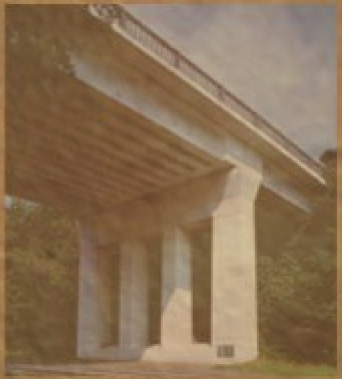
Advantages of Prestressed Concrete Bridges



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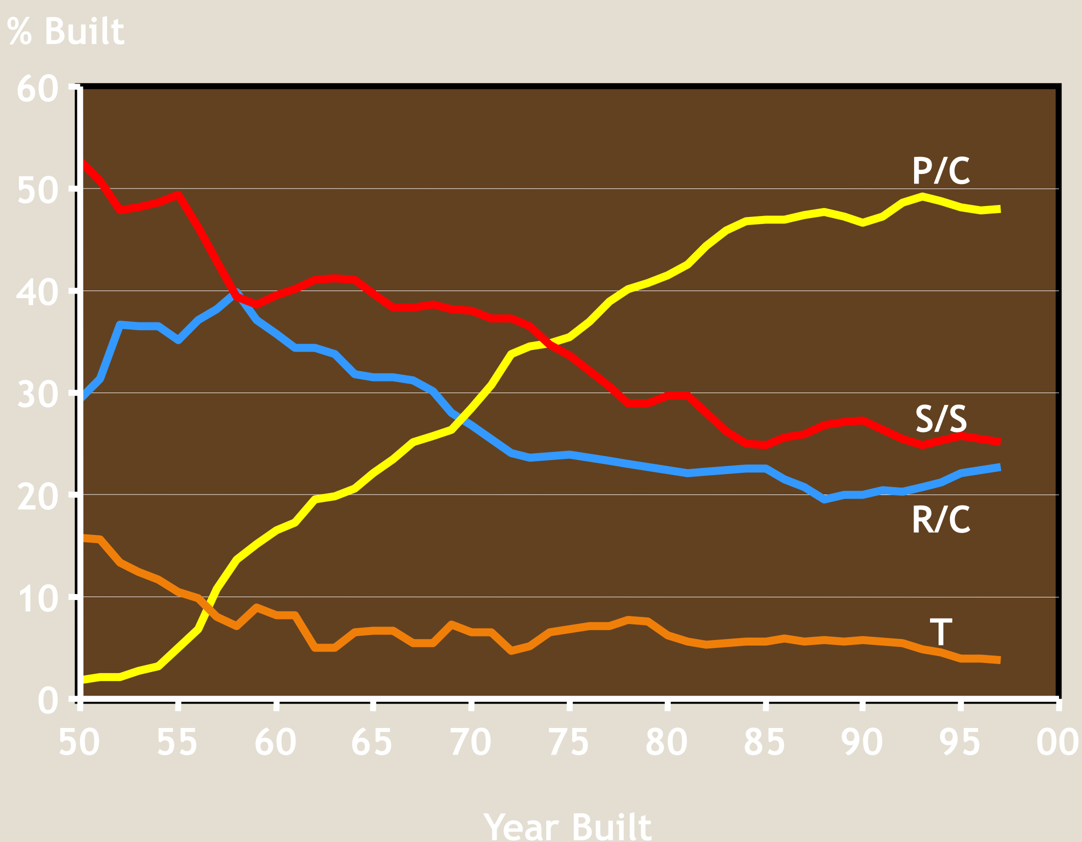
ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Bridges Built



- Owners and designers have long recognized the low initial cost, low maintenance needs and long life expectancy of prestressed concrete bridges. This is reflected in the increasing market share of prestressed concrete, which has grown from zero in 1950 to more than 55 percent today.

Source: National Bridge Inventory Data

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

- This growth continues very rapidly, not only for bridges in the short span range, but also for spans in excess of 150 feet which, heretofore, has been nearly the exclusive domain of structural steel.

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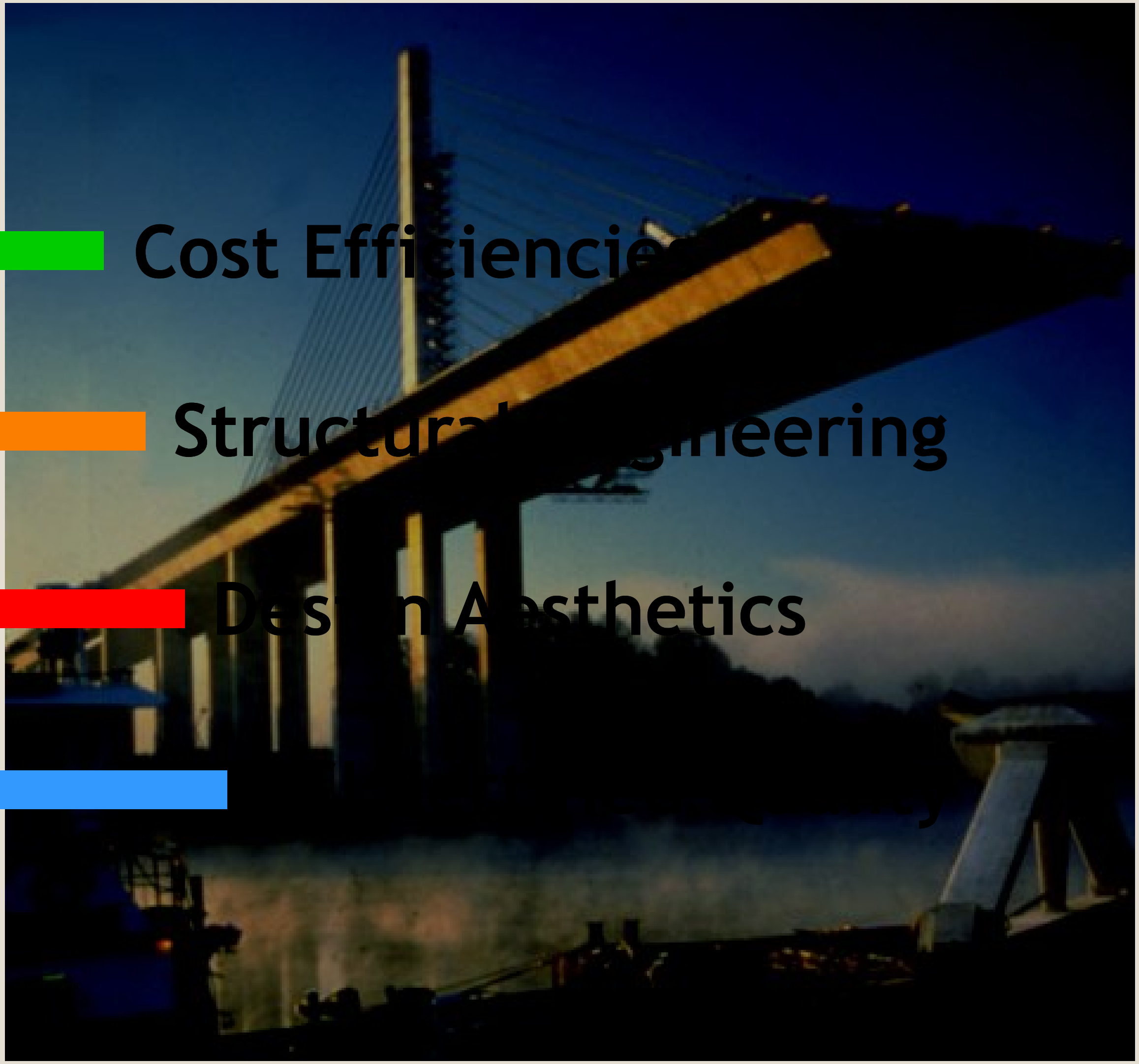
ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES



- The following examples illustrate some of these key advantages of precast, prestressed concrete bridges:

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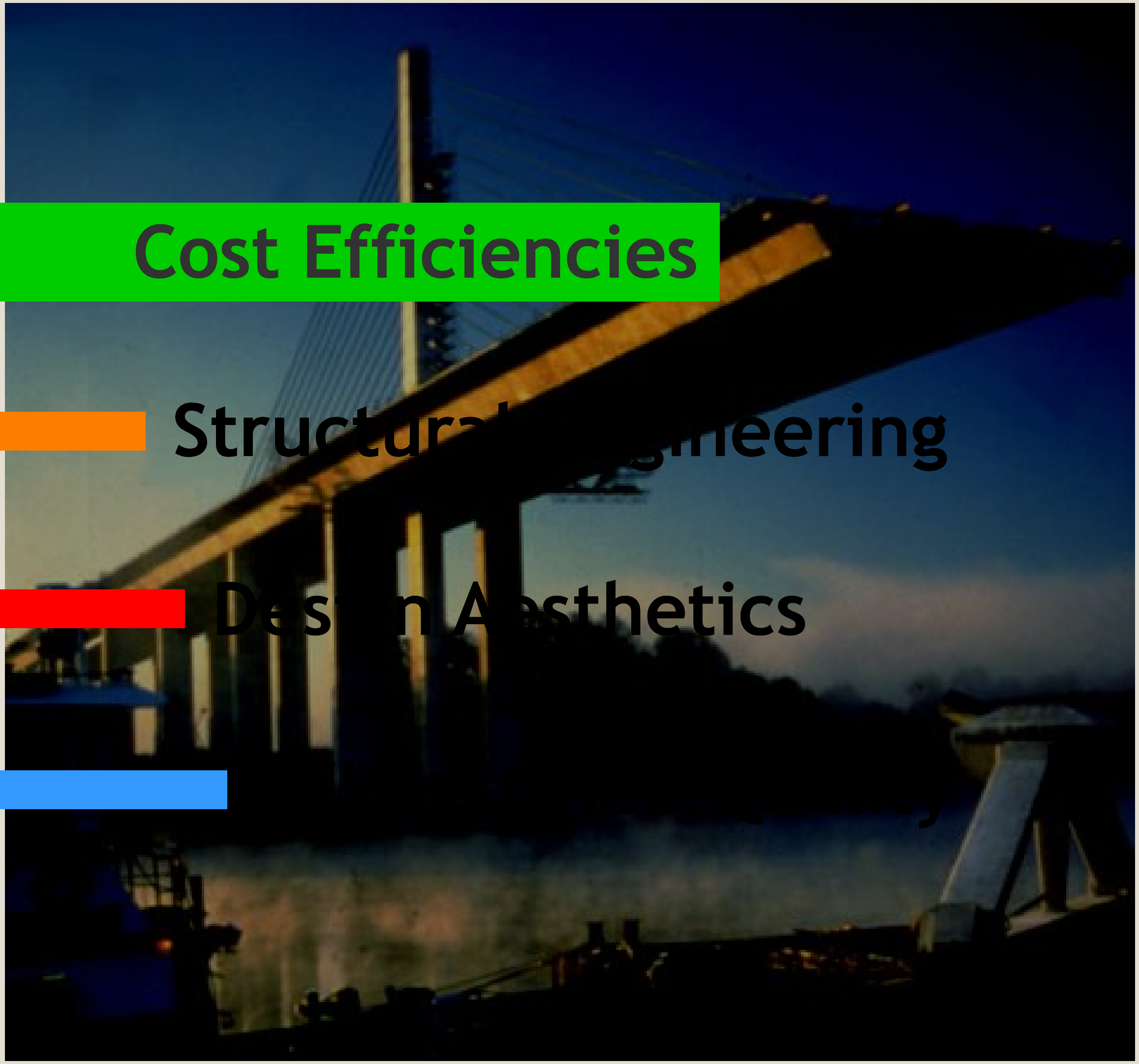
ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES



- Many bridge designers are surprised to learn that precast, prestressed concrete bridges are usually lower in first cost than all other types of bridges.
- Coupled with savings in maintenance, precast bridges offer maximum economy.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- An old bridge located on a main logging road in Idaho was replaced with a prestressed concrete bridge. The bridge consists of integral deck beams on precast concrete abutments and wing walls. The heavy spring runoff dictated the need for a shallow superstructure, and the load capacity of the bridge had to be sufficient to carry off-highway logging trucks that weigh as much as 110 tons each.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- The precast prestressed bridge system offered two principal advantages:
- it was *economical* and it provided *minimum downtime* for construction. Project duration was three weeks.

