

# SCHOOL WITHOUT WALLS WASHINGTON D.C.



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AE Senior Thesis    Spring 2010

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Existing Building Information

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### **Location**

- 2130 G Street, NW Washington, D.C
- Foggy Bottom District

### **Building Statistics**

- Function | Educational
- Occupant | District of Columbia Schools
- Size | 68,000 sq. ft.
- Stories | 4 stories (1 Below Grade)

### **Project Cost**

- \$39.2 million

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### **Existing Gravity System**

- Composite steel system
- W10 to W33 sections
- 3 1/4" LWC over 2" 20 GA LOK composite steel floor decking

### **Existing Foundation System**

- Shallow foundation
- Reinforced cast-in-place spread footings and grade beams
- Existing footings of the school require underpinning

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### **Existing Lateral System**

- The addition is divided by an expansion joint
- Joint creates total of three lateral systems
- Referred to as “Area 1” and “Area 2” in this presentation
- Braced frames and shear walls resist lateral loads
  - Braced frames comprised of HSS square sections
  - Shear Walls are 12” and 8” thick

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Project Goals

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### **Problem Statement**

- wide flange beams which range from W10 to W33 sections
- 5 1/4" decking system
- total floor depth amounts to 38 1/4"
- welded moment connections required for cantilever

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- Structural Depth Study | Redesign gravity system
  - Post tensioned slab and one way slab
  - Limit total floor depth
- Structural Depth Study | Redesign lateral system
  - Remove shear walls and braced frames
  - Concrete moment frames
- Construction Management Breadth Study
  - Cost effect of structural system change
  - Schedule influence of new structural system
- Architectural Breadth Study
  - Aesthetic influence of dropped ceilings



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Structural Depth Study

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### Floor Plan Alterations

- Area 1
  - Column lines G and 7 moved 6.25" towards the interior
  - Column line 5 was moved 14.25" to south
- Area 2
  - Column line A shifted 14" to west and B shifted 16" to east
  - Column lines 1 and 7 shifted 6" to south and north respectively
  - Columns along A.5 and C were deleted
  - Column located in green was added
  - was added



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## ▪ PT Overview

- Method of prestressing
- Tendon tensioned after concrete has hardened
- Chapter 18 of ACI 318-05
- Unbonded tendons
- Tendons fabricated with plastic sheathing and grease
- ½" diameter, 7 wire strands

Tendon Properties
Area= .153 in <sup>2</sup>
$f_{pu} = 270$ ksi
Estimated Prestress Loss= 15ksi
$f_{se} = .7 * (f_{pu}) - 15\text{ksi} = 174$
$P_{eff} = A * f_{se} = 26.6$ kip/tendon
P/A: Max=300, Min=150

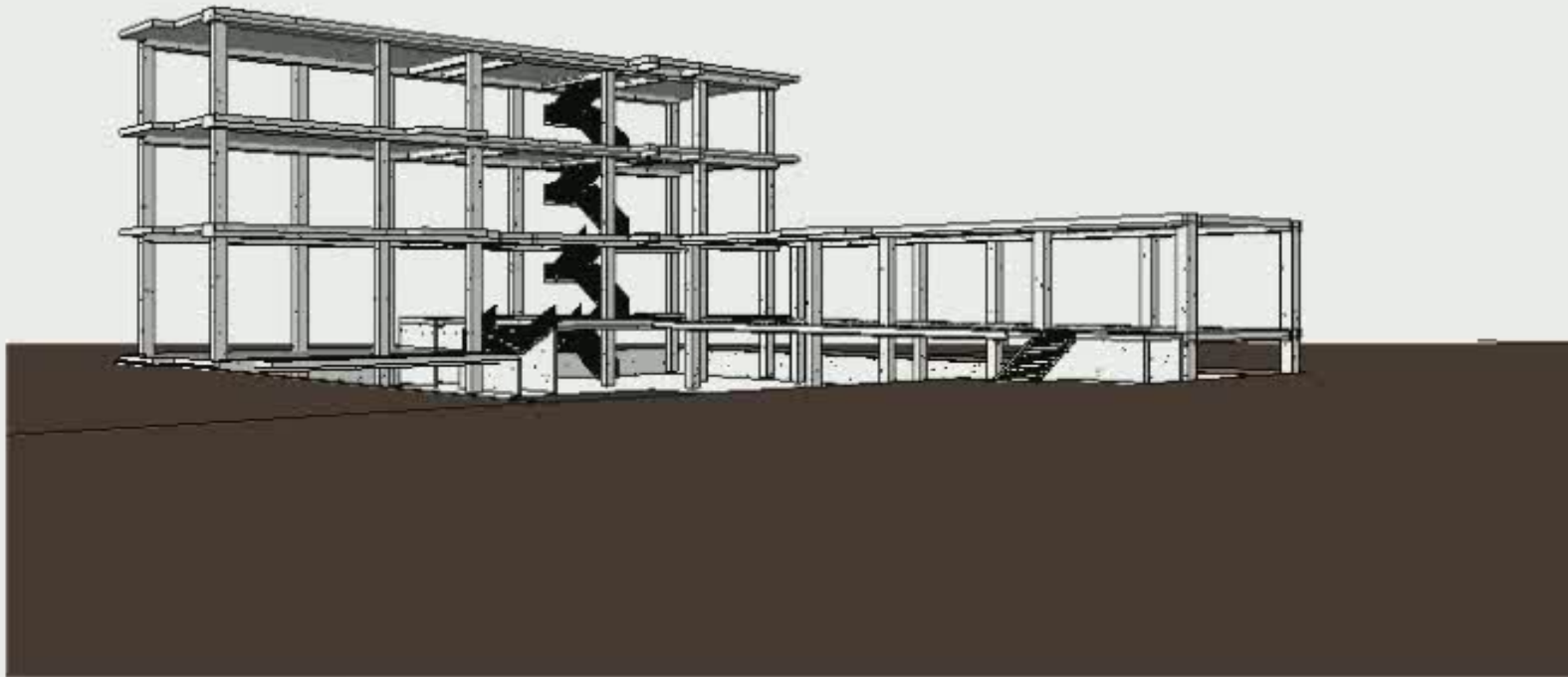
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### **Shortening Restraint**

