Introduction to Civil Engineering

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This presentation deals with

- Introduction to Civil Engineering
- Scope of Different fields of Civil Engineering
  - Architecture & Town Planning
  - Building Materials
  - Construction Technology
  - Environmental Engineering
  - Geotechnical Engineering
  - Hydraulics, Water Resource & Irrigation Engineering
  - Remote Sensing & GIS
  - Structural Engineering
  - Surveying
  - Transportation Engineering

This presentation also deals with

- Roads
  - Basic definition
  - Cross Section of road
  - Components of Road
  - Types of Road and their Functions
- Bridges
  - Definition
  - Functions
  - Classification
- Dams
  - Definition
  - Functions
  - Classification

This presentation also deals with

- Infrastructure
- Types of Infrastructure
- Role of Civil Engineers in Infrastructure Development
- Effect of Infrastructure on economic development of a country

Engineering

- ***Ingenious*** means ‘Clever person’ in Latin
- Engineer cleverly uses the available natural resources for the benefit of mankind
- Provides comfort to mankind and makes life comfortable.
- Application of scientific and mathematical knowledge and rational thinking to improve living standards

Civil Engineering

- Oldest branch of engineering, next to Military engineering. All engineering works other than for military purposes were grouped in to Civil Engineering. Mechanical, Electrical, Electronics & present day Information technology followed it.
- A professional engineering discipline that deals with the analysis, design, construction and maintenance of infrastructural facilities such as buildings, bridges, dams, roads etc.
- Constructions are against nature.
- Application of physical, mathematical and scientific principles for the convenience of civilization.
- Began b/w 4000 BC and 2000 BC (during Ancient Egypt, Mesapotamia, Indus Valley Civilisations).
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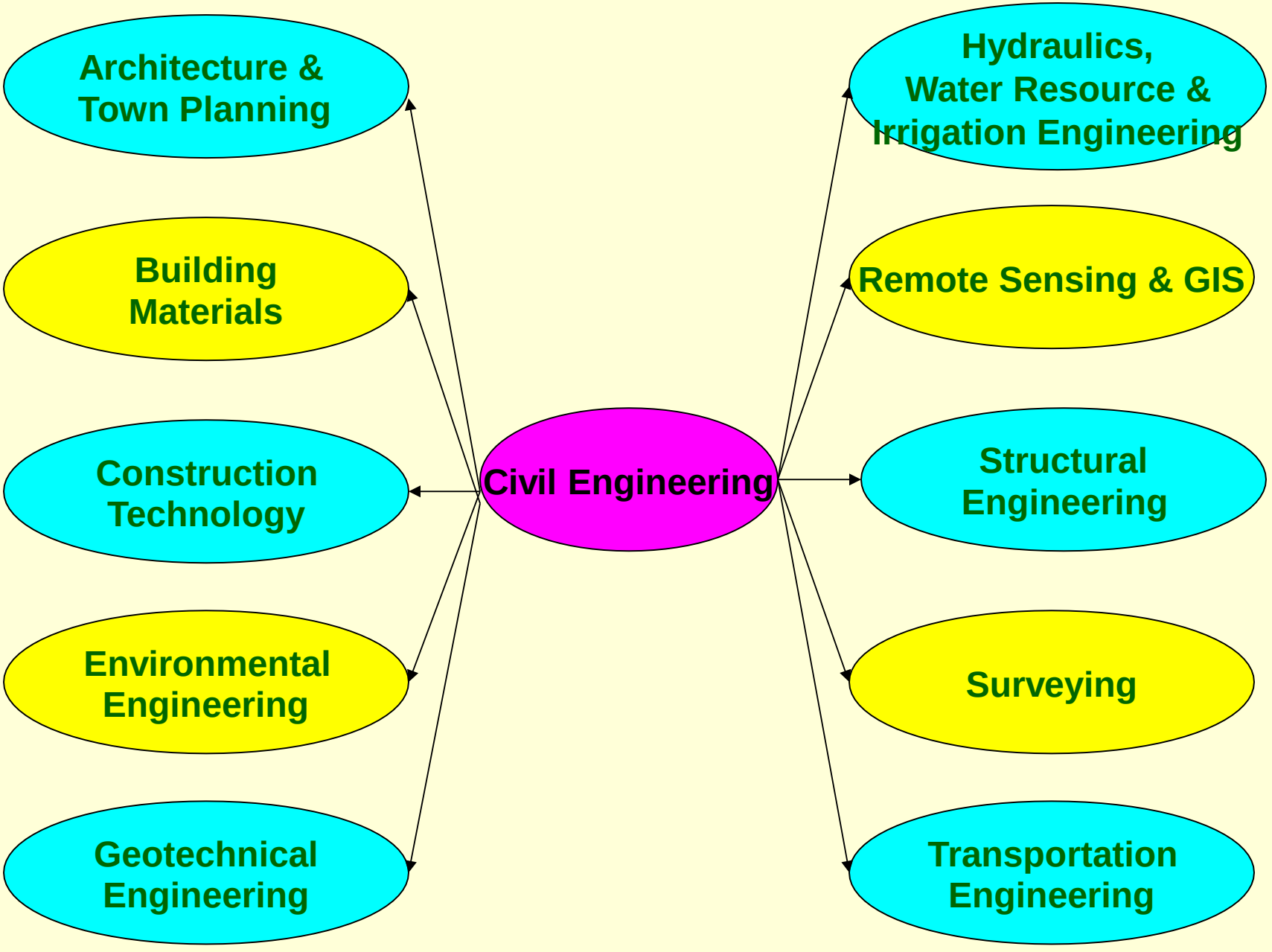
Civil Engineering is Everywhere

Civil Engineering is a composite of many specific disciplines that include structural engineering, water engineering, waste material management and engineering, foundation engineering etc. among many.

DISCIPLINES OF CIVIL ENGINERING



Architecture & Town Planning

- Giving beauty to buildings is architecture
  - Enhancing the appearance
  - Maintaining heritage
- Proper planning of towns & cities
  - Planning the layout
  - Planning the road
  - Separating the commercial, residential, academic and industrial areas
  - Planning green belt
  - Planning sewage disposal units
  - Planning water treatment plants and water storage units

Presently separated from Civil Engineering

Building Materials Technology

- This deals with materials used for construction. Brick, tiles, soil, cement, stone, sand, steel, aggregates, glass, wood, plastics etc. include construction materials. Some are natural and many are man made.
- This deals with the proper use of desired material economically and safely.
- The mechanical properties of these materials shall be sufficient to avoid failure and excessive deformation and provide durability.
- The chemical properties shall be to maintain good environment.

Construction Technology & Management

- Deals with planning, scheduling and execution of construction activity related to a project.
- Comprises of men, material, time and money management.
- Emphasis will be on new construction practice, use of appropriate and local technology, safety of men and material, utilization of marginal materials etc.

Construction Technology & Management

- Construction managers:
  - Review contracts,
  - Order materials,
  - Hire and schedule sub-contractors.
- The job of a construction manager is to:
  - Provide quality control and insure project is completed on time and.
  - Within budget.

Environmental Engineering

- Environment is the available nature around us. It includes the life support system such as water, air and land/Soil.
- Environmental engineering deals with the technology to save nature from human and natural abuse and pollution.
- The study involves balanced compromise between environment and safety.
- It deals with,
  - Technique of water collection, purification and supply
  - Waste water collection, treatment and disposal
  - Control of all types of pollution

Geotechnical Engineering

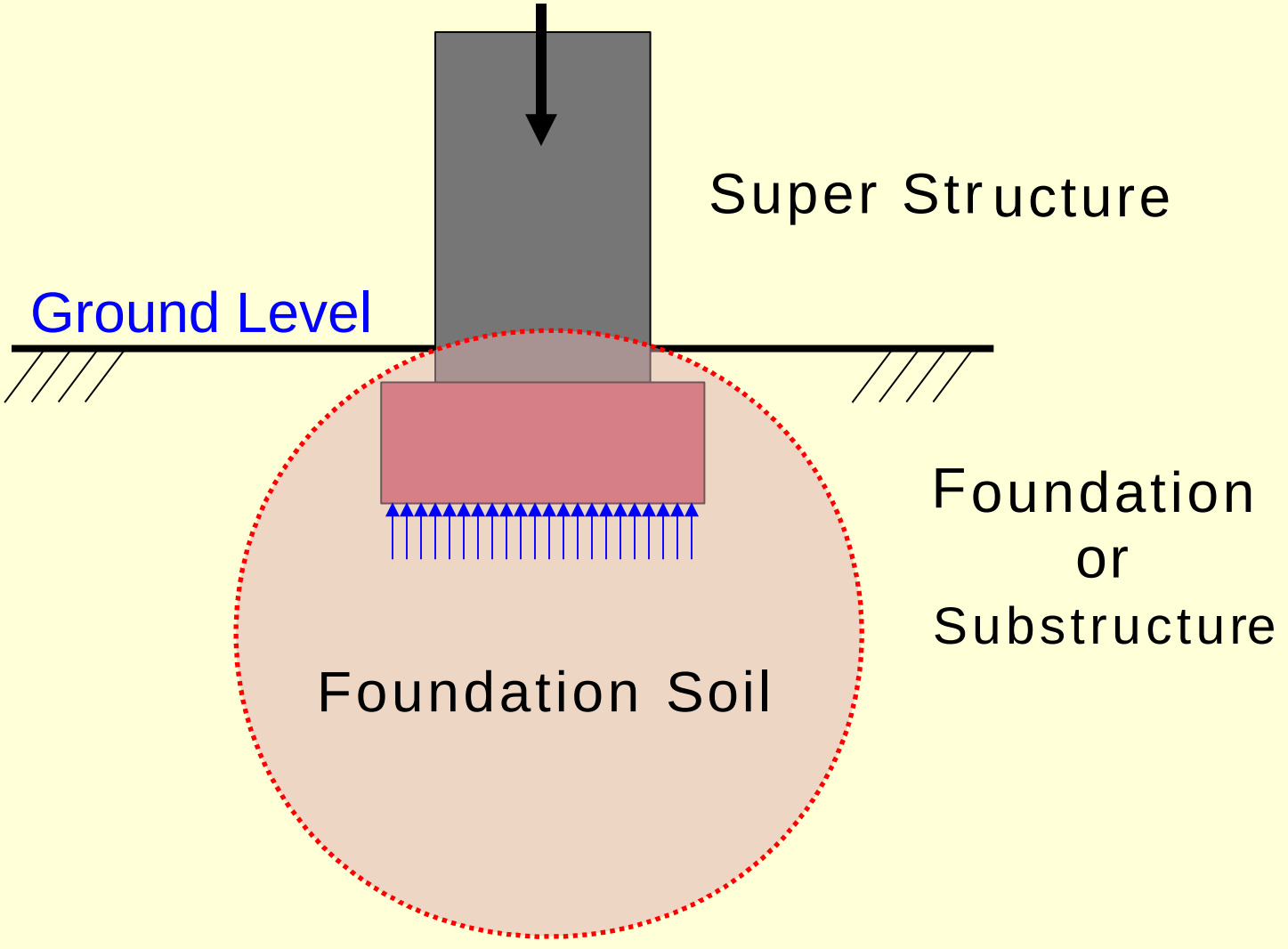
- All structures are founded on ground. Forces from structure are safely transferred to soil. Essential to understand ground behavior and interaction between soil and structure.

