Precast and BIM

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Precast Outline

• Precast BIM History
  – Importance to nearly every other trade
• IFC as a standardized method of exchange
• PCI Exchange Models
• AGC LOD Spec and Precast
• BIM Case Study
Where is Precast in BIM

Precast

Accessories

Architectural

HVAC

Structural

Electrical

Plumbing
Precast Model

- Preparing Drawings
- Erection Drawings
- Production Drawings
- Hardware Drawings
- Scheduling
- Reporting
- Reinforcing
- Accounting

September, 2013
Brief History 2001 - 2002

- 23 Precast companies formed the Precast Concrete Software Consortium
- Hired Georgia Tech to facilitate the development of an RFP for the creation of an industry specific BIM authoring tool
- RFP Details
  - Contained design and analysis linking
  - 3D Modeling
  - Drawing automation
  - Fabrication level detail and data
- RFP Did not cover data passing between applications
RFP Results

• About 12 vendors responded, single vendor selected, Tekla to enhance xSteel
• A second group was formed, not supported by the consortiums efforts, StructureWorks
• After multiple years of development, testing, and implementation, the technology was still “young” and not fully adopted
Fast Forward 7 years, (2009-2010)

- Autodesk Purchased Revit (2002) Added 7 yrs of Development
- PCI Created the BIM Advisory Committee (morphed into their BIM Committee)
  - Utilized Georgia Tech for Research with primary funding from the Charles Pankow Foundation
  - Focus on Data Exchange
  - Extend IFC to include Precast (at the time IFC vs 2x3 current version IFC4 released March 2013)
Why IFC

Precast

Structural

Architectural
Importance of Advisory Committee and Research

• Established a method to determine the required data exchanges and synthesized it to the smallest amount of data necessary for exchange

• Performed gap analysis of existing IFC 2x3 exchange methods and implemented required modifications in IFC4

• Initiated the development of IFC Data Translation Testing, “If I export data, is it accurate, and does it need to be certified?”
Information Delivery Manual Development

• Standardization the exchange of information
• Reviewed Multiple Delivery Models
  – Architectural Lead Project (Owner Driven)
  – Precast Lead Project (Design Build)
  – Precast as Subcontractor (Bid Build)
• Focused on Design · Fabrication · Delivery · Installation
Team Players and Exchanges

Process Map

Construction Phases

Exchange Model Notation

Review Comments
Process Map
133 Concepts for precast, 36 of them are re-used from other MVDEs
NOTE. In all cases, the cores are symmetrically distributed on either side of the plank center line, irrespective of whether the number of cores is odd or even. For planks with a center core with different geometry to that of the other cores, set CenterCoreSpacing > 0. When the number of cores is even, all Center Core parameters are ignored.

NOTE. Key chamfers and draft chamfer are all 45 degree chamfers.
Level of Detail
Modeling Challenges
As Cast vs In-Situ

Original Intent
Length before tensioning, batter ends, no camber

As Cast
Length before tensioning, batter ends, no camber

As Erected
Length after tensioning, \( \approx \) plumb ends, cambered
Level of Detail

/* Hollowcore Profile */

#116= IFCCARTESIANPOINT((0.0,0.0,0.0));
#120= IFCCARTESIANPOINT((2417.7625,0.0,0.0));
#124= IFCCARTESIANPOINT((2427.531731,9.76923077,0.0));
#128= IFCCARTESIANPOINT((2427.531731,19.53846154,0.0));
#132= IFCCARTESIANPOINT((2417.7625,29.30769231,0.0));
#140= IFCCARTESIANPOINT((2412.801563,106.3014423,0.0));
#144= IFCCARTESIANPOINT((2409.467188,111.2623798,0.0));
#148= IFCCARTESIANPOINT((2401.490625,156.3076923,0.0));
#152= IFCCARTESIANPOINT((2407.245313,191.2326923,0.0));
#156= IFCCARTESIANPOINT((2398.315625,202.3451923,0.0));
#160= IFCCARTESIANPOINT((19.446875,202.3451923,0.0));
#164= IFCCARTESIANPOINT((10.5171875,191.2326923,0.0));
#168= IFCCARTESIANPOINT((8.5328125,181.2686298,0.0));
#172= IFCCARTESIANPOINT((4.9609375,106.3014423,0.0));
#176= IFCCARTESIANPOINT((0.0,29.30769231,0.0));
#180= IFCCARTESIANPOINT((9.76923077,19.53846154,0.0));
#192= IFCCARTESIANPOINT((9.76923077,9.76923077,0.0));

