Lecture 13

CONCRETE WORKS

Ferdinand Fassa

Concrete works

- Concrete is a man-made (rock) construction material, which is a mixture of portland cement, water, aggregates, and in some cases, admixtures.
- The cement and water form a paste that hardens and bonds the aggregates together.
- Can be placed or molded into virtually any shape and reproduce any surface texture.
- Concrete is strong, durable, versatile, and economical.

Concrete works

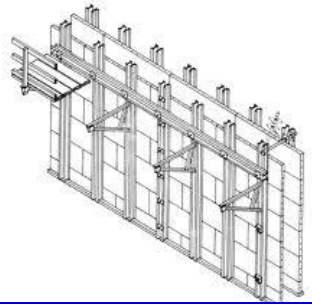
- Concrete will not warp or undergo change in dimensions
- When properly designed and placed it is nearly impermeable and extremely resistant to corrosion
- Has good resistance to natural and processing chemicals
- Economical but requires significant quality control

process

Aggregates
Cement
Water
additive

Batching
Proportioning

Mixing



Transporting

Wood Steel
Plastics

Formworking

Placing

Reinforcement

Compacting
Finishing
Curing

Stripping Out

CONCRETE in
PLACE

The overall Quality of Finished Product depends on:

- Quality of raw material
- Quality of handling material and/or products
- Quality of workmanship

PROBLEMS in CONCRETE WORKS:

- ☒ **Bad materials**
- ☒ **Improper batching, mixing, handling, transporting**
- ☒ **Improper formwork**
- ☒ **Improper curing and finishing**

Make sure all things are taken care of according to recommended practices and codes

INSPECTION, INSPECTION, INSPECTION, INSPECTION … !

Types of Portland cement

Cement type	Use
I[1]	**General purpose cement**, when there are no extenuating conditions
II[2]	Aids in providing **moderate resistance to sulfate attack**
III	When **high-early strength** is required
IV[3]	When a **low heat of hydration** is desired (in **massive concrete** structures)
V[4]	When **high sulfate resistance** is required
IA[4]	A type I cement containing an integral **air-entraining agent**
IIA[4]	A type II cement containing an integral air-entraining agent
IIIA[4]	A type III cement containing an integral air-entraining agent

Concreting Techniques

- Regular/common Concreting Techniques
  - Pouring concrete into ready-made formwork (in-situ)
  - Beams, columns, slabs, façades, foundations, etc.
- Special Concreting Techniques:
  - Precast Concrete:
    - On-site Production
    - Off-site Production
  - Slipform Construction (Traveling Formwork)
    - Vertical slipforming
    - Horizontal slipforming
  - Tilt-Up Construction
  - Lift-Slab Construction
  - Shotcrete Construction
  - Balloon construction
  - Prepacked Aggregate

Design and Construction Considerations

- Regular Formwork
  - Vertical loads and lateral concrete pressures
  - Dimensions & tolerances
  - Curing, finishing and stripping
  - Shoring
- Precast concrete
  - Joint system (wet vs. dry)
  - Transportation and handling loads
- Vertical Slipforming
  - Jacking system (hydraulics)
  - Slipforming operation
- Horizontal Slipforming
  - Lining and slopes

Concrete Mixing Plant

cement silo

concrete mixer

aggregate batching plant

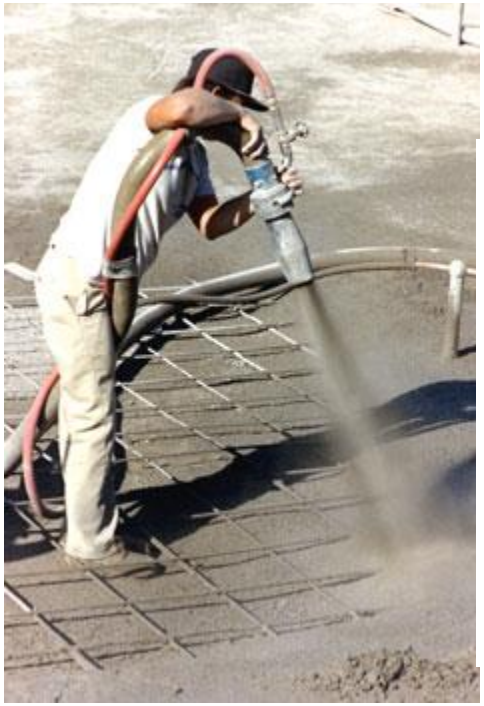
Batching and Mixing

Transporting & Delivery of Concrete

mobile concrete pump

ready-mix / agitator truck

Shotcreting



Shotcreting

Dry-Mix	Wet-Mix
Dry ingredient are placed into a hopper then pneumatically pumped out of a nozzle. Water is added at the nozzle	Concrete compound (cement, fine aggregate) and water are mixed in a hopper, then pumped out of a nozzle.
Good for small and repair works	Best for work in large volume
Quantity of water is controlled t the nozzle	Less dusty, less rebound, less waste

nozzle

concrete pumping hopper

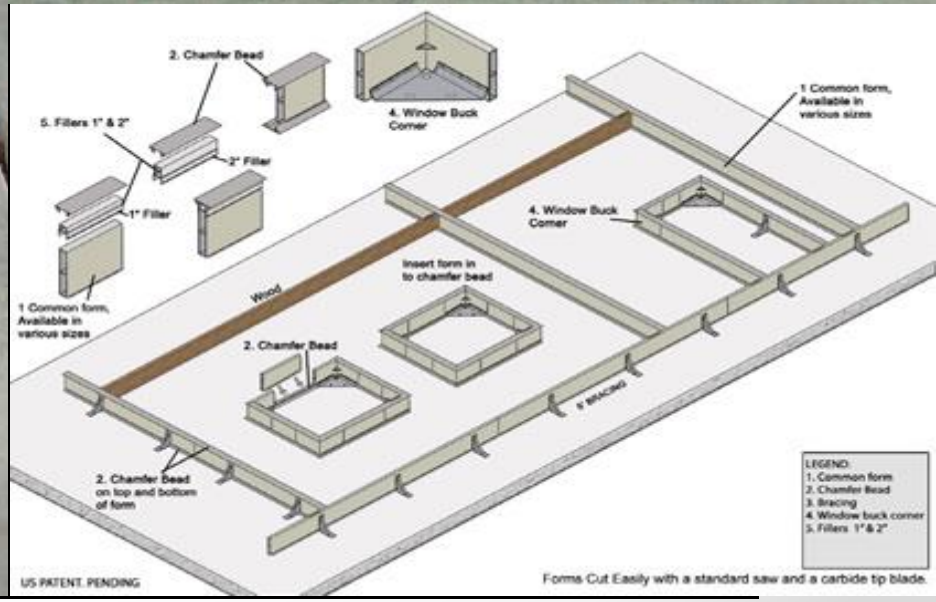
Tilt Up Construction

Tilt-Up Construction?

1. First, the slabs of concrete are cast on-site either using the building's floor as a casting surface or using horizontal casting beds.
2. After curing, the slabs are lifted or tilted - into place with a crane and set on concrete foundations to form the building exterior.
3. The load-bearing panels are temporarily braced, building steel is erected, and the panels and framework are connected.
4. The roof structure is constructed and anchored to the walls to complete the building system.
5. Following removal of panel braces, grout is applied at the base of the panels and all vertical joints are caulked

