

# SLEEVE-IT<sup>®</sup> SD1

## Technical Summary



## INTRODUCTION

Sleeve-It®SD-1 is a pre-engineered fence post anchoring solution for enhancing below-grade foundational stability in fences placed on top of a segmental retaining wall (SRW). Sleeve-It's patent-pending design allows stable fence footings to be integrated into the support structure of the SRW while it is being constructed. Because of its cantilevered form and other properties, using Sleeve-It during the SRW build permits a code-compliant fence to be constructed eliminating the 36" offset requirements of IBC 1015.2.

Code as defined for the purposes of this document refers to IBC 1015.2, IBC 1607.9.1, and ASCE 7 4.5.1.

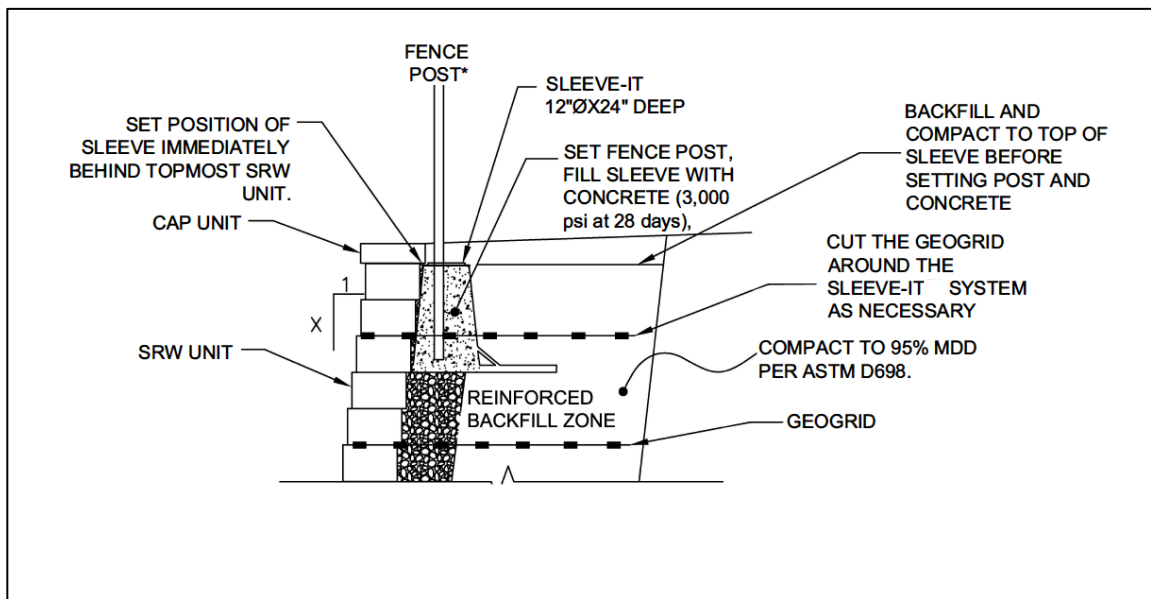


Figure No. 1: Detail of Fence Post Installation Using Sleeve-It SD1

# CODE REQUIREMENTS

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## IBC 2021 Load Requirements

### *Load Bearing*

IBC 2021 references load requirements in several sections. The following sections relate directly to bearing on handrails and guards:

- **Guards – 1015.2** – Guards shall be located along open-sided walking surfaces, including mezzanines, equipment platforms, aisles, stairs, ramps and landings that are located more than 30 inches (762 mm) measure vertically to the floor or grade below any point within 36 inches (914 mm) horizontally to the edge of the open side. Guards shall be adequate in strength and attachment in accordance with Section 1607.9.
- **Live Loads – 1607.9.1** – Handrails and guards shall be designed to resist a linear load of 50 pounds per linear foot (plf) (0.73 kN/m) in accordance with Section 4.5.1.1 of ASCE 7. Glass handrail assemblies and guards shall comply with Section 2407.

### *Deflection*

Deflection for fence systems, although a common concern, is not usually defined in building codes. **IBC Section 1604.3** addresses the serviceability requirements of structural members in general.

## ASCE/SEI 7-16

### *Chapter 4: Live Loads*

#### **4.5.1 Loads on Handrail and Guardrail Systems:**

All handrail and guardrail systems shall be designed to resist a single concentrated load of 200 lb (0.89 kN) 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. Further, all handrail and guardrail systems shall be designed to resist a load of 50 lb/ft (pound-force per linear foot) (0.73 kN/m) applied in any direction along the handrail or top rail. This load need not be assumed to act concurrently with the load specified in the preceding paragraph, and this load need not be considered for the following occupancies:

1. one- and two-family dwellings, and
2. factory, industrial, and storage occupancies, in areas that are not accessible to the public and that serve an occupant load not greater than 50.

