CIVIL ENGINEERING CONSTRUCTION

SBC2253

BRIDGES

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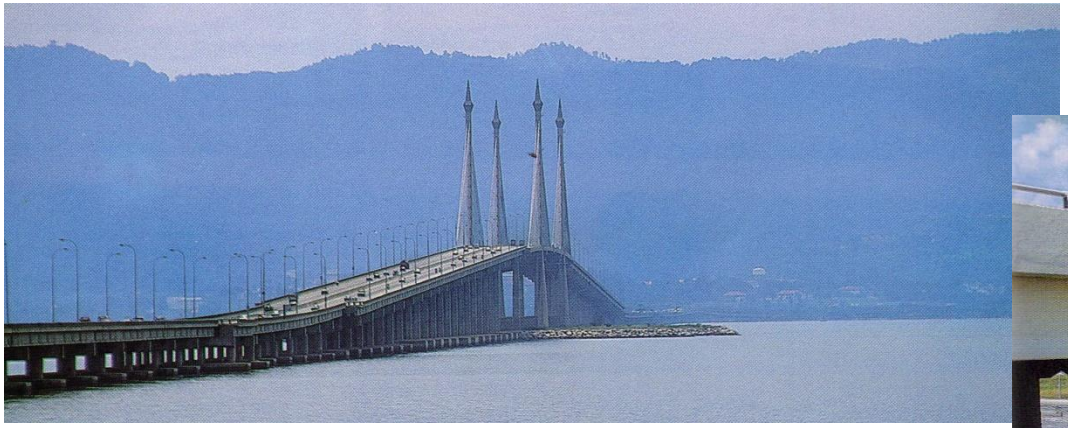
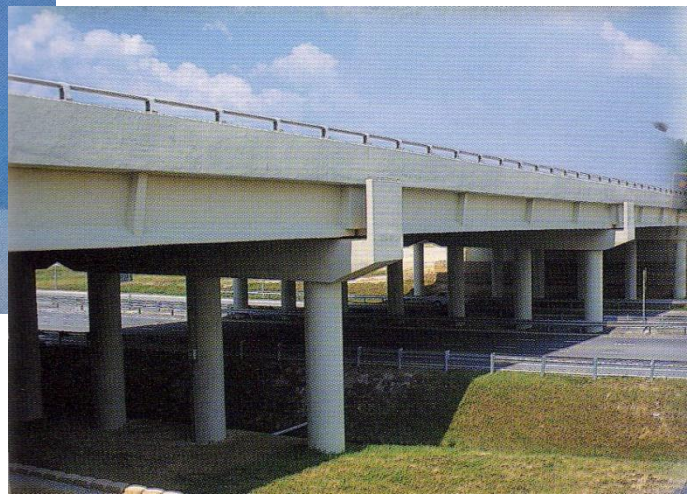
INTRODUCTION

- BRIDGE is a permanent raised structure which allows people or vehicles to cross an obstacle such as a river without blocking the way of traffic passing underneath.





INTRODUCTION

- Planning and executing the construction of a bridge is often very complicated
- As in building construction, the preliminary stage in bridge project involves selection of the best bridge system from available alternatives. This process is time-consuming.
- An incomplete structure of bridge may subjected to stresses and oscillations that would not arises after completion

INTRODUCTION (CONT'D)

- Construction works obstruct existing traffics and normal life in the area especially if it involve on-site works i.e. in-situ concreting works

- Substantial works in form of tests are required before any actual construction – soil tests, boreholes, wind speed and direction, records of water level and velocity, etc.

SELECTION OF BRIDGE TYPE

- When designing a bridge system, the objectives of the bridge construction and limiting factors have to be taken into account. The following are some considerations to be concerned:
  - Economics
  - Ease of construction
  - Site location and condition
  - Aesthetics
  - Safety : adjacent property, construction crew, highway traffic etc
  - Politic

COMMON TYPES OF BRIDGES

- Simply Supported Bridge
- Pseudo Continuous Bridge
- Continuous Bridge
- Arch Bridge
- Cable-Stayed Bridge
- Suspension Bridge

CLASSIFICATIONS OF BRIDGE

- ***Type of Material***
- ***Type f Structural Systems***
- ***Type of Material***

Types

- Can be classified according to:
  - Materials

    Reinforced concrete, Prestressed concrete

    Steel, Timber, Masonry
  - Functions

    Traffic, Railway, pedestrian, river, monument, landmark
  - Structural system

Types

The main feature that control the bridge types is the size of obstacle.

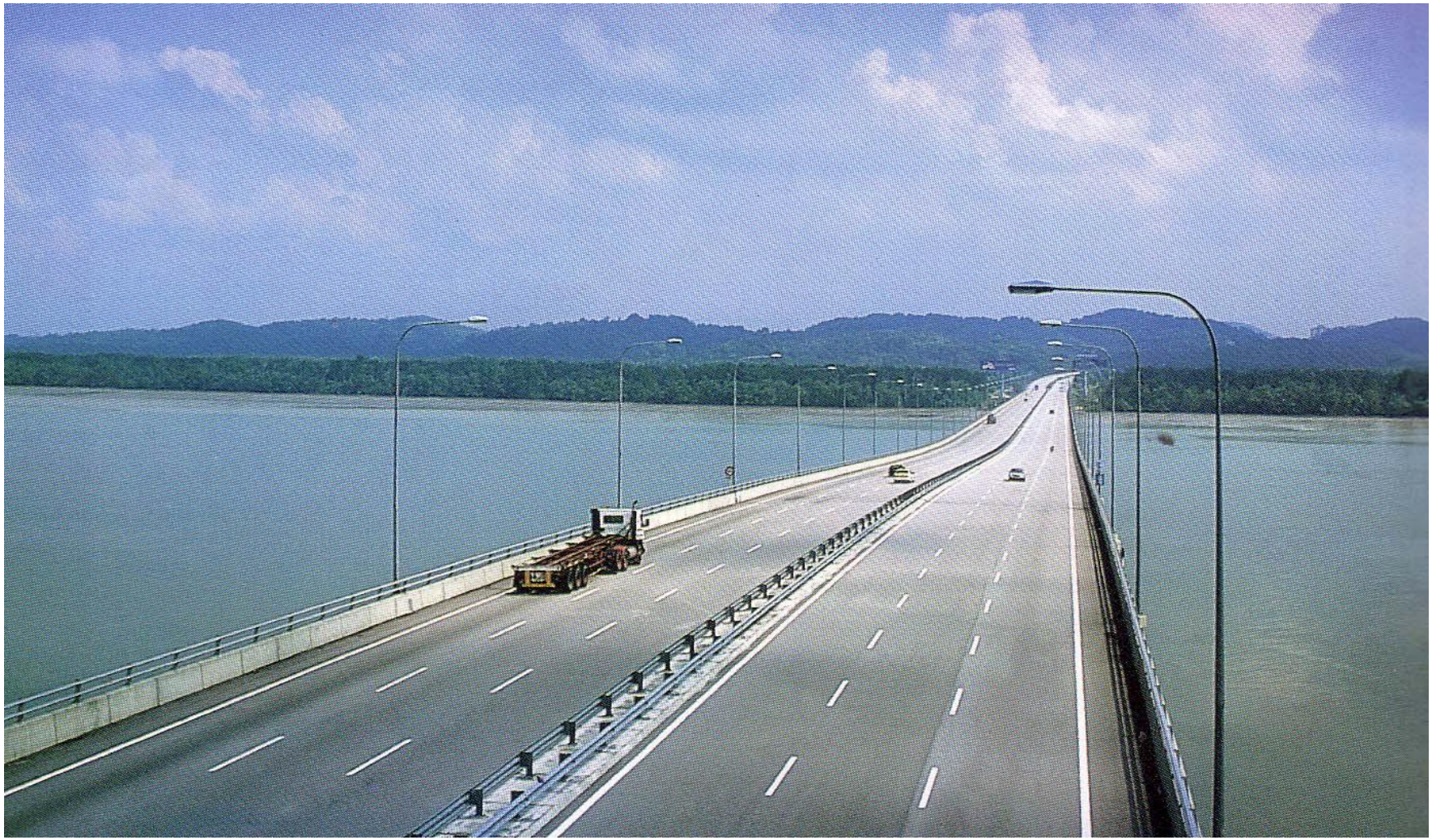
Type also governs by span size.

Span is the distance between two bridge supports.

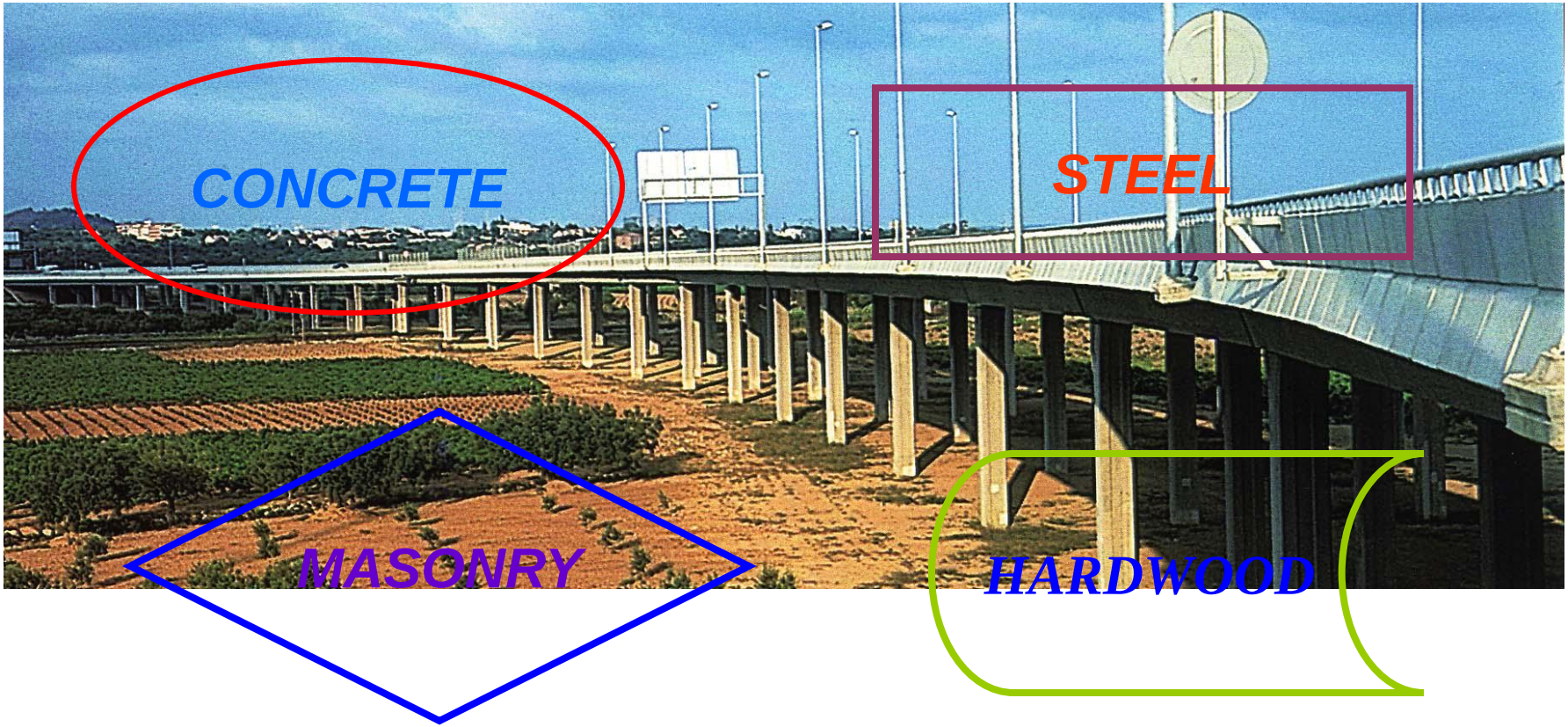
Types

- Beam bridge – up to 60 m
- Arch bridge – 240 – 300 m
- Suspension bridge – up to 2,100 m

This capabality depends on how the structural system can deal with the compression and tension forces.



TYPE OF MATERIAL



Structural system

- Girder bridge
  - Box
  - Beam
- Arch bridge
- Truss bridge
- Cantilever bridge
- ***Simply Supported***
- Integral bridge
- Suspension bridge
- Cable-stayed bridge
- ***Culvert***

Girder Bridge

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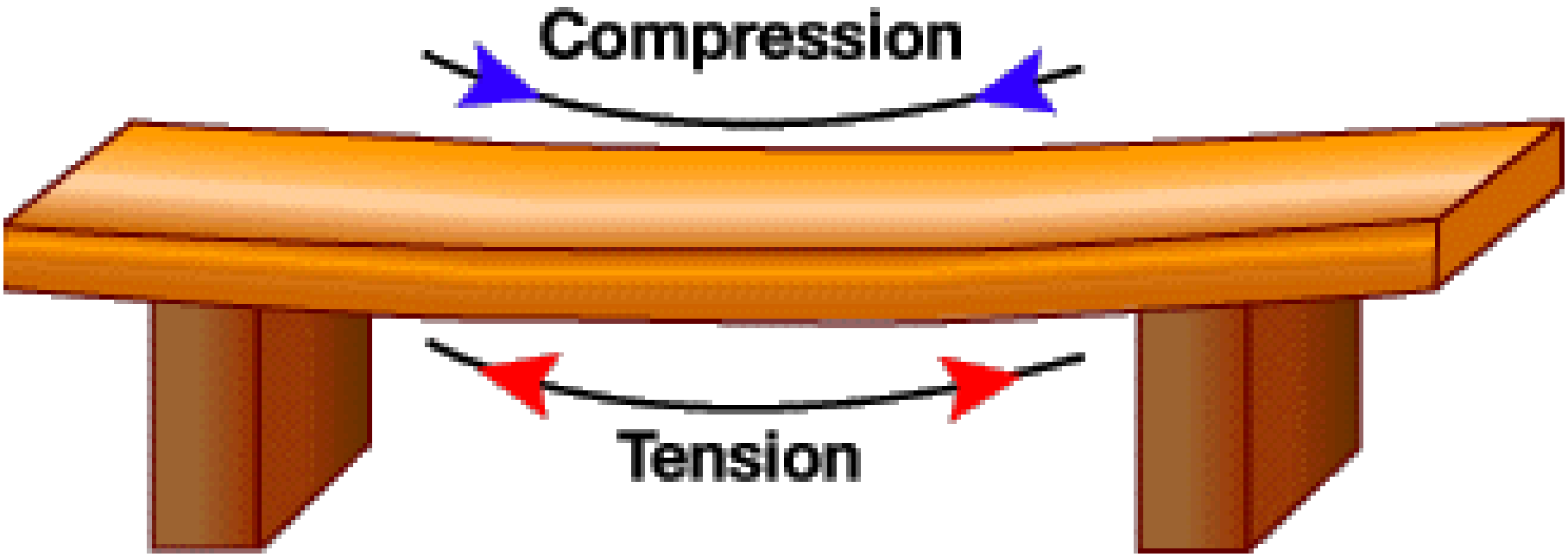
To improved



Girder Bridge

A beam or box girder bridge is basically a rigid horizontal structure that is resting on two piers, one at each end. The weight of the bridge and any traffic on it is directly supported by the piers. The weight is traveling directly downward.

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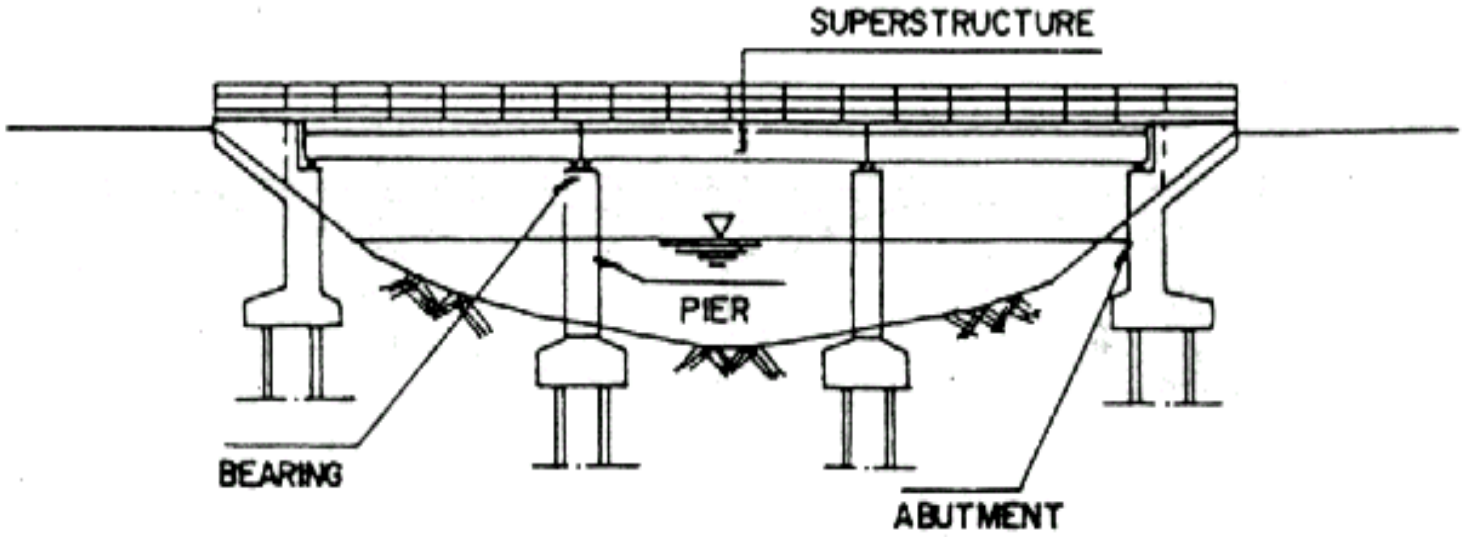
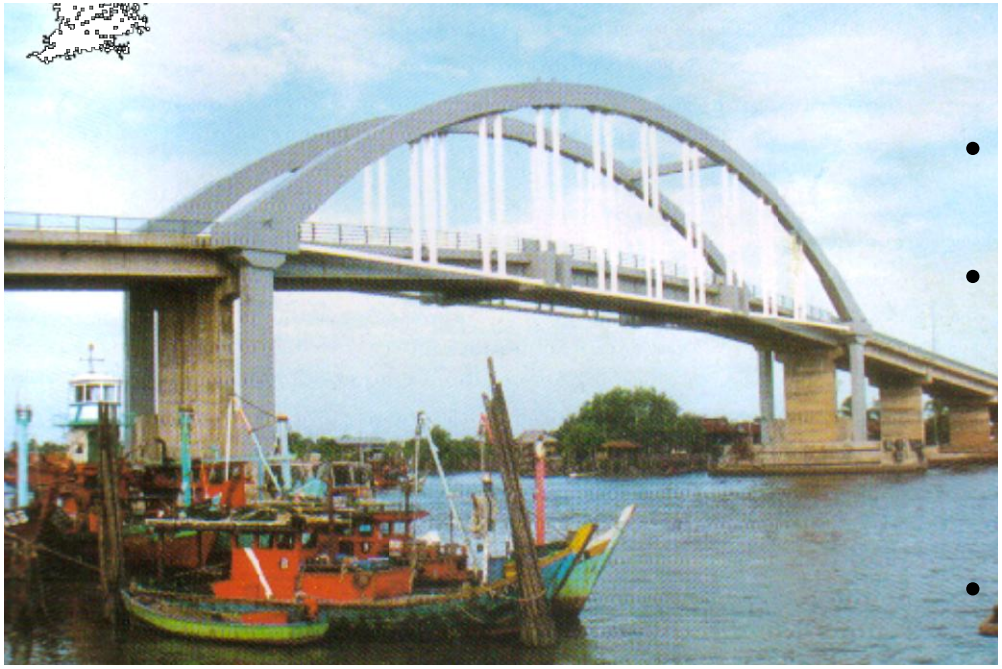
To improved

Simply Supported'

With 'hinge end'.