Tilt-Up Construction Process

Tilt Up Construction



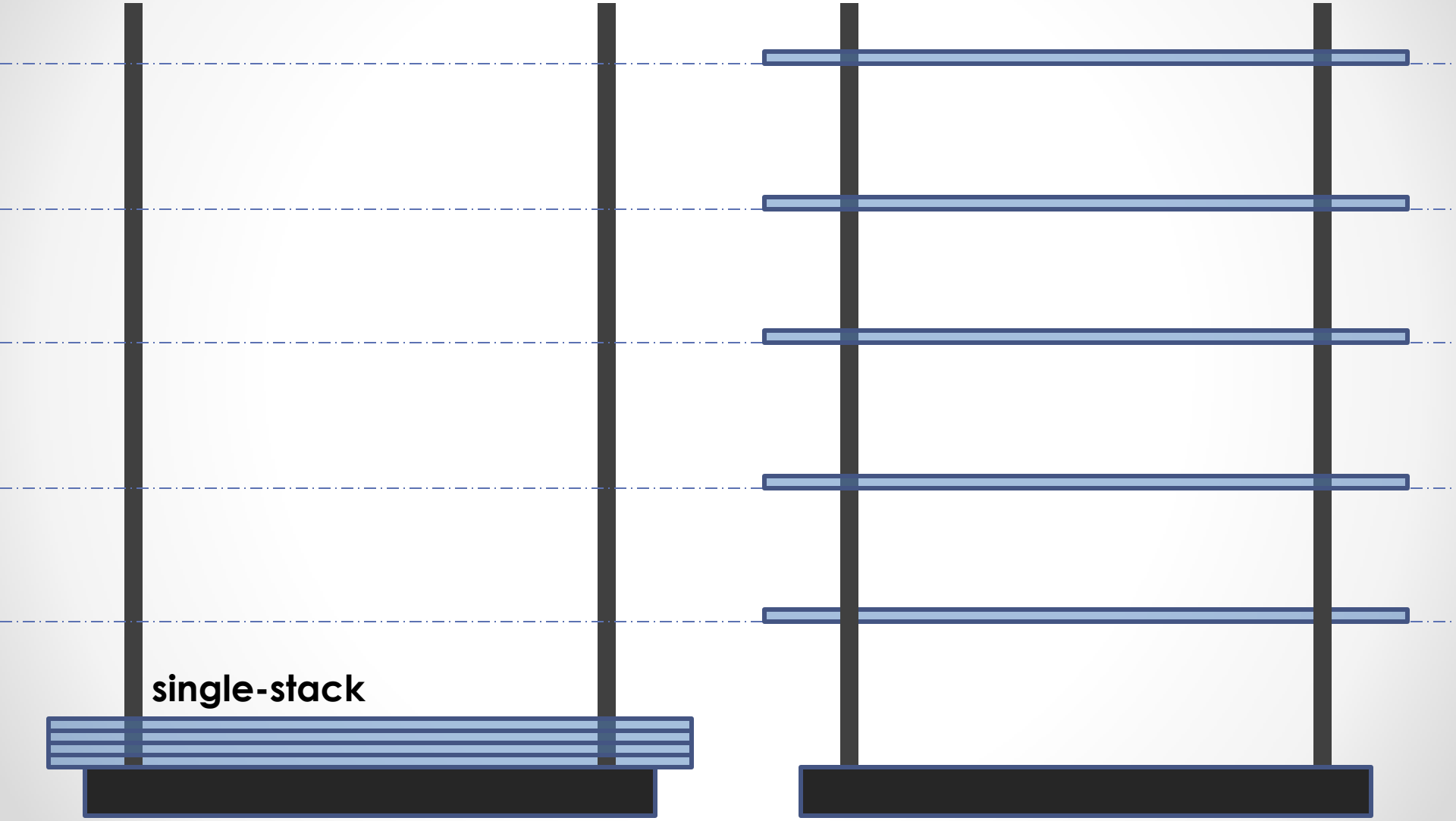
Lift-Slab Construction

- Slabs are poured on ground then lifted sequentially one by one onto their final position by means of a jacking system

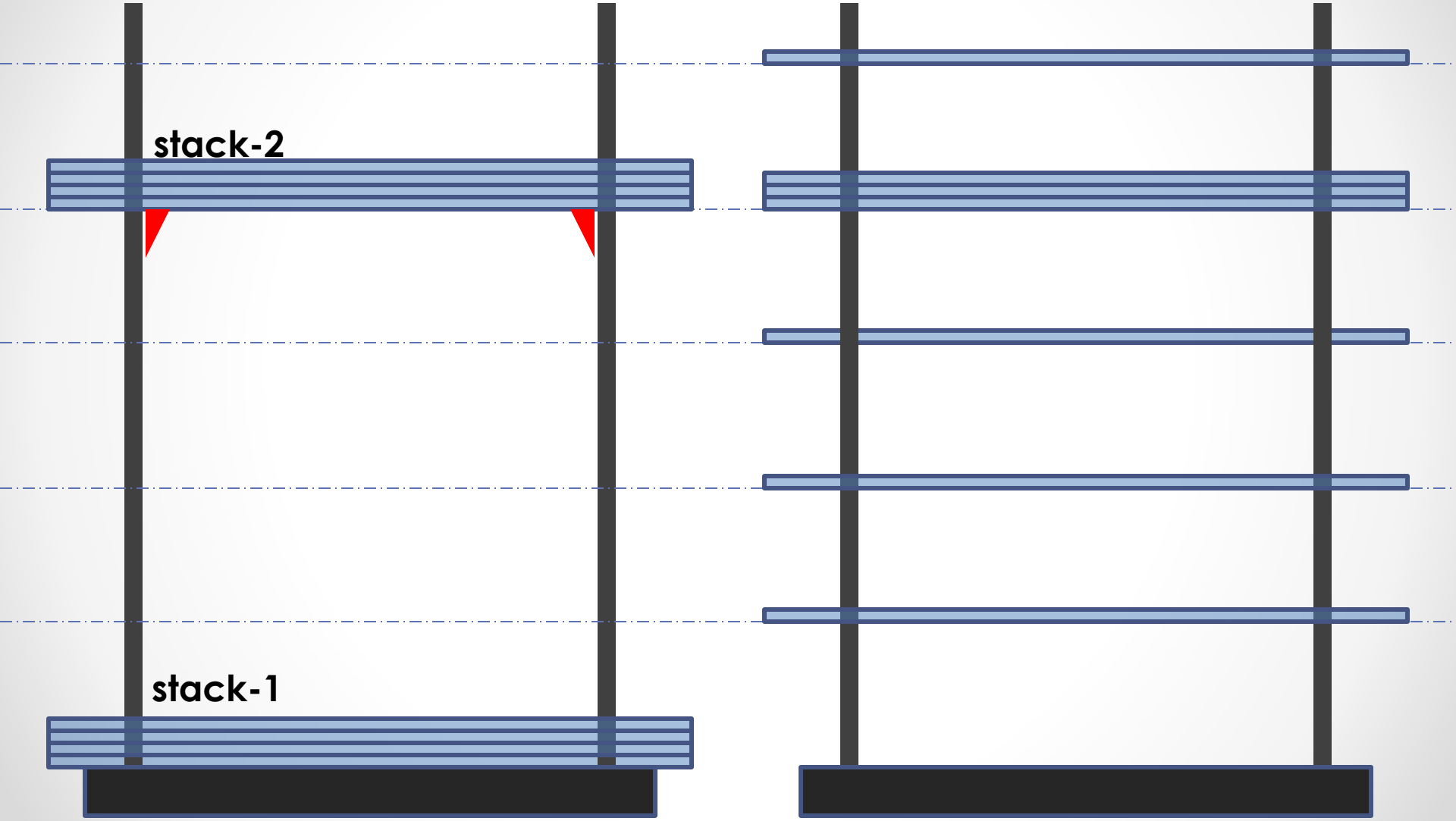
- At the final positions the slabs are fixed to the columns

