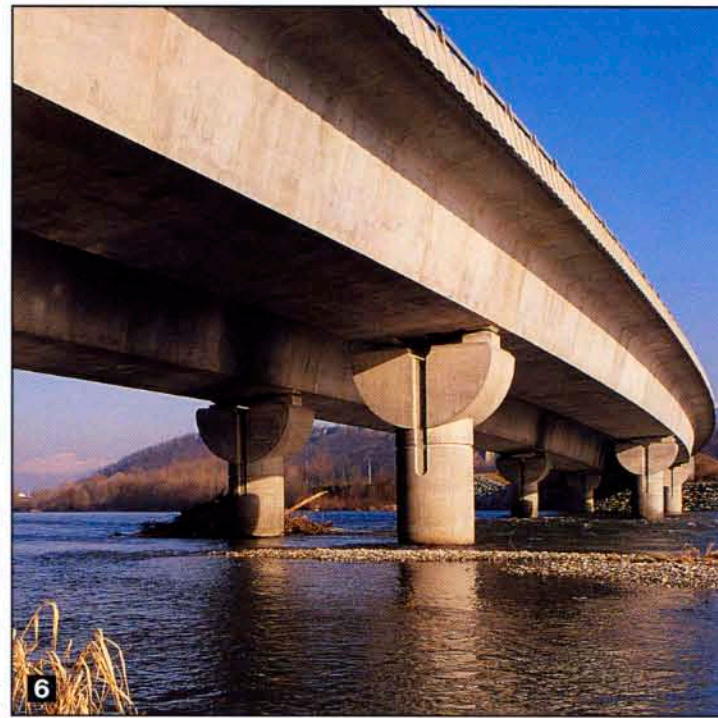


CAD ID COMPO - PRINTED IN FRANCE



- Romulo Betancourt Viaduct (Venezuela) 1
- Segments (worldwide!) 2
- Riverside Viaduct-I (Korea) 3
- Riverside Viaduct-IV (Korea) 4
- Riverside Viaduct-I (Korea) 5
- Francin Viaduct (France) 6

Photographs : Hausvirt - Liesse - Vigouroux  
Campanon Bernard SGE & Freyssinet Photographic Libraries



CONSTRUCTION METHODS  
**SPAN-BY-SPAN CONSTRUCTION**

## Span-by-span construction

At first associated with cantilever construction, prefabrication has initiated the extraordinary progress of another method: Span-by-span construction.

External prestressing, perfected in parallel by Freyssinet, allowed this technique to meet its full potential:

- simpler prefabrication and lighter segments;
- improved quality of prestressing;
- possibility of inspecting and monitoring the structures: reduction of working expenses;
- non-stop supply to the erection site with increased safety;
- great flexibility of use: adjustable alignment and spans of variable length.

To date, this is certainly the most economic and rapid construction method for very long bridges and viaducts with limited spans.



Riverside IV: assembly truss and pier segment

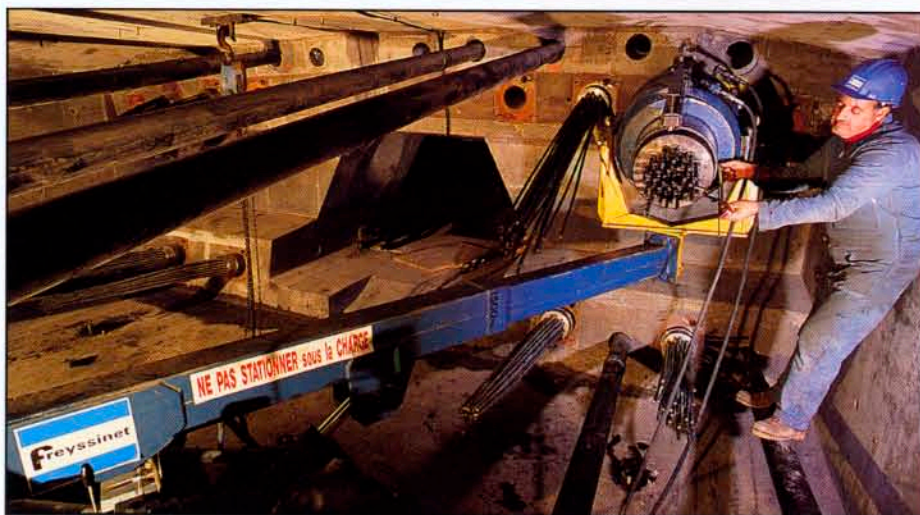
## External prestressing

The advantages resulting from an entirely external, longitudinal prestressing are numerous:

