Technical Note

BELGARD COMMERCIAL

USING TOPGUIDE™ FENCE POST SYSTEM TO MEET CODE REQUIREMENTS

The TopGuide system is a pre-engineered post support system allowing for the placement of fences and handrail posts directly behind a segmental retaining wall system (SRW). Using the TopGuide system will provide the necessary resistance to meet the loads outlined in building code requirements. For this report, the building codes referenced are the IBC (2024) 1015.2, IBC (2024) 1607.9, ASCE 7-22 Section 4.5.1 and ASCE 7-22 Section 4.5.1.1, and NBC Section 4.1.5.14.7.

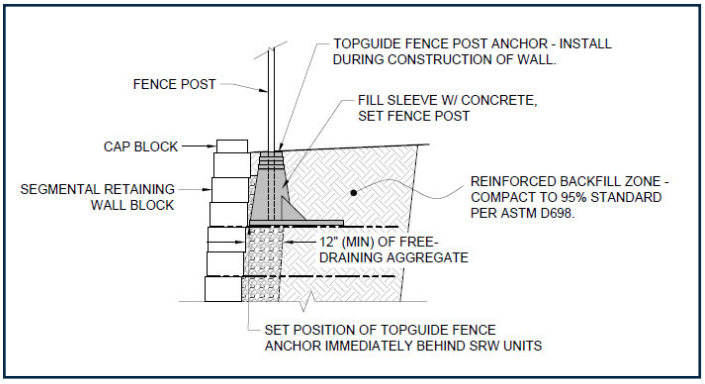

FIGURE 1 – FENCE POST INSTALLATION USING TOPGUIDE™

APPLICABLE CODE REQUIREMENTS FOR FENCE POSTS

The following building code references highlight applicable standards that should be considered by the retaining wall engineer. Project-specific fence post, handrail or guard system requirements required by the local jurisdiction should be confirmed.

INTERNATIONAL BUILDING CODE (IBC) – 2024

- IBC 1015.2 – Guards shall be located along open-sided walking surfaces that are located more than 30 inches measured vertically to the floor or grade blow at any point within 36 inches horizontally to the edge of the open side.
- IBC 1607.9 – Handrails and guards shall be designed and constructed for the structural loading conditions set forth in Section 1607.9
  - IBC 1607.9.1 – Concentrated load – Handrails and guards shall be designed to resist a concentrated load of 200 pounds in accordance with Section 4.5.1 of ASCE 7.
  - IBC 1607.9.1.1 – Uniform load – Handrails and guards shall be designed to resist a linear load of 50 pound per linear foot in accordance with Section 4.5.1.1 of ASCE 7.

ASCE 7-22 MINIMUM DESIGN LOADS AND ASSOCIATED CRITERIA FOR BUILDINGS AND OTHER STRUCTURES

- Section 4.5.1 – Handrail and guard systems shall be designed to resist a single concentrated load of 200 pound applied in any direction at any point on the handrail or top rail to produce the maximum load effect on the element being considered and to transfer this load through the supports to the structure.
- Section 4.5.1.1- Handrail and guard system shall also be designed to resist a load of 50 pounds per foot applied in any direction along the handrail or top rail and to transfer this load through the supports to the structure. This load need not be assumed to act concurrently with the concentrated load specified in Section 4.5.1.

NATIONAL BUILDING CODE OF CANADA (NBC) – 2020

- NBC Division B Section 4.1.5.14.7 – Handrails and their supports shall be designed and constructed to withstand the following minimum specified live loads, which need not be considered to act simultaneously:
  - 0.9 kN applied at any point and in any direction for all handrails
  - 0.7 kN/m applied in any direction for handrails not located within dwelling units.

TESTING PROGRAM AND SETUP

The purpose of the load testing was to show that a fence or handrail post incorporating the TopGuide system will meet the minimum requirements outlined in the previously referenced building codes. Construction of the testing setup was performed by the Oldcastle APG Research and Development team, and the testing was performed by Braun Intertec.

The testing setup consisted of nine post locations behind a 3-foot-high retaining wall. The TopGuide system was placed directly behind the retaining wall. Post locations were a minimum of 5 to 6 feet apart to limit or reduce the potential for lateral effects on subsequent testing. Steel I-beams (W4x13) were used as fence posts to eliminate any post deflection and ensure the transfer of the lateral load directly to the TopGuide system. The posts were set into the TopGuide system with concrete.

The soil placed behind the retaining wall up to grade consisted of silty sand compacted to 95 percent of the standard Proctor density (ASTM D698). Direct shear testing of the material indicated an internal friction angle of 34 degrees. All compaction testing and shear testing were performed by Braun Intertec.

FIGURE 2 – TEST SETUP

TESTING PROCEDURE

Upon completion of the retaining wall, lateral loads were applied using a hydraulic jack and deflection measurements were monitored at the face of the retaining wall.

