# CE8703 STRUCTURAL DESIGN AND DRAWING

# CIVIL - SEVENTH SEMESTER

# REG. 2017

## UNIT I RETAINING WALLS

### TOPIC 1.1 REINFORCED CONCRETE CANTILEVER AND COUNTER FORT RETAINING WALLS

### TOPIC 1.2 HORIZONTAL BACKFILL WITH SURCHARGE

1. Originally, Rankine's theory of lateral earth pressure can be applied to only _____
a) Cohesion less soil
b) Cohesive soil
c) Fine grained soil
d) Coarse grained soil

*Answer:* a
*Explanation:* As originally proposed, Rankine' s theory of lateral pressure is applied to uniform cohesion less soils only. Later, it was extended to include cohesive soil.

2. Rankine's theory of lateral pressure was extended to other soil by _____
a) Resal and Bell
b) Mohr
c) None of the mentioned
d) All of the mentioned

*Answer:* a
*Explanation:* The theory of lateral pressure was extended to cohesive, stratified, partially immersed and submerged soil was by Resal in 1910 and by Bell in 1915.

3. Based on the assumptions of Rankine's theory, the soil mass is _____
a) Stratified
b) Submerged
c) Homogeneous
d) All of the mentioned

*Answer:* c
*Explanation:* According to the assumption of Rankine's theory, the soil mass is semi-infinite, homogeneous, dry and cohesion less.

4. Which of the following cases for cohesion less backfill in Rankine's theory is considered?
a) Submerged backfill
b) Moist backfill with no surcharge
c) Backfill with sloping surface
d) All of the mentioned

*Answer:* d
*Explanation:* In Rankine's theory the following cases of cohesionless backfill are considered
i) Dry or moist backfill with no surcharge
ii) Submerged backfill
iii) Backfill with a sloping surface and inclined back and surcharge.

5. The factor that is responsible for inclination of resultant pressure to the retaining wall is _____
a) Frictional force
b) Surcharge
c) Earth pressure
d) Weight of the wall

*Answer:* a
*Explanation:* The retaining walls are constructed of masonry or concrete, due to this the frictional force develops. The existence of the friction makes the resultant pressure inclined to the wall at an angle that approaches the frictional angle between the soil and the wall.

6. If the sand filled behind the retaining wall with saturated water with water, then the possible lateral pressure is _____
a) Lateral pressure due to submerged weight and Lateral pressure due to water
b) Lateral pressure due to retaining wall
c) None of the mentioned
d) All of the mentioned

*Answer:* a
*Explanation:* The lateral pressure is made up of two components for wetted soil in back of the retaining wall:
i) Lateral pressure due to submerged weight '$\gamma$' of the soil, and
ii) Lateral pressure due to water.

7. The earth pressure at rest exerted on a retaining structure can be calculated using _____
a) Theory of plasticity
b) Theory of elasticity
c) Mohr's theory of rupture
d) None of the mentioned

*Answer:* b
*Explanation:* The earth pressure at rest, exerted on the back of the rigid, unyielding retaining structure, can be calculated using theory of elasticity.

8. The value of K0(coefficient of earth pressure at rest) for loose sand is _____
a) 0.6
b) 0.5
c) 0.4
d) 0.8

*Answer:* c
*Explanation:* The value of K0 for different soils is:
i) Loose sand – 0.4
ii) Dense sand – 0.6
iii) Soft clay – 0.6
iv) Hard clay – 0.5.

9. The expression for K0 as given by Jacky is _____
a) $K0 = 1 – \sin \varphi$
b) $K0 = \sin \varphi$
c) $K0 = 1 – \cos \varphi$
d) $K0 = 1 + \sin \varphi$

*Answer:* a
*Explanation:* K0 can be calculated by using the following equation as computed by Jacky in 1944:
$K0 = 1 – \sin \varphi$.

10. What will be the coefficient of earth pressure at rest for a rigid retaining wall, If the backfill consists of cohesion less soil having $\varphi = 26°$?
a) 0.1295
b) 0.6552
c) 0.5616
d) 0.7383

*Answer:* c
*Explanation:* Coefficient of earth pressure, K0 can be calculated using Jacky's formula:
Given: $\varphi = 26°$
Formula: $K0 = 1 – \sin \varphi$
$K0 = 1 – \sin 26°$
$K0 = 1 – 0.4383$
$K0 = 0.561628$.

## TOPIC 1.3 DESIGN OF SHEAR KEY - DESIGN AND DRAWING.

1. A force 2P is acting on the double transverse fillet weld. Leg of weld is h and length l. Determine the shear stress in a plane inclined at θ with horizontal.
a) $PSin\theta(Sin\theta+Cos\theta)/hl$
b) $P(Sin\theta+Cos\theta)/hl$
c) $Pcos\theta(Sin\theta+Cos\theta)/hl$
d) None of the listed

*Answer:* a
*Explanation:* $F=PSin\theta$ and width$=h/(Sin\theta+Cos\theta)$.

2. Maximum shear stress in transverse fillet weld of leg h and length l is
a) P/hl
b) 1.21P/hl
c) P/1.21hl
d) None of the listed

*Answer:* b
*Explanation:* $\tau= PSin\theta(Sin\theta+Cos\theta)/hl$, by maximising it θ=67.5' and hence find corresponding τ.

3. A sunk key fits in the keyway of the _____ only.
a) Hub
b) Sleeve
c) Both hub and sleeve
d) Neither hub nor sleeve

*Answer:* a
*Explanation:* Sunk key fits halfway in the hub and halfway in the shaft.

4. Hollow saddle key is superior to flat saddle key as far as power transmitting capability is concerned.
a) True
b) False

*Answer:* b
*Explanation:* The resistance to slip in case of flat key is more.

5. Saddle key is more suitable than sunk key for heavy duty applications.
a) True
b) False

*Answer:* b
*Explanation:* In sunk key, relative motion is also prevented by shear resistance of sunk key and hence sunk key is recommended.

6. The main advantage of sunk key is that it is a _____ drive.
a) Positive
b) Negative
c) Neutral
d) None of the listed

*Answer:* a
*Explanation:* Sunk key is a positive drive and no slip occurs.

7. Woodruff key permits _____ movement b/w shaft and the hub.
a) Axial
b) Radial
c) Eccentric
d) None of the listed

*Answer:* b
*Explanation:* Woodruff key is a sunk key and doesn't permit axial moment.

8. Determine the length of kennedy key required to transmit 1200N-m and allowable shear in the key is 40N/mm². The diameter of shaft and width of key can be taken as 40mm and 10mm respectively.
a) 49mm
b) 36mm
c) 46mm
d) 53mm

*Answer:* d
*Explanation:* $l=M/[db\tau\sqrt2]$.

9. Splines are keys.
a) True

b) False

*Answer:* a
*Explanation:* Splines are keys made with shafts.

10. Involute splines have stub teeth with a pressure angle of ___
a) 30
b) 45
c) 60
d) Can't be determined

*Answer:* b
Explannation: Pressure angle is 30' and not 60'.

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# UNIT II FLAT SLAB and BRIDGES

## TOPIC 2.1 DESIGN OF FLAT SLABS WITH AND WITHOUT DROPS BY DIRECT DESIGN METHOD OF IS CODE

1. The prestressed concrete slab systems are ideally suited for _____
a) Roofs
b) Slabs
c) Beam
d) Column

*Answer:* b
*Explanation:* Prestressed concrete slabs systems are ideally suited for floor and roof construction of industrial buildings where the live loads to base supported are of a higher order and the uninterrupted floor space is desirable for which reason longer span between the supporting elements are required.

2. The precast prestressed hollow core slabs, with or without topping is an important structural element in _____
a) Structures
b) Industries
c) Aquariums
d) Nurseries

*Answer:* b
*Explanation:* Precast prestressed hollow core slabs, with or without topping are important structural elements in industrialized and large panel building construction and the slabs, produced on long casting beds using the pretensioning systems and cut to shorter specified span lengths, are mainly used in one way floors which are freely supported by transverse walls or base.

3. Prestressed pretensioned cored slabs with differ types of cavities are widely used as _____
a) Floor panels
b) Tendons
c) Wall coatings
d) Reinforcements

*Answer:* a
*Explanation:* Prestressed pretensioned cored slabs with differ types of cavities are widely used as Floor panels of civil and industrial buildings in erstwhile U.S.S.R Graduck reports that these panels are produced in multiples of 200mm nominal width and lengths from 3.6 to 6.4m and hollow panels of oval cavity type are most economical for larger spans since they contain the least volume of concrete as compared to round cavity panels and prestressed concrete ribbons have been used as reinforcement for hollow-cored slabs and these consist of tensioned wires or strands embedded in high grade concrete of star of rectangular cross section.