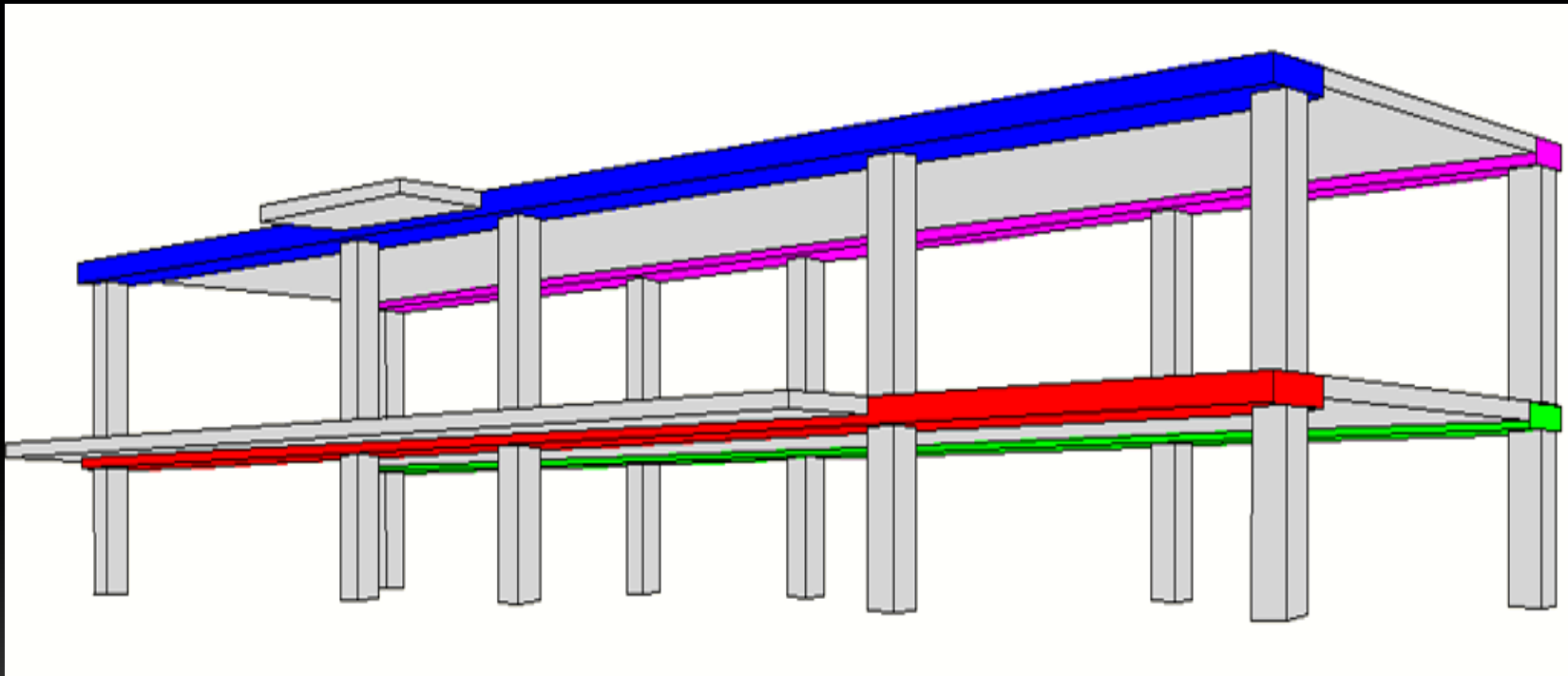
- Important to allow for the shortening of slab
- Reduces the amount of cracking due to shrinkage
- Isolate the slab from the foundation wall
- Isolate the perimeter columns
- Column lines were displaced from the foundation wall

