Visteon Village Corporate Center

Van Buren Township, MI

Thesis Proposal

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Executive Summary

The thesis that I am proposing will investigate the design changes required by changing the location of the Visteon Village Corporate center into a high seismic region and the benefits and drawbacks of introducing alternative lateral framing systems to the building. The current system is composed of special steel moment frames with beams spanning up to 40 feet. The intent of this thesis will be to optimize performance under high seismic loading while minimizing the amount of steel required by introducing various types of braced frame configurations as the main lateral force resisting system. This will require multiple full redesigns of the lateral framing system, which might also include a reconfiguration of the lateral framing locations. Knowledge gained from the seismic design and steel connection MAE courses will be used heavily throughout this thesis. The breadth studies will focus on the effects of the construction schedule and costs, and reconfiguration of the architectural floor plan to accommodate the changes in the lateral system. Once all of this data is gathered, a feasibility and cost analysis will be performed and recommendations will be made as to which system provides the maximum benefits to the Visteon Village Corporate Center project in its new location.

Introduction: Visteon Corporate Village Center

The Visteon Corporate Village Center is located in the Detroit metro area of Van Buren, MI. The facility is one of many office and laboratory buildings present on the corporate campus of the global automotive supplier. The campus is laid out and styled to provide a village type of atmosphere, complete with sidewalks and streetlights. All master planning, architecture and engineering of the campus and its various buildings was completed by the Detroit office of the SmithGroup.

The Visteon Corporate Village Center is five stories high, with the fifth story penthouse reaching a height of 72'-9" above grade, and has an overall size of 130,000 gross square feet. The building is a steel framed structure consisting of a composite steel decking system resisting gravity loading and a special steel moment frame system for lateral support. The majority of the building consists of 40'-0" x 20'-0" bays providing a large amount of floor area that is uninterrupted by column placement.

Existing Framing System

Foundation:

All of the foundation systems for the Visteon Village Corporate Center were designed based upon the findings of a geotechnical investigation performed by Somat Engineering on October 14, 2002**.** There is a deep foundation system to support all building columns, walls, grade beams and other foundation elements. The deep foundation elements are comprised of friction steel H-piles in native medium compact to compact sand. All H-piles consist of 75 foot long HP12x84 sections with concrete pile caps and are of ASTM A992 steel (Fy = 50 ksi). The number of piles for each foundation element range from 1 to 7 providing capacities of 100 kips to 1050 kips respectively. The concrete pile caps are of reinforced concrete construction with their top elevation at a minimum depth of 3'-6" below finished grade as to prevent frost heave. The dimensions of the caps range from 3'x3' for a single H-pile element up to 13'x11'-8" for a 7 H-pile element. All concrete used in the foundation systems has a minimum compressive strength of 3000 psi.

Columns:

All of the columns of the building are composed of structural steel. The main column system is made up of ASTM A992 wide flange shapes ranging in size from W14x43 to W14x311. Typically, these columns rest upon the deep foundation system and extend 72 feet to the penthouse level with a column splice at an elevation of 52 feet (falling within the third story). These multistory columns are also part of the special moment frame system that resists lateral loading.

