

CH2MHILL®

Incheon Bridge Project

*ASCE Structural Engineering Conference - Iowa
10 November 2014*



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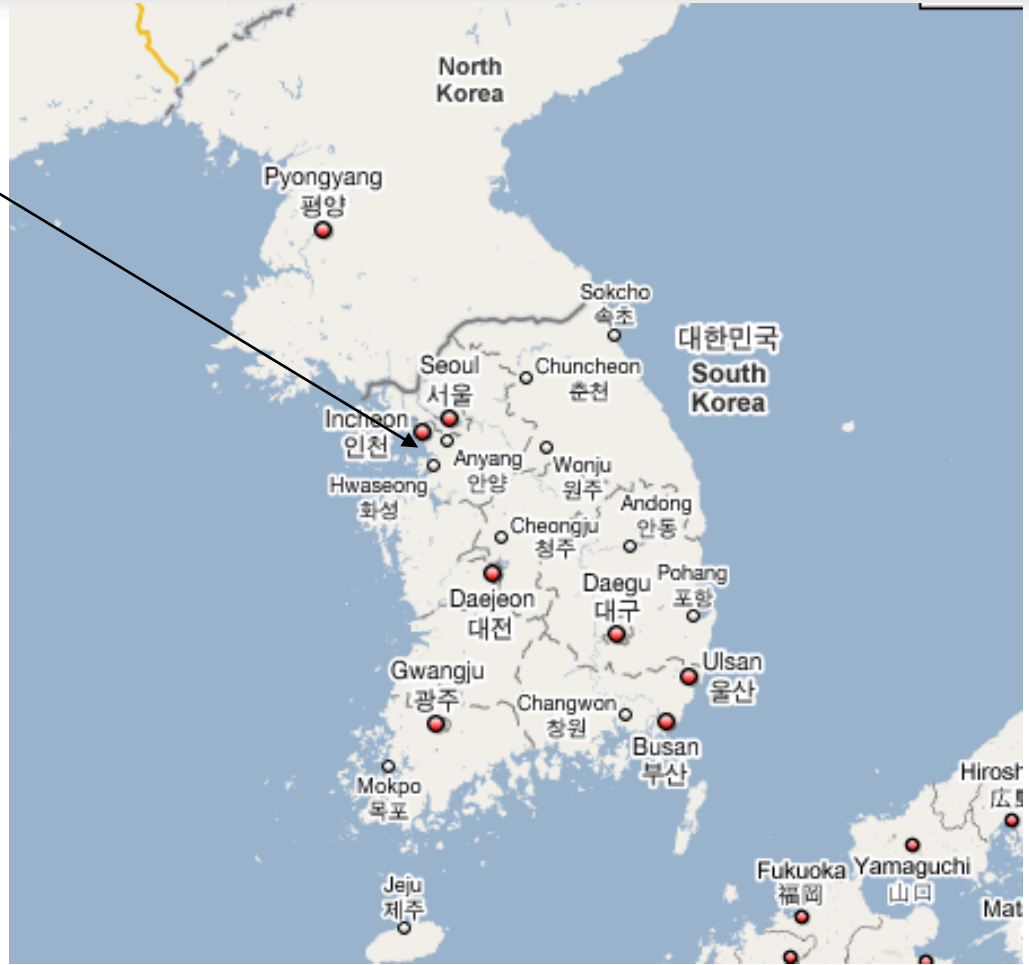
Contents

- Introduction to the Project
- Construction
- Role of the Contractors Checking Engineer (CCE)
- Conclusions

