



SHOP DRAWINGS FOR PRECAST CONCRETE

Hugh Martin, P.E. – National Precast Concrete Association



NPCA Education Class QC4
Friday February 7, 2025 – 8:00 AM – 9:30 AM

1

Learning Objectives



- Review the importance of planning before taking action
- Explore benefits of careful preparation and attention to detail to make effective shop drawings
- Learn practical tips and insights that enhance drawing skills and use them to increase the quality and effectiveness of shop drawings



2



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Overview

- Types and Formats That Work Best
- Key Elements of Shop Drawings
- Common Challenges
- Best Practices, Tips and Tricks



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3

Shop Drawings Are Vital!



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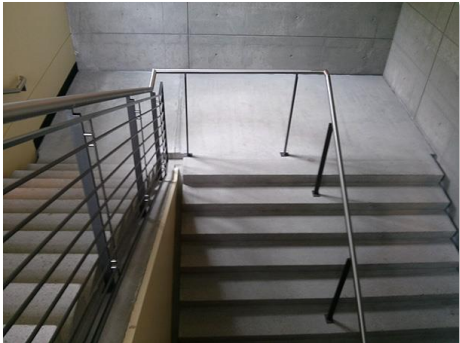
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Shop Drawings Are Vital!

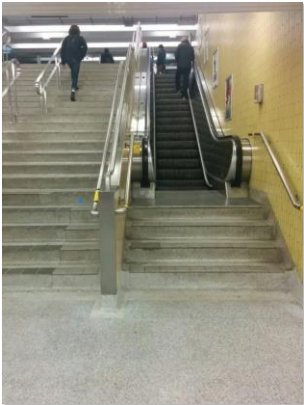


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Shop Drawings Are Vital!



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6

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Shop Drawings Are Vital!

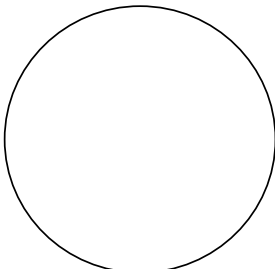


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7

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Creating Shop Drawings

Audience poll: What object is depicted by this circle?

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8

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Creating Shop Drawings

Audience poll: What object is depicted by the circle?



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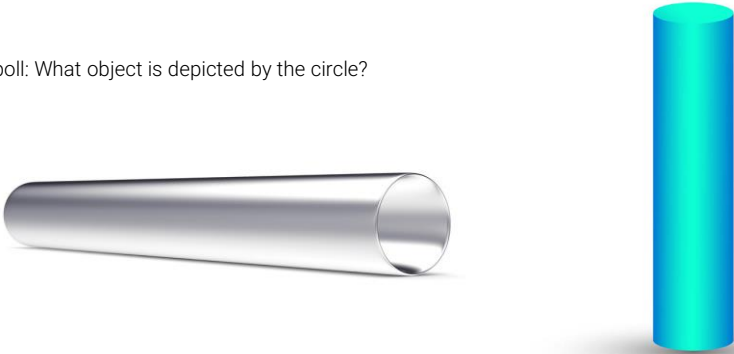


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Creating Shop Drawings

Audience poll: What object is depicted by the circle?



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10

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Creating Shop Drawings

Audience poll: What object is depicted by the circle?



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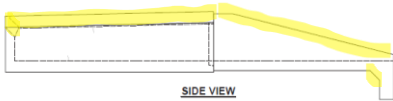
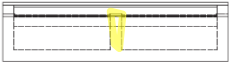
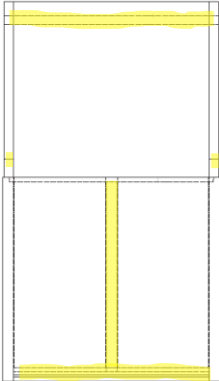
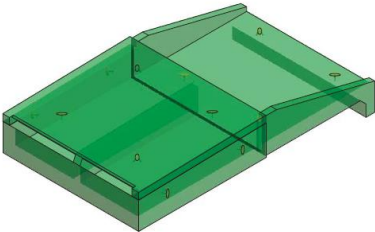
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Creating Shop Drawings

Multiple Views

- How many views are needed?

