UNIT-3 Bridge Engineering

QUESTION 1 State the various factors affecting selection of site of a bridge. (Sum-24, Marks-4) (Win-24, Marks-4). (Sum-22, Marks-4) .

ANS: **i. Width of river:** The width of river indicates length of bridge. It is desirable to have well defined and a narrow channel at bridge site as far as possible which will help in providing least possible length of bridge. The smaller the width of river, the cheaper will be the bridge in its initial cost as well as maintenance cost.

ii. A straight reach : The river should have straight reach over a reasonable long distance on upstream side and downstream side of the bridge site so that the utility of bridge can be maintained for the design period. On the other hand the curved reach of river is not desirable as it creates problems during construction and maintenance of bridge.

iii. Foundations : The nature of soil at bridge site should be such that good sound foundations should be available at reasonable depth. Such type of bridge site will save expense, labour and time required.

iv. Connections with roads : The bridge is constructed to connect the road on either side of a river. The bridge site should therefore form a proper link between the roads on either side of a river. The approaches at the bridge site should be such that the do not involve heavy expenditure.

v. Firm embankments : The embankment at bridge site should high, permanent, straight, solid and firm. Such embankments will not get disturbed at the time of heavy floods and they do not allow the course of stream to alter.

vi. Materials and labour : The site of the proposed bridge should be such that labour, construction material should easily available nearby site. The transportation charges for material and labour at the bridge site should be minimum. This type of bridge site will provide economy in the overall cost of construction

QUESTION 2. Define the terms: i. Effective span ii. Clear span iii. Economic span iv. Afflux (Sum-22, Marks-4)

Ans: **i. Effective span:** The center to center distance between any two adjacent supports of the bridge superstructure is called span or effective span of bridge.

ii. Clear span: The clear distance between any two adjacent supports of the bridge superstructure is called clear span.

iii. Economic span: The span for which the total cost of the bridge is minimum is known as economical span of a bridge.

iv. Afflux: It is the rise in water surface of water – course, caused due to the obstruction by the bridge in the flow of water. OR The heading up of the water above its normal level while passing under the bridge is called afflux.

QUESTION3. Discuss any two types of foundation provided for R.C.C. bridges. (Sum-22, Marks-4)

ANS: Following are the types of foundation provided for R.C.C. bridges:

i. Spread foundation: This type of foundation in shape is similar as provided for walls. It is best suited in situations where the scouring of the river bed is minimum and good hard soil is available within 2m to 3 m below river bed level. This type of foundation can be provided even if the bed contains erodible material as sand, but the scouring is prevented by driving sheet piles on upstream and downstream side and floor pitching.

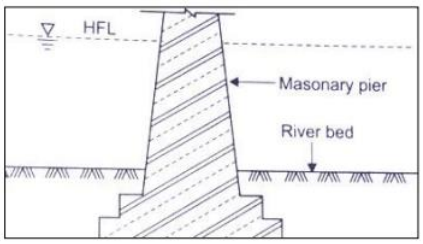


Fig. Spread Foundation.

ii. Raft foundation: A footing is a concrete support under a foundation that rests in solid ground and is wider than the structure supported. Footings distribute the weight of the structure over the ground. Raft foundation is a thick concrete slab reinforced with steel which covers the entire contact area of the structure like a thick floor. Sometimes area covered by raft may be greater than the contact area depending on the bearing capacity of the soil underneath. The reinforcing bars runs normal to each other in both top and bottom layers of steel reinforcement.

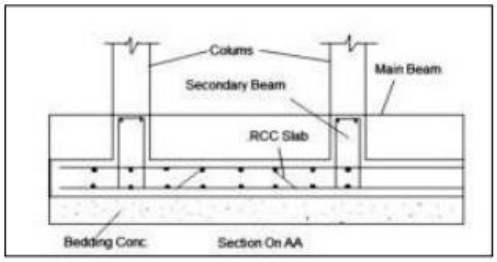


Fig. Raft Foundation.

iii. Grillage foundation: Grillage foundation is used when heavy structural loads from columns, piers or stanchions are required to be transferred to a soil of low bearing capacity. Grillage foundation is often found to be lighter and more economical. This avoids deep excavation and provides necessary area at the base to reduce the intensity of pressure within safe bearing capacity of soil.

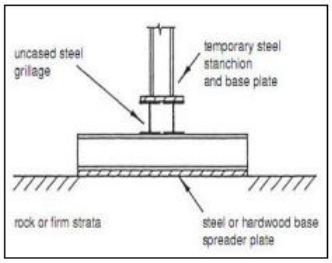


Fig. Grillage Foundation.

v. Pile foundation: A pile is basically a long cylinder of a strong material such as concrete that is pushed into the ground to act as a steady support for structures built on top of it.

