

# BRIDGESIDE POINT II

PITTSBURGH, PA



IMAGE COUTESY OF THE FERCHILL GROUP

## “BUILDING SYSTEM OPTIMIZATION”

THE DEPARTMENT OF ARCHITECTURAL ENGINEERING  
AT  
THE PENNSYLVANIA STATE UNIVERSITY

APRIL 14, 2008

ANTONIO DESANTIS VERNE

STRUCTURAL OPTION  
ADVISOR: PROF. PARFITT



# PRESENTATION OUTLINE

## PRESENTATION OUTLINE

THESIS GOALS

BUILDING INTRO

STRUCTURAL DEPTH

ARCHITECTURE BREADTH

ACOUSTICS BREADTH

SUMMARY  
&  
RECOMMENDATIONS

THANK YOU

QUESTIONS

## THESIS GOALS

## BUILDING INTRODUCTION

## STRUCTURAL DEPTH

- OPTIMIZATION STUDIES
- COST SAVINGS & BENEFITS
- RECOMMENDATIONS

## ARCHITECTURAL BREADTH

- INTRODUCTION
- COMPARISONS
- RECOMMENDATIONS

## ACOUSTICS BREADTH

- MECHANICAL ROOM LOCATION
- CALCULATIONS
- RECOMMENDATIONS

## RECAP & RECOMMENDATIONS

## QUESTIONS



PHOTO BY ANTONIO VERNE



# THESIS GOALS

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## OPTIMIZE BUILDING FEATURES

- HORIZONTALLY
- VERTICALLY

## ENHANCE BUILDING AESTHETICS

## REDUCE NOISE PROPAGATION



IMAGE COUTESY OF ATLANTIC ENGINEERING SERVICES



# BUILDING INTRODUCTION

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## BUILDING STATISTICS

- 5 FLOORS / 160,000 SQ. FT
- SPEC OFFICE & LABORATORY
- APPROX. \$19 MILLION (GMP)

## STRUCTURAL

- COMPOSITE STEEL FRAMING
- TYPICAL BAY SIZE: 30'-0" x 32'-0"
- LARGE, EXPOSED BRACED FRAMES

## ARCHITECTURE

- PRECAST STONE & METAL PANELS
- EXPANSIVE GLASS CURTAIN WALLS
- OPEN FLOOR PLAN
- 15'-0" FLOOR TO FLOOR HEIGHT

## PROJECT TEAM

- OWNER: THE FERCHILL GROUP
- ARCHITECT: STRADA, LLC
- STRUCTURAL: ATLANTIC ENGINEERING SERVICES
- CONSTRUCTION: TURNER CONSTRUCTION
- MEP: ALLEN & SHARIFF ENGINEERING



BACKGROUND IMAGE TAKEN FROM GOOGLE EARTH



# STRUCTURAL DEPTH

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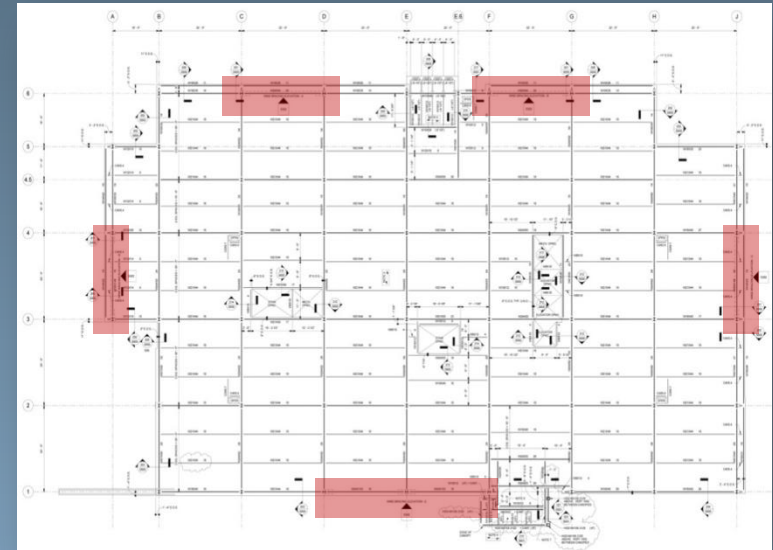
QUESTIONS