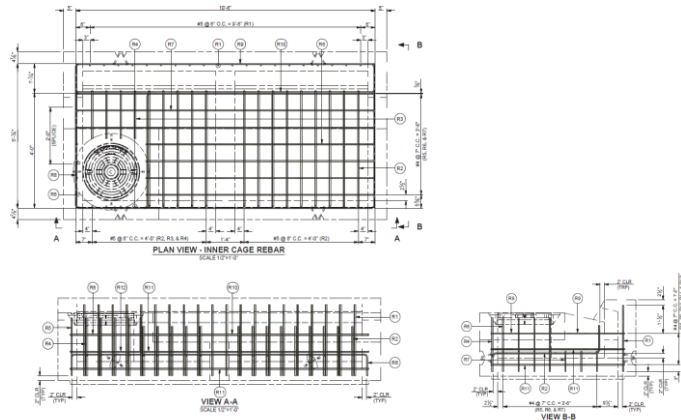


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12

Creating Shop Drawings

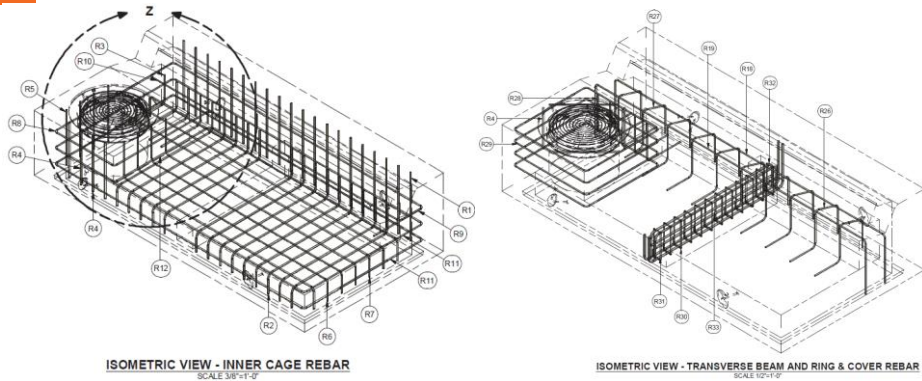


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13

Creating Shop Drawings



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14



Overview

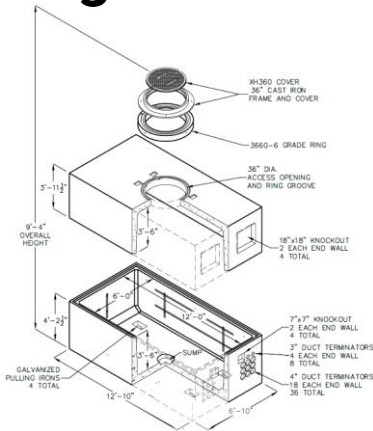
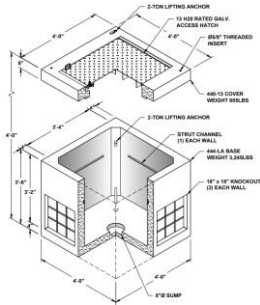
- Types and Formats That Work Best
- Key Elements of Shop Drawings
- Common Challenges
- Best Practices, Tips and Tricks



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Types of Shop Drawings

Catalog / Isometric Drawings

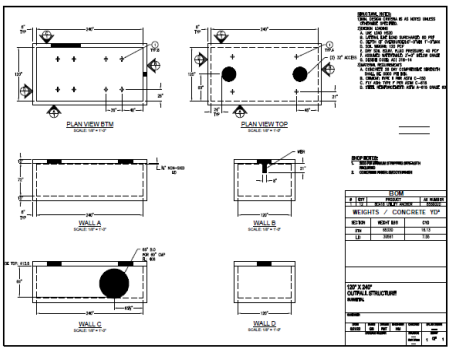
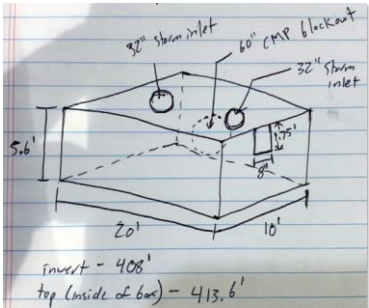


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Types of Shop Drawings

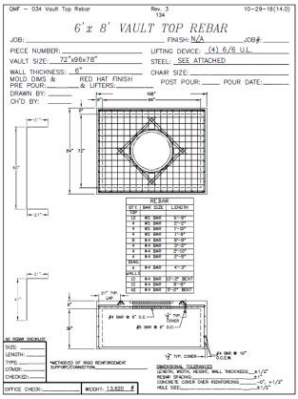
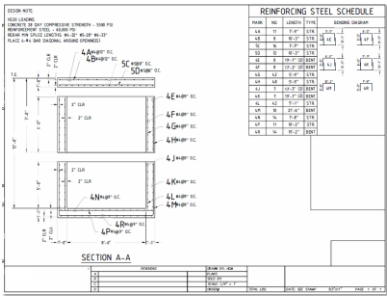
Submittal Drawings



