Rain-Wind Vibration: Different Approaches at Different Locations

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Parsons Brinckerhoff
Replacement of the Cooper River Bridges
Charleston, South Carolina

Michael J. Abrahams
Cable Stay Span

- Diamond Towers
- Roadway – 200 Feet Above Water
- 1546 Foot Long Span
- Tower Height – 570 Feet
- Longest Span in North and South America
- 140 Feet Wide Section – 8 Traffic Lanes Plus Pedestrian/bicycle Lane
Wind Tunnel Testing
Stay Cable System Features

- Freyssinet Monostrand, Isotension System
- Extensive System Testing Program (PTI)
- Freyssinet on Design – Build Subcontract
- Joint effort PB- Freyssinet - PBC
- Early Stage Parametric Excitation Study
- Early Integration of Damping System
- Provisions for Cross-ties
Strand Erection
Welding of Stay Pipes
Lifting of Stay Pipe
Upper Anchorage Inside Tower
Vibration Suppression Devices

STAY CABLES VIBRATION SUPPRESSION DEVICES
GENERAL ARRANGEMENT

SIDE SPAN

MAIN SPAN

NOTE:
HID: INTERNAL HYDRAULIC DAMPERS HOUSED IN GUIDE TUBE
BIRD: INTERNAL HYDRAULIC DAMPERS DOUBLE CELL HOUSED IN GUIDE TUBE
END: EXTERNAL HYDRAULIC DAMPERS ON STRUCTURAL STEEL FRAME

MAXIMUM STATIC FORCE AT STABILITY CABLE END OF ANCHORAGE IS EQUAL TO 154 KN AT SLS

TOTAL QUANTITY
DAMPER HID: (12+9) x 4 = 64
DAMPER BIRD: (4+5) x 4 = 28
DAMPER END: 4 x 4 = 16
STABILITY CABLES COLLARS 8 x 4 = 24
External Hydraulic Dampers
Internal Hydraulic Dampers
Lateral Supports
Concrete Blocks for Stiffness
Cooper River Bridges
Leonard P. Zakim Bunker Hill Bridge
Central Artery / Tunnel Project
Boston, Massachusetts

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Bridge Elevation
Main Span Superstructure
Back Span Superstructure
Stay Cable

Old Concept

New Concept
Internal Damper
Wind Tie
Required Damping (with Cross-ties)
South Tower Main Stays

- Damping (% critical)
- Logarithmic Decrement (%)
- Cable Length (m)

- IED+ at top and bottom
- IED+ at bottom only
- Damping to avoid rain/wind
- Damping to avoid galloping

- galloping (40 m/s)
- rain/wind
- IED+ at bottom only
- IED+ at top and bottom
Required Damping (with Cross-ties)
North Tower Main Stays

Graph showing damping requirements for North Tower Main Stays with cross-ties, indicating critical damping values and length of cables.
Visco-Elastic Dampers
Cross Tie Connection Overview
Cross Tie Detail

- 3/8" DIA. GALVANIZED FLEXIBLE WIRE ROPE
- CLOSES SWAGE SOCKET
- REPRESENTED AT MIDDLE OF STROKE
- 6" AFTER STRESSING (THEORETICAL VALUE)
- OPEN SWAGE SOCKET
- RAISED IN FIELD SURVEY
- JAM AND JAM TURNBUCKLE 1 1/4x12
- 32.6°
Cross Tie Connection Detail
Section A-A
Load Testing
Holiday Lighting Scheme
Elevation of Cable-Stayed Spans

KENTUCKY

C. ANCHOR PIER
152.44 m

C. TOWER PIER
365.85 m

C. TOWER PIER
152.44 m

INDIANA

M.H.W. EL. 121.03 m
Steel Composite Superstructure
Cable Connection

Note: Deck Slab Not Shown
Tower Head and Cable Connections
Access Inside Tower Head
The Goal of Longevity and Minimum Maintenance Have Been Achieved In Design.
Chao Phraya River Bridge
Southern Outer Bangkok Ring Road Project
Designer: Ruchu Hsu
36.7m Width (4 Lanes Each Way)

941m Total Length
Result of Engineer & Architect Cooperation
Tower & Anchor Pier Construction
Stay Cable

TYPICAL CABLE ASSEMBLY LAYOUT

TYPICAL CABLE CROSS SECTION
Wind Tie Layout and Details
Human Engineering
A User Friendly Bridge for Thailand