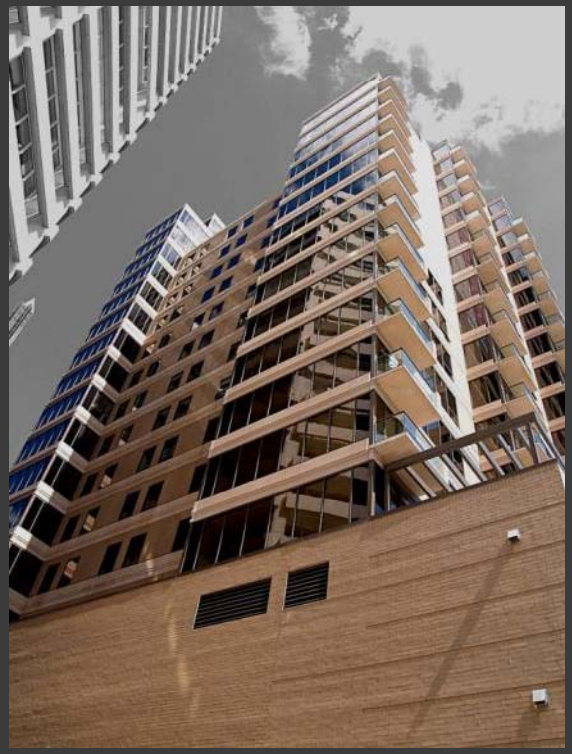
151 First Side

Pittsburgh, PA



William J. Buchko

Structural Option

Senior Thesis

April 14th, 2008

Advisor: Kevin Parfitt

Presentation Outline

- Overview
- Proposal
- Structural Depth
- Acoustics Breadth
- Construction Management Breadth
- Conclusions
- Acknowledgements
- Questions

Overview

- Location:
  - Pittsburgh, PA
- Significance:
  - First condominium built downtown since 1968
- Architecture:
  - 18 stories
  - 82 units
  - Open floor plan
  - 233,000 SF

Overview

- Mechanical:
  - 36.7 Ton roof top unit by AAON
  - Individual heat pumps
- Electrical:
  - 120/208 3 phase system
  - 1800a main switch
- Lighting:
  - Incandescent downlights in units
  - Fluorescent downlights and wall washers in corridors and public areas

Overview

- Construction:
  - $24M construction cost
  - Owned by Zambrano Corp., Ralph A. Falbo, Inc., and EQA Landmark Communities
  - Design-build construction
- Structural:
  - Hambro composite joist floor system
  - Braced frame and moment connection lateral system

Proposal

- Structural Depth
  - Decrease cost and increase performance by using typical structural systems
- Acoustics Breadth
  - Analyze proposed systems and check existing systems for acoustical quality
- Construction Management Breadth
  - Analyze and compare proposed systems to current systems

Structural Depth

- Floor System
  - Current Hambro MD2000 composite joist system compared to a typical composite beam system
- Lateral System
  - Current combination braced frame and moment connection system compared to concrete core, braced frame, and moment connection systems

Structural Depth

- Current Hambro floor system
  - 3¼” concrete on metal decking
  - Supported by joist with composite top chord

Structural Depth

- Proposed composite steel system
  - 4” light weight concrete on B-LOK decking with 1 stud/ft
  - Beams placed at third points of bays

