PLANNING AND DESIGN PARAMETERS BRIDGE STRUCTURES...

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Feasibility Study Preparation
CHARM2 Project

KEY ELEMENTS IN RURAL INFRA Planning & Design

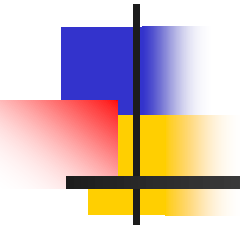
	Roads	Bridges And Culverts	Potable Water System	Communal Irrigation Project	Small Water Impounding Project
General Design Concept	X	X	X	X	X
Alignment Design – Horizontal and Vertical	X				
Hydrology and Drainage	X	X	X	X	X
Geology and Hydrogeology	O	X	X	O	X
Geotechnical and Foundation Design	X	X	O	X	X
Hydraulic Design	O	X	X	X	X
Structural Engineering	O	X	O	O	X
Quantities and Cost	X	X	X	X	X
Implementation Schedule	X	X	X	X	X
Environmental Concerns	O	O	O	X	X
Institutional Requirements	O	O	X	X	X
Electrical and/or Mechanical Aspects	O	O	O	O	X

X – Critical/essential element of review required

O - Necessary but may not be essential

BRIDGES

- Elements of Bridge Structure
- Bridge and Culverts
- Bridge Nomenclature
- Classification of Bridges by Materials
- Classification of Bridges by Structural System

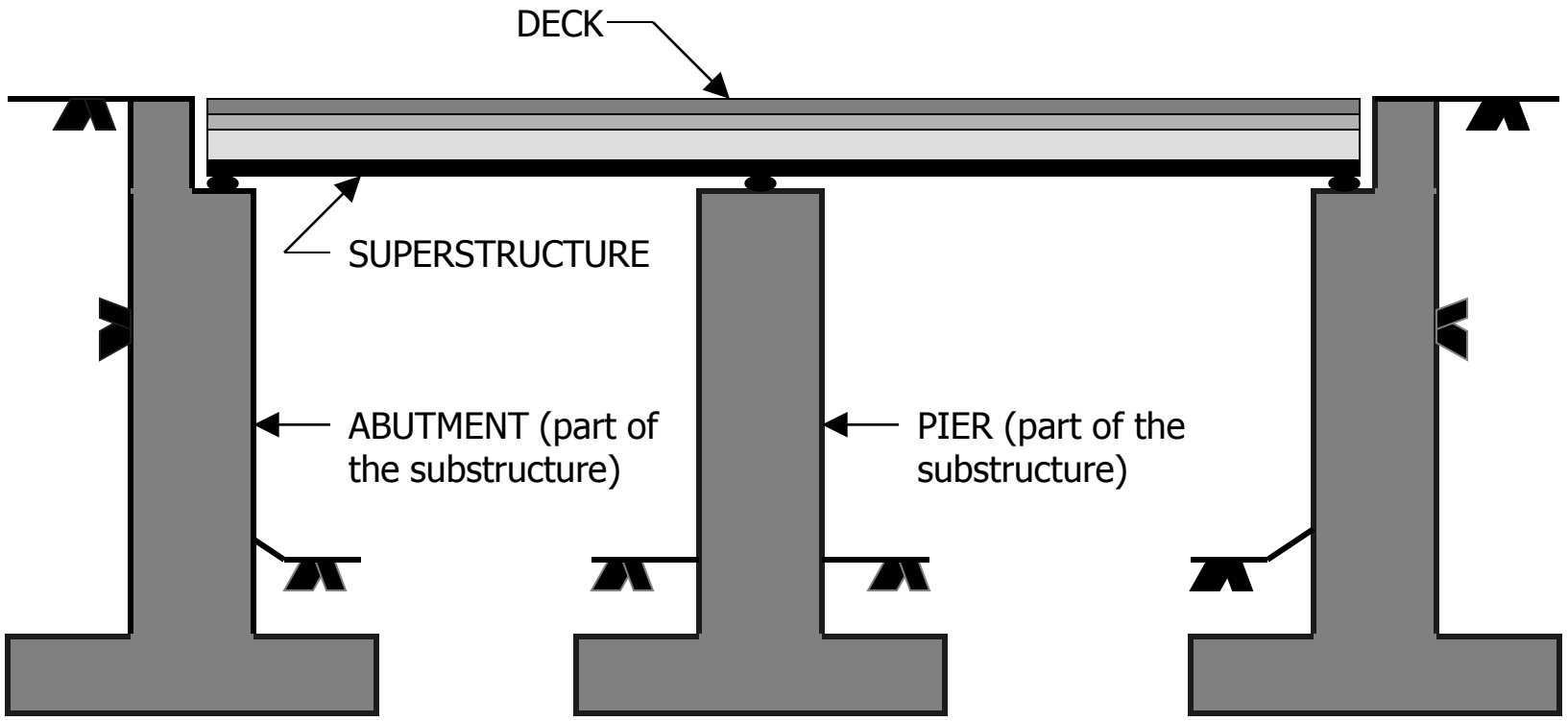


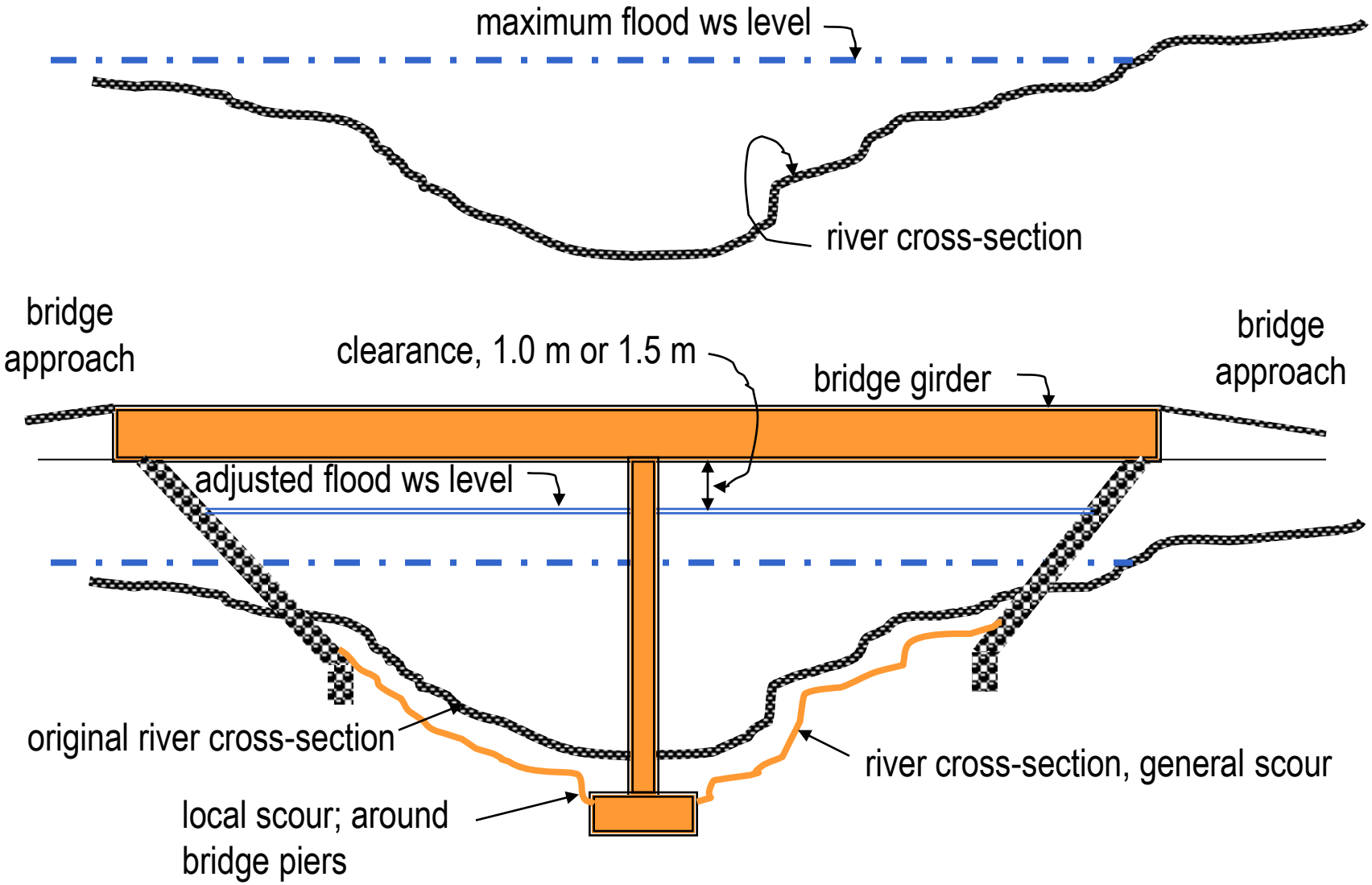
Elements of Bridge Structure

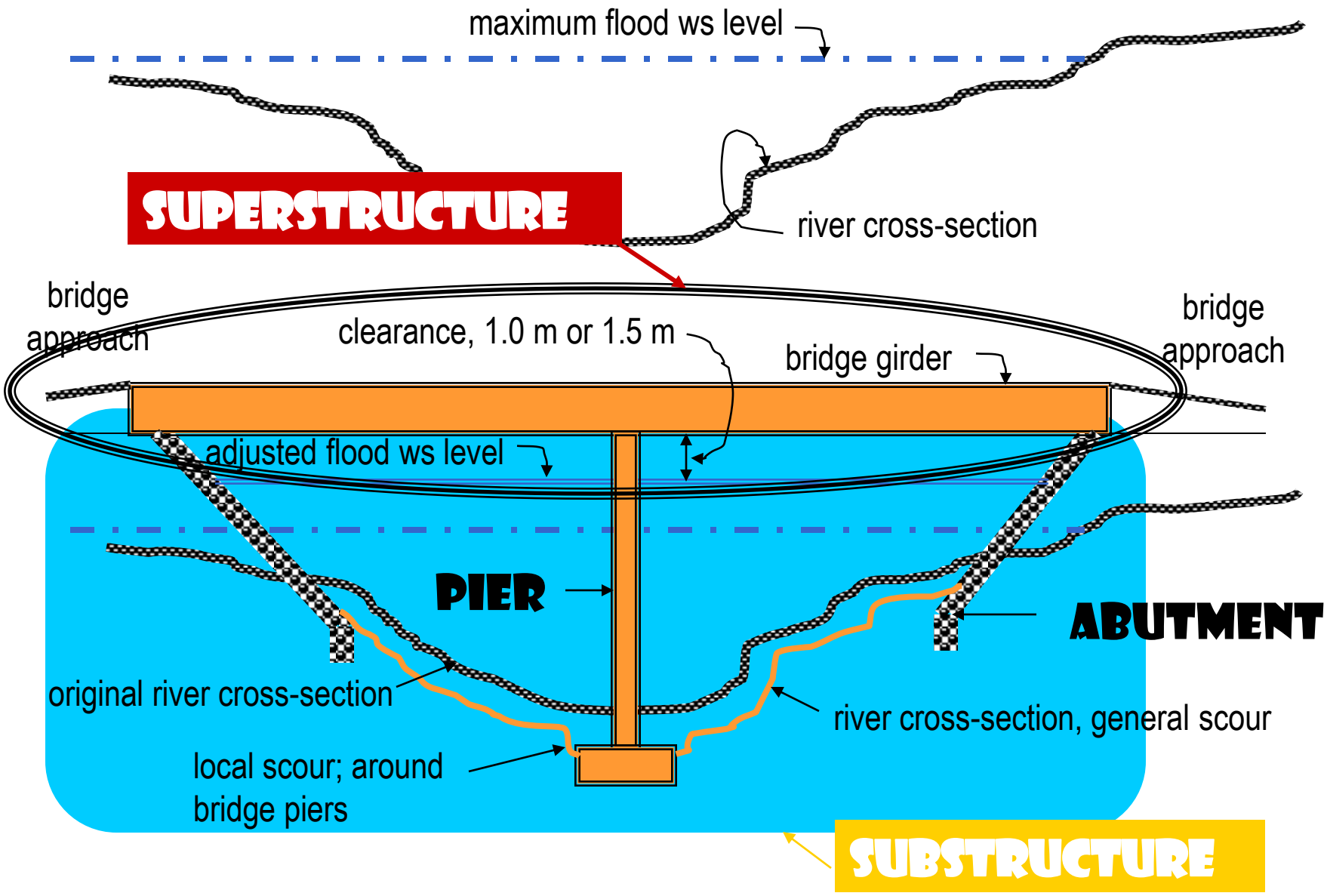
BRIDGES

- Bridge Location
- Waterways
- Site Data
- Hydrologic Analysis
- Hydraulic Analysis
- Pier Spacing, Orientation and Type
- Width of waterway and sidewalk
- Clearances
- Railings, Signages and Safety Devices

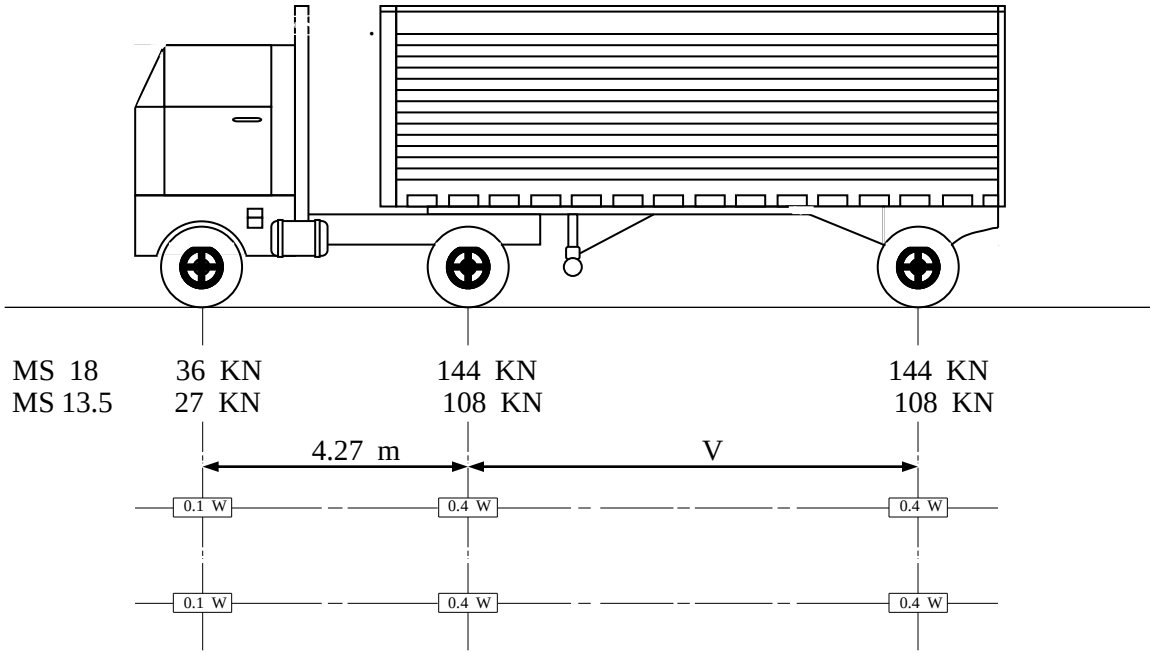
Bridge Basic Components

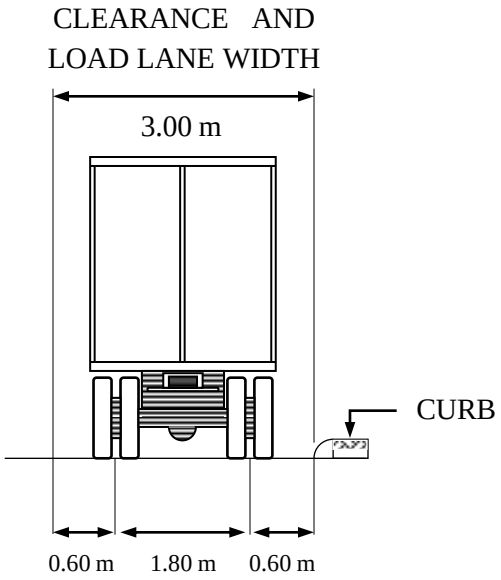



maximum flood ws level
river cross-section
bridge approach
clearance, 1.0 m or 1.5 m
bridge girder
bridge approach
adjusted flood ws level
original river cross-section
river cross-section, general scour
local scour; around bridge piers


maximum flood ws level
SUPERSTRUCTURE
river cross-section
bridge approach
clearance, 1.0 m or 1.5 m
bridge girder
bridge approach
adjusted flood ws level
PIER
ABUTMENT
original river cross-section
river cross-section, general scour
local scour; around bridge piers
SUBSTRUCTURE