Intermediate rails (all those except the handrail or top rail) and panel fillers shall be designed to withstand a horizontally applied normal load of 50 lb (0.22 kN) on an area not to exceed 12 in. by 12 in. (305 mm by 305 mm) including openings and space between rails and located so as to produce the maximum load effects. Reactions due to this loading are not required to be superimposed with the loads specified in either preceding paragraph.

## TESTING OVERVIEW

The purpose of the load testing is to show that Sleeve-It meets and exceeds the relevant compliance standards required by IBC and that the new Sleeve-It design outperforms the old unit. All of the testing was performed by a retaining wall company and monitored by SGI Testing Services, LLC for the entirety of the testing process.

The Fence Post Anchoring System components:

- Fence post
- Concrete
- Sleeve-It SD1
- Soil
- Wall

### Testing Set-Up

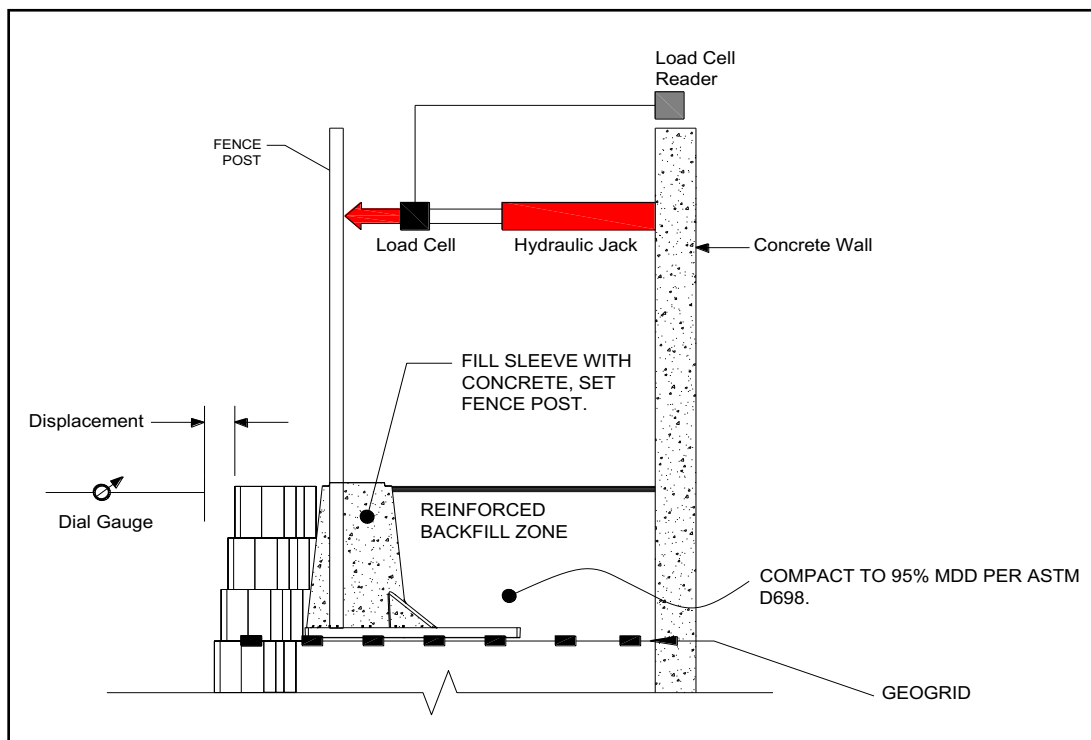


Figure No. 2: Testing Set-Up

## TESTING PROCEDURE

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### **Concentrated Load**

Figure No. 2 illustrates the testing set-up. The following is a summary of the testing procedure performed:

1. Applied a horizontal force on the fence post by means of a hydraulic jack equipped with a load cell and corresponding readout apparatus. Resistance to the hydraulic jack was created by a concrete wall.
2. Displacement (deflection) of the modular block retaining wall was measured at the top of the upper block by means of a dial gauge.
3. Measurement of the displacement was taken at regular intervals of horizontal load application. Displacement measurement was discontinued (ie, end of test) when the horizontal load could no longer be sustained.

### **Span Loading (5-ft Spacing)**

1. Applied a horizontal force at the midpoint of two fence posts by means of a hydraulic jack equipped with a load cell and corresponding readout apparatus. In this case, the fence posts were 5 feet apart. Resistance to the hydraulic jack was created by a concrete wall.
2. Displacement (deflection) of the modular block retaining wall was measured at the top of the upper block by means of a dial gauge.
3. Measurement of the displacement was taken at regular intervals of horizontal load application. Displacement measurement was discontinued (ie, end of test) when the horizontal load could no longer be sustained.