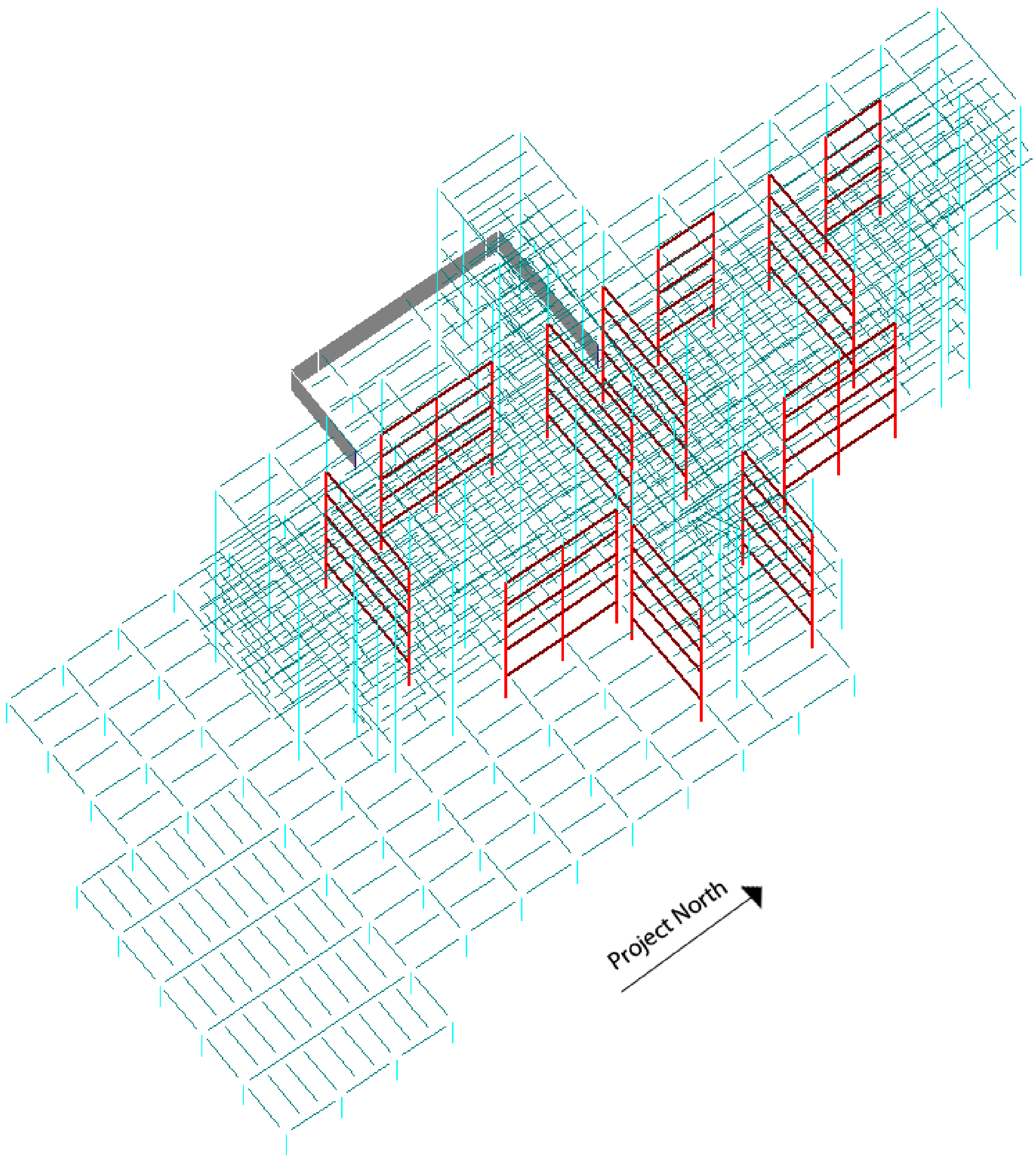
Floor and Roof Framing System:

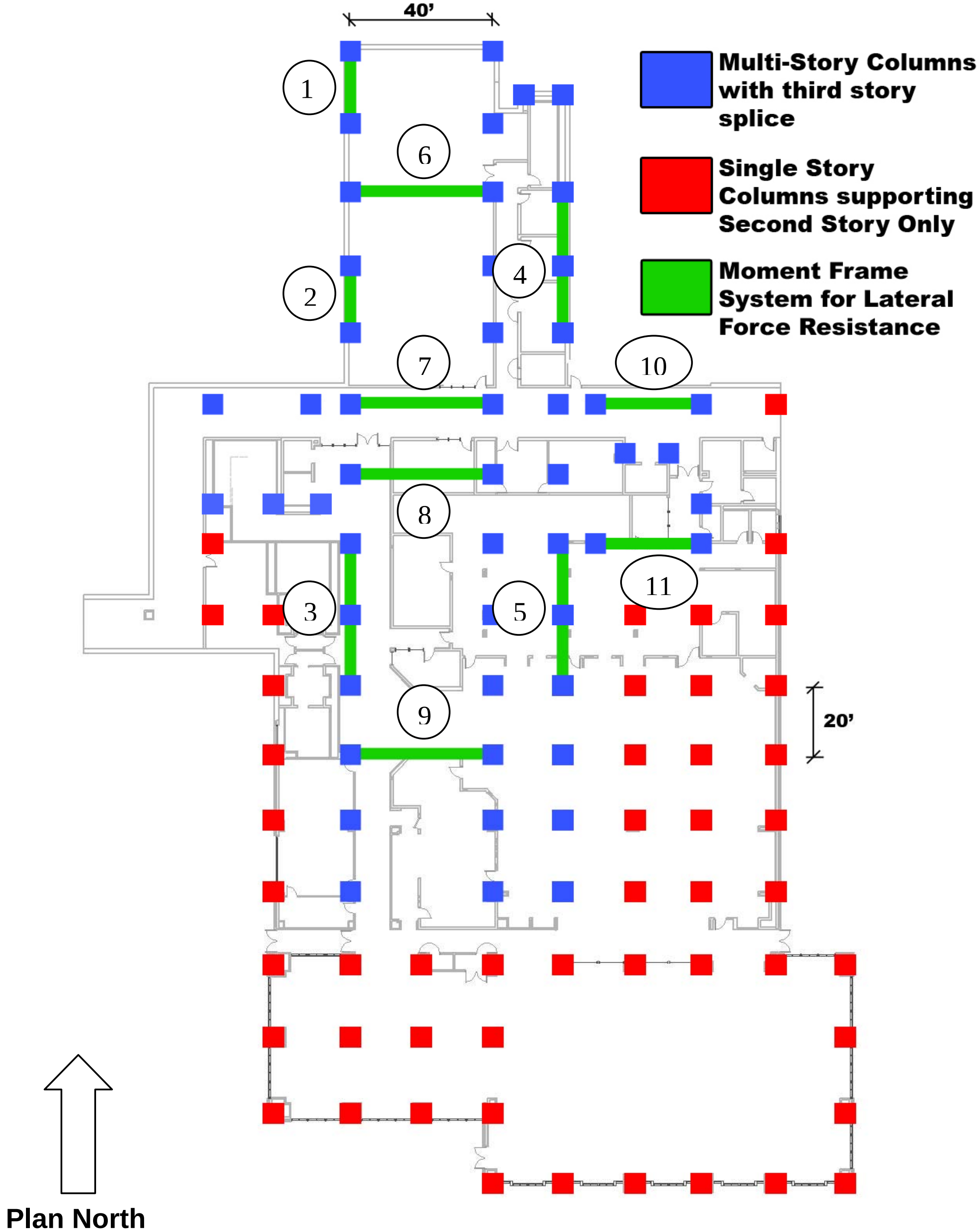
The typical framing system for the Visteon Village Corporate Center is composed of structural steel composite beams and girders. The supported floor consists of 40 foot long ASTM A992 wide flange shapes spanning a column free space. The typical bay for each floor is 40'x20' with wide flange beams spaced at 10' on center supporting 3" composite metal floor deck with 3-1/4" light weight concrete fill providing a total slab depth of 6-1/4". All supporting materials for this system can be found in the appendix.

Existing Lateral System

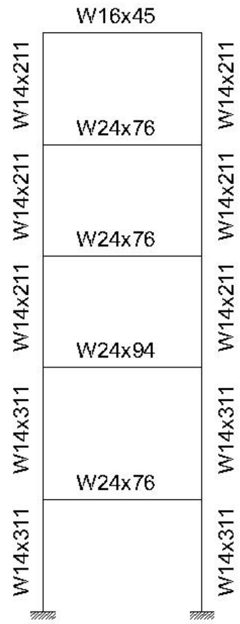
Lateral:

All lateral loads caused by wind and seismic forces are resisted by special steel moment frames. There are five moment frames running in the North/South direction of analysis and six moment frames running in the East/West direction of analysis. Each moment frame consists of multistory wide flange columns and wide flange beams. The columns are spliced at the third story, with the top three stories consisting of a W14x211 section being supported by a W14x311 extending through the lower two stories.