Simply Supported



- Transmits the loads vertically through piers or abutment and horizontally self-supporting.
- Span range : not exceeding 20 meters
- Advantages :
  - Simple to construct
  - Normal concrete required
  - Minimum Skilled Labour requirements
- Disadvantages :
  - Limited span to about 20 meters
  - Bigger self weight for long span

Continuous Span'

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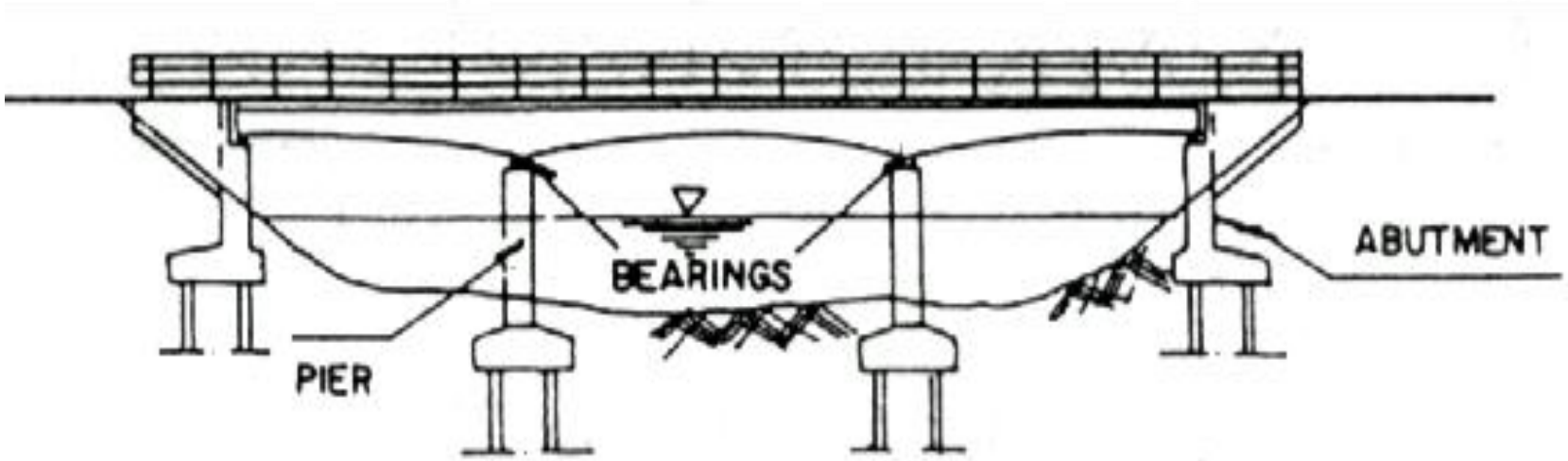
To improved

WITH 'intermediate support'.



Box girder

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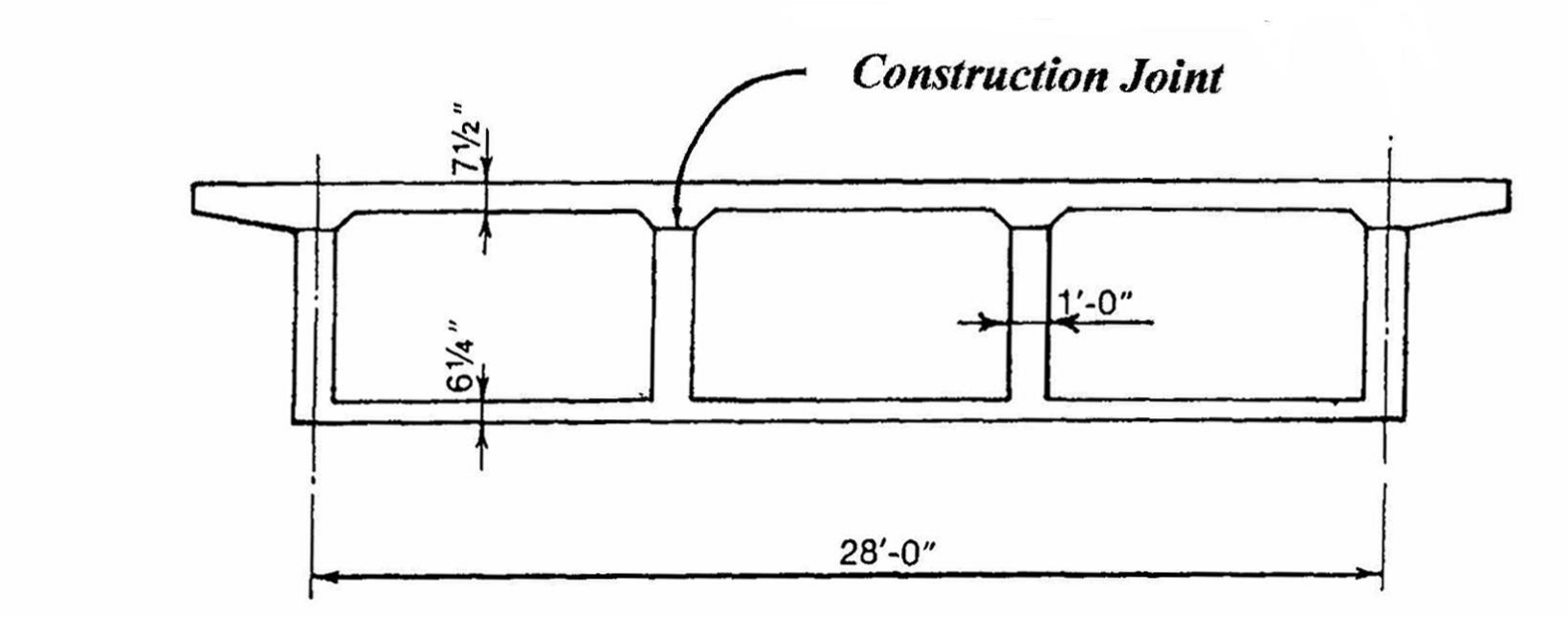

Prestress Bridge

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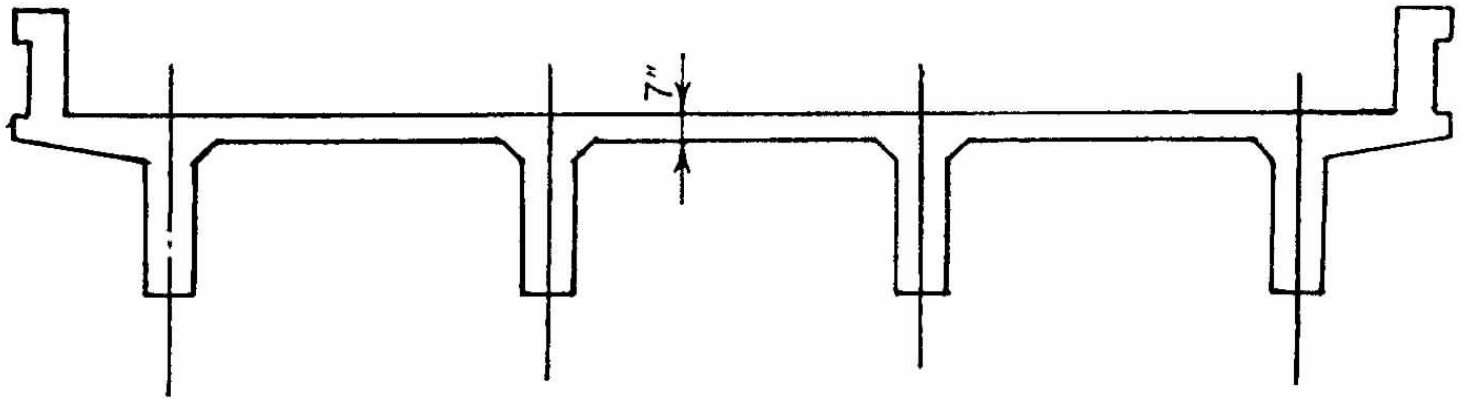
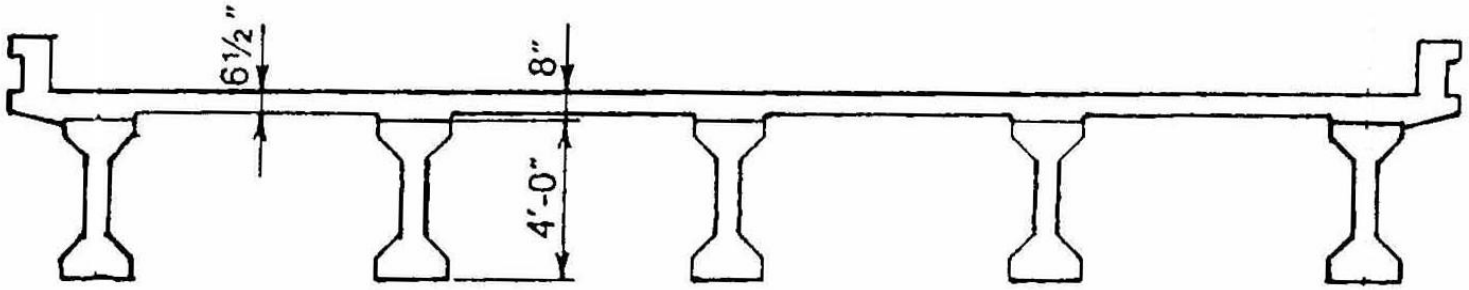


Prestress Bridge



Arch Bridges

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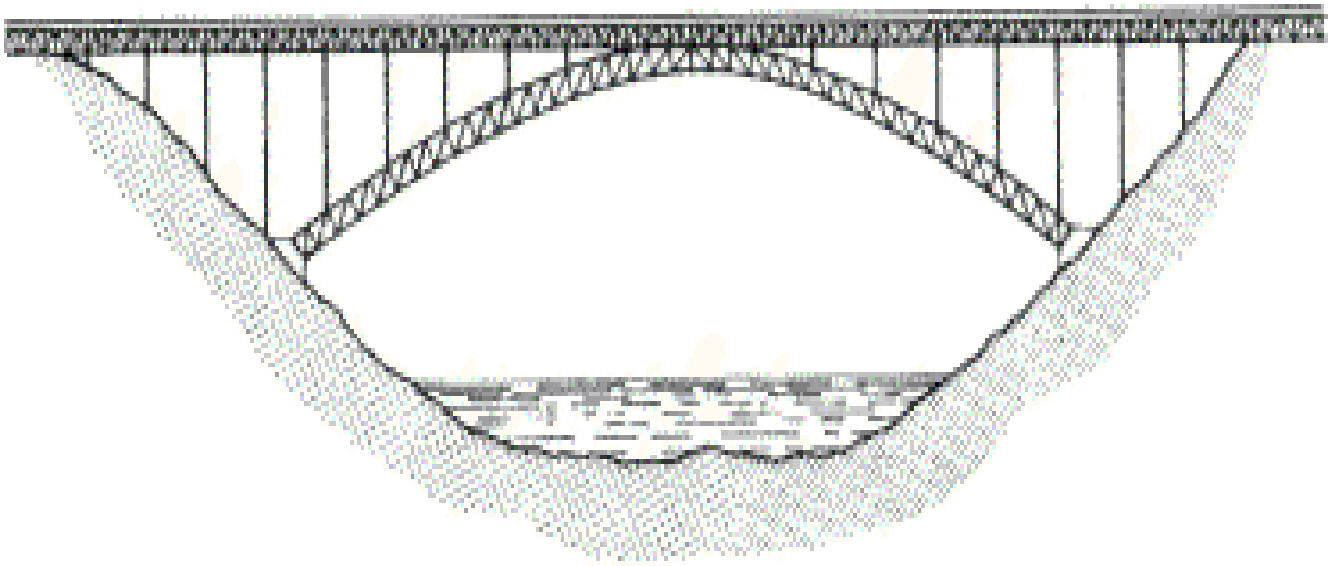
To improved



An arch bridge is a semicircular structure with abutments on each end. The design of the arch, the semicircle, naturally diverts the weight from the bridge deck to the abutments.

Arches

Sultan Iskandar Bridge

Spanning the Perak River. It is the longest steel arch bridge in Malaysia, comprising of seven spans with a total length of 284m.

Known as the Sultan Iskandar Bridge, this is one of the most attractive steel bridges in the country. Spanning the Perak River, it is located on the Federal Route 1, about 10km south of the Perak royal town of Kuala Kangsar. It is the longest steel arch bridge in Malaysia, comprising of seven spans with a total length of 284m. The bridge was constructed in 1932 and is one of the earliest long span bridges to be constructed in Malaysia. The bridge was repaired in 1985.

Sg. Dinding Bridge

Tied Arch bridge

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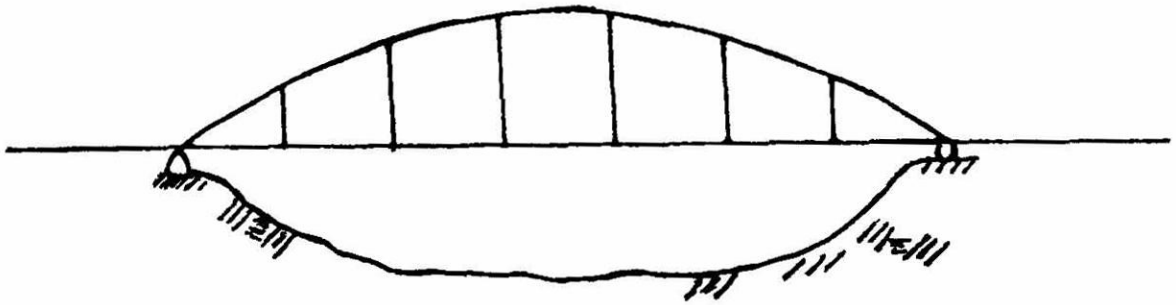
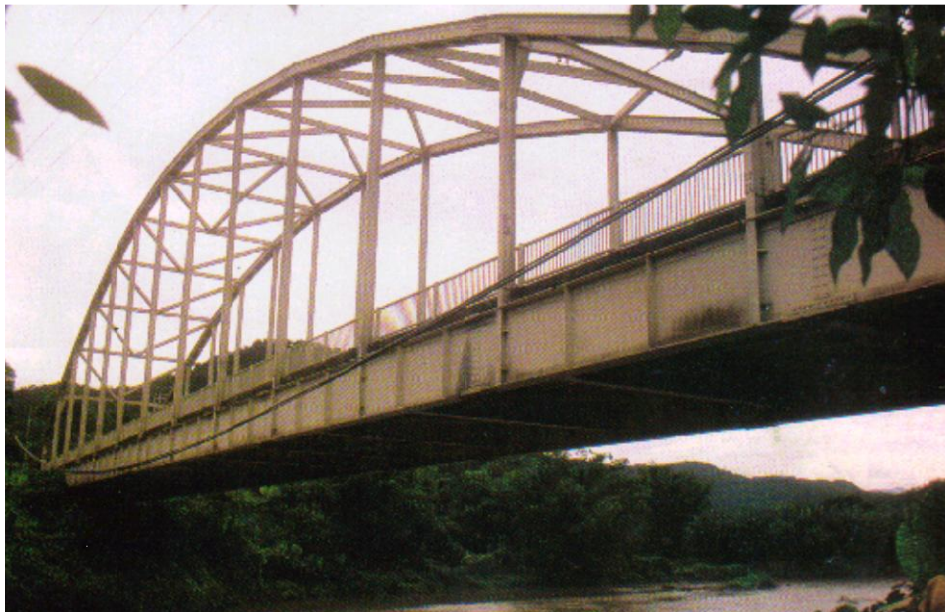
To improved



Arches

Tamparuli Bridge

Located in Papar is of a four span steel Pratt truss girder design.Total length of 122m with each span 30.5m long



Monolithic bridge

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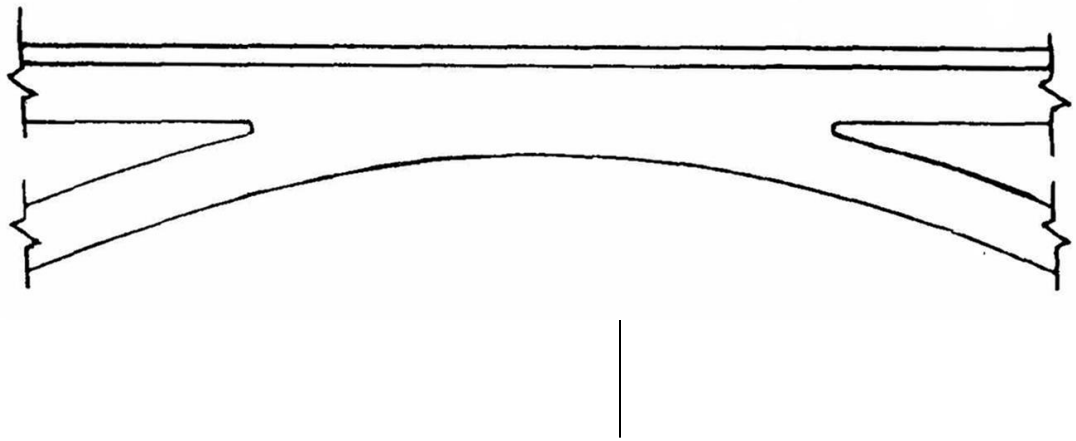
To improved