Introduction to Project

Project Location

Incheon



Project Location

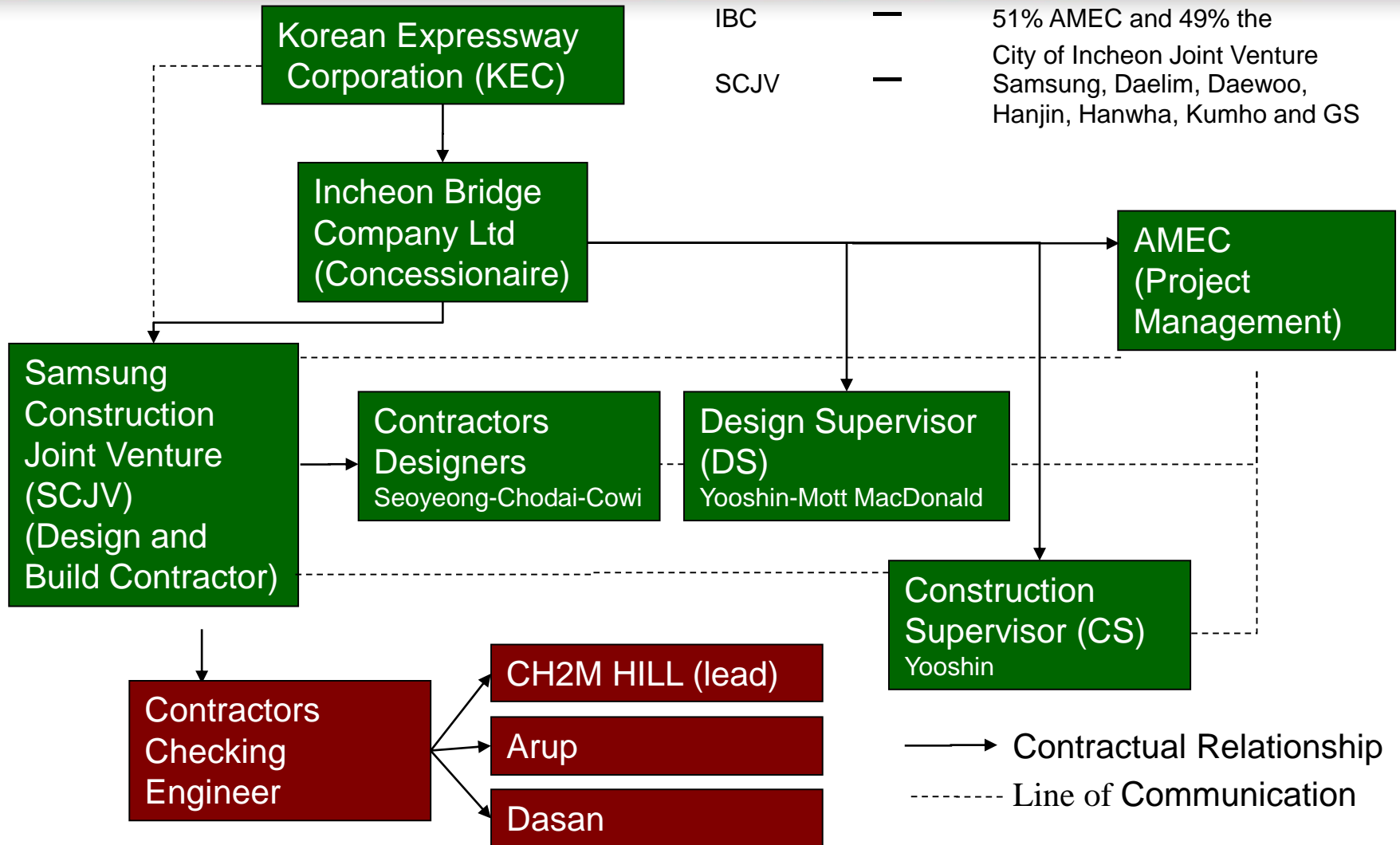


Project Details

- 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



IBC

—

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

SCJV

—

Construction

Site construction work area activities

Project Location



Site Construction Yard

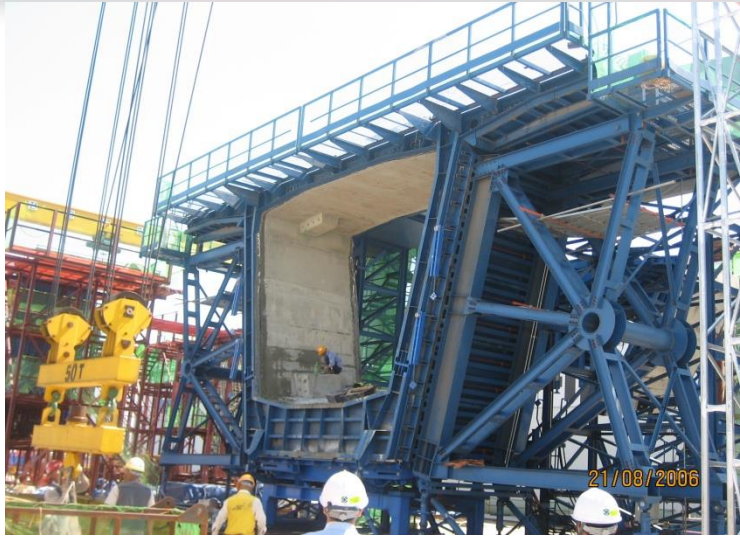


Pile Cage Prefabrication



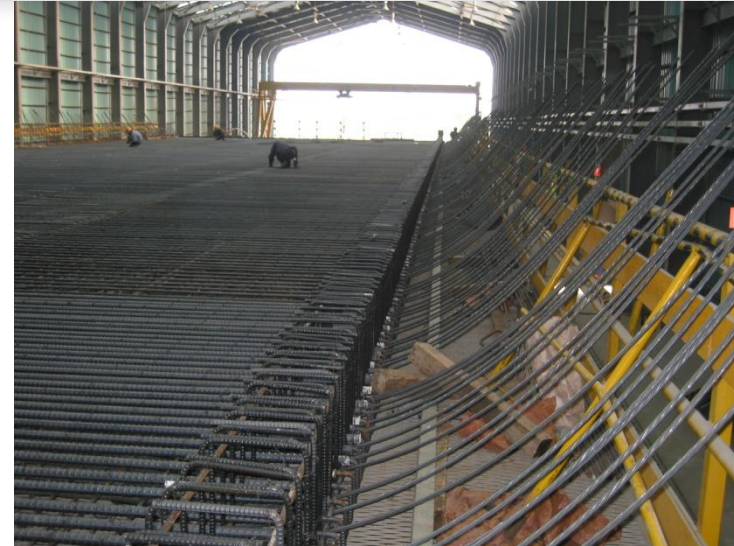
- Pile reinforcement cages fabricated in 12m lengths
