



September 15, 2021

Re: 123 Main Street, Anytown, PA

To whom it may concern:

PRELIMINARY INFORMATION

Identification of right, left, front, and back in this report is based on the view from the street, facing the house.

On September 14, 2021, Three Rivers assessed the structural soundness of the back foundation wall at the subject property.

DISCUSSION – DESCRIPTION OF FOUNDATION WALL

The back foundation wall, which spans the entire width of the house through the garage, laundry room, bathroom, and basement family room, has been displaced inwardly by the force of the ground being retained by this wall.

The back wall has displaced inwardly in both a tilting manner (that is, primarily remaining straight but rotating inward as though pivoting about a hinge at the basement floor level) and a bowing manner (that is, bulging inward relative to a straight line, whether tilted or vertical).

As measured at the middle of the garage wall's width, the wall was found to have tilted by $1 \frac{1}{4}$ inch, and the wall was found to have bowed inward by $1 \frac{7}{8}$ inch.

Three Rivers Inspection & Engineering, Inc.
4885-A McKnight Road #292, Pittsburgh, PA 15237
Phone (412) 331-5665 Fax (412) 353-0618
www.threeriversinspection.com



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DISCUSSION – TILTING

Inward displacement in a tilting manner causes the top edge of the back foundation wall to laterally shift toward the front. This top edge shifting starts to displace the house structure. As the house structure is pushed, the house structure pushes back with greater force, acting as a spring.

It is common to have the house structure's resistive force rise to equal the force attempting to displace the foundation wall. In that case, the foundation wall stops tilting to any significant extent.

In this case, however, especially in the garage area, the house structure has limited strength to resist the forces acting to tilt the wall. The house's strength is limited in this regard because of the large cut out in the house front wall (the garage door opening) and the walkout nature of the garage to the driveway (without ground outside of the opposite foundation wall to help resist the force acting from the other side of the house).

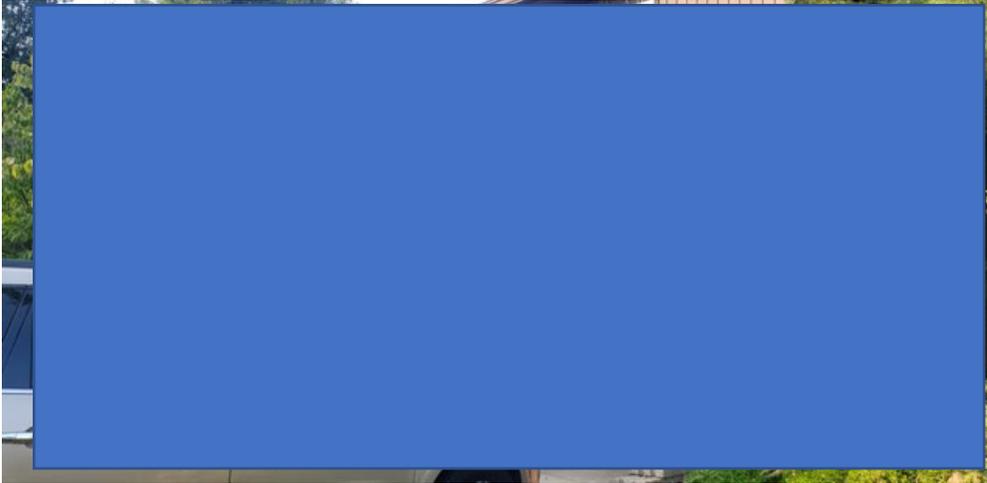


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DISCUSSION – BOWING

The capability of the foundation wall to resist further bowing is reduced as the wall bows further. In combination with an extent of force that is relatively constant over time, this reduction in strength is a primary reason why the wall can be expected to continue to displace in a bowing manner, at least, unless appropriate remedial actions are taken.

DISCUSSION – SOUNDNESS OF WALL AND GENERAL CONCLUSIONS

This wall is continuing to act as a retaining wall, and it is continuing to help support the weight of the structure above. However, the bowing and, likely, the tilting components of the back foundation wall displacement can be expected to continue unless at least one of two changes occur:

The force acting to displace the wall is significantly and verifiably reduced.

The wall is reinforced in some manner to allow it to resist further movement.

Efforts to prevent further displacement by reducing the force acting on the wall have uncertain effectiveness unless the extent to which the force has been reduced can be quantified. The most common approach to reducing the force acting on a wall is to install an exterior french drain at the footing elevation. However, the extent to which a french drain actually reduces the force on the wall cannot be readily predicted. Significantly reducing the height of the ground acting on the wall by radical regrading would verifiably reduce the force acting on the wall. Radical regrading of this type is not practical.

Therefore, to prevent further displacement of the back foundation wall, it will be necessary to reinforce the wall.

