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Executive Summary

American Eagle Outfitters: Quantum III is a steel framed office building located in the South Side Works of Pittsburgh, Pennsylvania. This report proposes the redesign of the building structure and it's adequacy on the basis of currently accepted national codes, economy, and flexibility.

The building is proposed to be moved to Los Angeles, California and the structural system will be redesigned for the wind and seismic loads acting. The braced frames will be upsized as required and the original system (composite metal deck and steel framing) will remain intact. Taking the new location of the building into account, it is considered feasible that stories will be added for the increased demand for space anticipated by the developer and owner.

Secondary goals for the relocation of Q3 include resizing the heating and cooling systems to account for climate differences. Also, as a result of the added floors, the shell architecture will have to be re-evaluated. The scale of the parapet and pedestal will be changed as well.

This redesign will allow me to understand the seismic and wind designs in detail. Also, differences in climate allow me to analyze mechanical systems with different heating and cooling requirements. The opportunity to do in depth seismic and wind calculations for severe circumstances will be invaluable to my engineering experience and career goals.

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I. Introduction

American Eagle Outfitters Quantum III: South Side Works is a genuine combination of structural design for flexibility and the blending of the architectural tastes of the developer, The Soffer Organization, with that of the existing South Side of Pittsburgh, PA. The building is 5 stories tall and contains loading, fire pump, and generator rooms on the first floor with the remainder of the first through the fifth floor having open plans for tenant fit-out. The roof holds a mechanical area surrounded by 12' tall windscreens for protection from the environment.

Open plans require a tradeoff between increased structural steel depths and beam span. The structural system of QIII reflects the need for flexibility with 30'x30' bays and a superimposed 20 psf partition load over all office spaces. The superimposed load is added onto the office live load with a supplemental 10 psf to account for the unpredictability of floor layouts.

Vertical trusses are placed at either the core of the building—the mechanical spaces, stairwells, and elevators; or the shell to limit interference with the open plan architecture. QIII is clad in curtain walls with interspersed brick façade. The overwhelming majority of the shell is composed of curtain walls including the entire north elevation shown below.

Following is a template for which to base analysis of the building on. American Eagle Outfitters: Quantum III is proposed to be relocated to Los Angeles, California as an attempt to open new revenues opportunities for the owner. The lateral force resisting elements will be completely redesigned to withstand increased wind and seismic loads. New corporate offices in California open an entire new market for American Eagle Outfitters, so additional floors will be added to the structure to allow for more offices. Architectural redesign of the shell will be needed due to the change in the building elevation. Also, new local materials will be analyzed as proponents to a building envelope redesign. Decreased heating and increased cooling requirements translate to a mechanical system reevaluation. An outline on how these analyses will be conducted is on the following pages.

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II. Structural Systems of Current Design – Pittsburgh

Foundations and Geotechnical Concerns

The foundation of Quantum III will be constructed on abandoned steel industry facility foundations with fills consisting of silty sand, cinder and slag. With the unpredictability of the subgrade to the deeper bedrock, and the Monongahela River directly adjacent to the building, shallow foundations cannot be used. The fill located deeper in the subgrade has a higher bearing capacity than the aforementioned soils. Therefore, Geo-Mechanics Inc. insisted on 16" diameter auger cast piles with an ultimate load capacity of 300 kips, and design load capacity of 120 kips. Bedrock is located roughly 85 feet below the surface. With the water table resting at 730 ft above sea level—slab on grade is proposed to be at 753'.

Since the building includes no plans for a basement, slab on grade connects with pile caps and grade beams to make up the foundation of QIII. Grade beams line the exterior of the building and connect pile caps where lateral frames are located. Interior gravity columns typically have four piles with a single, separate pile cap, while columns on the exterior wall tie in with grade beams and three- to four-pile configurations.

Floor Framing

Quantum III is designed for flexibility to allow individual tenants to lay out each floor as they please. It utilizes 30' by 30' bays with a two 'cores' containing elevators, stairs, mechanical openings and bathrooms. Since the extent of the work of the firms stated (Atlantic Engineering Services, The Design Alliance Architects, etc.) was core and shell—the exact placement of partitions is not addressed in the architectural plans as seen in Figure 1.