- Involves
  - Foundations
  - Slopes
  - Retaining Structures
  - Highway pavement design
  - Embankments and earth dams
  - Tunnels, underground structures and deep cuts

Geotechnical Engineering

- To assess the quality of soil or rock to carry the structure
- Proper knowledge of geotechnical engg is necessary for safety and stability of structures

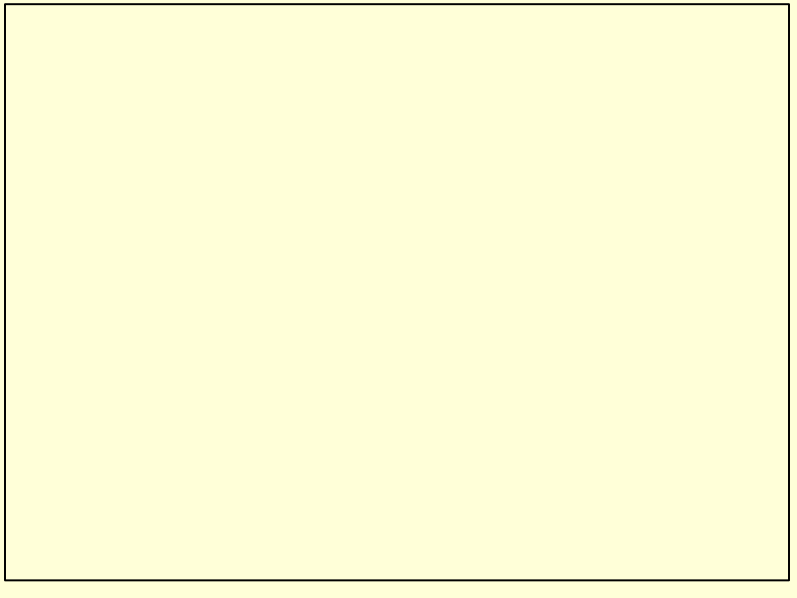
For a geotechnical engineer,



Foundation Soil and sub-structure should resist forces
without failure or excessive deformation

Hydraulics, Water Resource & Irrigation Engineering

- **Hydraulics deals with mechanics of water (fluid) flow.**
- **Water resource engineering deals with identification & utilization of available water resources minimizing the loss. Surface water such as river and lake water and ground water are usefully managed.**
- **This also deals with ground water utilization, ground water recharge and rain water harvesting.**



Hydraulics, Water Resource & Irrigation Engineering

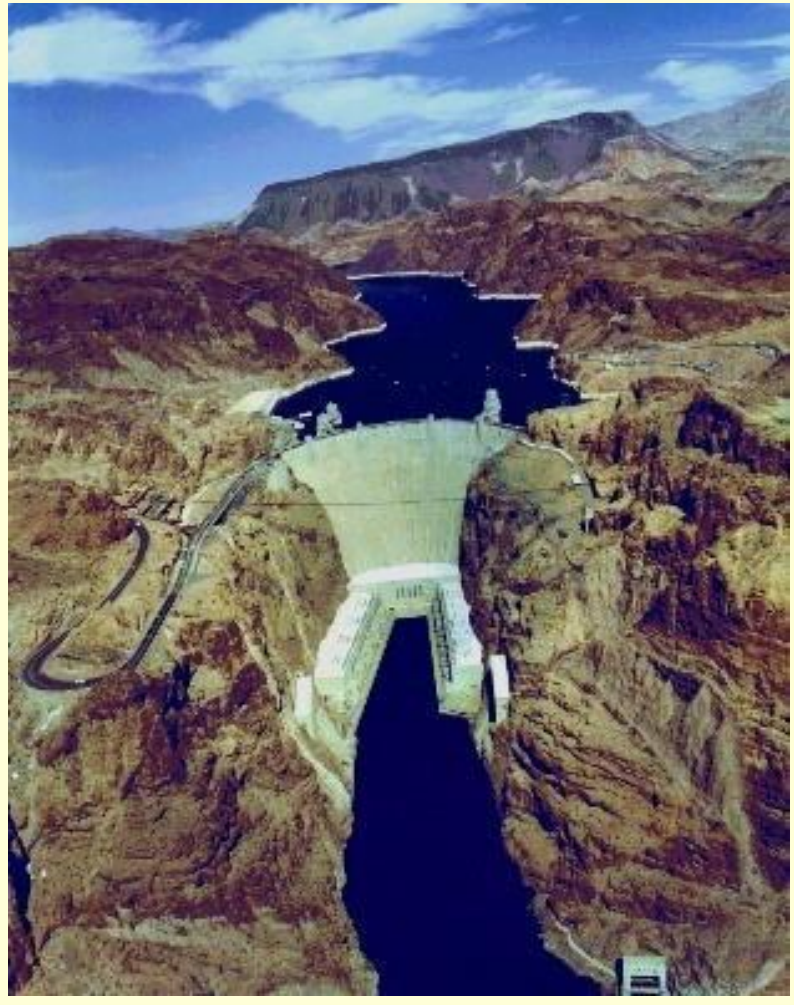
- Irrigation engineering deals with water management for agriculture purpose.
  Dams are constructed at the desired locations to store water
- in reservoir when the supply from river is good and to utilize for useful purpose during draught. Canals are built for the purpose. During excess input, water is allowed to main river through the body of dam to avoid flooding.

Falkirk Wheel in Scotland

Hoover Dam in USA

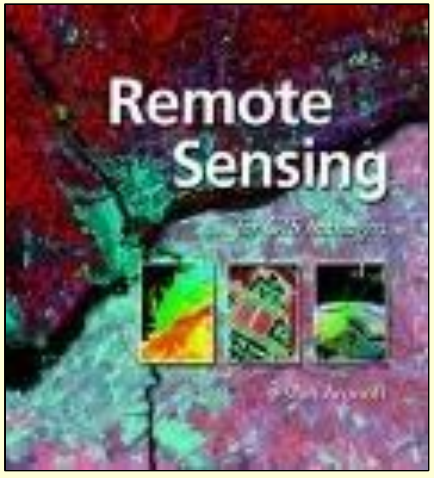
Hydraulics, Water Resource & Irrigation Engineering

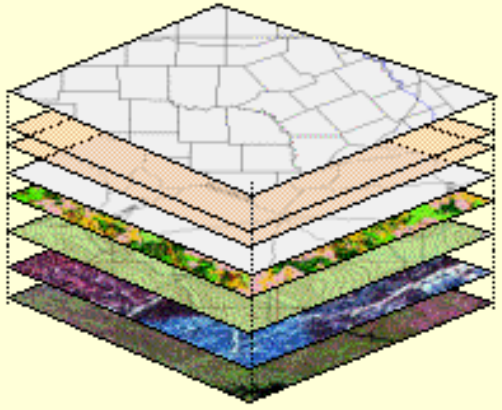
- Water management involves the use of hydrologic and hydraulic principles to design:
  - Drainage systems,
  - Detention/retention ponds,
  - Navigational waterways, and
  - Flood control levees, dams, and lakes.



Remote Sensing & GIS

- This is one of the new fields.
- The improvement in space technology, availability of GPS enhanced the scope of geographic information system.





- Good mapping technique helps to get required information accurately and quickly to effectively manage and monitor the available resources for optimal use.
- GIS is an hightech equivalent of map. It represents a means to locate ourselves in relation to world around us. It deals with measurement, mapping, monitoring and modeling of geographic information around us.

Structural Engineering

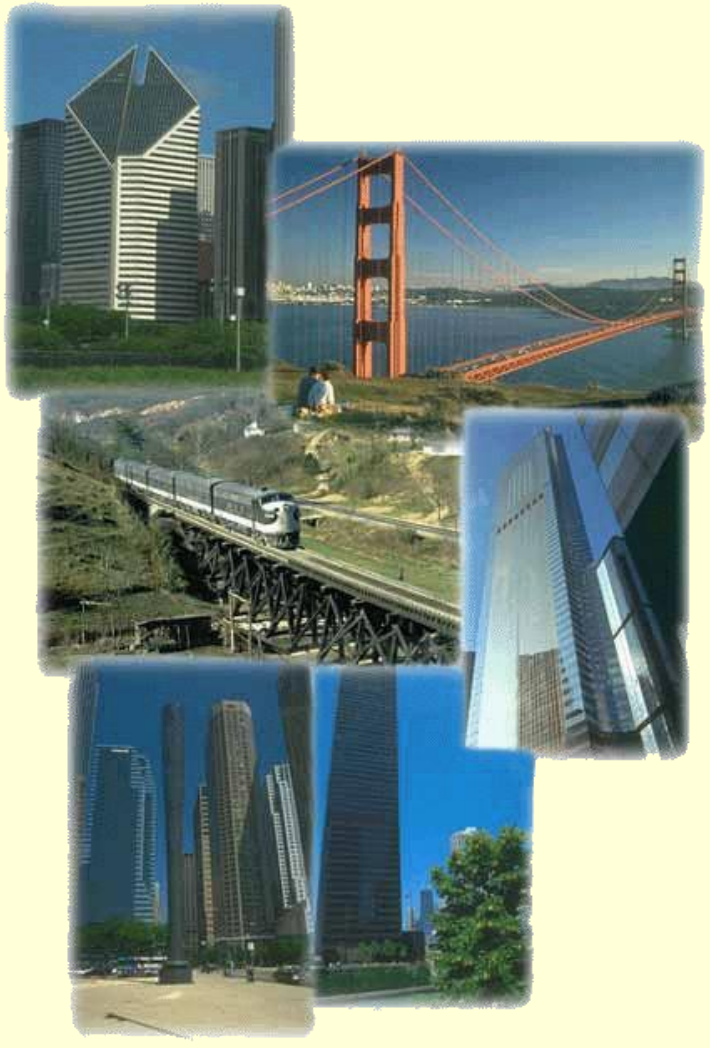
Burj Dubai

Petronas

- Structure is the assemblage of two or more basic elements such as beam, slab, column, truss, frame, shells etc.
- Deals with the requirements considering design for limit states of collapse and serviceability.

Structural Engineering

- Involves determination of support reactions, member forces and moments, deflection and deformations.
- Deals with planning of positions/layout of different elements and design (determination of size, shape an material) of component such that safety and serviceability requirements are not sacrificed, yet economy is considered.
- Repair, rehabilitation and maintenance is part of structural engineering.
- Dams, Bridges, Stadiums, Auditoriums, Multi-storeyed buildings are analysed & designe



Surveying

- Activity involved in collection of topographic features of a location for future construction.
- Feasibility survey, alternate and most suitable method is evolved
- Helps in environmental impact assessment

Surveying

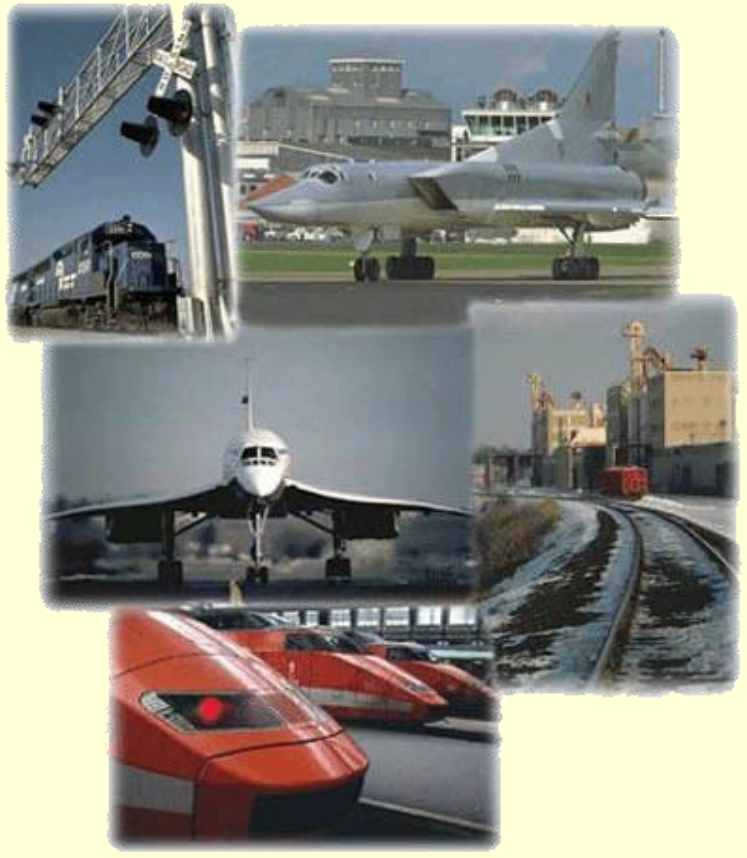
Objectives of Surveying

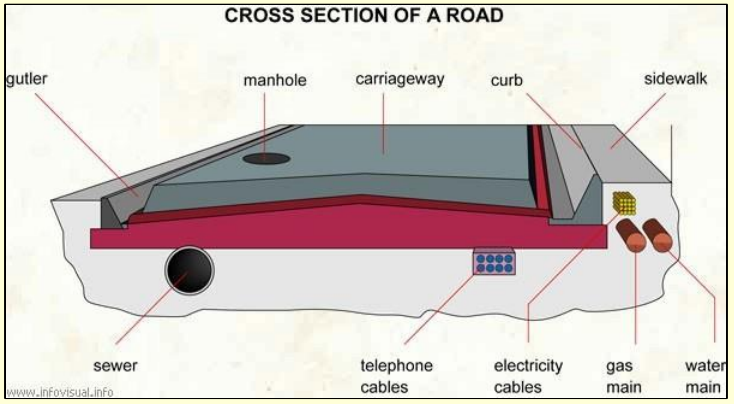
- Execution of survey to collect topographic data
- Calculation and analysis of data, plotting survey data to create design maps
- Provision of line, grade and other layout works