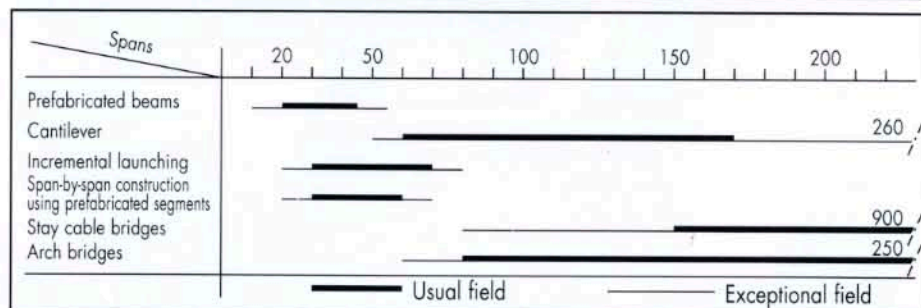
- improvement of concreting conditions;
- improvement of prestressing conditions (installation, grouting);
- possible replacement of prestressing tendons.

Freyssinet implement the following techniques:

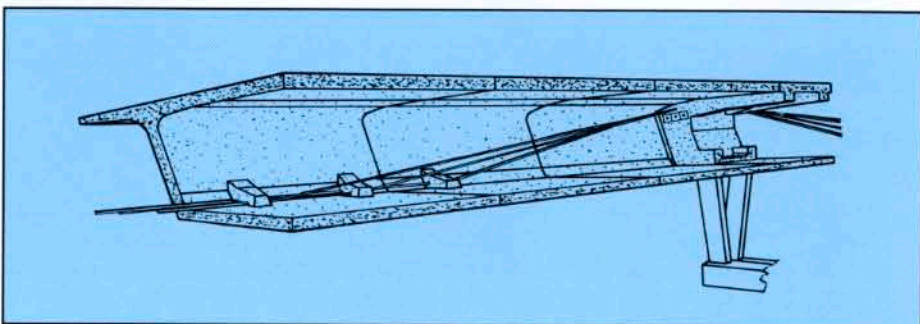
- cement grouted polyethylen tube with a double sheath in the anchoring zones and deviators, permitting the removal of the tendons;
- polyethylen tube grouted with a soft product (petroleum wax): utilisation of bare or galvanized strands;
- cement grouted polyethylen tube with sheathed and greased monostrands, the tensioning being carried out using a monostrand jack.



External prestressing: tensioning operation



Field of application of modern construction methods



External prestressing

## Construction sequence

This technique is based on a very simple concept: construct the deck continuously from one end of the structure to the other, starting from one abutment and carry out a methodic installation of segments, one after the other.