## LATERAL OPTIMIZATION

- SOFT-STORY ELIMINATION
- BRACING CONSISTENCY
- RESULTS & RECOMMENDATIONS

## VERTICAL OPTIMIZATION

- UTILIZE MAXIMUM ZONING HEIGHT
- IMPLEMENT BRACING SYSTEM FROM  
LATERAL OPTIMIZATION
- RESULTS & RECOMMENDATIONS



EXISTING LATERAL BRACING LOCATIONS



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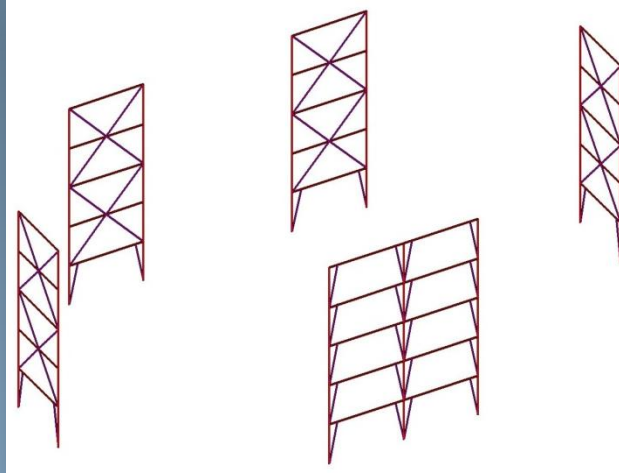
&

RECOMMENDATIONS

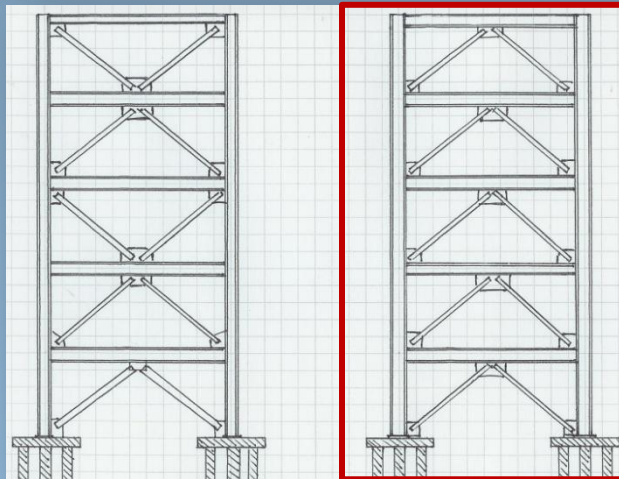
THANK YOU

QUESTIONS

## LATERAL OPTIMIZATION



EXISTING LATERAL BRACING



ALTERNATE LATERAL BRACING SCHEMES

## SOLUTION

- ELIMINATE KNEE BRACING
- REDUCE TWO-BAY FRAME
- PROVIDE MID-SPAN BRACING
  - MODIFIED “X-BRACE”
  - CHEVRON BRACE

✓ EXPLORE CHEVRON BRACE



# STRUCTURAL DEPTH

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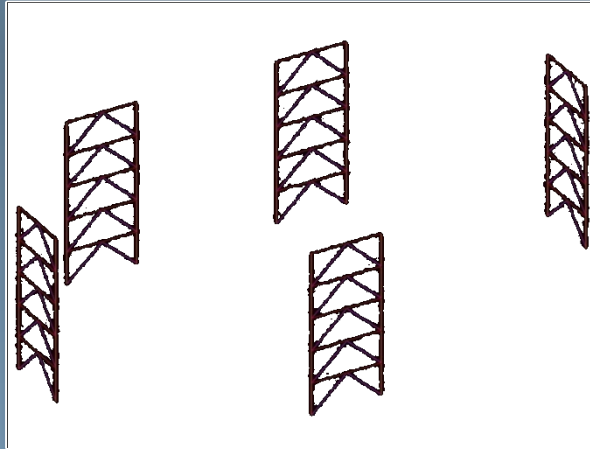
SUMMARY

