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

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Thesis Proposal, Rev. 1

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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. 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). The project manager indicated, in early design phases, anticipation for additional space in the future. 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.

Introduction

The Edward L Kelly Leadership center is an administration building for the Prince William County Public Schools. 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 central facility. The facility is daylight-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 geometry 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 with steel decking. The lateral system consists of moment frames. Nearly every column-to-girder connection is fixed.

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. Two distinct types of fixed connections are used. The first (Figure 1) is a fixed connection of the girder to the column flange. This connection is made through welds of the girder flange to the column flange. A shear plate connects the girder web to the flange. The second (Figure 2) is a fixed connection of the girder to the column web. This 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.

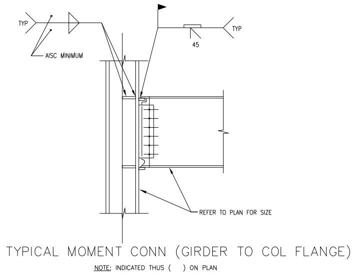

Figure 1. Moment Connection – Girder to Column Flange

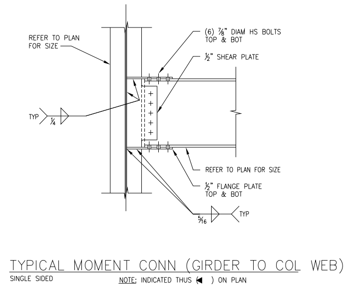

Figure 2. Moment Connection – Girder to Column Web

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.

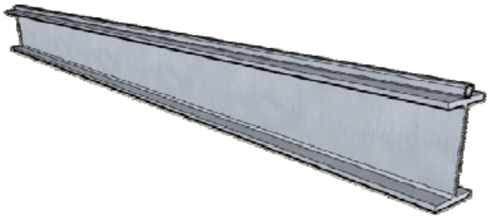

Figure 3

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 typical structural plans of the building.