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ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- The state of Minnesota saved more than 16% - a half a million dollars – by planning for a prestressed alternate to a steel bridge.
- The 700-foot-long bridge is jointless up to the abutments and is the longest continuous bridge in the state. It also contains the longest single concrete span.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- A Minnesota transportation official stated, “Originally, we didn’t think concrete was suited to this… bridge. However, the fabricator showed us it was a viable alternative. Everything went smoothly… we’re well satisfied…”

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- Precast, prestressed concrete bridge components are easy to erect, particularly when the tops of the units comprise the entire
deck slab to form an "integral deck" or "full-deck" beam.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- In a full-deck bridge, the formwork of the super-structure is eliminated. Connections between adjacent units often consist of welding matching plates and grouting continuous keyways. Carefully planned details speed the construction process and result in overall economy.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- Substandard bridges are easily replaced with precast prestressed sections. In some cases, existing abutments can be used…

BACK FORWARD

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- …but it may be easier and more economical to build new ones, or to utilize precast abutments and wing walls supported on cast-in-place footings. Because precast concrete integral deck bridges with precast abutments can be erected without delay in cold weather, they can be opened to traffic sooner.

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ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

Fast Construction

- Bridge departments are challenged to maintain traffic flow, minimize traffic interruptions, and reduce or eliminate detours during construction projects.
- This Florida bridge, damaged in a tanker fire, was completely rebuilt and opened to traffic in 18 days.

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ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- The fast construction of precast concrete integral deck bridges is a key advantage. Precast concrete bridges can be installed during all seasons and opened to traffic more rapidly than any other permanent type of bridge, because of the availability of plant-produced sections and the speed of erecting and finishing construction.

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ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

Fast Construction

- Replacing this bridge on
US Route 95 in Idaho illustrates another example of the advantages of very fast construction:
- New Year's Day: Rains and melting snow washed out this bridge over the Little Salmon River linking the northern and southern parts of the state.

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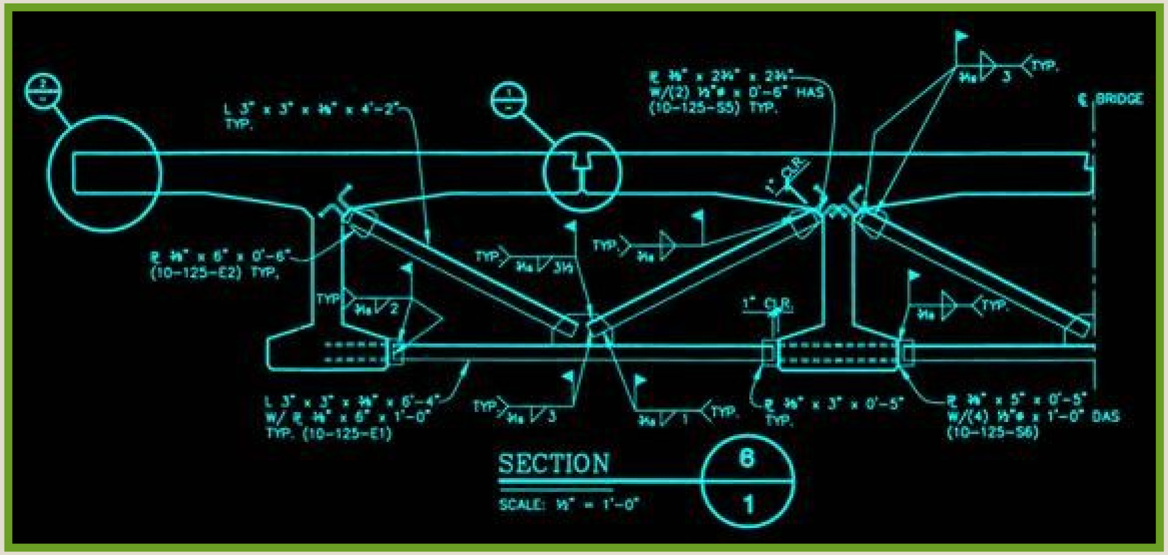
ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction



Fast Construction

- January 4: The Idaho Department of Transportation contacted the precaster to investigate solutions. They determined that the fastest way to replace the three spans was to use a single 80-foot span comprised of bulb-tees with an integral deck. The top flange would be 8-inches thick and 8'-6" wide. The end diaphragms would also be precast onto the girder ends.
- January 8: Engineers in the Bridge Section approved shop drawings and tensioning calculations.

Cost Efficiencies and Speed of Construction

Fast Construction

- January 18: Bulb-tees were shipped 240 miles and set in place…just 17 days after the flood! Included in the shipment was intermediate steel diaphragms, guard rail posts and guard rail…all the components to complete the structure.
- January 25: The project was completed. The bridge was in service just 24 days after the flood!

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

Simple Solution

- As a result of a Winter flood, this single lane bridge on a major forest road was washed out, cutting access to a U.S. highway for a half dozen residents…including one with a senior needing continuing medical care.
- Within only 15 of receiving plans, the precaster had fabricated the 135-foot-long spans with 7’-6”-wide integral decks, and the bridge was opened to traffic 3 days later – 18 days in all.

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ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

Adverse Weather Conditions

- In Ketchikan, Alaska a bridge on the only highway to the north was washed out when an old dam gave way on October 26. Integral deck girders were selected for the 85-ft span. The 12 girders were designed and precast in the state of Washington, then shipped by rail and barge to Alaska. The girders were installed and the bridge was completed and opened to traffic on December 19 - only 54 days after the washout - despite the problems of design, remote location, great distances, and adverse weather conditions during the onset of an Alaskan winter!

