

The Edward L Kelly Leadership Center Prince William County School Administration Center



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Thesis Proposal
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Executive Summary

The intent of this report is to introduce the proposed thesis for the building under investigation, The Edward L Kelly Leadership Center. The building is an administrative building for the Prince William County Public Schools located in the northern Virginian city of Manassas. Currently housed in separate facilities, the architectural goal of the building is to combine the several School Administration functions into one single facility. The facility is light-filled with a 3-story atrium with skylights and a clerestory entrance. The building program contains flexible office space for 500 employees as well as meeting and training rooms for the district.

The building is composed of essentially three distinct sections. The gross square footage of the building is approximately 150,000 square feet. There is a one-story section on the west of the building plan. It is here that the main School Board meeting rooms, meeting rooms, exercise, kitchen, and "public" spaces are located. This section of the building is approximately 25,000 square feet. On the northern portion of the building is a three-story, rectangular, 17,000 square foot section of the building where offices for district employees are located. The southern share consists of another three-story building that is radial in nature and has a footprint of approximately 19000 square feet. An atrium and walkways separate the two three-story buildings by approximately 36 feet at its midpoint and represent another 20,000 square feet of the building. The two three-story buildings are approximately 60 feet in width and the rectangular and radial buildings are 265 feet and 295 feet, respectively.

The structural system is steel construction. Steel beams and girders are supported by steel W- or HSS-shape columns. Steel joists fill in the bays. The construction is non-composite concrete decking. The lateral system is a space moment frame. Nearly every column-to-girder connection is fixed.

This report outlines proposed problems and solutions to the design of the structure. Structurally, it is proposed to reduce vibrations and overall depth by replacing the joist fillers and non-composite beams and deck with an entirely steel beam composite system. In addition, the lateral system changes will begin with a study of reducing the fixed connections or adding a new lateral system (braced framing, shear walls). For a breadth study, architecture will be investigated to add potentially needed additional gross square footage to the building. Lastly, with the many changes to the building program, a study will be performed on the construction management of the building. This involves a new cost study analysis as well as identifying major scheduling impacts.

Structural System

Lateral System

The lateral forces, such as wind and seismic forces, in the building are resisted entirely through moment frames. The engineer chose to implement a moment frame to resist these horizontal forces. The particular frame is a space moment frame, meaning that all of the steel frames are used in the moment frame system. Figures 1 and 2 below show typical details of moment connections used throughout the building. The girder to column flange connections is made through welds of the girder flange to the column flange. A shear plate connects the girder web to the flange. The girder to column web connection is made with a plate welded to the column web and bolted to the girder flange. A shear plate connects the web of the column and girder.

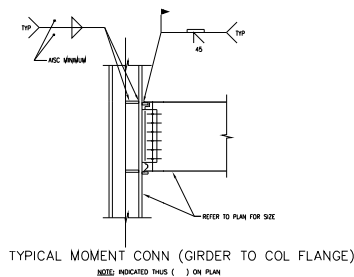


Figure 1. Moment Connection – Girder to Column Flange

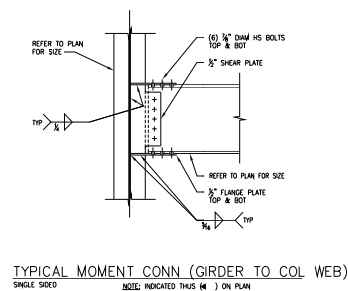


Figure 2. Moment Connection – Girder to Column Web

Floor and Roof Framing

Three-story portion:

W21 shapes with HSS2½ (TOP) are typically used for beams (Figure 3) while W24 are used for girders. The sizes of the bays are generally 24' wide and span approximately 30'. Steel joists are used to span inside the bays. 28K8 joists are the most common joist in the framing. Typical spacing is approximately 4' on center. Joists also frame the roof, where, to account for the heavy and asymmetric loads of mechanical equipment, KCS joists are commonly found. Roof beams are typically W18x35 and girders W21x44.

