Technical Report 3

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Structural Option
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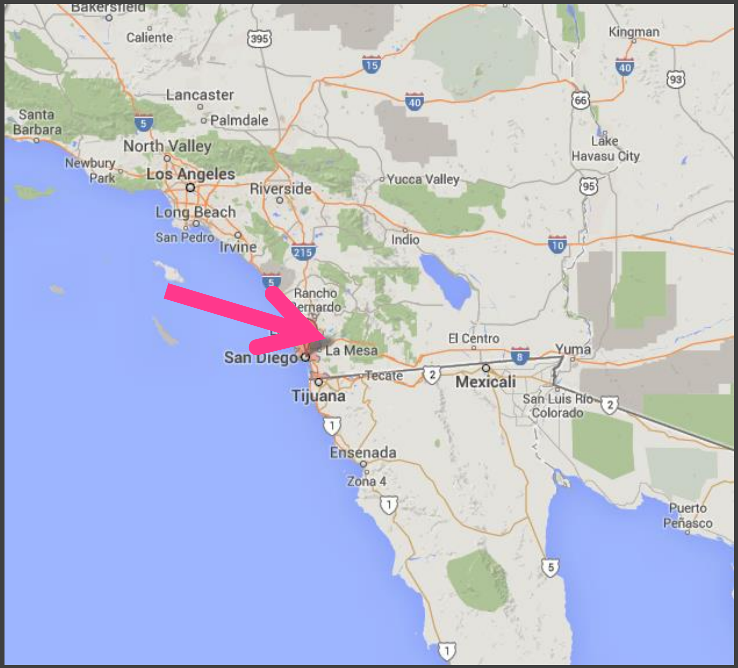
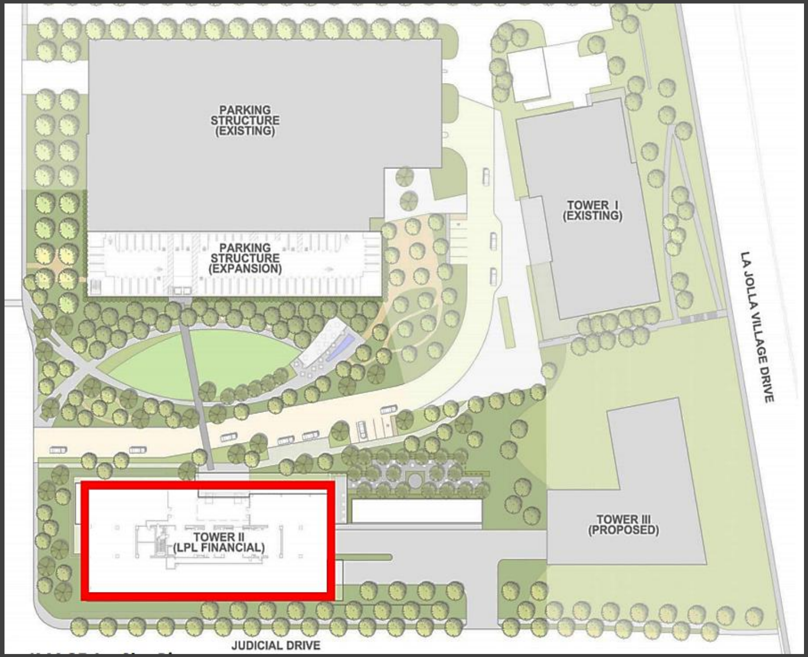
LA JOLLA COMMONS
PHASE II OFFICE TOWER