### **Fence Post Foundation Systems**

For the purposes of this testing, the following fence post foundation systems were used. These are:

1. Sleeve-It® SD1 Fence Post Foundation System, and
2. Sleeve-It® 1224R Fence Post Foundation System.

Both systems were placed directly behind the modular block retaining wall and founded within the reinforced soil zone at a depth of approximately 2 feet. The reinforced backfill is a soil which is commonly found in many areas of United States. It is a silty sand with fines (<No. 200 sieve) content of approximately 35% and is non-plastic. It was compacted in place to at least 95% of its Standard Proctor Dry Density (ASTM D698).

Soils commonly used for reinforced backfill in the construction of modular block retaining walls were used.

## TESTING RESULTS

The results of the testing program are presented on the graphs on Figure No. 3 and Figure No. 4.

### Sleeve-It® SD1

The graph on Figure No. 3 illustrates the load-displacement behavior of the new Sleeve-It®. The displacement of the modular block retaining wall increases as the horizontal load increases. Also indicated on the graph is the displacement of the retaining wall at the IBC load requirement (200 lbs). The displacement measured at this load is less than 0.1 inch. Also shown is the displacement (<0.3 inch) at 400 lbs horizontal load. Under the testing conditions, this load level is significant because it corresponds to a Factor of Safety (FoS) of 2. FoS is a term describing the load carrying capacity of a system beyond the expected or actual loads. Most civil engineering structures require safety factors to ensure confidence that the structure will behave better than intended.

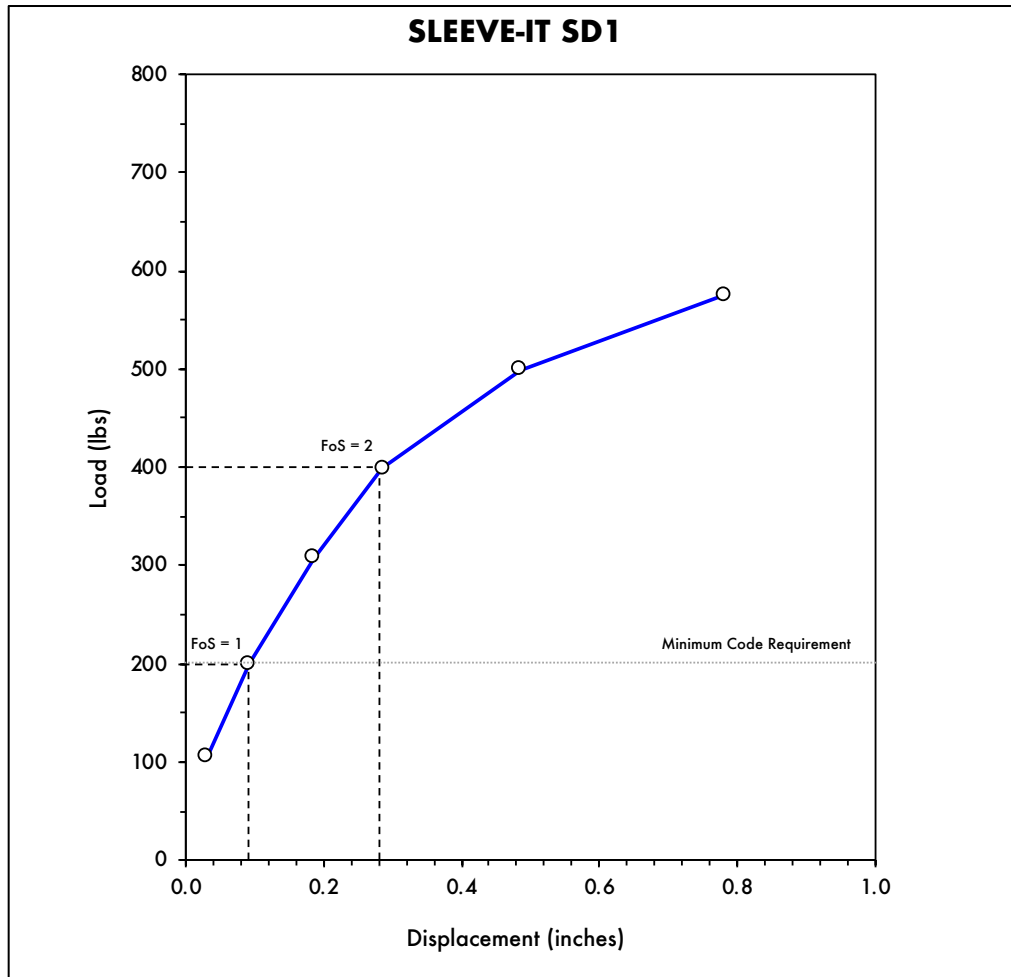


Figure No. 3: Load - Displacement Curve for Sleeve-It

## TESTING RESULTS

### Original Sleeve-It®

The graph on Figure No. 4 illustrates the load-displacement behavior of the original Sleeve-It®. As expected, the displacement of the modular block retaining wall increases as the horizontal load increases. Also indicated on the graph is the displacement of the retaining wall at the IBC load requirement (200 lbs). The displacement measured at this load is 0.12 inch. Also shown is the displacement (<0.4 inch) at 400 lbs horizontal load.

