

*Daniel Hancock  
Structural Option  
Senior Thesis Presentation*

*S&T Bank Corporate Headquarters, Indiana PA*



*The Pennsylvania State University Department Of Architectural Engineering*



## PRESENTATION OUTLINE:

- About S&T Bank
  - General Building Statistics
- Existing Building Conditions
  - Project Team
  - Foundation
  - Floor System
  - Framing System
- Problem Statement
  - Proposed Structural Depth
    - Slab System
    - Column Design
    - Footing Design
  - Construction Management Breadth
    - Cost Analysis
    - Schedule Analysis
  - Lighting Breadth
    - Existing Lighting Design
    - Proposed Lighting Design
- Recommendations

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*S&T Bank  
Indiana, PA*



*Project Overview*

- ★ Primarily an Office Building*
- ★ Total of 79,341 sf.*
- ★ Construction Start: June 2005*
- ★ Completion Deadline: August 2006*
- ★ Estimated Cost: \$6,577,00*
- ★ Zoning Class- B-1 (Business District)*
- ★ Max Building Height- 75 ft*
- ★ Requires Demolition of Previous Bank Before New Construction Can Commence*
- ★ Building Includes an S&T Branch Bank on the First Floor*

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S&T Bank  
Indiana, PA

## PROJECT TEAM

OWNER/CLIENT: S&T Bank



ARCHITECT: R.W. Larson Associates



STRUCTURAL ENGINEER: Watson Engineers

CIVIL ENGINEER: McIlvried, Didiano & Mox, LLC



MECHANICAL/ELECTRICAL ENGINEER:  
Firsching, Marsteller, Rusbarsky & Wolf Engineering INC



GENERAL CONTRACTOR: A.W. McCoy



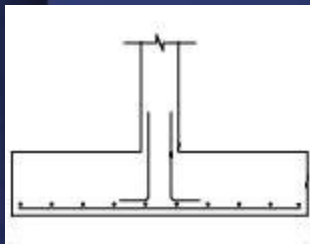
BANK EQUIPMENT & SECURITY SUPPLIER: Diebold Incorporated



## EXISTING CONDITIONS

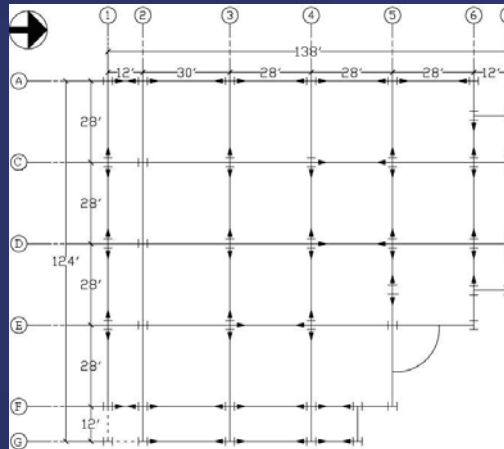
### FOUNDATION:

- Footings → Spread Footings
- ★ Typically 7½ feet square
  - ★ 24" Thick



Foundation → Masonry Wall

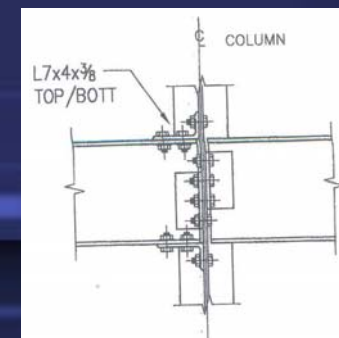
- ★ 12" Ivory Block Wall
- ★ Concrete Piers (1'-8" X 2'-4")



### FRAMING SYSTEM:

Framing System → A992 Steel

- ★ Typical Girder: W24 x 55
  - ★ Typical Beam: W14 x 22
  - ★ Typical Column: W12 x 53
- ☆ All Beams and Girders Frame Into a Column.
- ☆ Lateral Forces Resisted By Moment Connections