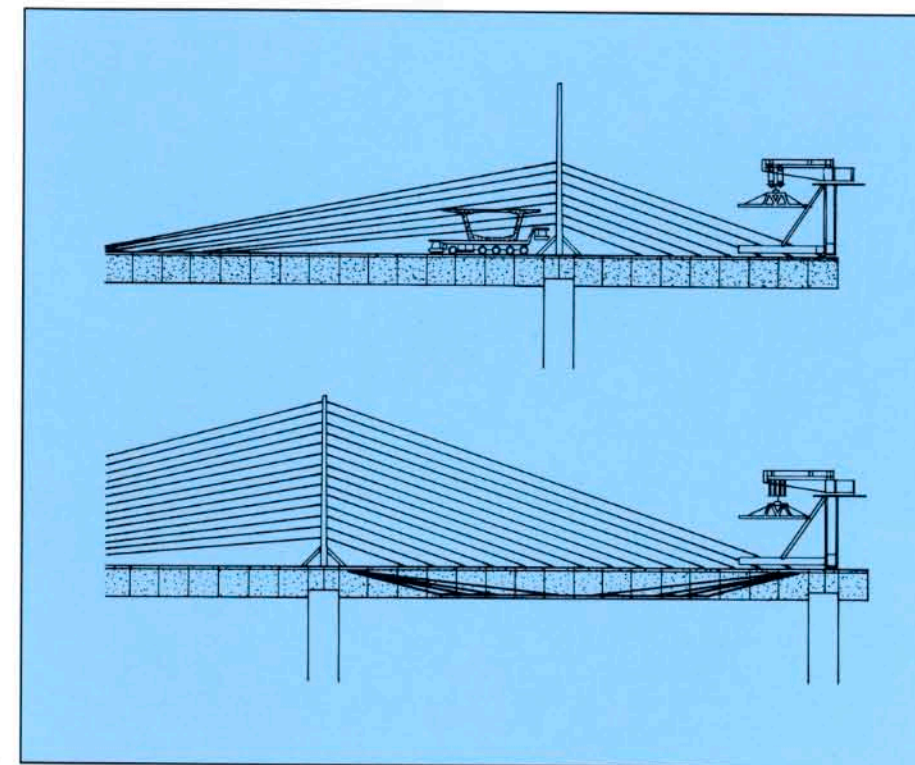
### ■ Temporary staying mast

The segments are transported on the part of the deck that is already built and installed at its extremity using simple handling equipment: gantry crane or swivel crane.

Each segment is then supported by a pair of temporary stay cables, anchored on a mast located at the pier. The longitudinal prestressing is installed after erection of the entire span.

### ■ Assembly truss

The segments are installed over a steel truss, then adjusted prior to being united by prestressing. The truss is then launched to the next span.



Construction with temporary stays

## Span-by-span erection phasing

### ■ Phase I

#### Installation of assembly truss

- 1 Place the erection brackets on the following pier shaft.
- 2 Move the truss to the next span and place it on the erection brackets.

