A Medical Office Building
For
The Primary Health Network

Sharon, Pennsylvania

Daniel Goff I Structural Option
Dr. Thomas Boothby I Faculty Advisor

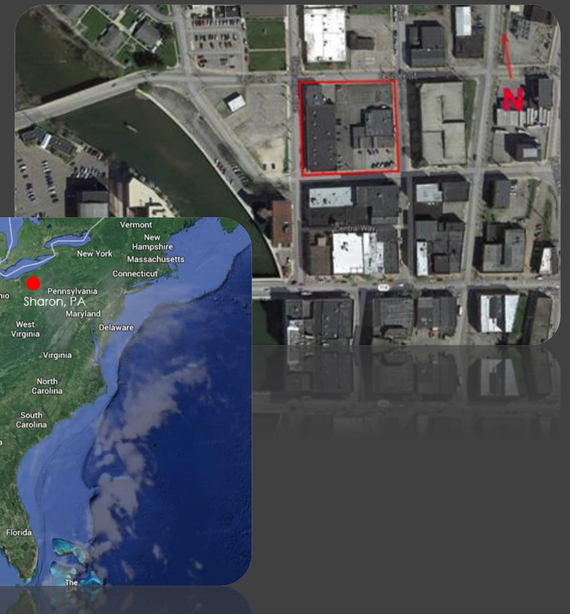
A Medical Office Building

Sharon, Pa

Building Introduction

Architect	John N. Gruitza Associates
Structural Engineer	Taylor Structural Engineers
Construction Dates	November 2014-January 2016
Height	79’-0”
Size	78,000 GSF
Primary Usage	Medical Office Building