RECOMMENDATIONS

Properly reinforcing the wall will prevent further displacement (both bowing and tilting).

Wall reinforcement can be accomplished in several different manners, but wall anchors are the best approach when both bowing and tilting movements must be stopped.

A wall anchor stabilizes the wall by connecting a steel washer on the inside face of the wall to a non-moving anchor installed below ground at least 8 to 10 feet out from the wall. A steel rod connects the washer on the inside surface of the wall to the exterior anchor point.

The entire back foundation wall will have to be reinforced, even though the only section of wall that was exposed to direct measurement was in the garage. Evidence of inward foundation wall displacement was found at the wall sections to the left of the garage:

The door into the bathroom couldn't be closed because the inward displacement of the foundation wall narrowed the door opening width.

The drywall on the left wall in the bathroom developed a horizontal split in response to inward foundation wall displacement in that area.



The paneling installed on the back foundation wall in the family room has split at the top edge.

Have a qualified wall anchor installation contractor in to install eight wall anchors across the entire width of the house back foundation wall.

Properly installed wall anchors can be expected to resist further wall displacement and may, over the long term, be used to shift the wall back closer to its original configuration.

It is recommended that an estimate for this work be obtained from a qualified contractor. Have the contractor confirm that eight wall anchors is the correct quantity to allow the contractor to offer a long-term warranty.

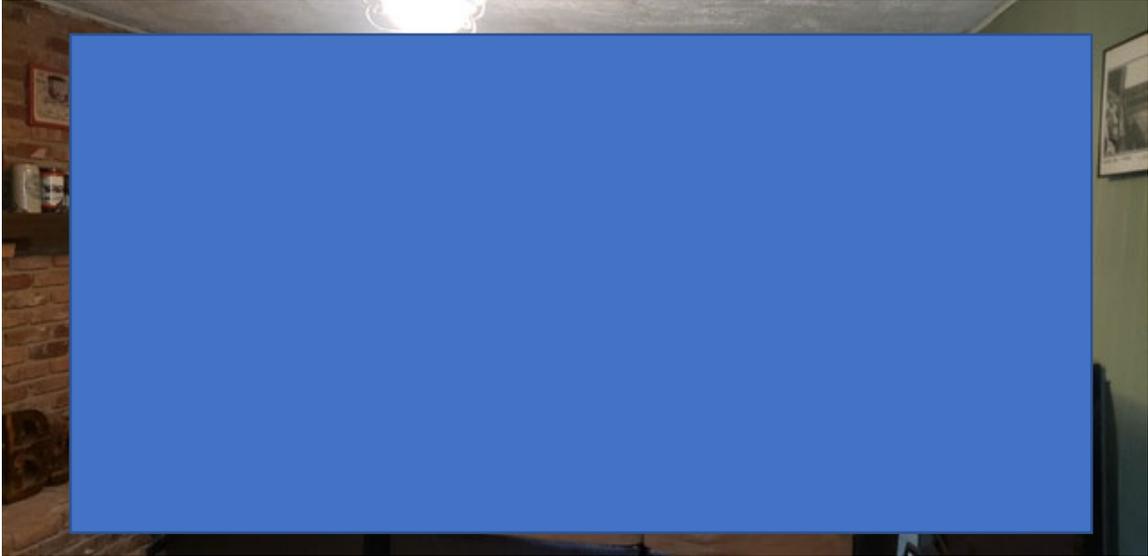
NOTES

For budgeting purposes, expect the cost to have eight wall anchors installed to be on the order of \$5000 to \$6000. Additional costs will be incurred to replace the paneling on the family room back wall and to patch the holes cut in the laundry room and bathroom drywall.

The anchors installed on the left half of the house will have to have extension rods to clear the deck structure.



Note that the paneling on the back wall of the basement family room will have to be removed to facilitate the installation of the wall anchors. In addition, it will be necessary to cut openings in the drywall on the back walls of the laundry room and basement bathroom to facilitate the installation of the wall anchors.



Other reinforcement methods often specified are not appropriate in this case. For instance, the installation of carbon fiber strips was considered. A carbon fiber strip is adhered to the wall with epoxy. The wall cannot bow to any additional extent because the bowing requires the wall vertical length to increase; and because the carbon fiber material is quite resistant to stretching. Installation of carbon fiber strips is not appropriate because the carbon fiber strips prevent further bowing but do not act against tilting. In fact, the portion of the total force acting by the ground outside the back foundation wall that was previously active in creating additional bowing could be transferred to create an even larger tilting force.

The same advice applies to the process of installing rebar through the vertical cavities within the concrete blocks (and then grouting those cavities).

Please feel free to call with any questions or for further information.

Sincerely,

Russell J. Kowalik
PA Professional Engineering Certificate PE-034754-E
President, Three Rivers Inspection & Engineering, Inc.