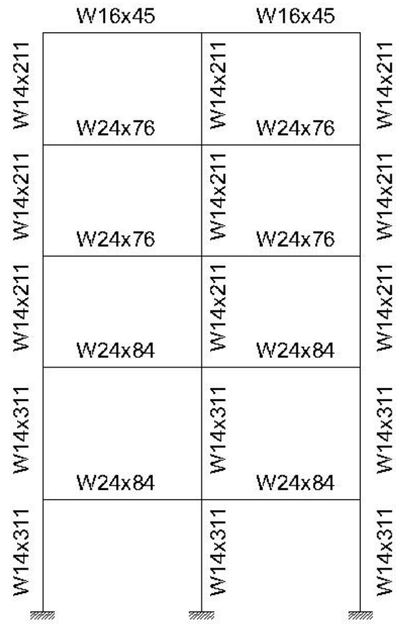



40'
20'
1
2
3
4
5
6
7
8
9
10
11
Multi-Story Columns with third story splice
Single Story Columns supporting Second Story Only
Moment Frame System for Lateral Force Resistance
Plan North

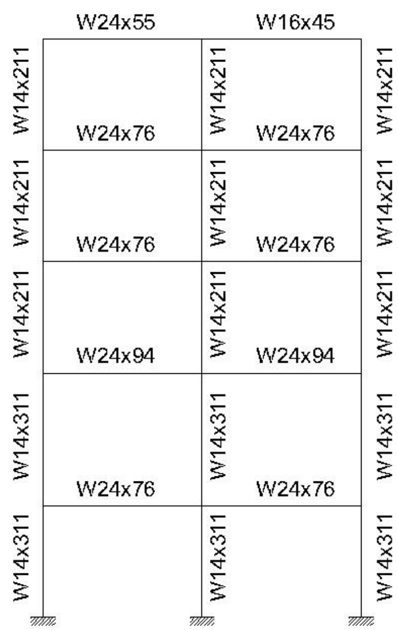
Frame elevations of special steel moment frames spanning in the North-South direction:



Frames 1&2



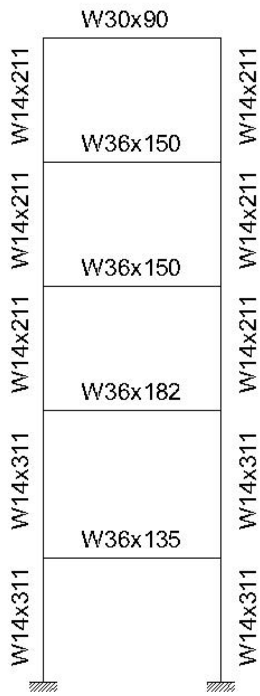
Frames 3&5



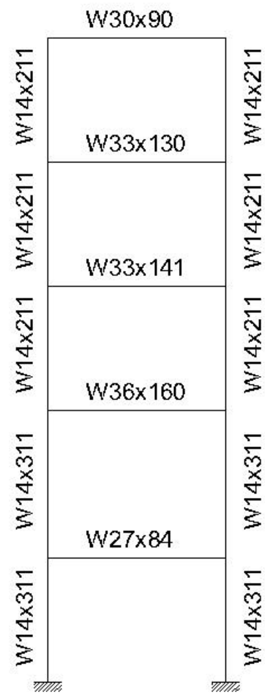
Frame 4

These diagrams are intended to show the frame sections and are not to scale.

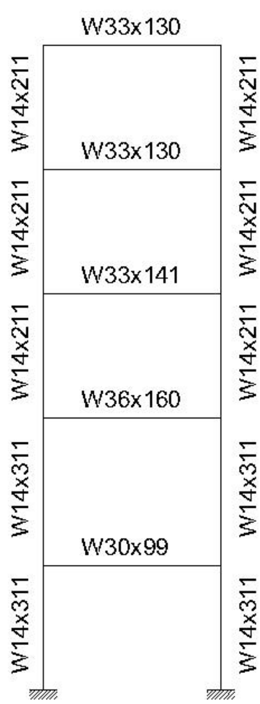
Frame elevations of the special steel moment frames spanning in the East-West direction:



Frames 6, 7, 8 & 9



Frame 10



Frame 11

These diagrams are intended to show the frame sections and are not to scale.

