The Honors Porch

Honors Capstone

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Abstract

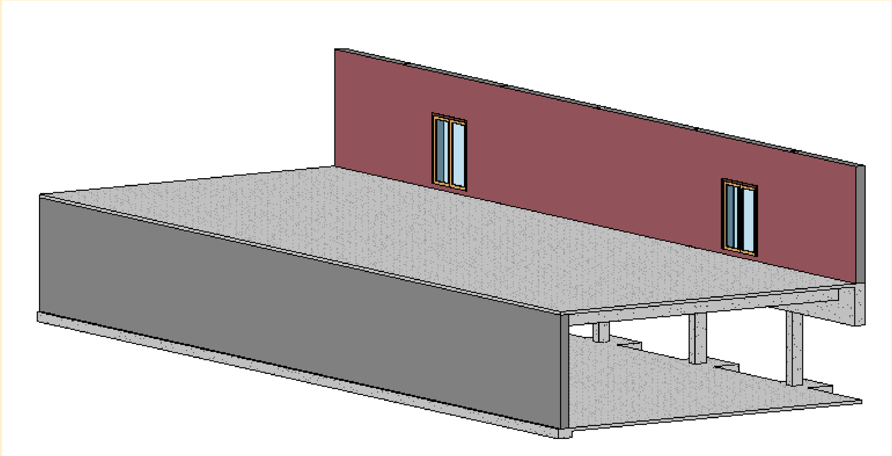
The goal of this project is to create a space through structural design for other Honors students to use and enjoy. I followed the typical structural design procedure of establishing loading and determining required capacity; however, an analysis of the existing, primarily concrete structure was also necessary. Following the analysis, I selected steel as the optimal structural material and developed three design iterations to meet the loading requirements. The most viable of these options is a hybrid cantilever option because it has the highest potential for economic constructability. Further analysis and research could be done on more complex support patterns, user preferences, and integration with a construction manager.

Design Approach

1. Establish loading patterns present on the structure
2. Evaluate existing conditions including geometry, existing structure material, and existing member construction
3. Ideate possible design solutions with licensed structural engineers
4. Create conceptual design of least integrative structural option based on AISC Steel Construction Manual Guidelines
5. Perform analysis of existing structure to establish capacity of existing structure
6. Create conceptual design of structure integrated with existing structure based on AISC Steel Construction Manual Guidelines
7. Iteratively refine and create new designs to optimize economic viability and constructability