4. One way slabs may be supported across the entire width of the slab by means of _____
a) Columns
b) Piers

c) Ridges
d) Footings

*Answer:* b
*Explanation:* One way slabs may be supported across the entire width of the slab by beams, piers or abutments or bearing walls, which are positioned perpendicular to the longitudinal axis of the span or the supports may be at an angle of the span directions and one way slabs may be continuous over one or several support.

5. The simple or continuous slabs are analyzed for _____
a) Design foundation
b) Design reinforcement
c) Design moments
d) Design slab

*Answer:* c
*Explanation:* The simple or continuous slabs are analyzed for design moments by considering a unit width of the slab and the prestressing force and the eccentricity of the cable required at prominent sections to resist the dead and live load moments are determined and the spacing of the cables or wires fixed based on the availability of type of tendon.

6. The design of a two-way-slab supported on all four sides involves the computation of _____
a) Moments
b) Cross sections
c) Bending moment
d) Deformations

*Answer:* c
*Explanation:* The design of a two way slab supported on all four sides involves the computation of bending moment in the principal directions of the slab and the slab may be supported on masonry walls or beams and mayor may not be continuous over the supports and transverse loads are resisted by the development of two way slab action,

resulting in moments in longer and shorter span directions.

7. The moment coefficients derived from the ultimate load method are generally lower in _____
a) Span
b) Eccentricity
c) Strength
d) Magnitude

*Answer:* d
*Explanation:* The moment coefficients derived from the ultimate load method are generally lower in magnitude than those evaluated from elastic theories thus naturally resulting in savings in reinforcement and however slabs designed by the ultimate load method should be checked service loads according to the principle of limit state design.

8. A simple prestressed flat slab is generally supported by a network of _____
a) Beams
b) Columns
c) Spans
d) Deflections

*Answer:* b
*Explanation:* A simple prestressed flat slab is generally supported by a network of columns without beams and prestressed in two perpendicular directions and the design of typical simple flat slab involves the analysis of moments in the two principal directions so that cables may be arranged to resist these moments and the slab is analyzed as one way slab and the total number of cables required to resist the moments in each of two principal directions are determined.

9. The proportioning of tendons in design of prestressed concrete simple flat slab between the column and middle strips may be based on _____
a) Moments
b) Codes

c) Deflections
d) Loads

*Answer:* b
*Explanation:* The column strips being stiffer than the middle strips, a greater percentage of the tendons are housed in the column strips and the proportioning of the tendons between the column and middle strips may be based on the provisions of codes such as IS:456 and BS:8110, where column strips share a higher proportion of total moment.

10. The design principles of continuous flat slab floors are similar to _____
a) One way slab
b) Two way slab
c) Continuous
d) Deformed

*Answer:* b
*Explanation:* The design of continuous flat slab floors are similar to those of two way reinforced concrete slabs and a strip of slab of unit width continuous over supports is analyzed as continuous beam and its prestressing results in secondary moments.

## TOPIC 2.2 DESIGN AND DRAWING - IRC SPECIFICATIONS AND LOADING

1. What will be the design load for bridges and culverts on National Highway?
a) I.R.C. Class-D loading
b) I.R.C. Class-C loading
c) I.R.C. Class-A loading
d) I.R.C. Class-B loading

*Answer:* c
*Explanation:* IRC a body of professional highway engineers provides the following services:
(i) It provides a forum for expression of collective opinion of its members for all matters affecting the construction and maintenance of roads in India.
(ii) It promotes the use of the standard specifications and practices.
(iii) It provided with the suggestions for the better methods of planning, designing, construction, administration and maintenance of roads.
(iv) It conducts periodical meetings to discuss technical problems regarding roads.
(v) It makes the laws for the development, improvement and protection of the roads.
(vi) It furnishes and maintains libraries and museums for encouraging the science of road making.

2. Hard, rough and durable granite stone ballast _____ gauge, shall be used.
a) 100 mm
b) 20 mm
c) 1mm
d) 60mm

*Answer:* d
*Explanation:* Ballast should not absorb water and should not be affected by weather action and shall be clean and free from dust, dirt, etc. Ballast should be stacked 30 cm high on the levelled side-berm of the road in a continuous stack along the road having the section as required per metre length of the road.

3. These are important roads within a district connecting areas of production with markets and connecting them with the State Highways & National Highways and are maintained by the State PWD?
a) State highway
b) National highway
c) District road
d) Rural road

*Answer:* c
*Explanation:* District roads are sub-classified into – Major District Roads and Other District Roads. As per the classification of roads broadly the MDRs are to have a minimum

width of 15 metres with traffic density of less than 10,000 PCUs but more than 5000 PCUs. It also connects Taluka headquarters and rural areas to District headquarters within the state. As on 31 March 2016, the total length of district roads was approximately 561,940 km of which 94.93 % of the total length were surfaced.

4. What will be the maximum superrelevation in hills on Major District roads?
a) 4 in 30
b) 1 in 10
c) 1 in 4
d) 1 in 60

*Answer:* b
*Explanation:* To counter-act the effect of centrifugal force and reduce the tendency of vehicle to overturn and to skid laterally outwards, pavement outer edge is raised with respect to inner edge. Thus, providing a transverse slope is known as Super elevation. It is represented by " e ".
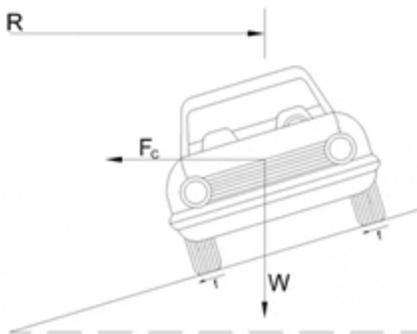


5. What will be the ruling gradient in hills on "Other district roads"?
a) 1 in 20
b) 1 in 5
c) 1 in 10
d) 1 in 3

*Answer:* c
*Explanation:* Ruling gradient (plural ruling gradients) (rail transport) The steepest uphill gradient in one direction on a section of railway line, which determines the load that can be pulled by one locomotive over that section, according to the power rating of the locomotive. A typical ruling gradient could be 1:50 (2%).

6. What will be the minimum visibility at vertical curves on National Highway?
a) 130 m
b) 200 m
c) 20 m
d) 100 m

*Answer:* d
*Explanation:* The length of a crest vertical curve is governed by visibility considerations. The minimum length is based on the stopping sight distance; the maximum length is based on the passing sight distance, and overtaking is allowed throughout its length. The object of the present paper is theoretical determination of the zone of overtaking visibility in a curve designed on a below-maximum basis. The analysis covers 2 cases: (a) overtaking vehicle inside oncoming vehicle outside the curve and (b) both vehicles outside the curve. The corresponding curve geometries were also considered.

7. What will be the width of metalled surface single lane on Major District road?
a) 1.70 m
b) 3.70 m
c) 0.70 m
d) 10 m

*Answer:* b
*Explanation:* A single carriageway or undivided highway is a road with one, two or more lanes arranged within a single carriageway with no central reservation to separate opposing flows of traffic.
A two-lane road or two-lane highway is a single carriageway with one lane for each direction. A single-track road has a single lane with passing places for traffic in both directions. Road traffic safety is generally worse for high-speed single carriageways than for dual carriageways due to the lack of

separation between traffic moving in opposing directions.

8. Subgrade shall be well consolidated and compacted each with a camber of 1 in 60.
a) True
b) False

*Answer:* a
*Explanation:* Subgrades are commonly compacted before the construction of a road, pavement or railway track, and are sometimes stabilized by the addition of asphalt, lime, portland cement or other modifiers. The subgrade is the foundation of the pavement structure, on which the subbase is laid. The load-bearing strength of subgrade is measured by California Bearing Ratio (CBR) test, falling weight deflectometer back calculations and other methods.

9. Inter coat shall be of stone ballast, or over burnt brick ballast of 50cm thick layer and consolidated and compacted by road roller to 0.8 cm.
a) True
b) False

*Answer:* b
*Explanation:* Inter coat shall be of stone ballast, or over burnt brick ballast of 12cm thick layer and consolidated and compacted by road roller to 8 cm.

