

Formwork Considerations for Building Design

Ceco Concrete Construction, L.L.C

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Ceco Concrete Construction


- Founded in 1912
- Concrete Engineering Company of Omaha
- Full range of concrete construction services from formwork to full concrete frame
- Owned equipment and in-house engineering
- Pre-bid collaboration with design teams

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Ceco Concrete Construction



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Agenda

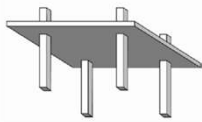
- Structural Concrete Systems
- Common Horizontal Forming Systems
- Formwork System Selection
- Building Design Factors That Affect Formwork Economy
- Formwork Economy and Constructability



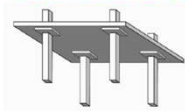
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Structural Systems

Flat Plate



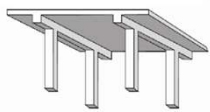
Flat Slab / Flat Plate with Drops



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Structural Systems


Beam and Slab




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Structural Systems


One-Way Joist Slab



Skip Joist / Wide Module



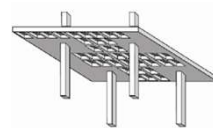
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Structural Systems

Two-Way Joist (Waffle)



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Structural Systems

Standard System Selection Guide						
Horizontal Structural System	Office Buildings	Hotels	Multi Family	Institutional *Hospitals/Schools	Parking Garages	Mixed Use
Standard One-Way Joist	x			x		x
Wide Module One-Way Joist	x			x		x
Standard Two-Way Joist				x		
Flat Plate		x	x			x
Beam and Slab					x	

Visit our website or contact a Ceco representative for more information on structural system selection

www.cecoconcrete.com


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Horizontal Forming Systems


- Formwork consists of the **labor** and **material** required to contain concrete in its plastic state
- Formwork costs can be as much as 50% of the cost of a concrete frame

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Horizontal Forming Systems


- The total load for a 12" deep, 10,000 SF slab is over 2,000,000 pounds (concrete + live load + form load)
- Formwork system temporarily supports the loads while reshores distribute loads throughout the structure

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Horizontal Forming Systems


- There are many ways to safely shore a supported slab, our mission is to find the "best way"
- Each forming system has different advantages and disadvantages

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Horizontal Forming Systems

- Stick / Hand-set
- Modular Framing
- Flying Table / Truss
- Steel Beam
- Column Mounted

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Stick / Hand-Set



- Loose framed members
 - lumber or aluminum
- Flexible / customizable
- Labor & time intensive
- Material intensive

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Stick / Hand-Set



Selection Considerations


- Odd sizes & Shapes
- Low re-use opportunity on equipment (1 – 2 uses)
- May not require crane
- Poor access conditions
- Low equipment cost, high labor cost


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Modular Framing


- Standardized panels & components
- Moderately efficient
- Flexible / modifiable to most conditions
- Material intensive



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Modular Framing




Selection Considerations

- Handles some slab profile changes/interruptions
- Smaller units - less weight
- Mid-range re-use opportunity on equipment (2 - 4 uses)
- Poor access conditions
- Mid-range equipment & labor cost


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Flying Table / Truss




- Designed from steel and aluminum to provide a lightweight, high capacity system
- Very efficient
- Hoisting intensive

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Flying Table / Truss



Selection Considerations

- Crane capacity & reach
- Highly repetitive footprint
- Schedule / fast cycle times
- High equipment cost, lower labor cost

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Steel Beam



Selection Considerations

- Steel beam form designed specifically for parking structures
 - Sections bolt together to create one piece beam form
 - Deck panels span from beam to beam
- Efficient system with only a few components
- Hoisting intensive

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Steel Beam



Selection Considerations


- Crane capacity & reach
- Repetitive footprint
- Schedule / fast cycle times
- High equipment cost, lower labor cost


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Column Mounted


- Prefabricated system that utilizes walls or columns for vertical support
- Reduces vertical shoring components
- Eliminates reshores
- Relies on consistent column placement
- Requires high level of formwork engineering



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Column Mounted



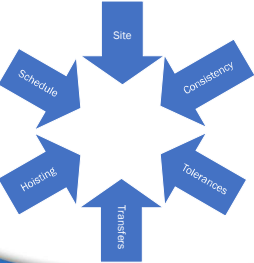
Selection Considerations

- Crane capacity & reach
- Repetitive footprint
- High equipment cost, lower labor cost

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System Selection



System selection is most often driven by building design

Other factors to consider.....