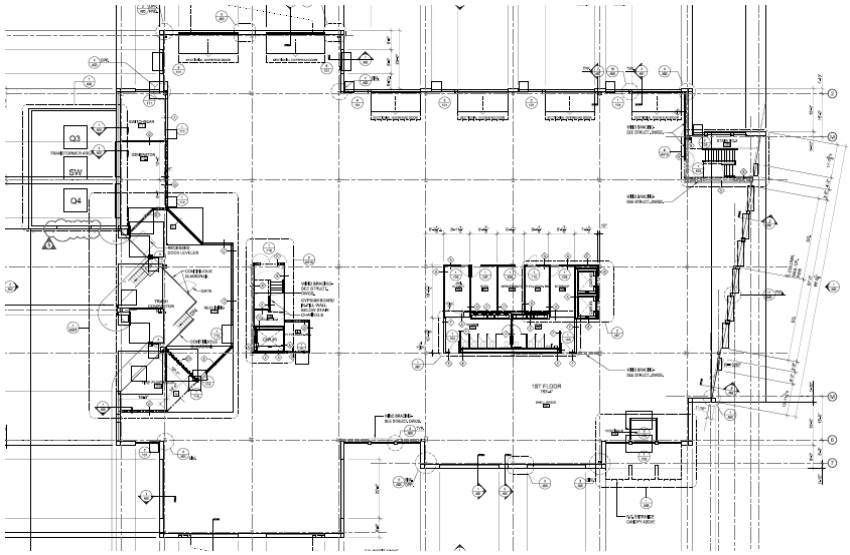

Figure 1 – Typical Architectural Floor Plan

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All floor framing and steel deck is composite. A lightweight concrete slab on 3" galvanized steel deck was incorporated. Shear studs are 4" long and ¾" diameter in 2.5" lightweight concrete topping. The total slab and deck thickness is 5.5". Typical roof framing consists of 3" metal roof deck, except the mechanical unit area. 2" deck with 3" lightweight concrete provides added support and dampens mechanical vibrations here. Typical girders are W24x55 with 28 studs. Infill beams are W18x35's spaced at 10' center to center with 16 studs. All exceptions are explained in Technical Report I, available online at Sam Jannotti's CPEP website.

Columns

American Eagle Outfitters: Quantum III has a wide range of column sizes, ranging from W10's to W14's. Gravity columns range from a W10x33 to a W12x72. Moment frame columns run from W14x74's to W14x193's. Floor to floor heights are typically 13'-8". Column splices for both gravity and lateral resistance are on the third and fifth floors with all roof framing columns being less than one floor height high. Unbraced length is not an issue in Quantum III since columns are braced at each floor.

Lateral Load Resisting System

Five vertical trusses are arranged throughout the building core and exterior. Three of the five trusses are forms of a Chevron truss, with one x braced frame and the last being a single strut truss. Only one truss is on the exterior and is an excellent display of structure—a curtain wall provides a view of it from the exterior of the building. The remaining four trusses are interior and border stairs, elevators, or mechanical shafts. One of the interior trusses is eccentric to avoid a conflict with stair access doors on the easternmost corner of the building. As shown in Figure 4, their placement was based on resisting interference with the open plan.