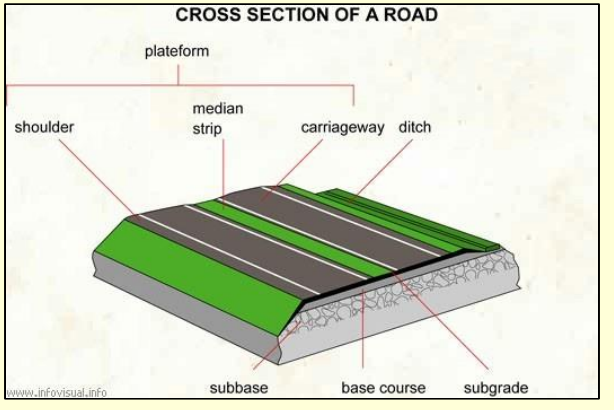
Total Station

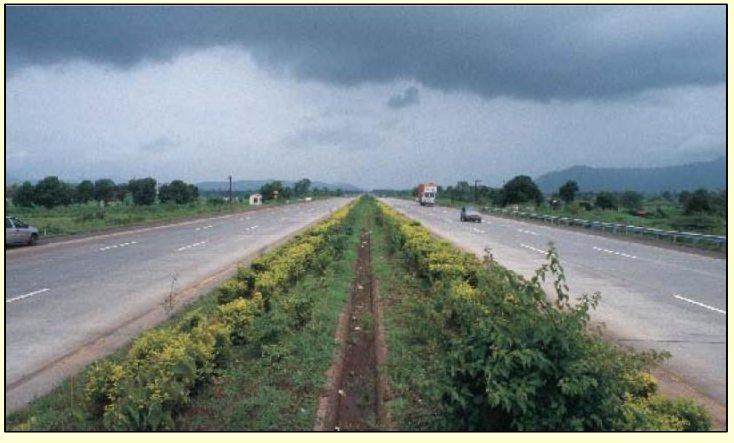
Transportation Engineering

- Application of scientific approach (planning, design, operation and management) of transportation systems such as roads, railway, sea/river & air transports.
- It involves planning, design, construction/operation and maintenance of transportation facilit
- In air strip runways, roads and railway, the study includes the desig of pavement system.
- Maintenance and upgradation of docks, harbors, airports, railway system based on requirements, population growth is a part of this discipline.









Deals with Transportation system Planning And high way material design

Roads, Bridges & Dams

Road

A road is an identifiable route, way or path between two or more places

Roads are typically smoothed, paved, or otherwise prepared to allow easy travel

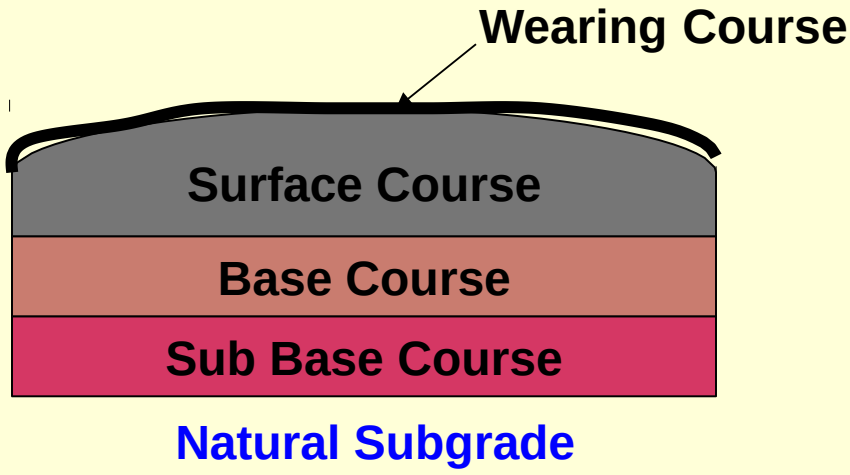
A "road" was simply any pathway fit for riding.

Classification of Roads

- Based on Size
  - Single, Double, Four, Six Lane Roads etc.
- Based on (Nagpur Road Plan) national principles
  - National Highways
  - State Highways
  - Major District Roads
  - Minor & Other District Roads
  - Village Roads
- Based on type of road surface
  - Bituminous Road
  - Concrete Road
  - Water bound macadam road
  - Mud Road

Components of Road

- Carriageway
- Berm / Kerb
- Drain
- Shoulder
- Footpath
- Cycle Track



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CROSS SECTION OF A ROAD

guller manhole carriageway curb sidewalk

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water

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cables cables main main

CROSS SECTION OF A ROAD

plateform

shoulder median strip carriageway ditch

www.infovisual.info

subbase base course subgrade

Bridges

- A bridge is a structure built to span a gorge, valley, road, railroad track, river, body of water, or any other physical obstacle.
- A bridge is designed for trains, pedestrian or road traffic, a pipeline or waterway for water transport or barge traffic.
- An aqueduct is a bridge that carries water, resembling a viaduct, which is a bridge that connects points of equal height.
- A road-rail bridge carries both road and rail traffic.
- A bridge's *structural efficiency* may be considered to be the ratio of load carried to bridge mass, given a specific set of material types.
- A bridge's *economic efficiency* will be site and traffic dependent, the ratio of savings by having a bridge (instead of, for example, a ferry, or a longer road route) compared to its cost.

Classification of Bridges

Based on Action

- Beam bridges
- Cantilever bridges
- Arch bridges
- Suspension bridges
- Cable-stayed bridges
- Truss bridges

Classification of Bridges

Based on Material used

- Concrete Bridge
- Steel Bridge
- Timber Bridge
- Composite Bridge

Classification of Bridges

Based on purpose

- Road Bridge
- Rail Bridge
- Rail & Road Bridge
- Pedestrian Bridge
- Aqueduct

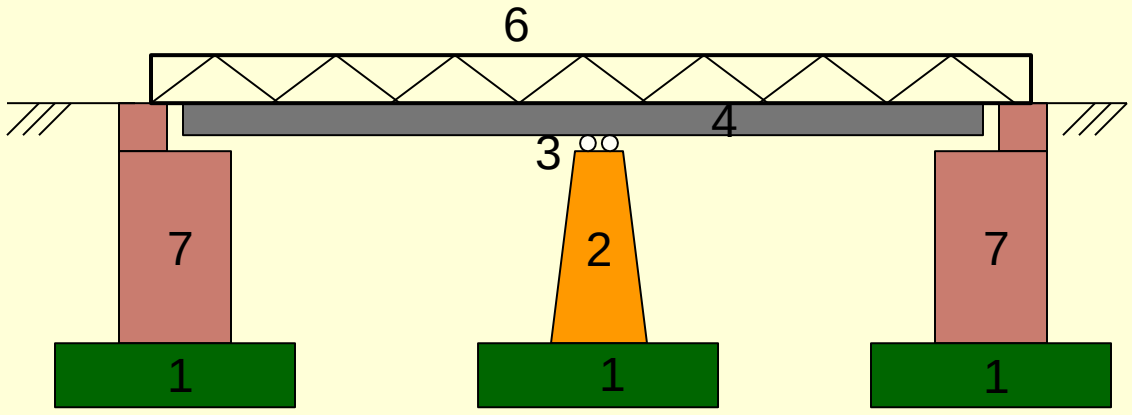
Classification of Bridges

Based on type of Support

- Simply Supported Bridges
- Continuous Bridges
- Fixed Bridges
- Cantilever Bridges