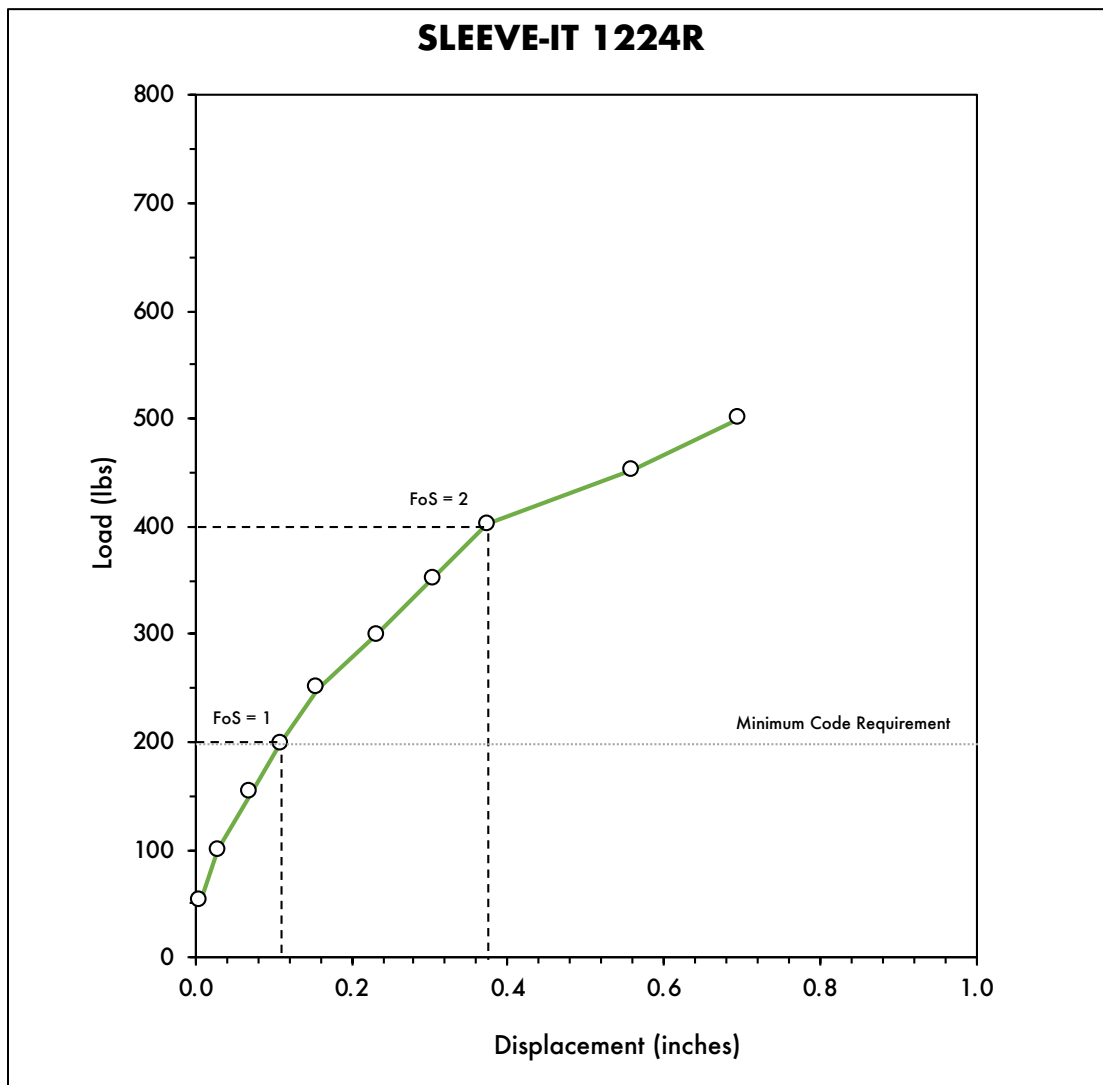


Figure No. 4: Load – Displacement Curve for Sleeve-It 1224R

## TESTING RESULTS

### Span Loading (5-ft Spacing)

The code requires that the posts be able to withstand a load of 50 lbs/lin ft. A horizontal force at the midpoint of two fence posts was applied. In this case, the fence posts were 5 feet apart. The results of this test are presented in Figure No. 5. Clearly, Sleeve-It SD1 complied with the code requirements. For a FoS = 2, the displacement is well under 0.25 inch.