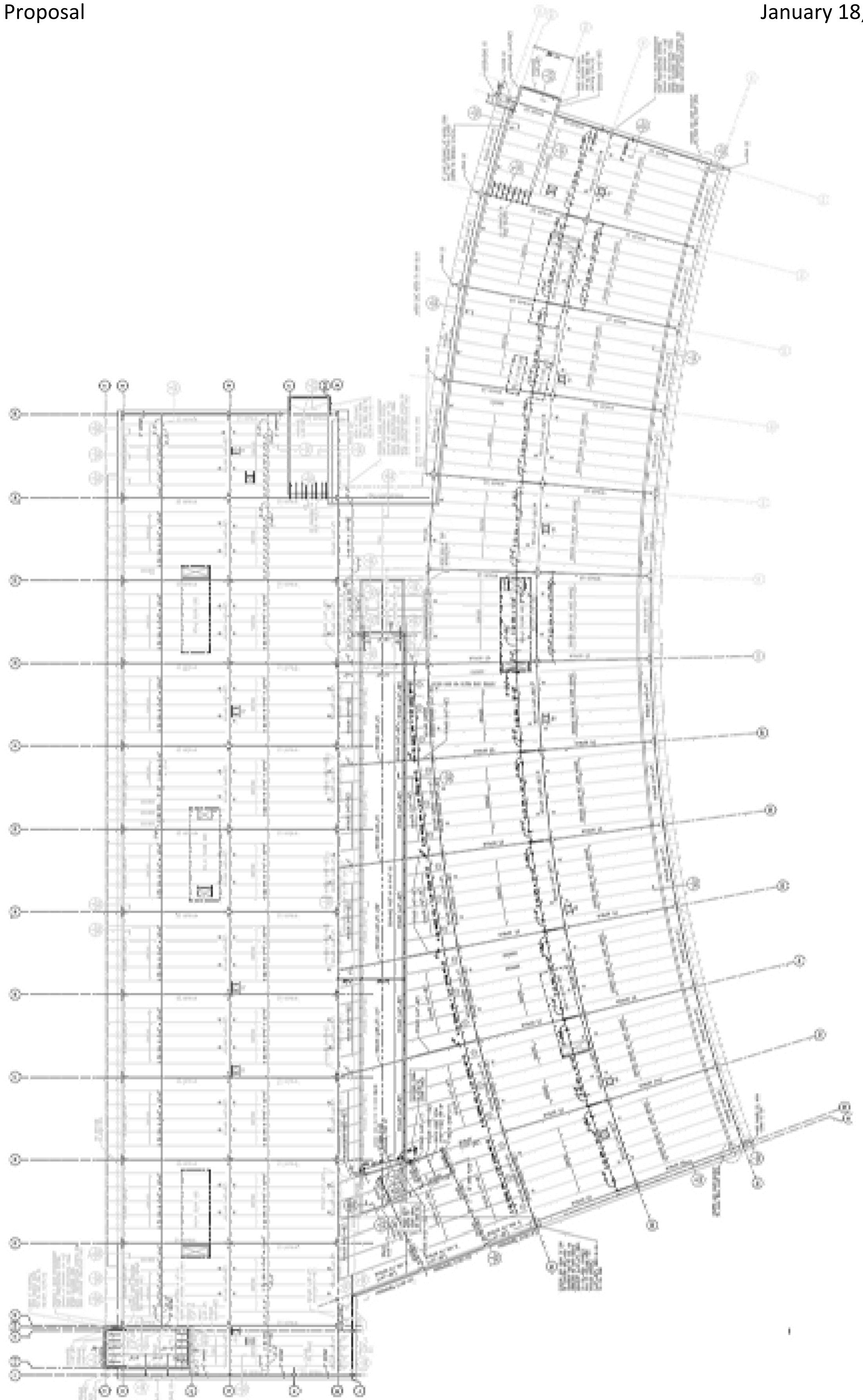

Figure 4 Structural Roof Plan (3-story wings only)

