



June 4, 2007

TO: J. McNutt/D. Philpott
Olympic Region, MS 47447

FROM: T. M. Allen/M. A. Frye
E&EP Geotechnical Division, 47365

SUBJECT: SR-101, MP 338.2 vic., XL3000
Debris Flow Containment Wall
Geotechnical Recommendations

The memorandum presents geotechnical recommendations for design of a soldier pile structure to contain debris flows in the vicinity of milepost 338.2 on SR 101. A debris flow covered the roadway and forced the closure of the highway in November 2006. The potential for future debris flows at this location is considered high. We are recommending construction of a cantilever soldier pile wall to prevent future debris flows from reaching SR 101.

This memorandum presents only information for the structural design of a soldier pile wall. A forthcoming report from this office will provide details of the field exploration, site conditions, and subsurface conditions.

Soldier Pile Retaining Wall Recommendations

We recommend the retaining wall be designed to accommodate two design level debris flow events before it is necessary to remove the debris from behind the wall. We are presenting earth pressure diagrams for four loading cases. Case 1 represents a debris flow impact on the wall. Case 2 represents the wall retaining the Case 1 debris flow in static conditions. Case 3 represents a second debris flow impact on the wall above the retained debris from Case 1. Case 4 represents the wall retaining both the Case 1 and Case 3 debris flows in static conditions.

Earth pressure diagrams for the structural design of the soldier piles are included in Figures 1 through 4. Horizontal earth pressures for static conditions are based on at-rest earth pressures as we anticipate the wall will deflect under the impact load and will remain displaced to some extent after the debris flow materials settle into a static condition. To provide an adequate factor of safety for global stability, the soldier piles should have a minimum embedment of 25 feet below finished grade at the toe of the wall. We recommend the lagging extend two feet below the finished grade in front of the wall. Soldier pile shafts should be backfilled with lean concrete or structural concrete. Controlled Density Fill should not be allowed for shaft backfill.

The following table presents soil design parameters used to develop the earth pressure diagrams shown in Figures 1 through 4.

Parameter	Debris Flow Material	Soils above elevation 80'	Soils below elevation 80'
Soil Unit Weight, γ , (pcf)	115	125	130
Soil Friction Angle, ϕ , (deg)	15	30	38
At Rest Earth Pressure Coefficient, K_o	0.81	N/A	N/A
Passive Earth Pressure Coefficient, K_p	N/A	3.00	4.20

The static containment of the debris flow materials should be designed for the Strength Limit State. The debris flow impacts should be designed as the Extreme Event Limit State. Resistance factors for each limit state are provided below. As the debris retained by the wall will be removed by WSDOT Maintenance crews, we have not provided seismic earth pressures. We consider the likelihood of a seismic event while debris is retained by the wall to be low.

	Strength Limit State	Extreme Limit State
Passive Resistance of Vertical Elements	0.75	1.0

There is no specific guidance in the AASHTO LRFD specifications on load factors for debris flows. We have applied a load factor of 1.5 to the calculated impact force due to the debris flow. Therefore, the impact force due to the debris flow shown in Figures 1 and 3 is a factored load. All other loads and resistances shown in Figures 1 through 4 are unfactored.

We understand the small stream flowing in the debris flow channel will be conveyed through or under the debris flow retention wall. Your office will need to work with the Bridge and Structures, and Hydraulics Office to develop the details for conveying the stream through or under the wall.

Construction Considerations

Caving soils and groundwater seepage should be expected in the shaft excavations. The contractor should be prepared to use casing, slurry, or other methods to maintain hole stability.

Recommended Additional Services

Because the future performance and integrity of the geotechnical elements of this project will depend largely on proper PS&E preparation and diligent construction procedures, we recommend that the Geotechnical Division (GD) in conjunction with the Regional Materials Engineer (RME) provide the following post-report services:

The GD should prepare the Summary of Geotechnical Conditions to be included in the PS&E as an appendix. The summary should be prepared as part of the PS&E review process.

The GD/RME should review all construction plans and specifications to verify that the design criteria presented in this report have been interpreted correctly and properly integrated into the design.

The GD/RME should attend pre-construction conferences with the Construction Project Engineer and Contractor to discuss important geotechnical related construction issues.

