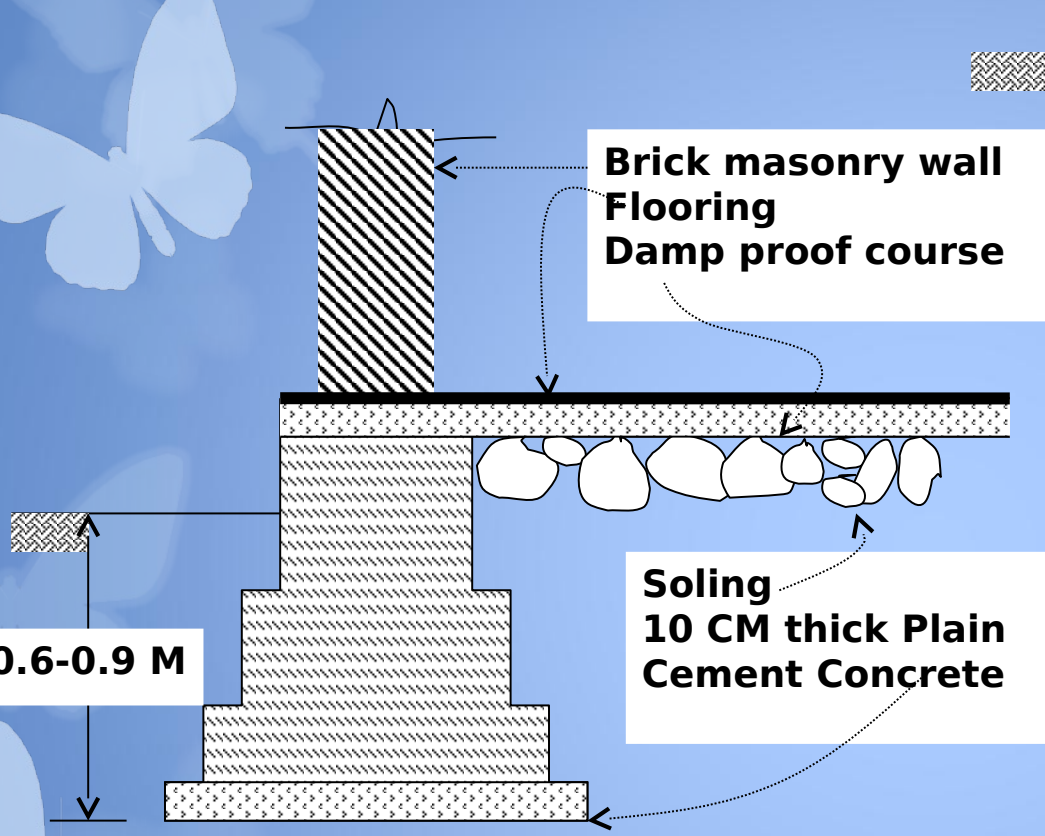
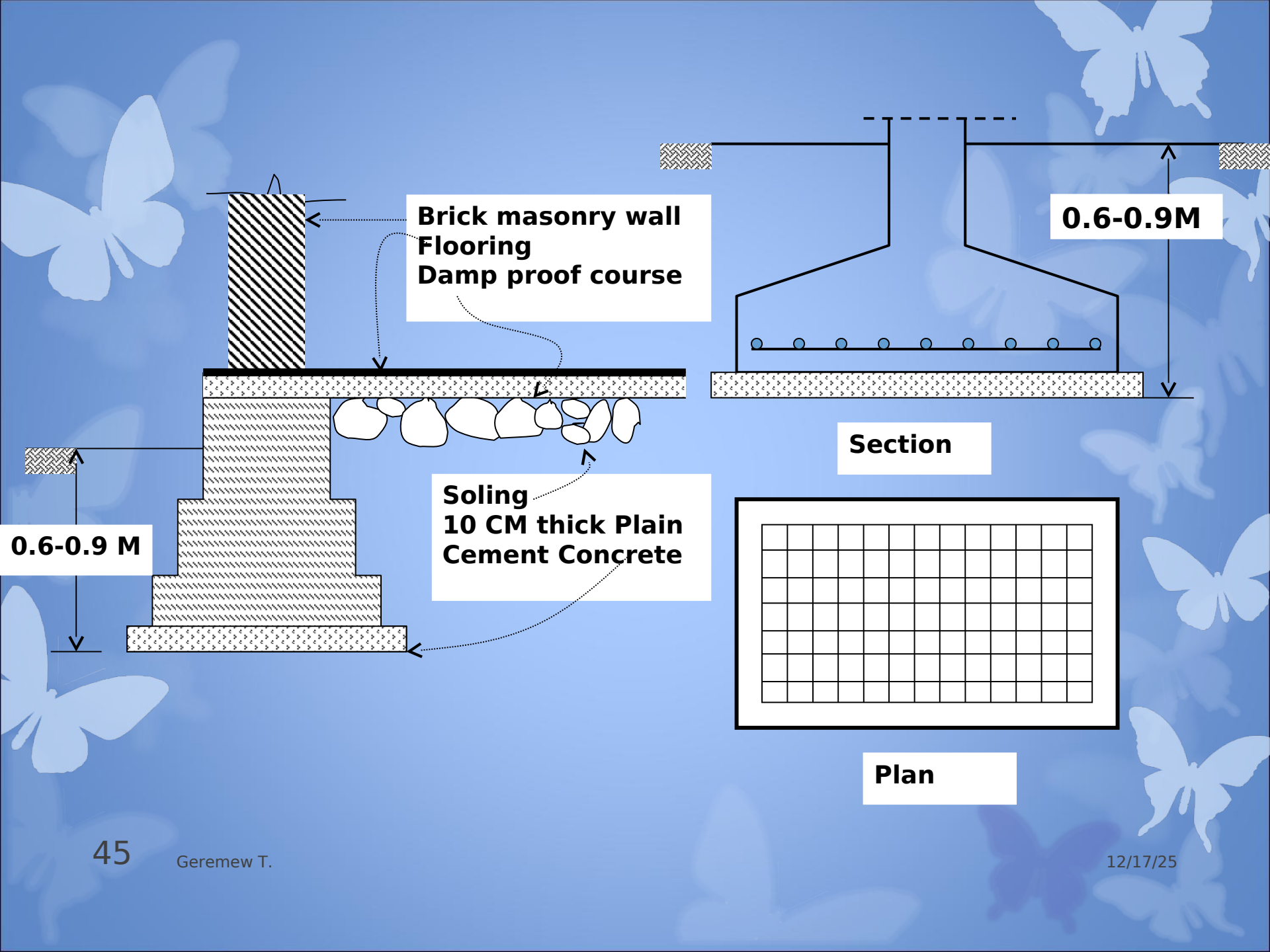
❑ Imagine a world without cement; you will understand its importance. Concrete, a rock like mass in the desired shape wouldn't have been a reality without cement.