Cantilever Bridge

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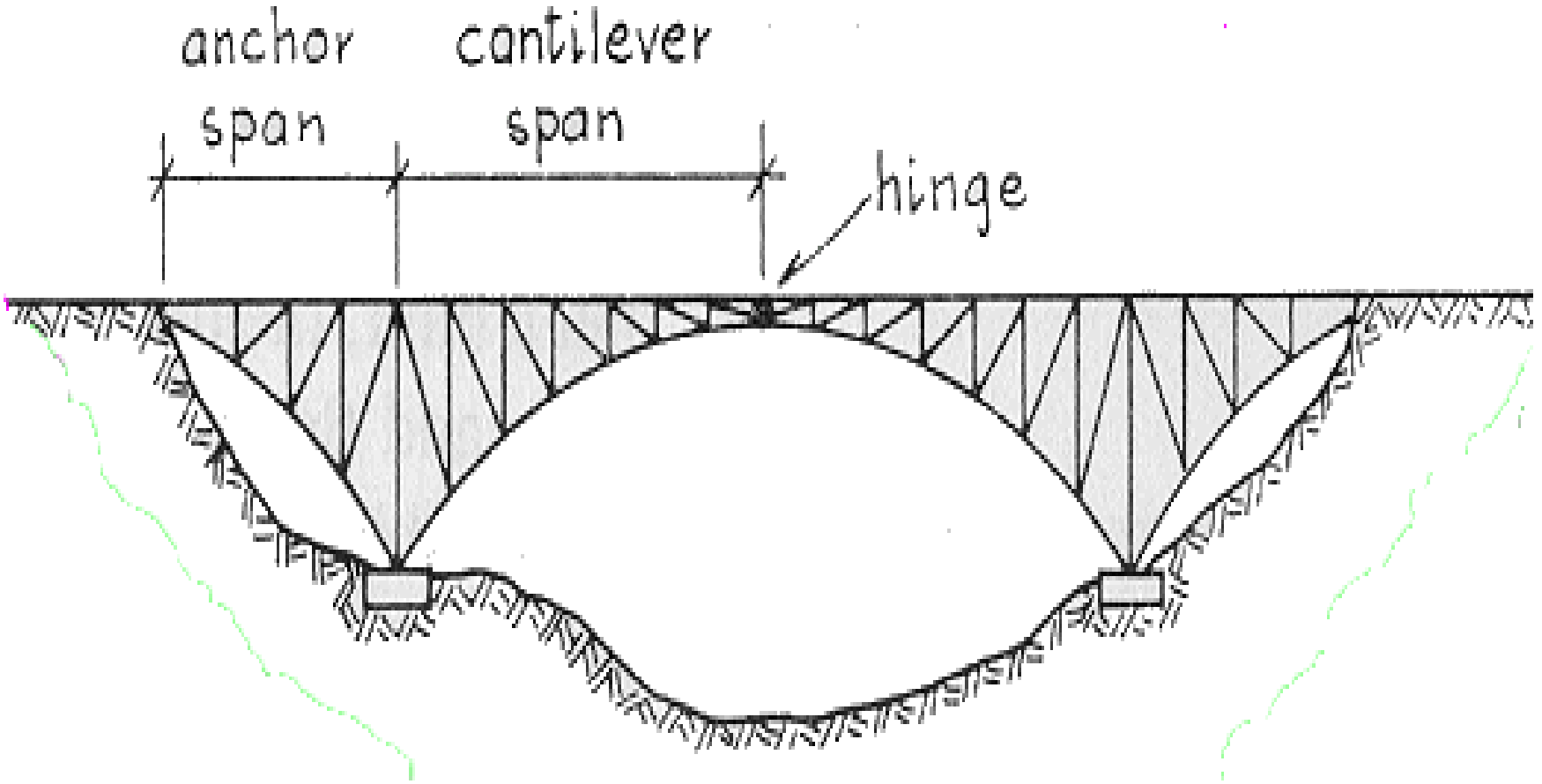
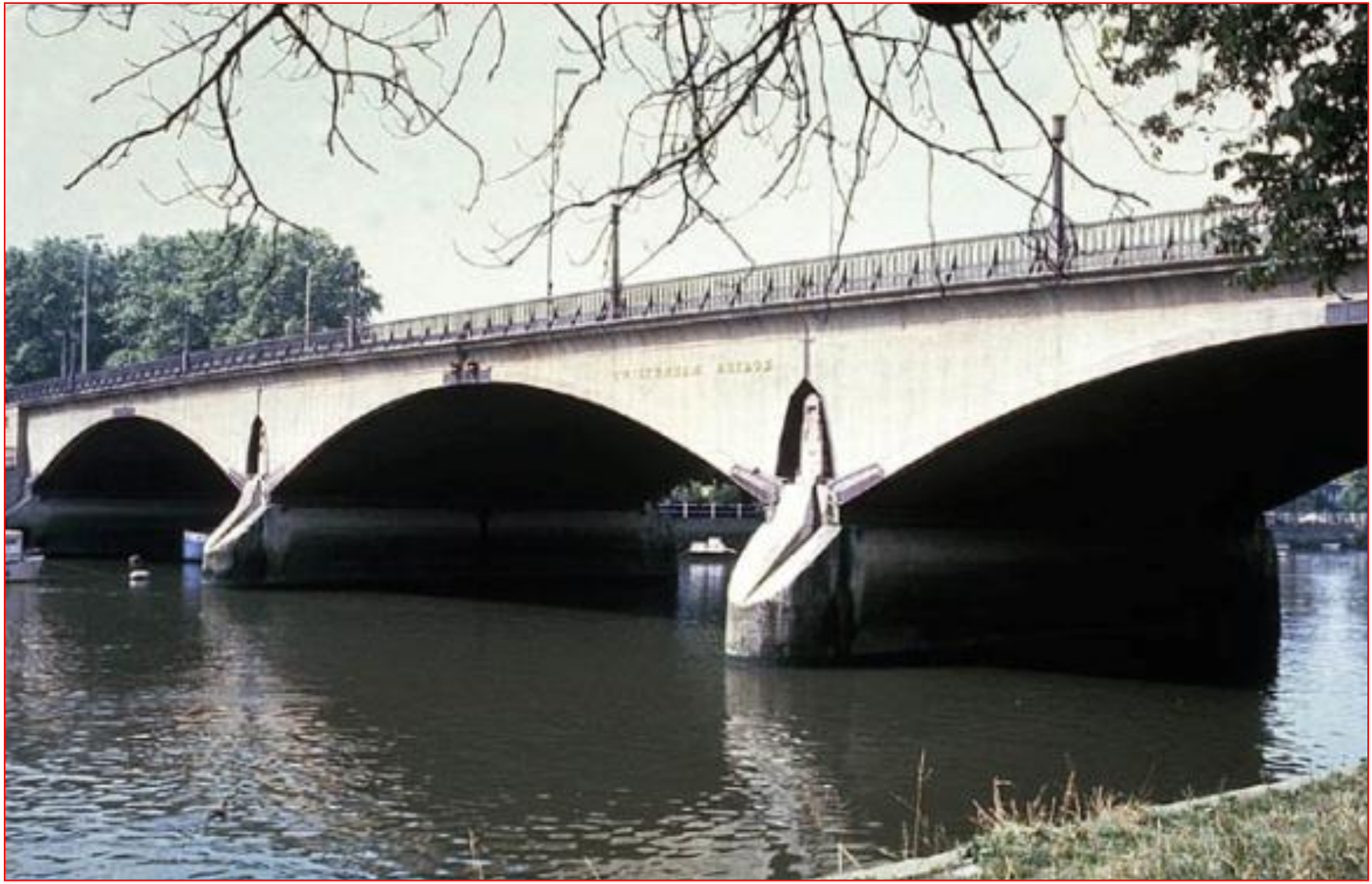
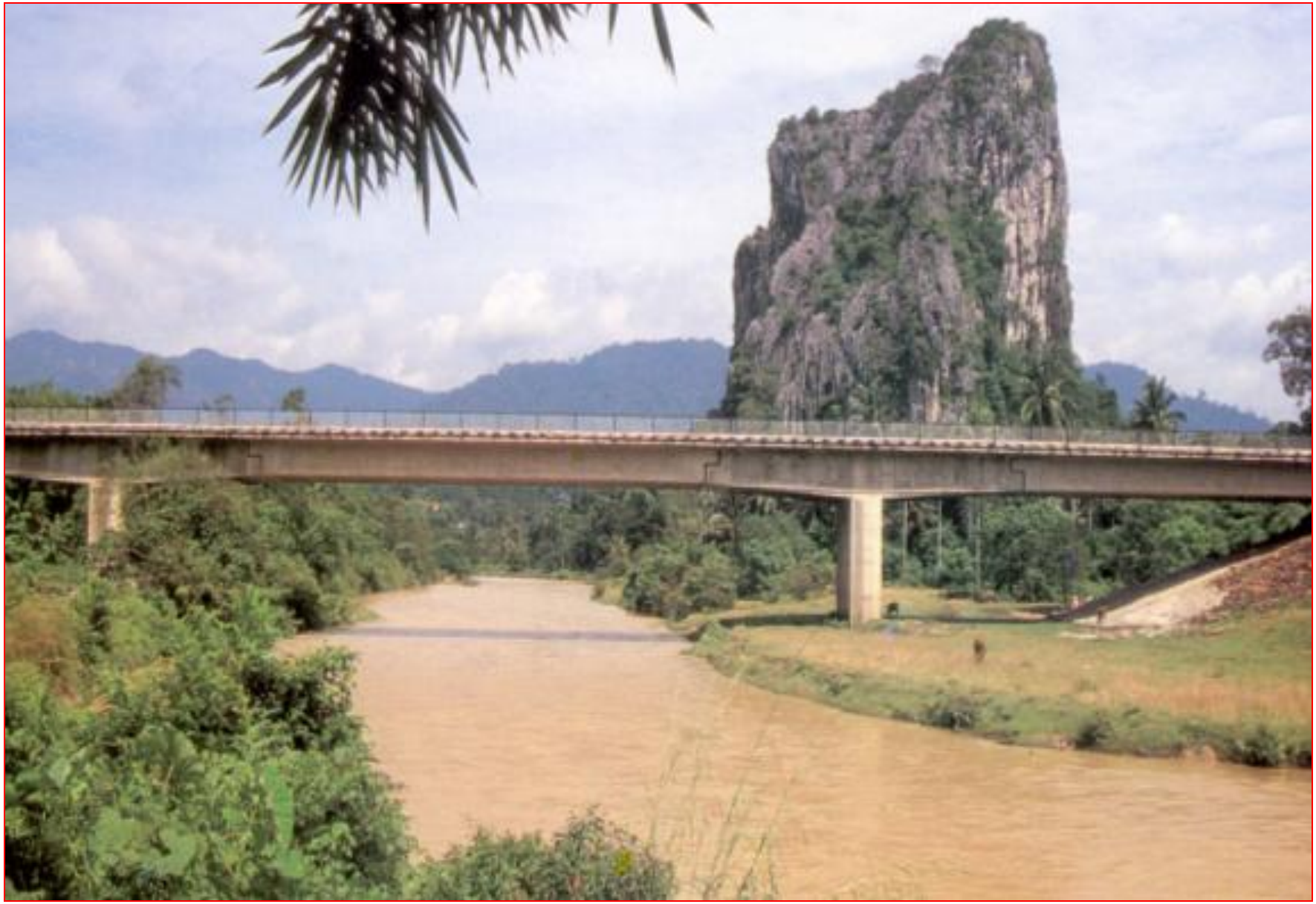
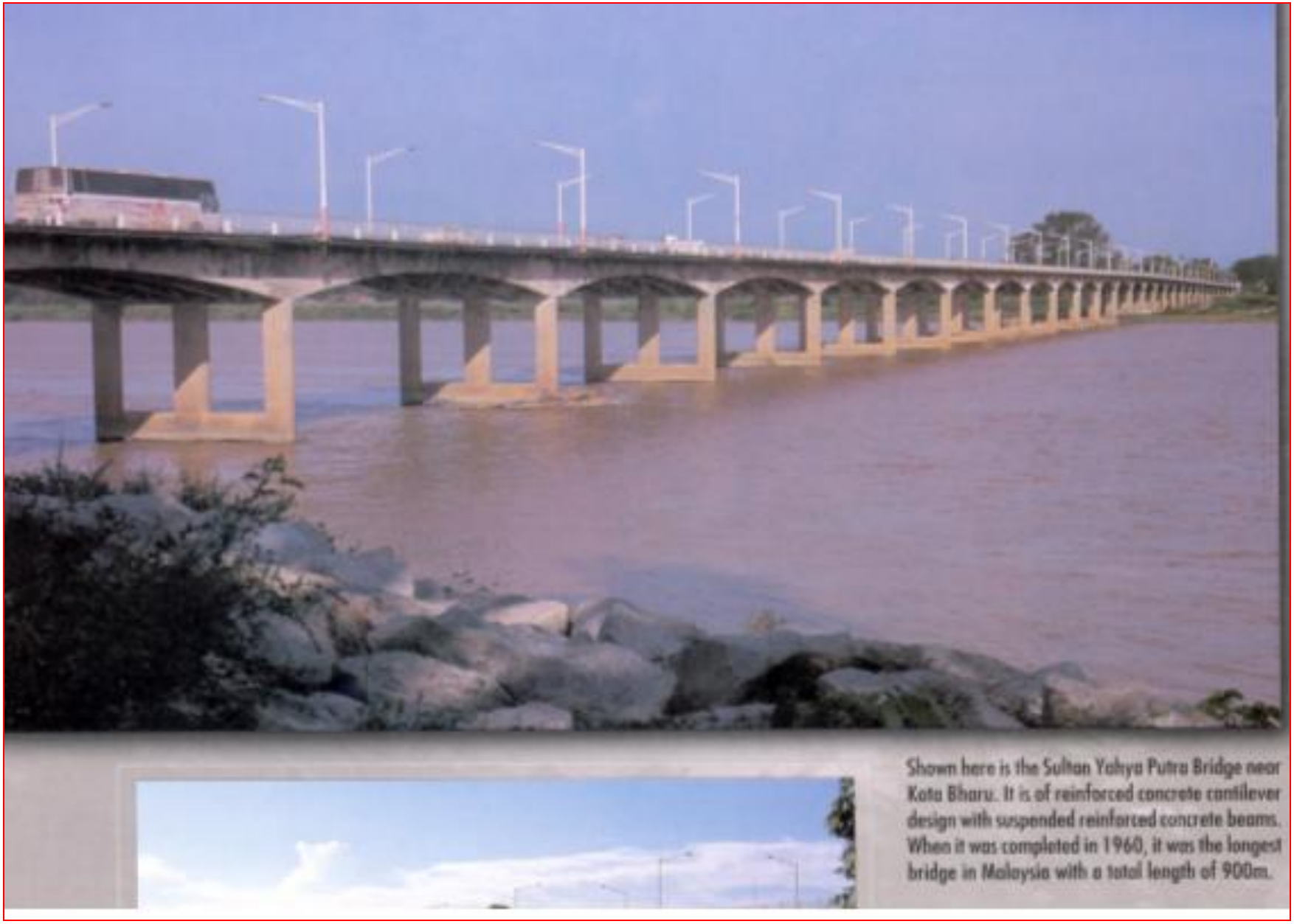
To improved

What is cantilever?







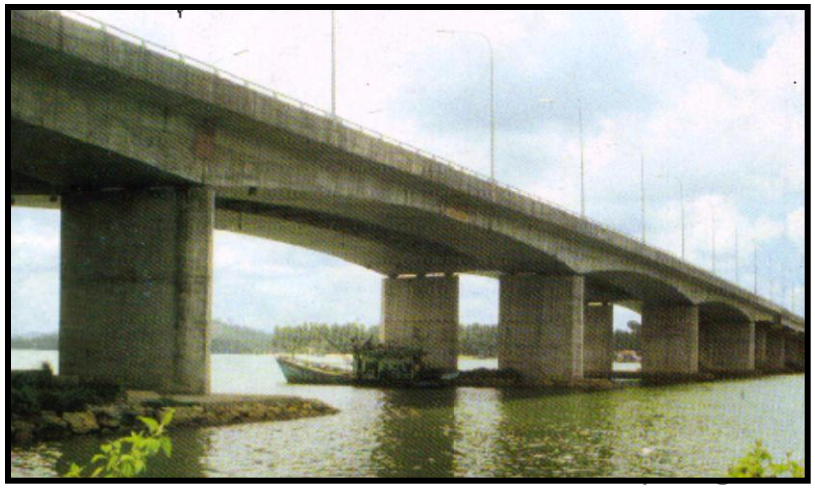


Shown here is the Sultan Yahya Putra Bridge near Kota Bharu. It is of reinforced concrete cantilever design with suspended reinforced concrete beams. When it was completed in 1960, it was the longest bridge in Malaysia with a total length of 900m.

Cantilever

Upper Pergau Bridge

- In the cantilever bridge, a pier supports the bridge deck stretching out either side like two arms, forming a solid and stable unit
- Advantages :
  - Very stable structure



Sultan Mahmud Bridge

Trussed Bridge

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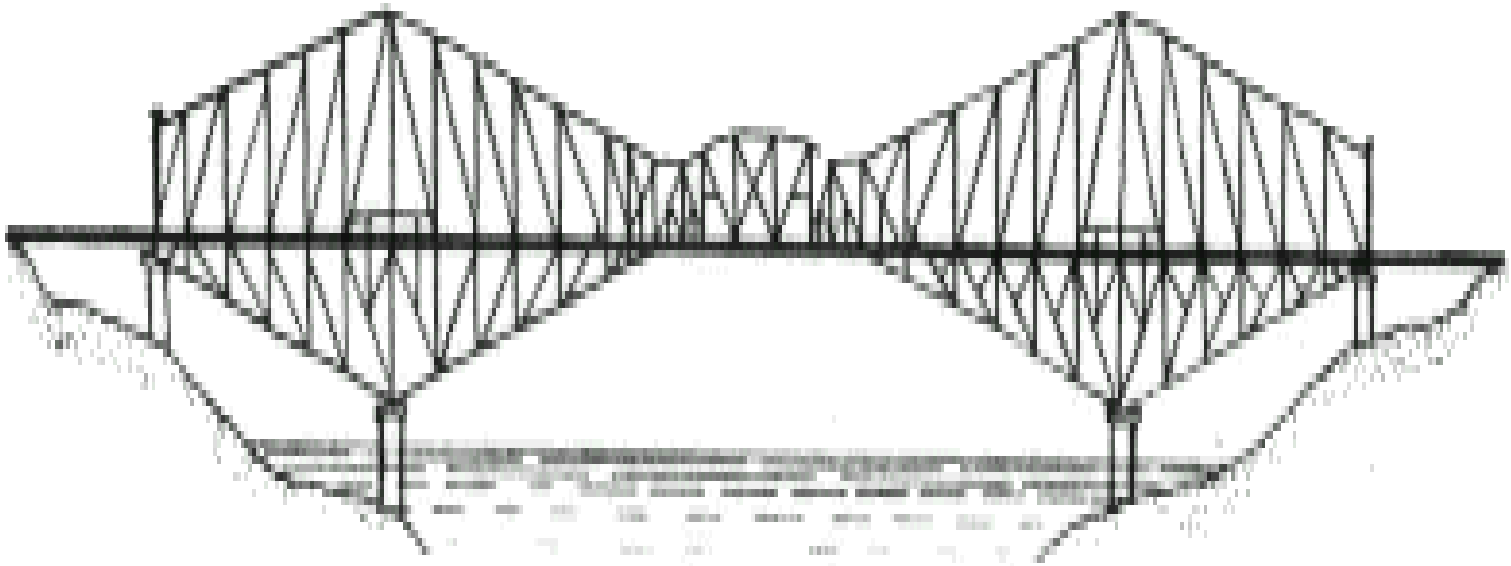
To improved



Trussed Bridge

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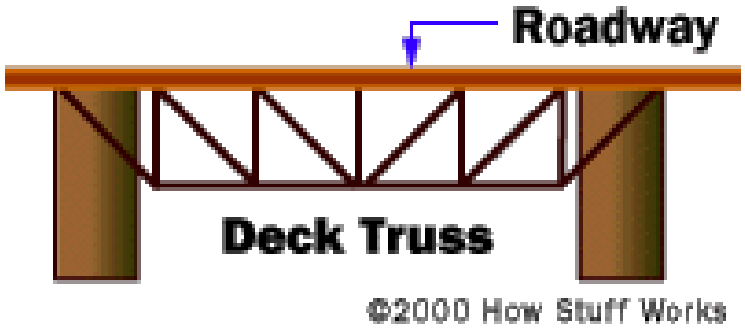
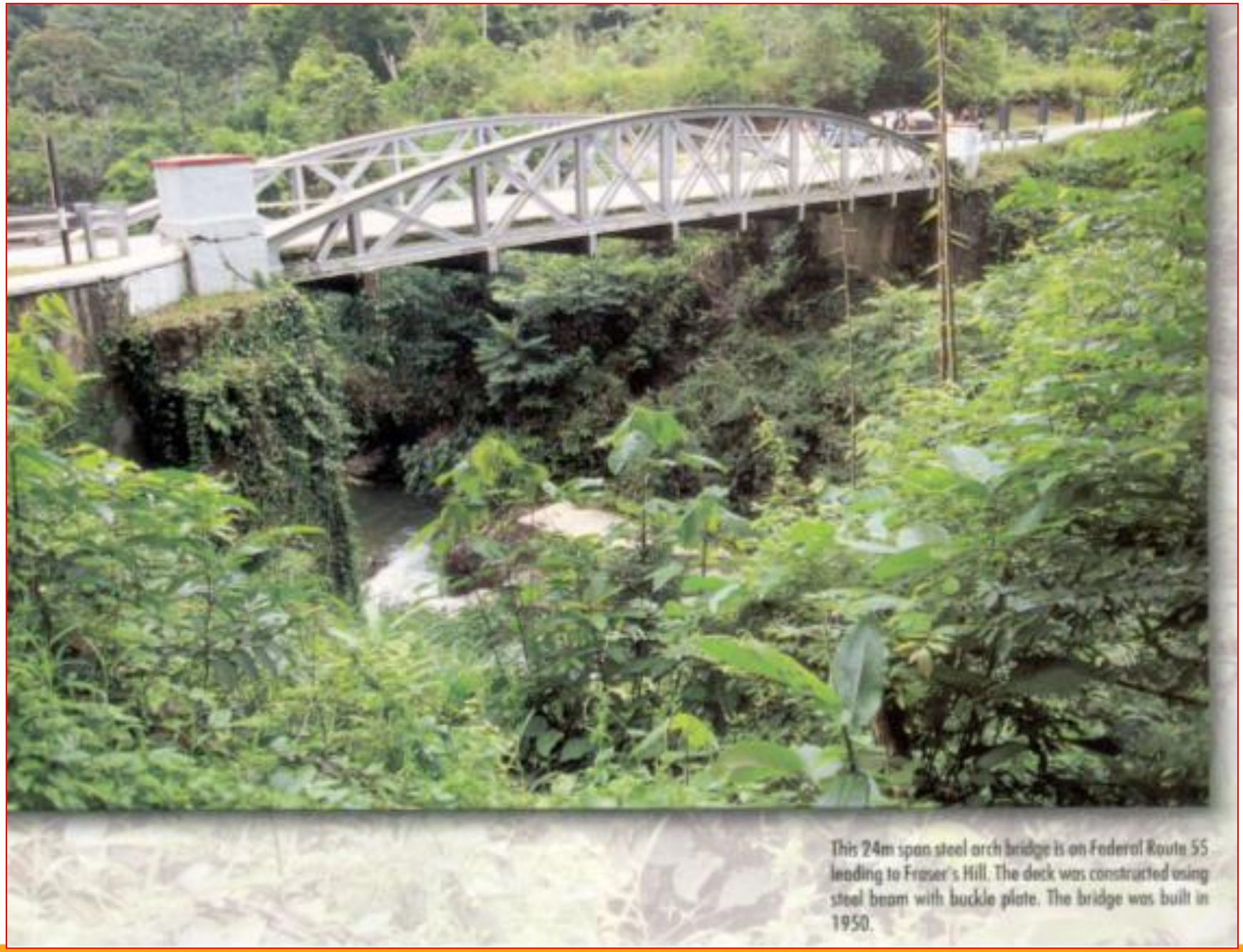
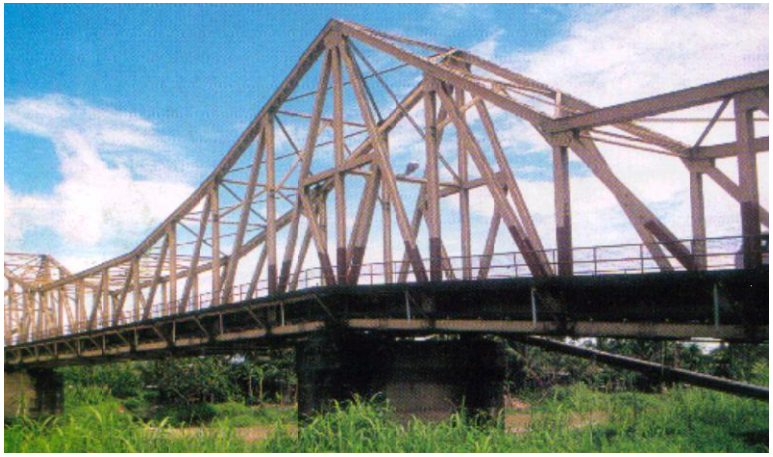




This 24m span steel arch bridge is on Federal Route 55 leading to Fraser's Hill. The deck was constructed using steel beam with buckle plate. The bridge was built in 1950.

