TVET CERTIFICATE IV in ROAD CONSTRUCTION

METAL BRIDGE CONSTRUCTION

RTCMB401

Perform metal Bridge Construction

Competence

Learning hours: 90

Credits: 9

Sector: Construction and Building Services

Sub-sector: Road construction

Module Note Issue date: August, 2020

Purpose statement

This is a core module which describes the performance outcomes, skills knowledge and attitude required to perform metal bridge construction which providing passage over the obstacle, usually something that can be detrimental to cross otherwise. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline

Table of Contents

	specifications	
	3.5. Proper fixing of bridge slab as per specification	

Total Number of Pages: 34

Learning Unit 1- Excavate for Foundation

1. Introduction to metal bridge

A bridge is a structure built to span a physical obstacle, such as a body of water (river), valley, road or railway without closing the way underneath.

It is constructed for the purpose of providing passage over the obstacle, usually something that can be detrimental to cross otherwise. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline.

Metal bridges are widely used around the world in different structural forms with different span length, such as highway bridges, railway bridges, and footbridges.

The main advantages of structural steel over other construction materials are its strength, ductility, easy fabrication, and rapid construction.

It has a much higher strength in both tension and compression than concrete, and relatively good strength to cost ratio and stiffness to weight ratio.

Basic Components and Parts of metal bridge Structures

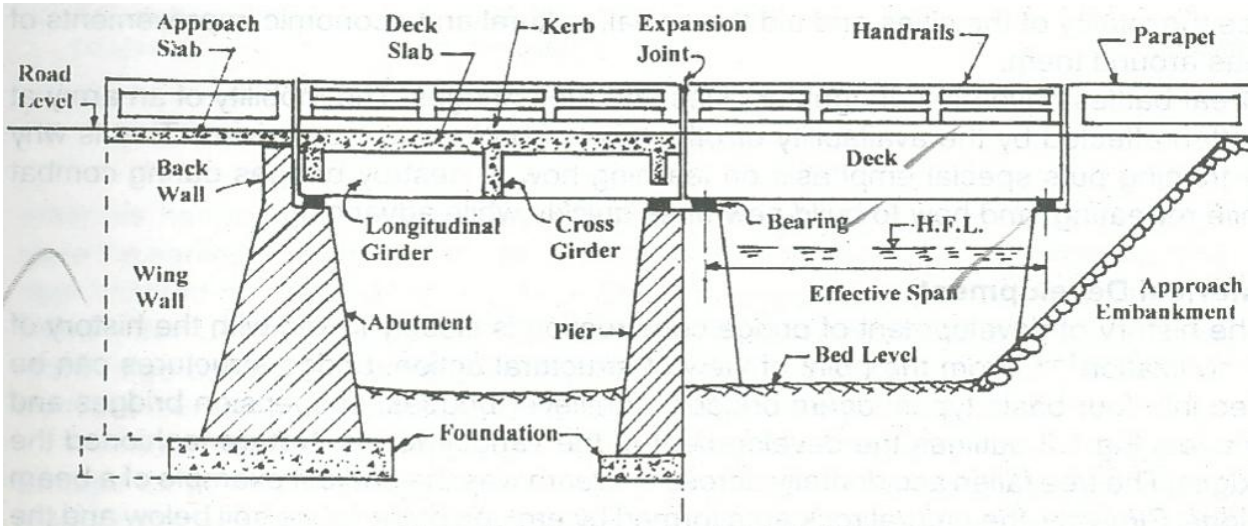


Figure 1.1 Components of a Typical Bridge.

The metal bridge structure consists of the three main components:

1. **Superstructure component:** the upper portion of the bridge above the beam seats where you drive or walk. The superstructure of the bridge structure consists of deck slab, girder, truss etc. These components vary based on the type of bridge (whether concrete or steel or composite). Superstructure of the bridge bears the load passing over it. This helps in transmitting the forces formed by the loads to the below substructures.

Includes:

- Beams
- Bearings
- Curbs
- Deck
- Deck wearing surface
- Floor beams
- Girders
- Parapets
- Sidewalks
- Trusses

2. Bearings components: The loads received by the decks are properly and safely transmitted to the substructure with the help of bearings. These are components of bridge that enables even distribution of load on the substructure material. This transmission is very essential in situations where the substructure is not designed to take the load action directly

3. Substructure Components: The substructure is under the superstructure and supports all of the bridge loads.

The components involved in substructure of bridges are:

- Piers
- Abutments
- Wing Walls and the Returns
- Foundation

LO 1.1 – PREPARE MATERIALS, TOOLS, EQUIPMENT AND WORKPLACE

Topic: Description the elements of metal bridge foundation

1.1.1. Identification of metal bridge foundation elements

A.Pile

Pile foundations are deep foundations. They are formed by long, slender, columnar elements typically made from steel or reinforced concrete, or sometimes timber. A foundation is described as 'piled' when its depth is more than three times its breadth.

A reinforced concrete slab or block which interconnects a group of piles and acts as a medium to transmit the load from wall or column to the Piles is called a Pile Cap. The capping beam should be kept clear of the ground where the purpose of the piles is to overcome the problem of the subsoil swell and shrinkage.

B.Pier

The piers are vertical structures used to support deck or the bearings provided for load transmission to underground soil through foundation. These structures serve as supports for the bridge spans at intermediate points.

The pier structure has mainly two functions:

- Load transmission to the Foundation
- Resistance to the horizontal forces

Most of the cases, piers are designed to resist the vertical loads alone. In areas which lie in the seismic zone, it is recommended to design the pier for lateral loads also.

Most of the piers are constructed using concrete. Steel for the construction of pier is used in very few cases till now. Use of composite columns i.e. steel columns filled with concrete is used as new technology of pier construction.

The pier is a vertical member that resist the forces by means of shear mechanism. These forces are mainly lateral forces. The pier that consist of multiple columns are called as bent.

Types of Piers in Bridge Construction

There are different types of piers based on the structural connectivity, the shape of the section and the framing configuration.

- Based on the structural connectivity, the pier can be classified as monolithic or cantilevered.
- Based on the shape of the section pier can be classified as solid or hollow, hexagonal, round or octagonal or rectangular.
- Based on the framing configuration the pier can be classified as single or multiple column bent, hammerhead or pier wall type.

C.Abutments

Abutments are vertical structures used to retain the earth behind the structure. The dead and the live loads from the bridge superstructure is supported by the bridge abutments.