17

Types of Shop Drawings

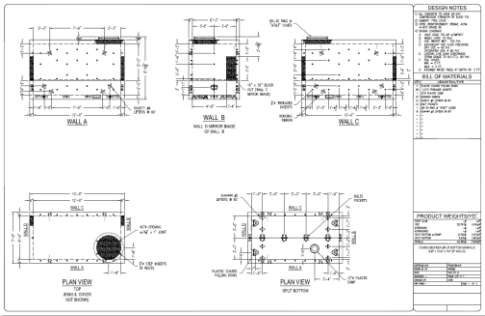
Reinforcing Drawings



18

Types of Shop Drawings

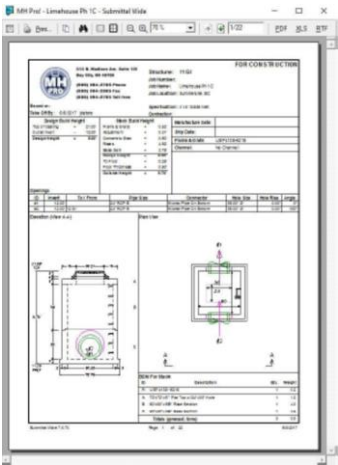
Production / Shop Drawings



Types of Shop Drawings

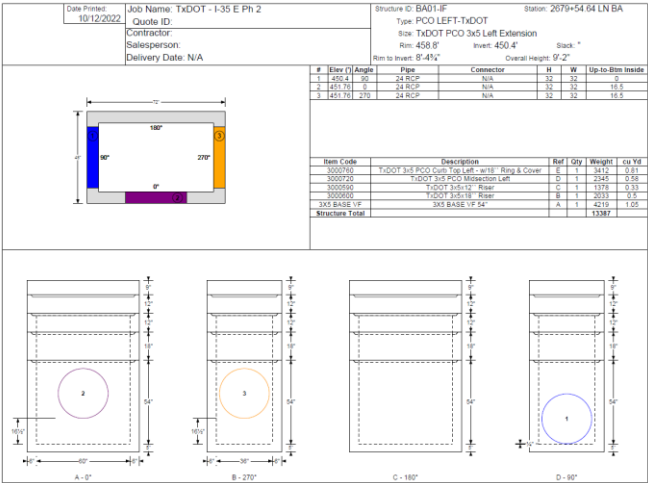
Automated Software

- Reduce time spent on common, higher-volume products
- Tabular input
- Uniform drawing format with limited views
- Often not to scale
- Integrate with ERP systems



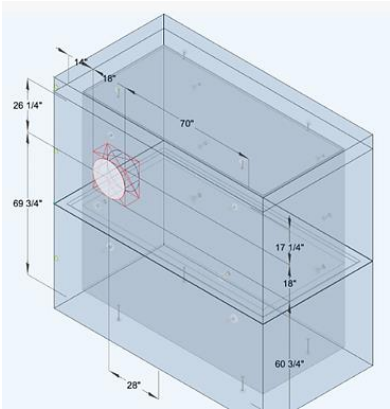
Types

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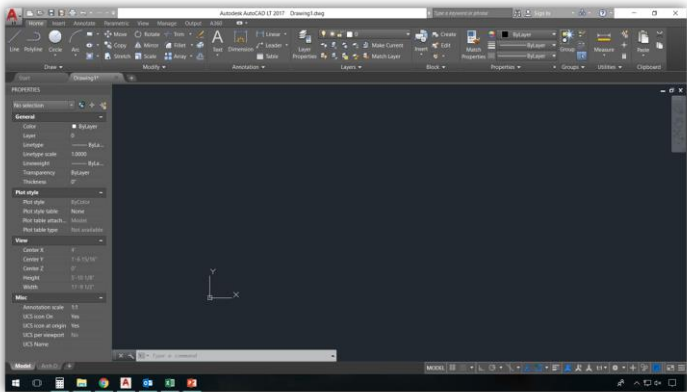
Types of Shop Drawings

- 3D Software (BIM)
- Drawings driven by 3D models
 - Mass properties built-in
 - Requires more processing power than 2D
 - May require customization to fit precast products
 - Learning curve