Problem Statement

The current design of the Visteon Village Corporate Center's lateral load resisting system is comprised of special steel moment frames. While it is important to note that during the third technical report this system was deemed adequate, there is the possibility to increase the efficiency of the design. The steel sections used to create these moment frames are quite large in order to accommodate the 40 foot spans while maintaining the capacity to handle the lateral loading caused by the critical seismic loading scenario. While the overall lateral drift of the Visteon Village Corporate Center was within the allowable limits, the second and third floors had large story drift ratios which are grounds for serviceability concerns about the building's performance as a whole. The moment connections utilized ensure that the frames adequately transfer the forces of the lateral loads, but are consequently expensive as well as time consuming to erect during the construction phase of the project. With these topics in mind, a new lateral framing system must be designed that will optimize performance using economical steel sections and construction techniques, while maximizing the capacity of the lateral load resistance of the structure.

Proposed Solution

The issues of economical design and drift optimization are the main areas that need to be addressed. This leads to the notion of a complete redesign of the lateral load resisting system of the Visteon Village Corporate Center using braced frame systems. Multiple concentric and eccentric braced framing schemes will be assessed for their feasibility of application to the project. Using a braced framing system to handle the lateral loading should provide a substantially more efficient way to keep story drifts under control, specifically on a floor by floor basis. These connections also require significantly less field welding, which will save on labor and material costs during the construction phase. The application of these connections should also expedite the erection process of the steel framing, causing the positive changes in the construction schedules. The advantages and disadvantages the framing changes have on the current construction process will be thoroughly investigated as a breadth study of this proposed thesis. By changing the current moment frame system to braced frames, the open layout of the floor plan could be potentially compromised if the frames were left in similar locations to the original design. Movement of the frames to accommodate the architectural flow of the building will be performed and assessed structurally, as well as a redesign of the floor plan layout to accommodate the frames in their current locations. These studies will encompass an architectural breadth to ensure unity between the structural and functional design. Once all analyses of the proposed and current systems are completed, a comparison will be performed to determine the system that’s the best fit in terms of feasibility, cost, and efficiency.

Breadth Options

In addition to the main structural redesign of the lateral framing system of the Visteon Village Corporate Center, two breadth studies will be performed. The first study will analyze the effects that the framing changes will have on the construction process. The second study will focus on the architectural accommodations that will be required to integrate the new framing system into the building.

The construction study will focus on the benefits and drawbacks the different types of braced framing systems provide to the construction process in comparison with the existing moment frame system as well as with each other. This study will cover the topics of cost, installation, estimating, and scheduling issues.

The architecture study will focus on the design issues caused by the implementation of the new braced frame system. Keeping the lateral resisting frames in their current locations would mean that multiple spans along the column grid which are currently open would have some sort of bracing interfering with the layout in the new design. A redesign of the floor plan would be in order to show that a feasible and functional change of the architectural layout can be achieved. Another option for this study is to change the locations of the lateral resisting members to optimize the functionality and convenience of the architectural plan, which would require additional structural analysis.

Methods

The new braced frame lateral load resisting systems will be designed to sufficiently resist lateral loading defined by the 2006 edition of the International Building Code and the 2005 edition of ASCE-7. All connection designs and member selections for the framing system will be aided by the 13th Edition Steel Construction Manual and Seismic Design Manual, both provided by AISC. Computer models will be constructed using RAM structural system and ETABS, where critical load cases will be determined and applied to the trial frame designs to assess the adequacy of their design. Using the analysis results, appropriate changes will be made to optimize the framing designs. Research will be done using RS Means and other sources of construction cost data to determine the changes to the overall building cost as a result of the implementation of this system. The various types of braced frames, braced frame connections, and moment frame connections will be thoroughly analyzed to determine the efficiency and economy of the separate schemes. Microsoft Project may also be a helpful tool when determining the effects the framing changes will have on the overall schedule of the project. Changes to architectural design will be shown in a conceptual manner, using hand drafting and AutoCAD software to express layout changes. These new architectural schemes will be assessed on their feasibility, functionality, and their ability to meet the projects program requirements.