Site and Location

- La Jolla Commons, San Diego, California

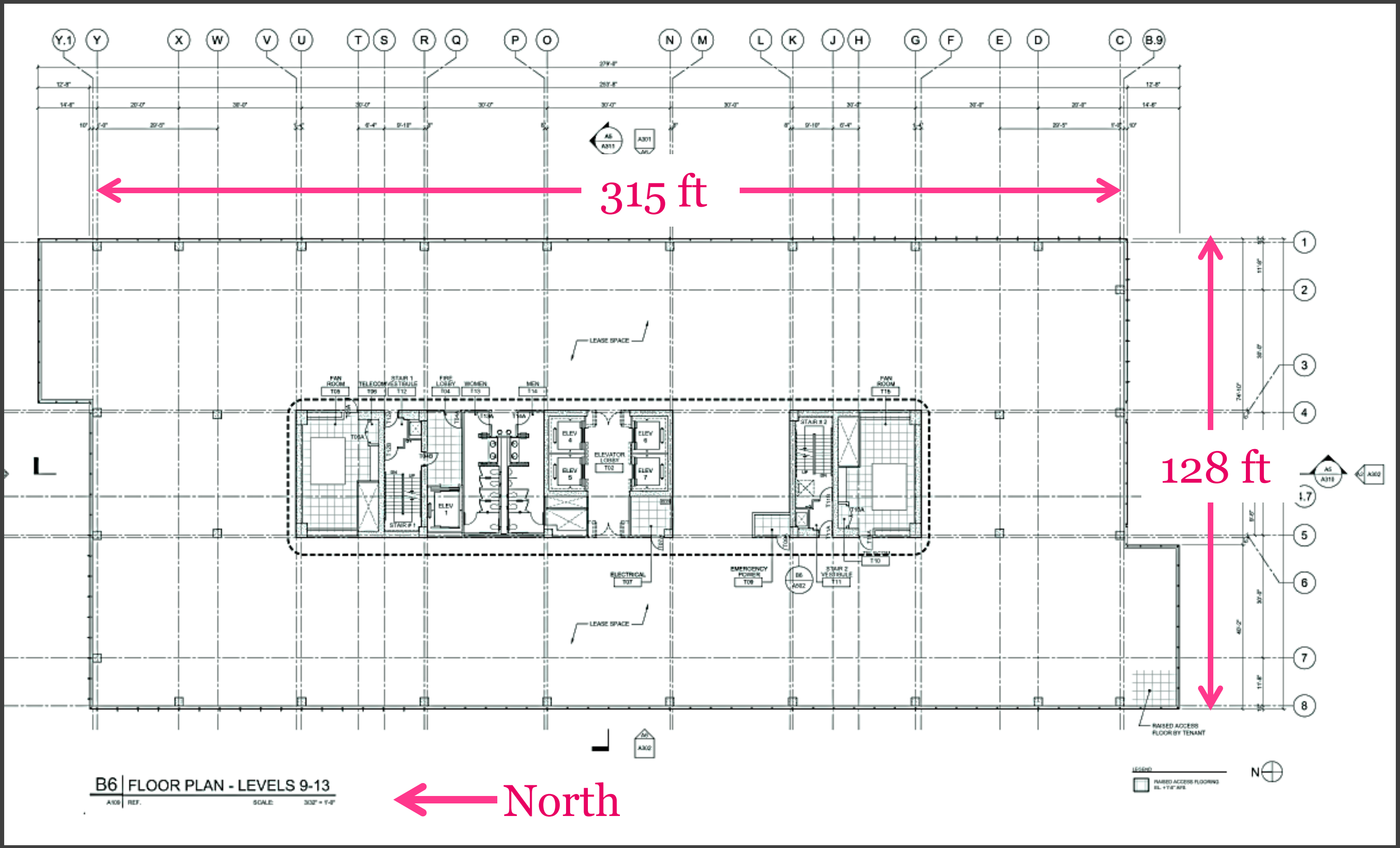




General Building Information

- La Jolla Commons Phase II Office Tower
- Height | 198’ 8” (13 stories)
- Square Footage | 462,301 GSF
- Location | San Diego, California
  - Seismic Design Category D
- Office Building
  - Multi-tenant capabilities
  - First Class A NetZero Office Building in the USA
- Special Features
  - Underfloor Air Distribution System
  - 15 foot cantilevers at both ends