Lift Slab Construction Process

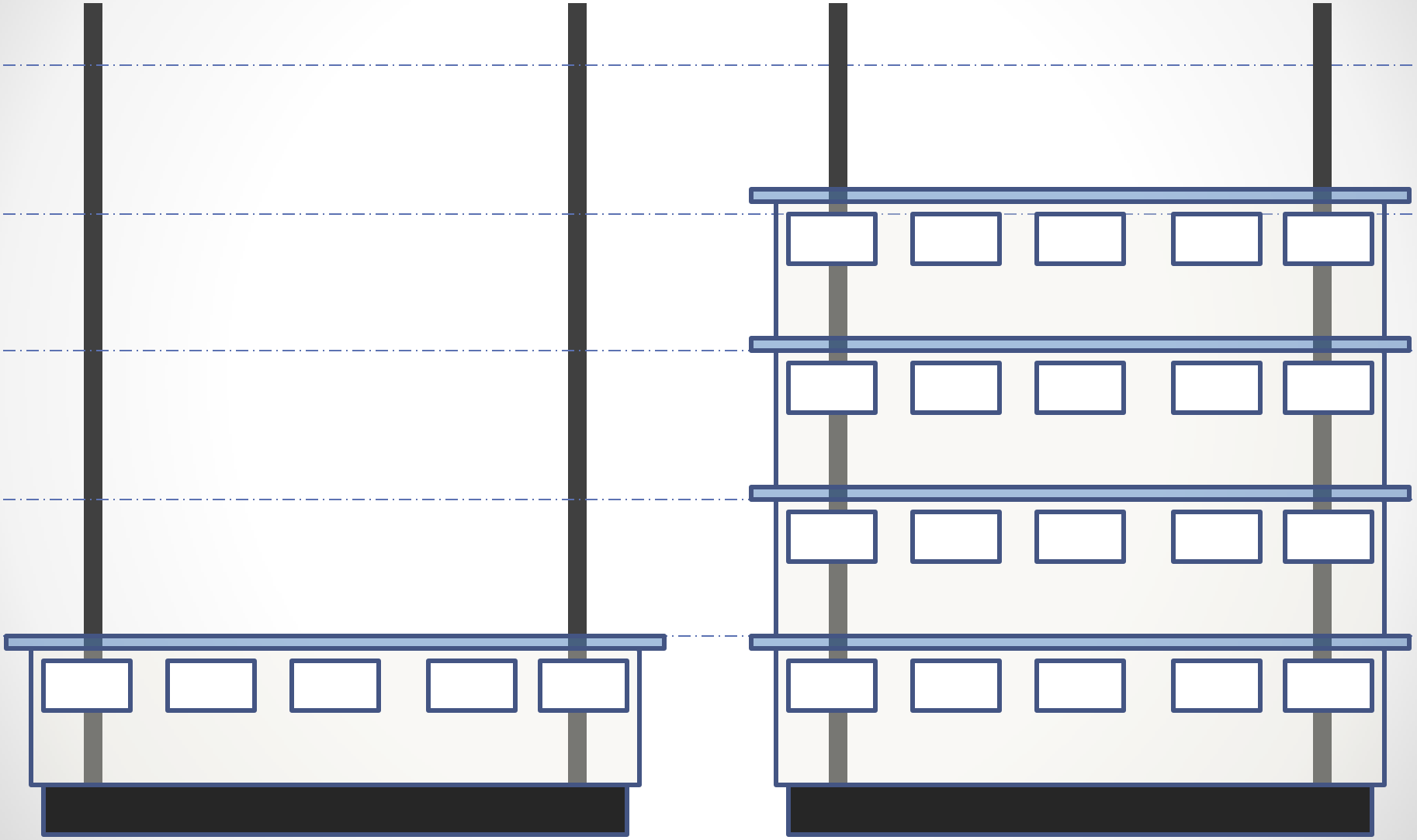
Tilt-up construction process



Tilt-up construction process



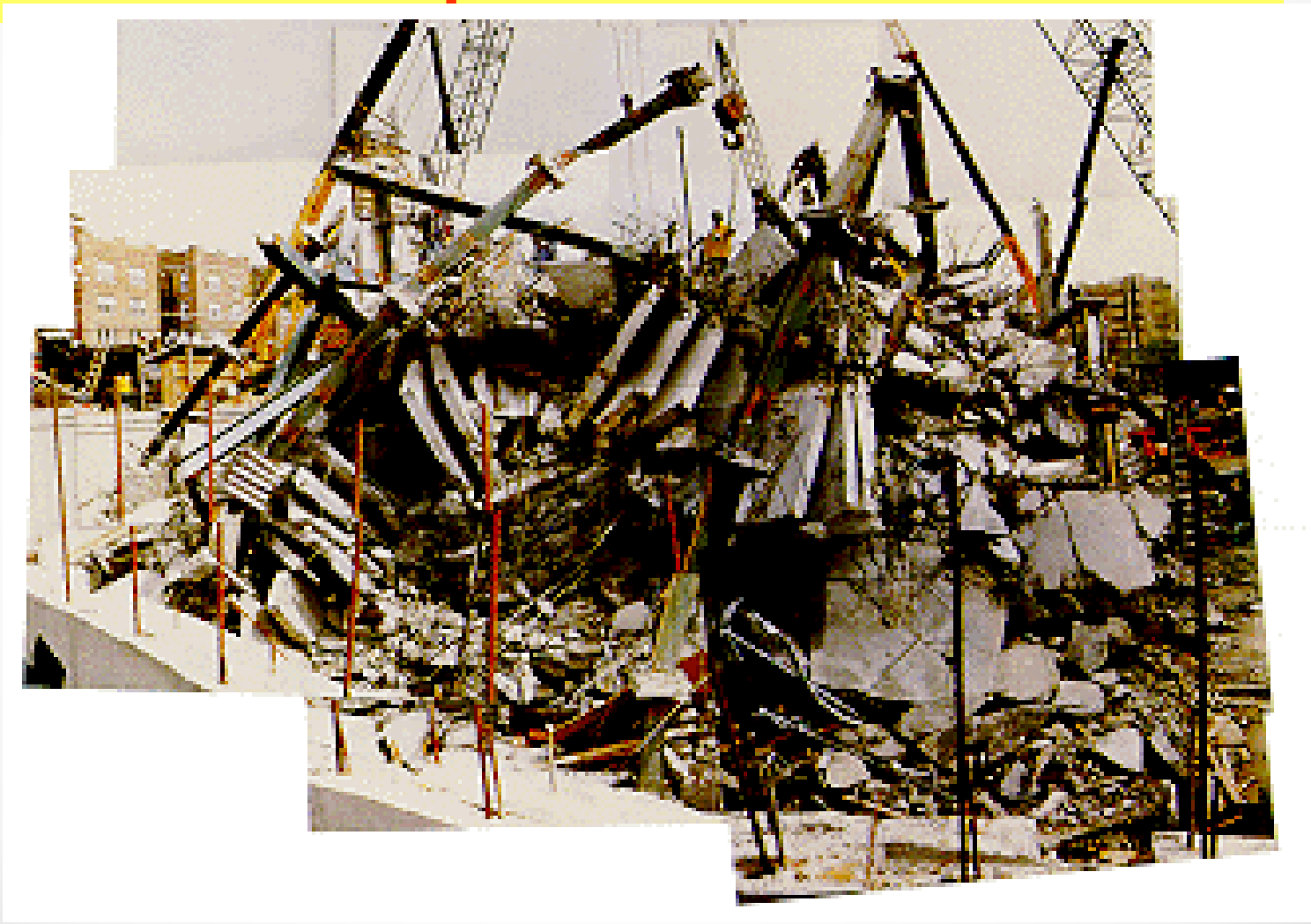
Tilt-up construction process



Lift Slab Construction Process

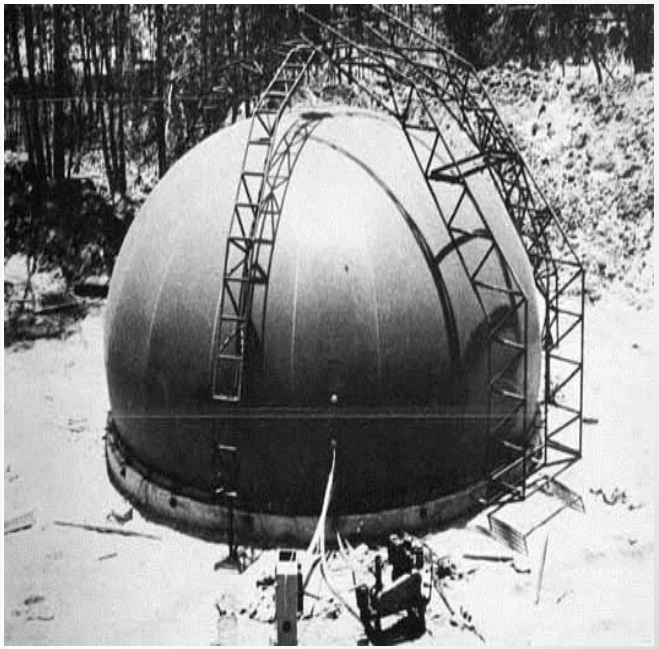
Lift Slab can be Dangerous Construction Process

Progressive collapsed of L'Ambiance Plaza



Heavy Lifting Construction Process

Balloon Construction → DOMES



Balloon Construction → DOMES

Design and Construction Considerations

- Traveling Forms
  - Traveling speed
  - Symmetrical loading
- Tilt-Up Construction
  - Lifting process (balancing)
  - Temporary shoring
- Lift-Slab Construction
  - Slab separation
  - Lifting and supporting system (vertical & horizontal alignment)
- Shotcrete
  - Consistency of flows
  - Dry vs. wet mix