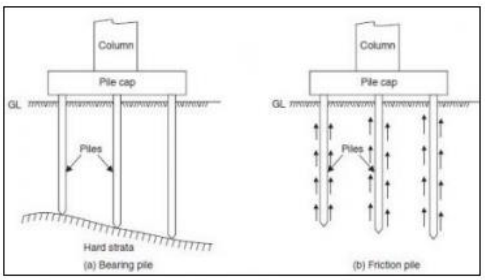


Fig. Pile Foundation.

Pile foundations are used in the following situations:

a) When there is a layer of weak soil at the surface. This layer cannot support the weight of the building, so the loads of the building have to bypass this layer and be transferred to the layer of stronger soil or rock that is below the weak layer.

b) When a building has very heavy, concentrated loads, such as in a high rise structure, bridge, or water tank.

QUESTION 4. Draw the sketches of Rocker bearing and Knuckle bearings used in bridges (Sum-22, Marks-4)

i. Rocker Bearing:

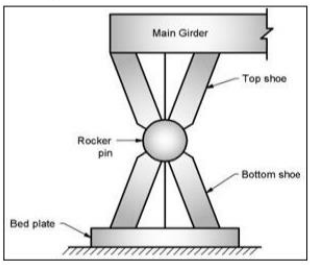


Fig. Rocker Bearing.

ii. Knuckle Bearing:

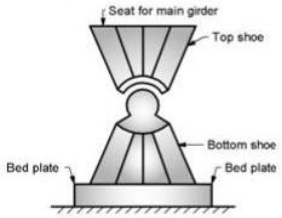


Fig. Knuckle Bearing.

QUESTION 5. State any four advantages and disadvantages of pressurised bridges. (Sum-24, Marks-4) (Sum-22, Marks-4)

Advantages of prestressed bridges:

i. Prestressed bridges have higher load carrying capacity.

ii. Fewer expansion joints. iii. Reduced deflection of girders.

iv. Lighter construction. v. More aesthetic appearance.

vi. More effective use of precast members. viii. Less cost of maintenance.

Disadvantages of prestressed bridge:

i. Use of high tensile steel results in high cost ii. Skill supervision required.

iii. Special equipment's are required. iv. Precast concrete bridges are especially suitable as urban highway bridges having long span.

QUESTION 6. Compare Temporary and Permanent bridges. Write any 4 points.

(Win-23, Marks-4) (sum-23, Marks-4) (Sum-22, Marks-4)

Sr.No	Points of Comparison Points of Comparison	Temporary Bridge	Permanent Bridge
01	Initial cost	Initial cost is low	Initial cost is high
02	Structural forms	These bridges are simple in their structural forms.	These bridges are simple as well as complex in their structural forms.
03	Skill required on construction	Less skill required for construction	More skill required for construction
04	Time required in construction	Require less time in construction	Require more time in construction
05	Load carrying capacity	These bridge can take light loads	These bridge can take heavy loads
06	Construction	Easy in construction	Difficult in construction
07	Suitability to traffic	Suitable for light traffic	Suitable for heavy traffic

QUESTION 7. Draw a labelled sketch of L-section of bridge showing its components.

(Sum-22, Marks-4)

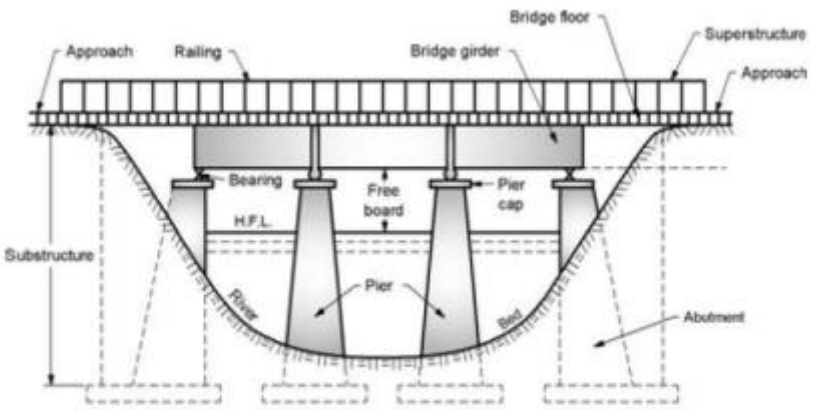


Fig. L-section of Bridge.