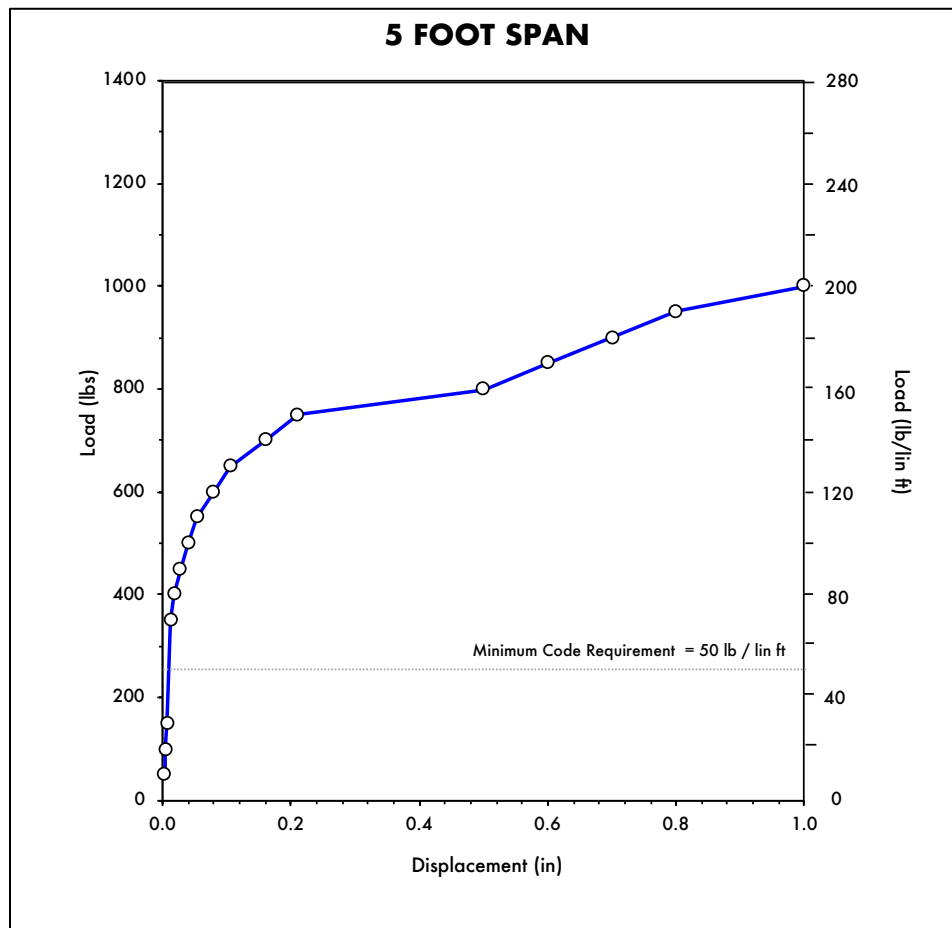


Figure No. 5: Load – 5 Foot Span



## TESTING CONCLUSIONS

The results of the Fence Post Foundation Systems testing program is summarized on the graph on Figure No. 6. The conclusions drawn from the testing are as follows:

1. Both the Sleeve-It SD1 and Sleeve-It 1224R Fence Post Foundation Systems meet the requirements of the Code.
2. Sleeve-It SD1 Fence Post Foundation System out-performed Sleeve-It 1224R.