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CHEVRON LATERAL BRACING

## CHEVRON BRACING

- REDUCES MEMBER SIZE
- CONSISTENT MEMBER CONTRIBUTION
- ELIMINATES SOFT-STORY EFFECT

### East - West Direction

Beams	29.61%
West Columns	11.99%
East Columns	12.02%
West Braces	23.15%
East Braces	23.23%

	Story Drift		Structure Drift		
	Actual	Allowable	Actual	Allowable	
Roof	0.117	0.450	0.731	2.220	OK
5th Floor	0.121	0.443	0.615	1.770	OK
4th Floor	0.211	0.443	0.493	1.328	OK
3rd Floor	0.132	0.443	0.283	0.885	OK
2nd Floor	0.151	0.443	0.151	0.443	OK



# STRUCTURAL DEPTH

## LATERAL OPTIMIZATION: RESULTS & RECOMMENDATIONS

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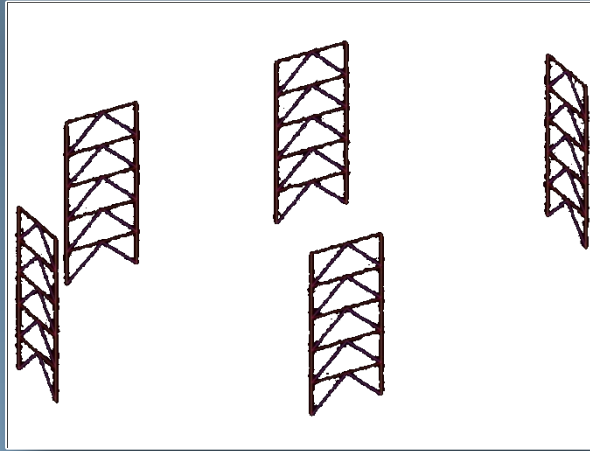
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CHEVRON LATERAL BRACING

- ELIMINATES SOFT-STORY
- CONSISTENT BRACING SCHEME
- REDUCES STEEL COST

Building System	Total Cost (Including MEP Alterations)	Cost Difference	Payback (Years)	Recommend
Existing Structure	\$19,126,000	\$0	8.38	-
Modified "X"-Brace	\$19,054,746	-\$71,254	8.35	Yes
*Modified Chevron Brace	\$19,040,189	-\$85,811	8.34	Yes

\* SYSTEM PRESENTED

✓ RECOMMEND CHEVRON LATERAL BRACING SYSTEM





# STRUCTURAL DEPTH

## VERTICAL OPTIMIZATION

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MODIFIED BUILDING

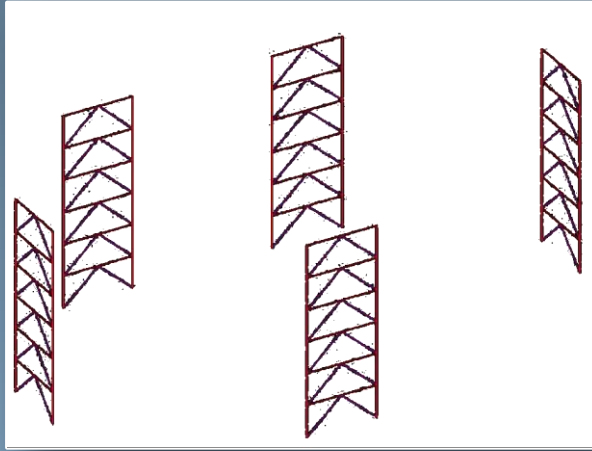
## SOLUTION

- INCREASE BUILDING HEIGHT TO 90'-0"
- RELOCATE PENTHOUSE TO GROUND FLOOR
- OPTIMIZE DRIFT



# STRUCTURAL DEPTH

## VERTICAL OPTIMIZATION



CHEVRON LATERAL BRACING

## CHEVRON BRACING

- REDUCES LATERAL MEMBER SIZE
- PROVIDES UNIFORM DRIFT
- MEETS CODE ALLOWABLE DRIFT LIMITS

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### East - West Direction

Beams	21.91%
West Columns	18.13%
East Columns	18.14%
West Braces	20.88%
East Braces	20.94%