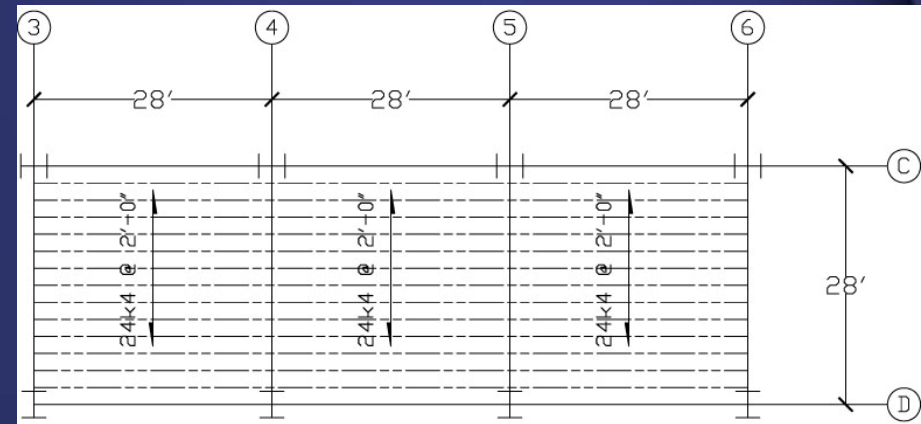


## EXISTING CONDITIONS

### FLOOR SYSTEM:

Floor System → Non-Composite Deck set on Steel Joists spaced at 2'-0" o.c.

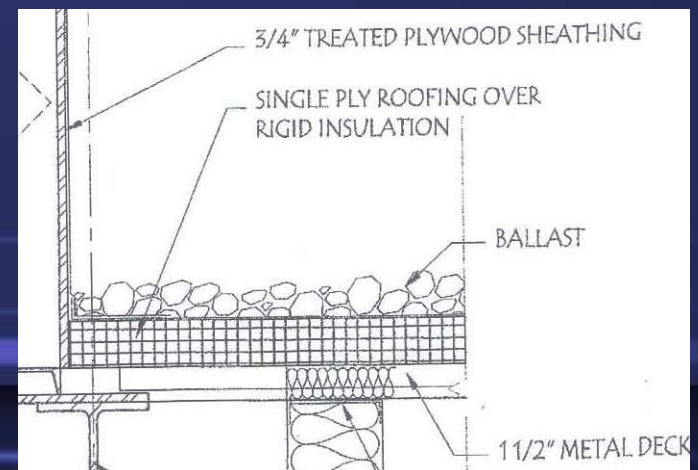
- ★ 24k4 Joists (typical)
- ★ 28 Gage Galvanized Deck
- ★ 3" Concrete Topping (3000psi)
  - Reinforced with 6x6 W1.4 x W1.4 WWF



### ROOF SYSTEM:

Roof System → Typical Built-Up Roof System

- ★ Stone Ballast System
- ★ Sits upon 1/2" glass sheathing roof membrane, R20 roof insulation, and 1 1/2" metal decking





## THESIS PROPOSAL

Problem Statement: Due to the simplicity of the original design and the straightforwardness of the building layout, a creative redesign that is appropriate for such a building is hard to discern.

*HOWEVER...* Can we be sure that steel is the most efficient construction material for this building?

Proposed Solution: To accurately make this comparison, the current steel system must be compared to a concrete system for the same building, and a structural system using concrete must be completely designed.

*Will a two-way concrete slab system be more efficient than a steel system?*



## PROPOSED BUILDING LOADS

### Building Codes

IBC 2003- International Building Code  
(In accordance with ASCE 7-05)

### Snow Loads

20psf

### Dead Loads

Superimposed DL: 12psf  
Floor Loads: 125psf  
(Slab Self-weight)

### Design Loads Used

Roof 23.98 kips  
4th Floor 57.94 kips  
3rd Floor 57.94 kips  
2nd Floor 66.52 kips  
1st Floor 16.9 kips  
(wind case controls at base)

### Live Loads

Floors 1, 2, 3, & 4 100psf (Lobby area)

The load combinations looked at, are as follows...