BACK FORWARD

Cost Efficiencies and Speed of Construction

Life Cycle Cost =

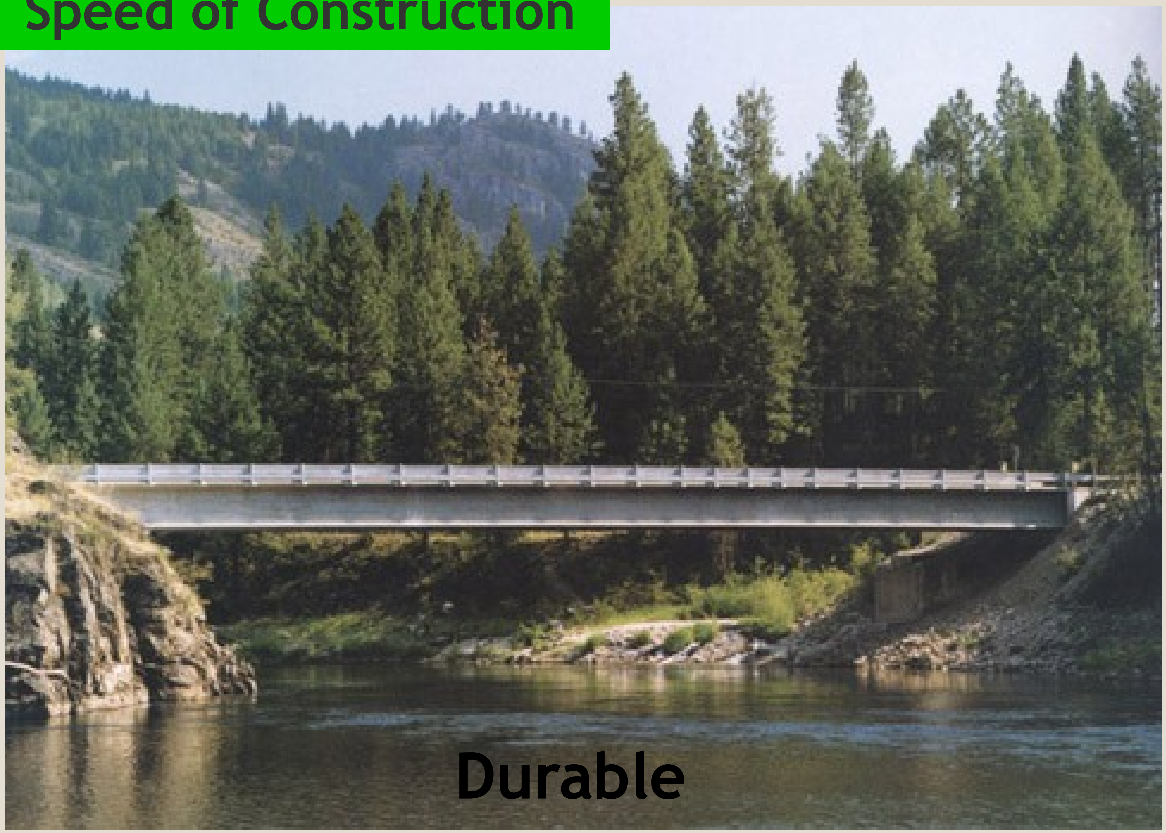
Initial Structure +

Total Operating Costs (Maintenance)

- To accurately compare costs, consider a bridge's life-cycle: The initial cost of the structure must be added to the total operating cost.
- For stationary bridges, the operating cost is the maintenance cost.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction



- The durability of precast prestressed concrete bridges designed and built in accordance with AASHTO or AREMA specifications means there should be little, if any need for maintenance. One of the reasons designers select integral deck prestressed concrete is the durability of the precast, prestressed concrete and the resulting low maintenance requirements.

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ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

- Fatigue problems are nonexistent because only minor net stresses are induced by traffic loads.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

Painting Steel Bridge

- And of course, no painting is needed. Some bridge engineers estimate the life-cycle cost of re-painting steel bridges to be 15 to 25% of the initial cost. Painting bridges is environmentally unfriendly and can be especially dangerous or expensive when done over busy highways, streams, railroad rights-of-way or in rugged terrain.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Cost Efficiencies and Speed of Construction

Minimal Maintenance

- On the Illinois Toll Highway, the superstructures of 224 bridges are precast prestressed concrete beams. These bridges, built during 1957 and 1958, have withstood heavy traffic and severe weathering and yet require very little maintenance. Other projects in all parts of North America have exhibited similar experience - little or no maintenance has been required on precast prestressed concrete bridges.