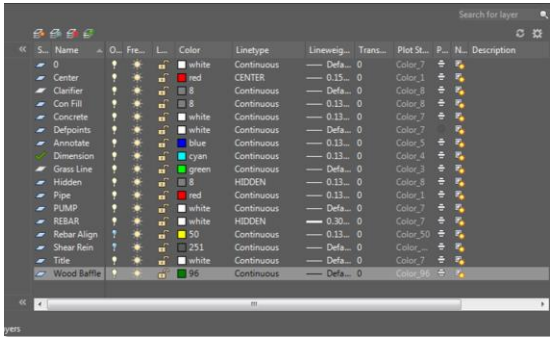
Types of Shop Drawings

- CAD Software
- Flexible
 - Customizable
 - Programmable
 - Widely-used
 - Learning curve
 - Output rate



Types of Shop Drawings

- CAD Standards
- Layers
 - Dimension Styles
 - Borders
 - Title Block
 - Fonts
 - Text Size
 - Tool Pallets
 - Plot Styles



By Roger Penwill, Courtesy of Catalyst

- Precast Concrete Utility Structure Manufacturing
- A Beginner's Guide to Lifting Devices
- Lifting Apparatuses: Holding Up Standards
- Safe Handling of Precast Products
- Cargo Securement Regulations for the Precast Concrete Industry
- NPCA Precast University – Master Precaster

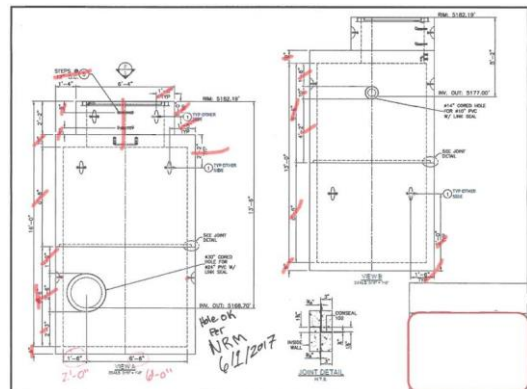


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25

- Detailed manufacturing instructions for production and quality control crews and/or contractor's installation crews
- Information for the project owner / reviewer to compare to the project specifications
- Engineering record for archive



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26

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Shop Drawings

Format – What works best for your plant?



Paper





Paperless

freepik, istockphoto, gettyimages

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27



Paper Shop Drawings

Format / Paper size
Legibility
Recordkeeping
Document control



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Digital Shop Drawings

Size of tablet device
Printable drawing size
Screen brightness and battery life
Robustness
Saving markups for recordkeeping
Connectivity and IT support

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28

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14



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Overview

- Types and Formats That Work Best
- **Key Elements of Shop Drawings**
- Common Challenges
- Best Practices, Tips and Tricks



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Key Elements

Lineweights and linetypes

- Bold – Object lines, section lines
- Thin – Hidden lines, dimensions

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Visible Object

Hidden Line

Center Line

Callout or Leader

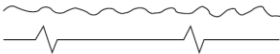
Dimension

Break Line

Reinforcing

Opening

Detail Cut

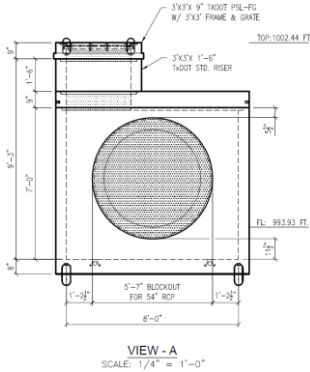
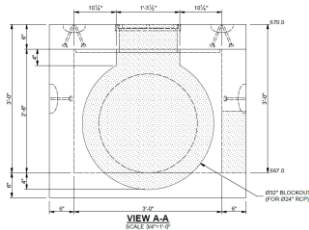


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Key Elements

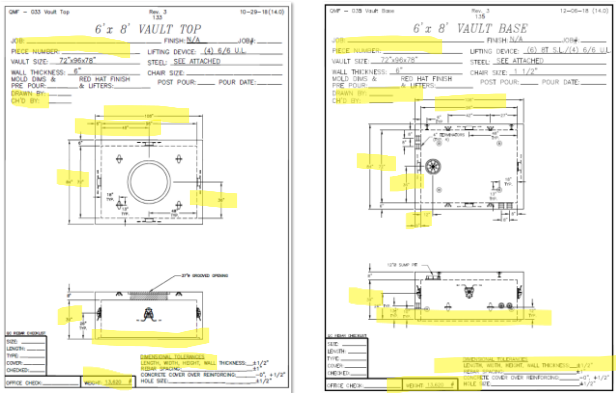
- Lineweights and linetypes
- Bold – Object lines, section lines
 - Thin – Hidden lines, dimensions



