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September 13, 2006
GDS Job No. 010-06-129

Arbor Gardner
[redacted]
Sandy, Utah 84070

Attention: Mr. Mike Maddox

Re: Geotechnical Review of Keystone Retaining Wall
Jordan Creek Drive at Riverwalk Subdivision
South Jordan, Utah

Gentlemen:

Introduction

In accordance with your request, GDS has reviewed the completed Keystone Retaining Wall for the above referenced project. This letter summarizes the results of our review and our opinions concerning the condition and expected performance of this wall.

Information provided for this review by Arbor Gardner included the following documents:

1. Geotechnical Investigation, The Village At River Walk Development, Approximately 700 West 10200 South, South Jordan, Utah, Prepared for Arbor Commercial/Residential, 45 West 10000 South, Suite 301, Sandy, Utah 84070, AGEC Project No. 1040659, August 24, 2004.

2. Site Geotechnical Investigation, Jordan River Drive, South Jordan, UT, prepared for South Jordan City, c/o Jeremy Nielson, 1600 West Towne Center Drive, South Jordan, Ut 84095, by IGES Inc., 4153 South Commerce Drive, Salt Lake City, Utah 84107, September 24, 2004.

3. Geotechnical Consultation, MSE Retaining Walls, The Village at Riverwalk, Approximately 10200 South 700 West, South Jordan, Utah, AGEC Project No. 1050873, dated September 9, 2005.

4. Daily Reports of Observations, Special Inspection and Testing, with accompanying Fill Observation and Testing Reports, dated 8/29/2005 to 10/31/2005, by AGEC, East Sandy Parkway, Sandy, Ut. 84070.

5. Construction Observations, Keystone Retaining Wall, Jordan River Drive near Mulligan's Golf Course, South Jordan, Utah, for Arbor Homes, 45 West 10000 South, Suite 301, Sandy, Utah 84070, by IGES Inc., 4153 South Commerce Drive, Salt Lake City, Utah 84107, February 28, 2006.

6. Printouts of digital photos presenting different stages of the construction of the modular block retaining wall supporting Jordan River Drive.

7. Invoice Nos. 615398, 624480, 624481, 624482, 620284, 620283, and 620287 from Geneva Rock Products, for 1 1/2-inch minus rock, 3/4-minus rock, 3-inch minus fill, 3/4-inch UDOT road base materials delivered to the project site between September 7, 2005 and September 30, 2005.

Situation

Arbor Homes began development of the Riverwalk project in 2005 (see Reference 1, above). As part of this construction, it was necessary to build a road into this area from 106th South. This access road (Jordan Creek Drive) included the construction of a Keystone Retaining Wall for support of a portion of the road. This wall had been previously designed for this road alignment by IGES for City of South Jordan, as outlined in Reference No. 2, above.

During the construction of this road, some trash fill materials were encountered in the foundation of wall near the maximum section. These materials were over-excavated and replaced and the wall completed over the top of this zone. Subsequent to the wall construction, utilities, including storm drains were installed in the roadway. Quality assurance testing of the wall is presented in Reference 4, above.

In October of 2005, the original wall designers, IGES, were requested to observe the wall, so that a report could be provided to South Jordan City regarding the wall construction and compliance with project requirements. As discussed in their letter (see Reference 5 noted above), IGES has noted some concerns with the wall construction, which are outlined as follows:

1. The total constructed height of the maximum section of the wall ended up being 19.5 feet instead of the originally designed 15.33 feet. The total exposed height of the completed wall after construction was subsequently identified as 15.33 feet, due to some fill placement at the toe.

2. The actual depth of the over-excavation beneath the wall could not be verified for record purposes.

3. The placement of additional backfill may increase consolidation and/or affect stability of the wall.

4. Spaces between the geogrid panels on the order of three to six inches (shown in photographs) are apparent as well as wider spacing between panels diverging along inside radius curves. IGES noted that this implies under-reinforcement in these areas.

5. The retaining wall was not constructed with the recommended face batter of 7.1 degrees. This may result in a visual affect of the wall tipping forward, should any additional settlement occur.

6. Utility placement in February of 2006 was conducted, which included placement of two storm drain catch basins and a collector pipe near the maximum wall section. The top layers of geogrid placed at these locations were to have been 26 feet long, but were cut in the process of excavation to a length of 10 feet from the wall face.

7. Rutting in the road during February by construction equipment exposed the top layer of geogrid at some locations, raising the question of potential geogrid damage.

8. IGES stated that pertinent quality assurance reports outline fill placement conditions and depth of over-excavation was promised but not provided to them.

Based upon the many questions which these observations raised, IGES alleged that the wall as constructed is different from their original design. IGES stated that it is not possible for them to determine whether the wall as constructed will meet current minimum factors of safety or perform to the intent of their design.

Subsequent to the IGES letter, Arbor Homes requested that Geotechnical Design Services Inc. (GDS) review the project data and the condition of the wall with the intent of determining if the wall would meet industry standard factors of safety and perform satisfactorily. GDS was provided with the documents outlined above and requested to observe the completed wall.

Geotechnical Design Services observed the conditions at the wall on or about March 15, 2006. At this time, it was observed that the wall face disclosed no significant distortions indicative of either differential settlement or pullout or internal failure. No cracking was observed behind the wall face. In general, the wall appeared to be performing in accordance with the project intent. The wall had by this time been completed for about four months.