1.4D  
1.2D+1.6L+(0.5L or 0.8W)  
1.2D+1.6W+0.5L+0.5S  
1.2D+1.0E+0.5L+0.5S  
0.9D+(1.6W or 1.0E)





## PROPOSED DESIGN

### SLAB SYSTEM:

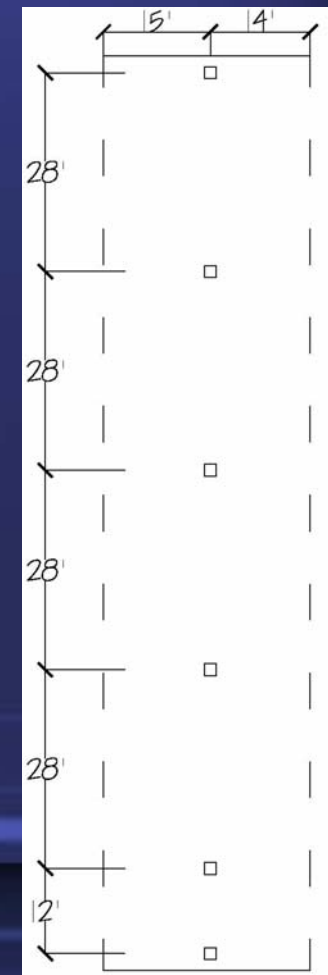
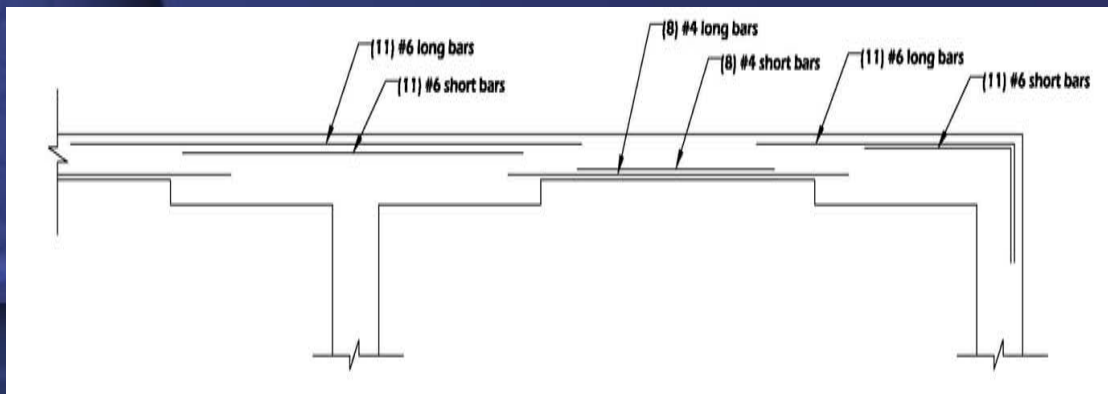
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Slab System  $\rightarrow$  Two-way Flat Slab with Drop Panels

