Ahsanullah University of Science and Technology
Department of Civil Engineering

Seminar On

Recent Trends in Bridge Engineering: Bangladesh Experience

Speaker 1
Prof. Dr. A. F. M. Saiful Amin
Department of CE, BUET

Chief Guest
Prof. Dr. M. H. Khan
Advisor and Founder VC, AUST

Keynote Speaker
Prof. Dr. Tahsin Reza Hossain
Department of CE, BUET

Special Guest
Prof. Dr. A. M. M. Safiullah
VC, AUST

Speaker 2
Prof. Dr. Md. Anwarul Mustafa
Department of CE, AUST

Chairman
Prof. Dr. Md. Mahmudur Rahman
Head, Department of CE, AUST

Venue: Prof. Dr. M. H. Khan Auditorium, AUST
Date: 13 January, 2016
Sponsored by: Crown Cement
Bridges of Bangladesh: Design, Construction and Challenges

Dr Tahsin Reza Hossain
Professor, Dept of Civil Engg, BUET
Bangladesh is a land of rivers
Bridges are essential for our development

- Two major rivers originated from Himalayas- Ganges and Brahmaputra pass through the country
- Meghna is another major river
- All together 700 rivers in the country
- After 1971, road connectivity improves rapidly through building many bridges
- Particularly in last 25 years, major bridges have been constructed
- We need more bridges for our continuous economic growth
Bridges of this presentation

1. Steel Truss bridge
   Patgati, Sunamganj
   Portable steel bridge-Bailey

2. Prestressed I-girder Bridge

3. Segmental Prestressed Box Girder bridge
   Kalna (Cast in situ),
   MMFP (Precast)

4. Pedestrian Bridge- Arch bridge over Crescent lake

5. Padma Bridge
STEEL TRUSS BRIDGE
PATGATI BRIDGE:
Sheikh Lutfor Rahman Bridge
• River name- Madhumati, Gorai (Gouri)
• Connecting Goplagenj and Bagerhat
• Most spans-Prestressed girder bridge, 48.5m
• Navigation –one 100m span
• Warren type steel truss
• Live load- HS20
Steel Truss: 100m span

- 10 nos 10m bays
- Height = 12m
- Top, bottom chord and diagonal are box sections
- Bracings are I sections
- Cross beams, stringer beams I section
- Analyzed and design checked using software SAP2000
- SAP video
Construction on temporary support from river bed

- 25m 200mm pipe (15m unsupported + 10m embedment)
- Construction Video
Future Beautification: nonstructural

BUET consultants
Dr Khan Mahmud Amanat
Dr Tahsin Reza Hossain
Dr. A.F.M. Saiful Amin

Architect: Ariful Islam
Sunamganj bridge on Surma river

- Span 115 m, similar bridge
- Connecting District HQ with Upazilas
- Difficult to construct in deep rivers (28m+12m)
- 400mm pipe
Steel bridges of Bangladesh

Hardinge railway bridge, Paksey 1910-15
Hardinge bridge,
Paksey, 1910-15
Span = 109m
Bhairab railway bridge, 1937
span - 91.5m
Kean bridge, Sylhet, 1936
Span 75m
Portable steel bridges (PSB), commonly known as Bailey Bridge. Also modular bridge.
Spans are multiple of 10ft (3m)
Span 15-36m

video
Kalna bridge over Madhumati

CAST IN SITU PC BOX GIRDER BRIDGE USING FORM TRAVELER
Kalna bridge

- Modhumoti/Gorai river, on Asian Highway AH1, connecting Kashiani and Lohagora
- Prestressed concrete box girder, 2.4 to 6.6m
- Central span 65+100+65m, navigation requirement
- other spans I-girder, 42.68m
• Live load: HL93 (higher than HS20)
• Analyzed and Designed by CSIBridge and other software
• Cantilever construction using form traveller to avoid scaffolding from river bed
Variable cross section

