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1. Project Synopsis

1.1 Project Summary: Songdo IBD Development (Int’l Business District)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developer</td>
</tr>
<tr>
<td>NSIC (Share Holdings: Gale International 70.1%, POSCO E&amp;C 29.9%), Established: 2002.3.18</td>
</tr>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Sections 1, 3 of Songdo Int’l City (including part of Sections 2, 4)</td>
</tr>
<tr>
<td>Developing Area</td>
</tr>
<tr>
<td>5,740,000 ㎡ (1.73 million PY)</td>
</tr>
<tr>
<td>Period</td>
</tr>
<tr>
<td>2003 ~ 2014</td>
</tr>
<tr>
<td>Planned Population</td>
</tr>
<tr>
<td>Resident: 61,500 people / 22,660 Residential Units</td>
</tr>
<tr>
<td>Full-time Employee: 264,000 people</td>
</tr>
</tbody>
</table>

Master Plan

<table>
<thead>
<tr>
<th>Section</th>
<th>Site Area</th>
<th>Total Floor Area</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>760,000㎡</td>
<td>4,360,000㎡</td>
<td>40 blocks</td>
</tr>
<tr>
<td>Commercial</td>
<td>160,000㎡</td>
<td>450,000㎡</td>
<td>20 blocks</td>
</tr>
<tr>
<td>Residential</td>
<td>360,000㎡</td>
<td>1,900,000㎡</td>
<td>36 blocks / 14,850 units</td>
</tr>
<tr>
<td>Mixed-use</td>
<td>410,000㎡</td>
<td>1,540,000㎡</td>
<td>7,180 units</td>
</tr>
<tr>
<td>Villa</td>
<td>150,000㎡</td>
<td>50,000㎡</td>
<td>1 building / 151 unit</td>
</tr>
<tr>
<td>Cultural/Educational/Medical</td>
<td>460,000㎡</td>
<td>1,070,000㎡</td>
<td></td>
</tr>
<tr>
<td>Sports/Parks/Others</td>
<td>2,130,000㎡</td>
<td>600,000㎡</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5,740,000㎡</td>
<td>10,200,000㎡</td>
<td></td>
</tr>
</tbody>
</table>

1.2 Songdo IBD Development Project Business Structure

NSIC Structure

Project Structure

Build an World-class Economic Hub of Northeast Asia
1. Project Synopsis

1.3 Project Summary and Characteristics

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
<td>Construction Management of Mixed-use Residential Block 125 of New Songdo International City</td>
</tr>
<tr>
<td>Owner</td>
<td>New Songdo International City Development LLC (NSIC)</td>
</tr>
<tr>
<td>Location</td>
<td># 4-1 Songdo-dong, Yeonsu-gu, Incheon City</td>
</tr>
<tr>
<td>Work Classification</td>
<td>High rise apartments, residential and office buildings, officetel</td>
</tr>
<tr>
<td>Project Scale</td>
<td>2F belowground, 46F 4 buildings, 26F 2 buildings, 17F 4 buildings, 7F retail 2 buildings, total floor area about 530,000㎡</td>
</tr>
<tr>
<td>Project Period</td>
<td>2005.1.30 ~ 2009.1.31</td>
</tr>
<tr>
<td>CM Service Period</td>
<td>2005.4.1 ~ 2009.1.31</td>
</tr>
<tr>
<td>Total Construction Cost</td>
<td>807,044 (million KRW)</td>
</tr>
<tr>
<td>CM Service Cost</td>
<td>22,980 (million KRW)</td>
</tr>
<tr>
<td>CM Terms of Payment</td>
<td>Fixed rate of the construction cost</td>
</tr>
<tr>
<td>CM Procurement Method</td>
<td>Other</td>
</tr>
<tr>
<td>Participation Stage</td>
<td>Design stage, Construction stage, Post-construction stage</td>
</tr>
</tbody>
</table>

Project Characteristics

- Forefront Pioneer Project in Songdo IBD
- The highest (225m) and largest pure RC structure building in Korea
- Cutting edge technologies such as TLCD, RC Outrigger, GFRC*, water-cooled air conditioning and etc. which were rare in Korea.
- Targeting LEED certified of US Green Building Council (LEED NC 2.2)

2. NSIC Project Management System


**CM Contract**

- **Contract background**
  - POSCO E&C was in charge of both CM and main contractor.
  - Draw a reasonable construction cost to satisfy both owner and contractor.
  - Based on the international standard contract
  - Fast Track construction type