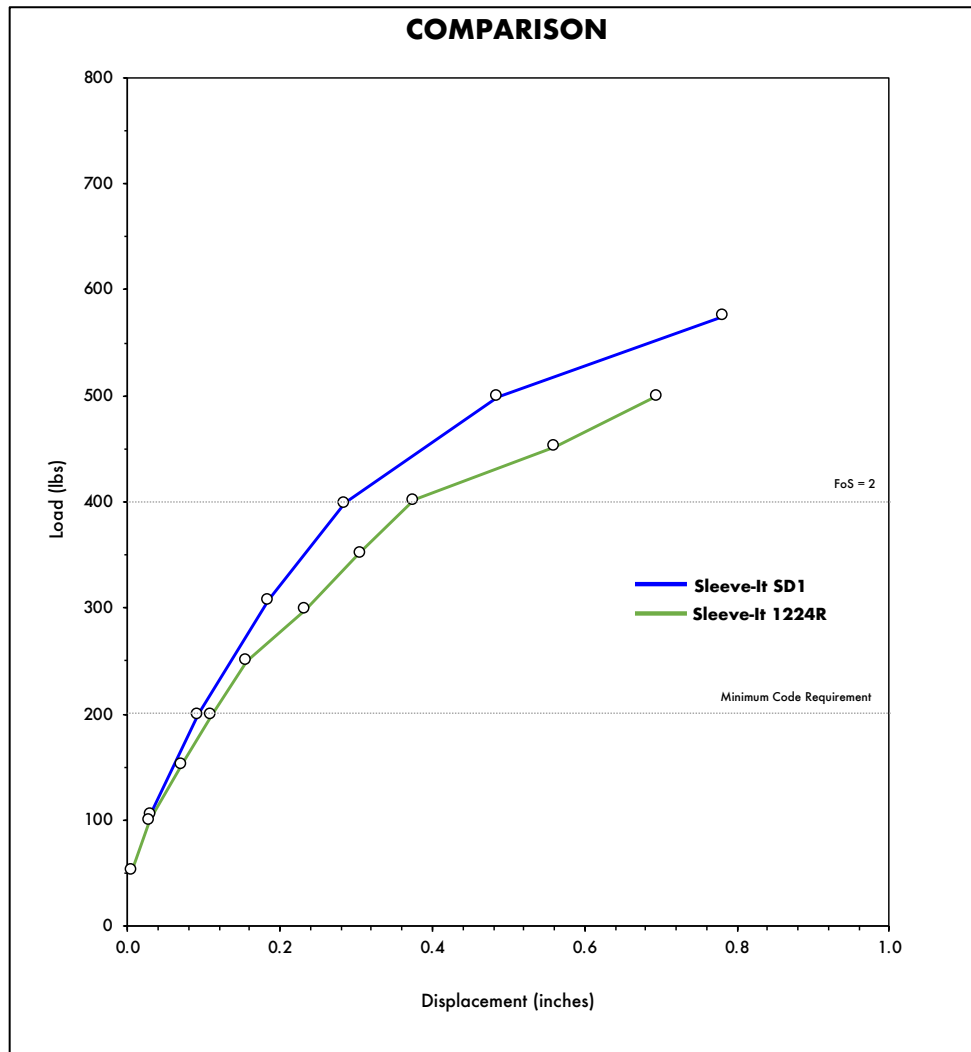


Figure No. 6: Load - Comparison

# ADDENDUM

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## Introduction

As a follow-up to the Sleeve-It® testing summarized in the preceding Technical Summary, Strata Systems, Inc. conducted a comparative testing with one of the most basic fence post installation systems – a concrete-filled 6-inch cardboard tube placed up to 6 inches behind the wall facing with a layer of geogrid reinforcement. The results and analysis of this testing, described in the following Addendum, demonstrate how Sleeve-It SD1 outperforms this basic system. All of the testing was performed by an independent, third-party retaining wall contractor and monitored by SGI Testing Services, LLC for the entirety of the testing process.

## Testing Set-Up

Additional testing was carried out on a standard 2-inch fence post with 6-inch diameter cardboard tubing foundation located directly behind the modular block retaining wall and 6 inches behind the modular block retaining wall. The cardboard tubing was placed 24 inches below the surface and filled with concrete. A layer of geogrid reinforcement was also placed at a depth of 12-inches below the surface. Soil parameters and installation conditions were virtually identical to previous testing.

For the purposes of this testing, the Basic Fence Post Anchoring System was comprised of the following components:

- Fence post
- Concrete
- 6-in Cardboard Tube
- Soil
- Wall

## Testing Procedure – Concentrated Load

Figure No. 7 illustrates the testing set-up. The following is a summary of the testing procedure performed:

1. Applied a horizontal force on the fence post by means of a hydraulic jack equipped with a load cell and corresponding readout apparatus. Resistance to the hydraulic jack was created by a concrete wall.
2. Displacement (deflection) of the modular block retaining wall was measured at the top of the upper block by means of a dial gauge.
3. Measurement of the displacement was taken at regular intervals of horizontal load application. Displacement measurement was discontinued (i.e., end of test) when the horizontal load could no longer be sustained.