- ★ 10" Slab
- ★ 7½ Drop Panels
- ★ Two Way Reinforcing

★ Designed with ADOSS which uses the Equivalent Frame Method  $\rightarrow$

★ Punching Shear Allows 16" x 16" Columns





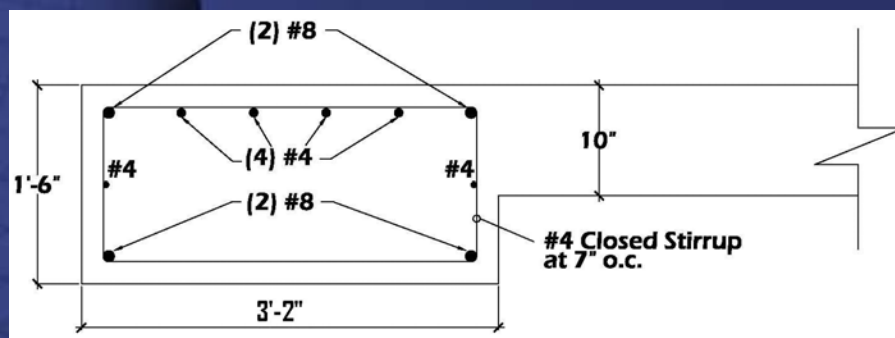
## PROPOSED DESIGN

### EDGE BEAM DESIGN:

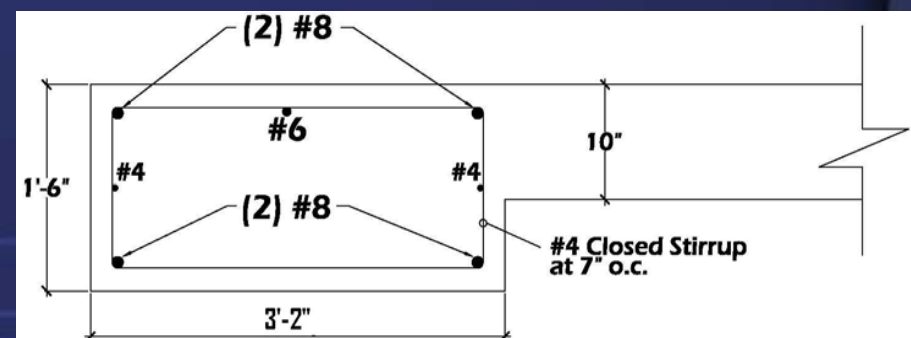
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Edge Beam  $\rightarrow$  Located Along Entire Perimeter

- ✦ 38" x 18" Beam
- ✦ Provides Resistance to Torsion
- ✦ Reduces Shear in Slab Along Exterior



Edge Beam Detail At Support



Edge Beam Detail At Mid-span



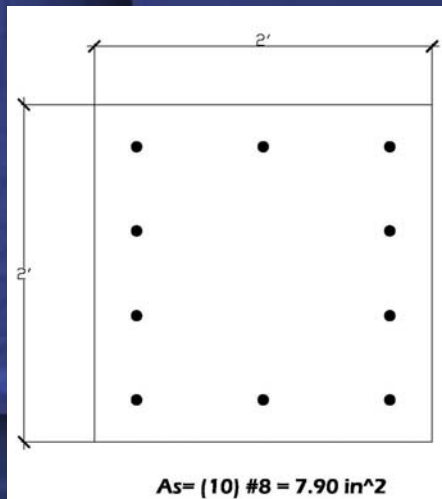
## PROPOSED DESIGN

### COLUMN DESIGN:

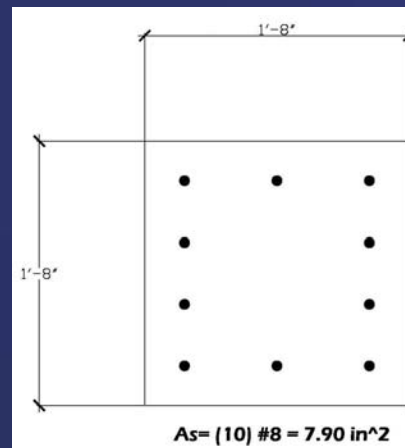
$F'_c = 4000 \text{ psi}$

☆ Designed using column interaction diagrams provided by the "Design of Concrete Structures" textbook.

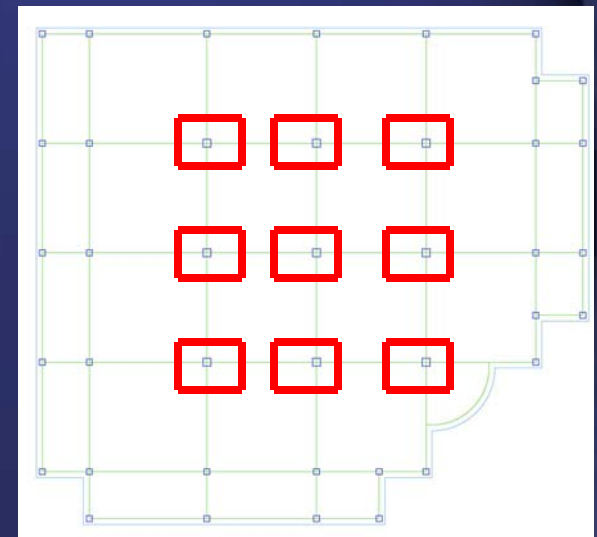
☆ Design was controlled by the bearing capacity of the footing, not by strength.