Sharon, Pa

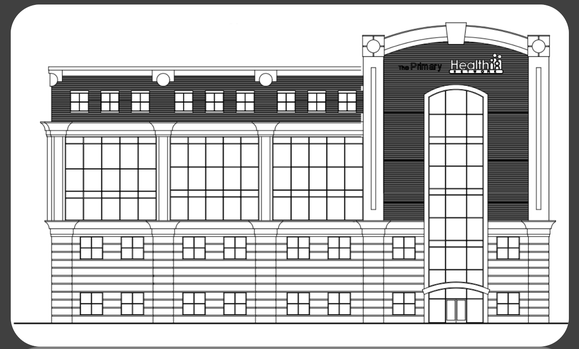


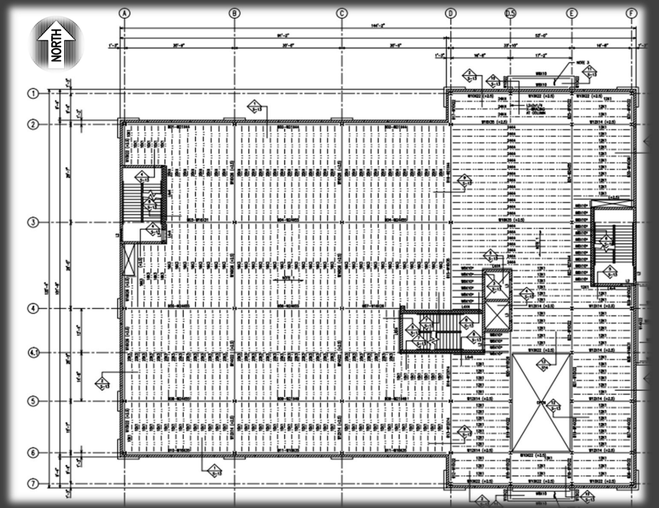
A Medical Office Building

Sharon, Pa

- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

Building Geometry





2nd Floor Plan

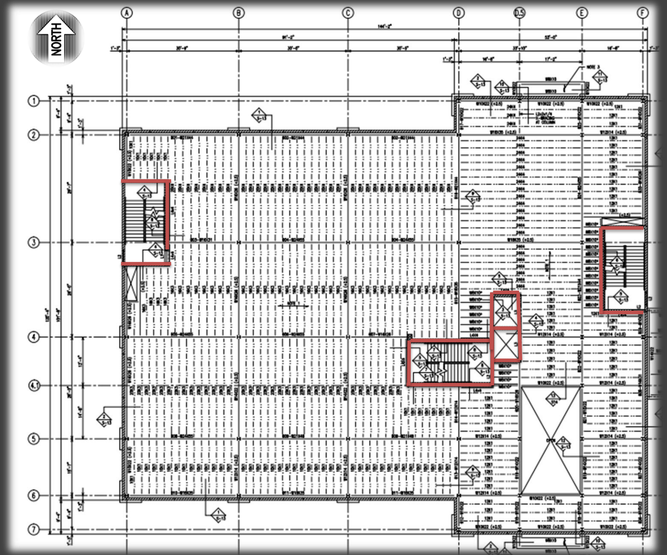
A Medical Office Building

Sharon, Pa

- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

Existing Gravity System

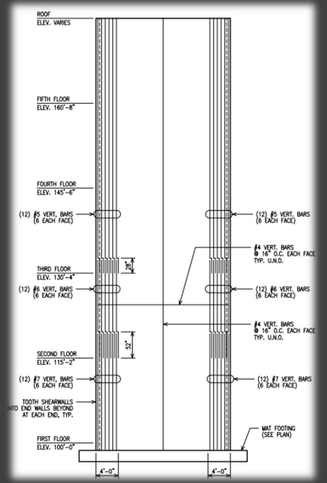
- Spread Footings
- Composite Floor deck
  - 19/32” 26 gage form deck
  - K series Bar Joists
- Wide Flange Members
- Masonry Bearing Walls



2nd Floor Plan

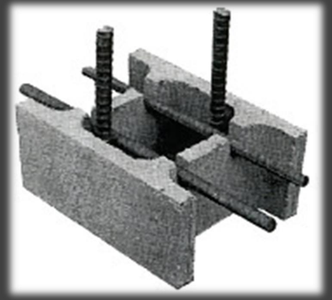
A Medical Office Building

Sharon, Pa

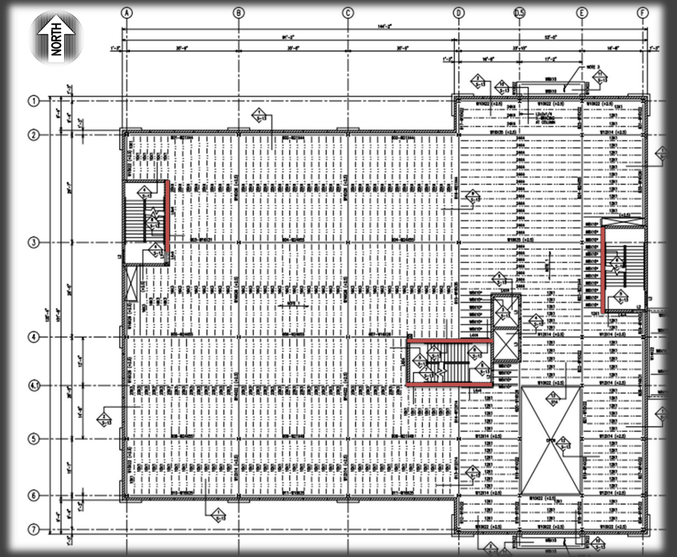


Existing Lateral System

- Masonry Shear Walls
  - Load Bearing
  - Ivany Block
  - f'm = 3000psi



Source: koltcz.com



2nd Floor Plan

A Medical Office Building

Sharon, Pa

Investigated Designs

- Non-Composite Beams
- Composite Beams
- Two-Way Flat Plate Slab

Decision Matrix

	Steel Joists	Non-Composite Steel	Composite Steel	Two-Way Flat Plate Slab
Cost	$18.71/S.F.	$16.29/S.F.	$19.91/S.F.	$15.59/S.F.
Weight	133psf	128psf	122psf	220psf
Max. Depth	24"	24"	18"	10"
Passive Fire Proofing	No	Yes	Yes	No
Active Fire Proofing	Yes	No	No	No
Fire Rating	1 hr.	2 hr.	2 hr.	4 hr.
Lateral System	Ivany Blockwall	Concrete Shearwall	Concrete Shearwall	Concrete Shearwall
Advantages	constructability	Lower square foot cost, higher fire rating	Lower weight, lower max. depth, higher fire rating	Lowest cost, lowest max. depth, higher fire rating
Disadvantages	High cost, high max. depth, low fire rating	Large max. depth	Highest cost	Highest weight, formwork required, low durability, low aesthetics
Feasible Redesign	N/A	Yes	Yes	Yes

