

University of Gondar

Institute of technology

School of civil and hydraulic engineering

Department of civil engineering

Introduction to bridge engineering

By

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Gondar ,Ethiopia 2019

Chapter one
TYPES OF BRIDGE

1. **INTRODUCTION**

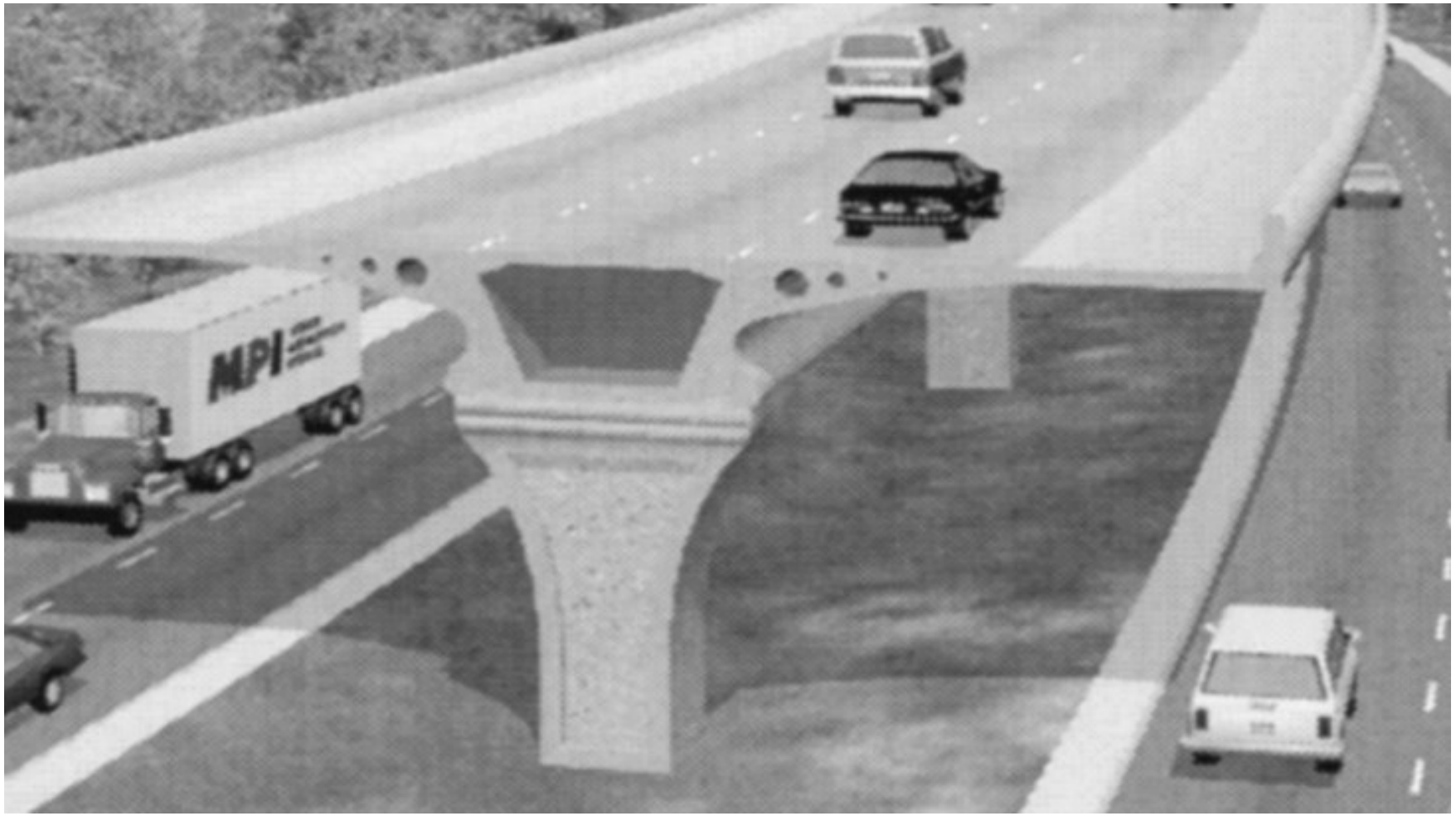
Bridge Engineering is field of engineering which covers:

- Planning,
- design,
- Construction, operation and maintenance of bridge structures.

A bridge is a structure which carries uninterrupted flow of traffic across any obstacle like.

A fly-over is a structure which allows traffic over and any other traffic flow or

Box girder Fly over



Conti….

A bridge is a key element in a transportation system for three reasons:

- It likely controls the capacity of the system.
- It is the highest cost per mile of the system.
- If the bridge fails, the system fails.

Types of bridges

We can classifies bridge according to the following

1.length (span) of the bridge
2.Kinds of Traffic(function)
3.position of the bridge floor relative to the superstructure
4.Material and Fabrication
5.Structural System of superstructure
6.Horizontals arrangement
7. the degree of redundancy
8.Movement
9.Span arrangement

Classification based on length (span) of bridge

Bridge –any structure having an opening not less than 6000mm that forms part of a highway or that is located over or under a highway other wise culvert. According to the length of the bridge as

1.culvert (less than 6 m)

2.minor bridge (6 m to 60 m)

3.major bridge (above 60 m)

4.long span bridge when the main span is above

Culvert

- **Span range: up to 6 meters.**
- **Purpose: for cross drainage works.**
- **Mostly the streams are dry during most of the months of a year.**

Four major types of culvert

1. **Pipe culverts**
2. **Box culverts**
3. **Arch culverts**
4. **Slab culverts**

Pipe culvert



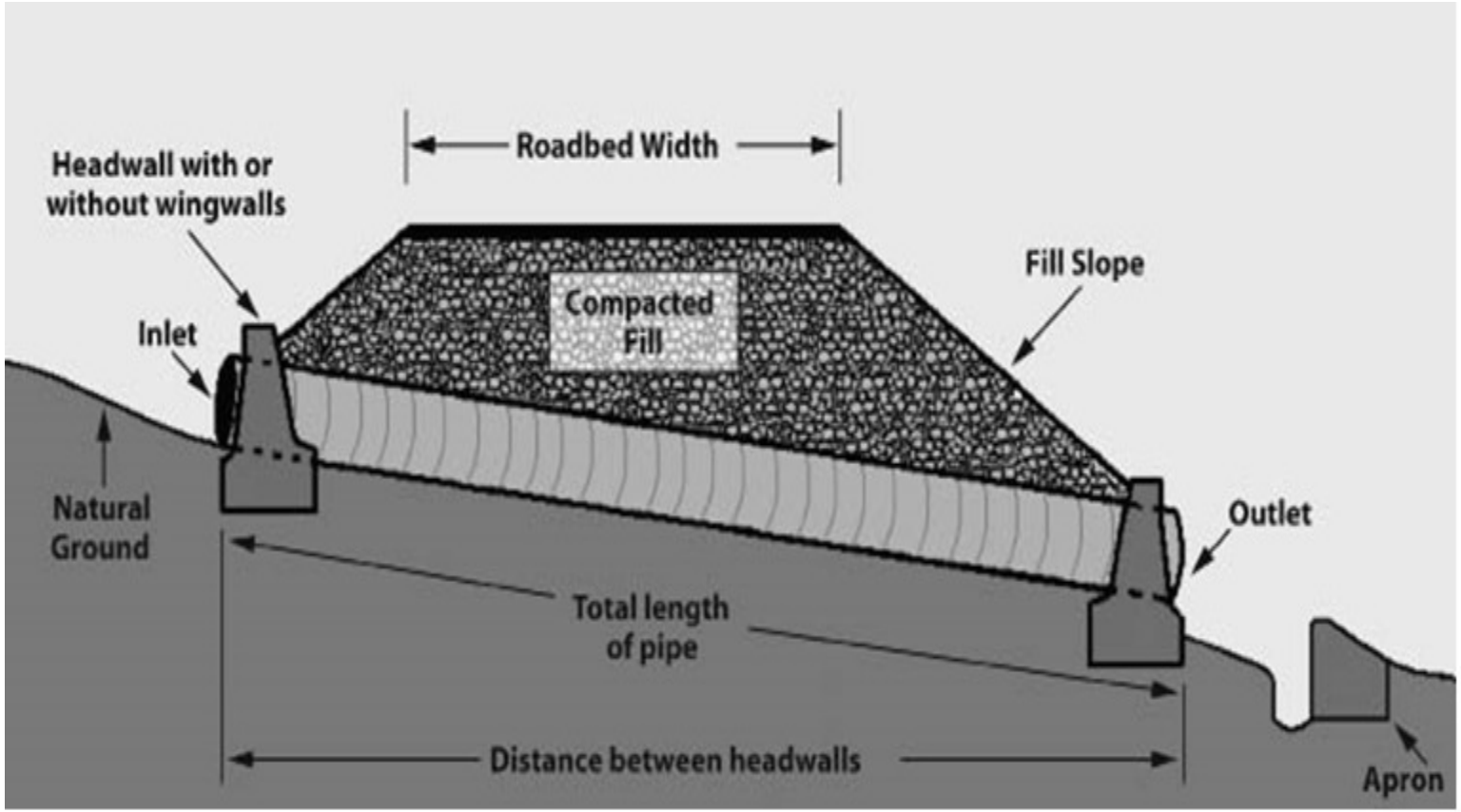
Conti…

- One or more pipes may be used; Exact number of pipes decided based on discharge of water that flow on the river.
- The diameter of pipe > 300 mm.
- Preferred when the discharge in the stream is low (say, about 10 m^3/sec)

Components of pipe culvert:

- Concrete bedding of suitable depth below the pipes.
- head wall The construction of head walls at the ends of the road formation width assists to retain the earth and prevents the stream water to damage the embankment.
- Earth cushion minimum specified depth should be provided at the top of the pipes.
- Material of pipe.
- Wing wall retain the embankments and

Pipe culvert along the longitudinal direction



Box culvert



Conti…

- May be square or rectangular openings with spans up to about 4m.
- The height of vent rarely exceeds 3m.
- The top of the box section can be at the road level or can be at a depth below road level with fill.

Components of box culvert:

- Concrete foundation bedding
- Wing walls
- Earth fill if necessary at the top of box section
- Barrel of box section accommodate the carriage way and the curbs.

Pre-cast box culvert



Box culvert with head and wing walls



Stone Arch Culvert



Arch Culvert

- Stone masonry arch culvert Span range: from 2m to 4m.
- Requires components similar to the other culvert types.

Slab Culvert



Slab Culvert

- Economical for shorter spans and the construction method is also easy to complete without much difficulty.
- To be designed as a one way spanning slab.

The components of Slab Culvert:

- deck slab
- Abutments
- wing walls
- concrete foundations for abutments and
- bedding concrete

❖ Single span slab bridges - most common bridges in Ethiopia.