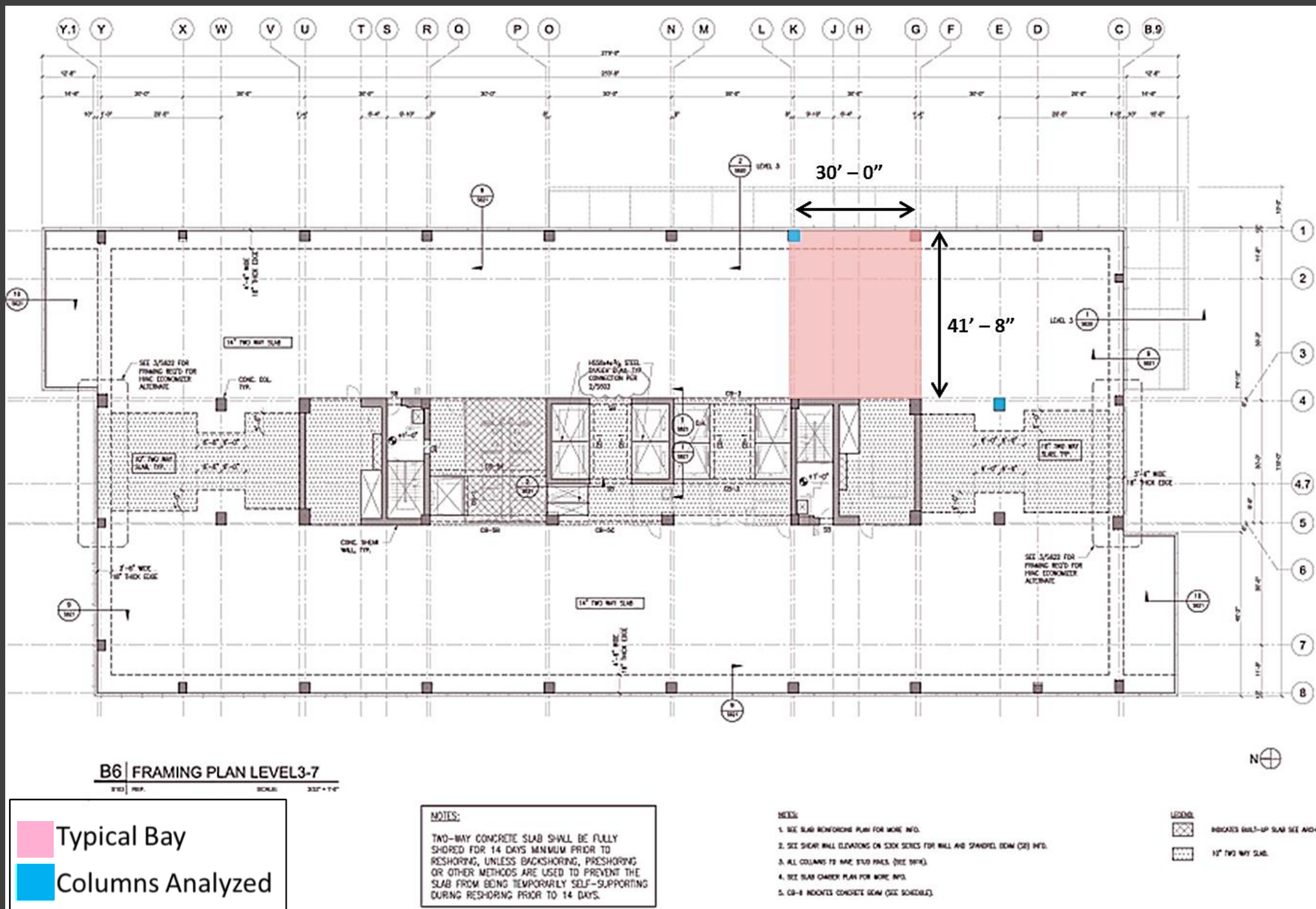
Typical Floor Plan



Existing Structural System

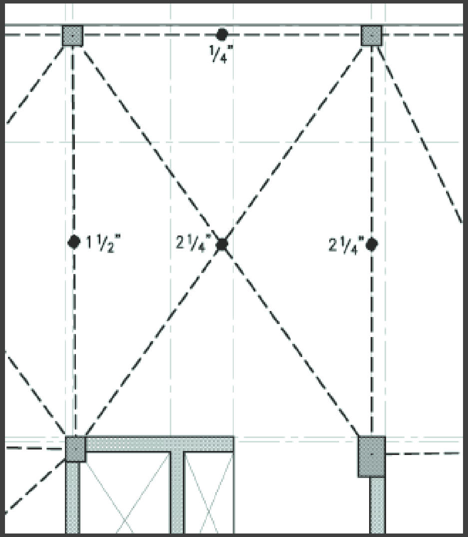
- Mild reinforced, cast-in-place concrete structure
- Mat Foundation
  - Thickness ranges from 3 ft to 6.5 ft
- Gravity System
  - Two-way, flat plate, reinforced concrete slab supported by a rectangular grid of concrete columns
  - Slab camber
  - Spandrel beam around slab edge
- Lateral System
  - Specially reinforced concrete shear walls
  - Collector beams in NS direction - levels below grade
- Special Features
  - 15 foot cantilevers at the North and South ends
  - Steel framed mechanical penthouse

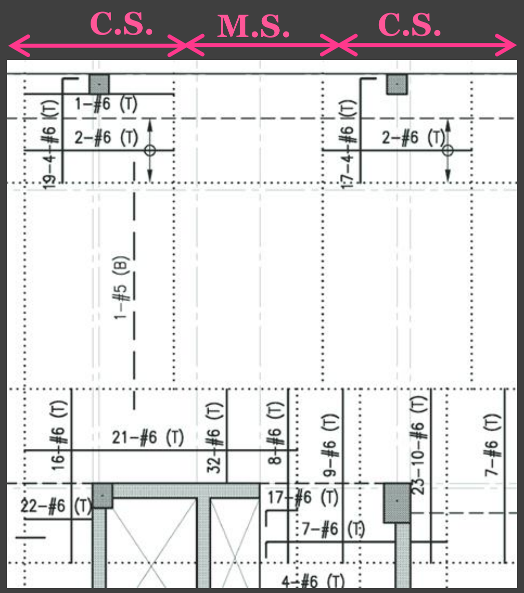
Typical Bay and Columns



Typical Bay - Details

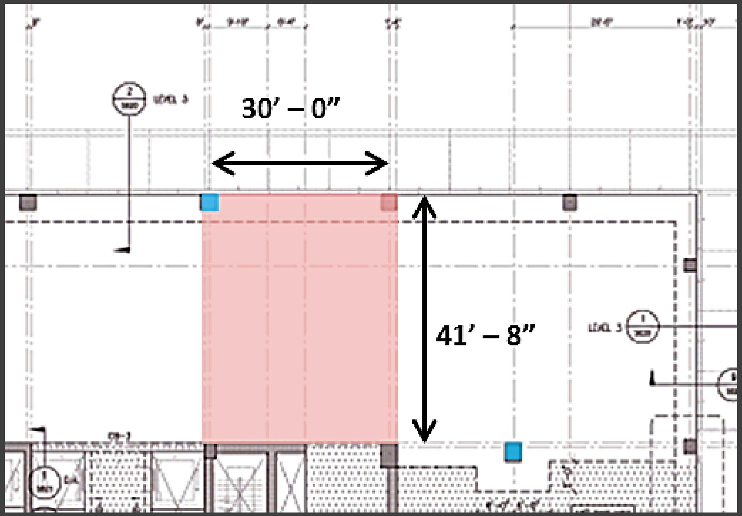
- 14 inch two-way slab
- 30 ft x 42 ft from centerline to centerline of columns
- 2 ¼” camber at mid-span
- 24” x 24” columns (at exterior)
- 18” spandrel beam, 4.5 feet wide
- Column strip and middle strip called out





Gravity Spot Checks: Punching Shear

- Deflection Control:
  - Table 9.5(c) - ACI 318-11
  - h_{min} = 14.4" < $h_{provided}$ = 14"
  - FAILED ! (camber used)
- Punching Shear – Edge Column K1
  - Punching shear critical section through h=18"
  - ϕ Vc = 358k > Vu=187k → OK!
  - PASSED!
- Punching Shear – Interior Column E4
  - Punching shear critical section through h=14"
  - ϕ Vc = 481.8k > Vu=427.6k → OK!
  - PASSED!



