The Structural Design Workflow Based on Revit as a Core Platform using Dynamo.

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Project Management
Construction Management

Renovation
Seismic Retrofitting Design
Introduction

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2017 Musashino Forest Sports Plaza

2014 Toranomon Hills
Let's begin the first topic.
Class summary

This class will present the new structural design workflow based on Revit software as a core platform. It improves your work dramatically. This workflow makes it easy to manage all the data together, such as data sharing with other industries, drawing, structural analysis, and so on.

This session will explore these techniques when they are used for actual building projects.
Key learning objectives

At the end of this class, you will be able to:

- Learn how to connect the acquired information from Revit to others
  (For example, other industries, software)
- Learn how to interconvert Revit to and from Microsoft Excel tools and in-house development program
- Learn how to use Dynamo as a converter from Revit to and from Robot Structural Analysis Professional
Agenda

- BIM and Structural design workflow
  - Characteristics of BIM and Integrated BIM
  - Structural design workflow using BIM
- Improving Structural design workflow efficiency
  - ① Primary frame design using BIM
  - ② Secondary members design using BIM
  - ③ Structural drawings using BIM
- Communication using BIM
  - Communication using information
  - BIM workflow between “Architecture and Structure”, “MEP and Structure”
BIM and Structural design workflow
Characteristics of BIM and Integrated BIM

- Characteristics of BIM
  BIM has “Visualization” and “Information”.

  ⇒ “Integrate each other” is important.

  ⇒ Application of
  “New structural workflow”.

Characteristics of BIM and Integrated BIM
Existing Structural design workflow

- Existing workflow:
  
  Concurrently work progress

  ⇒ Spend a lot of time
  
  “Check” and “Modification”.

  ⇒ Cause of “Inconsistency” and “Irrationality”.

"Check" and "Modification".
New Structural design workflow using BIM

- **BIM workflow:**
  - Link for **BIM data** to other data.

  ⇒ “Check” **only** BIM data.

  ⇒ Improving tasks of
    - “consistency” and “efficiency”.

New structural design workflow using BIM
Improving structural design workflow efficiency
Improving Structural Design Workflow Efficiency

① Primary frames design using BIM

② Secondary members design using BIM

③ Structural drawings using BIM
Primary Frame Design using BIM

- “BIM data” and “Structural analysis” (Primary frame)

New structural design workflow using BIM
Primary Frame Design using BIM

“NASCA “
In-house program for Structural Analysis

<table>
<thead>
<tr>
<th>Layer</th>
<th>X-direction Joint Rotation (rad)</th>
<th>X-direction Joint Shear Force (kN)</th>
<th>X-direction Plasticity</th>
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<td>1</td>
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<td>9</td>
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</table>

Nihonsekkei
Auto
Structural
Calculation for buildings design
Existing Structural Design Workflow

- Existing workflow:
  - Concurrently progress "Analysis" and "Drawing".

  ⇒ Spend a lot of time "Check" and "Modification".

  ⇒ Cause of "Inconsistency" and "Irrationality".
New Structural Design Workflow using BIM

- **BIM workflow**:
  - Link for BIM data to other data.

⇒ “Check” is only BIM data.

⇒ Improving tasks of “consistency” and “efficiency”.

New structural design workflow using BIM
Primary Frame Design using BIM

- Structural analysis data:
  Using In-house Program (NASCA)
  ⇒ Adaptability for variable analysis.

- BIM data:
  Using Revit
  ⇒ Integrate
  Architecture / Structure / MEP.

“Structural analysis data” and “BIM data”
Primary Frame Design using BIM

- Data conversion:

Different requirement

at each design phase.

⇒ Total conversion.

⇒ Partial conversion.

Data conversion between

“Structural Analysis Data” and “BIM Data”
Primary Frame Design using BIM

- New workflow:
  Intercommunicate between “BIM” and “Analysis”.

  ⇒ By-direction data conversion.

  ⇒ Workflow Based on Revit as a Core Platform.

  : NASCA-Revit Converter

  : Dynamo

New structural design workflow using BIM
Improving Structural Design Workflow Efficiency

① Primary frames design using BIM
② Secondary members design using BIM
③ Structural drawings using BIM
Secondary members design using BIM

- “BIM Data”
- “Structural Analysis” (Secondary members)

New structural design workflow using BIM
Secondary members design using BIM

Collecting Information in BIM.
⇒ Improve
“consistency” and “efficiency”

Connecting with existing tools.
⇒ help getting used to Revit and new workflow.
Using Dynamo to connect Calculation tools to BIM

⇒ Extracting information smoothly from the BIM data.