❖ Economical for spans from 1 m to 18 m

Slab Bridge

- Above 15 m they should preferably be ribbed.
- Prefabricated forms are also available for ribbed slab bridge.



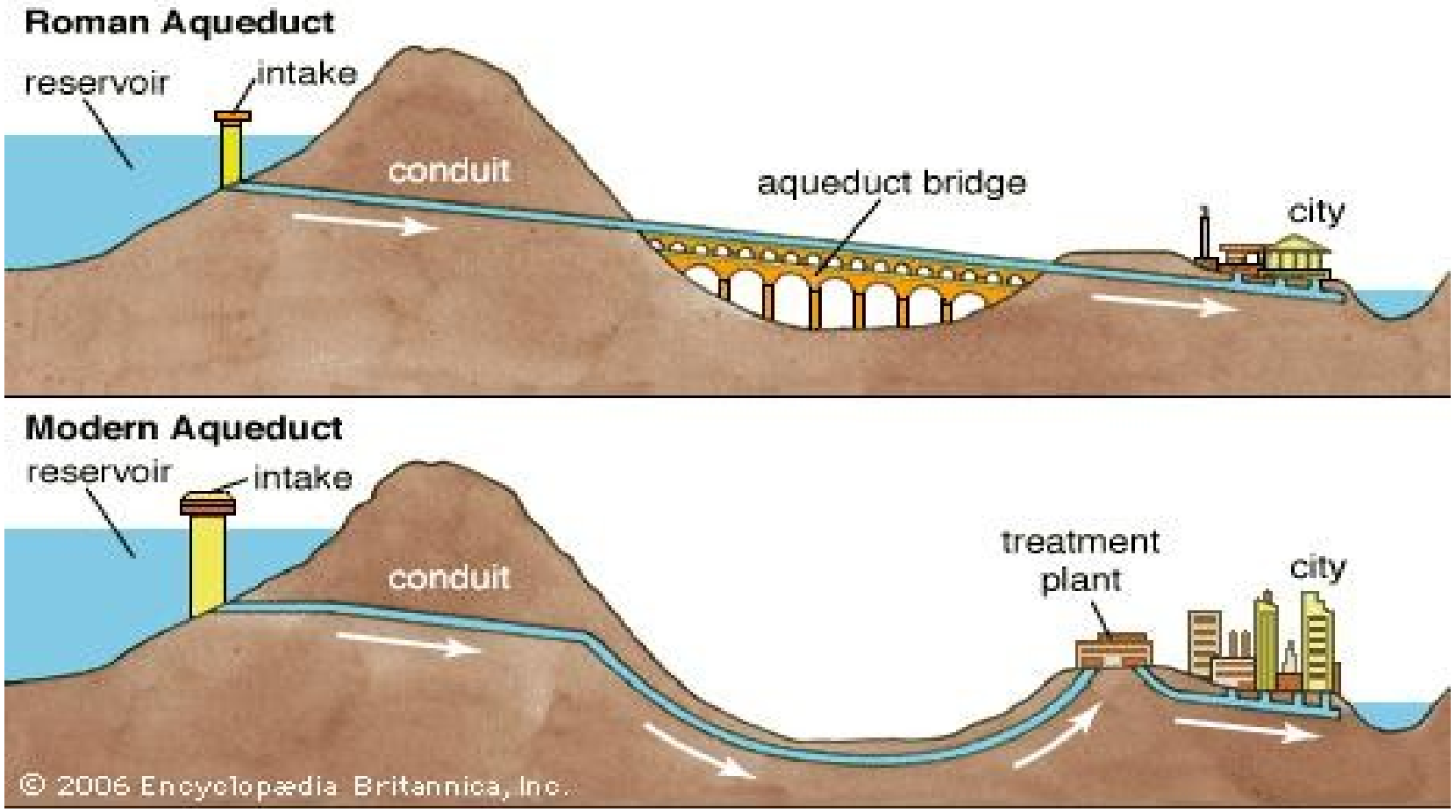
Skew Slab bridge



Types by traffic or function

1. Highway bridge
2. Pedestrian bridge (human bicycles)
3. railway bridge (train)
4. Transit guide way (city trains, monorail)
5. Other types(pipe line, utilities ,industrial, aqueduct)

Aqueduct


Roman Aqueduct
reservoir
intake
conduit
aqueduct bridge
city
Modern Aqueduct
reservoir
intake
conduit
treatment plant
city
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According to the position of the bridge floor relative to the superstructure as

1. Deck-type bridges refer to those in which the road deck is carried on the top flange or on top of the supporting girders. The deck slab or sleeper may cantilever out to some extent beyond the extreme longitudinal girder.
2. Through bridges In the through type bridges, the decking is supported by the bottom flange of the main supporting girders provided on either side.
3. Semi (half) through bridges The semi-through bridge has its deck midway and the deck load is transmitted to the girder

Types by Material & Fabrications

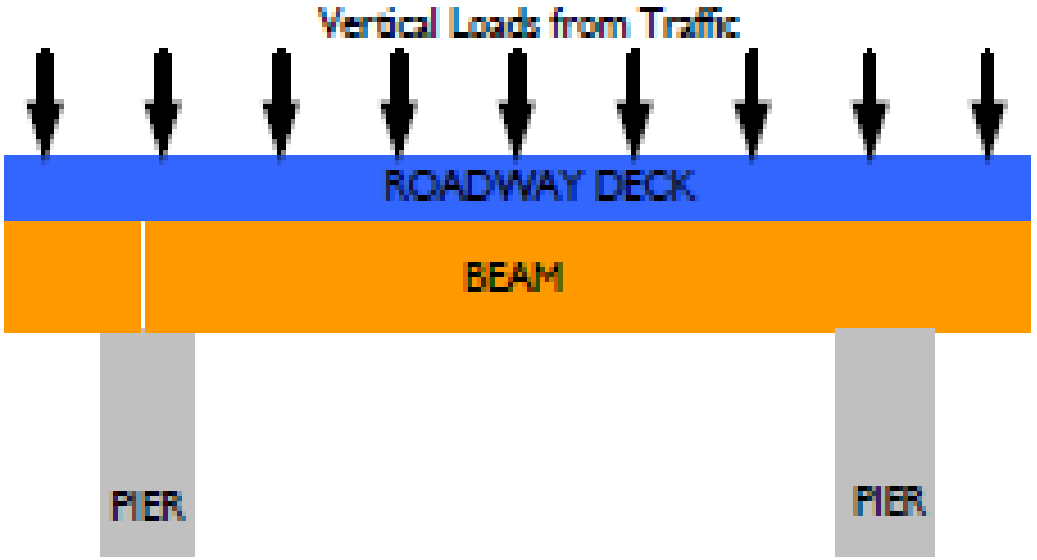
- Materials
  - Masonry (brick, rock)
  - Timber
  - Reinforced Concrete (RC)
  - Prestressed Concrete (PC)
  - Iron
  - Steel
  - Aluminum
  - Composites
  - Plastics
  - Etc…
- Fabrications
  - Precast (RC/PC)
  - Cast-in-place (RC/PC)
  - Pretensioned (PC)
  - Posttensioned (PC)
  - Prefabricated (steel)
  - Rivet (steel)
  - Bolted (steel/ timber)
  - Welded (steel)
  - Etc…

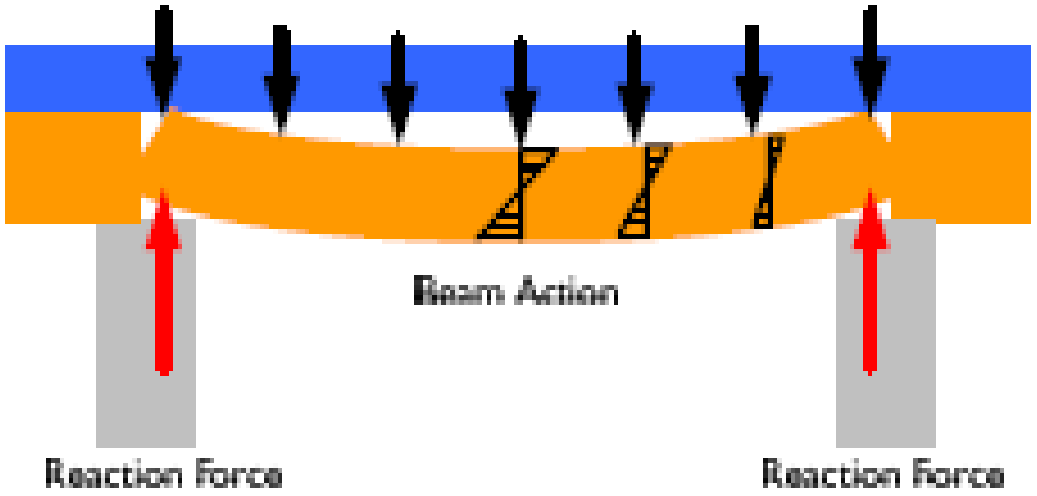
Types of bridge by super-structure(structural system)

1. Arch
2. T-girder
3. Box girder
4. Cantilever
5. Cable stayed
6. Suspension
7. Slab

Types: Beam/Girder Bridges

- The most basic type of bridge
- Typically consists of a beam simply supported on each side by a pier and can be made continuous later
- Typically inexpensive to build





Conti….

Girder bridge may be:-

1. T-girder
2. Box girder
3. Continuous

T-girder



Conti……

The T-beam Bridge is by far the most commonly adopted type in the span range of 10 to 25 meters.

For the longer spans, the longitudinal T beams are laterally supported by cross beams called as diaphragms at designed intervals.

Diaphragms offer resistance against the lateral torsional buckling of the longitudinal T-beams.

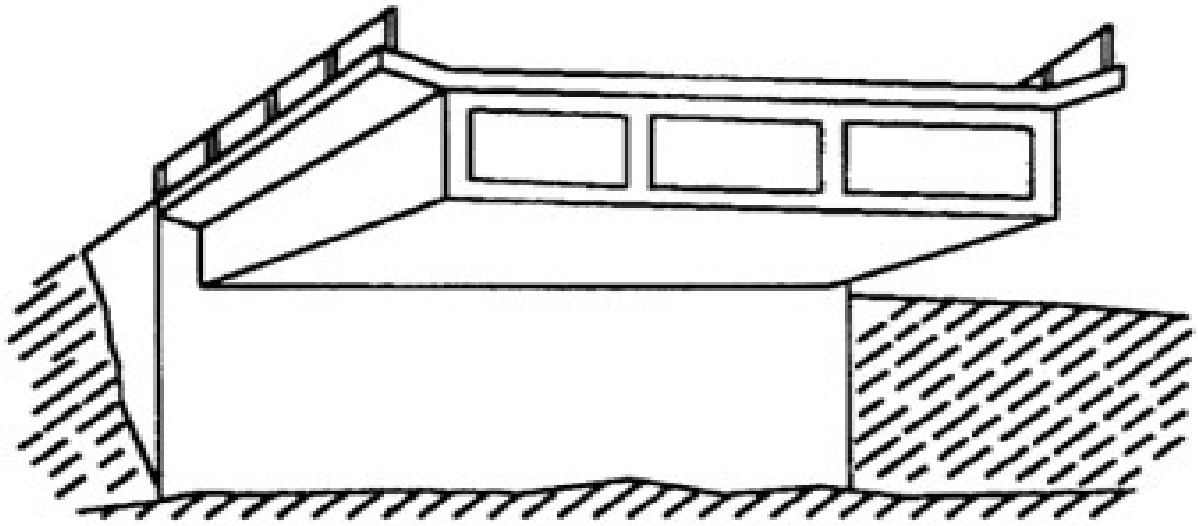
Hollow box girder bridges

- Reinforced concrete hollow box girder bridges are economical in the span range of 25 to 30 meters.
- The closed box shape provides torsion rigidity

The extra torsion stiffness of the section makes this form particularly suitable for grade separations, where the alignment is normally curved in plan.