Key Elements

Interior Dimensions	Wall and Slab Thicknesses	Joint type and Orientation	Locations of Openings, Embeds, etc.
Design Notes	Project Information	Weight (Volume)	Tolerances
Drawing Scale (or "N.T.S.")	Revision History	Number of Pages	Drawn By

Key Elements



Key Elements

Engineering and Metric Scales

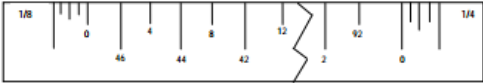
1 inch = 10 feet	1 inch = 40 feet
1 inch = 20 feet	1 inch = 50 feet
1 inch = 30 feet	1 inch = 60 feet



Key Elements

Architect Scale

3/32 = 1 foot	1/4 = 1 foot	3/4 = 1 foot
3/16 = 1 foot	3/8 = 1 foot	1 inch = 1 foot
1/8 = 1 foot	1/2 = 1 foot	1½ inches = 1 foot

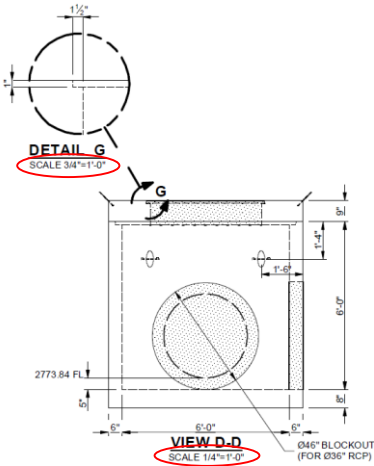


Key Elements

Use of scale

- Different scales on same drawing

CONTROL# C.N.	PROJECT# P.N.
DRAWN BY: SR	ORDER# 101593
DATE: 06/12/18	SOLD BY: TE
REVISIONS: -	SCALE: 1/4" = 1'
CHECKED BY:	DATE:
DWG NAME: -	PAGE 1 OF 3



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Key Elements

NPCA QC Manual

- 4.1.5 Machine-Made and/or Dry-Cast Products – “Verification of the reinforcing steel for conformance with the design shall be performed and documented...”
- 4.2.1 Fabrication of Reinforcement – “All reinforcing steel shall be fabricated to a detailed reinforcing steel plan document...”
- 4.3.3 Positioning of Reinforcement (Critical) - “Reinforcing steel shall be positioned as specified by the design...Plants shall maintain a documented process of reinforcing steel / cage inspections...”
- 4.3.4 Positioning of Miscellaneous Embedded Items – “Embedded items shall be positioned at locations specified in the design.”



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Key Elements

Reinforcing Type

Reinforcing Layers

Reinforcing Size / Area

Cut / Bend Lengths

Reinforcing Spacing

Extension Lengths

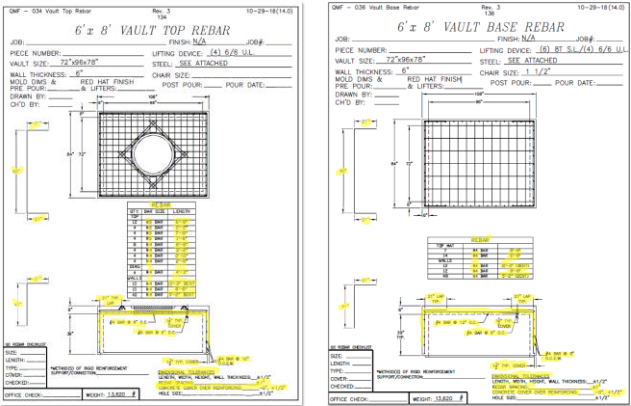
Concrete Cover

Tolerances

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Key Elements



Overview

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- **Common Challenges**
- Best Practices, Tips and Tricks