Single-cell Box at Piers P04 & P05

Single-cell Box at Mid-span & at Piers P03 & P06

BUET consultants
Dr. Khan Mahmud Amanat
Dr. Tahsin Reza Hossain
Dr. A.F.M. Saiful Amin
Cantilever construction

- Travelling form: Each segment cast in situ and prestressed: similar to Meghna, Gumti etc
- Starting from pier to midspan
Other type of construction: Launching girder and Precast segments for Jamuna Bridge

Photo credit: Mr. Kaikobad Hossain
Precast segments
Moghbazar Mouchak Fly-over Project
MMFP

PRESTRESSED I-GIRDER & PRECAST SEGMENTAL BOX GIRDER BRIDGE
Moghbazar Mouchak Flyover
Project: MMFP
Key features: MMFP

- Total length – approx. 8.25 km
- Span length- mostly 25m, 30m, 36m over road crossing, 40m over rail crossing
- Pier size- 2.4m x 2.4m, 3m x 3m, 3.86 x 3m (at expansion joint)
- Live load- HL 93 , AASHTO 2007 LRFD
- Both prestressed I girder and precast segmental Box girders are used
Prestressed I-girder construction: MMFP

- Video

- Difficult on river, temporary support using pipes: Bridge at Kalapara, Patuakhali
Prestressed I-girder construction:
Padma bridge access road Janjira
RC deck-girder is also possible

- Payra Port Access Road
- 25m span, single simply-supported span
- AASHTO LRFD 2007 with HL93 load
- Cast-in-situ construction
Segmental Box sections: MMFP

- Both Single-cell (7.8m wide-two lanes) and Twin-cell (15.6 m wide four lanes) boxes are used
- Mostly Four span continuous modules are used, some 3 spans, 2 spans
- Shock Transmission Unit (STU) are used to transmit the earthquake force in longitudinal direction at sliding bearing locations
- Piers are designed for seismic force which is 15% of gravity load
- Analyzed and Designed using CSI Bridge software and others
Precast segment casting
Twin cell Box segments are ready
Segments are being erected from launching girder
First span ready for prestress
From model to construction
From Bangla Motor towards Mouchak: Single-cell box
BUET consultants
Dr. Sk. Sekender Ali
Dr. AMMT Anwar
Dr. Md Shamsul Hoque
Dr. Bashir Ahmed
Dr. Khan Mahmud Amanat
Dr. Tahsin Reza Hossain
and others
Bridge over Crescent Lake

PEDESTRIAN BRIDGE
Pedestrian bridge

Fig. 1. A three dimensional view of the bridge as per initial architectural design
• Pedestrian bridge over crescent lake
• Span 57.3m: single span
• Steel framed deck with tampered glass panel
• Deck supported by hangers from two shallow arches
• Arches have curvatures in both plan and elevation
• Arches are connected by steel and RC ties
• Arches supported on 90 piles
Load transmission

- Glass deck
- Floor beam/cross girder, steel I section
- Stringer, steel I section (along bridge)
- Box girder at two end
- Pipes from arch supporting the box
- RC Arch resting on pile cap and pile
- RC and steel bracings connect arches
Dynamic Stability is a concern

- Apart from strength, dynamic stability is of concern for this bridge
- **London Millennium bridge had some problems**
- Lateral and vertical stabilities of the deck system and arches are vital
- Fundamental natural frequencies of the bridge are determined in 3D FE analysis to check resonance
- To find the most effective stiffening system to avoid resonance a parametric study is conducted.
Vibration serviceability requirement of pedestrian bridge

- After Millennium bridge problem, BS 5400: part 2 amended the vibration serviceability requirement of pedestrian bridges:
  - Bridge should be stiff enough so that Fundamental Natural Frequency of vibration is greater than
    - 5Hz in vertical direction
    - 1.5Hz in horizontal direction
## Table 1

Different options of arch-deck system considered for eigenvalue analysis

<table>
<thead>
<tr>
<th>Hanger system</th>
<th>Deck width</th>
<th>Deck bracings</th>
<th>Ties between arches at overhead locations</th>
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<tr>
<td>Straight</td>
<td>Inclined</td>
<td>4.27m, 7.9m</td>
<td>Yes, No</td>
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<td>A</td>
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<tr>
<td>E</td>
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## Table 2

Different deck-lake bed tie arrangements trial systems

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<th>Deck-lake bed tie number</th>
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Fig. 3. Finite element model of the footbridge (Option E, Table 1)
Fig. 10. Eigen frequencies determined for different Options and presented against the code requirements.