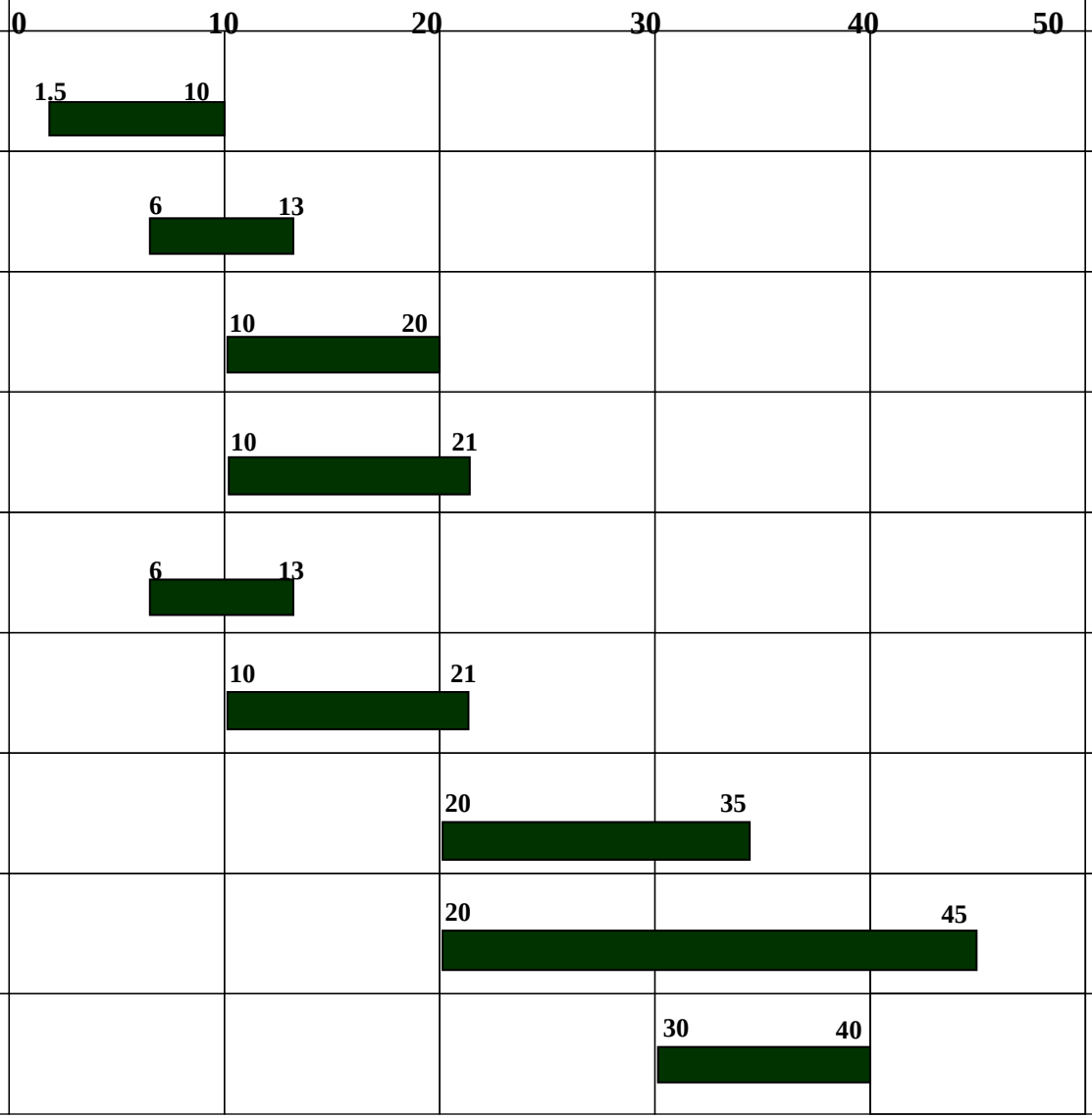
STANDARD MS TRUCK



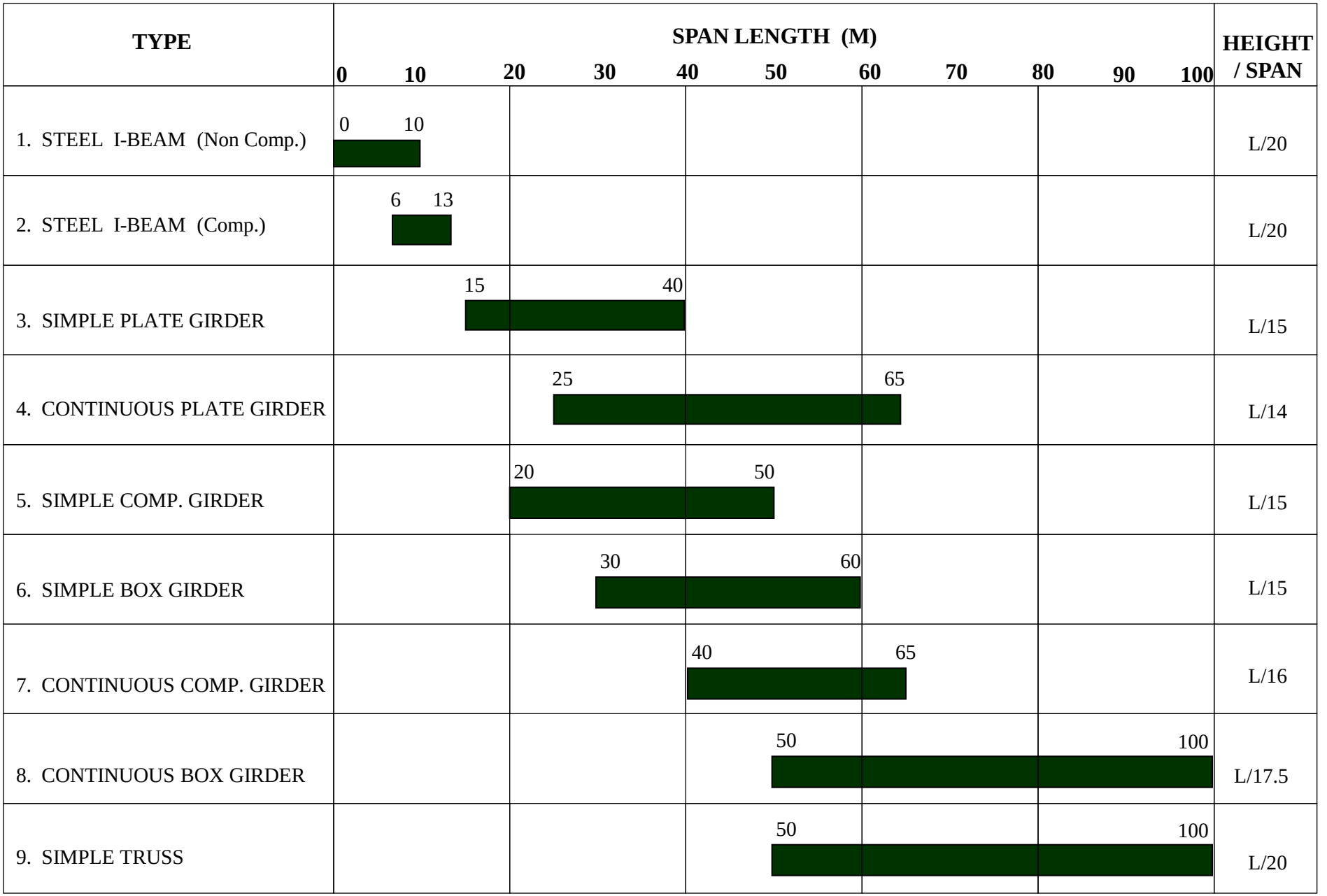


APPLICABLE TYPES OF CONCRETE DECK

TYPE	SPAN LENGTH (M)	HEIGHT / SPAN
1. RC - SLAB	1.5 – 10	L/20
2. RC - HOLLOW SLAB	6 – 13	L/20
3. RC - T-BEAM	10 – 20	L/15
4. PC HOLLOW (Pretension)	10 – 21	L/14
5. PC I-BEAM (Pretension)	6 – 13	L/15
6. PC T-BEAM (Pretension)	10 – 21	L/15
7. PC I-BEAM (Post)	20 – 35	L/16
8. PC T-BEAM (Post)	20 – 45	L/17.5
9. SIMPLE BOX GIRDER	30 – 40	L/20



APPLICABLE TYPES OF STEEL DECK



Bridge Sub-structure

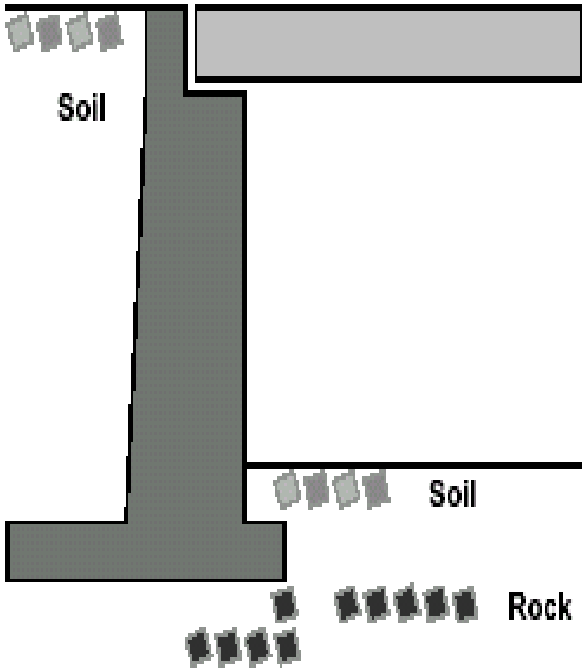
- **Abutment – a substructure which supports the end of a single span or extreme end of a multi-span superstructure, and which usually retains or supports bridge approach embankments/fills.**
  - Open or spill-through abutment
  - Close abutment
  - Wingwall (of sufficient length to retain roadway embankment to the required extent and to provide erosion protection)

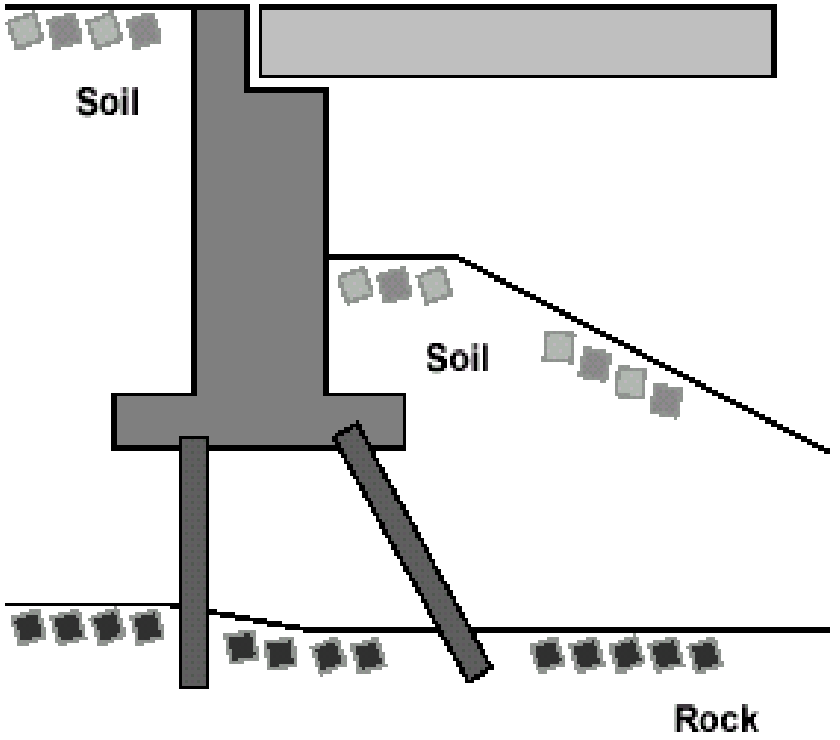
Bridge Sub-structure

Abutment types

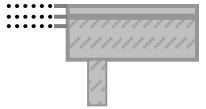
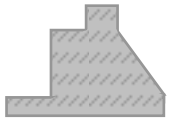
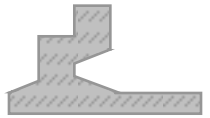
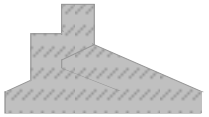
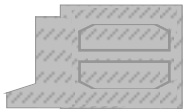
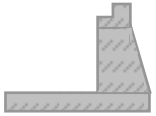
- On pile bent (RC Flat slab, RCDG or RCBG and when the pile exposure above the natural ground is not more than 2 meters.
- On two-columns (spill-thru type – unstable river banks, fill at approach is more than three meters high, or when foundation is of the spread footing type)

Abutment





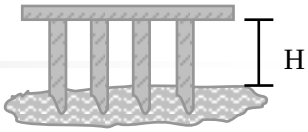
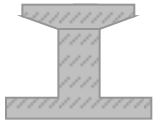
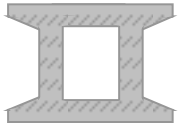
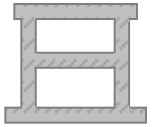
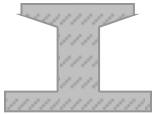
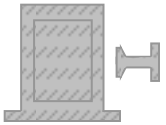
APPLICABLE TYPE OF ABUTMENT

TYPE		HEIGHT (m) 0 10 20 30	REMARKS
ABUTMENT - 1	DIAPHRAGM TYPE	3	
ABUTMENT - 2	GRAVITY SEAT TYPE	4	
ABUTMENT - 3	SEMI GRAVITY SEAT TYPE	4 6	
ABUTMENT - 4	INVERSE T SEAT TYPE	6 10	
ABUTMENT - 5	BUTTRESSED SEAT TYPE	10 15	
ABUTMENT - 6	BOX SEAT TYPE	10 20	
ABUTMENT - 7	RETAINING WALL SEAT TYPE	10 15	

Bridge Sub-structure

- **PIERS – transmit the load of the superstructure to the foundation material and provide intermediate supports between abutments**
- **TYPES OF PIERS**
  - piers on solid shaft
  - piers with two (2) columns
  - piers with single column (T-bent)
  - piers on pile bent (for short-span bridges; maximum height of pier bent shall be 4.00 meters from the river bed to the top of the bridge seat; for greater heights, piers on two columns should be used)

