



# Site Cast Flat Slab Construction

Building Technology IV  
FALL 2013  
T.A.R GROUP

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### Site-Cast Flat slab construction

- Overview

### Research topics

- **System spans and effective span**
- Construction time and cost

### Case study I

- Architectural finishes available
- Connection Details

### Case study II

- System strengths and weakness
- Flexibility of the system  
diversity of form available

### Case study III:

The Ritz Carlton Luxury  
Condominiums and Hotel , NY, NY

A **flat slab** is a reinforced slab supported directly by concrete columns without the use of beams.

It is either built in a factory or built on site.



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Site cast **reinforced concrete** options include:

- One-way slabs
- Two-way slabs
- Ribbed slabs
- Waffle slabs
- Flat slabs

Site cast concrete can also be **prestressed** after casting the concrete and this is known as post-tensioning, and the options include:

- Flat slabs
- One-way slabs
- Ribbed slabs

# One way solid slab

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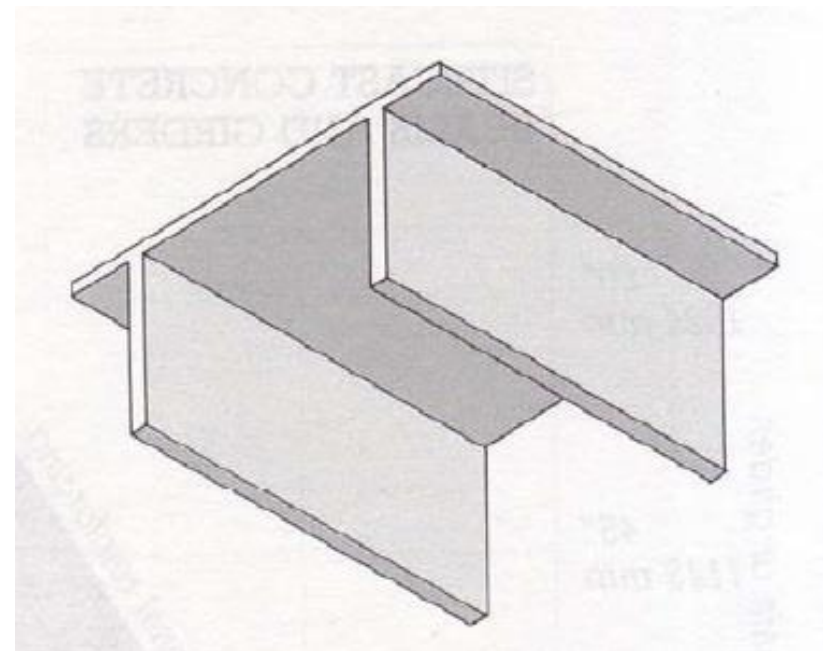
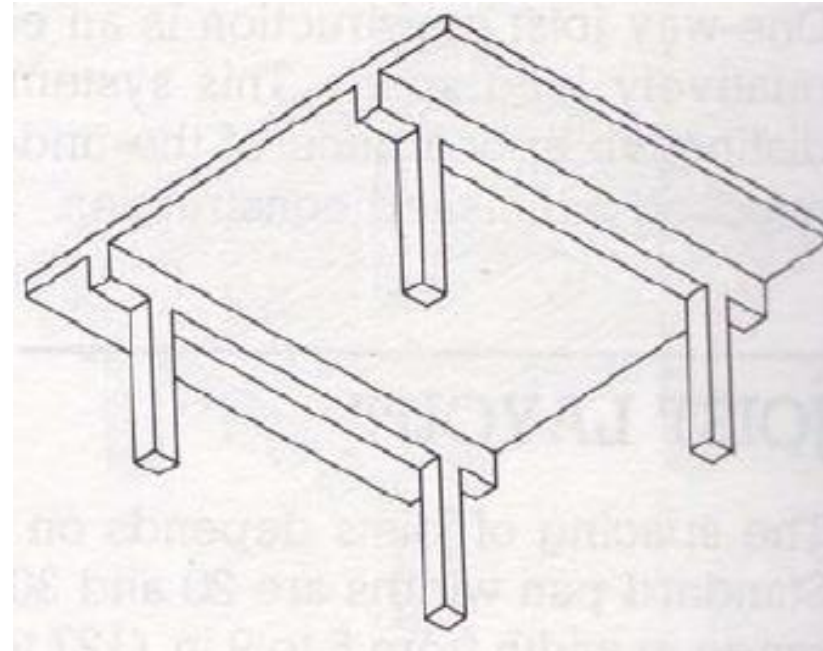
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- Least expensive
- Short spans and light loads
- Used for apartment buildings or hotels
- also used with bearing walls