Conti……

See figure below



Box Girder

Conti.....

Advantages

- Can take differential settlements and tectonic displacements
- Allow prefabrication (precast beams)

Disadvantages

- Large moments at the middle of the spans
- Danger of deck fall during earthquakes (require wide sitting areas)
- Not clear seismic response:
  - Asynchronous movement of decks
  - Danger of impact between adjacent decks

Continuous Girder Bridges

Continuous girder bridges, not connected monolithically to supports, are suitable when unyielding supports are available.

The bending moments and shears at the various sections of the bridges are evaluated by using influence lines.

Conti.....

Continuous girder bridges have the following advantages over simply supported girder bridges.

- Less number of bearings over the piers
- Reduced width of pier, thus less flow obstruction and less amount of material
- Requires less number of expansion joints due to which both the initial cost and maintenance cost become less
- Rigidity quality over the bridge is improved
- Lesser depth of girder, hence economical
- Better architectural appearance
- Lesser vibration and deflection

Disadvantages:

- Not suitable on yielding foundations
- Analysis is laborious and time consuming.

Types: Beam/Girder Bridges

Common Materials

- Timber Truss
- RC Beam
- Steel Plate Girder/ Box Girder
- Steel Truss Girder
- Prestressed Concrete Girders
  - I-Beam, U-Beam, T-Beam
  - Segmentally Prestressed Box Beam

Types: Beam/Girder Bridges

simple



cantilever

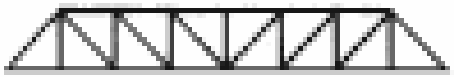


continuous

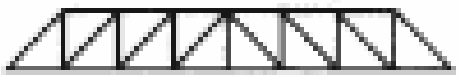


- Currently, most of the beam bridges are precast (in case of RC and PC) or prefabricated
- Most are simply-supported
- Some are made continuous on site

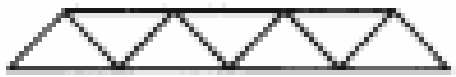
Types: Beam/Girder Bridges



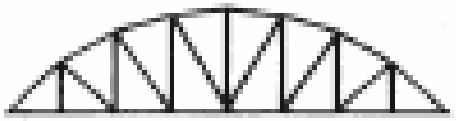
(a) Pratt



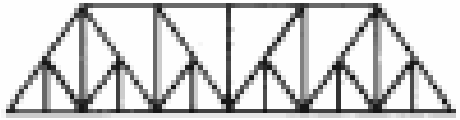
(b) Howe



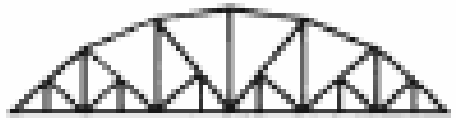
(c) Warren



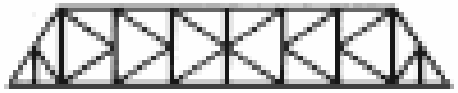
(d) Parker



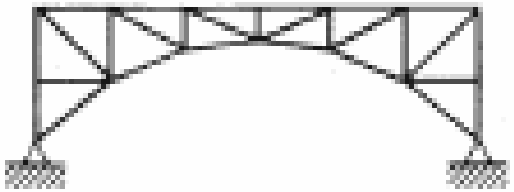
(e) Baltimore



(f) Petit (Pennsylvania)



(g) K truss



(h) Arch



(i) Cantilever

Truss bridge can be of beam type, arch type, or cantilever type depending on the primary load transfer mechanism

ARCH bridge

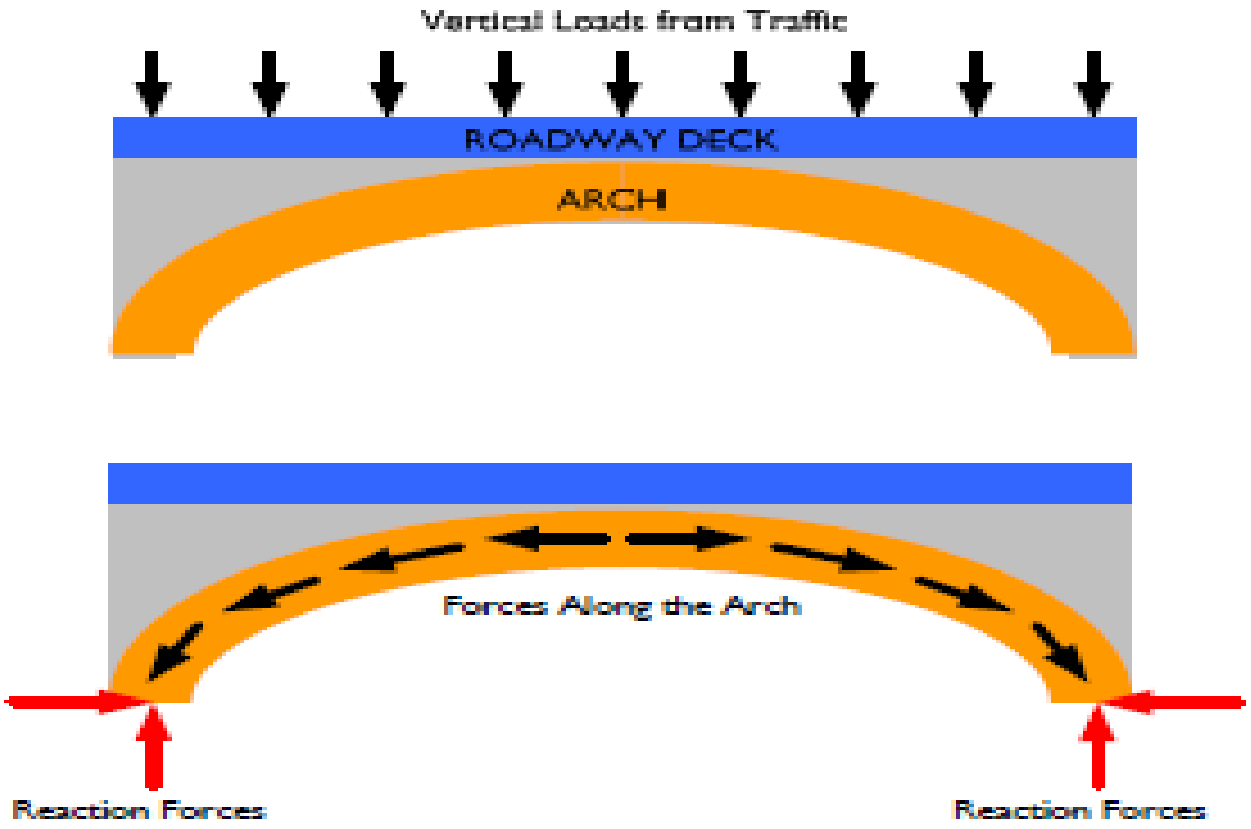
- Girder bridges of reinforced concrete will be uneconomical for spans beyond 35 meters. Arch type can be used advantageously in the span range of 35 to 200 meters
- An arch sometimes defined as curved structural member

Spanning an opening and serving as a support for the load above opening.

- The true or perfect arch theoretically is one in which only compressive force act at the centroid each element of the arch.

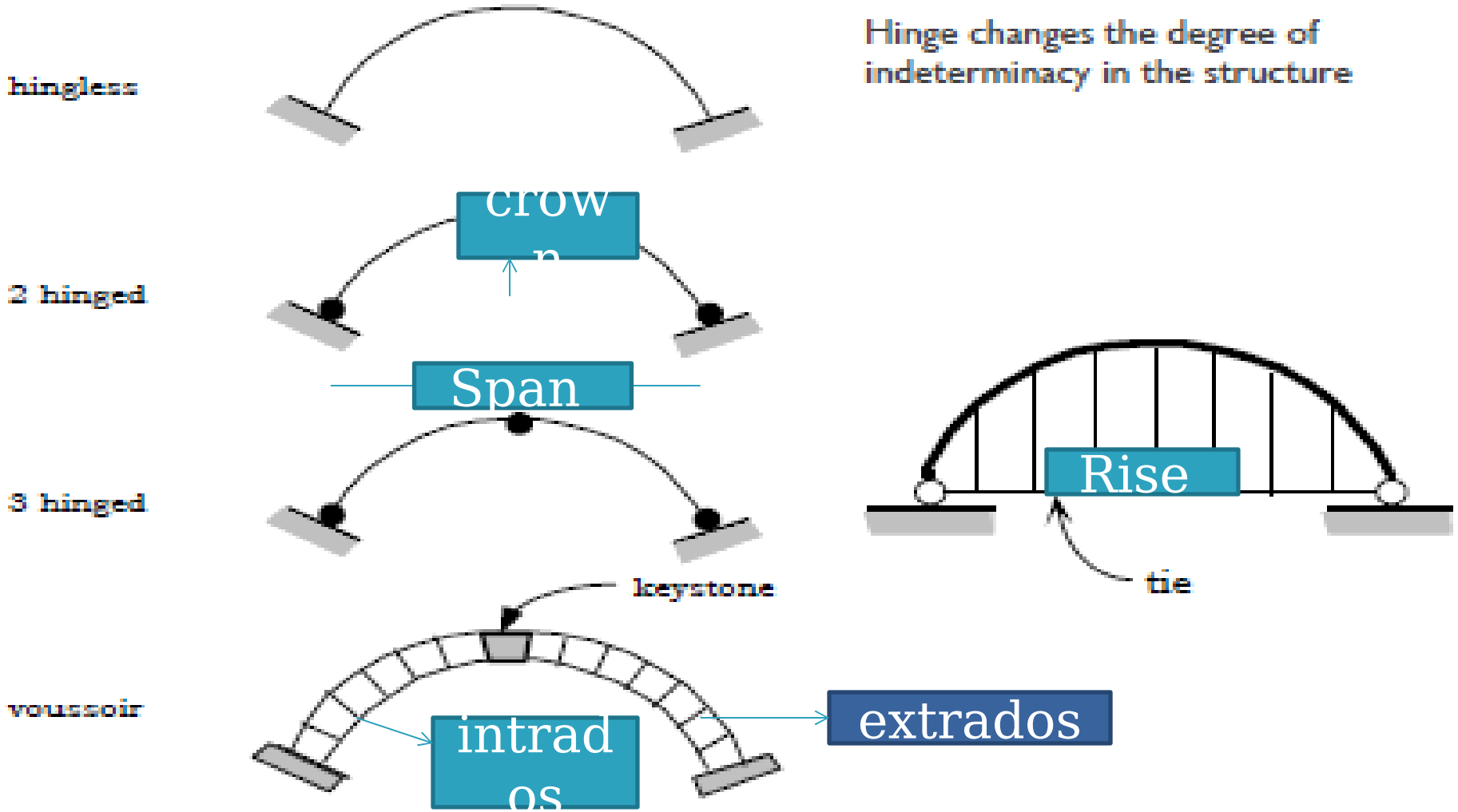
Conti.....