- **Review the standard contract of USA**
  - AIA A212 CMc: CM as Constructor, CPF-Guaranteed Maximum Price
  - AIA B801 CMa: CM as Advisor ▶ Assented and applied
  - AIA A101 & A201: Traditional Lumpsum Contract, Amended CPF-Lumpsum Contract

- **US AIA standard forms of contract**
  - Reviewed and proposed the AIA standard contract for CM and construction.
  - Construction contract: based on standard of AIA A101 & A201
  - CM contract: based on standard of AIA Document B811CMa

**Proposed Organization: the Int'l Project Type**

- Owner: Direct contractual relationship with CM, Designer, Consultants
- Contractor: Construction work within scope of contract
- Design Team: AIA A101, A201, AIA B801, LEED, TLCD
- Consultants: US, Korea
- Consultant: Provide technical support for specialized areas
- Contractor: Control the project teams on an owner's side and manage overall project

*GFRC*: Glass Fiber Reinforced Concrete
*TLCD*: Total Loading Control Design
*LEED*: Leadership in Energy and Environmental Design
*CM*: Construction Manager
*POSCO E&C*: POSCO Engineering & Construction
2. NSIC Project Management System

2.2. Roles & Responsibilities Matrix (based on differences from local residential PJT) ▶ Applied thru Songdo projects

- **Owner**
  - Official contracting party with each party
  - Final decision maker for important matters
  - Business plan, Project financing, Project overall management (weakens contractor’s power)

- **CM**
  - Review/comment on design at each phase, lead VE
  - Estimation of construction costs at each phase, Integrated management of design and cost
  - Review/comment on Owner’s contracts
  - Coordinate overall decision making

- **Design**
  - Actual review/approve of contractor’s submittals (Total 432)
  - Review of design stage by design team, (NCR total 50)
  - Actual review and approve of contractor’s RFDC
  - Provide clear information on unclear design issues (RFI total: 309)

- **QS**
  - Cost management for owner
  - Estimation of monthly payment
  - Cost management when design change is occurred
  - Finalize administrative procedures according to legal requirements based on fixed lump-sum (disadvantages imposed for arbitrary works without permission)

- **Contractor**
  - Final decision maker for important matters
  - Business plan, Project Financing, Project overall management (weaken contractor’s power)

- **Construction Supervisor**
  - Suggest limited opinion for duplicated works
  - Estimation of construction costs at each phase, Integrated management of design and cost
  - Review Owner’s contracts
  - Coordinate overall decision making (Total 432)
  - Finalize administrative procedures according to legal requirements

---

2. NSIC Project Management System

2.3. CM Work Scope Proposal (Based on the contract) ▶ Applied thru Songdo projects

### Pre-construction stage

**Project Management**
- Review the owner’s programme and requirements (schedule, budget, etc.)
- Support owner’s legal/statutory/planning requirements or constraints
- Develop a communication tool

**Design Management**
- Review the design at each stage and suggest the optimum idea (building system, method of construction, material selection, etc.)
- Value engineering
- Manage design process

**Cost Management**
- Draw up project cost plan and future cash flow
- Estimate practical construction costs at each design stage
- Analyze the cost of design alternatives

**Time Management**
- Make project schedule and update periodically
- Suggest the optimum project schedule analysis

### Construction stage

**Project Management**
- Establish and control construction progress procedures
- Construction administration and management
- Operation and maintenance of IWES
- Administrative management for contractor’s roles and responsibilities
- Design changes review, consultation of contractor’s proposals, advice

**Design Management**
- Review the design and suggest the optimum alternative
- Value engineering
- Design processes management

**Cost Management**
- Monitor the approved estimate of cost
- Suggest an excess over the estimates
- Revise monthly payments and the final payment

**Time Management**
- Establish and update the project master schedule
- Analyze the project progress and establish a catch-up plan

**Quality Management**
- Mediate and manage approval of contractor’s submittals
- Impact on quality teams and direct necessary corrective actions
3. Project Management

3.1. Performance of CM (Work Scope)

- POSCO E&C was delegated authority by owner
- Managed whole project teams (CM, Design Team, Consultants, Q/S, Contractor, etc.)
- Managed project progress to meet owner’s needs
- To meet the owner’s needs of construction engineering
  ▶ Employed outside services in addition to in-house employees for the extra engineering services
  ▶ Alliance team of POSCO E&C and Hanmiparsons comprised of engineers on each sector showed the great performance.
  ▶ Provided support as a CM Manager
  ▶ Technical review at design stage, design changes review, schedule management, quality management, etc.

