Long & Extra Long Span Bridges

Long Span Bridges:
- Composite Steel Plate Girder Bridge
- Cast-in-place Post-Tensioned concrete Box Girder
- Post-Tensioned Concrete Segmental Construction
- Concrete Arch and Steel Arch

Extra Long Span Bridges:
- Cable Stayed Bridge
- Suspension Bridge

Akashi Kaikyō Bridge
Longest Suspension Bridge (Longest span = 1,991 m)
Russian Russky Bridge
Longest Cable-stayed Bridge (Longest span = 1,104 m)

Chaotianmen Bridge
Longest Steel Arch Bridge (Longest span = 552 m)

Canada Pont de Quebec Bridge
Longest Steel Truss Bridge (Longest span = 549 m)

Wanxian Bridge
Longest Concrete Arch Bridge (Longest span = 420 m)
Shibanpo Bridge
Longest Prestressed Concrete Bridge (Longest span = 330 m)

Brazil Rio-Niterói Bridge
Longest Steel Box/Plate Girder Bridge (Longest span = 300 m)

Economical Span Ranges for Segmental Construction

<table>
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<th>Construction Method</th>
<th>Superstructure Depth – ft (m)</th>
<th>Economical Span Range – ft (m)</th>
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<td>Span-by-span</td>
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<td></td>
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<tr>
<td>Precast</td>
<td>Constant 6 (1.8)</td>
<td>up to 110 (to 33)</td>
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<tr>
<td>Precast</td>
<td>Constant 6 to 8 (1.8 to 2.4)</td>
<td>110-150 (33 - 45)</td>
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<td>Precast/Cast-in-place</td>
<td>Constant 7 to 12 (2.1 to 3.6)</td>
<td>120-160 (36 – 48)</td>
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<td>Incremental Launch</td>
<td>Cast-in-place</td>
<td>Constant 8 to 12 (2.4 to 3.6)</td>
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<td>Progressive Cantilever</td>
<td>Precast</td>
<td>Constant 8 to 10 (2.4 to 3.0)</td>
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<td>Balanced Cantilever</td>
<td>Precast</td>
<td>Constant 6 to 12 (1.8 to 3.6)</td>
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<tr>
<td></td>
<td>Precast</td>
<td>Variable 6 to 20 (1.8 to 6.0)</td>
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<td></td>
<td>Cast-in-place</td>
<td>Variable 6 to 40 (1.8 to 12.0)</td>
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<td>Cable Stay</td>
<td>Precast or Cast-in-place by cantilever erection</td>
<td>Constant 6 to 15 (1.8 to 4.5)</td>
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Span by Span Segmental Construction

- Disadvantage - the capital investment in the equipment for this type of construction is considerable.
- Advantage – quick, simple erection (2-3 spans/wk); Easy geometry control; savings from less MOT; min. user delays; simple design; durable structures
Incrementally Launched Segmental Construction

- Disadvantage - Inefficient use of materials. Stringent dimensional control is an absolute necessity at the stationary casting site. Straight or constant radius. (not recommended)

Progressive Cantilever Segmental Construction

- Note – Various radius. A movable temporary stay arrangement must be used to limit the cantilever stresses during construction to a reasonable level

Free Cantilever Segmental Construction

- Note - The form traveler moves forward on rails attached to the deck of the completed structure and is anchored to the deck at rear.
- 4 to 6 segments/day (45 ft)

Cable Stay Segmental Construction

- Viaduct main span 66.5 m
Post-tensioned Precast Piers

**Single-cell Box with Inclined Struts**

- Current trends in cross-section design lead to single cell box girders for increasingly wider bridges. Ribs or struts are used to provide additional transverse capacity.

Precast Pier Details & Erection

**Precast Joints**

- **Type A** joints include cast-in-place concrete joints, wet concrete joints or epoxy joints.
- **Type B** joints consist of dry joints between precast units.

- Keys (i.e. no reinforcing across joints)
- Epoxy
  - Temporary Clamping
  - Temperature
Cast-in-Place Joints

- Reinforcing Bars
- Joint Preparation
- Bulkheads

Grouting top & bottom slab cantilever and continuity tendon

- Outlet vent at top of anchor (A)
- Injection port at low point (B)
- Intermediate vent (C) when duct is longer than 100 ft
- Injection port (D) when (D) is more than 18" lower than vent (C) or (E)
- Outlet vent at top of anchor (E)

Anchor protection for interior & exterior anchors

- Seal coat min 6" overlap beyond corners
- Four level protection
  - Brass
  - Plastic cap
  - Seal coat
  - Surrounding box

Sava River Bridge, Serbia
Cable-Stayed Bridge Demonstration Project

Cable-Stayed Bridge Construction

Typology of Cable-Stayed Bridges

- Type 1 - symmetric forward cable arrangement with straight pylon
- Type 2 - symmetric reverse cable arrangement with straight pylon
- Type 3 - asymmetric cable arrangement with inclined pylon
- Type 4 - asymmetric cable arrangement without back-stays

Free Body Diagram for Member Forces in a Cable-Stayed Bridges
Form and Force Diagrams of a Basic Three-force System

(a) from form diagram to force diagram

(b) from force diagram to form diagram

Form and Force Diagrams for a Simple Symmetric Cable-stayed Bridge System

(a) form diagram for the right end loading

(b) force diagram clockwise

(c) force diagram for both loadings

(d) force diagram completed

Form and Force Diagrams for a Simple Asymmetric Cable-stayed Bridge System

(a) form diagram for a straight tower

(c) form diagram for an inclined tower

(b) form diagram for the straight tower

(d) form diagram for the inclined tower

Symmetric forward cable arrangement (modified harp case)

Legend:
P: Point loading
D: Deck
C: Cable
T: Tower
Symmetric forward cable arrangement (reverse of the modified harp case)

Asymmetric Cable Layout with Forward and Reverse Arrangement

(a) form diagram  
(b) force diagram (deck and cable forces)  
(c) force diagram (tower forces)

(a) form diagram  
(b) force diagram (deck and cable forces) for right side  
(c) balanced loadings  
(d) force diagram (deck and cable forces)  
(e) force diagram (tower forces)

Form and Force Diagrams showing Multi-level Load Path

Bridge Reconstruction

Bridge Destruction and Construction
- Port Mann Bridge Construction
- Port Mann Bridge Deconstruction

Bridge Replacement
- NJDOT Accelerated Bridge Construction

Bridge Widening
- Illinois Tollway Fox River Bridge