The Regent

950 N. Glebe Road
Arlington, VA

Architect: Cooper Carry Architects

Structural Technical Report 3
Executive Summary

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Executive Summary

The Regent is a 12-story office building located at 950 North Glebe Road in Arlington, VA. There is retail space on the first floor and a 3-level concrete parking garage below grade. The Regent is designed to a maximum allowable height of 176'.

The gravity framing system for the tower consists of a steel superstructure. The flooring system includes a 6 ¼" slab on metal deck. Shear studs provide the composite action between the slab on deck and the composite steel beams. Typical bays are 30' x 30' and 43'-46' x 30'.

The lateral system consists of five braced frames centrally located around the core of the building. There are two braced frames that resist the north / south lateral forces and three braced frames that resist the east / west lateral forces.

This report will focus on the lateral system analysis and confirmation of design. The lateral loads considered for this report are wind and seismic forces. Based on the load combinations of ASCE7-02, wind is the controlling lateral force in the east / west direction and in the north / south direction, seismic controls from the Roof level down to and including Level 6, and wind controls from Level 5 to Level 2.

The controlling lateral loads are distributed to the five braced frames based on the Lateral Load Distribution Procedure – Distribution by Rigidity. This method of lateral load distribution takes into account the relative stiffness of each braced frame and any torsional effects due to the braced frame configuration and the changing center of mass for each floor up through the building.

After the lateral loads were appropriately distributed to each braced frame, computer models were produced using ETABS in order to help analyze the lateral framing system through the calculation of member design checks, drifts, story drifts, and axial member forces. There were two types of computer models produced. The first series of computer models, referred to as the Single Frame models, analyzes each frame individually where as the second computer model, referred to as the Whole Building model, includes all five braced frames connected to rigid floor diaphragms.

Throughout this report, the results of the computer analyses, hand calculations, and the existing design and design loads are compared in order fully understand and analyze the lateral force resisting system and to confirm the lateral framing system design.

This report includes lateral member design checks, including a detailed study of critical diagonal bracing members, a check of building drift and story drift in comparison to industry standards L/400 and L/360, and a check of the building's resistance to the overturning moments induced by the lateral loads.

The bottom diagonal bracing members for Frames #2 and #3 were checked for strength. In comparing the results of all the analyses, it was determined that the existing designed

members should be adequate for strength, however the computer analyses for the diagonal member check of Frame #2, found that the diagonal member was not adequate for strength. Since the calculated loads were similar in magnitude across all of the analyses, it was determined that the computer models may not be an exact representation of the lateral framing system. The models need to be reviewed further in order to figure out why the results show they are not correctly designed for strength even though the loads match the other analyses which prove that under the applied loads, the diagonal member is adequate.

All of the other frames were checked for strength in both computer models. It was determined that most of the members met the strength requirements when analyzed as a single frame, however there were more members that did not meet the strength requirements when analyzed as part of the whole lateral force resisting system. The model of the whole lateral force resisting system more closely represents the actual building design and actual configuration. Since several of the members were not meeting the design strengths, this could be an indication of several concerns:

1. The loads applied are similar to the loads applied for the existing design, but the model is not an accurate representation of the existing design
2. The loads applied are more conservative than those assumed for the existing design which are resulting in a lot of the members not meeting the design strength check
3. The members may not be conservatively designed

The initial conclusion is that the computer models are not an exact representation of the lateral force resisting system as it was designed and the models will be corrected or reviewed further in order to make sure that they are accurately representing the existing lateral force resisting system.

The system was then checked for drift and story drift according to the industry standards of L/400 and L/360. The results of the Whole Building model analysis show that the top of the building displaces approximately 7” in the north / south direction and approximately 4” in the east / west direction. According to industry standards, the top of the building is allowed to drift a total of 5.28” to meet L/400 deflection limits and 5.87” to meet L/360 deflection limits. In the north / south direction the building exceeds both of the deflection limits by over 1”. In the east / west direction, the displacement of the top of the building meets both of the deflection limits by under and 1”. Therefore, according to the results of the Whole Building model analysis, the building drift is okay in the east / west direction, but does not meet the industry standard deflection limits in the north / south direction for the entire building displacement.

The average story drift for the Whole Building model in the north / south direction is approximately 0.6” per story. The average story drift in the east / west direction is approximately 0.35”. For the 13’ high stories, the L/400 and L/360 deflection limits are 0.39” and 0.43”, respectively. For the 18’ high story, the L/400 and L/360 deflection limits are 0.54” and 0.6”, respectively. The story displacements in the north / south direction are exceeded by approximately 0.2” per story. In the east / west direction, the average story drift meets the L/400 and L/360 story drift limitations.

Since the deflection limits are not met in the north / south direction, this is an indication that the calculated applied lateral loads in the north / south are higher than the actual lateral loads designed for, the computer model is not accurately representing the lateral force resisting system, or L/300 was an acceptable deflection limit for the design in this direction.

The results of the Single Frame model drift and story drift calculations concluded that if each frame is analyzed separately for frame displacements, all of the frames fail to meet the story drift limitations of L/400 and L/360 and only Frame #4 meets L/360 building deflection limit, while the other four frames do not meet any of the industry standards for total building drift.

The overturning moments for The Regent were calculated based off of the controlling lateral force distributed to each braced frame. The moments due to the self weight of the building were much greater than the overturning moments in all cases. Therefore, the building is able to resist the overturning moments induced by the lateral forces.

In conclusion, the lateral system and confirmation of design analyses performed for this report concluded that the building, as analyzed, does not meet all strength, drift, and story drift requirements. This is an indication that the critical load path for distribution of the designed structure does not match the analyses performed in this report. Further research and analyses will determine where and why the critical load paths do not match up. The computer models will be revised to more accurately represent the existing designed structure in order to be able to determine if the designed lateral system is adequate for the calculated loads. It is also a possibility that the calculated lateral loads used in all of the computer models and hand calculations are more conservative than those used in the actual design of the lateral load resisting system or that the lateral loads were not distributed properly among all of the braced frames. Further research and analysis will determine the accuracy of the computer models, the accuracy of the calculated applied lateral loads, and the accuracy of the distribution of the lateral loads to each lateral load resisting element. The results of all methods of analysis need to coincide so that it can be assumed that the critical load paths of the existing system match the critical loads paths developed through this series of technical reports.