Types: Arch Bridge



Types of arch bridge

Types: Arch Bridge



Conti....

- Pleasing appearance and aesthetic elegance
- Span range of 35 to 200 meters
- Has been applied up to 552 meters as in the case of Chaotianmen Bridge in China
- Best suited to deep gorges with steep rocky banks which furnish efficient natural abutment to receive the heavy thrust exerted by the ribs
- This thrust tends to reduce the bending moment at any section of the arch

Conti….

- Designers aim to maximize this reduction, so that the arch can have only compression in the section

The arch axis is generally governed by three considerations:

(a)span and rise from the road gradient and navigation or traffic clearance below,

(b)the economical shape from point of view of saving materials and

(c)the beauty of the intrados

Conti....

- Economical value of Rise-Span ratio lies between 0.30 and 0.20
- A large rise reduces the thrust and leads to thinner arch section
- The usual profiles in practice are
  - parabolic - suited in rugged country with exposed solid rock or abutments
  - circular segmental - plains and particularly for a spandrel filled arch
  - Elliptical - not much favored, except in cases where clearance requirements need an almost uniform soffit height

RC Arch Bridges
Spandrel filled and open spandrel arch



Conti.....

Spandrel Filled Arch Bridge

Concrete arch for bridges can be in the form of arch slab or arch ribs

- In the case of slab type for short spans, the space between the deck slab or road way and the arch slab (called spandrel) is usually filled with earth and the filling is retained by spandrel walls.

Open Spandrel Arch Bridge

- For spans longer than about 25 meters, the deck is supported on columns or walls resting on the arch and an arch of this

Old Abay River Bridge (Open Spandrel Arch Span)



Balanced Cantilever Bridges

if the soil conditions in the site is poor to bear the load and if supports are expected to be yielding, for medium spans in the range of about 35 to 60 meters

The connection between the suspended span and the edge of the cantilever is called an articulation.

The advantages of balanced cantilever bridges over simply supported girder bridges are listed below.

- Less concrete steel and form work are required for cantilever bridge constructions
- The reactions at the piers are vertical and

Conti.....

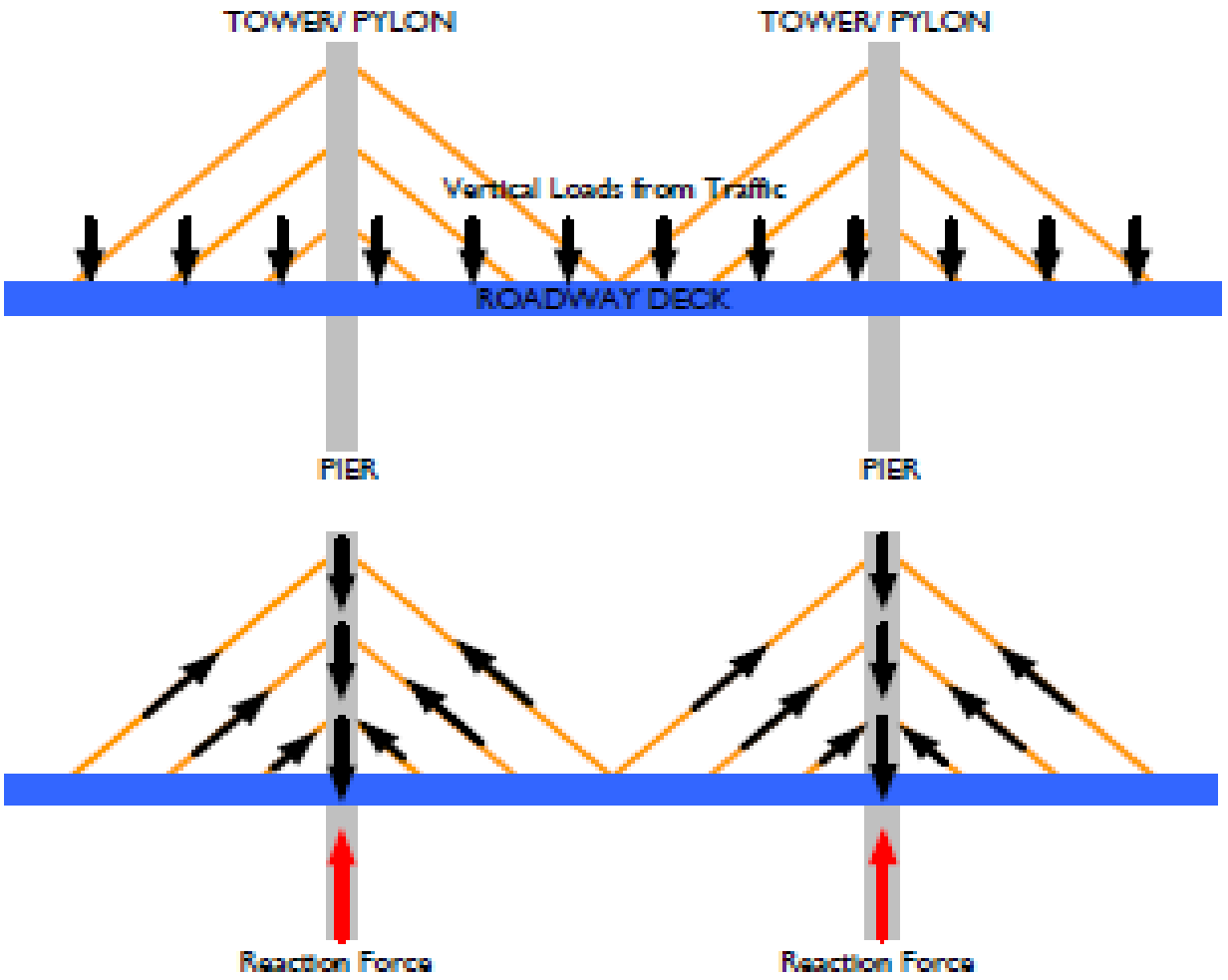
- Fewer expansion joints are needed for the full structure, resulting less initial cost and less maintenances cost.
- Disadvantages:
- Requires more skill on the part of designer.
- After settlement of supports the super structure will not maintain the same level at all the cross sections for the free traffic flow.

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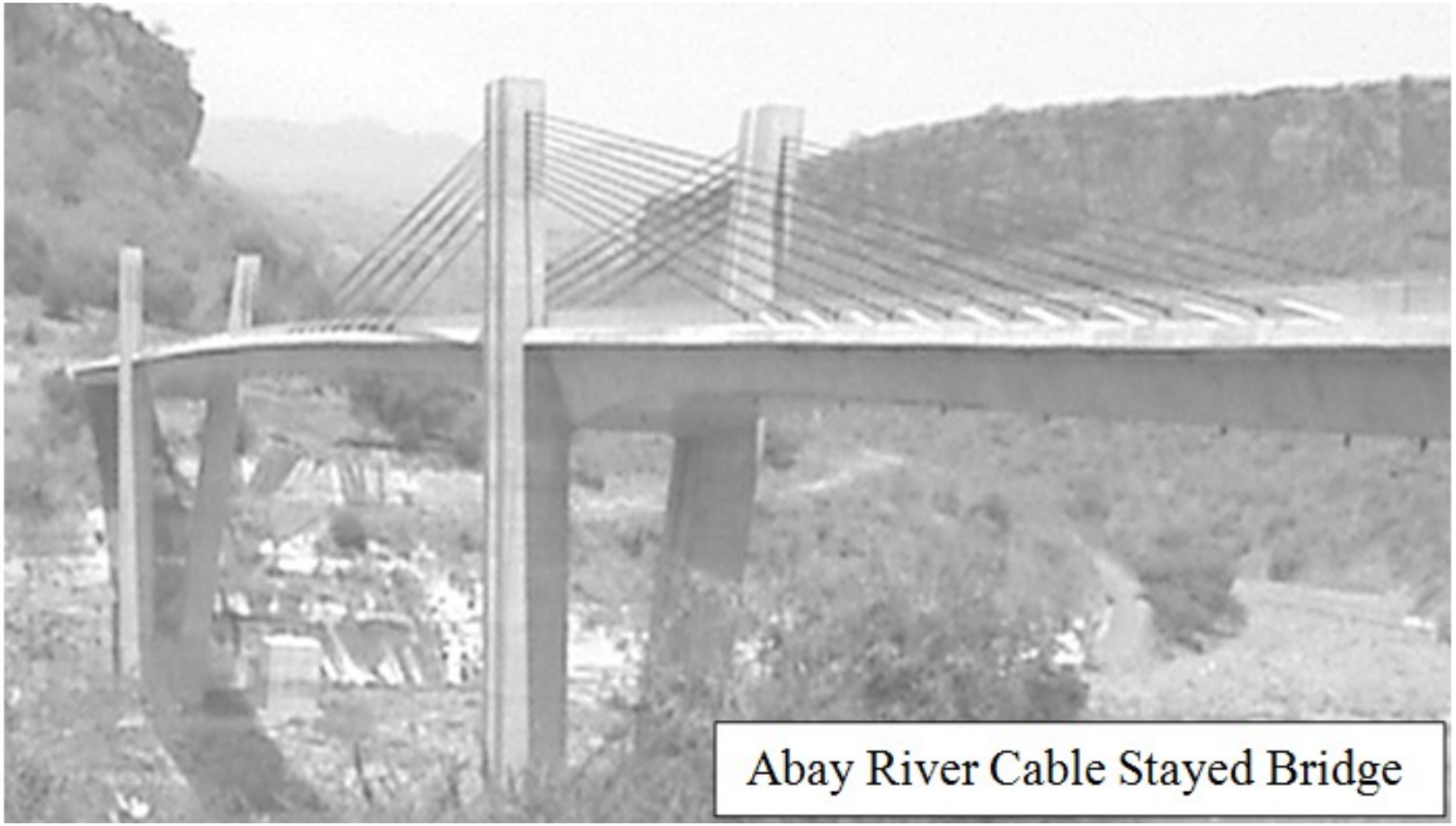