A Medical Office Building

Sharon, Pa

Proposed Alternate Solution

Gravity System

- Two-Way Concrete flat Slab
- Concrete Columns

Lateral

- Concrete Shear Walls

Goals

- No Change in Building Layout
- Reduced Structural Depth
- Reduced Cost

A Medical Office Building

Sharon, Pa

Proposed Alternate Solution

Architecture

- Façade redesign

Construction Management

- New Construction Timeline
- Cost estimate and comparison

Goals

- Modern aesthetics
- Integrate with existing architecture
- Reduced Cost
- Feasibility of schedule

Gravity System Design

Lateral System Design

Architecture

Gravity System Design

Lateral System Design

Architecture

A Medical Office Building

Sharon, Pa

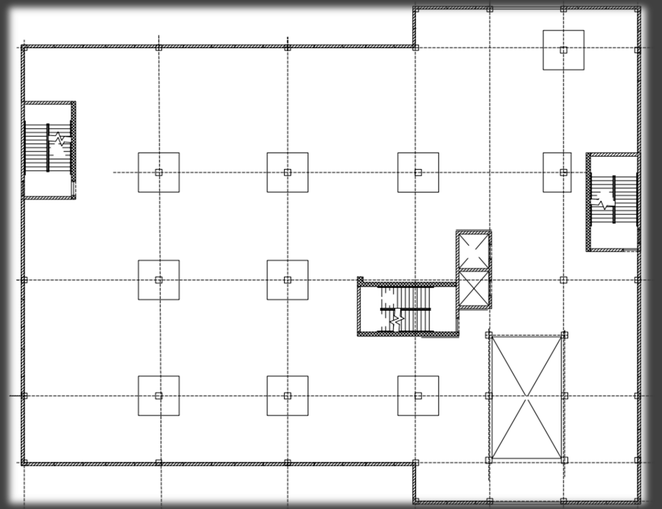
- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

Slab Design

Design
- Preliminary Design from CRSI
- spSlab
- Drop panels
- Edge Beams
- Constructability

Loading
- Live load of 80psf
- Superimposed Dead load of 20psf

Geometry
- 10” thick slab
- 9’ square drop panels
  - 8” thick
- 18” square edge beams



Typical Floor Plan

A Medical Office Building

Sharon, Pa

Deflections

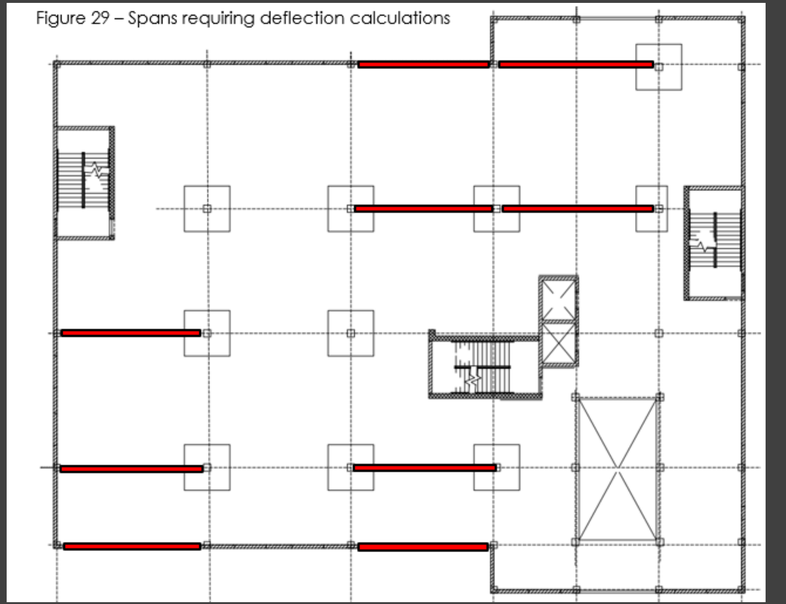
ACI 318-11 Table 9.5(c)

10” ⟶ 30’ span

ACI 318-11 Table 9.5(b)