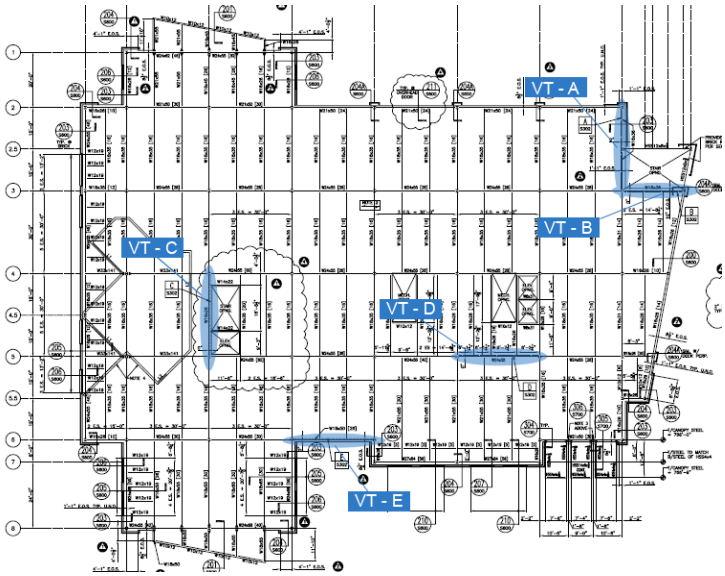

Figure 2 – Vertical Truss Locations

3D Model Images

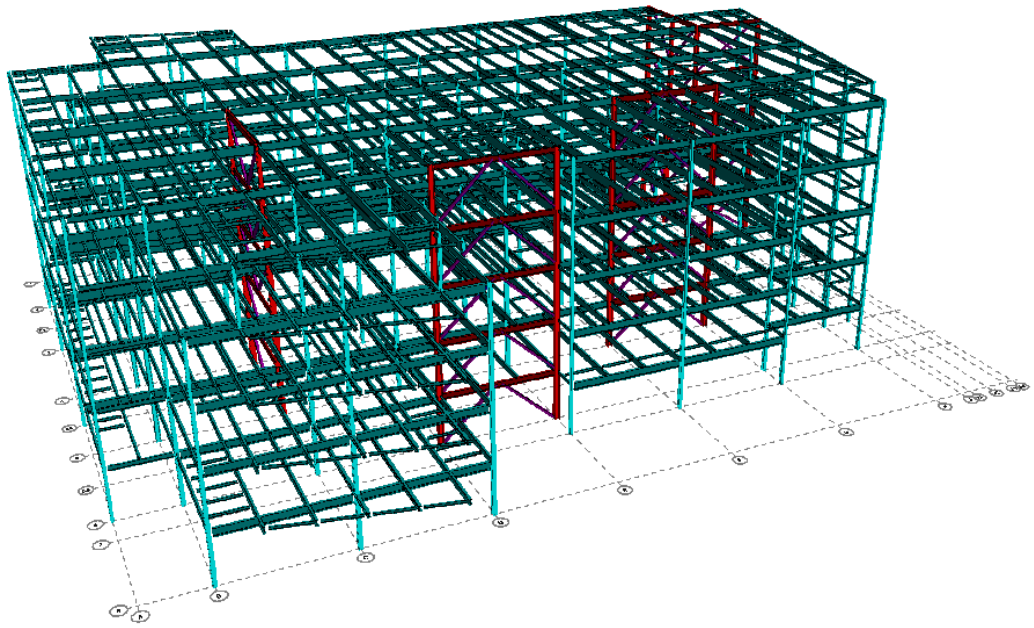

Figure 3 – 3D View from West Building Corner

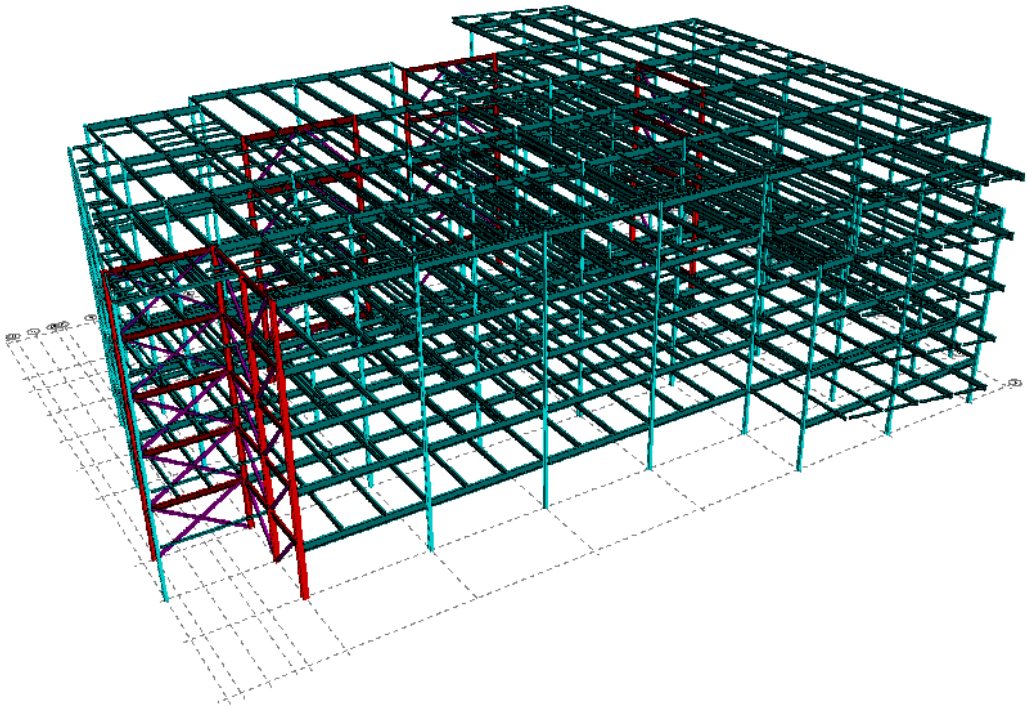

Figure 4 – 3D View from East Building Corner

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III. Problem Statement and Proposed Solution

Problem Statement

In the design of American Eagle Outfitters: Quantum III, flexibility and economy were the driving forces behind structural system selection. Not only are composite steel framed buildings quickly constructed, but they impose little weight on bearing soils. This is vital since Q3 borders the Monongahela River. Also, steel is the most familiar system used in Pittsburgh.

Viable new revenues for American Eagle Outfitters are in Los Angeles, California. Corporate offices are located primarily on the east coast including New York, Pittsburgh, and Boston; with other offices in Sioux Falls, South Dakota; and Lake Charles, Louisiana. Since the west coast is large new revenue, the number of building stories will be increased. Due to the intensity of seismic conditions of California, the redesign of lateral systems will be a vital and involved process. The coast wind conditions will also have a significant influence on lateral system design.

Increasing the buildings height also affects architecture. The building will be disproportional if the parapet and pedestal are unchanged. As a result, the building shell will be redesigned to fit these needs and blend with Los Angeles architectural styles.

The climate differences between Pittsburgh, Pennsylvania and Los Angeles, California will require the heating and cooling systems to be redesigned. The relocation translates to increased cooling systems and fewer heating needs.

Proposed Solution

Structural Depth

California is an earthquake prone region. A site analysis yields a Seismic Design Category of "D", indicating that extreme precautions must be taken when analyzing the lateral system. On top of this, Los Angeles has special wind conditions. Lateral systems will have to be entirely redesigned. In addition, increasing the number of stories will add to the complexity of lateral force resisting elements. Extra braced frames may be added to help distribute this load throughout the structure. Overall, a site evaluation will be performed and seismic and wind forces will be distributed to lateral force resisting elements. New braced frames will be added and all frames will be designed to withstand seismic and wind loads.