	Story Drift		Structure Drift		
	Actual	Allowable	Actual	Allowable	
Roof	0.162	0.450	1.252	2.663	OK
6th Floor	0.194	0.443	1.090	2.220	OK
5th Floor	0.246	0.443	0.895	1.770	OK
4th Floor	0.247	0.443	0.649	1.328	OK
3rd Floor	0.212	0.443	0.403	0.885	OK
2nd Floor	0.191	0.443	0.191	0.443	OK



# STRUCTURAL DEPTH

## VERTICAL OPTIMIZATION: RESULTS & RECOMMENDATIONS

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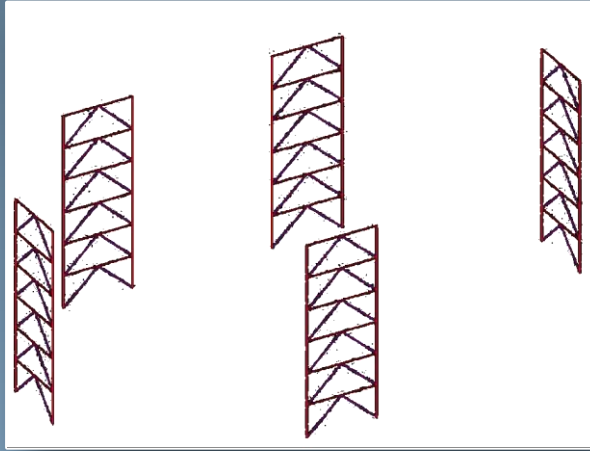
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CHEVRON LATERAL BRACING

- ADDITIONAL 30,000 SQ. FT. LEASABLE SPACE
- CONSISTENT BRACING SCHEME
- **FASTER PAYBACK**

Building System	Total Cost (Including MEP Alterations)	Cost Difference	Payback (Years)	Recommend
Existing Structure	\$19,126,000	\$0	8.38	-
Addition with "X"- Brace	\$21,496,806	\$2,370,806	7.85	Yes
*Addition with Chevron Brace	\$21,477,402	\$2,351,402	7.84	Yes

\* SYSTEM PRESENTED

✓ RECOMMEND ADDITIONAL FLOOR



# ARCHITECTURAL BREADTH

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## FACADE OPTIMIZATION

- LATERAL BRACING EXPOSURE
  - GROUND FLOOR
  - NORTH ELEVATION
- COMPATIBILITY OF AN ADDITIONAL FLOOR
- RESULTS & RECOMMENDATIONS



IMAGE COURTESY OF THE FERCHILL GROUP



# ARCHITECTURAL BREADTH

## FACADE OPTIMIZATION: LATERAL BRACING EXPOSURE

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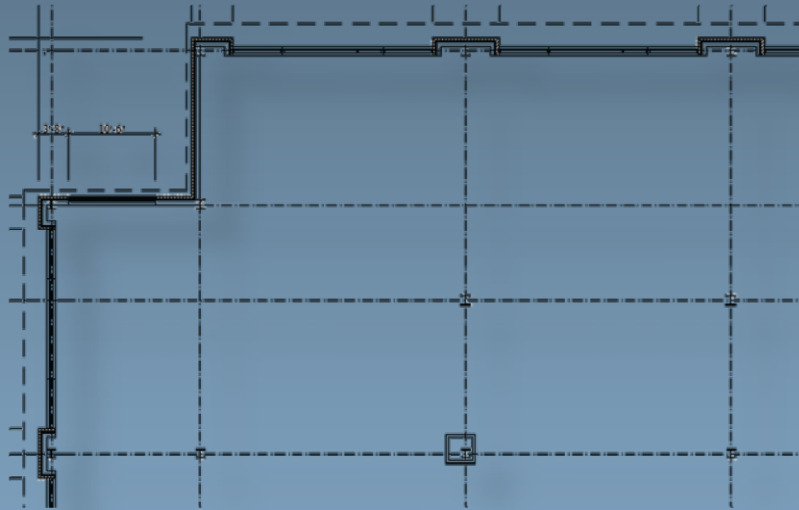
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EXISTING GROUND FLOOR