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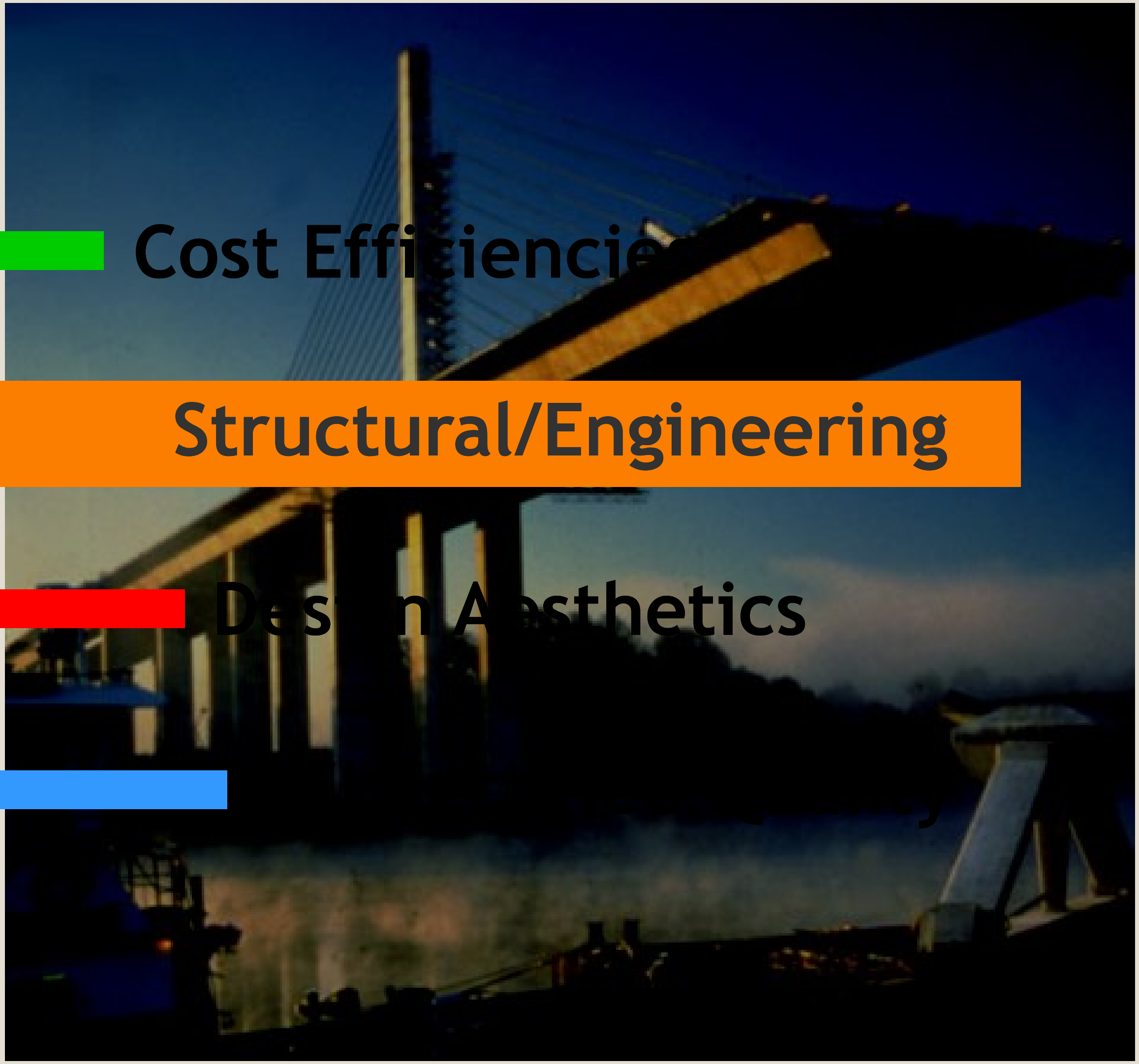
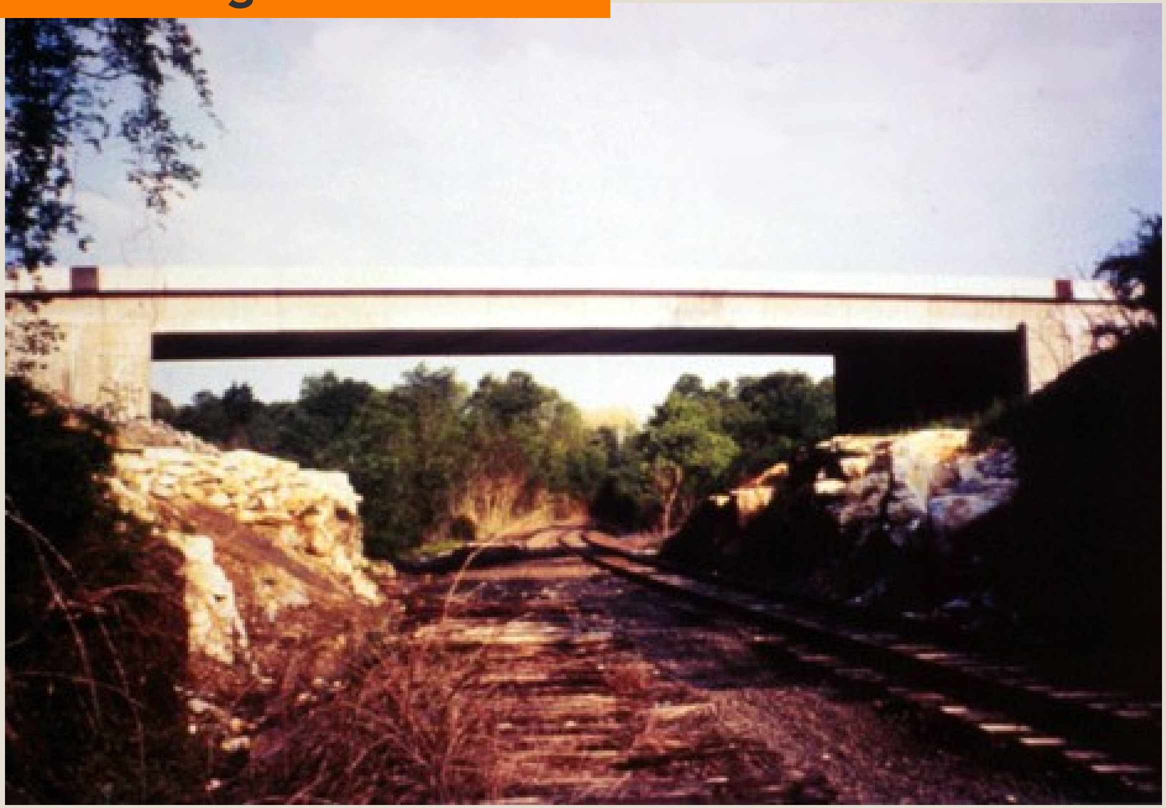
ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES



- Cost Efficiencies
- Structural/Engineering
- Design Aesthetics

- In addition to its cost efficiencies and speed of construction, precast concrete provides important structural and engineering advantages as well.

Structural/Engineering Advantages



Shallow Superstructure

- A common requirement of many bridges is that the superstructure be as shallow as possible in order to provide maximum clearance with minimum approach grades.
- Through the technique of prestressing, the designer can utilize the maximum possible span-to-depth ratio. This superstructure occupies just 13 inches of profile.