Cost Management
- General Manager 1
- Assistant Manager 1
- Engineer 1

Design Management
- Deputy General Manager 1
- Section Manager 1
- Engineer 1

Engineering
- Arch. 2 (POSCO 1, Hanmi 2)
- Civ. 2 (POSCO 1, Hanmi 1)
- Sch. 2 (POSCO 1, Hanmi 1)
- Mach. 2 (POSCO 1, Hanmi 1)
- Elec. 2 (POSCO 1, Hanmi 1)
- Land. 1 (POSCO 2)

3. Project Management

3.2. Establishing Critical Project Control Point

<table>
<thead>
<tr>
<th>Critical Control Point</th>
<th>Project Characteristic</th>
<th>Management Solution</th>
<th>Anticipated Effect</th>
</tr>
</thead>
</table>
| Applying international CM process/level due to overseas client | Client NSC: Foreign Company | Applying international CM process/level due to overseas client | ▪ Contribute to whole development by successful completion of forefront pioneer project  
▪ The great model case for following projects |
| Localising world-class int’l design | Design Development: International overseas designers  
Construction Document: Local designers | Maintain initial design intent  
Provisioning construction design to fit local condition | |
| Managing project participants’ decision making | Designer observed responsibility of main design issues (Applied international standard):  
Designer’s Construction Administration: continuously checking a construction fidelity | Managing decision making to fulfill owner’s and designer’s intent | |
| Finding and applying new technology/new method of construction | Applied cutting-edge technologies such as TLCD, R/R Outrigger, GRC*, water-cooled ducted system and etc. | Reducing obstacles: applying new techniques/new method of construction | |
| Completion within budget and time | Managing design costs, construction costs, etc. within owner’s planned budget | Design & Cost integrated management at design stage  
(maintenance cost forecast/analysis, etc.)  
Minimizing an additional cost such as design changes at construction stage | |
3. Project Management

3.3. Application of Project Management System

Responsibility Assignment Matrix

- Vested authority and responsibility in each team based on their contracts with an owner (Delegated an owner/contractor's authority/responsibility)
- Complied to RAM thoroughly (disadvantages when against RAM → reducing contractor's authority)

Standard Work Procedure

- Increased work efficiency by formulating agreed work procedures, duration of participate organization
- Total 4 times revision (through PMIS)
- This project's standard work procedure was applied to all following Songdo projects

Coordinate/Support Construction Administration

- Managed/control a series of procedures for construction to reflect design intent fully
- Made Submittal register & Packaging log (Total: 432)
- Managed submittal item

Establishing PMS for managing communication

- Plan, establishment and operation of PMS: developed for multinational participants' communication from a project manager's viewpoint (POSCO E&C CM leaded a development)
- Improved work efficiency by applying PMIS to whole IBD projects
- System Summary
  - Site Information – Project Info., Web Cam, Organization Chart, Weather Forecast
  - Documents Management – Letter, Mail, RFS, Transmittal, RFSDC, Change Order, CCD, NCR, DIN, SCAR, FS, DOS, Punch List
  - Design Management – Drawings, Specifications, Materials
  - Data Management – Databank, Web Hard
  - Cost Management – Public Cost, Private Cost
  - Time Management – Summary, Master Schedule, Bi-weekly Progress, Daily Report, Photo

Letterhead

POSOC WAY
3. Project Management

3.3. Application of Project Management System

Periodical Meeting and Reporting

- Periodic Meeting
  - Bi-weekly Meeting: Discussion for project main issues
  - Design Coordination Meeting & LEED Meeting: Discussion for each specialty section

- Periodic Reports
  - Bi-weekly Progress Report
  - Current Status of Issue Report
  - PM Report
  - CM Monthly Report

Construction Closeout

- Provided a guideline for contractor to close a project as by an owner wanted
- Criteria for construction completion and final estimation
- contract closeout checklist
- Project Closeout Checklist
- Project Financial Report
- Inspection
- O&M Manual

Design Review at Each Stage

- With participation of local and intl architects and consultants including KPF (US) in charge of basic design and architectural design, foreign consultants such as Cosentini (US), Weidlinger (US), Towers Golde (US), TTE (US), ALT (Philippines), and VOA (US) and Kunwon in charge of CD and approval and permit, and other local designers such as Woowon, Daeil, Ungdo, Saekil and Kyowoo, it took a long time to develop the design.

- Design review was a top priority to optimize degree of completeness by design stages owing to the characteristics of the project that the basic design was made by overseas architect and the domestic architects localized it.

