Structural Concrete Structures

Reinforced Concrete Construction
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- **Formwork**
  - Flat surfaces (element bottom: slabs, beams)
  - Vertical Surfaces (element sides: walls, beams, columns)
- **Reinforcing bar cage fabrication**
  - Placing bars and tying
- **Concrete fabrication and placing**
  - Bucket placing
  - Pumping

Wall Formwork
Slab Formwork
Footing Reinforcing Cage

Finished Wall Footing
Slab Reinforcement

Concrete Truck and Pump
Wall Construction

Concrete Pumping
Concrete Building: San Francisco, CA
Concrete Building: Phoenix, AZ

Post-tensioned slabs
Reinforced concrete shear walls
Bridges

Rigid Frames – Overpass
Slab and Beam Bridge

Bridge Frames Supporting Precast Concrete and Steel Beams
Post-Tensioned Segmental Bridge (I-70, Colorado)

Interior of Box Girder
Cantilever Bridge – Variable Cross-Section

Arch Bridges: Natchez Trace Parkway
Salginatobel, Austria

Salginatobel Bridge
Selah Creek, Yakima, Washington

Twin fixed concrete arch highway bridges.
Heavy arch ribs designed to resist axial force and bending.
Columns and deck not designed to resist longitudinal bending (very flexible).

Gotteron Bridge, Fribourg, Switzerland

Twin fixed concrete arches (supported on rock).
Bending stiffness of arch and deck are comparable indicating deck is relied upon for longitudinal flexural moment.
Concrete Arch, Austria

Alex Fraser Bridge – Cable-Stay Construction
<table>
<thead>
<tr>
<th>Bridge</th>
<th>Location</th>
<th>Construction duration</th>
<th>Main Span</th>
<th>Total Length</th>
<th>Pylons</th>
<th>Volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alex Fraser Bridge</td>
<td>Annacis, British Columbia, Canada (Fraser River)</td>
<td>1983-1986</td>
<td>steel deck/reinforced concrete slab; 465 m (1540 ft)</td>
<td>930 m</td>
<td>reinforced concrete, height 153.8 m</td>
<td>concrete: 80,000 m³; reinforcing steel: 11,600 T; prestressing steel 800 T</td>
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<td>Normandy Bridge</td>
<td>Seine River (Le Havre, France)</td>
<td>1988-1994 (Opened Jan. 20, 1995); $465 M</td>
<td>steel and prestressed concrete; 856 m (2810 ft)</td>
<td>2141 m</td>
<td>reinforced concrete, height 215 m</td>
<td>concrete: 80,000 m³; reinforcing steel: 11,600 T; prestressing steel 800 T</td>
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Roofs

Folded Plate, Las Vegas
Barrel Shells, Oakland Airport

Cantilever Shell
Hyperbolic-Paraboloid (Hypar) Roof, Berkeley

Thin Shell Dome
Y-Shaped Precast Roof Beams

Variable Section Precast Members
Double-Tee Precast Roof Beams

Buildings
Marina City
Chicago, IL

Year built: 1964
Structural system: Reinforced concrete
Concrete shear wall core
No. stories: 60 (bottom 18 parking)

311 South Wacker Dr.
Chicago, IL

Year built: 1990
Structural system: Reinforced concrete
No. stories: 65
Height: 292 m (960 ft)
Deep Beam (Transfer Girder), Chicago

Year built: 1998
Structural system: Steel, Reinforced concrete
The world’s tallest building (tip of spire) – 452 m (1483 ft) ft

Petronas Towers
Kuala Lumpur, Malaysia
Trump International Hotel & Tower
Chicago, IL

Completion: 2008
Structural system: Steel, Reinforced concrete
92 stories – 415 m (1362 ft)
Other Structures

CN Tower
Toronto, Canada

Year built: 1976
Structural system: Reinforced concrete
The world's tallest freestanding structure at time of construction
Hoover Dam
Black Canyon, Nevada

Year built: 1931-1936
Structural system: Concrete arch-gravity dam
Length: 1,244 ft (379 m)
Height: 726 ft (221 m)
Concrete volume: 3.25 M cu yd

Concrete Structures at UMass
Herter Hall

Balconies in Herter Hall