QUESTION 8. List different points to be observed for inspection of bridge.

(Sum-22, Marks-4)

Ans: The following points should be kept in view while inspecting a bridge:

i. Condition of wearing coat and its thickness. ii. Condition of kerbs and railings.

iii. Condition of expansion joints, whether functioning well or not in case of concrete bridge.

iv. Condition of concrete, whether in good condition or spalling in case of concrete bridge.

v. Condition of reinforcement, whether exposed anywhere or not in case of concrete bridge.

vi. Condition of paint in case of steel and iron bridge.

vii. Condition of steel work, material, members and connections in case of steel or iron bridge.

viii. Condition of material used in arches in case of arch bridge.

ix. Condition of masonry, whether good or weathered.

x. Condition of mortar joints in case of masonry arch bridge.

xi. Condition of bearings, whether functioning properly or not.

xii. Any sign of development of cracks in masonry or concrete immediately below the bearings.

QUESTION 9. Explain Pre- monsoon inspection of bridge. (Win-23, Marks-4)

(Win-19, Marks-4)

The Pre- Monsoon inspection shall cover the following points :

a) Any sign of settlement of Foundation. b) Check the condition of reinforcement.

c) Any sign of development of cracks in concrete abutments and piers.

d) Condition of paints. e) Condition of parapet walls.

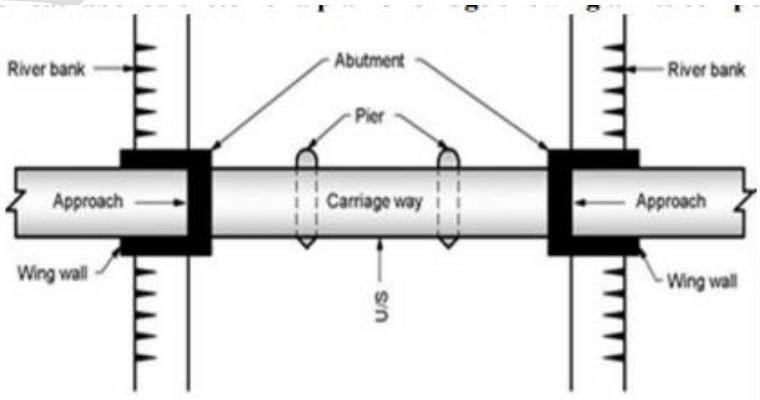
f) Condition of wearing coat and its thickness. g) Behaviour of expansion joints.

h) Any sign of scour along with maximum depth of scour.

i) Detailed inspection of steel works of girder.

j) Obstruction of water way. κ) Inspection of drainage system.

QUESTION 10. Draw a neat labelled sketch of a plan of bridge showing all its components (Win-23, Marks-4) (Win-19, Marks-4)



QUESTION 11.State the functions and requirements of a pier.(Win-19, Marks-4)

Ans: **Functions of piers:**

i) To divide the length of bridge into suitable number of spans.

ii) To transfer the load from bridge superstructure to subsoil through foundations.

Requirements of piers: 1. It should be easily and cheaply constructed.

2. It should be constructed of durable material.

3. It should have sufficient bearing area at its top to receive the bearings supporting the bridge girder.

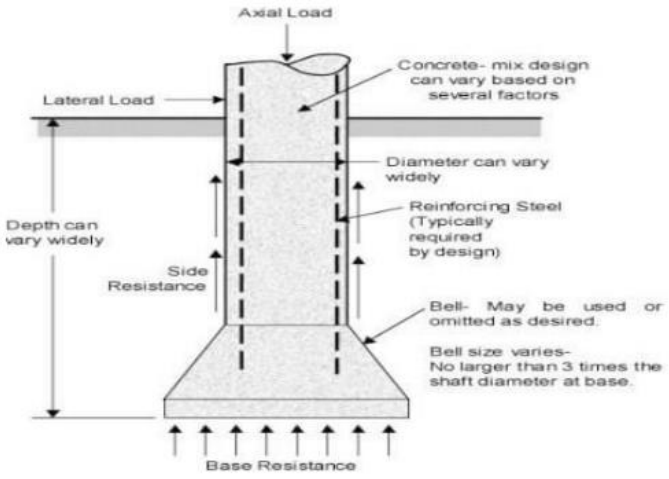
4. It should be stable against lateral and longitudinal thrust of water.