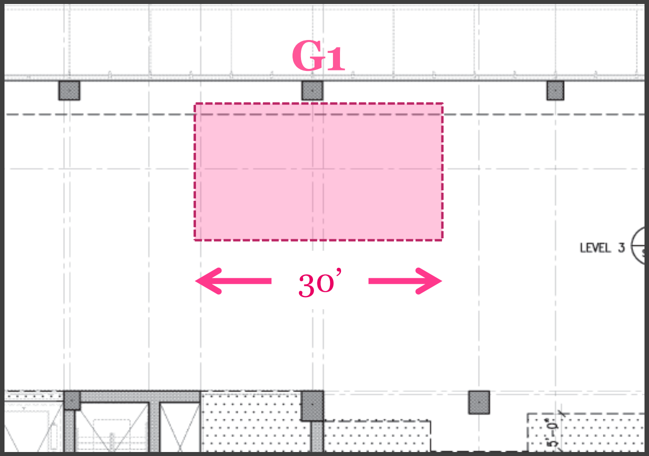
Gravity Spot Checks: One-Way Shear

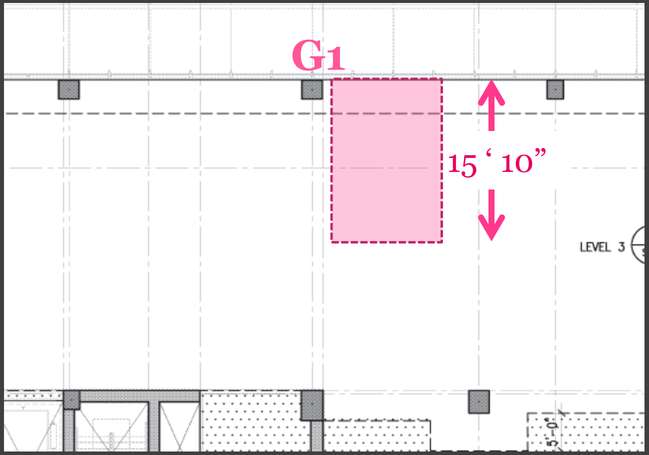
- One-Way Shear - 30’ direction:
  - Shear through h=18”
  - ϕ Vc = 643k > Vu=144k → OK!

PASSED!

- One-Way Shear – 15’ 10” direction:
  - Shear through h=18”
  - ϕ Vc = 340k > Vu=80k → OK!

PASSED!

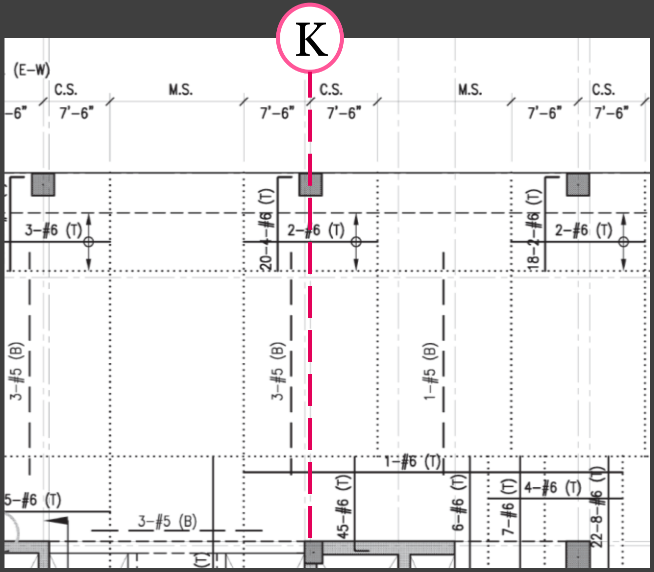




Gravity Spot Checks: Moment Capacity

- Moment Capacity – Column Line K:
  - Checks failed when column strip and middle strip were analyzed separately
    - @M+ Middle Strip: 693 ft-k >> ØMn=573.6 ft-k
  - Column strip and middle strip were *combined* for moment capacity checks
    - @ Mu+ = 1155 ft-kl < ØMn=1113 ft-k
    - @ Mu- Interior Column= 1555 ft-k < ØMn = 1630 ft-k
    - @ Mu- Exterior Column= 578 ft-k < ØMn = 1039 ft-k

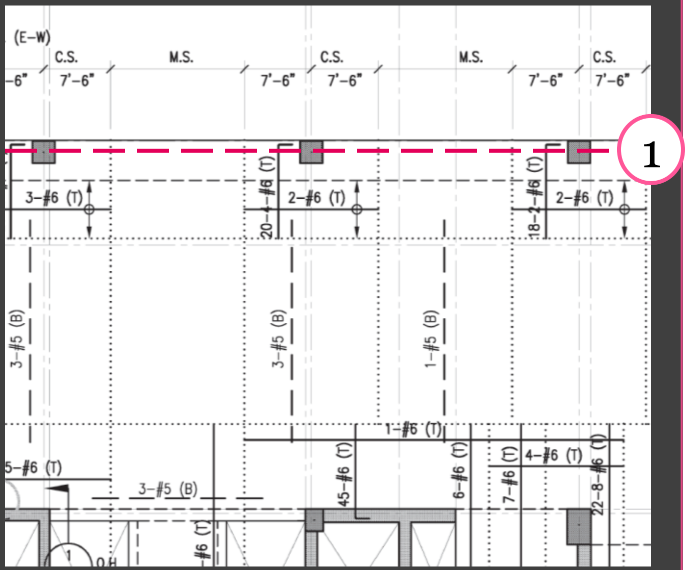
  PASSED!



Gravity Spot Checks: Moment Capacity

- Moment Capacity – Column Line 1:
  - Check of M_u^- of *Combined* C.S. and M.S.
    - M_u^- =512 ft-k > ϕMn=426 ft-k
    - However, edge beam was not accounted for… most likely would pass if this was included in analysis
  - Check of M_u^+ of *Combined* C.S. and M.S.
    - M_u^+ =276ft-k >> ϕMn=715 ft-k

  PASSED!

