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# ROLE OF FORMWORK SYSTEMS IN HIGH-RISE CONSTRUCTION

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# Outline

- **Introduction**
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  - Current practices
  - Research gap
  - Research Objectives
- **Background**
  - Formwork selection parameters
  - Formwork Types
- **Research method**
- **Research findings**



# Introduction

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- Topic
  - The paper studies the role of formwork systems in high-rise construction
- Current practices
  - Current practices in selecting formwork systems focus solely on optimizing concrete activities without relating formwork choice to the entire construction workflow
- Research gap
  - None of the literature reviewed targets this important aspect of formwork selection
  - Formwork choice is usually left to constructors experience and organizational knowledge

# Research Objectives

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Understand the differences between regular and advanced formwork systems

Map and trace major construction workflow changes resulting in each case

Highlight major enhancements on construction flows, productivity and safety

# Background – Formwork Selection Parameters

Table 1: Internal and external parameters governing the selection of formwork system (Gnida, 2010)

Internal Parameters		External Parameters	
Geometry	<ul style="list-style-type: none"> <li>• Repetitive</li> <li>• Simple/ Complex</li> <li>• Changing Geometry</li> </ul>	Space	<ul style="list-style-type: none"> <li>• Constraint of Existing Road or Building</li> <li>• Storage Area</li> <li>• Assembly Area</li> </ul>
Concrete	<ul style="list-style-type: none"> <li>• Rate of Pouring/ Concrete Pressure</li> <li>• Concrete Finish</li> <li>• Curing Time</li> </ul>	Wind	<ul style="list-style-type: none"> <li>• Wind Load</li> </ul>
Sequence of Work	<ul style="list-style-type: none"> <li>• Cycle Time</li> </ul>	Crane	<ul style="list-style-type: none"> <li>• Capacity</li> <li>• Availability</li> <li>• Type</li> <li>• Boom Reach</li> </ul>
Formwork Choice	<ul style="list-style-type: none"> <li>• Existing Formwork Material to be Reused</li> <li>• Rental or Purchase</li> <li>• Best Value for Current Project vs. Flexibility for Future Projects</li> </ul>	Safety	<ul style="list-style-type: none"> <li>• Special Requirements Needed</li> </ul>
		Construction Planning	<ul style="list-style-type: none"> <li>• Milestones</li> <li>• Working Schedule/ Shifts</li> <li>• Project Duration</li> <li>• Holidays</li> </ul>
		Local Rules and Regulations	<ul style="list-style-type: none"> <li>• Permits</li> <li>• Restricted Noise</li> <li>• Safety Requirements</li> </ul>