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System Selection



Site Considerations

- Staging area
- Make up area
- Ground conditions
- Air rights / neighbors

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System Selection



Consistency

- Structural system changes
- Footprint stepping in/out
- Story height changes

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System Selection

Tolerances

- Specified finish
- Exposed to view

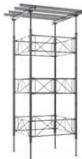
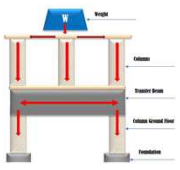



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System Selection

Transfer Conditions




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System Selection

Hoisting

- Crane
- Capacity of crane
- Reach of crane
- Crane location
- Availability of crane



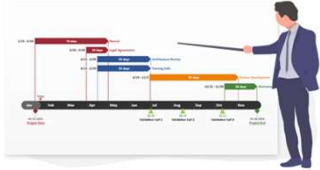
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System Selection

Schedule

- Cycle times
- Out of sequence work
- Interruptions/delays



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Design Factors Affecting Formwork Economy



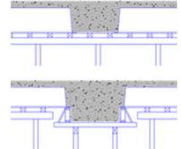
A consistent design leads to repeatability of forming systems

Repeatability = Savings \$\$

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Design Factors Affecting Formwork Economy



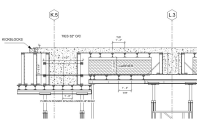
Flat soffits save money

- A 20x66 flat pan job will beat a 16x66 with 4" drop beams every time

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Design Factors Affecting Formwork Economy



Flat soffits save money

- Uniform beam depths bay to bay and floor to floor save money

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Design Factors Affecting Formwork Economy

Slim and Wide Module Pan Forms

- Standard sized pan forms are significantly cheaper than custom forms

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Design Factors Affecting Formwork Economy

Angled Edges

- Squared off end caps avoid costly wood framed angles

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Design Factors Affecting Formwork Economy

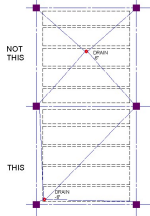
Drop Spandrels Increase Cost

- A flat spandrel with embeds for steel framing costs less than a drop spandrel

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Design Factors Affecting Formwork Economy



- Drain Locations
- Avoid locating drains in the center of a bay
 - One directional sloping is best



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Design Factors Affecting Formwork Economy



- Pour Delay Strips
- Increase shoring loads and tie up additional equipment
 - Impede ability to move material on lower floors



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Formwork Economy & Constructability



Best opportunity to save costs are realized during the design phase of a project.



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Formwork Economy & Constructability

Three basic principals for constructability and concrete frame economy

- Design repetition
- Industry standard forming materials
- Dimensional consistency



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Formwork Economy & Constructability



Design repetition



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Formwork Economy & Constructability

Figure 11 Designing to Nominal Lumber Dimensions

STANDARD NOMINAL LUMBER DIMENSIONS			
Nominal Size	Actual Size	Add for Joints	Total Drop
2X	1 1/2"	1/2"	2 1/2"
4K	3 1/2"	1/2"	4 1/2"
6K	5 1/2"	1/2"	6 1/2"
8K	7 1/2"	1/2"	8"



Industry Standard Forming Materials



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Formwork Economy & Constructability

Dimensional Consistency

- Maintain consistent construction depth
- Maintain consistent beam and joist spacing
- Maintain consistent joist, beam and column sizes



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Formwork Economy & Constructability

Overall Structure Cost



• Formwork • Reinforcing • Concrete

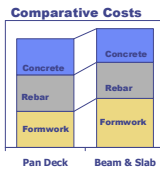
Minimize overall cost with a focus on formwork



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Formwork Economy & Constructability

Achieve lower cost by understanding the trade off between formwork labor and material



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Formwork Economy & Constructability

Materials

- Number of uses drives costs
- Handling material costs money (Pan project requiring 25,000 sf of material will have over 200 tons of materials)

Labor

- Consider 1 CY concrete is cheaper than 2 hours of labor

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Formwork Considerations for Building Design

Questions?

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