❑ Cement is manufactured using clay and lime stone which are again abundantly available in nature. Upon mixing with water it hydrates (chemically reacts with water) and gets transformed to calcium silicates and hardens to a rock mass. It has high cohesive and adhesive strength

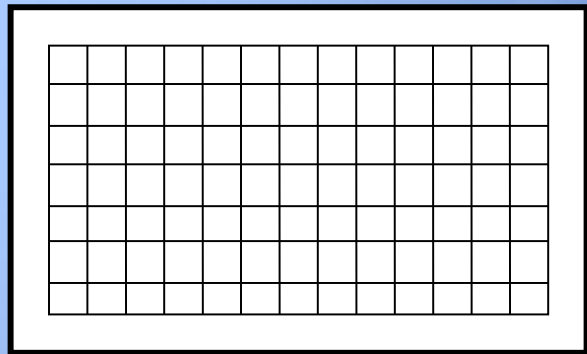
Building Construction

□ Buildings involves various components like Foundation, masonry walls, RCC columns, roof truss, roofing, false ceiling, flooring, electrification, water supply , sanitation, colouring etc. a discussion of all of them is impossible here. we shall discuss only three major components foundations, walls and roofing.

□ Foundations are part of a structure which is in contact with soil or rock and transfers the load of superstructure to them. In a load bearing wall structure usually the foundations of walls are made up of stone masonry. They are taken up to a competitive stratum or a minimum of 0.6-



Section



Plan