Architectural Breadth

Since floors will be added, the shell scaling will be reevaluated. Parapets and the pedestal will be resized relative to the increased height. Also, the materials in the shell will be analyzed based on the surrounding architecture, and will be changed to fit the scene of Los Angeles. Local materials can be emphasized to give a sense of place. The interior of American Eagle Outfitters:

Quantum III is open to allow for tenant fit out. This will not be changed; the focus of the architectural redesign is in the shell. The architectural changes will be presented in elevations, plans, and if required, renderings.

Mechanical Breadth

Since the climate in Los Angeles is considerably hotter, and the threat of snow is negligible, a complete reevaluation of the mechanical systems is vital. Heating systems aren't as necessary and the cooling capabilities must be upgraded. This will be done by analyzing the requirements of each floor, including losses due to shell permeability. The new equipment will be factored into the architectural redesign as well.

IV. Tasks and Methods

The depth and breadths described earlier will be performed in the following manner, and the timetable is available on page 9.

Structural Depth

1. **Redesign gravity system for American Eagle Outfitters: Quantum III**
    a. Insert new stories into building elevation
    b. Design new floor beams and girders
    c. Analyze gravity columns considering new floors and loading
2. **Analyze lateral system**
    a. Recalculate lateral loads based on ASCE7-05, using the new building loads and weight
    b. Determine the adequacy of braced frames and if new ones must be added
    c. Reanalyze center of rigidity
    d. Calculate braced frame relative rigidities using SAP2000
    e. Distribute seismic and wind loads to braced frames
    f. Design columns and braced frames using new loads and distribution
    g. Adjust design if needed
    h. Consider uplift effects on foundations
3. **Evaluate adequacy of structural design**
    a. Is the design cost effective
    b. Is it an optimal design for the given structural system
    c. Does the system coincide with the existing plan, with minimal disruption of existing floor layouts
    d. Does the system provide opportunity for clean meshing with architectural design and MEP layouts