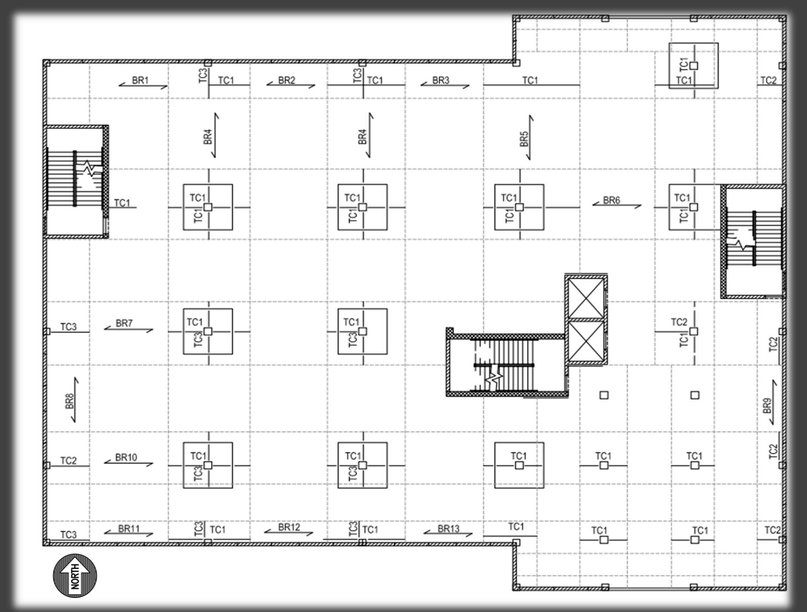
l/360

l/240



A Medical Office Building

Sharon, Pa



TYPICAL FLOOR FRAMING PLAN

SCALE: 1/8" = 1'-0"

PLAN NOTES:

1. SLAB CONSTRUCTION IS 10" NORMAL WEIGHT CONCRETE OF 4000 PSI COMPRESSIVE STRENGTH WITH 60,000 PSI REINFORCING STEEL.
2. BOTTOM MAT OF REINFORCING WILL BE #5@12" O.C. IN EACH DIRECTION CONTINUOUS. ADDITIONAL BOTTOM REINFORCING IN REINFORCING SCHEDULE AS NOTED ON PLAN AND SHALL RUN FROM COLUMN TO COLUMN.
3. TOP MAT OF REINFORCING WILL BE #5@12" O.C. IN EACH DIRECTION ADDITIONAL TOP REINFORCING IN REINFORCING SCHEDULE AS NOTED ON PLAN

REINFORCING SCHEDULE

CALLOUT	LAYER	REINFORCING DETAIL
BR1	BOTTOM	(4) #7 BARS
BR2	BOTTOM	(2) #7 BARS
BR3	BOTTOM	(2) #7 BARS
BR4	BOTTOM	(3) #7 BARS
BR5	BOTTOM	(3) #7 BARS
BR6	BOTTOM	(4) #7 BARS
BR7	BOTTOM	(4) #7 BARS
BR8	BOTTOM	(2) #7 BARS
BR9	BOTTOM	(1) #7 BARS
BR10	BOTTOM	(3) #7 BARS
BR11	BOTTOM	(3) #7 BARS
BR12	BOTTOM	(2) #7 BARS
BR13	BOTTOM	(2) #7 BARS
TC1	TOP	(2) #7 BARS
TC2	TOP	(1) #7 BARS
TC3	TOP	(3) #7 BARS

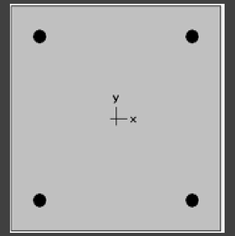
A Medical Office Building

Sharon, Pa

Column Design

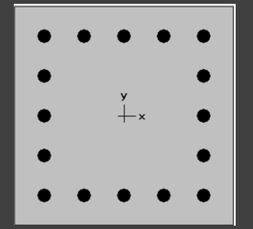
- 18”x18” Throughout
- 15’-6” Floor to Floor height
- Four columns analyzed
- spColumn
- Two Designs selected
- f’c = 4000psi