Structural Depth

introduction

overview

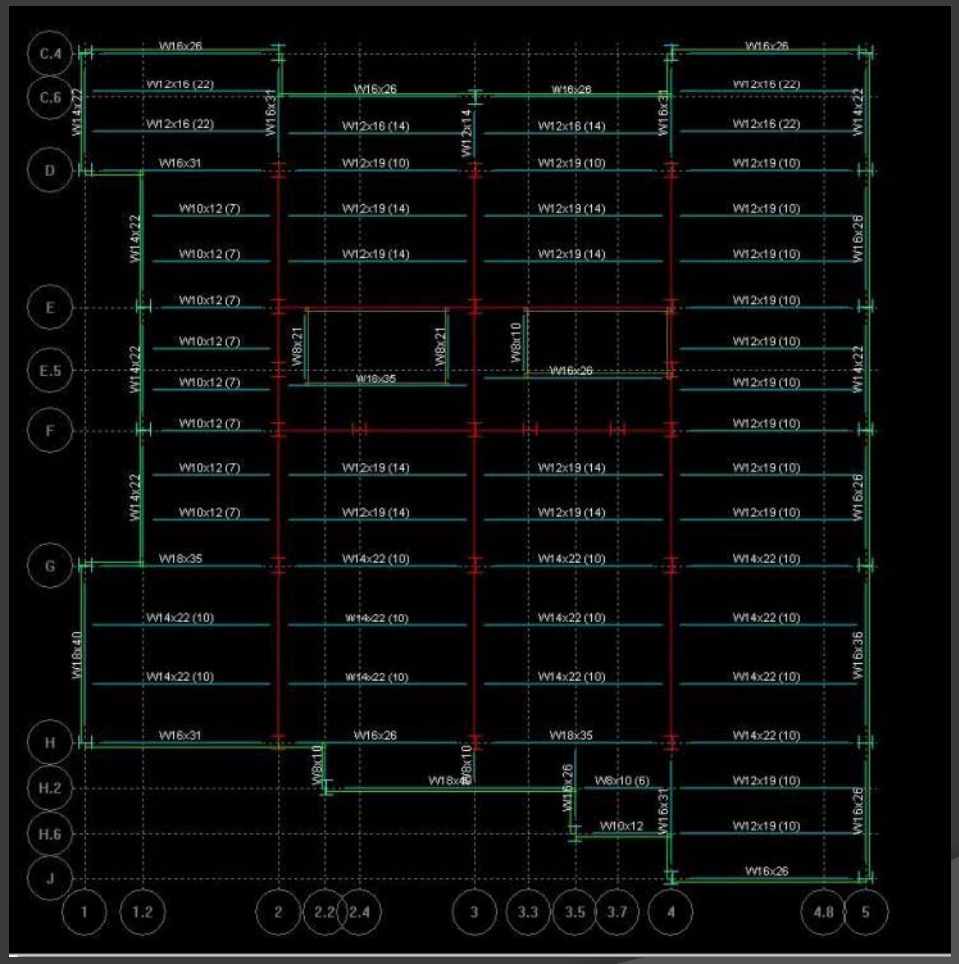
proposal

structural depth

acoustics breadth

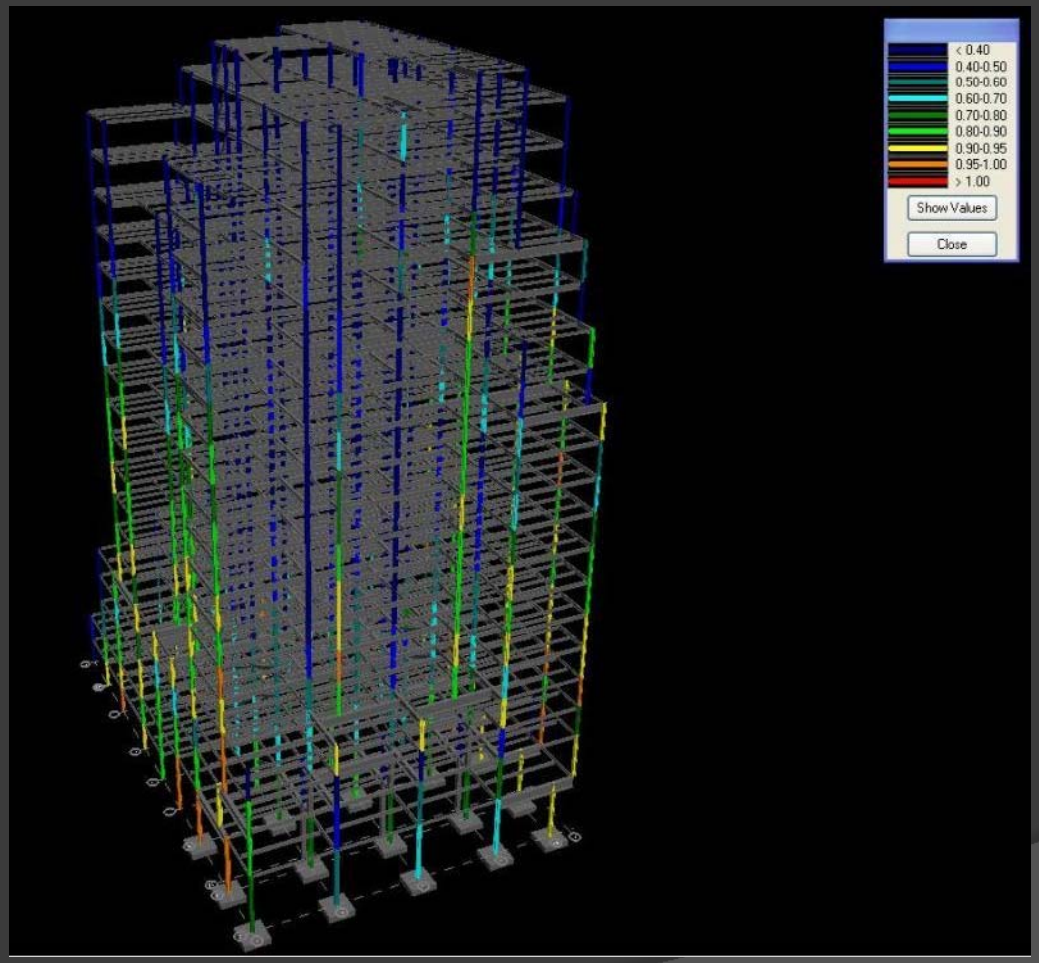
cm breadth

conclusions



Typical floor beam layout and design

Structural Depth



Column redesign

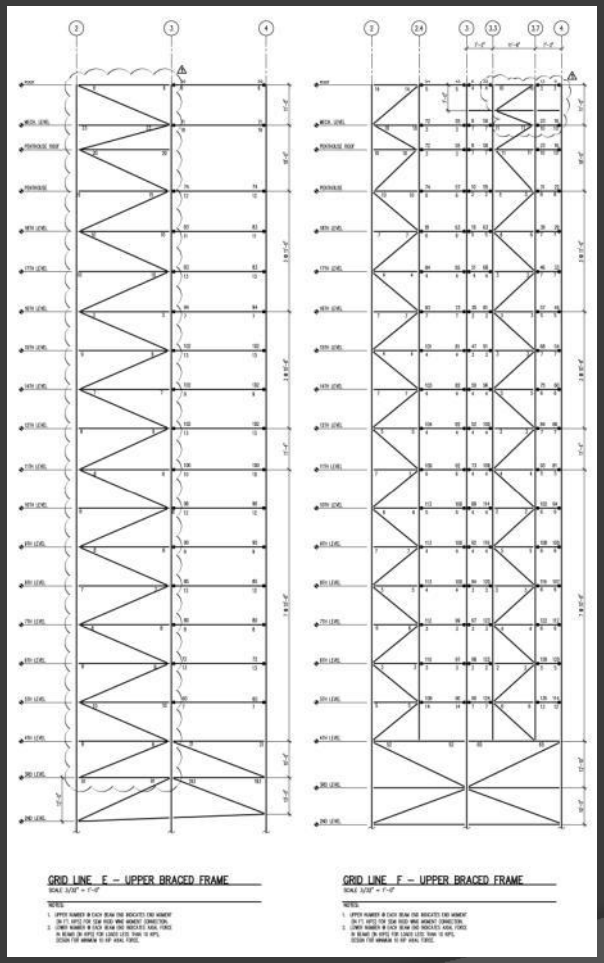
Structural Depth

- Current lateral system
  - Combination of braced frames and moment connections

Structural Depth

Frames long grids 2, 3, and 4 in north-south direction

Structural Depth



Frames long grids E and F in east-west direction

Structural Depth

- Concrete core lateral system
  - Utilizes concrete core to handle all lateral loading
  - Unacceptable due to interaction of trades