# Background - Formwork Selection Parameters

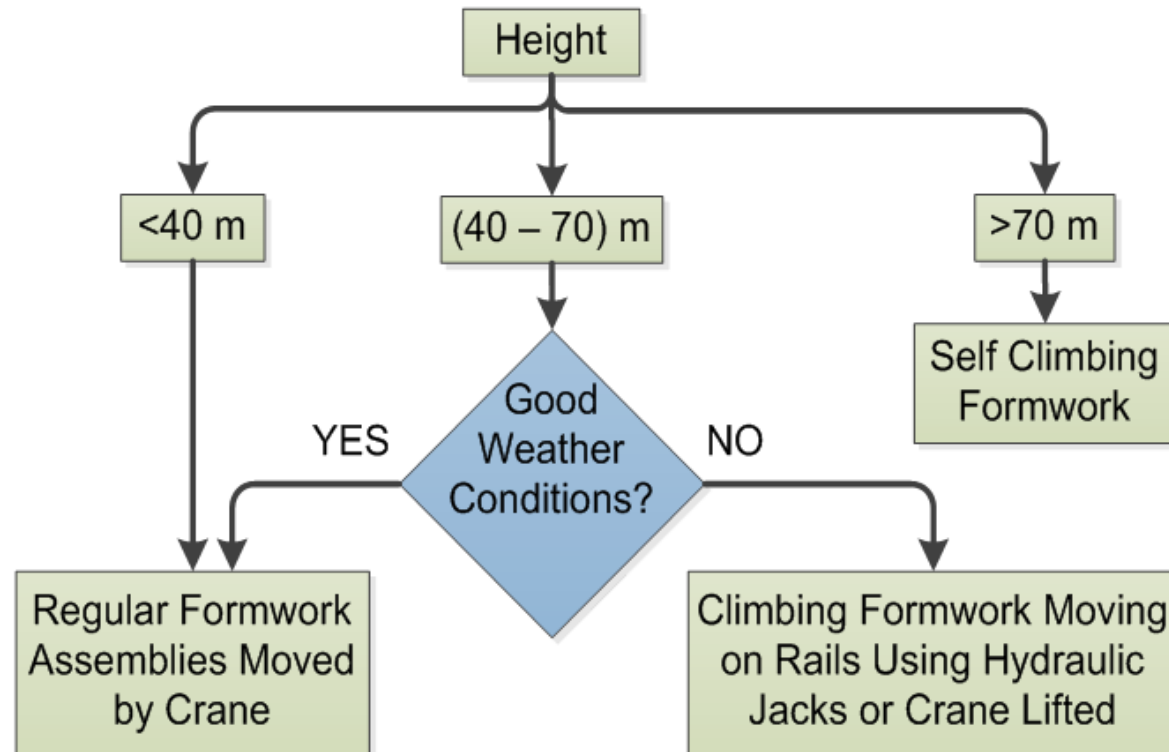


Figure 1: Formwork choice according to building height and weather conditions (Ciribini and Tramajoni, 2010)

# Background - Formwork Classification

Table 2: Formwork classification (Classification of Formwork, N.d.)

Classification Category			
Size	<ul style="list-style-type: none"> <li>• Small-Sized: operated manually</li> <li>• Large-Sized: crane facilities are required in the operation, or self-climbing</li> </ul>		
System vs. Location of Use	<ul style="list-style-type: none"> <li>• Traditional timber form /Aluminum form: irregular frame structure</li> <li>• Gang form /Climb form /Jump form: core wall</li> <li>• Table form: slabs</li> <li>• Tunnel form: repeated regular section</li> </ul>		
Construction Materials	<p>Timber:</p> <ul style="list-style-type: none"> <li>• Adaptable to complex shape.</li> <li>• Labor intensive</li> <li>• Environmentally unfriendly</li> <li>• Low initial cost</li> <li>• Most popular</li> </ul>	<p>Steel:</p> <ul style="list-style-type: none"> <li>• Sections: Hot rolled or Cold formed</li> <li>• Heavy weight</li> <li>• Suitable for large-sized panels</li> </ul>	<p>Aluminum:</p> <ul style="list-style-type: none"> <li>• Stiff and light weight</li> <li>• Excellent finish</li> <li>• High material and labor cost</li> </ul>
Nature of Operation	<ul style="list-style-type: none"> <li>• Manually Operated</li> <li>• Self-Lifted</li> <li>• Crane-Lifted</li> <li>• Gantry/Traveling/ Tunnel Type Systems</li> </ul>		