Trusses

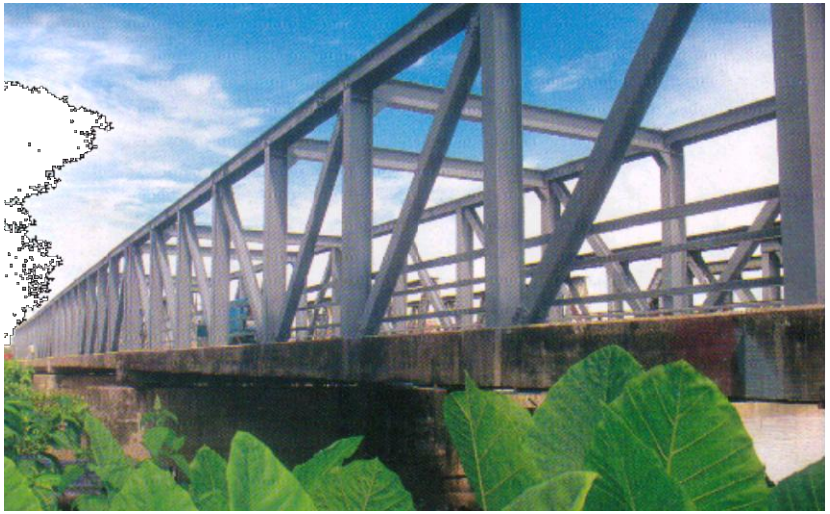


Beaufort Bridge

With total length of 135m, this unique steel Howe truss bridge forms a highly visible landmark of the small town of Beaufort, Sabah.

Papar Bridge

Spanning the Perak River. It is the longest steel arch bridge in Malaysia, comprising of seven spans with a total length of 284m.



Suspension Bridge

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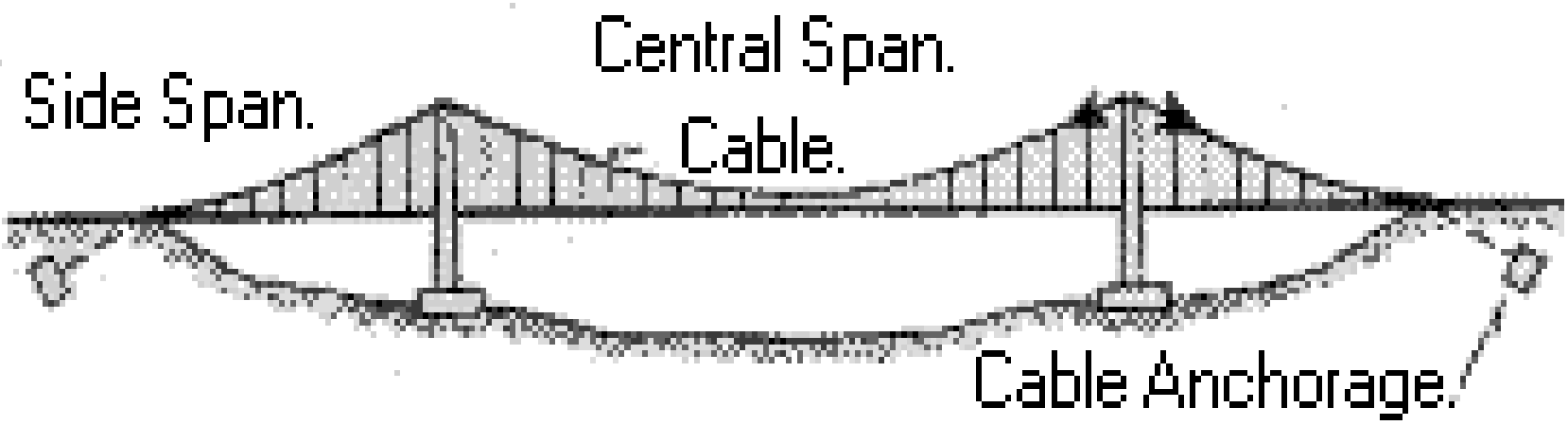
To improved



- With large spans such as 600m or more suspension bridges are used because they are more economical, but they can also be used for smaller spans if desired.

Suspension Bridge

- A suspension bridge is one where cables (or ropes or chains) are strung across obstacle
- The deck is suspended from these cables.
- Modern suspension bridges have two tall towers through which the cables are strung.
- The towers are supporting the majority of the roadway's weight.

Suspension Bridge

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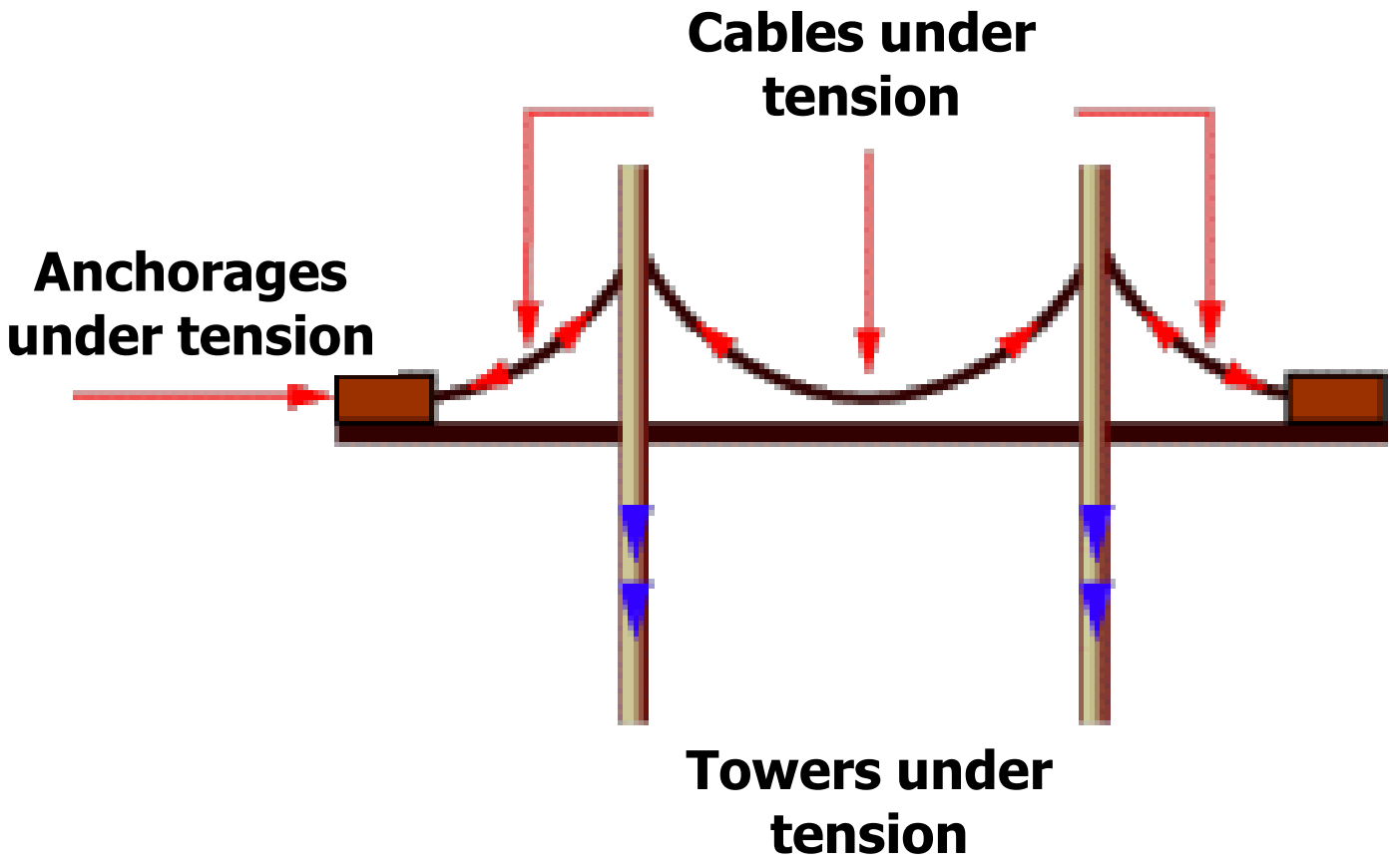
To improved



Suspension Bridge

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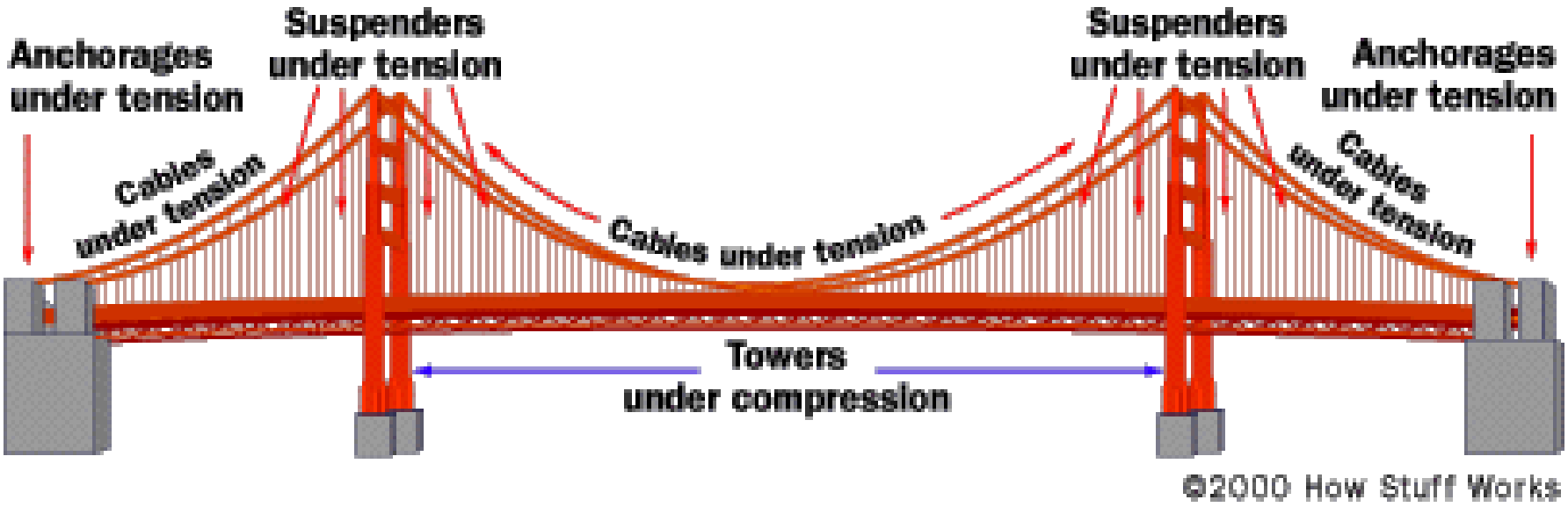
To improved



Suspension Bridge

Sultan Ismail Bridge

Kuala Krai, Kelantan.

Integral Bridge

"Integral bridges" are bridges without joints. Eliminating joints from bridges reduces construction and maintenance costs, but causes problems at the abutments.

Integral Bridge

Temperature increases, the bridge expands, pushing the abutment against the approach fill, and imposing loads on the piles that support the abutment. As the temperature drops, the bridge contracts, pulling the abutment away from the approach fill, and loading the piles in the opposite direction.

Cable-stayed Bridge

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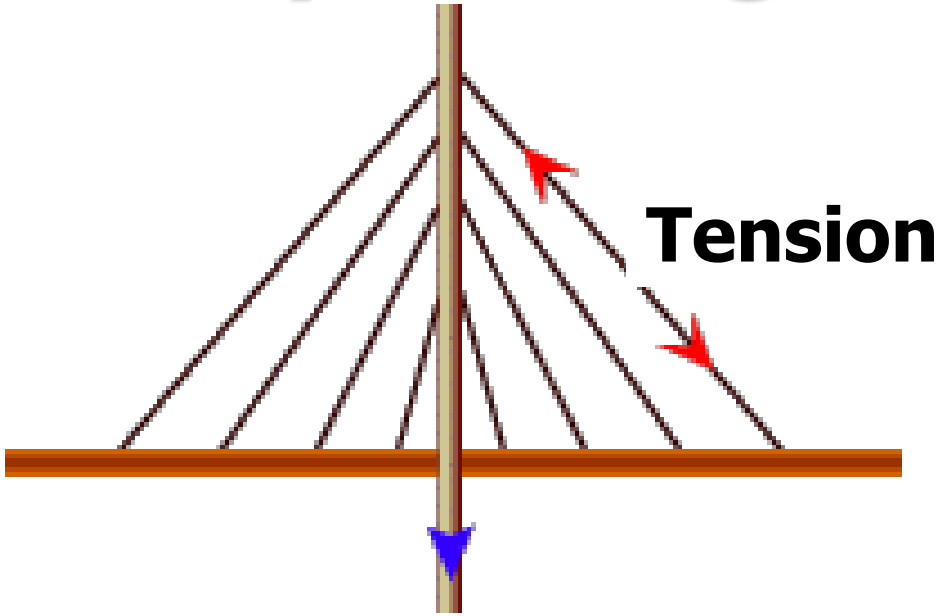
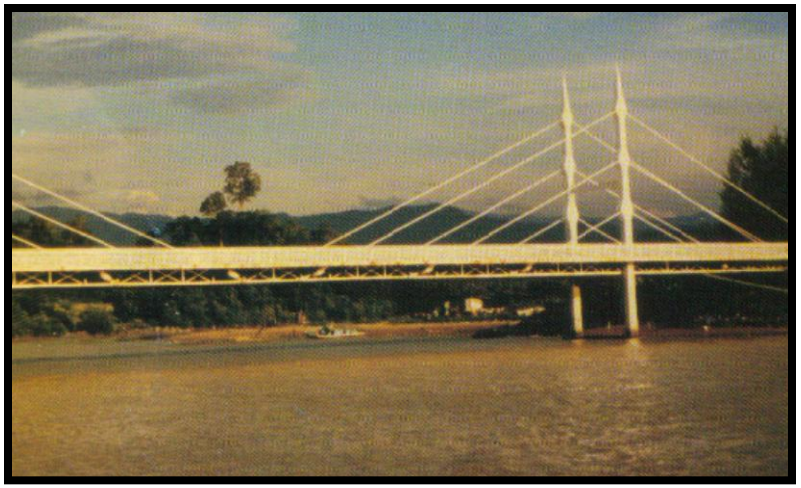
To improved

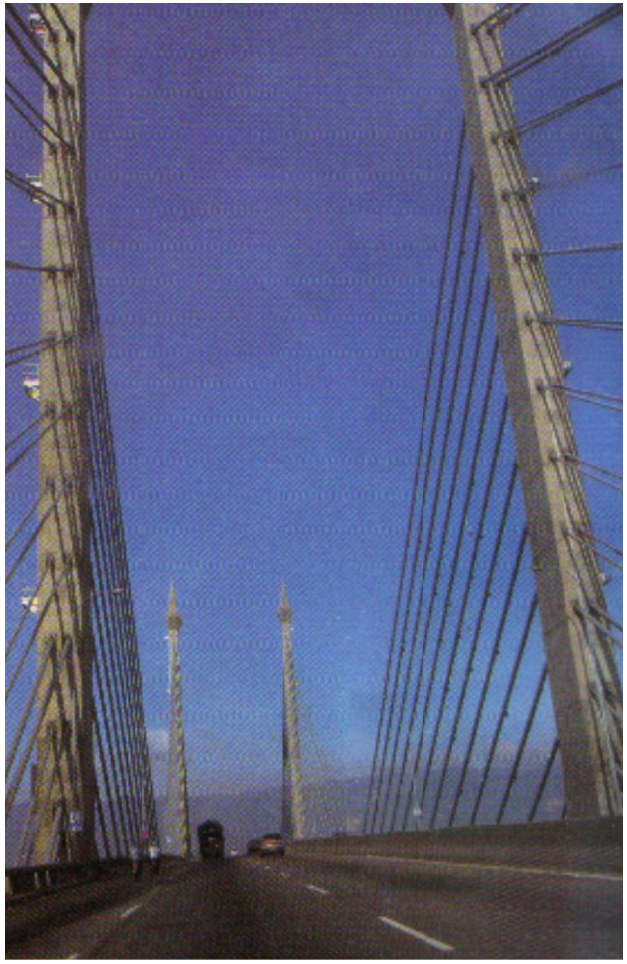


The cable-stayed bridge does not require two towers and four anchorages as does the suspension bridge. Instead, the cables are run from the roadway up to a single tower where they are secured.