Tasks

Task 1: Design Trial Braced Framing Scheme

i. Determine acceptable dead, live, and critical lateral loading for new location with high seismic activity

ii. Create multiple framing layouts

iii. Determine trial member sizes

Task 2: Analysis of New Framing Schemes

i. Create ETABS model of each new framing layout

ii. Identify pros and cons of each scheme

iii. Identify most efficient and economical solution

Task 3: Comparison of Framing Systems

i. Compare new model to existing scheme

ii. Determine any achieved advantages

iii. Integrate new trial framing scheme into the building

Task 4: Design of Additional Bracing Schemes

i. Establish multiple bracing configurations to apply to the established trial scheme

ii. Identify advantages and disadvantages to each system and their application to the framing layout

iii. Find trial member sizes for each system for analysis purposes

Task 5: Analysis of Additional Bracing Schemes

i. Create ETABS model for additional systems

ii. Determine the pros and cons of each system for the established framing scheme

iii. Identify the best overall solution in terms of efficiency, strength, and cost

Task 6: Overall Cost Benefit Analysis

i. Calculate new building cost with proposed framing system

ii. Compare results with the current building cost

iii. Determine final resulting benefits and feasibility of the proposed system

Task 7: Construction Process Breadth Study

i. Study current installation process and scheduling

ii. Research proposed installation process and scheduling

iii. Determine proper connection details

iv. Determine needed materials and labor

v. Determine how proposed system will affect the critical path of construction

vi. Identify benefits of proposed system

Task 8: Architecture Breadth Study

i. Identify architectural themes and flow of existing building

ii. Determine feasibility of keeping current architectural scheme with proposed system

iii. Make necessary design changes to provide a functional layout while accomodating new framing layout

iv. Determine pros and cons of design changes

v. Determine feasibility of changes made due to proposed system

Task 9: Applicable Changes Due to Consultant Feedback

i. Discuss major milestones with consultant
ii. Make necessary changes bases on consultant's expertise before proceeding to next critical step

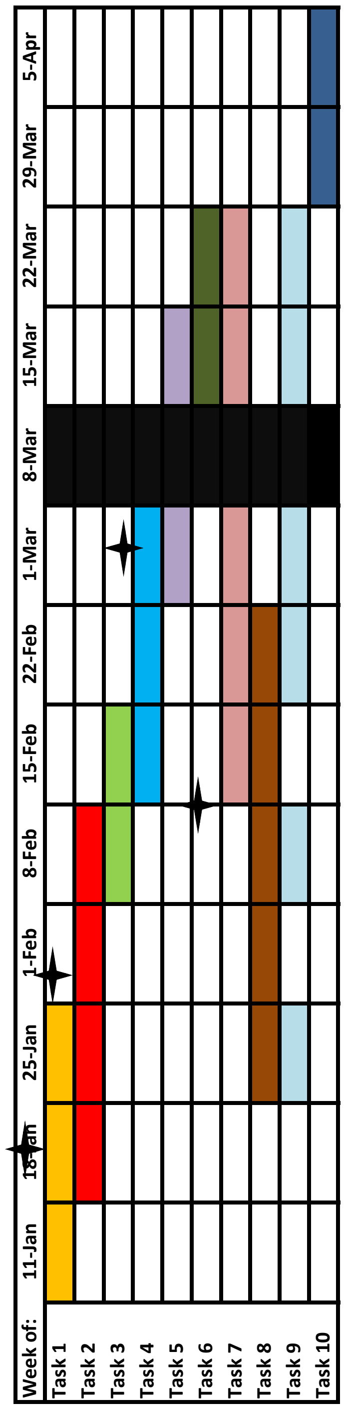
Task 10: Develop Presentation

i. Compilation of presentation materials
ii. Rehearsal of presentation

Schedule of Tasks

Milestones:

Jan 26: Determined all critical loading and have neared completion of trial scheme layouts, and begun analysis
Feb 9: Completed analysis of trial layouts and have begun analysis to determine best overall framing scheme to propose
Feb 23: Completion of architectural breadth study and integrated proposed framing scheme
Mar 16: Completed analysis of best bracing scheme and begin overall cost analysis which coincides with near completion of construction process breadth study



Concluding Remarks

The intent of the proposed thesis is to improve the efficiency of the current lateral framing system of the Visteon Village Corporate Center from the standpoint of economical and serviceability issues. By changing the current moment frame system to a braced frame system, story drift issues can be optimized, and the steel sections comprising the frames can be economically sized in an efficient manner. A feasible architectural layout will be established to fit with the new scheme and the changes in construction time and costs will be assessed. Hopefully, this thesis will prove that a change to the current lateral bracing system will not only be feasible, but beneficial to the building as a whole.