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Challenges & Limitations

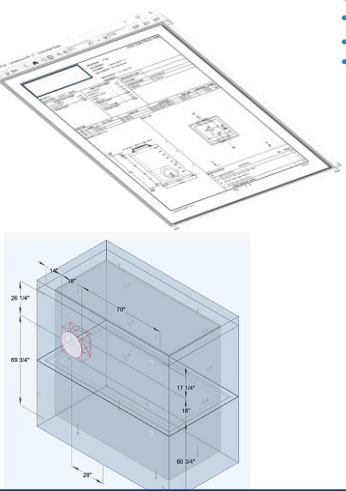
Automated Software

- Some limitations
- Fit the automation to the product



IN SOME RESPECTS WE ARE LIMITED BY OUR DESIGN SOFTWARE ORIGINALLY BEING AN ARCHITECTURAL PACKAGE

By Roger Penwill, Courtesy of Catalyst



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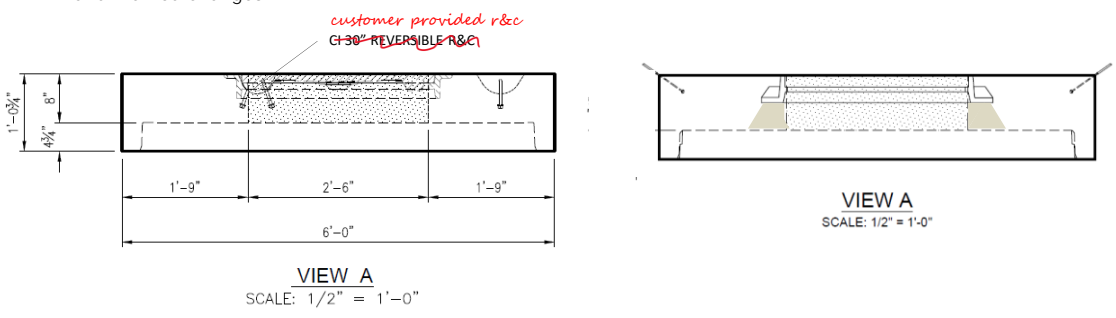


41

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Challenges

- Hand-marked changes



customer provided r&c
GI-30 REVERSIBLE R&C

VIEW A
SCALE: 1/2" = 1'-0"

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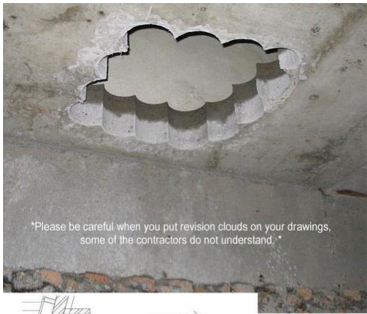
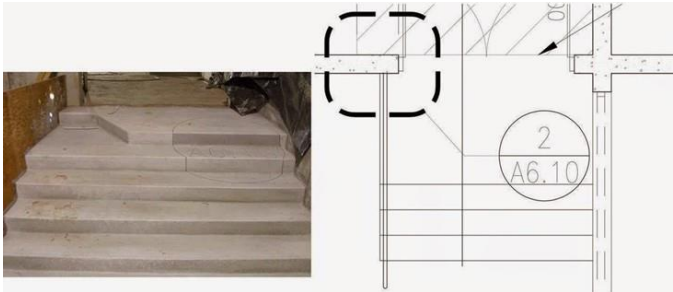
42

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21

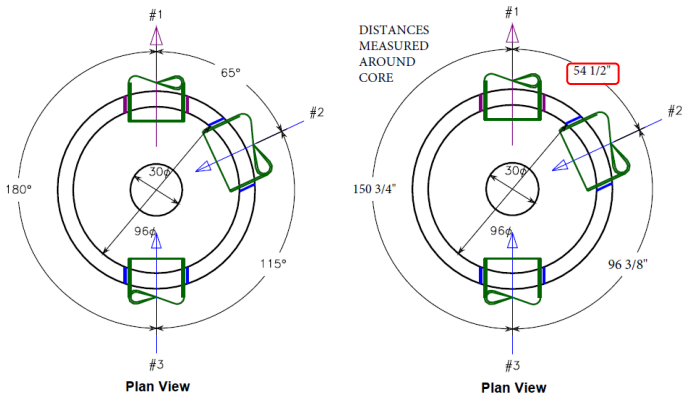
Challenges

- Labels inside objects



Challenges & Limitations

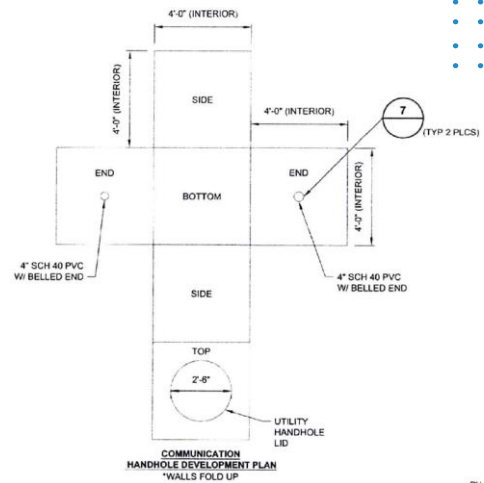
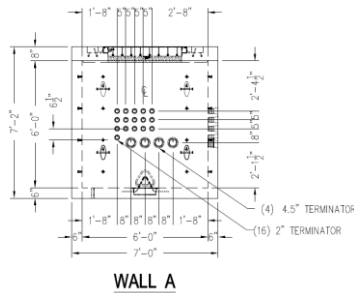
Automated
Software