Cable-stayed



Yayasan Sabah Bridge



Penang Bridge

Cable Stayed bridge

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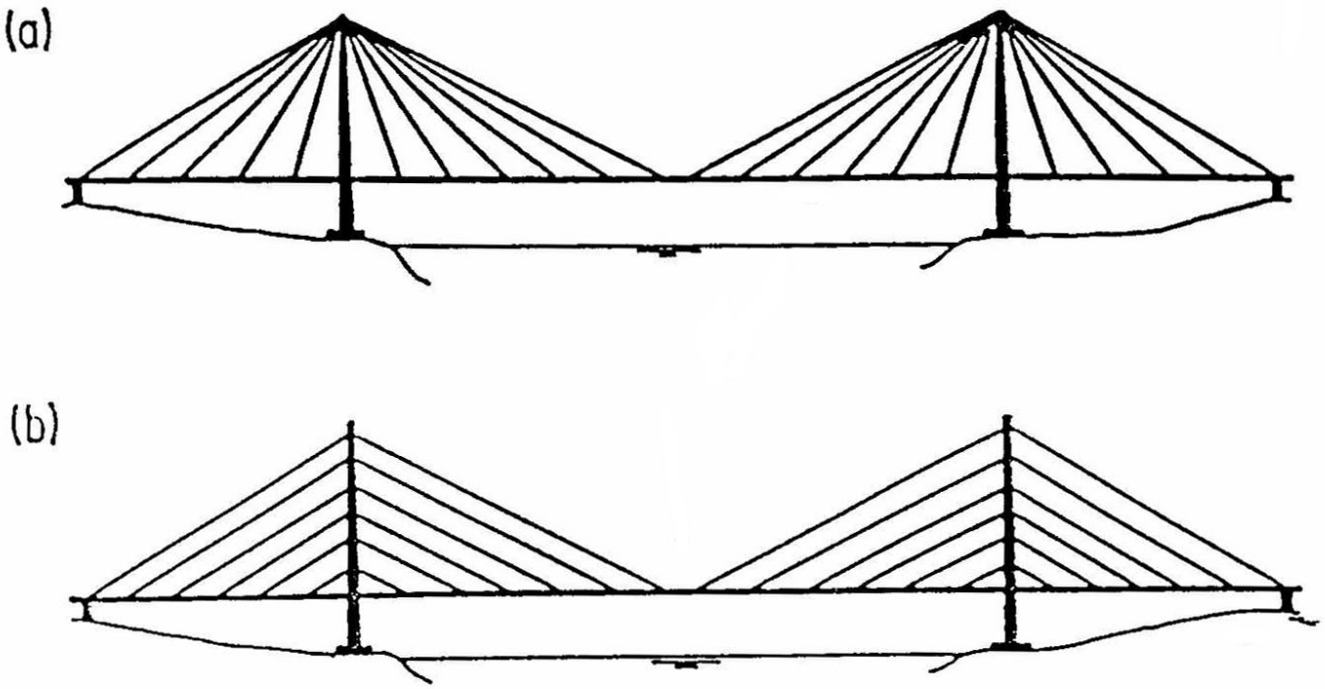
To improved



Putrajaya, Malaysia

Putrajaya, Malaysia

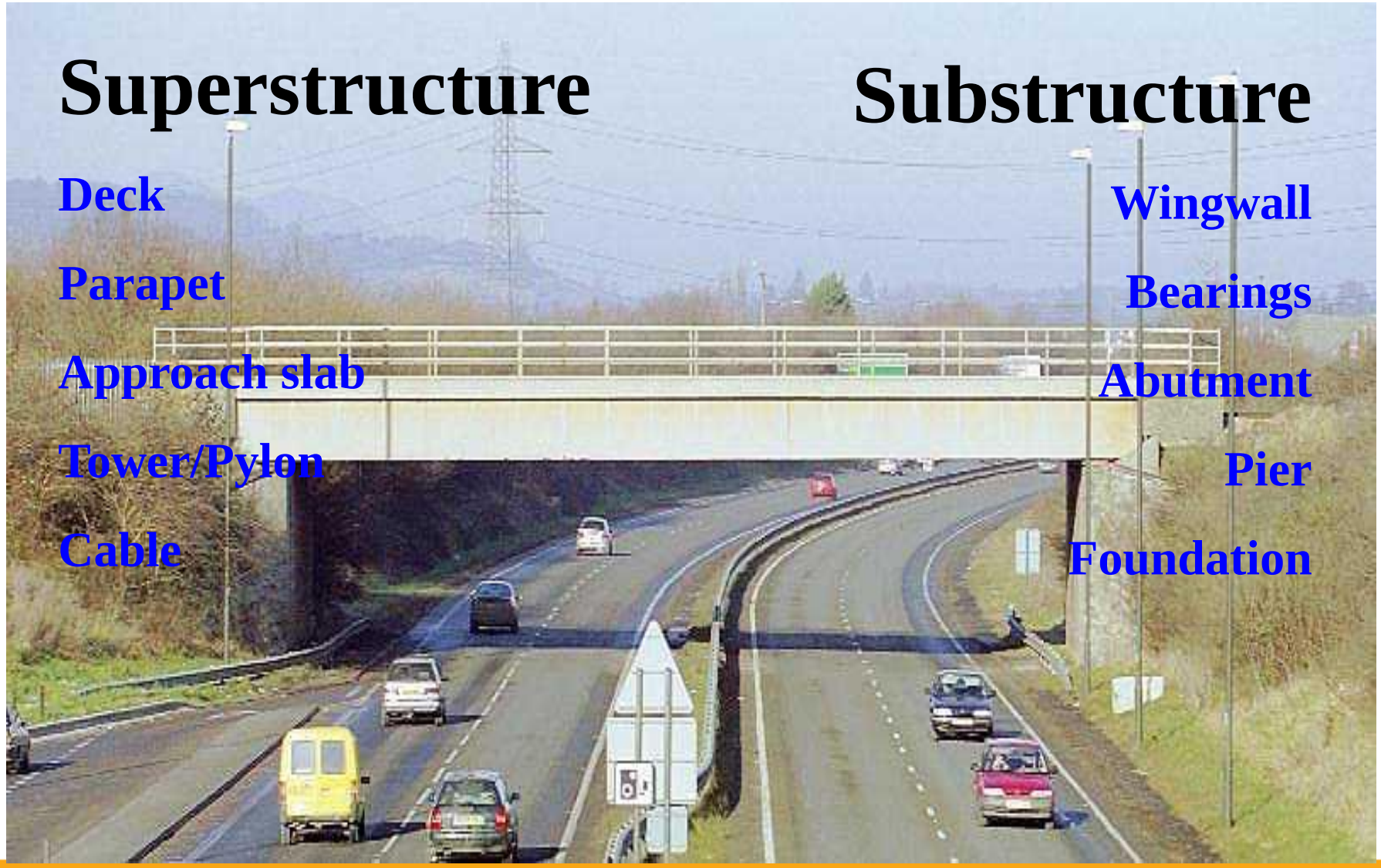
BRIDGES COMPONENTS

Bridges is a structure where their component perform each other with the environments.

They have three main component in the bridges construction;

- Superstructure
- Substructure
- Others

Bridge Components



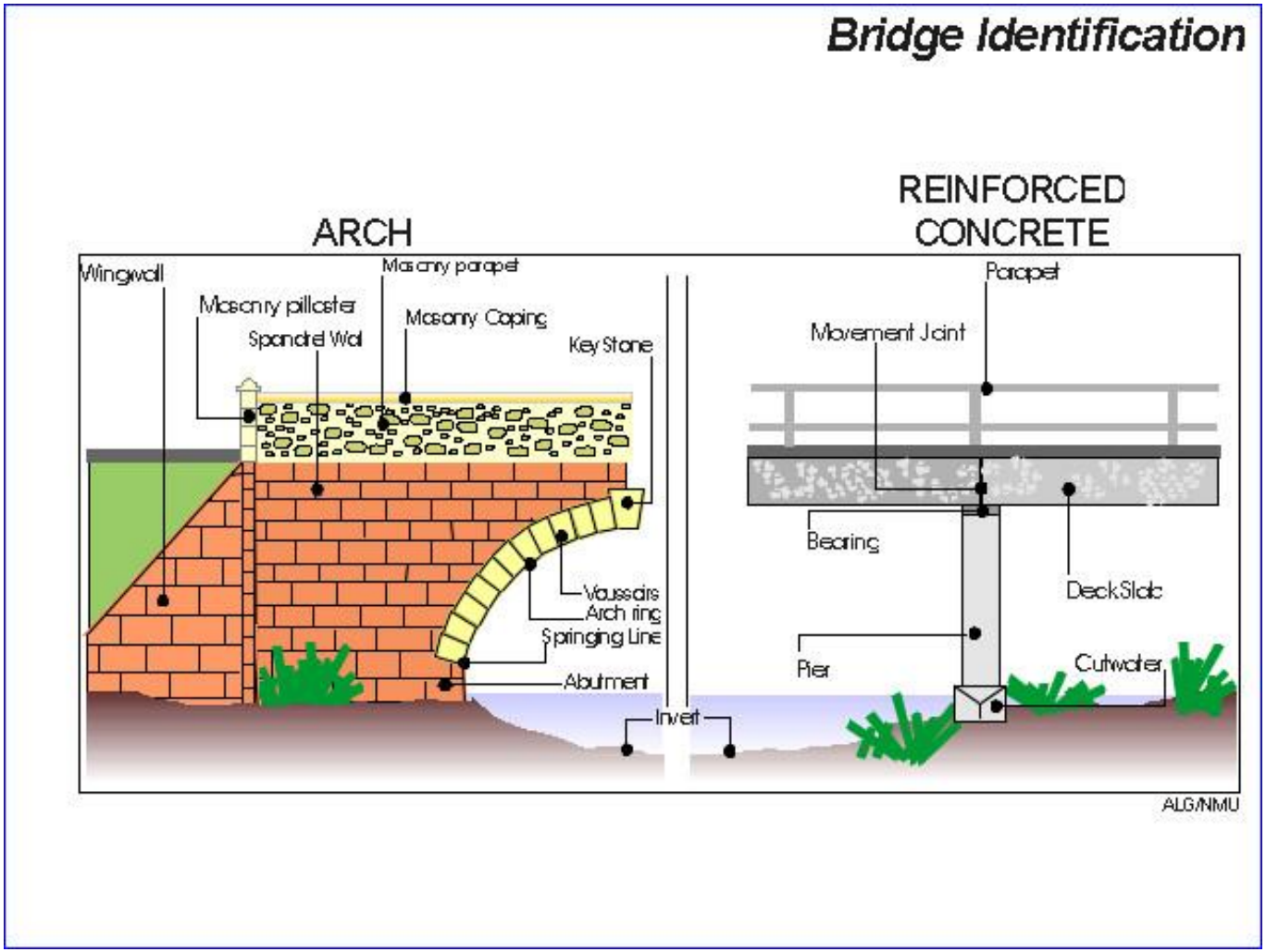
Bridge is the combination of many components that interact each other and the environment. These components can be categorised into 3 groups;

i. Substructure

ii. Superstructure dan

iii. Others component

Bridge identification



Substructure

Consists of structural components under the bearing. This includes;

- Abutments
- Piers
- Bearings
- Foundation system

Superstructure

Consists of structural components above the bearing. This includes

- deck slab,
- Beams or girders
- Diaphragms
- parapets

Miscellaneous Components

This includes

- Bridge surfacing or pavement
- Approach slab
- Expansion joints
- Drainage
- Slope & bank protection
- Railings
- Kerbs
- Sidewalks…etc

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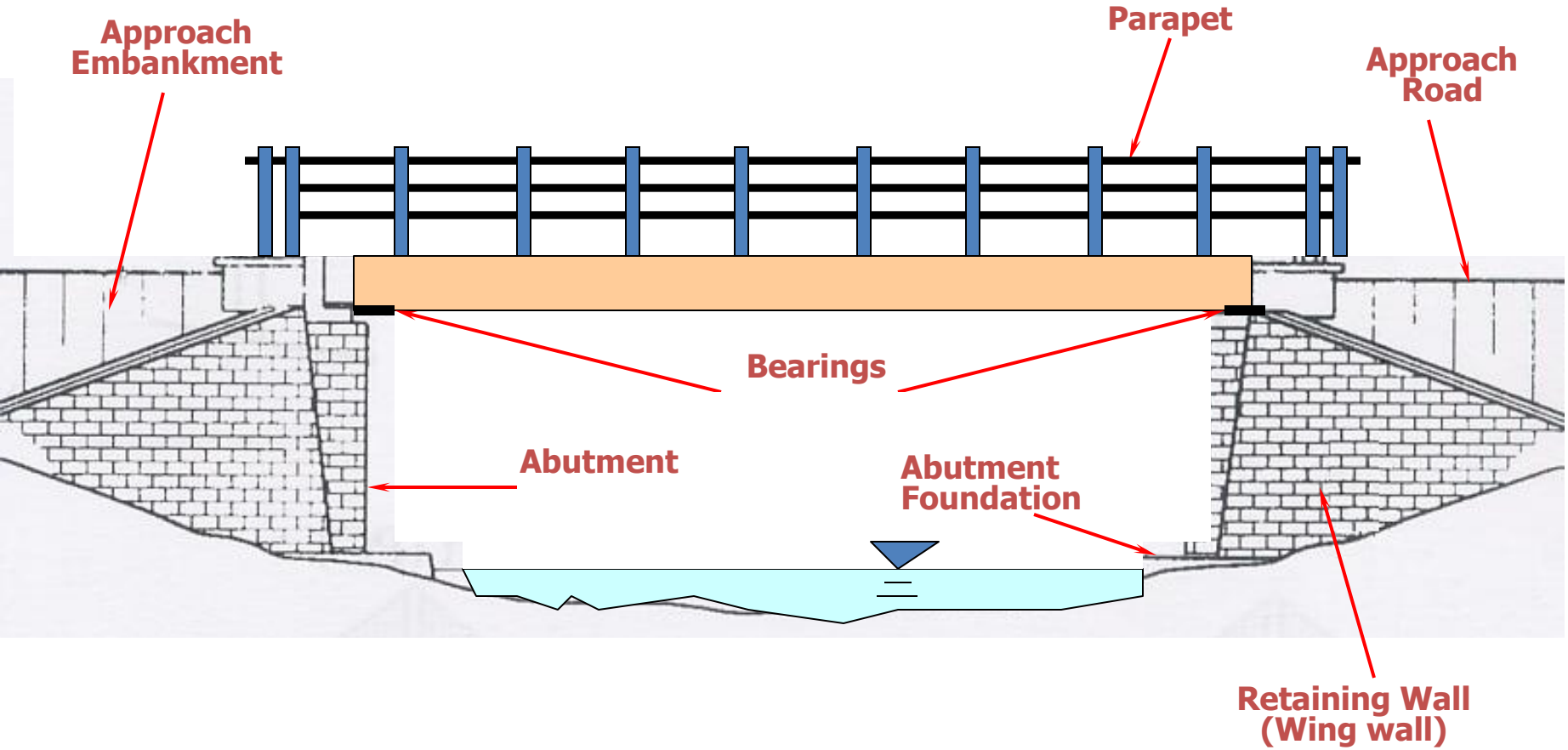
To improved


Approach Embankment
Parapet
Approach Road
Bearings
Abutment
Abutment Foundation
Retaining Wall (Wing wall)


parapet/railing
deck
bearing
approach slab
wingwall
abutment
foundation

abutment

pier

deck

deck

pier

Substructure

Consists of structural components under the bearing. This includes;

- Abutments
- Piers
- Bearings
- Foundation system

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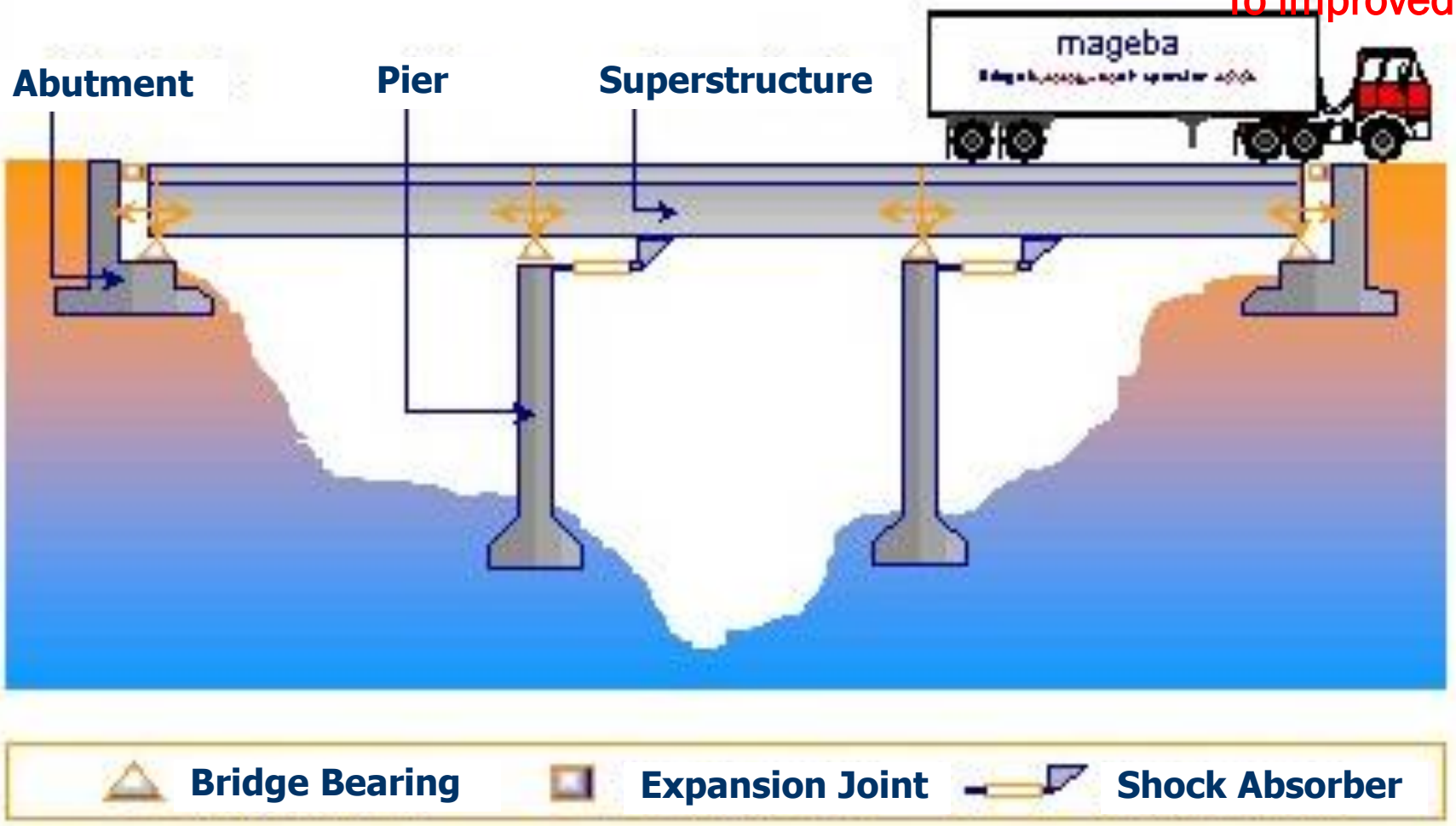
To improved


Abutment
Pier
Superstructure
mageba
Bridge Bearing
Expansion Joint
Shock Absorber

Abutments

The end supports of the bridge superstructure.