5. It should be strong enough to take loads.

6. It should involve less maintenance cost.

QUESTION 12. Describe in brief caisson foundation for a bridge with neat sketch. (Win-24, Marks-4) (Win-19, Marks-4)

Ans: **Caisson foundation:** A caisson foundation also called as pier foundation is a watertight retaining structure used as a bridge pier in the construction of a concrete dam or for the repair of ships. It is a prefabricated hollow box or cylinder sunk into the ground to some desired depth and then filled with concrete thus forming a foundation.



QUESTION 13. Explain in brief expansion bearing for steel girder bridge.

(Win-19, Marks-4)

Ans: Types of Expansion Bearing: 1. Sliding Plate Bearing 2. Deep cast with curve plate

3. Rocker bearing with curved base 4. Rocker & roller bearing

Types of Expansion Bearing:

1. Sliding Plate Bearing: It consists of sole plate which is provided between main girder and bed plate. It is the simplest type of expansion bearing.

2. Deep cast with curve plate: It consists of a sole plate which is fixed to underside of girder. The sole plate rests on a deep cast base with a curved bed plate

3. Rocker bearing with curved base: This is the type of rocker bearing. In this type of bearing, the bottom shoe is given a circular shape.

4. Rocker & roller bearing: It consists of a rocker pin which is provided between the top shoe and the bottom shoe. Bottom shoe rests on number of steel rollers.

QUESTION 14. Write the necessity of temporary bridge.(Win-23, Marks-2) (Sum-19, Marks-2)

Ans: I. these bridges help in facilitating the construction of permanent bridges.

II. When the bridges are required for shorter period or at the earliest time for temporary purpose.

III. Temporary bridges are required under emergency conditions.

IV. Temporary bridges are easy in construction and suitable for light traffic.

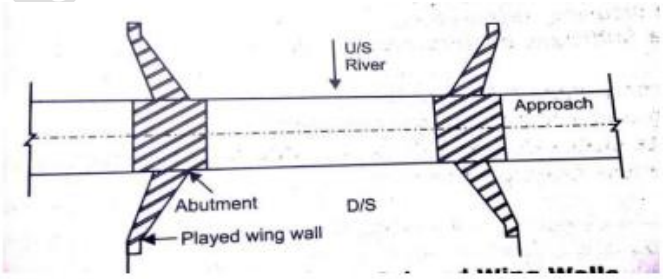
QUESTION 15. List the types of culverts (Win-19, Marks-2)

Ans: Types of culverts: 1. Arch culvert 2. Box culvert 3. Slab culvert 4. Pipe culvert

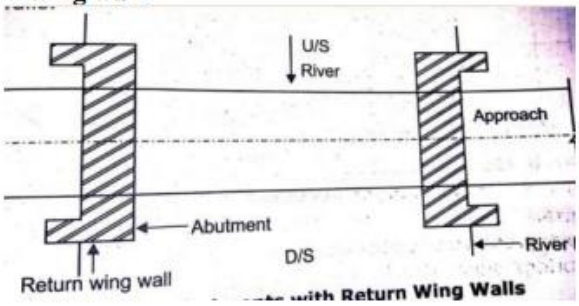
QUESTION 16 . Draw the labelled sketches of the following

i) Splayed wing wall **ii) Return wing wall** (Sum-19, Marks-2)

i) **Splayed wing wall**



ii) **Return wing wall**



QUESTION 17. Explain the sequential steps involved in bridge construction.

(Sum-24, Marks-4) (Sum-19, Marks-4)

Following are the steps involved in bridge construction

- Proposal:- Necessity of bridge hydraulic data collection
- Site selection
- Administrative approval
- Technical sanction
- Estimate
- Sanctioned estimate
- Design calculation
- Details of estimate
- Tendering process
- Soil testing
- Construction-substructure, super structure
- Completion report
- Open to traffic

QUESTION 18. Explain the functions of the following

i) Pier ii) Abutment iii) Bearing iv) Wing wall (Sum-24, Marks-4) (Sum-19, Marks-4)

Ans: **i) Functions of Pier:** 1) To divide the length of bridge into suitable number of spans.

2) To transfer the load from bridge superstructure to subsoil through foundations

ii) Functions of abutment : 1. To retain the earth pressure of embankment of the approaches.

2. To support the bridge superstructure and to transmit the load from itto the subsoil lying underneath.

3. To finish up bridge so that it can be put for use./ To provide finalformation level to the bridge superstructure

4. To transmit the reaction of superstructure to the foundation.

iii)Functions of bearings: 1. To distribute the load received over large area.