Core Column Design



Exterior Column Design

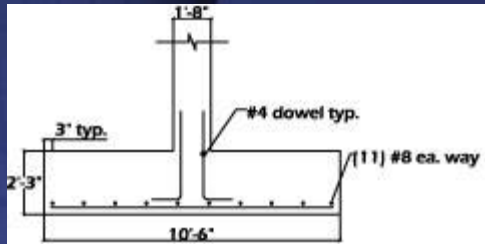




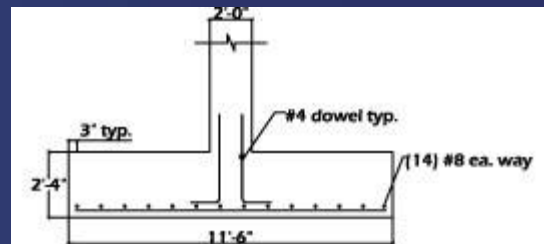
## PROPOSED DESIGN

### FOOTING DESIGN:

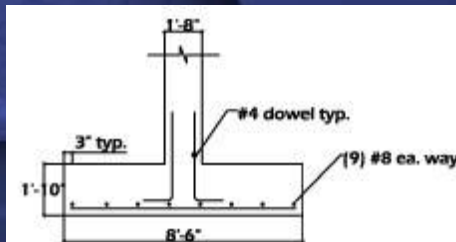
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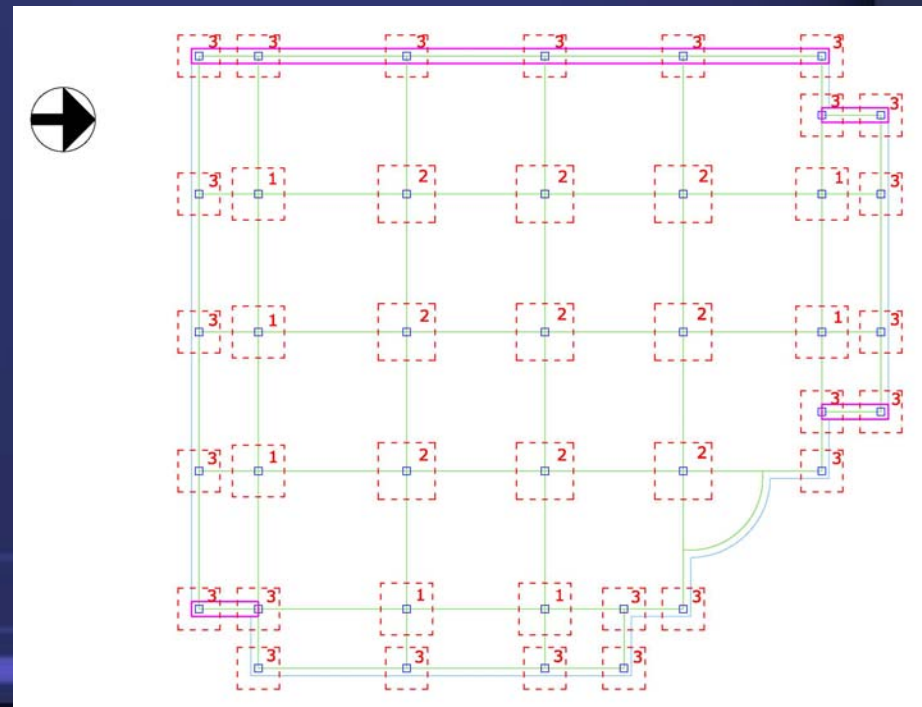
#1: Footings Second Row from the Exterior Except in the West Direction.