APPLICABLE TYPES OF PIER

TYPE		HEIGHT (m) 0 10 20 30 40	REMARKS
PIER - 0	PILE BENT	0 4	
PIER - 1	COLUMN TYPE	0 15	
PIER - 2	RIGID FRAME TYPE (1-STOREY)	5 15	
PIER - 3	RIGID FRAME TYPE (2-STOREY)	15 25	
PIER - 4	WALL TYPE	10 30	
PIER - 5	WALL TYPE (1-SECTION)	25 40	

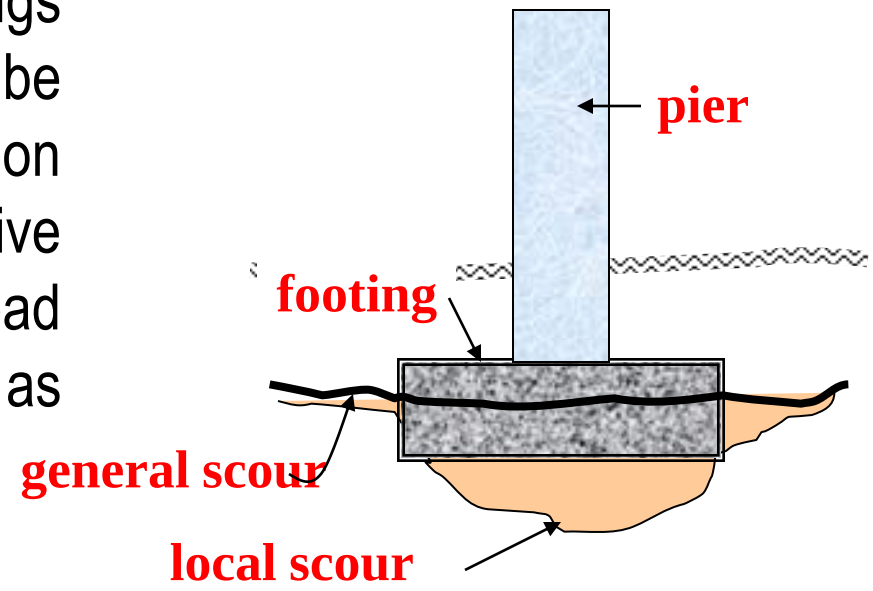
Bridge Sub-structure FOUNDATIONS

The type of foundation to be used are dictated by:

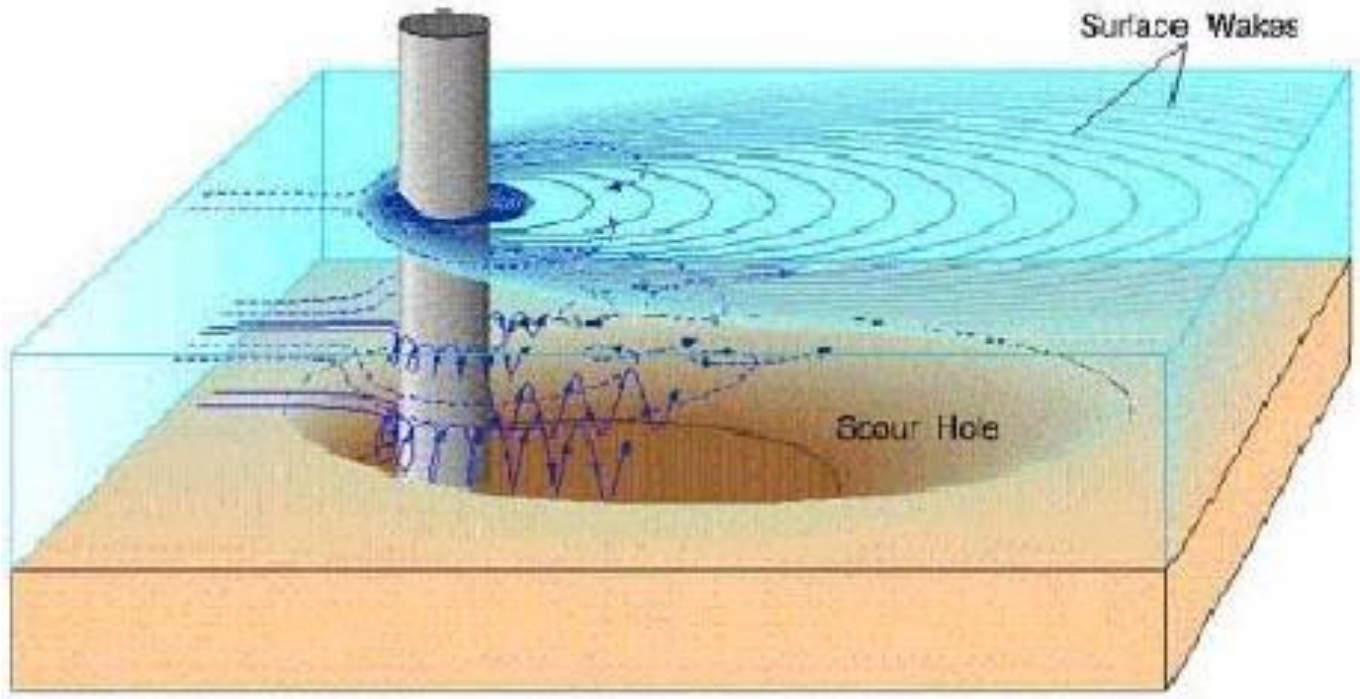
a) height of superstructure and;

b) characteristic of the foundation soil at the bridge site.

Piling shall be considered when footings cannot, at a reasonable expense, be founded on rock or other solid foundation material. When erosion and excessive scouring is expected in the spread footings, piles should be used as protection against scour.



Local Scour Due to Streamflow Behavior in Deep Water



Bridge Sub-structure PILE FOUNDATIONS

Types of Piles

- Timber
- Concrete Piles (pre-cast)
- Concrete Piles (cast-in-place)
- Steel Piles (H-piles, tubular piles)
- Composite concrete piles
- Prestressed piles

Penetration depths (General requirements)

Three (3.0) meters or 10 ft in hard cohesive or dense granular material

Six (6.0) meters or 20 feet in soft cohesive or loose granular material

Unless refusal is encountered, one-third (1/3) of the pile length should be embedded.

APPLICABLE TYPES OF FOUNDATION

TYPE	DEPTH (m) 0 10 20 30 40 50 60 70 80 90 100	APPLICABLE DIAMETER (m)
F-1 SPREAD FOUNDATION	0 10	-
F-2 RC PILE	6 15 25	0.3 - 0.5
F-3 PC PILE	12 30 40	0.35 - 0.5
F-4 STEEL PIPE PILE	20 60	0.5 - 0.8
F-5 CAST IN PLACE W/ CASING	10 30 40	1.0 - 1.2
F-6 EARTH AUGER	10 30	1.0 - 1.5
F-7 REVERSE CIRCULATION DRILL	25 60 90	1.0 - 1.2

Bridges – DATA REQUIREMENTS

Field Survey Information

- Reconnaissance Survey
- Preliminary and Topographic Survey
- Final Location Survey

Traffic Data

- Traffic Count/Survey
- Loadometer

Sub-surface Data

- Borings
- Samplings

Hydrologic/Hydraulic Data

- Low Flow
- Flood Flow
- Sediment Charge

Bridges – DATA REQUIREMENTS

Loads

- Dead Load
- Live Load
- Impact or dynamic effect of live load
- Wind load
- Seismic loading
- Thermal stresses (crack control for structures)
- Hydraulic stresses (on sub-structures/piles)

Typical Design Values

ANGLES OF REPOSE

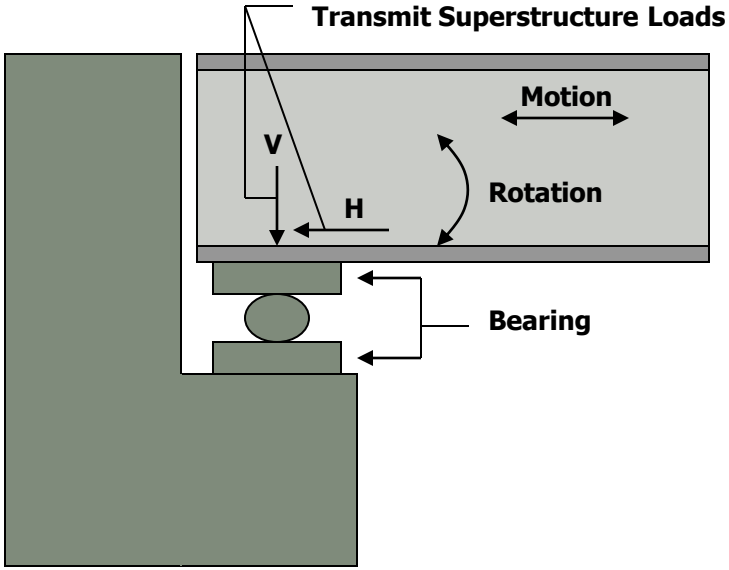
MATERIAL	**Angle (degrees)**
Earth, Loam	30 to 45
Dry Sand	25 to 35
Moist Sand	30 to 45
Wet Sand	15 to 30
Compact Earth	35 to 40
Gravel	30 to 40
Cinders	25 to 40
Coke	30 to 45

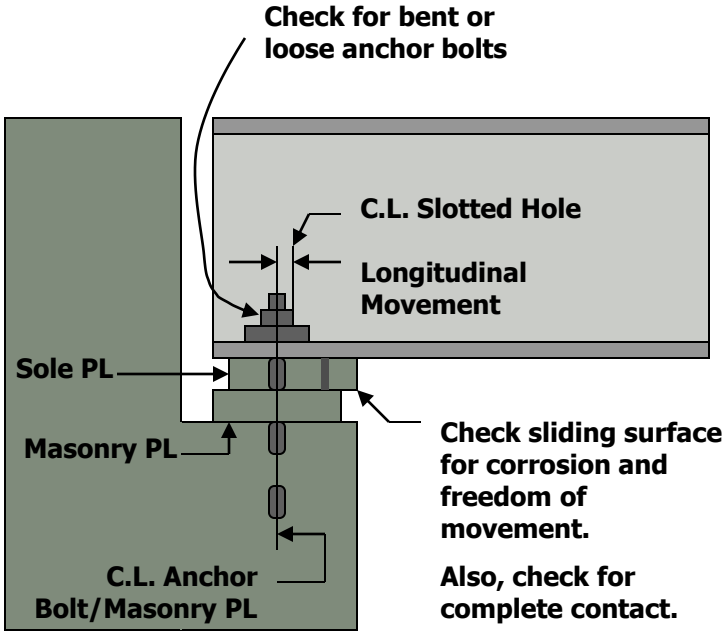
Typical Design Values

TYPICAL VALUES - Bearing Capacities

MATERIAL	Safe Bearing Capacity			
	Minimum Value		Maximum Value	
	(kPa)	(kip/ft2)	(kPa)	(kip/ft2)
Alluvial Soils	47.88	1.00	95.76	2.00
Clays	95.76	2.00	383.04	8.00
Sand, confined	95.76	2.00	383.04	8.00
Gravel	191.52	4.00	383.04	8.00
Cemented Sand and Gravel	478.80	10.00	957.60	20.00
Rock	478.80	10.00		

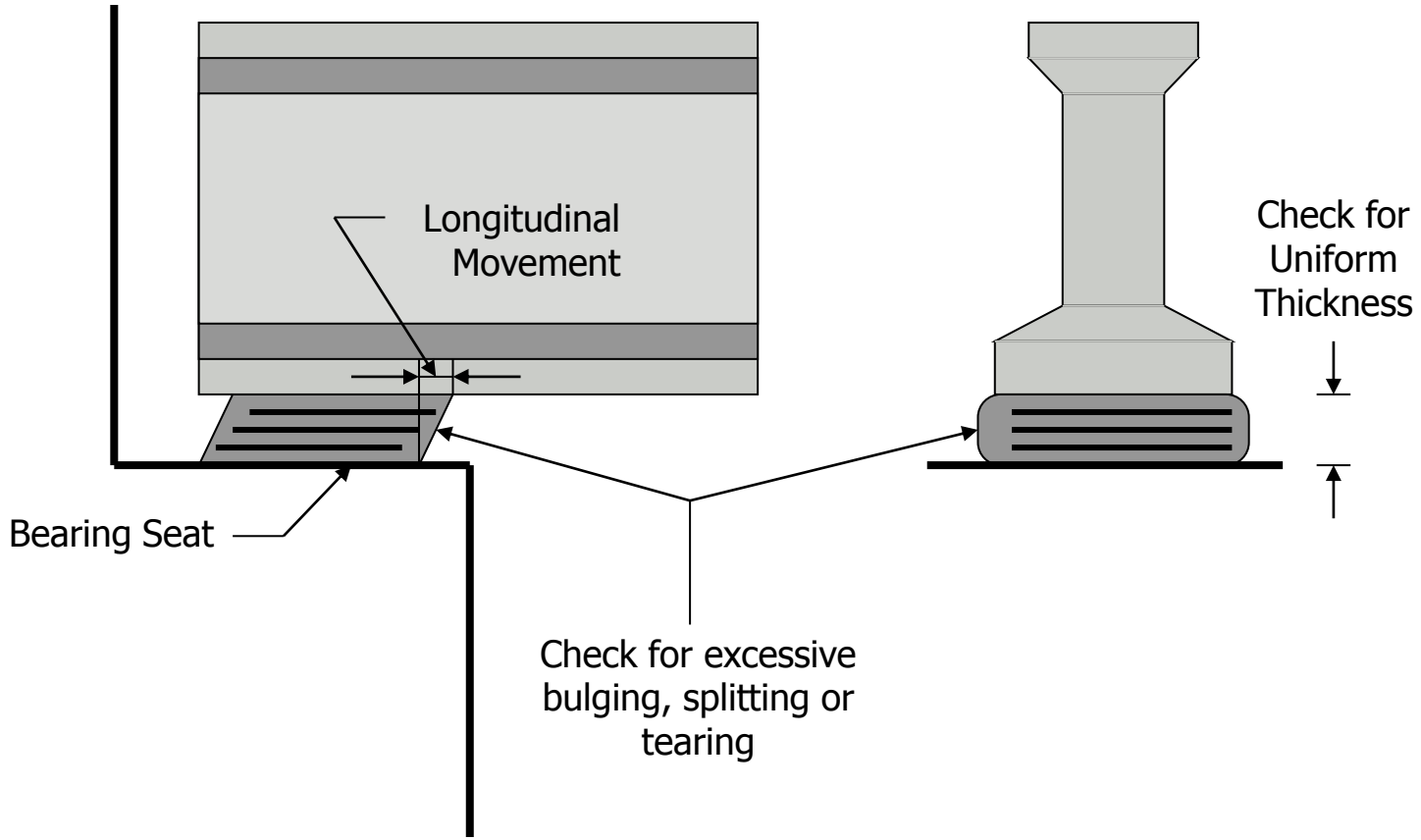
BRIDGE BEARINGS (metal type)





Sliding Plate Bearing Checklist Items

BRIDGE BEARINGS (elastomeric type)



Bridge Locations

- Straight reach of the river
- Steady river flow without serious whirls and cross currents
- Narrowest possible channel with permanent banks; banks high enough to contain expected maximum flood flows
- Rock or hard strata, resistant to erosion close to the river bed
- Economical and practicable approaches (sufficient sight distance, no difficult curves, free from natural obstacles, easy-to-acquire right-of-way)
- Absence or minimal river diversion works or care-of-water during construction
- Minimal river training works