The GD/RME should review Contractor submittals for all shoring walls and other geotechnical elements of this project.

The RME should observe all exposed subgrades after completion of stripping and excavation to contract elevations. The RME should confirm that suitable soil conditions have been reached and determine appropriate subgrade compaction methods.

In addition to the aforementioned services, the Geotechnical Division can provide inspector training for construction personnel, assist in change of condition claims, and review cost reduction incentive proposals (CRIPs).

Intended Report Use and Limitations

This report has been prepared to assist the Washington State Department of Transportation in the engineering design and construction of the subject project. It should not be used, in part or in whole for other purposes without contacting the EEP Geotechnical Division for a review of the applicability of such reuse. This report should be made available to prospective contractors for their information or factual data only and not as a warranty of ground conditions.

The conclusions and recommendations contained in this report are based on the Geotechnical Division's understanding of the project at the time that the report was written and on site conditions that existed at the time of the field exploration. If significant changes to the nature, configuration, or scope of the project occur during the design process, the Geotechnical Division should be consulted to determine the impact of such changes on the recommendations and conclusions presented in this report.

Site exploration and testing describes subsurface conditions only at the sites of subsurface exploration and at the intervals where samples are collected. These data are interpreted by members of the Geotechnical Division who then render an opinion regarding the general subsurface conditions. The distribution, continuity, thickness, and characteristics of identified (and unidentified) subsurface materials may vary considerably from that indicated by the subsurface data. While nothing can be done to prevent such variability, the Geotechnical Division is prepared to work with the Design Team to reduce the

impacts of variability on project design, construction, and performance. Periodic geotechnical observation during construction may be beneficial in this respect. This ongoing involvement of the Geotechnical Division throughout the design and project development process will also help to avoid costly mistakes associated with misinterpretation of the contents of this report and resulting shortcomings of project design or contract documents.

The conclusions and recommendations presented in this report assume that surface and subsurface conditions, as observed during field exploration activities are representative of the site conditions throughout the project area. Because of this assumption, these recommendations should be considered subject to change depending on the actual subsurface conditions encountered. Actual subsurface conditions can be discovered only during earthwork and construction operations. Accordingly, the Geotechnical Division should be involved in the construction of the project in order to make appropriate observations and recommendations for alteration in design, as appropriate.

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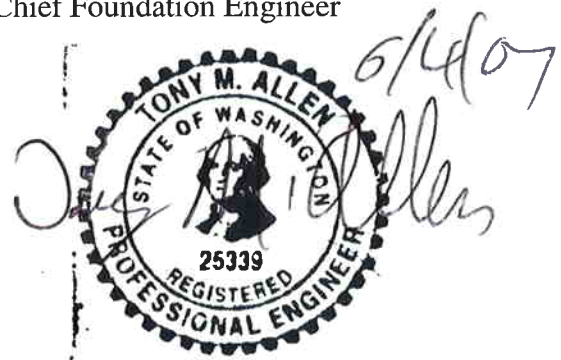
If you have questions or require further information, please contact Tony Allen at (360) 709-5450 or Mark Frye at (360) 709-5469.