WALL EXTENDED OUT TO MATCH  
OVERHANG OF UPPER FLOORS



MODIFIED GROUND FLOOR





# ARCHITECTURAL BREADTH

## FACADE OPTIMIZATION: LATERAL BRACING EXPOSURE

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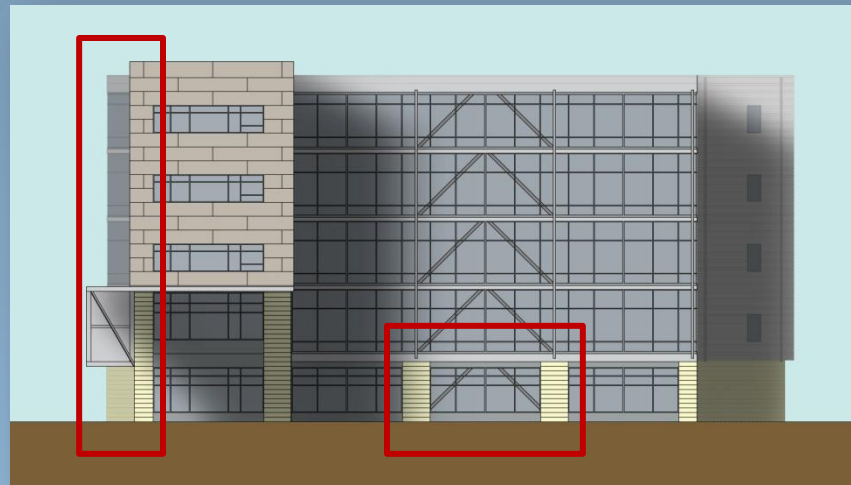
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EXISTING WEST ELEVATION



MODIFIED WEST ELEVATION



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## FACADE OPTIMIZATION: LATERAL BRACING EXPOSURE

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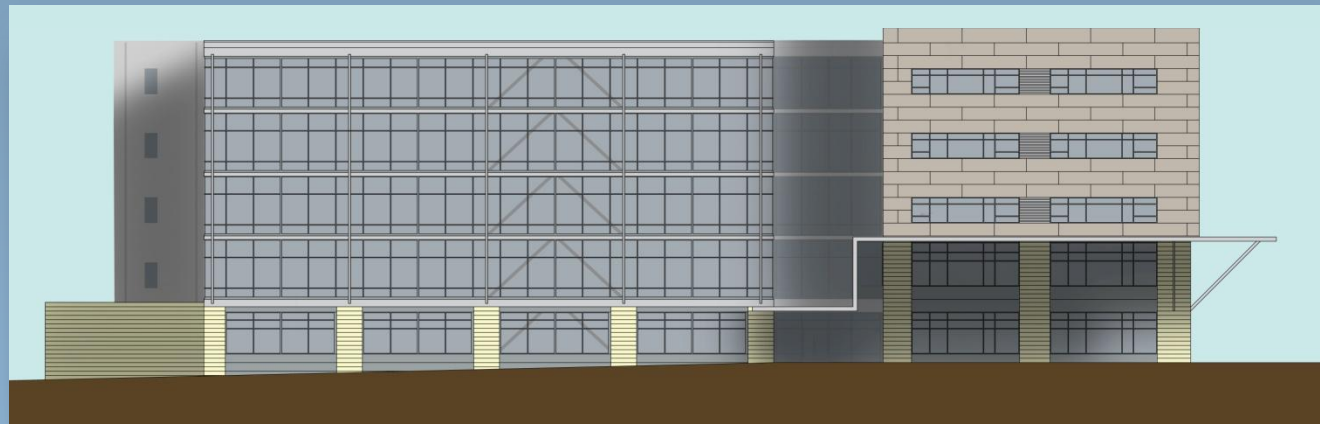
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EXISTING NORTH ELEVATION