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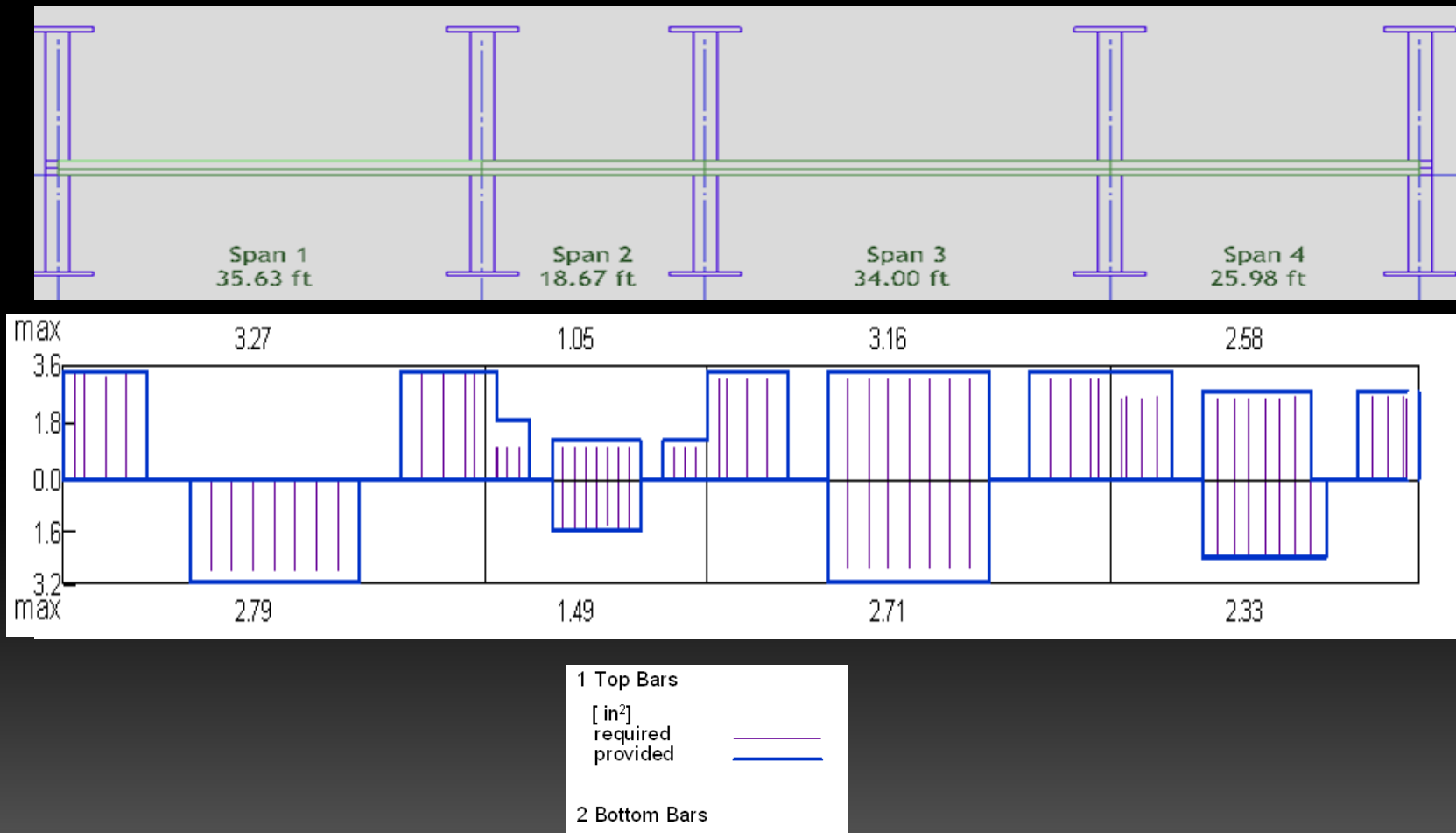