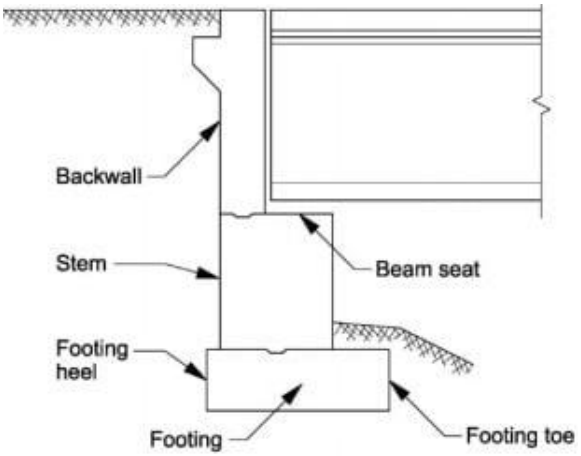
The abutments are also subjected to lateral pressures mainly from the approach embankment. The design loads on the abutment is mainly dependent on the:

- Type of abutment selected
- The sequence of construction

As seen from the above figure, the abutments have the design requirements similar to retaining walls as well as in pier construction. The abutments are primarily designed to resists the overturning and sliding. More focus is on the stability of the whole system.

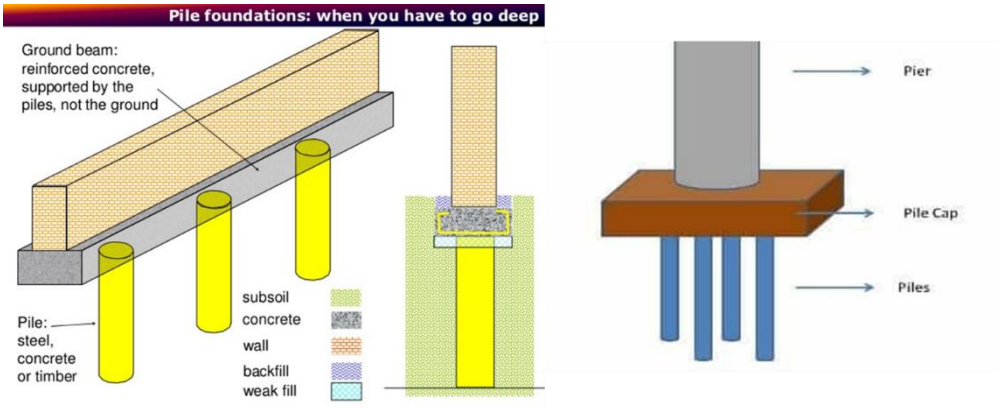
The special care has to be provided for the foundations of abutments. The abutment foundation must overcome the problems of differential settlement and excessive movements caused due to lateral forces or loads.

The below figure shows the components of abutments.



D.Pile cap

A reinforced concrete slab or block which interconnects a group of piles and acts as a medium to transmit the load from wall or column to the Piles is called a Pile Cap.



1.1.2. Materials used in excavation of metal bridge foundation

1. **Fuel**

A fuel is any material that can be made to react with other substances so that it releases energy as heat energy or to be used for work.

The heat energy released by reactions of fuels is converted into mechanical energy via a heat engine.

2. **Lubricants**

A lubricant is a substance which you put on the surfaces or parts of something, especially something mechanical, to make the parts move smoothly. In bridge construction, lubricant is used in different parts of some equipment to avoid friction.

3. **Caisson/formwork**

A caisson is a watertight retaining structure used, for example, to work on the foundations of a bridge pier, for the construction of a concrete dam. These are constructed such that the water can be pumped out, keeping the working environment dry.

Formwork is the term used for the process of creating a temporary watertight mould into which concrete is poured and formed. Traditional formwork is fabricated using timber, but it can also be constructed from steel, glass fibre reinforced plastics and other materials.

Installation

To install a caisson in place, it is brought down through soft mud until a suitable foundation material is encountered. While bedrock is preferred, a stable, hard mud is sometimes used when bedrock is too deep.

Requirements of good caisson /formwork

- The following requirements should be satisfied by good formwork:
- Strong enough to withstand dead and live loads.
- Capable of retaining its shape by being efficiently propped and braced horizontally and vertically.
- Joints should prevent leakage of cement grout.
- Should be capable of being removed in various parts without damaging the concrete.
- Material used to be suitable for reuse.
- Should be set accurately to the desired line.
- As lightweight as possible.

1.1.3. Equipment used in excavation of foundation

- **Excavators:** hydraulic excavators are widely used in earthmoving or digging the foundations for bridge .

- **Backhoe**:Is the excavating equipment consisting of a piece of digging bucket on the end of an articulated arm,backhoe is used to move earth during excavation of foundation

- **Bulldozers, Graders:**Is tractor equipment with an attached blade for pushing earth and surface grading during for excavating bridge foundation .
- **Wheel Tractor Scraper**:Is the excavator equipment used to transport the earth after digging the earth during bridge foundation works.
- **Trenchers:**Is the equipment used for digging the trenches.
- **Loaders:**Is the transport equipment used to transport(charge)excavated earth from one area to others

1.1.4. Types of tools used in excavation of foundation

a) **Cutting tools:**It is a sharp edged wedged small machine or device used to remove or cut excess materials like to reduce metal dimensions during excavation of metal bridge. Example: hack saw.
b) **excavating tools**:Are tools or small machine used to dig the earth during excavation of foundation.
Example:hoe
c) **Tape measure**:Is the flexible ruler used to measure size,dimension and distance on the given works.this measuring tools are used for taking dimensions before starting foundation excavation.
d) **Warning tape**:Is the tools used to provide a visual barricade to block off designed area,this tape is used to block where metal bridge works take the place.

1.1.4. Preparation of workplace step

1.Demarcation of work area: This the act of establishing limits or boundaries of working place.

2.Addressing of obstacles: Giving a full information about what happen.

3. Positioning signs for safety measures

The use of symbols and graphical images is a simple safety system used to convey safety messages at a glance.

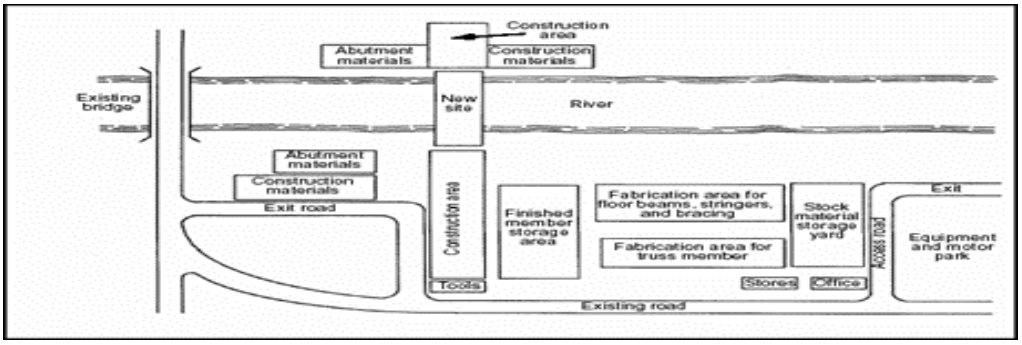
Colours and symbols appropriately used can provide information and warnings of hazards which are essential to safety at work, and in some instances may be independent of language.