#2: Footings Located in Central Core of Building Plan.



#3: Footings Located Along Outside Perimeter of Building.



Footing Plan



## Breadth #1: Construction Management

### Existing Statistics:

\*Structural Costs:  
\$1,320,000

\*Labor Costs:  
\$1,870,000

**TOTAL COSTS:**  
\$3,190,000

### Duration of Completed Structure

\*102 Days

### Proposed Statistics:

Structural Costs:  
\$1,045,340

Labor Costs:  
\$1,478,349

**TOTAL COSTS:**  
\$2,523,689

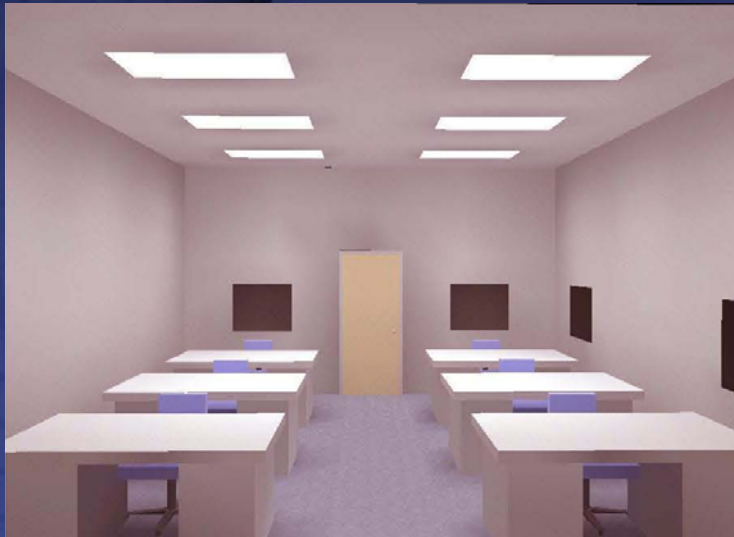
### Duration of Completed Structure

197 Days

\*Existing Estimates Provided  
by R.W. Larson Associates



## Research Room Lighting



### Existing Lighting Conditions:

- ✦ 2' x 4' Recessed Office Light
- ✦ Uses (2) T8, 32W Fluorescent Lamps
- ✦ 100% Direct Lighting
- ✦ Existing Lighting Levels Range From 32.7fc - 46.1fc on the Desktops

Ideal Foot Candle Range: 50-57

### Proposed Lighting Conditions:

- ✦ 8" x 4' Pendant Mount Fixture
- ✦ Uses (2) T8, 32W Fluorescent Lamps
- ✦ 100% Indirect Lighting
- ✦ Existing Lighting Levels Average at 54.1 fc on the Desktops





## RECOMMENDATIONS:

	<u>Concrete System:</u>	<u>Steel System:</u>
SLAB THICKNESS	15½" Deep Slab	27" Deep Slab
COLUMNS	24" x 24"	<b>12" x 12"</b>
COST	<b>\$2,523,689</b>	\$3,190,000
DURATION	197 Days	<b>102 Days</b>
SAVINGS	<b>\$666,311</b>	95 Days

★ The STEEL SYSTEM is the More Efficient Construction Material

- ★ Only \$100,000 in Savings After Accounting For PM Costs For the Extra Duration
- ★ Potential Profit Loss Waiting for Move-In

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## THANK YOU!!

*Thank you to the Pennsylvania State University for enabling me the opportunity to gain an education that will forever open doors that would normally be locked.*

*Thank you to Dr. Linda Managan for being supportive of the work that I was doing, and for being unwavering in her guidance and availability during the school year. She made it possible to ask questions without feeling intimidated.*

*Thank you to R.W. Larson Associates for always providing information in a timely manner, and for coordinating the acquisition of a set of drawings for S&T Bank.*

*Thank you to all of the professors who have answered random questions throughout the school year and for being flexible in class deadlines around busy thesis deadlines.*

*Above all, thank you to S&T Bank for permitting me to conduct my thesis research. Without them none of this could be possible.*



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QUESTIONS??