Structural Depth

- Braced frame lateral system
  - Utilizes braced frames for all lateral loading
  - Quicker installation
  - Low torsion due to design
  - Unacceptable due to diagonal braces within floor plan

Structural Depth

introduction

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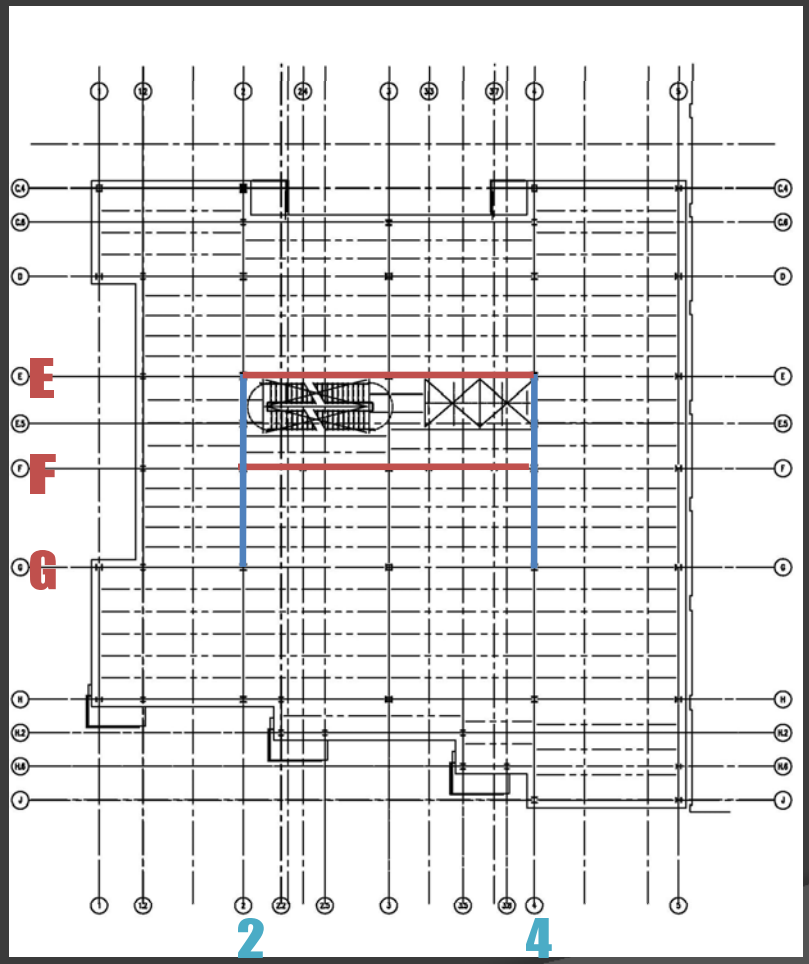
proposal

structural depth

acoustics breadth

cm breadth

conclusions



Proposed braced frame layout

Structural Depth

- Moment connection lateral system
  - Utilizes moment connections for all lateral loading
  - Fully restrained connections recommended for greater than 10 stories
  - Unacceptable due to cost and scheduling of fully restrained connections

Acoustics Breadth

- Floor system
  - Compare current Hambro system to proposed composite beam system
- Mechanical system
  - Analyze current issues and provide alternative solutions

Acoustics Breadth

- Current Hambro floor system
  - STC of 57
  - IIC of 30
  - Susceptible to structure born sound
  - Susceptible to “wave” phenomenon

Acoustics Breadth

- Proposed beam floor system
  - STC of 55
  - IIC of 35
  - Potential for better low end absorption
  - Not susceptible to “wave” phenomenon

Acoustics Breadth

- Mechanical system
  - Roof top unit in direct line of sight with penthouse terraces
  - Most common complaint from workers and potential tenants

Acoustics Breadth

- Existing sound levels
  - AAON representative unable or unwilling to provide acoustical data
  - Data obtained through IVIE IE-33 Pocket PC and similar unit
  - Values were confirmed by 3rd party acoustician