Cable stayed bridge

Types: Cable-Stayed Bridge



Conti……

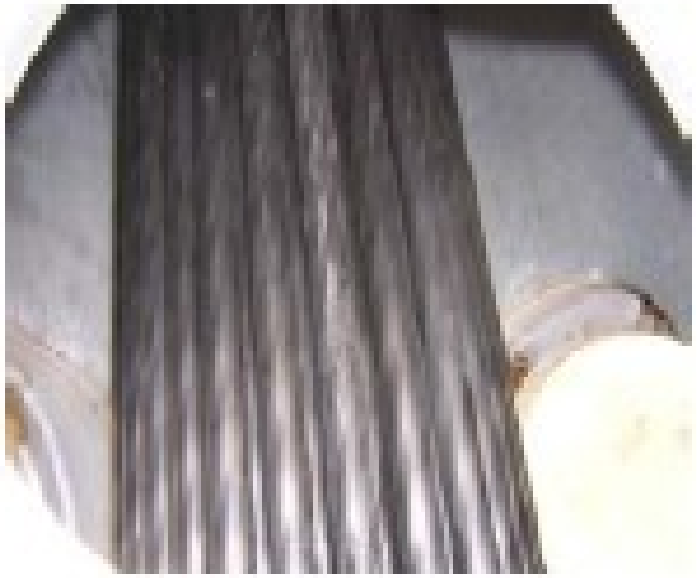


Abay River Cable Stayed Bridge

Types: Cable-Stayed Bridge

- Cable-stayed bridge uses the prestressing principles but the prestressing tendons are external of the beam
- All the forces are transferred from the deck through the cables to the pylon

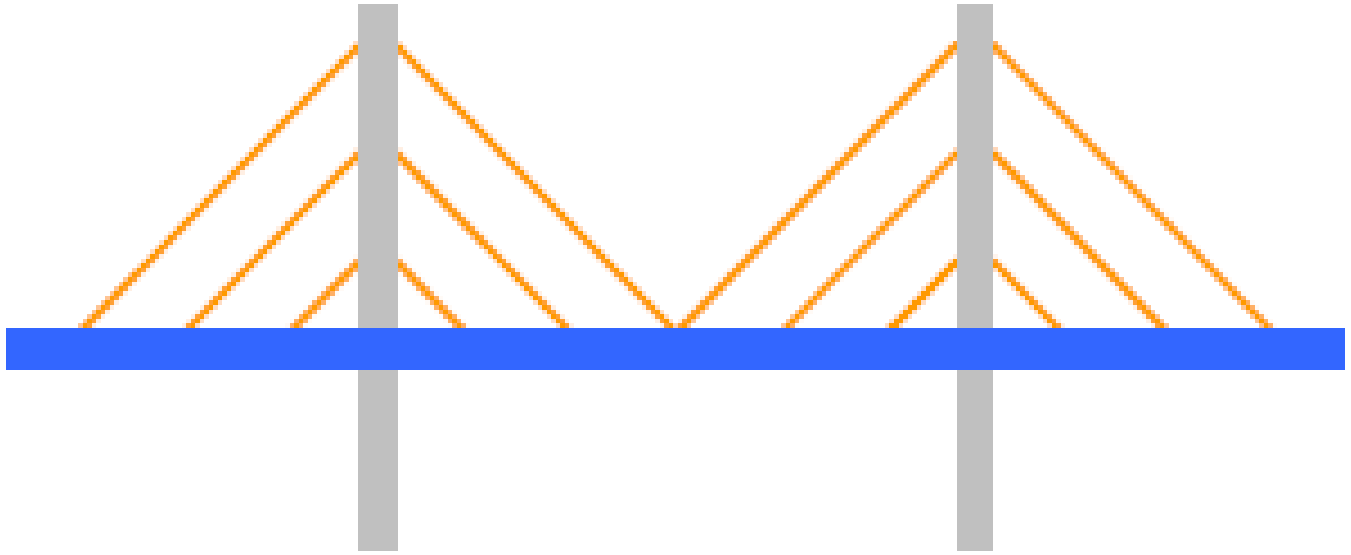




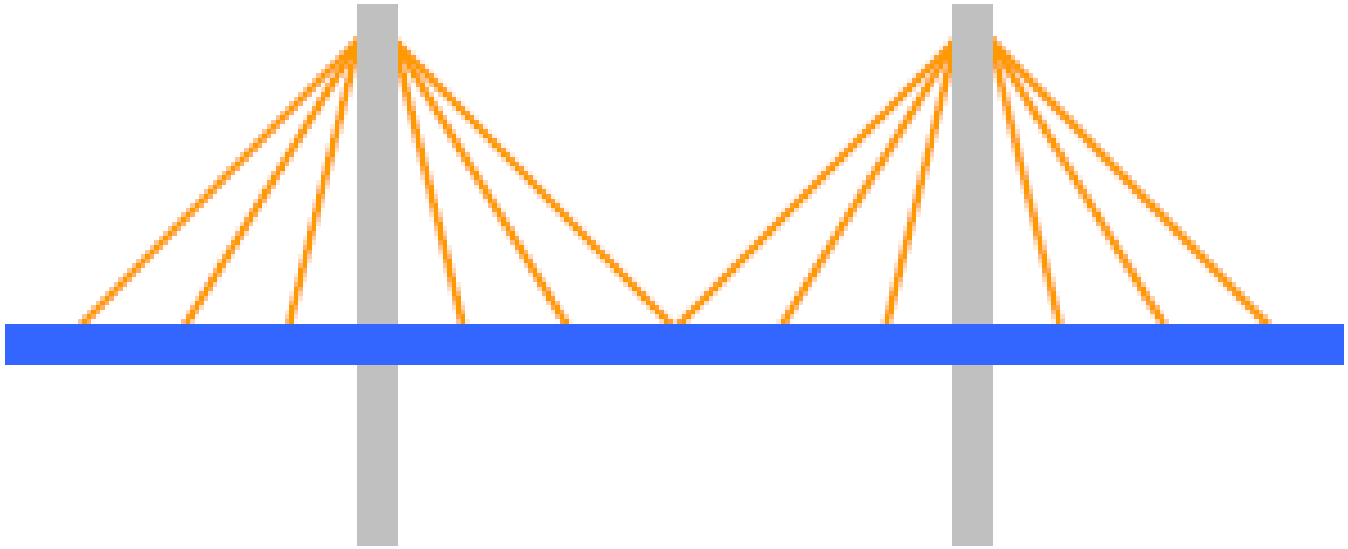
- Roadway deck can be:
  - (Prestressed) Concrete Box Deck
  - Steel Box Deck
  - Steel Truss Deck

Types: Cable-Stayed Bridge

- Harp Type



- Fan Type



Conti…

- Span range of 200 to 900 m
- Developed in Germany in the post war years in an effort to save steel which was then in short supply

Main Components:

(a)inclined cables, (b) towers and (c) orthotropic deck; apart from piers, abutments and foundation

- (Orthotropic means having different elastic properties in two mutually perpendicular directions. It evolved from steel deck plate in an effort to reduce the dead weight of highway bridges during the post second world war period. The most developed form

Conti..

- The cables connecting the deck and towers permits elimination of intermediate piers facilitating a larger width for purposes of navigation
- If the number of stay cables is between 2 and 6, the spans between the stay supports tend to be large (between 30 m and 60 m) requiring large bending stiffness
- In such case, the stay forces are large and the anchorages of cables become complicated.
- On the other hand, the use of multiple stay cables facilitates short distances between points of supports (between 8m and 15m) for the deck girders resulting in reduced

Conti…

- Cables can be arranged in a fan form or in a harp form.
- Fan type configuration results in minimum axial force in deck girders.
- The harp form requires larger quantity of steel for the cables induces higher compressive axial forces in the deck and causes bending moments in the tower.
- Fan shape is superior from structural and economical points of view.
- Harp configuration of cables also warrants erection of the tower and the deck to progress at the same time.

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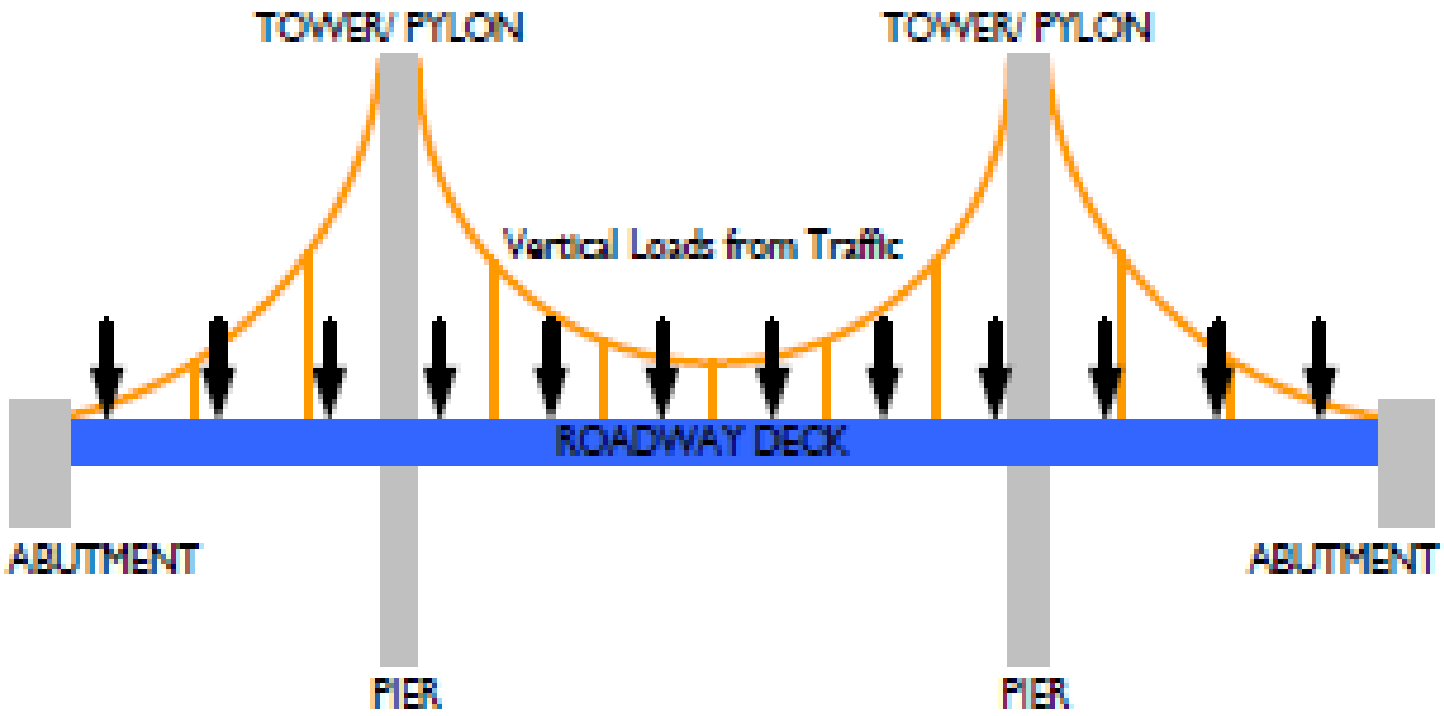
- The height of towers shall be 0.2 to 0.25 L_m (where L_m = the main span). It is not advantageous to increase the height beyond 0.25 *Lm.*
- Ultimate tensile strength (UTS) of steel used for cables - around 1600 MPa.
- High carbon fiber cables having UTS of about 3300 MPa are under development.
- Carbon fiber cables have negligible corrosion and possess high fatigue resistance.
- Cables are used either as parallel bundle strands of wire or coiled bundle of strands enclosed in a polyethylene tube.
- Anchorage of cables at the deck is fixed and has a provision for a neoprene pad damper to damp oscillations.