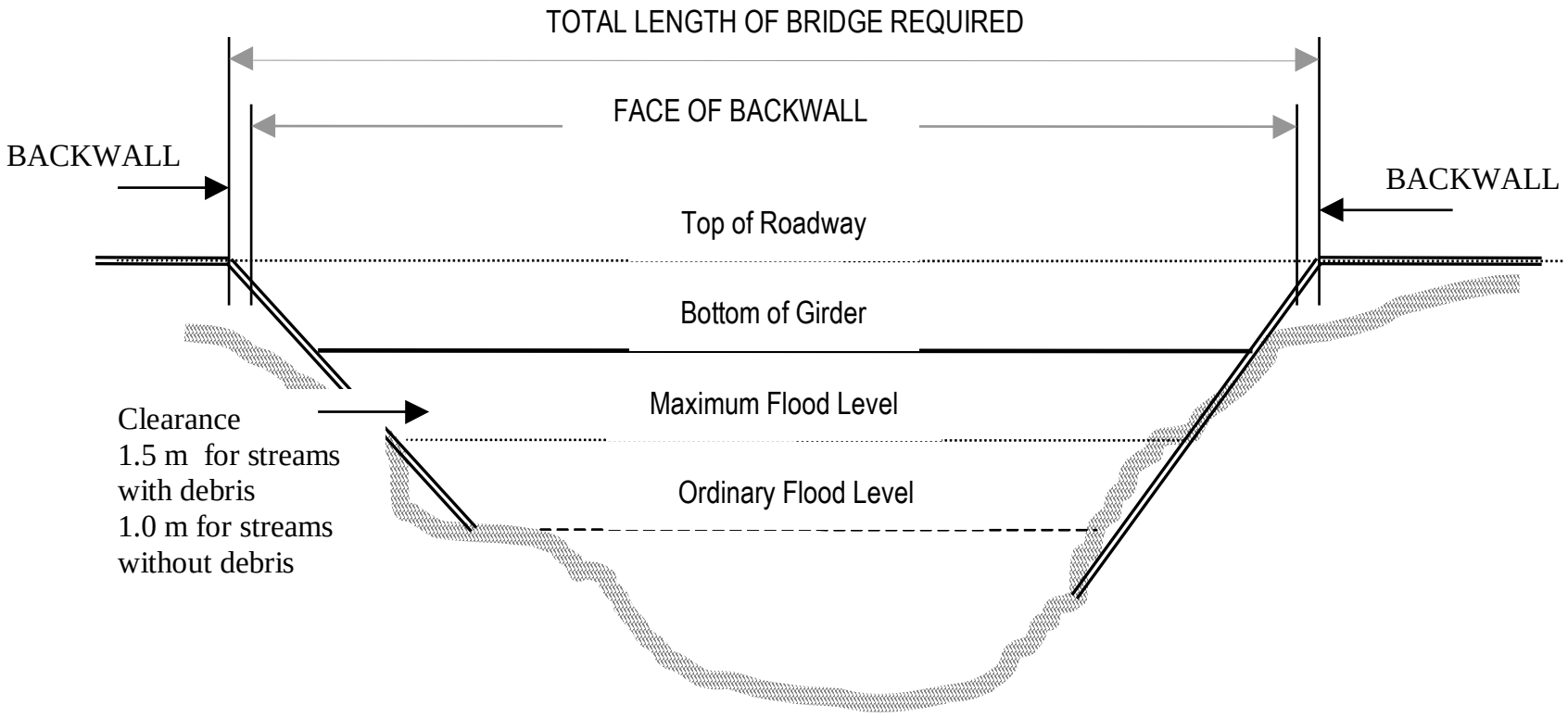
Bridge Geometrics

- Alignment
  - Normal, perpendicular to the banks of the waterway
  - Skewed, having an angle of less than 90 degrees from the bank of the river or creek
- Span of Bridges
  - Odd number of spans to avoid pier at the center of river or creek

No. of Bridge Girders – No. of Lanes

No. of Lanes	Minimum Width of Roadway	Minimum no. of Girders
1 lane	4.0 meters	3 girders
2 lanes	6.70 meters	4 girders (rural)
2 lanes	7.30 meters	4 girders (urban)
More than 2 lanes	variable	Not less than 6 girders

Length of Bridge



Type of Bridges

Materials Used

Timber Bridge
Concrete – reinforced concrete, pre-stressed concrete
Steel Bridge

System of Design

Simple spans
Continuous spans
Cantilever span
Suspension Bridge

Usage

Temporary
Permanent

Recommended Limits of Superstructures for Simple Span Bridges

Concrete Bridge

- Reinforced concrete pre-cast slab or reinforced flat slab shall be 6.00 meters
- Reinforced Concrete Deck Girder (RCDG) – span shall be 8.00 to 12.00 meters
- Reinforced Concrete Box Girder – span shall be from 22.00 m to 30.00 meters

Pre-stressed concrete

- Channel beams, 11 to 13.40 meters
- Tee-beams, 15.80 to 18.90 meters
- I-beams, 9.00 to 42.68 meters
- Box Girders, span over 30.00 meters

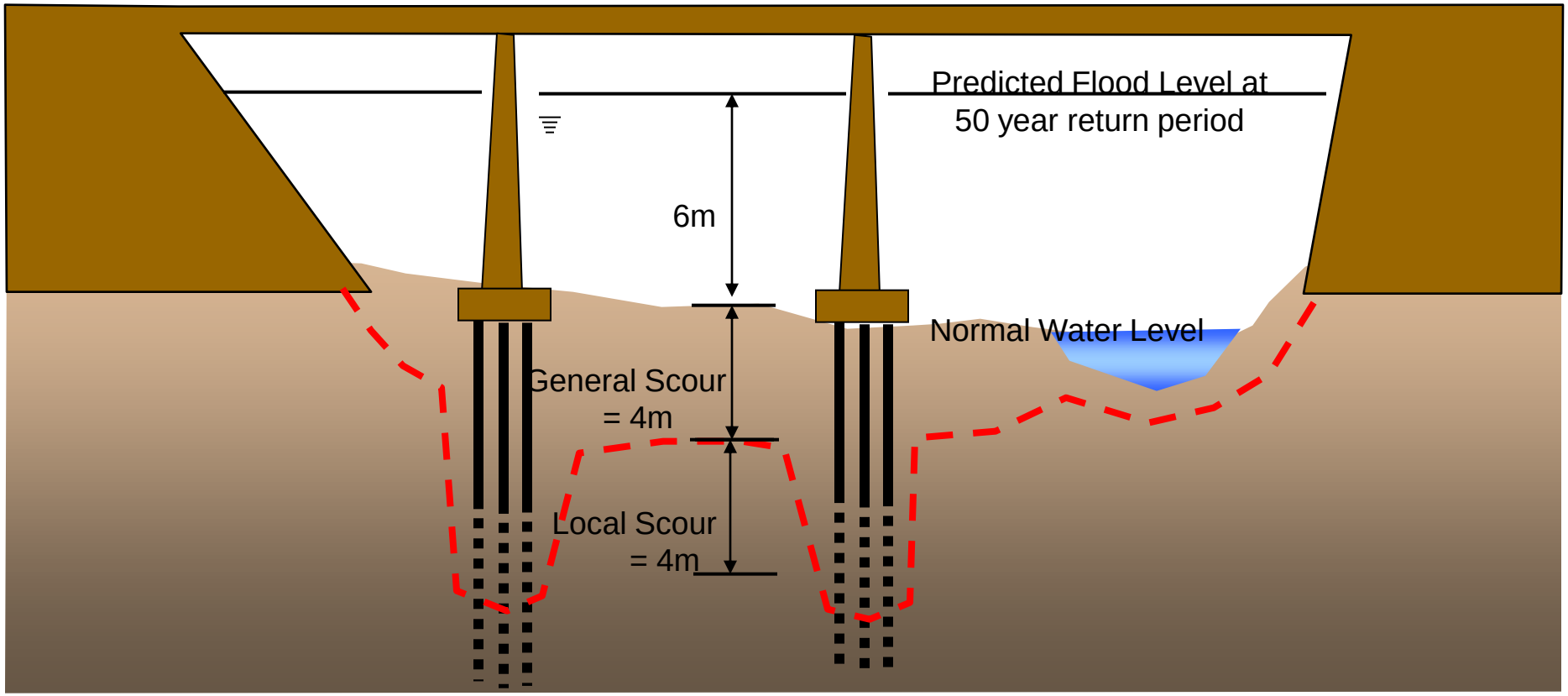
Timber trestle bridge,6.00 meters

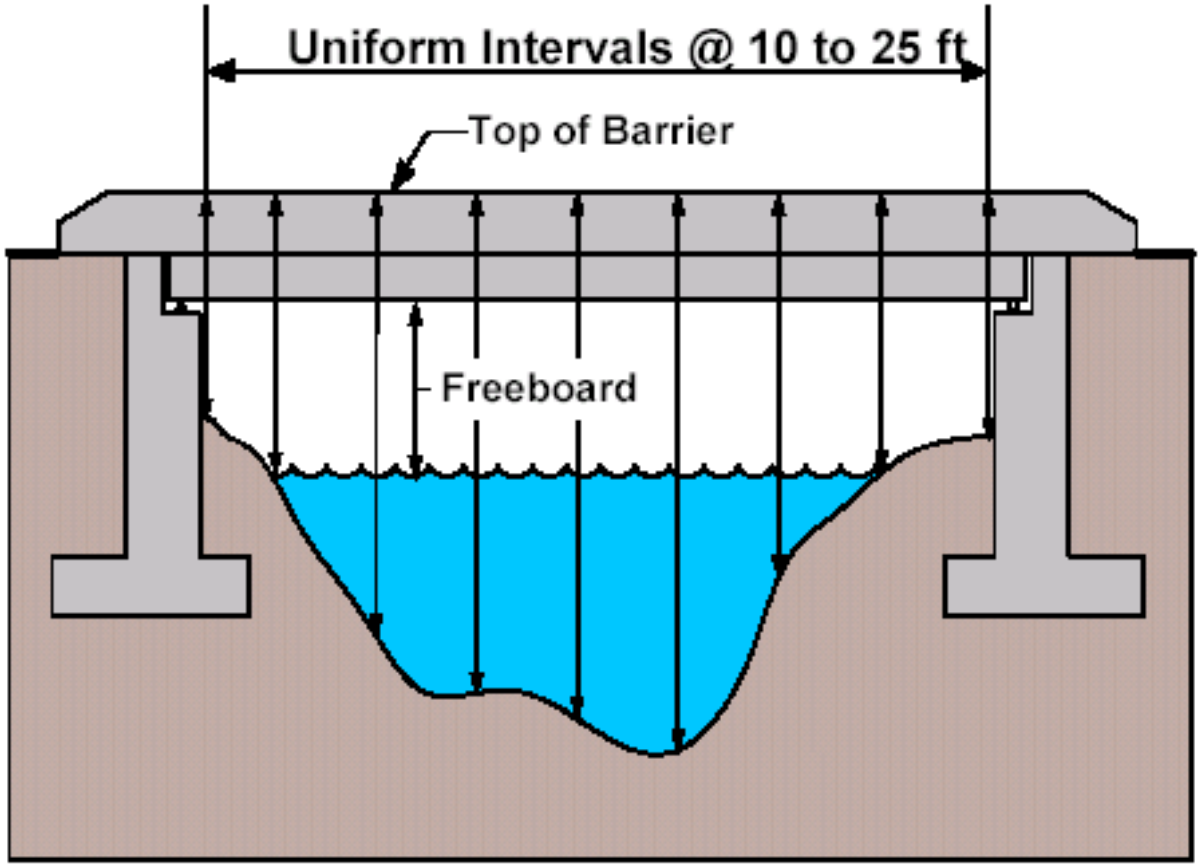
Recommended Limits of Superstructures for Simple Span Bridges

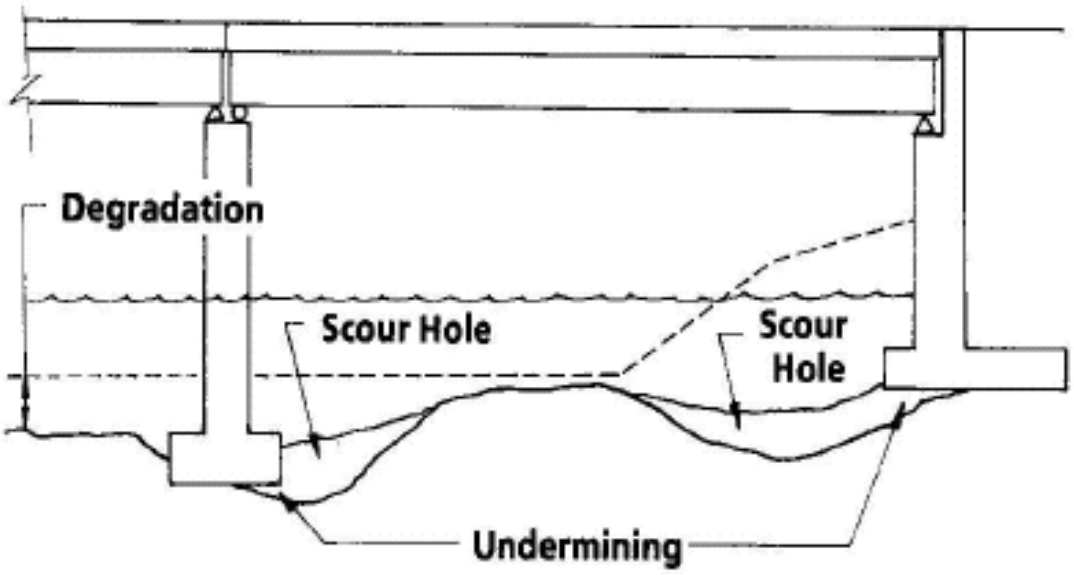
Steel Bridges

- Composite I-Beam, Span from 15 m to 30 m
- Steel Plate Girder, Span from 20 m to 50 m
- Bailey Bridge, Span from 9.0 m to 30 m
- Steel Truss, Span from 36.50 to 128 m

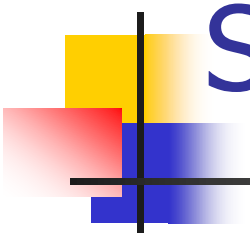
Suspension Bridge, span from 73 m & over


Predicted Flood Level at
50 year return period
6m
Normal Water Level
General Scour
= 4m
Local Scour
= 4m