4.Site installation: is the process of interpreting construction plans and marking the location

of proposed new structures such as roads or buildings. Construction staking is performed to ensure a project is built according to engineering design plans

Why is a site layout important?

Site layout and organization are important management functions which influence all aspects of work on a construction site - from construction methods and sequence to health, safety, and productivity.



LO 1.2 – SET OUT FOUNDATION

Topic : Explanation of the set out of foundation for metal bridge

1.2.1 Set out foundation

It is the process of developing the physical positions of corners and walls (abutment, pier) of a bridge, and it's done by transferring dimensions from the layout plan (also called as setting out plan, demarcation plan) to the ground.

It is a process of transferring the distance from the plan already prepared, to the ground before starting the construction. The plan as designed and prepared is set out on the ground in the correct position.

1.2.1. Interpretation of drawing

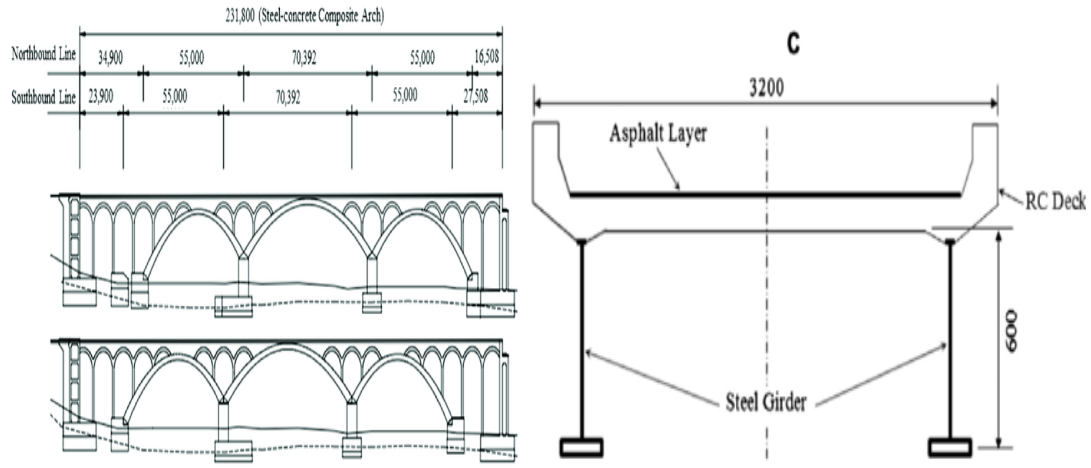
Interpretation in drawing is bending some of the rules, once you know them, to fit your own artistic style.

A. Dimensioning

A DIMENSION is a numerical value expressed in appropriate units of measurement and used to define the size, location, orientation, form or other geometric characteristics of a part.

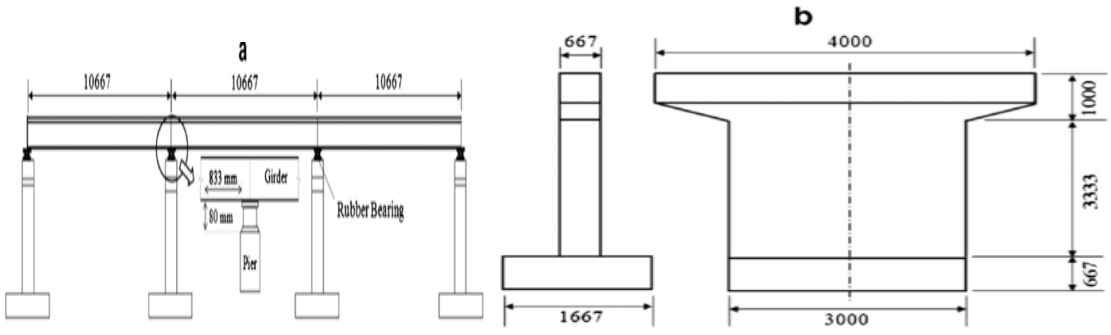
B. Views

This is an overall elevation view showing the general appearance, grade and type of structure to be built. Number spans and bents to agree with the plan view.



C. Section

A "Typical Deck Section" is a transverse cross -section of the superstructure showing the deck, girders, curbs and railing or parapets, if any. Required dimensions include the out-out width of the structure, roadway width, girder spacing, the location of these with respect to the designated alignment centerline and the deck thickness, reinforcement bends and bar spacing and clearances.



D. Verification

- The functioning of the structure or structural members under normal use.
- The comfort of people.
- The "appearance" of the construction work. This is related with such criteria as high
- Deflections and extensive cracking, rather than aesthetics.

- ❖ Stress limitation,
- ❖ Deformations: deflections and vibrations

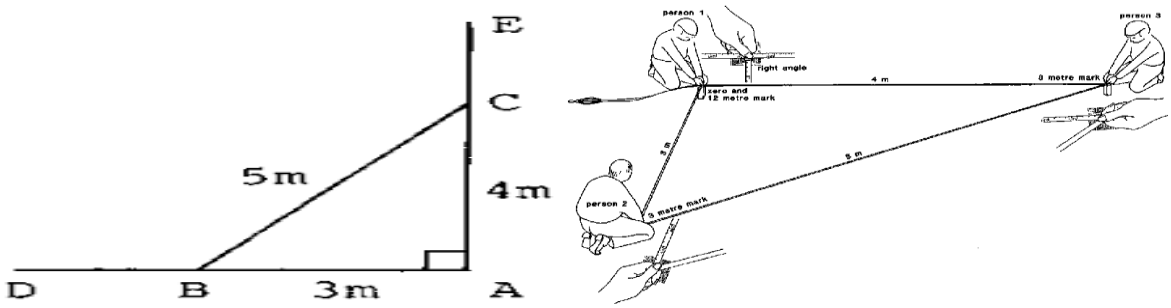
1.2.2. Setting out of the site datum

Datum is an abstract coordinate system with a reference surface (such as sea level) that serves to provide known locations to begin surveys and create maps. In this way, datum act similar to starting points when you give someone direction.

The Datum used to establish the elevations shown on the drawing should be indicated.