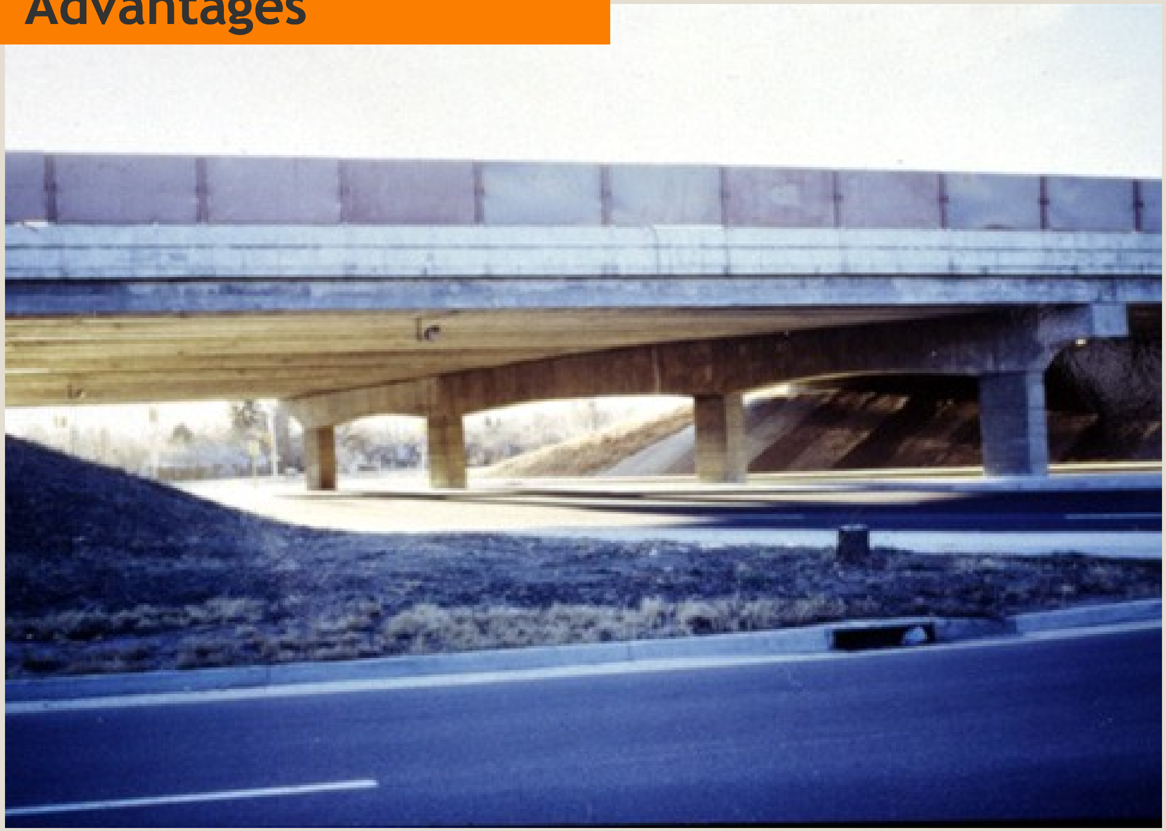
ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Structural/Engineering Advantages

Shallow Superstructure

- Span-to-depth ratios as high as 30:1 can be achieved with solid slabs, voided slabs, box beams, multi-stemmed units, or bulb-tee sections. Even though deeper sections will require less prestressing steel, the overall economy of a project may dictate the highest possible span-to-depth ratio.
- These HPC girders are 4'-6" deep and span 157 ft.
  A span/depth ratio of nearly 35!

Structural/Engineering Advantages



Adaptable to Many Situations

- Precast prestressed concrete integral deck girders were selected to provide a shallow superstructure for a bridge over a busy urban highway in Denver. Even though the bridge must carry frequent heavy truck traffic, the total depth of the girders is only 3 feet, including the 3-inch wearing surface, for a span of 80 feet.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Structural/Engineering Advantages

High Span-to-Depth Ratio

- This bridge illustrates the high span-to-depth ratios possible with integral deck prestressed concrete.

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ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Structural/Engineering Advantages

- Bridges are subjected to an assortment of hostile environments as well as repeated impact loadings. Some must endure intense sun, extreme temperatures and brackish waters. Others must withstand not only the freezing and thawing provided by nature but also the potential for damage through the use of de-icer chemicals. Dense, high strength prestressed concrete has excellent freeze-thaw and chemical resistance.

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ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Structural/Engineering Advantages

Fire Resistance

- Greater fire resistance is another advantage. This timber bridge experienced a dramatic fire…

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Structural/Engineering Advantages

- …it was replaced by a low maintenance prestressed concrete bridge erected without falsework over an environmentally-sensitive area…

Structural/Engineering Advantages

Excellent Riding Characteristics

- Prestressed concrete bridges have excellent riding characteristics that minimize traffic vibrations. The public will not only be safe but also feel secure and comfortable on a prestressed concrete bridge. Traffic vibrations are held to an absolute minimum. The owner will have a structure on which the deck is less likely to crack prematurely. Continuous spans even hold deck joints to a smooth minimum.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

Structural/Engineering Advantages

Excellent Riding Characteristics

- Steel girder bridges frequently exhibit noticeable vibrations. The natural frequency of vibration of these bridges often coincides with the frequencies of traffic and then resonance occurs. Because of their mass and stiffness, the natural frequency of vibration of prestressed girder bridges rarely coincides with the vehicle frequencies. Documented cases show that light bulbs in fixtures installed on steel bridges burn out more rapidly as a result of such vibrations. Reports are surfacing that indicate decks on steel bridges are more prone to cracking and deterioration.