### ■ Phase II

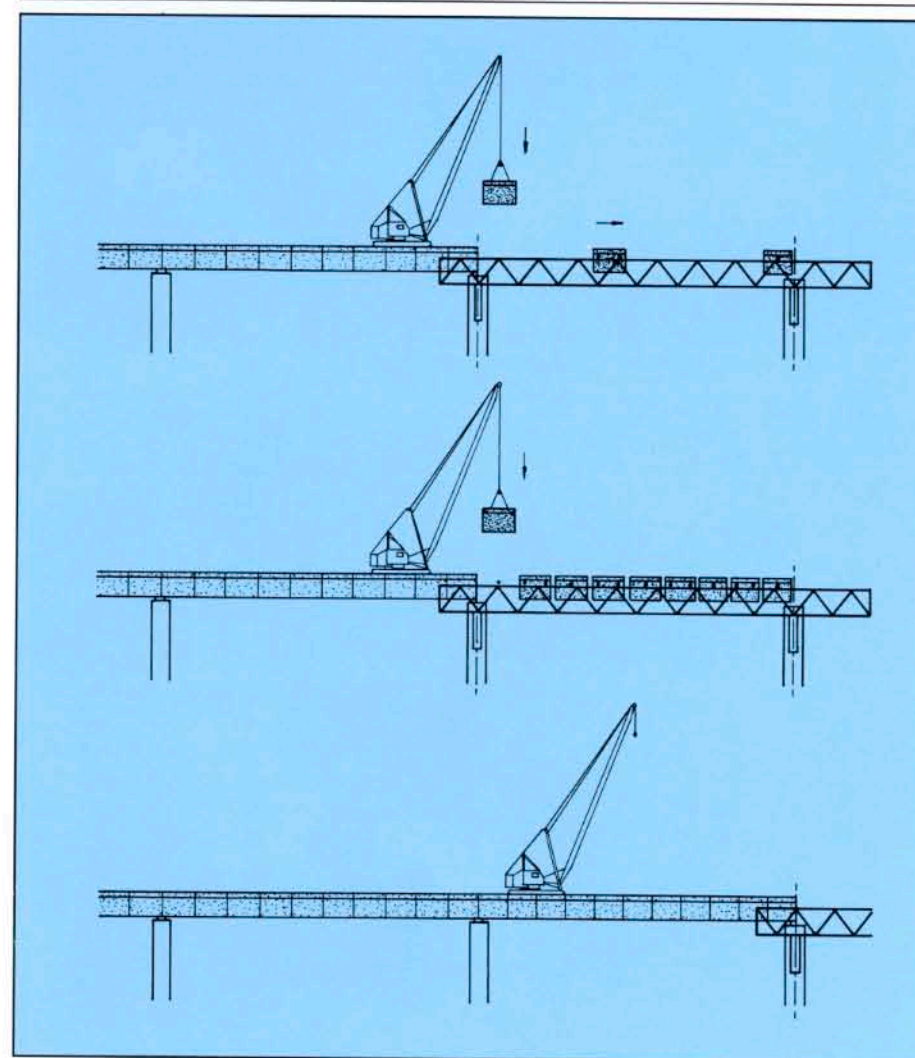
#### Installation of segment

- 1 The segments are transported to their respective span at ground level, either by lorry or barge.
- 2 Sliding pads are placed on the truss.
- 3 The segments are placed onto the sliding pads and slide down the truss to their correct location.
- 4 This phase is repeated until all typical segments are in place.
- 5 The pier segment is installed.

### ■ Phase III

#### Span assembly

- 1 The segments are adjusted on the truss.
- 2 Longitudinal post-tensioning tendons are threaded through the ducts.
- 3 Concrete spacer blocks are installed in the keying joint and a partial post-tensioning force is exerted.
- 4 Closure joints are cast.
- 5 The final longitudinal force is exerted.
- 6 The assembly truss is lowered by means of jacks located on the supports.
- 7 The longitudinal tendons ducts are grouted.
- 8 Phase I, II and III are repeated for each span.



Construction with assembly truss

## ROMULO BETANCOURT VIADUCT

Kempis-Chuspita  
Venezuela

### Characteristics

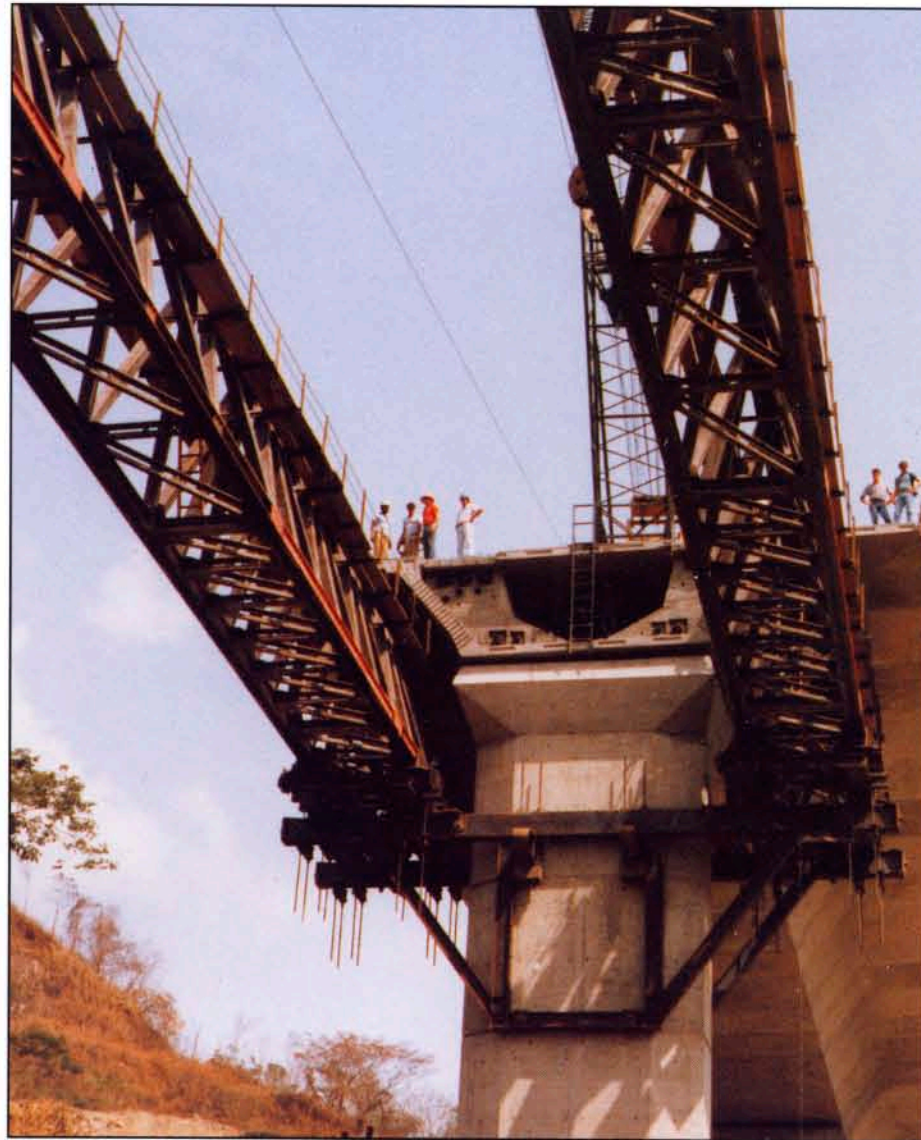
- Deck area: 84,000 m<sup>2</sup>.
- Total length: 5,520 m.
- Span length: 34 to 52 m.
- Total number of spans: 128 units.
- Minimum horizontal radius of curvature: 450 m.
- Number of segments: 1,800 units.  
Maximum weight: 55 t.
- Transverse slope: 0 to 7%.