1.2.3. Introduction on 3-4-5 method

Understand the 3-4-5 method. If a triangle has sides measuring 3, 4, and 5 feet (or any other unit), it must be a right triangle with a 90º angle between the short sides. If you can "find" this triangle in your corner, you know the corner is square. This is based on the Pythagorean Theorem from geometry: $A^2 + B^2 = C^2$ for a right triangle. C is the longest side (hypotenuse) and A and B are the two shorter "legs." 3-4-5 is a very convenient measurement to check because of the low, whole numbers. The math checks out: $3^2 + 4^2 = 9 + 16 = 25 = 5^2$



1.2.4. Marking of the profile positions

The profiles are positioned well away from the proposed excavations to allow an adequate working space. This is even more important when the excavations are to be carried out by a mechanical means. While setting up profiles, it is essential that they are as level as possible. This avoids inaccuracies when re measuring the walls and diagonals before commencing work.

Procedures to consider while marking the dimension on the ground

- ♦ checking Measurements
- ♦ marking the position of pegs
- ♦ Fixing of the pegs
- ♦ Fixing profile board
- ♦ Fixing of building line

The following points should be observed while setting out trenches:

1. In order to set out foundation plan, nails, pegs, profiles, strings, and lime are used.
2. In order to correctly determine the position of trenches, the sight rails have to be properly erected at the corners of the building.
3. Accurate center lines or axial lines can be determined and marked by using a theodolite.
4. To the nails or pegs on the profiles, strings are tied and stretched to achieve horizontal control of dimensions.
5. At a distance of 1 meter from the edges of excavation vertical reference pillars are erected. Hence vertical control is achieved during building construction.
6. A standard datum is previously determined and marked by the surveyor, based on which the levels on the site are obtained. The depth of trenches and other levels should also be regulated by measurements from this point.
7. Before placing the concrete into the trenches, the bottom must be properly rammed and compact.
8. The width is marked by means of lime powder when the excavation is performed by hand. These markings give accurate cutting.
9. Centreline is marked when the excavations are performed by a machine

LO 1.3 – EXCAVATE FOR FOUNDATION

Topic: discussion of the excavation for foundation of metal bridge

In the metal bridge construction, excavation consists of using tools, equipment, or explosives for the purposes of moving soil, rocks, or other materials.

Excavation is undertaken for a number of purposes, and different types of excavation are classified either by their specific purpose or the type of material being excavated.

Below are twelve common types of excavation, by both type and material.

Bridge, Borrow, Channel, Drainage/Structure, Dredge, Earth, Footing, Muck, Roadway, Rock, Topsoil, Underground.

1.3.1. Earth Excavation Method

1. **Manual**

In construction terms, excavation is the process of removing earth to form a cavity in the ground. On small sites or in confined spaces, excavation may be carried out by manual means using tools such as: **Warning tape, Tape measure, Pickaxe, Hoe, Fork hoe, Hummer, Spade, Levels, Pang, Axes.**

2. **Mechanical**

Through this Excavation is done by using mechanical equipment such as: **Jack hummer, Boring machine, Excavator machine, Compactor machine, Backhoe and Wheel loader**

L.O 1.4 – INSTALL GROUND SUPPORT

Topic: Description of the installation of ground support for metal bridge

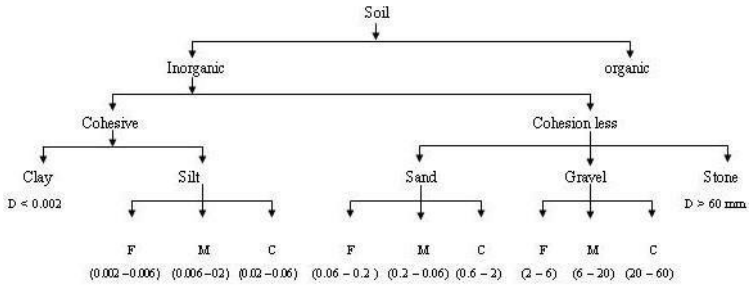
1.4.1. Requirements of soil protection:

a. Cohesive soil

Cohesion as the word itself denotes, is the attraction between particles of same type/origin/nature. Hence cohesive soil is a type of soil where there is inter-particular attraction. Clay is a very good example for a cohesive soil.

b. Non cohesive soil

Non-cohesive soil as the name indicates do not have cohesive forces. They are comparatively coarser particles with self-weight governing their behaviour. The particles have internal friction and their shear strength depends upon the angle of internal friction between particles. Sand is a typical example. Exclusively non-cohesive soils will have zero cohesion.



The size of particles in mm
Fig. (1) : Classification of Soil

c. Slope of existing soil

The slope of the soil is an important soil property to consider when building or planting. The slope gradient is the angle of incline or decline, expressed in the percent of rise or fall of the soil surface from horizontal over a distance of 100feet. Soil slope affects the flow of water that can erode the soil.

1.4.2. Protection of wall

What is retaining wall and types? A retaining wall is a structure designed and constructed to resist the lateral pressure of soil, when there is a desired change in ground elevation that exceeds the angle of repose of the soil. A basement wall is thus one kind of retaining wall.

A retaining wall is a structure that holds or retains soil behind it. There are many types of materials that can be used to create retaining walls like concrete blocks, poured concrete, treated timbers, rocks or boulders.

1.4.3. Classification of ground supports:

- **Temporary support:** this is used to provide a short-term support only during construction and removed at the completion of the structure.

- **Permanent support:** this is used to provide a long-term support not only during construction but also during service life of the structure.



Learning Unit 2- Construct for Foundation

LO 2.1 – PREPARE MATERIALS, TOOLS, EQUIPMENT AND WORKPLACE

Topic: explanation of materials, tools and equipment used in construction of metal bridge foundation

2.1.1. Materials used in construction of metal bridge foundation

1. **Concrete:** Concrete is commonly used for many bridge superstructure members such as decks, pre-stressed concrete beams, curbs, sidewalks and parapets (side traffic barrier walls).
2. **Steel:** Steel is commonly used in the bridge superstructure for armoring expansion joints, beams, bearings, floor beams, girders, reinforcing bars in concrete, traffic barriers and trusses.
3. **Stone:** Stone was commonly used for building the abutments and piers in the 1940's and earlier. This is particularly true where local field stone was readily available.
4. **Asphalt:** Asphalt is the material that has been used extensively for the wearing surfaces on corrugated metal decks, timber decks and concrete decks in Harford County.
5. **Iron:** Iron was used typically in beams and trusses that were built before 1900. Steel replaced iron because it has more tensile strength than iron and is less brittle.
6. **Timber:** Timber is used for several decks and traffic barriers. It is also used for the beams on one bridge and the abutments and piles on another bridge.
7. **Aluminum:** is sometimes used in fabricating bridge railings.
8. **Rubber:** Rubber and synthetic rubber products are used for bearings and for expansion joint material.
9. **Fuel**: is any material that can be made to react with other substances so that it releases energy as heat energy or to be used for work.