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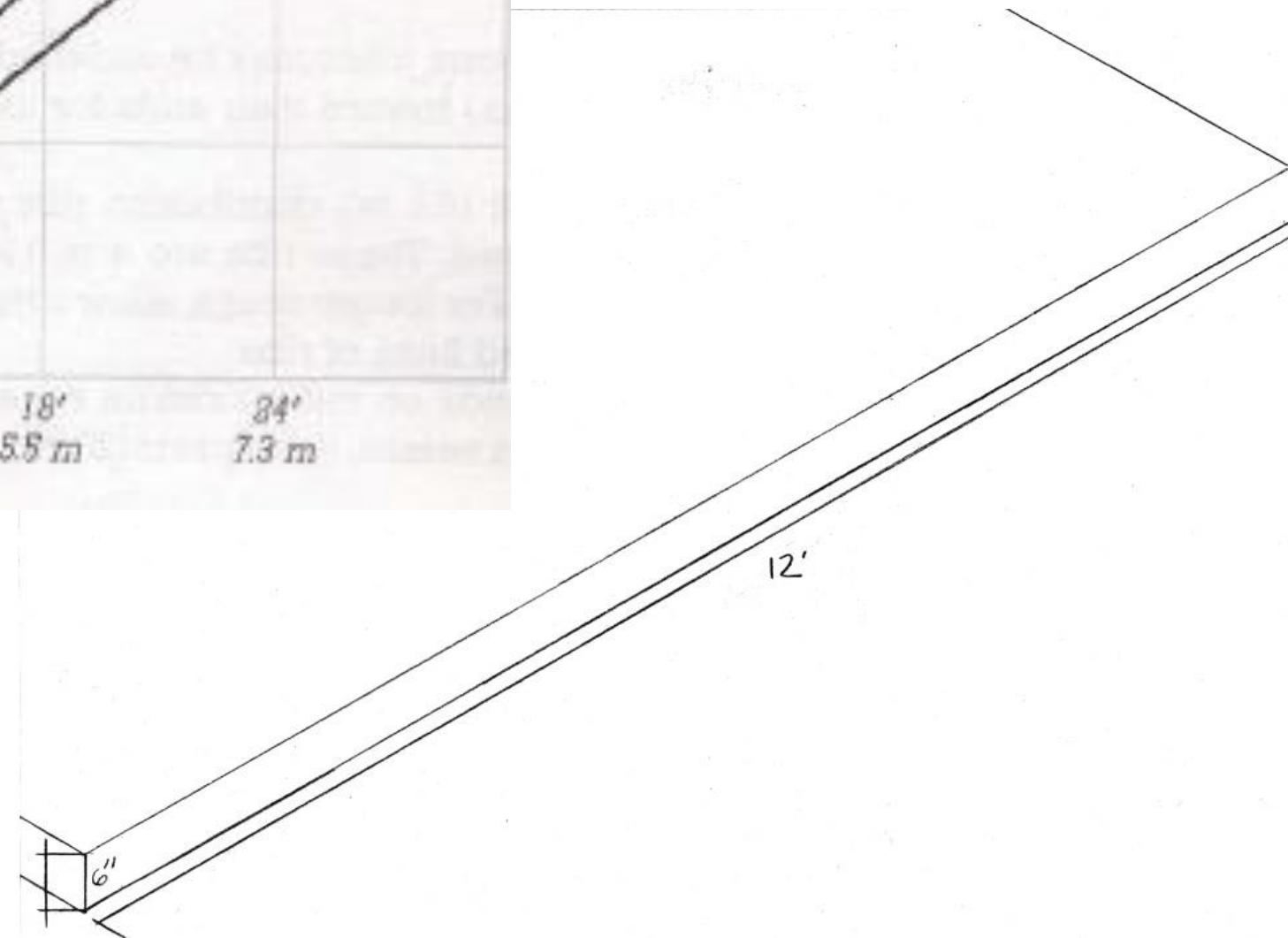
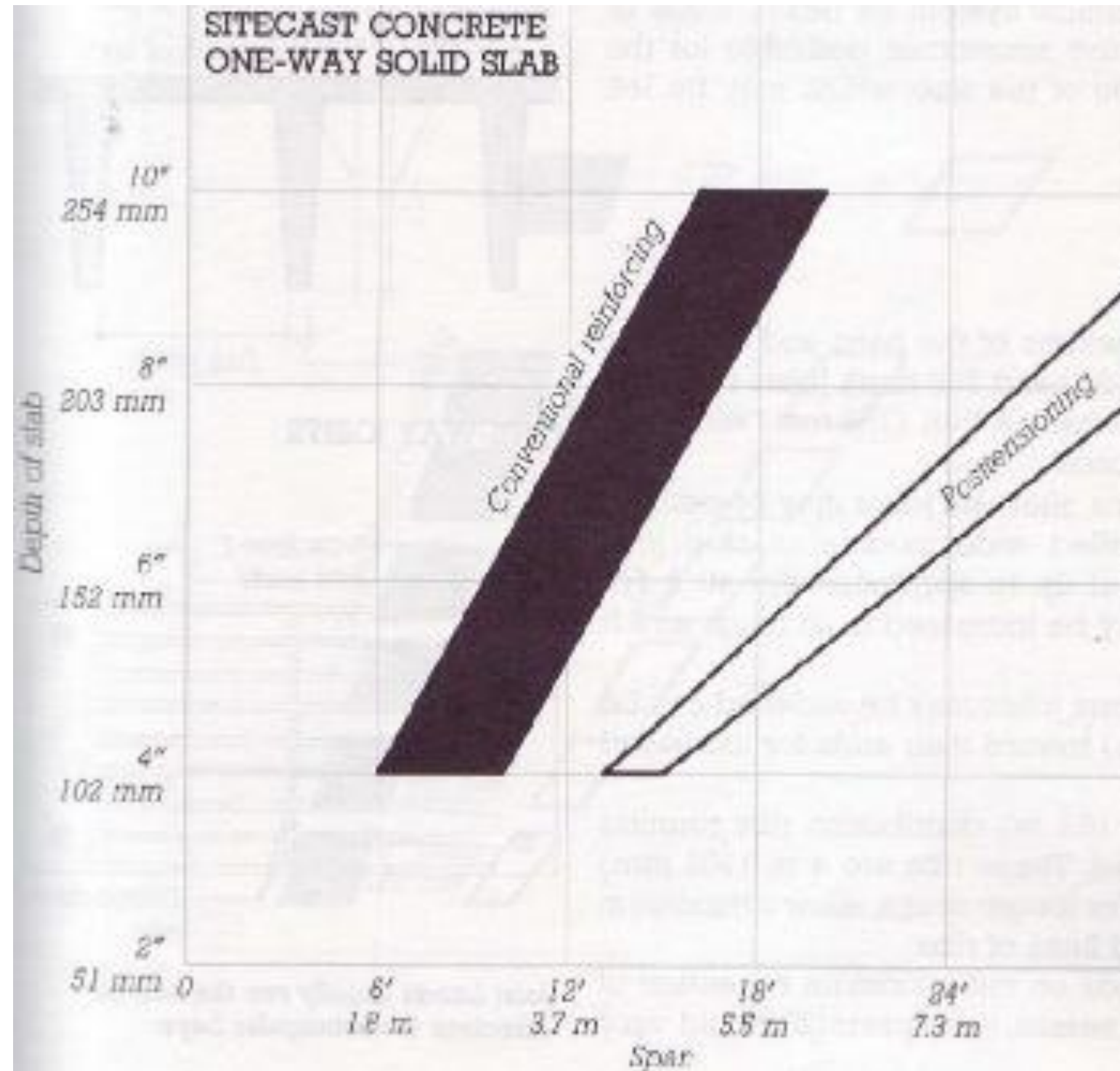
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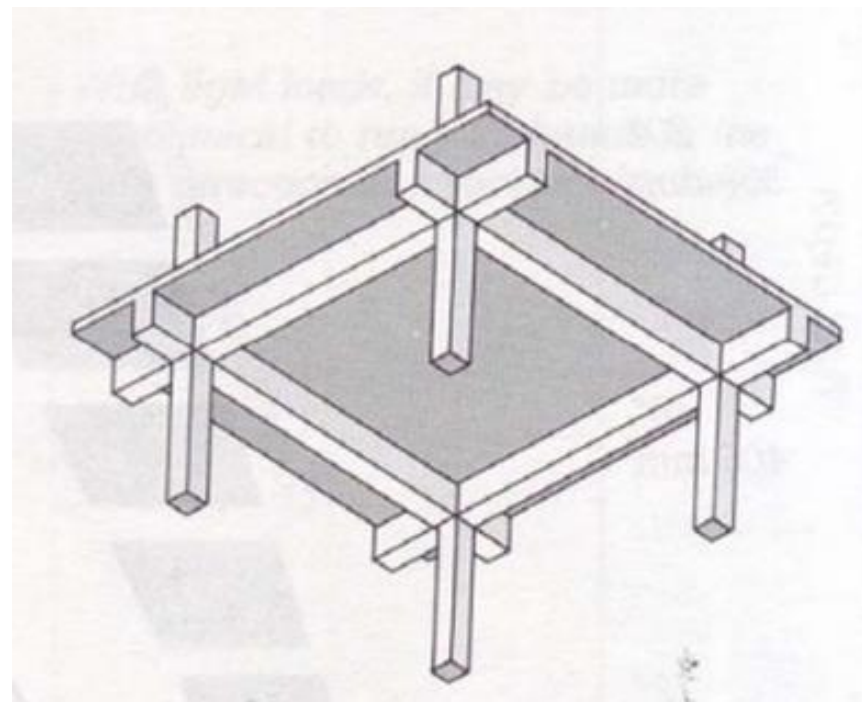
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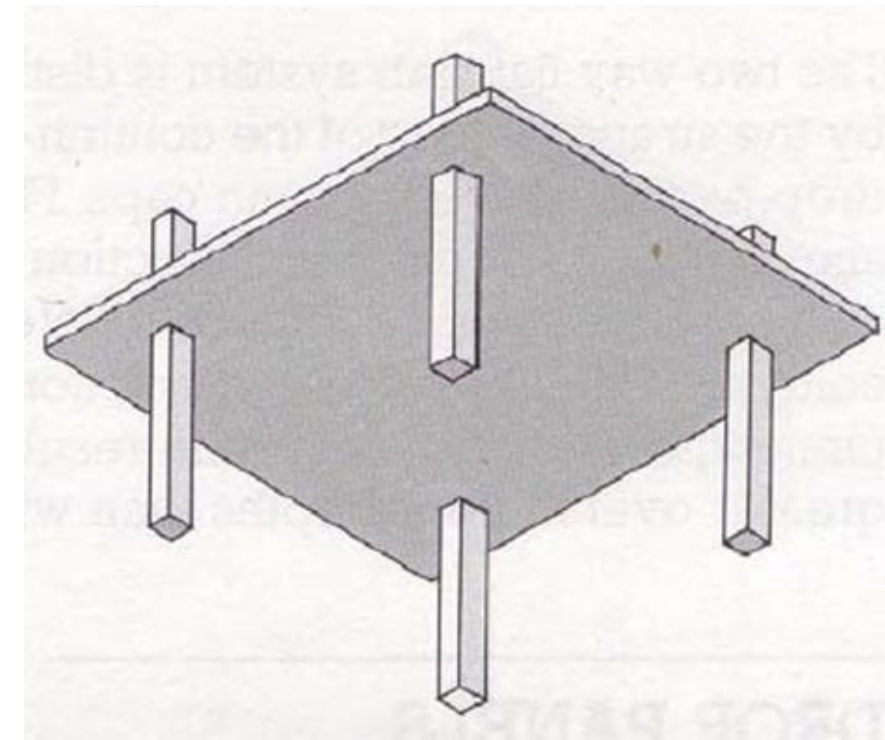
Condominiums and Hotel , NY, NY

- uses beams to support the slab between columns.
    - high construction cost
    - For heavy loads, like heavy industrial applications
    - Used where high resistance to lateral forces is required.
- \*Read on the posttensioning side of chart



## Two way slab and beam

## Two way flat plate



- economical concrete framing system
- Spans farther than one-way slabs
- simple to construct and easy to finish
- Commonly used in Residential buildings
  - Carries moderate live loads
- Flexibility of column placements permits greater ease of unit planning and layout