### ■ Prefabrication cells

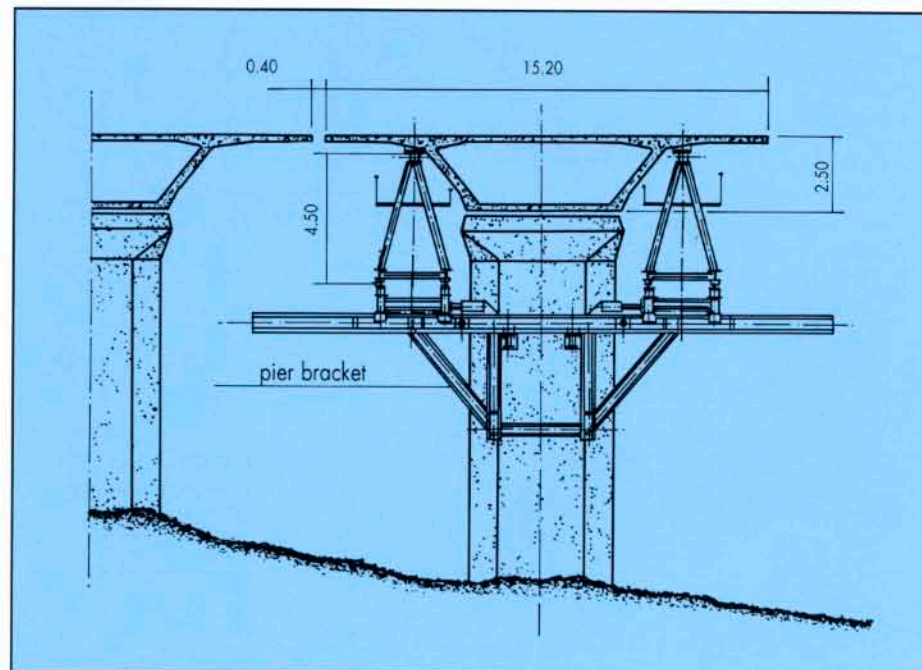
- 8 precasting cells for typical segments.
- 3 precasting cells for pier segments.
- Production schedule:  
1 typical segment per cell per day,  
1 pier segment per cell every 3 days,  
60 segments per week.

### ■ Assembly truss

- Two parallel steel trusses: 89 m long.
- Total weight: 200 t.
- Erection schedule: average of 2 spans per week.



Romulo Betancourt Viaduct: segment placing



Assembly truss and pier brackets

- Client:  
**Ministerio de Transportes y Comunicaciones (Venezuela).**
- Consultant:  
**Jean Muller International.**
- Contractor:  
**Consortium Kempis Chuspita (Ing. Pedro Torrès).**
- Special equipment:  
**Assembly truss, precasting cells: Freysinet.**
- Prestressing:  
**Freysinet.**