Components of Bridge

1. Caisson/Raft Foundation
2. Bridge Pier
3. Bearing
4. Deck Slab
5. Roadway
6. Railing
7. Abutment



Arch Bridge

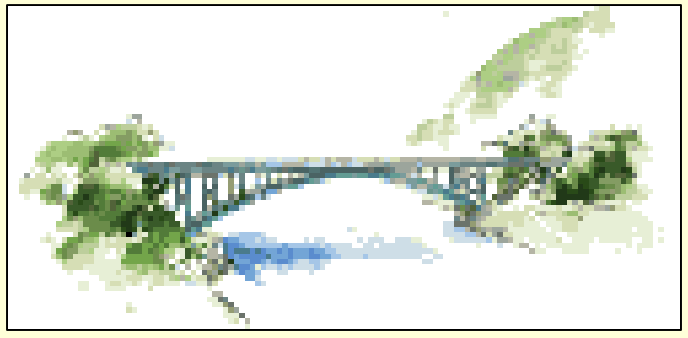
Beam Bridge

Cable Stayed Bridge

Cantilever Bridge

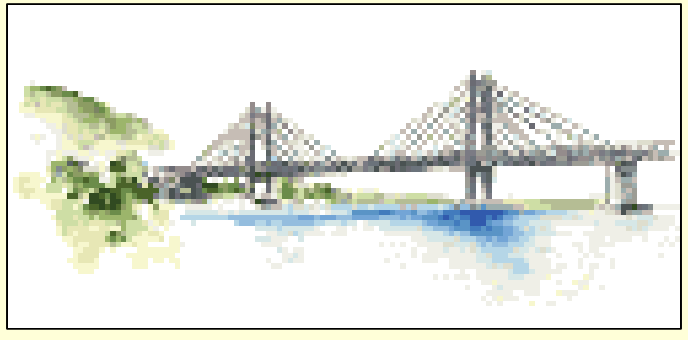
The Basic Bridge Types

Beam / Girder Bridge

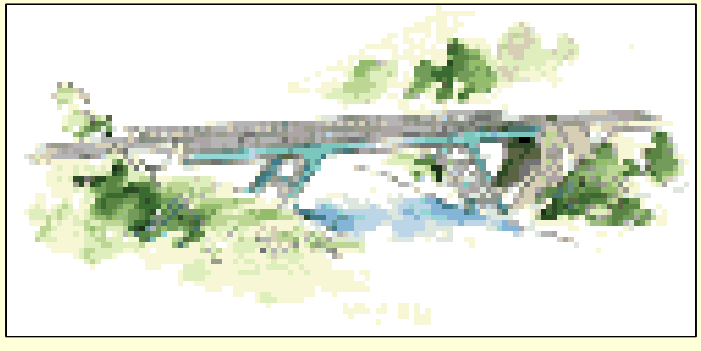


Arch Bridge

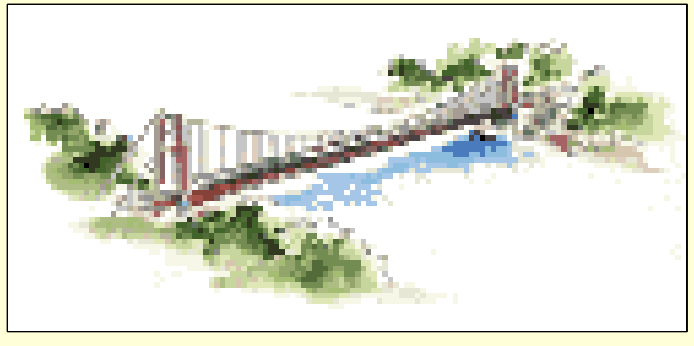
Truss Bridge



Cable Stayed Bridge

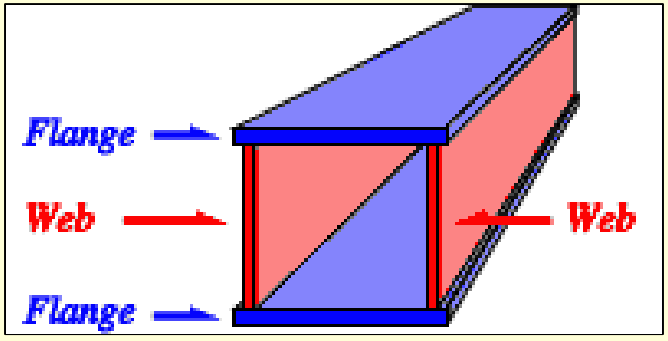


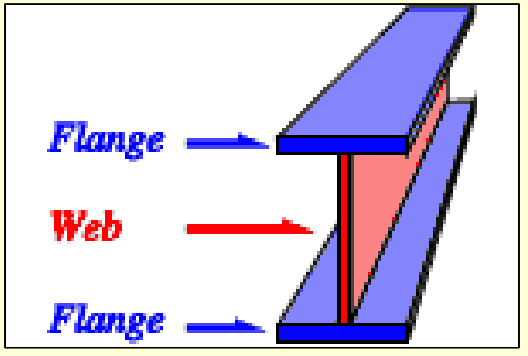
Rigid Frame Bridge



Suspension Bridge

GIRDER BRIDGE





Namihaya Bridge, Osaka, Japan

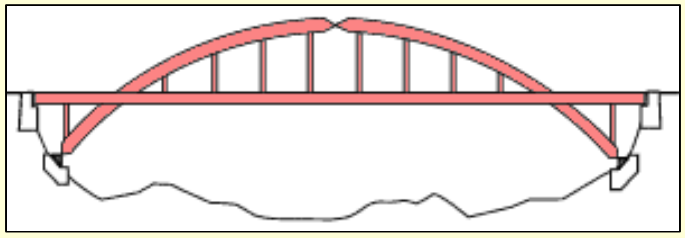
Typical Span Lengths

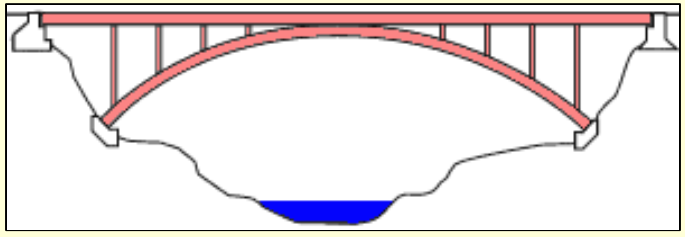
10m - 200m

World's Longest

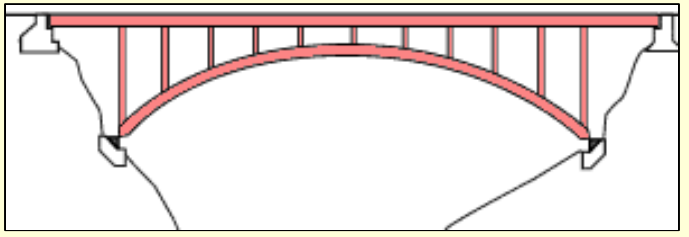
Ponte Costa e Silva, Brazil

Total Length	700m
Center Span	300m





ARCH BRIDGE



Meiwa Bridge, Edogawa-Ku, Tokyo

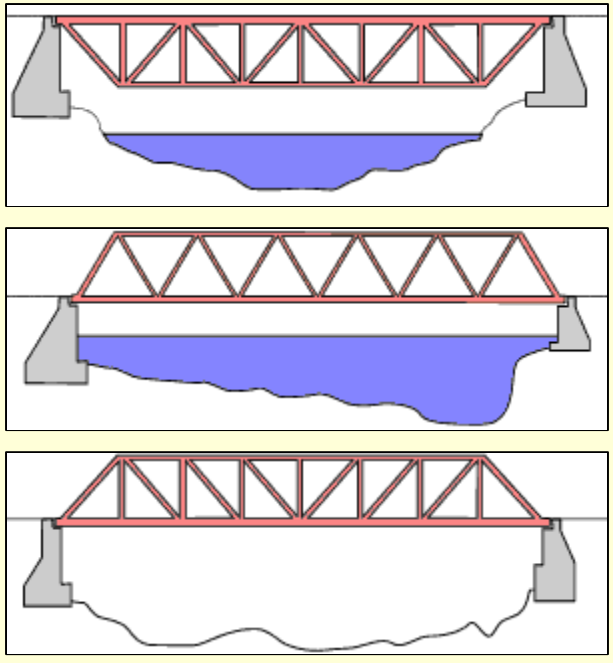
Typical Span Lengths

40m - 150m

World's Longest

New River Gorge Bridge, U.S.A.