The heat energy released by reactions of fuels is converted into mechanical energy via a heat engine.

10. **Lubricants:** is a substance which you put on the surfaces or parts of something, especially something mechanical, to make the parts move smoothly. In bridge construction, lubricant is used in different parts of some equipment to avoid friction.
11. **A caisson** is a watertight retaining structure used, for example, to work on the foundations of a bridge pier, for the construction of a concrete dam. These are constructed such that the water can be pumped out, keeping the working environment dry.

2.1.2. Equipment used in construction of concrete bridge foundation

Concrete work equipment:

a) Steel bender
b) Straightening machines
c) Cutting machine
d) Vibrating machine
e) Compactor
f) Concrete mixer

2.1.3. Tools used in construction of metal bridge foundation

A.Selection of tools:

a) Vice
b) Pliers
c) Pincers
d) Hacksaw
e) bar bender
f) tape measure
g) spades
h) hammer
i) trowel
j) saw

B. Cutting machine

a)Vice
b)Pliers
c)Pincers
d)Hacksaw
e)bar bender
f)tape measure

2.1.4. Preparation of workplace steps:

1. Positioning signs for safety measures
2. Demarcation of work area
3. Clearance of work area
4. Site installation

L.O.2.2- MAKE FORM WORK

Topic: Description of the formwork used in metal bridge works

Formwork is a temporary or permanent moulds into which concrete or similar materials are poured.

2.2.1. Setting out of form work

The formwork for the unit to be casted should be positioned within its proper position by considering the following important elements:

a) Measurement: dimensions should be respected as it is indicated according to the drawing.

b) Checking angle: after making the formwork according to the drawing, angles for every corner should be checked to prevent errors

2.2.2. Shuttering assembling

a) **Measurement**: shuttering Formworks are measured in terms of area, But generally, square meter and square foot of the contact area with concrete is taken as the unit of measurement. The dimensions of a formwork should be measure correct to the centimeter or inches whichever the case may be

b) Adjustment: Adjust the column widths so that can view all columns on the screen without scrolling. Not see some column headers in their entirety if their full text doesn't fit in the reduced column width, but making this adjustment will give you the ability to view all the columns.

c) **Supporting:** Formwork is typically supported by several levels of shores that carry the loads until the concrete gains enough strength to support its own weigh

2.2.3. Techniques of fixing Pranks/boards

a) Screwing: A short, slender, sharp-pointed metal pin with a raised helical thread running round it and a slotted head, used to join things together by being rotated so that it pierces wood or other material and is held tightly in place.

b) Nailing: A slim, pointed piece of metal hammered into material as a fastener

L.O.2.3- MAKE FRAMEWORK

Topic: Description the framework used for metal bridge

Framework is the arrangement of the supports or components that represent the general shape and size of the structural elements.

2.3.1. Interpretation of framework drawings

a) Dimension
b) Scale
c) Symbols

2.3.2. Cutting of Steel bars

a) **Manual cutting:** Is the techniques of cutting steel bars by using hand tools or small machine during metal bridge works construction. The main purpose of cutting steel bar is to obtain the required dimensions.

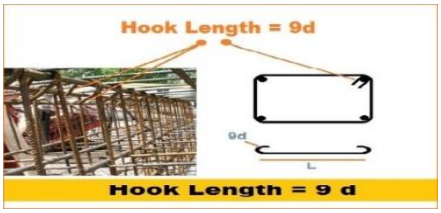
   Example: Hacksaw

b) **Mechanical cutting**: Is the techniques of cutting steel bars by using powered machine or big machine during metal bridge works construction.

   Example: circular saw

2.3.3. Bending of steel bars

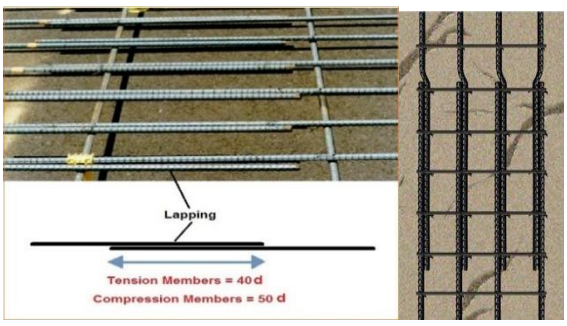
a. Hooks is defined as steel bent into a curved shape,typically with one end free and the other end secured to a rope or other attachment.

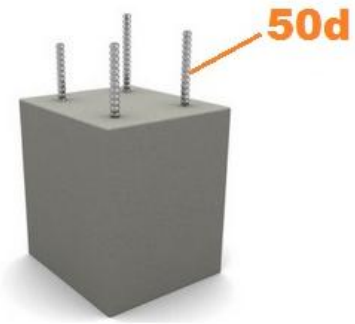


b.overlap

During placing the steel in RC structure if the required length of a bar is not sufficiently available to make a design length then lapping is done. Lapping means overlapping of two bars side by side to achieve required design length.

Lap length for tension members = 40d, Lap length for compression members = 50d., d = Diameter of bars.





2.3.4. Tying of steel bars

a) **Fixing of support bars:** fixing option for a support bar providing positioned at either end of the bar with a maximum centers.

b) **Tying of distribution reinforcements:** can be used to improve anchorage of the tie reinforcement bars, Compressive strut by avoiding the undesirable distribution of diagonal compression, are provided to resist the shear stress, cracks developed in the longer span.

L.O.2.4- CAST CONCRETE

Topic: Description of the cast concrete used in metal bridge works

Concrete is an intimate mixture of binding material, fine aggregate, coarse aggregate and water. This can be easily moulded to desired shape and size before it loses plasticity and hardens.

Major ingredients of concrete are:

1. Binding material (like cement, lime, polymer)
2. Fine aggregate (sand)
3. Coarse aggregates (crushed stone, jelly)
4. Water.
5. A small quantity of admixtures like air entraining agents, water proofing agents, workability agents etc.

2.4.1. Concrete mixing

1. Mixing ratio: Is defined as amount of concrete components mixture used to make a concrete.

2. Mixing

To produce uniform and good concrete, it is necessary to mix cement, sand and coarse aggregate, first in dry condition and then in wet condition after adding water.

The following methods are practiced:

a) Hand Mixing
b) Machine Mixing.

(a) Hand Mixing: Required amount of coarse aggregate for a batch is weighed and is spread on an impervious platform. Then the sand required for the batch is spread over coarse aggregate. They are mixed in dry condition by overturning the mix with shovels. Then the cement required for the batch is spread over the dry mix and mixed by shovels. After uniform texture is observed water is added gradually and mixing is continued. Full amount of water is added and mixing is completed when uniform colour and consistency is observed. This method of mixing is not very good but for small works it is commonly adopted.