Design change management

- Design changes - defined as amendment or change of technical requirements specified in the approved design document or the changed document
- Feasibility and applicability of the amended or changed documents and the impacts on the construction period and cost were comprehensively reviewed and managed.
- In particular, LEED was being pursued when construction was in full swing.
  ▶ A factor that made project design change management more difficult
  ▶ Coordinated and managed owner’s LEED consultants and designers, QS and contractor positively
  ▶ Applied LEED in a limited time

Design change management process

- Design changes occurred during construction
  ▶ Contractor or designer propose the request for design change through PMIS.
- When a design change is requested,
  ▶ CM nominates the relevant consultant who was to make a feasibility study on the proposed contents
  ▶ CM puts together various contents of review to give technical support for PM’s reasonable decision-making.
- Changes in construction cost and/or construction period
  ▶ Reflected to the contract through Change Order (C/O)
4. Project Cost Management

4.1. Summary

Design & Cost Integrated Management to complete the project within the owner's budget and time

- Most of project cost consists of construction hard & soft cost.
- Construction hard cost consists of contract construction cost and preliminary.
- Construction soft cost consists of consultant’s service fee such as CM, QS, CS, Design and others.
- Critical Control Point: Construction hard cost & soft cost
- Management Plan:
  - Pre-construction stage (D & C Integrated Management)
  - Construction stage (Contract Integrated Management)

4.2. Construction Hard Cost

4.2.1 Design & Cost Integrated Management at Pre-Construction Stage

<table>
<thead>
<tr>
<th>Design Stage</th>
<th>Design Review</th>
<th>Estimation Level</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schematic design</td>
<td>Yes Focusing on marketability in Korea housing market</td>
<td>-</td>
<td>Finalising DPR (Owner’s Project Requirement)</td>
</tr>
<tr>
<td>Concept design</td>
<td>Yes Reflecting contents of deliberation and finalising basic drawing</td>
<td>Basic</td>
<td>Finalising BOD (Basis of Design)</td>
</tr>
<tr>
<td>Design development 10%</td>
<td>Yes Checking reflection of negotiated changes</td>
<td>Basic</td>
<td>Continuation documents developing</td>
</tr>
<tr>
<td>Design development 75%</td>
<td>Yes Coordinating interference btw different parts</td>
<td>Basic</td>
<td>Increasing perfection of documents</td>
</tr>
<tr>
<td>Design development 100%</td>
<td>Yes Adjusting the perfection as a contract document</td>
<td>Basic</td>
<td>Finalising contract document</td>
</tr>
<tr>
<td>Document for Project Approval</td>
<td>Yes Coincidence with CD and local code as a contract document</td>
<td>Basic</td>
<td>Finalising contract document</td>
</tr>
<tr>
<td>Construction document 90%</td>
<td>Yes Coincidence with CD and owner’s requirements</td>
<td>Partially</td>
<td>Setting up target budget for undefined items</td>
</tr>
<tr>
<td>Construction document 100%</td>
<td>Yes Issues that wasn’t detailed due to the budget link</td>
<td>-</td>
<td>Finalising construction document and EAC</td>
</tr>
</tbody>
</table>

* Remaining design management items after binding a contract

Outstanding Design Issues
- TMD system
- Ubiquitous healthcare system
- Gymnasium
- Steel frame outrigger & belt truss
- Elevator spec down
- Mat concrete thickness
- Additional sheathing & excavation
- Link beam
- Concrete & Re-bar

Schematic design
- Concept design
- Design development 10%
- Design development 75%
- Design development 100%
- Document for Project Approval

Construction document 90%
- Construction document 100%
### 4. Project Cost Management

#### 4.2. Construction Hard Cost

##### 4.2.2 Understanding Construction Contract

**Summary**

- **Type**: Firmly Fixed Lump Sum
- **Basis Document**: DD100%, Project Approbation Document, Assumption

**Contract General**

- Based on a domestic standard contract, however, derived a part of design, contract, construction progress and payment management from AIA.

- **Contract, Design Change**
  - As a fixed L/S based on a contract document, later changes are approved as a design change.
  - As a contract as of DD 100% stage was not detailed as much as a construction document so that disputes of design change were arisen along by progress of detailing design.
  - Interpretation and application of "Reasonably inferable" clause of general conditions was a key point.

**Project Progress**

- As like as a characteristic of AIA A101 (standard form of contract) and A201 (General conditions), role and responsibility of owner, designer and contractor were prescribed precisely, and also rough outline of work procedure was noted on the contract.
  - According to this, after establishment of work procedure matrix, all works were enforced by the procedure. (similar to overseas projects).