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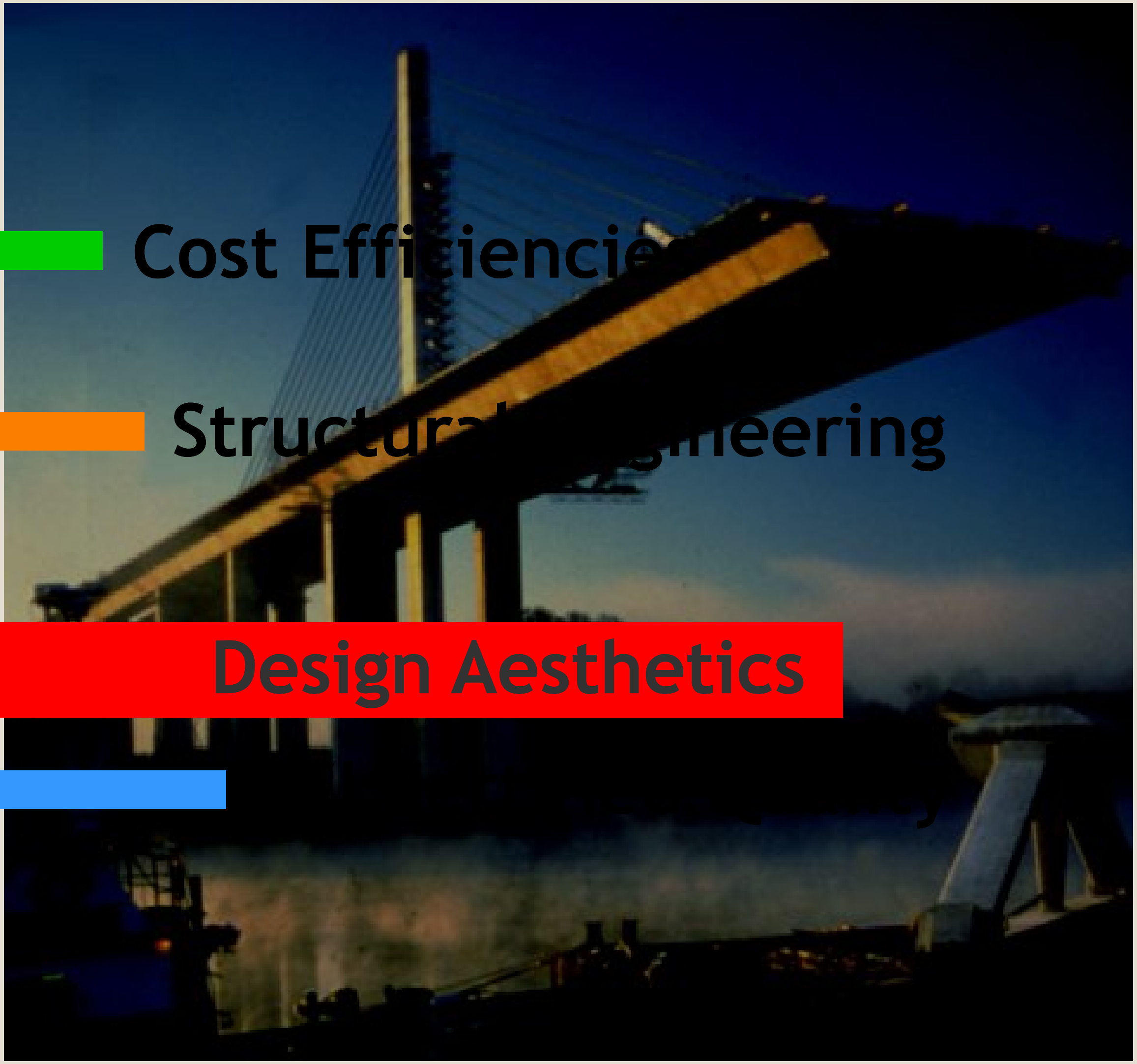
ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES



Cost Efficiencies

Structural Engineering

Design Aesthetics

- The clean, attractive lines of concrete beams also help bridge designers meet the most demanding aesthetic requirements.

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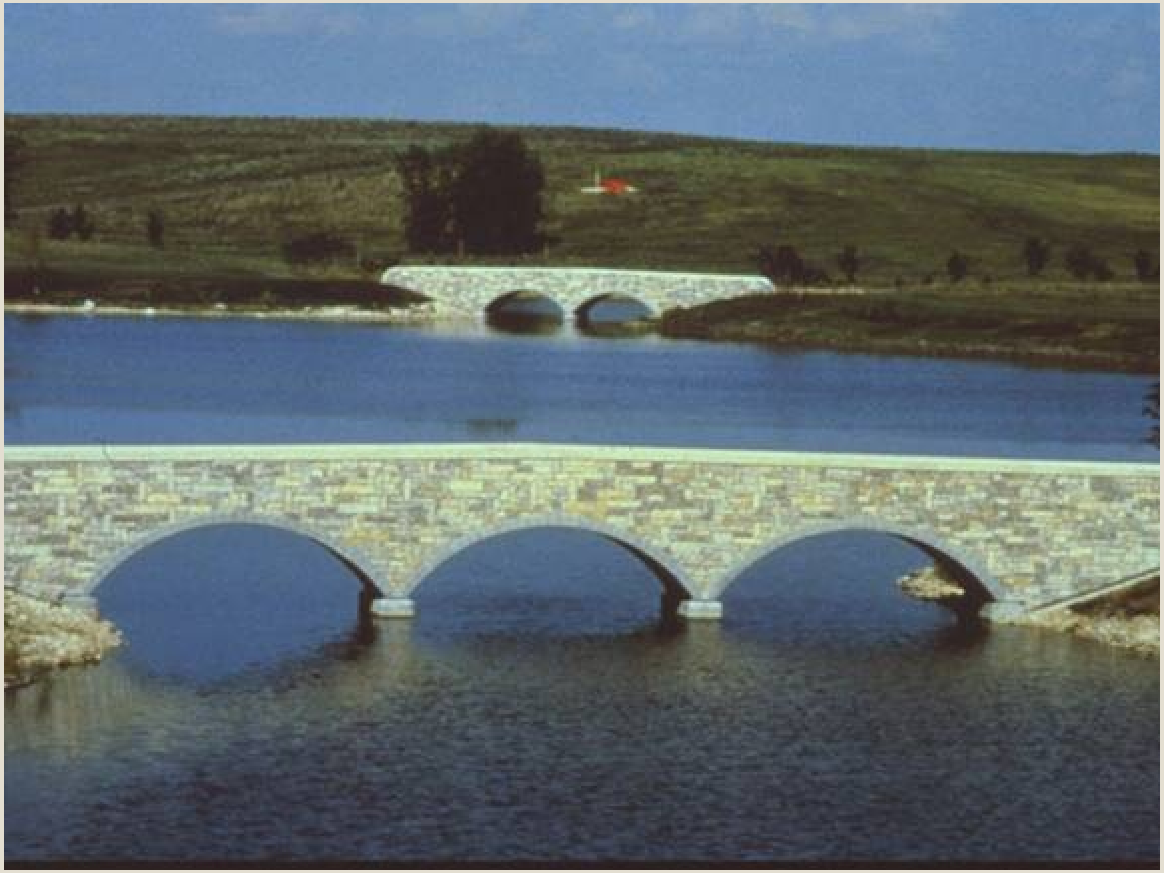
Design Aesthetics