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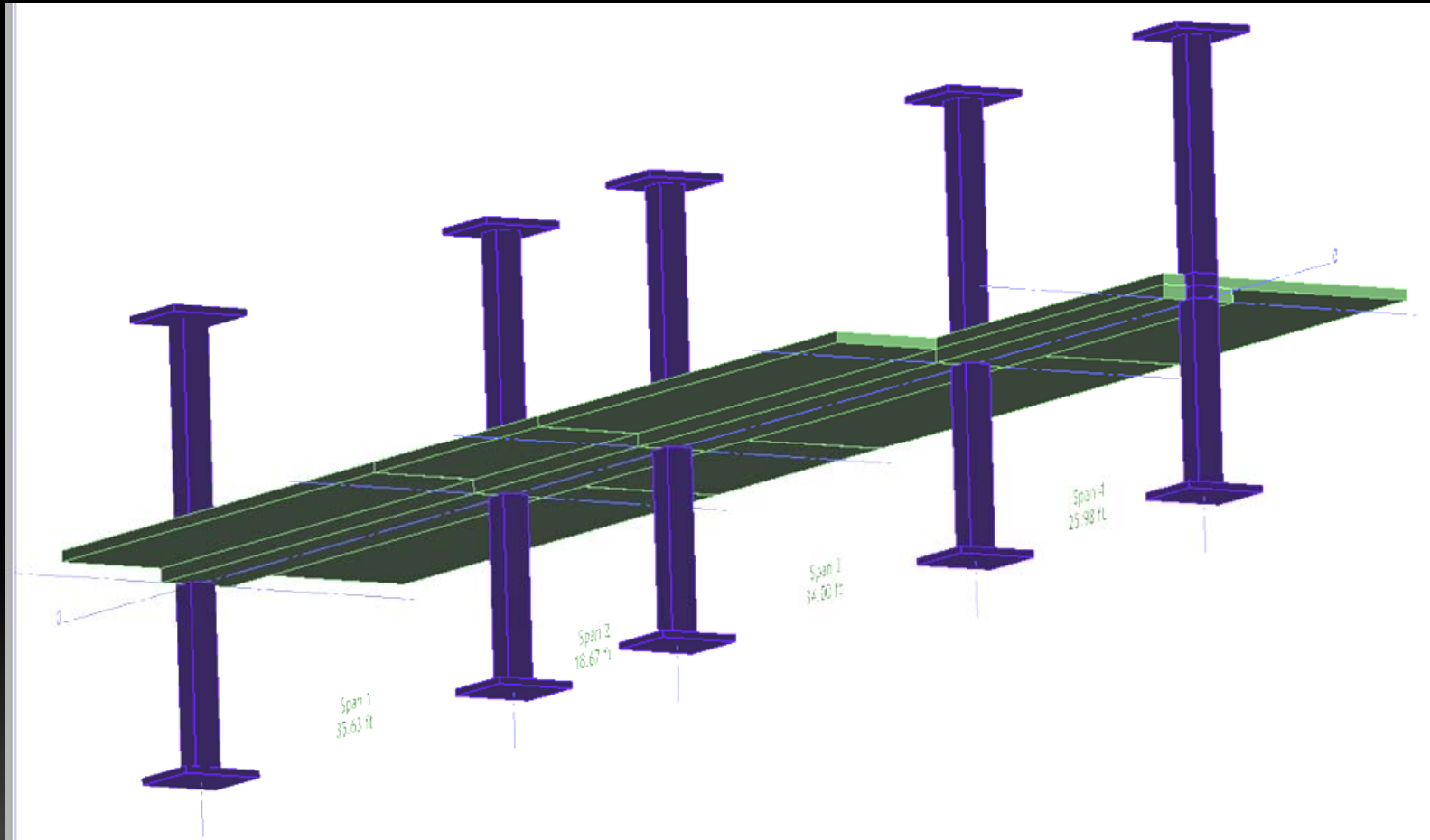
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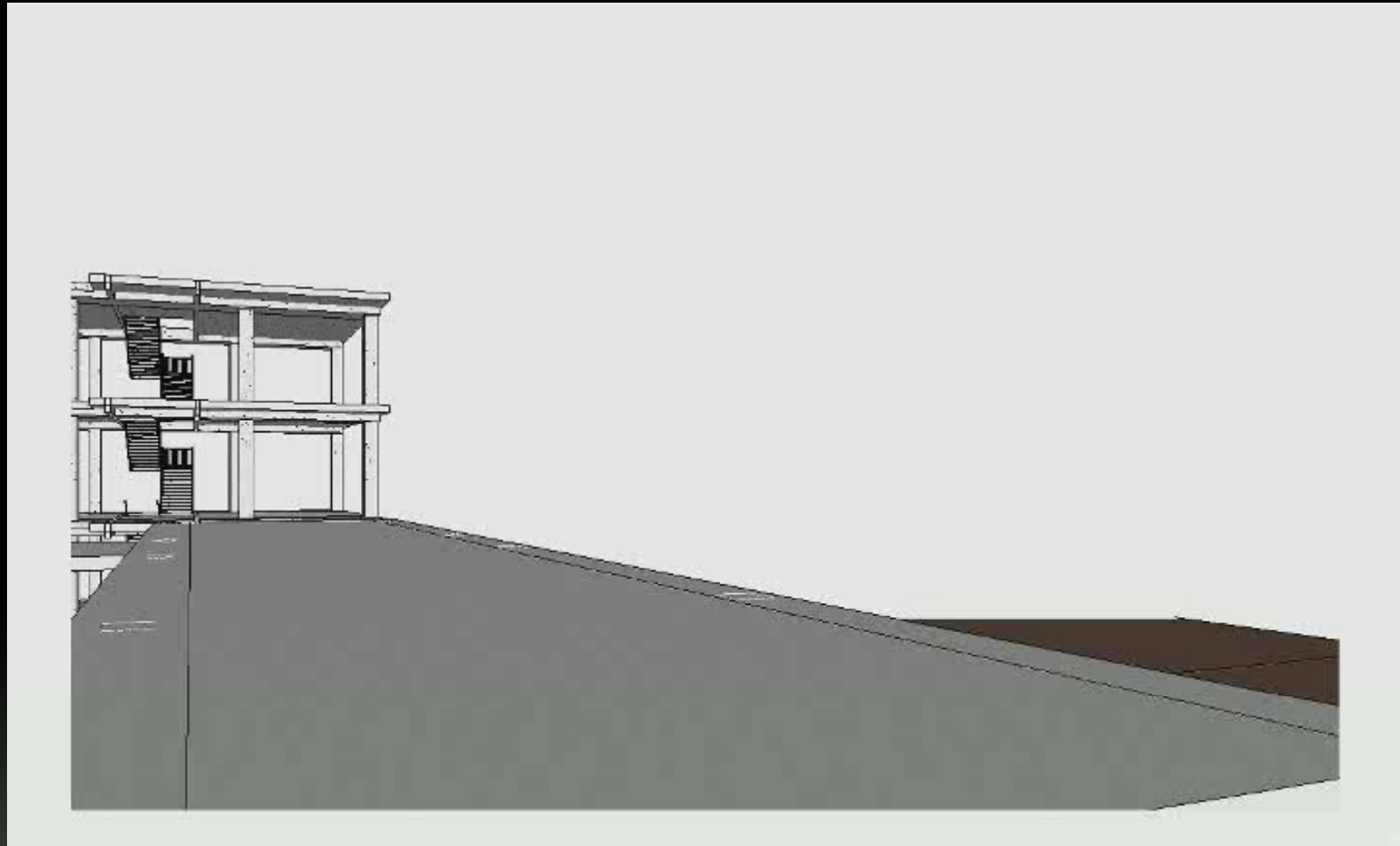