**Characteristics of General Conditions**

- **Contract Amount**
  - Cost added at finalizing design
  - Provisional items: app. 26 bil. KRW
  - VE for quantity of RC, Car (Contractor’s all risk insurance)

- **Adjustment of contract amount is essential btw contract document and construction document**
  - Contract is based on DD documents

- **Differences btw contractor’s assumption at DD and CD were admitted partially for a settlement of account.**

- **Interpretation and application of “Reasonably inferable” clause of general conditions was a key point.**

#### 4.2.3 Contract Integrated Management at Construction Stage

<table>
<thead>
<tr>
<th>Classification</th>
<th>Request for Change</th>
<th>Change Management</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Requested Items</td>
<td>Approved Items</td>
<td>Approved Amount</td>
</tr>
<tr>
<td>Arch</td>
<td></td>
<td></td>
<td>(bil KRW)</td>
</tr>
<tr>
<td>Structural</td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
<tr>
<td>Architecture</td>
<td>17</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>MEP</td>
<td>10</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Electrical</td>
<td>7</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>LEED</td>
<td>9</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Etc</td>
<td>10</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

- **RFDC : Request For Design Change**
  - To prevent contractor’s thoughtless RFDC, selected items needed for project were certified.

- **Value Engineering**
  - Application of ambiguous clauses is, according to intent of contract.
  - VE example: RC Outrigger, T/LCD, etc.

- **TOTAL 17.5 bil (56%) 2.2 bil (36%) 20.7 bil (90%) 43.5 bil (68%)**

- **Cost/Design Management for provided documents by CCD (Construction Change Directives) and CD Addendum**

- **Management of unsettled amount**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type</th>
<th>Contingency</th>
<th>Discount</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-reflected items on contract</td>
<td>31 bil</td>
<td>-30 bil</td>
<td>20 bil</td>
<td></td>
</tr>
<tr>
<td>Predicted additional cost</td>
<td>10 bil</td>
<td>20 bil</td>
<td>30 bil</td>
<td></td>
</tr>
<tr>
<td>Value Engineering</td>
<td>15 bil</td>
<td>30 bil</td>
<td>45 bil</td>
<td></td>
</tr>
<tr>
<td><em>TOTAL</em></td>
<td>57 bil</td>
<td>20 bil</td>
<td>108 bil</td>
<td></td>
</tr>
</tbody>
</table>

- **Noted Items of contract**

- **Additional Design Management**
  - Cost/Design Management for provided documents by CCD (Construction Change Directives) and CD Addendum

---

**Table:**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Requested Items</th>
<th>Approved Items</th>
<th>Approved Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
<tr>
<td>Arch</td>
<td></td>
<td></td>
<td>(bil KRW)</td>
</tr>
<tr>
<td>Structural</td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
<tr>
<td>Architecture</td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
<tr>
<td>MEP</td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
<tr>
<td>Electrical</td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
<tr>
<td>LEED</td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
<tr>
<td>Etc</td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>(KRW)</td>
</tr>
</tbody>
</table>
4. Project Cost Management

4.2. Construction Hard Cost

4.2.4 Value Engineering

**Value Engineering**

<table>
<thead>
<tr>
<th>Effect of Application</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RC Outrigger &amp; Belt truss</strong></td>
<td></td>
</tr>
<tr>
<td>Installing RC Outrigger and Belt Truss as a [] reinforcing structure of high-rise building (34F/60F)</td>
<td></td>
</tr>
<tr>
<td>Designed as a steel on CD</td>
<td></td>
</tr>
<tr>
<td>Concerned construction time increase as a complex process because the core structure was RC</td>
<td></td>
</tr>
<tr>
<td>Saved 2 Months</td>
<td></td>
</tr>
<tr>
<td>Cost burden as a contingency item which was predicted adjusting cost as of final design</td>
<td></td>
</tr>
<tr>
<td>Saved 3.8 bil KRW by VE</td>
<td></td>
</tr>
<tr>
<td>Time burden as a complex process because the core structure was RC</td>
<td></td>
</tr>
<tr>
<td>Saved 3.8 bil KRW by VE</td>
<td></td>
</tr>
</tbody>
</table>