❑ Walls may be of stone masonry or brick masonry. Now a day stone masonry is not widely used for walls because of its higher cost. Many forms of placing the stones (Ashlar masonry, rubble masonry, uncoursed masonry etc.) and surface finishing can be provided for stone masonry. They are left without rendering as they give pleasing appearance and are weather resistant.

❑ Brick masonry may be English bond or Flemish bond as shown in figure. For masonries of these bond wall should be minimum of 1 brick thickness. If wall is to be $\frac{1}{2}$ brick thickness then it can only be stretcher bond masonry as shown in figure. Brick walls of $1\frac{1}{2}$, 2 brick thickness can also be constructed with English and Flemish bond. Brick masonry is normally provided with rendering.



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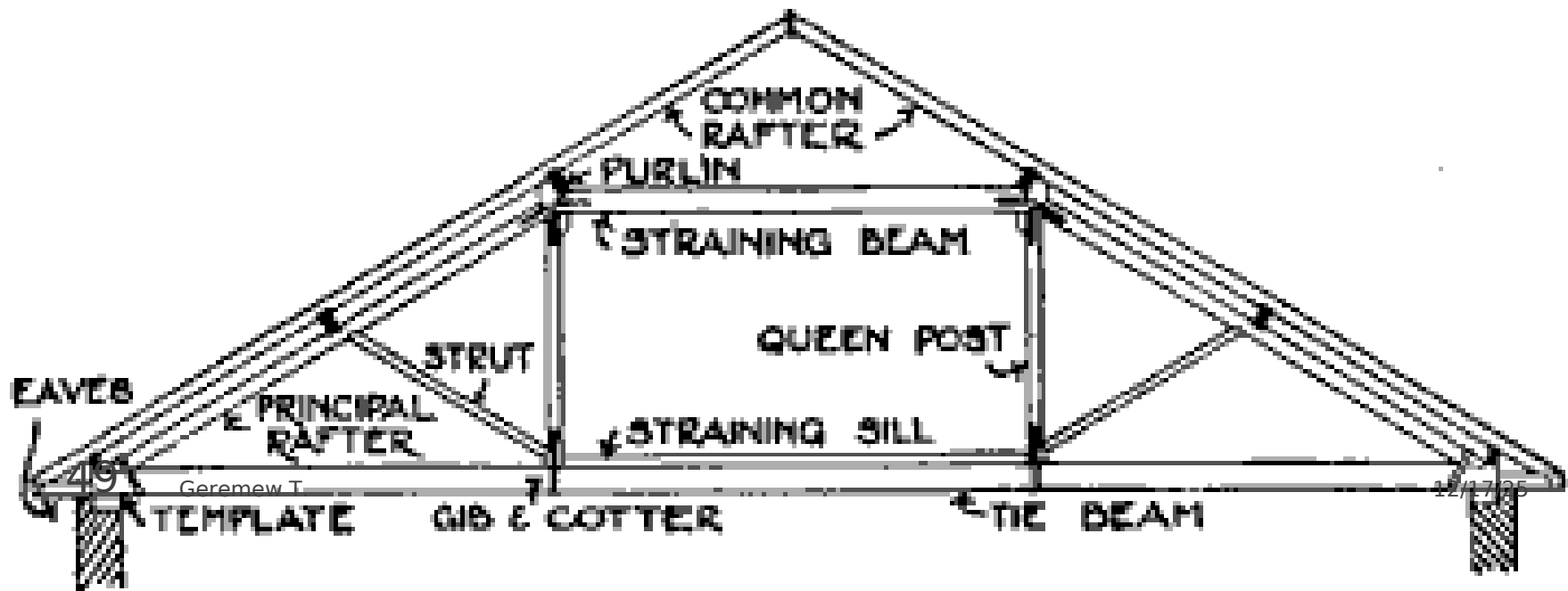
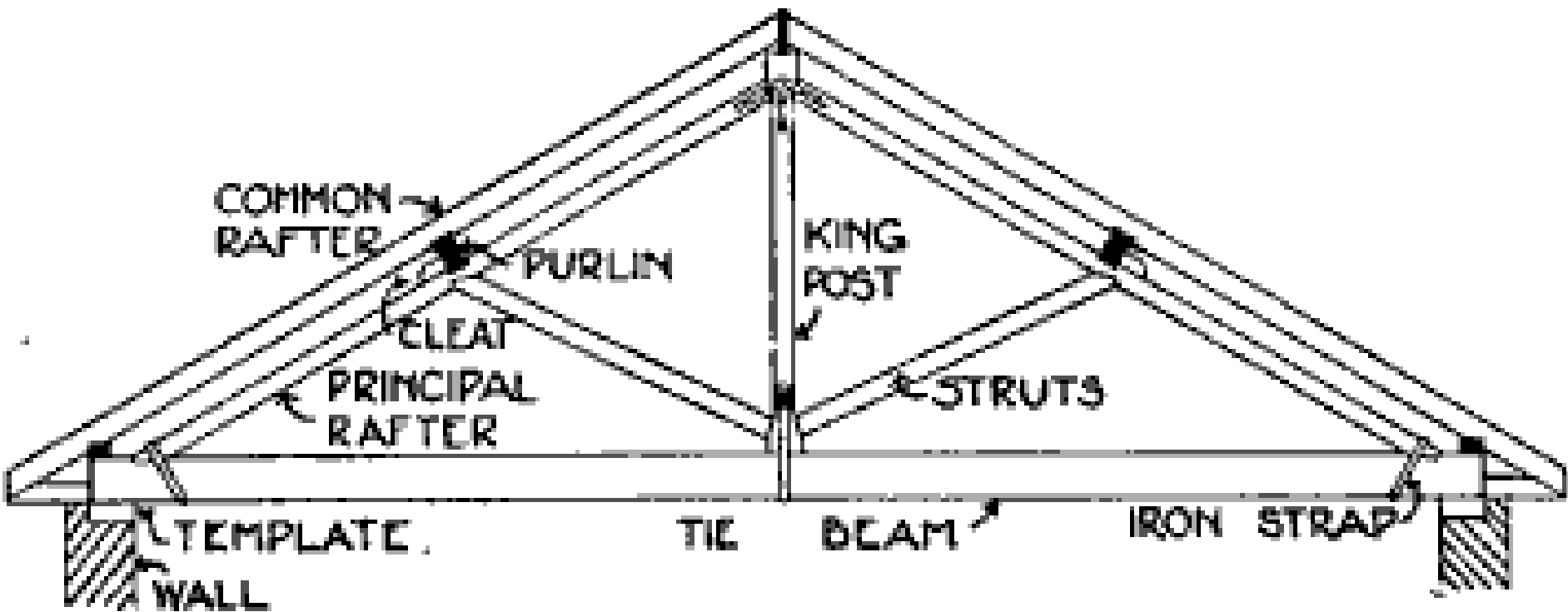
Random rubble masonry and brick masonry