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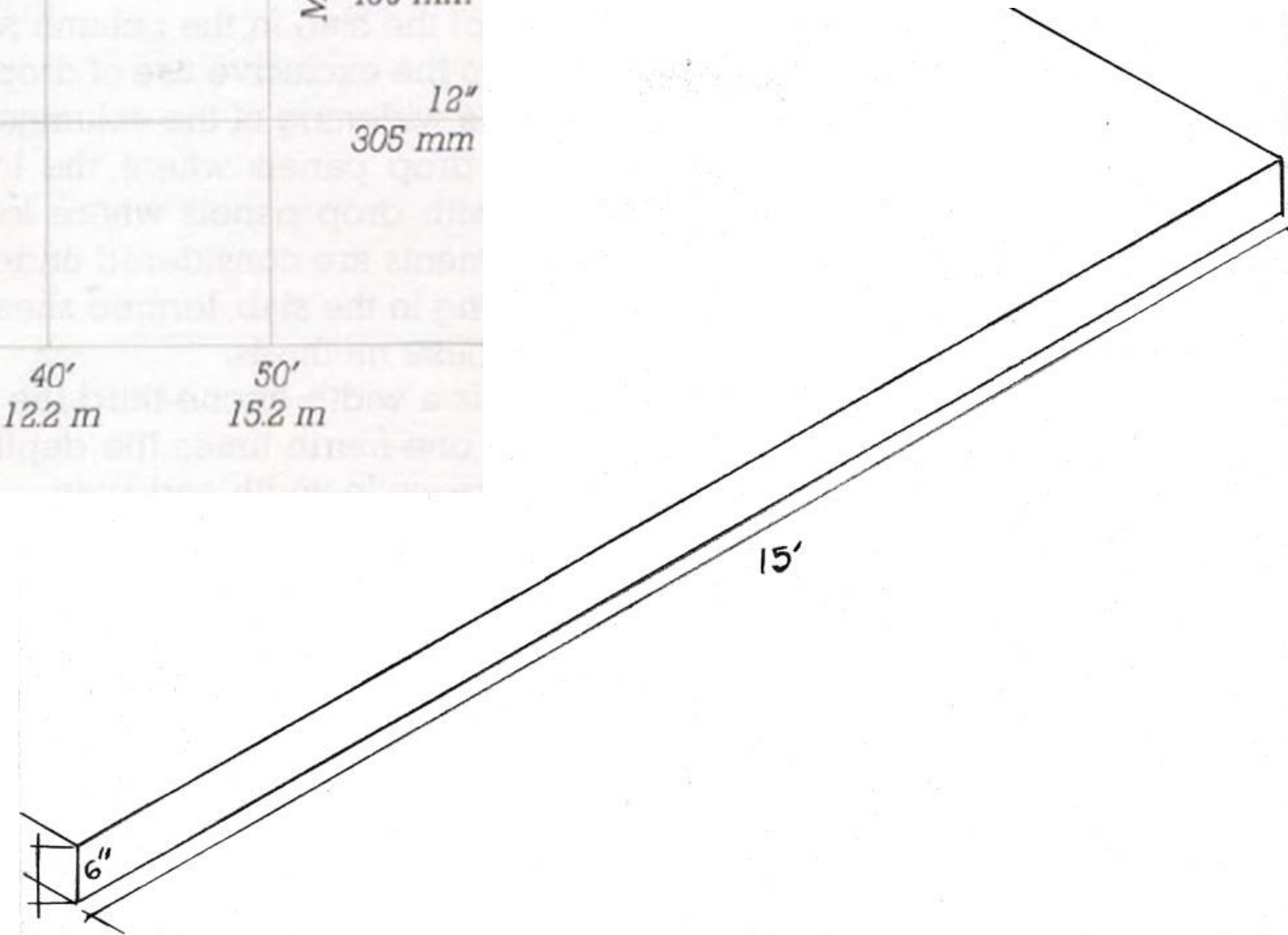
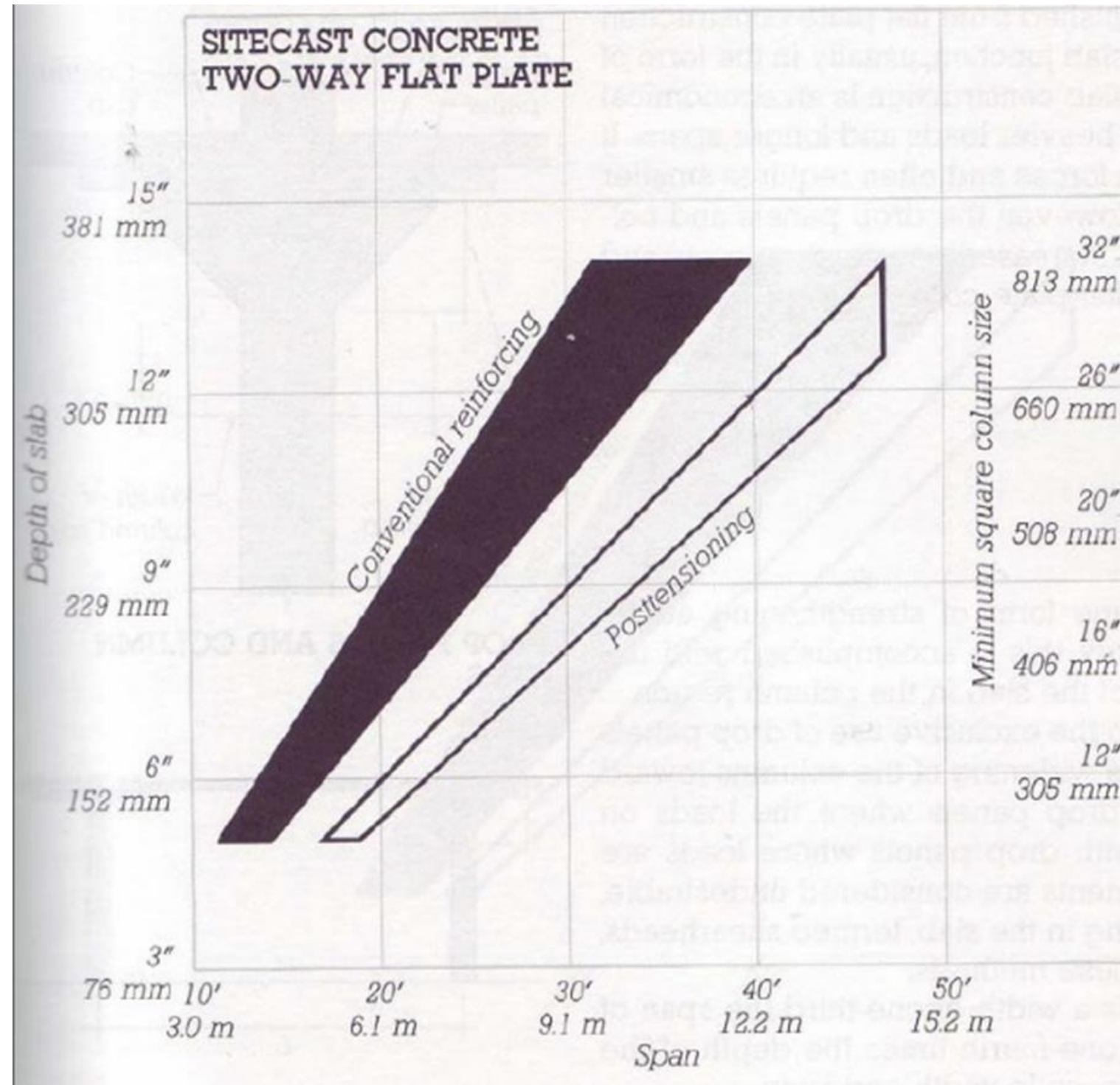
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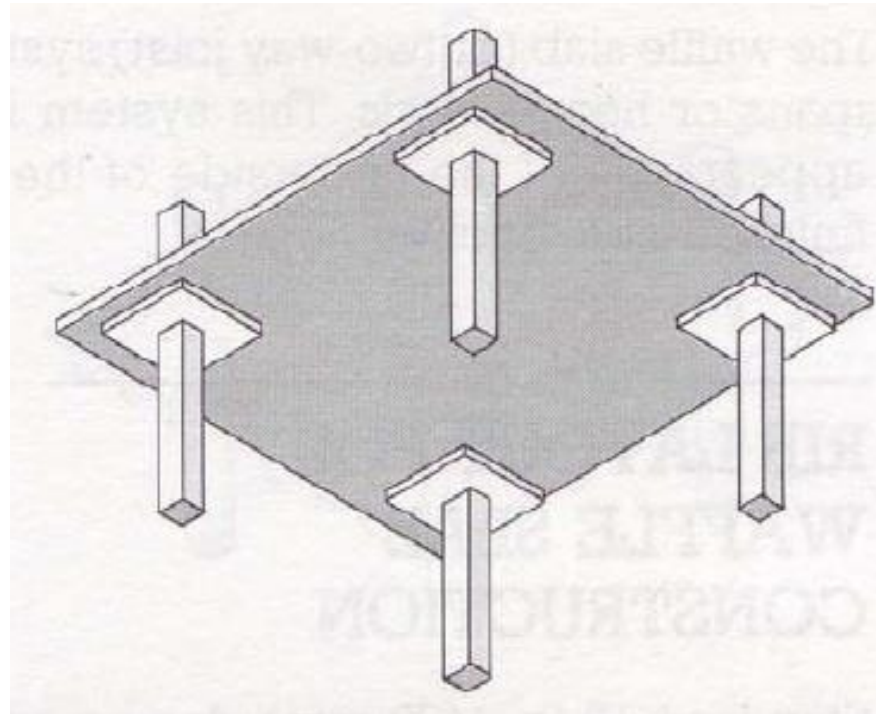
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# Two-way flat slab



This system distinguished from flat plate construction by the strengthening of the column-to-slab junction, usually in the form of drop panels and/or column caps.

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- an economical alternative to flat plate construction for heavier loads and longer spans
- increased resistance to lateral forces  
requires smaller columns than flat plate construction
- increased construction costs
- greater overall floor depths than with flat plate construction.



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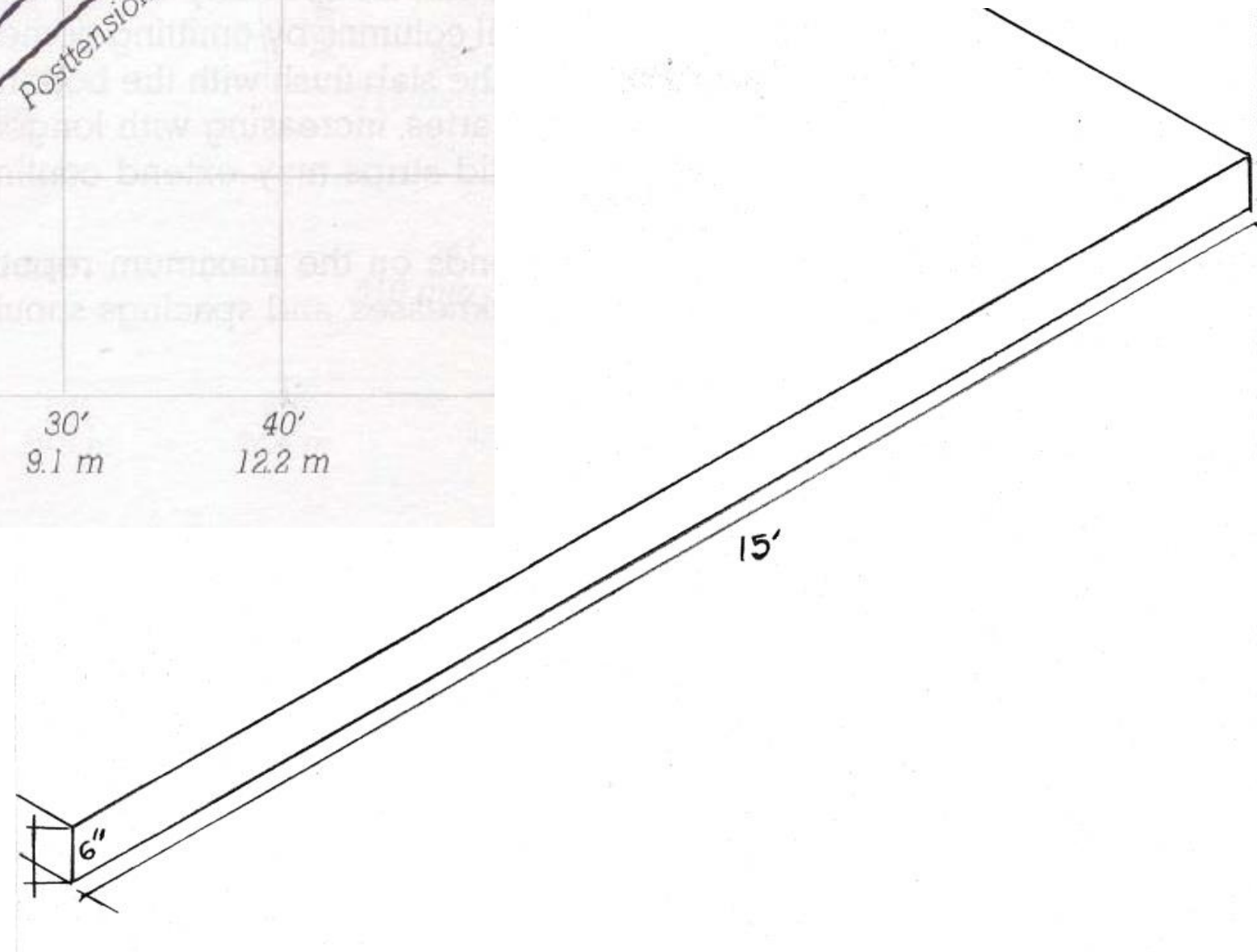
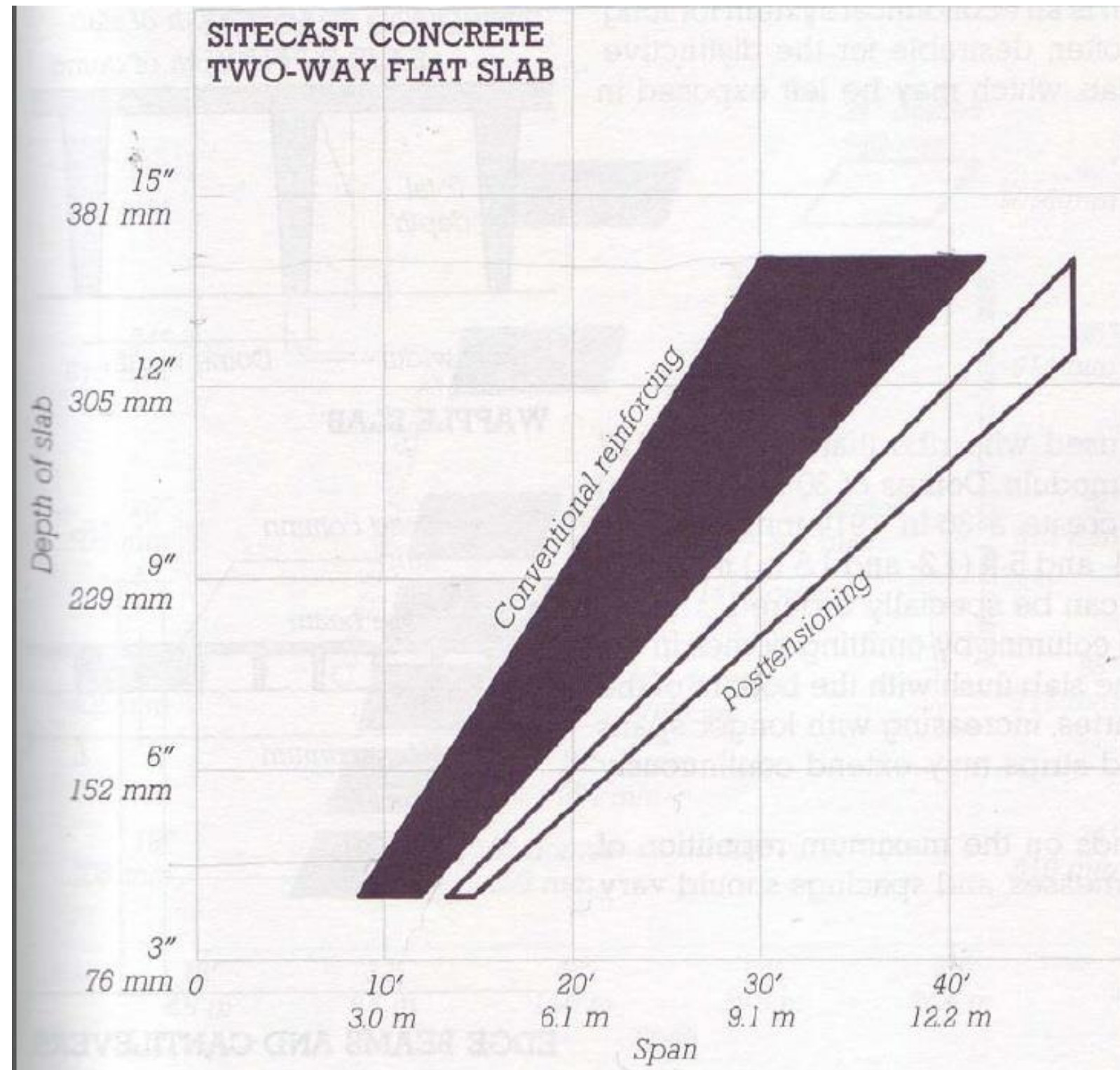
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## Elements that contribute to the cost of the system:

- Amount of concrete (account for spillage and slab depth variation)
- Strength (What is the best mix?)
- Delivery (overtime fees?)
- Concrete Forms & Finishes
- Concrete placing equipment
- Crew

\$120 and \$150 per **cubic yard** delivered in full truckloads (Standard concrete trucks commonly carry 10 cubic yards of concrete)

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$L$  (feet) x  $W$  (feet) x  $T$  (inches)  $\div$  12 = cubic feet of concrete (CF)

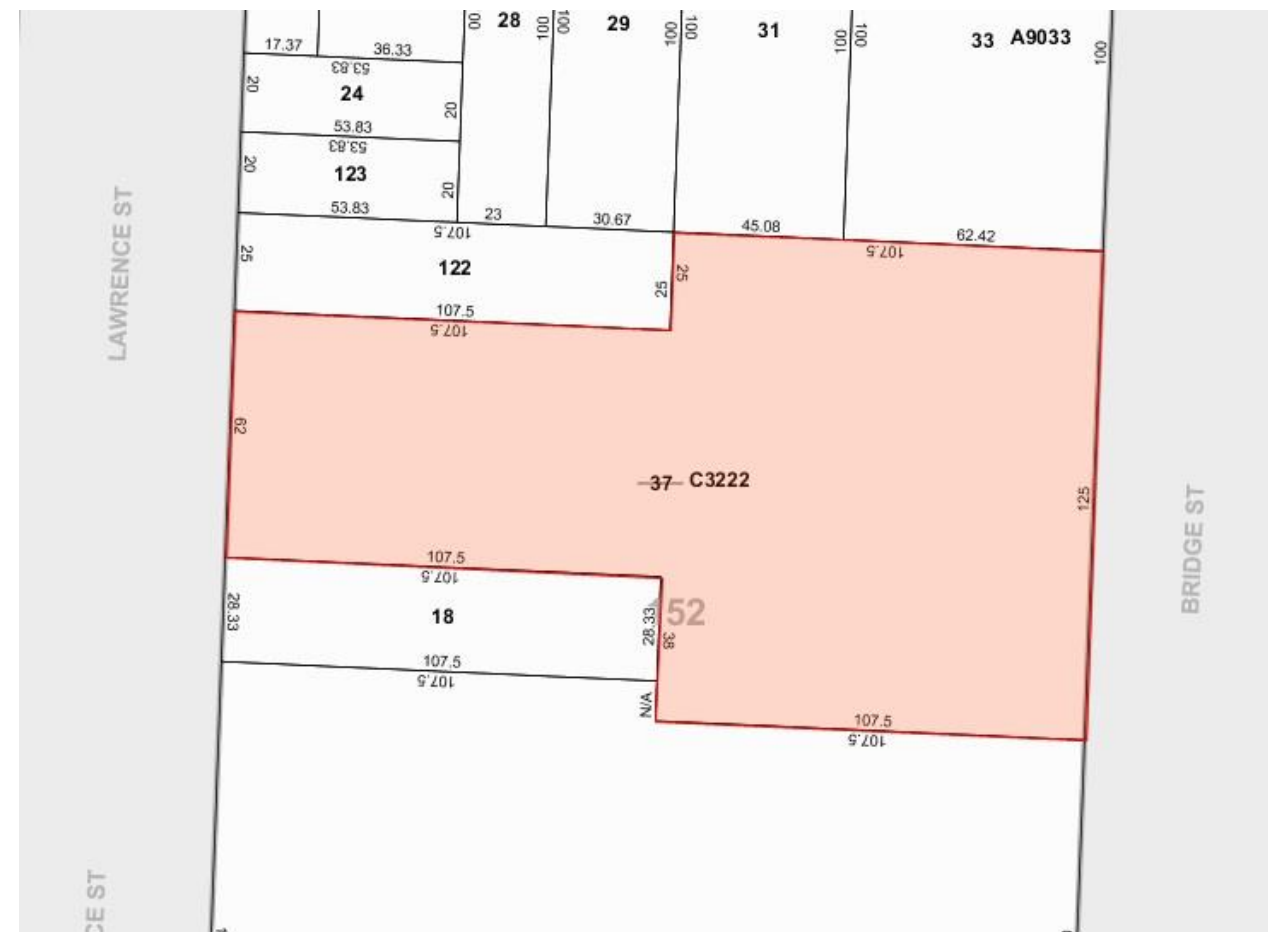
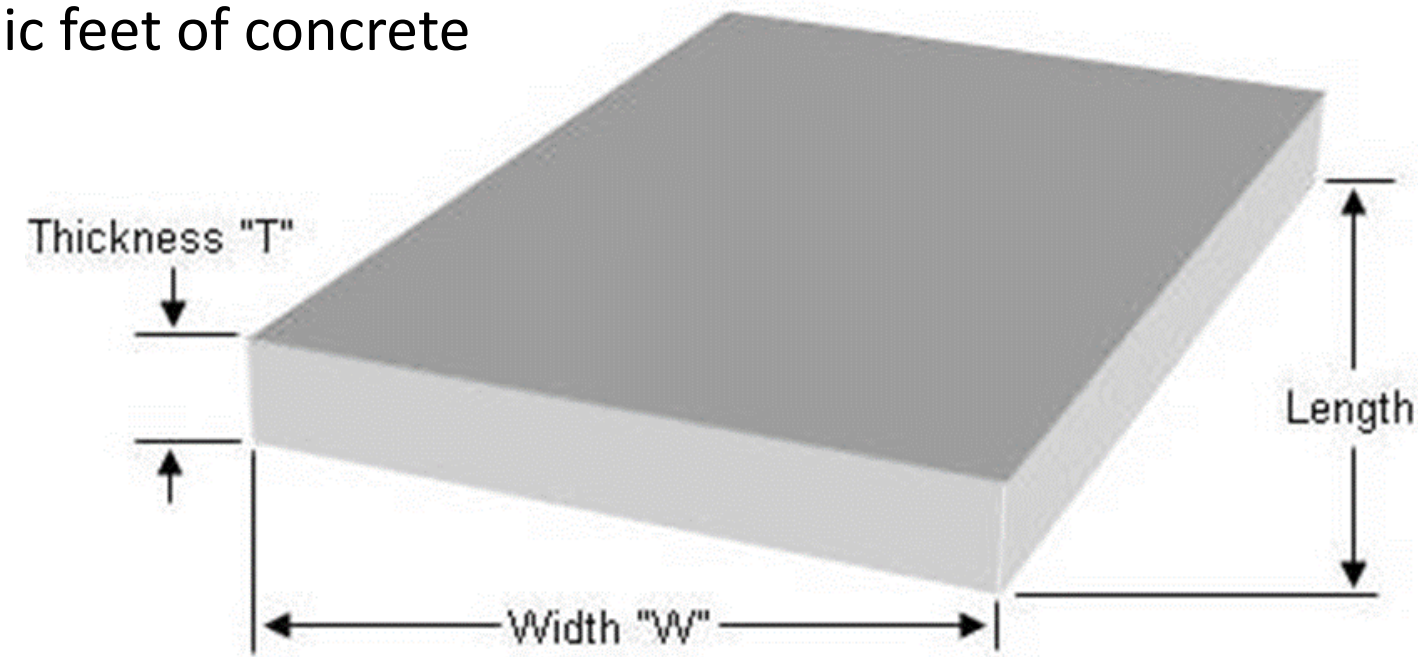
Number of bags of concrete needed:

$CF \div 0.45$  = number of 60 lb. bags

$CF \div 0.6$  = number of 80 lb. bags

Number of cubic yards of concrete needed:

$CF \div 27$  = cubic yards



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Lawrence Street



Bridge Street

388 Bridge St.  
Brooklyn, NY 11201

SLCE Architects  
Type: Residential  
Height: 53 Stories  
Units: 378  
Rental Units: 234  
Condominium Units: 144

\$265 million project

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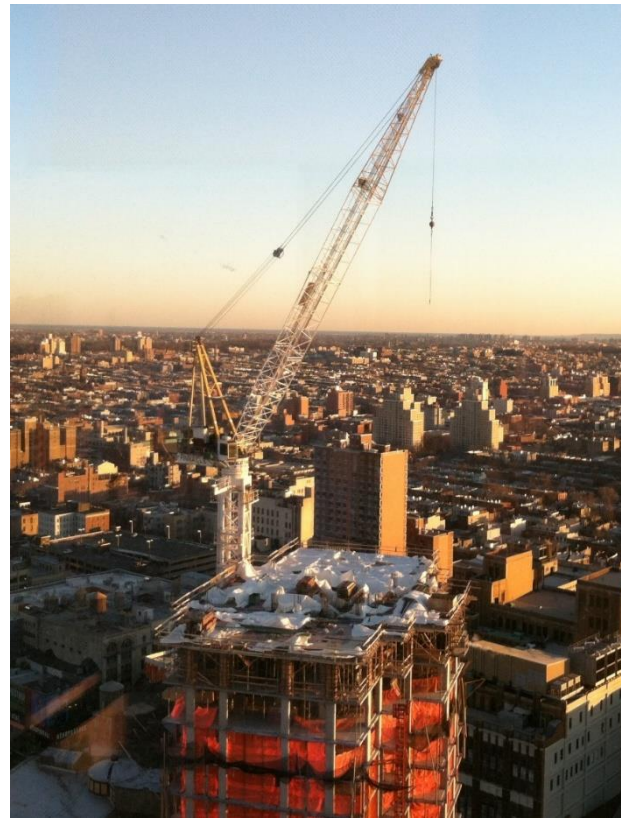
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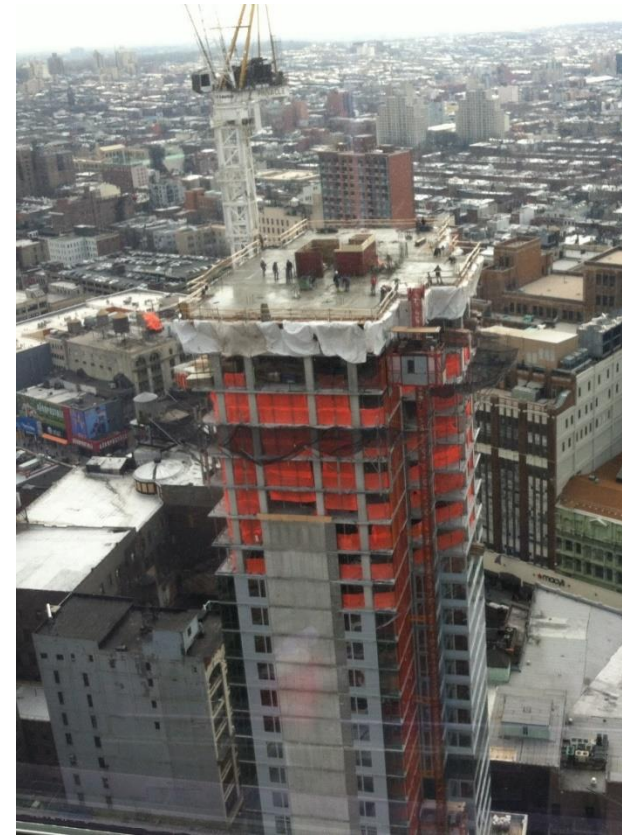
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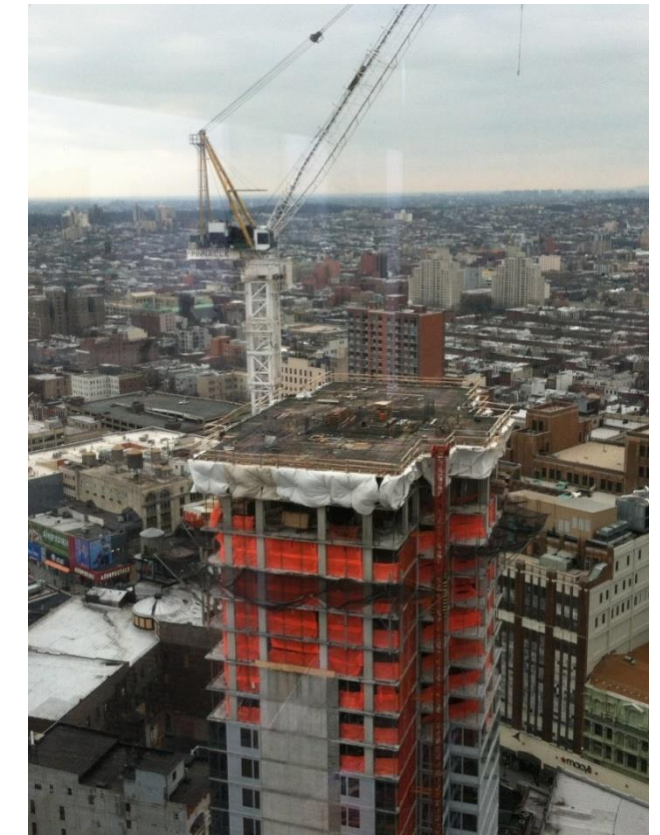
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Feb. 18, 2013



Feb. 24, 2013



Feb. 25, 2013



April 11, 2013



April 22, 2013



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May 18, 2013



17,440.6 cubic yards of concrete

2.6 million dollars

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# Concrete Slab Finishes

- Concrete that will be visible, such as slabs like driveways, highways, or patios, often needs finishing
- Concrete finishes come in a lot of different varieties. The different finishes are all part of the decorative concrete category and allow you to customize your concrete and create beautiful concrete patios, walkways and much more. The concrete finish types range from basic to extensive and there is sure to be a finish style that all can appreciate.



# Concrete Slab Finishes

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Concrete Screeding: screeding or strikeoff is the process of cutting off excess concrete to bring the top surface of the slab to proper grade





# Broom Finish Concrete

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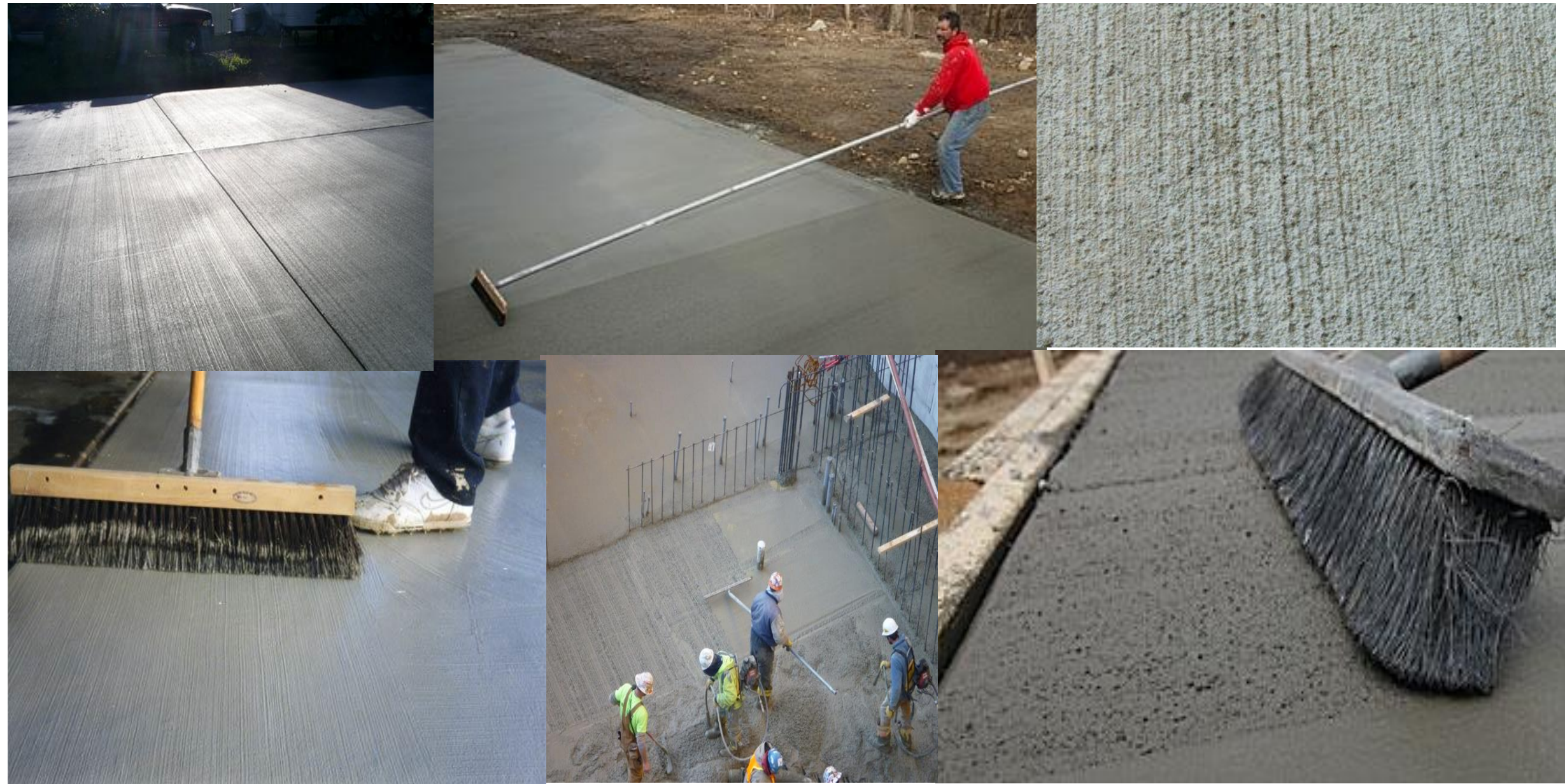
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Broom finish concrete is one of the most common types of concrete finishes. This finish is created when the concrete is almost set and a special broom is used to create a light texture on the surface. The broom texture creates an anti-slip texture