# Research Method

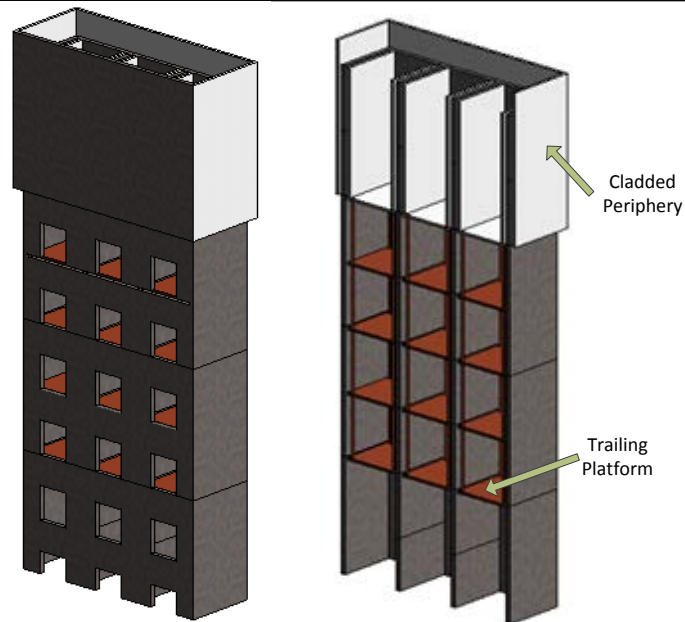




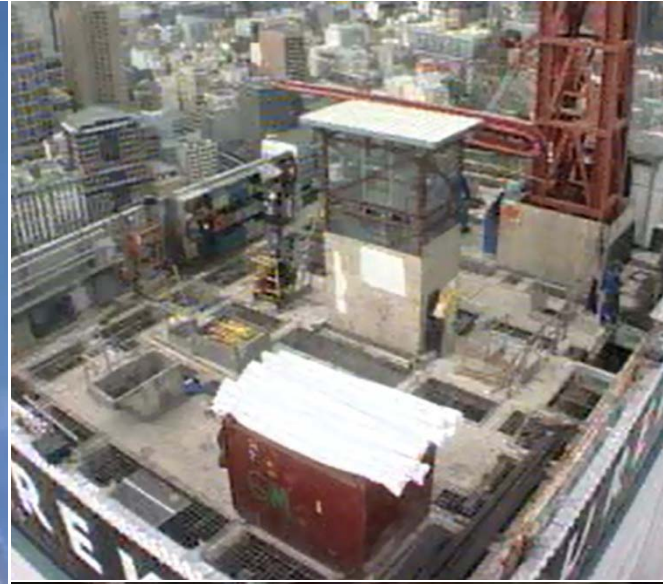
# Advanced and Regular Formwork Comparison

*Table 3: Advanced and regular formwork comparison*

Feature	Regular Formwork System	Advanced Formwork System
Self-Climbing Core-wall Formwork	✓	✓
Core wall Formwork Internal Lift	X	✓
Core wall Trailing Platform	X	✓
Perimeter System	X	✓
Internal Table Lifting Capacity	X	✓