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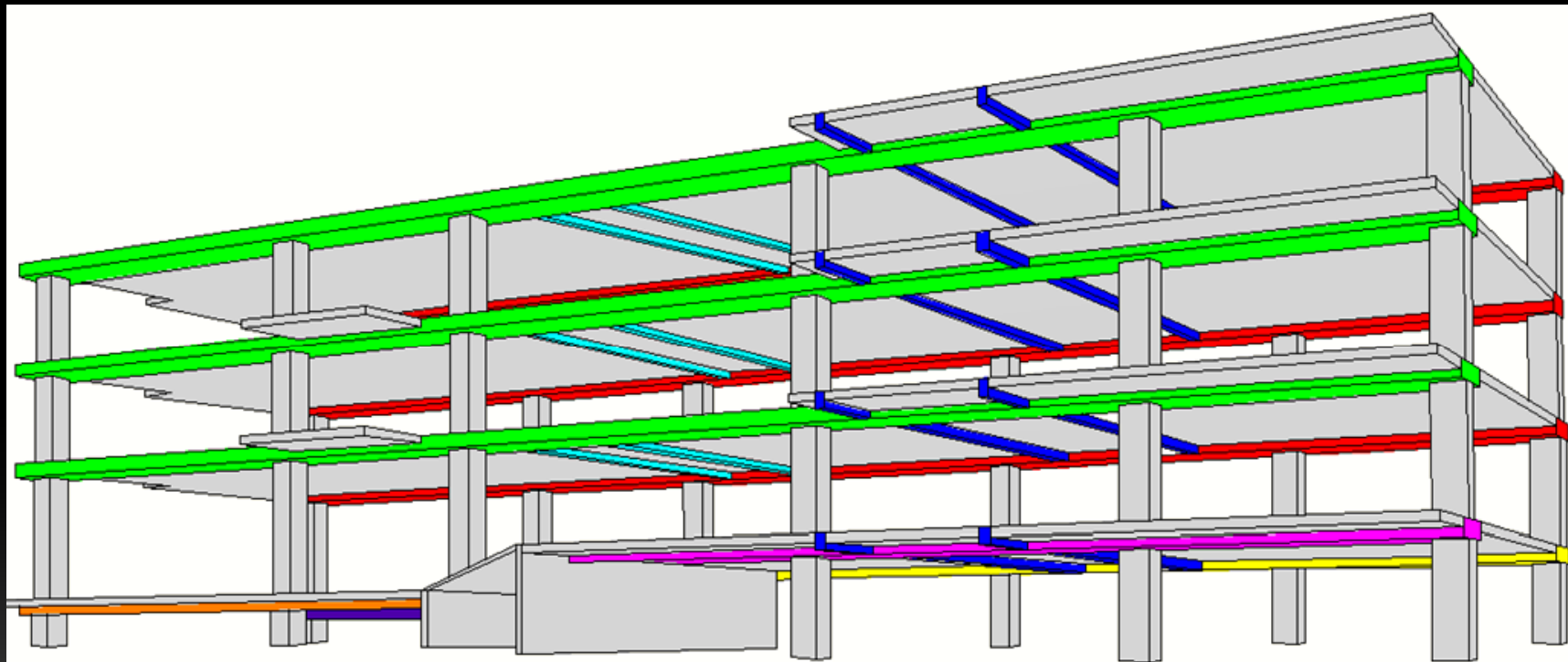


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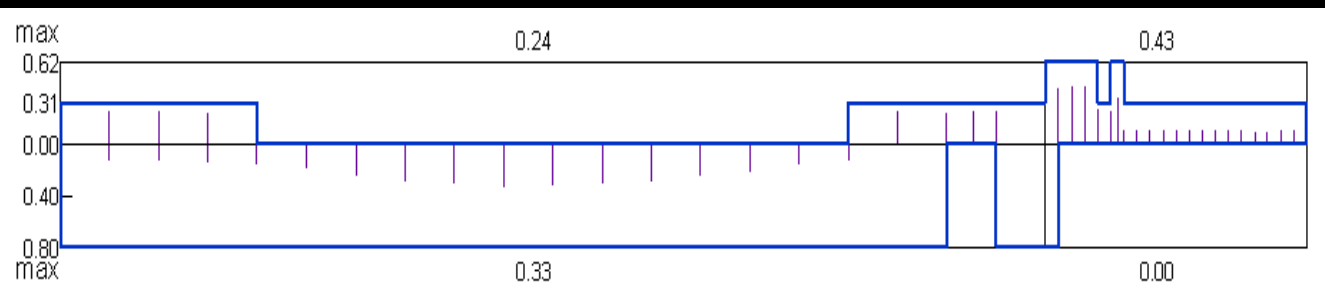
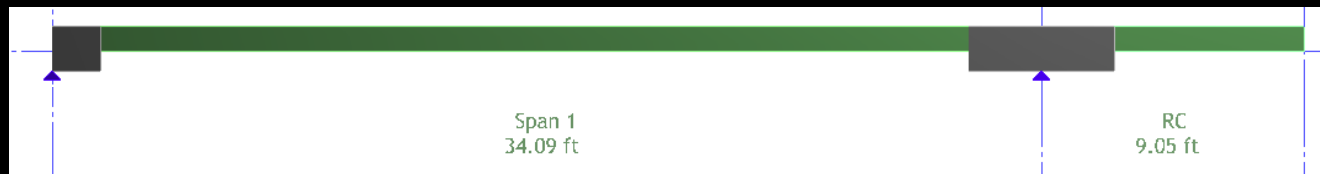


