

Project No. ANA19-039-00  
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211 Trade Center, Suite 300  
New Braunfels, TX 78130

P 830.214.0544  
F 830.214.0627  
TBPE Firm F-3257

John Tyler, P.E., RAS  
Pape-Dawson Engineers, Inc.  
2000 Northwest Loop 410  
San Antonio, Texas 78213

[WWW.RKCI.COM](http://WWW.RKCI.COM)

**RE: Retaining Wall Stability Analysis  
Klein Road Reconstruction – Phase II  
New Braunfels, Texas**

Dear Mr. Tyler:

RKCI has performed stability analyses to determine if acceptable factors of safety are available for rotational (global stability), sliding, and overturning stability and bearing capacity for the MSE walls in the vicinity of Borings B-101 and B-102. It is understood that the wall designers are responsible for the internal stability of the walls; therefore, internal stability checks were beyond the scope of our study.

Analyses have been performed for both the northeast and southwest “sides” of the wall. The southwest walls include Walls A, B, C, D, and E, and the northeast walls include Walls F, G, and H as shown in the Klein Road Phase 2 “Retaining Wall Plan & Profile” sheets.

The TxDOT Geotechnical Manual states that walls need to be designed such that they have a minimum factor of safety of 1.5 against sliding and 2.0 against overturning and for bearing capacity. In our analyses of sliding, overturning, and bearing capacity, the following wall properties were used:

Wall	Wall/Foundation Embedment Below Finished Grade (ft)	Strap Length*
SW Walls except Wall E	1	1.0*H
Wall E	1	16 ft
NE Walls except Wall F from STA 60+09 to 60+89.75	1	1.0*H
Wall F from STA 60+09 to 60+89.75	1	16 ft

\*H = total wall height, including embedded height

Additionally, MSE strap length of 8 ft or greater should be maintained for all walls.

Backfill Friction Angle (degrees)	Retained Soil Type	Retained Soil Friction Angle (degrees)	Retained Soil Cohesion (psf)	Foundation Soil Type	Foundation Soil Friction Angle (degrees)	Foundation Soil Cohesion (psf)
34	Item 423 Type DS Gravel	34	0	Native Clay	0 (U); 24.0 to 29.3 (D)	1,300 to 3,300 (U); 0 to 75 (D)

(U = undrained, D = drained analysis parameters)

Additionally, a traffic surcharge of 250 psf was utilized where applicable. Groundwater tables for flood conditions and top of wall elevations were based on a sheet titled "Klein Road Retaining Wall Plan and Profile", prepared by Pape-Dawson Engineers, dated January 9, 2020. The MSE wall was assumed to be backfilled with permeable Type DS select backfill.

Cross-sections were estimated based on the January 2020 Plan and Profile Sheets prepared by Pape-Dawson Engineers, assuming level soil in front of the wall.

**SLIDING, OVERTURNING, BEARING CAPACITY**

On the basis of our analyses, the retaining walls will have the following factors of safety against sliding and overturning:

Wall	Factor of Safety for Sliding	Factor of Safety for Overturning
SW Walls	2.7	6.7
NE Walls	2.4	6.6

The toe pressure and subsequent bearing factor of safety are summarized as follows:

Wall	Design Toe Pressure (psf)	Ultimate Bearing Pressure (psf)	Factor of Safety for Bearing
SW Walls	2,030	4,470	2.4
NE Walls	1,960	4,180	2.1

**ROTATIONAL (GLOBAL) STABILITY**

In addition to the above parameters, the external stability of the walls was analyzed for rotational stability. Thorough geotechnical evaluation of slope stability requires careful assessment of all the input parameters along with the selected method of analysis. While there are many different methods of stability analysis and numerous available computer programs, we have selected the program Slide 2018, ver. 8.011, a slope stability computer program developed by Rocscience. The Spencer method with a non-circular sliding surface was considered in the analysis. General consistency and density of the soil was obtained using the results of our laboratory testing.

The non-circular surface along which the calculated minimum factor of safety is obtained is considered the critical surface of failure. TxDOT recommends a minimum factor of safety of 1.3 for overall stability of retaining walls.

Each wall was analyzed for short term stability (undrained), long term stability (drained), and rapid drawdown conditions. The calculated factors of safety are summarized in the tables below. Critical slope stability curves with material and MSE strap parameters for each wall are provided in Figures 1 and 2.

Wall	Factor of Safety		
	Undrained Condition	Drained Condition	Rapid Drawdown Condition*
SW Walls except Wall E	> 3.0	1.5	1.3
Wall E	> 3.0	1.5	1.3
NE Walls except Wall F from STA 60+09 to 60+89.75	3.8	1.6	1.3
Wall F from STA 60+09 to 60+89.75	3.4	1.5	1.3

\*Drawdown of 3 ft in accordance with TxDOT Geotechnical Manual

These values meet or exceed the TxDOT recommended minimum factor of safety of 1.3 for overall stability of retaining walls assuming the minimum strap length to wall height ratios discussed previously are met. Typical base values for strap length are in the range 0.7\*H; however, in order to meet the Factor of Safety of 1.3 for the rapid drawdown condition, the strap lengths were increased to provide additional stability.