10. First coat of bituminous painting shall be with stone ballast no.3 and stone grit of 20 mm gauge at 220 kg of asphalt and 1.35 cu m of stone grit per 100 sq. m.
a) True
b) False

*Answer:* b
*Explanation:* First coat of bituminous painting shall be with Asphalt or Road tar No.3 and stone grit of 20 mm gauge at 220 kg of asphalt and 1.35 cu m of stone grit per 100 sq. m.

11. If subgrade is soft or weak, a thick sub-base of cheap and inferior materials well compacted should be used.
a) False
b) True

*Answer:* b
*Explanation:* In transport engineering, subgrade is the native material underneath a constructed road, pavement or railway (US: railroad) track. It is also called formation level. The term can also refer to imported material that has been used to build an embankment.

12. Laying and consolidation shall be done during dry season.
a) True
b) False

*Answer:* b
*Explanation:* Laying and consolidation shall be done during early rainy season, so that sufficient water is available for consolidation, and during the later part of the rains the ballast gets fully compacted.

13. Stone grits used for 1st coat and 2nd surface painting may be precoated in advance with advance with bitumen.
a) True
b) False

*Answer:* a
*Explanation:* Precoating prevents separation and disintegration of grits and improves the life of the road. For precoating stone grits 12kg to 16 kg of asphalt or road tar per cu m of grit may be used.

14. As soon as sufficient length of premix has been laid, rolling should be started with 2 to 4 tonne roller.
a) True
b) False

*Answer:* b
*Explanation:* As soon as sufficient length of

premix has been laid, rolling should be started with 7 to 8 tonne roller. Rolling should commence at the edge and progress towards the centre. After light rolling high spots or depressions which become apparent should be corrected by removing or adding premix and then rolled to thorough compaction.

15. Which authority is responsible for national highway?
a) Local governments and municipalities
b) Panchayats, JRY and PMGSY
c) Public Works Department of State/Union Territory
d) Ministry of Road Transport and Highways

*Answer:* d
*Explanation:* The Ministry of Road Transport and Highways is a ministry of the Government of India, is the apex body for formulation and administration of the rules, regulations and laws relating to road transport, and transport research, in order to increase the mobility and efficiency of the road transport system in India. Road transport is a critical infrastructure for economic development of the country. It influences the pace, structure and pattern of development. In India, roads are used to transport over 60% of the total goods and 85% of passenger traffic.

## TOPIC 2.3 RC SOLID SLAB BRIDGE - STEEL FOOT-OVER BRIDGEDESIGN AND DRAWING.

1. A structure that allows water to flow under a road, railroad, trail, or similar obstruction from one side to the other side is called as _____
a) drainage
b) bridges
c) tunnel
d) culverts

*Answer:* d
*Explanation:* Culverts are commonly used both as cross-drains for ditch relief and to pass water under a road at natural drainage and stream crossings. A culvert may be a bridge-like structure designed to allow vehicle or pedestrian traffic to cross over the waterway while allowing adequate passage for the water.

2. A structure that carries water above land is known as an _____
a) aqueduct
b) aquedant
c) over surface
d) outland

*Answer:* a
*Explanation:* Bridges for conveying water, called aqueducts or water bridges are constructed to convey watercourses across gaps such as valleys or ravines. The term aqueduct may also be used to refer to the entire watercourse, as well as the bridge. Large navigable aqueducts are used as transport links for boats or ships.

3. If the span of crossing is greater than 12 feet (3.7 m), the structure is termed as bridge and otherwise is culvert.
a) True
b) False

*Answer:* a
*Explanation:* A bridge is a structure built to span physical obstacles without closing the way underneath such as a body of water, valley, or road, for the purpose of providing passage over the obstacle. There are many different designs that each serve a particular purpose and apply to different situations.

4. Culverts cannot be constructed of a variety of materials including cast-in-place or precast concrete.
a) True
b) False

*Answer:* b
*Explanation:* Culverts can be constructed of a variety of materials including cast-in-place or precast concrete (reinforced or non-reinforced), galvanized steel, aluminium, or plastic, typically high-density polyethylene. Two or more materials may be combined to form composite structures. For example, open-bottom corrugated steel structures are often built on concrete footings.

5. Construction or installation at a culvert site generally results in disturbance of the site soil.
a) True
b) False

*Answer:* a
*Explanation:* Construction or installation at a culvert site generally results in disturbance of the site soil, stream banks, or streambed, and can result in the occurrence of unwanted problems such as scour holes or slumping of banks adjacent to the culvert structure.

6. Box culverts can be defined as a passage for water over a natural ground having a deck slab over it as path way for vehicles.
a) True
b) False

*Answer:* b
*Explanation:* Slab culvert- A passage for water over a natural ground having a deck slab over it as path way for vehicles.
Box culvert – Box culverts are usually made up of Reinforced Concrete (RCC) as a box shaped tunnel through which the water flows and the vehicular transmission takes place over the box.

7. A culvert can be used to span over a canyon, or depression, or even over a freeway or roadway.
a) True
b) False

*Answer:* b
*Explanation:* A bridge doesn't necessarily have to bridge over water. A bridge can be used to span over a canyon, or depression, or even over a freeway or roadway.

8. The process of removing culverts, which is becoming increasingly prevalent, is known as
_____
a) outlighting
b) culverting
c) daylighting
d) inlighting

*Answer:* c
*Explanation:* In urban design and urban planning, daylighting is the redirection of a stream into an above-ground channel. Typically, the goal is to restore a stream of water to a more natural state. Daylighting is intended to improve the riparian environment for a stream which had been previously diverted into a culvert, pipe, or a drainage system.

9. An _____ culvert is normally a low profile culvert. It allows them to be installed without disturbing the causeway as it will span over the entire drainage width.
a) box
b) rectangle
c) arch
d) circular

*Answer:* c
*Explanation:* They are normally made of metal, stone masonry or RCC. They are installed easily, and you don't need to use expensive water diversion structures to install it. Common shapes include semicircular arch, elliptical arch, and concrete box culverts. Another benefit of these type of structure is that the installation process will not take a lot of time, compared to traditional box culverts.

10. _____ culverts have a concrete (sometimes other materials can be used too) floor allowing the water to flow smoothly

through it.
a) Box
b) Cylindrical
c) Narrow
d) Long

*Answer:* a
*Explanation:* Box culverts are usually made up of Reinforced Concrete (RCC). Some box culverts can be built using composite structures and are great when water needs to change direction or when a large flow of water is expected. Box culverts can also be installed in such way that the top of the culvert is also the roadway surface. The most challenging part of installing these type of culverts is that you generally will need to have a dry surface to install the culvert, so dewatering or diversion of the water will be needed to complete the installation.

# UNIT III LIQUID STORAGE STRUCTURES

## TOPIC 3.1 RCC WATER TANKS - ON GROUND, ELEVATED CIRCULAR

1. Prestressed concrete tanks have been widely used for the storage of _____
a) Gas
b) Air
c) Fluids
d) Water

*Answer:* c
*Explanation:* Prestressed concrete tanks have been widely used for storage of fluids, such as water, oil, gas, sewage, granular materials like cement, process liquids and chemicals, slurries and more recently cryogens water storage tanks of large capacity are invariably made of prestressed concrete recent

applications include special forms of prestressed concrete tanks, which are triaxially prestressed and serve as containment vessels and biological shields for nuclear reactors.

2. Prestressed concrete although it is water tight, it is not _____
a) Gas tight
b) Liquid tight
c) Vapour tight
d) Material tight

*Answer:* a
*Explanation:* Tanks have been built for storing liquid oxygen at 230 degrees with capacities up to one million liters and prestressed concrete, although water tight, it is not gas tight were vapours under pressure are to be stored and in such cases, a thin membrane linear of steel provides rigidity and increases the steel tensile capacity of the pretressed concrete.

3. The metal linear concept in prestressed tanks has proved to be success in case of _____
a) Air tanks
b) Water tanks
c) Fluid tanks
d) Vapour tanks

*Answer:* b
*Explanation:* The metal linear concept has proved so successful that it is being increasingly used in America, even for large water tanks and in the case of sanitary structures like sludge digestion tanks, spherical shapes are preferred and for practical reasons, the tank is made up of a top and bottom conical shell connected by a circular cylindrical intermediate portion.