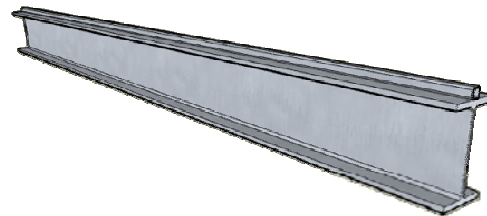


Figure 3

One-story portion:

This part of the building contains an elevated area that serves as an equipment platform. It covers a good portion of the footprint of this section. The "floor joists" are 26K9 spanning 30' in one part of this platform and 24K3/26K4 spanning 16'/19' respectively. Roof joists in the one-story portion are typically slightly larger than the 3-story building (28K10) since they span a much longer distance of around 47'. The structural plans show an area where the joists become increasingly closer to each other. This is due to the higher roof causing snow to drift

onto the lower roof in addition to windward drift. A few special joists (KSP) are used in certain areas of the one-story roof framing to account for unique loading. This is generally where there are folding partitions, causing heavy concentrated loading at points, in meeting rooms such as the School Board Meeting room.

Foundations

A shallow foundation type is used for this building. Foundations consist of spread footings and strip wall footings. The geotechnical engineer for the project indicated that the allowable bearing capacity of the soil is 3000 PSF. The top of the footings are set at (-2'-0") from grade. Reinforcement for spread footings range from (4)#5 BOT bars for the 3'-0"x3'-0" footings to (11)#7 TOP & BOT for the 11'-0"x11'-0" footings. Exterior column spread footings are typically 4'-0"x4'-0" to 6'-0"x6'-0" in the one-story portion and 7'-0"x7'-0" in the three-story portion. Interior column footings in the one-story portion are typically 6'-0"x6'-0" to 8'-0"x8'-0". The three-story interior column footings are 9'-0"x9'-0" to 11'-0"x11'-0". The strip wall footings are typically 2'-0" wide and 1'-0" thick. Reinforcement for strip footings are (3) continuous #5 bars. The strength of the concrete used for foundations is 3000 psi. The concrete strength for the 4" slab on grade is 3500 psi and contains 6x6-W1.4xW1.4 WWF at mid-depth.

COLUMNS:

All columns in the structural system are steel. In the one-story building, some typical interior columns include W12x79 and W10x68. Exterior columns are often rectangular HSS shapes. Typical shapes include HSS8x6x1/4 in the one-story building. In the three-story building, columns are, again, typically W-shapes for the interior and HSS shapes for the exterior. Typical shapes include W14x68 and W14x82 for the interior and circular HSS12.75x0.375 for the exterior.

The following figures represent the structural plans of the building.