Analysis of Retaining Wall

A review of the planned cross-section of the wall indicates that the minimum UX1400SB mat lengths of 10.5 feet at the base of the cross-section and the maximum lengths of 26 feet at the top are more than sufficient to maintain a cross-section height of 15.33 feet. As an example, a simple "KEYWALL" analysis (KeyStone Retaining Wall Wall Systems, Ver 1a, July, 1997, design software) requires only a 9.5 foot mat for a 15 foot wall and an 11.5 foot mat for an 18 foot wall. The inclusion of longer mats at the top allows the grid to more uniformly reinforce the base of the roadway, as well.

Further, typical walls designed for variable base applications (usually done with shorter mats on the bottom and longer mats for the top one-third to one-half of the cross-section) usually allow the base to be shortened up to 40% of the height (as low as 7 feet in this case). This is done only if the top segment is lengthened to 80 to 100 percent of the height (as long as 15 feet, in this instance).

By either criteria, the final wall cross-section appears to be adequate for mat length, even in the case of the storm drain catch basins. At these locations, mats were cut to ten feet long behind the block face. Because this only occurs in a short segment (roughly six feet), it is not expected that mats slightly shorter than required would initiate pullout. This is partly because of the buttressing provided by deeper wall segments on either side as well as the fact that the storm drain structure partially relieves the lateral pressure against the back of the wall.

As significant as the mat lengths is the material placement. Typical granular material appears to have been imported and placed to relatively high, in-place densities, according to the AGEC records made available to GDS (see Reference No.4, above). The test results appear to have been consistent with good practice throughout. No notes were presented that indicated the wall contractor was having difficulty with the materials on site.

Concerns about the small spacings between geogrid panels are also probably not an issue. The IGES design report (Reference No. 2) specifically allows for adjacent panels to have no panels added for mats on inside curves, as long as the interior angle between the mats does not exceed 20 degrees. In no case on this wall do any inside curves begin to approach this condition, therefore the inside curves on this project are not, by definition, required to have additional mats placed. As for the 3- to 6-inch spacing present along straight portions of the wall, there is sufficient redundancy in the system and arching between the mats so as to more than bridge this gap and provide uniform support to the wall. It has been our experience on a large number of projects that this type of construction joint is very common and we have not observed any deviant wall behavior that could be attributed to such a gap in the reinforcing.

The wall face was constructed with the nominal batter of 3.1 degrees. It is our opinion that this will have no affect on the serviceability of the wall. It may be that some settlement will occur to plumb up the face; this is entirely a perception and facade issue and will not affect the wall serviceability, regardless, unless so much settlement occurs as to begin toppling of the face block. In that case, it is unlikely that the deviation in the angle as designed and the angle used in the field will make any difference in the end.

The over-excavation at the base of the maximum section was not plotted or carefully surveyed out during the process of fill placement. This is not an uncommon procedure. Typically the contractor is required by the geotechnical engineer to remove all deleterious material to a depth of at least four feet (see Reference No. 3) below pavement areas, but this is done on-site, as it is encountered. Fill Observation and Testing Records indicate that material was removed and replaced to a depth of as much as 12 feet in the area between Stations 21+00 to 24+50. Replacement fill was adequately compacted to support the retaining wall. Photographs and material quantities trucked to the site indicate a substantial effort was performed (see Reference Nos. 5, 6, and 7, above).

Potential geogrid damage during rutting, while possible, is usually not significant. Geogrids placed at the top are under the least stress of all the layers, and consequently have the most reserve strength. It is not expected that sufficient damage would be likely as to impact the wall performance.

Finally, while some added consolidation settlement may occur due to the increased overall section height, it should be recognized that the driving force in consolidation is the net change in load. The additional weight adds only a small percentage and is not likely to make much difference in the total settlement.

All of these considerations and observations are made from the standpoint of overall serviceability and wall suitability. It was not possible for GDS to observe any portion of the wall cross-section during construction, and so our conclusions are subject to some qualification. Some localized anomalies are expected. In such instances, each problem must be dealt with as they occur, and considered as a separate, on-going maintenance issue. Reinforced soil is, in general, a very resilient and versatile technique, and it is expected that many, if not most of any internal deficiencies which may be present, will be absorbed by the performance of the wall in its entirety.

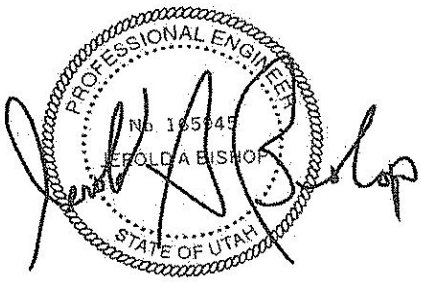
In general, however, based solely on the information available, it is our opinion that the Keystone Retaining Wall constructed for support of Jordan Creek Drive meets or exceeds current industry standards and will perform to the intent of the design.

Should conditions change, or additional information become available, GDS should be informed, so that our conclusions can be revised, if necessary. No warranties are expressed or implied, only that this analysis and accompanying observations and conclusions were made consistent with engineering standards at this time.

Arbor Gardner
GDS Job No. 010–6-129
September 13, 2006

This concludes our assessment of the modular block wall constructed for support of Jordan Creek Drive. We appreciate the opportunity to be of service. If you have questions or desire additional information, please do not hesitate to call.

Respectfully Submitted,
GEOTECHNICAL DESIGN SERVICES, Inc.



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