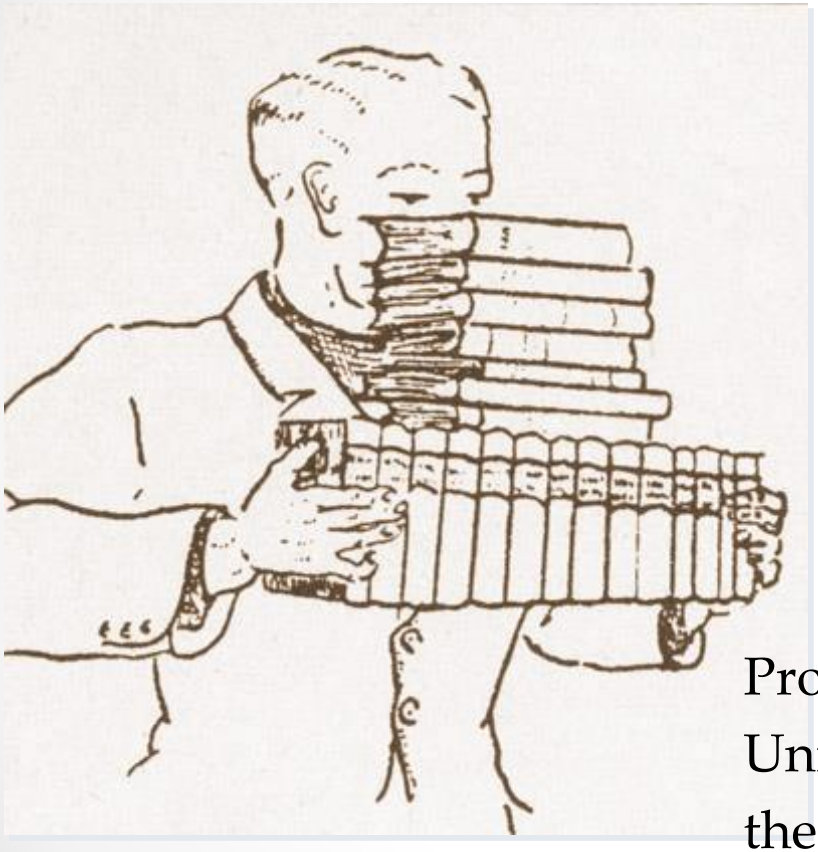
Prestressed Concrete

Important issues in Precast concrete

- Structural efficiency
- Flexibility in use
- Optimum use of materials
- Speed of construction
- Quality consciousness
- Adaptability
- Protection of the environment

Prestressed concrete

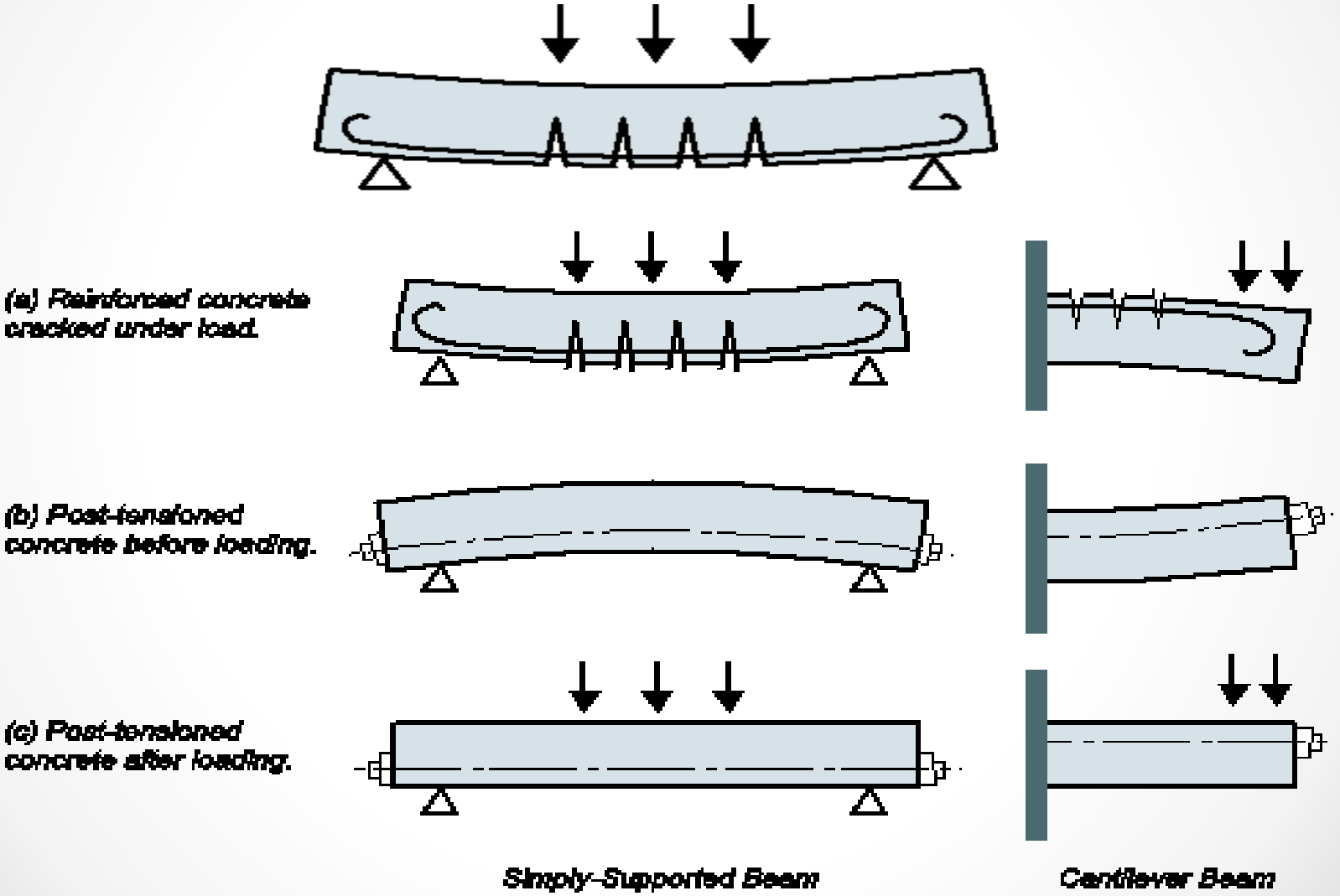
- Improve (loading) capacity of structural element



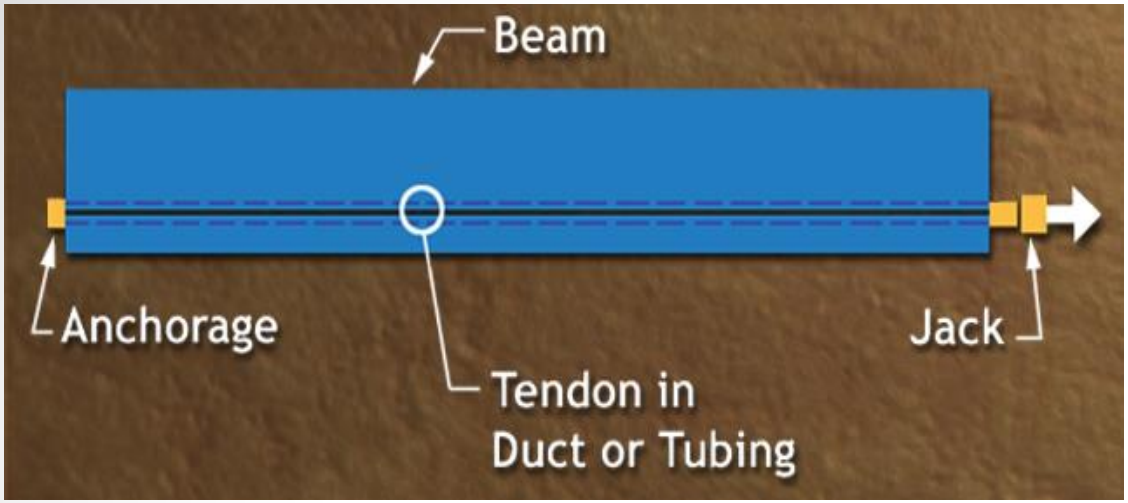
Professor Gustav Mangel from the University of Ghent in Belgium described the concept of pre-compressed concrete to his students using his well-known illustration of a stack of books…

Prestressed concrete

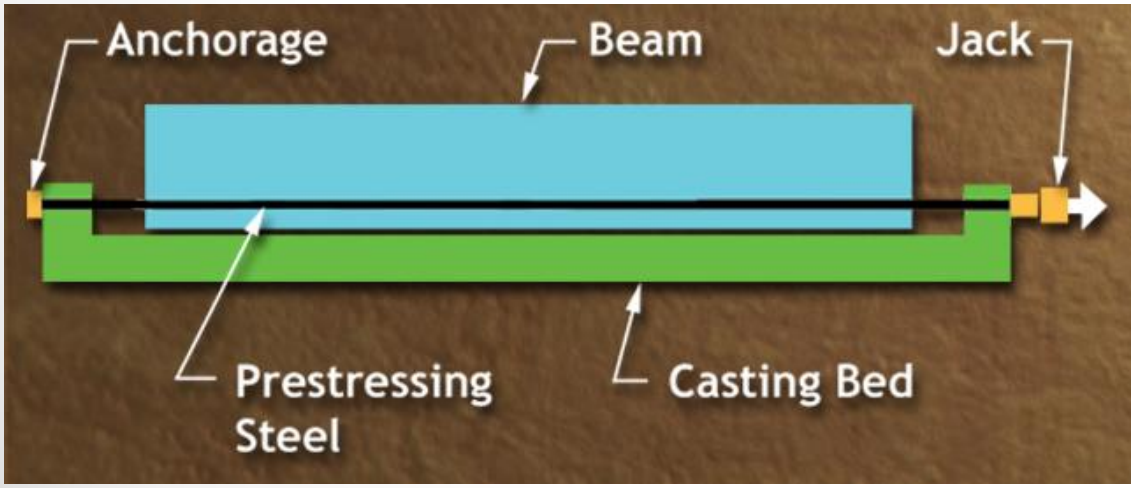
- Improve (loading) capacity of structural element