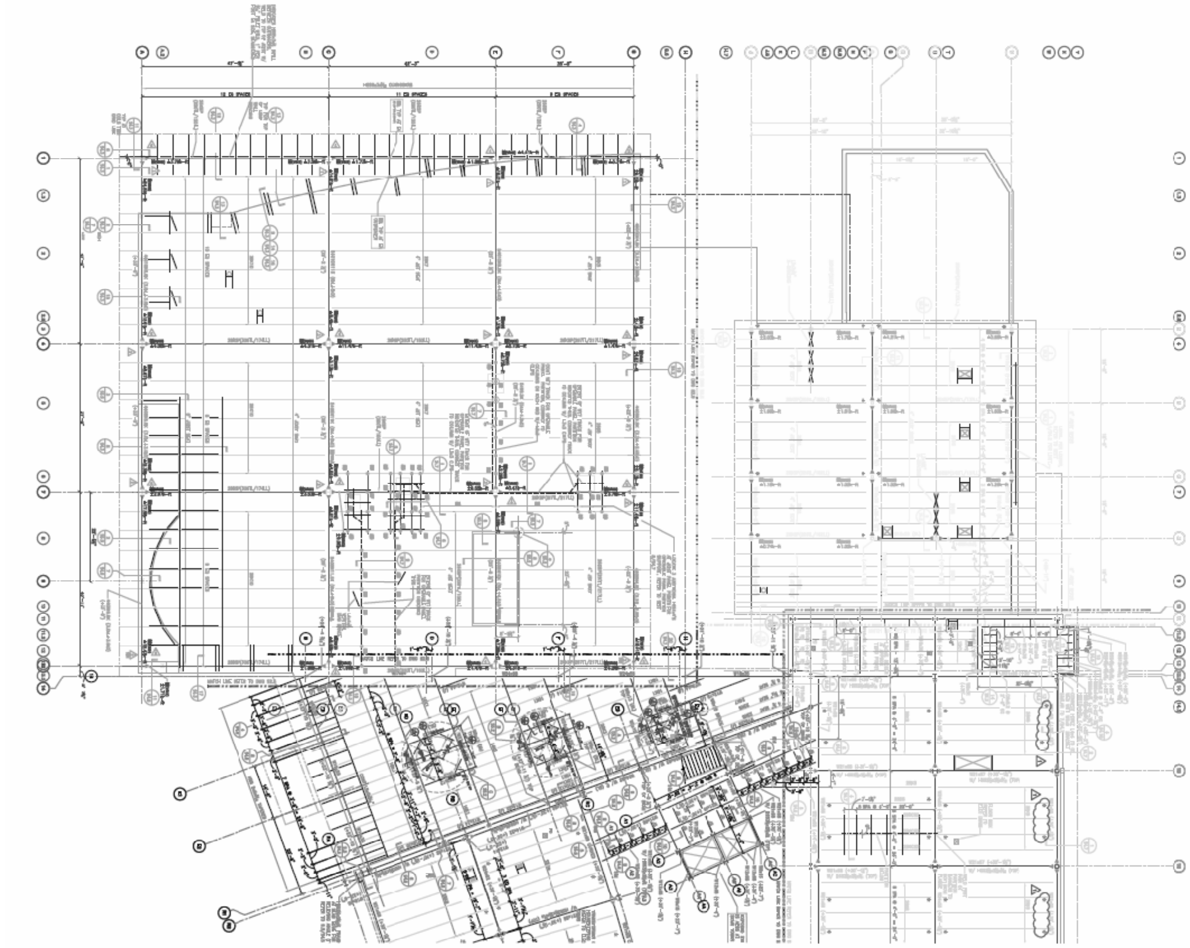

Figure 5 Roof Plan of One-story wing

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 Desks, 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. Specifically, there is a 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 with anticipation of creating a more efficient design.

Proposed Solution

While the current design utilizes a non-composite steel framing system, an alternative framing system will be investigated. The alternative will be remain as steel framing, but will consist of concrete on composite steel deck. In addition, rather than steel joists as fillers between main beams, composite 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 moment frames (see structural floor plans in previous Figures 4 and 5), 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 storefront windows. This is the biggest obstacle when considering alterations to the lateral system as it 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. Hand calculations will supplement computer output and used to verify results.

Breadth Topics

Breadth Study 1: 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. The functions currently housed in this part of the building could potentially be absorbed into the main building. This increase is building volume will have an effect on the mechanical and electrical systems and preliminary studies will be made in regard of the changes.

Breadth Study 2: 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. RSMeans Building Construction Data will be used to generate costs per square foot estimates. Scheduling times will also be estimated using appropriate RSMeans reference texts.

Solution Method

The new steel structural system will be analyzed based upon the specifications of the AISC Steel Construction Manual, 13th edition. Gravity and lateral loading will be determined with ASCE7-05. Using the computer program, RAM Structural System, a model of the building will be input. In addition to the use of computer models, hand calculations will supplement overall results and be used to confirm the output. 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. Vibration calculations will be performed using AISC Design Guide 11: Floor Vibrations Due to Human Activity as well as with the computer program, FloorVibe. The overall changes in building weight with regard to its impact on foundations will be investigated and, if problematic, changes to the foundation will be considered. 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. 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 of RSMeans Building Construction Data. All changes will be compared to the original design. The following chart (Figure *) estimates the scheduled process of achieving these goals.

Task	Week 1 January 14 January 20	Week 2 January 21 January 26	Week 3 January 28 February 3	Week 4 February 4 February 10	Week 5 February 11 February 17	Week 6 February 18 February 24	Week 7 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							
Calculate Floor Vibration							
Gravity Hand Calculations							
Lateral Hand Calculations							
Foundation Impacts							
Analyze Construction Cost/Sched							
Update Capstone Portfolio							
Final Review of Report							
Thesis Presentation							

Task	Week 8 March 3 March 9	Week 9 March 10 March 16	Week 10 March 17 March 23	Week 11 March 24 March 30	Week 12 March 31 April 6	Week 13 April 7 April 13	Week 14 April 14
Finalize Gravity Loading							
Begin Arch. Investigation		K					
Horizontal Expansion							
Vertical Expansion		A					
Begin RAM SS Model		E					
Update Loading, General Crit							
Finalize Arch. Investigation		R					
Determine Lateral Loads		B					
Finalize RAM SS Model							
Input Final Arch Plans							
Analyze Gravity Elements		G					
Analyze Lateral Elements							
Calculate Floor Vibration		N					
Gravity Hand Calculations		I					
Lateral Hand Calculations							
Foundation Impacts		R					
Analyze Construction Cost/Sched		P					
Update Capstone Portfolio							
Final Review of Report		S					
Thesis Presentation							

Figure 6. Proposed Task Schedule