#200= IFCPOLYLINE(#116,#120,#124,#128,#132,#136,#140,#144,#148,#152,#156,#160,#164,#168,#172,#176,#180,#184,#188,#192,#196);
IFC Export Testing

Exchanges reduced to 12 data sets or Exchange Models (EM)

EMPC-1: Building Concept (BC)
EMPC-2: Precast Concept (PC)
EMPC-3: Precast Contract Development (PCD)
EMPC-4: Engineering Design Development (EDD)
EMPC-5: Architectural Contract (AC)
EMPC-6: Engineering Contract (EC)
IFC Export Testing

Exchanges reduced to 12 data sets or Exchange Models (EM)

EMPC-7: Precast Detailed Coordination (PDC)
EMPC-8: Structural Review & Coordination (SRC)
EMPC-9: Engineering Analysis Results (EAR)
EMPC-10: Final Precast Detailing & Coordination (FPCD)
EMPC-11A: Production and Erection Data (PED)
EMPC-11B: Architectural Review and Coordination (ARC)
Current Status

• All 12 models have been validated and documented with ifcDoc
• Final report forthcoming
• PCI’s next step is to “encourage” software vendors to implement
• Multiple Sections pertain to Precast/Prestressed Concrete components and Structures
• Primary Sections To Include Precast As An Option:
  • Foundation
  • Structural Faming
  • Exterior Enclosure
LOD300 Element modeling valid for:

- All 200 attributes
- Specific sizes and locations of main members
- Concrete defined per spec - Metadata
- Drainage path and floor slopes
- Surface Finish Requirements - Metadata
- Required non-graphic information:
  - Penetrations for MEP, etc.
  - Finishes, camber, chamfers, etc.
  - Typical details
  - Embeds and anchor rods
  - Aggregate, clear clover
  - Reinforcing spacing
- Live loads
- Dead Loads
- Seismic, Wind
- Diaphragm Loads
LOD350/400 Element modeling valid for:

- Possible Sections – Spandrels, Column Covers, Wall Panels
- Concrete Color(s) – Face Mix, Backup
- Concrete Finish – Acid Etc., Sand Blast, Pains, Stain
- Inlay Details – Brick, Split Face CMU, Metal pan etc.
- Form Liner Details
- Architectural Feature Detail – Reveals, Slopes, Drafts,
- Joint / Corner Feature Detail - Quirk, Square / Butt
- Insulation Details for Sandwich Wall Panel System
- Interior and Exterior Wythe definitions
- Design Requirements – Loading, Inter-story Drift, Displacements
- Wall designation – Shear Wall vs Cladding
Precast LOD Models

LOD Specification

100  200  300  350  400

Wall

Column
This is a total precast structure
Pre-Sales (Revit for conceptual)
No model for estimating
Post Sale
• Architecture – Revit
• Mechanical – Revit
• Electrical – AutoCAD
• Fire Protection – Revit
• Plumbing – Custom plumbing Software
• Structure(Precast) – StructureWorks

Hotel
Parking Structure
StructureWorks

- Structure Completely modeled and all drawings (Individual, Erection, XceleRAYtor) developed from model.
- Sub-Trades Incorporated into Products via IFC Import (The blue plumbing was converted from an IFC File).
- Traditional Piece Drawings
- Laser Projection File Generation
- Light drawing versions still needed for post pour QC checks
- Erection Drawings
- Visual Erection Load List
Traditional Production Ticket

Laser Simulation

QC Simulation