- Prestressed concrete bridges can be attractive from above, below, and from the side because of the simple and clean shapes of the members used. The high span-to-depth ratios made possible through the use of prestressing, result in strong, tough, durable and yet graceful bridges.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

- Cost Efficiencies
- Structural Engineering
- Design Aesthetics
- **PCI Certified Quality**

- Prestressed concrete is efficient because it is a composite of high-strength steel and high-performance concrete. To ensure this efficiency and to comply with exacting project specifications, precasting plants have developed sophisticated quality assurance programs.

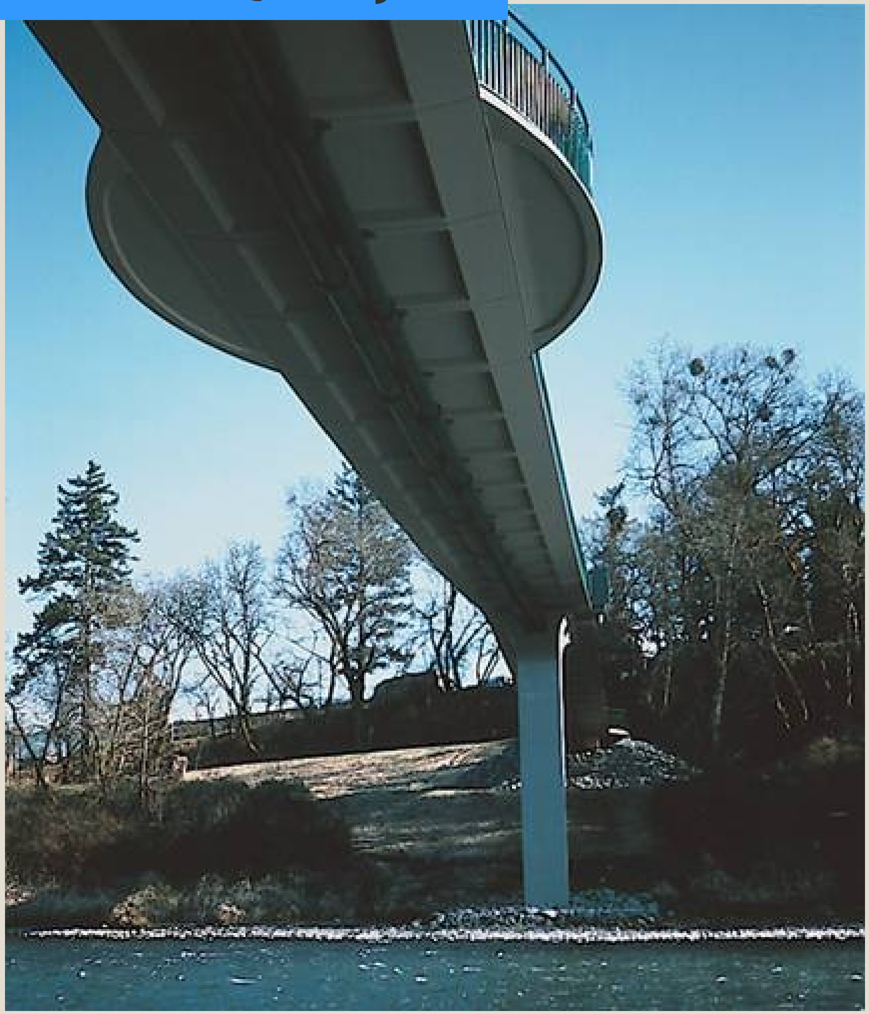
BACK FORWARD

PCI Certified Quality

- Precast, prestressed concrete products are inspected both during and following production.
- In fact, every operation in the manufacturing process provides a point of inspection and control.

ADVANTAGES OF PRESTRESSED BRIDGES -- CASE STUDIES

PCI Certified Quality



- Today’s bridge designs use more high-performance materials and sophisticated solutions than ever before. More and more, engineers are requiring only qualified sources with certified technicians and inspectors.

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PCI Certified Quality

- ✓ Independent Auditors; Unannounced Audits
- ✓ Audits Based on National Standards

•A plant that is PCI-certified tells the engineer five important things:

1. The production facility has demonstrated its capability to produce quality products to the satisfaction of a nationally recognized, independent consulting engineering and inspection firm engaged by PCI for multiple, unannounced annual audits.
2. The rigid audits the plant undergoes are based on published industry standards – the ***PCI Manual for Quality Control for Plants and Production of Precast Structural Concrete***.

PCI Certified Quality

- ✓ Independent Auditors; Unannounced Audits
- ✓ Audits Based on National Standards
- ✓ Documented Quality System
- ✓ Certified Personnel
- ✓ Confirmed Capabilities

- Five important things cont.:
- 3. The plant practices a documented and PCI-approved quality assurance program open for review.
- 4. The plant has PCI-certified QC personnel.
- 5. The producer has PCI *confirmed capabilities*.