**TLCD (Tuned Liquid Column Damper)**

<table>
<thead>
<tr>
<th>Effect of Application</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Considered TMD (Tuned Mass Damper) for a damper system of a high-rise building</td>
<td></td>
</tr>
<tr>
<td>Considered installing only 1 tower building of 4 tower buildings because of huge cost burden</td>
<td></td>
</tr>
<tr>
<td>However, due to predicting civil complaint a plan for installation of all 4 buildings was seek</td>
<td></td>
</tr>
<tr>
<td>Reviewed several systems such as TSD, TLD, etc. and then TLCD was selected finally</td>
<td></td>
</tr>
<tr>
<td>Original TMD has high prime cost, uncertain performance and wasted extra space at top of building</td>
<td></td>
</tr>
<tr>
<td>Reviewed failure cases of similar local system before using TLCD of Motioneering Company, and then corrected errors rising from difference between real building and model to improve TLCD design</td>
<td></td>
</tr>
<tr>
<td>Finished Tuning of TLCD perfectly. Achieved perfect design efficiency</td>
<td></td>
</tr>
<tr>
<td>Considered equity for installing only 1 building due to cost burden</td>
<td></td>
</tr>
<tr>
<td>Through innovative VE, saved cost (app. 6 mil KRW) and even also it could applied for all 4 building within the budget.</td>
<td></td>
</tr>
</tbody>
</table>
4. Project Cost Management

4.2. Construction Hard Cost

4.2.5 Management Outcome

- D&C Integrated Management
- RFDC Management
- Unsettled Amount Management
- Extra Added Design Management
- Construction Hard Cost Management

- Securing maximum leeway of owner’s budget by Design/Cost Integrated Management
- Managed design and contract at the same time for detailed design and extra design due to Fast Track design progress -> Optimization
- Unsettled cost were minimized by proactive Value Engineering
- Optimized management for additional Scopes such as LEED

- Met the target of Construction Hard Cost at the final settlement of account:
  - Achieved 99.93% of Contract Amount
  - 99.1% of EAC (Estimate at Completion)

4.3. Construction Soft Cost

4.3.1 Service Contract and Claim Management

- Additional Contract and Existing Contract
- Claim Management

- Service Contract Management
  - Additional Contract and Existing Contract
  - Claim for overall service contract

- Claim Management
  - Claim by Designer
  - Claim for owner’s claim issue
  - Negotiation by considering predicted possible disputes (Æ 1.6 bil KRW)
  - Inclusion of possible additional designs -> prevent future disputes

- CM Management for overall service contract
- Reviewed the omitted part and managing additional contract binding
- Claim for service and settlement of account

- Domestic Contract
  - Arch Construction Drawing
  - MEP Construction Drawing
  - Infra Change Design
  - MEP Design
  - MEP ME Design

- Omitted Contract
  - Arch Construction Drawing
  - MEP Construction Drawing
  - Infra Change Design
  - MEP Design
  - MEP ME Design

- CD documentation & modification
  - Requested 2.9 mil KRW
- Excepting Designer’s fault
  - Agreed 0.7 bil KRW

- Change for Project
  - Requested 2.9 mil KRW
- Except existing contract items
  - Agreed 0.7 bil KRW

- Additional Design
  - Requested 0.2 bil KRW

- CD documentation & modification
  - Requested 2.9 mil KRW
5. Time (Schedule) Management

5.1. Plan vs Actual, Revision Schedule Management (Primavera3)

Not limited to Construction Activity, managed whole schedule of Design, Permit, Procurement, Shop DWG and Submittals

CPM (Critical Path Method) Management

- WBS
  EPC: Milestone, Design & Permit, Procurement, Construction
  Construction: High Rise 4, Middle Rise 10
  - WBS (Code of account identifier)

Approval of Master Schedule and Revision Process

- Clarified the standard clearly when establishing early schedule management plan

Master Schedule

Plan and Actual Result Management

- Update progress status by bi-weekly
- Analyse actual result by plan and progress Trend
- Check critical issue and identify risks to report to an owner

CM Biweekly Report

[ Biweekly Update Issues ]
5. Time (Schedule) Management

5.2. Time/Cost Integrated Management by Earned Value Management

- Reclassification/gathering items of a breakdown of construction contract by a breakdown of each building/each floor for cost management of each activity
- Input a major resource to each activity

5.3. Integrated Management of Design, Procurement and Construction & Gradual Detailing of Master Schedule

- Design by Fast Track
- CA work by an overseas designer (KPF) and domestic designer
- Managing drawing publication and procurement schedule thoroughly
- Considering risk due to delay by approval of shop dwg and submittal before the commencement of construction
- Preventing delay of construction by shop dwg, submittal schedule management