4. In the case of large tanks, the base slabs is subdivided by _____
a) Water
b) Joints

c) Scale
d) Lines

*Answer:* b
*Explanation:* In the case of large tanks, the bars slab is subdivided by joints which are sealed by water stops and the floor slabs are cast in panels and according to the British standard the maximum length of side of such panels should not exceed 7.5m for reinforcement slabs and 6m for nominal slabs and they may be formed out of 50 to 80mm thick gunite reinforced with 0.5 percent of steel distributed in each of the principal directions.

5. The nominal reinforcement provided for floor slabs stipulated by Indian standard code is not less than?
a) 0.5
b) 0.7
c) 0.15
d) 0.8

*Answer:* c
*Explanation:* The Indian standard code stipulates the floor slabs of tanks resting on the ground should be provided with a nominal reinforcement of not less than 0.15 percent and the floor slabs should be cast in panels of area not more than $4.5m^2$ with contraction or expansion joints and these slabs are to be cast over a layer of concrete not less than 75mm thick with a sliding layer of bitumen paper provided to prevent the bond between the screed and the floor slab.

6. In the fixed base joint the junction is between the tank wall and _____
a) Slab
b) Footing
c) Beams
d) Columns

*Answer:* b
*Explanation:* In fixed base joint the junction is between the tank wall and footing is the most vulnerable location as far as leakage is

concerned and hence in the case of tanks storing penetrating liquids, it is necessary to form the wall and footing in monolithic construction and this type of connection is generally well suited for shallow tanks with diameters up to 30m, where the fixing moment developed at the wall base does not result in excessively high stresses and congestion of reinforcement.

7. When a sliding joint is made what is interposed at the junction of wall and base?
a) Rubber
b) Timber
c) Plastic
d) Soil

*Answer:* a
*Explanation:* A sliding joint is made by interposing rubber or neoprene pads at the junction of the wall and the base and the preload engineering company has developed this type of sliding base in which a vertical water stop is inserted between two rubber strips and in the present state of art, single neoprene pads have also used and the main function of these pads is to allow for free horizontal movement of the wall relative to the base by shear deformation of the rubber joint, which does not exceed a critical value of 30 degrees.

8. The most common method of wire wrapping for circular tanks consists of _____
a) VBR machine
b) Slump cone
c) Cassagrande apparatus
d) Traction machine

*Answer:* d
*Explanation:* The most common method of wire wrapping circular tanks consists of a traction machine, and it is suspended from a trolley which runs along the top of the tank walls and the high tensile wire is drawn through a die while it is wound on the tank to achieve the designed tension in the wire and

as a precaution the wires are anchored by clips, the wall at regular intervals to ensure that in the event of wire fracture, the winding does not get detached.

9. Calculate minimum wall thickness given a cylindrical prestressed water tank of internal diameter 30m over a depth of 7.5m and the permissible compressive stress at transfer is $13n/mm^2$ and the maximum compressive stress under working pressure is $1n/mm^2$ and the loss ratio is 0.75?
a) 43.8
b) 82.3
c) 64.5
d) 90.4

*Answer:* b
*Explanation:* D = 30m, H = 7.5m, $N_d$ = 720n/mm, $\eta$ = 0.75, $f_{ct}$ = $13n/mm^2$, pressure is $1n/mm^2$
T = $N_d/\eta f_{ct}$-$f_{min.w}$ = 720/ (0.75X 13) – (1) = 82.3mm.

10. Calculate circumferential prestress of a cylindrical prestressed concrete water tank given that the thickness is 12mm, loss ratio is 0.75, the maximum stress under working pressure is $1n/mm^2$($N_d$ value is 720)?

a) $9.4n/mm^2$
b) $5.6n/mm^2$
c) $11.2n/mm^2$
d) $15.2n/mm^2$

*Answer:* a
*Explanation:* $N_d$ = 720, $f_{min.w}$ = 1, $\eta$ = 0.75, t = 120mm
$F_c$ = $N_d/\eta_t$+ $f_{min.w}/\eta$ = 720/0.75 x 120+1/0.75 = $9.4n/mm^2$.

11. Calculate vertical prestressing force if wires of 5mm diameter with an initial stress of $1000n/mm^2$ are available for circumferential winding and Freyssinet cables made up of 12 wires of 8mm diameter stressed to $1200n/mm^2$ are to be used for vertical prestressing?
a) 15
b) 12
c) 8
d) 4

*Answer:* b
*Explanation:* 5mm diameter wires stress is $1000n/mm^2$, 12 wires of 8mm diameter are stressed to $1200n/mm^2$, $f_c$ = (12x1000x200)/(1000) = 2400kn.

12. Calculate circumferential prestress if loss ratio 0.75, thickness is 120mm, working pressure is $1n/mm^2$ and Nd is given as 840n/mm?
a) $10.75n/mm^2$
b) $14.8n/mm^2$
c) $12.6n/mm^2$
d) $10.65n/mm^2$

*Answer:* a
*Explanation:* Given $N_d$ = 840, $f_{min.w}$ = 1, $\eta$ = 0.75, t = 120mm,
$F_c$ = $N_d/\eta_t$+ $f_{min.w}/\eta$ = 840/0.75×120+ 1/0.75 = $10.75n/mm^2$.

13. Calculate the spacing of 5mm wires having a loss ratio of 0.075, compressive stress is $10.75n/mm^2$, 5mm diameter wires stress is $1000n/mm^2$, 12 wires of 8mm diameter are stressed to $1200n/mm^2$($N_d$ = $840n/mm^2$)?
a) 15.4mm
b) 11.6mm
c) 12.4mm
d) 18.5mm

*Answer:* b
*Explanation:* $\eta$ = 0.075, t = 120mm, internal diameter is $30×10^3$, $N_d$ = 840
S =

$2 \times 840/0.075 \times 1000 \times 20/10.75 \times 30 \times 103 \times 120 = 11.6$mm.

14. Calculate the maximum vertical moment due to prestress if given self weight moment is 16.5kn/m, thickness is 0.115m and loss ratio is 0.0075?
a) 15.4
b) 21.5
c) 25.4
d) 2.6

*Answer:* c
*Explanation:* $M_w = 16.5$kn/m, $t = 0.115$, $\eta = 0.075$
$M_t = M_w \times W_t / \eta$ $16500(0.11/0.075) = 25.4 \times 10^6$nmm/m.

15. Find vertical prestressing force if characteristic strength is 8.2, wires are stressed at $1000$n/mm$^2$, diameter is 150mm?
a) 1500kn
b) 1230kn
c) 4567kn
d) 8967kn

*Answer:* b
*Explanation:* $f_c = 8.2$, stress = 1000, diameter = 150mm
$F = (8.2 \times 1000 \times 150)/1000 = 1230$kn.

## TOPIC 3.2 UNDERGROUND RECTANGULAR TANKS - HEMISPHERICAL BOTTOMED STEEL WATER TANK -DESIGN AND DRAWING

1. Prestressed concrete tanks have been widely used for the storage of _____
a) Gas
b) Air
c) Fluids
d) Water

*Answer:* c
*Explanation:* Prestressed concrete tanks have been widely used for storage of fluids, such as water, oil, gas, sewage, granular materials like cement, process liquids and chemicals, slurries and more recently cryogens water storage tanks of large capacity are invariably made of prestressed concrete recent applications include special forms of prestressed concrete tanks, which are triaxially prestressed and serve as containment vessels and biological shields for nuclear reactors.

2. Prestressed concrete although it is water tight, it is not _____
a) Gas tight
b) Liquid tight
c) Vapour tight
d) Material tight

*Answer:* a
*Explanation:* Tanks have been built for storing liquid oxygen at 230 degrees with capacities up to one million liters and prestressed concrete, although water tight, it is not gas tight were vapours under pressure are to be stored and in such cases, a thin membrane linear of steel provides rigidity and increases the steel tensile capacity of the pretressed concrete.

3. The metal linear concept in prestressed tanks has proved to be success in case of _____
a) Air tanks
b) Water tanks
c) Fluid tanks
d) Vapour tanks

*Answer:* b
*Explanation:* The metal linear concept has proved so successful that it is being increasingly used in America, even for large water tanks and in the case of sanitary structures like sludge digestion tanks, spherical shapes are preferred and for practical reasons, the tank is made up of a top

and bottom conical shell connected by a circular cylindrical intermediate portion.