Total Length	924m
Center Span	518m



TRUSS BRIDGE

Typical Span Lengths

40m - 500m

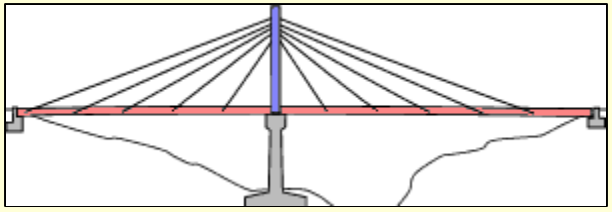
World's Longest

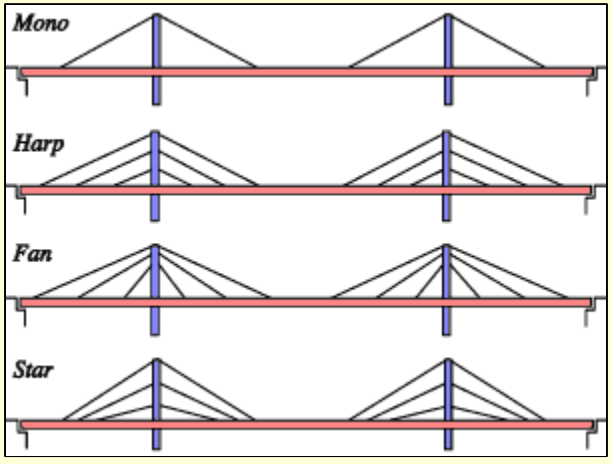
Pont de Quebec

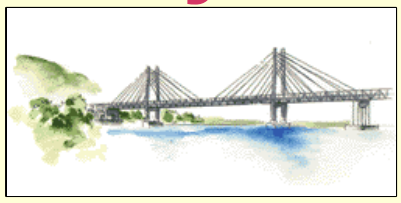
Total Length	863m
Center Span	549m

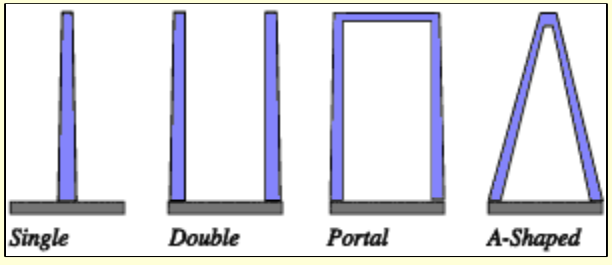
2nd Mameyaki Bridge, Saitama, Japan

Cable Stayed Bridge









Tsurumi Tsubasa Bridge

Typical Span Lengths

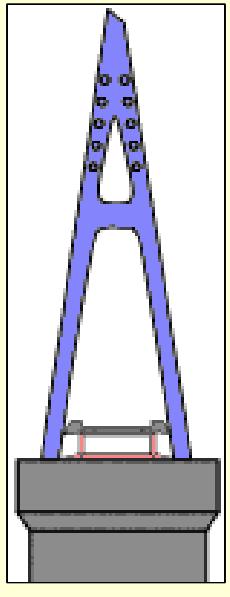
110m - 480m

World's Longest

Tatara Bridge, Japan

Total Length	1,480m
Center Span	890m

Pylon

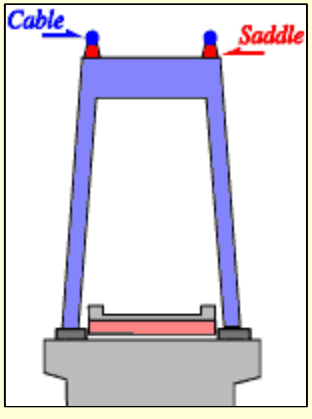


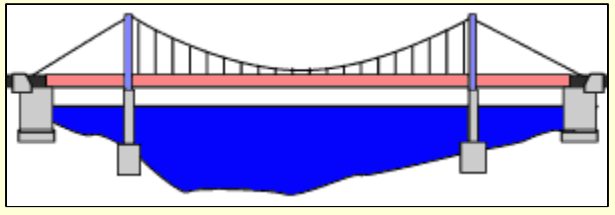
Suspension Bridge

Ohnaruto Bridge

Hakucho Bridge

Pylon





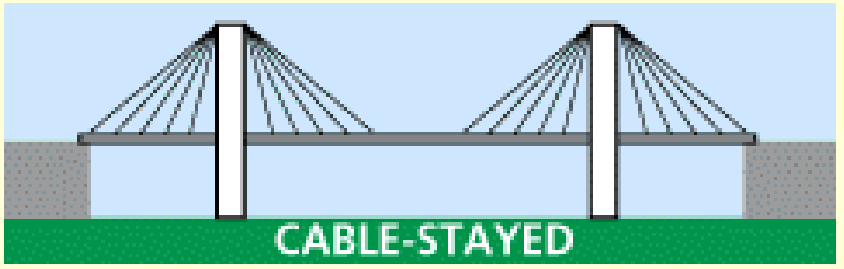
Typical Span Lengths

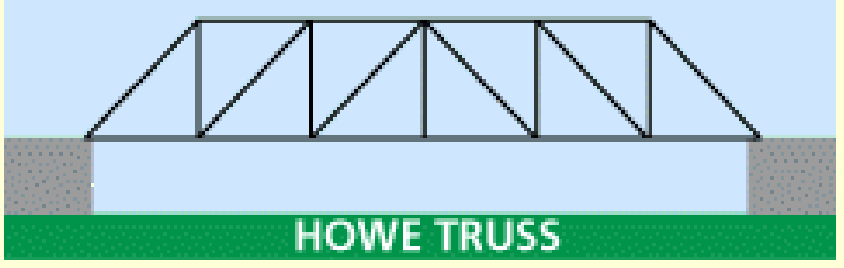
70m - 1,000m+

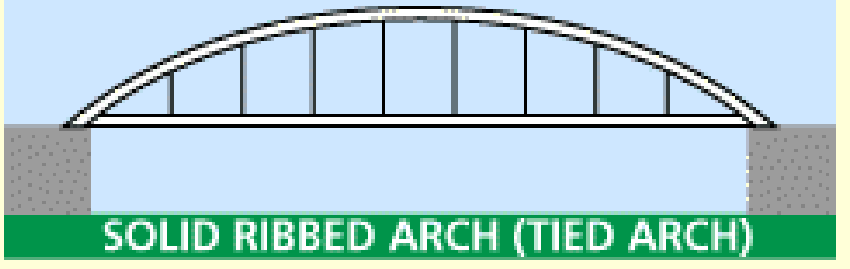
World's Longest

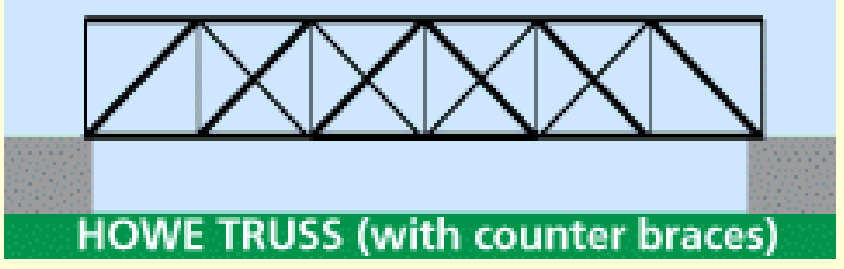
Akashi Kaikyo Bridge, Japan

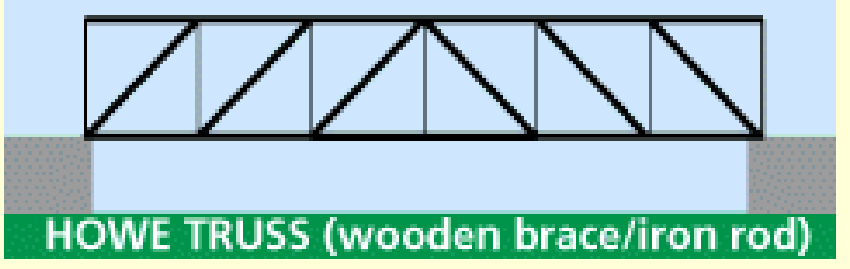
Total Length	3,911m
Center Span	1,991m



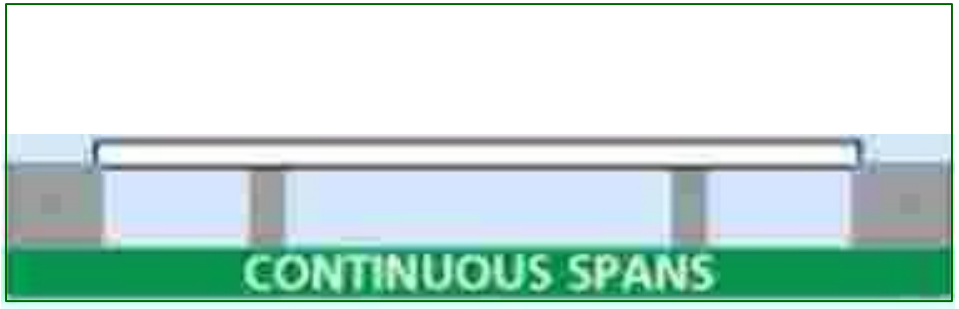


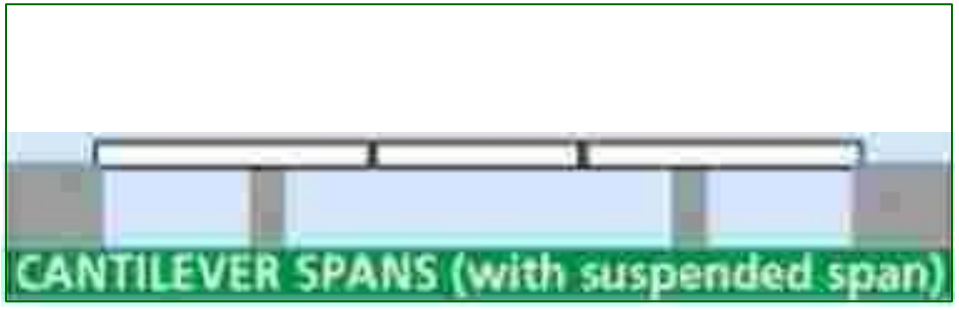


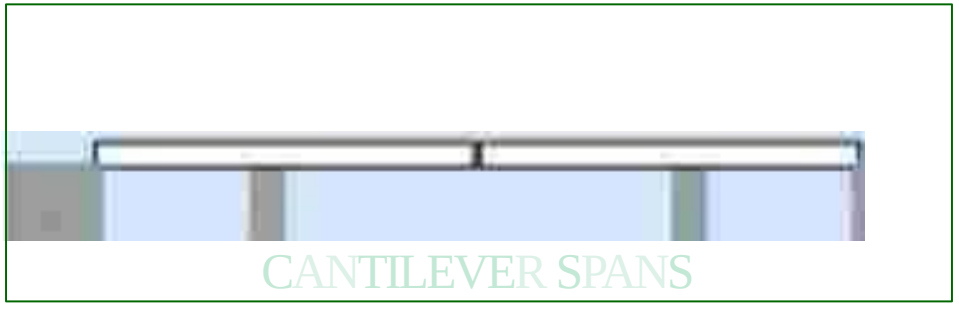


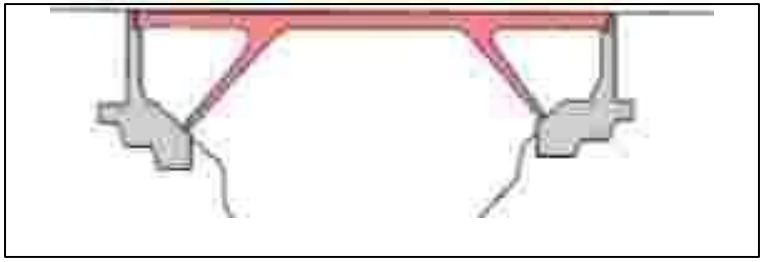


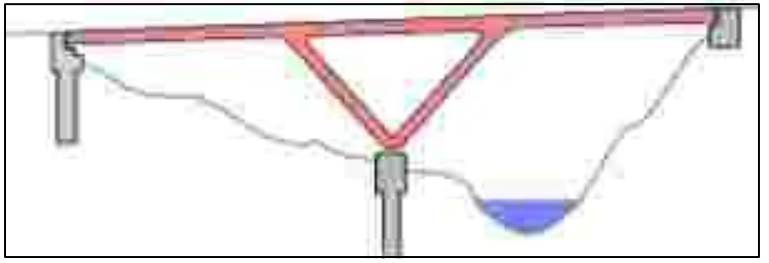
Types of Bridges



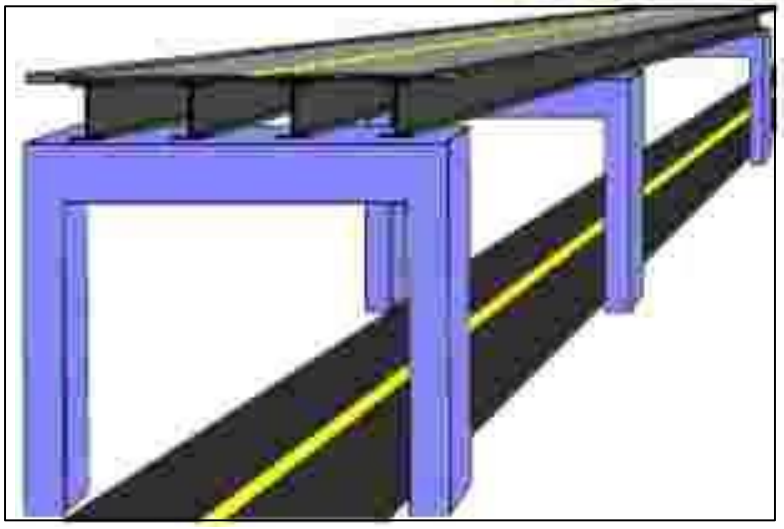




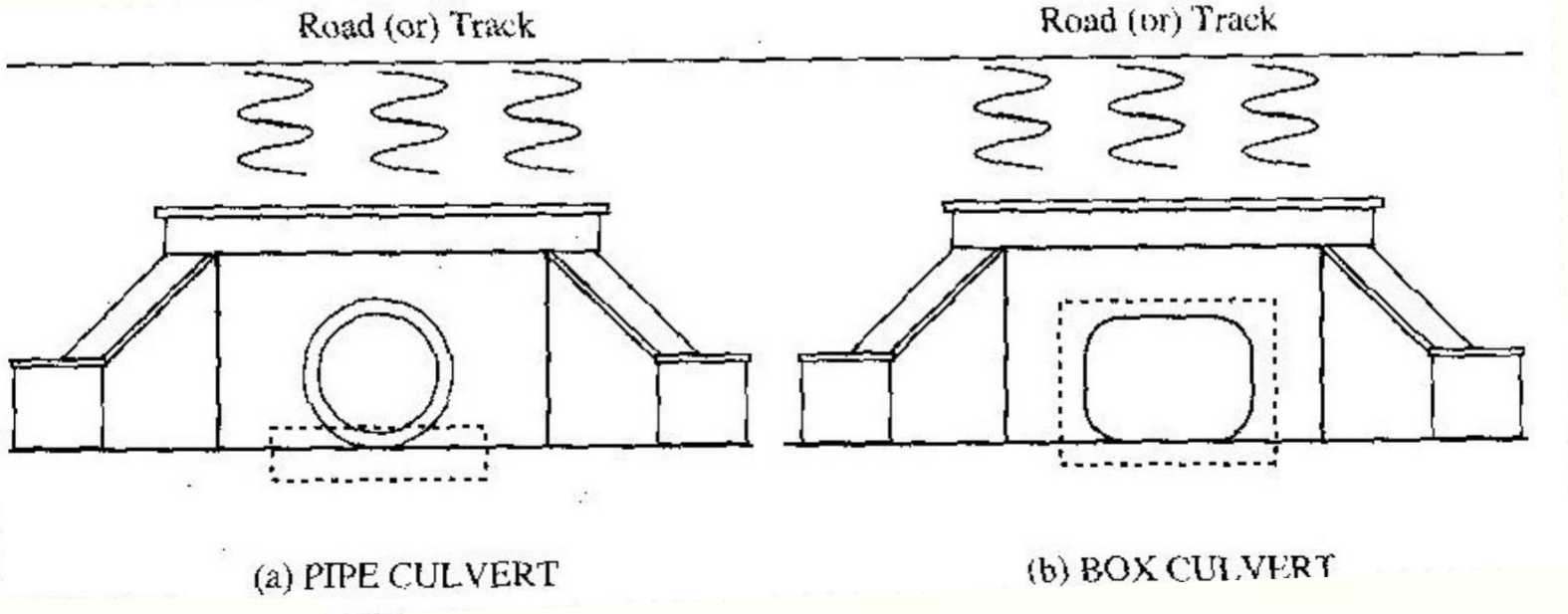




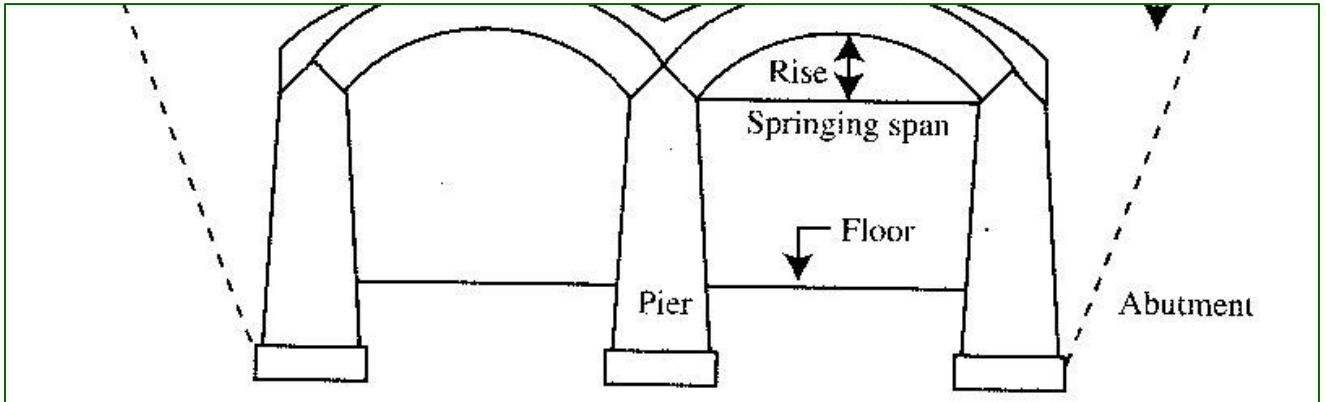
Types of supports



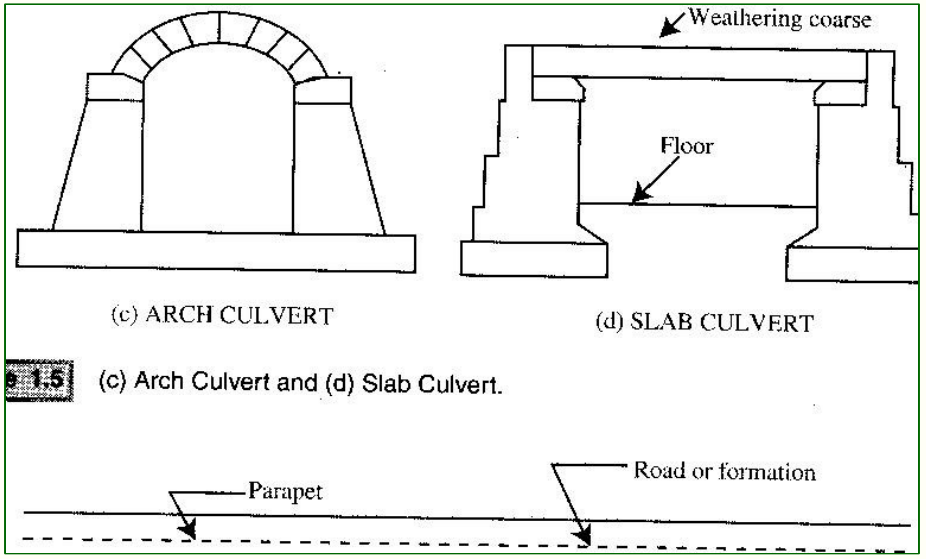
Beam/Girder Bridge



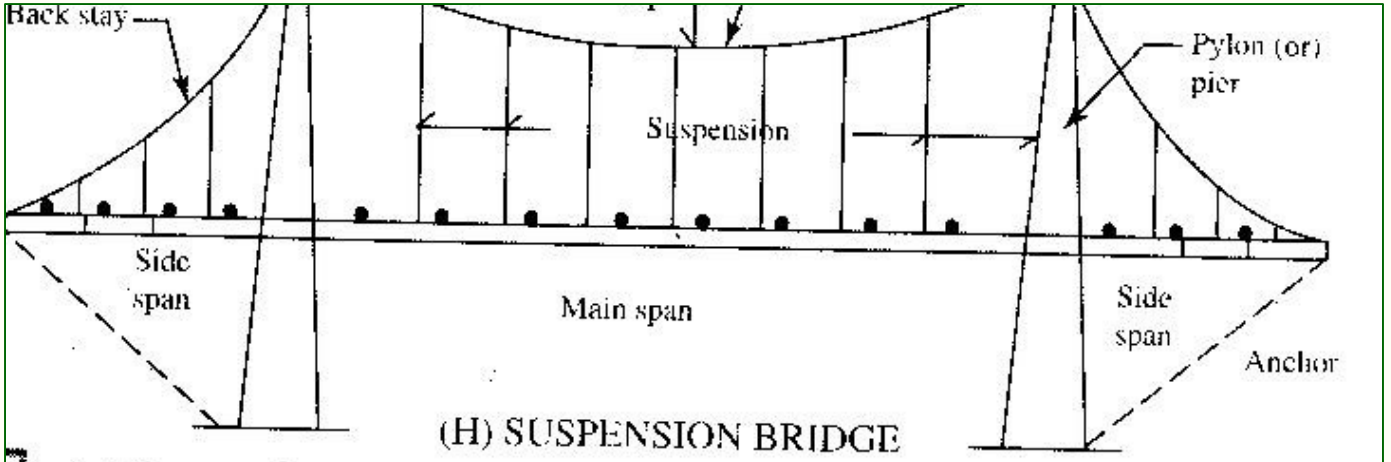
Culverts are smaller bridges, normally with one span built across small streams, drains or sewer carrying road on top