Pretensioning



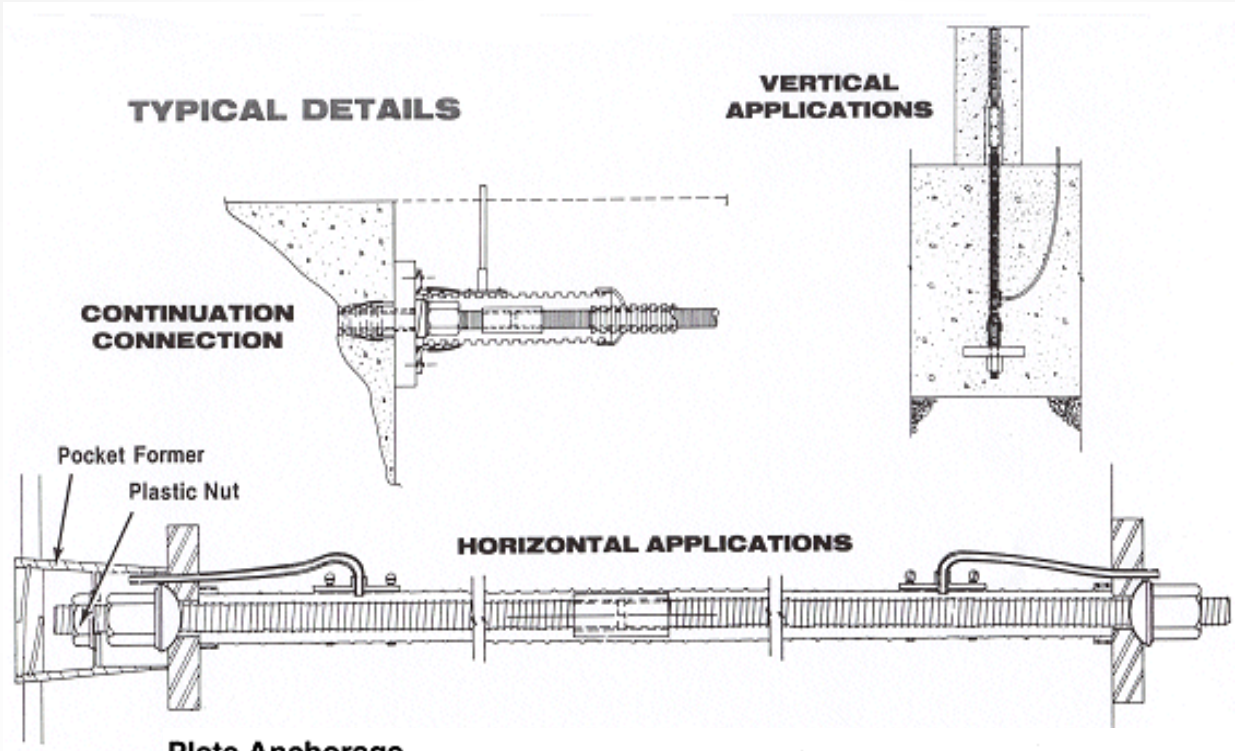
The combination of high strength steel – to resist tensile stress – and concrete – to provide compressive strength and durability – make this composite material adaptable to many situations, especially the design and construction of bridges.

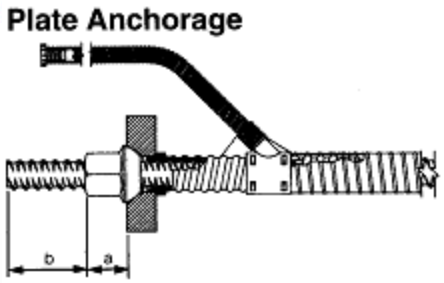


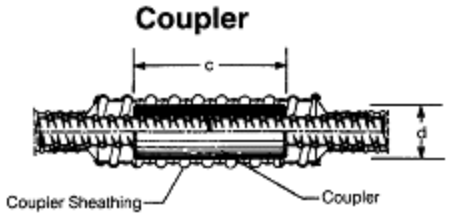
Precasting plants and in-plant pretensioning…