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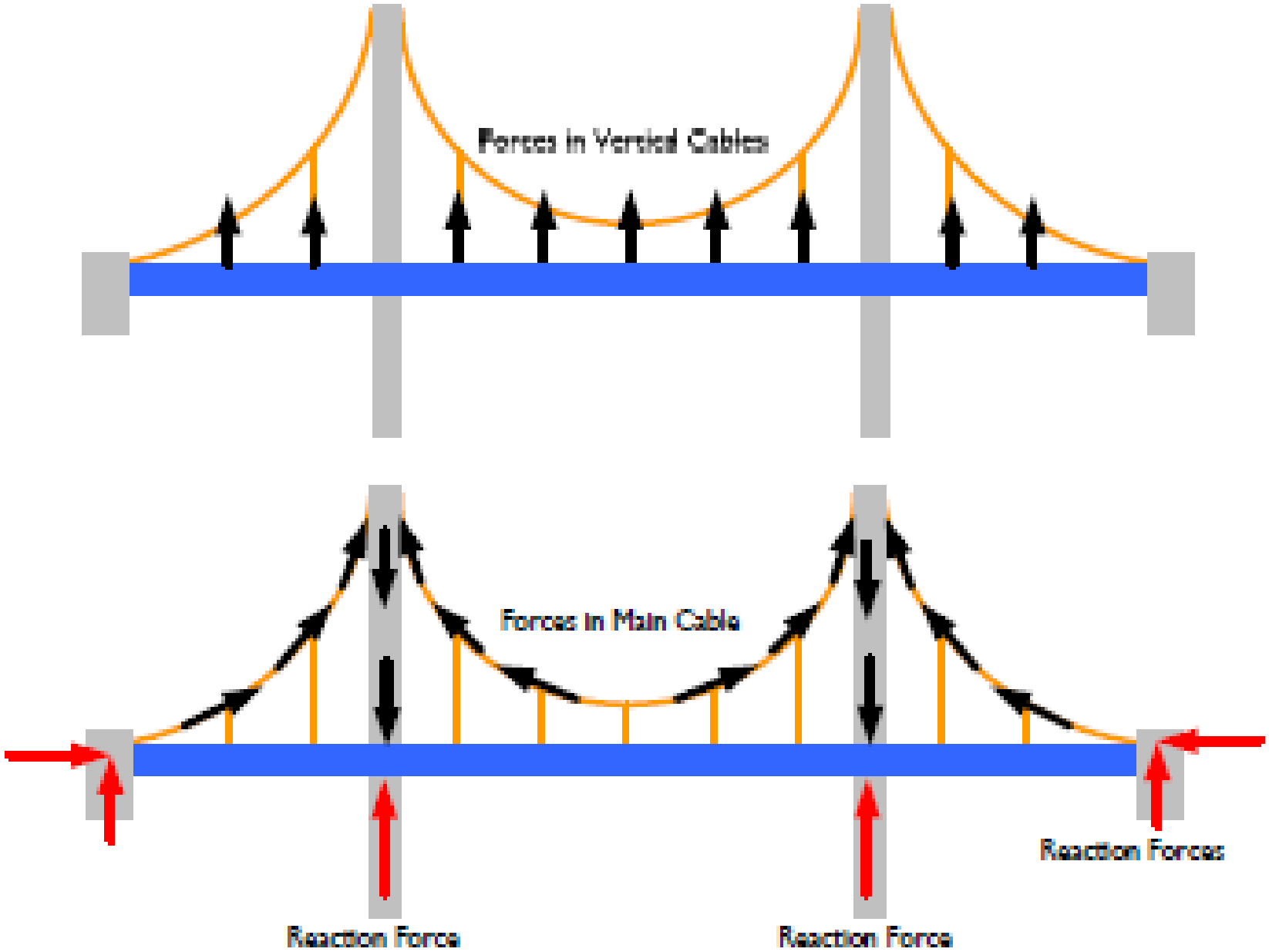


Types: Suspension Bridge

- Suspension bridge carries all the weight of the structure and traffic through large cables (usually 2) suspended over towers
- The main cables have to be very strong
- Cables are anchored at the abutment → abutment has to be massive



Types: Suspension Bridge



Conti.....



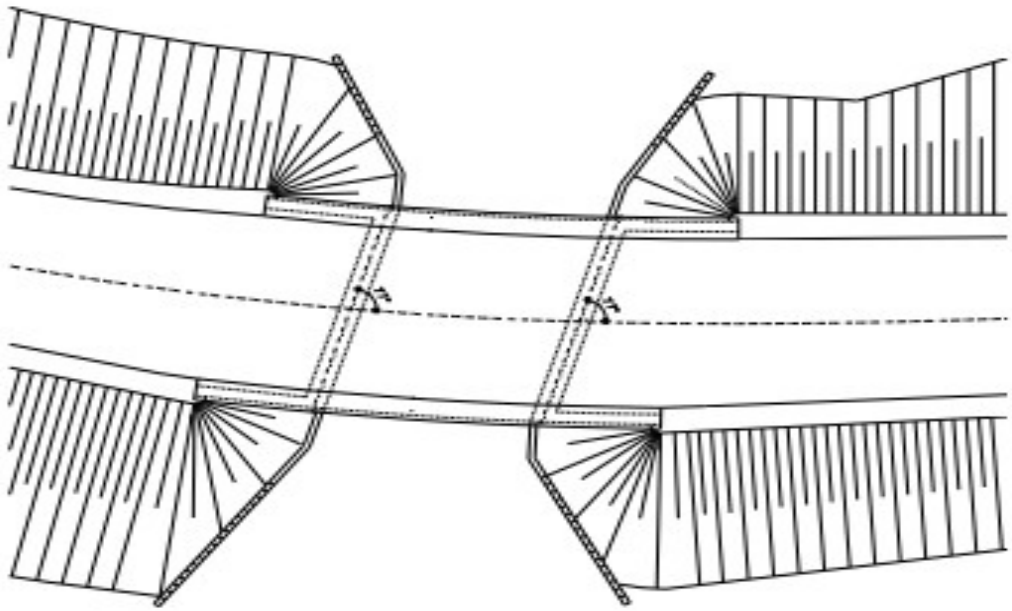
Suspension Bridge

- Currently the only solution for spans in excess of 900 m
- Consist of two large or main cables that are hung (suspended) from towers
- The main cables of a suspension bridge drape over two towers, with the cable ends buried in enormous concrete blocks known as anchorages
- The roadway is suspended from smaller vertical cables that hang down from the main cables

Types by horizontal arrangement

1.Normal or skew

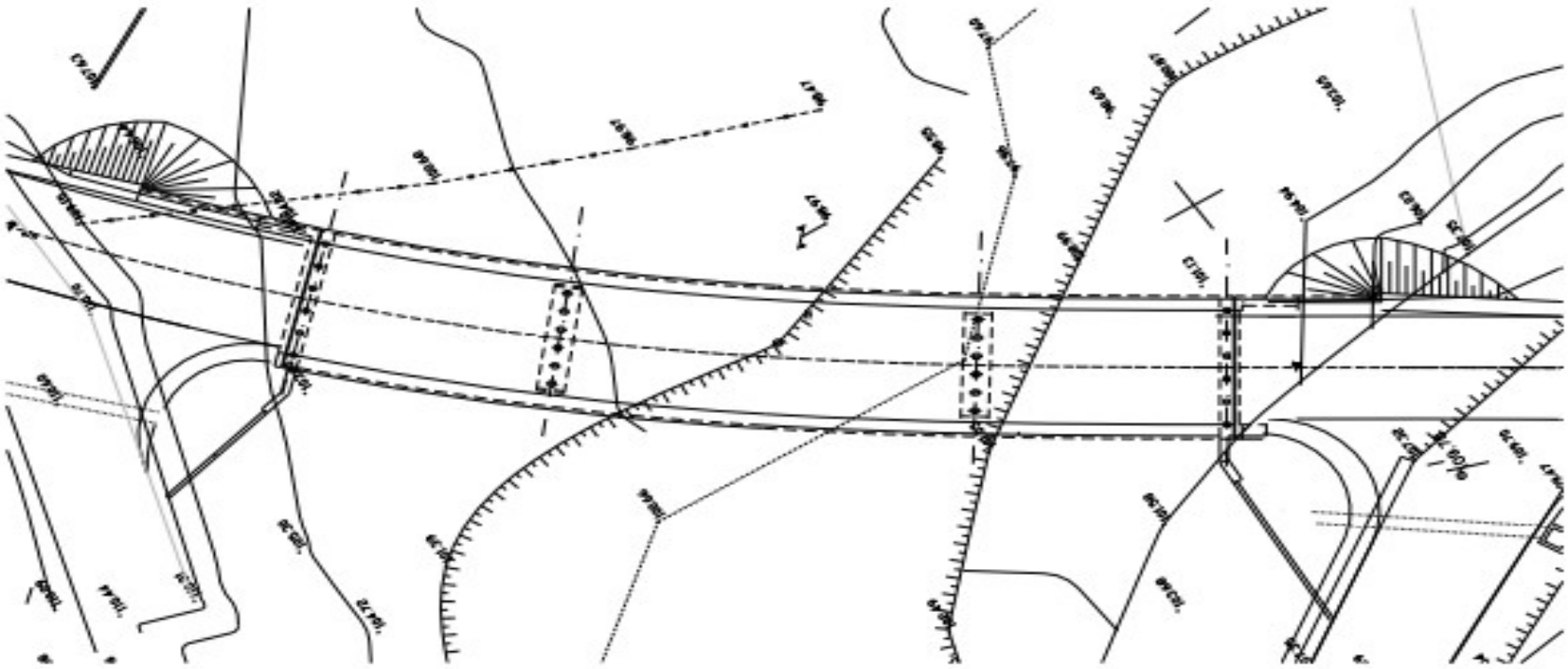
- Normal: The axis of each pier is normal to the axis of the bridge.
- Otherwise it is skew



Example of a skew bridge

Conti.....