Uniform Intervals @ 10 to 25 ft
Top of Barrier
Freeboard

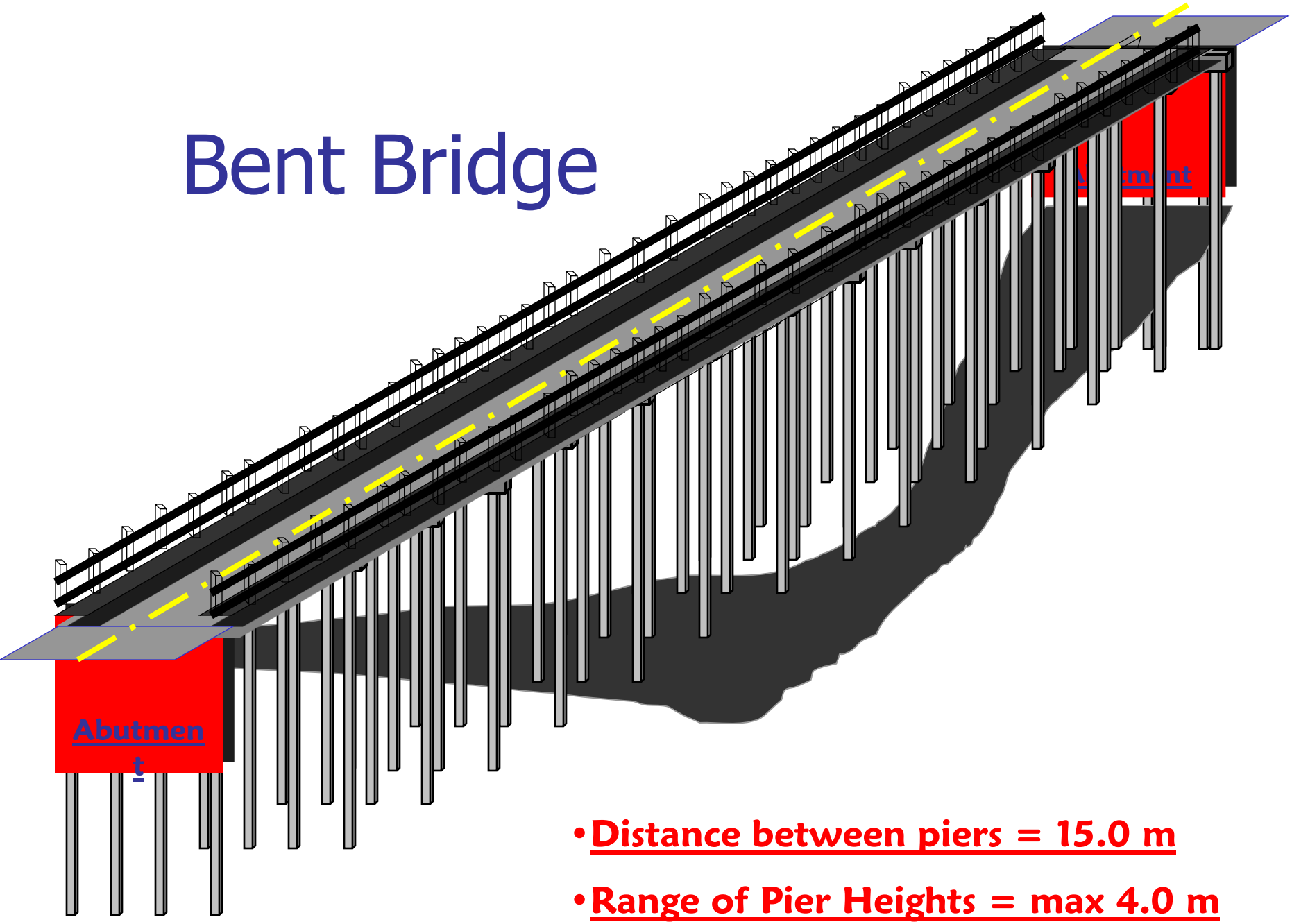


Channel Cross-Section



Sample Bent RCDGBridge

Bent Bridge



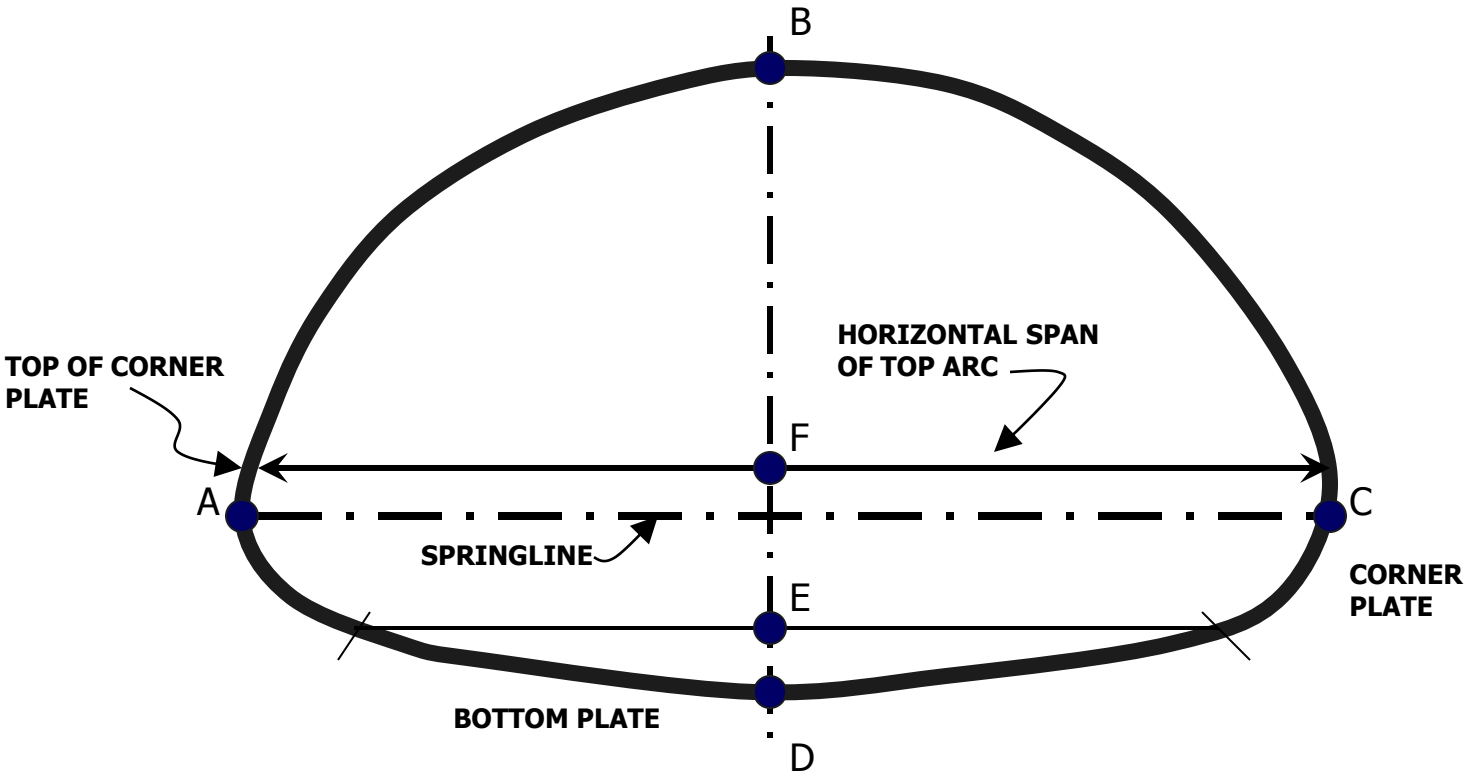
- **Distance between piers = 15.0 m**
- **Range of Pier Heights = max 4.0 m**

Bridges & Culverts

APPLICABLE TYPES OF CULVERTS

Type	Length	Width/Span Diameter	Height/ Diameter
RCPC	1000mm	300-2400mm	300-2400mm
RCBC	3 Barrels	600-3000mm	600-3000mm
RC Elliptical	3 Barrels	3000mm minor	3000mm major
Corrugated Metal	3000mm/ unit	18000mm	8000mm

Corrugated Metal Culvert



CMC Image

RCBC

Multi-Barrel

Multi-Barrel Traffic Slab

Circular Metal Culvert

Timber Culvert

CMC Image

Twin-Barrel Multi-Purpose

RCBC Apron

RCBC Energy Dissipator

CMC Interior View

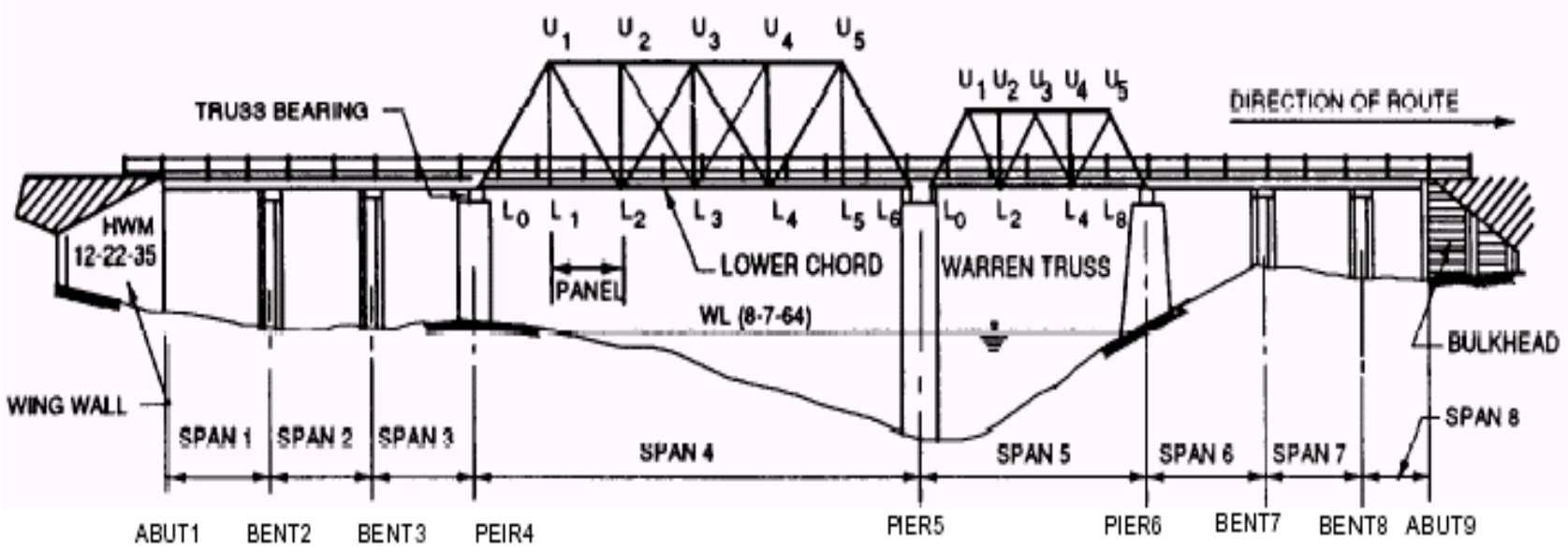
CMC Wingwall

Timber Culvert

Arch Bridge/Culvert?

Bridge Nomenclature

General Bridge Nomenclature



ABBREVIATIONS

COF CREOSOTED DOUGLAS FIR (PRESSURE TREATED)

WS WEARING SURFACE

WL WATER LEVEL

HWM HIGH WATER MARK

RC REINFORCED CONCRETE

RW REDWOOD

UF UNTREATED FIR

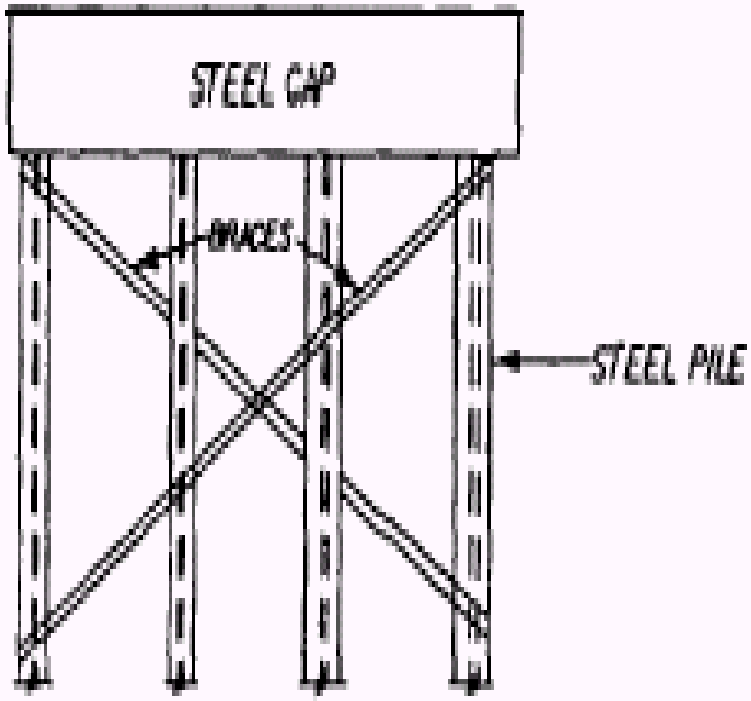
BTF BRUSHED TREATED FIR (WOOD PRESERVATIVE)