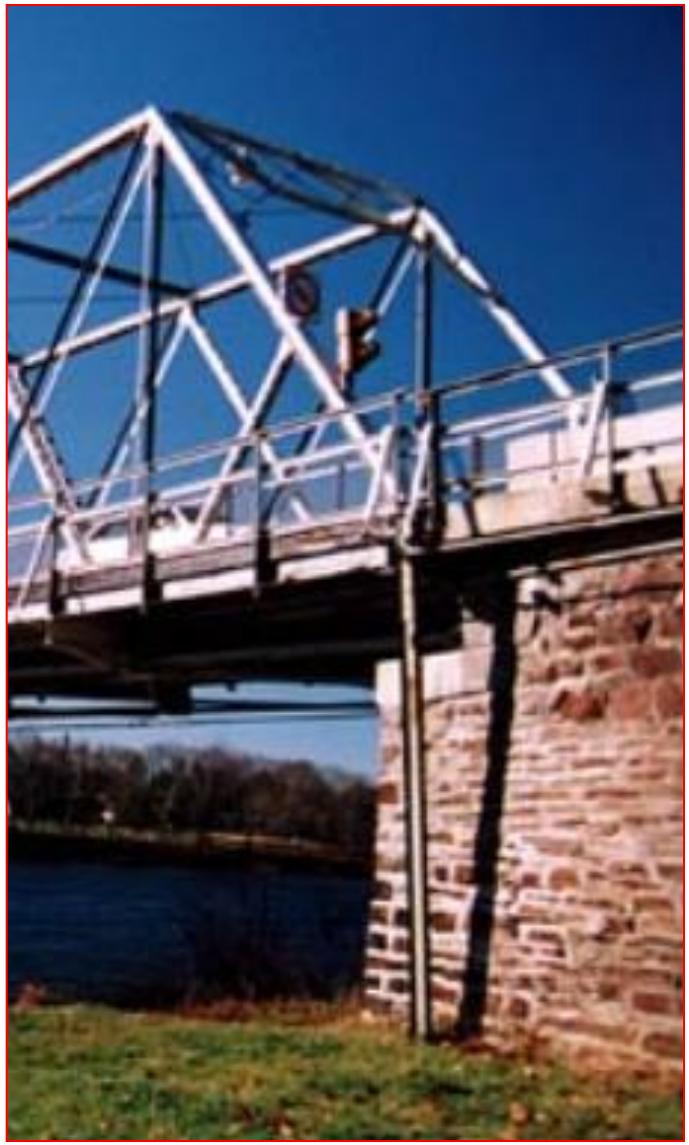
Providing the following purposes;

- To transmit the reaction of superstructure to the foundations
- To retain the earth filing
- To connect the superstructure to the approach roads

Common types of abutments are;

- Bank seat
- Retaining wall
- Pile bents

Details of these are given in the notes



TYPES OF ABUTMENT

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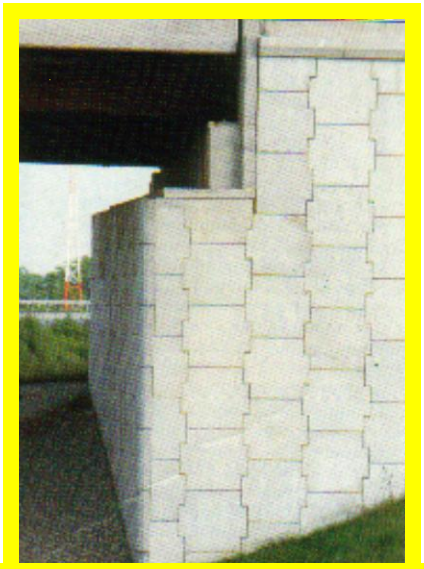
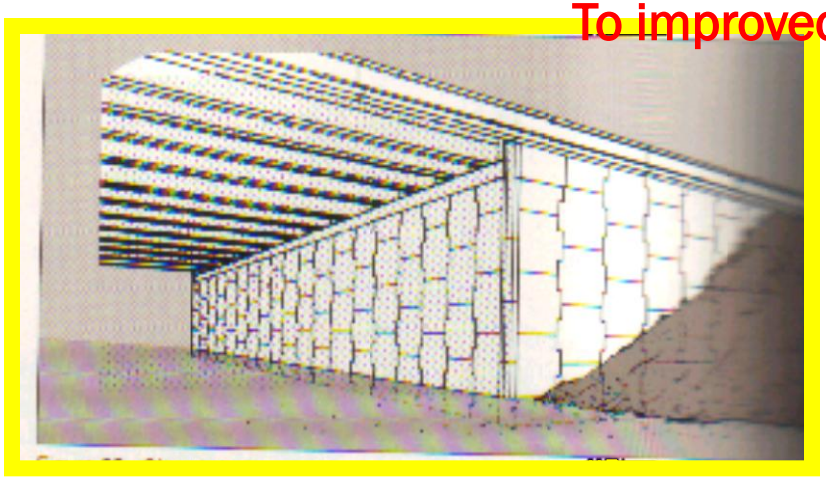
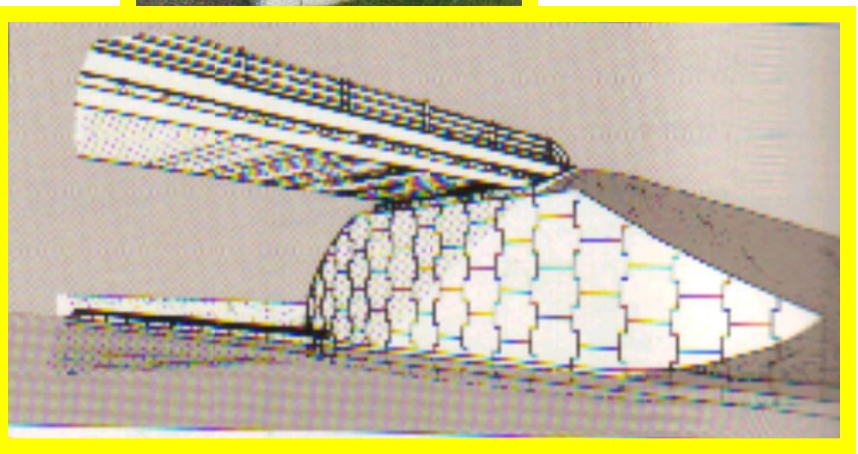
To improved



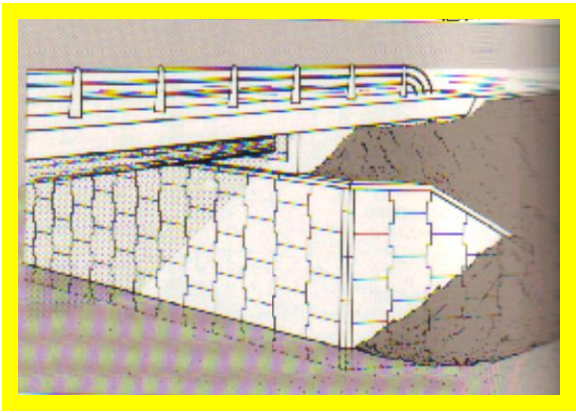
BANK SEAT



CLOSE ABUTMENT WITH RETURN WALL



OPEN ABUTMENT WITH CURVED WING WALL



OPEN ABUTMENT WITH OBLIQUE WING WALLS

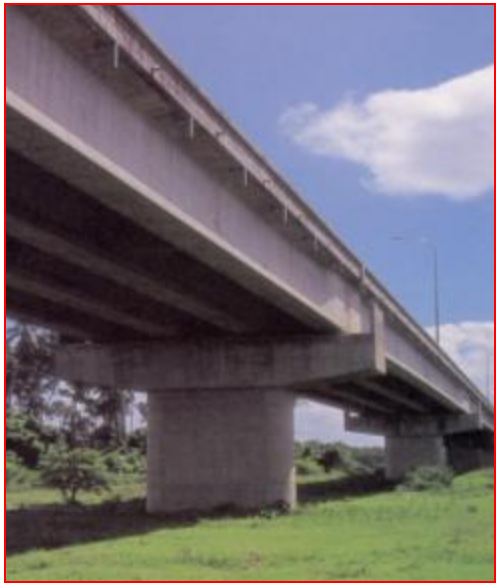
TYPES OF ABUTMENT(Cont'd)

Other type of abutment

- Cantilevered Abutment
- Counterfort Abutment
- Abutment Homogenous with superstructure
- Special Abutment

Piers

An intermediate support for the superstructure. Piers allow the total length of the bridge to be devided into viable span lengths.



Common types of piers are;

- Wall type
- Pile bents
- RC frame on pile foundation

PIERS

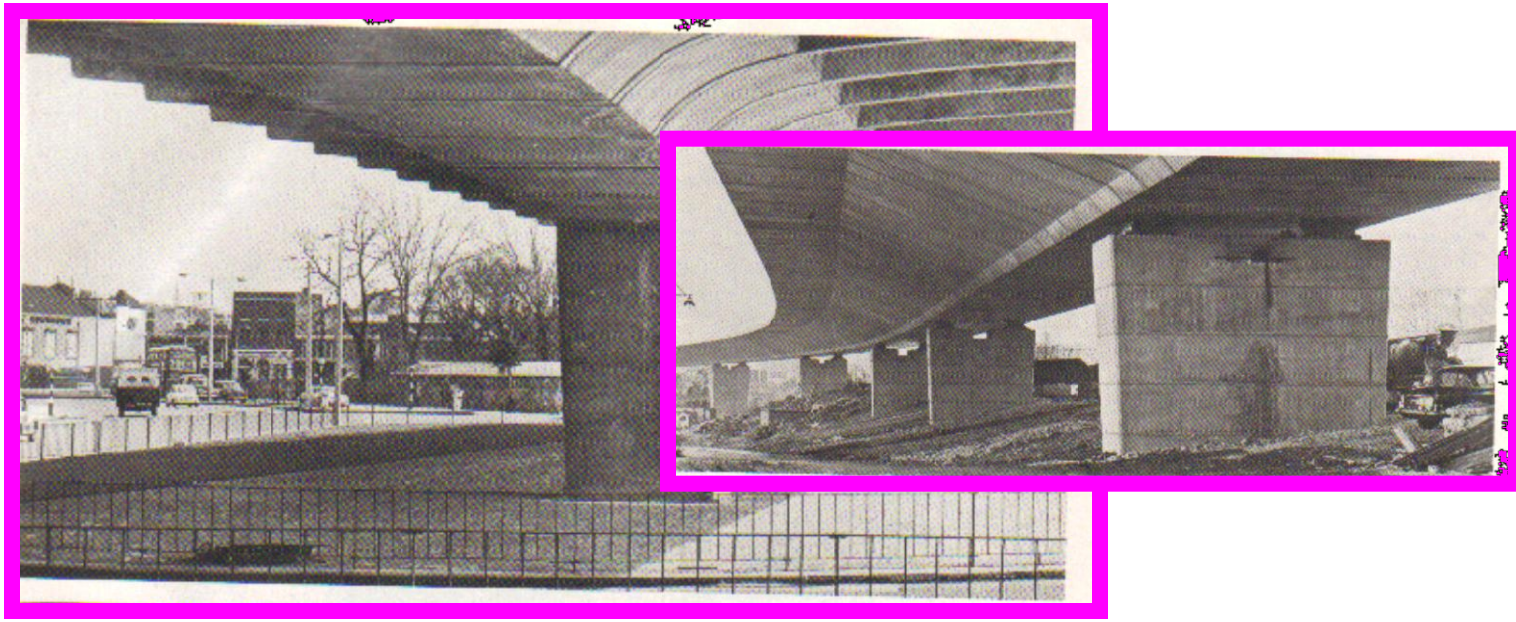
Function:

- To support the superstructure within interior spans.

Types;

- Cantilevered piers
- Piers homogeneous with deck
- Truss type piers
- Piers made for foundation piles

Beam & Deck



Bearings

Provided over the supports (piers and abutments) for the following purposes;

- Transfer loads from superstructure to substructure
- To accommodate expansion and contraction movements
- to damp down vibrations and minimize the effect of impact loading

Bearings

Can be either free or fixed

- **Free bearing allow displacement and rotation movements**
- **Fixed bearing allow only rotational movement**

Can be made from rubber of steel.

Bearing

- Situated between Superstructure and Substructure

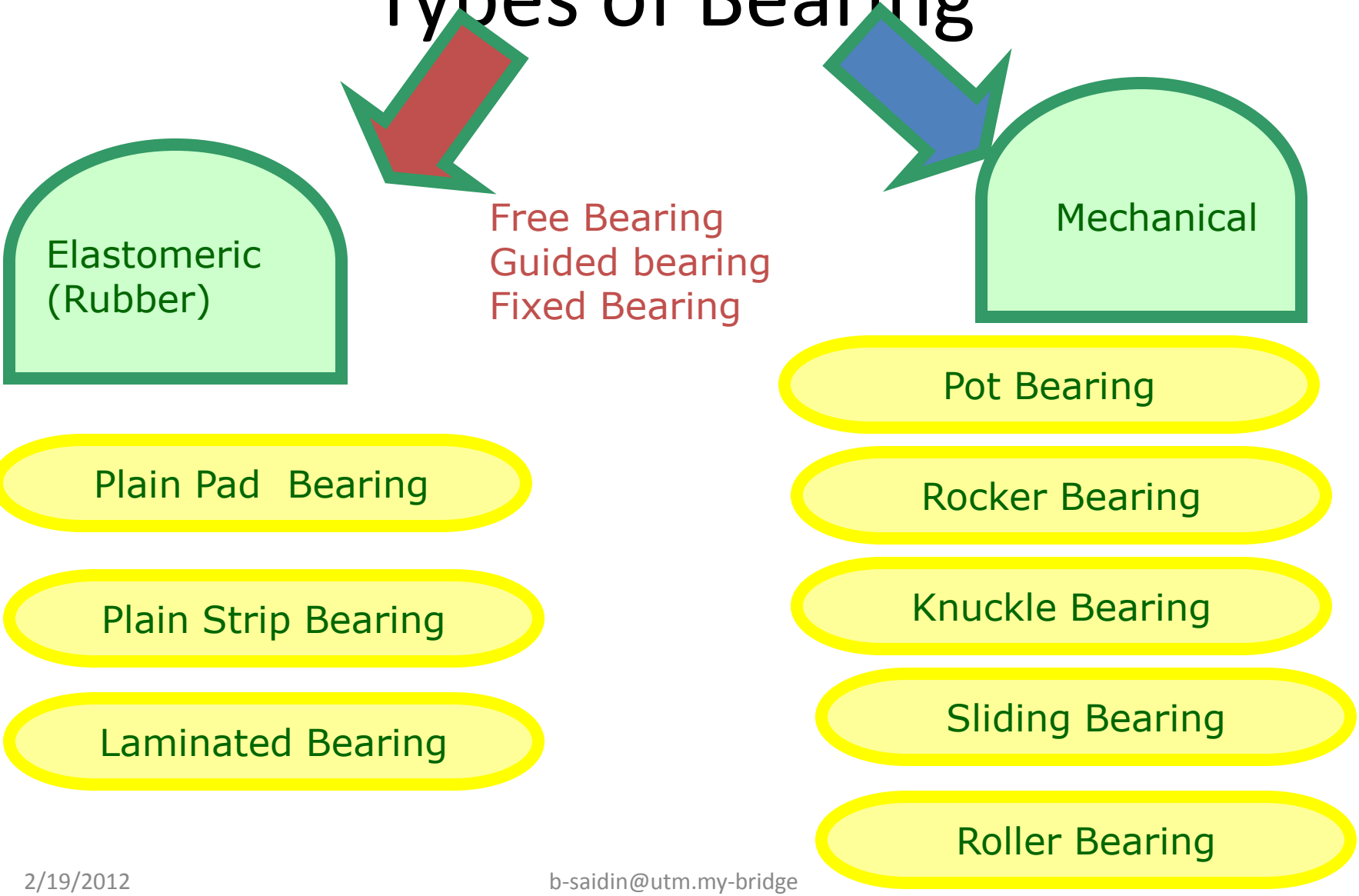
Functions

i. To support s/structure & transmit load to substructure

ii. to allow rotational movement

iii. to provide a horizontal restrain the movement.

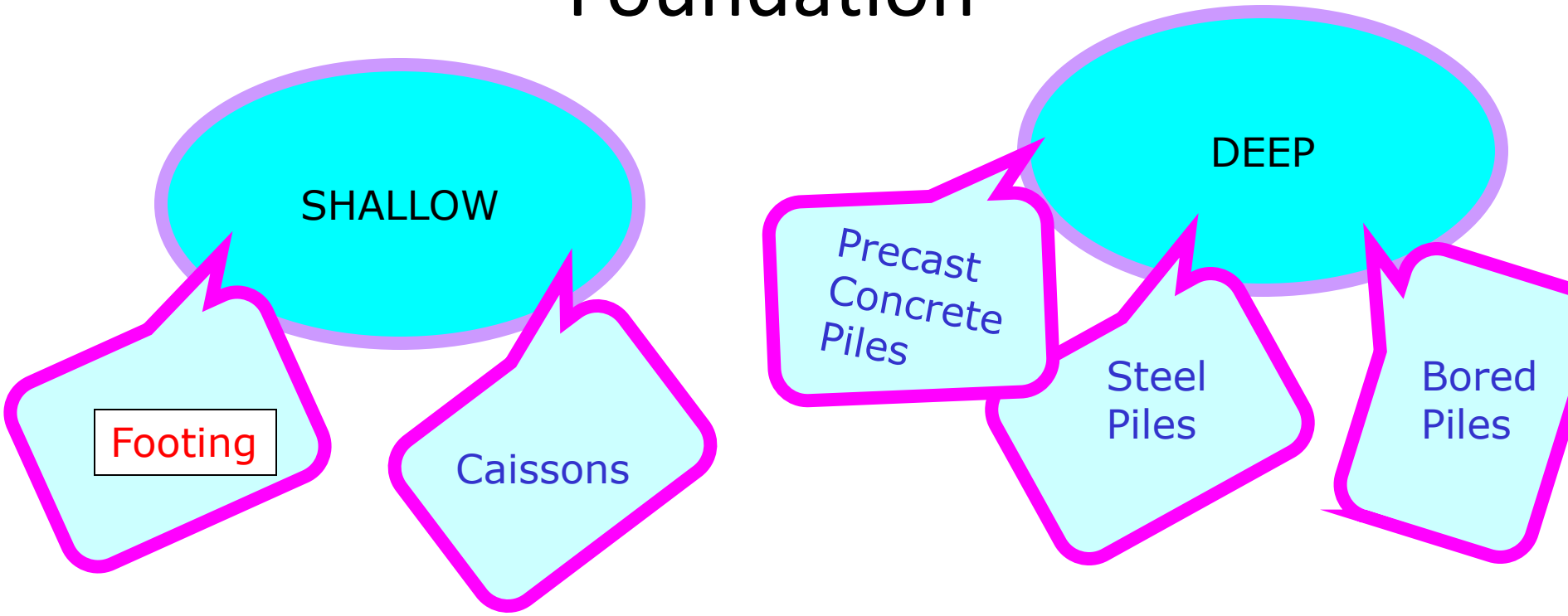
Types of Bearing



Foundations

- Supports all vertical load and horizontal forces from sub and superstructures
- Type of foundation depends on the soil type underlying the foundation
- rock or soil with enough baring capacity, pad or strip footing are used
- Softer soil with inadequate bearing capacity, piles are needed

Foundation



Transfer loads to soil formation
Defend on the soil condition

Bridge Pilings

Long precast concrete piles are driven into the ground using either an air-powered or diesel powered pile driver.