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Span	Class	Type	W k/ft2
ALL	LL	U	0.050
ALL	SDL	U	0.015

$$L = L_o \left( 0.25 + \frac{15}{\sqrt{K_{LL} A_T}} \right)$$

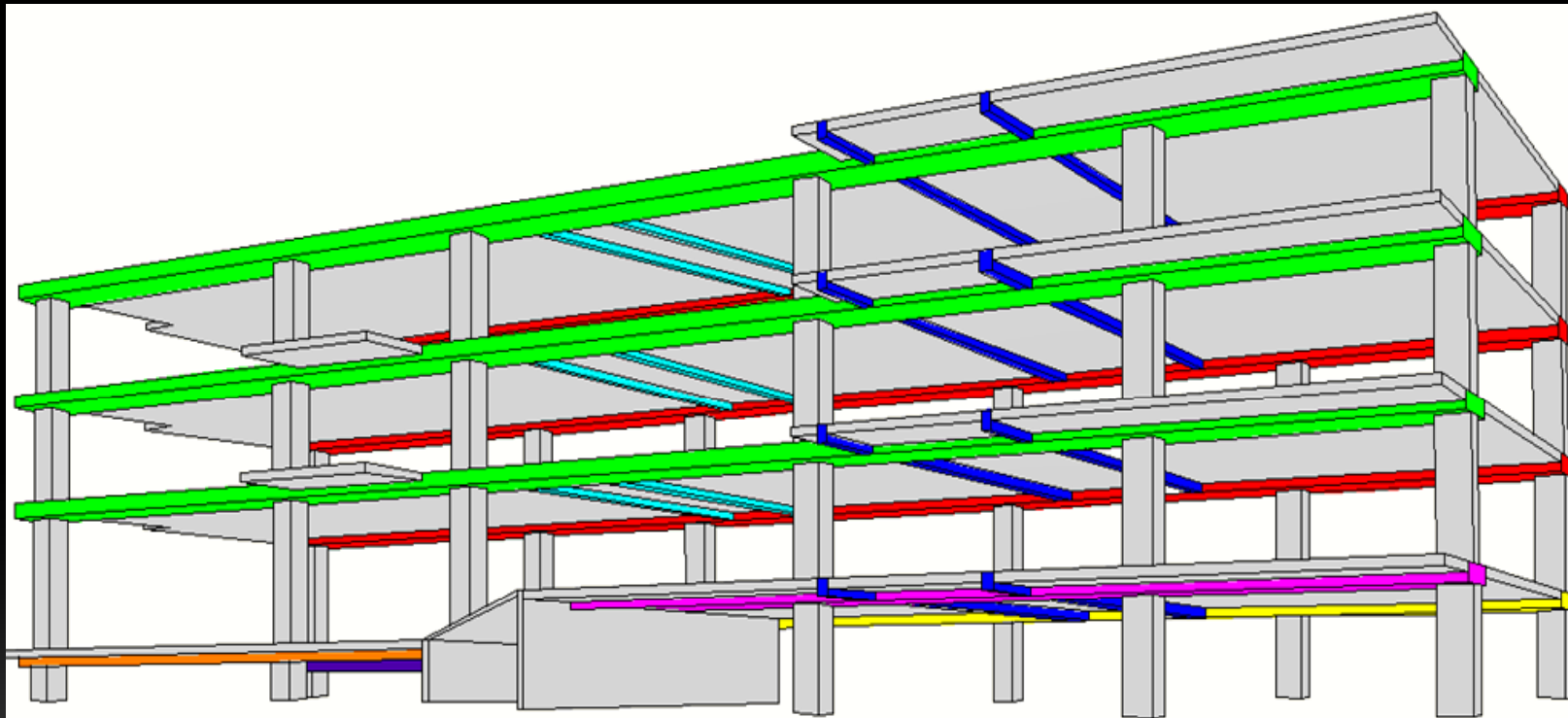
[ in<sup>2</sup> ]  
required  
provided

— (purple)  
— (blue)