Crescent lake pedestrian bridge
BUET consultants
Dr. Alamgir Habib
Dr. Shamim Z Bosunia
Dr. Abdul Muqtadir
Dr. Abdul Jabbar Khan
Dr Tahsin Reza Hossain
Dr. A.F.M. Saiful Amin

Architect: Md. Masudur Rahman Khan
Bashat Architects Engineers Ltd
Padma Bridge
Key features: Padma Bridge

- Main bridge- 6.15km
- Viaduct- 3.15km Road, 532m Rail
- Span- 150m, 41 nos, 7 modules (6X6+1x5)
- Warren Type steel truss, 13.6m high
- Railway through, single track dual gauge
- Roadway on RC on upper deck- 22m wide, 4 lane
- Navigational clearance-18.3m
- Total project cost-28,800 Crore BDT (3.69 Billion USD)

video
Pile

- Racked/Batter (1H:6V) steel tubular driven pile
- Pile diameter - 3m
- Pile length - 101-117m
- Pile 60m unsupported
- 6 Nos in each pier, total 40x 6 = 240
Pile: steel tubular driven pile

Padma bridge pile foundation will be the deepest pile foundation of its type in the world.
Pile construction
Pile being driven
Fully fabricated truss will be lifted into place by floating crane
### Table 1. Major river crossings in Bangladesh in order of major span, year of construction, total length, superstructure and foundation type.

<table>
<thead>
<tr>
<th>Geological formation/Canal</th>
<th>Name of bridge</th>
<th>Major span (m)</th>
<th>Year of completion</th>
<th>Total length (m)</th>
<th>Superstructure for longest span</th>
<th>Foundation</th>
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<tr>
<td>Ganges-Brahmaputra-Meghna</td>
<td>Padma Bridge</td>
<td>150.0</td>
<td>-</td>
<td>6150</td>
<td>Steel-composite</td>
<td>CFT⁶</td>
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<td>Lamanaki Bridge</td>
<td>122.0</td>
<td>1984</td>
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<td>Sadipur Bridge</td>
<td>120.0</td>
<td>2000</td>
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<td>Sunamgong Bridge</td>
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<td>403</td>
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<td>Bhairab Road Bridge</td>
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<td>Hardinge Bridge</td>
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<td>Caisson</td>
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<td>Moktarpur Bridge</td>
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<td>Khan Jahan Ali Bridge</td>
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<td>Bangabandhu Jamuna Bridge</td>
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<td>4800</td>
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<td>Bhairab Rail Bridge</td>
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<td>1937</td>
<td>640</td>
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<td>Sultana Kamal Bridge</td>
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<td>1072</td>
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<td>Caisson, bored pile</td>
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<td>Gumti Bridge¹</td>
<td>87.0</td>
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<td>Meghna Bridge²</td>
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<td>Dapapia Bridge</td>
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<td>Keane Bridge</td>
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<td>Buriganga-I Bridge³</td>
<td>72.0</td>
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<td>847</td>
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<td>Kachpur Bridge</td>
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<td>2003</td>
<td>918</td>
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</table>

¹Japan-Bangladesh Friendship Bridge-II, ²Japan-Bangladesh Friendship Bridge-II, ³China-Bangladesh Friendship Bridge-I, ⁴China-Bangladesh Friendship Bridge-V, ⁵Concrete filled tube, ⁶Dismantled


Amin, Okui, Bhuiyan, Ueda (eds.)
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