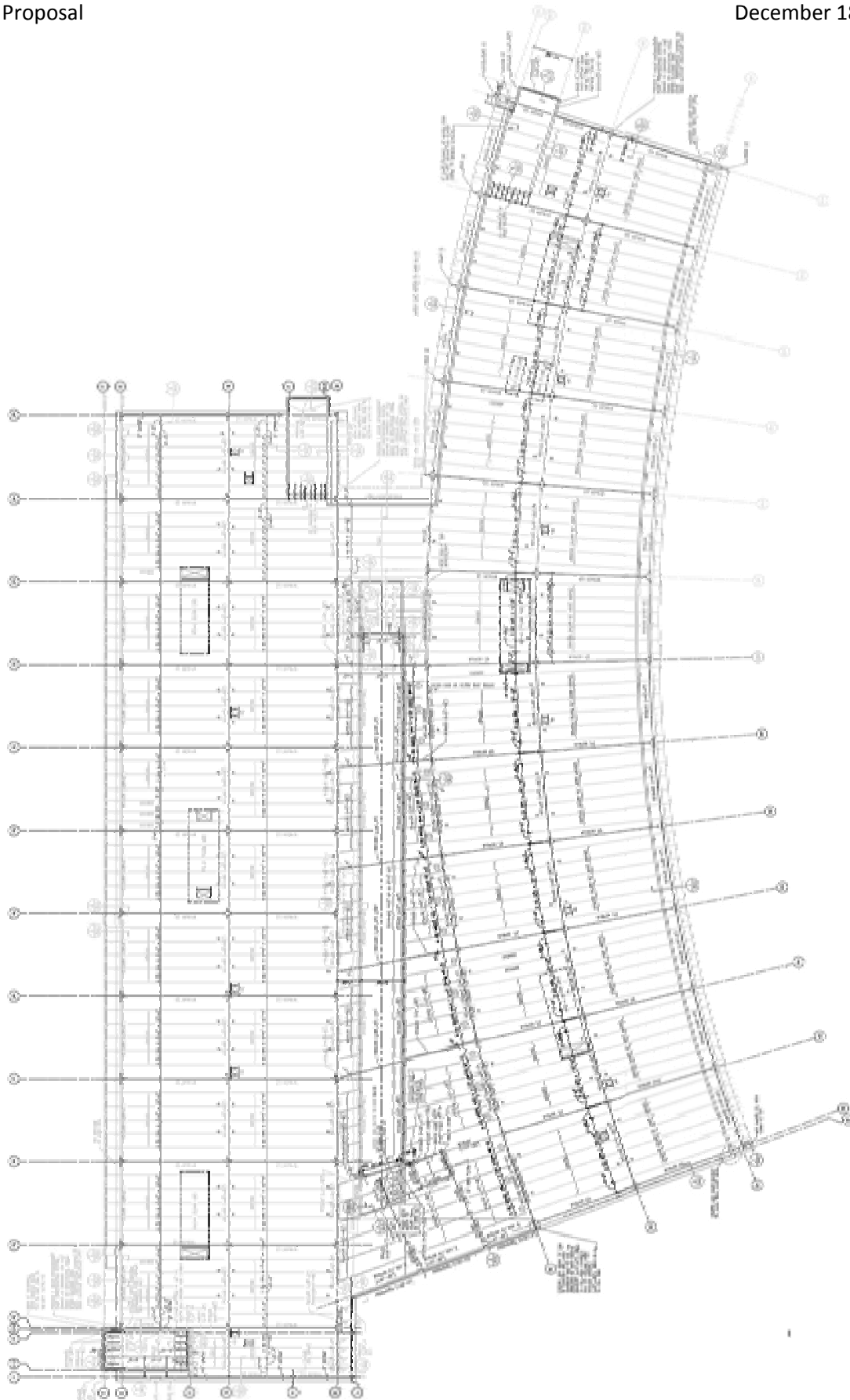


Figure 4 Structural Roof Plan (3-story wings only)