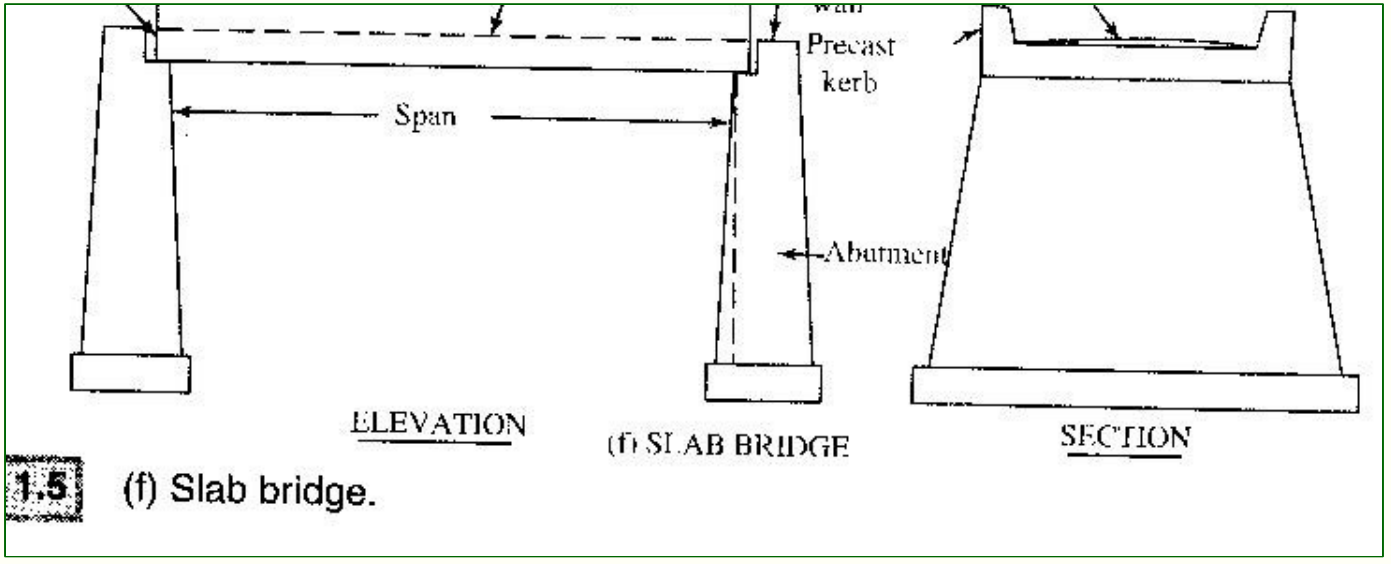
1.5 (e) Arch bridge.



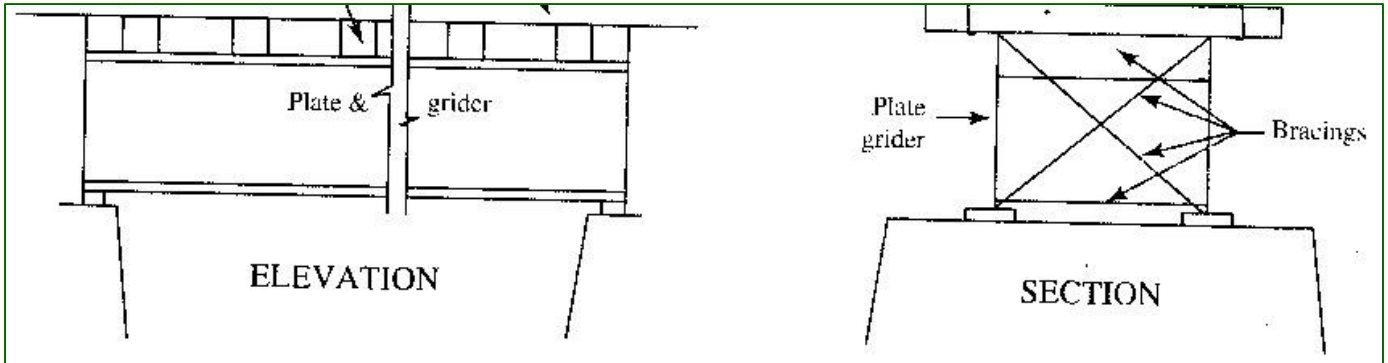
1.5 (c) Arch Culvert and (d) Slab Culvert.



(h) Suspension bridge.



1.5 (f) Slab bridge.



(g) PLATE GIRDER RAILWAY BRIDGE

ure 1.5 (g) Plate girder railway bridge.

- Steel dams
- Arch dams
- Solid gravity dam

(b) Non-rigid dams –

- Earth dams
- Rock fill dams
- Combined rock and earth fill dams

ccording to hydraulic design, dams are classified into:

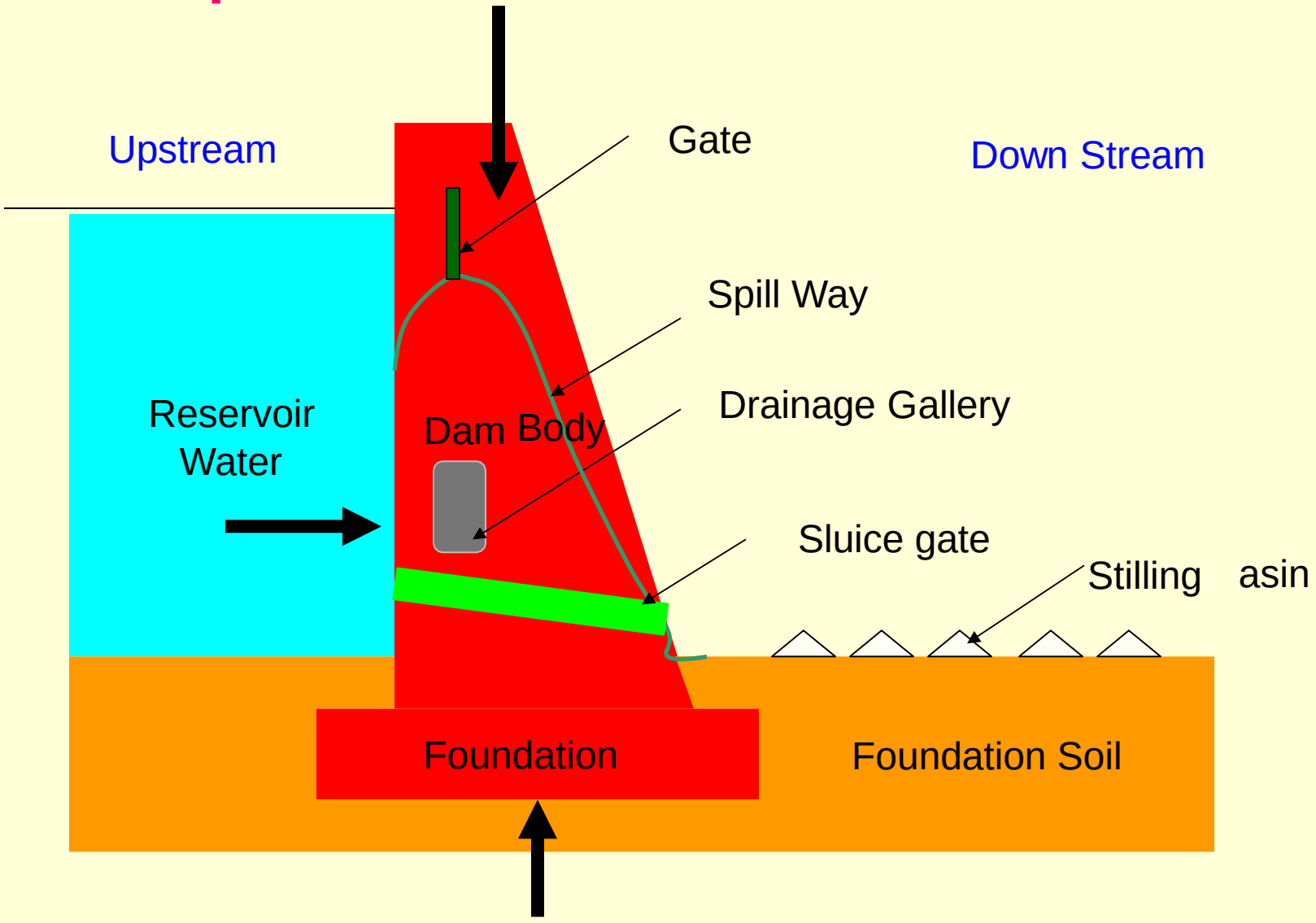
Dam

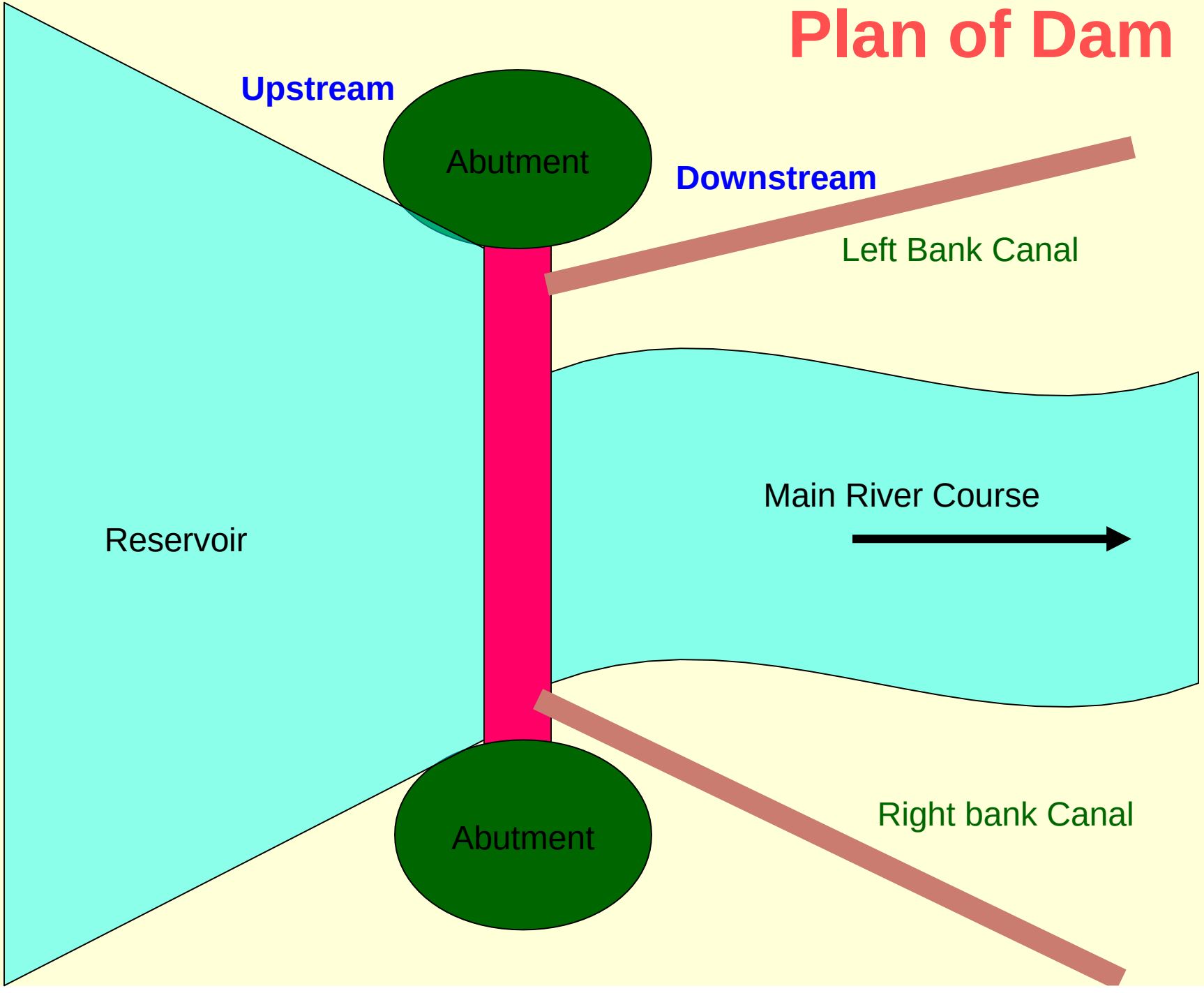
- Barrier that stores water at two levels.
- The primary purpose of dam is to store water whenever available in plenty for use during scarcity.
- Built across rivers
- Excess water is released to river and useful water is transferred thro canals

Components of Dam

- Body of Dam
- Foundation
- Top road
- Gates and lifting devices
- Spill way or Sluice
- Canal
- Reservoir
- Main river course
- Stilling Basin
- Drainage gallery

Components & Forces in Dams




Plan of Dam
Upstream
Abutment
Downstream
Left Bank Canal
Main River Course
Reservoir
Abutment
Right bank Canal

FUNCTIONS OF DAMS

Function	Example
Power generation	Hydroelectric power is a major source of electricity in the world. many countries have rivers with adequate water flow, that can be dammed for power generation purposes. For eg, the Itaipu on the Paraná River in South America generates 14 GW and supplied 93% of the energy consumed by Paraguay and 20% of that consumed by Brazil as of 2005.
Stabilize water flow / irrigation	Dams are often used to control and stabilize water *flow*, for agricultural purposes and irrigation. They can help to stabilize or restore the water *levels* of inland lakes and seas. They store water for drinking and other direct human needs,
Flood prevention	Dams are created for flood control.
Land reclamation	Dams (often called dykes or levees) are used to prevent ingress of water to an area that would otherwise be submerged, allowing its reclamation for human use.
Water diversion	Dams are used for the purpose of diversion.