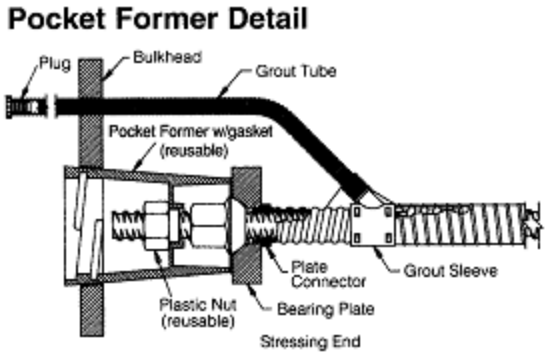
Single to 7-wrire strands…

Anchorage System

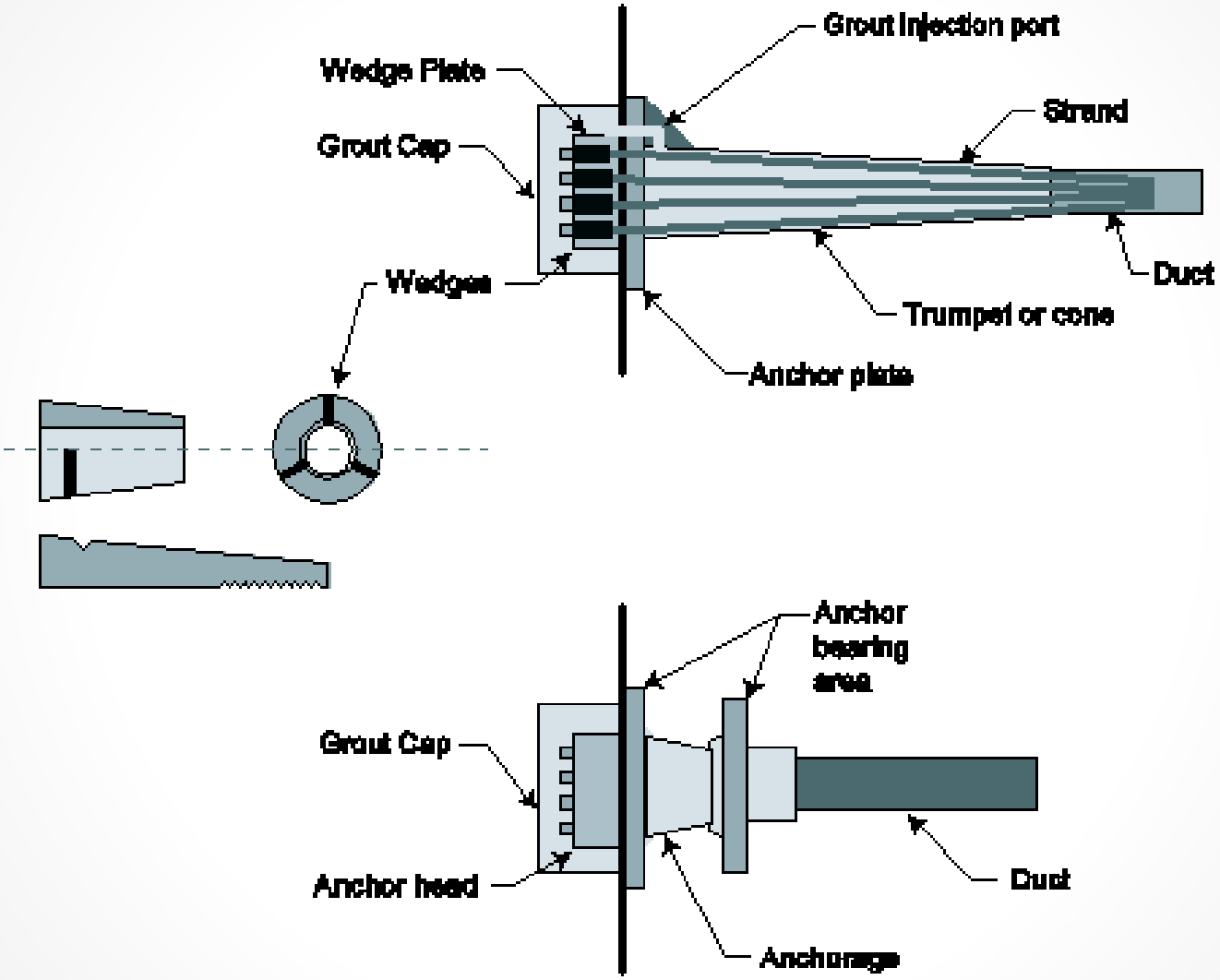






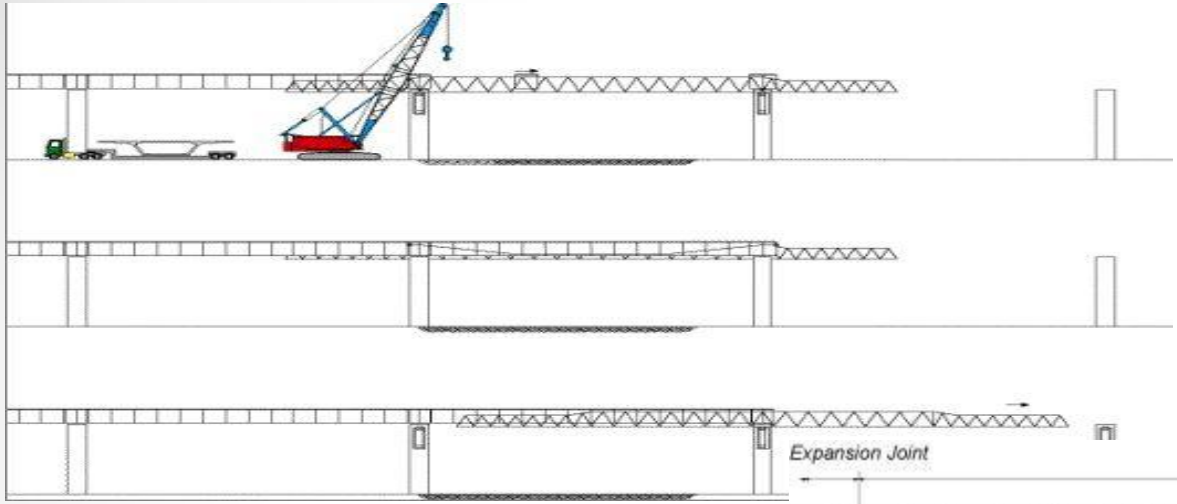


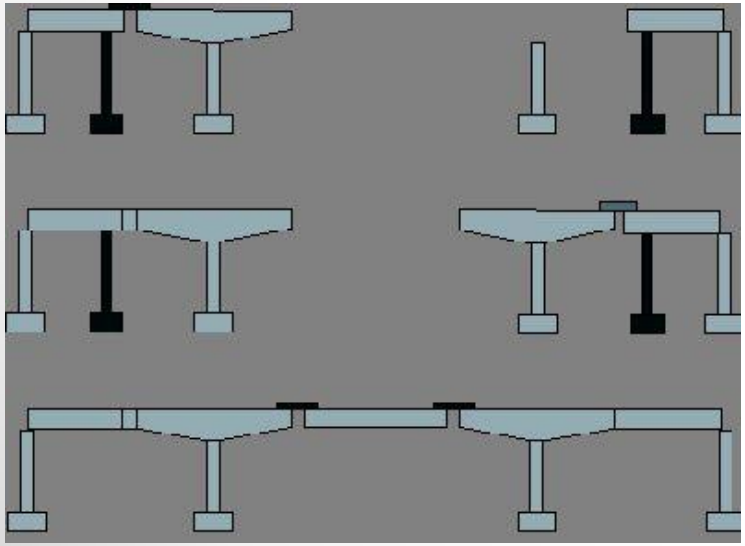
Anchorage System

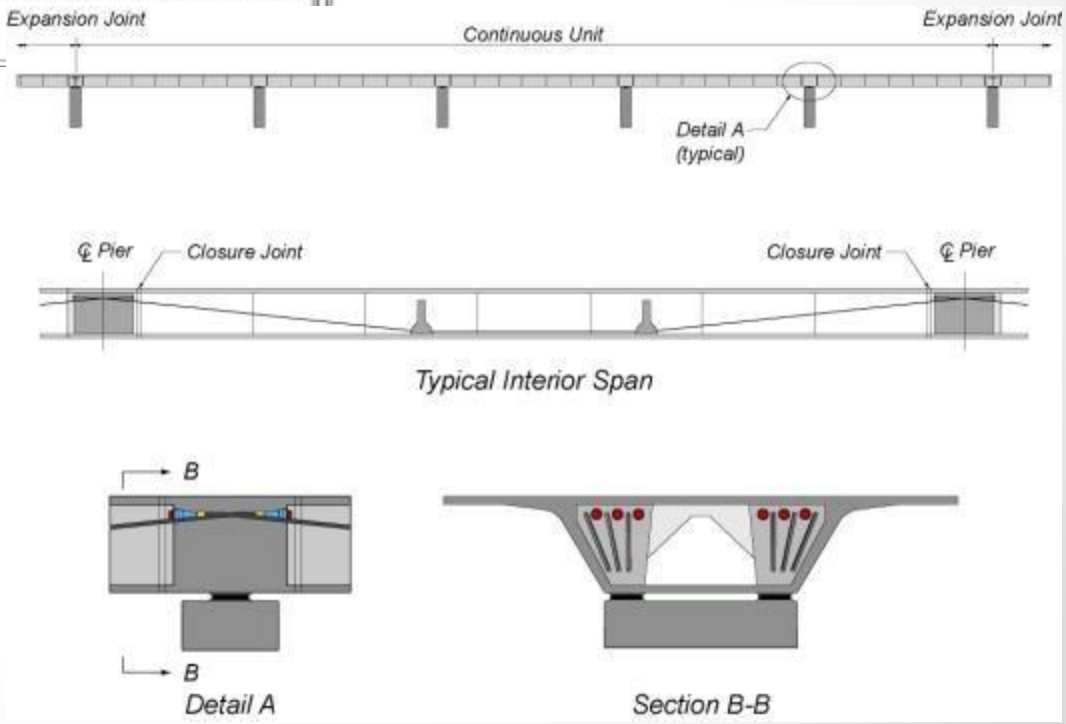


Post-tensioning for segmental bridge construction

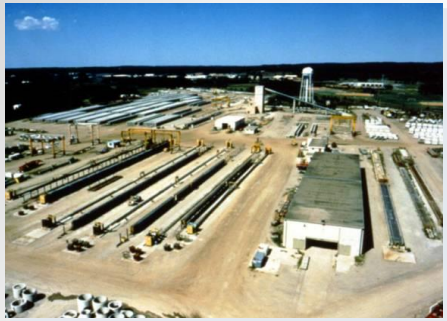
- Integrating (structural) elements







Post-tensioning for segmental bridge construction