CONCENTRATED LOADS

Figure 3 illustrates the general testing set-up. The following is a summary of the testing procedure:

1. A horizontal load was applied to the fence post at 42 inches above grade using a hydraulic jack equipped with a load cell. The load data was transferred to a readout station.
2. Displacement or movement of the retaining wall was measured at the top of the upper block. A maximum value of 0.5 inches of wall deflection was used as failure criteria.
3. Measurement of loads and corresponding displacements were obtained at regular intervals. Both displacement and load application were discontinued once the system could no longer provide resistance to the applied load or where the available resistance of the system exceeded our ability to push the system to failure.
4. The various codes require the system to resist the load in any direction, so concentrated loads were also applied parallel to the system in addition to towards the soil side of the retaining wall.

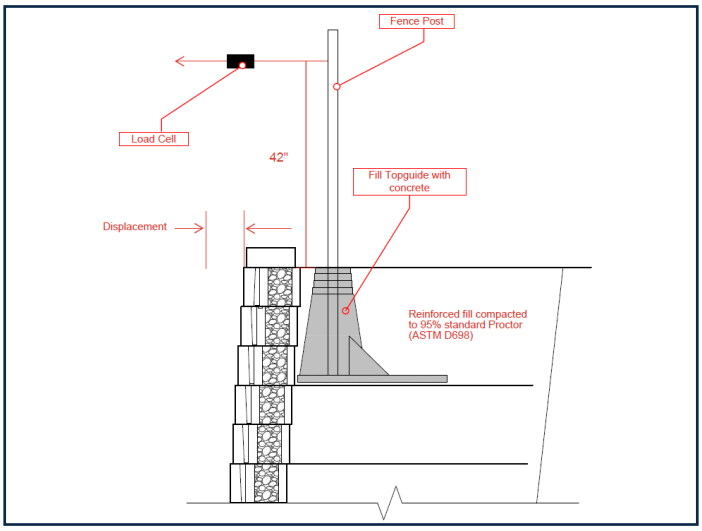

FIGURE 3 – TEST SET-UP

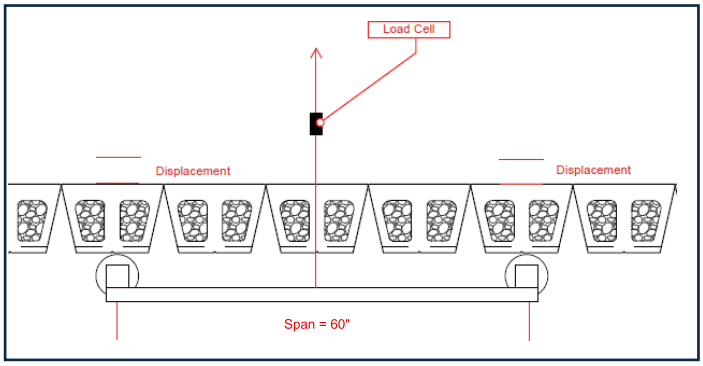

FIGURE 4 – TEST SET-UP

UNIFORM LOADS

Figure 4 illustrates the general testing set-up the uniform load testing. The following is a summary of the testing procedure:

1. A horizontal load was applied to the midpoint of the span between two fence posts at 42 inches above grade using a hydraulic jack equipped with a load cell. The load data was transferred to a readout station.
2. Displacement or movement of the retaining wall was measured at the top of the upper block directly in front of each post. A maximum value of 0.5 inches of wall deflection was used as failure criteria.
3. Measurement of loads and corresponding displacements were obtained at regular intervals. Both displacement and load application were discontinued once the system could no longer provide resistance to the applied load or where the available resistance exceeded our ability to push the system to failure.
4. The various codes require the system to resist the load in any direction, so the load was also applied towards the soil side of the retaining wall.

The results of the testing program are presented in the following graphs (Figures 5 and 6)

CONCENTRATED LOADS

The graph below (Figure 5) shows the load versus displacement curves generated for concentrated loads applied to the post at 42 inches above grade. Testing was performed in three directions, towards the drop, into the soil (away from the drop), and parallel to the wall. The curve for the load applied towards the drop or outward from the wall face is clearly the critical direction. The testing was terminated once the system could no longer provide resistance or prior to failure, once we reached the limitation of the testing equipment. The results for the load applications into the soil and parallel to the wall were what we expected given that to fail the system, the test would need to fully mobilize the soil's passive earth pressure.