## LONG KEY BRIDGE

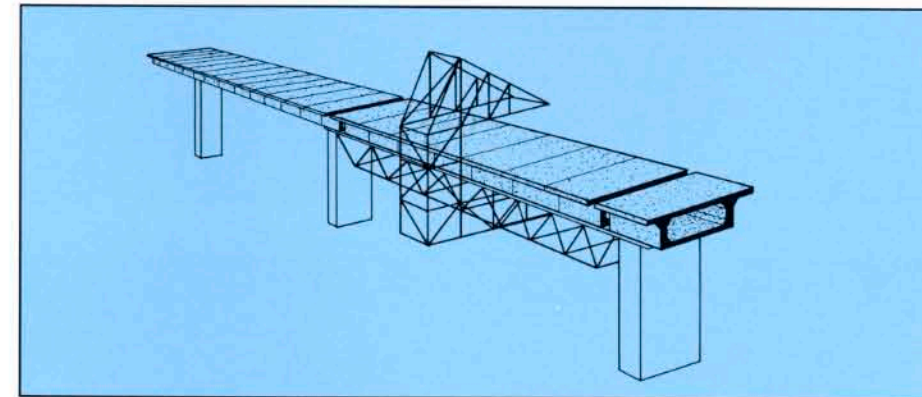
Key West - Florida/USA

### Characteristics

- Deck area: 43,300 m<sup>2</sup>.
- Total length: 3,700 m.
- Spans: 103 x 36 m.
- Number of segments: 722 units.  
Maximum weight: 65 t.
- Erection schedule: 2 spans per week.
- Assembly truss: 95 t.



Long Key Bridge: construction site

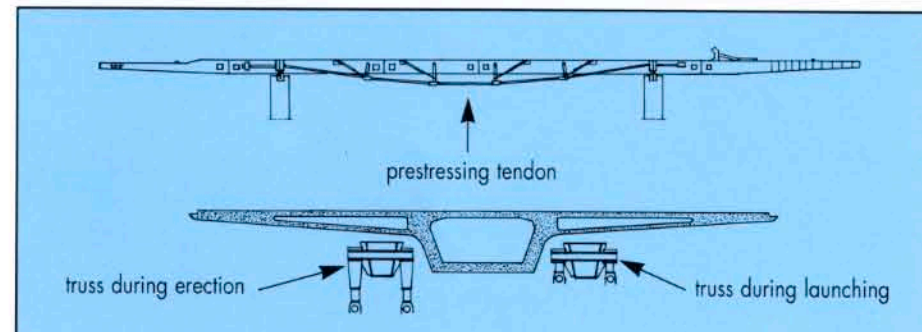


Long Key Bridge assembly truss

- Client:  
**Florida Department of Transportation.**
- Consultant:  
**Figg and Muller Engineers Inc.**
- Contractor :  
**Michael Construction Co.**
- Special equipment design:  
**Assembly truss: Freysinet and The Prescon Corp.**
- Prestressing:  
**Freysinet and The Prescon Corp.**



San Antonio Viaduct assembly truss



San Antonio Viaduct assembly truss

## SAN ANTONIO VIADUCT

San Antonio - Texas/USA

### Characteristics

- Deck area: 52,430 m<sup>2</sup>.
- Total length: 2,700 m.
- Number of segments: 1,853 units.  
Maximum weight: 50 t.
- Spans: 24 to 34 m long.
- Erection schedule: 2 spans per week.

- Client:  
**Texas Department of Transportation.**
- Consultant:  
**Figg and Muller Engineers Inc.**
- Contractor:  
**The Prescon Corporation.**
- Special equipment design:  
**Freysinet for The Prescon Corp.**
- Prestressing:  
**Freysinet and The Prescon Corp.**

## FREBUGE & FRANCCIN BRIDGES

France

### Characteristics

#### ■ Frebuge

- Deck area: 8,560 m<sup>2</sup>.
- Spans: 20 x 49 m.
- Number of segments: 284 units. Maximum weight: 42 t.
- Erection schedule: 1 span every 6 days.

#### ■ Francin

- Deck area: 3,560 m<sup>2</sup>.
- Spans: 8 x 54 m.
- Number of segments: 148 units. Maximum weight: 42 t.
- Erection schedule: 1 span every 8 days.