\* \* \* \* \*

We appreciate the opportunity to be of service on this project, please call or email if you have any questions.

Very truly yours,

**RABA KISTNER CONSULTANTS, INC.**

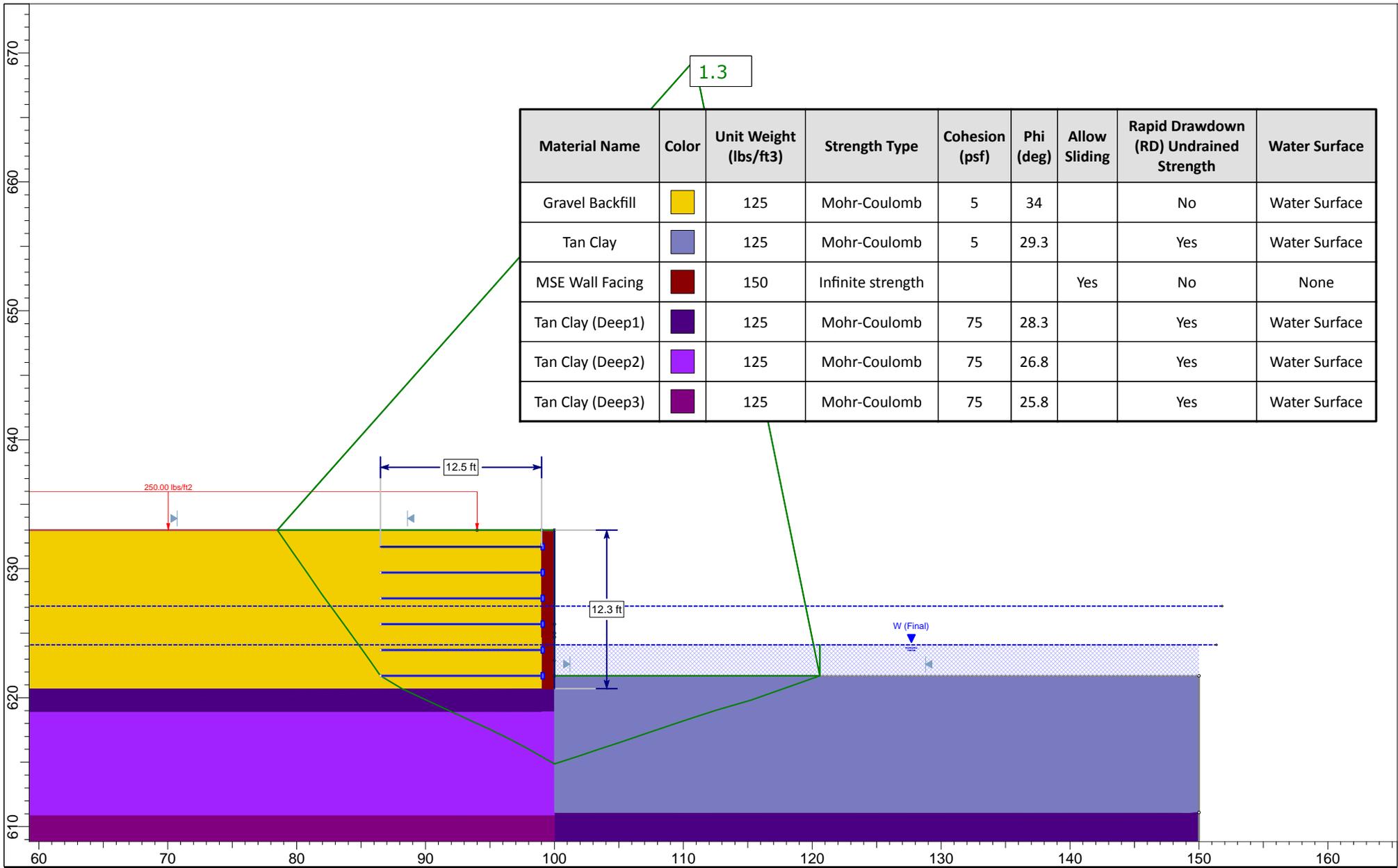
  
 Richard T. Shimono, P.E.  
 Project Engineer

  
 T. Ian Perez, P.E.  
 Associate



RTS/TIP/smb  
 Attachments: SLIDE Critical Slip Surfaces  
 Copies Submitted: Above (Email Only)