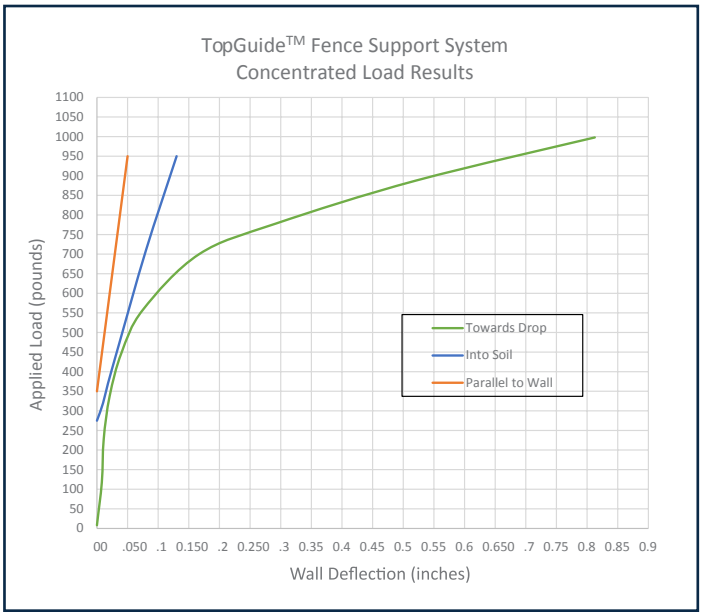

FIGURE 5 – CONCENTRATED LOADS

SPAN LOADING (5 – FOOT POST SPACING)

The graph below (Figure 6) shows the load versus displacement curve generated for the rail or uniform loading condition. Testing was performed in two directions, towards the drop and away from the drop. The curve for the load applied towards the drop or outward from the wall face is clearly the critical direction. The testing was terminated once the system could no longer provide resistance or prior to failure once we reached the limitation of the testing equipment. The results for the load applications into the soil were what we expected given that to fail the system, the test would need to fully mobilize the soil's passive earth pressure.

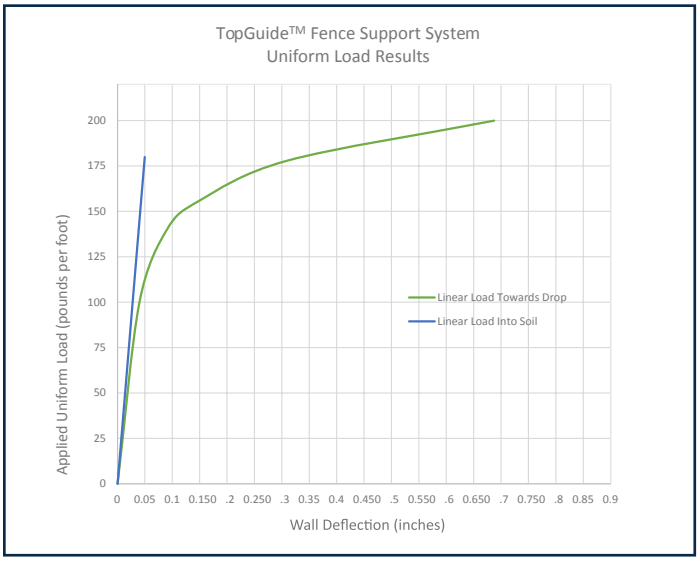

FIGURE 6 – UNIFORM APPLIED LOAD

TESTING CONCLUSIONS

The results of the TopGuide testing program are summarized in the graph below (Figure 7). The TopGuide System provides a handrail solution for retaining walls meeting the referenced code requirements while providing factors of safety well above code requirements with minimal wall displacement. We have also included the minimum code requirements in the curve below. Deflections at the required loads are well under 0.02 inches, with wall deflections under 0.1 inches at a factor or safety 3.0.

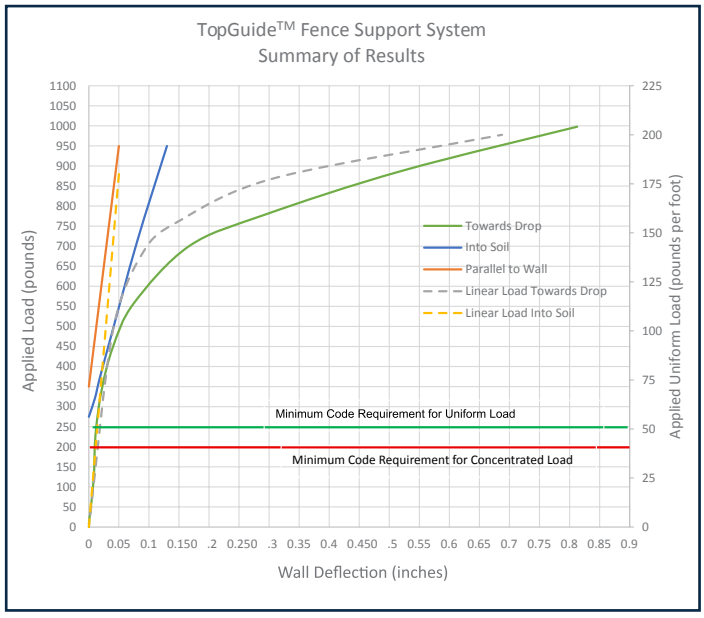

FIGURE 7 – SUMMARY OF TESTING RESULTS

REFERENCES

International Building Code (IBC) – 2024

- IBC 1015.2
- IBC 1607.9

ASCE 7-22 Minimum Design Loads and Associated Criteria for Buildings and Other Structures

- Section 4.5
- Section 4.5.1.1

National Building Code of Canada (NBC) – 2020

- NBC Division B Section 4.1.5.14.

Braun Intertec Project B2410568 (11/21/24) – Design Testing, Oldcastle Fence System