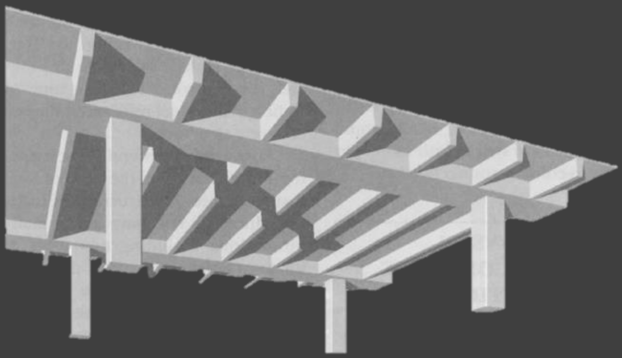


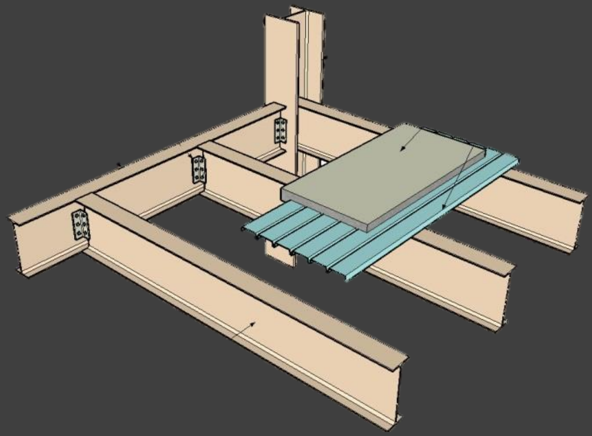
Gravity Spot Checks: Summary

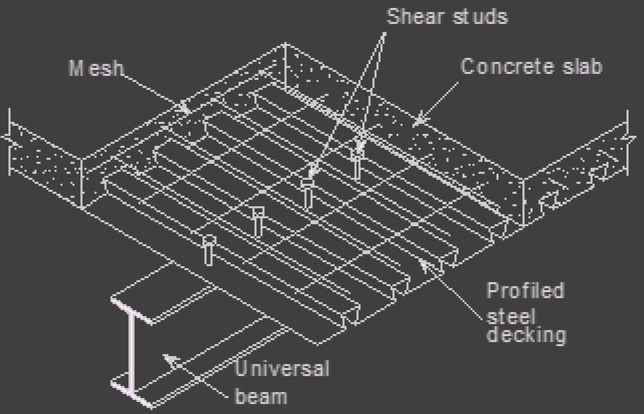
Check	Status
Two-Way Shear	Pass ✓
One-Way Shear	Pass ✓
Moment Capacity	Pass (if combined) ✓

Alternate Floor System Designs

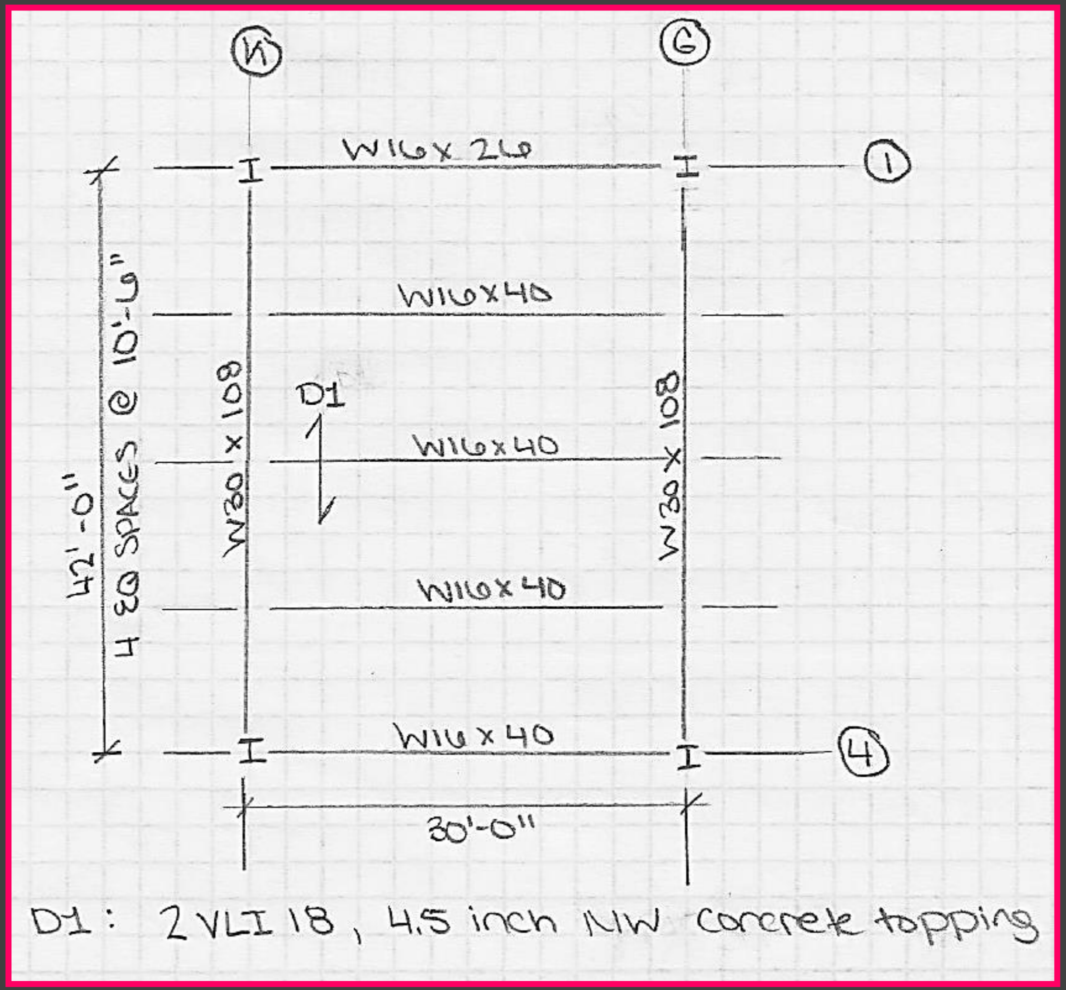
- Floor System Design #1: Non-Composite Steel
- Floor System Design #2: Composite Steel
- Floor System Design #3: One Way Concrete Slab