Classification of Dams

- Based on Size
- Based on function
- Based on material used

Classification based on Size

- Small Dam (<10 m high)
- Medium size Dam (10 – 25 m high)
- Large Dam (>25 m high)
- Major Dam (>150 m high)

Classification based on Purpose

- Hydro-electric dam
- Irrigation dam
- Water supply dam for city for the purposes of drinking water, recreation, navigation thro canals, industrial use.
- Flood Control
- Habitat dam for fishes & wild life
- Effluent containing dams from industry, mine, factory etc.
- Multi-purpose dam

Classification based on Material of construction

- Masonry Dam
- Concrete Dam
- Timber Dam
- Steel Dam
- Earth Dam
- Rockfill Dam
- Composite Dam

Classification based on action

- Gravity Dam
- Arch Dam
- Saddle Dam
- Check Dam
- Diversion Dam
- Overflow Dam
- Cofferdam

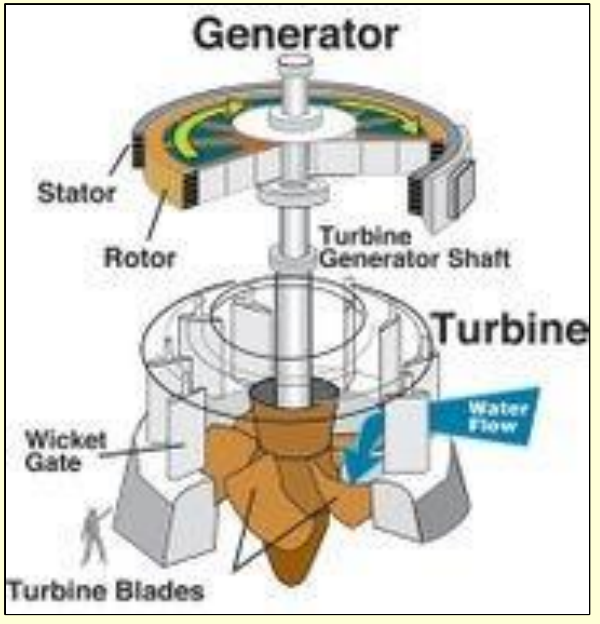
Gravity Dam

Timber Dam

San Luis Dam near Los Bonos, California – an Embankment Dam

Steel Dam

Cofferdam



Power generation Plant

Spillway

Hoover Arch Dam

Detention dam: To withhold flood flows temporarily
Storage dam: To store surplus flows creating a reservior to
during dry season

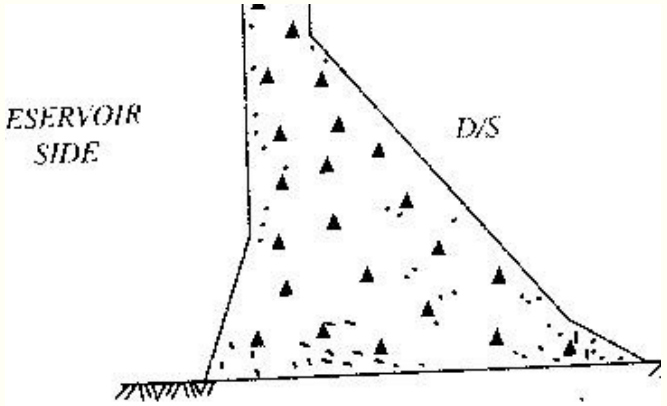
ketches of the following types of dams (a) Timber dam
d) Solid gravity dam (e) Rock fill dam (f) Combine
th dam

Timber Dam

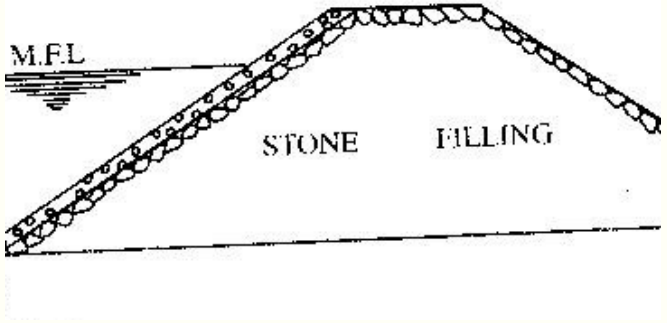
ility considerations, dams are classified into:

y dam: External forces like water pressure, upli
re are resisted mostly by the weight of the dam
ple: Concrete dams, masonry dams
ravity dam: weight of the dam is not the main s
ple: Arch dam.

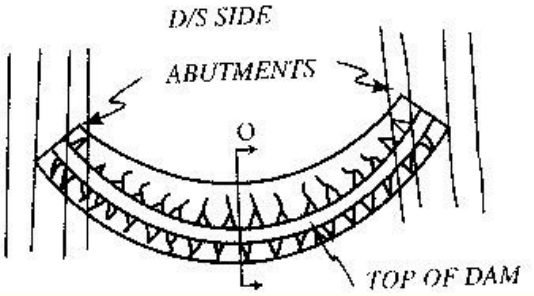
Steel Dam



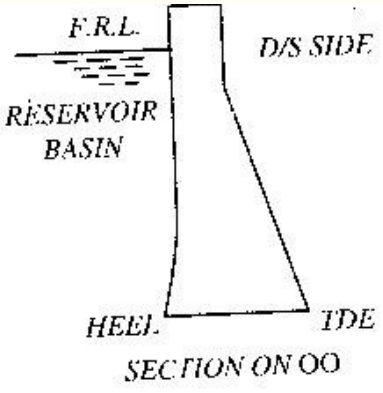
.vity dam.



Arch Dam

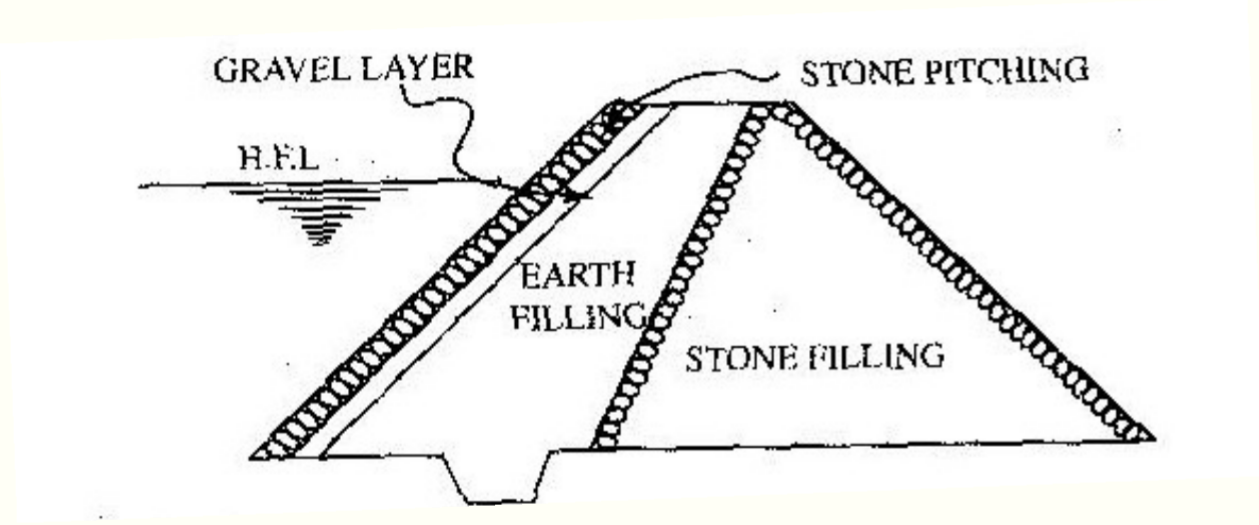


Rockfill Dam



m.

Solid Gravity Dam



Combined Earth & Rockfill Dam

Infrastructure

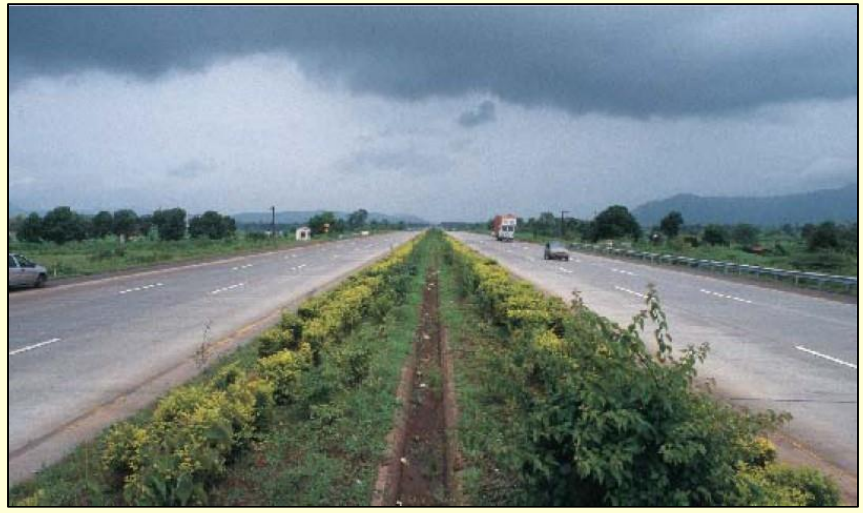
Infrastructure

Interstate 80, the second-longest U.S. Interstate highway, runs from California to New Jersey

- **Infrastructure** is the framework of supporting system consisting of roads, airports, bridges, buildings, parks and other amenities for the comfort of mankind.
- Economically, infrastructure are the structural elements that allow for production of goods and services without themselves being part of the production process, e.g. roads allow the transport of raw materials and finished products.
- The word is a combination of "infra" and "structure". The term came to prominence in the United States in the 1980s following the publication of *America in Ruins* (Choate and Walter, 1981), which initiated discussion of the nation's "infrastructure crisis" caused by inadequate investment and poor maintenance of public works.

Infrastructure deals with

- **Transportation**
  - Road Network
  - Railway
  - Ports & Harbors
  - Air travel and Airports
- **Television Network**
- **Telephone Network**
  - Landline connections
  - Mobile phone connections
- **Energy Sector**
  - Electrification
  - Reduction in energy loss
  - Use of renewable energy such as Solar, Wind, Biogas plants
- **Agricultural Activity**
  - Largest economic investment
- **Construction Activity**
  - Second largest economy in India
  - Lifelines



India's Infrastructure policy

- Additional power generation capacity of about 70,000 MW
- Construction of Dedicated Freight Corridors between Mumbai and Delhi, and Ludhiana and Kolkata
- Capacity addition of 485 million MT in major ports, 345 million MT in minor ports
- Modernisation and redevelopment of 21 railway stations
- Development of 16 million hectares through major, medium and minor irrigation works
- Modernisation and redevelopment of 4 metro and 35 non-metro airports
- Six-laning 6,500 km of Golden Quadrilateral and selected National Highways
- Construction of 1,65,244 km of new rural roads, and renewing and upgrading existing 1,92,464 km covering 78,304 rural habitations
- Infrastructure growth at 15 % P.A
- Construction sector to be the biggest beneficiary. Second largest after agriculture, 11% of Gross Domestic Product (GDP) & 50 % of Gross Fixed Capital Formation (GFCF), 65 % of total investment

Why infrastructure growth ?