2. To allow for longitudinal expansion or contraction due to changesin the temperature.

3. To allow for angular movement at support due to deflection ofgirders.

4. To allow for vertical movement due to sinking of supports.

5. To transfer horizontal forces occurring due to application of brakesto the vehicle etc.

6. To keep the compressive stress within safe limits.

iv)The functions of wing walls are as follows:

1. To retain the earth banks of the river.

2. To protect the earth banks from the action of water.

QUESTION 19. Classify the bridges based on:

I. Span of bridge II. Purpose of bridge (Sum-19, Marks-4)

Ans: Classification of bridges according to span.

I. Culverts II. Minor bridges III. Major bridges IV. Long span bridge

Classification of bridges according to purpose:

I. Aqueducts II. Viaducts III. Foot Bridges IV. Highway Bridges V. Railway Bridges

QUESTION 20. Discuss suspension bridge with neat sketch.

(Sum-23, Marks-4) (Sum-19, Marks-4)

Ans: **Suspension bridge: -** The Bridge consisting of two or more cables hanging in a curve, which supports the roadways, are known as suspension bridges. They are used where it is difficult to adopt other type of bridges they are economically used for every large span. These are single span bridges having two main cables on each side of roadways.They are carried over solid piers and are securely anchored to the banks. The road way is suspended from two main cables by means of suspenders. Sometime two sides span are added besides the main central span.

The side spans rest either over a separate supported system or suspended from the back stays. Suspension bridges are not rigid the dip is usually taken as 1/10th of span.

The Advantages of Suspension Bridges

1. Cost effective and economical in construction. 2. Can be built up to great heights.

3. Spans great lengths. 4. Has flexibility for wind pressure and earthquake.

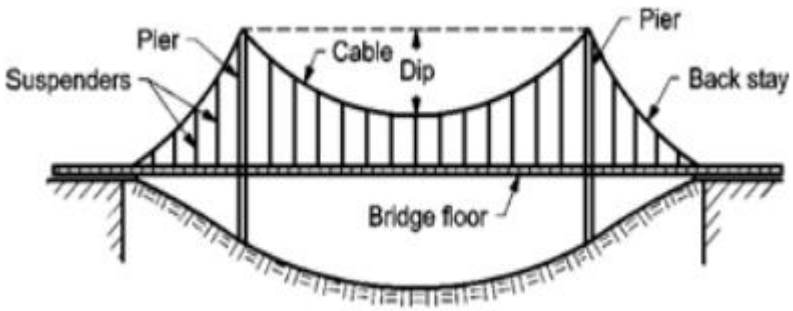
5. Simple in construction

Disadvantages of Suspension Bridges

1. Needs extensive foundation work for soft ground. 2. Too flexible for high speed winds.

3. Cannot support high traffic as very less support is available for deck.

4. Cannot withstand heavy load.



QUESTION 21. Discuss fixed and expansion bearing with their suitability.

(Sum-23, Marks-4) (Win-23, Marks-4)

Ans: **fixed Bearing:** The bearings which do not permit any longitudinal movement of the bridge girders are known as fixed bearing.

Usually angular movement or deflections of girders are allowed by fixed bearing.

Suitability: suitable for spans up to 12 m.

Tyoes of fixed bearing:

1- shallow and fixed plate bearings 2- Deep cast base bearings

3- Rocker bearings 4- Knuckle bearings

Expansion Bearings: The bearings which allow longitudinal movement of the bridge girders are known as Expansion or free bearing.

Types of expansion bearings:

1- Sliding plate bearing 2- deep cast base curved plate bearing

3- Rocker bearing with curved base 4- Rocker and roller bearings

QUESTION 22. Define the terms: i. Free Board ii. Economic span iii. Scouring iv. Afflux (Win-23, Marks-4)

Ans: **i. Free Board:** The difference between the highest flood level after allowing the afflux if any and the lowest point on the underside of the bridge superstructure is called free board.

iii. Economic span: The span for which the total cost of the bridge is minimum is known as economical span of a bridge.

iii. Scouring: The vertical cutting of river bed is called scour.

iv. Afflux: It is the rise in water surface of water – course, caused due to the obstruction by the bridge in the flow of water. OR The heading up of the water above its normal level while passing under the bridge is called afflux.

QUESTION 23. Describe high level and low level causeway.

(Sum-24, Marks-4) (Win-23, Marks-4)

High level Causeway: A high level causeway is submersible road bridge designed to be overtopped in floods, it is also known as submersible bridge.

Low level Causeway: The causeways having one or more vent provided under the roadway slab for passing the small discharge through them during dry season are known as low level causeway.