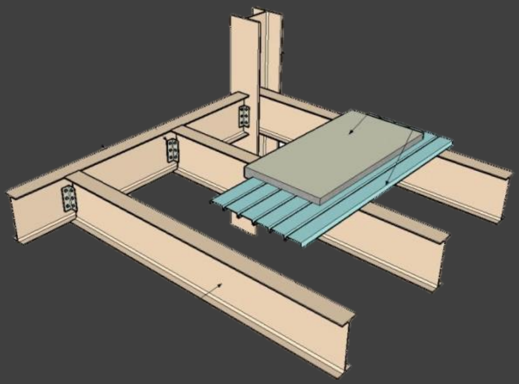


Alternate Design 1: Non-Composite Steel



Alternate Design 1: Non-Composite Steel

- Increase in overall system depth
  - Original: 18” maximum slab thickness
  - New: 30” beam depth + 6.5” slab = 36.5”
- Fire Protection/Fire ratings
  - Fireproofing required on beams & bottom of deck
  - 4.5” topping for 2 hr fire rating
- Cost using R.S. Means Assembly B1010 254 → $38.19/SF
- System Weight → 80.6 PSF
- Durability → This assembly is used often in office spaces and can handle the normal wear and tear of this occupancy



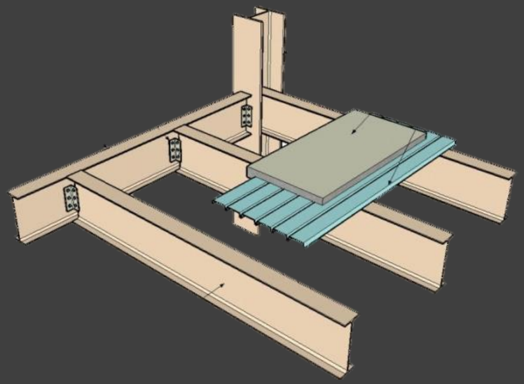
Alternate Design 1: Non-Composite Steel

- Lateral System Options:

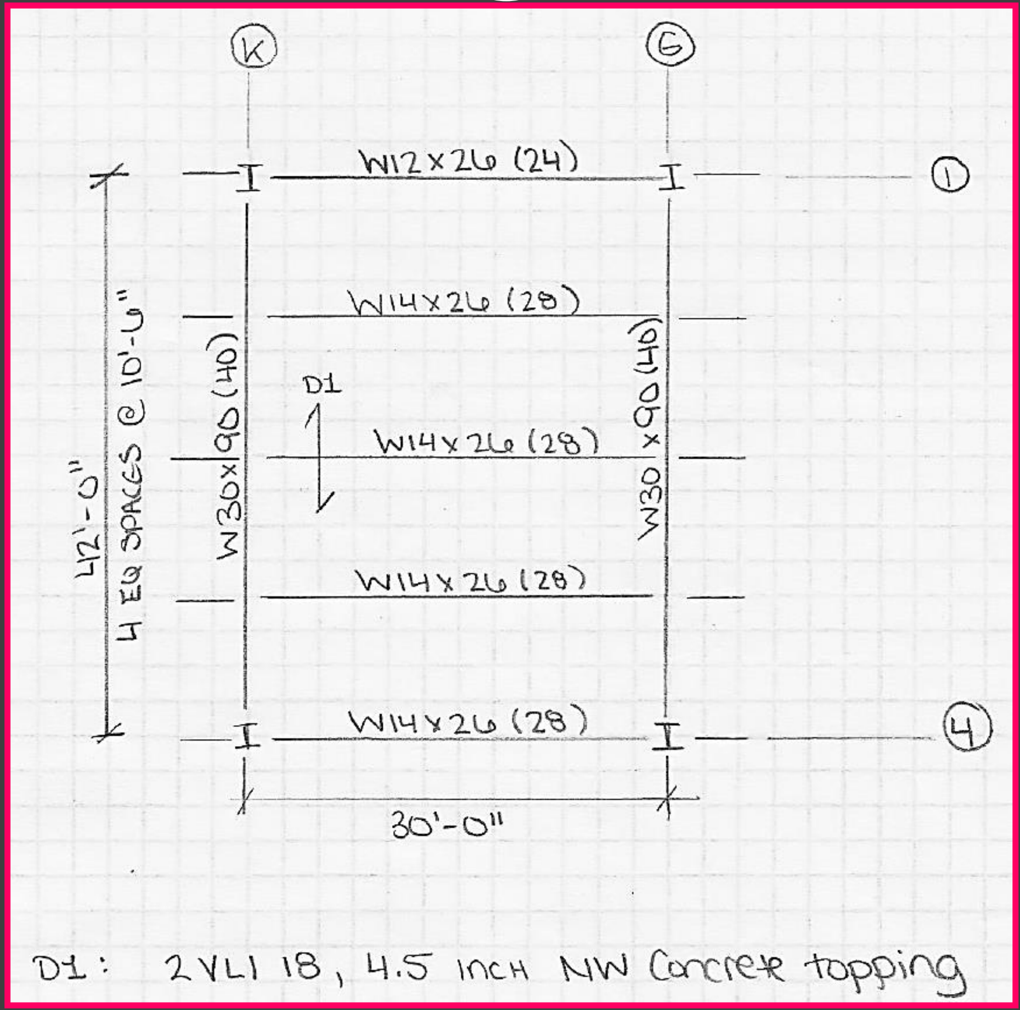
  (seismic detailing)