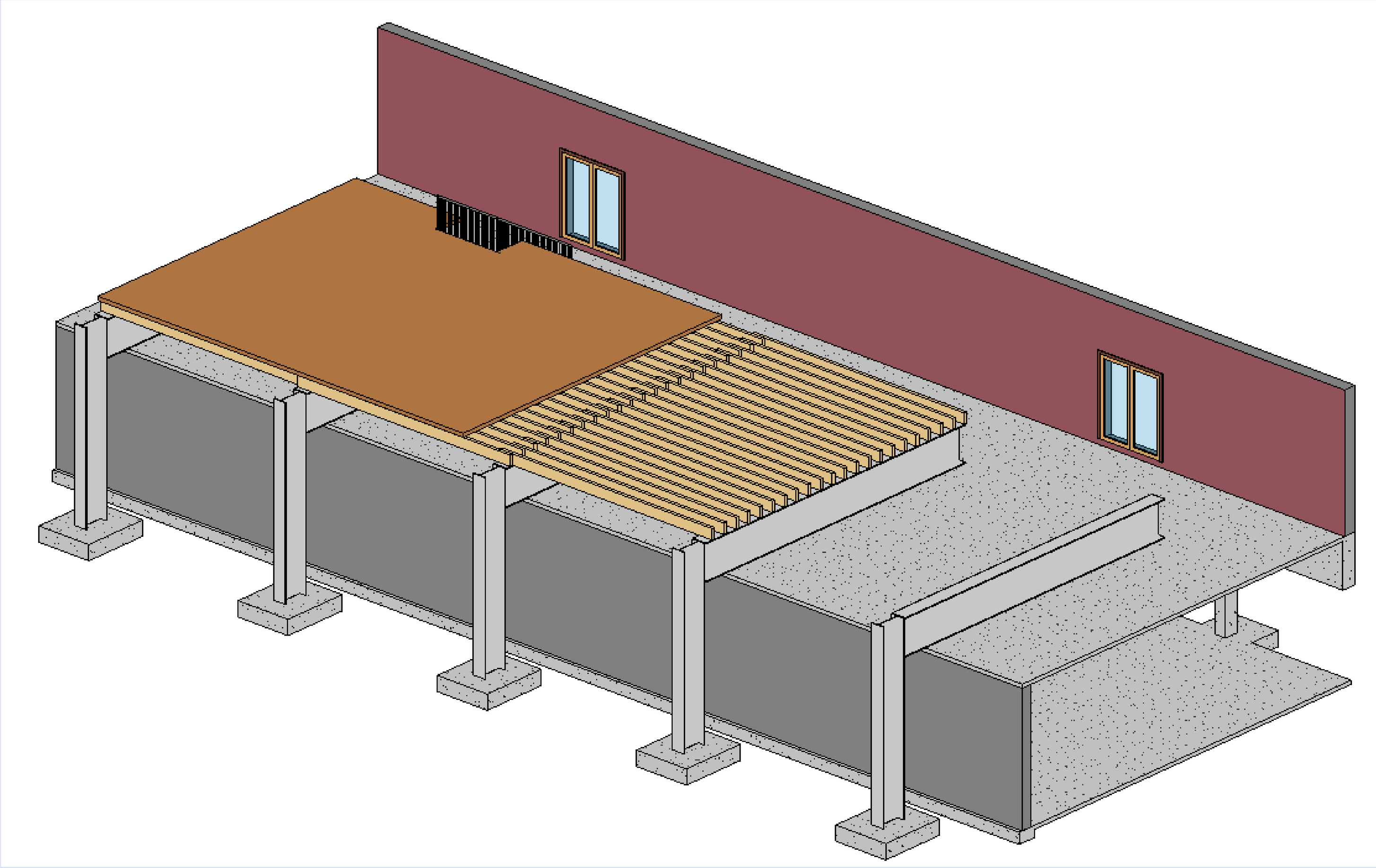
Current Building

- Modeled area of interest based on original, structural plans
- Current structure is primarily concrete
- Steel beams framing up on second floor
- Grade comes up approx. 9 feet on basement wall
- Original, structural plans detail member sizing and reinforcing, soil borings, and geometry