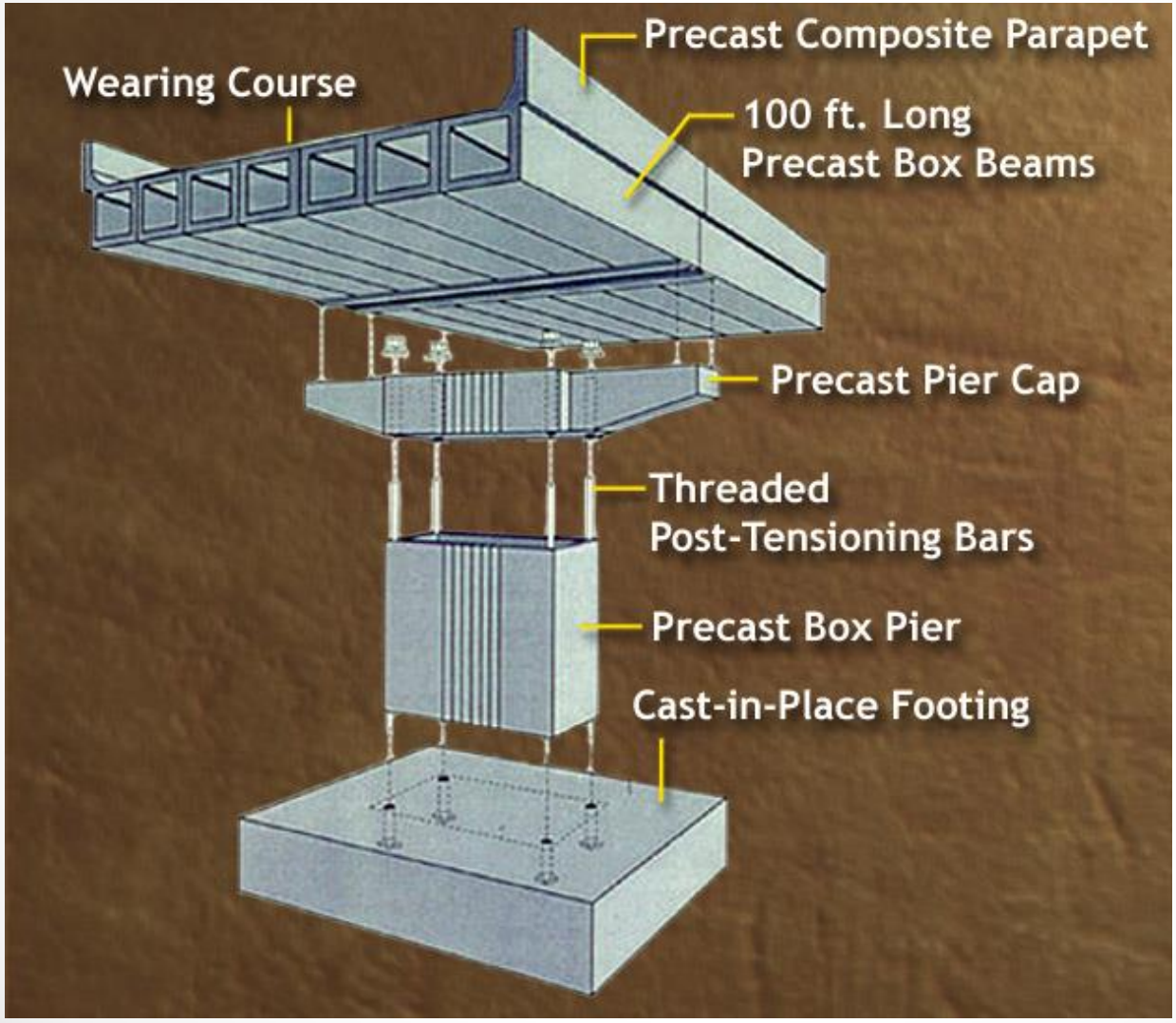
FABRICATION OF PRECAST CONCRETE

PRECAST CONCRETE ELEMENTS

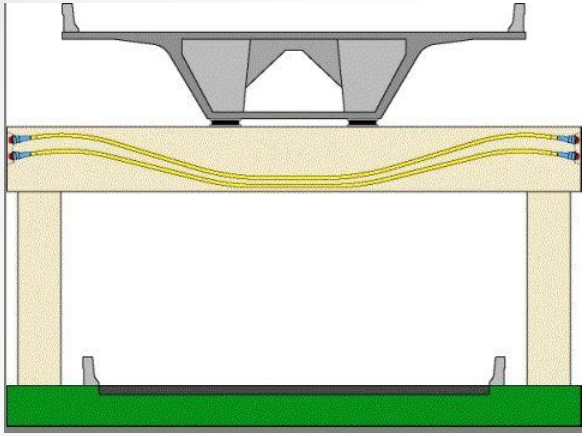
TRANSPORTATION OF PRECAST CONCRETE ELEMENTS

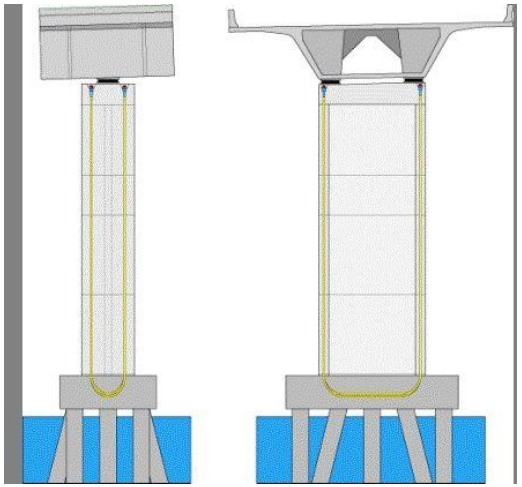
ERECTION OF PRECAST CONCRETE PIERS AND GIRDERS

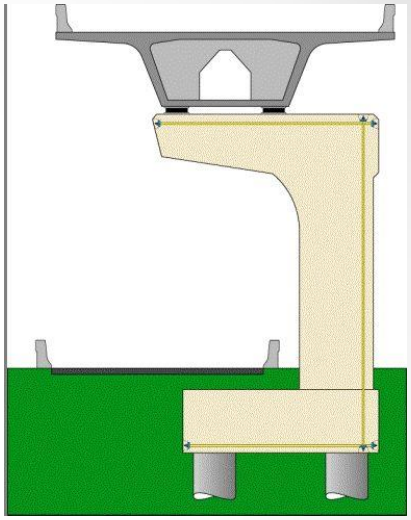
Bridge precast concrete

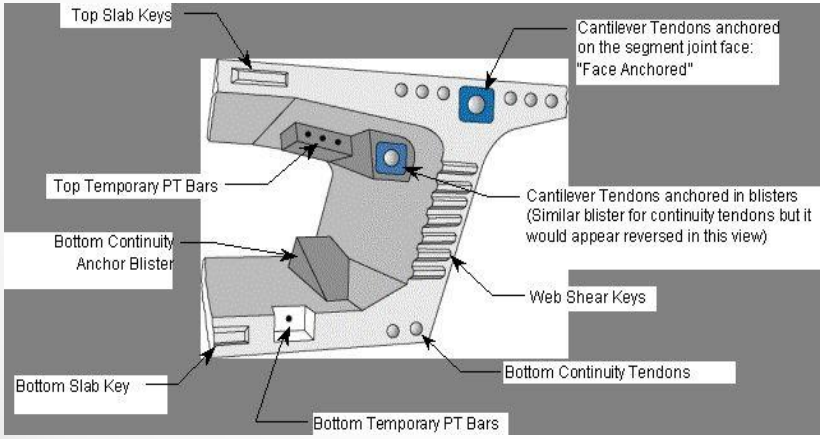


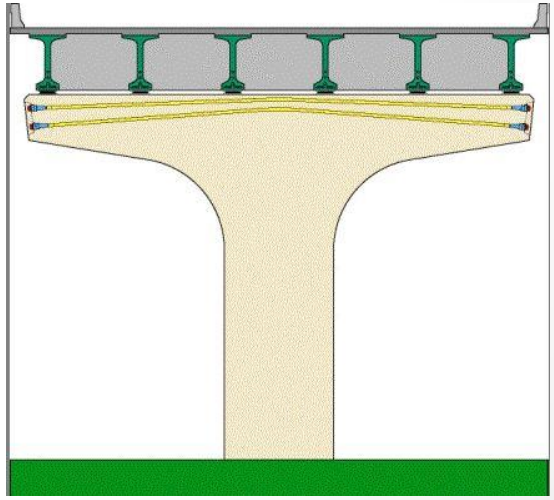
Bridge precast concrete



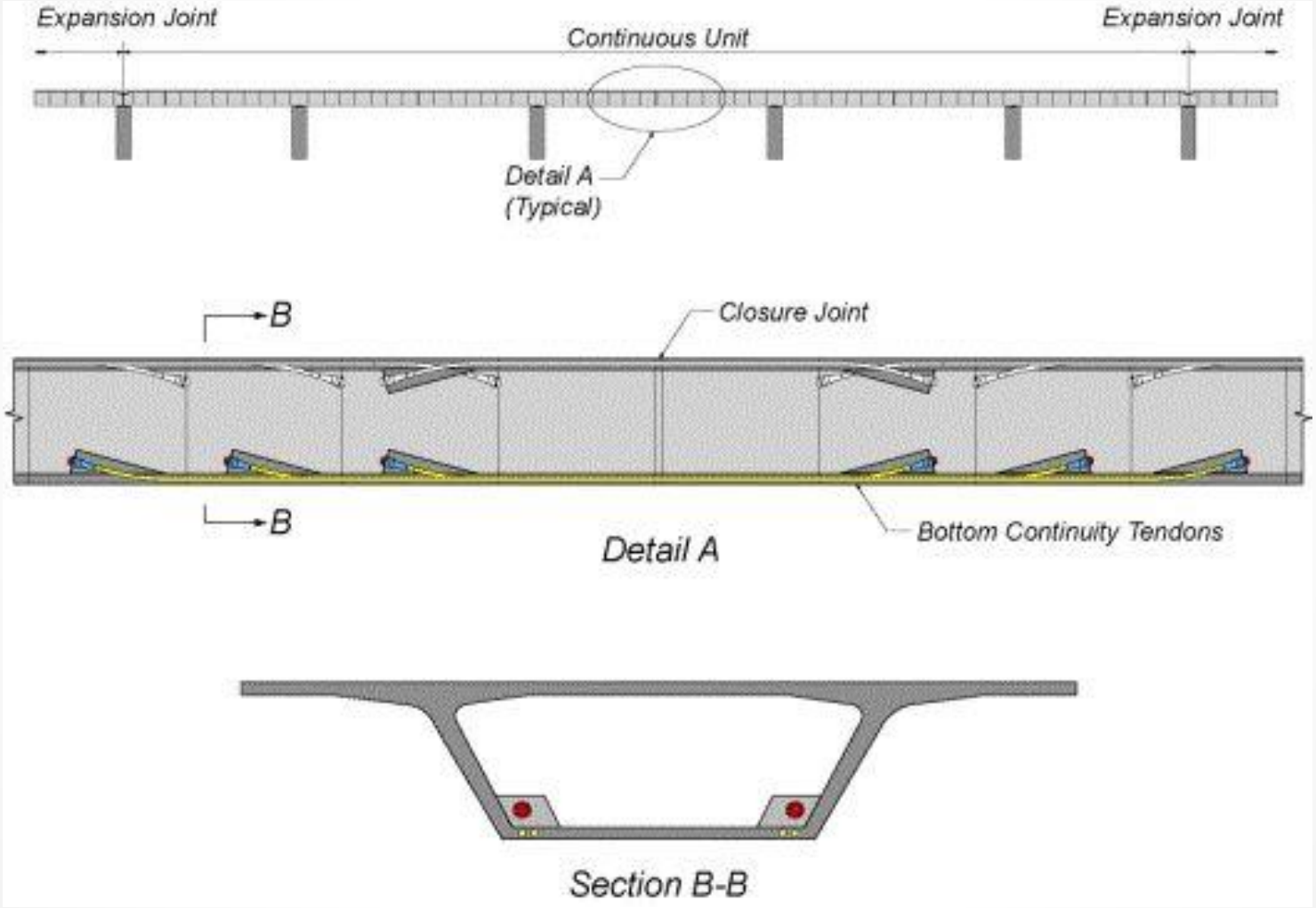