  - Reinforced Concrete Shear Walls
    - Efficient, laid out in existing system at elevator and stair core
  - Steel Moment Frame
    - Integrate around exterior in conjunction with core shear walls for additional stiffness
    - Not efficient alone
  - Steel Braced Frame
    - Braces would obstruct office space and/or facade.

- Conclusion:
  - **Viable Option**
  - Will integrate well with architecture
  - Options for lateral systems will work for high seismic loading
  - Lighter than existing system

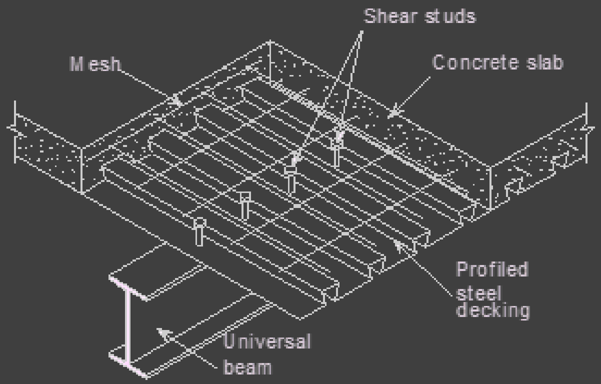


Alternate Design 2: Composite Steel



Alternate Design 2: Composite Steel

- Increase in overall system depth
  - Original: 18” maximum slab thickness
  - New: 30” beam depth + 6.5” slab = 36.5”
- Fire Protection/Fire ratings
  - Fireproofing required on beams & bottom of deck
  - 4.5” topping for 2 hr fire rating
- Cost using R.S. Means Assembly B1010 256→ $25.50/SF
- System Weight → 79.3 PSF
- Durability → This assembly is used often in office spaces and can handle the normal wear and tear of this occupancy



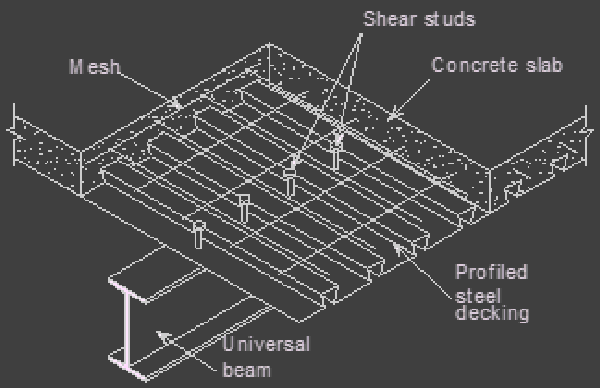
Alternate Design 2: Composite Steel

- Lateral System Options:

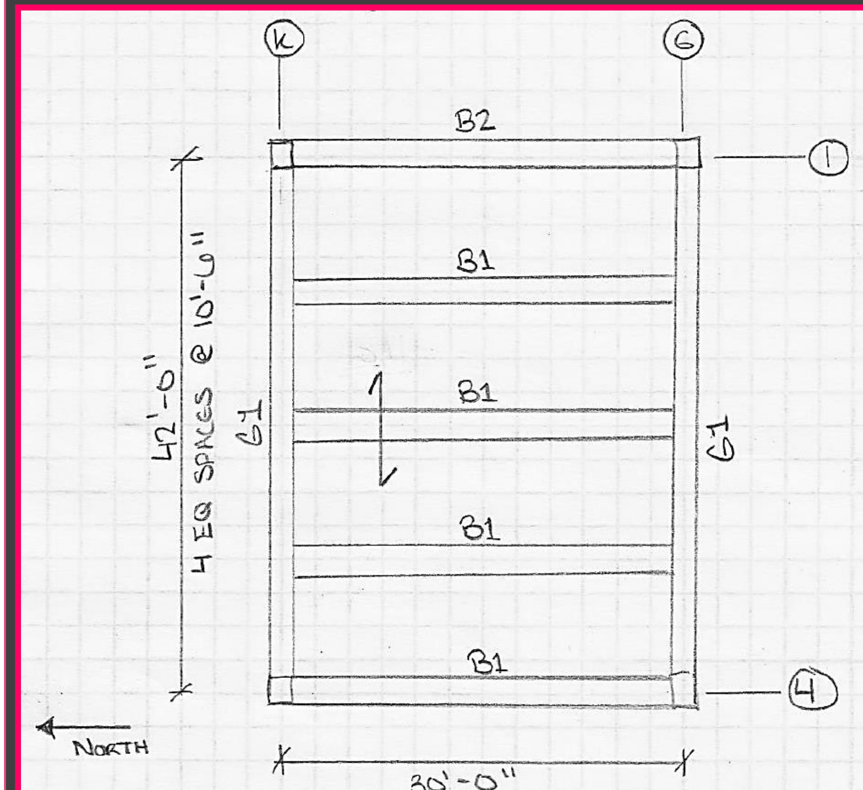
  (seismic detailing)