4. In the case of large tanks, the base slabs is subdivided by _____
a) Water
b) Joints
c) Scale
d) Lines

*Answer:* b
*Explanation:* In the case of large tanks, the bars slab is subdivided by joints which are sealed by water stops and the floor slabs are cast in panels and according to the British standard the maximum length of side of such panels should not exceed 7.5m for reinforcement slabs and 6m for nominal slabs and they may be formed out of 50 to 80mm thick gunite reinforced with 0.5 percent of steel distributed in each of the principal directions.

5. The nominal reinforcement provided for floor slabs stipulated by Indian standard code is not less than?
a) 0.5
b) 0.7
c) 0.15
d) 0.8

*Answer:* c
*Explanation:* The Indian standard code stipulates the floor slabs of tanks resting on the ground should be provided with a nominal reinforcement of not less than 0.15 percent and the floor slabs should be cast in panels of area not more than $4.5m^2$ with contraction or expansion joints and these slabs are to be cast over a layer of concrete not less than 75mm thick with a sliding layer of bitumen paper provided to prevent the bond between the screed and the floor slab.

6. In the fixed base joint the junction is between the tank wall and _____
a) Slab
b) Footing

c) Beams
d) Columns

*Answer:* b
*Explanation:* In fixed base joint the junction is between the tank wall and footing is the most vulnerable location as far as leakage is concerned and hence in the case of tanks storing penetrating liquids, it is necessary to form the wall and footing in monolithic construction and this type of connection is generally well suited for shallow tanks with diameters up to 30m, where the fixing moment developed at the wall base does not result in excessively high stresses and congestion of reinforcement.

7. When a sliding joint is made what is interposed at the junction of wall and base?
a) Rubber
b) Timber
c) Plastic
d) Soil

*Answer:* a
*Explanation:* A sliding joint is made by interposing rubber or neoprene pads at the junction of the wall and the base and the preload engineering company has developed this type of sliding base in which a vertical water stop is inserted between two rubber strips and in the present state of art, single neoprene pads have also used and the main function of these pads is to allow for free horizontal movement of the wall relative to the base by shear deformation of the rubber joint, which does not exceed a critical value of 30 degrees.

8. The most common method of wire wrapping for circular tanks consists of _____
a) VBR machine
b) Slump cone
c) Cassagrande apparatus
d) Traction machine

*Answer:* d
*Explanation:* The most common method of wire wrapping circular tanks consists of a traction machine, and it is suspended from a trolley which runs along the top of the tank walls and the high tensile wire is drawn through a die while it is wound on the tank to achieve the designed tension in the wire and as a precaution the wires are anchored by clips, the wall at regular intervals to ensure that in the event of wire fracture, the winding does not get detached.

9. Calculate minimum wall thickness given a cylindrical prestressed water tank of internal diameter 30m over a depth of 7.5m and the permissible compressive stress at transfer is $13n/mm^2$ and the maximum compressive stress under working pressure is $1n/mm^2$ and the loss ratio is 0.75?
a) 43.8
b) 82.3
c) 64.5
d) 90.4

*Answer:* b
*Explanation:* D = 30m, H = 7.5m, $N_d$ = 720n/mm, $\eta$ = 0.75, $f_{ct}$ = $13n/mm^2$, pressure is $1n/mm^2$
T = $N_d/\eta f_{ct}$-$f_{min.w}$ = 720/ (0.75X 13) – (1) = 82.3mm.

10. Calculate circumferential prestress of a cylindrical prestressed concrete water tank given that the thickness is 12mm, loss ratio is 0.75, the maximum stress under working pressure is $1n/mm^2$($N_d$ value is 720)?

a) $9.4n/mm^2$
b) $5.6n/mm^2$
c) $11.2n/mm^2$
d) $15.2n/mm^2$

*Answer:* a
*Explanation:* $N_d$ = 720, $f_{min.w}$ = 1, $\eta$ = 0.75, t = 120mm

$F_c$ = $N_d/ \eta_t$+ $f_{min.w}/ \eta$ = 720/0.75 x 120+1/0.75 = $9.4n/mm^2$.

11. Calculate vertical prestressing force if wires of 5mm diameter with an initial stress of $1000n/mm^2$ are available for circumferential winding and Freyssinet cables made up of 12 wires of 8mm diameter stressed to $1200n/mm^2$ are to be used for vertical prestressing?
a) 15
b) 12
c) 8
d) 4

*Answer:* b
*Explanation:* 5mm diameter wires stress is $1000n/mm^2$, 12 wires of 8mm diameter are stressed to $1200n/mm^2$, $f_c$ = (12x1000x200)/(1000) = 2400kn.

12. Calculate circumferential prestress if loss ratio 0.75, thickness is 120mm, working pressure is $1n/mm^2$ and Nd is given as 840n/mm?
a) $10.75n/mm^2$
b) $14.8n/mm^2$
c) $12.6n/mm^2$
d) $10.65n/mm^2$

*Answer:* a
*Explanation:* Given $N_d$ = 840, $f_{min.w}$ = 1, $\eta$ = 0.75, t = 120mm,
$F_c$ = $N_d/ \eta_t$+ $f_{min.w}/ \eta$ = 840/0.75×120+ 1/0.75 = $10.75n/mm^2$.

13. Calculate the spacing of 5mm wires having a loss ratio of 0.075, compressive stress is $10.75n/mm^2$, 5mm diameter wires stress is $1000n/mm^2$, 12 wires of 8mm diameter are stressed to $1200n/mm^2$($N_d$ = $840n/mm^2$)?
a) 15.4mm
b) 11.6mm

c) 12.4mm
d) 18.5mm

*Answer:* b
*Explanation:* $\eta$ = 0.075, t = 120mm, internal diameter is $30 \times 10^3$, $N_d$ = 840
S =
2×840/0.075x1000x20/10.75x30x103x120 = 11.6mm.

14. Calculate the maximum vertical moment due to prestress if given self weight moment is 16.5kn/m, thickness is 0.115m and loss ratio is 0.0075?
a) 15.4
b) 21.5
c) 25.4
d) 2.6

*Answer:* c
*Explanation:* $M_w$ = 16.5kn/m, t = 0.115, $\eta$ = 0.075
$M_t = M_w \times W_t / \eta$ 16500(0.11/0.075) =
$25.4 \times 10^6$ nmm/m.

15. Find vertical prestressing force if characteristic strength is 8.2, wires are stressed at 1000n/mm$^2$, diameter is 150mm?
a) 1500kn
b) 1230kn
c) 4567kn
d) 8967kn

*Answer:* b
*Explanation:* $f_c$ = 8.2, stress = 1000, diameter = 150mm
F = (8.2 x 1000 x 150)/1000 = 1230kn.

# UNIT IV INDUSTRIAL STRUCTURES 9+6

TOPIC 4.1 STRUCTURAL STEEL FRAMING - STEEL ROOF TRUSSES - ROOFING ELEMENTS - BEAM COLUMNS - CODAL

1. What is beam?
a) structural member subjected to transverse loads
b) structural member subjected to axial loads only
c) structural member subjected to seismic loads only
d) structural member subjected to transverse loads only

*Answer:* a
*Explanation:* Beam is a structural member subjected to transverse loads that is loads perpendicular to its longitudinal axis. The mode of deflection of beam is primarily by bending.

2. Structural members subjected to bending and large axial compressive loads are known as
a) strut
b) purlin
c) beam-column
d) lintel

*Answer:* c
*Explanation:* Structural members subjected to bending accompanied by large axial compressive loads at the same time are known as beam-column. A beam-column differs from column only by presence of eccentricity of load application, end moment, transverse load.

3. What is girt?
a) vertical beam spanning between wall column of industrial buildings
b) horizontal beam spanning between wall column of industrial buildings
c) vertical beam spanning between wall

column of residential buildings
d) horizontal beam spanning between wall column of residential buildings

*Answer:* b
*Explanation:* Girt is horizontal member fastened to and spanning between peripheral column of industrial buildings. It is used to support wall cladding such as corrugated metal sheet.

4. Members used to carry wall loads over wall openings are called
a) purlin
b) rafter
c) girder
d) lintels

*Answer:* d
*Explanation:* Lintels are beam members used to carry wall loads over wall openings for doors, windows, etc.

5. Load transfer by a beam is primarily by
a) bending only
b) shear only
c) bending and shear
d) neither bending nor shear

*Answer:* c
*Explanation:* The load transfer by beam is primarily by bending and shear. The mode of deflection of beam is primarily by bending.

6. What are spandrels?
a) exterior beams at floor level of buildings
b) interior beams at floor level of buildings
c) exterior columns
d) interior columns

*Answer:* a
*Explanation:* Spandrels are exterior beams at floor level of buildings, which carry part of floor load and exterior wall.