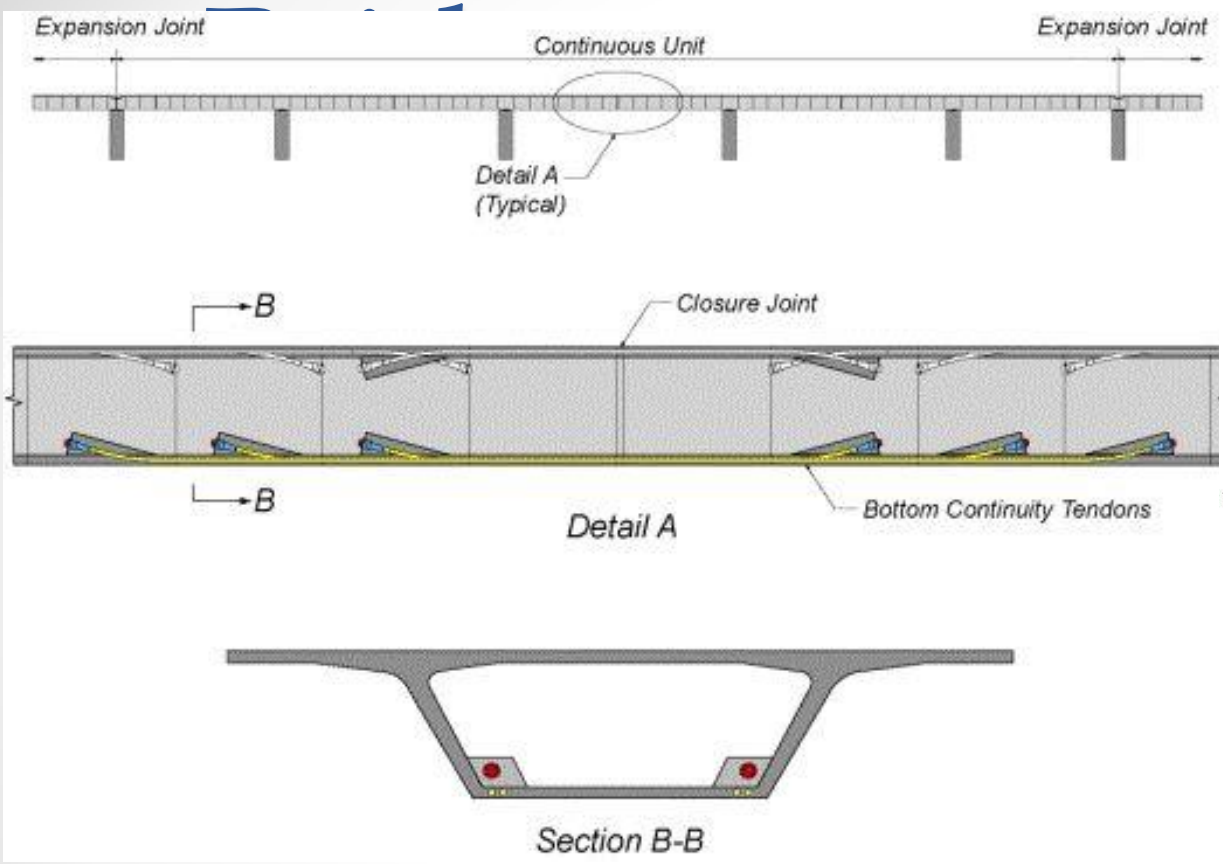


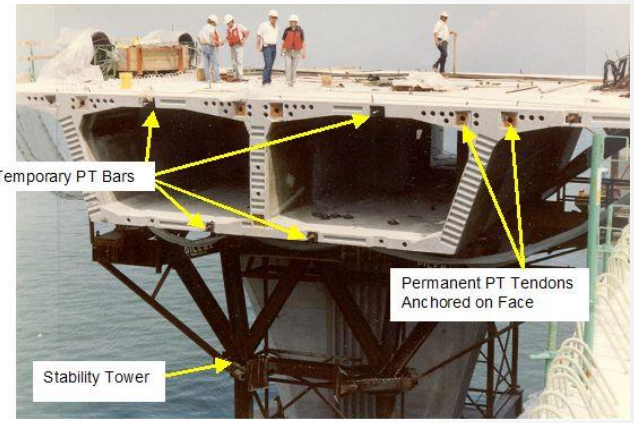


Bridge precast concrete



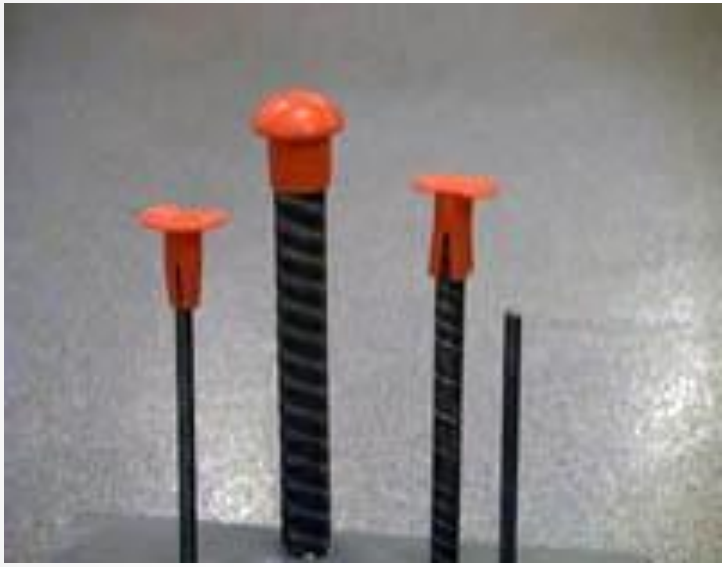
oncrete


Expansion Joint
Continuous Unit
Expansion Joint
Detail A
(Typical)
B
Closure Joint
B
Bottom Continuity Tendons
Detail A
Section B-B


Temporary PT Bars
Permanent PT Tendons
Anchored on Face
Stability Tower

Concrete safety practices

- Protruding steel bars must be covered



- Improper loading of wet concrete