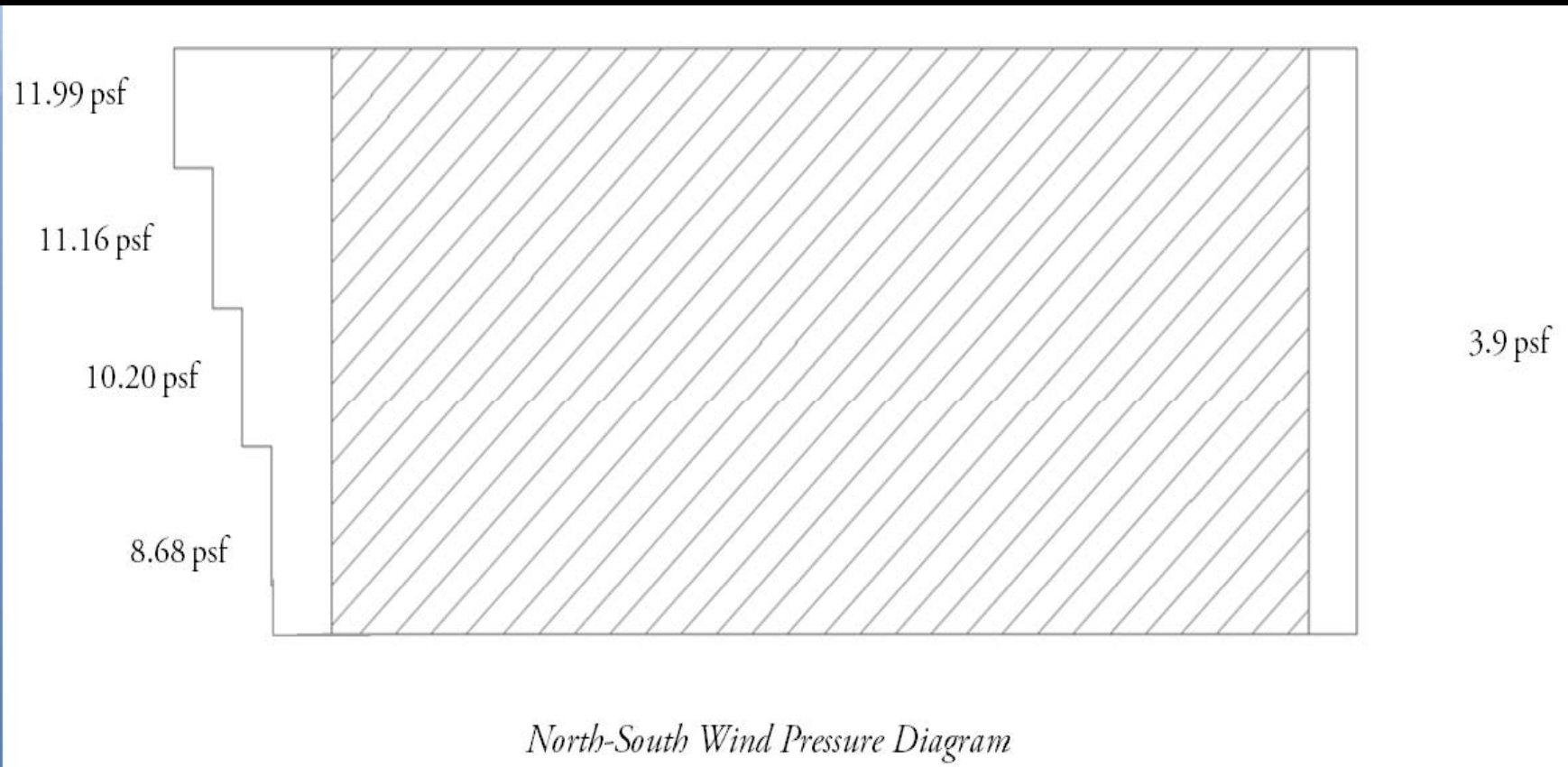
Reinforcement perpendicular to tendons:  
 $A_s = .0018 * b * h$