Roofs

□ It be pitched roof or flat roof. Pitched roofs may be truss and roof covering or RCC roof. In case of truss and roof covering, King post truss or Queen post truss are used. While King post truss is used for spans of 8-10 M, Queen post truss is used spans up to 15M.

□ Trusses were usually of timber earlier. Now they are commonly made out of steel sections. Roof covering may be clay tiles, cement tiles, corrugated galvanised iron sheets, asbestos sheets, Fibre reinforced plastic sheets etc.

□ Flat roofs may be only of RCC. However a minimum slope to drain off rain water is ensured. RCC roof is just same as any floor slab except that is treated for water proofing during its construction and above it after its construction.



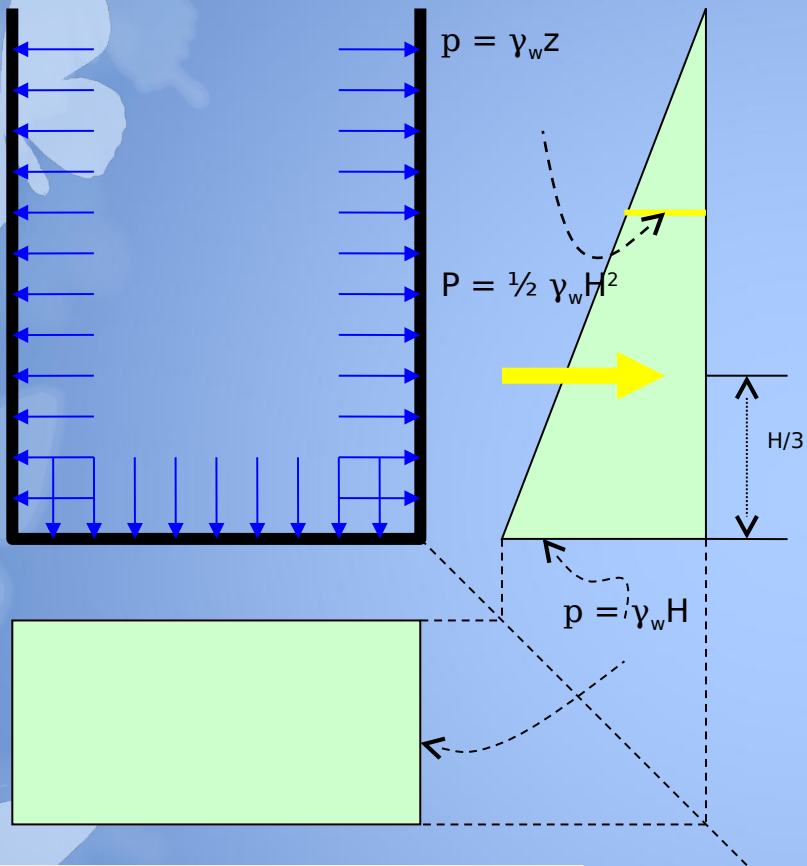




Hydraulic

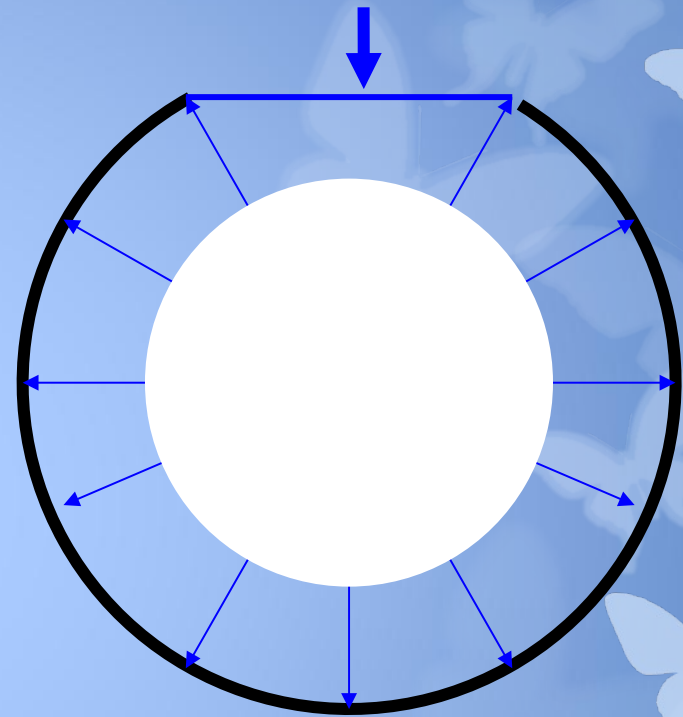
□ In civil and urban engineering we come across innumerable number of engineering problems related to static and moving fluids. Pressure exerted by reservoir water on dam, on walls of water tanks, motion properties of fluid when they are flowing in irrigation and other channels, when they are flowing in closed conduits for water supply are some of the examples of such problems.

□ A static fluid exerts pressure equally in all directions. Greater is the depth of point in the liquid larger is the pressure. It is learnt that it varies linearly with depth. It is known as hydrostatic pressure. Hydrostatic pressure will be normal to the surface of contact.