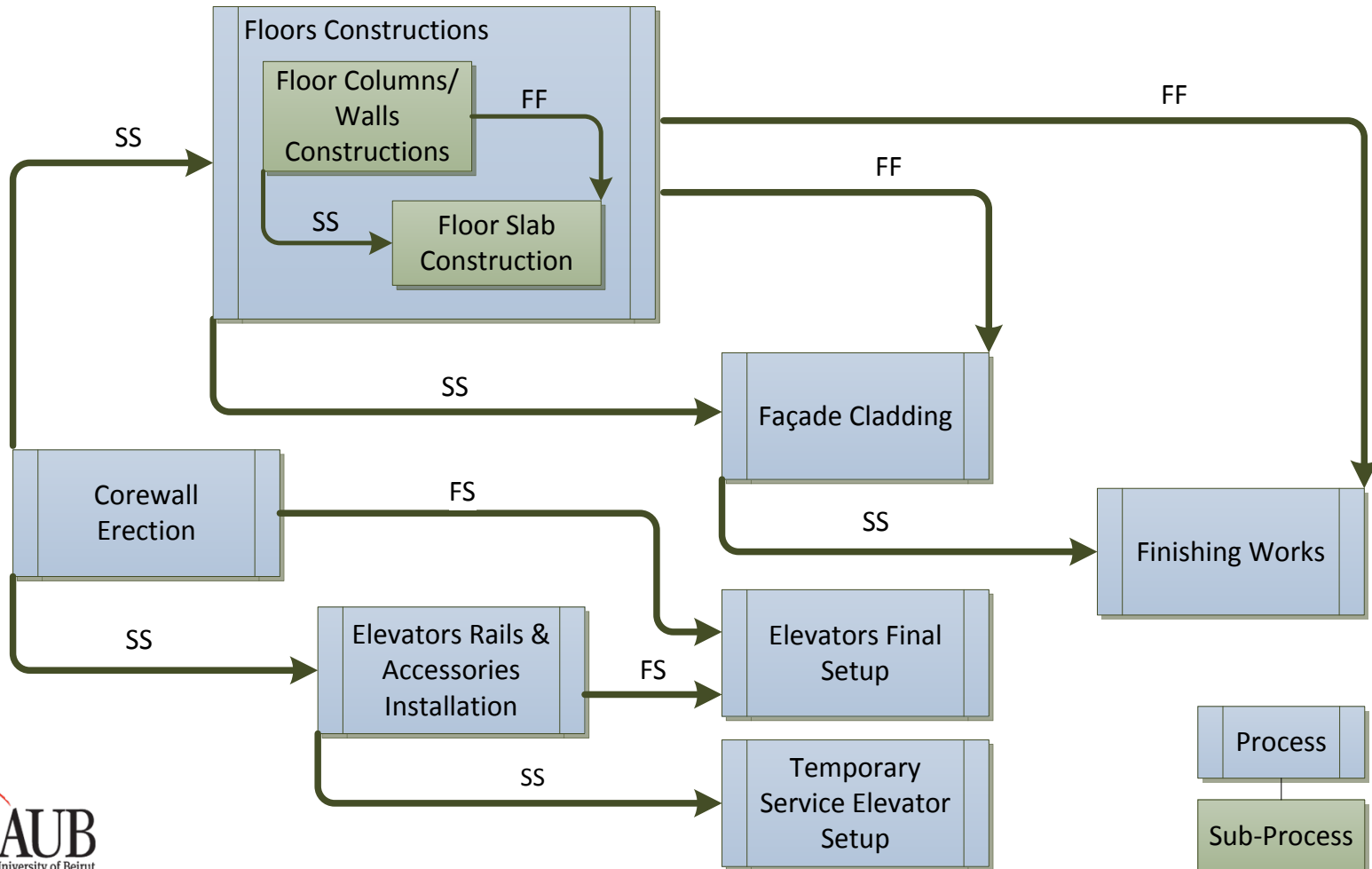
# Advanced and Regular Formwork Comparison