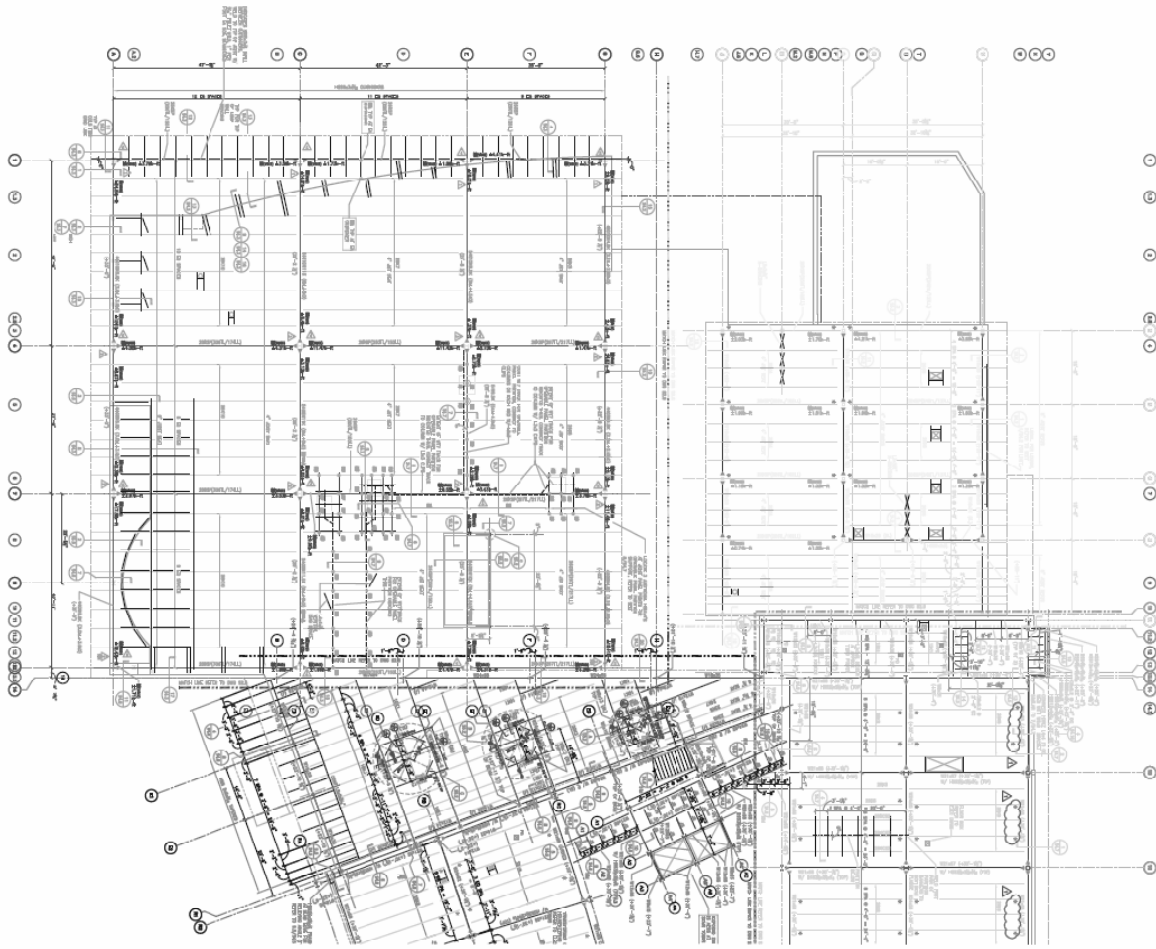


Figure 5 Roof Plan of One-story wing

Codes and Loading

The Virginia Uniform Statewide Building Code (VUSBC), 2000 edition was used for the design of the Edward L Kelly Leadership Center. This code absorbs much of its code from the International Building Code (IBC). IBC2000 will be used when referencing the original design of this building. In addition to IBC, the following codes and specifications were also implemented into the design.

- ASCE 7-98, Minimum Design Loads for Buildings and Other Structures
- ACI 530-99, Building Code Requirements for Masonry Structures With Commentary
- AISC Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design
- AISC Code of Standard Practice for Steel Buildings and Bridges
- Steel Deck Institute Design Manual for Composite Decks, Form Decks, and Roof Decks
- AISI Specification for the Design of Cold Formed Steel Structural Members

Live Loads	IBC 2006	Snow Load
Meeting Rooms	50 + 20 PSF	
Office Space	50 + 20 PSF	
1st Floor Corridors	100 PSF	
Corridors above 1st Floor	80 PSF	
Stairwell	100 PSF	
Mechanical Rooms	150 PSF	
Storage	125 PSF	
Flat Roof		21 PSF
Sloped Roof		21 PSF

Floor - Superimposed Dead Loads	
Mechanical	4 PSF
Electrical / Lighting	3 PSF
Sprinklers	3 PSF
Drop Ceiling	5 PSF
Total	15 PSF

Roof - Superimposed Dead Loads	
Roofing / Insulation	5 PSF
Mechanical	4 PSF
Electrical / Lighting	3 PSF
Sprinklers	3 PSF
Drop Ceiling	5 PSF
Total	20 PSF

Problem Statement

Based on the analyses performed thus far on the Edward L Kelly Leadership center, the structural system is satisfactory in its ability to resist the required loading conditions of gravity, wind, and seismic. However, it is my hypothesis that there is a great amount of redundancy that creates an inefficient structural system. I am specifically referring to the seemingly excessive use of fixed connections of the steel beams. Discussions with the architects of the project allude to the necessity for future expansion of the building to accommodate the growing school system. These issues will be investigated to create a more efficient design.