⇒ Visualizing the process.
Secondary Members Design using BIM Workflow Steps

Step 1: Confirming BIM data

1. Secondary members arrangement.
2. Relationship between secondary beams and interior and exterior.
3. Interference with MEP ducts.
Secondary Members Design using BIM Workflow Steps

Step 2: Getting information using Dynamo

1. Geometrical Information
   - Length / Location / mark

2. Analytical Information
   - Load Condition /
   - Boundary Support Condition

BIM Data
- Check Location
- Check Level
- Check Detail

Load Condition
- Load
- Section

Boundary Support Condition
- Load
- Section
Secondary Members Design using BIM Workflow Steps

Step 3: Calculating with Excel tool

1. Set the information from Revit automatically

2. Calculating beams with Excel tool

<table>
<thead>
<tr>
<th>荷重内訳</th>
<th>房荷重</th>
<th>居室</th>
<th>Lx (m)</th>
<th>P (kN)</th>
<th>Ly (m)</th>
<th>Ly&lt;1/300 (rad)</th>
<th>Q (kN)</th>
<th>δ (mm)</th>
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<tr>
<td>居室</td>
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<td>7.20</td>
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<td>-</td>
<td>-</td>
<td>125.0</td>
<td>59.2</td>
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</table>

※ cells marked yellow are the information form Revit
Secondary Members Design using BIM Workflow Steps

Step 4: Reflecting Information into BIM

Reflect analysis result
Information

Member Marks
Section Information

Step 4: Reflecting information in BIM
Improving Structural Design Workflow Efficiency

① Primary Frames design using BIM
② Secondary member design using BIM
③ Structural drawings using BIM
Structural Drawings using BIM

- “BIM data”
  and
- “Structural drawing”

New structural design workflow using BIM
Workflow Creation of Structural Drawings

Existing workflow:
Convert 2D CAD from analysis data.

Our New workflow:
Output structural drawings from BIM data.
Creating Structural Drawings Workflow using BIM

- NASCA ⇔ Revit converter (Set “view Template”)
- Command automation for framing plans, framing elevations, and section lists
- Structural Drawing from Revit

Framing plan
Framing elevation
Section schedule
## Comparison of the Drawing Representation between Previous and New Methods

<table>
<thead>
<tr>
<th>Problem</th>
<th>How to correspond with the in-house drafting standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Previous method</td>
</tr>
<tr>
<td>way</td>
<td>manually</td>
</tr>
</tbody>
</table>

- Correspond with the in-house drafting standards.
- **Previous**: Draw manually
- **Current**: Draw automatically using add-in program

**Comparison of the Drawing Representation**
Communication using BIM
Communication using BIM

- Visualizing information

⇒ **Existing workflow**:

Pick up necessary information with **manual operation**.

⇒ **BIM workflow**:

Pick up necessary information using **Dynamo**.

“Previous Workflow” and “new workflow using BIM”
Communication with “Architects or MEP engineers” using BIM

- Examples

Communication with Architects

Communication with MEP engineers

New structural design workflow using BIM
Communication with “Architects or MEP engineers” using BIM

- Communication between
  “Architects and Structural engineers”

- Communication with “MEP engineers and Structural engineers”

Various Drawings for Communication using BIM:
- Level of structure
- Live Load Plan
- Girder height
- Check penetration at beam
Developing tools
Dynamo Tools for Structural Design

- Dynamo Tools

⇒ Tools for each design phase.

⇒ Apply existing tools to new technology.
Dynamo Tools for Structural Design Example

- Original node using “Revit API”.

⇒ Output results of structural analysis.

⇒ Customize the rendered images.
Dynamo Tools for Structural Design Example

- Developing Dynamo script using RSA.

⇒ Optimize the structure.

⇒ Visualize the calculation result.
Dynamo Tools for Structural Design Example 2

- Using **RSA** to adapt structural optimization.

  ⇒ Use the **Genetic Algorithm**.

    (Dynamo package of "Optimo")

  ⇒ **Simple beam** loaded with **concentrate force**.
Conclusion
Conclusion: The Structural Design Workflow Based on Revit as a Core Platform with Dynamo.

- Characteristics of BIM
  "Visualization" and "Information".
  ⇒ Integrate them is important.
- New Structural design workflow using BIM
- Communication using BIM
  ⇒ Improve tasks of "consistency" and "efficiency".

New structural design workflow using BIM
Question?

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