# Colored Concrete

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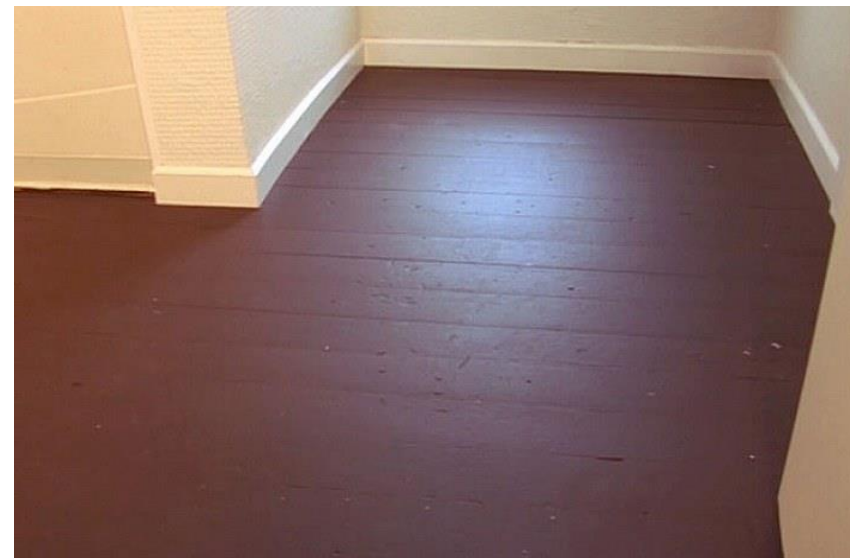
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Colored concrete is one of the many concrete finishes. Both integral colored concrete and shake-on color hardener colored concrete are part of this category. Also concrete colored that is colored with concrete dyes is also part of this finish category. Stained concrete is another type of concrete finish. Concrete stains can be both water-based and acid-based. Acid based concrete stains create a variegated finish while water-based stains create a more uniform finish.



# Exposed and Seeded Aggregate Concrete

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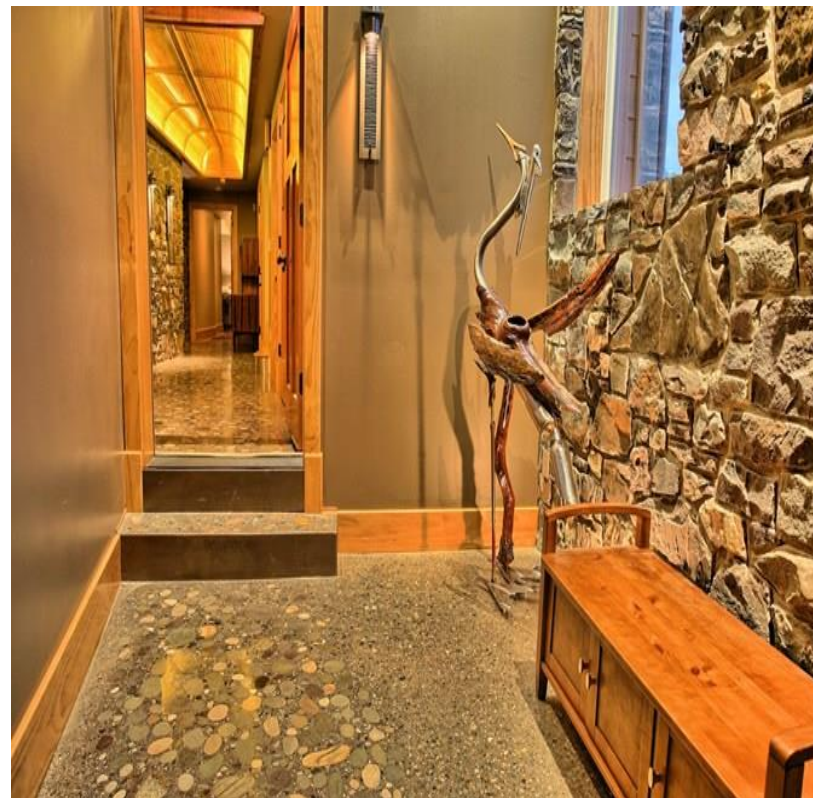
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Exposed Aggregate and Seeded aggregate finishes are also great options. Exposed aggregate is the process of removing the outer layer of the concrete to expose the natural aggregate. Seeded aggregate is similar to exposed aggregate but a layer of aggregate is seeded into the top layer of the concrete to create a custom concrete finish. Salt finish concrete is a concrete finish time where there are small indentations on the concrete surface that are created by distributing rock salt onto the finished concrete. A textured imprint roller can be used to create this look as well.



# Stenciled Concrete

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- Concrete stenciling is a process which is used to create a pattern in freshly poured concrete or in a concrete overlay applied to an existing concrete installation. When this process is done well, the result can be very aesthetically pleasing, creating the illusion of a tiled, cobblestoned, or similarly patterned surface.
- Developed more than 10 years ago, stencils offer nearly unlimited options for taking concrete interior floors over the top. Now there are more options than ever for producing attractive yet economical color and texture combinations with concrete stenciling.



# CONNECTION DETAILS

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## What is connection in architecture?

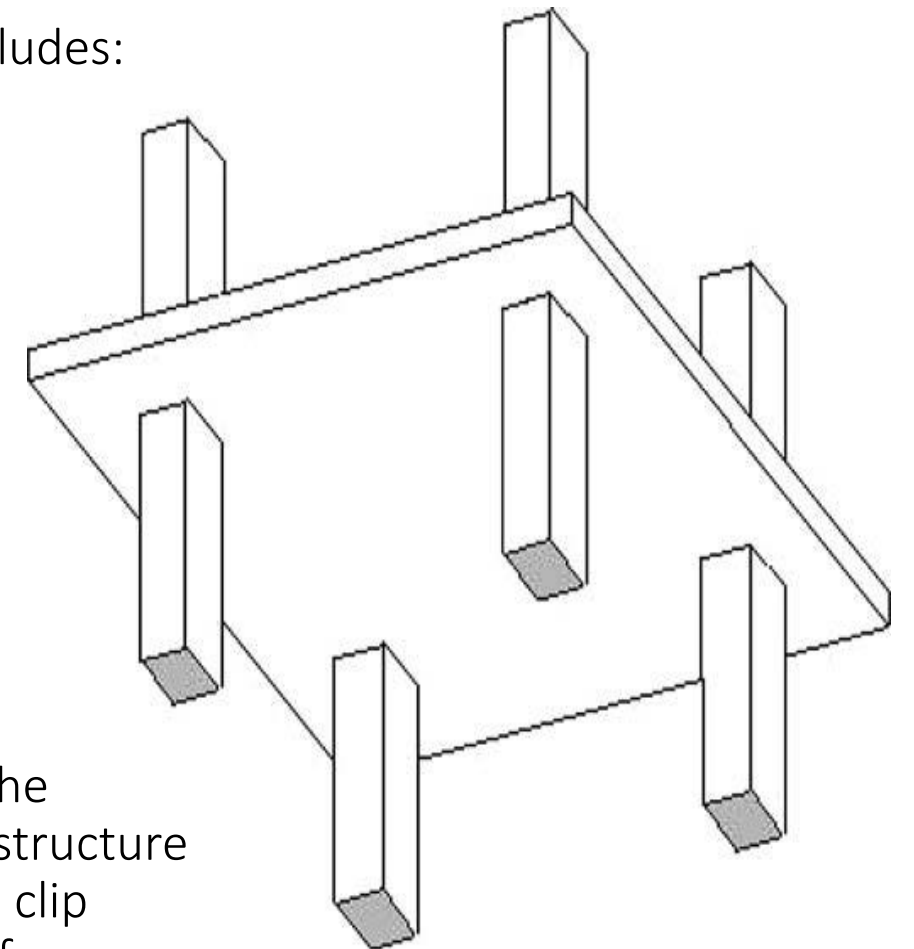
It is in general, ways forms, and the ability to join or fasten one kind of material to another to form a single stable structure during construction. Also one of its main purpose is to transfer load to the supporting structure.

Factors that influences the design of connections elements includes:

- Strength:
- Volume change accommodations
- Constructability
- Durability
- Fire resistance
- Ductility.