#### ■ Staying mast

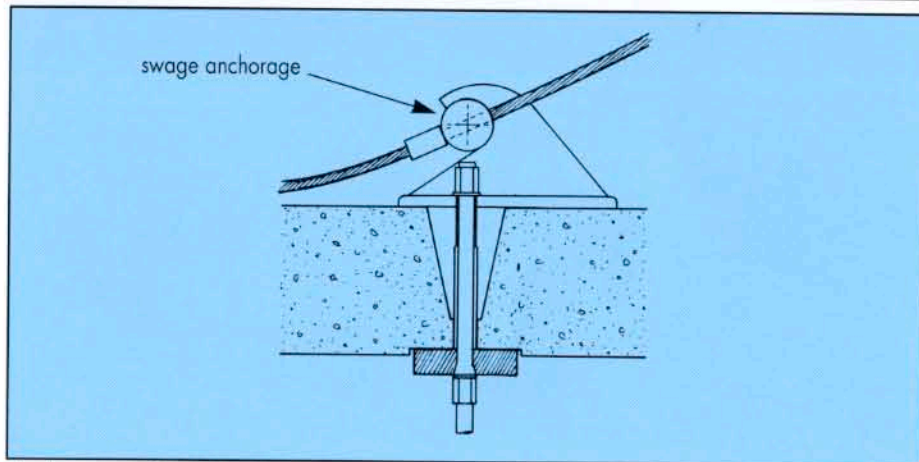
- Height: 23 m.
- Total weight: 95 t.
- Range of application: spans up to 60 m, minimum horizontal radius of curvature: 350 m, transverse slope: 7.2%, maximum segment weight: 50 t.



Frebuge Bridge: staying mast and swivel crane



Francin Bridge: segment placing with swivel crane



Anchorage of temporary stays

- Client: **SAPRR**
- Consultant: **Scetauroute.**
- Final design: **Europe Etudes Gecti.**
- Contractor: **Campenon Bernard.**
- Special equipment design: **Staying mast: Freyssinet.**

## RIVERSIDE VIADUCTS

Seoul - Korea

### Characteristics

#### ■ Riverside I

- Twin parallel decks.
- Deck area: 122,640 m<sup>2</sup>.
- Total length: 3,650 m.
- Spans: 146 x 50 m.
- Number of segments: 2,628 units. Maximum weight: 66 t.

#### ■ Assembly truss

- Twin parallel decks.
- Two 104 m long parallel steel trusses.
- Total weight: 268 t.

#### ■ Riverside IV

- Deck area: 111,000 m<sup>2</sup>.
- Total length: 3,300 m.
- Spans: 132 x 50 m.
- Number of segments: 2,640 units. Maximum weight: 87 t.

#### ■ Assembly truss

- Two 104 m long parallel steel trusses.
- Total weight: 440 t.
- Lifting equipment: 70 t.

#### ■ Riverside I

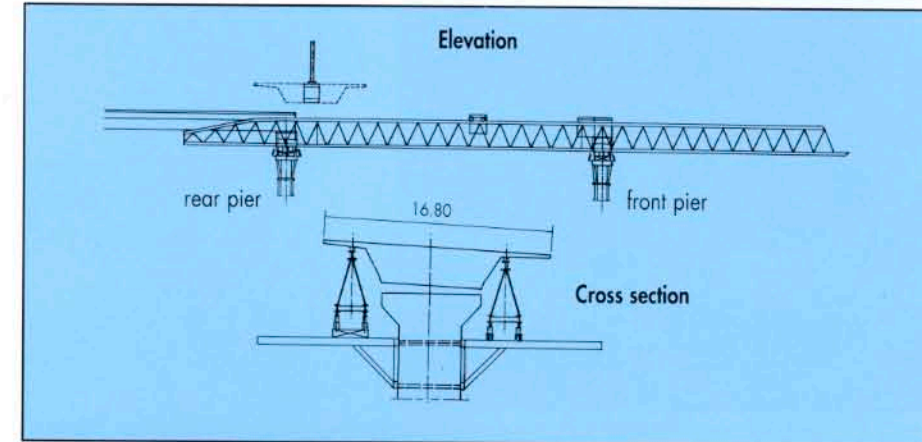
- Client: **Seoul City Municipality.**
- Consultants: **KECC and Europe Etudes Gecti.**
- Contractor: **Nam Kwang Engineering and Construction Co.**
- Construction methods, and special equipment design: **Freyssinet.**

#### ■ Riverside IV

- Client: **Seoul City Municipality.**
- Consultant: **KECC.**
- Contractor: **Hyundai.**
- Construction methods, and special equipment design: **Freyssinet.**
- Deck erection and prestressing: **Freyssinet.**



Riverside I: construction site



Assembly truss



Riverside IV: lifting equipment