Pressure distribution on base of tank

Pressure distribution against wall



Pressure distribution on the wall of a circular tank

□ Its magnitude at any depth is $\gamma w z$, where γw is the unit weight of the liquid and z is the depth of point upon which pressure is required. Total pressure per unit length of wall over its entire height, $P = \frac{1}{2} \gamma w H^2$.

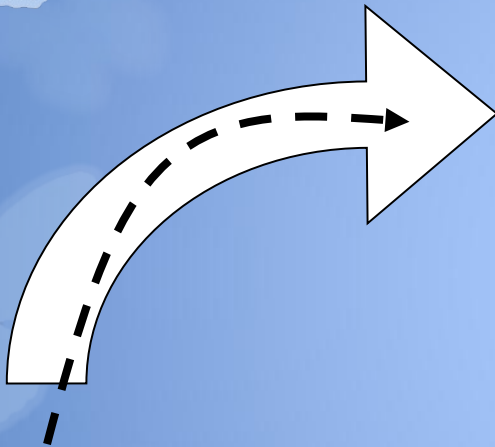
□ When there is pressure difference / head difference between two points in a liquid, liquid will flow from point of higher energy to point of lower energy. Depending on the velocity of flow it may be laminar flow or turbulent flow. Turbulent flow causes maximum energy loss and is detrimental to the surface of contact.

□ Most of the flow problems in civil engineering are laminar flow or they are regulated to be laminar flow. When fluids are flowing through pipes or channels there will be drag force applied by the surfaces of contact against the flow. Some energy of fluid is lost in overcoming it. Also due to viscosity and varied velocity of flow between layers

❑ **Flowing fluids possess energy in three forms viz. potential energy, kinetic energy and pressure energy. When fluid is flowing one form of energy gets transformed to another form along with some energy lost to overcome above said drag forces. However sum of energy remains constant, this is known as Bernoulli's theorem.**

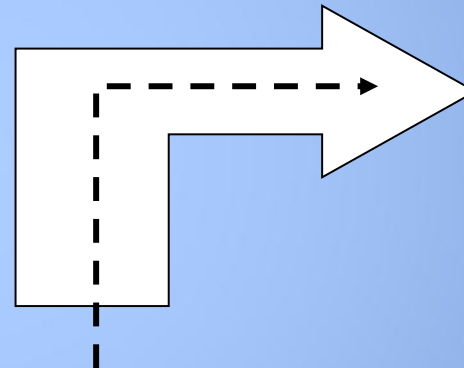
❑ **Allowing the fluid to flow at higher velocities either in pipes or open channels requires the contact surfaces (pipes and channel lining) to be abrasion resistant. As such materials are costly and head losses in such cases are high, velocities of flow in engineering problems are controlled.**

Bends, Elbows, Tee's in pipe network also contribute considerably to head loss.