Deg.	Inches of Circumference	
	I.D.	O.D.
10	8.375	10
20	16.75	19.875
30	25.125	29.875
40	33.5	39.75
50	41.875	49.75
60	50.25	59.75
70	58.625	69.625
80	67	79.625
90	75.375	89.5
100	83.75	99.5
110	92.125	109.375
120	100.5	119.375
130	108.875	129.375
140	117.25	139.25
150	125.625	149.25
160	134	159.125
170	142.375	169.125
180	150.75	179.125

Limitations

Perspective: Outside-Looking-In



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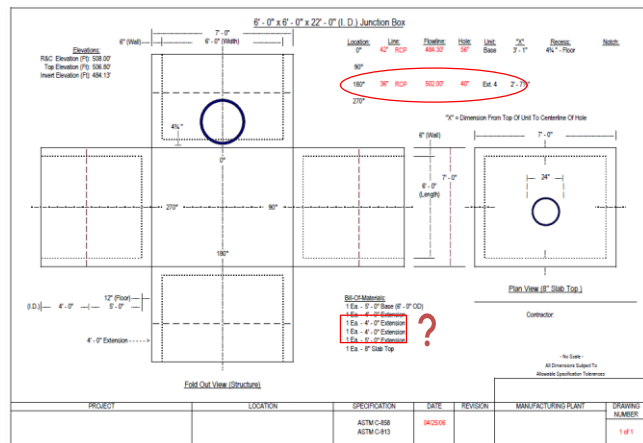
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45

Limitations

Limitations of “butterfly” layout

- Inside-Looking-Out
- Items not depicted
- Not to scale



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46



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Overview

- Types and Formats That Work Best
- Key Elements of Shop Drawings
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- **Best Practices, Tips and Tricks**



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Best Practices

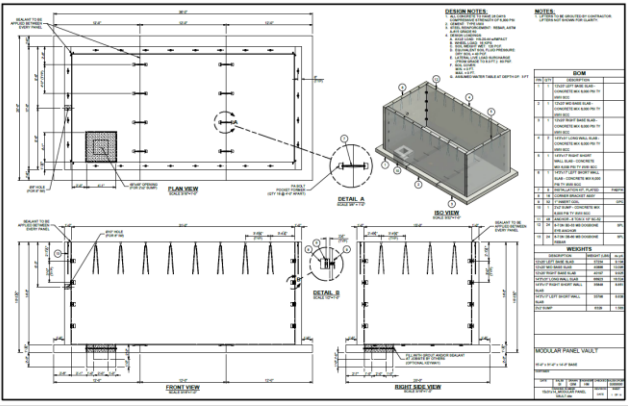
- Drawing size and reproduction
- Drawing layout and information location
 - Duplicate information
 - Use of notes
 - Callouts
- Check, check, check
- Automate frequent tasks
 - Standard or Special?
- Training
- Continuing education

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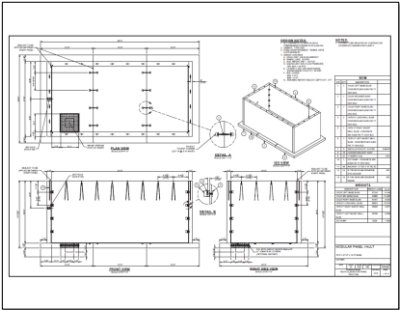
Drawing Size