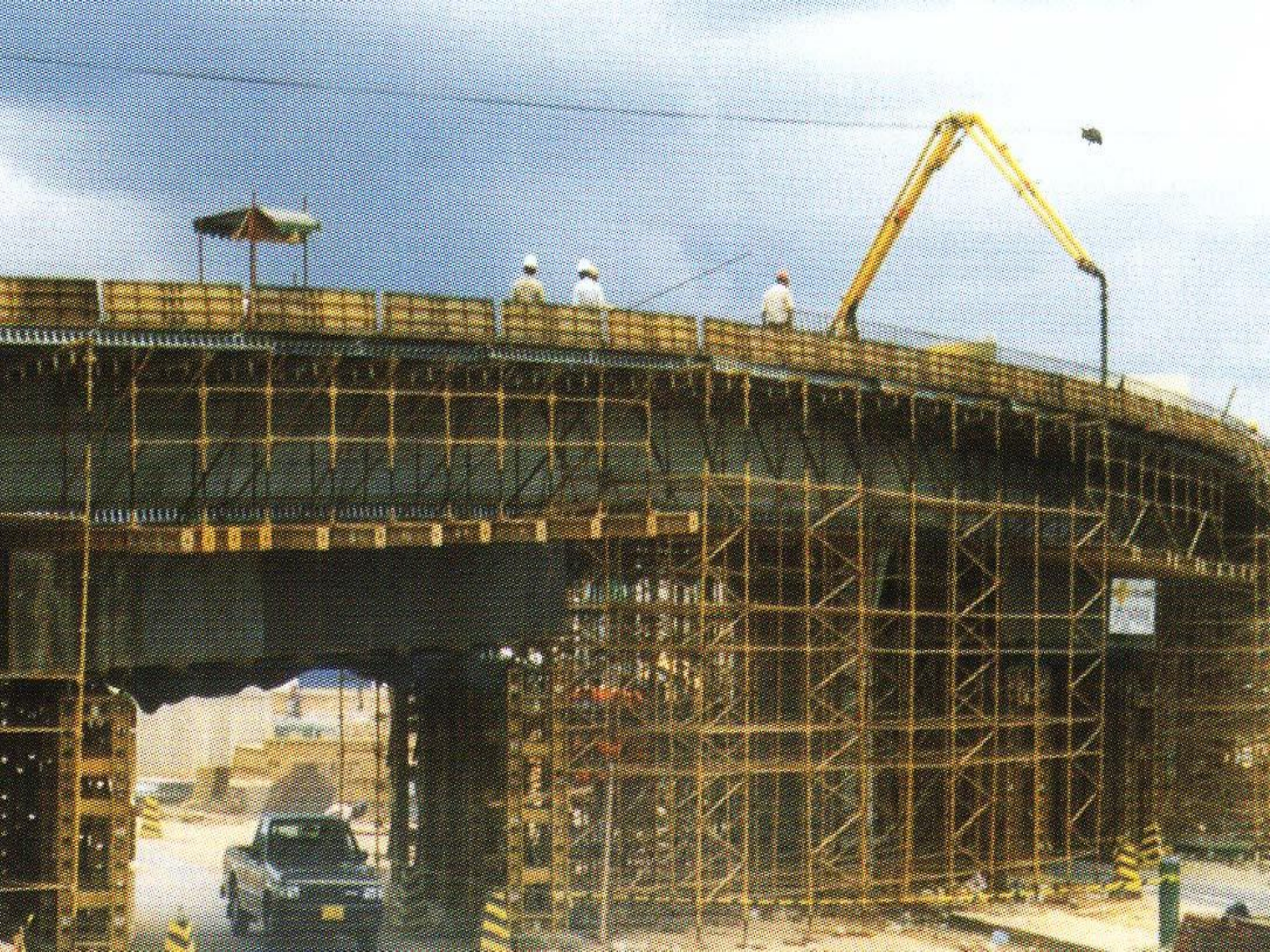
These pilings carry the weight of the bridge and traffic down into the soil below.

Bridge Pilings

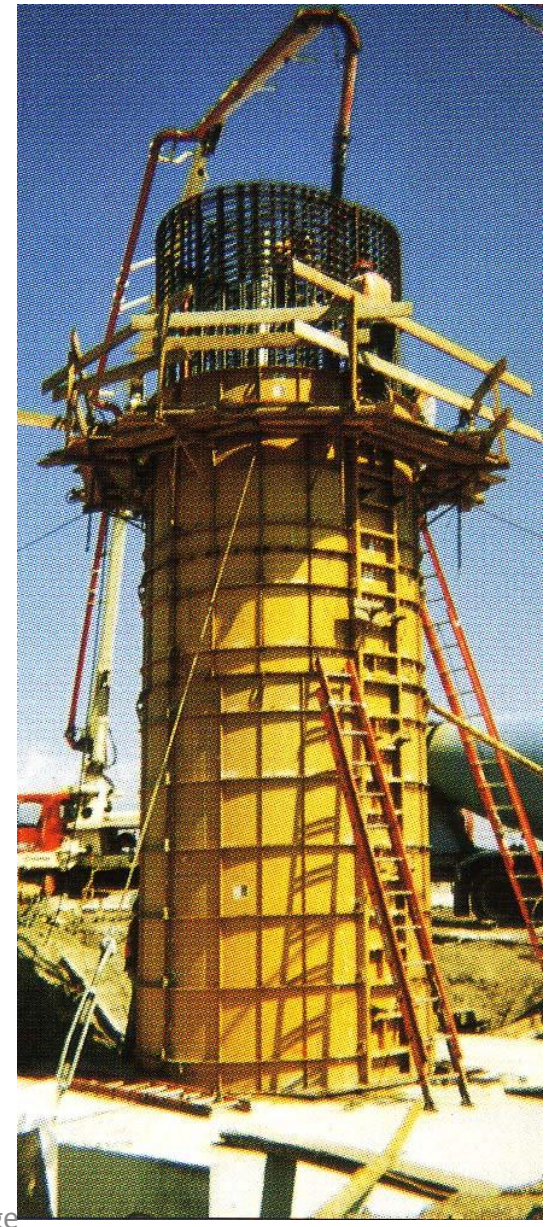
In some cases, the piles must be driven very deeply into the ground in order to reach a layer of soil or rock that will properly support these loads. In rocky soil, shorter steel pilings are used.

Each row of piling is called a bent. A concrete cap is poured on top of each pile, allowing bridge girders and the concrete bridge deck to be placed on top of the caps.

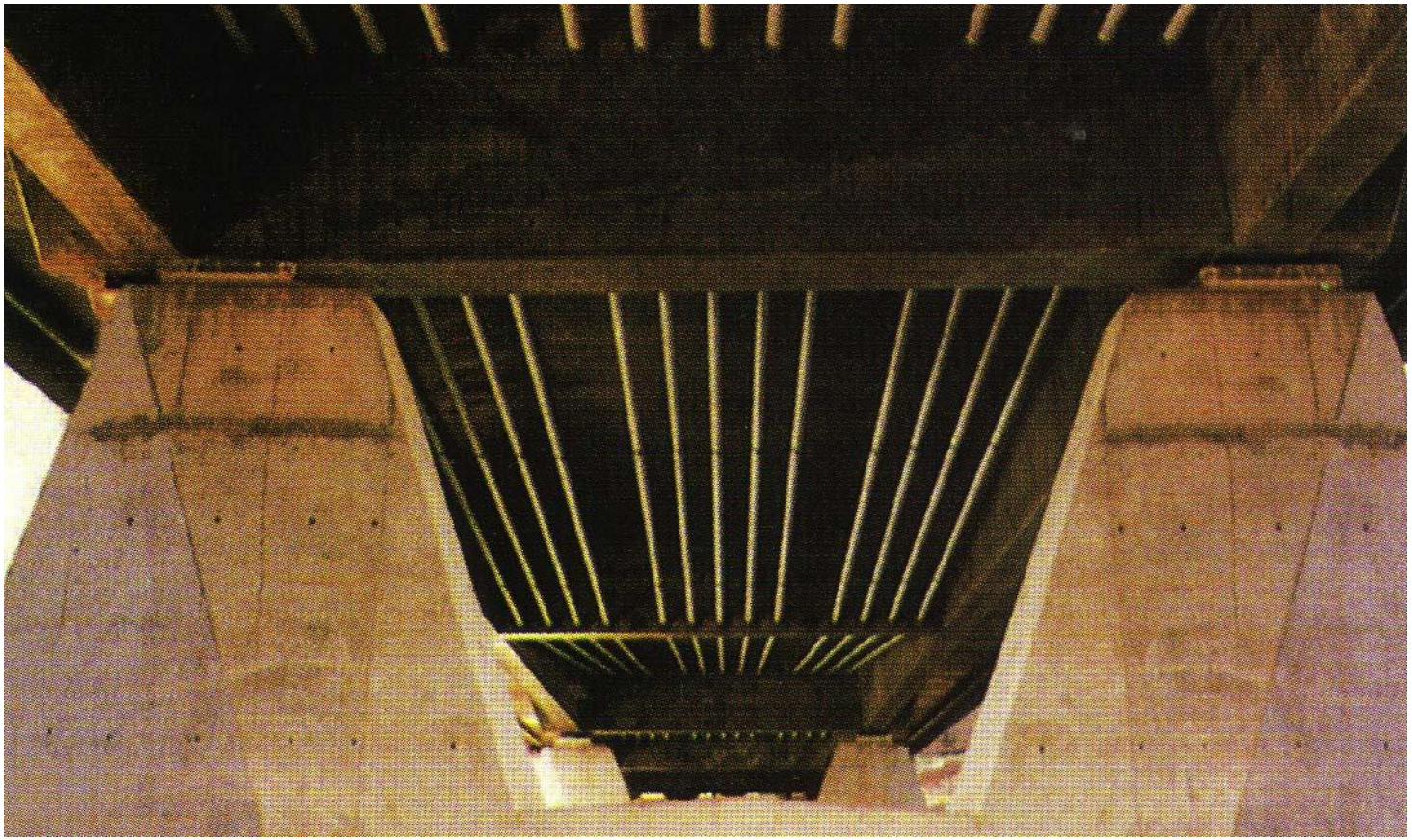
Retaining wall



pier



'Bearing'



Superstructure

Consists of structural components above the bearing. This includes :

- **deck slab,**
- **Beams or girders**
- **Diaphragms**
- **parapets**

Bridge Components (Deck)

Deck Slabs

Deck forms the platform which carries the traffic and distributes the live loads and dead loads to the supporting members.

Deck can be in the form of concrete, steel or timber. However the selected for the deck is depend on the type of the floor and beam to be use

Concrete decking can be in the various types.

Superstructure Component

Deck Slab

Important/valuable

Surfaces layer after beam heap under abutment.

Function:

- The transfer of isolated loads and distributed loads from the lain to the beams
- When connected to the beam, the slab combined with them to take up the vertical & horizontal loads on the bridges deck.
- It acts with the cross members for the transverse distribution of the loads to the beam.

SUPERSTRUCTURE

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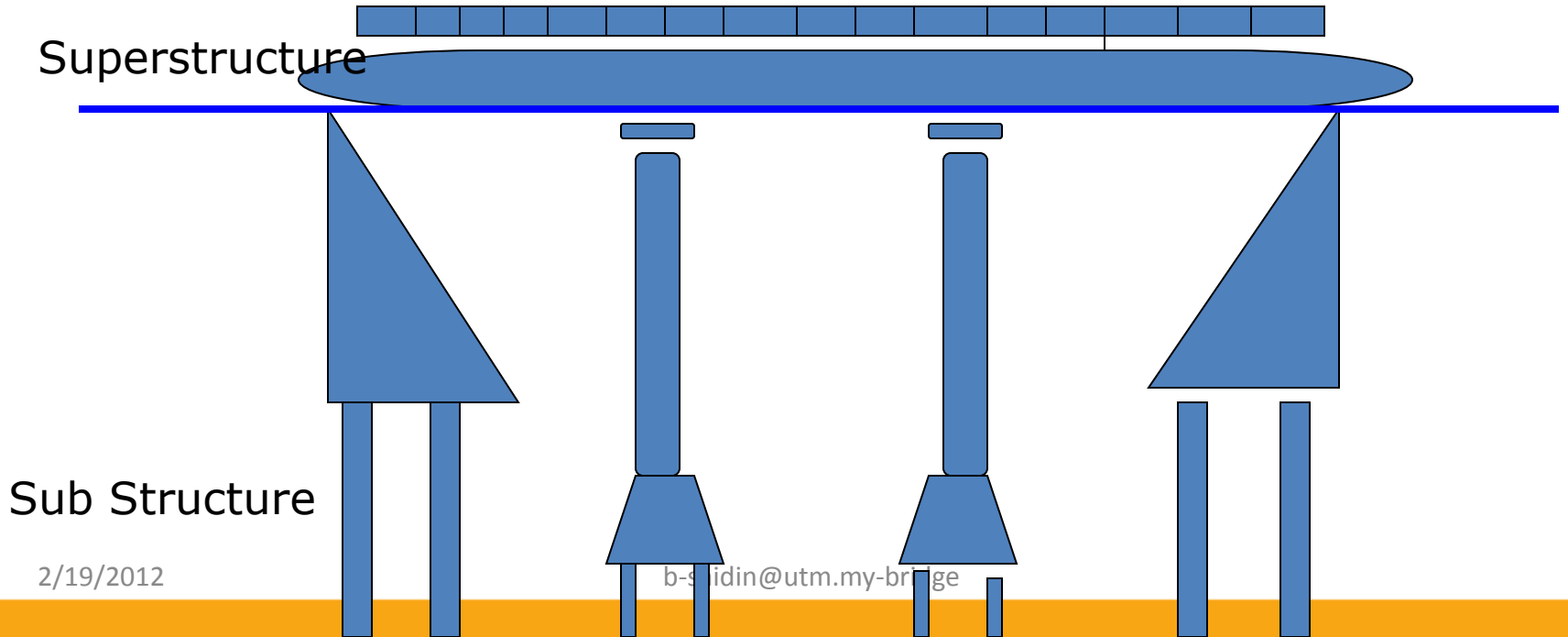
To improved

- Definition: The construction build above the other construction
- Component build above the bearing



Type of Deck

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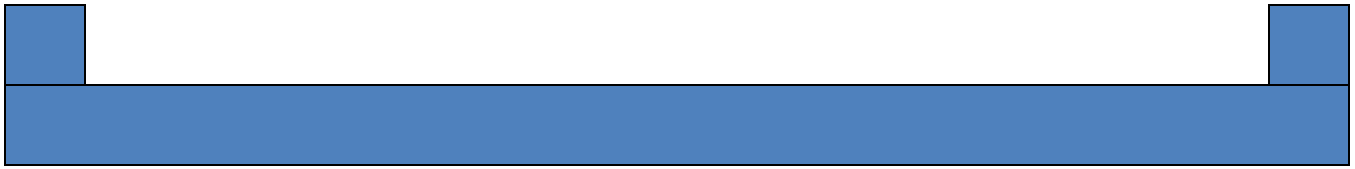
To improved

1. Reinforcement Concrete Slab

Simplest form. Economic for short span and connected with the abutment.

Suggested for span up to 8 meter

Max depth: 800 mm without voids



Bridge Components (Deck)

Beams and Girders

Is the main load-carrying elements of bridge superstructure. Can be in the form of steel or concrete.

Concrete beams can be :

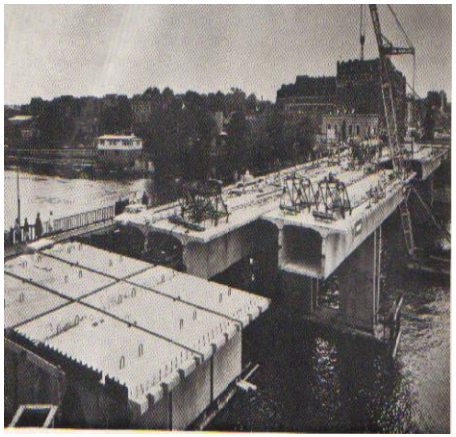
- Cast in situ
- precast
- Post-tensioned prestressed
- Pretensioned prestressed

Type of Slab

2. Reinforcement Concrete Slab (RCB)
3. Precast Reinforcement Concrete Beam
4. Voided Concrete Slab

Span range 10 to 20 meter

Advantages
- Simple construct
- Normal concrete required
- Minimum skill labour
-Smaller self weigh



Type of Slab

5. Prestressed Concrete I Beam

Produced by factory – Standard size and length

To help the bridges can be built quickly, efficiently & repetitively

Transportation- to carrying beam makes the distance between factory and bridges site- effect cost.

Type of Slab

5. Prestressed Concrete I Beam

Type of precast prestressed concrete beam may be used;

Prestressed Concrete M Beam- max. span 6 – 16 m
Prestressed Concrete T Beam – max span 15-29 m
Prestressed Concrete box Beam – max span 14-36 m
Prestressed Concrete U Beam – max. span 17 – 36 m

Type of Slab

5. Prestressed Concrete I Beam

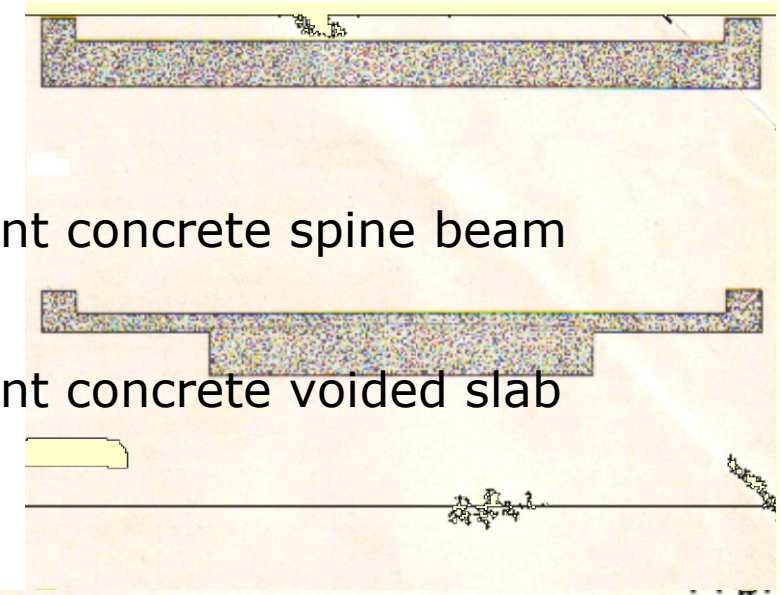
Construction method;

Precast prestressed beam which are placed closely side by side and topped with concrete to finally behave as an integral slab.

Type of Slab

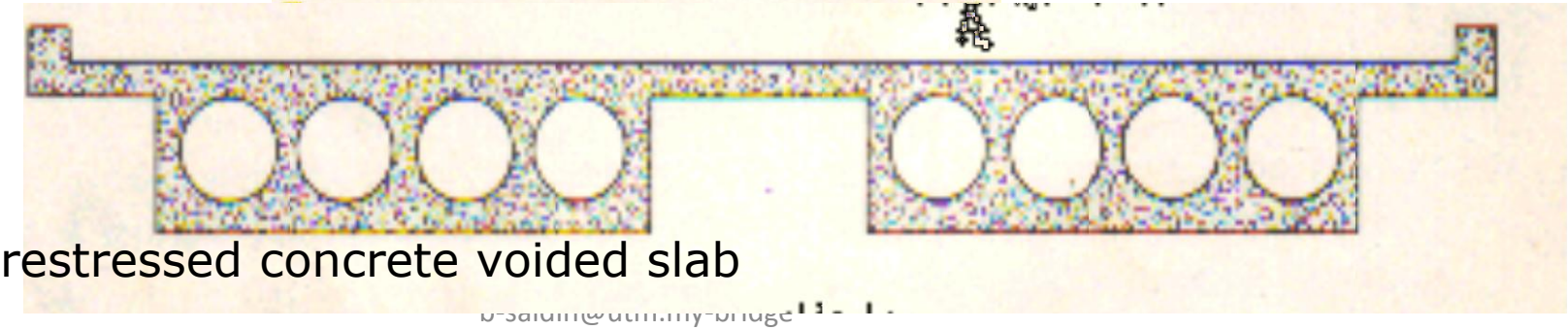
***
To improved

Reinforcement concrete slab



Reinforcement concrete spine beam

Reinforcement concrete voided slab



Prestressed concrete voided slab

Type of Slab

6. Steel beam and concrete slab
7. Steel beam encased and slab
8. Steel Buckle Plate (SBP)
9. Steel Trough (ST)
10. Timber Deck (TD)

Beam and Girder

Material

concrete; cast in situ precast, post tensioned prestessed & pre-tensioned prestressed.

Ex: Rectangular Beam, Inverted T' Beam,'I' Beam,'M'Beam & 'U' Beam –Steel ; Rolled 'I' Beam, Riveted 'I' Beam and Welded Plated Girder.

Transportation by road, barge, boat or railway.