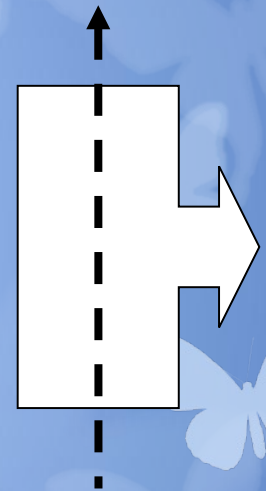


Bend

Tee

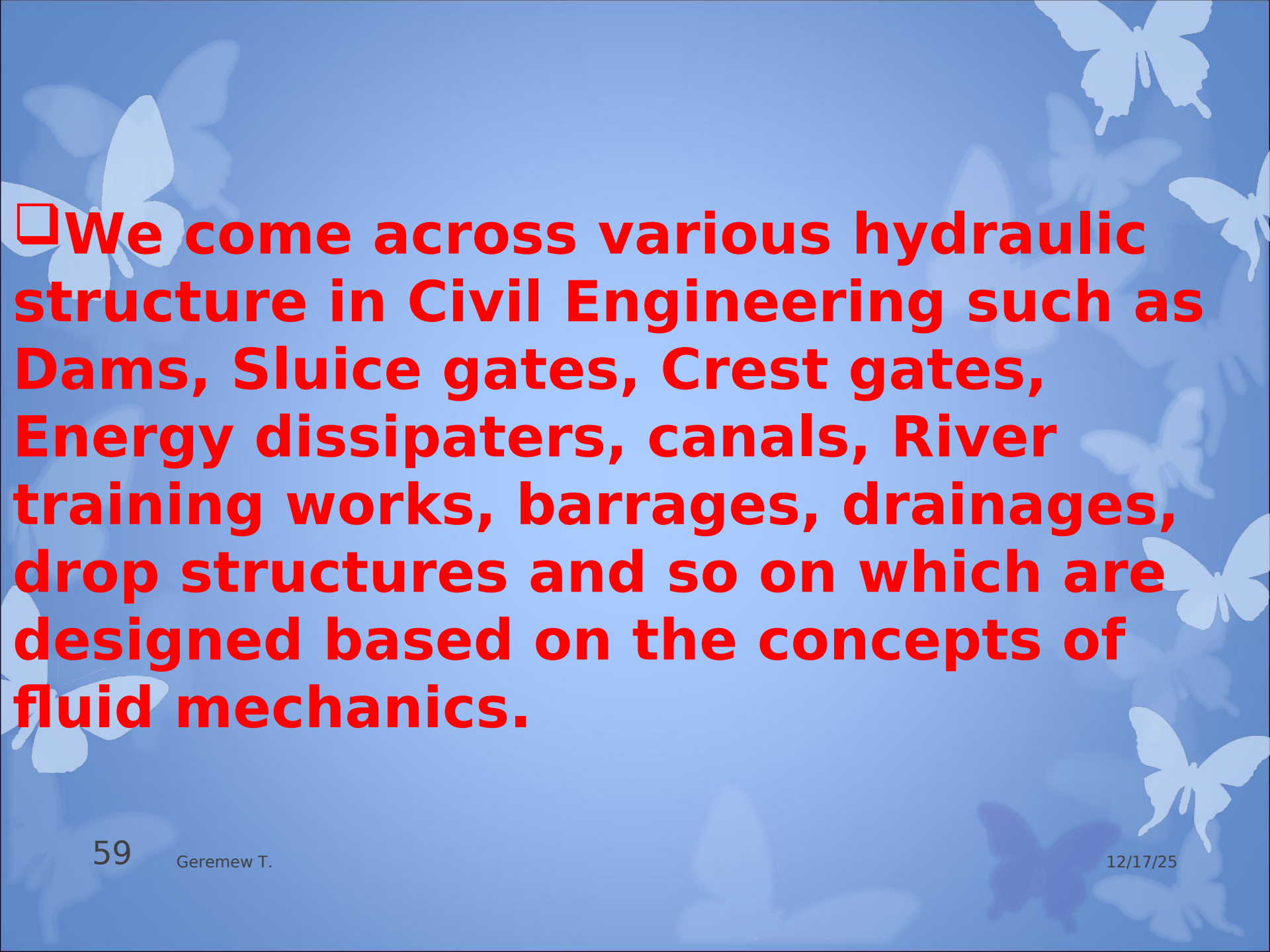


Elbow









□ We come across various hydraulic structure in Civil Engineering such as Dams, Sluice gates, Crest gates, Energy dissipaters, canals, River training works, barrages, drainages, drop structures and so on which are designed based on the concepts of fluid mechanics.

Water supply

❑ Urbanisation of society has put a great thrust on many civic services. Water supply is one important service among them. Providing potable water to a large population congregated at one place is a big challenge.

❑ Availability of required quantum of water may not be near the human settlement. Finding a suitable source, treating it to make it potable and transporting it large distances to supply to end user is a massive task.



❑ Water supplied for domestic consumption should be free from suspended and harmful dissolved substances. It should also be ensured that it is free of harmful bacteria. This is done by filtration, Sedimentation, ion exchange process, membrane filters and by adding chemicals. These treatment plants are big and they are designed, constructed and maintained by Civil engineers.

❑ Distribution of water through a wide network, maintenance of the network, metering of individual consumption, collection of water charges is usually major activity of an urban administration body.





Thank you!!!