7. Members used in bridges parallel to traffic are called
a) spandrel

b) stringers
c) purlin
d) joist

*Answer:* b
*Explanation:* Stringers are members used in bridges parallel to traffic to carry the deck slab. They will be connected by transverse floor beams.

8. Match the pair

```
            I                    II

    (A) joist           (i) tension member in roof truss

    (B) girder          (ii) member supporting purlin

    (C) tie             (iii) member supporting roof in a building

    (D) rafter          (iv) major floor beam in building
```

a) A-i, B-ii, C-iii, D-iv
b) A-iv, B-iii, C-ii, D-i
c) A-ii, B-iv, C-iii, D-i
d) A-iii, B-iv, C-i, D-ii

*Answer:* d
*Explanation:* Joist is a member supporting roof in a building. Girder is a major floor beam in building. Tie is tension member in roof truss and rafter is a member supporting purlin.

9. Which of the following statement is correct?
a) beams are termed as fixed beams when end condition do not carry end moments
b) beams are termed as simply supported beams when ends are rigidly connected to other members
c) beams are termed as fixed beams when ends are rigidly connected to other members
d) beams are termed as continuous beams when they do not extend across more than two support

*Answer:* c
*Explanation:* Beams may be termed as simply supported beams when end condition do not carry any end moments from any continuity developed by connection. A beam is called continuous beam when it extends continuously across more than two supports. A fixed beam has its ends rigidly connected to other members, so that moments can be carried across the connection.

10. Complex stresses may occur when
a) loads are inclined to principal axes
b) loads are along principal axes
c) symmetrical section are used
d) small values of shear and bending moment occur at section

*Answer:* a
*Explanation:* Complex stresses may arise when loads are inclined to principal axes, when unsymmetrical sections are used or when large values of shear and bending moment occur at section.

11. Simple bending takes place if
a) loading passes above shear centre for single symmetric open section
b) loading passes below shear centre for single symmetric open section
c) loading plane coincides with one of the principal planes of doubly symmetric section
d) loading plane do not coincide with one of the principal planes of doubly symmetric section

*Answer:* c
*Explanation:* Simple bending takes place if loading plane coincides with one of the principal planes of doubly symmetric section such as I-section or in case of singly symmetric open section such as channel section, the loading passes through shear centre and is parallel to the principal plane. Unsymmetrical bending occurs if loading does not pass through shear centre.

12. Which of the following buckling does not occur in beam?
a) lateral buckling of whole beam
b) local buckling of web
c) local buckling of flanges
d) longitudinal buckling of web

*Answer:* b
*Explanation:* Buckling may take place in many ways : (i) lateral buckling of whole beam between supports, (ii) local buckling of flanges, (iii) longitudinal buckling of web and buckling in depth direction under concentrated loads.

# TOPIC 4.2 PROVISIONS - DESIGN AND DRAWING

1. The maximum area of tension reinforcement in beams shall not exceed?
a) 1.5%
b) 4%
c) 7%
d) 0.5%

*Answer:* b
*Explanation:* If tensile reinforcement of beam should exceed 4% of total gross area then some crack will be developed in concrete.

2. The diameter of longitudinal bars of a column should never be less than?
a) 12 mm
b) 6 mm
c) 10 mm
d) 8 mm

*Answer:* a
*Explanation:* Minimum diameter of longitudinal bar in RCC column shall not be less than 12mm (IS456:2000, cl 26.5.3.1 d). Indian standards specify 12mm as the least diameter of a vertical bar and 5mm as the least diameter of lateral bar or stirrup.

3. The number of treads in a flight is equal to _____
a) risers in the flight
b) risers plus one
c) risers minus one
d) risers plus three

*Answer:* c
*Explanation:* It is often not simply the sum of the individual tread lengths due to the nosing overlapping between treads. If there are N steps, the total run equals N-1 times the going: the tread of the last step is part of a landing and is not counted.

4. A foundation rests on _____
a) base of the foundation
b) foundation soil
c) subgrade
d) foundation soil and subgrade

*Answer:* d
*Explanation:* A foundation (or, more commonly, base) is the element of an architectural structure which connects it to the ground, and transfers loads from the structure to the ground. Foundations are generally considered either shallow or deep. Foundation engineering is the application of soil mechanics and rock mechanics (Geotechnical engineering) in the design of foundation elements of structures.

5. For initial estimate for a beam design, the width is assumed?
a) 1/10th of span
b) 1/30th of span
c) 1/15th of span
d) 1/5th of span

*Answer:* b
*Explanation:* Design codes prescribe beam width limitations to minimise the shear lag effect on the formation of full-width plastic hinges and achieving the expected capacity. However, owing to insufficient experimental and analytical studies, empirical design formulas for the beam width limitation, with

remarkably different results, have been implemented in different design codes. In this paper, parametric studies of the influence of key parameters on the behaviour of wide beam–column connections are conducted based on available test results. An effective beam-width model is analytically developed using the equivalent-frame representation, where the effects of torsion of transverse beams and flexure around the joint core are considered. The validity of the model is verified using flexural strengths of test specimens, covering a wide range of design parameters.

6. Design of R.C.C. simply supported beams carrying U.D.L. is based on the resultant B.M. at _____
a) mid span
b) supports
c) every section
d) quarter span

*Answer:* a
*Explanation:* Since BM is maximum at midspan, design should be done for maximum bending moment so that it will take care for other section. Moment formula we are using is (wl2/8) which mid span moment.

7. High strength concrete is used in prestressed member?
a) To ovecome bursting stresses at the ends
b) To provide high bond stresses
c) To overcome cracks due to shrinkage
d) To overcome bursting stresses, provide high bond stresses and overcome cracks

*Answer:* d
*Explanation:* The primary difference between high-strength concrete and normal-strength concrete relates to the compressive strength that refers to the maximum resistance of a concrete sample to applied pressure. Although there is no precise point of separation between high-strength concrete and normal-strength concrete, the American Concrete Institute defines high-strength

concrete as concrete with a compressive strength greater than 6,000 psi.

8. The advantage of reinforced concrete is due to _____
a) monolithic character
b) moulding in any desired shape
c) fire-resisting and durability
d) monolithic character, moulding any shape and fire-resisting

*Answer:* d
*Explanation:* Reinforced concrete (RC) is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength or ductility. The reinforcement is usually, though not necessarily, steel reinforcing bars (rebar) and is usually embedded passively in the concrete before the concrete sets. Reinforcing schemes are generally designed to resist tensile stresses in particular regions of the concrete that might cause unacceptable cracking and/or structural failure. Modern reinforced concrete can contain varied reinforcing materials made of steel, polymers or alternate composite material in conjunction with rebar or not. Reinforced concrete may also be permanently stressed (in tension), so as to improve the behaviour of the final structure under working loads.

9. Cracking of the concrete section is nearly impossible to prevent.
a) True
b) False

*Answer:* a
*Explanation:* However, the size and location of cracks can be limited and controlled by appropriate reinforcement, control joints, curing methodology and concrete mix design. Cracking can allow moisture to penetrate and corrode the reinforcement. This is a serviceability failure in limit state design. Cracking is normally the result of an inadequate quantity of rebar, or rebar spaced at too great a distance. The concrete then cracks either under excess loading, or due to internal effects such as early thermal shrinkage while it cures.
Ultimate failure leading to collapse can be caused by crushing the concrete, which occurs when compressive stresses exceed its strength, by yielding or failure of the rebar when bending or shear stresses exceed the strength of the reinforcement, or by bond failure between the concrete and the rebar.

10. The architect is usually the lead designer on buildings, with a structural engineer employed as a sub-consultant.
a) False
b) True

*Answer:* b
*Explanation:* The degree to which each discipline actually leads the design depends heavily on the type of structure. Many structures are structurally simple and led by architecture, such as multi-storey office buildings and housing, while other structures, such as tensile structures, shells and gridshells are heavily dependent on their form for their strength, and the engineer may have a more significant influence on the form, and hence much of the aesthetic, than the architect.