Design Iterations

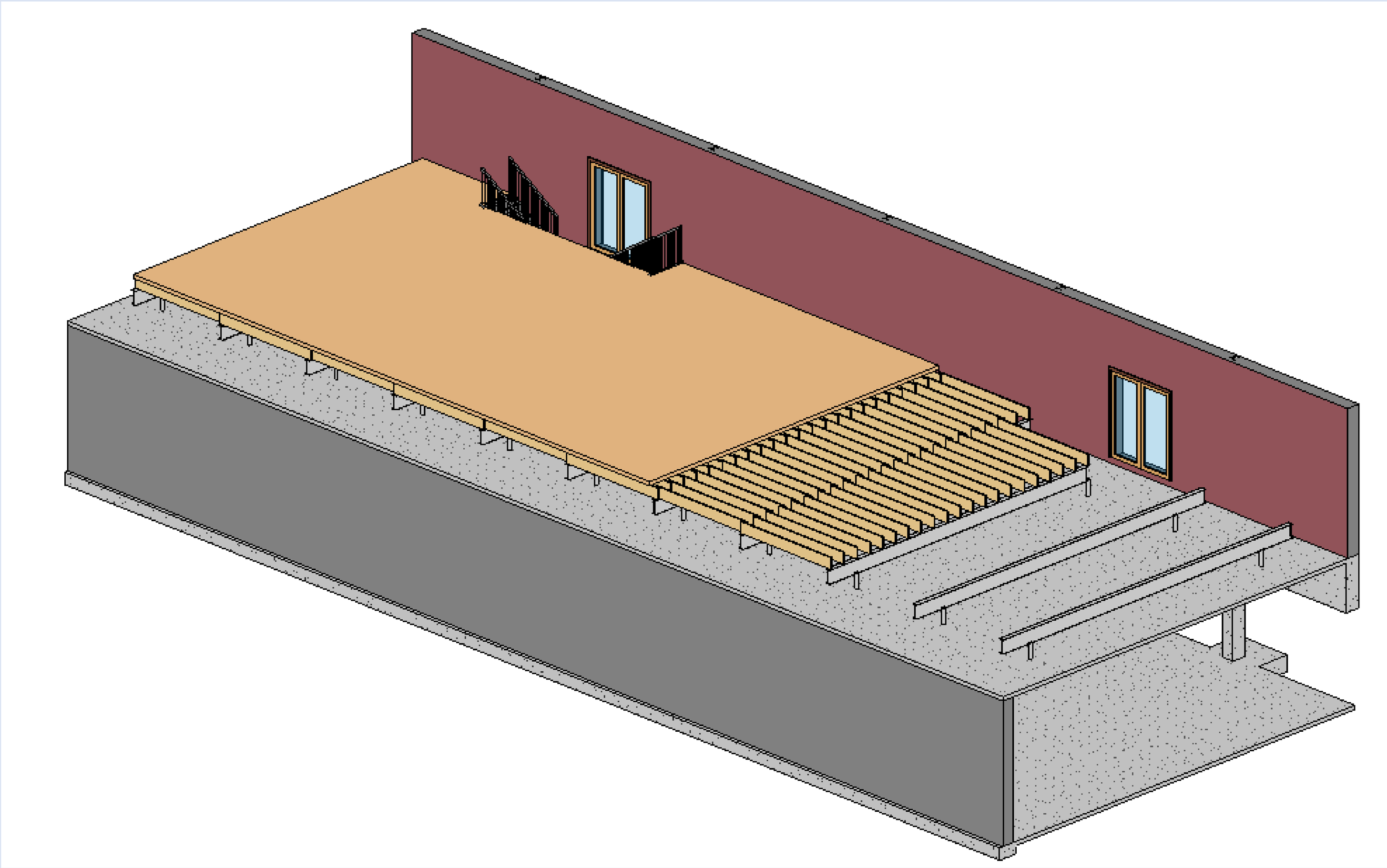
Design 1: Cantilever Structure



Advantages:
- Minimal interaction with existing building structure
- Only geometry of roof and wall required for design

Disadvantages:
- Heavy primary beams (200 lb/ft)
- Large structural depth of approximately 5 ft
- Large foundations are likely and would increase length of cantilever
- Large size timber filler beams is required