Exterior Column



4 #9 Bars

Interior Column



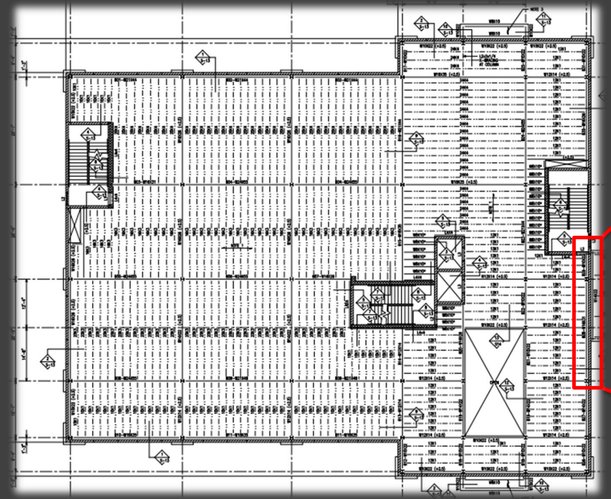
16 #9 Bars

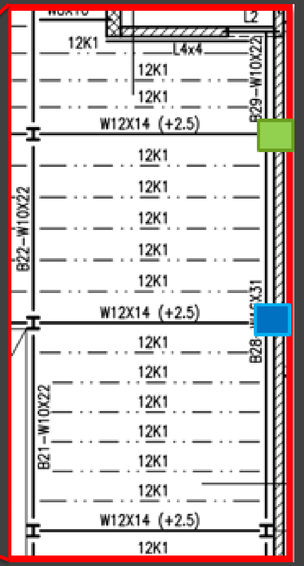
A Medical Office Building

Sharon, Pa

- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

Column Locations





Gravity System Design

Lateral System Design

Architecture

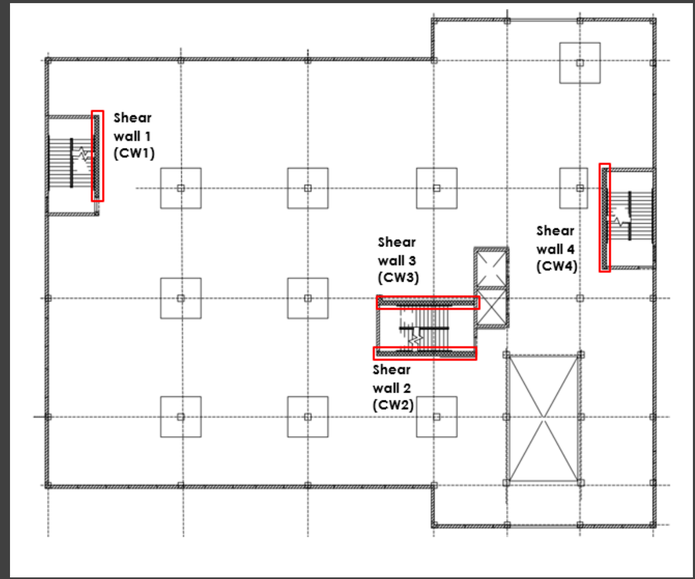
A Medical Office Building

Sharon, Pa

- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

Shear Wall Design

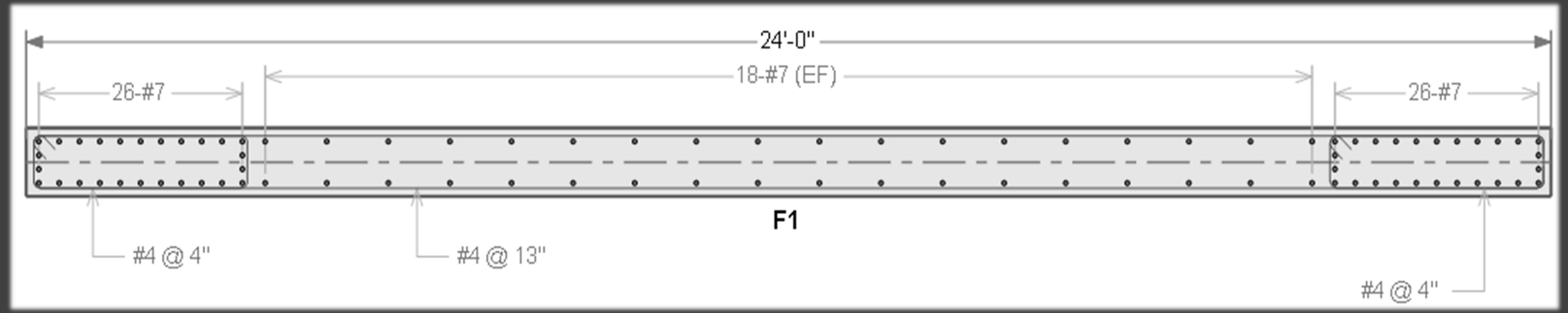
- Significant increase in building weight
- Layout
- ETABS 2013
- f’c = 4000psi
- 12” Thick