Rev. No. | Approval Date | Reason for Change | Master Changed Item | Activity
---|---|---|---|---
Revision 0 | 2005.6.23 | Original rough master schedule for a contract | Master Schedule of Contract (Original) |
Revision 1 | 2005.11.29 | To identify detailed schedule status, making progress schedule for early management by adjusting WBS, Activity and Resource Allocation | Detailed Progress Schedule for Contract |
Revision 1.1 | 2006.5.17 | Issued/Rejected | Due to change of project approval schedule, the commencement date and completion of construction was changed.
| | | Change by a delay of RCD & PHC pile construction (3.2~4.5 mths) | Commencement: 05.4.15 to 05.5.1
| | | Completion: 08.12.31 to 09.1.31 (Total 48 mths) |
Revision 2 | 2006.12.28 | Complementing Rev. 1.1 by negotiating w/ site teams | Shortened 2.2 mths of structure than Rev. 1.1
| | | Exterior Finish Work: changed the start day by 15th Jan 2007
| | | Interior Finish Work: changed the start day by 22nd Feb 2007 |
Revision 3 | 2008.3.24 | Fragmented middle and low rise building to manage by Work Crew Schedule | Fragmented change of critical schedule |

Master & Payment Schedule Integrated Management

- Paid a contract payment of construction contract monthly by 90% of SPI (Schedule Performance Index = EV/SV)
- When up to the standard, paid the payment by payment schedule
- When below the standard, inspected actual payment by a cost consultant
5. Time (Schedule) Management

5.4. Time Management Result

- Pile, RCD Construction
  - Complaint for noise
  - Changed the piling method due to belemnite layer (Percussion->PRD)
  - Delayed 2~3 mths

- Exterior Work
  - Delay of GRC contract and Shop, Mock up
  - Delay due to insufficiency of GRC
  - Delayed

- Structure Construction
  - Core: 4 day cycle, Slab: 3 day cycle
  - Reduced 2.2~2.7 mths of structure work

- Interior Work
  - Performed plasterwork after installing a dry wall
  - Rearranged Work Crew Schedule
  - Adjusted floor cycle by put additional workers
  - Completion of construction

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6. Quality Management

6.1. Quality Management Summary

**Quality Management of Pre & Post-Construction Stage**

**Pre-Construction Stage**
- Review and approval of a construction plan
- Review and approval of materials
- Review and approval of submittals
- Review and approval of a work plan regarding LEED

**Post-Construction Stage**
- Applying Quality Inspection Work Process
- Performing Site Inspection
- Issuing NCR and Final Inspection Report
- Inspections regarding LEED works and performing tests

**Results of Quality Management**

- Issued total 20 NCR and confirmed correction works
- Checked coincidence with LEED standard and passage of LEED tests
- Issued Final Inspection Report & confirmed correction works

**Faulty Work Penalty**
- ZERO

- Achieved 93.1 point of POSCO E&C Quality Index (Target: 80 point)
- Achieved LEED Certified grade Quality

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7. Health & Safety Management (KOSHA 18001)

7.1. Achieving Zero Accident Goal by SAFUN (= Safety + Fun)

Health & Safety Management System

- KOSHA 18001 Operation Flow-chart
  - Health & Safety Management System
  - Health & Safety Management Target and Plan
    - Adopt KOSHA 18001
    - Practice/Improve H&S Management by establishing a voluntary safe system of site
    - Monitoring voluntary practicing as a part of life
  - Dangerousness Valuation
  - Weekly H&S Meeting
  - H&S Activity
    - Safety education in the morning/afternoon
    - Making daily safe work directions
    - Managing safety work status
    - Safety Patrol
  - H&S Education
    - Education for a newcomer
    - Periodic Safety Education
    - Safety Education at any time
    - Education for a Safety Supervisor
  - Improvement
    - H&S Check
    - CM/Site H&S Meeting
    - Practice / Improvement

H&S Activity Cycle Management Items

- Monthly: Monthly H&S Union Meeting, joint inspection and Safety Check Day Ceremony
- Weekly: Safety Check and Dangerousness Valuation of each zone, Weekly Safety Progress Meeting
- Daily: TBM, One-day Safety Work Directions, Daily Safety Meeting and Recording Safety Activities