(b) Machine Mixing: In large and important works machine mixing is preferred. Required quantities if sand and coarse aggregates are placed in the drum of the mixer. 4 to 5 rotations are made for dry mixing and then required quantity of cement is added and dry mixing is made with another 4 to 5 rotations. Water is gradually added and drum is rotated for 2 to 3 minutes

during which period it makes about 50 rotations. At this stage uniform and homogeneous mix is obtained.

2.4.2. Setting time of concrete

1.Initial setting time: is the time when the paste starts losing its plasticity. Initial setting time test is important for transportation, placing and compaction of cement concrete. Initial setting time duration is required to delay the process of hydration or hardening.

2.Final setting time: is the time when the paste completely loses its plasticity. It is the time taken for the cement paste or cement concrete to harden sufficiently and attain the shape of the mould in which it is cast. The Final Setting Time is 600 minutes (10hrs)

2.4.3. CONCRETE VIBRATION

Vibration of concrete is carried out for the sake of consolidation. The main objective of vibration is to compact the concrete and to achieve the maximum possible density of concrete. Almost 5 to 8% by volume of freshly placed concrete in the form is occupied by air bubbles.

A concrete vibrator is a construction tool typically used on concrete pouring sites. These machines and an assortment of attachments are designed for multiple

applications built by a variety of manufacturers. The vibrators are used to ensure that the pour is free of air bubbles and are even.

2.4.4. Types of Concrete Vibrators

Concrete particles are different sizes and it is best to use vibrators that have different speeds. Vibrators that are used for compacting concrete are many times referred to as poly-frequency vibrators. These are best used for compacting concrete that is of stiff consistency. The frequencies of vibration used are from between 2800 to 15000 rpm. 4 different types of concrete vibrators used for compaction are described in brief below.

1. Needle Vibrators

These are also known as immersion vibrators. It has a steel tube, called a poker, with one end being closed and rounded. There is an eccentric vibrating element inside it. The poker is connected to an electric motor, sometimes a diesel motor, through a flex tube.

These needle vibrators come in a variety of sizes from 40 to 100 mm in diameter. The poker's diameter is determined by the spacing between the reinforcing bars in the form work. The general range of vibrations for a needle vibrator is between 3000 to 6000 rpm. The period of vibration necessary can be from 30 seconds to 2 minutes and the concrete should be placed in layers no more than 600mm high

2.Shutter Vibrators

A shutter vibrator is also called an external vibrator and is clamped rigidly to the form work at pre-determined points. This allows for the form and concrete to be vibrated. They are more powerful for a given compaction than an internal vibrator.

These vibrators operate at a frequency of around 3000 to 9000 rpm and an acceleration of 4g. The shutter vibrators are used more often for precasting of thin sections that do not have the thickness needed for internal vibrators.

3.Surface Vibrators

Surface vibrators are placed on the concrete mass and are best used for the compaction of shallow elements. These should not be used when the depth of the concrete is more than 250mm.

Mixes that are extremely dry can be most effective compacted using surface vibrators. There are two surface vibrators that are most commonly used: pan vibrators and vibrating screeds. Operating frequency for these vibrators is generally 4000 rpm. The best use for surface vibrators includes small slabs that do not exceed 150mm in thickness

4. Vibrating Table

A vibrating table is a rigidly built steel platform that is mounted on flexible springs. It is driven by an electric motor. A vibrating table has a normal frequency of 4000 rpm

2.4.5. Concrete defects

1.Segregation: Segregation can be defined as separating out of the ingredients of concrete mix so that mix is no longer in homogeneous condition. Only stable homogeneous mix can be fully compacted.

2.Bleeding: This refers to the appearance of the water along with cement particles on the surface of the freshly laid concrete. This happens when there is excessive quantity of water in the mix or due to excessive compaction.

3.Laitance: an accumulation of fine particles on the surface of fresh concrete due to an upward movement of water (as when excessive mixing water is used).

causes segregation of concrete

➢ Poorly graded aggregate & excessive water content is the major cause of segregation.

➢ A badly proportioned mix, where sufficient matrix is not there to bond and contain the aggregate cause aggregates to settle down.

➢ Insufficiently mixed concrete with excess water content shows a higher tendency for segregation.

➢ When height of dropping of concrete is more (ex. In case of concreting long column) it will result in segregation.

➢ If a mixer used for mixing concrete is badly designed or a mixer with worn out blades, then the concrete shows a tendency for segregation.

➢ If a high slump concrete or pumpable concrete are not compacted with sufficient care then it is likely to result in segregation of concrete.

➢ Immediate working on the concrete on placing, without any time interval is likely to press the coarse aggregate down, which results in movement of excess matrix or paste towards the surface, resulting segregation.

➢ Chances of segregation are more when concrete is to be placed under water.

➢ Segregation also increases when concrete is placed in heavily reinforced concrete members

2.4.6. Concrete curing technique

Curing may be defined as the process of maintaining satisfactory moisture and temperature conditions for freshly placed concrete for some specified time for proper hardening of concrete. Curing in the early ages of concrete is more important. Curing for 14 days is very important. Better to continue it for 7 to 14 days more.

The concrete hardens because of hydration. The chemical actions, which accompany the setting of concrete, are dependent on the presence of water. It improves properties of concrete such as water-tightness, wear resistance, strength, volume stability and durability.

Concrete curing technique

(a) water curing: Walls, columns, plastered surfaces are cured by sprinkling water.

(b) Membrane curing: Columns and other vertical surfaces may be cured by covering the surfaces with wet gunny bags or straw.

(**c) Master cure or Chemical curing:** Compounds like calcium chloride may be applied on the curing surface. The compound shows affinity to the moisture and retains it on the surface. It keeps the concrete surface wet for a long time.

L.O.2.5-CONSTRUCT ABUTMENT

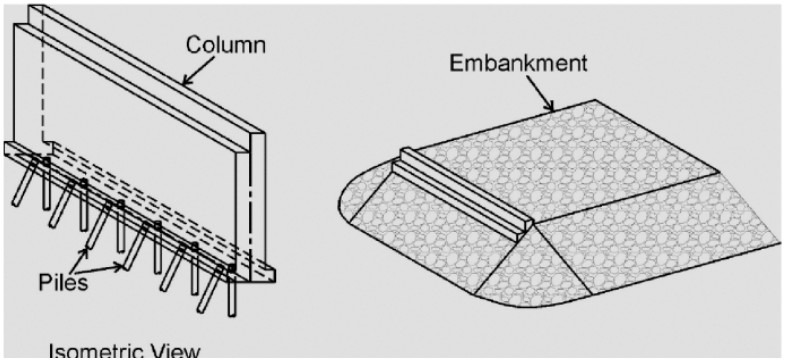
2.5.1. Interpretation of abutment drawings

The construction of abutment is based on interpretation of drawings and analysis the following items: ✓ Dimension

- ✓ Scale
- ✓ Symbols

In engineering, abutment refers to the substructure at the ends of a bridge span or dam whereon the structure's superstructure rests or contacts.

