Incheon Bridge Project

ASCE Structural Engineering Conference - Iowa
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Introduction to Project
Project Location

Incheon
Project Location
Project Details

Cable Stayed Bridge
- 1480m total length
- 800m main span
- 74m high navigation clearance

Approach Bridges
- 1778m total length
- 145m span lengths

Low Level Viaduct
- 8400m total length
- 50m span lengths

Crossing length 12.3 km
Project Details

- **Project Statistics**
  - Total construction cost of €1.1 billion
  - 52 month construction period
  - Completion date of October 2009

- **Contractors Checking Engineer (CCE) Role**
  - CH2M HILL – Arup – Dasan JV
  - CH2M HILL lead consultant
  - Period of service March 2005 to December 2009
Project Organisation

Korean Expressway Corporation (KEC)

Incheon Bridge Company Ltd (Concessionaire)

Samsung Construction Joint Venture (SCJV) (Design and Build Contractor)

Contractors Designers
Seoyeong-Chodai-Cowi

Design Supervisor (DS)
Yooshin-Mott MacDonald

Construction Supervisor (CS)
Yooshin

Contractors Checking Engineer

CH2M HILL (lead)
Arup
Dasan

AMEC (Project Management)

IBC — 51% AMEC and 49% the City of Incheon Joint Venture Samsung, Daelim, Daewoo, Hanjin, Hanwha, Kumho and GS

SCJV — Samsung, Daelim, Daewoo, Hanjin, Hanwha, Kumho and GS

Contractual Relationship

Line of Communication
Construction
Site construction work area activities
Project Location

Construction work area
Site Construction Yard

- Concrete batching plant
- Site offices and staff accommodation
- Reinforcement storage cutting and bending
- Prefabricated pile reinforcement cage storage
- 50m viaduct deck precasting shed (1 unit every 2 days)
- 50m viaduct deck storage and loading area
- Approach Bridge pier-head segment precasting
- CSB pylon precast cross-beams
- Approach Bridge deck precast segment fabrication
Pile Cage Prefabrication

- Pile reinforcement cages fabricated in 12m lengths
- Link reinforcement rolled onto the pile cage
- Up to 3.0m diameter piles
- Accurate assembly allows the use of threaded couplers to join cages
Balanced Cantilever Deck Segments

- Short bed match casting
Viaduct Deck Spans (50m)

- Target 1 span every 2 days
- 3 stage fabrication
  - Reinforcement stage 1
  - Internal formwork + complete reinforcement
  - External formwork + stressing + concreting
- Longitudinally and transversely pre-tensioned
- 1400t each
Construction activities on site
Deep Water Piles

- Piles constructed in up to 25m deep water
- Permanent steel casing to rock level
- Pile diameters between 1.8m and 3.0m
Shallow Water Piles

- 2km long steel temporary access trestle
- Driven steel piles
- Access for construction of piles and cross beams
Pilecaps

- Pilecap precast formwork up to 1650t lifted using 3000t floating crane
- Precast formwork sealed onto steel pile casings - dry working area for fabrication of pilecap reinforcement
- Temporary pilecap working enclosure (upto 70mx25m in plan)
Pilecaps

- Temporary enclosure for pilecap concreting and curing
- Low level viaducts consist of pile bent and in-situ cross beam below deck level
Viaduct Deck

- 1500t viaduct deck units brought out to deep water using 3000t floating crane
- Loaded onto multi-wheel carrier
- Multi-wheel carrier moves deck unit out to launching girder operating in shallow water area inaccessible to floating crane
- Units lifted onto bearings using launching gantry
Viaduct Deck
Viaduct Deck Construction
Viaduct Deck
Approach Bridge Balanced Cantilevers

- Precast pier head segments erected using 3000t floating crane
- Precast deck segments lifted from barges using derrick cranes erected on the cantilever
Approach Bridge Balanced Cantilevers
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Cable Stayed Bridge

- 225m high pylons erected using self-climbing jump formwork
- Backspan erected with 80m long large segments supported on temporary piers
- Mainspan cantilevered out in 15m segments
Pylon Construction

- Precast, post tensioned crossbeams
- In-situ connection to pylon legs
Pylon Construction
Deck Construction - Side Spans
Deck Construction - Main Span
Contractor’s checking engineer
Role of the Contractor’s Checking Engineer

**INPUTS**
- Independent Design Check of the Permanent Works
- Independent Design Review of the Temporary Works
- Review Technical Notes produced by others
- Provide Technical Assistance to the Contractor

**DELIVERABLES**
- Design Check Certificates (DCC) for permanent works
- Design Review Certificates (DRC) for temporary works
- Design Review Certificates (DRC) for technical reports
Role of the Contractor’s Checking Engineer

Design Standards

2 key documents
- Project Performance Requirements (PPR)
  - Written by the Ministry of Construction and Transportation
- Concessionaire’s Supplementary Requirements (CSR)
  - Written by Incheon Bridge Company Ltd (IBC)

AASHTO LRFD (3rd Edition) & Korean Bridge Design Standards
- Interpretation of LRFD required – new document
  - CCE produced many Technical Notes
- Design Manual produced by SCJV
Role of the Contractor’s Checking Engineer

Cable Stayed Bridge Design Check
- 1480m long with 800m main span
- 33.4m wide steel orthotropic deck
- Pylon – reinforced concrete hollow section in diamond configuration
- Design tools – TDV RM2000, Oasys GSA, LARSA
- Fast track design & check – 12 weeks to start of piling
- Interaction with the Designer – agree loads before detailing re-bar
- Wind buffeting analysis, response spectrum seismic analysis
Role of the Contractor’s Checking Engineer

Approach Bridge Design Check
- 145m long spans by balanced cantilever construction
- Built in pier tops – no bearings apart from end spans
- Design tools – LARSA, stage construction & time dependent effects
- REPUTE – non-linear analysis of pile groups in multiple soil strata
- Camber curves checked for casting yard segment alignment
- Sub-structure certified for construction before deck checked

Low Level Viaduct Design Check
- 50m spans built by the span-by-span method
- Pre-tensioned 1400 tonne units erected by floating crane
- Majority of sub-structure on pile bents
- Represented the majority of the crossing
Role of the Contractor’s Checking Engineer

Temporary Works

– Major Temporary Works (MTW)
  • 2km long temporary jetty
  • temporary back span piers for the CSB
  • temporary struts to prop the inclined pylon legs
  • self-launching overhead gantry for the viaduct

– Temporary Works (TW)

– Method Statements (MS)

– Independent design check for MTW’s

– Independent design review for TW’s and MS’s
Role of the Contractor’s Checking Engineer

Technical Reports for Review
- Probabilistic Seismic Hazard Assessment
- Oceanographic Investigations
- Ground Investigations
- Pile Load Tests
- Wind Tunnel Testing
- Ship Impact Protection Test Programme and Results
- Scour Test Report
Role of the Contractor’s Checking Engineer

- 16,700 drawings reviewed
- 140 ‘Design’ and ‘For Construction’ check certificates issued
- 149 review certificates issued
- 40 technical notes issued
Role of the Contractor’s Checking Engineer

- Independent professional verification of design
- Wide ranging international input to design process
- Co-location advantageous
- ‘Fast-track’ partial certification
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