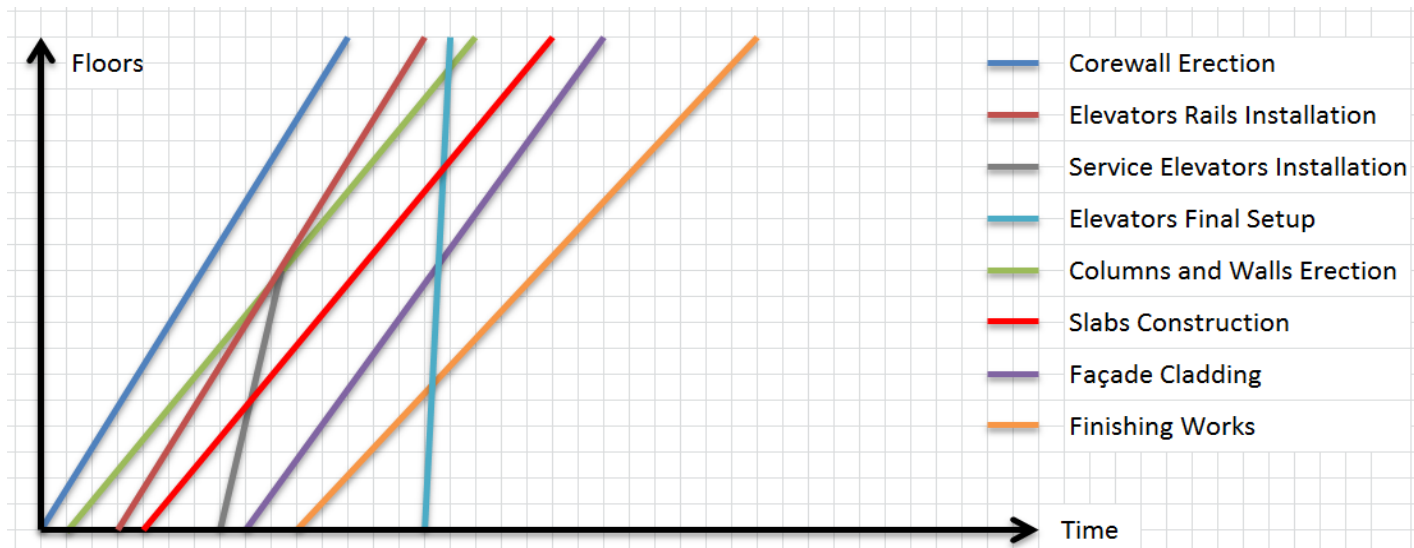
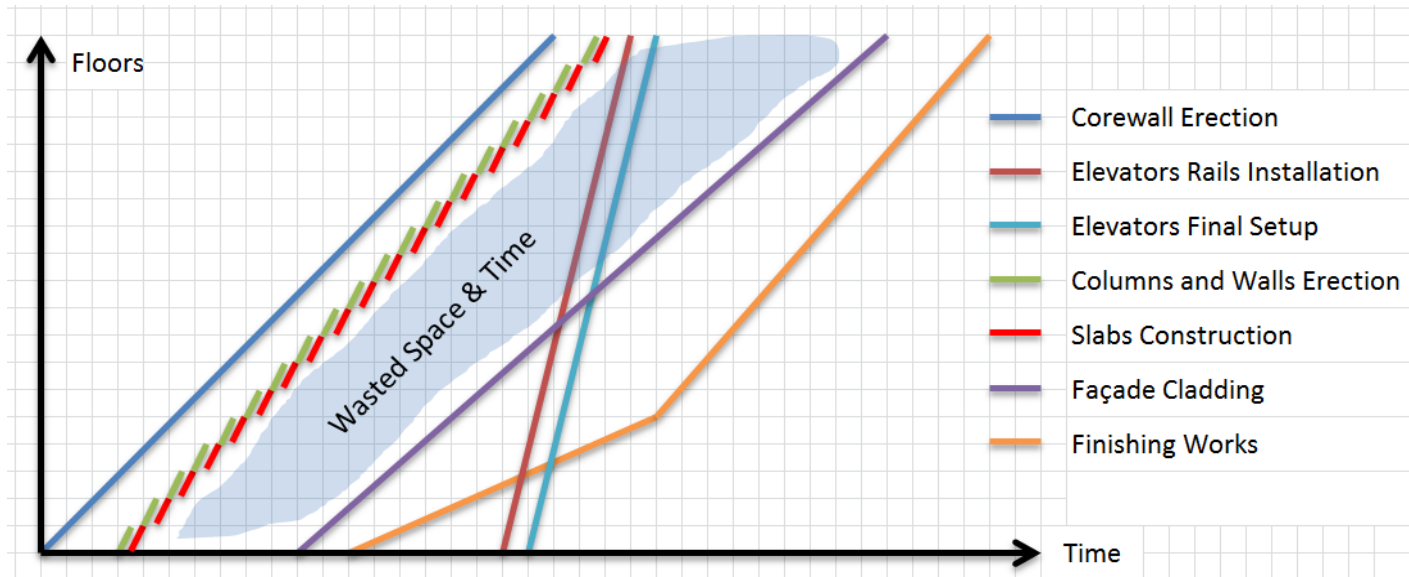
Advanced formwork systems  
(Double-Jump System  
Grocon, n.d.)

# Construction Workflow Alterations

- Case of advanced formwork



# Research Findings



# Research Findings

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- Workflow enhancement and cycle time reduction
  - Streamlined concrete and non-concrete activities
  - Independent construction of columns and slabs
  - Early setup of lifts
  - Early commencement of finishing activities
- Waste reduction
  - Less material wasted to follow design standards (couplers, rebar overlap)
  - Less material and labor idle time due to increased delivery capacity
  - More work space occupied (core-wall shafts)
- Reduced variability and increased flexibility
  - Enhanced labor and material flow on site
  - Stabilized production with smaller work batches

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# THANK YOU