2. Straight or curved



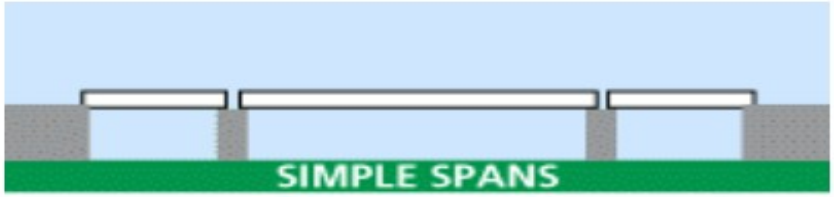
A bridge can be curved and normal

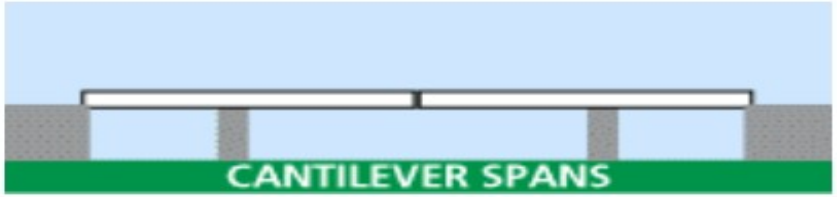
Life Span

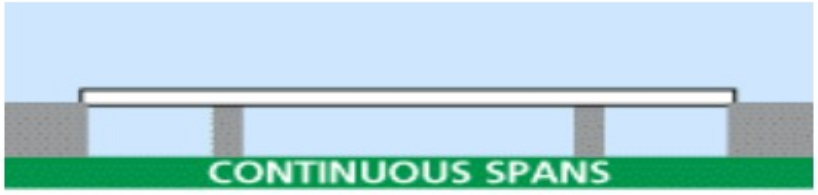
- Temporary bridges
- Permanent bridges
- Semi-permanent bridges

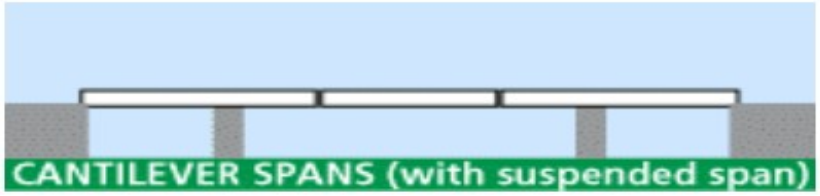
Span arrangement

- Simply supported
- Continuous
- Cantilever









Movements

- Movable Bridges
- Fixed Bridges



Note:- None of these bridge classifications are mutually exclusive.

Site selection of bridge

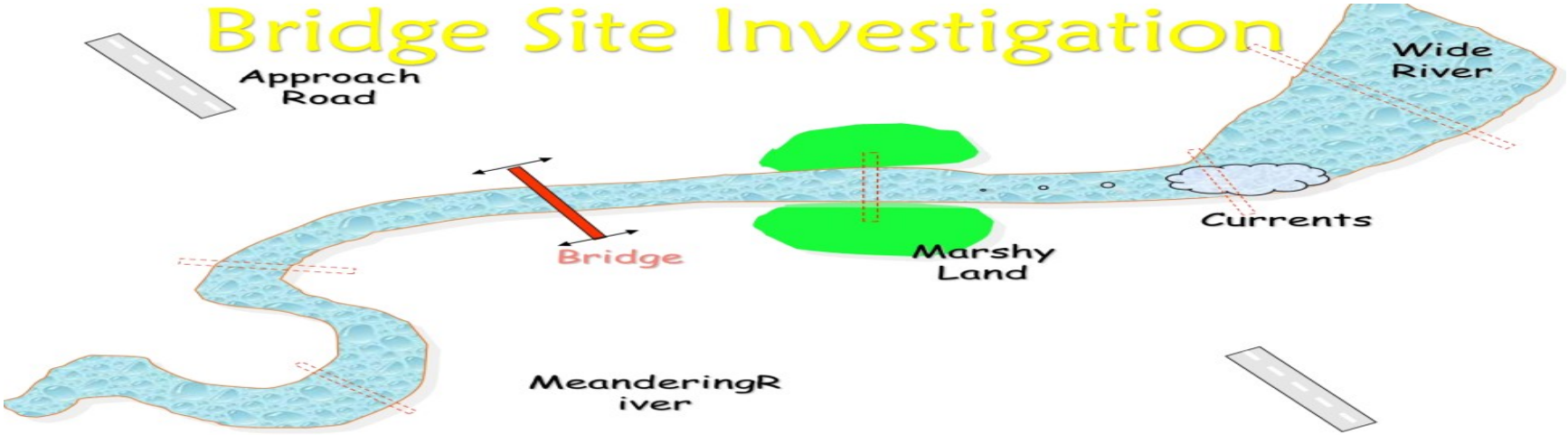
Introduction

The aim of bridge site investigation is to select a suitable site from possible alternatives at which a bridge can be built economically, at the same time satisfying the demands of safety, traffic, stream, and aesthetics.

- On the basis of field surveys and information concerning:
  - ✓ the proposed road alignment
  - ✓ the local terrain and site conditions
  - ✓ the required design life of the bridge
  - ✓ the likely traffic volumes ;

engineer who is responsible to design a bridge

Conti....



- The required design life and the resources available to construct the bridge will influence the choice of materials and construction methods.
- The traffic volume predictions enable the engineer to determine the necessary width of the bridge.

- The local terrain and site conditions indicate the vertical and horizontal length and number of spans, and the design of substructure elements and foundations.

Cost vs. Span Length



Substructure here is expensive compared with the superstructure

If the water is shallow, substructure is inexpensive compared with the superstructure



Conti…

Site Selection

Preliminary Survey

For selection of a suitable site for a bridge, the investigating engineer should make a reconnaissance survey for

- about one km on the upstream and down stream side of the proposed bridge site and
- should journey along the road for about one km on either side of the road from the bridge site in order to form the best suited and economical alignment of the road with the suitable bridge site by considering the

Conti…

- It may not be possible always to have a wide choice of sites for a bridge. This is particularly so in case of bridge in urban areas and flyovers. For river bridges in rural areas, usually a wider choice may be available.
- The objective of the preliminary survey is to study more than one alternative bridge sites
- Possible bridge sites are first located on topographic maps. (Ethiopian Mapping Authority)
- After locating the possible bridge sites on these maps, these sites are visited to collect certain preliminary data required for thorough

Conti….

In locating a bridge site the following requirements should be considered

- ✓The reach of the river should be straight (if the river is meandering the best crossing site will be at the nodal point of the course, which are not affected by meandering)
- ✓The channel in the reach should be well defined
- ✓The crossing site should be as narrow as possible
- ✓The crossing site should have firm high banks which are fairly unreadable.
- ✓should have uniform flow without serious rotations and cross currents
- ✓has reasonably straight approach roads and permits as perpendicular a crossing as possible.
- ✓The site should be selected where skewness can be avoided …..
- ✓has no need of expensive river training works

Conti…

- A bridge aligned at right angles to the river result in the shortest superstructure.
- A skewed bridge requires more material and is more complicated to design and construct.
- If a skew is unavoidable, the angle should preferable not exceed 20 degree due to the increased cost.

❖ There are two types of rivers namely **alluvial** and **incised**.

- ✓ **Alluvial rivers** are winding and they erode their banks and scour their beds; and are continually active, scouring and depositing materials on the banks and transporting sediments.
- ✓ **Incised rivers** have a relatively stable banks and are generally narrower and deeper than alluvial rivers.

- Bridge crossings over alluvial rivers nearly always require training works to stabilize the channel flow within the bridge waterway opening.

Conti…

Data and Data Collection for bridge

- Once the engineer has identified a likely site for the bridge, he/she needs to obtain field information on the catchment area and run off, local terrain, river conditions and water levels, navigational and other clearance requirements, and soil information.

1. Catchment Area and Run off Data

The information which is of interest are:

- catchment size, catchment grade, and catchment cover
- presence of any artificial or natural storage such as dams, lakes etc.
- possibility of any change in the nature of the catchment due to forestation or deforestation in the future

Conti...

2.Drawings

.Index Map – showing the proposed location of the bridge, the alternative bridge sites investigated and rejected, towns and villages in the vicinity and the general topographic of the area. Scale may be 1:50,000.

.Contour Survey Plan of the river showing all topographic feature for a sufficient distance on either side of the site to give indication of the features, which would influence the location, and the design of the bridge and its approaches.

.Site plan – showing the details of the selected site and of the stream to a distance of 100 to 200m upstream and downstream of the selected site. This should show the crossing point and alignment of approaches, location and reduced level of benchmark, location of cross section and longitudinal sections of road and stream taken within area of the plan, and location of buildings, rock outcrops and other possible obstructions to the road alignment.

.Cross-section and longitudinal sections of the river – Cross-sections are taken at suitable distances both upstream and downstream of the proposed bridge site. These should indicate the

Conti....

3.River Survey

General Information of the river

- ✓ river name
- ✓ flow direction
- ✓ name of nearest town
- ✓ bench marks

•Water level

- ✓ LWL(*Low Water Level)*: -level of water during dry season
- ✓ OFL(Ordinary flood level) -is the level to which the river normally rises during the wettest season of the year.
- ✓ HFL (*Highest know Flood Level)*: -the maximum recorded flood level

•The design flood is the maximum flow that can pass through the bridge without

- ✓ Causing unacceptable disruption to traffic
- ✓ Endangering the pier and abutment foundations with scours
- ✓ Damaging approach embankments

Conti…

- The maximum discharge may be determined by the following methods
  - ✓ Using empirical formula

    Q=C*An, Q=C*A Ryve's formula
  - ✓ Using rational formula

    Q=C*I*A
  - ✓ Area-velocity method

    Q=V*A
  - ✓ Using unit hydrograph

Conti…

4. Soil Investigation

- Soil investigation is required to get soil profile, engineering property of the foundation material and foundation level for the abutments and piers for design of the foundations. This information is obtained by analyzing samples taken from boreholes, test pits or geophysical surveying.

Conti....

5.Span Determination

Economical Span

•For a given lineal waterway the total cost of the superstructure increase and the total cost of the substructure decrease with increase in span length. The most economical span length is that for which the cost of superstructure equals the cost of substructure, the point at which the total cost is a minimum.

Hydraulic Requirements

•Bridges are designed to accommodate design discharge at design flood.