VC VERTICAL CLEARANCE

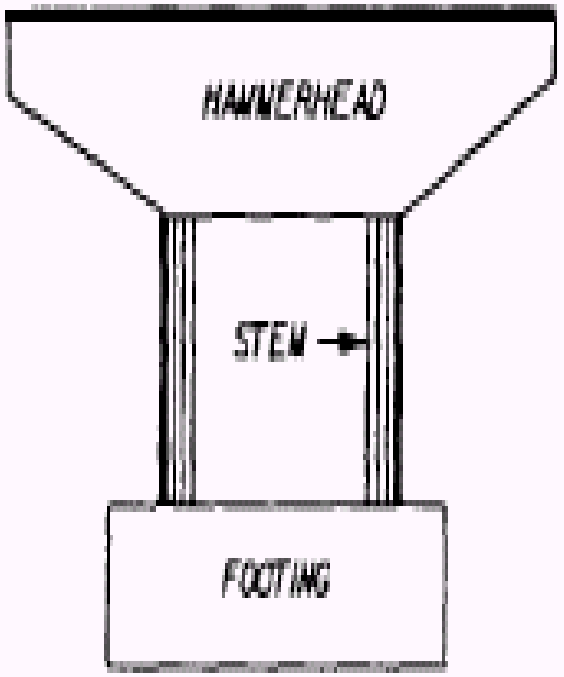
b b DISTANCE BACK TO BACK

b b DISTANCE BACK TO BACK

Pier Nomenclature



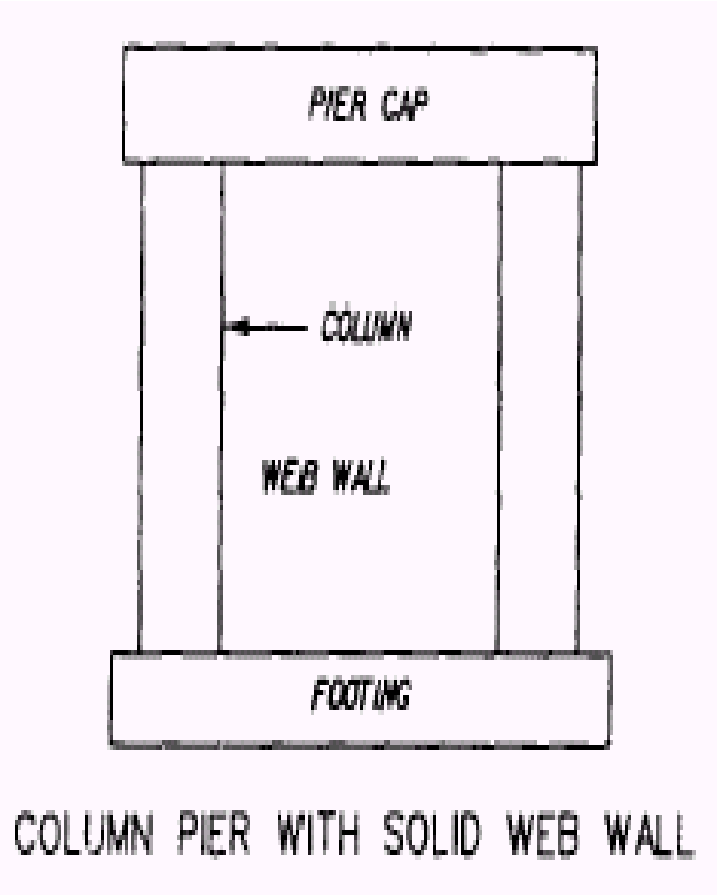
STEEL BENT



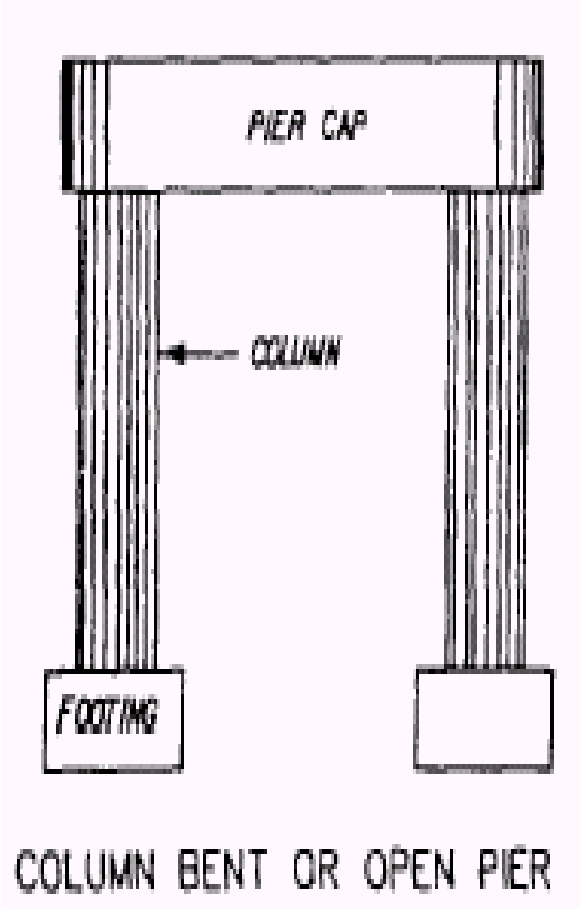
CANTILEVER PIER OR HAMMERHEAD

Hammerhead

Pier Nomenclature



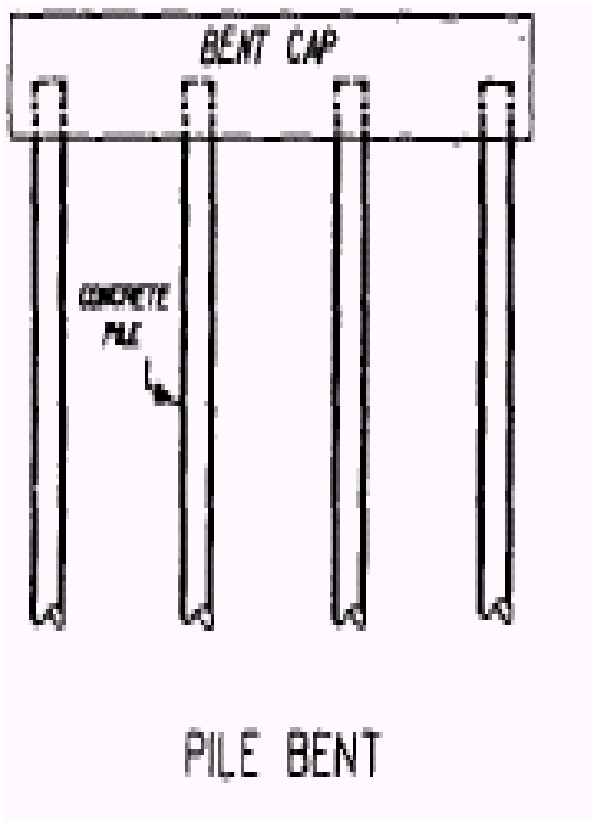
COLUMN PIER WITH SOLID WEB WALL



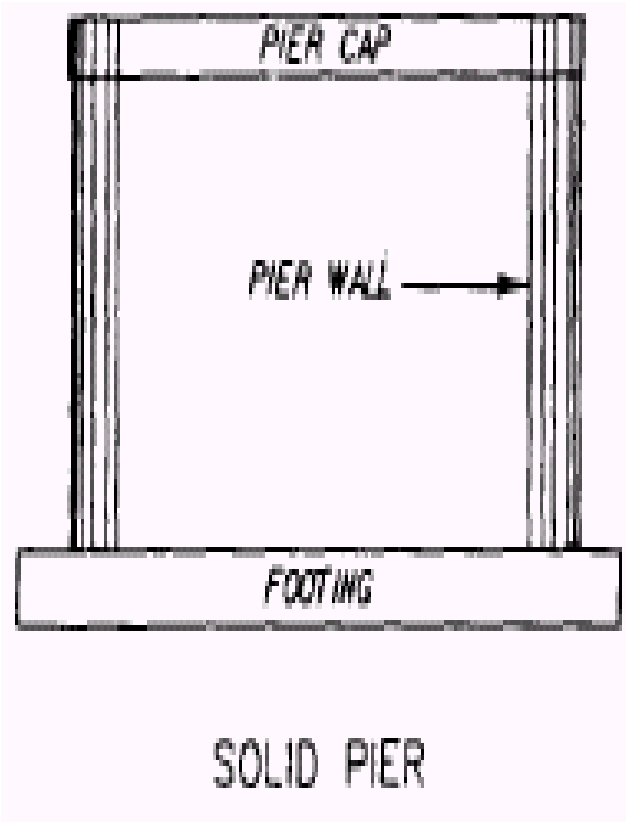
COLUMN BENT OR OPEN PIER

Tied Column

Pier Nomenclature



PILE BENT

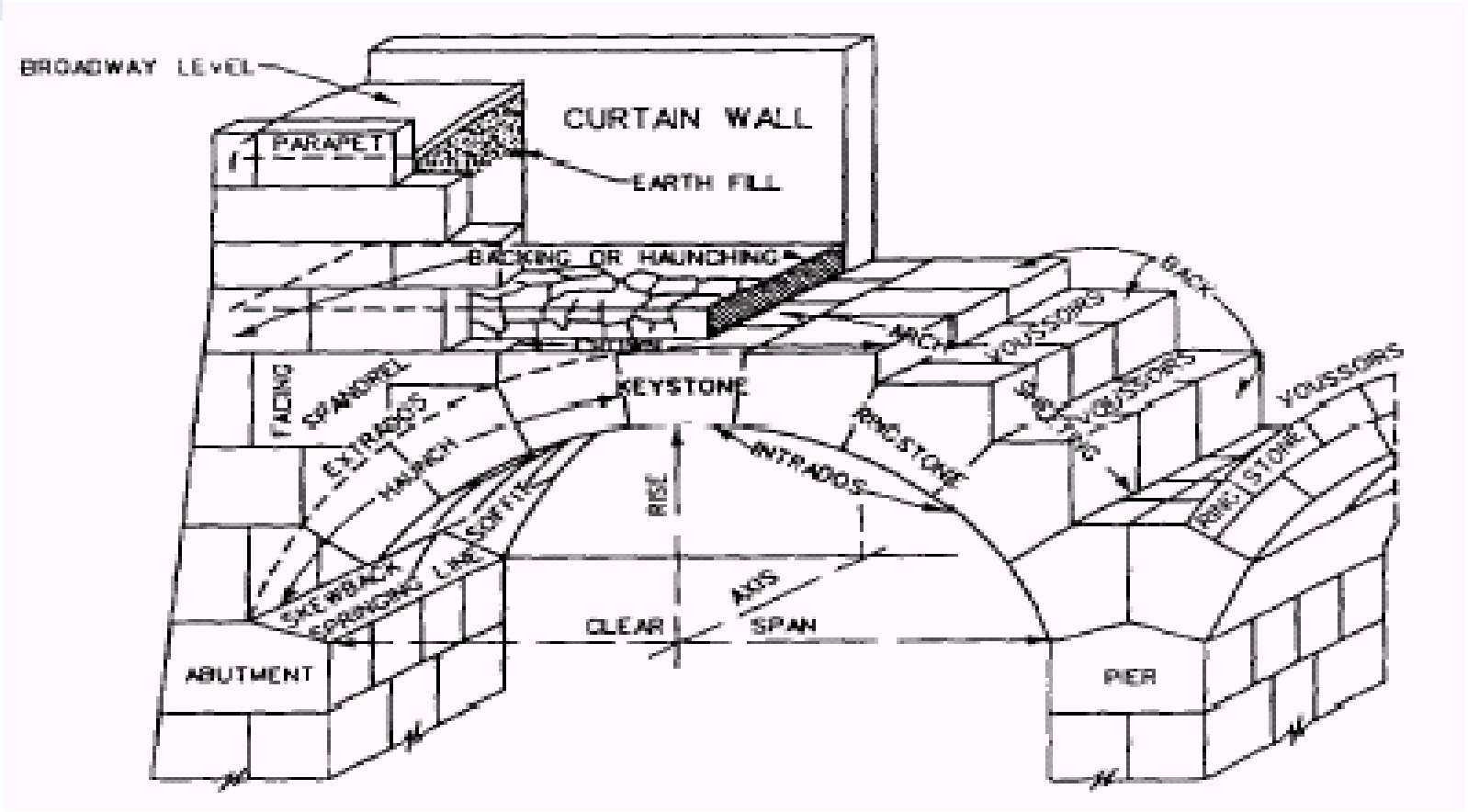


SOLID PIER

Pile Bent

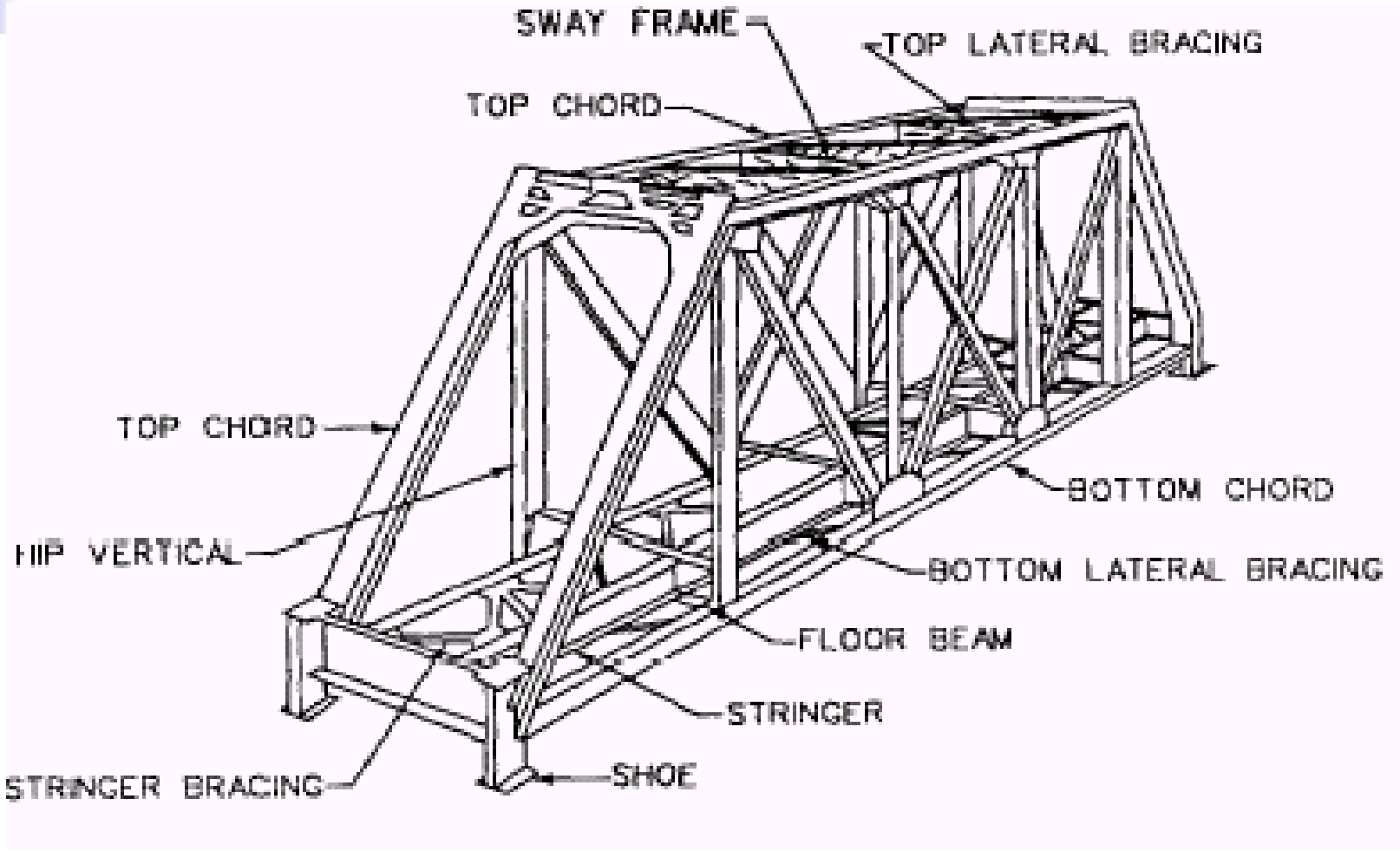
Solid Pier

Arch Bridge Nomenclature

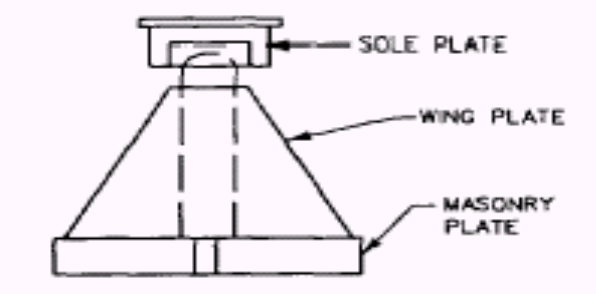


Arch Masonry

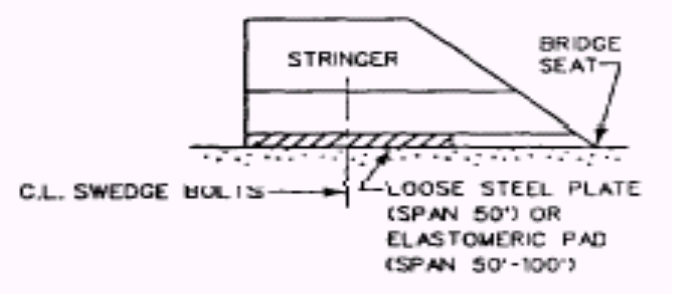
Truss Nomenclature



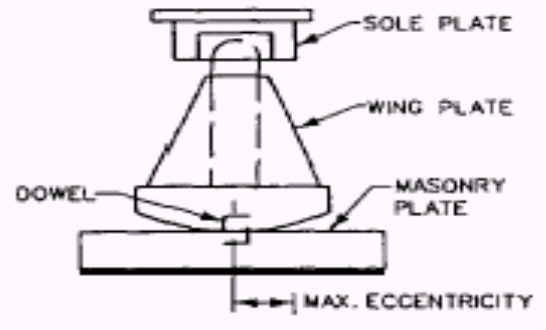
Bearing Nomenclature



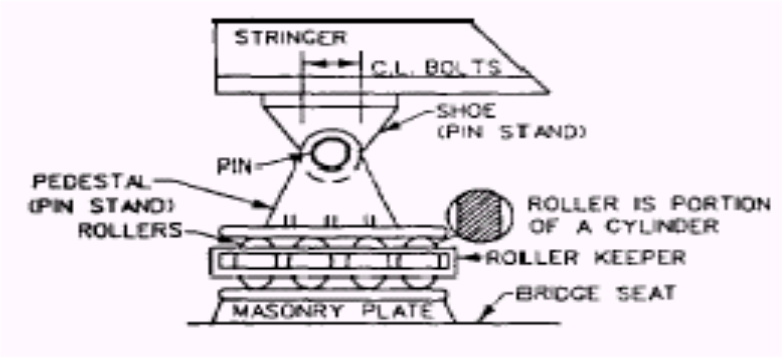
A. FIXED BEARING.