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Architectural Breadth

1. **Analyze Q3's shell scaling**
    a. Add floors into building elevation
    b. Provide elevation of adjusted building height with existing pedestal and parapet scale
    c. Consider resized MEP equipment on roof in redesign
    d. Redesign building pedestal and parapet considering new scale, factoring in new MEP equipment on roof
2. **Determine adequacy of shell materials in Los Angeles, California**
    a. Evaluate local materials for new building location
    b. Determine availability of materials taking account of economy
3. **Design building shell using local materials with adjusted scale**

Mechanical Breadth

1. **Evaluate climate effects of building relocation**
    a. Find climatic data for Los Angeles, CA
    b. Determine new heating and cooling loads
    c. Redesign heating and cooling equipment
    d. Consider distribution of MEP systems and evaluate their meshing with other building systems
    e. Apply loads of new equipment on building roof
    f. Factor new loading in structural design

V. Schedule

The following calendars outline the schedule of calculations, and the approach taken on the redesign and relocation of American Eagle Outfitters: Quantum III.

January						
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday/ Sunday**
Week 1	14	15	16	17	18	19 and 20
	Insert added floors into building elevation and model Research common building materials in Los Angeles					
Week 2	21	22	23	24	25	26 and 27
	Design AEO: QIII gravity system					
Week 3	28	29	30	31		
	Design Lateral System					

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February						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday/ Sunday
Week 3					1	2 and 3
	Design Lateral System					
Week 4	4	5	6	7	8	9 and 10
	Optimize Lateral System					
Week 5	11	12	13	14	15	16 and 17
	Draft report on structural redesign				**Draft Report: Structural Redesign**	
Week 6	18	19	20	21	22	23 and 24
	Sketch building including new floors in elevation Research Los Angeles building materials					
Week 7	25	26	27	28	29	
	Add new materials in building shell design					

March						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday/ Sunday
Week 1						1 and 2
Week 2	3	4	5	6	7	8 and 9
	Add new materials in building shell design Begin sketches showing new building shell					
Week 3	10	11	12	13	14	15 and 16
	Spring Break					
Week 4	17	18	19	20	21	22 and 23
	Draft report on architectural redesign				**Draft Report: Shell Archi-cture Redesign**	
Week 5	24	25	26	27	28	29 and 30
	Research Los Angeles climatic data Determine required changes to mechanical systems Consider MEP changes in architectural redesign					
Week 6	31					
	Draft mechanical report				**Draft Report: Mechanical Redesign**	

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April						
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday/ Sunday**
Week 1		1	2	3	4	5 and 6
	Draft mechanical report				**Report: Mechanical Redesign**	
Week 2	7	8	9	10	11	12 and 13
	Review previous reports and write final report Draft and practice presentation			**Final Report Due**		
Week 3	14	15	16	17	18	19 and 20
	Presentations					
Week 4	21	22	23	24	25	26 and 27
Week 5	28	29	30	31		

VI. Conclusions

Throughout the spring I will sharpen my engineering skills through a complete redesign of lateral force resisting systems of American Eagle Outfitters: Quantum III. The relocation of the building causes great increases in seismic and wind loads, requiring a complete reanalysis. Not only will I gain invaluable experience in an earthquake prone region, but I will delve deeper into how it affects braced frames. Therefore, a deeper knowledge of center of rigidities and torsional affects on lateral design will be gained. Addition of floors to the building constitutes heavier column sections and more in depth lateral system checks.

The architectural taste of the building is characteristic of Pittsburgh, and materials may imply this sense of place. New materials will be researched and analyzed on their adequacy for building shell redesign. With the addition of floors, shell architecture changes as a result of scale. Parapets and pedestals may need resized or redesigned based on this. Plan architecture is neglected due to the open plan proposed for tenant fit-out.

The mechanical design will exercise the changes brought by climatic differences throughout the country. Redesigning these systems requires knowledge of heating and cooling loads, building envelope permeability, and losses due to human traffic in and out of the building. Since the plan is open for tenant fit-out, rooms will not be analyzed based on their individual heating and cooling requirements.