Large Scale, High Production Assembly and Erection of Girder Assemblies for the New Tappan Zee Bridge

Tappan Zee Plate Girder Approach Erection

Project Participants:
• Owner – New York State Thruway Authority
• Design/Build Team – Tappan Zee Constructors
  – American Bridge
  – Traylor Brothers
  – Granite Construction
  – Fluor
  – Buckland and Taylor (Main Span)
  – HDR (Approaches)
• Construction Engineering Consultant
  – Zieman Engineering, LLC, Stamford, CT
Tappan Zee Bridge Rendering

Tappan Zee Bridge – Key Plan

- Eastbound and westbound roadway
- Units 1 to 7 and Units 8 to 9 are plate girder spans
- Each unit is a 5 span continuous plate girder
- Each span is approximately 350’ long, each unit 1750’ long
- Units erected by methods in this presentation – units 3 to 8, and portions of units 2 and 9
Typical Roadway Cross Section
- 5 Girders 12’ deep
- Substringers midway between girders
- Girder spacing 21'-0" (westbound) or 18'-9" (eastbound)
- Superelevation up to 6%

Approach Girder Erection Quantities and Duration
- 67 spans on average 350’ long to be erected (4.4 miles)
- 84,000 tons of steel
- 16 month duration of steel erection (not continuous)
- One 350’ span erected per week

To Achieve Production Level Required
- Preassemble spans offsite into two large preassembles per span and erect with large crane
- 135 assemblies required – 2 per week erected
- Average 1200 tons (2,400,000 lbs) steel erected per week
Left Coast Lifter Shear
Leg Crane
- Built by American Bridge for San Francisco/Oakland Bay Bridge
- 1700 metric tonne capacity (3740 kips)
- 100' x 400' barge

Girder Erection Sequence
Preassembly Types

- Two girder assemblies or three girder assemblies
- 410’ long or 350’ long or 290’ long
- Curved or straight girders
- 21’-0” girder spacing or 18’-9” girder spacing
- 24 general types of preassemblies – weights 900 to 2200 kips

All equipment designed for project had to accommodate all different types of preassemblies.

Preassembly Yard
Coeymans Assembly Yard

Location – Coeymans, NY

- 115 miles north of bridge on Hudson River
- Site chosen for truck and water access, flat site, large storage area, minimal dredging, on-site warehouse buildings

Coeymans Assembly Yard

Assembly Line/Float-Out Area
Barge Delivery Slit
Girder Segment Storage
Girder Segment Storage
Assembly Area

Connection Painting, Inspection, Load-Out to Barge
Connection Painting
Electrical Installation
Catwalk/Miscellaneous Installation
Girder/Crossframe Assembly

Assembly Line Stations
Assembly Line Components

- Intermediate Girder Grillages for Assembly
- Tower Crane
- Girder Assembly Support Grillages
- Girder Transporters
- Land Runways
- Trestle Runways
- Winch System
- Barge Grillage
- Straddlecrap Trestle

Girder Assembly

- Girder assembly with straddle crane
- Crossframe assembly with tower crane
- One intermediate grillage per splice location
Girder Support Grillage
- Support grillages are only at runways 260’ apart (2 points along girder length)
- Installed with Girder Transporter
- Adjustable in height 30”
- Allow girder transporter to pass through

Girder Assembly Move to Next Station
Girder Transporter

- Approximately 700 girder assembly moves required
- One bogie per girder – 450 kip capacity each
- 13” synchronized lift using 4 cylinders 8” bore per bogie
- Hydraulically adjustable spacing to accommodate 21’-0” and 18’-9” girder spacing
- On board diesel powered hydraulic power unit, solenoid valves and electric controls
- Each bogie rides on four 24” diameter steel wheel riding on rails
- Pulled along runway using cables and external winch system
Trestle Runway

Winch System to Move Transporter

- Four electric winches with 40,000# line pull
- Each winch equipped with variable frequency drive, line speed and line pull indicator
- Control and coordination of line pull and speed was done by computer based on feedback from the individual winch speed and line pull indicators
Field Erection of Assemblies
Girder Assembly Lifting Frame
- 175’ long x 42’ wide
- Supported on crane with 14” diameter wire rope slings
- Adjustable girder connections to accommodate different types of assemblies
- Hydraulically adjustable to slope frame to match assembly superelevation, longitudinal slope and center of gravity location

Lifting Frame Length Determination
- Deflection analysis at time of girder splice connection
Lifting Frame Structural Design

- 175’ long longitudinal struts required
- These were made primarily with re-used radial struts from the 550’ tall Las Vegas High Roller Ferris wheel erection
- Struts were 7’ square lattice sections
Lifting Frame Slope Adjustment

Slope adjustment was required to align girder splices as accurately as possible. To accomplish this, the rigging had to adjust for the following:

• Superelevation of girder assemblies
• Longitudinal slope of girder assemblies
• Exact location of transverse and longitudinal center of gravity of assemblies
• Deflections of girders within the assemblies
• Deflections of girders that were already erected

Hydraulic Adjustment Rationale

Sloping of the lifting frame was accomplished by changing the length of the lifting slings with a hydraulic mechanism. This provided the following advantages:

• The slope adjustment could be made with the girder assembly hanging from the crane, thus accounting for all deflections and c.g. locations and allowing for direct measurement of the relative splice elevations.
• Based on large rigging component size, adjustments would have otherwise required auxiliary cranes to handle rigging and been very slow.
• The adjustment could be made remotely, thus eliminating the need to bring in a barge to land the lifting frame on. The lifting frame remained on the crane hook.
Hydraulic Adjustment

- Hydraulic power unit (HPU) and controls mounted on shear leg crane barge
- Lifting frame connected to HPU on barge with “umbilical cord”
- All adjustment done immediately after assembly lifted off barge
- After adjustment, umbilical cord was disconnected to erect girder assembly
- All valve controls and transducers on lifting frame were electric and radio remote controlled from barge, thus allowing monitoring of hydraulics after umbilical cord disconnected.
Questions?