B. SIMPLE EXPANSION BEARING



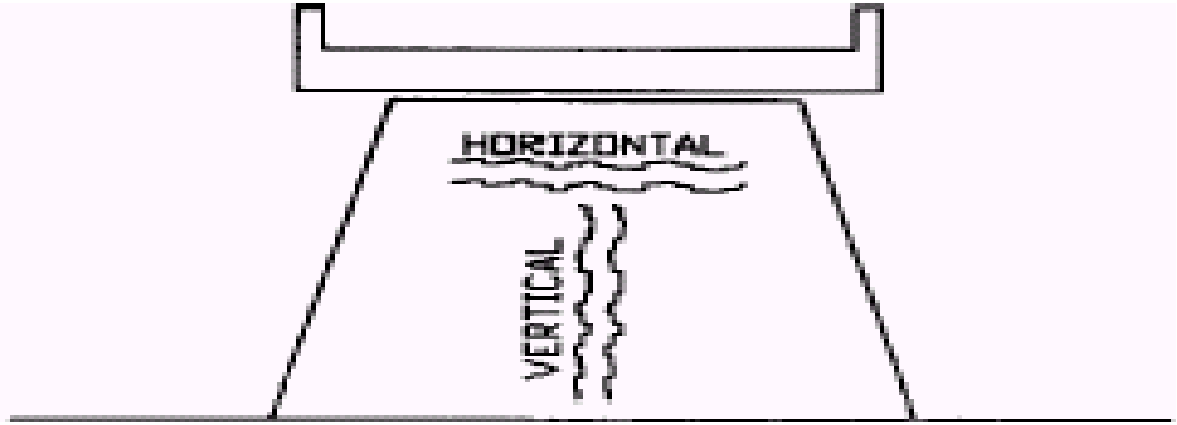
C. EXPANSION BEARING.