EXPIRES 03-13-08

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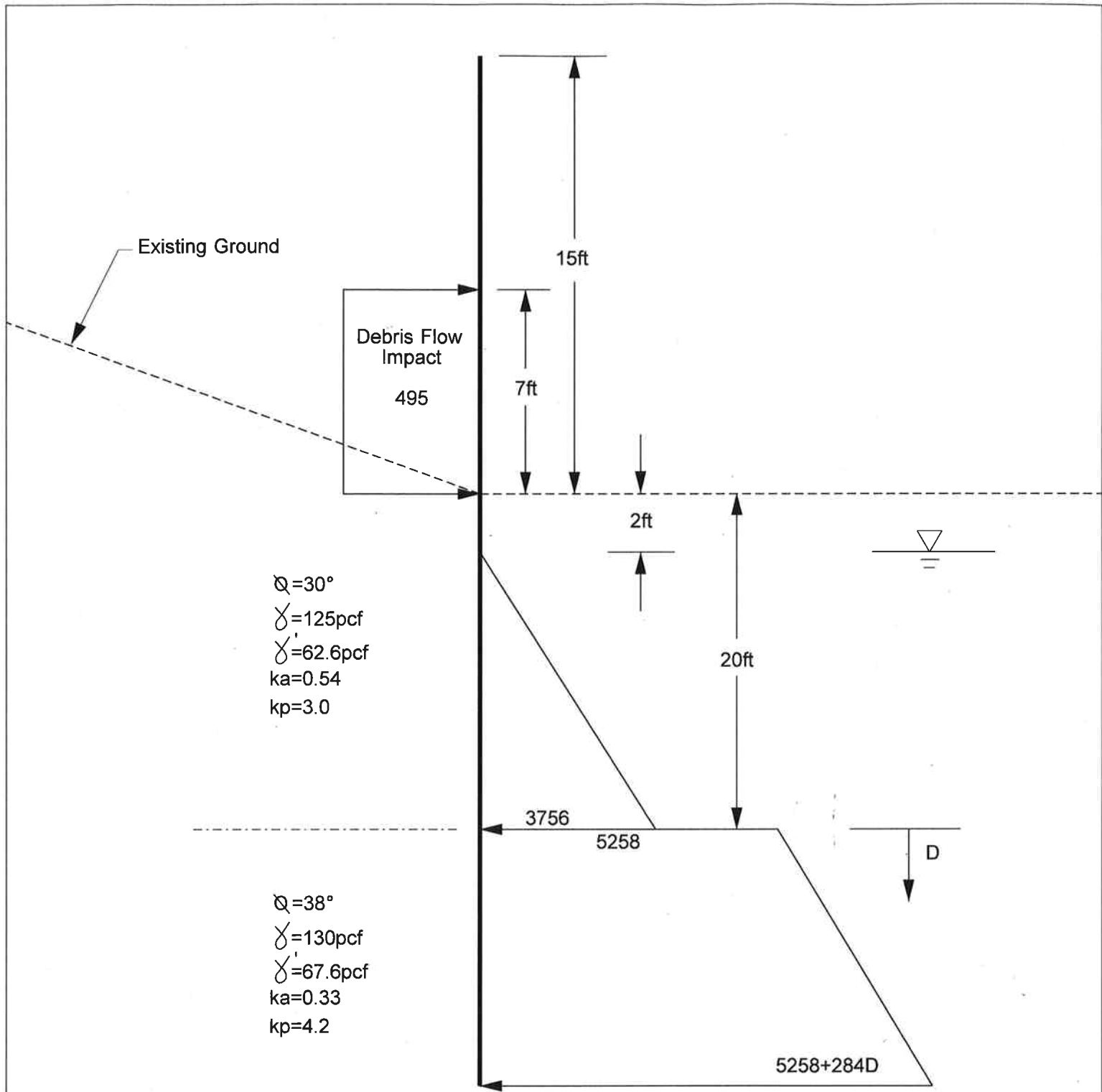
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Agency Approval Authority:
Tony M. Allen
State Geotechnical Engineer

TMA/maf

Attachments: Figures 1 - 4


cc: B. Khaleghi, Bridge and Structures Office, MS 47340
B. Dias, Olympic Region Materials Engineer, MS 47440
M. Gaines, HQ Construction, MS 47354