It is usual for the top width of the earth fill embankment to accommodate minimally a road width of 7.22m plus two shoulders of width 8ft (2.41m), giving an overall top width of 40ft (12.04m). the side-slopes of earth fill approach embankments commonly are set at 2H:1V, through slopes range from about 2H:1V to 3H:1V



An abutment may be used for the following:

1. To transfer loads from a superstructure to its foundation elements
2. To resist and/or transfer self-weight, lateral loads (such as the earth pressure) and wind loads
3. To support one end of an approach slab
4. To maintain a balance in between the vertical and horizontal force components of an arch bridge.

2.5.2. Types of abutment according to the common material of construction

a) **Concrete abutment**: Is the type of abutment composed of the mixtures of cement, sand,gravel,water and admixtures
b) **Masonry abutment**: Is the type of abutment which composed of stones or bricks.

Types of abutments: According to standard specifications, the abutments are categorized as follow

a) **Gravity abutment**, resists horizontal earth pressure with its own dead weight
b) **U abutment**, U-shaped gravity abutment
c) **Cantilever abutment**, cantilever retaining wall designed for large vertical loads
d) **Full height abutment**, cantilever abutment that extends from the underpass grade line to the grade line of the overpass roadway
e) **Stub abutment**, short abutments at the top of an embankment or slope, usually supported on piles
f) **Semi-stub abutment**, size between full height and stub abutment
g) **Counterfort abutment**, similar to counterfort retaining walls
h) **Spill-through abutment**, vertical buttresses with open spaces between them

Pile bent abutment, similar to spill-through abutment

2.5.3. Erection of abutment walls

How to choose perfect abutments: On the basis of the following factors: -

a) Construction and maintenance cost
b) Cut or fill earthwork situation
c) Traffic maintenance throughout construction
d) Construction period
e) Protection of construction workers
f) Accessibility and cost of backfill material
g) Superstructure depth
h) Size of abutment
i) Horizontal and vertical alignment alterations
j) Area of excavation
k) Attractiveness and conformity with adjoining structures
l) Prior knowledge with the type of abutment
m) Ease of use for assessment and maintenance.
n) Predicted life, loading condition, and acceptability of deformations.

L.O.2.6- CLEAN TOOLS, EQUIPMENT AND WORKPLACE

Topic: Identification of methods of cleaning tools and equipment

2.6.1.A. Methods of cleaning tools and equipment

1. Wet method: Is the method of cleaning tools and equipment after or before work by using water and oil

2. Dry method: Is the method of cleaning tools and equipment after or before work by using brush and air compressor. This is the best method used to avoid rust which can damage the tools and equipment.

B. Methods of cleaning work place

We don't have to remain the working area dirty, we have to clean the workplace after construction activities. The following are the different methods used to clean the working area: cleaning workplace by using water, by brush and by air compressor.

2.6.2. A. Storing tools and equipment procedures:

✓ Selection of area for storing tools and equipment
✓ Prioritize tools and equipment
✓ Divide tools and equipment
✓ Discard unused tools and equipment

Importance of proper storage of tools and equipment

1. Improve safety and health of the employees
2. Improves appearance of construction areas
3. Reduces overall tool cost through maintenance
4. It ensures that tools are in good repair at hand

Learning Unit 3 – Construct Bridge Superstructures

LO 3.1 – PREPARE MATERIALS, TOOLS, EQUIPMENT AND WORKPLACE

Topic : Identification of materials,tools,equipment and steel section used in construction of metal bridge superstructure

The bridge superstructure is the upper portion of the bridge above the beam seats where you drive or walk. The superstructure of the bridge structure consists of deck slab, girder, truss etc. These components vary based on the type of bridge (whether concrete or steel or composite). Superstructure of the bridge bears the load passing over it. This helps in transmitting the forces formed by the loads to the below substructures.

3.1.1. Materials used in construction of metal bridge superstructure

a) **Steel:** Is commonly used in the bridge superstructure for armoring expansion joints, beams, bearings, floor beams, girders, reinforcing bars in concrete, traffic barriers and trusses.

b) Bolts:consist of a head and cylindrical body with screw threads along a portion of its length which is used to fix the traffic barriers for metal bridge.

c) **Nuts** is fastener material with threaded hole which used to fix rails or traffic barriers for metal bridge.

d) **Cutting disc**:Are made from solid abrasive disc which are used for cutting metal or steel used for construction of metal bridge.

e) **Welding rod**:Are used to stick welding when you do not use nut and bolt for metal bridge construction.

3.1.2.Equipment used in construction of metal bridge superstructure

a) Lifting equipment: is any work equipment for lifting and lowering loads, and includes any accessories used in doing so (such as attachments to support, fix or anchor the equipment)

i. overhead cranes and their supporting runways
ii. motor vehicle lifts
iii. vehicle tail lifts and cranes fitted to vehicles
iv. goods and passenger lifts
v. telehandlers and fork lifts

b) Cutting equipment: Are the equipment or powered machine used to cut out parts of steel bar or metal for gaining required dimensions.

Example: Grinding machine

c) **Surveying instruments:** Are instrument used in surveying operation to measure angles and distance between bridge railing.

Example: Theodolite

d) **Welding machines:** includes the welding machine, power supplies, used to conduct the welding process for the rapid assembly of the parts welded during superstructure metal parts (railing bridge)

3.1.3.Types of tools

a) Measurement tools
b) Cutting tools
c) Welding tools
d) Drilling tools
e) Holding tools

3.1.4.Identification of steel section

a) **T section** is used in bridge construction for increasing load bearing of bridge,this T section serve as a flange for resisting compressive stresses applied on bridge.
b) L section: This section called also (longitudinal section of the bridge) consist of griders and deck slab which can resist on vary load applied on bridge.
c) I section: Are the simplest section form for bridge span supported by abutment or pier at each end.
d) C section:called also channel section are formed in the shape of C and placed legs down when erected,the function as both superstructure and deck are typically used for shorter span bridge.
e) Box section: Is the special section where the bridge element is on or multiple closed cells that are acting in bending.
f) Steel panels: Is used as a bridge deck.They are made up transverse sections to distribute the load across main rail members providing strength of the decking system.