Achieved Zero Accident Hours

- '06. 03. ~ '06. 09. Zero Accident 1 time (1 mil Hours)
- '06. 09. ~ '07. 01. Zero Accident 2 times (2 mil Hours)
- '07. 01. ~ '07. 04. Zero Accident 3 times (3 mil Hours)
- '07. 04. ~ '07. 07. Zero Accident 4 times (4 mil Hours)
- '07. 07. ~ '07. 10. Zero Accident 5 times (5 mil Hours)
- '07. 10. ~ '08. 01. Zero Accident 6 times (6 mil Hours)

Results of H&S Management and Awards

- Awards
  - POSCO E&C H&S Plus site of the second half of 2006
  - POSCO E&C The Best H&S site of the second half of 2007

8. Other Remarkable Facts

8.1 LEED Certification (Certification of US Green Building Council)

- Provide Landscape Space and Public Space
  - 2 times larger landscape space than legal standard
  - Environmental contribution such as providing wildlife habitat, preventing heat island effect and improving rainwater permeability

- Reduction of Greenhouse Gas (GHG)
  - Provided bicycle storage for over 15% of occupants in line with Incheon City Policy of encouraging bicycle usage
  - Provided privilege parking lots for high efficiency performance cars
  - Restrict usage of car and car emissions to reduce GHG emission

- Healthy Indoor Environment
  - Prevent passive smoking by pressurizing public hall
  - Installed CO2 sensors at high density of population space and measuring instruments at low density of population space to provide indoor fresh air at ordinary times; preventing unnecessary energy consumption
  - Constructed indoor finishes material after approving Volatile Organic Compounds (VOC) test result

- Energy Reduction
  - Achieve 17.4% energy cost saving effect than ASHRAE 90.1 standard building by optimizing energy performance of building
  - For more energy system, carried out commissioning by a third party to achieve effects such as decreasing building management expenses, systematic documentation of building system, reconsideration of occupant’s productivity and verification of system installation
## 8. Other Remarkable Facts

### 8.2 Engineering Results

<table>
<thead>
<tr>
<th>Field</th>
<th>Main Categories</th>
<th>Number of Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture</td>
<td>Temporary Construction (Review Crane, Concrete Equipment and etc.)</td>
<td>6</td>
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<tr>
<td></td>
<td>Framework Construction (Review a ferro-structure and etc.)</td>
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<tr>
<td></td>
<td>Foundation (Review control method of pile construction and etc.)</td>
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<td></td>
<td>Water-proof Construction (Underground structure water-proof plan and etc.)</td>
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<tr>
<td></td>
<td>Exterior Construction (GFRC Cladding review and etc.)</td>
<td>37</td>
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<td>Fishes Construction (AL heat insulating board review and etc.)</td>
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<tr>
<td>Structure</td>
<td>Review an optimization method of tower building’s Link Beam</td>
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<tr>
<td></td>
<td>Review to optimise quantity of steel for tower building’s outer column</td>
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<tr>
<td></td>
<td>Check the validity of applying damper system</td>
<td></td>
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<tr>
<td></td>
<td>Review slab structure system of High-Rise Building’s roof</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review slab construction and delay joint</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Field</th>
<th>Main Content</th>
<th>Number of Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>Review estimated use of designed transformer</td>
<td>12</td>
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<tr>
<td></td>
<td>Review the installing of lighting conductors at 64F of tower building</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review the installing of an unmanned postal service facility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review the problem of remote reading the meter system of air conditioning facilities</td>
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</tr>
<tr>
<td></td>
<td>Listed categories and etc.</td>
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<tr>
<td>Mechanical</td>
<td>Review of water-cooled air conditioning system</td>
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<td></td>
<td>Review of a unit FCU system</td>
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<td>Review of Volume Damper system</td>
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<td></td>
<td>Review of underground floor ventilation plan</td>
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<tr>
<td>Civil</td>
<td>Review of RCD pile lay-out</td>
<td>14</td>
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<td>Review of Jacket Anchor system</td>
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<tr>
<td></td>
<td>Listed categories and etc.</td>
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</tr>
</tbody>
</table>

## 9. Conclusion

### 9.1. Summary of Project Management Results

- Established a project management structure and direction of NSIC whole projects
- Applied and performed the international standard project management
- Project cost management through the whole project stages
- Time management by integrating design/procurement/construction
- Applied new technology/technique

- Gained a foothold for whole Songdo projects
- Loyal to the owner’s and designer’s intention
- Completed a project within the owner’s budget
- Minimised delay, Completed project within the time
- Contributed greatly for whole Songdo Development Project by completed a forefront project successfully
- Exemplary project for later projects in Songdo IBD.

- TLCD, RC Outrigger, GFRC cladding, Water Cooled Ducted System, LEED, etc.