MODIFIED NORTH ELEVATION



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## FACADE OPTIMIZATION: COMPATIBILITY OF AN ADDITIONAL FLOOR

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EXISTING WEST ELEVATION



MODIFIED WEST ELEVATION





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## FAÇADE OPTIMIZATION: COMPATIBILITY OF AN ADDITIONAL FLOOR

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EXISTING NORTH ELEVATION



MODIFIED NORTH ELEVATION

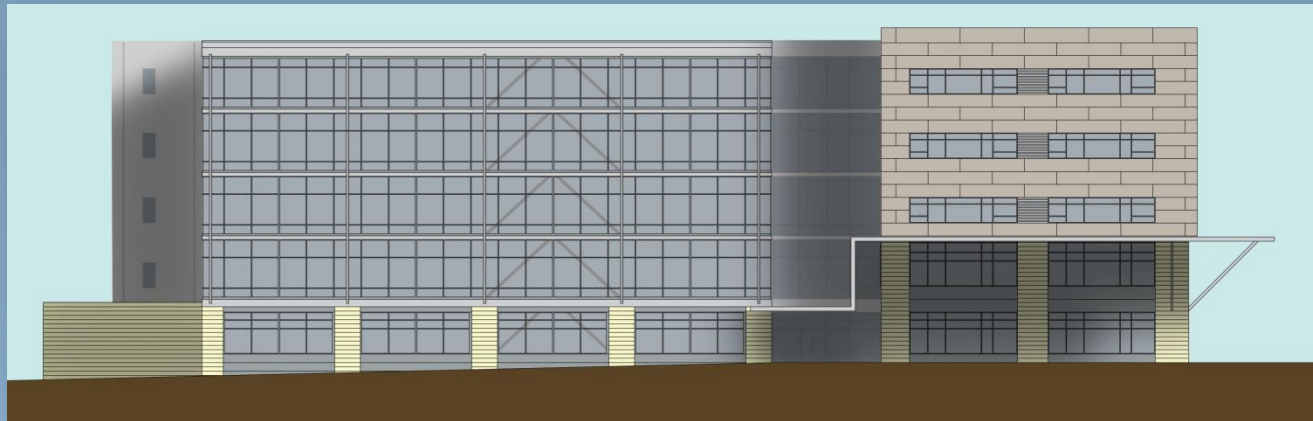




# ARCHITECTURAL BREADTH

## FACADE OPTIMIZATION: RESULTS & RECOMMENDATIONS

- AESTHETIC ENHANCEMENT
  - REALIZED LOAD PROGRESSION
  - HOMOGENEOUS ELEVATIONS
- 
- ✓ CHANGES ARE RECOMMENDED
  - ✓ INTRODUCE CHANGES AT THE SCHEMATIC DESIGN PHASE



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# ACOUSTICS BREADTH

REDUCTION OF NOISE PROPAGATION: RELOCATION OF MECHANICAL ROOM

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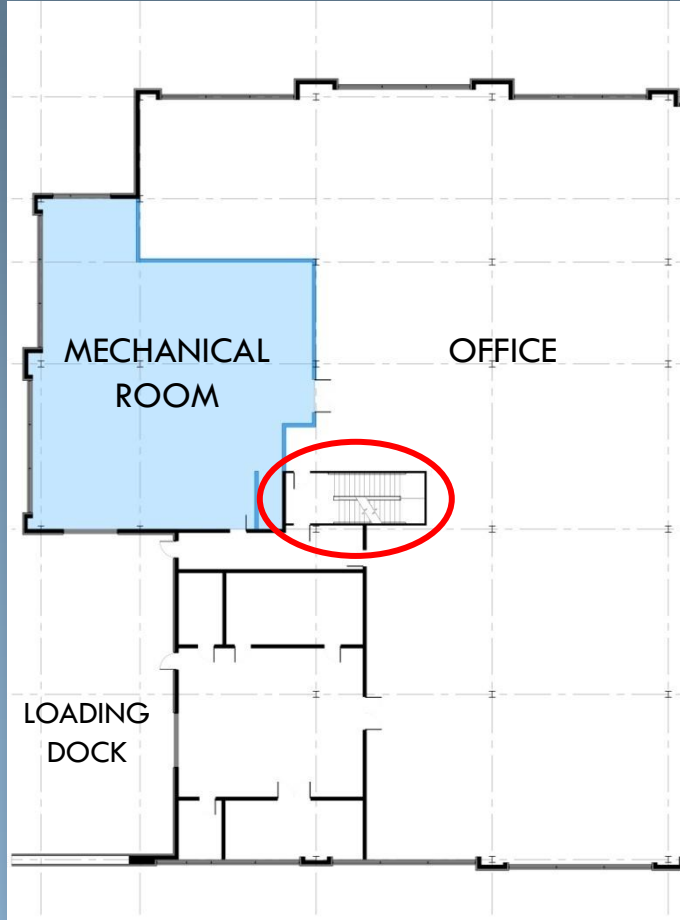
ARCHITECTURE BREADTH