- Link reinforcement rolled onto the pile cage
- Up to 3.0m diameter piles
- Accurate assembly allows the use of threaded couplers to join cages

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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Approach Bridge Balanced Cantilevers



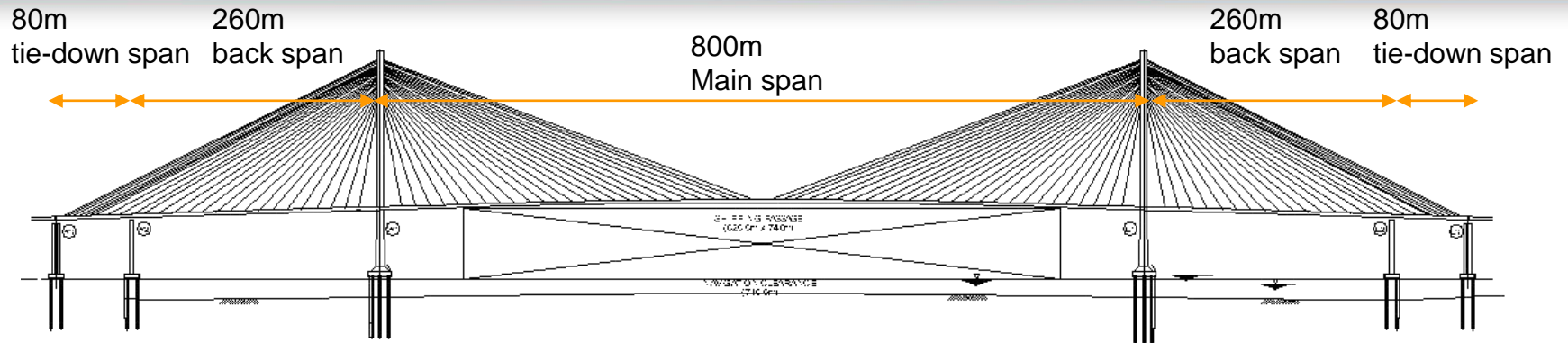
Approach Bridge Balanced Cantilevers



Approach Bridge Balanced Cantilevers



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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