3.1.6.Preparation of workplace steps:

a) Positioning signs for safety measures
b) Demarcation of work area
c) Clearance of work area
d) Site installation

LO 3.2 - PREPARE STRUCTURE MEMBERS

Topic: discussing the Prepare structure members and the Fix bridge beams, truss and slab

3.2.1. Interpretation of drawing

a) Dimensioning
b) Views
c) Section
d) Verification

3.2.2. Methods of jointing steel members

a) **With welding**: Is the methods of joining steel members by using the welding machine, power supplies, used to conduct the welding process for the rapid assembly of the parts welded during superstructure metal parts (railing bridge)
   i. Cylinder welding
   ii. Electrical welding

b) With bolts: Is the methods of joining steel members consist of a head and cylindrical body with screw threads along a portion of its length which is used to fix the traffic barriers for metal bridge.

LO 3.3 - FIX BRIDGE BEAMS

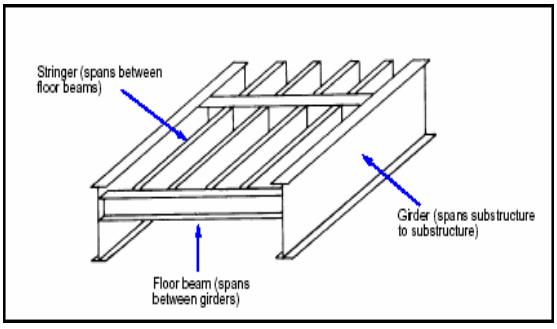
Topic: Discussing the types of bridge beams used for metal bridge

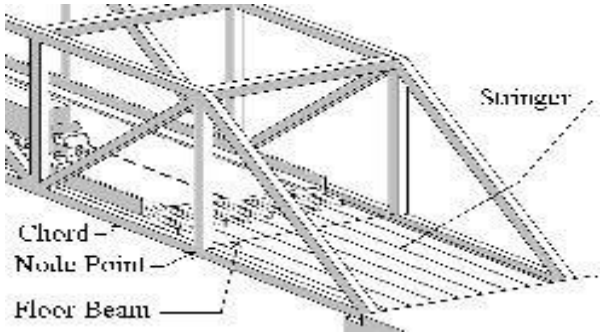
Beam bridges basically consist of beam that is laid across the piers or supports. The beam should possess the strength to bear the loads that are expected to be placed on it. The loads cause the beam top edge to be compressed, while the lower edge is being stretched and is under tension.

3.3.1. Types of beams

a) Floor beam

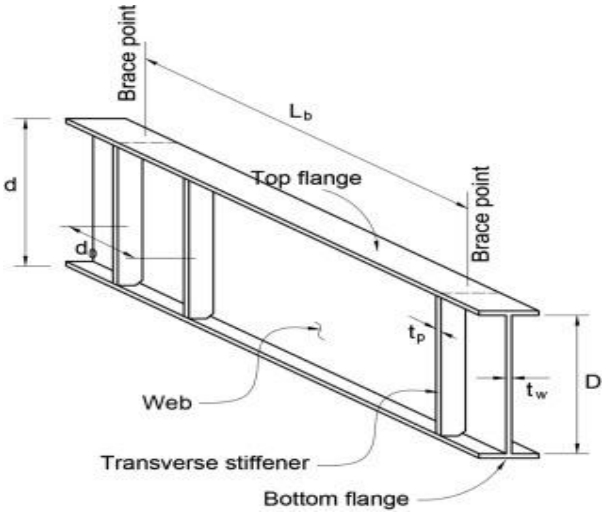
In a bridge deck the lightly loaded longitudinal beams are the stringers; the heavier, transverse members are called floor beams.





b) Stringers beam/ Girders

Girders are the main horizontal supports of a structure, and support smaller beams. All



girders are beams, but not all beams are girders.

- Beams are generally milled or rolled sections. They tend to be small in comparison to girders because their size is limited by the capacity of milling equipment.
- Girder is called stringer beam. Main steel member along the longitudinal direction is called stringer beam. Longitudinal beams supporting load from the decking to the floor beams.

3.3.2. Procedures of fixing a metal beam

1. Fixing of bridge bearing for proving the support of superstructures of bridge.
2. Cutting steel used in bridge beam, rails and decks before fixing.
3. Drilling steel for tying parts of bridge
4. Lifting beam for positioning in the right place.
5. Fixing beam by using screw

L.O.3.4. FIX BRIDGE TRUSS

Topic: Discussing the Steps of assembling of truss

3.4.1. Steps of assembling of truss

1. Fixing braces
2. Vertical Braces
3. Diagonal braces

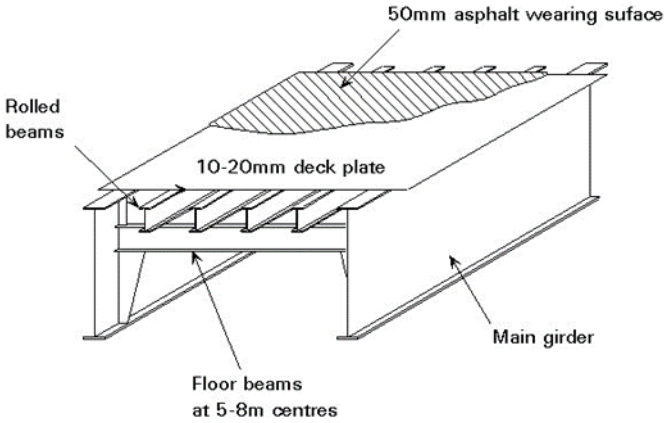
3.4.2. Positioning of truss

1. Check and read all assembly drawings and information provided by technician
2. Ensure all personal protective equipment (PPE) is worn and correctly fitted
3. Ensure scaffolding is in place and signed off
4. A safe working platform within the bridge structure is strongly recommended
5. Ensure hop-ups and scaffolding edge protection are in place

6.After reading the truss layout drawings, identify the easiest starting point and the truss position.

7. Place and install truss on the right place and fix well.

3.5. Fix bridge slab



A deck is the surface of a bridge. A structural element of its superstructure, it may be constructed of concrete, steel, or wood.

3.5.1. Procedures of fixing a metal slab deck

1. Cutting steel panels by using grinding machine or cutting saw
2. Drilling steel panels by using drilling machine
3. Fixing with bolts by using nults and bolt
4. Fixing with rivet
5. Fixing with welding by using SMAW welder machine.

Reference(s):

1. Construction principles and practices by Denis WALTON,first published 1995
2. Building construction by **Dr B.C PUNMIA, ASHOK KUMAR JAIN ARUN KUMAR JAIN**
3. https://theconstructor.org
4. https://www.nrmca.org
5. www.iricen.gov.in.res.html.test-27
6. https://civilread.com on 18 May 2018