Proposed Solution

While the current design utilizes a non-composite steel framing system (see Figure *), an alternative framing system will be investigated. The alternative will remain as steel framing, but will consist of a composite concrete deck. In addition, rather than steel joists as fillers between main beams, steel beams will be investigated to fill the bays. While steel joists offer advantages such as low weight and open webs to accommodate mechanical systems, steel beams will more than likely offer a more shallow system, combat vibration issues, and can be spaced at greater distances than allowed by joists.

While the current lateral system is composed purely of a space moment-frame (see Figure *), a new lateral system will be investigated. The current architectural program consists of a very open floor plan. The exterior walls consist either of glass curtain walls or covered storefront windows. This is the biggest obstacle when considering alterations to the lateral system and limits the areas where steel bracing or shear walls can be used. The existing moment framing will also be investigated, but in a much more limited sense compared to the current system. The most up-to-date codes, such as ASCE7-05, IBC 2006, and all applicable codes will be utilized in the structural re-design process. Existing RAM Structural System models will be used and adapted, as needed, for the new framing system. Changes to the lateral system will be investigated through use of this model with braced frames or a reduction in fixed connections.

Breadth Topics

Architecture

The architect has indicated that an expansion to the building may be necessary to make room for future employees. Therefore, to accommodate for future expansion, an architectural breadth study will be conducted. A look at multiple configurations will be considered. Based on the site plan, expanding the building is possible horizontally. In addition, a vertical expansion is possible with the addition of floors to the main three-story wings. A further investigation will be made on the necessity of the one-story wing to see if it can be consolidated within the rest of the building.

Construction

A second breadth study will be conducted on the construction process. Because the architectural plans will be expanded and the structural system will be revised, scheduling will become an issue. A cost analysis will be conducted on the new floor system and compared to the previous system. An in-depth scheduling investigation will be conducted and solutions will be compiled to fully compare the existing building with the new design.

Solution Method

The new steel structural system will be analyzed based upon the specifications of the AISC Steel Construction Manual, 13th edition. All loading conditions will be determined with IBC2006/ASCE7-05. Using the computer program, RAM Structural System, a model of the building will be input. The appropriate changes to the current building, such as the change to composite decking and beams and the elimination of steel joists within the bays will be made within the model. Investigations into several changes to the lateral elements will be conducted within RAM. A reduction in the number of moment connections will be made initially and then later the addition of braced frames and shear walls will be analyzed. Wind and seismic loading will be re-analyzed with the new architectural system. The new loading will be distributed to the newly proposed lateral system. Lastly, scheduling and costs will be investigated using up to date versions (2008) of RSMeans Building Construction Data. The following chart estimates the scheduled process of achieving these goals.

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
	January 14 January 20	January 21 January 26	January 28 February 3	February 4 February 10	February 11 February 17	February 18 February 24	February 25 March 2
Finalize Gravity Loading							
Begin Arch. Investigation							
Horizontal Expansion							
Vertical Expansion							
Begin RAM SS Model							
Update Loading, General Crit							
Finalize Arch. Investigation							
Determine Lateral Loads							
Finalize RAM SS Model							
Input Final Arch Plans							
Analyze Gravity Elements							
Analyze Lateral Elements							
Analyze Construction Cost/Sched							
Update Capstone Portfolio							
Final Review of Report							
Thesis Presentation							

Task	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
	March 3 March 9	March 10 March 16	March 17 March 23	March 24 March 30	March 31 April 6	April 7 April 13	April 14
Finalize Gravity Loading							
Begin Arch. Investigation							
Horizontal Expansion							
Vertical Expansion							
Begin RAM SS Model							
Update Loading, General Crit							
Finalize Arch. Investigation							
Determine Lateral Loads							
Finalize RAM SS Model							
Input Final Arch Plans							
Analyze Gravity Elements							
Analyze Lateral Elements							
Analyze Construction Cost/Sched							
Update Capstone Portfolio							
Final Review of Report							
Thesis Presentation							