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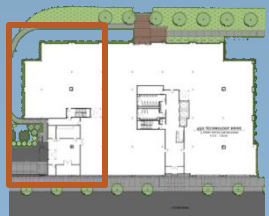
QUESTIONS



TAKES ADVANTAGE OF STAIRWELL

MINIMAL INTRUSION TO OPEN PLAN

CONVENIENT ACCESS TO LOADING DOCK





# ACOUSTICS BREADTH

## REDUCTION OF NOISE PROPAGATION: COMMON WALL DESIGN

### PRESENTATION OUTLINE

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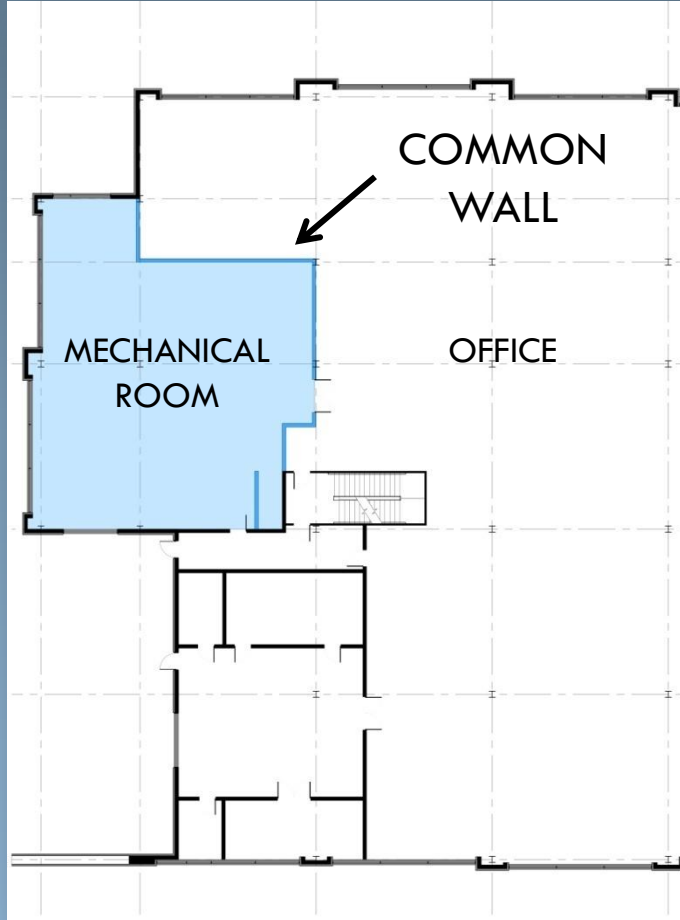
ARCHITECTURE BREADTH

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### COMMON WALL CHARACTERISTICS