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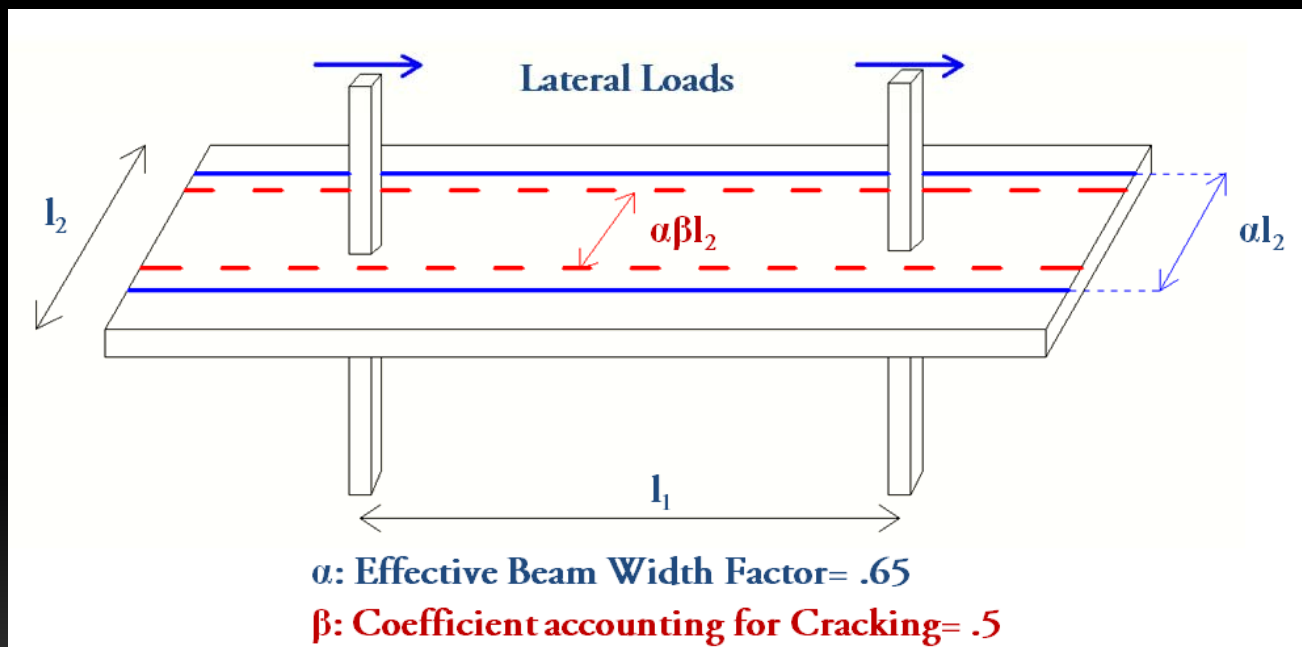
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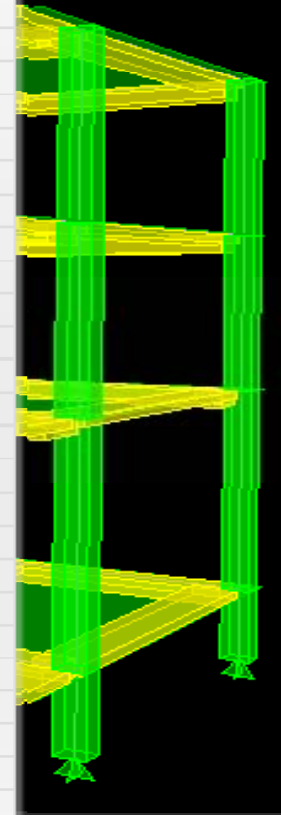
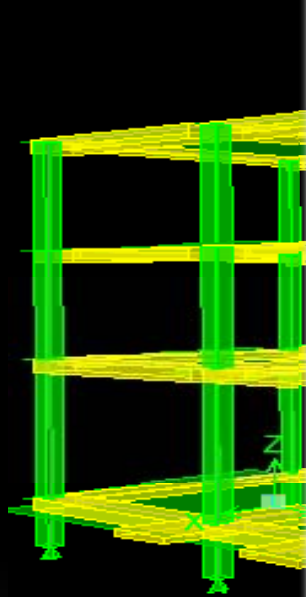


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Story	Diaphragm	Load	UX (in)	UY (in)
STORY4	D4	XWIND	1.1218	0.0007
STORY4	D4	YWIND	-0.0012	0.1851
STORY4	D4	XQUAKE	1.331	0.0016
STORY4	D4	YQUAKE	0.0013	0.7267
STORY4	D4	CASE3	0.8405	0.1394
STORY4	D4	CASE2X	0.8772	0.0033
STORY4	D4	CASE2Y	-0.0047	0.1386
STORY4	D4	CASE4	0.8725	0.1418
STORY3	D3	XWIND	0.9105	0.0003
STORY3	D3	YWIND	-0.0008	0.1591
STORY3	D3	XQUAKE	1.0466	0.0003
STORY3	D3	YQUAKE	0.0007	0.6051
STORY3	D3	CASE3	0.6823	0.1196
STORY3	D3	CASE2X	0.705	-0.0002
STORY3	D3	CASE2Y	-0.0029	0.1194
STORY3	D3	CASE4	0.7021	0.1192
STORY2	D2	XWIND	0.5796	0.0004
STORY2	D2	YWIND	-0.0003	0.1097
STORY2	D2	XQUAKE	0.6395	0.0002
STORY2	D2	YQUAKE	0.0003	0.4
STORY2	D2	CASE3	0.4345	0.0826
STORY2	D2	CASE2X	0.4444	-0.0008
STORY2	D2	CASE2Y	-0.0013	0.0824
STORY2	D2	CASE4	0.4431	0.0816
ENTRANCE	D1	XWIND	0.0622	0.0001
ENTRANCE	D1	YWIND	0	0.0116
ENTRANCE	D1	XQUAKE	0.0652	0
ENTRANCE	D1	YQUAKE	0	0.0401
ENTRANCE	D1	CASE3	0.0466	0.0088
ENTRANCE	D1	CASE2X	0.0467	-0.0006
ENTRANCE	D1	CASE2Y	0	0.0088
ENTRANCE	D1	CASE4	0.0467	0.0082

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Construction Management  
Breadth Study



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Description	Existing Steel Structure	Concrete Structure
	Total \$	Total \$ **
Formwork	2,743	76,057
Concrete reinforcing	4,557	38,921
Cast in place concrete	12,077	31,576
Structural framing	53,590	
Metal deck	11,135	
Fire and smoke protection	10,304	
<b>Total Estimate</b>	<b>94,406</b>	<b>146,555</b>

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### Existing Steel Structure

### Concrete Structure

Description	Total \$ **	Total \$
Formwork	82,989	178,464
Concrete reinforcing	63,058	95,135
Cast in place concrete	47,731	80,011
Structural framing	161,102	
Metal deck	25,506	
Fire and smoke protection	17,734	
<b>Total Estimate</b>	<b>398,121</b>	<b>353,610</b>

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Conclusions

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Acknowledgements

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Questions  
&  
Comments