A Medical Office Building

Sharon, Pa

Shear Wall Reinforcement Layout



A Medical Office Building

Sharon, Pa

Design Checks & Assumptions

- P-Delta Effects
- Out of Plane Stiffness
- Drift Checks $\Delta \leq 0.23$”
- Non-Sway assumption
- Rigid Diaphragm

$$\theta = \frac{P_x \Delta I_e}{V_x h_{sx} C_d} \qquad (12.8\text{-}16)$$

$$Q = \frac{\Sigma P_u \Delta_o}{V_{us} \ell_c} \leq 0.05 \qquad (10\text{-}10)$$

$$\frac{k\ell_u}{r} \leq 34 - 12(M_1/M_2) \leq 40 \qquad (10\text{-}7)$$

Gravity System Design

Lateral System Design

Architecture

A Medical Office Building

Sharon, Pa

- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

Background

- First new project since 1969
- Surrounding architecture
- Existing façade

Source: sharonherald.com

A Medical Office Building

Sharon, Pa

- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

Case Studies

Tsinghua Law Library

Architect: KokaiStudios

www.archdaily.com

Diana Center at Barnard College

Architect: Weiss/Manfredi

www.flickr.com

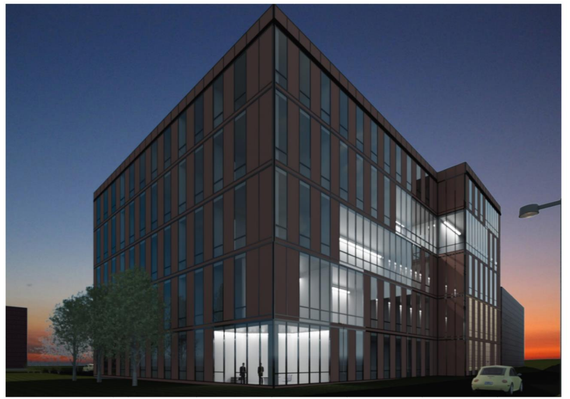
A Medical Office Building

Sharon, Pa

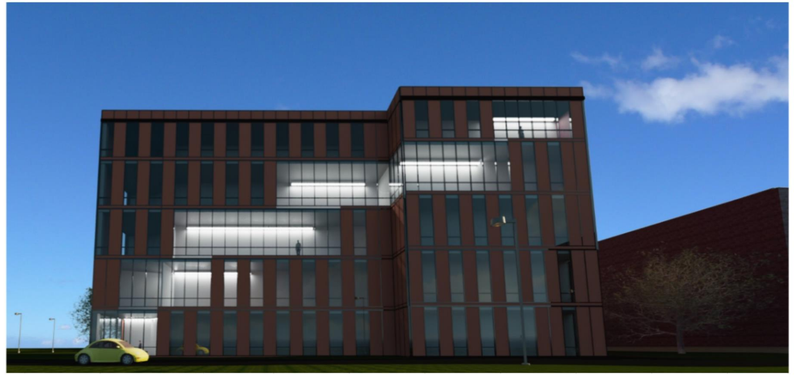
- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

New Façade

North East View



North View



A Medical Office Building

Sharon, Pa

Conclusions

- 40% reduction in structural depth
- Met all requirements for strength & serviceability
- 12% increase in structural cost
- 127% increase in façade cost

Structural Redesign: **Viable Option**

Façade Redesign: **Not Feasible**

A Medical Office Building

Sharon, Pa

Acknowledgements

Special Thanks to:

- Thomas Boothby
- Linda Hanagan
- Taylor Structural Engineers
- The AE Faculty
- My friends and family

A Medical Office Building

Sharon, Pa

- Building Introduction
- Proposal
- Gravity System Redesign
  - Slabs
  - Columns
- Lateral System Redesign
  - Design
  - Assumptions
- Architecture Breadth
  - Background
  - Façade
- Conclusion
- Acknowledgements

Questions