Resolution loss due to reproduction



Drawing Size

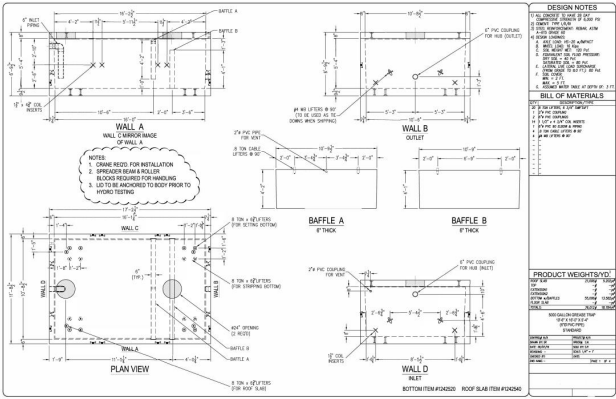
Resolution loss due to reproduction



Hard to read
Scale is lost

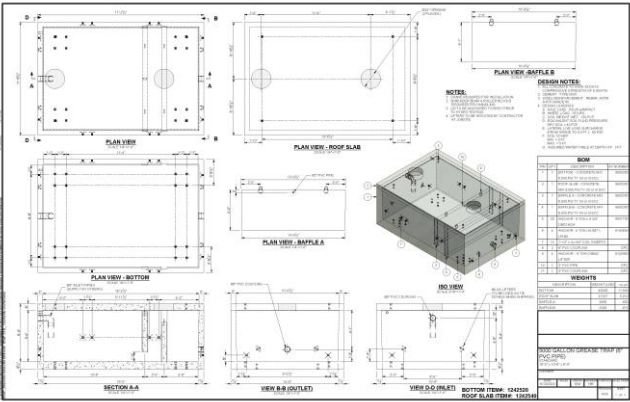
Layout & Information Location

- Duplicate information
- Use of notes
- Callouts



Layout & Information Location

- Duplicate information
- Use of notes
- Callouts





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Layout & Information Location

ITEM	QTY	UNIT	DESCRIPTION
1	1	EA	PRECAST CONCRETE WALL
2	1	EA	PRECAST CONCRETE FLOOR
3	1	EA	PRECAST CONCRETE ROOF
4	1	EA	PRECAST CONCRETE COLUMN
5	1	EA	PRECAST CONCRETE BEAM
6	1	EA	PRECAST CONCRETE JOIST
7	1	EA	PRECAST CONCRETE SLAB
8	1	EA	PRECAST CONCRETE CURB
9	1	EA	PRECAST CONCRETE SILL
10	1	EA	PRECAST CONCRETE CHASE
11	1	EA	PRECAST CONCRETE NICH
12	1	EA	PRECAST CONCRETE LINT
13	1	EA	PRECAST CONCRETE SKE

THE PRECAST SHOW
DALLAS, TX
REVIEWED

55

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Best Practices

- Cross checking
- Use of approval stamp

REVIEWED

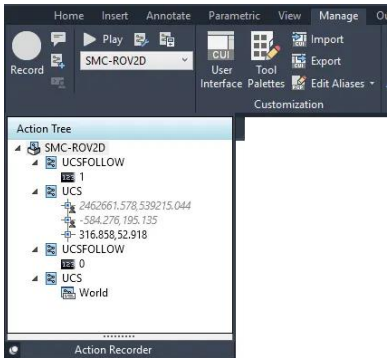
By Hugh Martin, P.E. at 12:36 pm, Jan 15, 2025

DATE	SALES	DRAWN	ENGINEER	CHECKED	SALES ORDER
6/24/22	PV	VJM	HM		S035284
DRAWING NUMBER				REVISION	SHEET
				2	1 OF 5
				REV DATE	
				4/26/22	

56

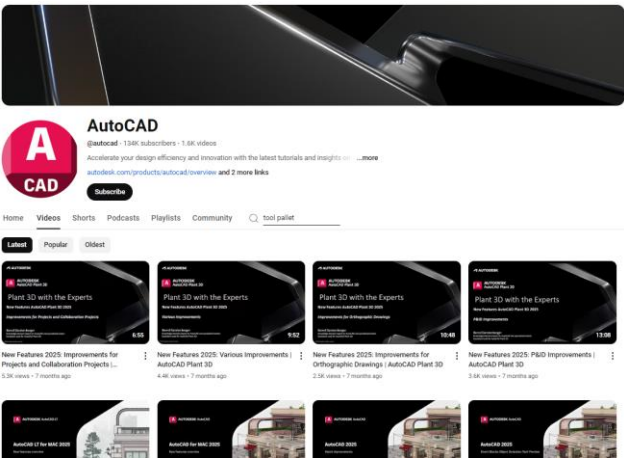
Best Practices

- Automate repetitive tasks
 - Macros & Scripts
 - LISP
 - Object-oriented (VB.NET)
 - Fortify CAD block library
 - Consider compatibility



Best Practices

- Training and Continuing Education
 - New team members
 - Veteran team members
 - Sources





Conclusion





The Seven C's of Precast Shop Drawings:

- Clear – Easy to understand
- Correct – Drawings are much less expensive than concrete!
- Concise – Too much information is almost as bad as too little
- Consistent – Must follow well-established drawing standards
- Common – There should be a detailed drawing for every fabricated product in the plant
- Convenient – An unused drawing is as bad as none at all
- Checked – Peer-reviewed to reduce or eliminate errors

59





Questions and Discussion

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60

61

62