•When a river has a wide flood plain, the economical solution may be using short span bridge with proper scour and erosion protection for the embankments, abutments and piers.

Grade Requirements

•Often in mountainous areas the roadway grade is governed by capacity of heaviest vehicle to climb, vertical curve and sight distance. These grade

Conti...

Location of Piers

- Piers should be located in such a manner that they can provide the required lineal waterway and navigational clearance. They should be located to cause a minimum of obstruction to the flow. Piers should not be located in the river if there is boulder transport during flood.
- The alignment of piers and abutments should, if possible, be set parallel to the direction of flow during maximum flood.

Free Board

- The waterway below the superstructure must be designed to pass the design flood and the floating debris carried on it. The free board allows for uncertainty in determ free board above the de le below unless a refined

Discharge(m3/s)	Free Board(m)
0-3	0.3
3-30	0.6
30-300	0.9
>300	1.2

Conti....

- For arched structures, the clearance shall be measured at the quarter points of the span.
- The clear height of roads shall normally be 5.1 meters for underpasses.
- Light superstructures (i.e. timber, steel trusses, steel girders, etc.) above roadways shall have a clearance height of **at least 5.3 m.**

CROSS FALL

- For adequate dewatering while minimizing the use of materials for the bridge deck, a cross fall of 2% (1 to 50), as well as longitudinal slope/grade of 1% (1 to 100), should be provided. Sometimes this is not achievable at transitions to skews. In these cases a close cooperation with the road designer should be established in order to find an acceptable solution.

Cont....

the characteristics of an ideal site for a bridge across a river are:

a.Straight reach of the river.

b. Steady river flow without cross currents:

c. A narrow channel with firm banks

d. Suitable high banks above high flood level on each side.

e. Rock or other hard in erodible strata close to the river bed level.

f. Economical approaches danger of floods, the approaches should be free from obstacles such as hills, frequent drainage crossings, scared places, graveyards

Conti…

h. Absence of expensive river training works;

i. Avoidance of excessive underwater construction.

j.social

in case of new alignments, site is chosen taking into consideration of maximum commercial and social benefits with three criteria

1. Efficiency
2. Effectiveness
3. Equity

Selection of bridge types

Once decision is made that bridge needs to be replaced (new bridge is to be built) the types of bridge structure needs to be determined.

Selection of Bridge Type

One of the key submittals in the design process is engineer's report to the owner about the type, size and location of the proposed bridge. In selection of a bridge type, there is no unique answer.

Factors to be considered in Selection

- For each span length range there will have more than one bridge type that will satisfy the design criteria.
- Selection of bridge type in general is related to economy, safety and aesthetics.
- Generally the following factors and conditions should be considered and will be evaluated with respect to economy, safety and aesthetics in the

1.Geometric Condition of the Site

- The type of bridge selected will often depend on the horizontal and vertical alignment of the highway route and on the clearances above and below the road way.
- E.g. If the alignment is on a curve, box and slab type bridges are best options, because they have a pleasing appearance, can readily be built on a curve, and have a relatively high torsional resistance.
- Relatively high bridges over navigable waterways will require a different bridge from that required by a flood plain.

2.Subsurface Conditions of the Site

- The foundation soil type and its bearing capacity determine whether or not piers and abutments can be founded on spread footings or piles. If settlement is a problem, the bridge type selected must be able to accommodate this. Surface and subsurface drainage conditions affect magnitude of earth pressure, movement and stability of embankments. These influence choice of substructure, which in turn influence type of superstructure selected.
- For example, rigid frame bridge requires strong foundation material that can resist both horizontal and vertical thrust. If the foundation material is weak, then another bridge type is

3.Functional Requirements

- The bridge must function to carry not only present but also future volumes of traffic.
- Decision must be made on the number of lanes of traffic to accommodate present and future volumes of traffic, inclusion of sidewalks, future wearing surface, possibility of future widening and the like.
- E.g. If future widening or replacement of bridge decks is a concern girder type bridge is best option.
- In the case of stream and flood plain crossings, the bridge must continue to function during flood and should not impose constriction to

4.Aesthetics

- It should be the goal of the bridge designer to obtain a positive aesthetic response to the bridge type selected.
- It is necessary to understand what qualities and features of a bridge tend to make that aesthetics statement a good one.
- This understanding requires training and time.
- When a bridge is placed across a relatively shallow valley, the most pleasing appearance occurs when there are an odd number of spans with span lengths that decrease going up the side of the valley.
- Harmony between the whole structure and its surrounding needed to be addressed.
- Repeating similar spans too many times can become monotonous, just as hearing the same music with a heavy beat that is repeated over and over again can be uncomfortable.



Beauty and Stability
 Bridge and Environment
Integration
 Material Choice
Moderate Lightings

Aesthetics

- Determinant of bridge's appearance (in order of importance)
  - Vertical and Horizontal geometry relative to surrounding topography and other structures
  - Superstructure type: arch, girder, etc…
  - Pier placement
  - Abutment placement
  - Superstructure shape, parapet and railing
  - Pier shape
  - Abutment shape
  - Color, surface texture, ornamentations
  - Signing, Lighting, Lanscaping

5. Economics and ease of maintenance

- In comparison of the economics of different bridge types, the construction cost and maintenance cost should be taken together.
- A general rule is that a bridge with the minimum number of spans, fewest deck joints, and widest spacing of girders will be the most economical.
- By reducing the number of spans, the construction cost of one pier is eliminated.
- Deck joints are a high maintenance cost item, so minimizing their number will reduce the life cycle cost of the bridge.
- Generally, concrete structures require less

6.Construction and erection time considerations

- The selection of the bridge type to be built is often governed by construction and erection considerations.
- In general, the larger the prefabricated or precast member, the shorter the construction time.
- However, the larger the members, the more difficult they are to transport and lift into place.
- The availability of skilled labor and specified materials will also influence the choice of a particular bridge type.

Speed of construction

- In urban areas, the construction of bridge may disrupt traffic
  - Prefabricated/ Precast member are the only choice
  - Substructure construction may disrupt traffic more than the superstructure erection → may consider longer spans



Precast I-Girder

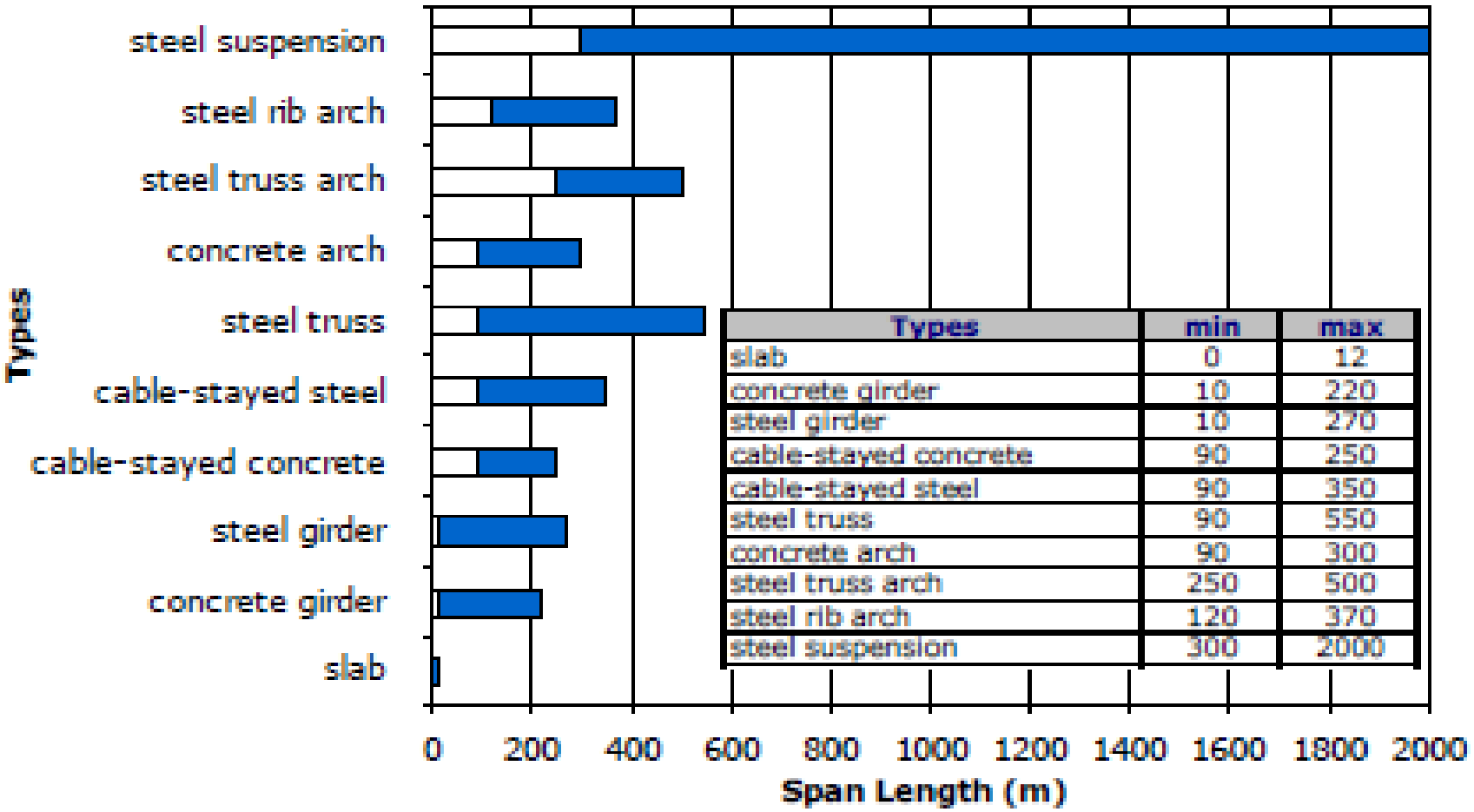
7.Legal Considerations

The requirements of environmental laws and other applicable laws must be met

Conti....

Span Length

Economical span length for each bridge type



Types	min	max
slab	0	12
concrete girder	10	220
steel girder	10	270
cable-stayed concrete	90	250
cable-stayed steel	90	350
steel truss	90	550
concrete arch	90	300
steel truss arch	250	500
steel rib arch	120	370
steel suspension	300	2000

Oftentimes engineers deceive themselves into believing that if they have gathered enough information about a bridge site and the traffic loads, the selection of a bridge type for that situation will be automatic.

Conti....

Factors Affecting Selection of Bridge Construction Methods

Before a bridge can be built an appropriate method of construction must be chosen. The decision is made by the design team. The principle factors considered by the design team when choosing a suitable method of construction are given below:

- The scale of the bridge
- The obstacles to be crossed
- The regularity of the span lengths
- The horizontal and vertical profiles of the bridge decks
- The nature of the soil strata
- The local weather
- The local cost of materials
- The local labor markets
- The accessibility of the site