- 8" CMU WALL
- FULL MORTAR BED
- SAND FILLED VOIDS
- 1" THICK PLASTER COATING





# ACOUSTICS BREADTH

## REDUCTION OF NOISE PROPAGATION: COMMON WALL DESIGN

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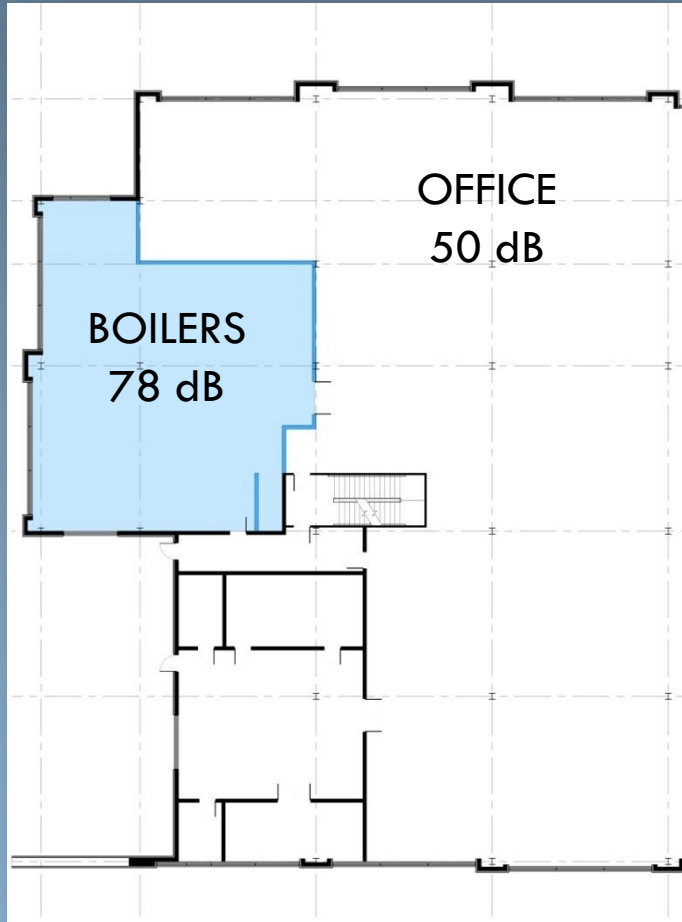
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### COMMON WALL CHARACTERISTICS

- 8" CMU WALL
- FULL MORTAR BED
- SAND FILLED VOIDS
- 1" THICK PLASTER COATING

	Sound Pressure Level (dB)					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Sound in Source Room	78	73	63	58	53	48
Sound in Receiving Room	50	50	50	50	50	50
Required Noise Reduction	28	23	13	8	3	0
Provided Noise Reduction	28	37	42	47	50	52
Actual Sound Pressure Level	50	36	21	11	3	0
Acceptable	Yes	Yes	Yes	Yes	Yes	Yes

✓ WALL DESIGN IS ACCEPTABLE





# ACOUSTICS BREADTH

## REDUCTION OF NOISE PROPAGATION: RESULTS & RECOMMENDATIONS

- LOCATION PROVIDES VERTICAL ACCESS TO BUILDING
  - CONVENIENT ACCESS TO LOADING DOCK
  - COMMON WALL PROVIDES ACCEPTABLE NOISE REDUCTION
- 
- ✓ CHANGES ARE RECOMMENDED
  - ✓ INTRODUCE CHANGES AT THE SCHEMATIC DESIGN PHASE

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## GOALS

- ✓ OPTIMIZE BUILDING FEATURES
  - ✓ HORIZONTALLY – MORE EFFICIENT LATERAL SYSTEM
  - ✓ VERTICALLY – FASTER PAYBACK WITH ADDITIONAL FLOOR
  - ✓ RECOMMEND IMPLEMENTATION OF STRUCTURAL SOLUTIONS
  
- ✓ ENHANCE BUILDING AESTHETICS
  - ✓ HOMOGENEOUS ELEVATIONS
  - ✓ REALIZED LOAD PATH
  - ✓ RECOMMEND IMPLEMENTATION OF ARCHITECTURAL SOLUTIONS
  
- ✓ REDUCE NOISE PROPAGATION
  - ✓ MASSIVE COMMON WALL
  - ✓ NON-INTRUSIVE MECHANICAL ROOM LOCATION
  - ✓ RECOMMEND IMPLEMENTATION OF ACOUSTICS SOLUTIONS



# THANK YOU

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THE AUTHOR WISHES TO EXTEND ACKNOWLEDGMENTS AND THANKS TO THE FOLLOWING INDIVIDUALS, FACULTY, PROFESSIONALS, AND FIRMS FOR THEIR GENEROUS AIDE WITH THIS THESIS:

THE FERCHILL GROUP

STRADA, LLC

TURNER CONSTRUCTION

ATLANTIC ENGINEERING SERVICES:

ANDY VERRENGIA

THE PENNSYLVANIA STATE UNIVERSITY:

PROF. PARFITT

PROF. HOLLAND

DR. GESCHWINDER

PROF. LING

AND THE REST OF THE AE FACULTY & STAFF

A VERY SPECIAL THANKS TO MY FRIENDS AND FAMILY, ESPECIALLY MY MOM AND DAD





# QUESTIONS

AT THIS TIME THE AUTHOR WILL ADDRESS ANY FACULTY QUESTIONS

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# QUESTIONS?