# UNIT V GIRDERS AND CONNECTIONS

## TOPIC 5.1 PLATE GIRDERS - BEHAVIOUR OF COMPONENTS-DEIGN OF WELDED PLATE GIRDER

1. A plate girder is used when
a) span is large and loads are heavy
b) span is small and loads are heavy

c) span is small and loads are light
d) span is large and loads are light

*Answer:* a
*Explanation:* A plate girder is deep flexural member used to carry loads that cannot be economically carried by rolled beams. When load is heavier and span is also large, there are three options : i) two or more I0sections, connected appropriately (ii) plate girder (iii)truss girder. Of the above alternatives, first is uneconomical. So, plate girder or truss girder can be used. Plate girder is used since cost of fabrication of truss girder is high.

2. Why plate girder is preferred over truss girder?
a) plate girder requires costly maintenance
b) higher vertical clearance required for plate girder than truss girder
c) cost of fabrication of plate girder is high
d) cost of fabrication of truss girder is high

*Answer:* d
*Explanation:* When load is heavier and span is also large, either plate girder or truss girder can be used. But, plate girder is preferred because of the disadvantages of truss girder. The disadvantages of truss girder are higher cost of fabrication and erection, problem of vibration and impact, requirements of higher vertical clearance and costly maintenance.

3. Bending resistance of plate girders can be increased by
a) decreasing distance between flanges
b) increasing distance between flanges
c) reducing distance between flanges to half
d) bending resistance cannot be increased

*Answer:* b
*Explanation:* Plate girders are built-up flexural members. Their bending resistance can be increased by increasing the distance between flanges. This also increases the shear resistance as web area increases.

4. Which of the following is economical if depth is limited and loads are too large?
a) rolled section beam
b) truss girder
c) welded box plate girder
d) bolted box plate girder

*Answer:* c
*Explanation:* When the loads and span are large, plate girder sections either with riveted/bolted connections or welded connections may be provided. The number of flange plates can be increased depending upon the moment to be resisted. If depth is limited and loads are too large, welded box plate girder is provided. A box girder with riveted/bolted connections can b e provided but it is too costly as compared to welded one. Box girders have great resistance to lateral buckling.

5. An ideal bolted plate girder section consists of
a) flange angles and cover plates for both compression flange and tension flange
b) flange angles and cover plates for compression flange and only flange angle for tension flange
c) only flange angle for compression flange and flange angles and cover plates for tension flange
d) flange angles for both compression flange and tension flange

*Answer:* b
*Explanation:* An ideal bolted plate girder section consists of flange angles and cover plates for compression flange and only flange angle for tension flange. The various elements of riveted/bolted/welded plate girder are : web plate, flange angles with or without cover plates for riveted/bolted plate girder and only flange angles for welded plate girder, stiffeners – bearing, transverse and longitudinal, splices for web and flange.

6. The modes of failure of plate girder are
a) by yielding of compression flange only

b) by buckling of tension flange only
c) by yielding of tension flange and buckling of compression flange
d) by yielding of compression flange and buckling of tension flange

*Answer:* c
*Explanation:* The limit states considered for plate girder are yielding of tension flange and buckling of compression flange. The compression flange buckling can take place in various ways, such as vertical buckling into the web or flange local buckling. Flange buckling can also be caused due to lateral-torsional buckling.

7. At high shear locations in the girder web, principal plane will be _____ to longitudinal axis of member
a) inclined
b) parallel
c) perpendicular
d) coincides

*Answer:* a
*Explanation:* At high shear locations in the girder web, usually near supports and neutral axis, the principal planes will be inclined to longitudinal axis of the member. The principal stresses will be diagonal tension and diagonal compression along the principal planes.

8. Which of the following causes web buckling in plate girder?
a) diagonal tension
b) diagonal compression
c) diagonal tension and diagonal compression
d) neither diagonal tension nor diagonal compression

*Answer:* b
*Explanation:* The principal planes will be inclined to longitudinal axis of the member at high shear locations in the girder web. Along the principal planes, the principal stresses will be diagonal tension and diagonal compression. Diagonal tension does not cause

any problem but diagonal compression causes the web to buckle in the direction perpendicular to its action.

9. Which of the following statement is correct for reducing web buckling due to diagonal compression?
a) not providing web stiffeners to increase shear strength
b) providing web stiffeners to reduce shear strength
c) increasing depth-to-thickness ratio
d) reducing depth-to-thickness ratio

*Answer:* d
*Explanation:* Diagonal compression causes web to buckle in the direction perpendicular to its action. This problem can be solved by any of the following ways : (i) reduce depth-to-thickness ratio of web such that problem is eliminated, (ii) provide web stiffeners to form panels that would enhance shear strength of web, (iii) provide web stiffeners to form panels that would develop tension field action to resist diagonal compression.

10. Which of the following is correct during tension field action?
a) web can resist diagonal compression
b) horizontal component of diagonal compression is supported by flanges
c) vertical component of diagonal compression is supported by flanges
d) vertical component of diagonal compression is supported by stiffeners

*Answer:* b
*Explanation:* As web begins to buckle , the web loses its ability to resist diagonal compression. The diagonal compression is transferred to transverse stiffeners and flanges. The vertical component of diagonal compression is supported by stiffeners and horizontal component is resisted by flanges. The web resists only diagonal tension and this behaviour of web is called tension field action.

11. Which of the statement is not true about intermediate stiffeners?
a) they reduce shear capacity of web
b) they improve shear capacity of web
c) they can be used to develop tension field action
d) their main purpose is to provide stiffness to the web

*Answer:* a
*Explanation:* Intermediate stiffeners can be used to develop tension field action and improve shear capacity of web. The main purpose of these stiffeners is to provide stiffness to the web rather than to resist the applied loads. Additional stiffeners called bearing stiffeners are provided at points of concentrated loads to protect the web from the direct compressive loads.

# TOPIC 5.2 DESIGN OF INDUSTRIAL GANTRY GIRDERS

1. Which of the following is correct regarding gantry girders?
a) It is laterally supported except at the columns
b) It is subjected to impact load
c) It should not be analysed for unsymmetrical bending
d) It is not subjected to longitudinal load

*Answer:* b
*Explanation:* Gantry girder are different from beams in buildings. It is generally laterally unsupported except at the columns. It is subjected to impact load. It must be analysed for unsymmetrical bending because of lateral thrust from the starting and stopping of the crab. It is subjected to longitudinal load due to starting and stopping of crane bridge itself. They are always simply supported.

2. Which of the following loads are not considered in the design of gantry girders?
a) longitudinal loads

b) gravity loads
c) lateral loads
d) wind loads

*Answer:* d
*Explanation:* The loads considered in the design of gantry girders are vertical loads or gravity loads, longitudinal loads, lateral loads and impact loads. The vertical force is the reaction from crane girder, acting vertically downward. The longitudinal thrust is due to starting and stopping of crane acting in longitudinal direction. The lateral thrust is due to starting and stopping of the crab acting horizontally normal to the gantry girder.

3. The wheel load transferred from trolley to gantry girder is given by
a) $W_1 = [W_t(L_c+L_1)]/(2L_c)$
b) $W_1 = [W_t(L_c-L_1)](2L_c)$
c) $W_1 = [W_t(L_c-L_1)]/(2L_c)$
d) $W_1 = [W_t(L_c+L_1)]/( L_c)$

*Answer:* c
*Explanation:* Since trolley moves on the crane girder along the span of truss, its weight is transferred to the crane wheels as the axle load and finally to gantry girder. The wheel load transferred from trolley to gantry girder is given by $W_1 = [W_t(L_c-L_1)]/(2L_c)$, where $W_1$ is load of each wheel on gantry girder, $W_t$ is weight of trolley or crab car, $L_c$ is distance between gantry giders, $L_1$ is distance between centre of gravity of trolley and gantry.

4. For gantry girders carrying electrically operated overhead travelling cranes, the lateral forces are increased by _____ for impact allowance.
a) 10% of weight of crab and weight lifted on the crane
b) 20% of weight of crab and weight lifted on the crane
c) 25% of maximum static wheel load
d) 50% of maximum static wheel load

*Answer:* a
*Explanation:* For gantry girders carrying electrically operated overhead travelling cranes, the lateral forces are increased by 10% of weight of crab for impact allowance and weight lifted on the crane. The vertical forces can be increased by 25% of maximum static wheel load.

5. For gantry girders carrying hand operated cranes, the vertical forces are increased by____ for impact allowance
a) 10% of maximum static wheel load
b) 25% of maximum static wheel load
c) 10% of weight of crab and weight lifted on the crane
d) 20% of weight of crab and weight lifted on the crane

*Answer:* c
*Explanation:* For gantry girders carrying hand operated cranes, the vertical forces are increased by 10% of maximum static wheel load for impact allowance. The lateral forces can be increased by 5% of weight of crab and weight lifted on the crane.