TYPE AND SPAN BEAM

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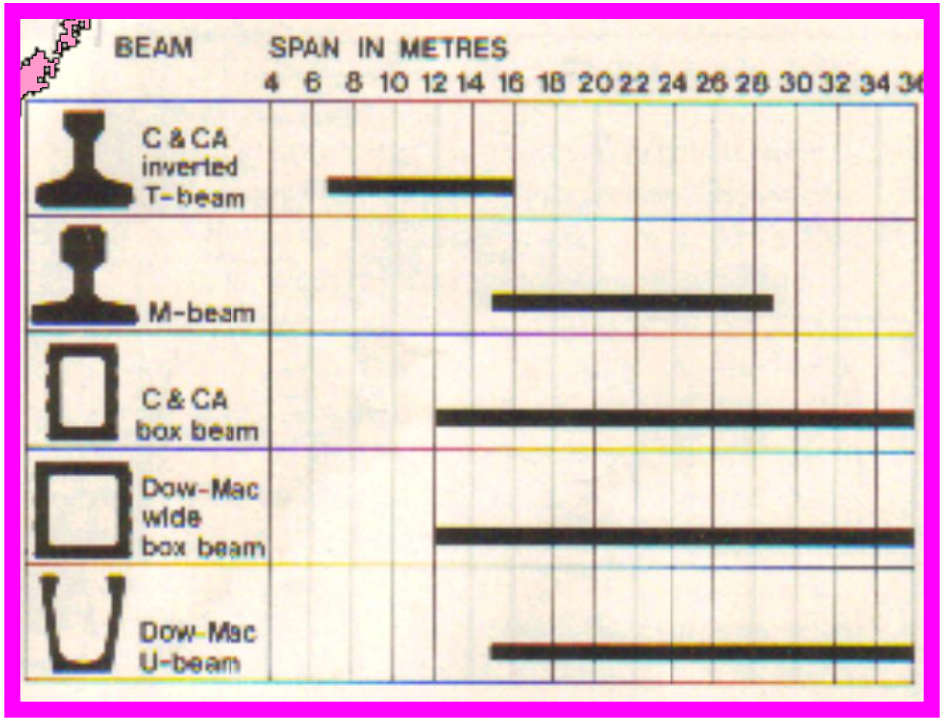
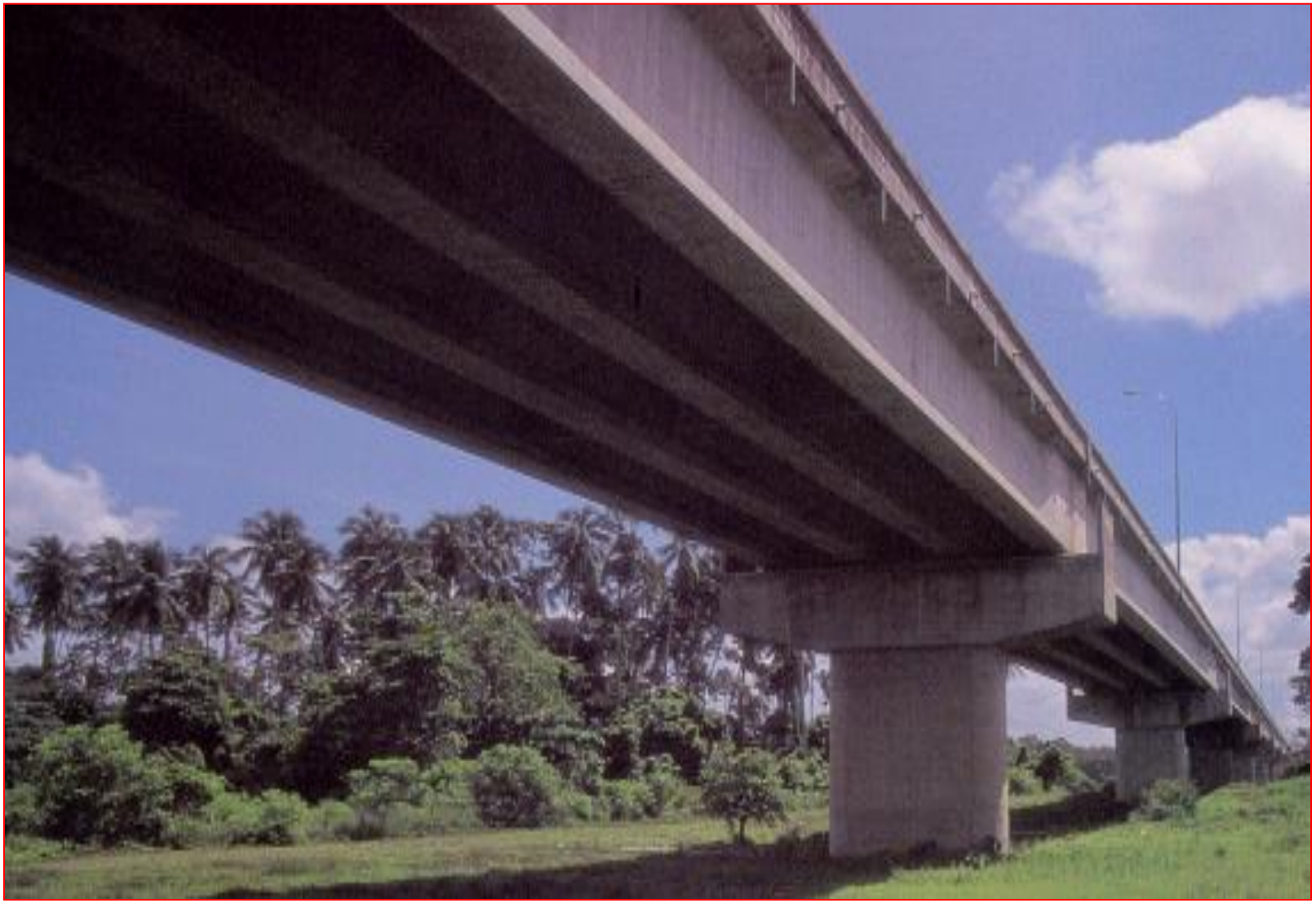
To improved



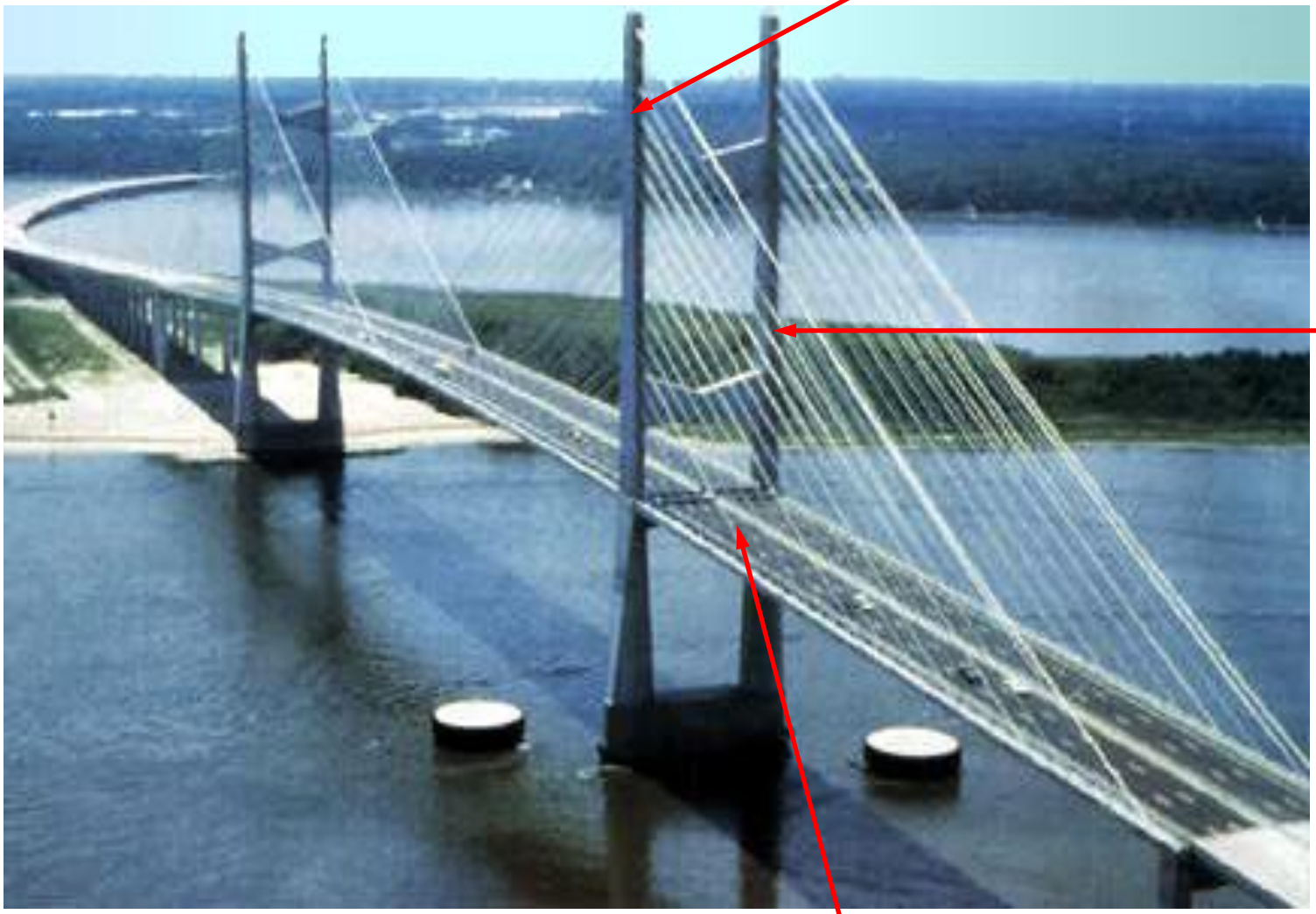
Bridge Components (Deck)

Bridge Components (Deck)



Bridge Components (Deck)

pylon



cable

deck

Diaphragms

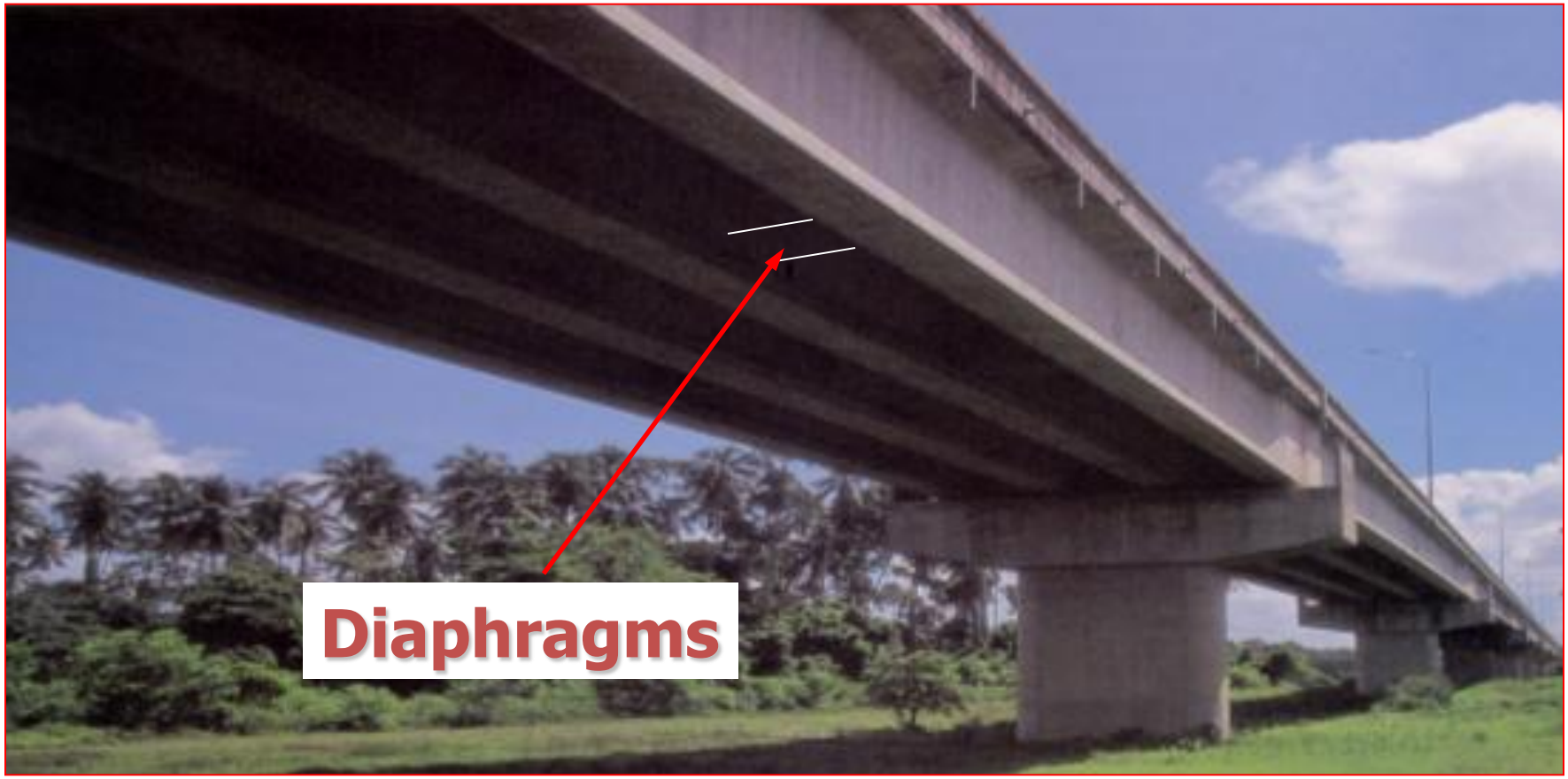
Transverse beams connecting the longitudinal girders to prevent movement of girders with respect to each other and provide stiffness in the transverse direction.

Diaphragm

- Horizontal beam to link between longitudinal2 girder
- To avoid the movement between girder

- Types;
  - i) end diagram,
  - ii) intermediate diaphragm

Diaphragms



Parapet

- Vertical wall located at the outmost edge of the bridge deck.
- Provided for vehicular and pedestrian safety.
- Designed to take impact load
- Preventing vehicles from falling off the bridge

Parapet

- Function: To prevent pedestrians from accidentally falling from a bridge deck
- Type ; fundamental important of bridge.

New Jersey
Parapet with
Galvanized railing

Standard Kerb
With Steel Railing

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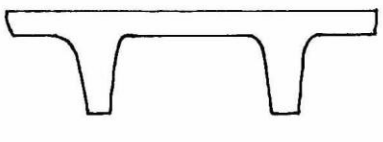
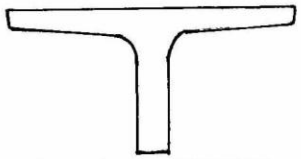
To improved

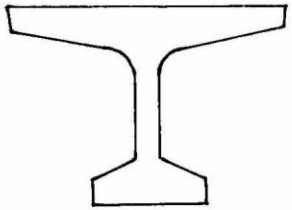
Types of beam design for prestress bridge



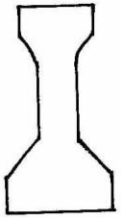
Rasuk *Double Stem*



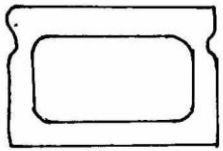
Rasuk *Single Stem*



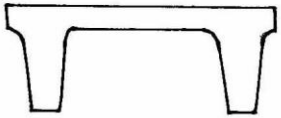
Rasuk *Bulb Tee*



Rasuk Berbentuk I



Rasuk Kekotak



Rasuk *Channel*

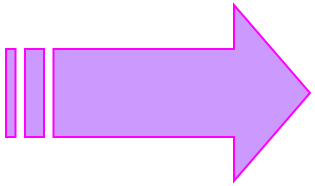
Loading of bridge components

Bridge construction

Miscellaneous Components

This includes

- **Bridge surfacing or pavement**
- **Approach slab**
- **Expansion joints**
- **Drainage**
- **Slope & Embankment protection**
- **Railings**
- **Kerbs**
- **Sidewalks…etc**



Expension Joint :

-Asphaltic Elastomeric joint
-Reinforced Elastomeric joint
-Covered Gap Joint
-Compression Seal Joint

Surface or pavement

- **Forming the wearing surface of the deck**
- **Concrete or steel decks are typically covered with premix surfacing**

Approach Slab

- **Joining the both side roads**
- **Normally provided for short length of the approach road adjoining the bridge abutment**

Expansion Joints

Provided at joints between span members to accommodate various movements at joints.

Problem of expansion and shrinkage

Movements due to traffic

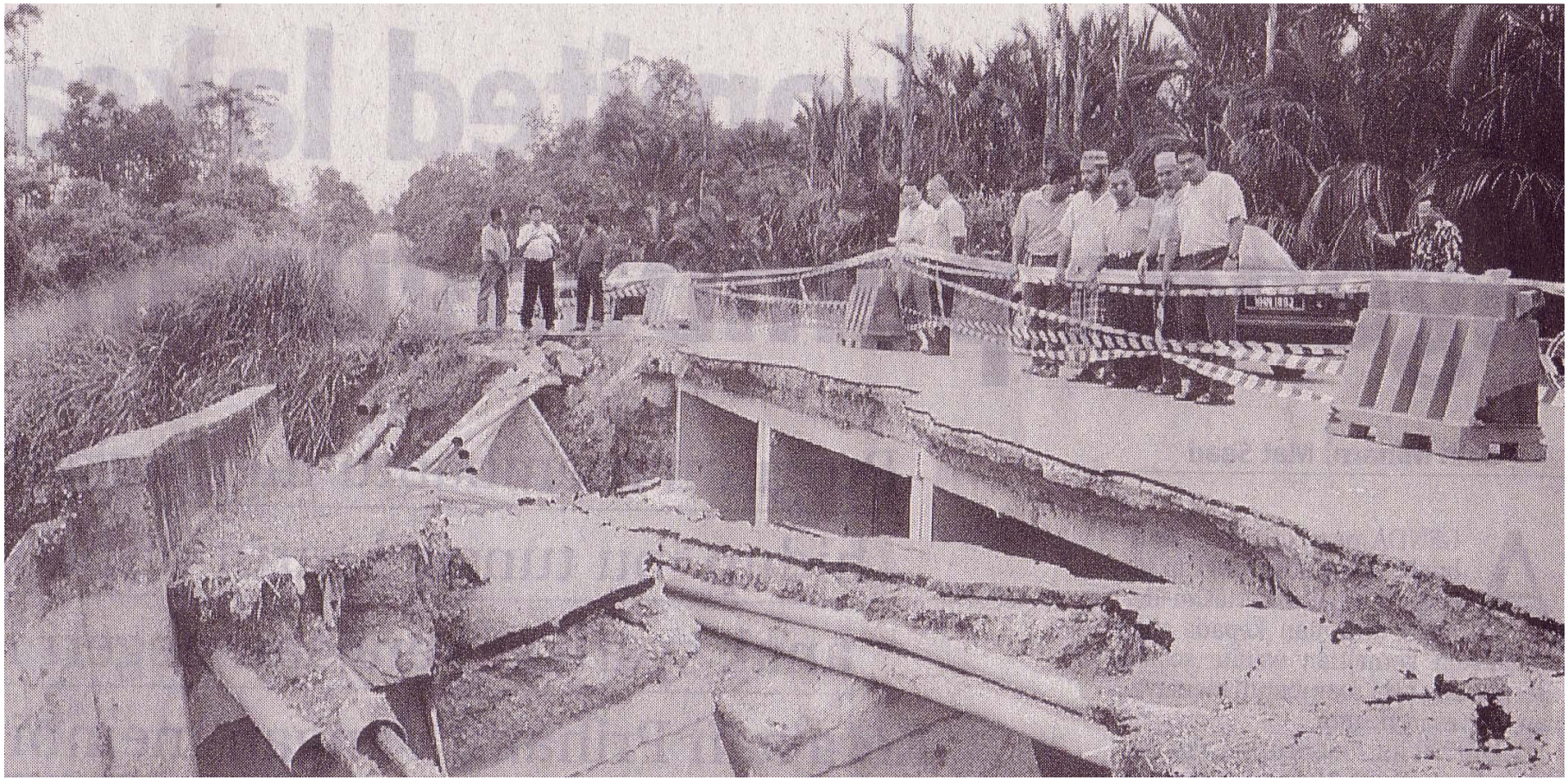
Details of bearing are given in the note

Drainage

- Allowing water from bridge deck to be drained out
- Protecting the deck and pavement from damage due to combine effect of traffic and water

Embankment and slope protection

- It is a sloped fills or cut in the vicinity of the structure
- The surface protecting the effect of errosion or scour
- Most commonly used are rubble pitching and gabion matress



THANK YOU