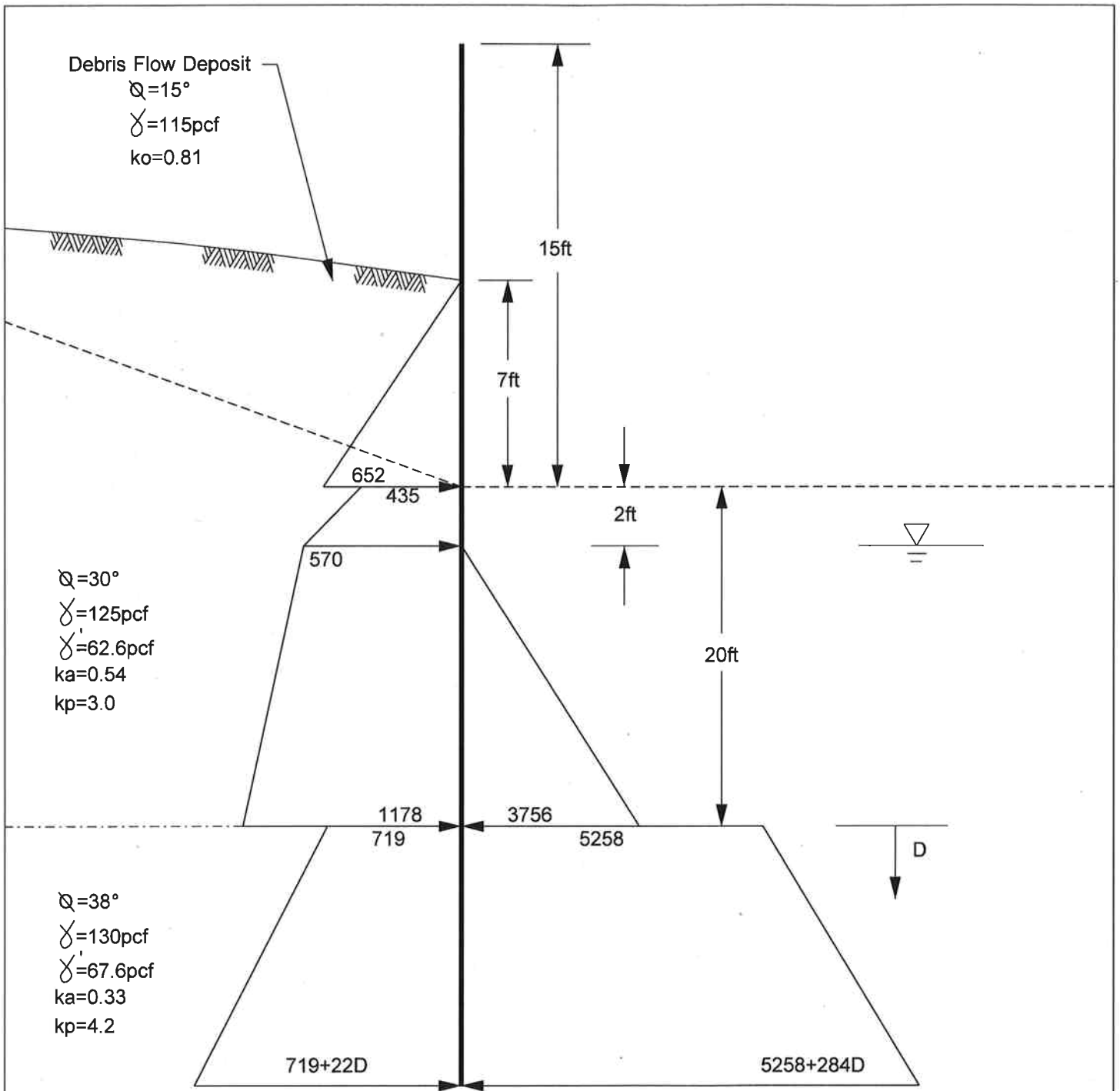


NOTES:

- 1) All pressures shown in pounds per square foot.
- 2) Passive pressures shown should be applied over 3 pile diameters.
- 3) Debris flow pressure is factored. All other pressures shown are unfactored.
- 4) Ignore passive pressures below finished grade in front of wall for a distance of 2 feet.
- 5) Extend lagging 2 feet below finished grade in front of wall.
- 6) Active pressures below bottom of lagging acts over 1 pile width.

Figure 1- CASE 1: Initial Debris Flow Impact

JOB <u>XL-3002</u> S.R. <u>101</u>	
SR 101 Vicinity MP 338.2 Debris Flow	
 WASHINGTON STATE DEPARTMENT OF TRANSPORTATION GEOTECHNICAL DIVISION	DATE <u>6/2007</u> SCALE <u>N.T.S.</u> VERT. SHEET <u> </u> OF <u> </u> HORIZ. DRAWN BY <u>WM</u>



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- 1) All pressures shown in pounds per square foot.
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- 6) Active pressures below bottom of lagging acts over 1 pile width.