6. Fatigue effect for light and medium duty cranes need not be checked if
a) $N_{sc} > 10{\times}10^6\ [(27/\gamma_{mft})/\gamma_{mt}]$.
b) $N_{sc} < 5{\times}10^6\ [(27/\gamma_{mft})/\gamma_{mt}]^3$
c) $N_{sc} > 5{\times}10^6\ [(27/\gamma_{mft})/\gamma_{mt}]^2$
d) $N_{sc} < 5{\times}10^6\ [(27/\gamma_{mft})\gamma_{mt}]$.

*Answer:* b
*Explanation:* Fatigue effect for light and medium duty cranes need not be checked if normal and shear design stress ranges $f \leq (27/\gamma_{mft})$ or if actual number of stress cycles, $N_{sc} < 5{\times}10^6\ [(27/\gamma_{mft})/\gamma_{mt}]^3$, where f = actual fatigue stress range, $\gamma_{mft}$ = partial safety factor for strength, $\gamma_{mf}$ = partial safety factor for material = 1.10.

7. The maximum wheel load is obtained when
a) crane crab is farthest to gantry girder
b) crane crab is closest to gantry girder
c) crane crab is not attached
d) crane crab is at mid span

*Answer:* b
*Explanation:* The maximum wheel load is obtained when crane crab is closest to gantry girder. The crab in such position on the crane girder gives maximum reaction on the gantry girder. The vertical reaction of crane girder is transferred through its two wheels on to the gantry girder. Therefore, the maximum wheel load is half of this reaction. This maximum wheel load is then increased for impact and used for design of gantry girder.

8. The bending moment due to dead load of girder is maximum at
a) one-third distance at span
b) two-third distance at span
c) end of span
d) centre of span

*Answer:* d
*Explanation:* The bending moment considered in the design of gantry girder are the bending moment due to maximum wheel loads (with impact) and the bending moment due to dead load of the girder and rails. The bending moment due to dead loads is maximum at the centre of span.

9. What is the maximum vertical deflection allowed for a gantry girder where the cranes are manually operated?
a) L/500
b) L/700
c) L/600
d) L/800

*Answer:* a
*Explanation:* The vertical deflection of gantry girder where the cranes are manually operated should not exceed L/500, where L is the span of gantry girder. The maximum vertical deflection allowed for a gantry girder

where the cranes are travelling overhead and operated electrically upto 500kN is L/750 and operated electrically over 500kN is L/1000. When gantry girders carry moving loads such as charging cars, the deflection should not exceed L/600.

10. The minimum recommended rise of trusses with Galvanised Iron sheets is
a) 1 in 12
b) 1 in 6
c) 1 in 10
d) 1 in 18

*Answer:* b
*Explanation:* The pitch of truss depends upon the roofing material. The minimum recommended rise of trusses with galvanised iron sheets is 1 in 6 and with asbestos cement sheets is 1 in 12.

11. The economic spacing of roof truss depends on
a) cost of purlins only
b) cost of purlins and cost of roof covering
c) dead loads
d) cost of roof covering and dead loads

*Answer:* b
*Explanation:* The economic spacing of the truss is the spacing that makes the overall cost of trusses, purlins, roof coverings, columns, etc. the minimum. It depends upon the relative cost of trusses, purlins, roof coverings, spacing of columns, etc. If the spacing is large, the cost of these trusses per unit area decreases but the cost of purlin increases. But if the spacing of trusses is small, the cost of trusses per unit area increases. Roof coverings cost more if the spacing of trusses is large.

12. Which of the following is true for economic spacing?
a) cost of trusses should be equal to twice the cost of purlins
b) cost of trusses should be equal to twice the cost of purlins minus cost of roof coverings

c) cost of trusses should be equal to the cost of purlins plus cost of roof coverings
d) cost of trusses should be equal to twice the cost of purlins plus cost of roof coverings

*Answer:* d
*Explanation:* For economic spacing of roof trusses, the cost of trusses should be equal to twice the cost of purlins plus cost of roof coverings. This equation is used for checking the spacing of trusses and not for design of trusses.

13. Which of the following load combination is not considered for design of roof trusses?
a) Dead load + crane load
b) Dead load + wind load
c) Dead load + earthquake load
d) Dead load + live load + wind load

*Answer:* c
*Explanation:* Earthquake loads are not significant for roof trusses because of the small self weights. The following load combinations can be considered : (i) Dead load + snow load, (ii) Dead load + partial/full live load, (iii) dead load + live load + internal positive air pressure, (iv) dead load + live load + internal suction air pressure, (v) dead load + live load + wind load.

14. Live load for roof truss should not be less than
a) $0.4kN/m^2$
b) $0.2kN/m^2$
c) $0.75kN/m^2$
d) $0.8kN/m^2$

*Answer:* a
*Explanation:* The live load for roof truss should not be less than $0.4kN/m^2$. For roof slopes $\leq 10^o$ and access provided, the live load to be taken is $1.5kN/m^2$ of plan area. For roof slopes $> 10^o$ and access is not provided , the live load to be taken is $0.75kN/m^2$ of plan area.

## TOPIC 5.3 DESIGN OF ECCENTRIC SHEAR AND MOMENT RESISTING CONNECTIONS

1. Simple connections are used to transmit _____
a) forces
b) moments
c) stresses
d) both force and moment

*Answer:* a
*Explanation:* Simple Connection is required to transmit force only and there may not be any moment acting on the group of connectors. This connection may be capable of transmitting some amount of moment. Simple connections are also called flexible connections.

2. Which of the following statement is true?
a) lap joint eliminates eccentricity of applied load, butt joint results in eccentricity at connection
b) lap joint and butt joint eliminates eccentricity at connection
c) lap joint results in eccentricity of applied load, butt joint eliminates eccentricity at connection
d) lap joint and butt joint results in eccentricity of applied load

*Answer:* c
*Explanation:* Lap joints and butt joints are used to connect plates or members composed of plate elements. Lap joint results in eccentricity of applied load, butt joint eliminates eccentricity at connection.

3. In a lap joint, at least _____ bolts should be provided in a line.
a) 0
b) 1
c) 2
d) 3

*Answer:* c
*Explanation:* In lap joint, members to be connected are simply overlapped and connected together by means of bolts and welds. To minimize the effect of bending due to eccentricity in a lap joint, at least two bolts in a line should be provided.

4. Use of lap joints is not recommended because
a) stresses are distributed unevenly
b) eccentricity is eliminated
c) bolts are in double shear
d) no bending is produced

*Answer:* a
*Explanation:* In lap joint the centre of gravity of load in one member does not coincide with centre of gravity of load in other member. It results in eccentricity of applied loads and bending. Due to eccentricity, stresses are also not evenly distributed, Hence lap joint is not recommended.

5. Why is double cover butt joint preferred over single cover butt joint or lap joint?
a) bolts are in single shear
b) eliminates eccentricity
c) bending in bolts
d) shear force is not transmitted

*Answer:* b
*Explanation:* Double cover butt joint preferred over single cover butt joint or lap joint because (i) eccentricity of load is eliminated, hence no bending in bolts, (ii) total shear force to be transmitted is split into two parts, hence bolts are in double shear. Shear capacity of double cover butt joint is double the shear capacity of single cover butt joint or lap joint.

6. Clip and seating angle connection is provided for
a) lateral support
b) bending support
c) frictional support
d) hinged support

*Answer:* a
*Explanation:* Clip and seating angle connection transfer reaction from beam to column through angle seat. The cleat angle is provided for lateral or torsional support to the top flange of the beam and bolted to the top flange.

7. In flexible end plate design, beam is designed for the
a) maximum bending moment
b) shear force
c) torsional moment
d) zero end moment

*Answer:* d
*Explanation:* In flexible end plate design. beam is designed for the zero end moment and the end plates augment the web shear and bending capacity of beams.

8. which of the following condition is true for web side plate connection?
a) HSFG bolts should be used
b) Bolts should be designed to fail by shear of bolt
c) Bolts should be designed to fail by bearing of connected plies
d) Edge distances must be less than two times the bolt diameter

*Answer:* c
*Explanation:* The following condition must be considered for web side plate connection (i) only ordinary bolts should be used, (ii) bolts should be designed to fail by bearing of connected plies ad not by shear of bolt, (iii) edge distances must be greater than two times the bolt diameter.