## ADDENDUM

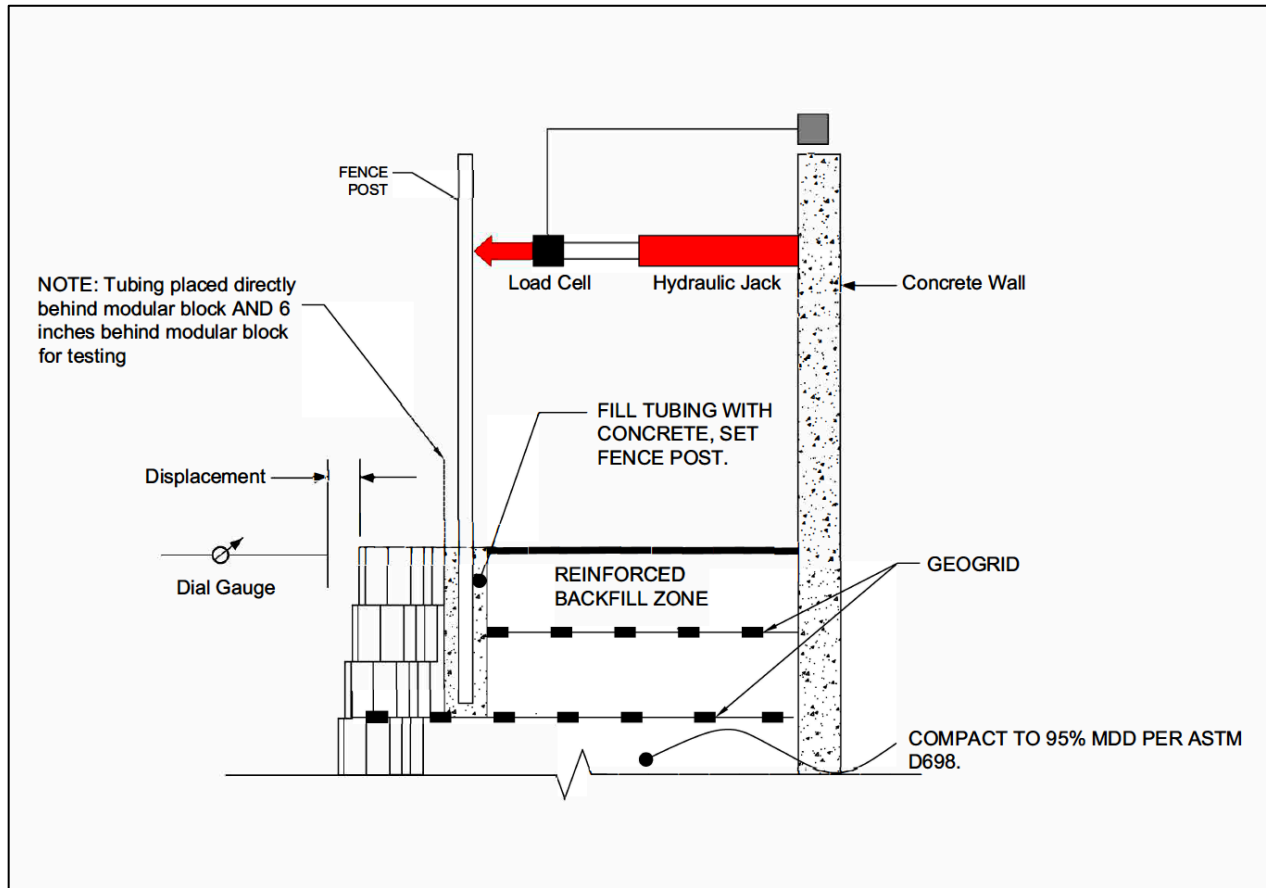


Figure No. 7: Testing Set-Up – Cardboard Tube

## ADDENDUM

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### Results

Initially, both the horizontal load and the displacement of the modular block retaining wall increased. However, at a load of 100 lbs, the deflection of the cardboard tube increased without any increase in horizontal load. The results demonstrate that the fence post did not sustain a load greater than 100 lbs. The results of the testing are presented on Figure No. 8.