  - Reinforced Concrete Shear Walls
    - Efficient, laid out in existing system at elevator and stair core
  - Steel Moment Frame
    - Integrate around exterior in conjunction with core shear walls for additional stiffness
    - Not efficient alone
  - Steel Braced Frame
    - Braces would obstruct office space and/or facade

- Conclusion:
  - **Viable Option**
  - Will integrate well with architecture
  - Could possibly control depth with heavier beams
  - Currently the lightest system
  - Cheaper than non-composite steel
  - Several lateral system options



Alternate Design 3: One-Way Slab System



Slab Schedule			
Thickness	E-W		N-S
	Top	Bottom	
10"	#4@11"	#4@11"	#4 @ 11" for temperature and shrinkage

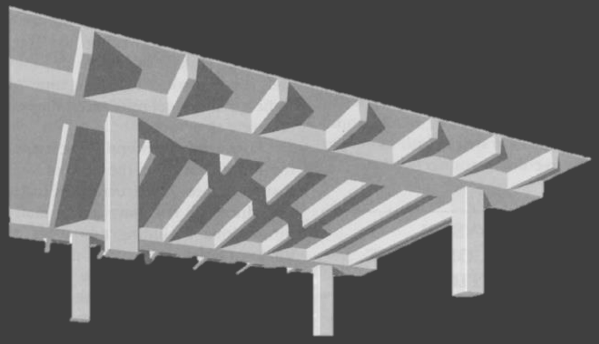
BEAM SCHEDULE			
Beam Label	Size, bxh	Longitudinal Bottom Reinf.	Shear Reinforcement
B1	17"x24"	(6) #8	#3 @ 11"
B2	15"x21"	(5) #8	#3 @ 9"
G1	33"x41"	(10) #11	#4 @ 19"

Notes:

1. 4000 PSI, Normal Weight Concrete
2. Rebar f_y=60 ksi and f_{yt}= 60ksi

Alternate Design 3: One-Way Slab System

- Increase in overall system depth
  - Original: 18” maximum slab thickness
  - New: 41” girder depth
- Fire Protection/Fire ratings
  - Fireproofing not required but minimum rebar cover must be met
  - Fire rating → Meets at least 2 hr requirement
- Cost using R.S. Means Assembly B1010 256→ $23.89/SF
- System Weight → 215.4 PSF
- Durability → This system can be very durable and has proven endurance in office spaces



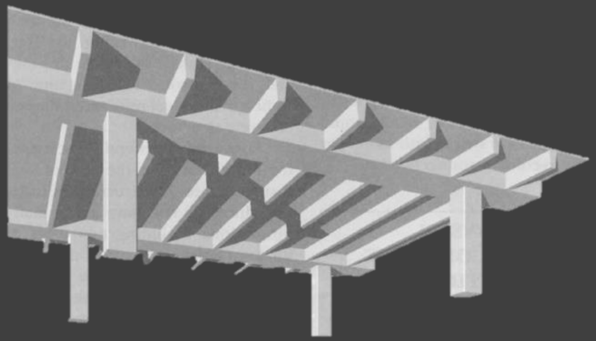
Alternate Design 3: One-Way Slab System

- Lateral System Options:

  (seismic detailing required)

  - Reinforced Concrete Shear Walls ✓
    - Efficient, laid out in existing system at elevator and stair core
  - Concrete Moment Frame ✓
    - Relatively inefficient compared to shear walls
    - Potentially integrate with shear wall system
  - Steel Frames – NOT ADVISED ✗

- Conclusion:
  - **Not a Viable Option**
  - High beam depths will significantly decrease floor to ceiling height
    - Beams were designed as b=4/5d
  - Heaviest system



Floor System Comparison

		Gravity Floor Systems			
Considerations		**Flat-Plate Concrete Slab**	**Non-Composite Steel**	**Composite Steel**	**One-Way Concrete Slab**
Architectural Considerations					
Maximum Depth		18"	36.5"	36.5"	41"
Fire Protection Required?		No	Yes	Yes	No
2 hr Fire Rating achieved?		Yes	Yes	Yes	Yes
System Statistics					
Cost Per Square Foot		$21.53/SF	$38.19/SF	$25.50/SF	$23.89/SF
System Weight		180.4 PSF	80.6 PSF	79.8 PSF	215.4 PSF
Durability		Acceptable	Acceptable	Acceptable	Acceptable
Future Design Considerations					
Lateral System Options	Reinforced Concrete Shear Walls	Yes	Yes	Yes	Yes
	Steel Moment Frame	No	Yes	Yes	No
	Steel Braced Frame	No	No	No	No
	Concrete Moment Frame	No	No	No	Yes
Advantages		Maximum floor to ceiling heights, cheapest system, no fire protection required	Light system weight, several options for lateral system	Lightest system weight, several options for lateral system, system used in LJC Tower I	Same material as existing system, cheapest of alternative systems
Disadvantages		None	Most expensive system, fire protection required, large beam depth, fire protection required, Vibrations	Higher cost than concrete systems, large beam depth, fire protection required, vibrations	Heaviest system, large beam depth will significantly decrease floor to ceiling height
Viable Option?		**N/A**	**Yes**	**Yes**	**No**

Any Questions?

La Jolla Commons Phase II Office Tower