# ATTACHMENTS

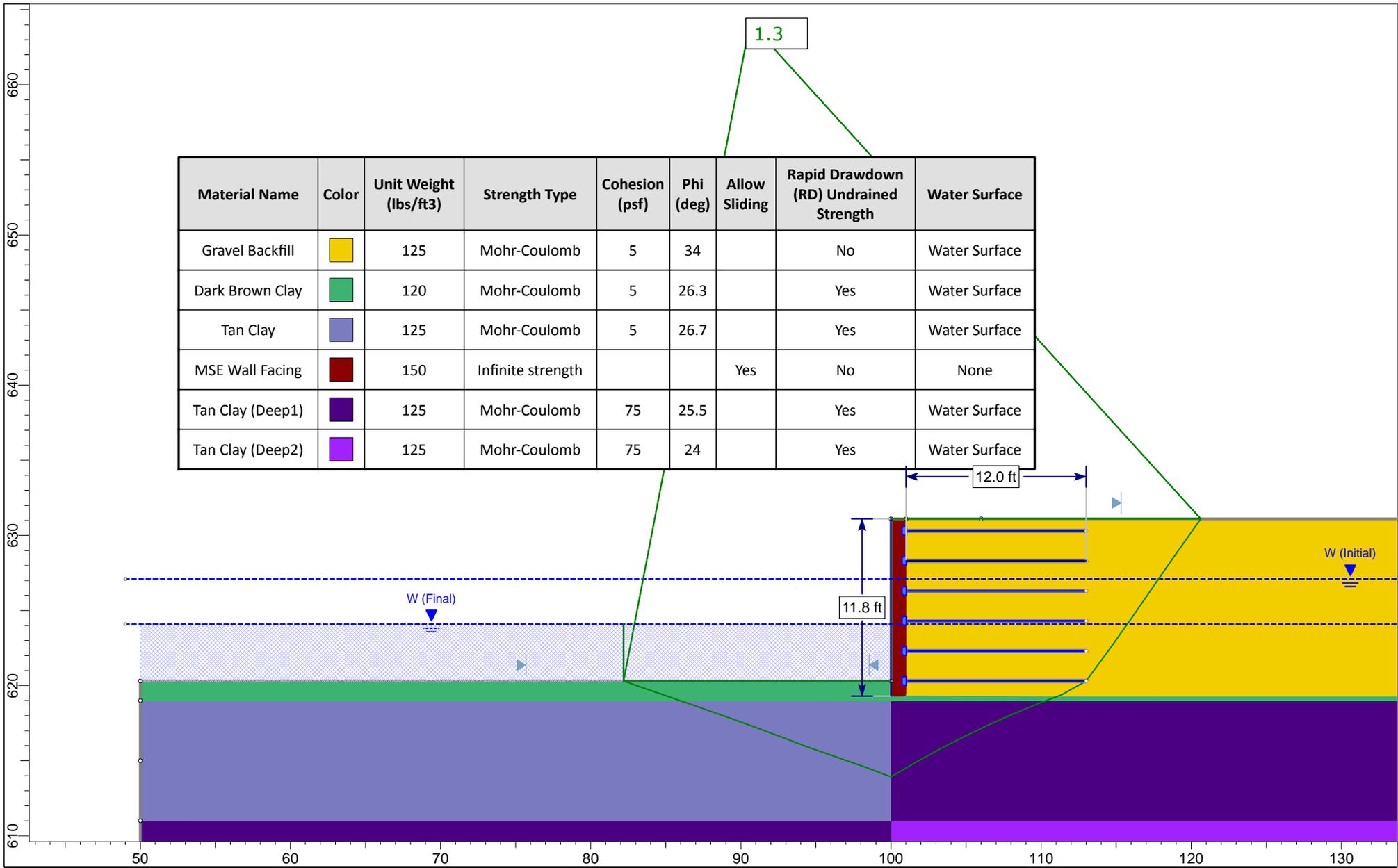


Klein Road - Phase II  
New Braunfels, Texas

Wall D  
Rapid Drawdown Condition

Figure 1





Material Name	Color	Unit Weight (lbs/ft <sup>3</sup> )	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Rapid Drawdown (RD) Undrained Strength	Water Surface
Gravel Backfill		125	Mohr-Coulomb	5	34		No	Water Surface
Dark Brown Clay		120	Mohr-Coulomb	5	26.3		Yes	Water Surface
Tan Clay		125	Mohr-Coulomb	5	26.7		Yes	Water Surface
MSE Wall Facing		150	Infinite strength			Yes	No	None
Tan Clay (Deep1)		125	Mohr-Coulomb	75	25.5		Yes	Water Surface
Tan Clay (Deep2)		125	Mohr-Coulomb	75	24		Yes	Water Surface

Klein Road - Phase II  
New Braunfels, Texas

Wall F  
Rapid Drawdown Condition

Figure 2