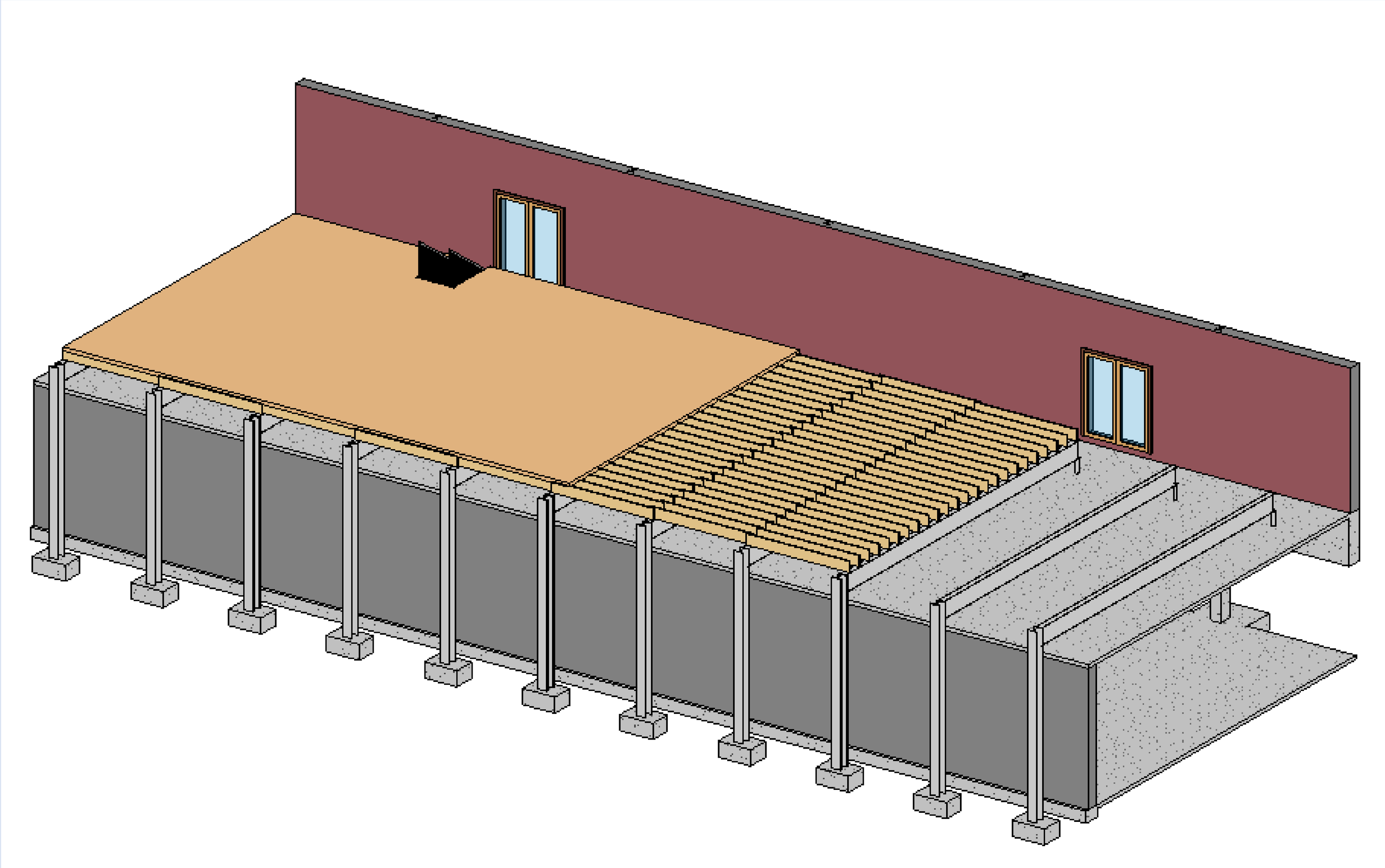
Design 2: Beam Supported by Existing Structure



Advantages:
- Standard size dimensional lumber for filler beams
- Structural depth of 2.5 ft
- No foundation designs required
- Potential for time and cost savings

Disadvantages:
- Requires concrete beam retrofit to increase shear capacity
- Limited possible connection points with existing structure
- Requires beam spacing to be smaller to reduce shear load

Design 3: Hybrid Cantilever Structure



Advantages:
- Standard size dimensional lumber for filler beams
- Structural depth of 3 ft
- Potential for time and cost savings
- Limited interaction with existing structure
- Potential for cost and time savings during construction

Disadvantages:
- Requires foundation design
- Requires beam spacing to be smaller to reduce shear load

Key Takeaways

- Dimensional lumber or timber has sufficient flexural capacity to carry the deck loads to reduce structural weight.
- The existing concrete structure has sufficient capacity to carry most loadings, with shear being the most likely to limit design.
- The hybrid structural design has the highest potential for constructability and economic viability.
- Access from existing roof access doors is a limiting factor in porch design due to accessibility concerns.
- Other design iterations could include more complex support options that would require plastic or computational analysis.

Future Actions

Select and Complete Design:
- Perform plastic analysis on more complex designs
- Evaluate options for economic viability and constructability
- Design connections for all members
- Develop construction drawings

Create Opportunity for Community Involvement:
- Get student input on preference between design options
- Survey architectural and deck feature ideas

Evaluate Construction Options:
- Establish budget with a general contractor or design build firm
- Evaluate and revise design for constructability and availability of materials
- Evaluate availability of materials based on price volatility from the Covid-19 pandemic
- Present plan to the University to gauge interest and funding opportunities

Acknowledgements

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American Concrete Institute (ACI) 318 Building Code

American Institute of Steel Construction (AISC) Steel Construction Manual 360-16

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Gershwinder, L., Liu, J., & Carter, C. *Unified Design of Steel Structures*

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