Things the hardware design must be able to do

- Hardware design for connections should be able to consider the tolerance for both the precast concrete components and the structure which its getting attached to. These considerations may need clip angles, and plates with slots or oversize holes to compensate for dimensional variations, field welding or sufficient shim spaces to allow variations in elevations.
- Should be capable of transmitting the internal forces, without developing significant moments which might adversely affect the members or the structure as a whole.
- Be capable of accepting the resulting rotations under the design loads



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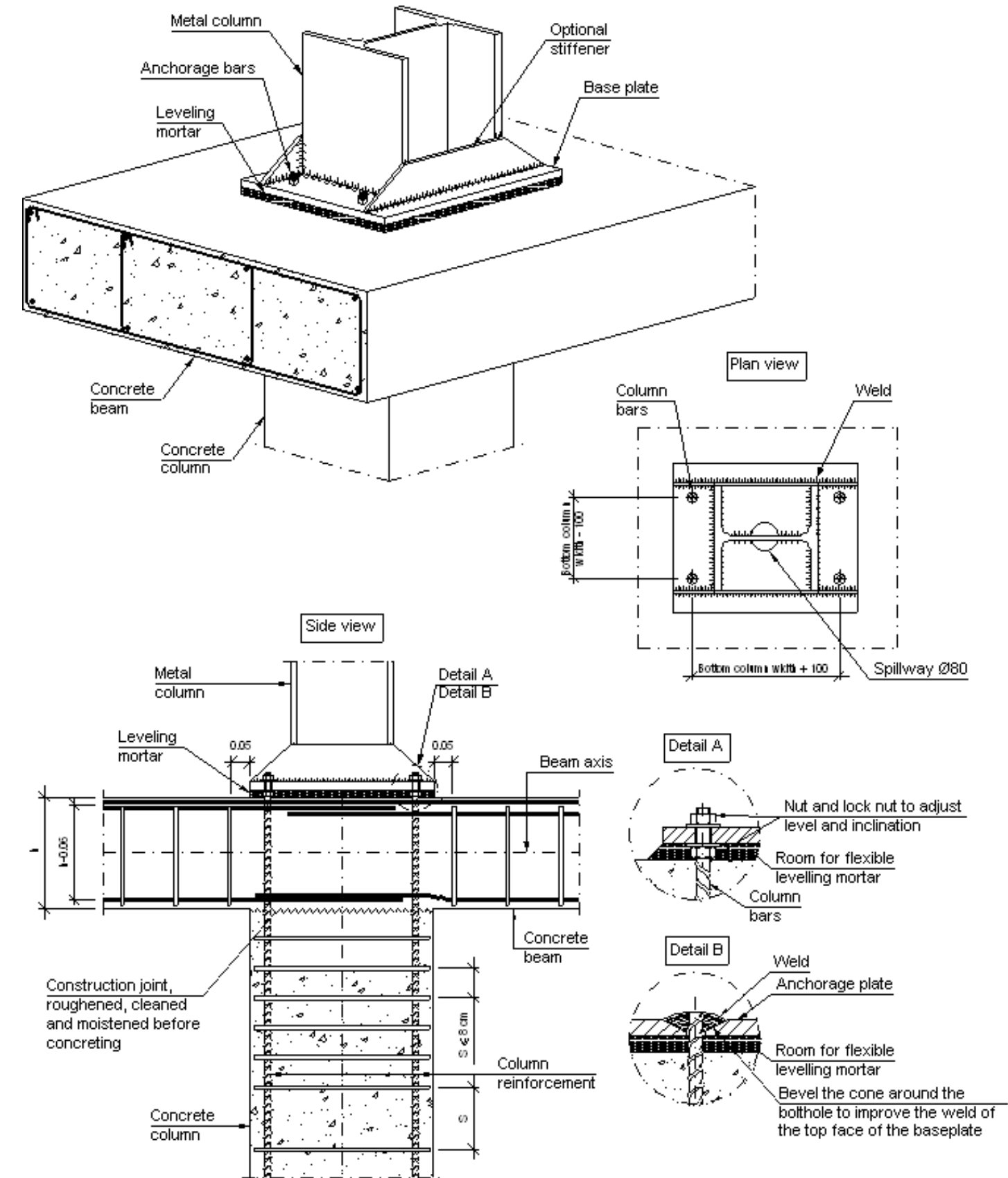
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• Connection of a concrete beam or continuous slab on a concrete column below and steel column above.

• Depending on the moment at the base of the steel column, it may be necessary to stiffen the connection between the column and the base plate with side stiffeners 3/8 in. thick



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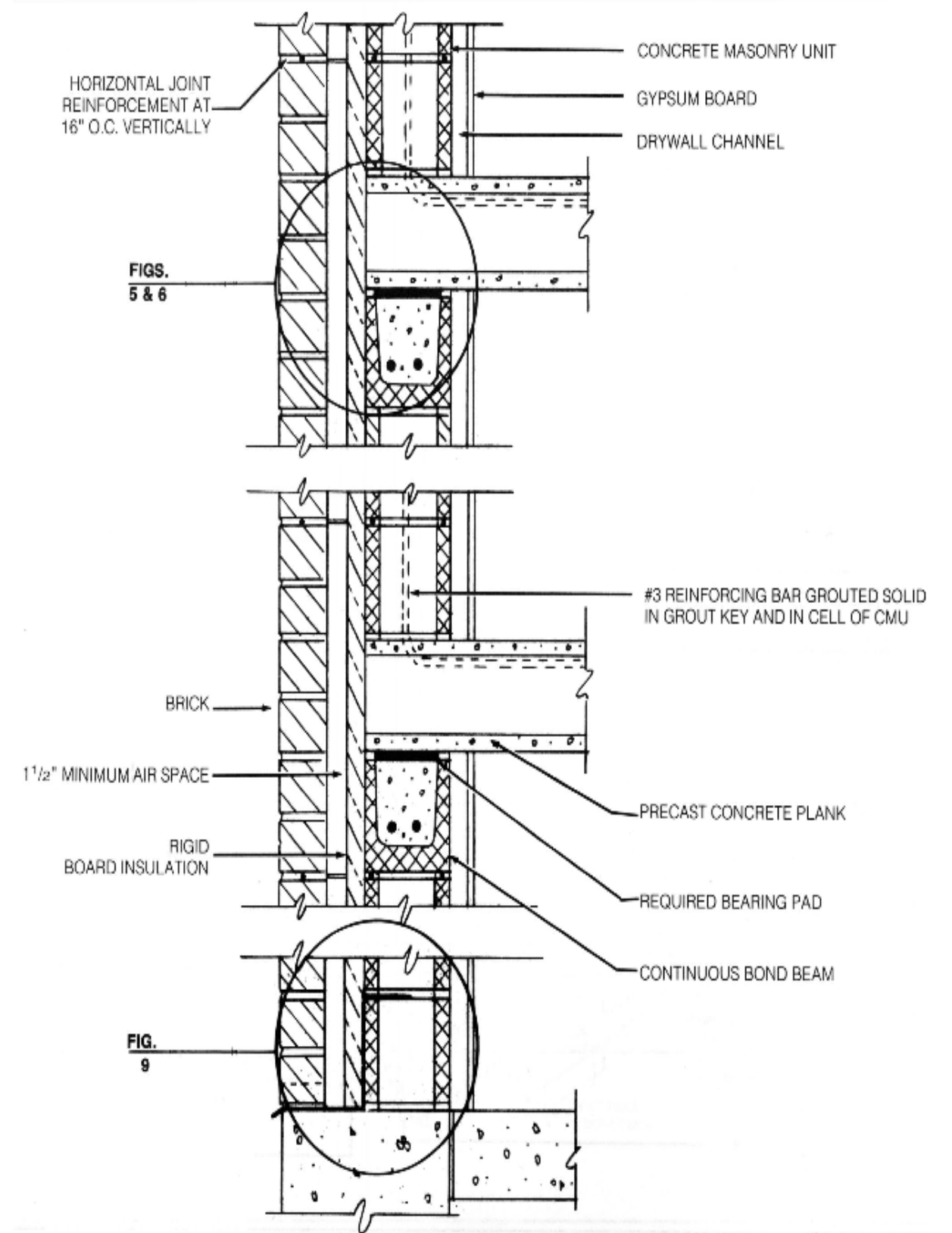
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## Concrete Plank Masonry Curtain Wall



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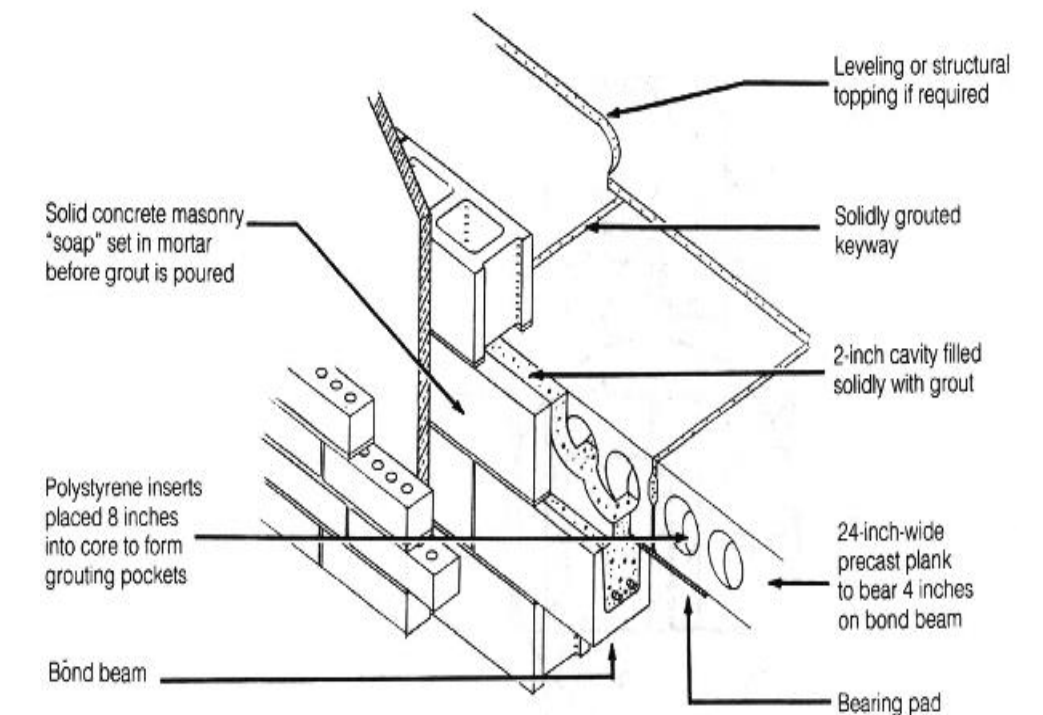
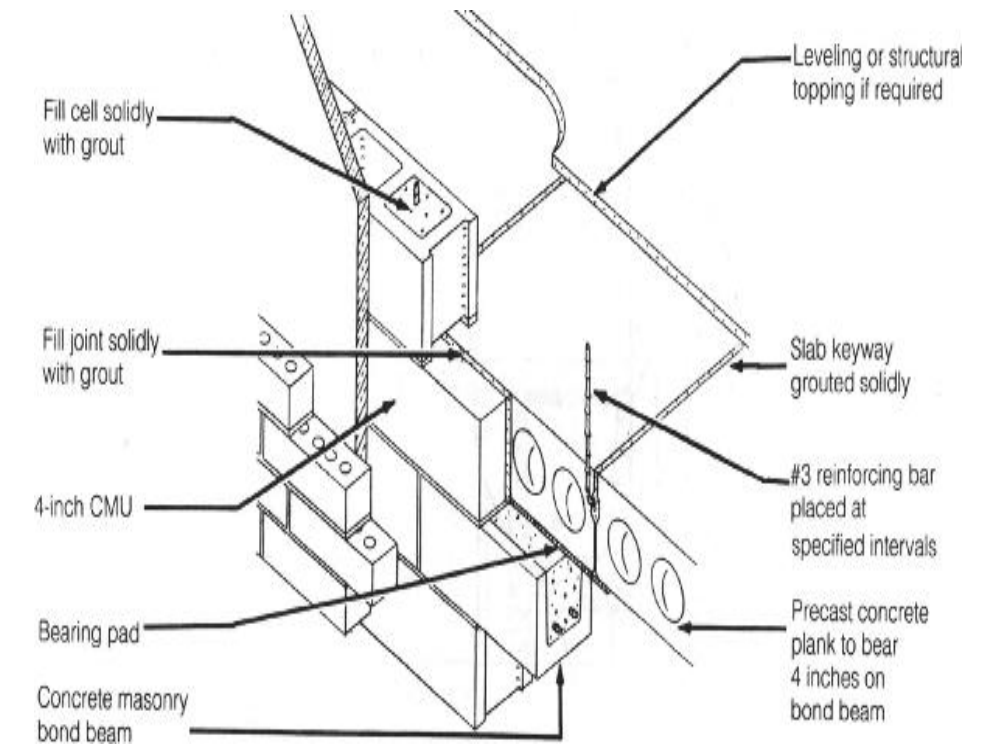
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# CONNECTION DETAILS