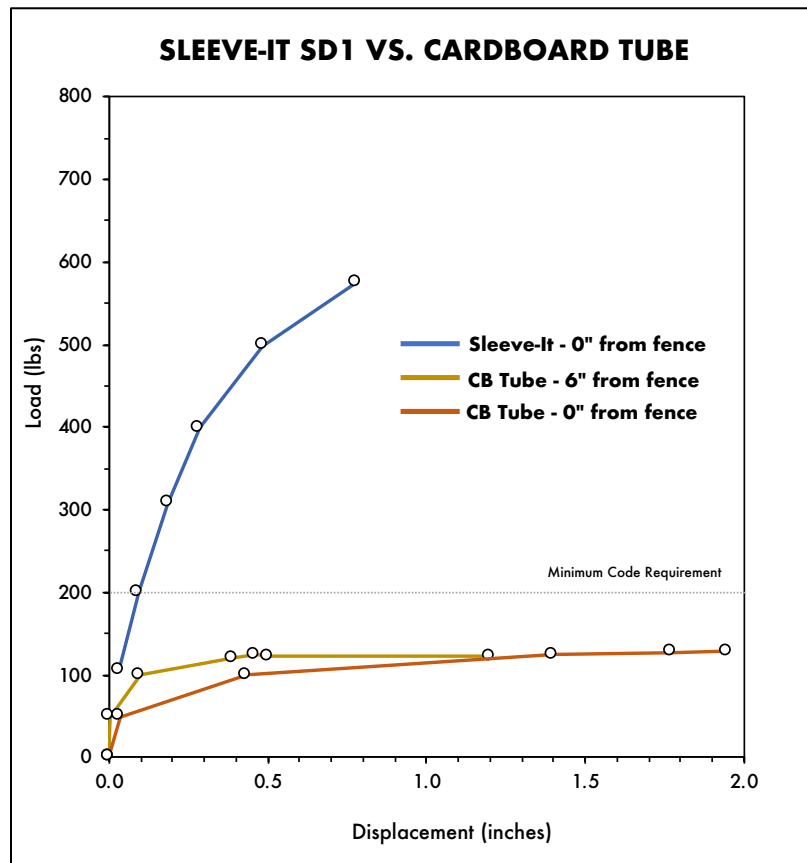


Figure No. 8: Displacement Curve Comparison for Cardboard Tube

## ADDENDUM

### Conclusion

The 6-inch diameter concrete-filled cardboard tube fencing foundation system did not meet the Code. The specified 200-lb concentrated load was not achieved, even with a geogrid reinforcement element included at a depth of 12 inches. Figure No. 9 shows the comparison to Sleeve-It SD1 and the cardboard tube fencing foundation. The results indicate that the performance of Sleeve-It SD1 is superior to that of the cardboard tube in terms of the concentrated load.

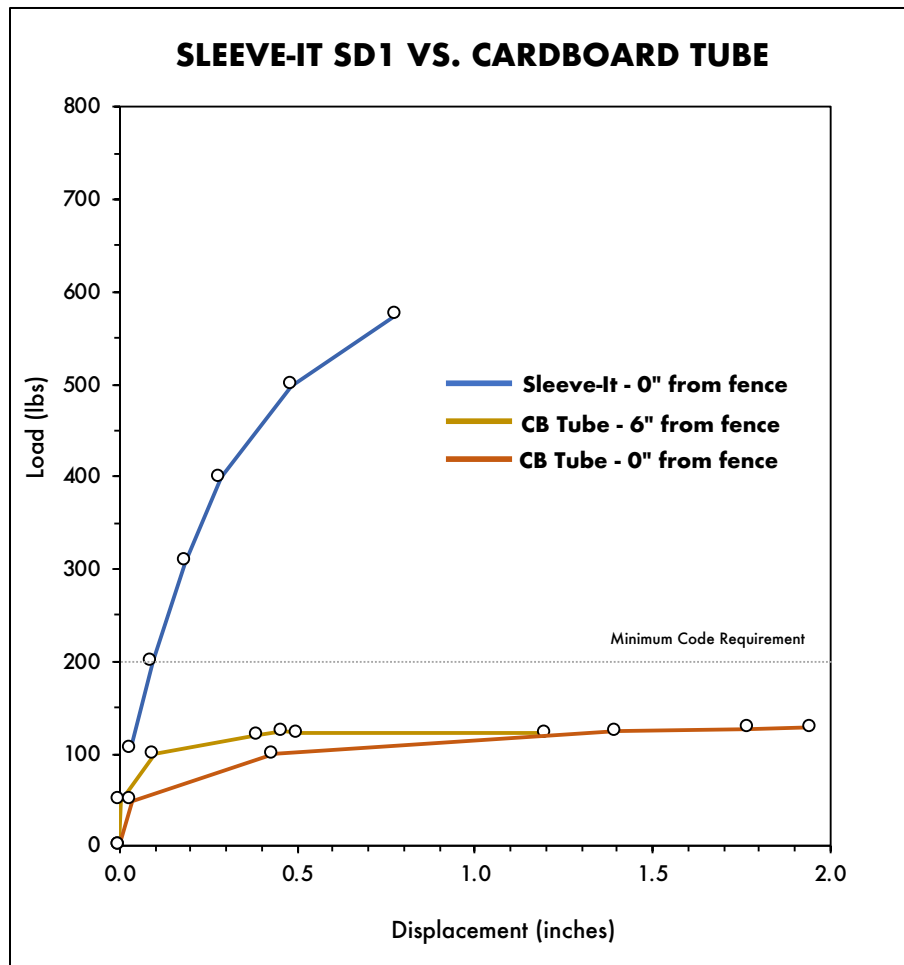


Figure No. 9: Displacement Curve Comparison for Sleeve-It SD1 vs. Cardboard Tubes

## REFERENCES

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