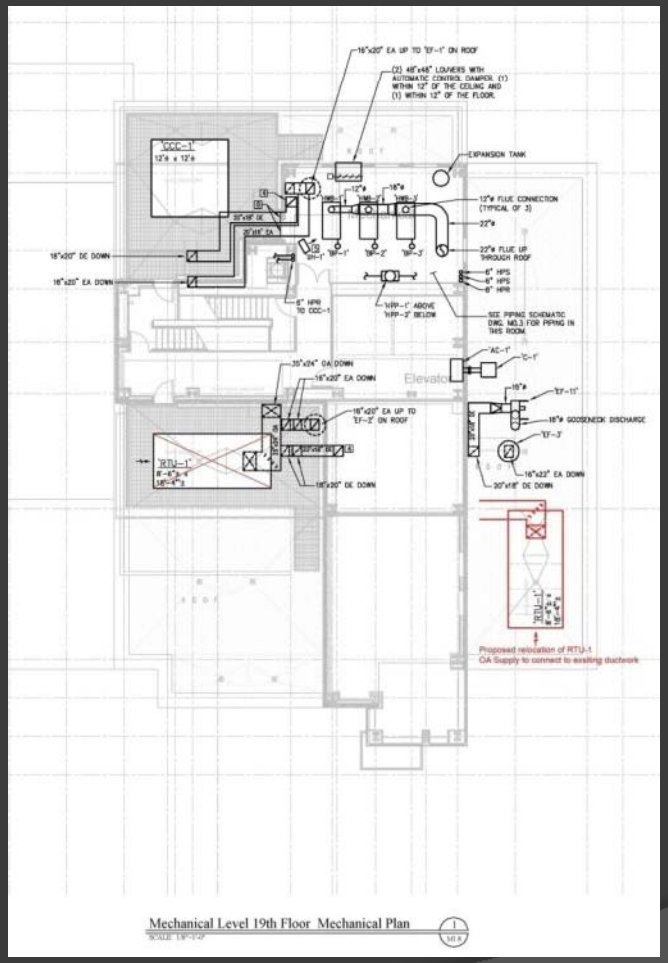
Acoustics Breadth

IVIE IE-33 Graph

Acoustics Breadth

- Proposed solutions
  - Acoustical barrier would only provide 6dB reduction
  - System can be relocated to minimize sound levels on terraces

Acoustics Breadth



Proposed roof top unit relocation

Acoustics Breadth

- Relocation effects
  - 30ft gives 15dB reduction
  - Nosier supply intake now faces away from all occupied spaces
  - Two walls separate unit from terraces, adding approximately 20dB of reduction

Construction Management Breadth

- Schedule
  - Compare scheduling impacts of proposed systems both on and off of the critical path
- Cost
  - Compare cost of proposed systems to current systems

Construction Management Breadth

- Schedule
  - Steel placement takes 177 days and is unaffected by floor system change
  - Pouring of proposed floor system would save a minimum of 1 day per floor, though not on the critical path
  - A potential 10 days could be saved through fire protection
  - The braced frame lateral system could save 5 days along critical path, but was found to be unacceptable

Construction Management Breadth

- Cost
  - Larger slab and more expensive concrete offset with cheaper steel, resulting in a similar cost between floor systems
  - Redesign of columns and beams save 131 Tons of steel, which saves approximately $228,000
  - Labor savings estimated at approximately $30,000
  - Total system savings over 1% of total building cost

Conclusions

- Structural Depth
  - A composite beam floor system would be both feasible and economical to use
  - No better lateral system was found
- Acoustics Breadth
  - A composite beam floor system could provide equal acoustical qualities
  - Mechanical system can be moved to provide a better sound level on outdoor terraces
- Construction Management Breadth
  - All proposed systems could be implemented without a change in the critical path
  - All proposed systems would be similar in cost or less expensive

Acknowledgements

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- Cenkner Engineering Associates, Inc.
- Professor Kevin Parfitt
- Professor Moses Ling
- The Thesis Mentors
- Family and friends for their support and understanding

Dedication

This Thesis presentation and year long project is dedicated to the memory of:

Nicholas Buchko
9/15/15 – 12/6/06
“Never give up.”

Questions?