## CONNECTION FOR MASONRY CURTAIN WALL

One way to anchor precast concrete plank into curtain concrete masonry wall is to create a positive tie with reinforcing bars bent at 90 degree angles. The reinforcing bar is set into the lay way formed between the concrete planks and grouted solid. The exposed portion of the reinforcement fits into the cell of the concrete masonry unit, a positive connection is formed when the cell is grouted.





# FLAT PLATE SYSTEM CONSTRUCTION (STRENGTH)

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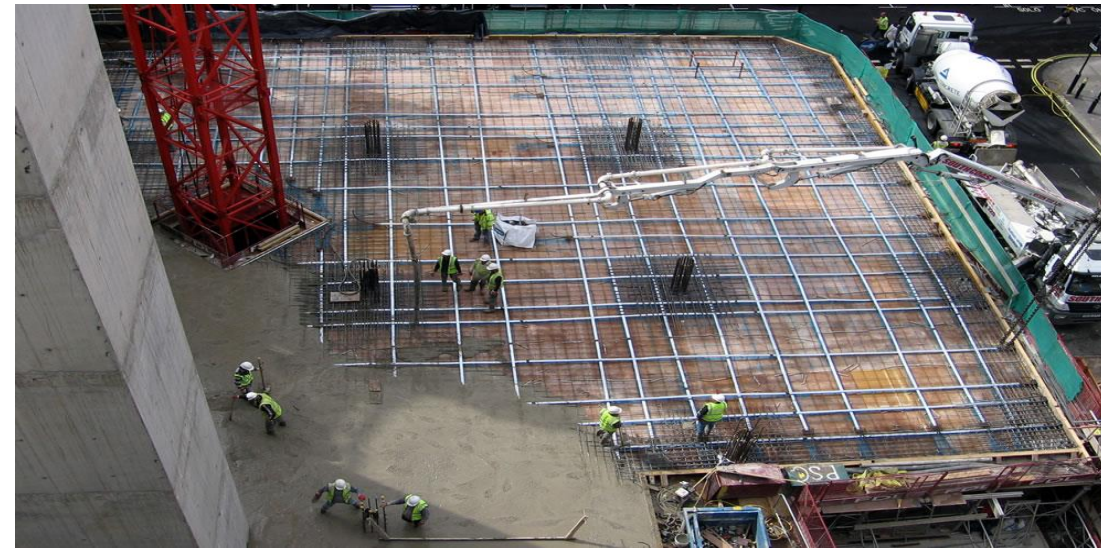
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- The flat plate system can be the most economical system to form, although it usually requires more concrete and more reinforcing steel than in ribbed system.
- Flat plates are normally formed against wood plyform against a wood panel whose uncut, standard size is 4 x 8 feet.
- The flat slab system has been used for a wide range of building occupancy uses.



# SITE CAST FLAT SLAB CONSTRUCTION STRENGTHS & WEAKNESSES

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Strengths	Weakness
<ul style="list-style-type: none"> <li>▪ <u>Faster constructions:</u> flat slabs without drop can be build faster because formwork is simplified and minimized.</li> </ul>	<ul style="list-style-type: none"> <li>• Dealing with deflection</li> </ul>
<ul style="list-style-type: none"> <li>▪ <u>Reduced services and cladding cost:</u> Flat slab construction places no restrictions on the positioning of horizontal services and partitions and can minimized floor- to – floor height</li> </ul>	<ul style="list-style-type: none"> <li>• Dealing with holes</li> </ul>
<ul style="list-style-type: none"> <li>▪ <u>Flexibility for the occupier-</u> It offers considerable flexibility to the occupier who can easily alter internal layout to accommodate change in use of the stricture</li> </ul>	<ul style="list-style-type: none"> <li>• Dealing with construction loads</li> </ul>
<ul style="list-style-type: none"> <li>▪ <u>Flexibility in the room layout:</u></li> </ul>	
<ul style="list-style-type: none"> <li>▪ <u>Slab thickness:</u> Thinner slabs not only save on direct materials costs for the frame and the supporting foundations.</li> </ul>	

# TYPES OF STRUCTURES SYSTEM IS TYPICALLY USED WITH

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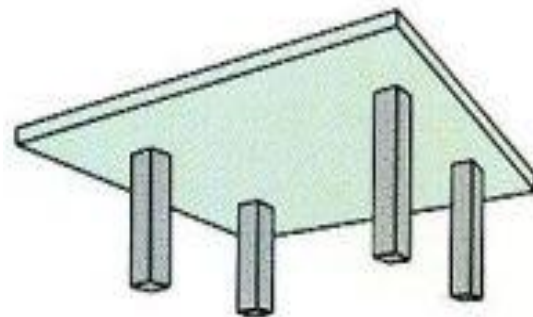
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- There are four different types of structure that can be used in a flat slab system which are flat slab, flat slab with drop panel, flat slab with column head, flat slab with drop and column head.

The illustration below show the structure and its usage:

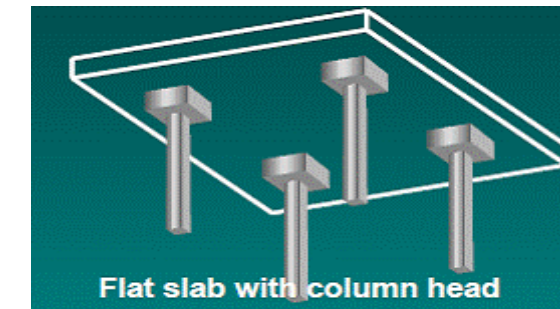
Flat Slab



#### Uses of flat slab:

- A reinforced concrete slab supported directly by concrete column without the use of beams

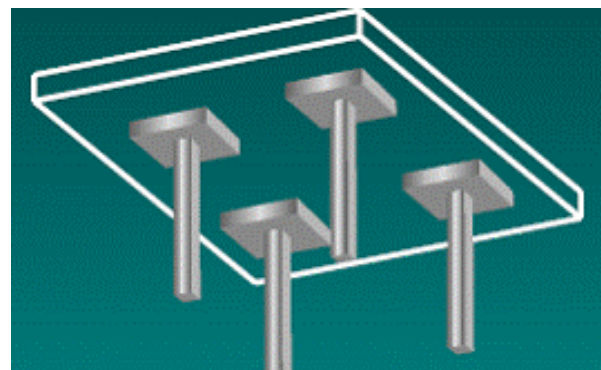
Flat slab with column head



#### Uses of column head:

- Increase shear strength of slab
- Reduces the moment in the slab by reducing the clear or effective span

Flat slab with drop panel



#### Uses of drop panels:

- Increase shear strength of slab
- increase negative moment capacity of the slab
- Stiffen the slab and hence reduce deflection

Flat slab with drop panel and column head



#### Uses of column head:

-

# TYPES OF STRUCTURES CAST FLAT SLAB SYSTEM CAN BE EFFICIENT

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- A flat plate flooring system is a two- way concrete slab supported directly on column with reinforcement in two orthogonal directions
- This system is mostly used in hotels, multi family residential building and hospital.



Great western hospital



Tribeca Green, nyc



Trump Hotel Las Vegas

# TYPES OF STRUCTURES WHERE CAST FLAT SLAB SYSTEM WILL NOT BE EFFICIENT

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- These are few types of structure that the flat slab system will not be most effective because of the long span and because it doesn't have a grid system.  
ex. Auditorium, health club etc.
- Typical panel must be rectangular
- The spans must be similar length



Auditorium



Health club

# FLEXIBILITY OF THE SYSTEM

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- System spans and effective span

- Construction time and cost

### Case study I

- Architectural finishes available

- Connection Details

### Case study II

- System strengths and weakness

- Flexibility of the system diversity of form available

### Case study III:

The Ritz Carlton Luxury  
Condominiums and Hotel , NY, NY

•The flexibility of flat slab construction can head to high economy and yet allow the architect have a great freedom of form.

•The slab construction offers flexibility to the occupier who can easily alter internal layouts to accommodate changes in the use of the structure.



# FLEXIBILITY OF THE SYSTEM : TYPES OF SYSTEM SHAPES

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- Most of the design shapes that site cast flat slab are vertical and use a grid flooring system.

- Grid Floor system consisting of beams spaced at regular intervals in perpendicular direction, monolithic with the slab.



# THE RITZ CARLTON LUXURY CONDOMINIUMS AND HOTEL

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## OVERVIEW

- The Ritz-Carlton Luxury Condominiums and Four Star Hotel is a 40-story mixed-use building situated at the southern most tip of Manhattan.
- Cast in place concrete was selected for this design as the material for this project because of its speed application.

## ADAVANTAGE/ STRENGTH

- The Flat plate construction used minimizes the floor-to-floor heights while providing a smooth ceiling surface requiring no additional framing for hotel rooms and condominiums.
- The concrete framing systems provided this structure with inherent damping benefits to resist movement due to high winds at the tip of Manhattan



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Podium east facade with its many jogs, setbacks and overhangs.



Monostrand tendons in a post-tensioned beam being laid out.



Post-tension transfer beams and tendon profiles..



The curved facade allows the hotel floors unlimited views.