D. ROLLER EXPANSION BEARING

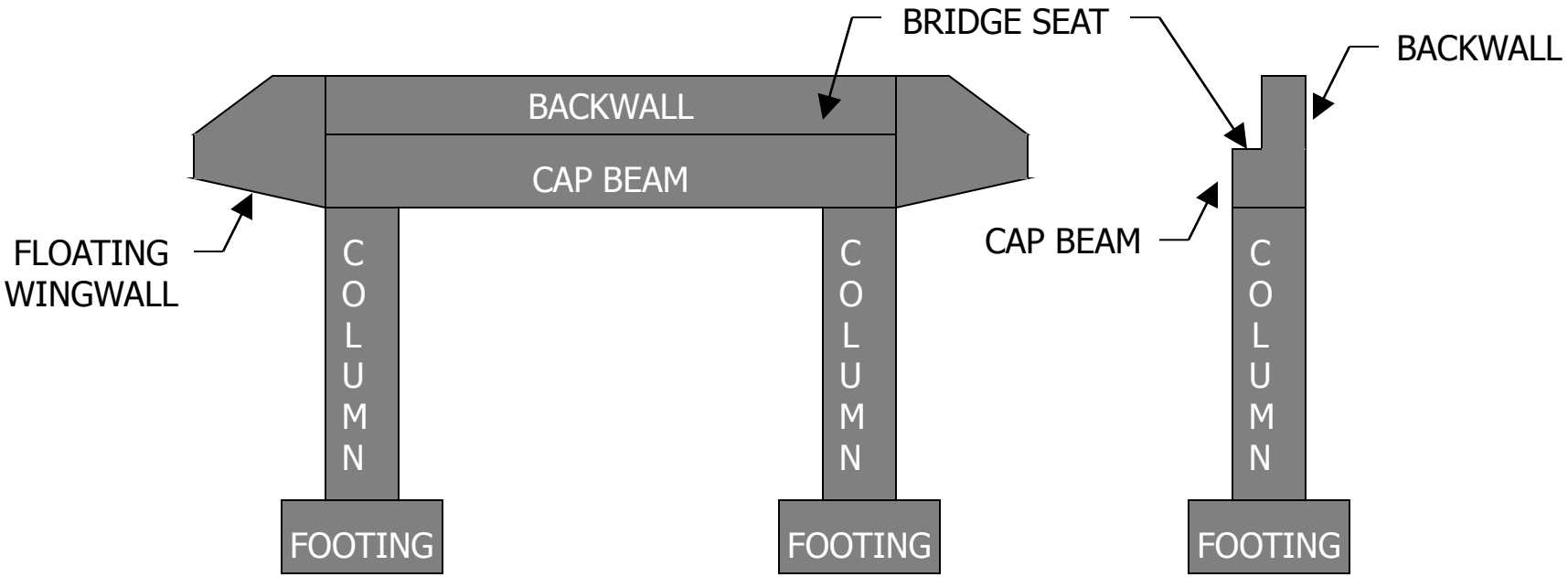
Cracks Nomenclature

PLAN VIEW OF A BRIDGE DECK

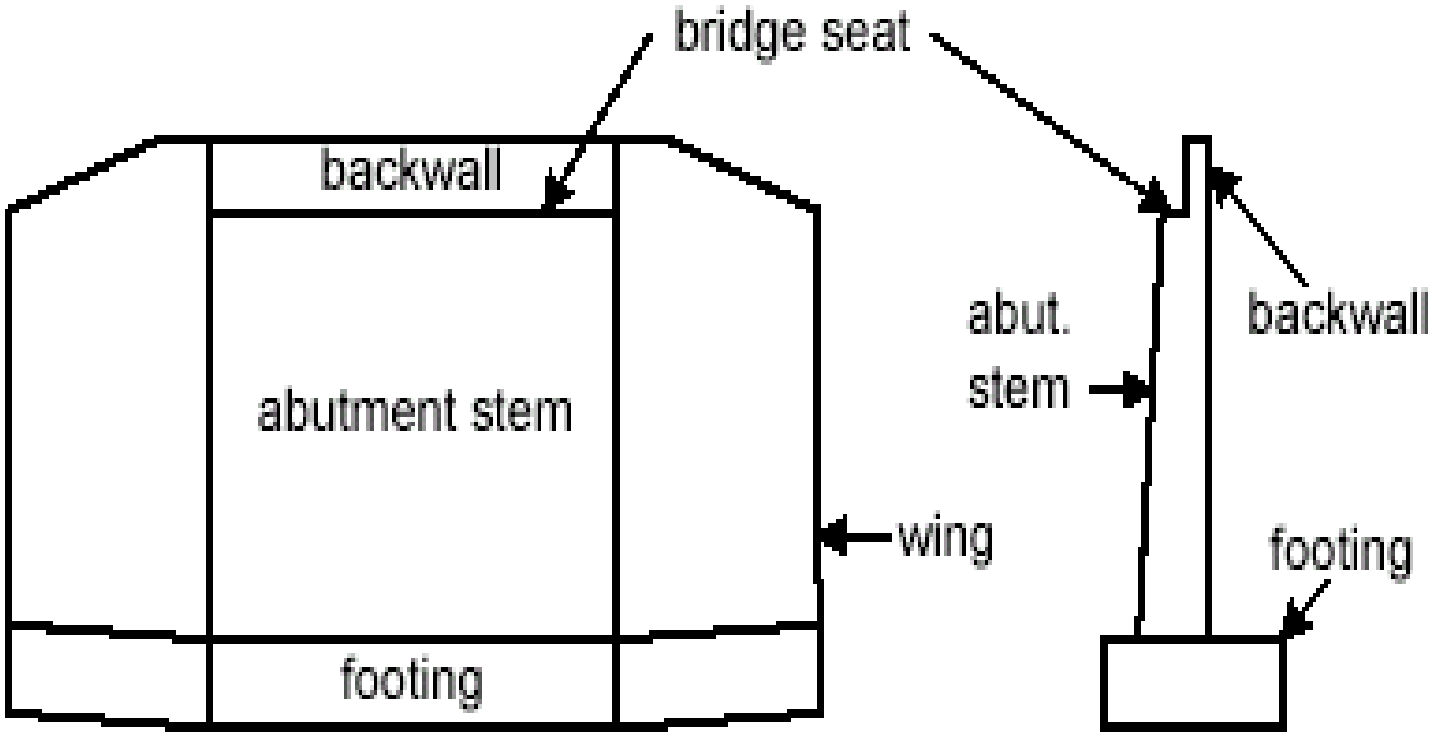


ELEVATION VIEW OF A PIER

Abutment Components



Abutment Components



Classification of Bridges by Materials

- Timber
- Concrete
- Steel
- Masonry

Bailey Bridge w/o Running Board

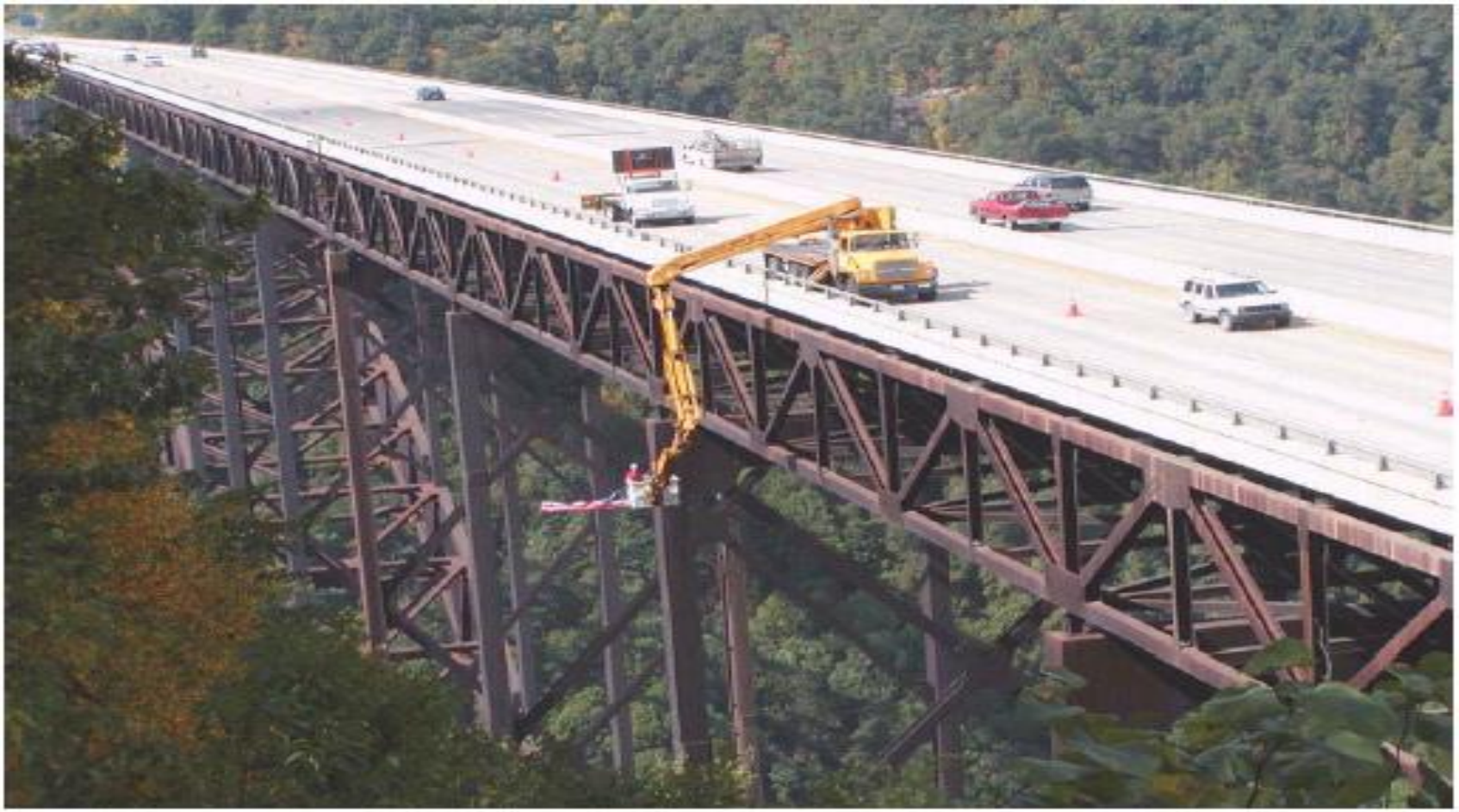
Glue Laminated Bridge

Concrete (RCDG) Bridge

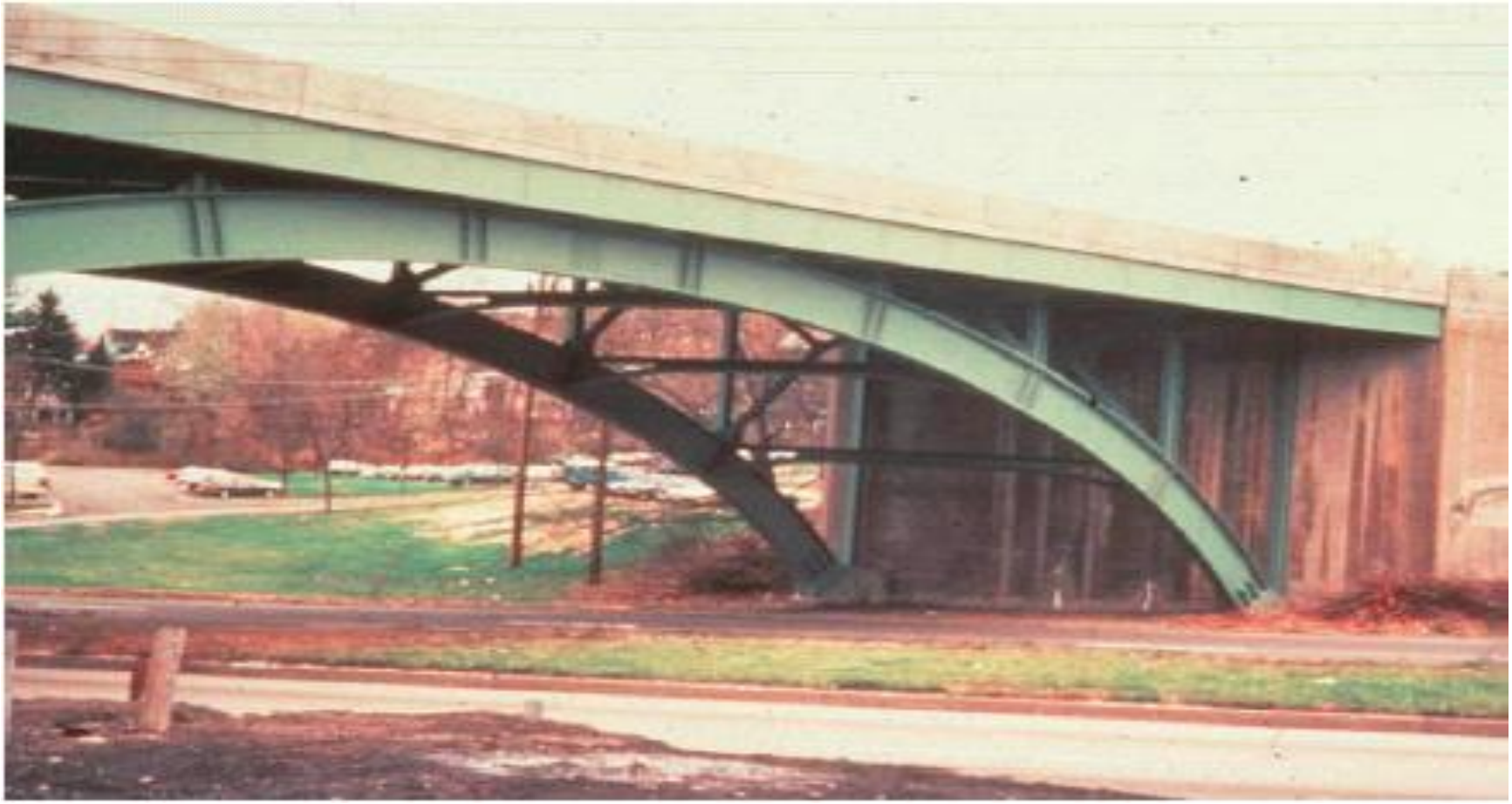
Concrete Arch Bridge

Steel Girder Bridge

Steel Truss Girder Bridge



Steel Arch Bridge



Steel Truss Through Bridge

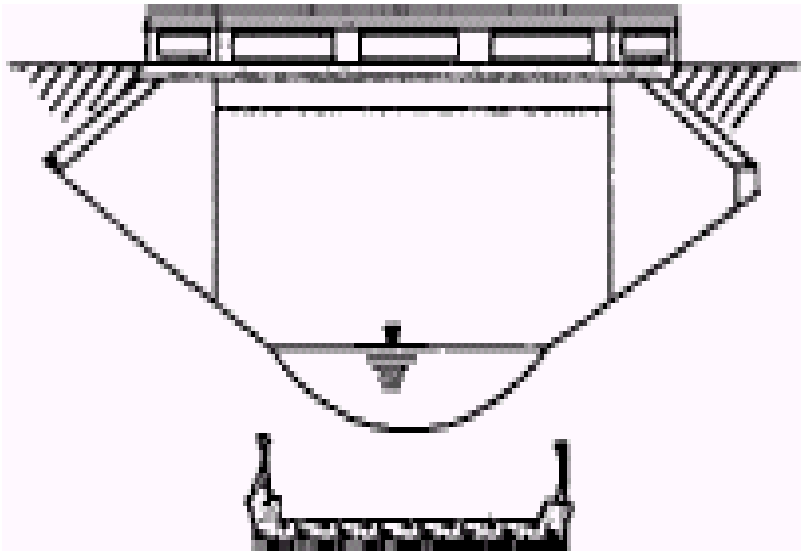
Suspension Bridge

Special Steel Bridge

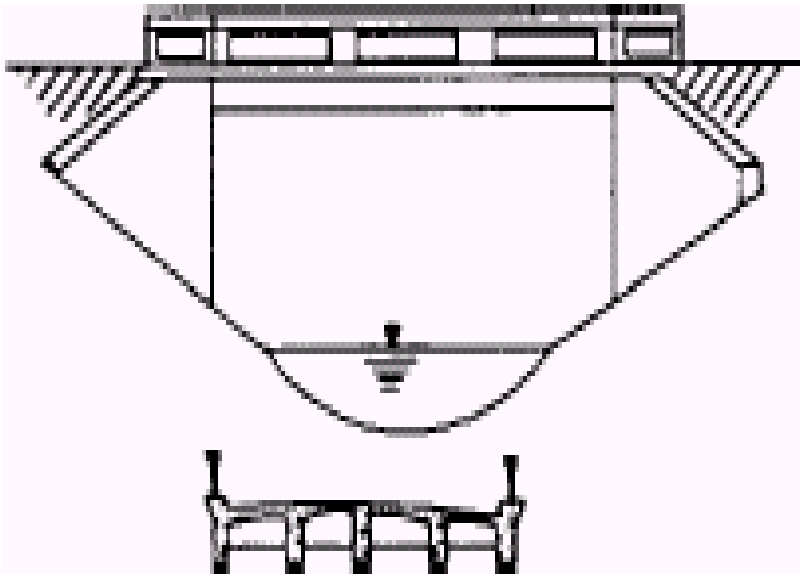
Classification of Bridges by Structural Systems

- Slab/T-Beam
- Deck Girder
- Through Bridge
- Multi-Span
- Continuous Splan
- Arch Bridge
- Rigid Frame
- Tied Arch Bridge
- Suspension
- Cable Stayed

Slab/T-Beam Bridge



SLAB SECTION

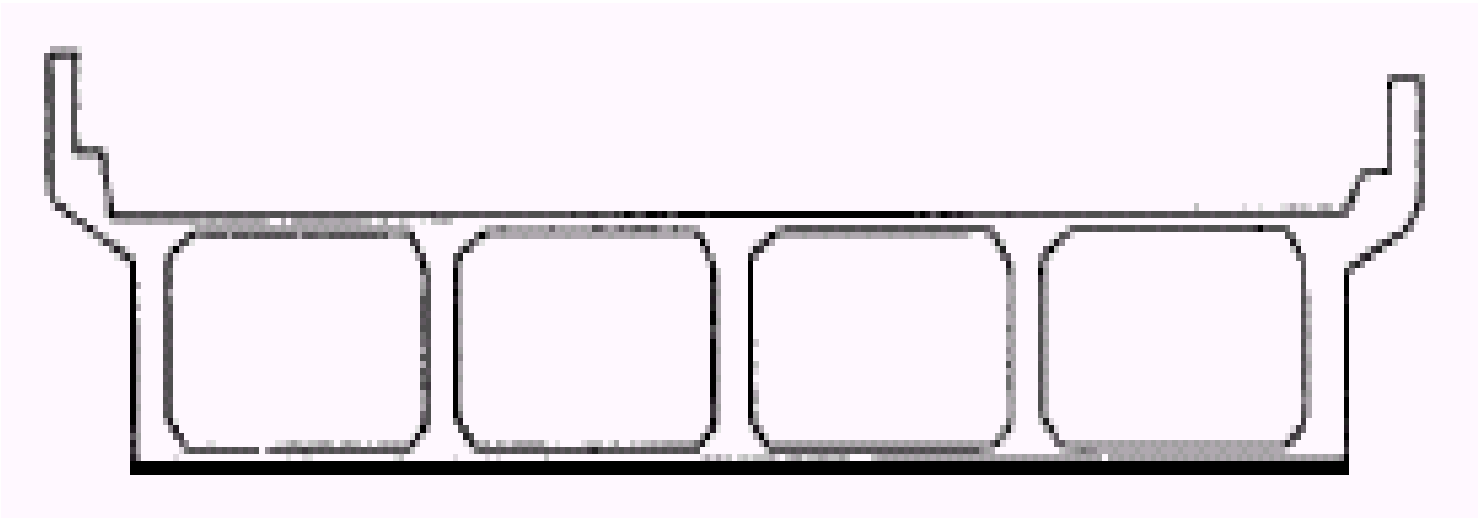


T-BEAM SECTION

Concrete Slab Bridge

Concrete T-Beam Bridge

Deck Girder Bridge

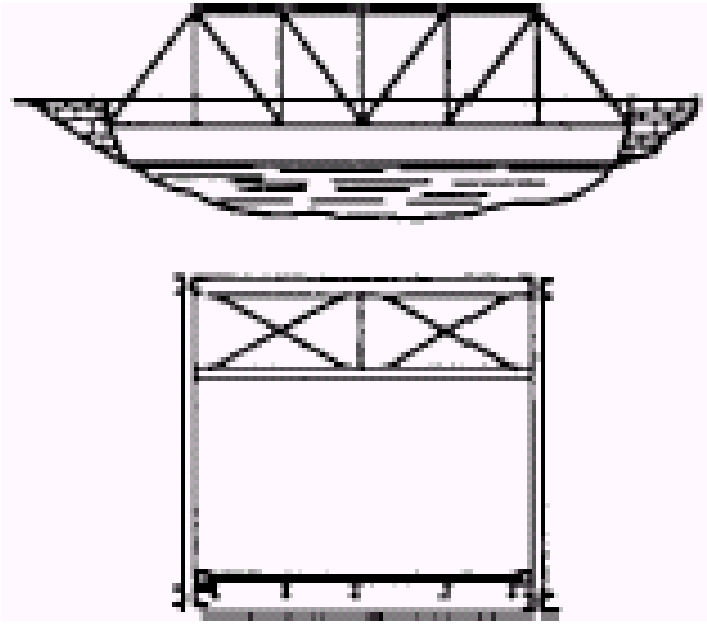


ROADWAY SECTION
BOX GIRDER

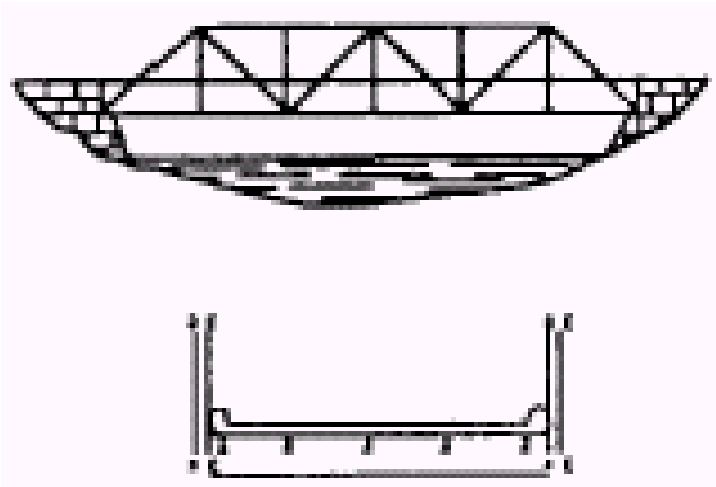
I-Girder Bridge

Box Girders

Through Bridge



THROUGH TRUSS

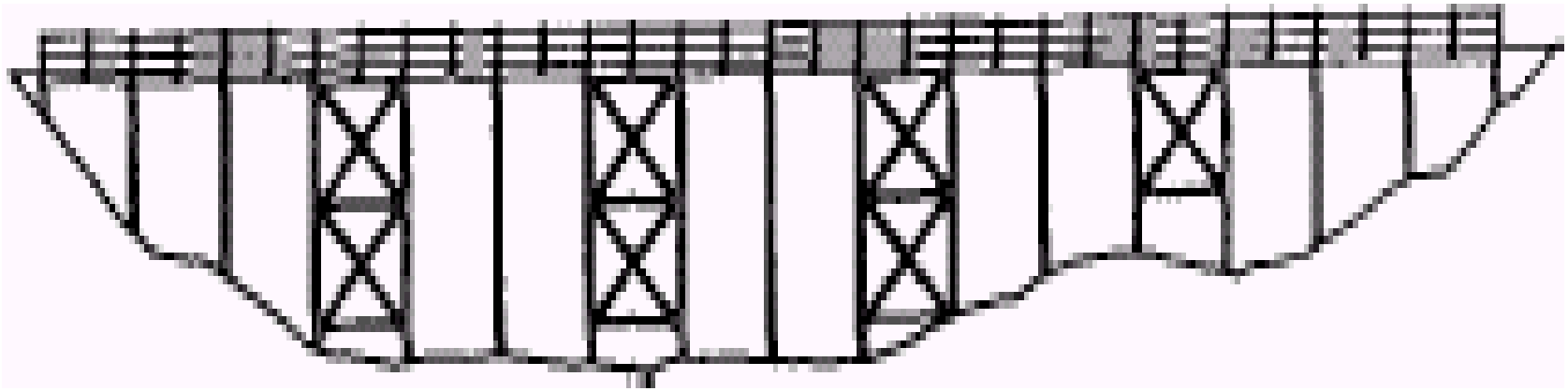


PONY TRUSS

Steel Truss Through Bridge

Timber Through Bridge

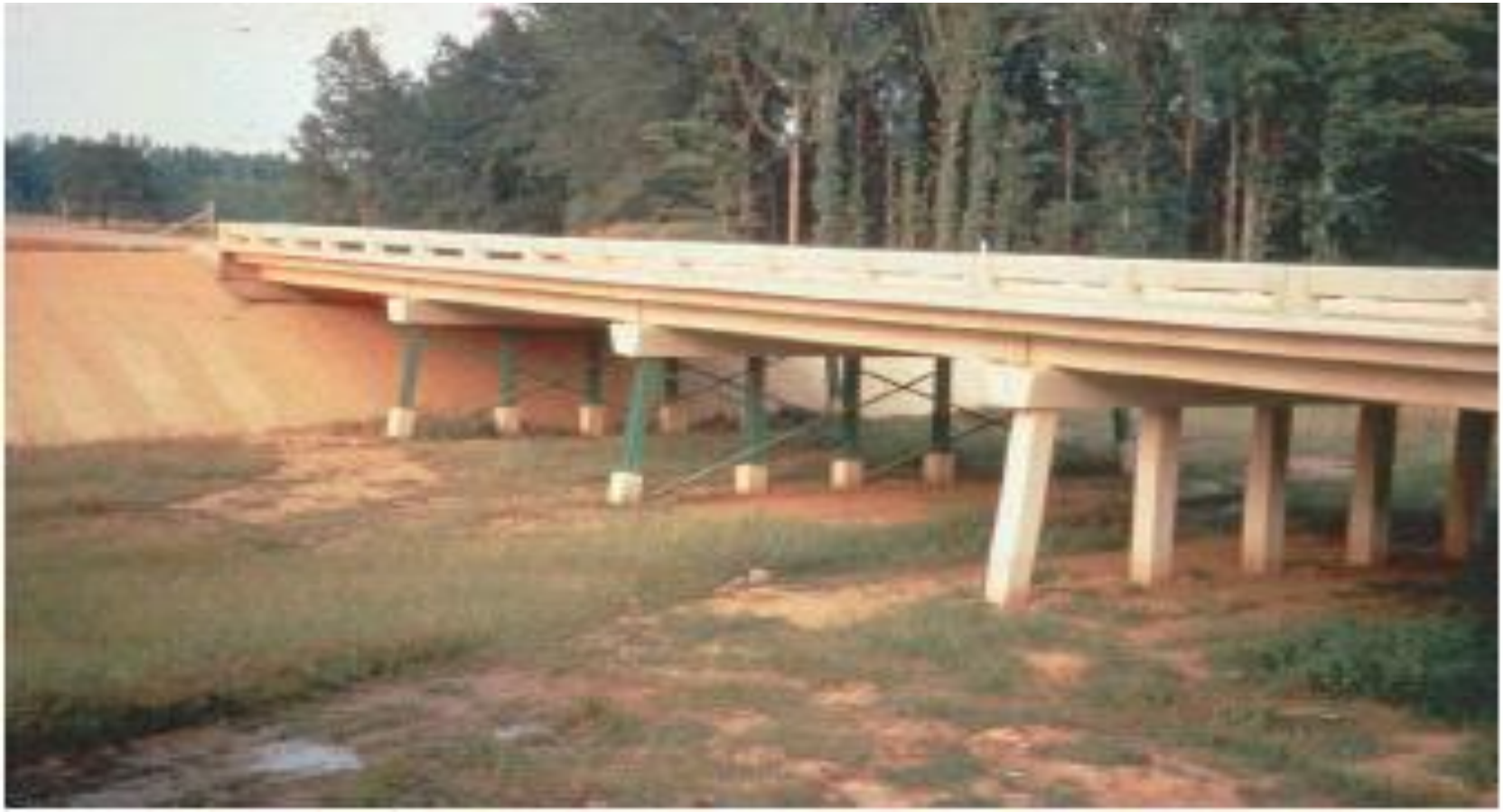
Multi-Span Simple Bridge



TIMBER TRESTLE

Multi-Span w/Column Bents

Multi-Span Concrete



Multi-Span

End of Presentation