Figure 2-Case 2: First Debris Flow, Static Containment

JOB XL-3002 S.R. 101

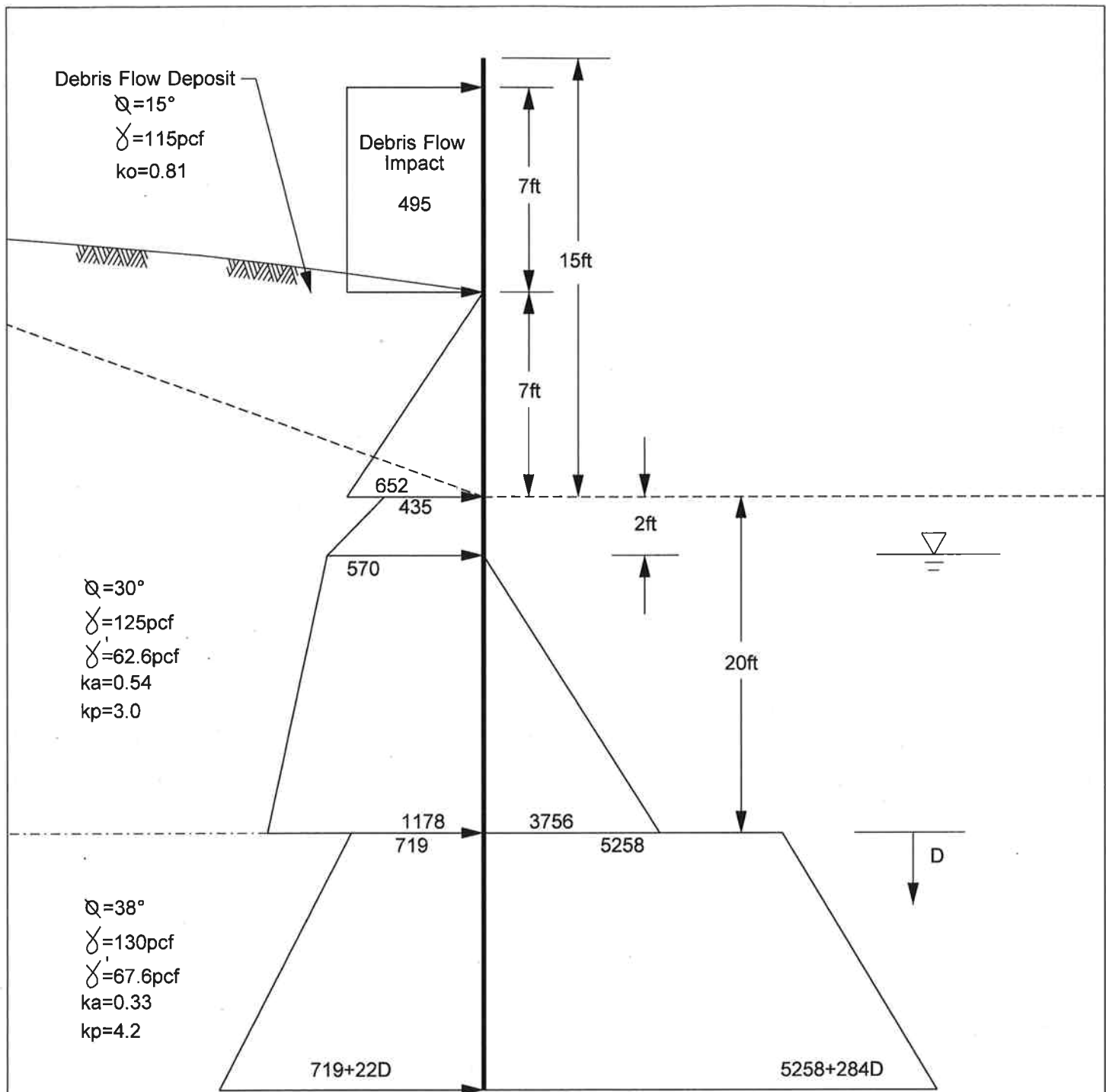
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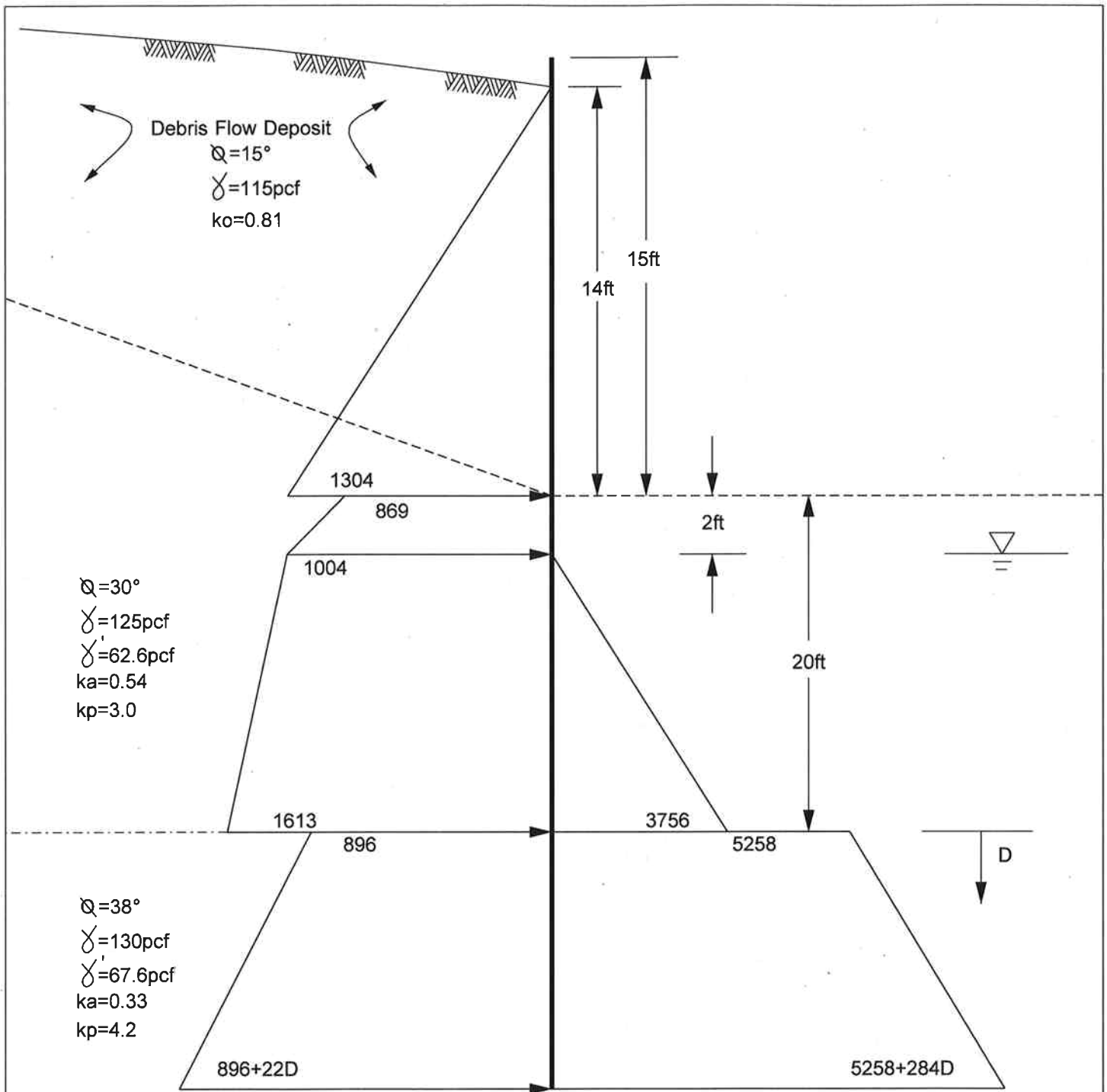


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- 4) Ignore passive pressures below finished grade in front of wall for a distance of 2 feet.
- 5) Extend lagging 2 feet below finished grade in front of wall.
- 6) Active pressures below bottom of lagging acts over 1 pile width.

Figure 3- CASE 3: Second Debris Flow Impact

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NOTES:

- 1) All pressures shown in pounds per square foot.
- 2) Passive pressures shown should be applied over 3 pile diameters.
- 3) All pressures shown are unfactored.
- 4) Ignore passive pressures below finished grade in front of wall for a distance of 2 feet.
- 5) Extend lagging 2 feet below finished grade in front of wall.
- 6) Active pressures below bottom of lagging acts over 1 pile width.

Figure 4-Case 4: Second Debris Flow, Static Containment

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