- Political will
- Funding from multi-lateral agencies such as ADB, World Bank, Japan Bank etc.
- Increased private participation
- Innovative modes of funding
  - Cess on petrol & diesel
  - Special tax on air travel
  - Levying tonnage tax on ships
  - Infrastructure tax in Bangalore
- Build Operate Transfer (BOT) projects

Recent Statistics about Indian Infrastructural progress

(Rs. bn)	Budgetary Grant	Debt		Internal Accurals	Privatisation/ BOT	Funding not tied up	Total	Construction Component	
		Multi laternal	Market borrowings					(%)	(Rs. bn)
Power	245	175	1,274	413	885	–	2,973	53.9	1,803
Roads	368	296	167	–	1,286	350	2,466	100.0	2,466
Ports	100	–	–	–	150	–	250	50.0	125
National Martime Dvlpt Program	69	–	–	30	235	–	335	60.0	201
Railways	248	241	–	50	211	–	749	42.0	315
Airport	7	–	5	5	212	–	228	42.0	96
Pipelines	–	–	250	150	–	–	400	40.0	160
SEZ	10	5	10	–	91	–	116	45.0	52
Irrigation & Water supply	156	181	81	8	35	–	461	45.0	207
Bus Terminals	–	–	–	–	9	–	9	70.0	8
Urban Infra	67	195	33	35	300	–	630	60.0	378
Total	1,269	1,092	1,821	691	3,394	350	8,618	65.1	5,609

Source: SSKI, September 2005

Impact of infrastructural development of a country

- Increase in food production
- Protection from drought, famine, flood
- Healthy and comfortable housing facility
- Safe domestic and industrial water supply
- Safe and scientific waste disposal
- Improvement in communication and transportation
- Generation of electricity from, nuclear, hydel, thermal, solar or wind energy
- Improved, wealth, prosperity, standard of living
- Overall growth of a nation

Impact of infrastructural facility on socio-economic growth of a nation

- Large scale budget allocation for infrastructure leads to agricultural and industrial developments.
- Provide employment, eradicates poverty and enhances per capita income.
- Urban growth only can lead to population drift from rural sectors leading to explosion in population in cities and inadequate development of villages and improper care for agricultural
- sector.
  Use of infarstructural facility only by upper class leads to imbalance.

Role of Civil engineers in Infrastructural development

- Construction of roads, railway, ports, harbors and airports
- Construction of dams and proper utilization of water resources.
- Construction of Housing, commercial and industrial complexes
- Maintenance of facility
- Rebuilding, Rehabilitation, Retrofitting and Repair

Road development

- Golden Quadrilateral – 6000 km (New Delhi, Kolkata, Chennai & Mumbai)
- North-South & East-West (NSEW) corridor – 7300 km (Srinagar-Kanyakumari, Silchar-Porbandar)
- Port connectivity & other projects
- Pradhana Mantri Bharath Jodo Pariyojana – 10000 km
- Pradhana Mantri Grameena Sadak Yojana – connectivity to 160000 rural habitation

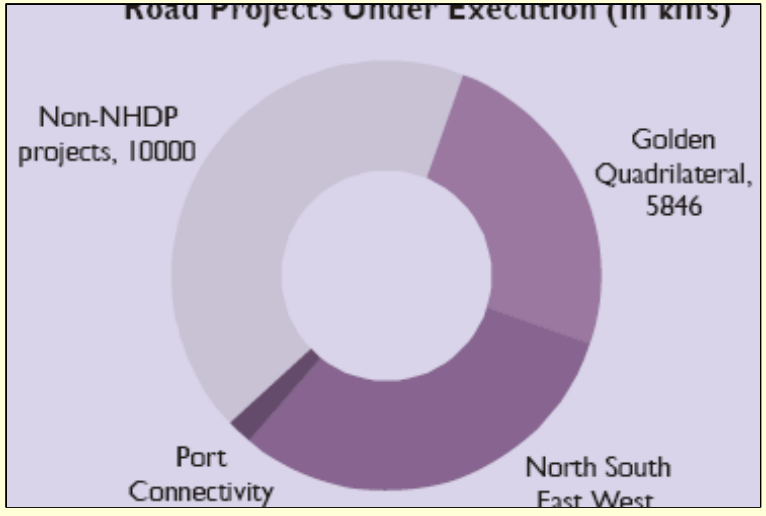
India's Road Infrastructure (May 05)

Types of Road	Length (km)	Percentage of Total
National Highways	65,569	2.0
State Highways	131,899	4.0
Major District Roads	467,763	14.1
Village and Other Roads	2,650,000	79.9
Total	**3,315,231**	**100**

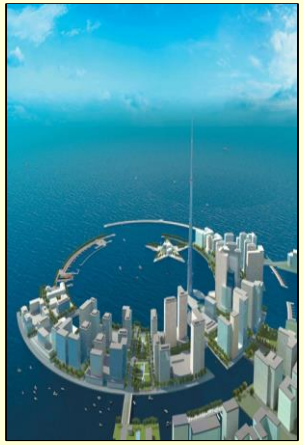
(Source: National Highway Development Authority)

Road Projects under execution

Scheme	Period 2001-2011		Period 2011-2021	
	Length (km)	Amount (Rs. million)	Length (km)	Amount (Rs. million)
A. Expressways	3000	300,000	7000	700,000
B. National Highways				
i) Four Laning/Six Laning	16,000	640,000	19,000	760,000
ii) Two-Laning with hard shoulders	15,000	187,500	7,000	87,500
iii) Strengthening Weak Pavements	20,000	150,000	24,000	180,000
iv) Bypasses, bridges, over bridges, safety and drainage measures	Lump sum	72,500	Lump sum	92,000
v) Expansion of NH System	10,000	150,000	12,000	180,000
Total for National Highways		**1,200,000**		**1,30,000**
C. State Highways				
i) Four Laning/Six Laning	3,000	100,000	7,000	250,000
ii) Two-Laning with hard shoulders	35,000	280,000	60,000	500,000
iii) Strengthening Weak Pavements	30,000	220,000	40,000	300,000
iv) Bypasses, bridges, over bridges, safety and drainage measures	Lump sum	100,000	Lump sum	100,000
v) Expansion of SH System	10,000	50,000	20,000	100,000
Total of State Highways		**750,000**		**1,250,000**



Port Development



Model For Privatization

Models	Asset Ownership	Operations & Maintenance	Capital Investment	Duration	Areas
Service contract	Public	Public/Private	Public	1-2 years	Towage, Dredging, Equipment and crafts
Management Contract	Public	Private	Public	3-5 years	Canteen Operations
Concession	Public	Private	Public/ Private	10-30 years	Terminals, channels Entire greenfield port
Build Own Operate	Public & Private	Private	Private	Indefinite	Terminals, channels
Divesture	Private	Private	Private	Indefinite	Entire ports complex

Source: SSKI, September, 2005

Pipeline of private port projects

Project Name	Port Name	Capacity (m tonnes)	Project Cost (Rs. m)
Container Terminal	JNPT	7.2	9,650
Liquid Cargo Berth	JNPT	5.5	2,000
Container Terminal at Chennai (Stage I)	Chennai	5.6	9,699
Multipurpose Gerneral Cargo Berths	Mormugao	5.0	2,240
Redevelopment of bulk terminal into container terminal	JNPT	15.6	9,000
Oil Jetty and related facilities	Vadinar (Kandla)	10.0	2,500
Construction of a berth for handling coal on BOOT basis	Mumbai	1.5	2,000
International Container Transshipment Terminal at Vallarpadam	Cochin	5.0	21,180
Construction of Jetty for POL Products/Chemicals	Ennor	3.0	2,000

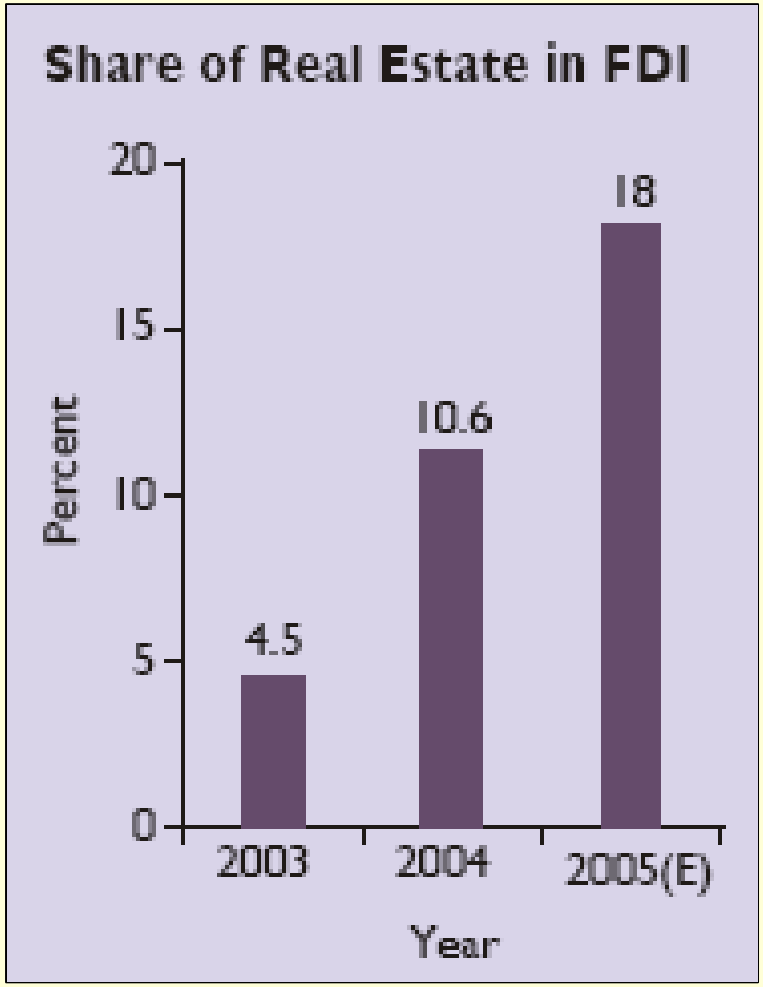
Source: IPA

Privatised berths in India

Port	Type of Port Facility	Private Developer/Operator
Kolkata	Multipurpose Berth	SAIL
Haldia Berth	Multipurpose Berth	TISCO & IQ MartradelSPL
Paradeep	Fertiliser Berth Multipurpose Cargo Berth (MPB – I)	Paradip Phosphate Ltd. Oswal Chemicals & Fertiliser
Vizag	Container terminal, bulk cargo berths	Dubai Port Authority Gammon India Ltd.
Ennore	Coal Jetty	TNEB
Chennai	Jawahar Dock I Jawahar Dock 5	Ege Seramik (Malaysia) & T Arumaidurai & Co. ACT India Ltd
Tuticorin	Container terminals	P&O Ports, Australia and PSA SICAL Terminal Ltd
Mormugao	Coal & general cargo berth & waterfront (ship repair)	ABG Goa Port Ltd & Western India Group
Mumbai	Berth at Pir Pau	Tata Electric Company
JNPT	Berths for handling POL & container terminal	BPCL, IOCL, PSOCP&O Ports, Australia
Kandla	Virtual Jetties, Oil Jetty, Oil Jetty	Geepee Corp., Thailand IOCL, HPCLEssar Oil and IFFCO

Source: Ministry of Shipping

Foreign Direct Investment Growth in Real Estate

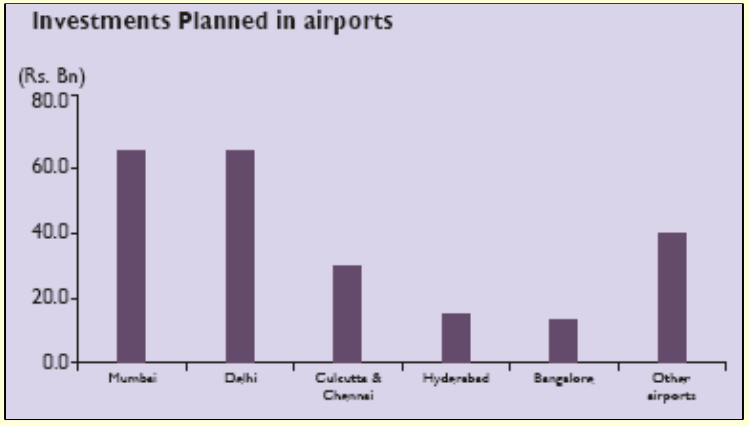


Airports – Ready to take off

- Upsurge in air traffic
- Upgradation of Metro city airports
- Development of new airports

	# of flights	# of destinations
Indian Airlines	250	58
Air Decann	180	45
Air Sahara	123	22
Spice Jet	60	11
Go Air	7	4
Jet Airways	275	43
Paramount Air	18	4

Source: Business India, December



Airport	Area for Commercial Development (Acres)	Real Estate Plans	% of Revenue Expected	Expected Investment (US$ Million)
Bangalore	300	Hotels, Office Space, malls	N.A.	400-500
Hyderabad	600-800	NA	N.A.	500-600
Kolkata	300	Golf Course, 4 hotels, convention centre	70-80	750-850